

Section I



National Summary of Water Quality Conditions

The Quality of Our Nation's Water

Introduction

The National Water Quality Inventory Report to Congress is the primary vehicle for informing Congress and the public about general water quality conditions in the United States. This document characterizes our water quality, identifies widespread water quality problems of national significance, and describes various programs implemented to restore and protect our waters.

The *National Water Quality Inventory Report to Congress* summarizes the water quality information submitted by 58 States, American Indian Tribes, Territories, Interstate Water Commissions, and the District of Columbia (hereafter referred to as States, Tribes, and other jurisdictions) in their 1996 water quality assessment reports. As such, the report identifies water quality issues of concern to the States, Tribes, and other jurisdictions, not just the issues of concern to the U.S. Environmental Protection Agency (EPA). Section 305(b) of the Clean Water Act (CWA) requires that the States and other participating jurisdictions submit water quality assessment reports every 2 years. Most of the survey information in the 1996 Section 305(b) reports is based on water quality information collected and evaluated by the States, Tribes, and other jurisdictions during 1994 and 1995.

It is important to note that this report is based on information submitted by States, Tribes, and other jurisdictions that do not use identical survey methods and criteria to rate their water quality. The States,



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Tribes, and other jurisdictions favor flexibility in the 305(b) process to accommodate natural variability in their waters, but there is a trade-off between flexibility and consistency. Without known and consistent survey methods in place, EPA must use caution in comparing data or determining the accuracy of data submitted by different States and jurisdictions. Also, EPA must use caution when comparing water quality information submitted during different 305(b) reporting periods because States and other jurisdictions may modify their criteria or survey different waterbodies every 2 years.

For over 10 years, EPA has pursued a balance between flexibility and consistency in the Section 305(b) process. Recent actions by EPA, the States, Tribes, and other jurisdictions include implementing the recommendations of the

National 305(b) Consistency Workgroup and the National Water Quality Monitoring Council. These actions will enable States and other jurisdictions to share data across political boundaries as they develop watershed protection strategies.

EPA recognizes that national initiatives alone cannot clean up our waters; water quality protection and restoration must happen at the local watershed level, in conjunction with State, Tribal, and Federal activities. Similarly, this document alone cannot provide the detailed information needed to manage water quality at all levels. This document should be used together with the individual Section 305(b) reports (see the inside back cover for information on obtaining the State and Tribal Section 305(b) reports), watershed management plans, and other local documents to develop integrated water quality management options.

Index of Watershed Indicators

The Index of Watershed Indicators (IWI) is a compilation of information on the condition of aquatic resources in the United States. Using data from many sources, IWI maps 15 indicators on a watershed basis. Together these indicators point to whether these watersheds are "healthy" and whether activities on the surrounding lands are making these waters more vulnerable to pollution (see map).

While this new assessment tool is broader and more inclusive than the National Water Quality Inventory, State 305(b) assessment information is the most important data source in the IWI.

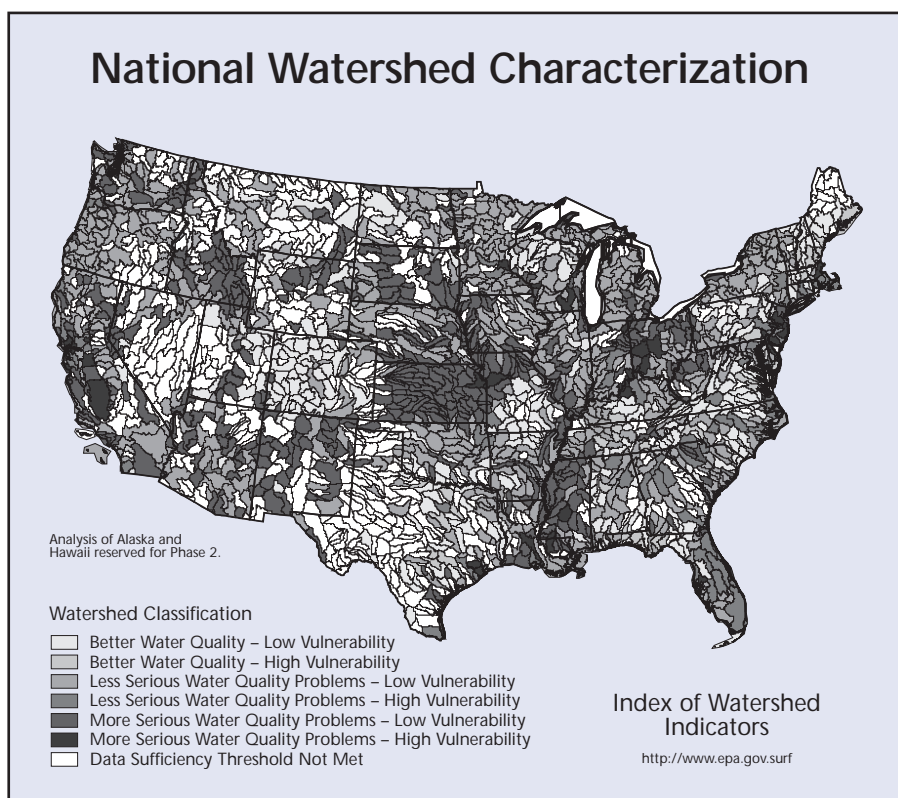
State 305(b) information is included as one of the 15 indicator maps in IWI as: Assessed Rivers Meeting All Designated Uses Set in State/Tribal Water Quality Standards. The IWI uses data compiled on a watershed basis from a number of national assessment programs from several EPA programs, from U.S. Department of Agriculture (USDA), National Oceanic and Atmospheric Administration (NOAA), U.S. Geological Survey (USGS), the Corps of

Engineers, and the Nature Conservancy, and from the States, Tribes and other jurisdictions. Six other indicator maps show EPA's rating of the condition of watersheds; eight additional indicator maps show EPA's rating of the vulnerability of watersheds. Vulnerability factors include, for example, the rate of population growth, the potential of various forms of nonpoint source pollution, and compliance facility permits. Using this approach, the IWI characterizes nearly three-quarters of the 2,111 watersheds in the 48 contiguous States.

The IWI was released in October 1997 and is updated

periodically. In October 1997, 16% of the watersheds had good water quality problems, 36% had moderate water quality problems, 21% had more serious problems, and sufficient data were lacking to fully characterize the remaining 27%. In addition, 1 in 14 watersheds in all areas was vulnerable to further degradation from pollution, primarily from urban and rural runoff.

The IWI enables managers and community residents to understand and help protect the watershed where they live. The information is easily available on the Internet at <http://www.epa.gov/surf/iwi>.



Key Concepts

Measuring Water Quality

The States, participating Tribes, and other jurisdictions survey the quality of their waters by determining if their waters attain the water quality standards they established. Water quality standards consist of beneficial uses, numeric and narrative criteria for supporting each use, and an antidegradation statement:

■ **Designated beneficial uses** are the desirable uses that water quality should support. Examples are drinking water supply, primary contact recreation (such as swimming), and aquatic life support. Each designated use has a unique set of water quality requirements or criteria that must be met for the use to be realized. States, Tribes, and other jurisdictions may designate an individual waterbody for multiple beneficial uses.

■ **Numeric water quality criteria** establish the minimum physical, chemical, and biological parameters required to support a beneficial use. Physical and chemical numeric criteria may set maximum concentrations of pollutants, acceptable ranges of physical parameters such as flow, and minimum concentrations of desirable parameters such as dissolved oxygen. Numeric biological criteria describe the expected attainable community attributes and establish values based on measures such as species richness, presence or absence of indicator taxa, and distribution of classes of organisms.



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■ **Narrative water quality criteria** define, rather than quantify, conditions and attainable goals that must be maintained to support a designated use. Narrative biological criteria establish a positive statement about aquatic community characteristics expected to occur within a waterbody. For example, “Aquatic life shall be as it naturally occurs,” or “Ambient water quality shall be sufficient to support life stages of all indigenous aquatic species.” Narrative criteria may also describe conditions that are desired in a waterbody, such as, “Waters must be free of substances that are toxic to humans, aquatic life, and wildlife.”

■ **Antidegradation statements**, where possible, protect existing uses and prevent waterbodies from deteriorating even if their water quality is better than the fishable and swimmable goals of the Act.

The CWA allows States, Tribes, and other jurisdictions to set their own standards but requires that all beneficial uses and their criteria comply with the goals of the Act. At a minimum, beneficial uses must provide for “the protection and propagation of fish, shellfish, and wildlife” and provide for “recreation in and on the water” (i.e., the fishable and swimmable goals of the Act), where attainable. The Act prohibits States and other jurisdictions from designating waste transport or waste assimilation as a beneficial use, as some States did prior to 1972.

Section 305(b) of the CWA requires that the States biennially survey their water quality for attainment of the fishable and swimmable goals of the Act and report the results to EPA. The States, participating Tribes, and other jurisdictions measure attainment of the CWA goals by determining how well their waters support their designated beneficial uses. EPA encourages States, Tribes, and other jurisdictions to survey waterbodies for support of the following individual beneficial uses:



Aquatic Life Support

The waterbody provides suitable habitat for protection and propagation of desirable fish, shellfish, and other aquatic organisms.



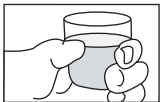
Fish Consumption

The waterbody supports fish free from contamination that could pose a human health risk to consumers.



Shellfish Harvesting

The waterbody supports a population of shellfish free from toxicants and pathogens that could pose a human health risk to consumers.



Drinking Water Supply

The waterbody can supply safe drinking water with conventional treatment.



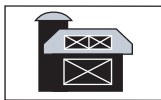
Primary Contact Recreation – Swimming

People can swim in the waterbody without risk of adverse human health effects (such as catching waterborne diseases from raw sewage contamination).



Secondary Contact Recreation

People can perform activities on the water (such as boating) without risk of adverse human health effects from ingestion or contact with the water.



Agriculture

The water quality is suitable for irrigating fields or watering livestock.

States, Tribes, and other jurisdictions may also define their own individual uses to address special concerns. For example, many Tribes and States designate their waters for the following beneficial uses:



Ground Water Recharge

The surface waterbody plays a significant role in replenishing ground water, and surface water supply and quality are adequate to protect existing or potential uses of ground water.



Wildlife Habitat

Water quality supports the waterbody's role in providing habitat and resources for land-based wildlife as well as aquatic life.

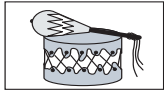
Tribes may designate their waters for special cultural and ceremonial uses:

Water Quality Monitoring

Water quality monitoring consists of data collection and sample analysis performed using accepted protocols and quality control procedures. Monitoring also includes subsequent analysis of the body of data to support decisionmaking. Federal, Interstate, State, Territorial, Tribal, Regional, and local agencies, industry, and volunteer groups with approved quality assurance programs monitor a combination of chemical, physical, and biological water quality parameters throughout the country.

- Chemical data often measure concentrations of pollutants and other chemical conditions that influence aquatic life, such as pH (i.e., acidity) and dissolved oxygen concentrations. The chemical data may be analyzed in water samples, fish tissue samples, or sediment samples.
- Physical data include measurements of temperature, turbidity (i.e., light penetration through the water column), and solids in the water column.
- Biological data measure the health of aquatic communities. Biological data include counts of aquatic species that indicate healthy ecological conditions.
- Habitat and ancillary data (such as land use data) help interpret the above monitoring information.

Monitoring agencies vary parameters, sampling frequency, and sampling site selection to meet program objectives and funding constraints. Sampling may occur at regular intervals (such as monthly, quarterly, or annually), irregular intervals, or during one-time intensive surveys. Sampling may be conducted at fixed sampling stations, randomly selected stations, stations near suspected water quality problems, or stations in pristine waters.



Culture

Water quality supports the waterbody's role in Tribal culture and preserves the waterbody's religious, ceremonial, or subsistence significance.

The States, Tribes, and other jurisdictions assign levels of use support to each of their waterbodies (Table 1). If possible, the States, Tribes, and other jurisdictions determine the level of use support by comparing monitoring data with numeric criteria for each use designated for a particular waterbody. If monitoring data are not available, the State, Tribe, or other jurisdiction may determine the level of use support with qualitative information. Valid qualitative information includes land use data, fish and game surveys, and predictive model results. **Monitored assessments** are based on recent monitoring data collected during the past 5 years. **Evaluated assessments** are based on qualitative information or monitored information more than 5 years old.

For waterbodies with more than one designated use, the States, Tribes, and other jurisdictions consolidate the individual use support information into a summary use support determination:

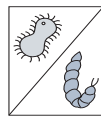


Good/Fully Supporting All Uses – All designated beneficial uses are fully supported.



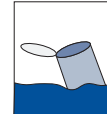
Good/Threatened for One or More Uses – One or more designated beneficial uses are threatened

and the remaining uses are fully supported.



Impaired for One or More Uses – One or more designated beneficial uses are partially or not supported and the remaining uses are fully supported or threatened.



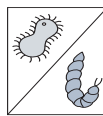
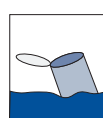
These waterbodies are considered impaired.



Not Attainable – The State, Tribe, or other jurisdiction has performed a use-attainability analysis and demonstrated that use support of one or more designated beneficial uses is not attainable due to one of six biological, chemical, physical, or economic/social conditions specified in the *Code of Federal Regulations* (40 CFR Section 131.10).

These conditions include naturally high concentrations of pollutants (such as metals); other natural physical features that create unsuitable

Table 1. Levels of Summary Use Support

Symbol	Use Support Level	Water Quality Condition	Definition
	Fully Supporting All Uses	Good	Water quality meets designated use criteria.
	Threatened for One or More Uses	Good	Water quality supports beneficial uses now but may not in the future unless action is taken.
	Impaired for One or More Uses	Impaired	Water quality fails to meet designated use criteria at times.
	Not Attainable	—	The State, Tribe, or other jurisdiction has performed a use-attainability analysis and demonstrated that use support is not attainable due to one of six biological, chemical, physical, or economic/social conditions specified in the <i>Code of Federal Regulations</i> .

aquatic life habitat (such as inadequate substrate, riffles, or pools); low flows or water levels; dams and other hydrologic modifications that permanently alter waterbody characteristics; poor water quality resulting from human activities that cannot be reversed without causing further environmental degradation; and poor water quality that cannot be improved without imposing more stringent controls than those required in the CWA, which would result in widespread economic and social impacts.

■ **Impaired Waters** – Waterbodies either partially supporting uses or not supporting uses.

The EPA then aggregates the use support information submitted by the States, Tribes, and other jurisdictions into a national assessment of the Nation's water quality.

How Many of Our Waters Were Surveyed for 1996?

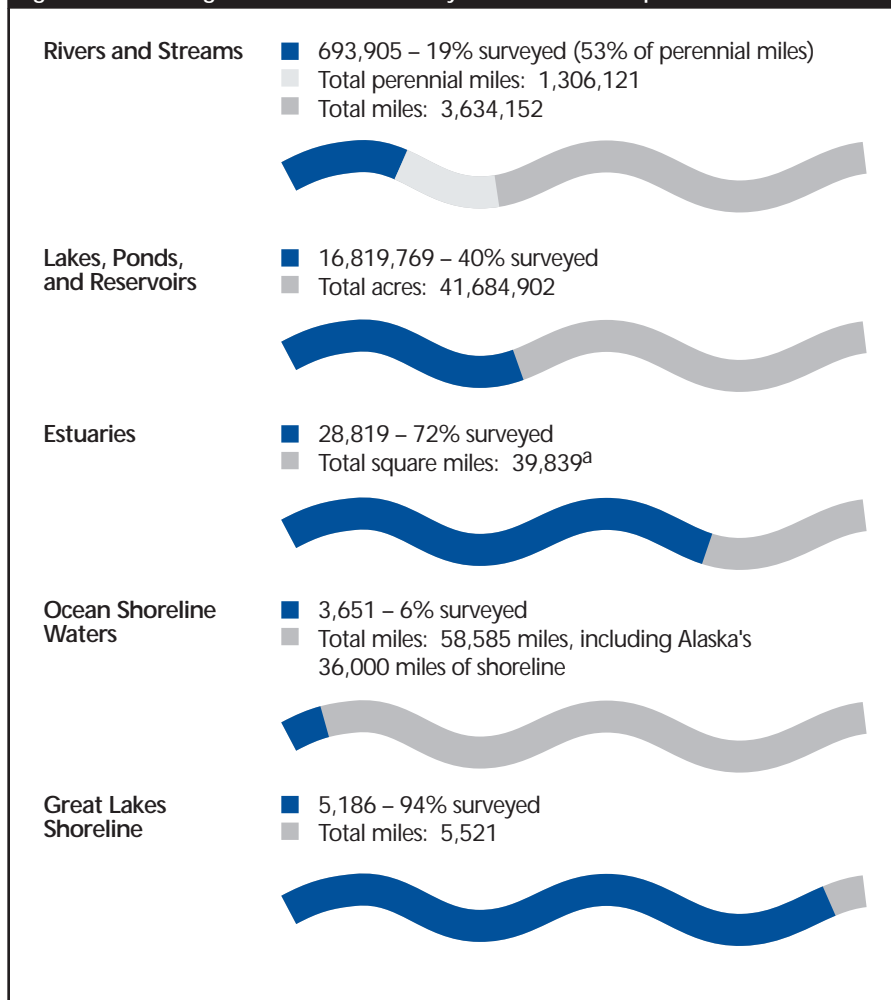
National estimates of the total waters of our country provide the foundation for determining the percentage of waters surveyed by the States, Tribes, and other jurisdictions and the portion impaired by pollution. For the 1992 reporting period, EPA provided the States with estimates of total river miles and lake acres derived from the EPA Reach File, a database containing traces of waterbodies adapted from 1:100,000 scale maps prepared by the U.S. Geological Survey. The States modified these total water estimates where necessary. Based on the 1992 EPA/State figures, the

national estimate of total river miles doubled in large part because the EPA/State estimates included nonperennial streams, canals, and ditches that were previously excluded from estimates of total stream miles.

Estimates for the 1996 reporting cycle are a minor refinement of the 1992 figures and indicate that the United States has:

- More than 3.6 million miles of rivers and streams, which range in size from the Mississippi River to small streams that flow only when wet weather conditions exist (i.e., nonperennial streams)
- Approximately 41.7 million acres of lakes, ponds, and reservoirs
- About 39,839 square miles of estuaries (excluding Alaska)

Figure 1. Percentage of Total Waters Surveyed for the 1996 Report



Source: 1996 Section 305(b) reports submitted by the States, Tribes, Territories, and Commissions.

^aExcluding estuarine waters in Alaska because no estimate was available.

- More than 58,000 miles of ocean shoreline, including 36,000 miles in Alaska
- 5,521 miles of Great Lakes shoreline
- More than 277 million acres of wetlands such as marshes, swamps, bogs, and fens, including 170 million acres of wetlands in Alaska.

Most States do not survey all of their waterbodies during the 2-year reporting cycle required under CWA Section 305(b). Thus, the surveyed waters reported in Figure 1 are a subset of the Nation's total waters. In addition, the summary information based on surveyed waters may not represent general conditions in the Nation's total waters because States, Tribes, and other jurisdictions

often focus on surveying major perennial rivers, estuaries, and public lakes with suspected pollution problems in order to direct scarce resources to areas that could pose the greatest risk. Many States, Tribes, and other jurisdictions lack the resources to collect use support information for nonperennial streams, small tributaries, and private ponds. This report does not predict the health of these unassessed waters, which include an unknown ratio of pristine waters to polluted waters.

The National Water Quality Monitoring Council

In 1992, the Intergovernmental Task Force on Monitoring Water Quality (ITFM) convened to prepare a strategy for improving water quality monitoring nationwide. The ITFM was a Federal/State partnership of 10 Federal agencies, 9 State and Interstate agencies, and 1 American Indian Tribe. The EPA chaired the ITFM with the USGS as vice chair and Executive Secretariat as part of their Water Information Coordination Program pursuant to OMB memo 92-01.

The mission of the ITFM was to develop and aid implementation of a national strategic plan to achieve effective collection, interpretation, and presentation of water quality data and to improve the availability of existing information for decisionmaking at all levels of government and the private sector. A permanent successor to the ITFM, the National Monitoring Council provides guidelines and support for institutional collaboration, comparable field and laboratory methods, quality assurance/quality control, environmental indicators, data management and sharing, ancillary data, interpretation and techniques, and training.

The National Monitoring Council is also producing products that can be used by monitoring programs nationwide, such as an outline for a recommended monitoring program, environmental indicator selection criteria, and a matrix of indicators to support assessment of State and Tribal designated uses.

For a copy of the first, second, and final ITFM reports, contact:

The U.S. Geological Survey
 417 National Center
 Reston, VA 22092
 1-800-426-9000

Pollutants and Processes That Degrade Water Quality

Where possible, States, Tribes, and other jurisdictions identify the pollutants or processes that degrade water quality and indicators that document impacts of water quality degradation. The most widespread pollutants and processes identified in rivers, lakes, and estuaries are presented in Table 2. Pollutants include sediment, nutrients, and chemical contaminants (such as dioxins and metals). Processes that degrade waters include habitat modification (such as destruction of streamside vegetation) and hydrologic modification (such as flow reduction). Indicators of water quality degradation include physical, chemical, and biological parameters. Examples of biological parameters include species diversity and abundance. Examples of physical and chemical parameters include pH, turbidity, and temperature. Following are

descriptions of the effects of the pollutants and processes most commonly identified in rivers, lakes, estuaries, coastal waters, wetlands, and ground water.

Low Dissolved Oxygen

Dissolved oxygen is a basic requirement for a healthy aquatic ecosystem. Most fish and beneficial aquatic insects “breathe” oxygen dissolved in the water column. Some fish and aquatic organisms (such as carp and sludge worms) are adapted to low oxygen conditions, but most desirable fish species (such as trout and salmon) suffer if dissolved oxygen concentrations fall below 3 to 4 mg/L (3 to 4 milligrams of oxygen dissolved in 1 liter of water, or 3 to 4 parts of oxygen per million parts of water). Larvae and juvenile fish are more sensitive and require even higher concentrations of dissolved oxygen.

Many fish and other aquatic organisms can recover from short periods of low dissolved oxygen availability. However, prolonged episodes of depressed dissolved oxygen concentrations of 2 mg/L or less can result in “dead” waterbodies. Prolonged exposure to low dissolved oxygen conditions can suffocate adult fish or reduce their reproductive survival by suffocating sensitive eggs and larvae or can starve fish by killing aquatic insect larvae and other prey. Low dissolved oxygen concentrations also favor anaerobic bacterial activity that produces noxious gases or foul odors often associated with polluted waterbodies.

Oxygen concentrations in the water column fluctuate under natural conditions, but severe oxygen

depletion usually results from human activities that introduce large quantities of biodegradable organic materials into surface waters. Biodegradable organic materials contain plant, fish, or animal matter. Leaves, lawn clippings, sewage, manure, shellfish processing waste, milk solids, and other food processing wastes are examples of oxygen-depleting organic materials that enter our surface waters.

In both pristine and polluted waters, beneficial bacteria use oxygen to break apart (or decompose) organic materials. Pollution-containing organic wastes provide a continuous glut of food for the bacteria, which accelerates bacterial activity and population growth. In polluted waters, bacterial consumption of oxygen can rapidly outpace oxygen replenishment from the atmosphere and photosynthesis performed by algae and aquatic plants. The result is a net decline in oxygen concentrations in the water.

Toxic pollutants can indirectly lower oxygen concentrations by killing algae, aquatic weeds, or fish, which provides an abundance of food for oxygen-consuming bacteria. Oxygen depletion can also result

from chemical reactions that do not involve bacteria. Some pollutants trigger chemical reactions that place a chemical oxygen demand on receiving waters.

Other factors (such as temperature and salinity) influence the amount of oxygen dissolved in water. Prolonged hot weather will depress oxygen concentrations and may cause fish kills even in clean waters because warm water cannot hold as much oxygen as cold water. Warm conditions further aggravate oxygen depletion by stimulating bacterial activity and respiration in fish, which consume oxygen. Removal of streamside vegetation eliminates shade, thereby raising water temperatures, and accelerates runoff of organic debris. Under such conditions, minor additions of pollution-containing organic materials can severely deplete oxygen.

Nutrients

Nutrients are essential building blocks for healthy aquatic communities, but excess nutrients (especially nitrogen and phosphorus compounds) overstimulate the growth of aquatic weeds and algae. Excessive growth of these organisms, in

Table 2. Five Leading Causes of Water Quality Impairment

Rank	Rivers	Lakes	Estuaries
1	Siltation	Nutrients	Nutrients
2	Nutrients	Metals	Bacteria
3	Bacteria	Siltation	Priority Toxic Organic Chemicals
4	Oxygen-Depleting Substances	Oxygen-Depleting Substances	Oxygen-Depleting Substances
5	Pesticides	Noxious Aquatic Plants	Oil and Grease

Source: Based on 1996 Section 305(b) reports submitted by States, Tribes, Territories, Commissions, and the District of Columbia.

turn, can clog navigable waters, interfere with swimming and boating, outcompete native submerged aquatic vegetation (SAV), and, with excessive decomposition, lead to oxygen depletion. Oxygen concentrations can fluctuate daily during algal blooms, rising during the day as algae perform photosynthesis, and falling at night as algae continue to respire, which consumes oxygen. Beneficial bacteria also consume oxygen as they decompose the abundant organic food supply in dying algae cells.

Lawn and crop fertilizers, sewage, manure, and detergents contain nitrogen and phosphorus, the nutrients most often responsible for water quality degradation. Rural areas are vulnerable to ground water contamination from nitrates (a compound containing nitrogen) found in fertilizer and manure. Very high concentrations of nitrate (>10 mg/L) in drinking water cause methemoglobinemia, or blue baby syndrome, an inability to fix oxygen in the blood.

Nutrients are difficult to control because lake and estuarine ecosystems recycle nutrients. Rather than leaving the ecosystem, the nutrients cycle among the water column, algae and plant tissues, and the bottom sediments. For example, algae may temporarily remove all the nitrogen from the water column, but the nutrients will return to the water column when the algae die and are decomposed by bacteria. Therefore, gradual inputs of nutrients tend to accumulate over time rather than leave the system.

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Sedimentation and Siltation

In a water quality context, sedimentation usually refers to soil particles that enter the water column from eroding land. Sediment consists of particles of all sizes, including fine clay particles, silt, sand, and gravel. Water quality managers use the term “siltation” to describe the suspension and deposition of small sediment particles in waterbodies.

Sedimentation and siltation can severely alter aquatic communities. Sediment may clog and abrade fish gills, suffocate eggs and aquatic insect larvae on the bottom, and fill in the pore space between bottom cobbles where fish lay eggs. Suspended silt and sediment interfere with recreational activities and aesthetic enjoyment at waterbodies by reducing water clarity and filling in waterbodies. Sediment may also

carry other pollutants into waterbodies. Nutrients and toxic chemicals may attach to sediment particles on land and ride the particles into surface waters where the pollutants may settle with the sediment or detach and become soluble in the water column.

Rain washes silt and other soil particles off of plowed fields, construction sites, logging sites, urban areas, and strip-mined lands into waterbodies. Eroding stream banks also deposit silt and sediment in waterbodies. Removal of vegetation on shore can accelerate streambank erosion.

Bacteria and Pathogens

Some waterborne bacteria, viruses, and protozoa cause human illnesses that range from typhoid and dysentery to minor respiratory and skin diseases. These organisms

may enter waters through a number of routes, including inadequately treated sewage, stormwater drains, septic systems, runoff from livestock pens, and sewage dumped overboard from recreational boats. Because it is impossible to test waters for every possible disease-causing organism, States and other jurisdictions usually measure indicator bacteria that are found in great numbers in the stomachs and intestines of warm-blooded animals and people. The presence of indicator bacteria suggests that the waterbody may be contaminated with untreated sewage and that other, more dangerous organisms may be present. The States, Tribes, and other jurisdictions use bacterial criteria to determine if waters are safe for recreation and shellfish harvesting.

Toxic Organic Chemicals and Metals

Toxic organic chemicals are synthetic compounds that contain carbon, such as polychlorinated biphenyls (PCBs), dioxins, and the pesticide DDT. These synthesized compounds often persist and accumulate in the environment because they do not readily break down in natural ecosystems. Many of these compounds cause cancer in people and birth defects in other predators near the top of the food chain, such as birds and fish.

Metals occur naturally in the environment, but human activities (such as industrial processes and mining) have altered the distribution of metals in the environment. In most reported cases of metals contamination, high concentrations of

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metals appear in fish tissues rather than the water column because the metals accumulate in greater concentrations in predators near the top of the food chain.

pH

Acidity, the concentration of hydrogen ions, drives many chemical reactions in living organisms. The standard measure of acidity is pH, and a pH value of 7 represents a neutral condition. A low pH value (less than 5) indicates acidic conditions; a high pH (greater than 9) indicates alkaline conditions. Many biological processes, such as reproduction, cannot function in acidic or alkaline waters. Acidic conditions also aggravate toxic contamination problems because sediments release toxicants in acidic waters. Common sources of acidity include mine drainage, runoff from mine tailings, and atmospheric deposition.

Habitat Modification/ Hydrologic Modification

Habitat modifications include activities in the landscape, on shore, and in waterbodies that alter the physical structure of aquatic ecosystems and have adverse impacts on aquatic life. Examples of habitat modifications to streams include:

- Removal of streamside vegetation that stabilizes the shoreline and provides shade, which moderates instream temperatures
- Excavation of cobbles from a stream bed that provide nesting habitat for fish
- Stream burial
- Excessive suburban sprawl that alters the natural drainage patterns by increasing the intensity, magnitude, and energy of runoff waters.

Hydrologic modifications alter the flow of water. Examples of hydrologic modifications include channelization, dewatering, damming, and dredging.

Other pollutants include salts and oil and grease. Fresh waters may become unfit for aquatic life and some human uses when they become contaminated by salts. Sources of salinity include irrigation runoff, brine used in oil extraction, road deicing operations, and the intrusion of sea water into ground and surface waters in coastal areas. Crude oil and processed petroleum products may be spilled during

extraction, processing, or transport or leaked from underground storage tanks.

Sources of Water Pollution

Sources of impairment generate the pollutants that violate use support criteria (Table 3). Point sources discharge pollutants directly into surface waters from a conveyance. Point sources include industrial facilities, municipal sewage treatment plants, and combined sewer overflows. Nonpoint sources deliver pollutants to surface waters from diffuse

origins. Nonpoint sources include urban runoff, agricultural runoff, and atmospheric deposition of contaminants in air pollution. Habitat alterations, such as hydromodification, dredging, and streambank destabilization, can also degrade water quality.

Throughout this document, EPA rates the significance of causes and sources of pollution by the percentage of impaired waters impacted by each individual cause or source (obtained from the Section 305(b) reports submitted by the States, Tribes, and other jurisdictions). Note that the cause and source rankings do not describe the condition of all waters in the United States because the States identify the causes and sources degrading some of their impaired waters, which are a small subset of surveyed waters, which are a subset of the Nation's total waters. For example, the States identified sources degrading some of the 248,028 impaired river miles, which represent 36% of the surveyed river miles and only 7% of the Nation's total stream miles.

Table 3. Pollution Source Categories Used in This Report

Category	Examples
Industrial	Pulp and paper mills, chemical manufacturers, steel plants, metal process and product manufacturers, textile manufacturers, food processing plants
Municipal	Publicly owned sewage treatment plants that may receive indirect discharges from industrial facilities or businesses
Combined Sewer Overflows (CSOs)	Single facilities that treat both storm water and sanitary sewage, which may become overloaded during storm events and discharge untreated wastes into surface waters.
Storm Sewers/ Urban Runoff	Runoff from impervious surfaces including streets, parking lots, buildings, and other paved areas.
Agricultural	Crop production, pastures, rangeland, feedlots, animal operations
Silvicultural	Forest management, tree harvesting, logging road construction
Construction	Land development, road construction
Resource Extraction	Mining, petroleum drilling, runoff from mine tailing sites
Land Disposal	Leachate or discharge from septic tanks, landfills, and hazardous waste sites
Hydrologic Modification	Channelization, dredging, dam construction, flow regulation
Habitat Modification	Removal of riparian vegetation, streambank modification, drainage/filling of wetlands

“The term ‘point source’ means any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural storm water discharges and return flows from irrigated agriculture.”

Clean Water Act, Section 502(14)

Table 4 lists the leading sources of impairment related to human activities as reported by States, Tribes, and other jurisdictions for their rivers, lakes, and estuaries. Other sources cited include removal of riparian vegetation, forestry activities, land disposal, petroleum extraction and processing activities, and construction. In addition to human activities, the States, Tribes, and other jurisdictions also reported impairments from natural sources. Natural sources refer to an assortment of water quality problems:

- Natural deposits of salts, gypsum, nutrients, and metals in soils that leach into surface and ground waters

- Warm weather and dry conditions that raise water temperatures, depress dissolved oxygen concentrations, and dry up shallow waterbodies

- Low-flow conditions and tannic acids from decaying leaves that lower pH and dissolved oxygen concentrations in swamps draining into streams.

With so many potential sources of pollution, it is difficult and expensive for States, Tribes, and other jurisdictions to identify specific sources responsible for water quality impairments. Many States and other jurisdictions lack funding for monitoring to identify all but the most

apparent sources degrading waterbodies. Local management priorities may focus monitoring budgets on other water quality issues, such as identification of contaminated fish populations that pose a human health risk. Management priorities may also direct monitoring efforts to larger waterbodies and overlook sources impairing smaller waterbodies. As a result, the States, Tribes, and other jurisdictions do not associate every impacted waterbody with a source of impairment in their 305(b) reports, and the summary cause and source information presented in this report applies exclusively to a subset of the Nation's impaired waters.

Table 4. Five Leading Sources of Water Quality Impairment Related to Human Activities

Rank	Rivers	Lakes	Estuaries
1	Agriculture	Agriculture	Industrial Discharges
2	Municipal Point Sources	Unspecified Nonpoint Sources	Urban Runoff/ Storm Sewers
3	Hydrologic Modification	Atmospheric Deposition	Municipal Point Sources
4	Habitat Modification	Urban Runoff/ Storm Sewers	Upstream Sources
5	Resource Extraction	Municipal Point Sources	Agriculture

Source: Based on 1996 Section 305(b) reports submitted by States, Tribes, Territories, Commissions, and the District of Columbia.

Rivers and Streams

Rivers and streams are characterized by flow. **Perennial** rivers and streams flow continuously, all year round. **Nonperennial** rivers and streams stop flowing for some period of time, usually due to dry conditions or upstream withdrawals. Many rivers and streams originate in nonperennial headwaters that flow only during snowmelt or heavy showers. Nonperennial streams provide critical habitats for nonfish species, such as amphibians and dragonflies, as well as safe havens for juvenile fish to escape from predation by larger fish.

The health of rivers and streams is directly linked to habitat integrity on shore and in adjacent wetlands. Stream quality will deteriorate if activities damage shoreline (i.e., riparian) vegetation and wetlands, which filter pollutants from runoff and bind soils. Removal of vegetation also eliminates shade that moderates stream temperature as well as the land temperature that can warm runoff entering surface waters. Stream temperature, in turn, affects the availability of dissolved oxygen in the water column for fish and other aquatic organisms.

Overall Water Quality

For the 1996 Report, 54 States, Territories, Tribes, Commissions, and the District of Columbia surveyed 693,905 miles (19%) of the Nation's total 3.6 million miles of rivers and streams (Figure 2). The surveyed rivers and streams represent 53% of the 1.3 million miles of perennial rivers and streams that flow year round in the lower 48 States.



Georgia Mimnich, Durham, NC

Altogether, the States and Tribes surveyed 78,099 more river miles in 1996 than in 1994. Although most States surveyed about the same number of river miles in both reporting cycles, Illinois, Maryland, North Dakota, and Tennessee collectively account for an increase of over 75,000 surveyed river miles. Since 1994, Illinois, North Dakota, and Tennessee have refined their stream estimates, increasing the mileages associated with surveyed streams.

The following discussion applies exclusively to surveyed waters and cannot be extrapolated to describe conditions in the Nation's rivers as a whole because the States, Tribes, and other jurisdictions do not consistently use statistical or probabilistic survey methods to characterize all their waters at this time. EPA is working with the States, Tribes, and other jurisdictions to expand survey

coverage of the Nation's waters and expects future survey information to cover a greater portion of the Nation's rivers and streams.

Figure 2. River Miles Surveyed

Total rivers = 3.6 million miles
Total surveyed = 693,905 miles

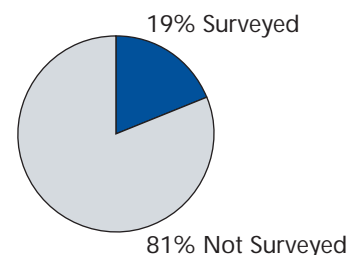
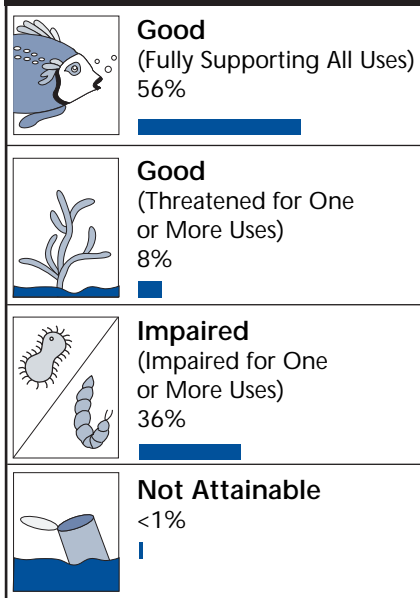


Figure 3. Levels of Overall Summary Support – Rivers



Source: Based on 1996 State Section 305(b) reports submitted by States, Tribes, Territories, Commissions, and the District of Columbia.

Of the Nation's 693,905 surveyed river miles, the States, Tribes, and other jurisdictions found that 64% have good water quality. Of these waters, 56% fully support their designated uses, and an additional 8% support uses but are threatened and may become impaired if pollution control actions are not taken (Figure 3). Some form of pollution or habitat degradation prevents the remaining 36% (248,028 miles) of the surveyed river miles from fully supporting a healthy aquatic community or human activities all year round.

What Is Polluting Our Rivers and Streams?

The States and Tribes report that siltation, composed of tiny soil particles, remains one of the most widespread pollutants impacting rivers and streams, impairing 126,763 river miles (18% of surveyed river miles (Figure 4).

Siltation is the most widespread pollutant in rivers and streams, affecting 18% of the surveyed river miles.

Siltation alters aquatic habitat and suffocates fish eggs and bottom-dwelling organisms. Excessive siltation can also interfere with drinking water treatment processes and recreational use of a river.

In addition to siltation, the States and Tribes also reported that nutrients, bacteria, oxygen-depleting substances, habitat alterations,

and metals impact more miles of rivers and streams than other pollutants and processes. Often, several pollutants and processes impact a single river segment. For example, a process, such as removal of shoreline vegetation, may accelerate erosion of sediment and nutrients into a stream.

Where Does This Pollution Come From?

The States and Tribes reported that agriculture is the most widespread source of pollution in the Nation's surveyed rivers (Figure 4). Agriculture generates pollutants that degrade aquatic life or interfere with public use of 173,629 river miles (25% of the surveyed river miles) in 50 States and Tribes.

Twenty-four States reported the size of rivers impacted by specific types of agricultural activities:

- Nonirrigated Crop Production – crop production that relies on rain as the sole source of water.
- Irrigated Crop Production – crop production that uses irrigation systems to supplement rainwater.
- Rangeland – land grazed by animals that is seldom enhanced by the application of fertilizers or pesticides, although managers sometimes modify plant species to a limited extent.
- Pastureland – land upon which a crop (such as alfalfa) is raised to feed animals, either by grazing the animals among the crops or harvesting the crops.

- Feedlots – facilities where animals are fattened and confined at high densities.

- Animal Operations – generally livestock facilities other than large cattle feedlot operations.

- Animal Holding Areas – facilities where animals are confined briefly before slaughter.

The States reported that non-irrigated crop production impaired the most river miles, followed by irrigated crop production, rangeland, feedlots, pastureland, and animal operations.

Many States reported declines in pollution from sewage treatment

Agriculture is the leading source of impairment in the Nation's rivers, contributing to impairment of 25% of the surveyed river miles.

plants and industrial discharges as a result of sewage treatment plant construction and upgrades and permit controls on industrial discharges. Despite the improvements, municipal sewage treatment plants remain the second most common source of pollution in rivers (impairing 35,087 miles) because population growth increases the burden on our municipal facilities.

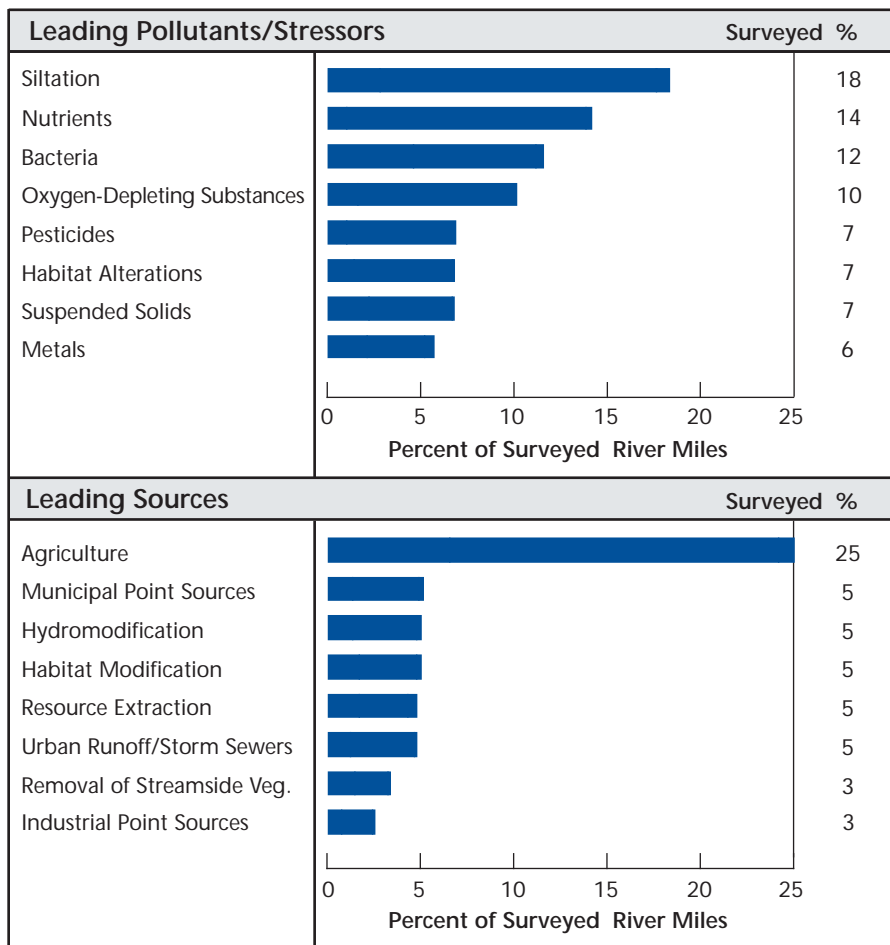
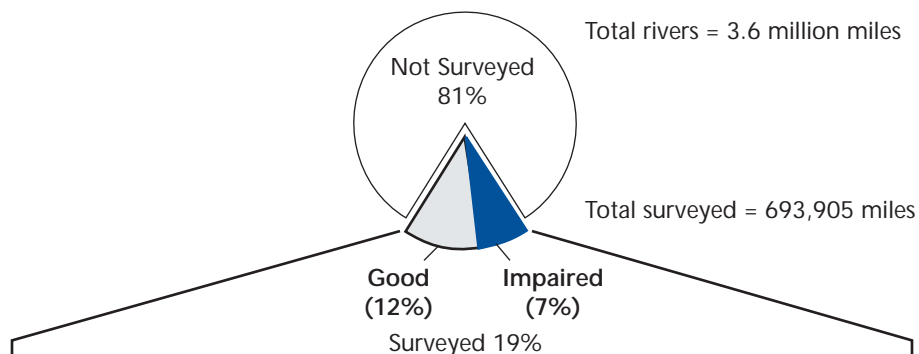
Hydrologic modifications and habitat alterations are a growing concern to the States. Hydrologic modifications include activities that alter the flow of water in a stream,

such as channelization, dewatering, and damming of streams. Habitat alterations include removal of streamside vegetation that protects the stream from high temperatures and scouring of stream bottoms. Additional gains in water quality conditions will be more subtle and require innovative management strategies that go beyond point source controls.

The States, Tribes, and other jurisdictions also reported that resource extraction impairs 33,051 river miles (5% of the surveyed rivers), and urban runoff and storm sewers impair 32,637 river miles (5% of the surveyed rivers).

The States, Tribes, and other jurisdictions also report that "natural" sources impair significant stretches of rivers and streams. "Natural" sources, such as low flow and soils with arsenic deposits, can prevent waters from supporting uses in the absence of human activities.

Figure 4. Surveyed River Miles: Pollutants and Sources



Based on 1996 State Section 305(b) reports submitted by States, Tribes, Territories, Commissions, and the District of Columbia.

Note: Percentages do not add up to 100% because more than one pollutant or source may impair a river segment.

Lakes, Ponds, and Reservoirs

Lakes are sensitive to pollution inputs because lakes flush out their contents relatively slowly. Even under natural conditions, lakes undergo eutrophication, an aging process that slowly fills in the lake with sediment and organic matter (see sidebar on next page). The eutrophication process alters basic lake characteristics such as depth, biological productivity, oxygen levels, and water clarity. Eutrophication is commonly defined by a series of trophic states as described in the sidebar.

Overall Water Quality

Forty-five States, Tribes, and other jurisdictions surveyed overall use support in more than 16.8 million lake acres representing 40% of the approximately 41.7 million total acres of lakes, ponds, and reservoirs in the Nation (Figure 5). For 1996, the States surveyed about 300,000 fewer lake acres than in 1994.

The number of surveyed lake acres declined because several States faced funding constraints that limited the number of lakes sampled.

The States and Tribes reported that 61% of their surveyed 16.8 million lake acres have good water quality. Waters with good quality include 51% of the surveyed lake acres fully supporting uses and 10% of the surveyed lake acres that are threatened and might deteriorate if we fail to manage potential sources of pollution (Figure 6). Some form of pollution or habitat degradation impairs the remaining 39% of the surveyed lake acres.



Greg Despopoulos, Raleigh, NC

What Is Polluting Our Lakes, Ponds, and Reservoirs?

Forty-one States, the District of Columbia, and Puerto Rico reported the number of lake acres impacted by individual pollutants and processes.

The States and Puerto Rico identified more lake acres polluted by nutrients and metals than other pollutants or processes (Figure 7). The States and Puerto Rico reported that metals and extra nutrients pollute 3.3 million lake acres (51% of the impaired lake acres). Healthy lake ecosystems contain nutrients in small quantities, but extra inputs of nutrients from human activities unbalance lake ecosystems. States consistently report metals as a major cause of impairment to lakes. This is mainly

Figure 5. Lake Acres Surveyed

Total lakes = 41.7 million acres
Total surveyed = 16.8 million acres

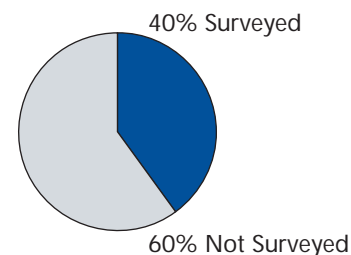
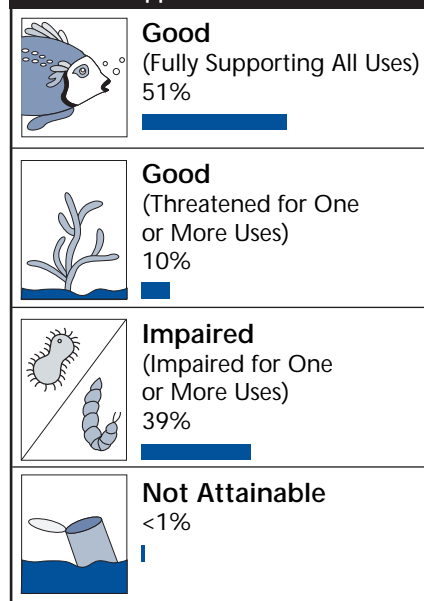


Figure 6. Levels of Summary Use Support – Lakes



Source: Based on 1996 State Section 305(b) reports submitted by States, Tribes, Territories, Commissions, and the District of Columbia.

due to the widespread detection of mercury in fish tissue samples. States are actively studying the extent of the mercury problem, which is complex because it involves transport from power-generating facilities and other sources.

In addition to nutrients and metals, the States, Puerto Rico, and the District of Columbia report that siltation pollutes 1.6 million lake acres (10% of the surveyed lake acres), enrichment by organic

wastes that deplete oxygen impacts 1.4 million lake acres (8% of the surveyed lake acres), and noxious aquatic plants impact 1.0 million acres (6% of the surveyed lake acres).

States reported more impairments due to metals and nutrients than other pollutants.

Thirty-seven States also surveyed trophic status, which is associated with nutrient enrichment, in 8,951 of their lakes. Nutrient enrichment tends to increase the proportion of lakes in the eutrophic and hypereutrophic categories. These States reported that 16% of the lakes they surveyed for trophic status were oligotrophic, 38% were

Trophic States

Oligotrophic	Clear waters with little organic matter or sediment and minimum biological activity.
Mesotrophic	Waters with more nutrients and, therefore, more biological productivity.
Eutrophic	Waters extremely rich in nutrients, with high biological productivity. Some species may be choked out.
Hypereutrophic	Murky, highly productive waters, closest to the wetlands status. Many clearwater species cannot survive.
Dystrophic	Low in nutrients, highly colored with dissolved humic organic matter. (Not necessarily a part of the natural trophic progression.)

The Eutrophication Process

Eutrophication is a natural process, but human activities can accelerate eutrophication by increasing the rate at which nutrients and organic substances enter lakes from their surrounding watersheds. Agricultural runoff, urban runoff, leaking septic systems, sewage discharges, eroded streambanks, and similar sources can enhance the flow of nutrients and organic substances into lakes. These substances can overstimulate the growth of algae and aquatic plants, creating conditions that interfere with the recreational use of lakes and the health and diversity of native fish, plant, and animal populations. Enhanced eutrophication from nutrient enrichment due to human activities is one of the leading problems facing our Nation's lakes and reservoirs.

Acid Effects on Lakes

Increases in lake acidity can radically alter the community of fish and plant species in lakes and can increase the solubility of toxic substances and magnify their adverse effects. Eighteen States reported the results of lake acidification assessments. These States assessed pH (a measure of acidity) at 5,269 lakes and detected acidic conditions in 194 lakes and a threat of acidic conditions in 1,087 lakes. Most of the States that assessed acidic conditions are located in the Northeast, upper Midwest, and the South.

Only 13 States identified sources of acidic conditions. Maine and New Hampshire attributed most of their acid lake conditions to acid deposition from acidic rain, fog, or dry deposition in conjunction with natural conditions that limit a lake's capacity to neutralize acids. Alabama, Kansas, Maryland, Oklahoma, Tennessee, and West Virginia reported that acid mine drainage resulted in acidic lake conditions or threatened lakes with the potential to generate acidic conditions.

mesotrophic, 36% were eutrophic, 9% were hypereutrophic, and less than 1% were dystrophic. This information may not be representative of national lake conditions because States often assess lakes in response to a problem or public complaint or because of their easy accessibility. It is likely that more remote lakes—which are probably less impaired—are underrepresented in these assessments.

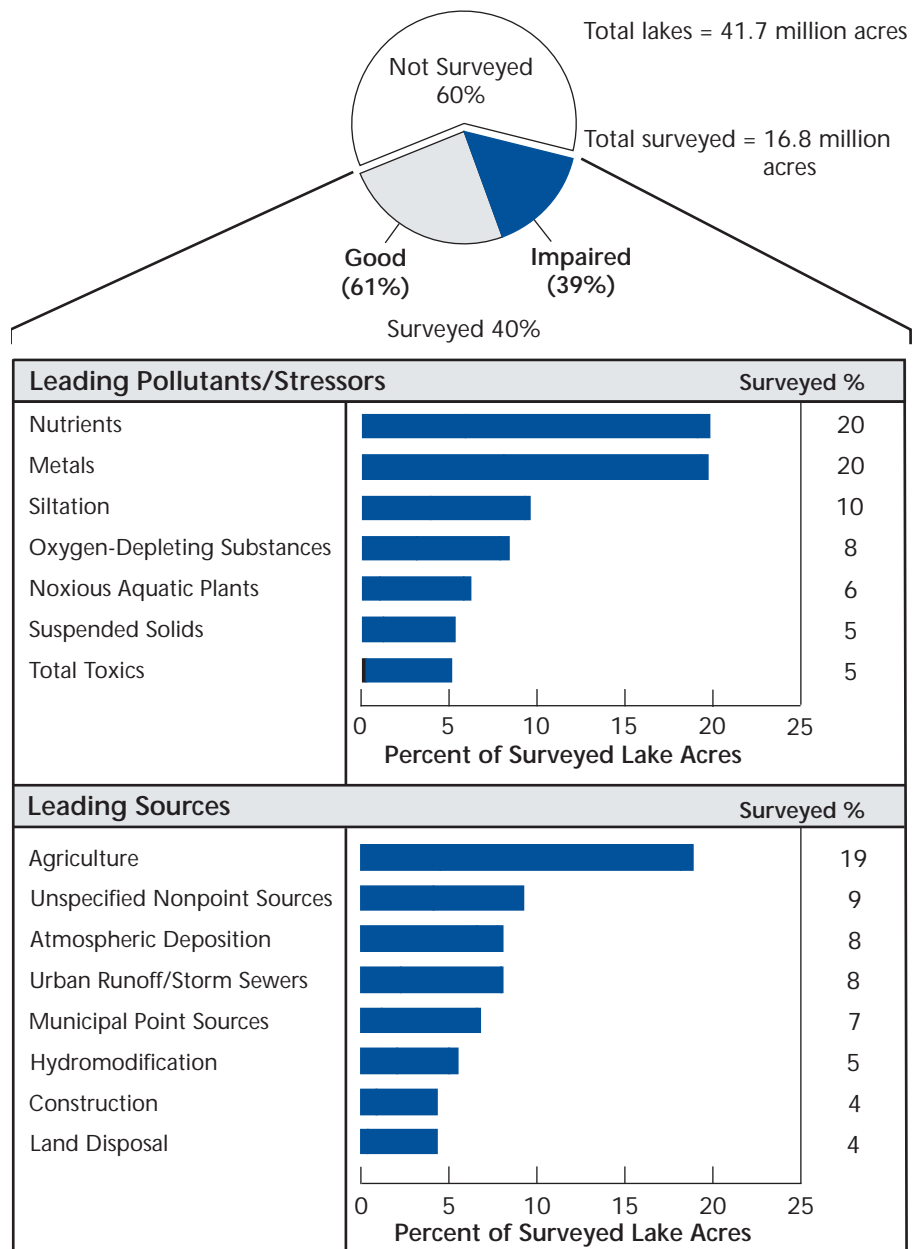
Where Does This Pollution Come From?

Forty-one States and Puerto Rico reported sources of pollution in some of their impacted lakes, ponds, and reservoirs. These States and Puerto Rico reported that agriculture is the most widespread source of pollution in the Nation's surveyed lakes (Figure 7). Agriculture generates pollutants that degrade aquatic life or interfere with public use of 3.2 million lake acres (19% of the surveyed lake acres).

Agriculture is the leading source of impairment in lakes, affecting 19% of surveyed lake acres.

The States and Puerto Rico also reported that unspecified nonpoint sources pollute 1.6 million lake acres (9% of the surveyed lake acres), atmospheric deposition of pollutants impairs 1.4 million lake acres (8% of the surveyed lake acres), urban runoff and storm sewers pollute 1.4 million lake acres (8% of the surveyed lake acres), municipal

Figure 7. Surveyed Lake Acres: Pollutants and Sources



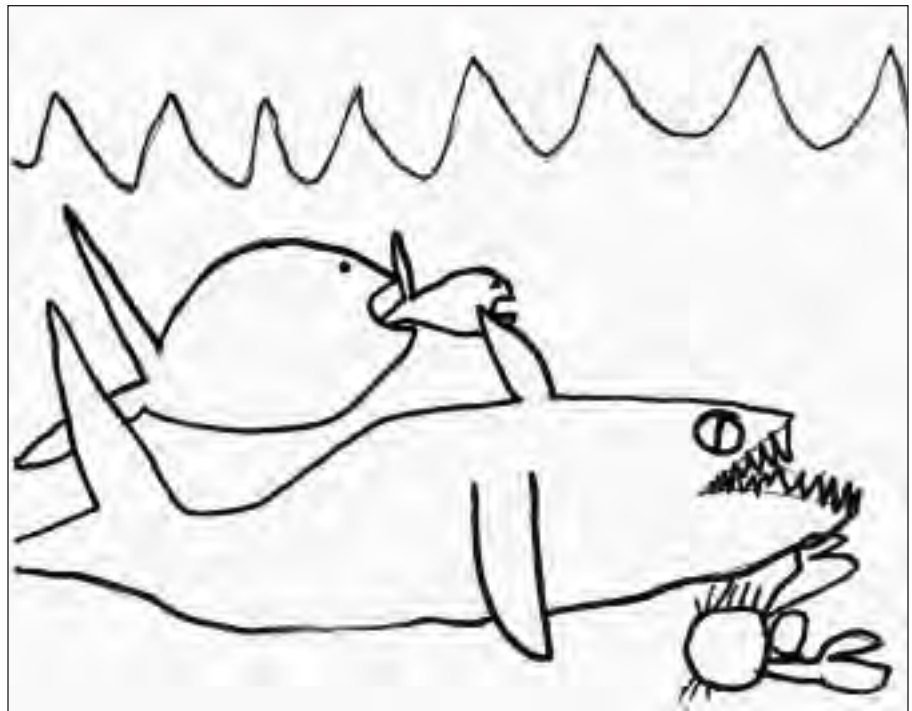
Based on 1996 State Section 305(b) reports submitted by States, Tribes, Territories, Commissions, and the District of Columbia.

Note: Percentages do not add up to 100% because more than one pollutant or source may impair a lake.

sewage treatment plants pollute 1.2 million lake acres (7% of the surveyed lake acres), and hydrologic modifications degrade 924,000 lake acres (5% of the surveyed lake acres). Many more States reported lake degradation from atmospheric deposition in 1996 than in past reporting cycles. This is due, in part, to a growing awareness of the magnitude of the atmospheric deposition problem.

The States and Puerto Rico listed numerous sources that impact several hundred thousand lake acres, including land disposal of wastes, construction, industrial point sources, onsite wastewater systems (including septic tanks), forestry activities, habitat modification, flow regulation, contaminated sediments, highway maintenance and runoff, resource extraction, and combined sewer overflows.

Ed Carney, Kansas Department of Health and Environment



Sam Baskir, 1st grade, Estes Hills Elementary, Chapel Hill, NC

The Great Lakes

The Great Lakes contain one-fifth of the world's fresh surface water and are stressed by a wide range of pollution sources, including air pollution. Many of the pollutants that reach the Great Lakes remain in the system indefinitely because the Great Lakes are a relatively closed water system with few natural outlets. Despite dramatic declines in the occurrence of algal blooms, fish kills, and localized "dead" zones depleted of oxygen, less visible problems continue to degrade the Great Lakes.

John Theilgard, Bynum, NC



Overall Water Quality

The States surveyed 94% of the Great Lakes shoreline miles for 1996 and reported that fish consumption advisories and aquatic life concerns are the dominant water quality problems, overall, in the Great Lakes (Figure 8). The States reported that most of the Great Lakes nearshore waters are safe for swimming and other recreational activities and can be used as a source of drinking water with normal treatment. However, only 2% of the surveyed nearshore waters fully support designated uses, and 1% support all uses but are threatened for one or more uses (Figure 9). About 97% of the surveyed waters do not fully support designated uses because fish consumption advisories are posted throughout the nearshore waters of the Great Lakes and water quality conditions are unfavorable for supporting aquatic life in many cases. Aquatic life impacts result from persistent toxic pollutant burdens in birds, habitat degradation and destruction, and competition

Figure 8. Great Lakes Shore Miles Surveyed

Total Great Lakes = 5,521 miles
Total surveyed = 5,186 miles

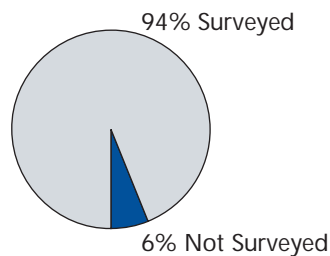
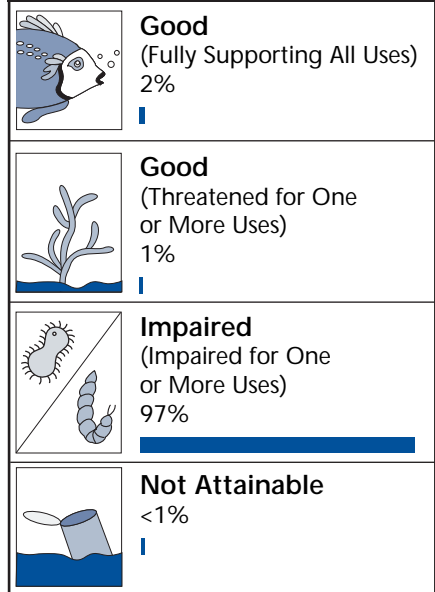


Figure 9. Levels of Summary Use Support - Great Lakes



Source: Based on 1996 State Section 305(b) reports submitted by States, Tribes, Territories, Commissions, and the District of Columbia.

and predation by nonnative species such as the zebra mussel and the sea lamprey.

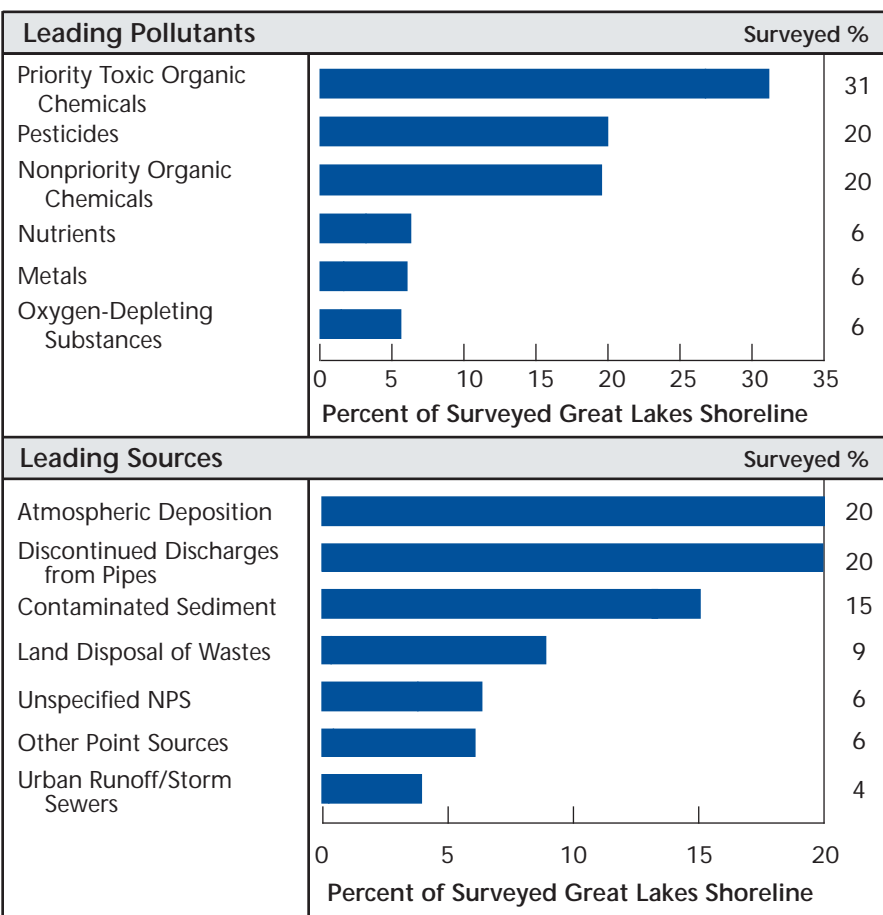
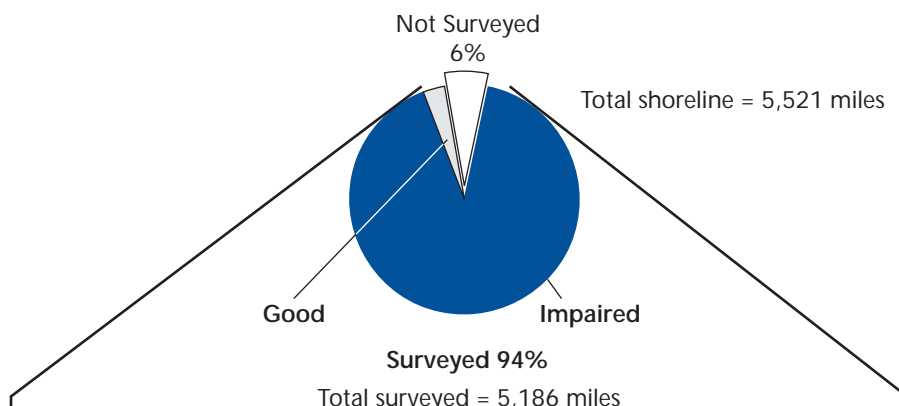
Considerable progress has been made in controlling conventional pollutants, but the Great Lakes are still subject to the effects of toxic pollutants.

These figures do not address water quality conditions in the deeper, cleaner, central waters of the Lakes.

What Is Polluting the Great Lakes?

The States reported that most of the Great Lakes shoreline is polluted by toxic organic chemicals—primarily PCBs—that are often found in fish tissue samples. The Great Lakes States reported that toxic organic chemicals impact 32% of the surveyed Great Lakes shoreline miles. Other leading causes of impairment include pesticides, affecting 21%; nonpriority organic chemicals, affecting 20%; nutrients, affecting 7%; metals, affecting 6%; and oxygen-depleting substances, affecting 6% (Figure 10).

Figure 10. Surveyed Great Lakes Shoreline: Pollutants and Sources



Based on 1996 State Section 305(b) reports submitted by States, Tribes, Territories, Commissions, and the District of Columbia.

Where Does This Pollution Come From?

Only three of the eight Great Lakes States measured the size of their Great Lakes shoreline polluted by specific sources. These States have jurisdiction over one-third of the Great Lakes shoreline, so their findings do not necessarily reflect conditions throughout the Great Lakes Basin.

- Wisconsin identifies atmospheric deposition and discontinued discharges as a source of pollutants contaminating all 1,017 of their surveyed shoreline miles. Wisconsin also identified smaller areas impacted by contaminated sediments, nonpoint sources, industrial and municipal discharges, agriculture, urban runoff and storm sewers, combined sewer overflows, and land disposal of waste.

- Ohio reports that nonpoint sources pollute 86 miles of its 236 miles of shoreline, contaminated sediment impacts 33 miles, and land disposal of waste impacts 24 miles of shoreline.

- New York identifies many sources of pollutants in their Great Lakes waters, but the State attributes the most miles of degradation to contaminated sediments (439 miles) and land disposal of waste (374 miles).

Barry Burgan, U.S. EPA



Estuaries

Estuaries are areas partially surrounded by land where rivers meet the sea. They are characterized by varying degrees of salinity, complex water movements affected by ocean tides and river currents, and high turbidity levels. They are also highly productive ecosystems with a range of habitats for many different species of plants, shellfish, fish, and animals.

Many species permanently inhabit the estuarine ecosystem; others, such as shrimp, use the nutrient-rich estuarine waters as nurseries before traveling to the sea.

Estuaries are stressed by the particularly wide range of activities located within their watersheds. They receive pollutants carried by rivers from agricultural lands and cities; they often support marinas, harbors, and commercial fishing fleets; and their surrounding lands are highly prized for development. These stresses pose a continuing threat to the survival of these bountiful waters.

Overall Water Quality

Twenty-three coastal States and jurisdictions surveyed 72% of the Nation's total estuarine waters in 1996 (Figure 11). The States and other jurisdictions reported that 62% of the surveyed estuarine waters have good water quality that fully supports designated uses (Figure 12). Of these waters, 4% are threatened and might deteriorate if we fail to manage potential sources of pollution. Some form of pollution or habitat degradation impairs the remaining 38% of the surveyed estuarine waters.



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What Is Polluting Our Estuaries?

The States identified more square miles of estuarine waters polluted by nutrients than any other pollutant or process (Figure 13). Eleven States reported that extra nutrients pollute 6,254 square miles of estuarine waters (57% of the impaired estuarine waters). As in lakes, extra inputs of nutrients from human activities destabilize estuarine ecosystems.

Twenty-one States reported that bacteria pollute 4,634 square miles of estuarine waters (22% of the impaired estuarine waters). Bacteria provide evidence that an estuary is contaminated with sewage that may contain numerous viruses and bacteria that cause illness in people.

Figure 11. Estuary Square Miles Surveyed

Total estuaries = 39,839 square miles
Total surveyed = 28,819 square miles

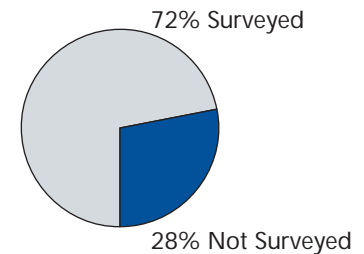
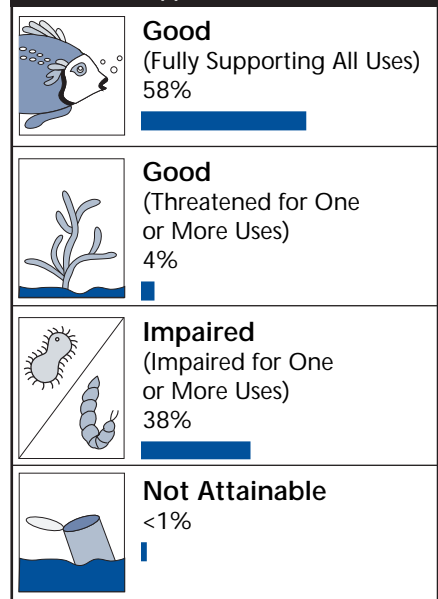
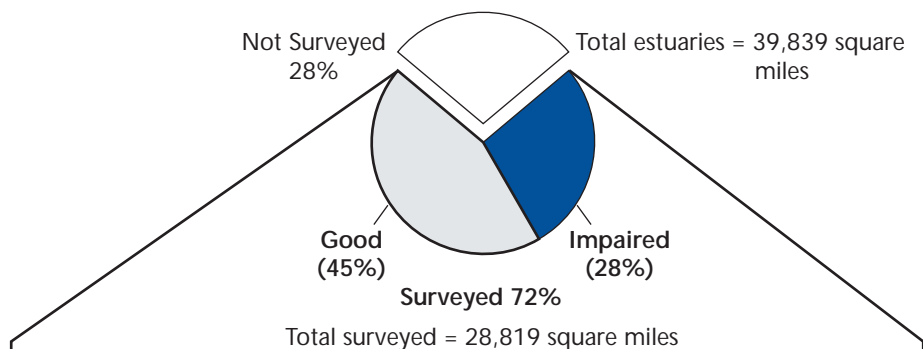


Figure 12. Levels of Summary Use Support – Estuaries



Source: Based on 1996 State Section 305(b) reports submitted by States, Tribes, Territories, Commissions, and the District of Columbia.

Figure 13. Surveyed Estuaries: Pollutants and Sources



Leading Pollutants/Stressors	Surveyed %
Nutrients	22
Bacteria	16
Priority Toxic Organic Chemicals	15
Oxygen-Depleting Substances	12
Oil and Grease	8
Salinity	7
Habitat Alterations	6

Percent of Surveyed Estuarine Square Miles

Leading Sources	Surveyed %
Industrial Discharges	21
Urban Runoff/Storm Sewers	18
Municipal Point Sources	17
Upstream Sources	11
Agriculture	10
Combined Sewer Overflows	8
Land Disposal of Wastes	7

Percent of Surveyed Estuarine Square Miles

The States also report that priority organic toxic chemicals pollute 4,398 square miles (15% of the surveyed estuarine waters); oxygen depletion from organic wastes impacts 3,586 square miles (12% of the surveyed estuarine waters); oil and grease pollute 2,170 square miles (8% of the surveyed estuarine waters); salinity, total dissolved solids, and/or chlorine impact 1,944 square miles (7% of the surveyed estuarine waters); and habitat alterations degrade 1,586 square miles (6% of the surveyed estuarine waters).

Where Does This Pollution Come From?

Twenty-one States reported that industrial discharges are the most widespread source of pollution in the Nation's surveyed estuarine waters. Pollutants in industrial discharge degrade aquatic life or interfere with public use of 6,145 square miles of estuarine waters (21% of the surveyed estuarine waters) (Figure 13).



Sydney Locker, Quaker Ridge School, Scarsdale, NY

Based on 1996 State Section 305(b) reports submitted by States, Tribes, Territories, Commissions, and the District of Columbia.

Note: Percentages do not add up to 100% because more than one pollutant or source may impair an estuary.

The States also reported that urban runoff and storm sewers pollute 5,099 square miles of estuarine waters (18% of the surveyed estuarine waters), municipal

discharges pollute 4,874 square miles of estuarine waters (17% of the surveyed estuarine waters), and upstream sources pollute 3,295 square miles (11% of the surveyed

estuarine waters). Urban sources contribute more to the degradation of estuarine waters than agriculture because urban centers are located adjacent to most major estuaries.



Dana Soady, 4th Grade, Burton GeoWorld, Durham, NC

Ocean Shoreline Waters



Paul Goetz, Cary, NC

Although the oceans are expansive, they are vulnerable to pollution from numerous sources, including city storm sewers, ocean outfalls from sewage treatment plants, overboard disposal of debris and sewage, oil spills, and bilge discharges that contain oil and grease. Nearshore ocean waters, in particular, suffer from the same pollution problems that degrade our inland waters.

Overall Water Quality

Ten of the 27 coastal States and Territories surveyed only 6% of the Nation's estimated 58,585 miles of ocean coastline (Figure 14). Most of the surveyed waters (3,085 miles, or 87%) have good quality that supports a healthy aquatic community and public activities (Figure 15). Of these waters, 315 miles (9% of the surveyed shoreline) are threatened and may deteriorate in the future. Some form of pollution

or habitat degradation impairs the remaining 13% of the surveyed shoreline (467 miles).

Only six of the 27 coastal States identified pollutants and sources of pollutants degrading ocean shoreline waters. General conclusions cannot be drawn from this limited source of information. The six States identified impacts in their ocean shoreline waters from bacteria, turbidity, nutrients, oxygen-depleting substances, suspended solids, acidity (pH), oil and grease, and metals. The six States reported that urban runoff and storm sewers, land disposal of wastes, septic systems, municipal sewer discharges, industrial discharges, recreational marinas, and spills and illegal dumping pollute their coastal shoreline waters.

Figure 14. Ocean Shoreline Waters Surveyed

Total ocean shore = 58,585 miles including Alaska's shoreline
Total surveyed = 3,651 miles

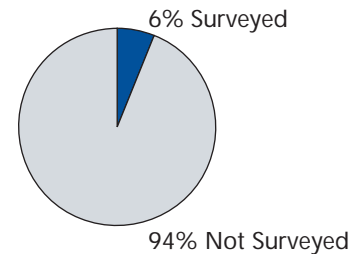
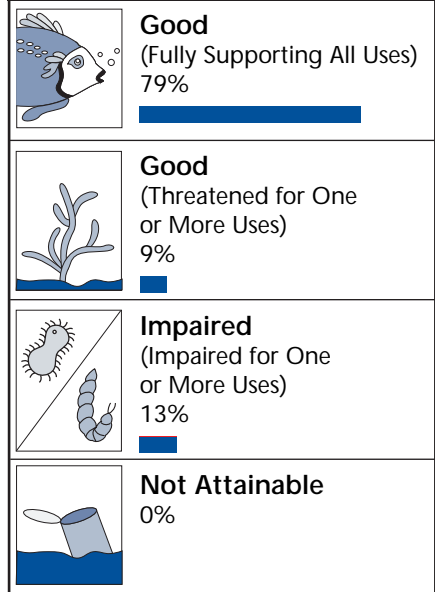


Figure 15. Levels of Summary Use Support – Ocean Shoreline Waters



Source: Based on 1996 State Section 305(b) reports submitted by States, Tribes, Territories, Commissions, and the District of Columbia.

Note: Percentages may not add up to 100% due to rounding.

Wetlands

Wetlands are areas that are inundated or saturated by surface water or ground water at a frequency and duration sufficient to support (and that under normal circumstances do support) a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands, which are found throughout the United States, generally include swamps, marshes, bogs, and similar areas.

Wetlands are now recognized as some of the most unique and important natural areas on earth. They vary in type according to differences in local and regional hydrology, vegetation, water chemistry, soils, topography, and climate. Coastal wetlands include estuarine marshes; mangrove swamps found in Puerto Rico, Hawaii, Louisiana, and Florida; and Great Lakes coastal wetlands. Inland wetlands, which may be adjacent to a waterbody or isolated, include marshes and wet meadows, bottomland hardwood forests, Great Plains prairie potholes, cypress-gum swamps, and southwestern playa lakes.

In their natural condition, wetlands provide many benefits, including food and habitat for fish and wildlife, water quality improvement, flood protection, shoreline erosion control, ground water exchange, as well as natural products for human use and opportunities for recreation, education, and research.

Wetlands help maintain and improve water quality by intercepting surface water runoff before it reaches open water, removing or retaining nutrients, processing chemical and organic wastes,



Sam Becker, Stennis, MS

and reducing sediment loads to receiving waters. As water moves through a wetland, plants slow the water, allowing sediment and pollutants to settle out. Plant roots trap sediment and are then able to metabolize and detoxify pollutants and remove nutrients such as nitrogen and phosphorus.

Wetlands function like natural basins, storing either floodwater that overflows riverbanks or surface water that collects in isolated depressions. By doing so, wetlands help protect adjacent and downstream property from flood damage. Trees and other wetlands vegetation help slow the speed of flood waters. This action, combined with water storage, can lower flood heights and reduce the water's erosive potential. In agricultural areas, wetlands can help reduce the likelihood of flood damage to crops. Wetlands within and upstream of

urban areas are especially valuable for flood protection because urban development increases the rate and volume of surface water runoff, thereby increasing the risk of flood damage.

Wetlands produce a wealth of natural products, including fish and shellfish, timber, wildlife, and wild rice. Much of the Nation's fishing and shellfishing industry harvests wetlands-dependent species. A national survey conducted by the Fish and Wildlife Service (FWS) in 1991 illustrates the economic value of some of the wetlands-dependent products. Over 9 billion pounds of fish and shellfish landed in the United States in 1991 had a direct, dockside value of \$3.3 billion. This served as the basis of a seafood processing and sales industry that generated total expenditures of \$26.8 billion. In addition, 35.6 million anglers spent \$24 billion on

freshwater and saltwater fishing. It is estimated that 71% of commercially valuable fish and shellfish depend directly or indirectly on coastal wetlands.

Overall Water Quality

The States, Tribes, and other jurisdictions are making progress in developing specific designated uses and water quality standards for wetlands, but many States and Tribes still lack specific water quality criteria and monitoring programs for wetlands. Without criteria and monitoring data, most States and Tribes cannot evaluate use support. To date, only nine States and Tribes reported the designated use support status for some of their wetlands. Only Kansas used quantitative data as a basis for the use support decisions.

EPA cannot derive national conclusions about water quality conditions in all wetlands because the States used different methodologies to survey only 3% of the total wetlands in the Nation. Summarizing State wetlands data would also produce misleading results because two States (North Carolina and Louisiana) contain 91% of the surveyed wetlands acreage.

What Is Polluting Our Wetlands and Where Does This Pollution Come From?

The States have even fewer data to quantify the extent of pollutants degrading wetlands and the sources of these pollutants. Although most

States cannot quantify wetlands area impacted by individual causes and sources of degradation, nine States identified causes and sources known to degrade wetlands integrity to some extent. These States listed sediment and nutrients as the most widespread causes of degradation impacting wetlands, followed by draining and pesticides (Figure 16). Agriculture and hydrologic modifications topped the list of sources degrading wetlands, followed by urban runoff, draining, and construction (Figure 17).

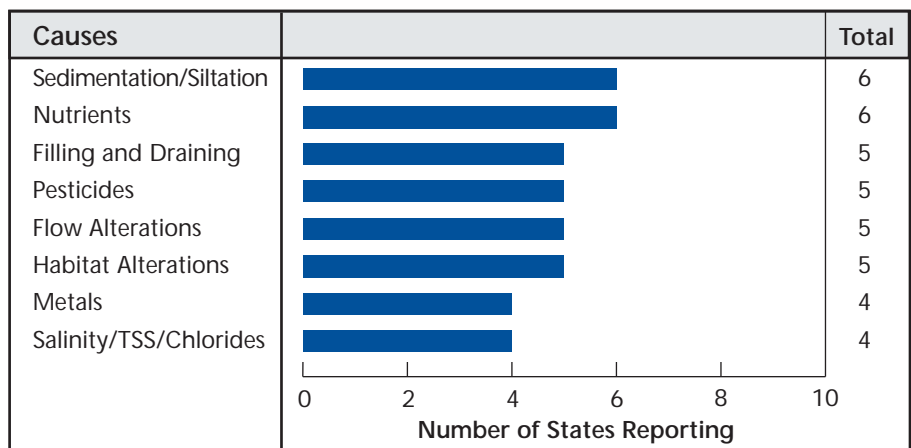
Wetlands Loss: A Continuing Problem

It is estimated that over 200 million acres of wetlands existed in the lower 48 States at the time of European settlement. Since then, extensive wetlands acreage has been lost, with many of the original

wetlands drained and converted to farmland and urban development. Today, less than half of our original wetlands remain. The losses amount to an area equal to the size of California. According to the U.S. Fish and Wildlife Service's *Wetlands Losses in the United States 1780's to 1980's*, the three States that have sustained the greatest percentage of wetlands loss are California (91%), Ohio (90%), and Iowa (89%).

According to FWS status and trends reports, the average annual loss of wetlands has decreased over the past 40 years. The average annual loss from the mid-1950s to the mid-1970s was 458,000 acres, and from the mid-1970s to the mid-1980s it was 290,000 acres. Agriculture was responsible for 87% of the loss from the mid-1950s to the mid-1970s and 54% of the loss from the mid-1970s to the mid-1980s.

Figure 16. Causes Degrading Wetlands Integrity (10 States Reporting)



Source: Based on 1996 Section 305(b) reports submitted by States, Tribes, Territories, Commissions, and the District of Columbia.

A more recent estimate of wetlands losses from the National Resources Inventory (NRI), conducted by the Natural Resources Conservation Service (NRCS), indicates that 792,000 acres of wetlands were lost on non-Federal lands between 1982 and 1992 for a yearly loss estimate of 70,000 to 90,000 acres. This net loss is the result of gross losses of 1,561,300 acres of wetlands and gross gains of 768,700 acres of wetlands over the 10-year period. The NRI estimates are consistent with the trend of declining wetlands losses reported by FWS. Although losses have decreased, we still have to make progress toward our interim goal of

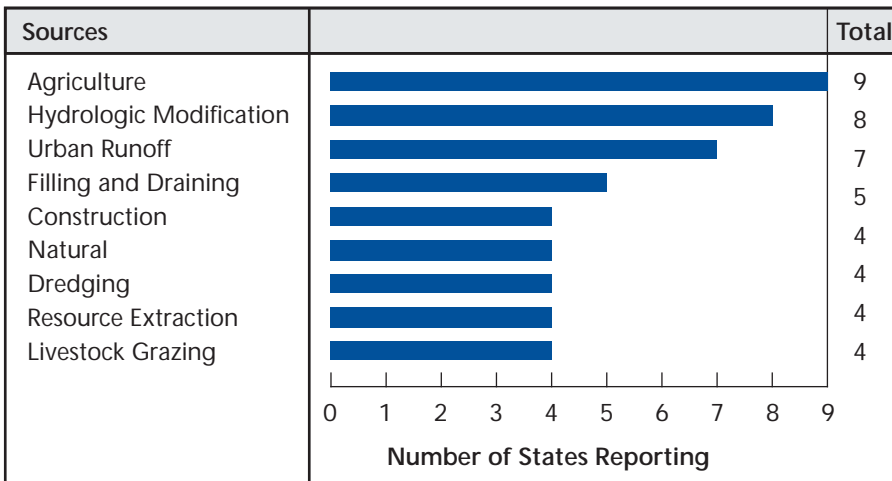
no overall net loss of the Nation's remaining wetlands and the long-term goal of increasing the quantity and quality of the Nation's wetlands resource base.

The decline in wetlands losses is a result of the combined effect of several trends: (1) the decline in profitability in converting wetlands for agricultural production; (2) passage of Swampbuster provisions in the 1985, 1990, and 1996 Farm Bills that denied crop subsidy benefits to farm operators who converted wetlands to cropland after 1985; (3) presence of the CWA Section 404 permit programs as well as development of State management programs; (4) greater

public interest and support for wetlands protection; and (5) implementation of wetlands restoration programs at the Federal, State, and local level.

Twelve States listed sources of recent wetlands losses in their 1996 305(b) reports. Residential development and urban growth was cited as the leading source of current losses. Other losses were due to agriculture; construction of roads, highways, and bridges; hydrologic modifications; channelization; and industrial development. In addition to human activities, a few States also reported that natural sources, such as rising lake levels, resulted in wetlands losses and degradation.

Figure 17. Sources Degrading Wetlands Integrity (9 States Reporting)



Source: Based on 1996 Section 305(b) reports submitted by States, Tribes, Territories, Commissions, and the District of Columbia.



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More information on wetlands can be obtained from the EPA Wetlands Hotline at 1-800-832-7828.

Ground Water

Although 75% percent of the earth's surface is covered by water, only 3% is fresh water available for our use. It has been estimated that more than 90% of the world's fresh water reserve is stored in the earth as ground water. Ground water—water found in natural underground rock formations called aquifers—is a vital national resource that is used for myriad purposes. Unfortunately, this resource is vulnerable to contamination, and ground water contaminant problems are being reported throughout the country.

To ascertain the extent to which our Nation's ground water resources have been impacted by human activities, Section 106(e) of the Clean Water Act requests that each State monitor ground water quality and report the findings to Congress in their 305(b) State Water Quality Reports. Recognizing that an accurate representation of our Nation's ambient ground water quality conditions required developing guidelines that would ultimately yield quantitative data, EPA, in partnership with interested States, developed new guidelines for assessing ground water quality. It was these guidelines that were used by States for reporting the 1996 305(b) ground water data.

Despite variations in reporting style, the 1996 305(b) State Water Quality Reports represent a first step in improving the assessment of State ambient ground water quality. Forty States, one Territory, and two Tribes used the new guidelines to assess and report ground water quality data. For the first time, States provided quantitative data describing ground water quality.



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Furthermore, States provided quantitative information pertaining to contamination sources that have impacted ground water quality.

Ground Water Contamination

Not too long ago, it was thought that soil provided a protective "filter" or "barrier" that immobilized the downward migration of

Ground water provides drinking water for 51% of the population.

contaminants released on the land surface and prevented ground water resources from being adversely impacted or contaminated. The discovery of pesticides and other contaminants in ground water demonstrated that ground water

resources were indeed vulnerable to contamination resulting from human activities. The potential for a contaminant to affect ground water quality is dependent upon its being introduced to the environment and its ability to migrate through the overlying soils to the underlying ground water resource.

Ground water contamination can occur as relatively well defined plumes emanating from specific sources such as spills, landfills, waste lagoons, and/or industrial facilities. Contamination can also occur as a general deterioration of ground water quality over a wide area due to diffuse nonpoint sources such as agricultural fertilizer and pesticide applications, septic systems, urban runoff, leaking sewer networks, application of lawn chemicals, highway deicing materials, animal feedlots, salvage yards, and mining activities. Ground water quality degradation from diffuse nonpoint sources affects large areas, making it difficult to specify the exact source of the contamination.

Ground water contamination is most common in highly developed areas, agricultural areas, and industrial complexes. Frequently ground water contamination is discovered long after it has occurred. One reason for this is the slow movement of ground water through aquifers, sometimes on the order of less than an inch per day. Contaminants in the ground water do not mix or spread quickly, but remain concentrated in slow-moving plumes that may persist for many years. This often results in a delay in the detection of ground water contamination. In some cases, contaminants introduced into the

subsurface more than 10 years ago are only now being discovered.

Ground Water Contaminant Sources

As reported by States, it is evident that ground water quality may be adversely impacted by a variety of potential contaminant sources. In 1996, EPA requested each State to indicate the 10 top sources that potentially threaten their ground water resources. The list was not considered comprehensive and States added sources as was necessary based on State-specific concerns. Factors that were considered by States in their selection include the number of each type of source in the State, the location of the various sources relative to ground water used for drinking water purposes, the size of the population at risk from contaminated drinking water, the risk posed to human health and/or the environment from releases, hydrogeologic sensitivity (the ease with which contaminants enter and travel through soil and reach aquifers), and the findings of the State's ground water protection strategy and/or related studies.

Thirty-seven States provided information related to contaminant sources. Those most frequently reported by States include:

■ **Leaking underground storage tanks.** Leaking underground storage tanks (USTs) were cited as the highest priority contaminant source of concern to States. The primary causes of leakage in USTs are faulty

installation and corrosion of tanks and pipelines. As of March 1996, more than 300,000 releases from USTs had been confirmed. EPA estimates that nationally 60% of these leaks have impacted ground water quality, and, in some States, the percentage is as high as 90%.

■ **Landfills.** Landfills were cited by States as the second highest contaminant source of concern. Landfills are used to dispose of sanitary (municipal) and industrial wastes. Municipal wastes, some industrial wastes, and relatively inert substances such as plastics are disposed of in sanitary landfills. Common materials that may be disposed of in industrial landfills include plastics, metals, fly ash, sludges, coke, tailings, waste pigment particles, low-level radioactive wastes, polypropylene, wood, brick, cellulose, ceramics, synthetics, and other similar substances. States indicated that the most common contaminants associated with landfills were metals, halogenated solvents, and petroleum compounds. To a lesser extent, organic and inorganic pesticides were also cited as a contaminant of concern.

■ **Septic systems.** Septic systems were cited by 29 out of 37 States as a potential source of ground water contamination. Ground water may be contaminated by releases from septic systems when the systems are poorly designed (tanks are installed in areas with inadequate soils or shallow depth to ground water), poorly constructed; have poor well

seals; are improperly used, located, or maintained; or are abandoned. Typical contaminants from domestic septic systems include bacteria, nitrates, viruses, phosphates from detergents, and other chemicals that might originate from household cleaners.

Ground Water Quality Assessments

Thirty-three States reported data summarizing ground water quality. In total, data were reported for 162 specific aquifers and other hydrogeologic settings. States used data from ambient monitoring networks, public water supply systems (PWSs), private and unregulated wells, and special studies. Nationally, more States reported data for nitrates, metals, volatile organic compounds (VOCs), and semivolatile organic compounds (SVOCs) than any other parameter grouping. Nitrates, metals, SVOCs, and VOCs generally represent instances of ground water degradation resulting from human activities.

Due to the importance of ground water as a drinking water resource, many of the aquifers that were evaluated for 1996 are used to supply water for public and private consumption. The aquifers are also used for irrigation, commercial, livestock, and industrial purposes. In general, water quality problems affected irrigation, commercial, livestock, and industry uses less frequently than drinking water. This may reflect the high water quality standards set for drinking water.

Water Quality Protection Programs

Although significant strides have been made in reducing the impacts of discrete pollutant sources, our aquatic resources remain at risk from a combination of point sources and complex nonpoint sources, including air pollution. Since 1991, EPA has promoted the watershed protection approach as a holistic framework for addressing complex pollution problems.

The watershed protection approach is a place-based strategy that integrates water quality management activities within hydrologically defined drainage basins—watersheds—rather than areas defined by political boundaries. Thus, for a given watershed, the approach encompasses not only the water resource (such as a stream, lake, estuary, or ground water aquifer), but all the land from which water drains to the resource. To protect

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Under the Watershed Protection Approach (WPA), a “watershed” is a hydrogeologic area defined for addressing water quality problems.

For example, a WPA watershed may be a river basin, a county-sized watershed, or a small drinking water supply watershed.

water resources, it is increasingly important to address the condition of land areas within the watershed because water carries the effects of

human activities throughout the watershed as it drains off the land into surface waters or leaches into the ground water.

EPA’s Office of Water envisions the watershed protection approach as the primary mechanism for achieving clean water and healthy, sustainable ecosystems throughout the Nation. The watershed protection approach enables stakeholders to take a comprehensive look at ecosystem issues and tailor corrective actions to local concerns within the coordinated framework of a national water program. The emphasis on public participation also provides an opportunity to incorporate environmental justice issues into watershed restoration and protection solutions.

In May of 1994, the EPA Assistant Administrator for Water, Robert Perciasepe, created the Watershed Management Policy Committee to coordinate the EPA water program’s

support of the watershed protection approach. Since then, EPA’s water program managers, under the direction of the Watershed Management Policy Committee, evaluated their programs and identified additional activities needed to support the watershed protection approach in an action plan.

EPA’s Office of Water will continue to promote and support the watershed protection approach and build upon its experience with established place-based programs, such as the Chesapeake Bay Program and the Great Lakes National Program to eliminate barriers to the approach. These integrated programs laid the foundation for the Agency’s shift toward comprehensive watershed management and continue to provide models for implementing the “place-based” approach to environmental problem-solving.

The Clean Water Act

A number of laws provide the authority to develop and implement pollution control programs. The primary statute providing for water quality protection in the Nation's rivers, lakes, wetlands, estuaries, and coastal waters is the Federal Water Pollution Control Act of 1972, commonly known as the Clean Water Act.

The CWA and its amendments are the driving force behind many of the water quality improvements we have witnessed in recent years. Key provisions of the CWA provide the following pollution control programs.

Water quality standards and criteria – States, Tribes, and other jurisdictions adopt EPA-approved standards for their waters that define water quality goals for individual waterbodies. Standards consist of designated beneficial uses to be made of the water, criteria to protect those uses, and antidegradation provisions to protect existing water quality.

Effluent guidelines – EPA develops nationally consistent guidelines limiting pollutants in discharges from industrial facilities and municipal sewage treatment plants. These guidelines are then used in permits issued to dischargers under the National Pollutant Discharge Elimination System (NPDES) program. Additional controls may be required if receiving

The Watershed Protection Approach (WPA)

Several key principles guide the watershed protection approach:

- **Place-based focus** – Resource management activities are directed within specific geographic areas, usually defined by watershed boundaries, areas overlying or recharging ground water, or a combination of both.
- **Stakeholder involvement and partnerships** – Watershed initiatives involve the people most likely to be affected by management decisions in the decision making process. Stakeholder participation ensures that the objectives of the watershed initiative will include economic stability and that the people who depend on the water resources in the watershed will participate in planning and implementation activities. Watershed initiatives also establish partnerships between Federal, State, and local agencies and nongovernment organizations with interests in the watershed.
- **Environmental objectives** – The stakeholders and partners identify environmental objectives (such as “populations of striped bass will stabilize or increase”) rather than programmatic objectives (such as “the State will eliminate the backlog of discharge permit renewals”) to measure the success of the watershed initiative. The environmental objectives are based on the condition of the ecological resource and the needs of people in the watershed.
- **Problem identification and prioritization** – The stakeholders and partners use sound scientific data and methods to identify and prioritize the primary threats to human and ecosystem health within the watershed. Consistent with the Agency's mission, EPA views ecosystems as the interactions of complex communities that include people; thus, healthy ecosystems provide for the health and welfare of humans as well as other living things.
- **Integrated actions** – The stakeholders and partners take corrective actions in a comprehensive and integrated manner, evaluate success, and refine actions if necessary. The watershed protection approach coordinates activities conducted by numerous government agencies and nongovernment organizations to maximize efficient use of limited resources.

waters are still affected by water quality problems after permit limits are met.

Total Maximum Daily Loads –

The development of Total Maximum Daily Loads, or TMDLs, establishes the link between water quality standards and point/nonpoint source pollution control actions such as permits or Best Management Practices (BMPs). A TMDL calculates allowable loadings from the contributing point and nonpoint sources to a given waterbody and provides the quantitative basis for pollution reduction necessary to meet water quality standards. States, Tribes, and other jurisdictions develop and implement TMDLs for high-priority impaired or threatened waterbodies.

Permits and enforcement – All industrial and municipal facilities that discharge wastewater must have an NPDES permit and are responsible for monitoring and reporting levels of pollutants in their discharges. EPA issues these permits or can delegate that permitting authority to qualifying States or other jurisdictions. The States, other qualified jurisdictions, and EPA inspect facilities to determine if their discharges comply with permit limits. If dischargers are not in compliance, enforcement action is taken.

Loans – The Clean Water State Revolving Fund (CW-SRF) is an innovative water quality financing program that is designed to

provide low-cost project financing to solve important water quality problems. The SRF program is made up of 51 state-level infrastructure funds (Puerto Rico has one, too) that operate much like banks. These funds were created by the 1987 Amendments to the Clean Water Act and are intended to provide permanent and independent sources of funding for municipal sewage treatment, nonpoint source, and estuary projects. EPA and the States are capitalizing or providing “seed money” to establish these revolving funds. The goal is to capitalize the 51 programs so that they can provide in excess of \$2 billion in loans for water quality projects each year for the foreseeable future. The CW-SRF is, by far, the most powerful financial tool available to the water quality program.

The 1996 Amendments to the Safe Drinking Water Act (SDWA) created the new Drinking Water State Revolving Fund (DW-SRF) program. The primary purpose of this program is to upgrade drinking water infrastructure to facilitate compliance with the SDWA. Congress has appropriated \$2 billion to begin the capitalization of this program. The long-term strategy is to continue capitalization of this program so that the SRFs will be able to provide in excess of \$500 million each year in assistance for priority drinking water projects. In January 1997, EPA released the first Drinking Water Needs Survey, which

identified \$138.4 billion in needs over the next 20 years. EPA is currently working with the States to set up their drinking water SRFs.

Grants – EPA provides States with financial assistance to help support many of their pollution control programs. The programs funded include water quality monitoring, permitting, and enforcement; nonpoint source; ground water; National Estuary Program; and wetlands.

Nonpoint source control – EPA provides program guidance, technical support, and funding to help the States, Tribes, and other jurisdictions control nonpoint source pollution. The States, Tribes, and other jurisdictions are responsible for analyzing the extent and severity of their nonpoint source pollution problems and developing and implementing needed water quality management actions.

The CWA also established pollution control and prevention programs for specific waterbody categories, such as the Clean Lakes Program. Other statutes that also guide the development of water quality protection programs include:

■ **The Safe Drinking Water Act**, under which States establish standards for drinking water quality, monitor wells and local water supply systems, implement drinking water protection programs, and implement Underground Injection Control (UIC) programs.

■ **The Resource Conservation and Recovery Act**, which establishes State and EPA programs for ground water and surface water protection and cleanup and emphasizes prevention of releases through management standards in addition to other waste management activities.

■ **The Comprehensive Environmental Response, Compensation, and Liability Act (Superfund Program)**, which provides EPA with the authority to clean up contaminated waters during remediation at contaminated sites.

■ **The Pollution Prevention Act of 1990**, which requires EPA to promote pollutant source reduction rather than focus on controlling pollutants after they enter the environment.

Protecting and Restoring Lakes

Since the 1980s, EPA has encouraged States to develop lake projects with a watershed perspective. This ensures that protection and restoration activities are long term and comprehensive. EPA offers sources of funding assistance for lake projects and also encourages States to develop their own independent mechanisms to provide resources for their lake management programs.

A good example of a State-based lakes initiative is the Illinois Conservation 2000 Clean Lakes program. Illinois' system adopted major features of the Federal Clean Lakes program. The process leading to the Conservation 2000 program can be traced back to legislative actions in the late 1980s that set up the basic framework and identified agency

roles and responsibilities. The program now has assured ongoing funding to support lake restoration projects and to underwrite a variety of technical support and educational activities.

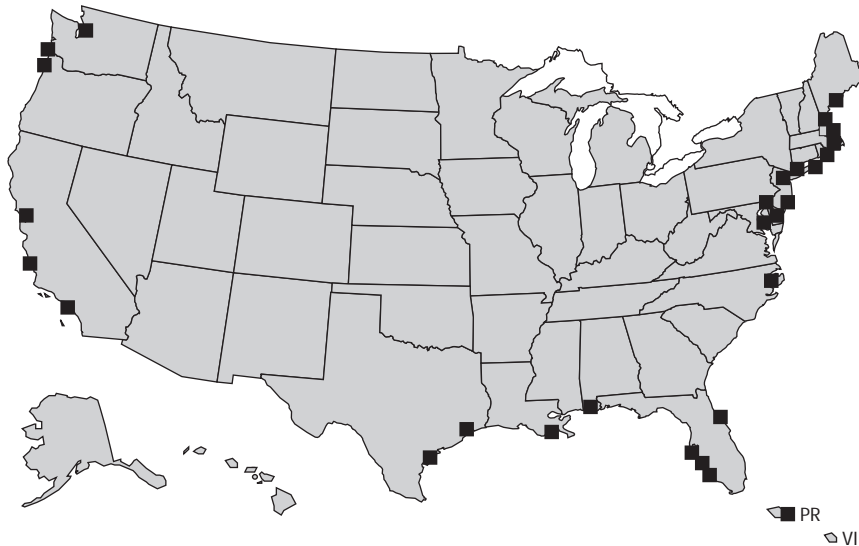
At the Federal level, EPA offers support for watershed-oriented lake

projects through Nonpoint Source 319(h) grants included under State Nonpoint Source Management Programs. Other EPA resources may be available under provisions of the reauthorized Safe Drinking Water Act, with its emphasis on source water protection.



Jerome Pitt, U.S. EPA, Region 9

Figure 18. Locations of National Estuary Program Sites



Successful lake programs require local stakeholder support and an awareness on the part of stakeholders of how to identify pollution concerns as well as knowledge of appropriate lake protection and restoration management measures. EPA provides support for a variety of local stakeholder outreach and education initiatives. A good example is the Great American Secchi Dip-In, an event held for the past 4 years, in which volunteer lake and reservoir monitoring programs from across the country take a Secchi disk measurement on one day in a period surrounding July 4th. Secchi disks are typically flat, black and white disks that are used to measure the transparency of water. Transparency is one indicator of the impact of human activity on lake water quality.

The National Estuary Program

Section 320 of the Clean Water Act (as amended by the Water Quality Act of 1987) established the National Estuary Program (NEP) to protect and restore water quality and living resources in estuaries. The NEP adopts a geographic or watershed approach by planning and implementing pollution abatement activities for the estuary and its surrounding land area as a whole.

The NEP embodies the ecosystem approach by building coalitions, addressing multiple sources of contamination, pursuing habitat protection as a pollution control mechanism, and investigating cross-media transfer of pollutants from air and soil into specific estuarine waters. Under the NEP, a State governor nominates an estuary in his or her State for participation in the program. The State must

demonstrate a likelihood of success in protecting candidate estuaries and provide evidence of institutional, financial, and political commitment to solving estuarine problems.

If an estuary meets the NEP guidelines, the EPA Administrator convenes a management conference of representatives from interested Federal, Regional, State, and local governments; affected industries; scientific and academic institutions; and citizen organizations. The management conference defines program goals and objectives, identifies problems, and designs strategies to control pollution and manage natural resources in the estuarine basin. Each management conference develops and initiates implementation of a Comprehensive Conservation and Management Plan (CCMP) to restore and protect the estuary.

The NEP currently supports 28 estuary projects.

The NEP integrates science and policy by bringing water quality managers, elected officials, and stakeholders together with scientists from government agencies, academic institutions, and the private sector. Because the NEP is not a research program, it relies heavily on past and ongoing research of other agencies and institutions to support development of CCMPs.

With the addition of seven estuary sites in July of 1995, the NEP currently supports 28 estuary projects (see Figure 18). These 28 estuaries are nationally significant in their economic value as well as in their ability to support living

The 1993 Wetlands Plan

Shortly after coming into office, the Clinton Administration convened an interagency working group to address concerns with Federal wetlands policy. After hearing from States, developers, farmers, environmental interests, members of Congress, and scientists, the working group developed a comprehensive 40-point plan for wetlands protection to make wetlands programs more fair, flexible, and effective. This plan was issued on August 24, 1993.

The Administration's Wetlands Plan emphasizes improving Federal wetlands policy by

- Streamlining wetlands permitting programs
- Increasing cooperation with private landowners to protect and restore wetlands
- Basing wetlands protection on good science and sound judgment
- Increasing participation by States, Tribes, local governments, and the public in wetlands protection.

resources. The project sites also represent a broad range of environmental conditions in estuaries throughout the United States and its Territories so that the lessons learned through the NEP can be applied to other estuaries.

Each of the 28 estuaries in the NEP is unique. Yet the estuaries share common threats and stressors. Each estuary faces expanding human activity near its shores that may degrade water quality and habitat. Eutrophication, toxic substances (including metals), pathogens, and changes to living resources and habitats top the list of problems being addressed by NEP Management Conferences.

Protecting Wetlands

A variety of public and private programs protect wetlands. Section 404 of the CWA continues to provide the primary Federal vehicle for regulating certain activities in wetlands. Section 404 establishes a permit program for discharges of dredged or fill material into waters of the United States, including wetlands.

The U.S. Army Corps of Engineers (COE) and EPA jointly implement the Section 404 program. The COE is responsible for reviewing permit applications and making permit decisions. EPA establishes the environmental criteria for making permit decisions and has the authority to review and veto Section 404 permits proposed for issuance by the COE. EPA is also responsible for determining geographic jurisdiction of the Section 404 permit program, interpreting statutory exemptions, and overseeing Section 404 permit programs assumed by individual States. To date, only two States (Michigan and New Jersey) have assumed the Section 404 permit program from the COE. The COE and EPA share responsibility for enforcing Section 404 requirements.

The COE issues individual Section 404 permits for specific projects or general permits (Table 5). Applications for individual permits go through a review process that includes opportunities for EPA, other Federal agencies (such as the U.S. Fish and Wildlife Service and the National Marine Fisheries

Table 5. Federal Section 404 Permits

General Permits (streamlined permit review procedures)				Individual Permits
Nationwide Permits	Regional Permits	Programmatic Permits		<ul style="list-style-type: none"> • Required for major projects that have the potential to cause significant adverse impacts • Project must undergo interagency review • Opportunity for public comment • Opportunity for 401 certification review
<ul style="list-style-type: none"> • Cover 39 types of activities that the COE determines to have minimal adverse impacts on the environment 	<ul style="list-style-type: none"> • Developed by COE District Offices to cover activities in a specified region 	State Programmatic Permits	Others	
		<ul style="list-style-type: none"> • COE defers permit decisions to State agency while reserving authority to require an individual permit 	<ul style="list-style-type: none"> • Special Management Agencies • Watershed Planning Commissions 	

Service), State agencies, and the public to comment. However, the vast majority of activities proposed in wetlands are covered by Section 404 general permits. For example, in FY96, over 64,000 people applied to the COE for a Section 404 permit. Eighty-five percent of these applications were covered by general permits and were processed in an average of 14 days. It is estimated that another 90,000 activities are covered by general permits that do not require notification of the COE at all.

General permits allow the COE to permit certain activities without performing a separate individual permit review. Some general permits require notification of the COE before an activity begins. There are three types of general permits:

- Nationwide permits (NWPs) authorize specific activities across the entire Nation that the COE determines will have only minimal individual and cumulative impacts on the environment, including construction of minor road crossings and farm buildings, bank stabilization activities, and the filling of up to 10 acres of isolated or headwater wetlands.

- Regional permits authorize types of activities within a geographic area defined by a COE District Office.

- Programmatic general permits are issued to an entity that the COE determines may regulate activities within its jurisdictional wetlands. Under a programmatic general permit, the COE defers its permit decision to the regulating entity but

reserves its authority to require an individual permit.

Currently, the COE and EPA are promoting the development of State programmatic general permits (SPGPs) to increase State involvement in wetlands protection and minimize duplicative State and Federal review of activities proposed in wetlands. Each SPGP is a unique arrangement developed by a State and the COE to take advantage of the strengths of the individual State wetlands program. Several States have adopted comprehensive SPGPs that replace many or all COE-issued nationwide general permits. SPGPs simplify the regulatory process and increase State control over their wetlands resources. Carefully developed SPGPs can improve wetlands protection while reducing regulatory demands on landowners.

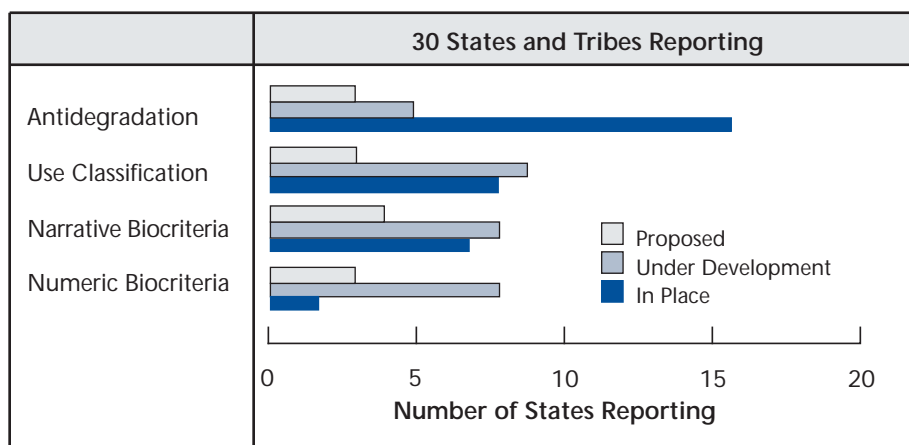
Water quality standards for wetlands ensure that the provisions of CWA Section 303 that apply to other surface waters are also applied to wetlands. In July 1990, EPA issued

guidance to States for the development of wetlands water quality standards. Water quality standards consist of designated beneficial uses, numeric criteria, narrative criteria, and antidegradation statements. Figure 19 indicates the State's progress in developing these standards.

Standards provide the foundation for a broad range of water quality management activities under the CWA including, but not limited to, monitoring for the Section 305(b) report, permitting under Sections 402 and 404, water quality certification under Section 401, and the control of nonpoint source pollution under Section 319.

States, Territories, and Tribes are well positioned between Federal and local government to take the lead in integrating and expanding wetlands protection and management programs. They are experienced in managing federally mandated environmental programs, and they are uniquely equipped to help resolve local and regional conflicts

Figure 19. Development of State Water Quality Standards for Wetlands



and identify the local economic and geographic factors that may influence wetlands protection.

Section 401 of the CWA gives States and eligible American Indian Tribes the authority to grant, condition, or deny certification of federally permitted or licensed activities that may result in a discharge to U.S. waters, including wetlands. Such activities include discharge of dredged or fill material permitted under CWA Section 404, point source discharges permitted under CWA Section 402, and Federal Energy Regulatory Commission's hydropower licenses. States review these permits to ensure that they meet State water quality standards.

Section 401 certification can be a powerful tool for protecting wetlands from unacceptable degradation or destruction especially when implemented in conjunction with wetlands-specific water quality standards. If a State or an eligible Tribe denies Section 401 certification, the Federal permitting or licensing agency cannot issue the permit or license.

Until recently, many States waived their right to review and certify Section 404 permits because these States had not defined water quality standards for wetlands or codified regulations for implementing their 401 certification program into State law. Now, most States report that they use the Section 401 certification process to review Section 404 projects and to require mitigation if there is no alternative to degradation of wetlands. Ideally, 401 certification should be used to augment State programs because activities that do not require Federal

permits or licenses, such as some ground water withdrawals, are not covered.

State/Tribal Wetlands Conservation Plans (SWCPs) are strategies that integrate regulatory and cooperative approaches to achieve State wetlands management goals, such as no overall net loss of wetlands. SWCPs are not meant to create a new level of bureaucracy. Instead, SWCPs improve government and private-sector effectiveness and efficiency by identifying gaps in wetlands protection programs and identifying opportunities to improve wetlands programs.

States, Tribes, and other jurisdictions protect their wetlands with a variety of other approaches, including permitting programs, coastal management programs, wetlands acquisition programs, natural heritage programs, and integration with other programs. The following trends emerged from individual State and Tribal reporting:

- Most States have defined wetlands as waters of the State, which offers general protection through antidegradation clauses and designated uses that apply to all waters of a State. However, most States have not developed specific wetlands water quality standards and designated uses that protect wetlands' unique functions, such as flood attenuation and filtration.
- Without specific wetlands uses and standards, the Section 401 certification process relies heavily on antidegradation clauses to prevent significant degradation of wetlands.

- In many cases, the States use the Section 401 certification process to add conditions to Section 404 permits that minimize the size of wetlands destroyed or degraded by proposed activities to the extent practicable. States often add conditions that require compensatory mitigation for destroyed wetlands, but the States do not have the resources to perform enforcement inspections or followup monitoring to ensure that the wetlands are constructed and functioning properly.

- More States are monitoring selected, largely unimpacted wetlands to establish baseline conditions in healthy wetlands. The States will use this information to monitor the relative performance of constructed wetlands and to help establish biocriteria and water quality standards for wetlands.

Although the States, Tribes, and other jurisdictions report that they are making progress in protecting wetlands, they also report that the pressure to develop or destroy wetlands remains high. EPA and the States, Tribes, and other jurisdictions will continue to pursue new mechanisms for protecting wetlands that rely less on regulatory tools.

Protecting the Great Lakes

Restoring and protecting the Great Lakes requires cooperation from numerous organizations because the pollutants that enter the Great Lakes originate in both the United States and Canada, as

well as in other countries, and pollutants enter the lakes via multiple media (i.e., air, ground water, and surface water). The International Joint Commission (IJC), established by the 1909 Boundary Waters Treaty, provides a framework for the cooperative management of the Great Lakes. Representatives from the United States and Canada, the Province of Ontario, and the eight States bordering the Lakes sit on the IJC's Water Quality Board. The Water Quality Board recommends actions for protecting and restoring the Great Lakes and evaluates the environmental policies and actions implemented by the United States and Canada.

The EPA Great Lakes National Program Office (GLNPO) coordinates activities within the United States at all government levels and works with academia, industry, and nongovernment organizations to protect and restore the lakes. The GLNPO provides leadership through its annual Great Lakes Program Priorities and Funding Guidance. The GLNPO also serves as a liaison to the Canadian members of the IJC and the Canadian environmental agencies.

The 1978 Great Lakes Water Quality Agreement (as amended in 1987) lay the foundation for ongoing efforts to restore and protect the Great Lakes. The Agreement committed the United States and Canada to developing Remedial Action Plans (RAPs) for Areas of Concern and Lakewide Management Plans (LaMPs) for each lake. Areas of Concern are specially designated waterbodies around the Great Lakes that show symptoms of



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serious water quality degradation. Most of the 42 Areas of Concern are located in harbors, bays, or river mouths entering the Great Lakes. RAPs identify impaired uses and examine management options for addressing degradation in an Area of Concern. LaMPs use an ecosystem approach to examine water quality issues that have more widespread impacts within each Great Lake. Public involvement is a critical component of both LaMP development and RAP development.

EPA advocates pollution prevention as the most effective approach for achieving the virtual elimination of persistent toxic discharges into the Great Lakes. The GLNPO has funded numerous pollution prevention grants throughout the Great Lakes Basin since FY93. The GLNPO is targeting its grant dollars to support projects that further the goal of virtual elimination of persistent toxic

substances. As part of the efforts to protect Lake Superior, EPA, the States, and Canada are implementing a virtual elimination initiative for Lake Superior that seeks to eliminate new contributions of critical pollutants, especially mercury.

The Great Lakes Water Quality Initiative is a key element of the environmental protection efforts undertaken by the United States in the Great Lakes Basin. The purpose of the Initiative is to provide a consistent level of protection in the Basin from the effects of toxic pollutants. In 1989, the Initiative was organized by EPA at the request of the Great Lakes States to promote consistency in their environmental programs in the Great Lakes Basin with minimum requirements.

Initiative efforts were well under way when Congress enacted the Great Lakes Critical Programs Act of 1990. The Act requires EPA to publish proposed and final water quality guidance that specifies minimum water quality criteria for the Great Lakes System. The Act also requires the Great Lakes States to adopt provisions that are consistent with the EPA final guidance within 2 years of EPA's publication. In addition, Indian Tribes authorized to administer an NPDES program in the Great Lakes Basin must also adopt provisions consistent with EPA's final guidance.

To carry out the Act, EPA proposed regulations for implementing the guidance on April 16, 1993, and invited the public to comment. The States and EPA conducted public meetings in all of the Great Lakes States during the comment period. As a result, EPA received over 26,500 pages of comments from

over 6,000 commenters. EPA reviewed all of the comments and published the final guidance in March of 1995.

The final guidance prioritizes control of long-lasting pollutants that accumulate in the food web—bioaccumulative chemicals of concern (BCCs). The final guidance includes provisions to phase out mixing zones for BCCs (except in limited circumstances), more extensive data requirements to ensure that BCCs are not underregulated due to a lack of data, and water quality criteria to protect wildlife that feed on aquatic prey. Publication of the final guidance was a milestone in EPA's move toward increasing stakeholder participation in the development of innovative and comprehensive programs for protecting and restoring our natural resources.

The Chesapeake Bay Program

The Chesapeake Bay is an enormously complex and dynamic system of fish, waterfowl, and vegetation in an estuary where salt water from the Atlantic Ocean and fresh water from its many tributaries in the 64,000-square-mile watershed come together. The extremely shallow and productive Bay presents formidable challenges to the understanding and management of this great estuary. In many areas of the Bay, water quality is not sufficient to support living resources year round. In the warmer months, large portions of the Bay contain little or no dissolved oxygen, which may cause fish eggs and larvae to die. The growth and reproduction of oysters,

clams, and other bottom-dwelling animals are impaired. Adult fish find their habitat reduced and their feeding inhibited.

Many areas of the Bay also have cloudy water from excess sediment in the water or an overgrowth of algae (stimulated by excessive nutrients in the water). Turbid waters block the sunlight needed to support the growth and survival of Bay grasses, also known as submerged aquatic vegetation (SAV). Without SAV, critical habitat for fish and crabs is lost. Although there has been a recent resurgence of SAV in some areas of the Bay, most areas still do not support abundant populations as they once did.

The main causes of the Bay's poor water quality and aquatic habitat loss are elevated levels of the nutrients nitrogen and phosphorus. Both are natural fertilizers found in animal wastes, soil, and even the atmosphere. These nutrients have always existed in the Bay, but not at the present elevated concentrations. When the Bay was surrounded primarily by forests and wetlands, very little nitrogen and phosphorus ran off the land into the water. Most of it was absorbed or held in place by the natural vegetation. As the use of the land has changed and the watershed's population has grown, the amount of nutrients entering the Bay has increased tremendously.

The Chesapeake Bay Program is a unique regional partnership leading and directing the restoration of Chesapeake Bay since 1983. The Chesapeake Bay Program partners include the States of Maryland, Pennsylvania, and Virginia; the District of Columbia; the Chesapeake

Bay Commission; and EPA. The Chesapeake Executive Council, made up of the governors of Maryland, Pennsylvania, and Virginia; the mayor of the District of Columbia; the EPA administrator; and the chair of the Chesapeake Bay Commission, provides leadership for the Bay Program and establishes program policies to restore and protect the Bay and its living resources.

The Bay Program has set itself apart by adopting strong numerical goals and commitments with deadlines, and tracking progress with an extensive array of environmental indicators. In the 1987 Chesapeake Bay Agreement, Chesapeake Bay Program partners set a goal to reduce the nutrients nitrogen and phosphorus entering the Bay by 40% by the year 2000. In the 1992 amendments to the Agreement, partners agreed to maintain the 40% goal beyond the year 2000 and to attack nutrients at their source—upstream in the tributaries. Recent agreements have outlined a regional focus to address toxic problem areas, set specific goals and commitments for federally owned lands throughout the watershed, involved the 1,650 local governments in the Bay restoration effort, and addressed land use management in the watershed, including a riparian buffer initiative.

Since its inception, the Chesapeake Bay Program's highest priority has been the restoration of the Bay's living resources—its finfish, shellfish, Bay grasses, and other aquatic life and wildlife. Now, the Chesapeake is clearly on the upswing. Bay grasses have increased by 70% since 1984, with recent population changes suggesting that many of these

populations may rebound if water quality conditions are improved and maintained. Striped bass populations have reached historically high levels and wild shad are increasing in numbers as hatchery-reared shad successfully reproduce and their offspring make their runs back up into tributaries. Bald eagles are also returning to the Chesapeake Bay, with over 500 young produced in 1996, up from only 63 young in 1977.

Other improvements have also been observed in the Bay. The Bay Program, through 1996, has reopened 272 miles of fish spawning habitat through its fish passage initiative. According to the Toxics Release Inventory, chemical releases in the Bay watershed have shown a 55% drop between 1988 and 1994, and Toxics of Concern have declined by 62% during the same period.

In spite of near record-high flows in 3 of the past 4 years, most of the Bay's major rivers are running cleaner than they were 10 years ago. Phosphorus concentrations have shown significant reductions throughout most of the Bay, and nitrogen levels have remained steady in spite of the high flows and population increases. Overall, these nutrient trends indicate that water quality conditions in this important tributary are improving basinwide.

Despite these promising trends in nutrients, dissolved oxygen levels are still low enough to cause severe impacts and stressful conditions in the mainstem of the Bay and several of the larger tributaries. A long-term decline in the abundance of the native waterfowl is also of great concern. The necessary corrective



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action to reverse this trend is habitat improvement and resurgence of SAV.

The blue crab is currently the most important commercial and recreational fishery in the Bay. With increasing fishing pressures and relatively low harvests in recent years, there is growing concern for the health of the stocks. While scientists agree that neither the crab population nor the fishery are on the verge of collapse, they concur that the stock is fully exploited. The 1997 Blue Crab Fisheries Management Plan contains recommendations to maintain regulations, limit access to the fishery, prevent exploitation and improve research and monitoring and incorporates an enhanced habitat section recommending protection and restoration of Bay grasses and water quality.

Overall, the Chesapeake Bay still shows symptoms related to stress from an expanding population and

the changes such growth brings about in land use. However, the concentrated restoration and management effort begun 12 years ago has produced tangible results. When taken as a whole, results from cooperative monitoring of input from the Bay's rivers generally show very encouraging signs.

The Gulf of Mexico Program

The Gulf of Mexico Program (GMP) was established in August 1988 as a partnership to provide a broad geographic focus on the major environmental issues in the Gulf before they become irreversible or too costly to correct. Its main purpose is to develop and implement strategies for protecting, restoring, and maintaining the health and productivity of the Gulf of Mexico in ways consistent with the economic well being of the

Region. This partnership also includes representatives from State and local government, Federal agencies, and the citizenry in each of the five Gulf States, the private sector (business, industry, and agriculture), and the academic community. The partnership provides:

- A mechanism for addressing complex problems that cross Federal, State, and international jurisdictional lines
- Better coordination among Federal, State, and local programs, increasing the effectiveness and efficiency of the long-term commitment to manage and protect Gulf resources
- A regional perspective to access and provide the information and address research needs required for effective management decisions
- A forum for affected groups using the Gulf, for public and private educational institutions, and for the general public to participate in the solution process.

Through its partnerships, the GMP is working with the scientific community, policy makers at the Federal, State and local levels, and the public to help preserve and protect America's abundant sea. It has made significant progress identifying the environmental issues in the Gulf Ecosystem and organizing a program to address those issues. Eight issue areas were initially identified as Program concerns:

- Habitat degradation in such areas as coastal wetlands, seagrass beds, and sand dunes

- Freshwater inflow changes in the volume and timing of flow resulting from reservoir construction; diversions for municipal, industrial, and agricultural purposes; and modifications to watersheds with concomitant alteration of runoff patterns
- Nutrient enrichment resulting from such sources as municipal wastewater treatment plants, storm water, industries, and agriculture
- Toxic substances and pesticides contamination originating from industrial, urban, and agricultural sources
- Coastal and shoreline erosion caused by natural and human-related activities
- Public health threats from swimming in, and eating seafood products coming from, contaminated water
- Marine debris from land-based and marine recreational and commercial sources
- Sustainability of the living aquatic resources of the Gulf of Mexico ecosystem.

The current focus of the GMP is on nutrient enrichment, shellfish restoration, critical habitat, and introduction of exotic species.

The GMP is now focusing its limited resources on implementation of actions to address specific

problems that emerged as the Program concerns were characterized. The current focus is on nutrient enrichment, shellfish restoration, critical habitat, and introduction of exotic species. Other operational efforts provide public education and outreach and data and information transfer.

Since its formation in 1988, the GMP has been committed to sponsoring projects that will benefit the environmental health of the region. These projects, numbering over 200, vary immensely, from "shovel-in-the-ground" demonstration projects to scientific research to public education. Examples include a wetlands restoration project in Texas' Galveston Bay System, a Bay Rambo Artificial Oyster Reef project in Louisiana, a Shellfish Growing Water Restoration project in Mississippi, a demonstration project in sewage management in Alabama, and a health professional education program in Florida.

Ground Water Protection Programs

The sage adage that "An ounce of prevention is worth a pound of cure" is being borne out in the field of ground water protection. Studies evaluating the cost of prevention versus the cost of cleaning up contaminated ground water have found that there are real cost advantages to promoting protection of our Nation's ground water resources.

Numerous laws, regulations, and programs play a vital role in protecting ground water. The following Federal laws and programs enable, or provide incentives for,



EPA and/or States to regulate or voluntarily manage and monitor sources of ground water pollution:

- The Safe Drinking Water Act (SDWA) authorizes EPA to ensure that water is safe for human consumption. One of the most fundamental ways to ensure consistently safe drinking water is to protect the source of that water (i.e., ground water). Source water protection is achieved through three SDWA programs: the Wellhead Protection Program, the Sole Source Aquifer Program, and the Underground Injection Control Program. The 1996 Amendments to the SDWA also created the Source Water Assessment Program to ensure that States conduct assessments to determine the vulnerability of drinking water to contamination.

- The Resource Conservation and Recovery Act (RCRA) addresses the problem of safe disposal of the huge volumes of solid and hazardous waste generated nationwide each year. RCRA is part of EPA's comprehensive program to protect ground water resources through the development of regulations and methods for handling, storing, and disposing of hazardous material and through the regulation of underground storage tanks—the most frequently cited source of ground water contamination.

- The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 created several programs operated by EPA, States, Territories, and Tribes that act to protect and restore contami-

nated ground water. Restoration of contaminated ground water is one of the primary goals of the Superfund program. As stated in the National Contingency Plan, EPA expects to return usable ground waters to their beneficial uses, whenever possible, within a time frame that is reasonable given the particular circumstances of the site.

- Clean Water Act Sections 319(h) and (i) and 518 provide funds to State agencies and Indian Tribes to implement EPA-approved nonpoint source management programs and ground water protection activities. Such activities include assessing and characterizing ground water resources; delineating wellhead protection areas; and addressing ground water protection priorities.

Comprehensive State Ground Water Protection Programs

A Comprehensive State Ground Water Protection Program (CSGWPP) is composed of six "strategic activities." They are:

- Establishing a prevention-oriented goal
- Establishing priorities, based on the characterization of the resource and identification of sources of contamination
- Defining roles, responsibilities, resources, and coordinating mechanisms
- Implementing all necessary efforts to accomplish the State's ground water protection goal
- Coordinating information collection and management to measure progress and reevaluate priorities
- Improving public education and participation.

■ Section 102 of the Clean Water Act grants States the authority to develop Comprehensive State Ground Water Protection Programs (CSGWPPs) tailored to their goals and priorities for the protection of ground water resources. CSGWPPs attempt to combine all of the above efforts and emphasize contamination prevention. The programs provide a framework for EPA to give greater flexibility to a State for management and protection of its ground water resources. CSGWPPs guide the future implementation of all State and Federal ground water programs and provide a framework for States to coordinate and set priorities for all ground-water-related activities.

Another means of protecting our Nation's ground water resources is through the implementation of Wellhead Protection Plans (WHPs). EPA's Office of Ground Water and Drinking Water is supporting the development and implementation of WHP Programs at the local level through many efforts. For example, EPA-funded support is provided through the National Rural Water Association (NRWA) Ground Water/Wellhead Protection programs. As of December 31, 1996, over 2,600 communities had become involved in developing local WHP plans.

Comprehensive State ground water protection programs support State-directed priorities in resource protection.



Meg Turville-Heitz, Madison, WI

These 2,600 communities represent over 6 million people. Over 1,600 of these communities have completed their plans and are managing their wellhead protection areas to ensure the community that their water supplies are protected.

As a result of the 1996 Amendments to the SDWA, source water protection has become a national priority. Accordingly, EPA included a source water protection goal in a draft of *Environmental Goals for America With Milestones for 2005*, which was released in January 1996. The draft goal states that "by the year 2005, 60% of the population served by community water systems will receive their water from systems with source water protection

programs in place." This goal will be achieved using a three-phased approach, which builds upon key accomplishments and foundations, such as the WHP Program, and maximizes the use of new tools and resources provided for under the 1996 Amendments. The new emphasis on public involvement and new State Source Water Assessment Programs should lead to State Source Water Protection Programs. Also, the Amendments provide States an unprecedented opportunity for source water assessment and protection programs to use new funds from the Drinking Water State Revolving Fund (DW-SRF) program for eligible set-aside activities.

What You Can Do

Federal and State programs have helped clean up many waters and slow the degradation of others. But government alone cannot solve the entire problem, and water quality concerns persist. Nonpoint source pollution, in particular, is everybody's problem, and everybody needs to solve it.

Examine your everyday activities and think about how you are contributing to the pollution problem. Here are some suggestions on how you can make a difference.

Be Informed

You should learn about water quality issues that affect the communities in which you live and work. Become familiar with your local water resources. Where does your drinking water come from? What activities in your area might affect the water you drink or the rivers, lakes, beaches, or wetlands you use for recreation?

Learn about procedures for disposing of harmful household wastes so they do not end up in sewage treatment plants that cannot handle them or in landfills not designed to receive hazardous materials.

Be Responsible

In your yard, determine whether additional nutrients are needed before you apply fertilizers, and look for alternatives where fertilizers might run off into surface waters. Consider selecting plants and grasses that have low maintenance requirements. Water your lawn conservatively. Preserve existing trees and plant new trees and shrubs to help prevent erosion and

Paul Kazys, Maryland Department of Natural Resources



promote infiltration of water into the soil. Restore bare patches in your lawn to prevent erosion. If you own or manage land through which a stream flows, you may wish to consult your local county extension office about methods of restoring stream banks in your area by planting buffer strips of native vegetation.

Around your house, keep litter, pet waste, leaves, and grass clippings out of gutters and storm drains. Use the minimum amount of water needed when you wash your car. Never dispose of any household, automotive, or gardening wastes in a storm drain. Keep your septic tank in good working order.

Within your home, fix any dripping faucets or leaky pipes and install water-saving devices in shower heads and toilets. Always follow directions on labels for use and disposal of household chemicals. Take used motor oil, paints, and other hazardous household

materials to proper disposal sites such as approved service stations or designated landfills.

Be Involved

As a citizen and a voter there is much you can do at the community level to help preserve and protect our Nation's water resources. Look around. Is soil erosion being controlled at construction sites? Is the community sewage plant being operated efficiently and correctly? Is the community trash dump in or along a stream? Is road deicing salt being stored properly?

Become involved in your community election processes. Listen and respond to candidates' views on water quality and environmental issues. Many communities have recycling programs; find out about them, learn how to recycle, and volunteer to help out if you can. One of the most important things you can do is find out how your

community protects water quality, and speak out if you see problems.

Volunteer Monitoring: You Can Become Part of the Solution

In many areas of the country, citizens are becoming personally involved in monitoring the quality of our Nation's water. As a volunteer monitor, you might be involved in taking ongoing water quality measurements, tracking the progress of protection and restoration projects, or reporting special events, such as fish kills and storm damage.

Volunteer monitoring can be of great benefit to State and local governments. Some States stretch their monitoring budgets by using data collected by volunteers, particularly in remote areas that otherwise might not be monitored at all. Because you are familiar with the water resources in your own neighborhood, you are also more

likely to spot unusual occurrences such as fish kills.

The benefits to you of becoming a volunteer are also great. You will learn about your local water resources and have the opportunity to become personally involved in a nationwide campaign to protect a vital, and mutually shared, resource. If you would like to find out more about organizing or joining volunteer monitoring programs in your State, contact your State department of environmental quality, or write to:

Alice Mayo
Volunteer Monitoring
Coordinator
U.S. EPA (4503F)
401 M St. SW
Washington, DC 20460
(202) 260-7018

For further information on water quality in your State or other jurisdiction, contact your Section 305(b) coordinator listed at the

back of this document. Additional water quality information may be obtained from the Regional offices of the U.S. Environmental Protection Agency (see inside back cover).

For Further Reading

EPA's Volunteer Monitoring Program. EPA-841-F-95-001. February 1995. Contains a brief description of EPA activities to promote volunteer monitoring.

Volunteer Monitoring. EPA-800-F-93-008. September 1993. A brief fact sheet about volunteer monitoring, including examples of how volunteers have improved the environment.

National Directory of Citizen Volunteer Environmental Monitoring Programs, Fourth Edition. EPA-841-B-94-001. January 1994. Contains information about 519 volunteer monitoring programs across the Nation.

Volunteer Stream Monitoring: A Methods Manual. EPA-841-D-95-001. 1995. Presents information and methods for volunteer monitoring of streams.

Volunteer Estuary Monitoring: A Methods Manual. EPA-842-B-93-004. December 1993. Presents information and methods for volunteer monitoring of estuarine waters.

Volunteer Lake Monitoring: A Methods Manual. EPA-440/4-91-002. December 1991. Discusses lake water quality issues and methods for volunteer monitoring of lakes.

Many of these publications can also be accessed on the Internet at <http://www.epa.gov/volunteer/epasvmp.html>.



Nancy Malmgren, Seattle, WA

Fish Consumption Advisories

States issue fish consumption advisories to protect the public from ingesting harmful quantities of toxic pollutants in contaminated fish and shellfish. Fish may accumulate dangerous quantities of pollutants in their tissues by ingesting many smaller organisms, each contaminated with a small quantity of pollutant. This process is called bioaccumulation or biomagnification. Pollutants also enter fish and shellfish tissues through the gills or skin.

Fish consumption advisories recommend that the public limit the quantity and frequency of consumption of fish caught in specific waterbodies. The States tailor individual advisories to minimize health risks based on contaminant data collected in their fish tissue sampling programs. Advisories may completely ban fish consumption in severely polluted waters, or limit fish consumption to several meals per month or year in cases of less severe contamination. Advisories may target a subpopulation at risk (such as children, pregnant women, and nursing mothers), specific fish species, or larger fish that may have accumulated high concentrations of a pollutant over a longer lifetime than a smaller, younger fish.

The EPA fish consumption advisory database tracks advisories issued by States and Tribes. For 1996, the database listed 2,196 fish consumption advisories in effect in 47 States, the District of Columbia, and American Samoa. Fish consumption advisories are unevenly



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distributed among the States because the States use their own criteria to determine if fish tissue concentrations of toxics pose a health risk that justifies an advisory. States also vary the amount of fish tissue monitoring they conduct and the number of pollutants analyzed. States that conduct more monitoring and use strict criteria will issue more advisories than States that conduct less monitoring and use weaker criteria. For example, 70% of the advisories active in 1996 were issued by the States surrounding the Great Lakes, which support extensive fish sampling programs and follow strict criteria for issuing advisories.

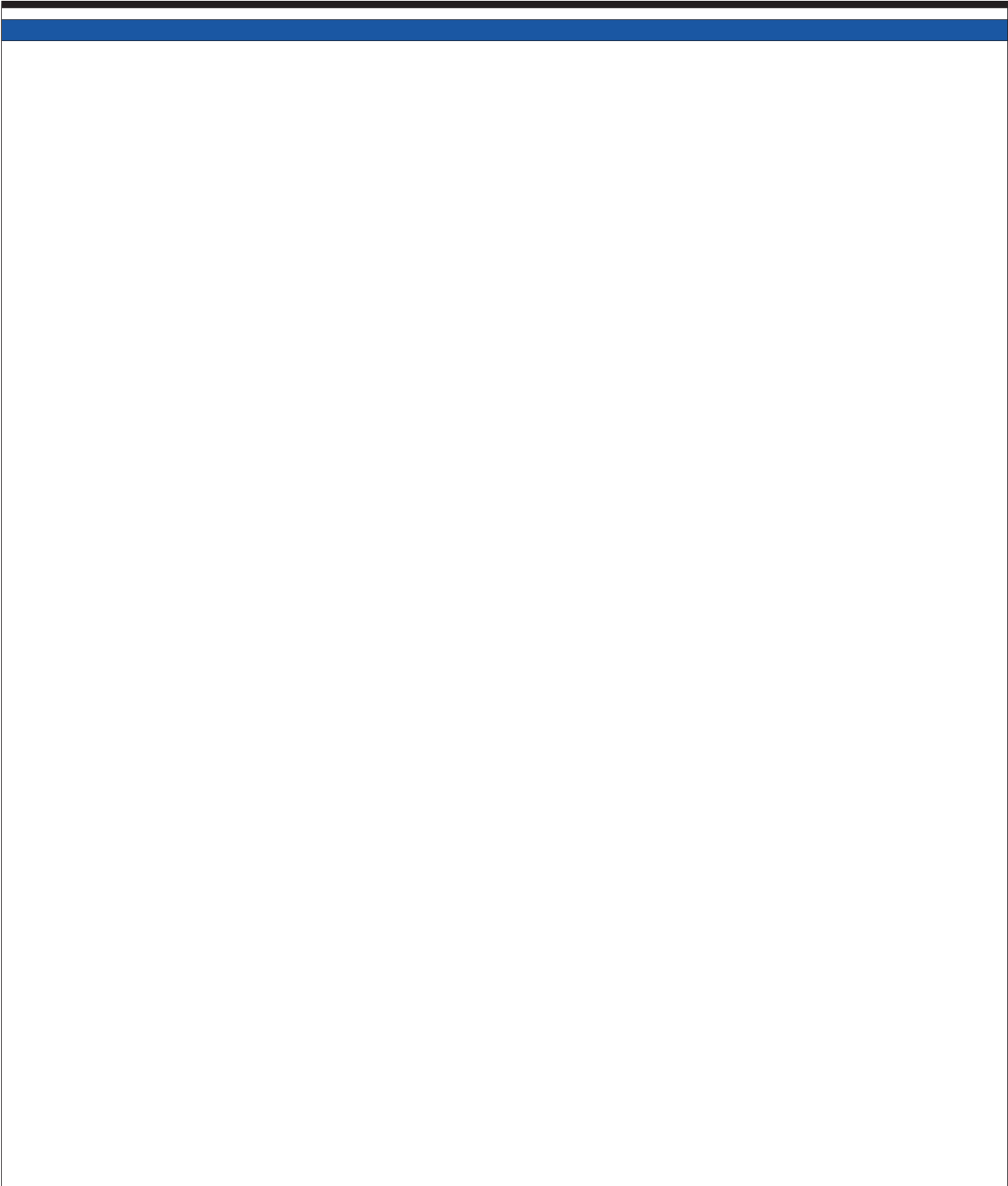
Most of the fish consumption advisories (76%) are due to mercury. The other pollutants most

commonly detected in elevated concentrations in fish tissue samples are polychlorinated biphenyls (PCBs), chlordane, dioxins, and DDT (with its byproducts).

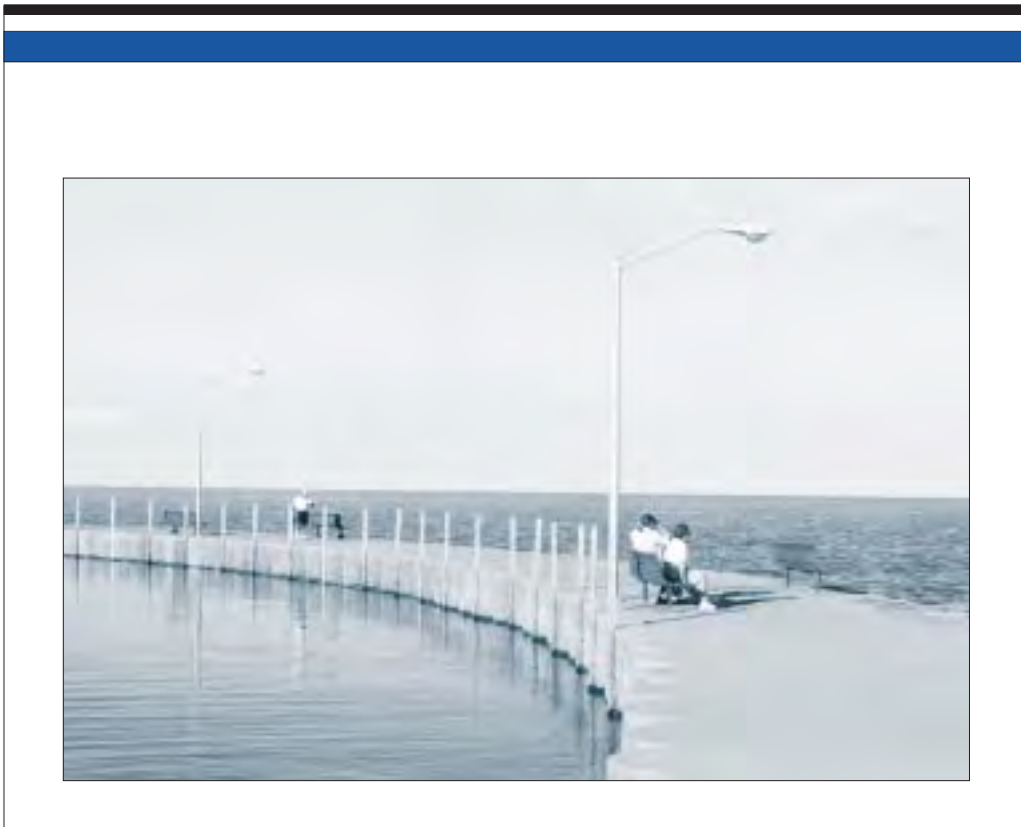
Many coastal States report restrictions on shellfish harvesting in estuarine waters. Shellfish—particularly oysters, clams, and mussels—are filter-feeders that extract their food from water. Waterborne bacteria and viruses may also accumulate on their gills and mantles and in their digestive systems. Shellfish contaminated by these microorganisms are a serious human health concern, particularly if consumed raw.

States currently sample water from shellfish harvesting areas to measure indicator bacteria, such as total coliform and fecal coliform bacteria. These bacteria serve as indicators of the presence of potentially pathogenic microorganisms associated with untreated or under-treated sewage. States restrict shellfish harvesting to areas that maintain these bacteria at concentrations in sea water below established health limits.

In 1996, 10 States reported that shellfish harvesting restrictions were in effect for 4,804 square miles of estuarine and coastal waters during the 1994-1996 reporting period. Five States reported that nonpoint sources, point sources, urban runoff and storm sewers, municipal wastewater treatment facilities, marinas, septic tanks, and industrial discharges restricted shellfish harvesting.



Section II



Presenting Water Quality Information

Presenting Water Quality Information: 305(b) and the Index of Watershed Indicators

Introduction

Water quality data can be interpreted by resource managers, researchers, conservation groups, and other interested parties in a variety of ways, depending on how the data are collected, compiled, and presented. Because of these differences in data gathering and presentation, similar data gathered by different agencies might not be directly comparable. This section focuses on two ways water quality data are presented — through the 305(b) process and in EPA's Index of Watershed Indicators (IWI). Examples from South Carolina are used to illustrate the two methods of data presentation.

There are important links between the 305(b) process and the IWI. 305(b) data are an integral part of the indices used in the IWI. Both 305(b) and the IWI report on the condition and vulnerability of waterbodies. Condition indicators describe the current status and functions of a waterbody while vulnerability is influenced by environmental factors or activities that can place stress on the resource, though perhaps not to the point that its values or functions are impaired.

What is the Index of Watershed Indicators?

The Index of Watershed Indicators (IWI) is a compilation of information on the condition of aquatic resources in the United States. Just as a physician might take your temperature and blood pressure, check



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your pulse, and listen to your heart-beat and respiration to determine the status of your health, the Index looks at a variety of indicators that point to whether rivers, lakes, streams, wetlands, and coastal areas are “well” or “ailing” and whether activities on the surrounding lands are placing these waters at risk.

The Index is in large part based on the June 1996 *Environmental Indicators of Water Quality in the United States*, developed by EPA in partnership with States, Tribes, private organizations, and other Federal agencies. The Indicators Report presents 18 national indicators of the health of our water resources. The Index evaluates a similar set of indicators, categorized as “condition” and “vulnerability” indicators, for each of 2,111 watersheds in 48 States. (Alaska, Hawaii, and the Territories will be added in future versions of the Index.)

Why Watersheds?

A watershed is defined in nature by topography. It is the land area that drains to a body of water, such as a lake, an estuary, or a river. The watershed's drainage affects the water flow or water level and, in many cases, the overall condition of downstream bodies of water. Thus, a lake, river, or estuary is a reflection of its watershed. EPA's Office of Water, along with many local groups and State agencies, has been emphasizing the importance of organizing water quality improvement efforts on a watershed basis. Downstream conditions are affected by all contributing input from upstream tributaries and adjacent land use activities.

What Is the Size of These Watersheds?

The U.S. Geological Survey (USGS) has developed and mapped a geographic Hydrologic Unit Classification (HUC) System of watersheds at four different scales. The lower 48 States, for example, are comprised of 18 basins known as regions. Subregions, identified with a 4-digit number, nest within the regions, and 6-digit accounting units are smaller yet. Within those accounting units are 8-digit cataloging units, which define watersheds that are generally greater than 700 square miles in drainage area. For the Index, watersheds are depicted at the 8-digit scale — the smallest unit in the nationally consistent HUC System. South Carolina, for example, has 31 cataloging units, which vary in size from about 500 to 1,800 square miles.

What Are the Indicators?

Phase I of the IWI project uses 15 indicators or data layers. They were selected because they are appropriate to the IWI objectives, they have relatively uniform availability across the Nation, and they can be depicted at the 8-digit HUC scale. Seven of the indicators are related to the condition of the aquatic resources, and eight are related to vulnerability. Phase II will include Alaska, Hawaii, and Puerto Rico and will add more data layers such as ground water.

Condition Indicators

1. **Assessed Rivers Meeting All Designated Uses Established by State or Tribal Water Quality Standards (§305(b)):** Information reported by States and Tribes on the percentage of waters within the watershed that meet all uses established for those waters as reported in 1994 or 1996 reports to Congress required under Clean Water Act Section 305(b).
2. **Fish and Wildlife Consumption Advisories:** Advisories recommended by States to restrict consumption of locally harvested fish or game due to the presence of contaminants. (data from EPA's National Listing of Fish and Wildlife Consumption Advisories)
3. **Indicators of Source Water Quality for Drinking Water Systems:** Three data sets combined to give insight on the extent to which waters from rivers, lakes, or reservoirs require treatment before use as drinking water based on (1) attainment of the "water supply" designated use under Section 305(b) based on river and lake waterbodies, (2) community water supply systems with treatment in place beyond conventional treatment or systems that were in violation of source-related standards in 1995 (Safe Drinking Water Information System [SDWIS]), and (3) presence of

Condition Indicators

Condition indicators describe the current status and functions of a waterbody. In the 305(b) process, States and Tribes evaluate conditions in a waterbody and report on whether it supports, partially supports, or does not support beneficial uses. The Index reports on a number of condition indicators, including fish consumption advisories, contaminated sediment, and wetlands loss.

contaminants in source water at levels that exceed one-half the maximum contaminant level (MCL). (The MCL is the level to which a contaminant must be removed from drinking water to meet Safe Drinking Water Act safety requirements.) (data from EPA's STORET database)

4. **Contaminated Sediments:** The level of potential risk to human health and the environment derived from sediment chemical analysis, sediment toxicity data, and fish tissue residue data. (data from EPA's National Sediment Inventory)
5. **Ambient Water Quality Data — Four Toxic Pollutants:** Ambient water quality data showing percent exceedances of national criteria levels, over a 6-year period (1990-1996), of copper, hexavalent chromium, nickel, and zinc. (data from STORET)

Vulnerability Indicators

Vulnerability indicators describe environmental factors or activities that can place stress on the resource, though perhaps not to the point that its values or functions are impaired. In the 305(b) process, States and Tribes report on waterbodies that currently support a beneficial use, but are threatened for that use do to circumstances in the surrounding watershed. The Index reports on a number of vulnerability indicators, including species at risk, pollutant loads, runoff potential, etc.

6. **Ambient Water Quality Data — Four Conventional Pollutants:** Ambient water quality data showing percent exceedances of national reference levels, over a 6-year period (1990-1996), of ammonia, dissolved oxygen, phosphorus, and pH. (data from STORET)
7. **Wetlands Loss Index:** Percentage of wetlands loss over a historic period (1870-1980) and more recently (1986-1996). (data from U. S. Fish and Wildlife Service's National Wetland Inventory and Natural Resources Conservation Service's National Resource Inventory, respectively)
8. **Aquatic/Wetlands Species at Risk:** Watersheds with high occurrences of species at risk. (data from The Nature Conservancy and State Heritage databases)
9. **Pollutant Loads Discharged Above Permitted Discharge Limits — Toxic Pollutants:** Discharges over a 1-year period for toxic pollutants, combined and expressed as a percentage above or below the total discharges allowed under the National Pollutant Discharge Elimination System (NPDES) permitted amount. (data from EPA's Permit Compliance System)
10. **Pollutant Loads Discharged Above Permitted Discharge Limits — Conventional Pollutants:** Discharges over a 1-year period for conventional pollutants combined and expressed as a percentage above or below the total discharges allowed under the NPDES permitted amount. (data from EPA's Permit Compliance System)
11. **Urban Runoff Potential:** An estimate of the potential for urban runoff impacts based on the percentage of impervious surface in the watershed, e.g., roads, paved parking, and roofs. (data from USGS and Census Bureau)
12. **Index of Agricultural Runoff Potential:** A composite index composed of (1) a nitrogen runoff potential index, (2) modeled sediment delivery to rivers and streams, and (3) a pesticide runoff index. (data from Natural Resources Conservation Service)
13. **Population Change:** Population growth rate as a surrogate of many stress-producing activities from urbanization. (data from Census Bureau)
14. **Hydrologic Modification — Dams:** An index that shows relative reservoir impoundment volume in the watershed. The process of impounding streams changes their characteristics, and the reservoirs and lakes formed in the process can be more susceptible to pollution stress. (data from Corps of Engineers)
15. **Estuarine Pollution Susceptibility Index:** An index that measures an estuary's susceptibility to pollution based on its physical characteristics and its propensity to concentrate pollutants. (data from National Oceanic and Atmospheric Administration)

What are Some of the Benefits of the Index?

- **A focus on watershed resources:** The Index provides easy-to-get information from many sources about local watersheds and their needs.
- **Knowledge is power:** The Index enables managers and residents to understand, and therefore act responsibly about, their watershed.
- **Progress:** Together, many organizations and people have been working to maintain and improve our water quality, and they have been successful in many areas, while maintaining population and economic growth.
- **Partners:** Various Federal, State and nongovernmental organizations have begun to combine their information to tell a coordinated story. Using this information, the combined forces of these organizations can work together to better address our remaining problems and protection needs.
- **Missing data:** Indicators with too little data are clearly shown in grey, indicating where information needs to be collected.
- **Monitoring:** IWI uses information from many public and private sources to provide a full picture of watershed health.

Where Can You View the IWI?

The Index of Watershed Indicators can be viewed on the Internet at <http://www.epa.gov/surf/iwi> and in a hard copy report available from the National Center for Environmental Publications and Information (NCEPI). The Index includes a map of the United States with color-coded information on the overall condition/vulnerability of each watershed, as well as national maps depicting each data layer for all watersheds. The Internet version of the Index provides links to a broad range of support material.

For instance, an individual *Watershed Profile* page (see example from South Carolina) presents a map of each Cataloging Unit shown in relation to adjacent watersheds and the boundary of the State in which it is primarily located. This profile also describes the physical features and demographics of the watershed and display its *Overall Watershed Score* (one of seven categories) and the scores for each individual indicator.

How Is the Overall Watershed Score Developed?

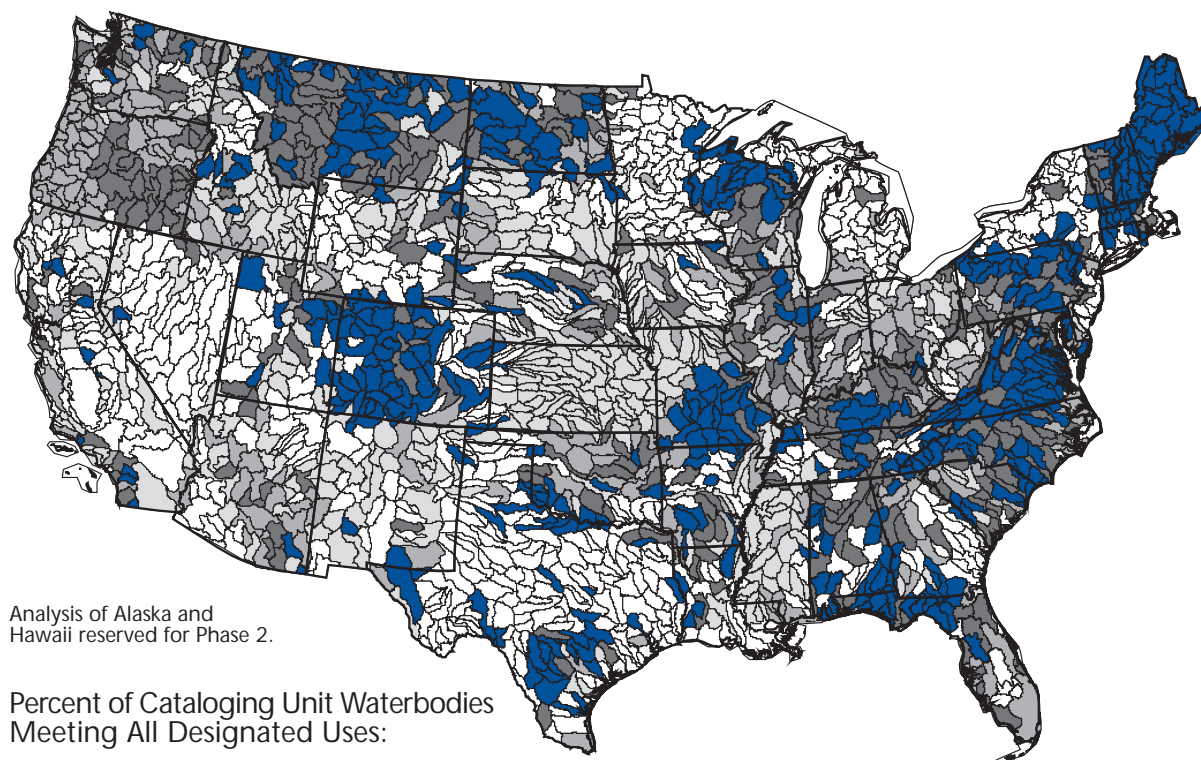
Each watershed is identified as having good quality, less serious or more serious problems, and high or low vulnerability. There is a separate category for watersheds with too little data for a valid characterization. Condition and vulnerability indicators are evaluated separately for each watershed.

For the indicators, a minimum number of observations is necessary to assign a "score." If data for a particular indicator are insufficient, that is displayed on the map and indicated in the Profile. At least 4 of 7 condition indicators and 6 of 8 vulnerability indicators must be present to calculate the overall index for any given watershed.

NOTE: Detailed information on sources of data, the method used to characterize each data layer, and the method for combining individual indicators into the overall Index is available through the Internet at www.epa.gov/surf.

In aggregating the 15 indicators into the overall Index, Indicator 1, Assessed Rivers Meeting All Designated Uses, is weighted more heavily than other indicators because it is a comprehensive assessment and EPA believes considerable weight should be given to the State and Tribal 305(b) assessment process.

Figure 1. Assessed Rivers Meeting All Designated Uses Set in State/Tribal Water Quality Standards 1994/1996



Analysis of Alaska and Hawaii reserved for Phase 2.

Percent of Cataloging Unit Waterbodies Meeting All Designated Uses:

- 80 - 100% Met
- 50 - 79% Met
- 20 - 49% Met
- < 20% Met
- Insufficient Data

Index of Watershed Indicators

Sources: U.S. Environmental Protection Agency:
National Water Quality Inventory

All other indicators are weighted equally. If Indicator 1 is not available, the values of the other condition indicators are increased by a factor of 3 to derive an Index score.

How Are 305(b) Data Used in the IWI?

The IWI map of "assessed rivers meeting all designated uses established by state or tribal water quality standards" (Figure 1) presents a

national picture of the overall health condition of individual watersheds. Correctly read, the information provided is interpreted as follows: "In X watershed, Y percent (as a range) of the assessed stream miles in the watershed meet all designated uses." Watersheds in which a high percentage of waterbodies meet designated uses generally have better water quality than watersheds in which the percentage is low. Designated uses can be drinking

water supply, aquatic life support, fish and shellfish consumption, primary and secondary contact recreation, and agriculture. Where a watershed shows a lower degree of overall designated use attainment, it is helpful to be able to break out data summaries for specific uses. Different uses employ different benchmarks to define use attainment (e.g., bacteria counts for swimming use and dissolved oxygen levels for aquatic life use).

Data summaries on such pollution stressors or the sources of the stressors may also be needed for many management decisions. The potentials of such supplemental data presentations are illustrated below.

Data Presentations — South Carolina Example

While the 305(b) process and the IWI depict similar water quality data, they differ both in scope and scale. As discussed, the Index deals with a variety of indicators, a number of which draw on data gathered through means other than the 305(b) process. IWI and 305(b) data are also presented at different scales. 305(b) data are typically gathered at the waterbody level and then aggregated to the State level for reporting in the *National Water Quality Inventory*, while IWI presents data at the HUC level. The following example using data from South Carolina demonstrates how data are reported through IWI and the 305(b) process and compares and contrasts the two presentations.

Figure 2 is a table of individual use support in South Carolina taken

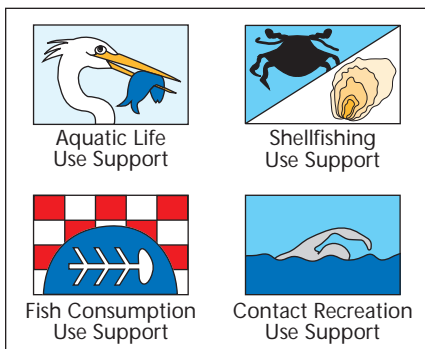


Figure 2. Individual Use Support in South Carolina in 1994

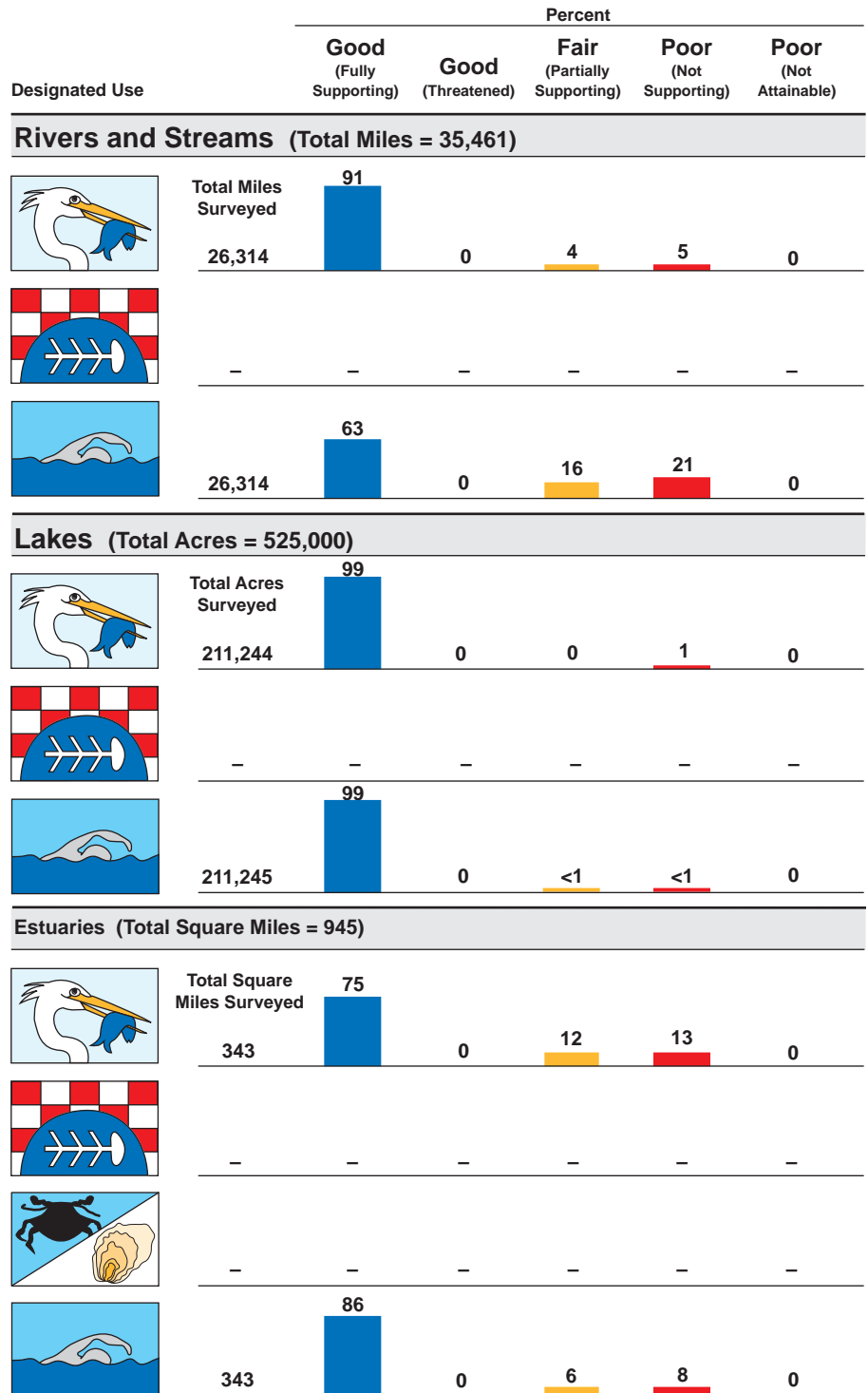
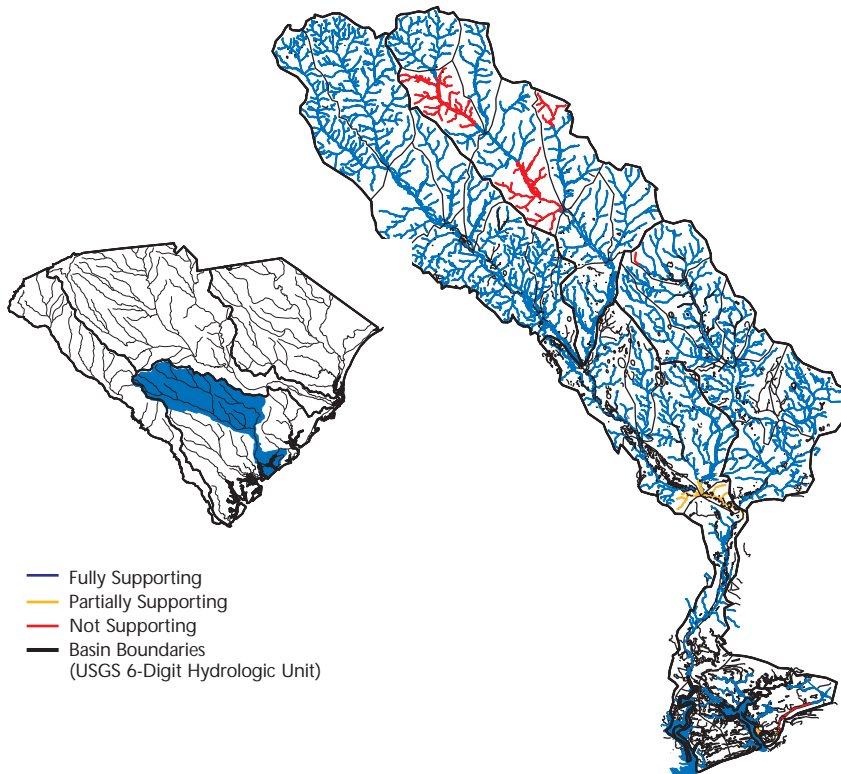


Figure 3. South Carolina's Edisto Watershed

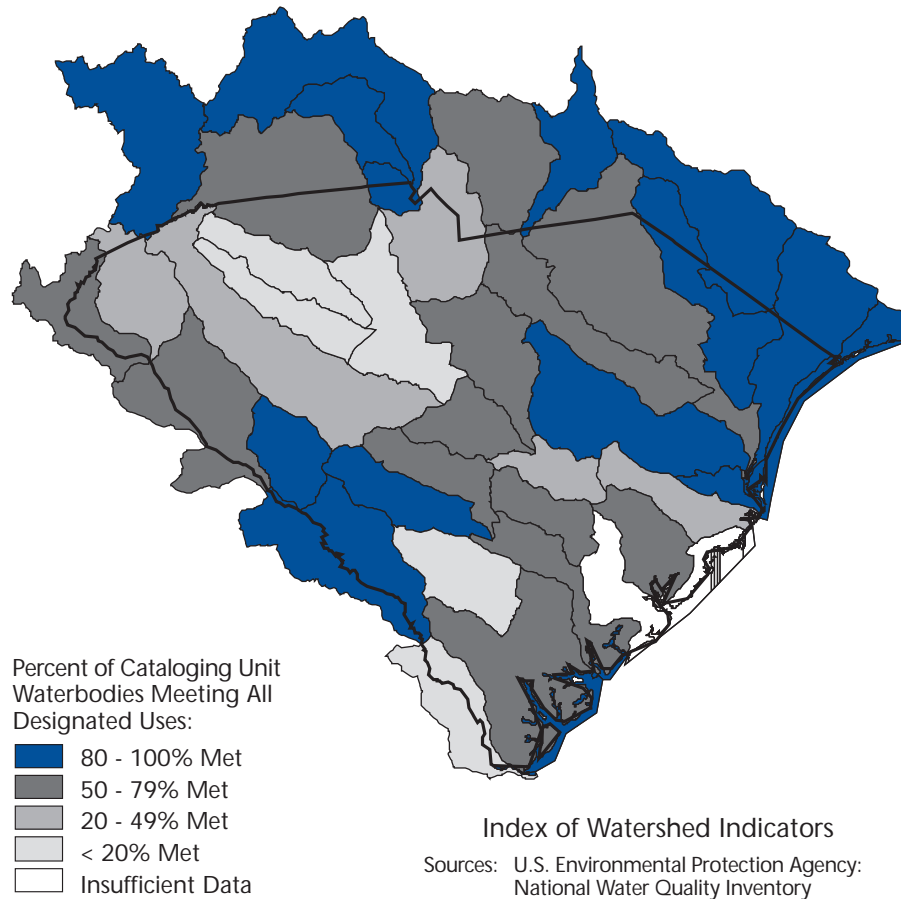


from the 1994 *National Water Quality Inventory* summary document. These data were originally gathered at the waterbody level. In other words, State resource managers assessed particular rivers, lakes, and estuaries in South Carolina, then compiled statistics at the statewide level. For example, the data show that 91% of rivers in South Carolina fully support aquatic life use, as opposed to 75% of estuarine waters. In this format, the data are useful to individuals interested in general water quality conditions across the State, such as a concerned citizen or legislator.

Figure 3, also taken from the 1994 *National Water Quality Inventory* summary document, represents another depiction of 305(b) data. This figure shows a map of South Carolina's Edisto watershed. Each stream in the watershed is color-coded to its corresponding use support status. This type of map is particularly helpful to watershed resource managers who need to prioritize water quality monitoring and restoration projects in a watershed. For example, red areas (which do not support all beneficial uses) might be targeted for improvement measures or additional research.

The map in Figure 3 was generated through a process called reach indexing, whereby waterbody-level 305(b) use support data were linked to a map of South Carolina's hydrography. Reach indexing is the process of linking water quality information to the EPA Reach File, a hydrography dataset at the 1:100,000 scale that will eventually become part of a Federal standard National Hydrography Dataset (NHD). The link between the map and the water quality data is made using a geographic information system (GIS). Reach indexing gives States powerful mapping and spatial analysis capabilities for specific streams within a watershed.

Figure 4. Assessed Rivers Meeting All Designated Uses in South Carolina



IWI displays information at the same watershed scale as the map of the Edisto watershed shown above. Figure 4 is an example of one way in which the IWI presents information. The figure shows all the watersheds in South Carolina color-coded by the IWI indicator of the percent of the watershed meeting all designated uses. A map at this scale might benefit a State resource manager who needs information on how to allocate resources across South Carolina.

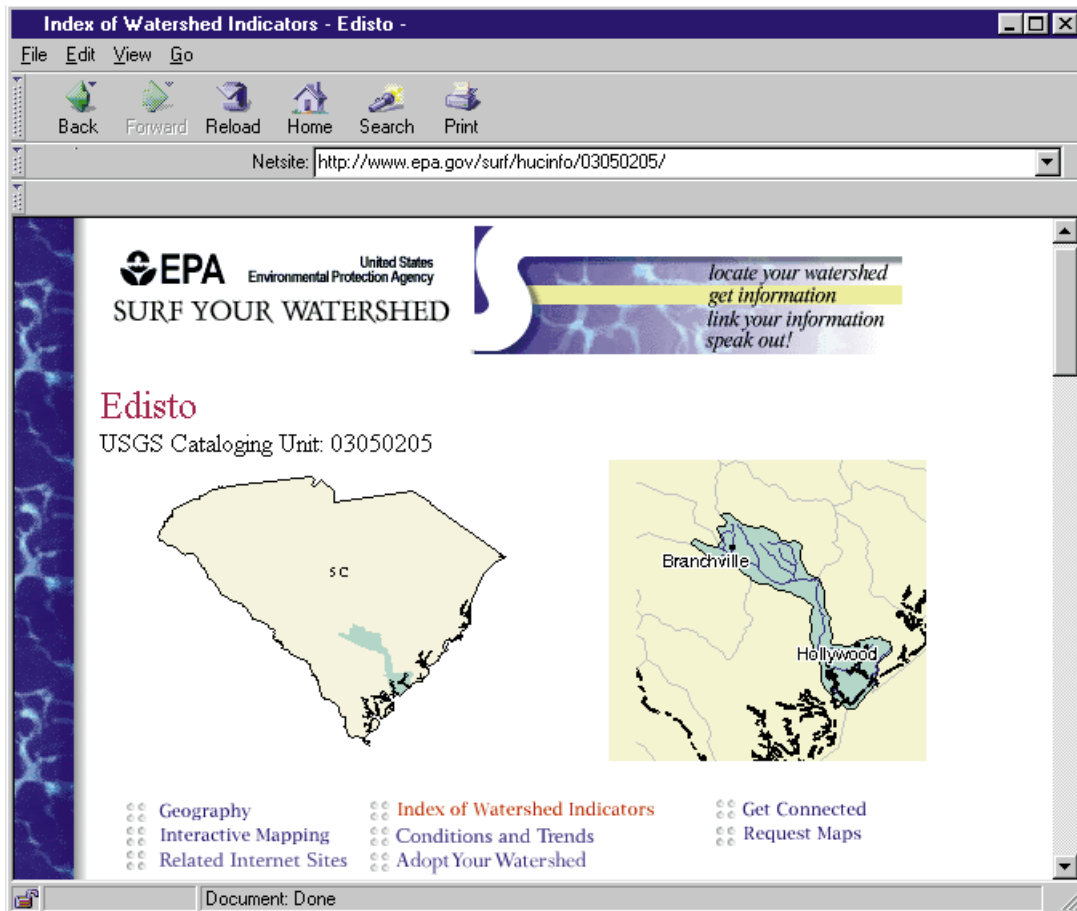
A resource manager might also want to view information just for a single watershed in South Carolina. Through EPA's World Wide Web page, *Surf Your Watershed*, individuals can choose a particular watershed in a State and obtain IWI information. Figure 5 shows the option of obtaining IWI information for the Edisto watershed.

Figure 6 presents the IWI indicators for the Edisto watershed as they are displayed in *Surf Your Watershed*. In addition to an overall watershed

score, there are also scores for both the condition and vulnerability of the Edisto watershed. As discussed above, 305(b) assessment data for the watershed are used to determine the designated use attainment score. This indicator is weighed more heavily than the others.

Through *Surf Your Watershed*, the IWI makes available 305(b) data aggregated at the watershed scale. Figures 7 and 8 display aquatic life use support in the Edisto watershed for rivers and estuarine waters,

Figure 5. Surf Your Watershed World Wide Web Page for the Edisto Watershed



respectively. The data show that over 90% of the rivers and estuarine waters in the watershed fully support aquatic life use. It is interesting to compare these values to the statewide numbers presented in Figure 2. While statewide, 91% of South Carolina rivers fully supported aquatic life use, only 75% of the State's estuarine waters fully supported this use. Thus, the data tell us that the Edisto watershed has better than average estuarine water quality than compared to the State

as a whole. This type of information can be helpful for a water quality manager interested in targeting resources across the State.

The IWI also makes available 305(b) data on the causes and sources of impairment at the watershed level. As Figure 3 demonstrates, there is a "hot spot" in the Edisto basin where a number of streams do not support all beneficial uses. It might be helpful for resource managers planning programs to improve water quality in

the area to have information on the causes and sources of this impairment. The cause and source information for the Edisto watershed available through the IWI (Figures 9 and 10) indicates that the most prevalent causes of impairment in rivers are pathogens and turbidity, and the most prevalent sources of pollution are agriculture, natural sources, and municipal point sources.

Figure 6. Water Quality Information Presented Graphically on Surf Your Watershed

As displayed in *Surf Your Watershed*, IWI indicators of the condition of the watershed are scored and assigned to one of three categories — better water quality, water quality with less serious problems, and water quality with more serious problems. Second, indicators of vulnerability are scored to create two characterizations of vulnerability — high and low. These two sets of indicators are then combined to create the Overall Watershed Score illustrated at the right.

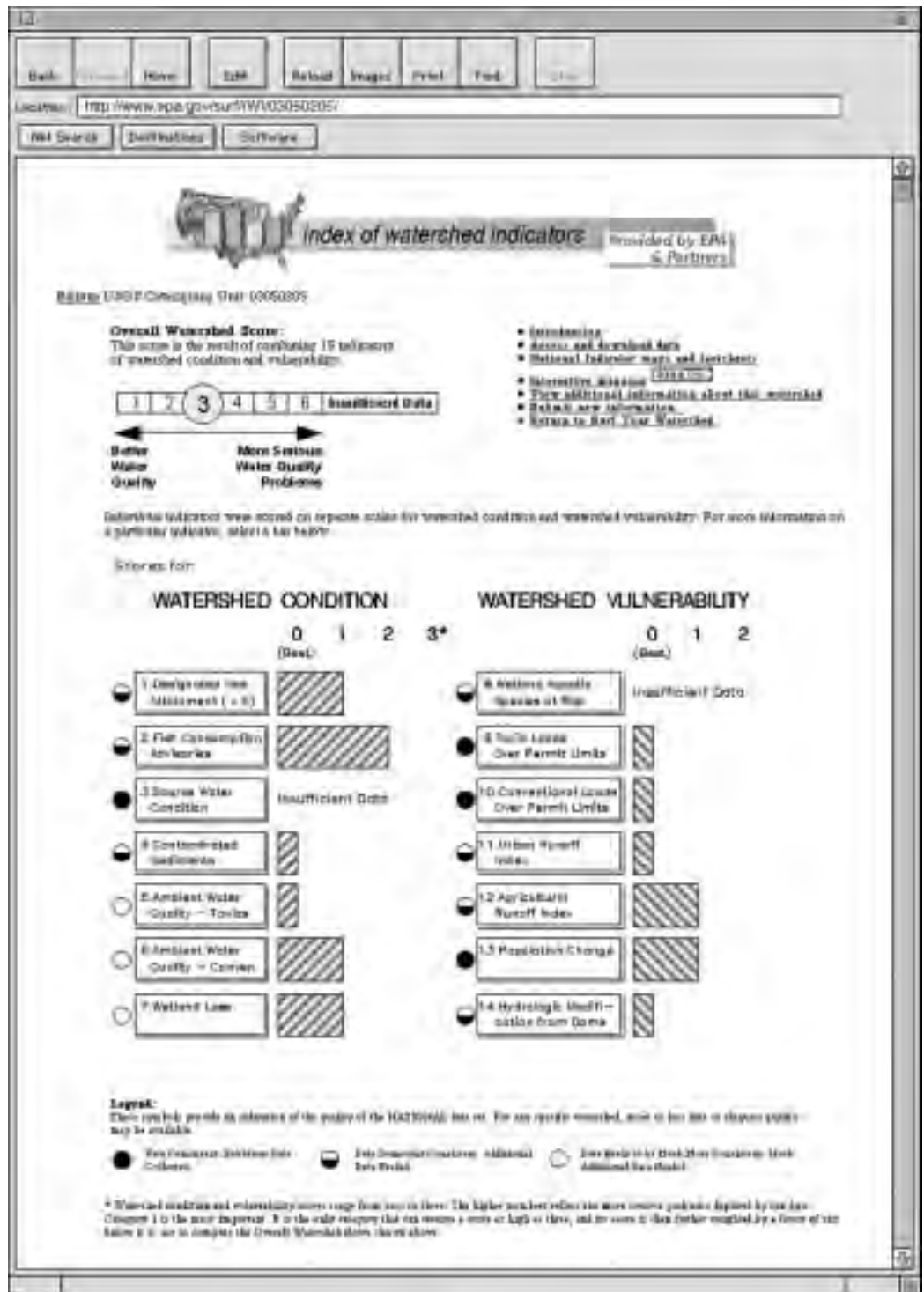


Figure 7. Aquatic Life Use Support for Rivers in the Edisto Watershed

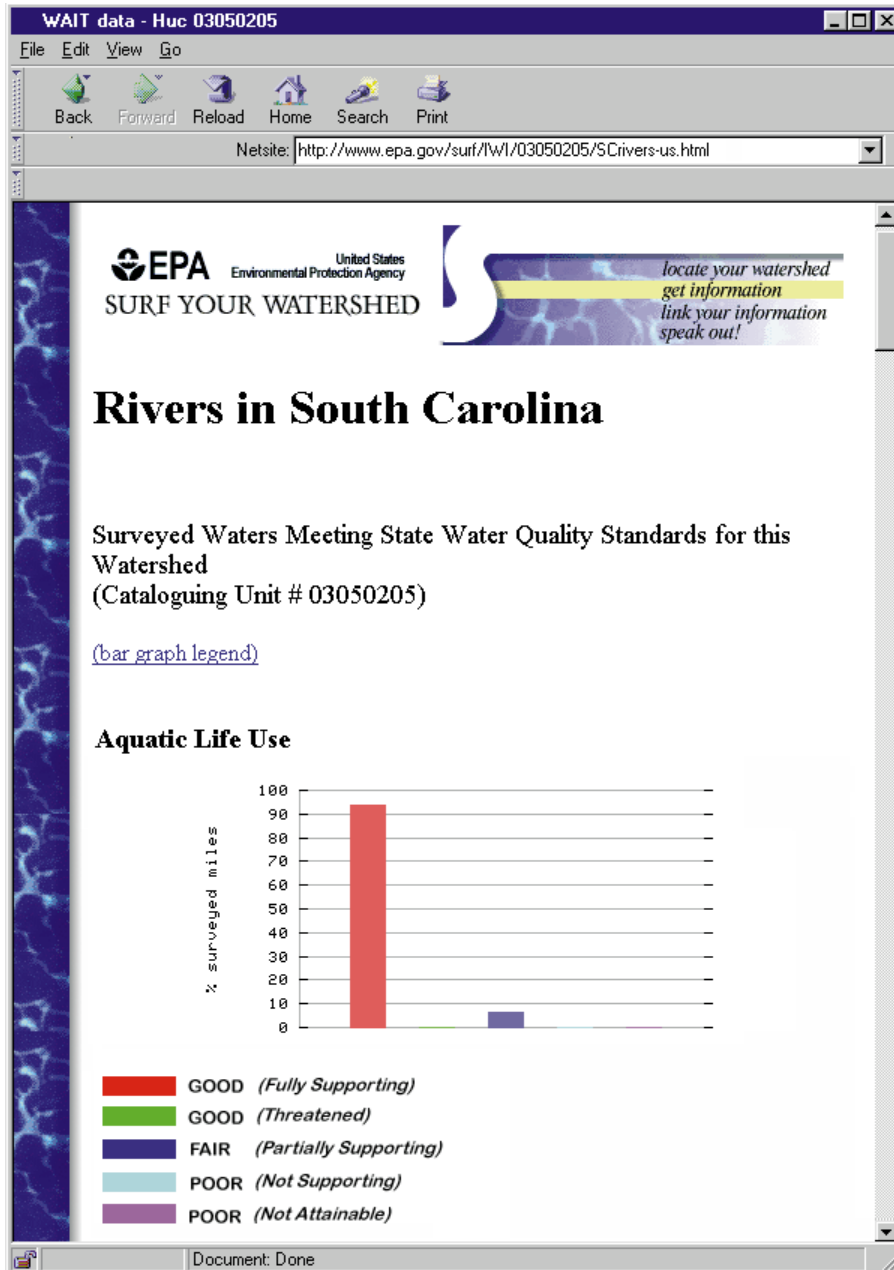


Figure 8. Aquatic Life Use Support for Estuarine Waters in the Edisto Watershed

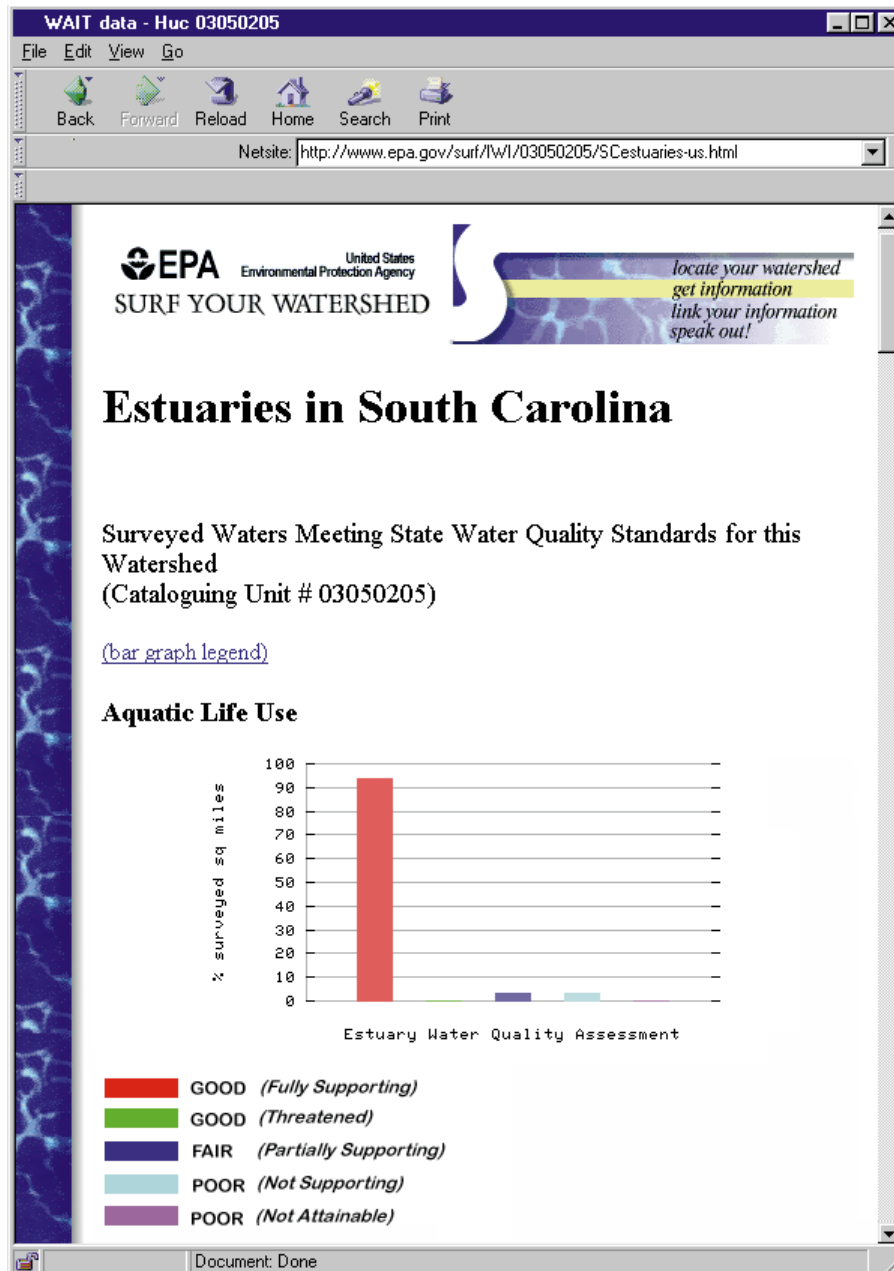
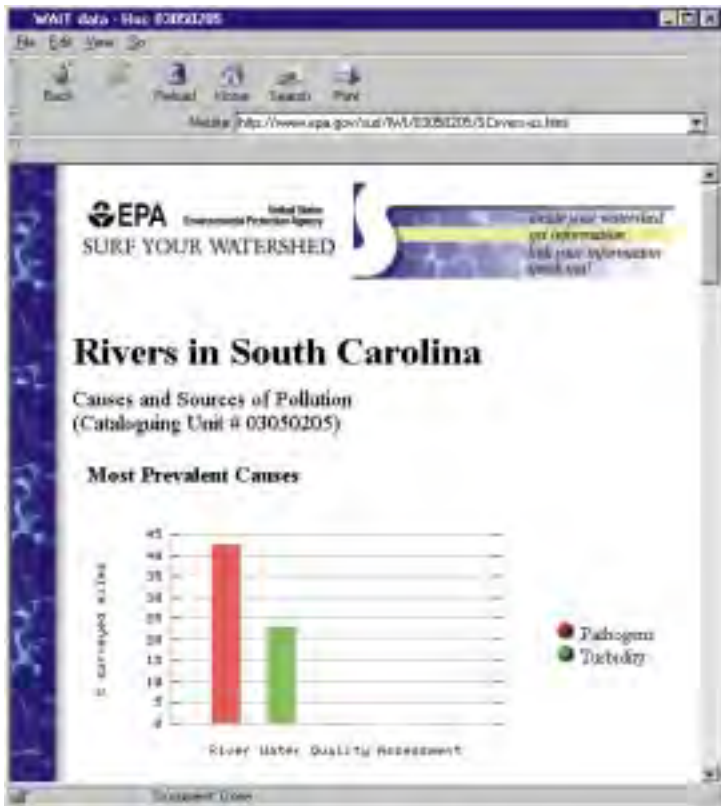


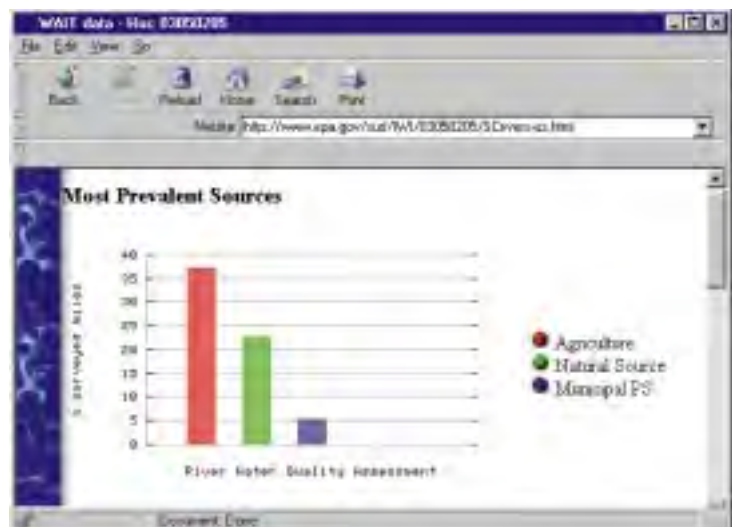
Figure 9. Major Causes of Impairment to Rivers in the Edisto Watershed

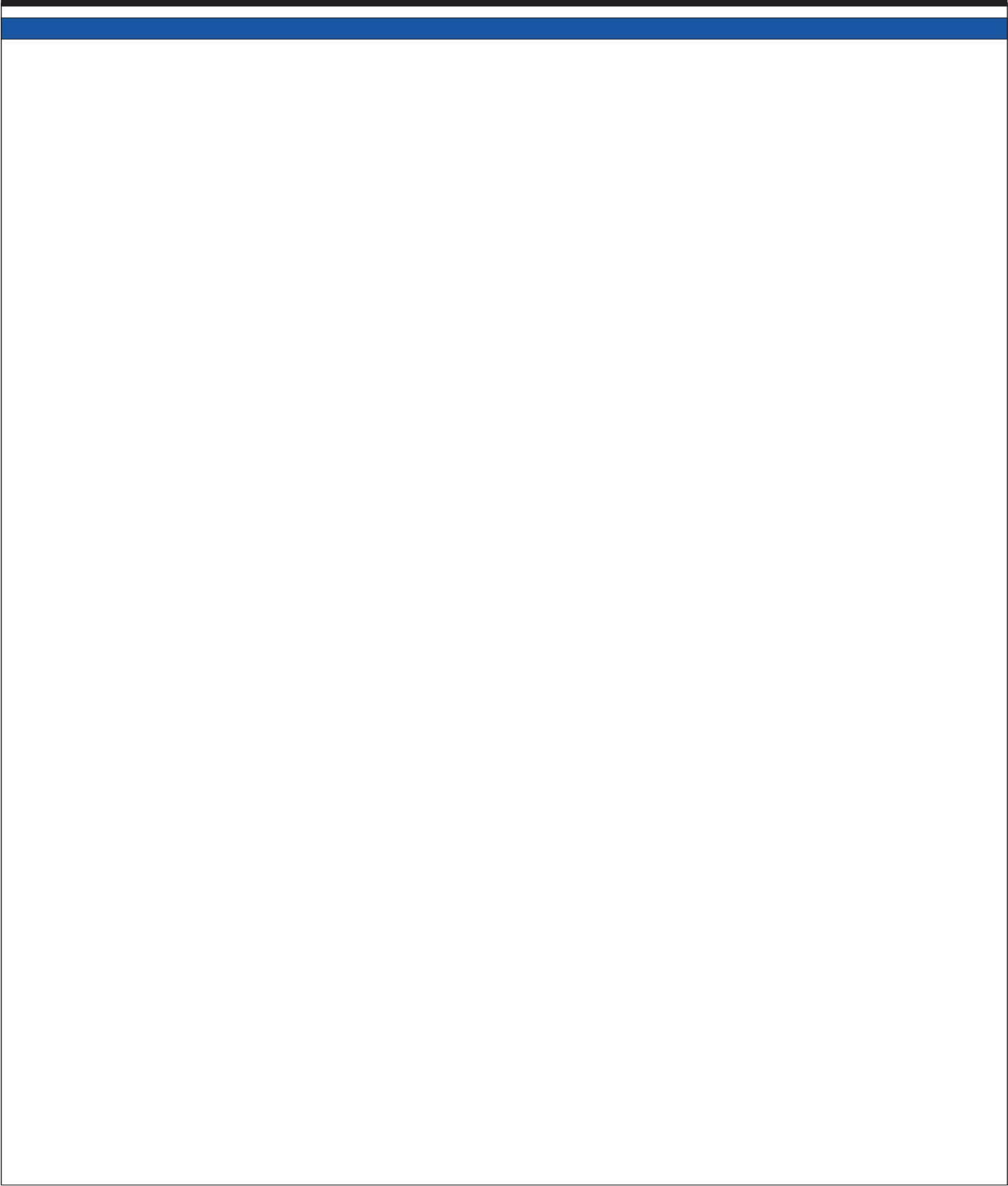


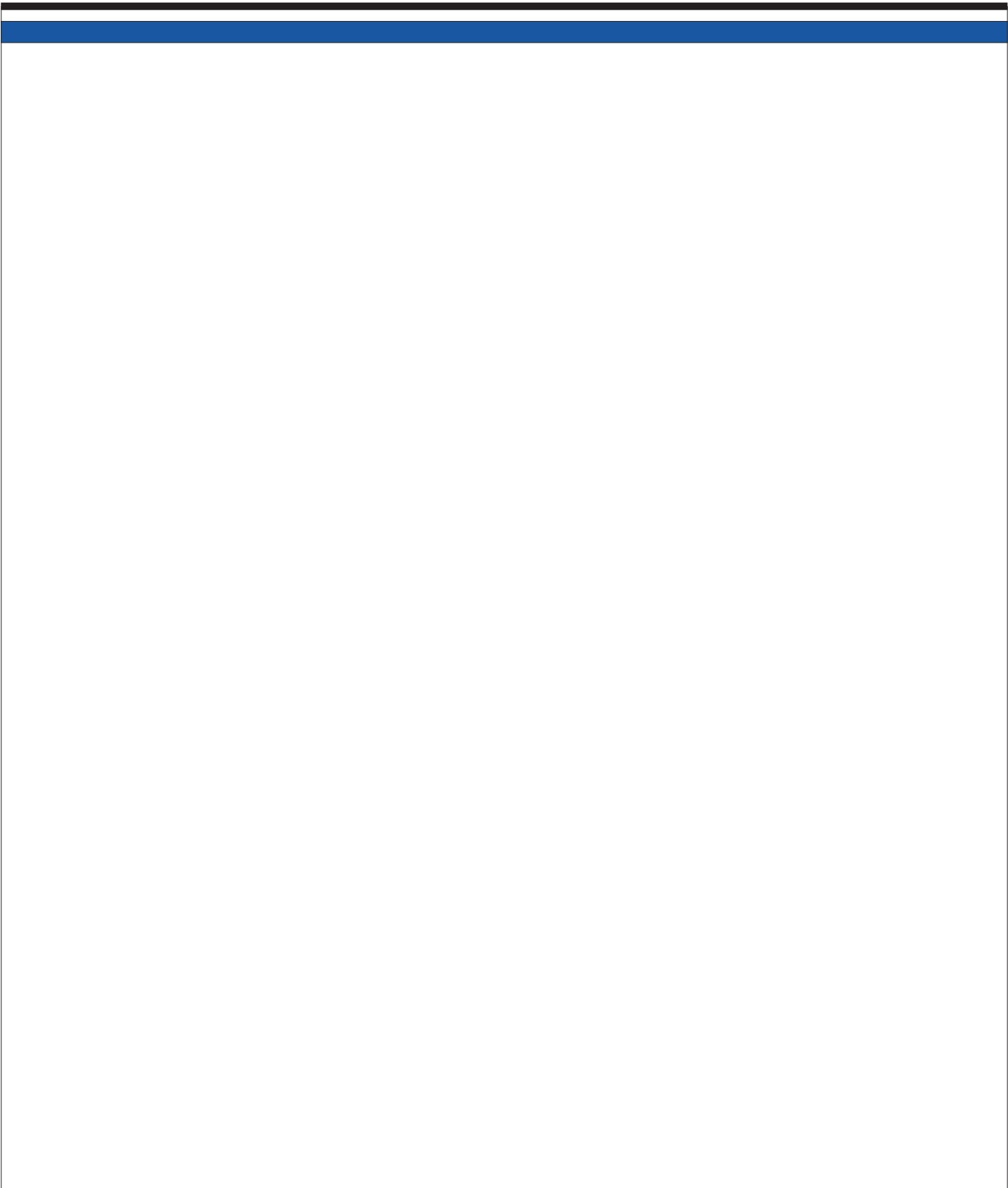
Conclusion

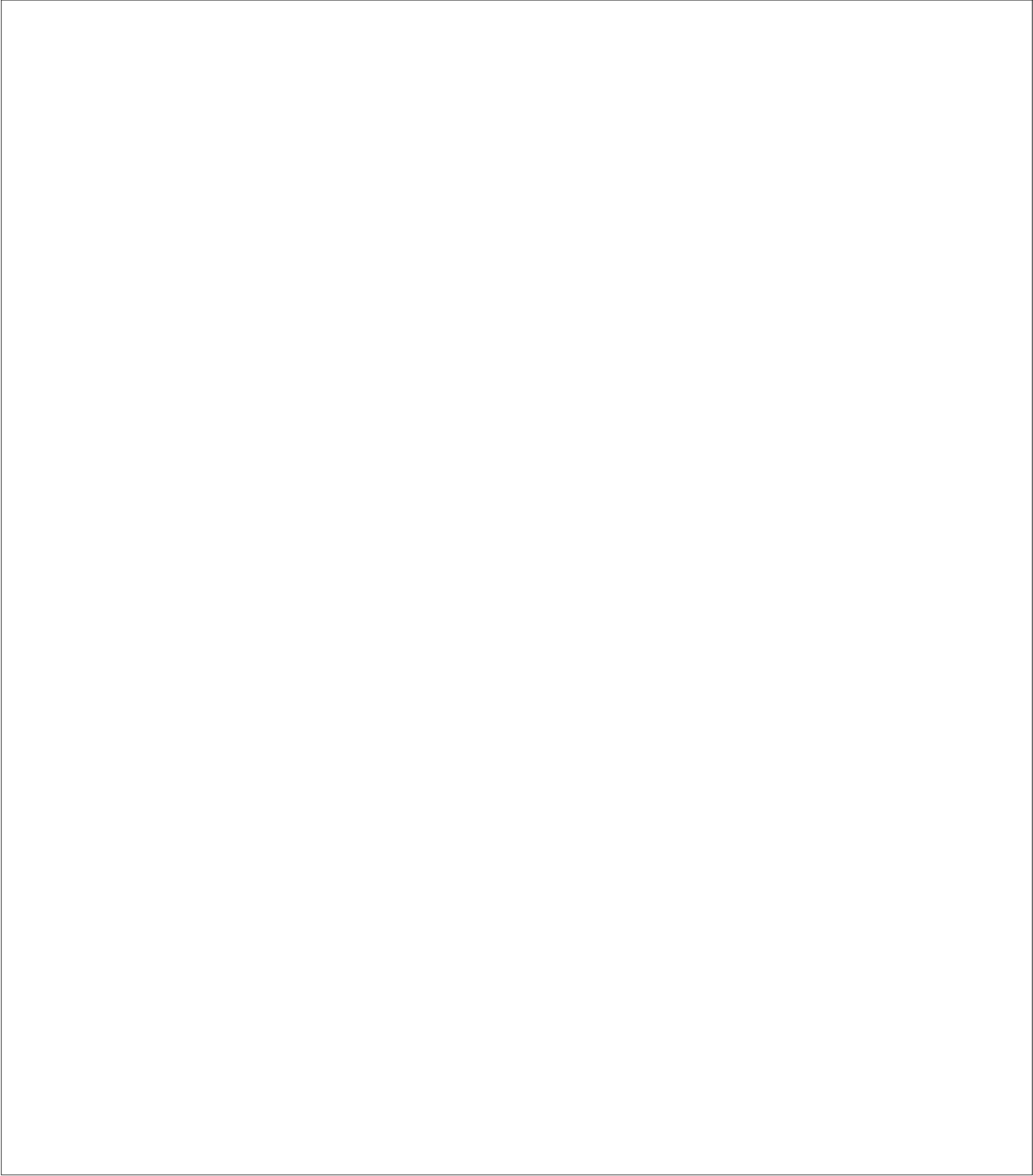
As the South Carolina example demonstrates, 305(b) and the IWI offer many ways of viewing water quality information. The scale at which data are aggregated, whether it be at the National, regional, State, watershed, or waterbody level, provides us with various “snapshots” of water quality conditions and vulnerability. All of the presentations are valid, but each is an attempt to present information in a different way, and each has strengths and weaknesses. Determining which presentation is best depends on the needs of the resource manager.

Figure 10. Major Sources of Impairment to Rivers in the Edisto Watershed









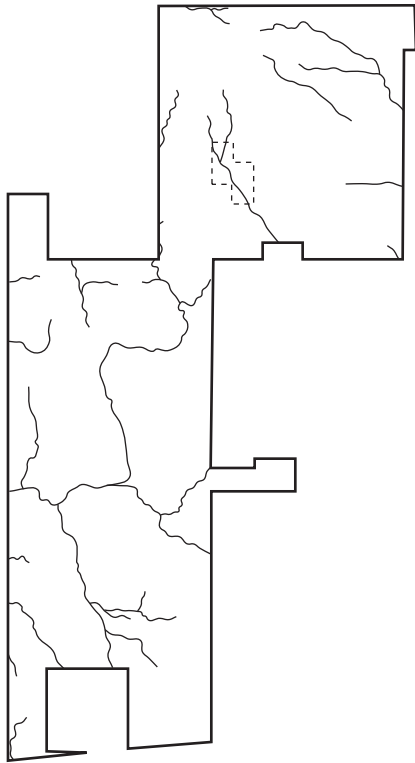
Tribal Summaries

This section provides individual summaries of the water quality survey data reported by six American Indian Tribes in their 1996 Section 305(b) reports. Tribal participation in the Section 305(b) process grew from two Tribes in 1992 to six Tribes during the 1996 reporting cycle, but Tribal water quality remains unrepresented in this report for the hundreds of other Tribes established throughout the country. Many of the other Tribes are in the process of developing water quality programs and standards but have not yet submitted a Section 305(b) report. As Tribal water quality programs become established, EPA expects Tribal participation in the Section 305(b) process to increase rapidly. To encourage Tribal participation, EPA has sponsored water quality monitoring and assessment training sessions at Tribal locations, prepared streamlined 305(b) reporting guidelines for Tribes that wish to participate in the process, and published a brochure, *Knowing Our Waters: Tribal Reporting Under Section 305(b)*. EPA hopes that subsequent reports to Congress will contain more information about water quality on Tribal lands.

Phil Johnson, U.S. EPA Region 8



Campo Indian Reservation



Location of Reservation

For information about water quality on the Campo Indian Reservation, contact:

Stephen W. Johnson or
Michael L. Connolly
Campo Environmental Protection
Agency
36190 Church Road, Suite #4
Campo, CA 91906
(619) 478-9369
Surface Water Quality

The Campo Indian Reservation covers 24.2 square miles in southeastern San Diego County, California. The Campo Indian Reservation has 31 miles of intermittent streams, 80 acres of freshwater wetlands, and 10 lakes with a combined surface area of 3.5 acres.

The natural water quality of Tribal streams, lakes, and wetlands ranges from good to excellent. There are no point source discharges within or upstream of the Reservation, but grazing livestock have degraded streams, lakes, and wetlands with

manure containing fecal coliform bacteria, nutrients, and organic wastes. Livestock also trample streambeds and riparian habitats. Septic tanks and construction also threaten water quality.

Ground Water Quality

Ground water supplies 100% of the domestic water consumed on the Campo Indian Reservation. Nitrate and bacteria from nonpoint sources occasionally exceed drinking water standards in some domestic wells. The proximity of individual septic systems to drinking water wells poses a human health risk because Reservation soils do not have good purification properties. Elevated iron and manganese levels may be due to natural weathering of geologic materials.

Programs to Restore Water Quality

The Campo Environmental Protection Agency (CEPA) has authority to administer three Clean Water Act programs. The Section 106 Water Pollution Control Program supports infrastructure, the 305(b) assessment process, and development of a Water Quality Management Plan. The Tribe is inventorying its wetlands with funding from the Section 104(b)(3) State Wetlands Protection Program. The Tribe has used funding from the Section 319 Nonpoint Source Program to stabilize stream banks,







construct sediment retention structures, and fence streams and riparian zones to exclude livestock. CEPA promulgated water quality standards in 1995 to establish beneficial uses, water quality criteria, and antidegradation provisions for all Tribal waters.

In 1994, the General Council passed a resolution to suspend cattle grazing on the Reservation for at least 2 years and to concurrently restore degraded recreational water resources by creating fishing and swimming ponds for Tribal use.

Programs to Assess Water Quality

Streams, wetlands, and lakes on Tribal lands were not monitored until CEPA initiated its Water Pollution Control Program in 1992. Following EPA approval of CEPA's Quality Assurance Project Plan in May 1993, CEPA conducted short-term intensive surveys to meet the information needs of the 305(b) assessment process. Based on the results of the 1994 305(b) assessment, CEPA developed a long-term surface water monitoring program in 1995. CEPA will consider including biological monitoring, physical and chemical monitoring, monthly bacterial monitoring in lakes, toxicity testing, and fish tissue monitoring in its monitoring program.

Individual Use Support in Campo Indian Reservation

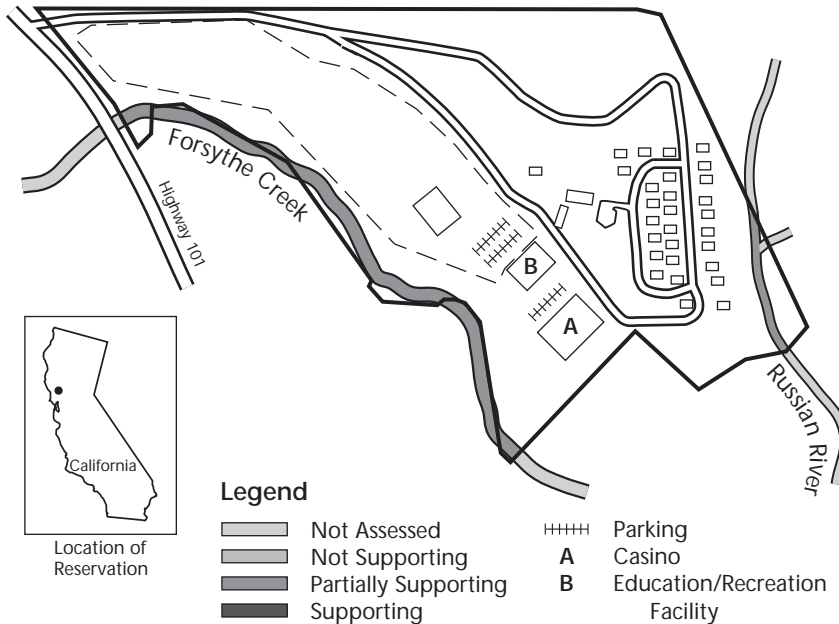
Designated Use ^a	Percent				
	Good (Fully Supporting)	Good (Threatened)	Fair (Partially Supporting)	Poor (Not Supporting)	Poor (Not Attainable)
Rivers and Streams (Total Miles = 31)^b					
 Total Miles Assessed	-	-	-	-	-
	-	-	-	-	-
	-	-	-	-	-
Lakes (Total Acres = 3.5)					
 Total Acres Assessed	-	-	-	-	-
	-	-	-	-	-
	-	-	-	-	-

- Not reported in a quantifiable format or unknown.

^a A subset of Campo Indian Reservation's designated uses appear in this figure. Refer to the Tribe's 305(b) report for a full description of the Tribe's uses.

^b Includes nonperennial streams that dry up and do not flow all year.

Coyote Valley Reservation



Russian River, potential contamination of Forsythe Creek from a malfunctioning septic system leachfield, and habitat modifications in both streams that impact aquatic life. Past gravel mining operations removed gravel spawning beds, altered flow, and created very steep banks. In the past, upstream mining also elevated turbidity in Forsythe Creek. The Tribe is also concerned about a potential trend of increasing pH values and high water temperatures in Forsythe Creek during the summer.

Ground Water Quality

The Coyote Valley Reservation contains three known wells, but only two wells are operable, and only one well is in use. The old shallow irrigation well (Well A) was abandoned because it went dry after the gravel mining operation on Forsythe Creek lowered the water table. Well B, located adjacent to Forsythe Creek, is used as a water supply for an education/recreation facility on the Reservation. Well C, located on a ridge next to the Reservation's housing units, is not in use due to severe iron and taste problems. Sampling also detected high levels of barium, total dissolved solids, manganese, and conductivity in Wells B and C. However, samples from Well B did not contain organic chemicals, pesticides, or nitrate in detectable amounts. Human waste contamination from septic systems may pose the greatest threat to ground water quality.

For information about water quality on the Coyote Valley Reservation, contact:

Jean Hunt or Sharon Ibarra
 The Coyote Valley Reservation
 P.O. Box 39
 Redwood Valley, CA 95470
 (704) 485-8723

Surface Water Quality

The Coyote Valley Band of the Pomo Indians is a federally recognized Indian Tribe, living on a 57-acre parcel of land in Mendocino County, California. Segments of the Russian River and Forsythe Creek flow past the Reservation, although flow diminishes in the summer and fall. Fishing, recreation, and religion are important uses for surface waters within the Reservation.

Currently, the Tribe is concerned about bacteria contamination in the

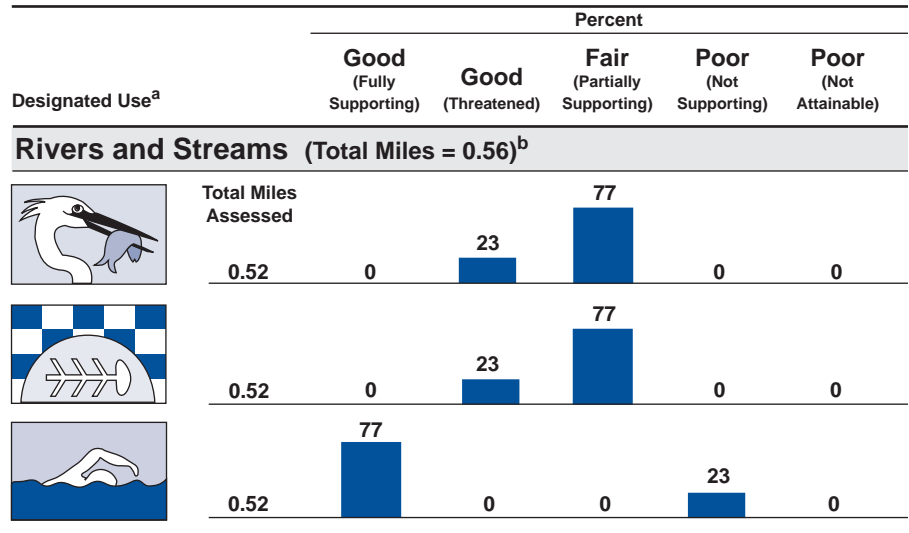
Programs to Restore Water Quality

Codes and ordinances for the Reservation will be established to create a Water Quality and Management Program for the Reservation. With codes in place, the Coyote Valley Tribal Council will gain the authority to restrain the discharge of pollutants that could endanger the Reservation water supply and affect the health and welfare of its people, as well as people in the adjacent communities.

Programs to Assess Water Quality

The Tribal Water Quality Manager will design a monitoring system with assistance from environmental consultants. The Water Quality Manager will sample a temporary monitoring station on Forsythe Creek and a proposed sampling station on the Russian River every month. A fisheries biologist will survey habitat on the rivers every other year, as funding permits. These activities will be funded through an EPA General Assistance Program (GAP) grant. GAP grants assist Tribes in increasing their capacity to administer environmental programs.

Individual Use Support in Coyote Valley Reservation

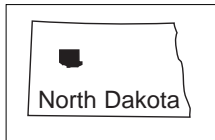
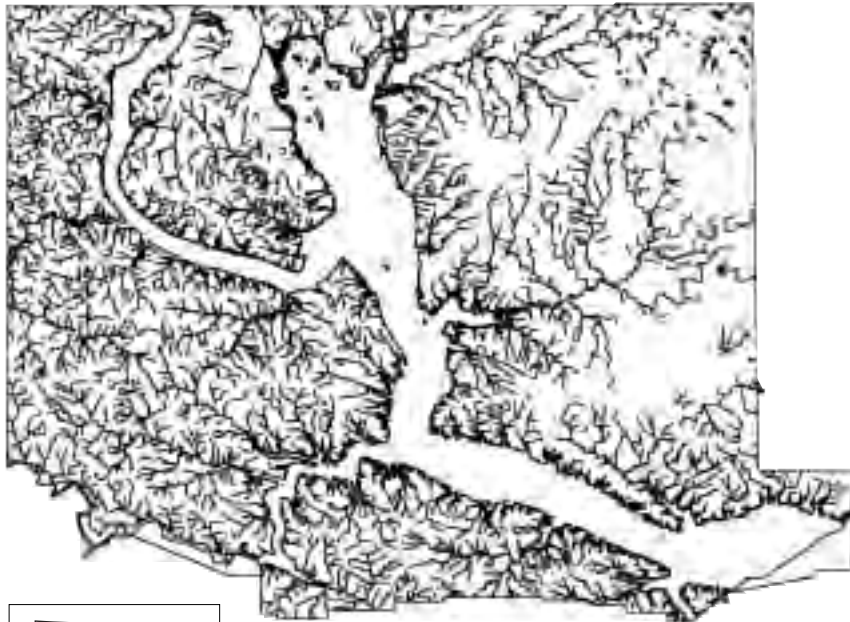


^a A subset of Coyote Valley Reservation's designated uses appear in this figure.

Refer to the Tribe's 305(b) report for a full description of the Tribe's uses.

^b Includes nonperennial streams that dry up and do not flow all year.

Fort Berthold Reservation



Location of Reservation

For information about water quality at the Fort Berthold Reservation, contact:

Jim Heckman
Three Affiliated Tribes
Environmental Division, HC3 Box 2
New Town, ND 58763
(701) 627-4569

Surface Water Quality

The Fort Berthold Indian Reservation, located in northwestern North Dakota, was originally established by the Fort Laramie Treaty of 1851. The current boundaries, as determined by an Act of Congress in 1891, encompass approximately 1,540 square miles of which about half is held in trusts by the United States for either the Three Affiliated Tribes or individual Native Americans.

The large manmade lake, Lake Sakakawea, occupies 242 square miles of land in the center of the Reservation. Created by the construction of the Garrison Dam on the Missouri River, the lake stretches

178 miles in length between Williston and Riverdale, North Dakota, with a drainage area of 181,400 square miles. The dam created a lake with a surface area at full pool of 575 square miles surrounded by 1,300 miles of shoreline, six hundred of which lie within the Reservation boundaries.

Lake Sakakawea provides municipal water for three of the six Reservation communities. Two additional communities are in the construction phase. The lake is also a major source of recreational opportunities including fishing, boating, and water skiing. Industrial use of the lake resources is minimal due to the lack of industrial development on the Reservation.

Aside from Lake Sakakawea, surface water resources include the Little Missouri River on the southern border of the Reservation, numerous small tributaries and ephemeral streams, seasonal wetlands areas and small manmade impoundments, all of which are used to some extent by livestock and/or wildlife.

A major concern of water quality impairment on the Reservation is that very few of the farmers and ranchers are currently implementing best management practices (BMPs). The majority of the livestock located within the Reservation boundaries are allowed to drink directly from the surface waters. This has caused the riparian habitat of the surface waters to become denuded of vegetation accelerating erosion of the banks. The water quality is being degraded through increased sedimentation, turbidity and fecal coliform, and fecal streptococci bacteria.

Ground Water Quality

The Three Affiliated Tribes Division of Environmental Quality's primary focus is currently on the Reservation's surface waters.

Programs to Restore Water Quality

The draft water quality standards for the Fort Berthold Indian Reservation have been submitted to the EPA Region 8 for review and comment. Once the standards are in place, the Three Affiliated Tribes will be able to write and enforce ordinances and codes to protect the surface and ground waters on the Reservation.

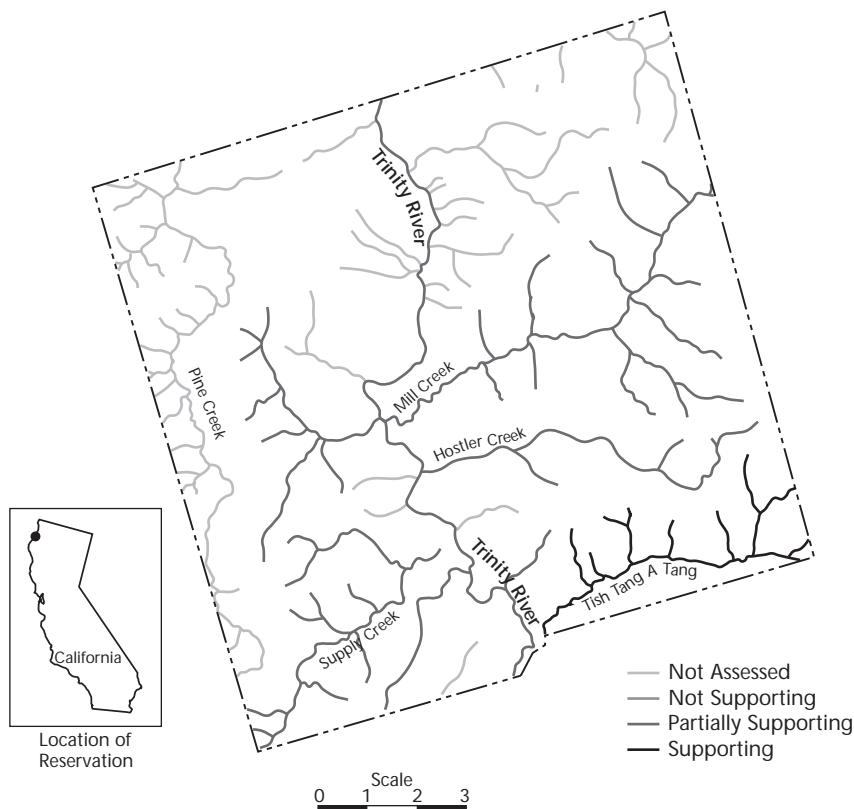
An ecosystem protection initiative project is currently being implemented on the Reservation.

Programs to Assess Water Quality

The surface water monitoring program established by the Three Affiliated Tribes Division of Environmental Quality is in the second year of collecting monitoring data at six monitoring sites. Three additional sites are in their first year of being monitored.

The U.S. Geological Survey has three continuous recording gaging stations and two miscellaneous discharge measurement sites on and adjacent to the Fort Berthold Indian Reservation. The USGS report *Variations in Land Use and Non-point Source Contamination on the Fort Berthold Indian Reservation, West Central North Dakota, 1990-93*, assesses water quality based on data from these sites.

Hoopa Valley Indian Reservation



For a copy of the Hoopa Valley Indian Reservation 1996 305(b) report, contact:

Ken Norton
P.O. Box 1348
Hoopa, CA 95546
(916) 625-5515

Surface Water Quality

The Hoopa Valley Indian Reservation covers almost 139 square miles in Humboldt County in northern California. The Reservation contains 133 miles of rivers and streams, including a section of the Trinity River, and 3,200 acres of wetlands. The Reservation does not contain any lakes.

Surface waters on the Reservation appear to be free of toxic organic chemicals, but poor forest management practices and mining operations, both on and off the Reservation, have caused significant siltation that has destroyed gravel spawning beds. Water diversions,

including the damming of the Trinity River above the Reservation, have also stressed the fishery by lowering stream volume and flow velocity. Low flows raise water temperatures and reduce flushing of accumulated silt in the gravel beds. Upstream dams also stop gravel from moving downstream to replace excavated gravel. Elevated fecal coliform concentrations also impair drinking water use on the Reservation.

Ground Water Quality

Ground water sampling revealed elevated concentrations of lead, cadmium, manganese, iron, and fecal coliforms in some wells. The Tribe is concerned about potential contamination of ground water from leaking underground storage tanks, septic system leachfields, and abandoned hazardous waste sites with documented soil contamination. These sites contain dioxins, herbicides, nitrates, PCBs, metals, and other toxic organic chemicals. The Tribe's environmental consultants are designing a ground water sampling program to monitor potential threats to ground water.

Programs to Restore Water Quality

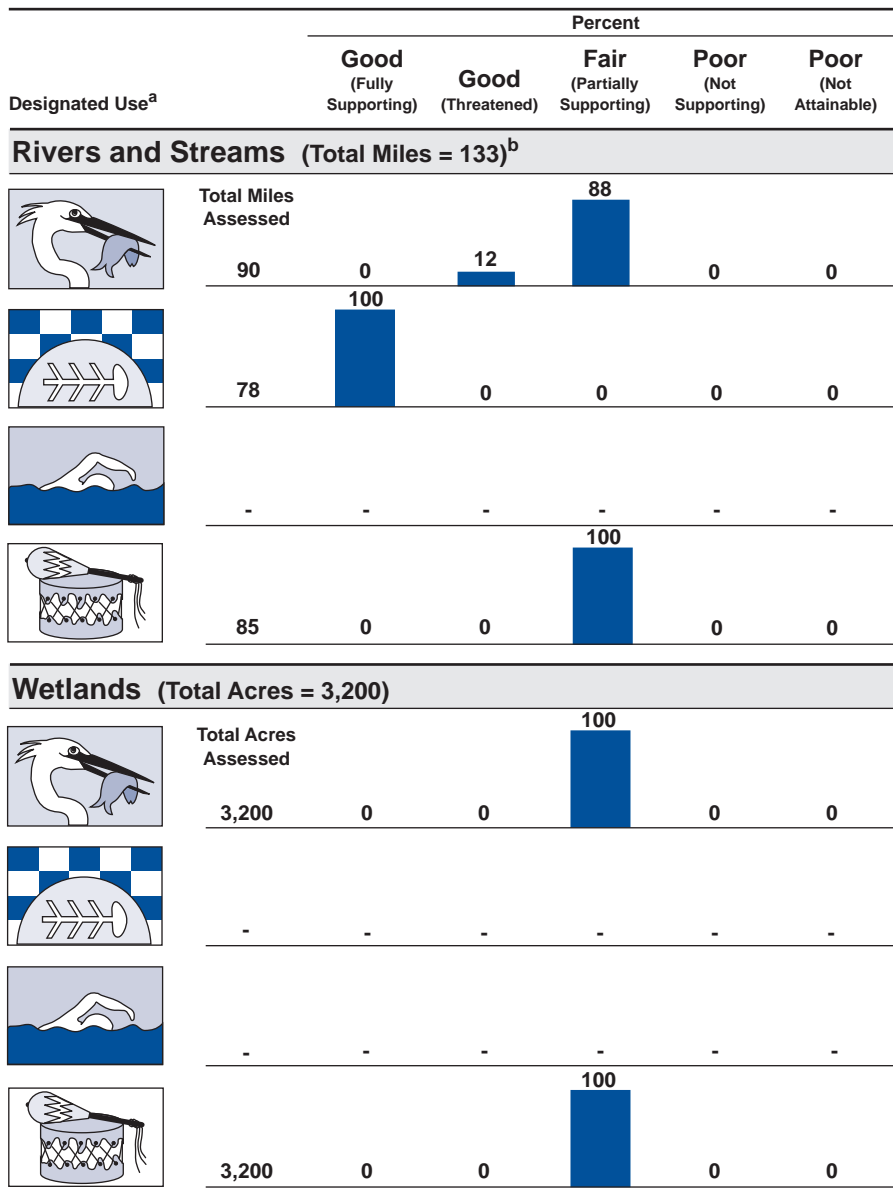
In 1990, EPA approved the Hoopa Valley Tribe's application for treatment as a State under Section 106 of the Clean Water Act. In May of 1995 the Hoopa Valley Tribal Council approved Reservation-wide water quality standards and beneficial uses for all waters within the Reservation. EPA approved the Tribe's application for Treatment as a State

with respect to Sections 303 and 401 of the Clean Water Act. The Tribe currently issues dredge and fill permits through the Tribe's Riparian Protection and Surface Mining Ordinance and Section 401 of the Clean Water Act. In July 1996 the Tribe completed a Non-Point Source Assessment and Non-Point Source Management Plan and applied for Treatment as a State under Sections 404 and 319 of the Clean Water Act. This application is currently pending approval.

Programs to Assess Water Quality

The Tribe is currently developing permanent monitoring stations to collect primary water quality data and determine water quality trends. Currently, the Tribal Fisheries, Forestry, and EPA have been working closely together to coordinate the purchase and installation of five water quality monitoring stations and enhance the two existing stations in upper and lower Mill Creek. The overall purpose of collecting water quality information is to monitor forest management practices and determine if these practices impact fishery habitat. Substantial data from throughout northern California indicate that existing unmaintained roads, new road construction, and road reconstruction have the largest impacts on fisheries habitat compared to other forest management practices. The three departments have been working closely with the U.S. Forest Service, Pacific Southwest Forest and Range Experiment Station in Arcata, which has installed many similar water quality monitoring stations throughout northern California.

Individual Use Support in Hoopa Valley Indian Reservation



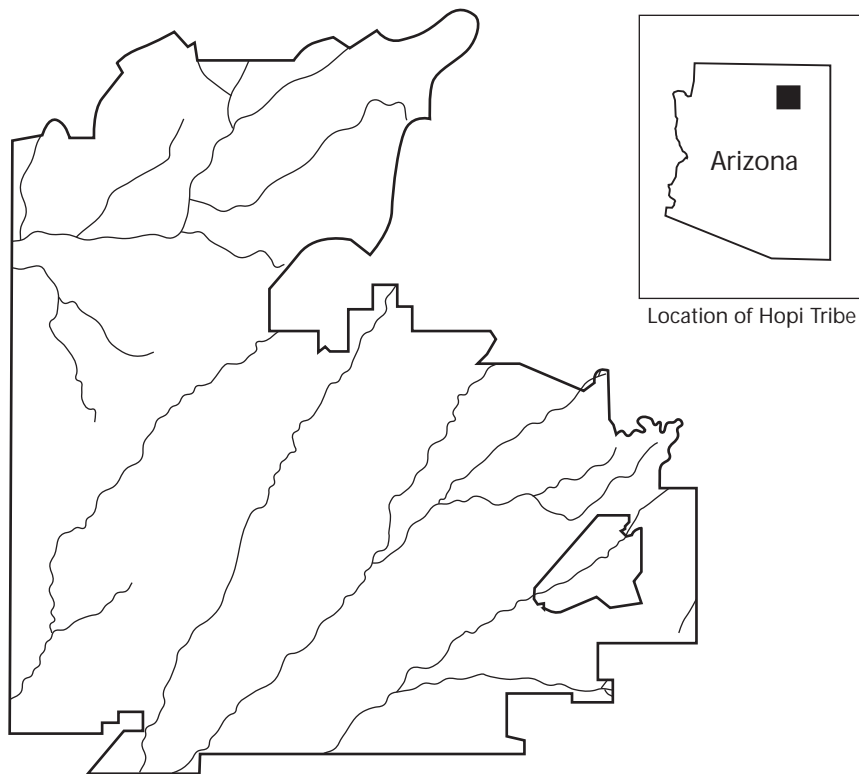
- Not reported in a quantifiable format or unknown.

^a A subset of Hoopa Valley Indian Reservation's designated uses appear in this figure.

Refer to the Tribe's 305(b) report for a full description of the Tribe's uses.

^b Includes nonperennial streams that dry up and do not flow all year.

Hopi Tribe



For a copy of the Hopi Tribe's 1996 305(b) report, contact:

Phillip Tuwaletstiwa
The Hopi Tribe
Water Resources Program
Box 123
Kykotsmovi, AZ 86039
(520) 734-9307

Surface Water Quality

The 2,439-square-mile Hopi Reservation, located in northeastern Arizona, is bounded on all sides by the Navajo Reservation. Surface water on the Hopi Reservation consists primarily of intermittent or ephemeral streams. Only limited data regarding stream quality are available. The limited data indicate that some stream reaches may be deficient in oxygen, although this conclusion has not been verified by repeat monitoring.

In addition to the intermittent and ephemeral washes and streams,

surface water on the Hopi Reservation occurs as springs where ground water discharges as seeps along washes or through fractures and joints within sandstone formations. The Hopi Tribe assessed 18 springs in 1992 and 1993. The assessment revealed that several springs had one or more exceedances of nitrate, selenium, total coliform, or fecal coliform. The primary potential sources of surface water contamination on the Hopi Reservation include mining activities outside of the Reservation, livestock grazing, domestic refuse, and wastewater lagoons.

Ground Water Quality

In general, ground water quality on the Hopi Reservation is variable. Ground water from the N-aquifer provides drinking water of excellent quality to most of the Hopi villages. The D-aquifer, sandstones of the Mesaverde Group, and alluvium also provide ground water to shallow stock and domestic wells, but the quality of the water from these sources is generally of poorer quality than the water supplied by the N-aquifer.

Mining activities outside of the Reservation are the most significant threat to the N-aquifer. Extensive pumping at the Peabody Coal Company Black Mesa mine may induce leakage of poorer quality D-aquifer water into the N-aquifer. This potential problem is being investigated under an ongoing monitoring program conducted by the U.S. Geological Survey. In addition, the U.S. Department of Energy

is investigating ground water impacts from abandoned uranium tailings at Tuba City. Other potential sources of contamination in shallow wells include domestic refuse, underground storage tanks, livestock grazing, wastewater lagoons, and septic tanks.




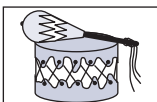
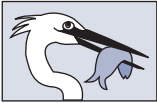


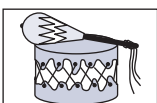
Programs to Restore Water Quality

Draft water quality standards (including an antidegradation policy) were prepared for the Tribe in 1993. The Tribe is also reviewing a proposed general maintenance program to control sewage lagoons. The Tribe has repeatedly applied for EPA grants to investigate nonpoint source pollution on the Reservation, but the applications were denied.

Programs to Assess Water Quality

Several surface and ground water assessment activities have occurred since the 1994 report was submitted. These include collections of water samples from shallow alluvial wells, surface water samples along the main stem of the Little Colorado River, and surface water samples from wetlands areas. Additionally, the USGS completed a well and spring inventory, and the U.S. Bureau of Reclamation (USBR) conducted water quality assessment activities at selected wells and surface water locations.

Individual Use Support in Hopi Reservation

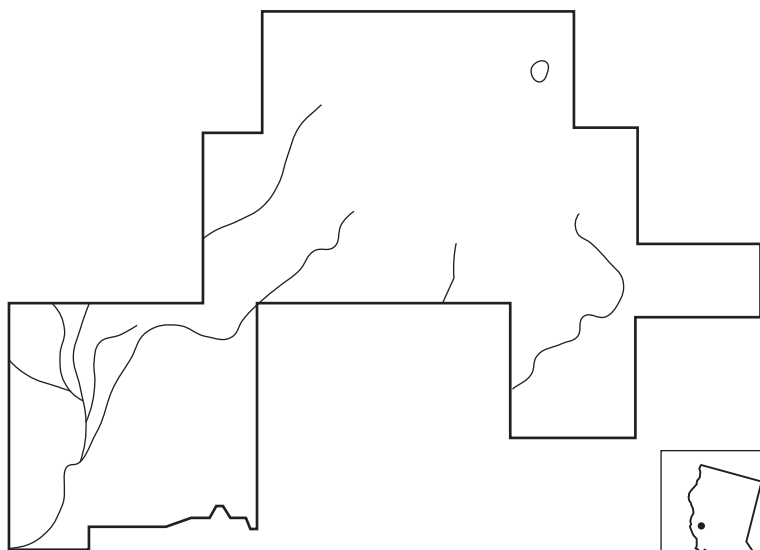
Designated Use ^a	Percent				
	Good (Fully Supporting)	Good (Threatened)	Fair (Partially Supporting)	Poor (Not Supporting)	Poor (Not Attainable)
Rivers and Streams (Total Miles = 280)^b					
	Total Miles Assessed				
	51	28	0	29	0
	22	0	0	0	100
	-	-	-	-	0
	-	-	-	-	-
Springs (Total Number = 175)					
	Total Number Assessed				
	19	11	0	0	89
	-	-	-	-	-
	-	-	-	-	-
	19	32	0	0	68

- Not reported in a quantifiable format or unknown.

^a A subset of the Hopi Tribe's designated uses appear in this figure. Refer to the Tribe's 305(b) report for a full description of the Tribe's uses.

^b Includes nonperennial streams that dry up and do not flow all year.

Hopland Band of Pomo Indians



Location of Reservation

For a copy of the Hopland Reservation 1996 305(b) report, contact:

R. Jake Decker
Hopland Band of Pomo Indians
P.O. Box 610
Hopland, CA 95449
(707) 744-1647

Surface Water Quality

The jurisdictional boundary of the Hopland Reservation includes 2,070 acres in the Mayacmas Mountains of southeastern Mendocino County about 90 miles north of San Francisco. Surface water on the reservation is scarce. Streams are intermittent rather than perennial, rendering them unreliable as water supply sources or for recreation,

fishing, shellfishing, agriculture, or aquatic life use support.

Ground Water Quality

Ground water at the Hopland Reservation, and the larger McDowell Valley area, is contained in two aquifers — fractured basement rocks of the Franciscan Assemblage and younger sedimentary deposits. This water is the sole source of supply for about 200 tribal members and non-Indian residents living in the developed area of the reservation at the north end of McDowell Valley.

Ground water contamination from manmade sources is not a major concern for water resources management at the reservation. Water quality concerns at the Hopland Reservation and elsewhere in McDowell Valley are predominantly related to natural chemical reactions between ground water and the rocks and sediments that compose the aquifers. Potential sources of contamination from human activities include agricultural activities at vineyards, leachate from septic drain fields, and infiltration of contaminants from dumping sites. To date, no pesticides or herbicides have been detected in samples from three wells near the reservation vineyards and no pathogen indicators have been detected in public supply wells. Maximum contaminant levels for

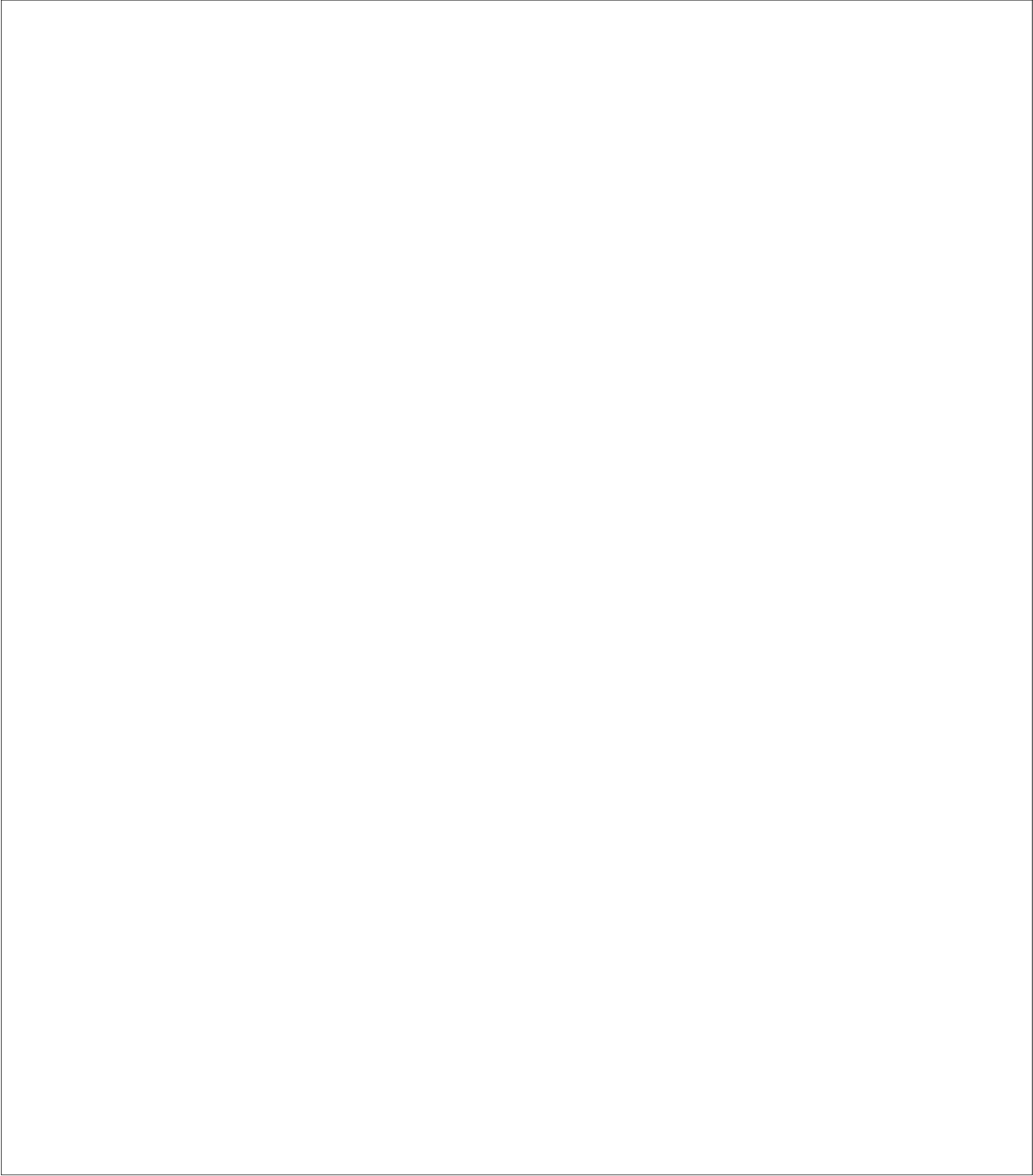
secondary drinking water standards, which are designed to regulate the taste, odor, or appearance of drinking water, were exceeded at three wells.

Programs to Restore Water Quality

No ground water protection programs have been formalized on the Hopland reservation other than the adoption of a no-dumping ordinance. The Tribe views their 1996 305(b) report as an initial step in a ground water protection program in that it provides the hydrogeologic framework of aquifers at the reservation and describes the ambient ground water quality.

Programs to Assess Water Quality

Ground water quality was determined by analyzing samples of ground water from wells and springs in the reservation area during the summers of 1993 and 1994. Samples were collected for analysis of common inorganic constituents (major ions), trace elements, radionuclides, common pesticides and herbicides, and pathogen indicators. The Tribe reports on whether tested waters meet Federal primary and secondary drinking water standards.



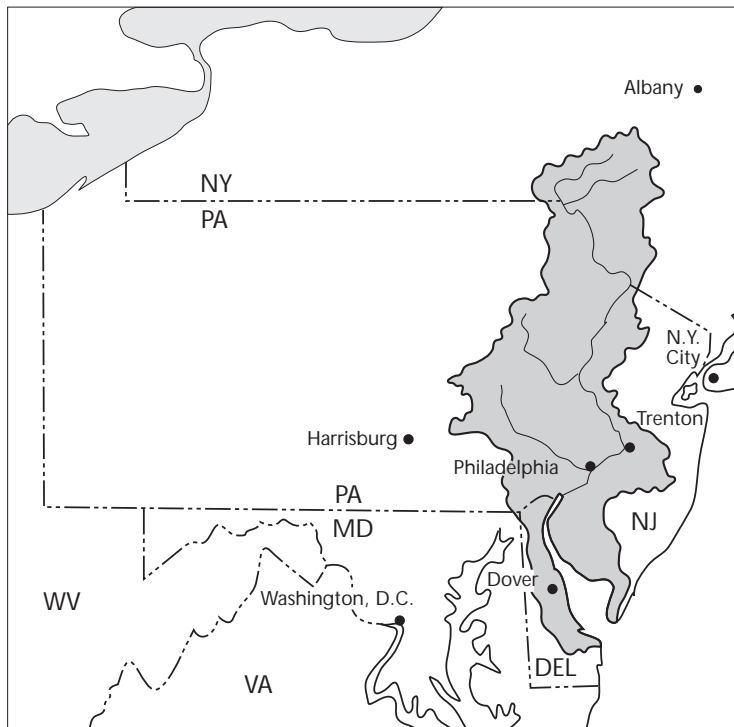
Interstate Commission Summaries

Interstate Commissions provide a forum for joint administration of large waterbodies that flow through or border multiple States and other jurisdictions, such as the Ohio River and the Delaware River and Estuarine System. Each Commission has its own set of objectives and protocols, but the Commissions share a cooperative framework that embodies many of the principles advocated by EPA's watershed management approach. For example, Interstate Commissions can examine and address factors throughout the basin that contribute to water quality problems without facing obstacles imposed by political boundaries. The information presented here summarizes the data submitted by three Interstate Commissions in their 1996 Section 305(b) reports.

Ed Carney, Kansas Department of Health and Environment



Delaware River Basin Commission



— Basin Boundaries
(USGS 6-Digit Hydrologic Unit)

For a copy of the Delaware River Basin Commission 1996 305(b) report, contact:

Robert Kausch
Delaware River Basin Commission
P.O. Box 7360
West Trenton, NJ 08628-0360
(609) 883-9500, ext. 252
e-mail: bkausch@drbc.state.nj.us

Surface Water Quality

The Delaware River Basin covers portions of Delaware, New Jersey, New York, and Pennsylvania. The Delaware River system consists of a 206-mile freshwater segment, an 85-mile tidal reach, and the Delaware Bay. Nearly 8 million people reside in the Basin, which is also the home of numerous industrial facilities and the port facilities of Philadelphia, Camden, and Wilmington.

All of the riverine waters and over 87% of the estuarine waters in the Basin have good water quality that fully supports aquatic life uses. Over 26% percent of the riverine waters do not fully support fish consumption. All riverine waters fully support swimming. In estuarine waters, poor water quality impairs shellfishing in over 14% of the surveyed waters. Low dissolved oxygen concentrations and toxic contaminants in sediment degrade portions of the lower tidal river and estuary. Toxic contaminants and metals impair a portion of the Delaware River. Shellfishing advisories affect 96 square miles of the Delaware Bay.

In general, water quality has improved since the 1994 305(b) assessment period. Tidal river oxygen levels were higher during the critical summer period, and the level of pH and fecal coliforms dropped slightly in some nontidal sections.

Programs to Restore Water Quality

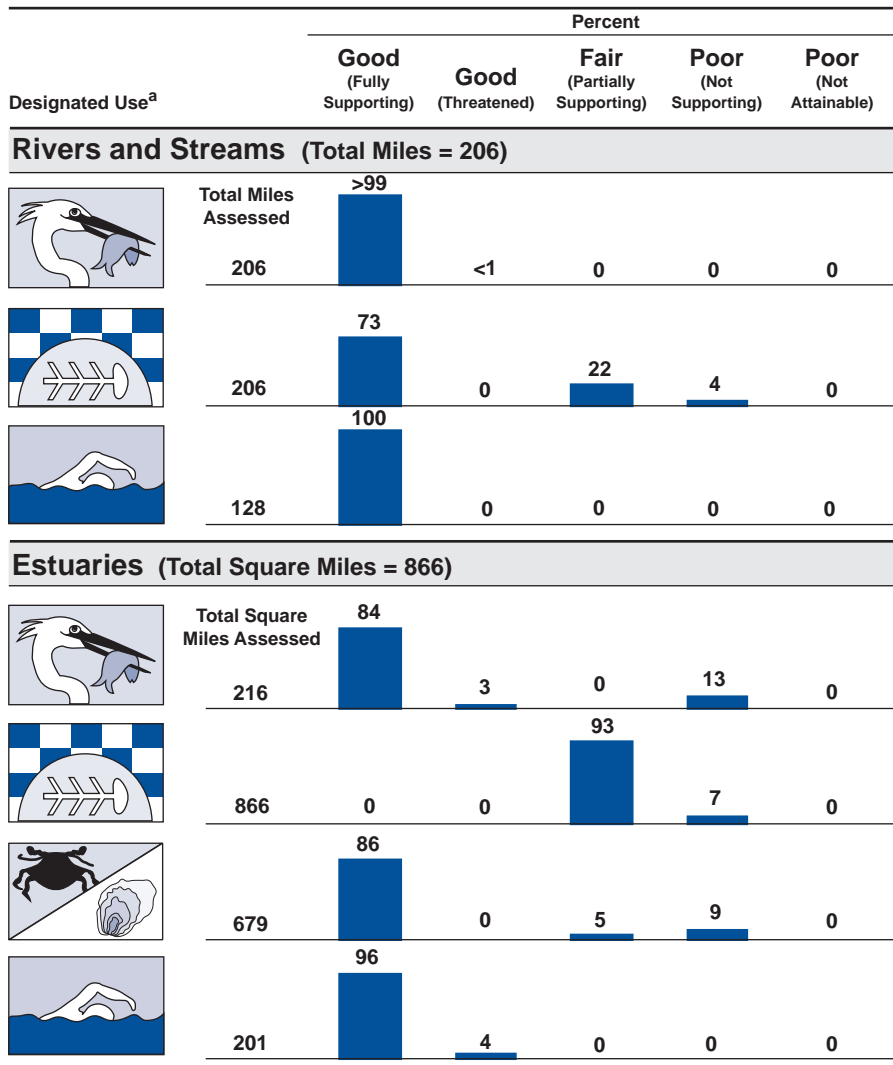
The Commission's Toxics Management Program is designed to identify the substances (and their sources) that impair fish consumption, aquatic life, and drinking water. Further, the relative contribution of point and nonpoint sources to the pollution loading in the tidal reach of the river is being addressed by a 3-year study of combined sewer overflows. The DRBC and the States have carried out an aggressive program for many years to reduce point sources of oxygen-demanding materials and other pollutants and will

continue to do so. As part of an ongoing effort to provide more support for fish and aquatic life, the Commission is developing a new model to evaluate the impacts of point and nonpoint pollutants on dissolved oxygen levels. The Commission's Special Protection Waters regulations protect existing high water quality in the upper reaches of the nontidal river from the effects of future population growth and land development. A comprehensive watershed management approach to pollution control in this area will eliminate the occasional occurrence of elevated levels of pH, bacteria, contaminants, nutrients, and BOD.

Programs to Assess Water Quality

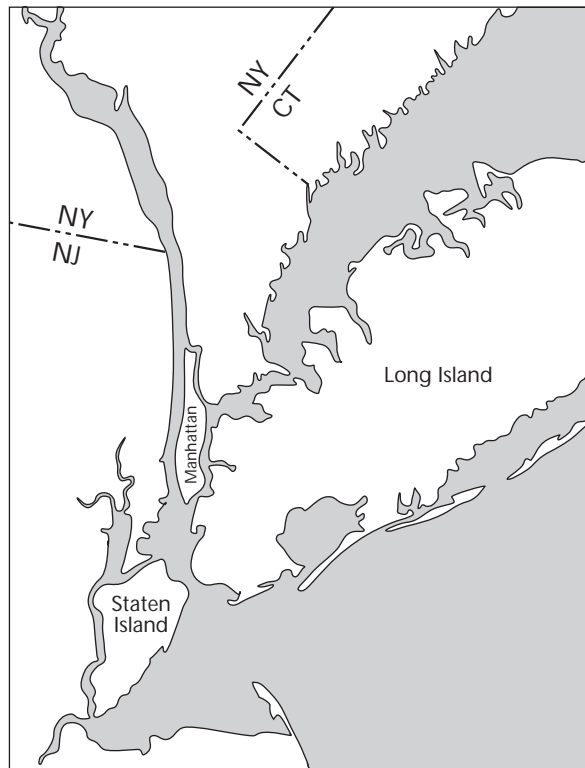
The Commission conducts an intensive monitoring program along the entire length of the Delaware River and Estuary. At least a dozen parameters are sampled at most stations, located about 7 miles apart. The new Special Protection Waters regulations requires more comprehensive monitoring and modeling, such as biological monitoring and continuous water quality monitoring. The Combined Sewer Overflow Study and the Toxics Study have used specialized water sampling programs to acquire data for mathematical models. New management programs will very likely require customized monitoring programs.

Individual Use Support in the Delaware River Basin



^a A subset of the Delaware River Basin Commission's designated uses appear in this figure. Refer to the Commission's 305(b) report for a full description of the Commission's uses.

Interstate Sanitation Commission



— Basin Boundaries
(USGS 6-Digit Hydrologic Unit)

For a copy of the Interstate Sanitation Commission 1996 305(b) report, contact:

Peter L. Sattler or **Howard Golub**
Interstate Sanitation Commission
311 West 43rd Street
New York, NY 10036
(212) 582-0380

Surface Water Quality

Established in 1936 by Federal mandate, the Interstate Sanitation Commission (ISC) is a tristate environmental agency of the States of New Jersey, New York, and Connecticut. The Interstate Sanitation District encompasses approximately 797 square miles of estuarine waters in the Metropolitan Area shared by the States, including the Arthur Kill/Kill Van Kull, Newark Bay, Lower Hudson River, Raritan Bay, Sandy Hook Bay, Upper and Lower New York Bays, western Long Island Sound, and the Atlantic Ocean.

Notwithstanding the significant environmental gains that have been

made in recent years, a tremendous amount of work remains to be done. In the past several years, due to a great degree to ISC's year-round disinfection requirement, which went into effect in 1986, thousands of acres of shellfish beds have been opened on a year-round basis and, during the last six bathing seasons, only a few beach closings occurred due to elevated levels of coliform bacteria or washups of debris. However, due to a combination of factors, including, but not limited to, habitat loss, hypoxia, and overfishing by commercial and recreational interests, bag limits and minimum size restrictions for several finfish species (i.e., black sea bass and porgy) were promulgated by the coastal States.

Topics of concern to the ISC include compliance with ISC regulations, toxic contamination in District waters, pollution from combined sewer overflows, closed shellfish waters, and wastewater treatment capacity to handle growing flows from major building projects.

Ground Water Quality

The ISC's primary focus is on surface waters shared by the States of New Jersey, New York, and Connecticut.

Programs to Restore Water Quality

The ISC actively participates in the Long Island Sound Study, the New York-New Jersey Harbor Estuary Program (HEP), the New York Bight Restoration Plan, and the Dredged Material Management Plan for the Port of New York and New Jersey.




The ISC has representatives on the Management Committees and various workgroups for each program. During the 1994-1995 reporting period, approximately 2.5 BGD of treated sewage discharged in the Interstate Sanitation District received secondary treatment. Yet to be addressed are the untreated discharges from combined sewer overflows and storm sewers.

The Commission's water pollution abatement programs continue to provide assistance for the effective coordination of approaches to regional problems. ISC's long-standing goal of making more areas available for swimming and shellfishing remains a high priority. The Commission's programs include enforcement, minimization of the effects of combined sewers, participation in the National Estuary Program, compliance monitoring, pretreatment of industrial wastes, toxics contamination, land-based alternatives for sewage sludge disposal, ocean disposal of dredged material, and monitoring the ambient waters.

Programs to Assess Water Quality

The ISC performs intensive ambient water quality surveys and samples effluents discharged by publicly owned and private wastewater treatment facilities and industrial facilities into District waterways. The ISC's effluent requirements are incorporated into the individual discharge permits issued by the participating States.

Individual Use Support in Interstate Sanitation Commission Waters

Designated Use ^a	Percent				
	Good (Fully Supporting)	Good (Threatened)	Fair (Partially Supporting)	Poor (Not Supporting)	Poor (Not Attainable)
Estuaries (Total Square Miles = 72)					
 Total Miles Assessed	-	-	-	-	-
	-	-	-	-	-
	-	-	-	-	-

- Not reported in a quantifiable format or unknown.

^a A subset of the Interstate Sanitation Commission's designated uses appear in this figure. Refer to the Commission's 305(b) report for a full description of the Commission's uses.

Note: All waters under the jurisdiction of the Interstate Sanitation Commission are estuarine.

Ohio River Valley Water Sanitation Commission (ORSANCO)



— Basin Boundaries
(USGS 6-Digit Hydrologic Unit)

For a copy of the ORSANCO 1996 305(b) report, contact:

Jason Heath
ORSANCO
5735 Kellogg Avenue
Cincinnati, OH 45228-1112
(513) 231-7719
e-mail: jheath@orsanco.org

Surface Water Quality

The Ohio River Valley Water Sanitation Commission (ORSANCO) was established in 1948 by the signing of the Ohio River Valley Water Sanitation Compact by Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Virginia, and West Virginia. ORSANCO is an interstate agency with multiple responsibilities that include detecting interstate spills, developing waste treatment standards, and monitoring and assessing the Ohio River mainstem. The mainstem runs 981 miles from

Pittsburgh, Pennsylvania, to Cairo, Illinois.

The most common problems in the Ohio River are PCB and chlor-dane contamination in fish and bacteria, pesticides, and metals in the water column. The States have issued fish consumption advisories along the entire length of the Ohio River based on ORSANCO data. ORSANCO also suspects that community combined sewer overflows along the entire length of the river elevate bacteria levels and impair swimming. ORSANCO detected bacteria contamination at all seven monitoring stations downstream of major urban areas with a large number of CSOs.

A majority of Ohio River manual sampling stations exhibited one to several violations of the chronic warm water aquatic life criterion for lead. Sporadic violations for ammonia, chromium, copper, zinc, and nickel for selected waters, in conjunction with lead violations, resulted in a moderately supporting aquatic life use classification for the Markland Pool.

Public water supply use of the Ohio River is impaired by 1,2-dichloroethane near Paducah and by atrazine near Louisville and the mouth of the River at Grand Chain, Illinois. The extent of atrazine contamination is unknown because few sites are monitored for atrazine.

Ground Water Quality




ORSANCO does not have jurisdiction over ground water in the Ohio River Basin.

Programs to Restore Water Quality

In 1992, an interagency work-group developed a CSO program for the Ohio River Basin with general recommendations to improve coordination of State CSO strategies. In 1993, ORSANCO added requirements for CSOs to the Pollution Control Standards for the Ohio River and the Commissioners adopted a strategy for monitoring CSO impacts on Ohio River quality. The Commission also established a Nonpoint Source Pollution Abatement Task Force composed of ORSANCO Commissioners, representatives from State NPS control agencies, and representatives from industries that generate NPS pollution.

In 1995, an Ohio River Watershed Pollutant Reduction Program was established to address, on a whole-watershed basis, pollutants causing or contributing to water quality impairments. These pollutants include dioxin, PCBs, chlordane, atrazine, copper, lead, nitrogen, and phosphorous. The objective of the program is to determine the extent of impairment, identify sources, quantify impacts, and recommend to the States abatement scenarios necessary to achieve water quality objectives. The program is being implemented following a phased approach without the establishment of new regulatory structures to implement controls that are environmentally meaningful, technically sound, and economically reasonable.

Individual Use Support in the Ohio River Valley Basin

Designated Use ^a	Percent					
	Good (Fully Supporting)	Good (Threatened)	Fair (Partially Supporting)	Poor (Not Supporting)	Poor (Not Attainable)	
Rivers and Streams (Total Miles = 981)						
 Total Miles Assessed	981	19	-	81	0	-
	981	0	-	100	0	-
	981	0	-	82	18	-

- Not reported in a quantifiable format or unknown.

^aA subset of ORSANCO's designated uses appear in this figure. Refer to the Commission's 305(b) report for a full description of the Commission's uses.

Programs to Assess Water Quality

ORSANCO operates several monitoring programs on the Ohio River mainstem and several major tributaries, including fixed-station chemical sampling, daily sampling of volatile organic chemicals at water supply intakes, bacterial monitoring, fish tissue sampling, and fish community monitoring. ORSANCO uses the Modified Index of Well Being (MIwb) to assess fish community characteristics, such as total biomass and species diversity. ORSANCO is currently developing a numerical biological criteria.



Part II

Water Quality Assessments

Georgia Minnich, Durham, NC



Rivers and Streams

Forty-seven States, two Interstate River Commissions, one Territory, the District of Columbia (hereafter collectively referred to as States), and three American Indian Tribes rated river water quality in their 1996 Section 305(b) reports (see Appendix A, Table A-1, for individual State and Tribal information). These States and Tribes surveyed conditions in 693,905 miles of rivers and streams; most of the surveyed rivers and streams are perennial waterbodies that flow all year. The surveyed rivers and streams represent 53% of the 1.3 million miles of perennial rivers and streams in the lower 48 States, or 19% of the estimated 3.6 million miles of all

rivers and streams in the country, including nonperennial streams that flow only during wet periods (Figure 2-1).

Altogether, the States and Tribes surveyed 78,099 more river miles in 1996 than in 1994. While most States surveyed about the same number of river miles in both reporting cycles, Illinois, Maryland, North Dakota, and Tennessee collectively account for an increase of over 75,000 surveyed river miles. Since 1994, Illinois, North Dakota,

States and Tribes SURVEYED
19%
of their total river miles^a
(53% of their perennial miles) for the 1996 report

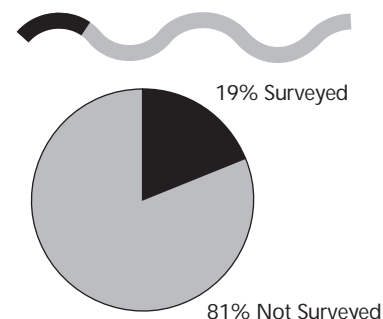
Figure 2-1



Based on data contained in Appendix A, Table A-1.

River Miles Surveyed by States and Tribes

1996 ■ 693,905 miles = 19% surveyed
■ Total miles: 3,634,152^a



1994 ■ 615,806 miles = 17% surveyed
■ Total miles: 3,548,738^b



1992 ■ 642,881 miles = 18% surveyed
■ Total miles: 3,551,247^c



1990 ■ 647,066 miles = 36% surveyed
■ Total miles: 1,800,000^d



^aSource: 1996 State and Tribal Section 305(b) reports.

^bSource: 1994 State and Tribal Section 305(b) reports.

^cSource: 1992 State and Tribal Section 305(b) reports.

^dSource: *National Water Quality Inventory: 1990 Report to Congress*, U.S. EPA, 1992.

Note: In comparison with 1990, it appears that the States and Tribes assessed a smaller percentage of the Nation's rivers in 1996. However, in 1996, most States and Tribes included intermittent streams, canals, and ditches that were excluded from the 1990 estimates of total stream miles. As a result, the national estimate of total stream miles almost doubled from 1.8 million miles in 1990 to more than 3.6 million miles in 1996.

The EPA Reach File Version 3 (RF3) is a database containing the geographic locations of over 3 million stream, lake, and estuary reaches in the continental U.S. and Hawaii. A reach is a stretch of stream between confluences or a segment of lake or estuary shoreline. RF3 provides unique identification numbers for points on these surface waters and built-in river mileages. With RF3, users can prepare computerized maps of healthy and impaired waters, monitoring sites, drinking water intakes, pollution sources, and many other features. RF3 also allows computer modeling of the movement of pollutants through its hydrologically connected network of waters.

and Tennessee have indexed all of their streams to the Reach File 3 (RF3) level in order to perform 1:100,000 scale geographic analyses (see sidebar for a description of RF3). The refined stream estimates have increased the mileage associated with surveyed streams. These States have also initiated new monitoring projects since 1994. Illinois now assesses all RF3 streams except for unnamed tributaries. North Dakota has initiated a new biological monitoring program in the Red River basin. Tennessee has also expanded its biological monitoring thanks to the Division of Water Pollution Control's ecoregion project and the Tennessee Valley Authority's River Action Teams. Maryland reported on all waters of the State for their 1996 305(b) report, of which approximately 11,000 river miles were not monitored or evaluated but were presumed to be of good water quality.

The summary information presented in this chapter applies strictly to the portion of the Nation's rivers surveyed by the States and Tribes. EPA cannot make generalizations about the health of all of our Nation's rivers based on data extracted from the 305(b) reports because most States and Tribes rate their waters with information obtained from water monitoring programs designed to detect degraded waterbodies. Very few States or Tribes select water sampling sites with a statistical design to represent a cross section of water quality conditions in their jurisdictions. Instead, many States and Tribes direct their limited

monitoring resources toward waters with suspected problems. As a result, the surveyed rivers reflect conditions of targeted waters rather than a representative sampling of all waters.

In the future, increased use of statistically based monitoring programs will enable EPA and the States and Tribes to report more comprehensively on the general health of the Nation's waters. Examples of statistically based programs include probability designs implemented by Delaware, Maryland, and Indiana; EPA's Environmental Monitoring and Assessment Program (EMAP); and EPA's Regional Environmental Monitoring and Assessment Program (R-EMAP). EMAP is a long-term monitoring program with a unique approach that combines a probability-based sampling strategy with ecological indicators (quantifiable expressions of an environmental value) to assess the overall condition of ecological resources. R-EMAP applies the concepts, methods, and approach developed by EMAP to resolve specific environmental issues of importance to the EPA Regions and the States. (See highlight)

National data from other Federal agencies, such as the U.S. Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA), and private organizations, such as The Nature Conservancy, will also clarify national water quality trends. (See Chapter 13 for additional information about monitoring and assessment programs.)

Summary of Use Support

The States and Tribes rate whether their water quality is good enough to fully support a healthy community of aquatic organisms as well as human activities, such as swimming, fishing, and drinking. The States designate specific activities for their rivers and streams, termed “individual designated uses.” EPA and the States use the following terminology to rate their water quality:

- **Good/Fully Supporting:** Good water quality supports a diverse community of fish, plants, and aquatic insects, as well as the array of human activities assigned to a river by the State.
- **Good/Threatened:** Good water quality currently supports aquatic life and human activities in and on the river, but changes when factors such as land use threaten water quality or data indicate a trend of increasing pollution in the river.
- **Fair/Partially Supporting:** Fair water quality supports aquatic communities with fewer species of fish, plants, and aquatic insects, and/or occasional pollution interferes with human activities. For example, occasional siltation problems may reduce the population of some aquatic species in a river, while other species are not affected.
- **Poor/Not Supporting:** Poor water quality does not support a healthy aquatic community and/or prevents some human activities on

the river. For example, persistent PCB contamination in river sediments (originating from discontinued industrial discharges) may contaminate fish and make the fish inedible for years.

- **Not Attainable:** The State has performed a use-attainability analysis and demonstrated that use support of one or more designated uses is not attainable due to one of six specific biological, chemical, physical, or economic/social conditions (see Chapter 1 for additional information).

Most States and Tribes rate how well a river supports individual uses (such as swimming and aquatic life habitat) and then consolidate individual use ratings into a table of summary use support data. This table divides rivers into those miles fully supporting all of their uses, those fully supporting all uses but threatened for one or more uses, and those impaired for one or more uses. Impaired waters are the sum of partially and not supporting waters (see Chapter 1 for a complete discussion of use support).

Forty-three States, three Tribes, two Interstate Commissions, Puerto Rico, and the District of Columbia reported summary use support status for rivers and streams in their 1996 Section 305(b) reports (see Appendix A, Table A-2, for individual State and Tribal information). Another four States reported individual use support status but did not report summary use support status. In such cases, EPA used aquatic life use support status to represent summary water quality conditions in the State’s rivers and streams.

**64% OF SURVEYED
rivers have good
water quality.**

Surveyed Waters

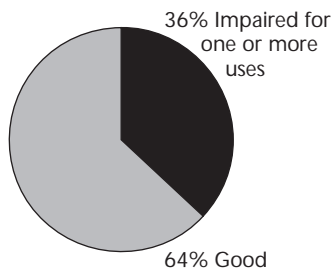
Total rivers = 3.6 million miles^a
 Total surveyed = 693,905 miles^b



Of the surveyed miles:

- 51% were monitored
- 41% were evaluated
- 8% were not specified

Surveyed Water Quality



^aSource: 1996 State and Tribal Section 305(b) reports.

^bDoes not include miles assessed as not attainable (<0.5% of total rivers).

Altogether, States and Tribes reported that 64% of 693,905 surveyed river miles fully support all of their uses. Of these waters, 56% fully support designated uses and 8% have good water quality that fully supports all uses but is threatened for one or more uses. These threatened waters may deteriorate if we fail to manage potential sources of pollution (Figure 2-2). Some form of pollution or habitat degradation impairs the remaining 36% of the surveyed river miles.

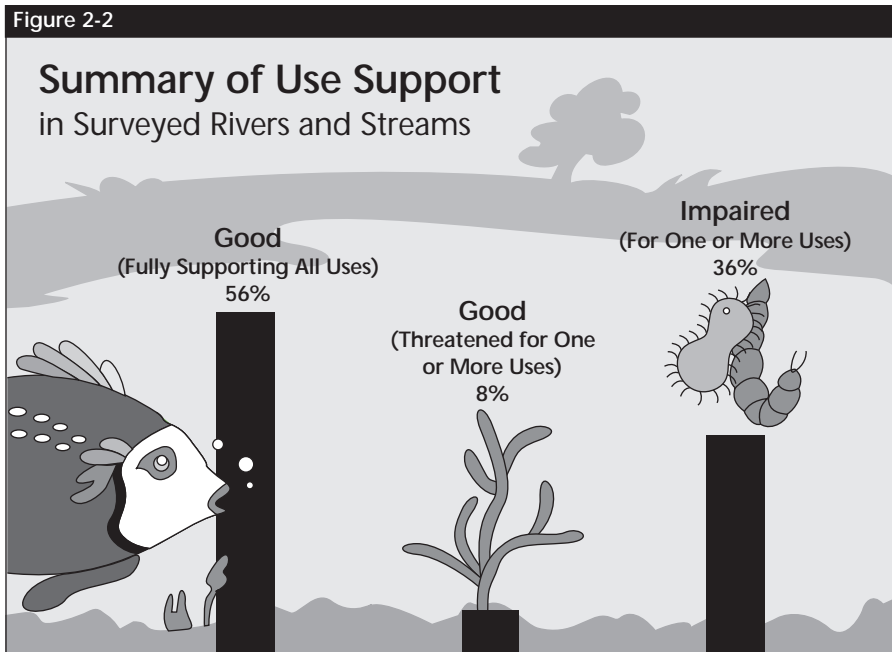
Individual Use Support

Individual use support information provides additional detail about water quality problems in our Nation's surface waters. The States are responsible for designating their rivers and streams for State-specific

uses, but EPA requests that the States rate how well their rivers support six standard uses so that EPA can summarize the State data.

- Aquatic life support – Is water quality good enough to support a healthy, balanced community of aquatic organisms, including fish, plants, insects, and algae?
- Fish consumption – Can people safely eat fish caught in the river or stream?
- Primary contact recreation (swimming) – Can people make full body contact with the water without risking their health?
- Secondary contact recreation – Is there a risk to public health from recreational activities on the water, such as boating, that expose the public to minor contact with the water?
- Drinking water supply – Can the river or stream provide a safe water supply with standard treatment?
- Agricultural uses – Can the water be used for irrigating fields and watering livestock?

Only six States did not report individual use support status of their rivers and streams (see Appendix A, Table A-3, for individual State and Tribal information). The reporting States and Tribes surveyed the status of aquatic life and swimming uses most frequently and identified more impacts on aquatic life and swimming uses than on the other individual uses (Figure 2-3). These States and Tribes reported that fair



Based on data contained in Appendix A, Table A-2.

or poor water quality impacts aquatic life in 201,558 stream miles (31% of the 641,611 miles surveyed for aquatic life support). Fair or poor water quality conditions also impair swimming activities in 86,710 miles (20% of the 434,421 miles surveyed for swimming use support).

Many States and Tribes did not rate fish consumption use support because they have not codified fish consumption as a use in their standards. Some of these States consider fishing use as a component of aquatic life use, i.e., that rivers and streams can provide a healthy habitat to support fishing activities even though anglers may not be able to eat their catch in these States. EPA encourages the States to designate fish consumption as a use in their waterbodies to promote consistency in future reporting. Most States report information on fish consumption advisories (species and size of fish that should not be eaten) to EPA (see Chapter 7).

Water Quality Problems Identified in Rivers and Streams

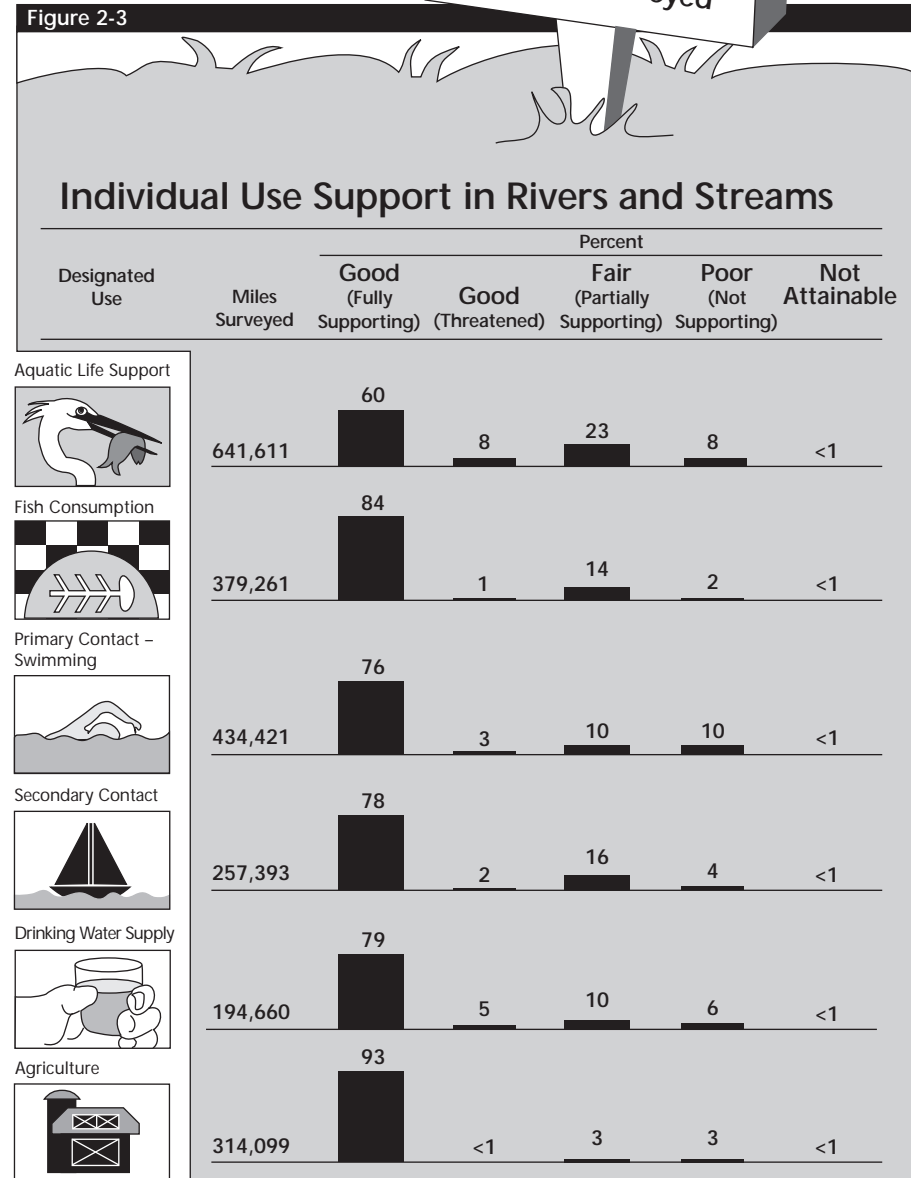
Figures 2-4 and 2-5 identify the pollutants and sources of pollutants that impair the most river miles (i.e., prevent them from fully supporting designated uses), as reported by the States and Tribes. The two figures are based on the same data (contained in Appendix A, Tables A-4 and A-5), but each figure provides a different perspective on the extent of impairment attributed to individual pollutants and sources. Figure 2-4 compares

the impacts of the leading pollutants and sources in all surveyed rivers. Figure 2-5 presents the relative impact of the leading pollutants and sources in impaired rivers, the subset of surveyed rivers with identified water quality problems.

The following sections describe the leading pollutants

Good water quality fully supports aquatic life in 68% of the river miles surveyed

Figure 2-3



Based on data contained in Appendix A, Table A-3.

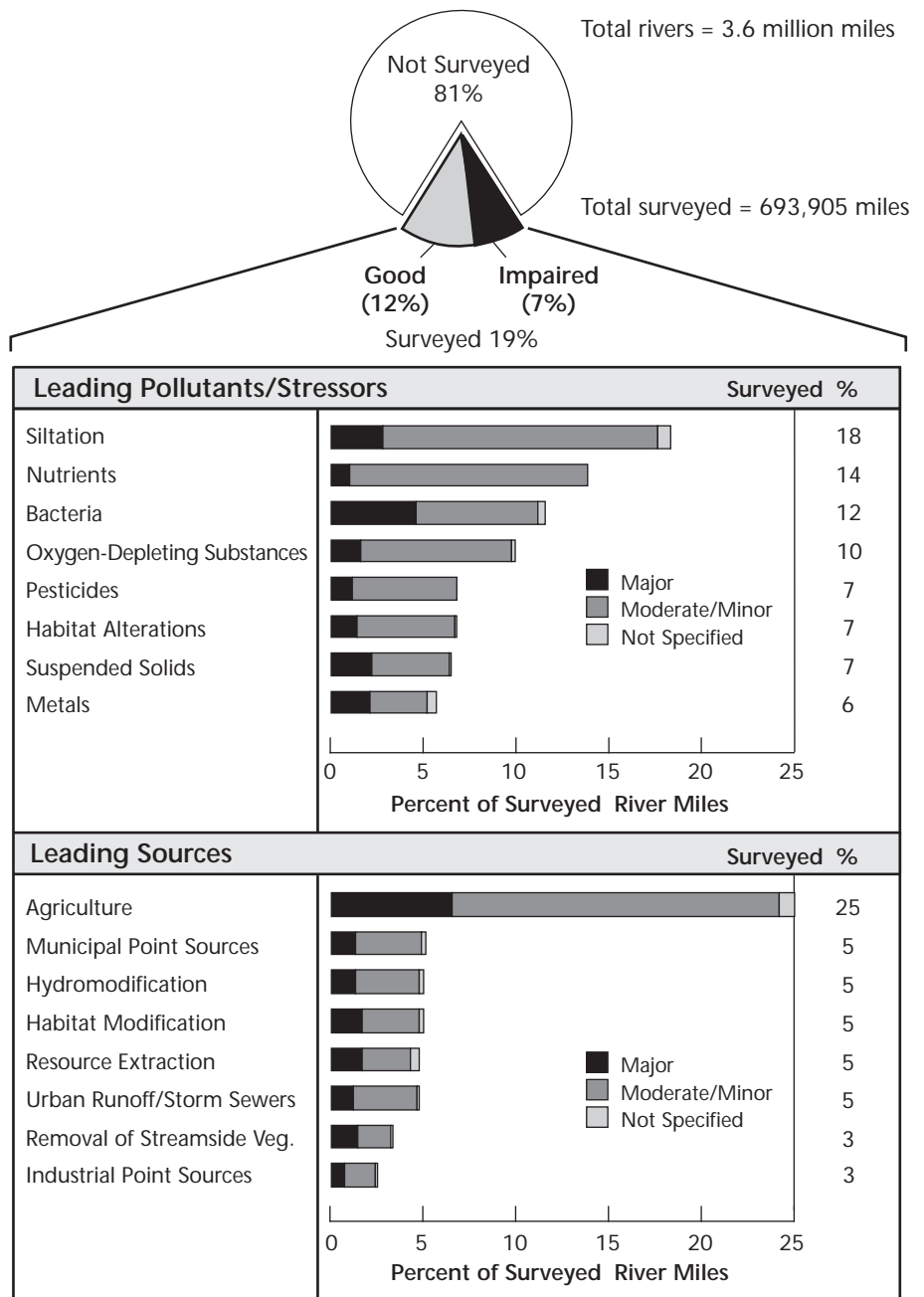
Figure 2-4

The pollutants/processes and sources shown here may not correspond directly to one another (i.e., the leading pollutant may not originate from the leading source). This may occur for a number of reasons, such as a major pollutant may be released from many minor sources or States may not have the information to determine all the sources of a particular pollutant/stressor.

AGRICULTURE is the leading source of pollution in surveyed rivers and streams. According to the States, agricultural pollution problems

- affect 25% of all rivers and streams surveyed, and
- contribute to 70% of all water quality problems identified in rivers and streams (see Figure 2-5).

SURVEYED River Miles: Pollutants and Sources

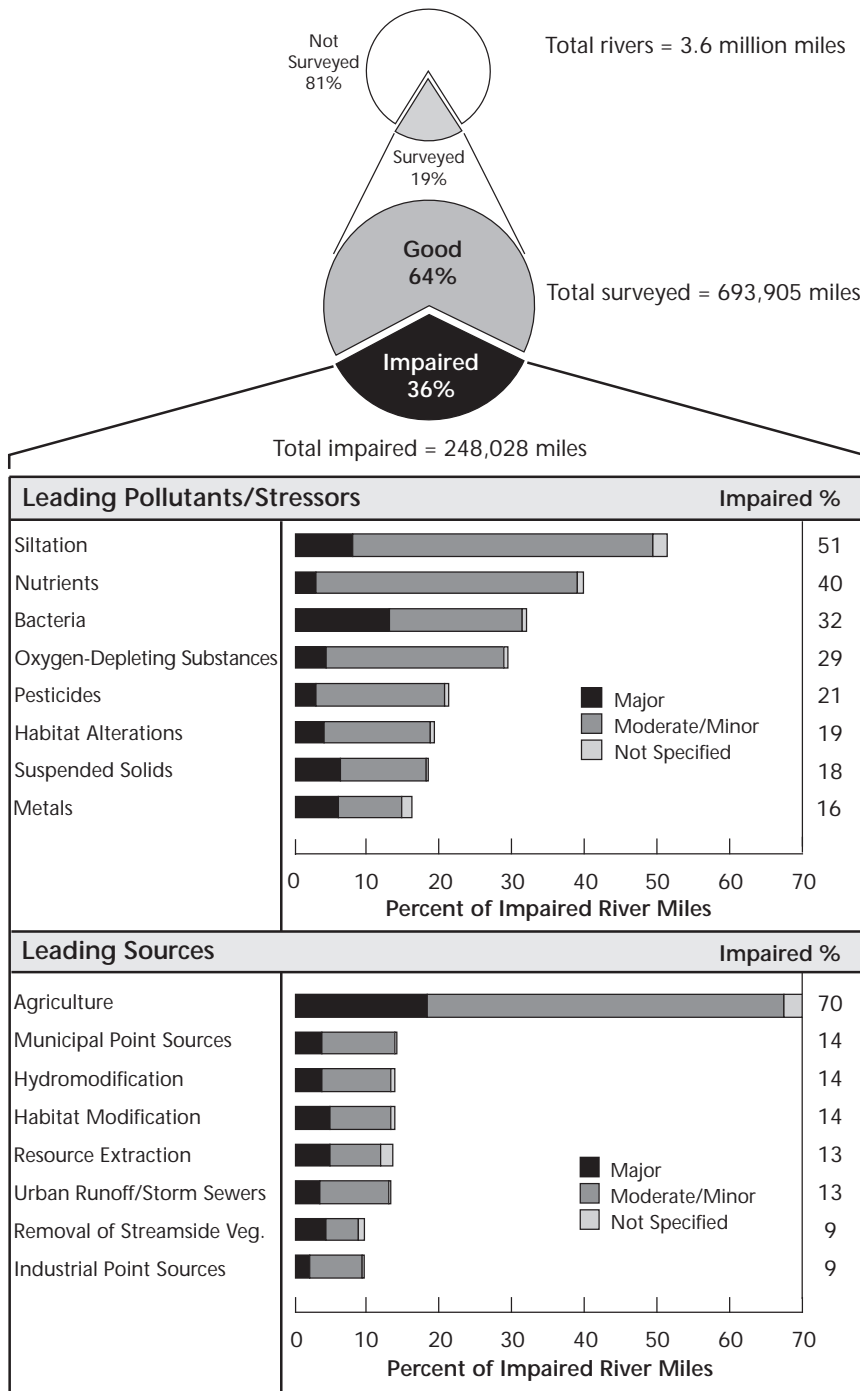


Based on data contained in Appendix A, Tables A-4 and A-5.

Note: Percentages do not add up to 100% because more than one pollutant or source may impair a river segment.

Figure 2-5

IMPAIRED River Miles: Pollutants and Sources



SILTATION is the most common pollutant affecting surveyed rivers and streams. Siltation is found in 18% of all rivers and streams surveyed (see Figure 2-4), and contributes to 51% of all the water quality problems.

Note: Percentages do not add up to 100% because more than one pollutant or source may impair a river segment.

Based on data contained in Appendix A, Tables A-4 and A-5.

and sources of impairment identified in rivers. It is important to note that the information about pollutants and sources is incomplete because the States do not identify the pollutant or source of pollutants responsible for every impaired river segment.

In some cases, a State may recognize that water quality does not fully support a designated use, but the State may not have adequate data to document that a specific pollutant or process is responsible for the impairment. Sources of impairment are even more difficult

to identify than pollutants and processes.

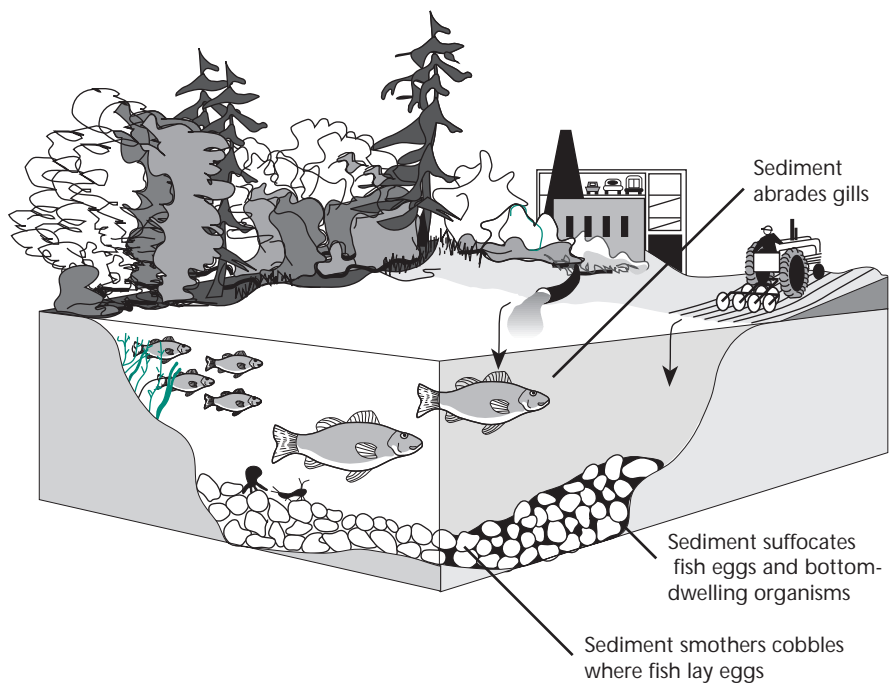
Pollutants and Stressors Impacting Rivers and Streams

Fifty-one States and Tribes reported the number of river miles impacted by individual pollutants and stressors, such as invasion by exotic species (see Appendix A, Table A-4, for individual State and Tribal information). EPA ranks the pollutants and stressors by the geographic extent of their impacts on aquatic life and human activities (i.e., the number of river miles impaired by each pollutant or stressor) rather than actual pollutant loads in rivers and streams. This approach targets the pollutants and stressors causing the most harm to aquatic life and public use of our waters, rather than the most abundant pollutants in our rivers and streams.

The States and Tribes report that siltation, composed of tiny soil particles, remains one of the most widespread pollutants impacting rivers and streams, impairing 126,763 river miles (18% of the surveyed river miles). Siltation alters aquatic habitat and suffocates fish eggs and bottom-dwelling organisms (see Figure 2-6). Aquatic insects live in the spaces between cobbles, but their habitat is destroyed when silt fills in these spaces. The loss of aquatic insects adversely impacts fish and other wildlife that eat these insects. Excessive siltation can also interfere with drinking water treatment processes and recreational use of a river. Sources of siltation include

Figure 2-6

The Effects of Siltation in Rivers and Streams



Siltation is one of the leading pollution problems in the Nation's rivers and streams. Over the long term, unchecked siltation can alter habitat with profound adverse effects on aquatic life. In the short term, silt can kill fish directly, destroy spawning beds, and increase water turbidity resulting in depressed photosynthetic rates.

agriculture, urban runoff, construction, and forestry.

Nutrient pollution emerges as a significant cause of water quality impairment in the 1996 305(b) reports, with States and Tribes reporting impacts to 98,040 river miles (14% of the surveyed river miles). While nutrient pollution has commonly been a problem in the Nation's lakes and ponds (see Chapter 3), water quality managers have given significant attention to its effects on rivers and streams, particularly those that flow to sensitive estuarine and coastal waters (see Chapter 4). Excessive levels of nitrogen and phosphorus may accelerate growth of algae and underwater plants, depleting the water column of dissolved oxygen necessary to maintain populations of fish and desirable plant species. Nutrients may enter surface waters from municipal and industrial wastewater treatment discharges and runoff from agricultural lands, forestry operations, and urban areas.

The States and Tribes also report that bacteria (pathogens) pollute 79,820 river miles (12% of the surveyed river miles). Bacteria provide evidence of possible fecal contamination that may cause illness if the public ingests the water. States use bacterial indicators to determine if rivers are safe for swimming and drinking. Bacteria commonly enter surface waters in inadequately treated sewage, fecal material from wildlife, and runoff from pastures, feedlots, and urban areas.

In addition to siltation, nutrients, and bacteria, the States and Tribes also reported that oxygen-depleting substances, pesticides,

habitat alterations, suspended solids, and metals impact more miles of rivers and streams than other pollutants and stressors. Often, several pollutants and processes impact a single river segment. For example, a process such as removal of shoreline vegetation may accelerate erosion of sediment and nutrients into a stream. In such cases, the States and Tribes count a single mile of river under each pollutant and process category that impacts the river mile. Therefore, the river miles impaired by each pollutant or process do not add up to 100% in Figures 2-4 and 2-5.

Most States and Tribes also rate pollutants and processes as major or moderate/minor contributors to impairment. A major pollutant or process is solely responsible for an impact or predominates over other pollutants and processes. A moderate/minor pollutant or process is one of multiple pollutants and processes that degrade aquatic life or interfere with human use of a river.

Currently, EPA ranks pollutants and processes by the geographic extent of their impacts (i.e., the number of miles impaired by each pollutant or process). However, less abundant pollutants or processes may have more severe impacts on short stream reaches. For example, a toxic chemical spill can eliminate aquatic life in a short stream while widely distributed bacteria do not affect aquatic life but occasionally indicate a potential human health hazard from swimming. The individual State and Tribal 305(b) reports provide more detailed information about the severity of pollution in specific locations.

It is relatively easy to collect a water sample and identify pollutants causing impairments, such as fecal coliform bacteria indicating pathogen contamination. However, detecting and ranking sources of pollutants can require monitoring pollutant movement from numerous potential sources, such as failing septic systems, agricultural fields, urban runoff, municipal sewage treatment plants, and local waterfowl populations. Often, States are not able to determine the particular source responsible for impairment. In these cases, many States report the source of impairment as "unknown."

Some pollutant sources play a more significant role at a regional level.

Sources of Pollutants Impacting Rivers and Streams

Fifty-one States and Tribes reported sources of pollution related to human activities that impact some of their rivers and streams (see Appendix A, Table A-5, for individual State and Tribal information). These States and Tribes reported that agriculture is the most widespread source of pollution in the Nation's surveyed rivers. Agriculture generates pollutants that degrade aquatic life or interfere with public use of 173,629 river miles (which equals 25% of the surveyed river miles) in 50 States and Tribes (Figures 2-4 and 2-5).

Twenty-two States reported the size of rivers impacted by specific types of agricultural activities:

- **Nonirrigated Crop Production** – crop production that relies on rain as the sole source of water.
- **Irrigated Crop Production** – crop production that uses irrigation systems to supplement rainwater.
- **Rangeland** – land grazed by animals that is seldom enhanced by the application of fertilizers or pesticides, although land managers sometimes modify plant species to a limited extent.
- **Pastureland** – land upon which a crop (such as alfalfa) is raised to feed animals, either by grazing the animals among the crops or harvesting the crops. Pastureland is actively managed to encourage selected plant species to grow, and fertilizers or pesticides may be

applied more often on pastureland than rangeland.

- **Feedlots** – generally facilities where animals are fattened. By EPA's definition, feedlots are large sites where many animals are confined at high densities for market. These facilities are often located near packing plants or railroad access points.
- **Animal Holding Areas** – facilities for confining animals briefly before slaughter. By EPA's definition, animal holding areas confine fewer animals than feedlots.
- **Animal Operations** – generally livestock facilities other than large cattle feedlot operations. They may contain facilities for supplemental feeding or rearing animals, primarily poultry or swine.

Nonirrigated crop production leads the list of agricultural activities impacting rivers and streams, followed by irrigated crop production, rangeland, pastureland, feedlots, animal operations, animal holding areas, and riparian grazing (Figure 2-7). Runoff from irrigated and nonirrigated cropland may introduce commercial fertilizers (that contain nitrogen and phosphorus), pesticides, and soil particles into rivers and streams. Manure applied to cropland as a fertilizer may also wash off of irrigated and nonirrigated fields and prevent rivers and streams from fully supporting designated uses.

Sources of pollution from intensive animal operations include feedlots, animal operations, and animal holding areas. Animal waste runoff from these operations can

introduce pathogens, nutrients (including phosphorus and nitrogen), and organic material to nearby rivers and streams. Rangeland may generate both soil erosion and animal waste runoff. Pastureland usually has good ground cover that protects the soil from eroding, but pastureland can become a source of animal waste runoff if animals graze on impermeable frozen pastureland during winter. Riparian grazing may generate streambank erosion and animal waste runoff and result in modification of streamside habitat.

The States and Tribes also report that municipal sewage treatment plants pollute 35,087 river miles (5% of the surveyed river miles), hydrologic modifications degrade 34,190 river miles (5% of the surveyed river miles), habitat modifications degrade 34,127 river miles (5% of the surveyed river miles), resource extraction (e.g., mining and oil production) pollutes 33,051 river miles (5% of the surveyed river miles), urban runoff and storm sewers pollute 32,637 river miles (5% of the surveyed river miles), and removal of streamside vegetation pollutes 23,349 river miles (3% of the surveyed river miles).

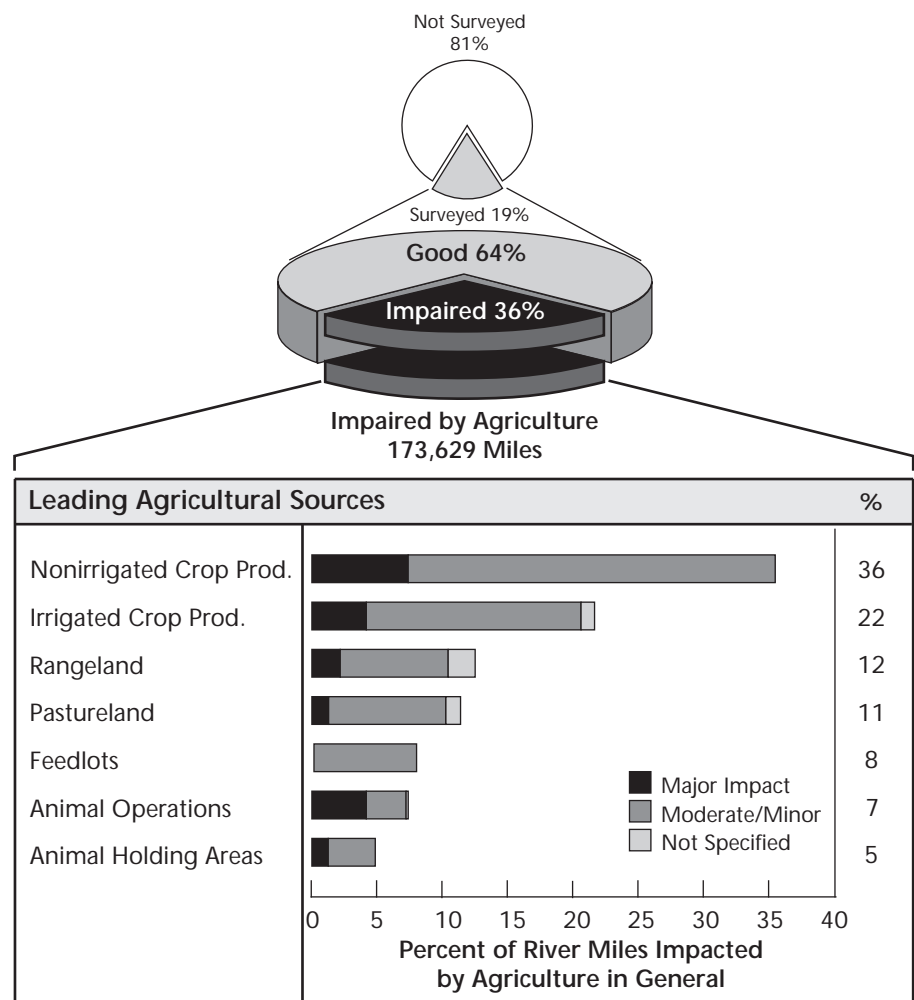
The States and Tribes also report that "natural" sources impair many miles of rivers and streams in the absence of human activities. Natural sources include soils with natural deposits of arsenic or salts that leach into waterbodies, waterfowl (a source of nutrients), and low-flow conditions and elevated water temperatures caused by drought. The total size of rivers impaired by natural sources is probably exaggerated because some States may automatically

attribute water quality impairments to natural sources if the State cannot identify a human activity responsible for a water quality problem.

Sources such as mining and forestry activities can play a more

Figure 2-7

Agricultural Impairment: Rivers and Streams (22 States Reporting Subcategories of Agricultural Sources)



Based on data contained in Appendix A, Table A-6.

Note: Percentages do not add up to 100% because more than one pollutant or source may impair a river segment.

significant role in degrading water quality at a regional or local level than at the national level. For example, resource extraction (including acid mine drainage) contributes to the degradation of 36% of the impaired river miles in the coal belt States of Kentucky, Maryland, Ohio, Pennsylvania, and West Virginia. These States report that resource extraction impairs about 6,550 miles of rivers and streams. Yet, at the national level, resource extraction contributes to the degradation of only 13% of all the impaired river miles in the Nation. At the local level, streams impacted by acid mine drainage are devoid of fish and other aquatic life due to low pH levels and the smothering effects of iron and other metals deposited on stream


beds. The primary sources of acid mine drainage are abandoned coal refuse disposal sites and surface and underground mines.

In the Pacific Northwest State of Washington, water quality managers identify forestry activities as responsible for almost a third (32%) of the impaired river miles, but, at the national level, States report that forestry activities contribute to the degradation of only 7% of the Nation's total impaired river miles. Forestry activities include harvesting timber, constructing logging roads, and stand maintenance. California, Florida, Louisiana, Mississippi, Montana, and West Virginia also report that forestry activities degrade over 1,000 miles of streams in each State.

Many States reported declines in pollution from sewage treatment plants and industrial discharges since enactment of the Clean Water Act in 1972. The States attributed improvements in water quality conditions to sewage treatment plant construction and upgrades and permit controls on industrial discharges. Despite the improvements, municipal sewage treatment plants remain the second most common source of pollution in rivers because population growth increases the burden on our municipal facilities.

Several States reported that they detected more subtle impacts from nonpoint sources, hydrologic modifications, and habitat

alterations as they reduced conspicuous pollution from point sources. Hydrologic modifications and habitat alterations are a growing concern to the States. Hydrologic modifications include activities that alter the flow of water in a stream, such as channelization, dewatering, and damming of streams. Habitat alterations include removal of streamside vegetation that protects the stream from high temperatures and scouring of stream bottoms. Additional gains in water quality conditions that address these concerns will be more subtle and require innovative management strategies that go beyond point source controls.





Maryland Biological Stream Survey

The Maryland Biological Stream Survey (MBSS), initiated by the Maryland Department of Natural Resources in 1993, is one of the first statewide probability-based monitoring networks in the United States. The MBSS is intended to provide environmental decision-makers with the information they need to most effectively design

policies to protect and restore Maryland's rivers and streams.

The MBSS is different from most other stream monitoring surveys in Maryland for three reasons. First, the probability-based sampling design allows accurate estimates of variables, such as the number of miles of stream with degraded habitat, that can be extrapolated to the watershed, drainage basin, or statewide level. The design also permits reliable estimation of sampling variance, so that estimates of status can be made with quantifiable confidence. Second, MBSS monitoring and assessments focus on biological indicators of response to stress; measures of pollutant stress and habitat condition are taken simultaneously to provide a context for interpreting biological response. MBSS fish abundance estimates allow the State to track the population of a living resource. Third, the scale of MBSS is basinwide and statewide, rather than site-specific.

To meet its objectives, the MBSS has established a list of questions of interest to environmental decisionmakers. The survey is designed to answer these questions. Examples include:

Fishability

- What is the size range of smallmouth bass in third-order streams in the Patuxent basin? How many legal size smallmouth per mile of stream are there?
- What percentage of first- and second-order streams in the Patapsco basin support natural reproduction of brown trout?

Biological Integrity

- Does the percentage of streams with nonsupporting or partially supporting habitat differ among basins in the State?
- Rare or endangered fish or amphibian species are most likely to occur in what size of stream and in what basins of the State? What is the "best" basin for nongame species? The worst?

Holistic

- Based on their observed impacts, which anthropogenic stressors need to receive intensified management and enforcement activities?
- What types of land use are compatible with preventing the deterioration of water quality and stream resources?

Objectives and Questions

The primary objectives of the MBSS are to assess the current status of biological resources in Maryland's nontidal streams and establish a benchmark for long-term monitoring of trends. The secondary



objectives of the survey are to quantify the extent to which acidic deposition has affected or may be affecting critical biological resources in the State; examine which other water quality, physical habitat, and land use factors are important in explaining the current status of biological resources in streams; and focus habitat protection and restoration activities.

Sampling Design

One common problem to many monitoring projects is that there is often no scientifically rigorous basis for extrapolating monitoring results beyond individual sampling sites. MBSS employs a special probability-based design called lattice sampling to schedule sampling of basins over a 3-year period. This design optimizes the efficiency of field efforts by minimizing the travel time between sampling locations.

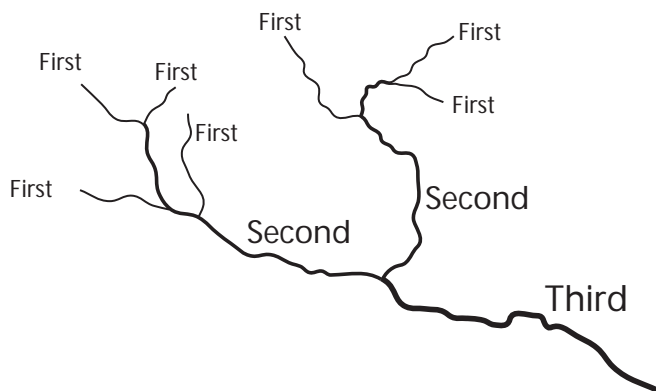
The MBSS study area is divided into three geographic regions with five to seven basins each: western, central, and eastern. Each basin is sampled at least once during a given 3-year cycle, and all basins have some probability of being resampled.

The MBSS survey design is based on random selections from all streams in the State that can be

physically sampled. Sampling within each basin is restricted to nontidal, first-, second-, and third-order stream reaches (i.e., headwater streams), excluding unwadeable or otherwise unsamplable areas. Stream reaches are further divided into nonoverlapping 75-meter segments for sampling.

About 300 stream segments are selected for sampling each year. An approximately equal number of segments are selected from each of the three stream orders across basins. Within each basin, segments

Each basin consists of many watersheds with varying degrees of complexity. The smallest permanent flowing stream in a watershed is termed first-order, and the union of two first-order streams creates a second-order stream. A third-order is formed where two second-order streams join.





are randomly selected from the three stream orders, with the number of segments selected for a particular stream order approximately proportional to the number of stream miles in the basin. For example, if Basin A has 200 miles of first-order streams, and Basin B has 100 miles of first-order streams, twice as many first-order segments are randomly selected from Basin A as from Basin B.

This type of study design, often referred to as subsampling with units of unequal size, allows the estimation of summary statistics (e.g., means and proportions) for the entire basin, or for subpopulations of special interest.

Data Collection and Measurement

The MBSS field studies involve collecting biological, physical habitat, and water quality data. Biological measurements include abundance, size, and health of fish; taxa composition of benthic invertebrates; and presence of herpetofauna (reptiles and amphibians). Water chemistry samples include pH, acid-neutralizing capacity (ANC), sulfate, nitrate, conductivity, and dissolved organic carbon (DOC). Physical habitat measurements include stream gradient, maximum depth, wetted width, streamflow (discharge), embeddedness, in-stream habitat structure, pool and riffle

quality, bank stability, shading, and riparian vegetation. Other qualitative habitat parameters include aesthetic value, remoteness, and land use, based on the surrounding area immediately visible from the segment.

Results

The major findings of MBSS projects to date include:

- Low pH and low ANC streams were primarily limited to the eastern shore and to the mountainous western portion of the State.
- Moderate sulfate and relatively low DOC values throughout the State suggest that acidic deposition is far more prevalent as a source of low ANC than is acid mine drainage.
- The abundance and diversity of fish was positively related to ANC.
- Fish surveys detected a wider distribution of several fish species than have been reported previously, and two species thought to be extirpated were collected.
- In four of the six basins sampled during 1995, more than 40% of stream miles were acidic or acid-sensitive ($\text{ANC} \leq 200 \mu\text{eq/L}$).



- In four of the six basins sampled during 1995, more than 50% of stream miles had in-stream habitat structure in poor to marginal condition.
- A large percentage of streams sampled had impaired physical habitat.

For Further Information

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Lakes, Reservoirs, and Ponds

Forty-five States, Puerto Rico, and the District of Columbia (hereafter collectively referred to as States), and one Tribe rated lake water quality in their 1996 Section 305(b) reports (see Appendix B, Table B-1, for individual State and Tribal data). These States and Tribes surveyed over 16.8 million acres of lakes, reservoirs, and ponds, which equals 40% of the 41.7 million acres of lakes in the Nation (Figure 3-1). The States and Tribes based 74% of their survey on monitored data and evaluated 20% of the surveyed lake acres with qualitative information (including best professional judgment by water quality managers). The States did not specify whether the remaining 7%

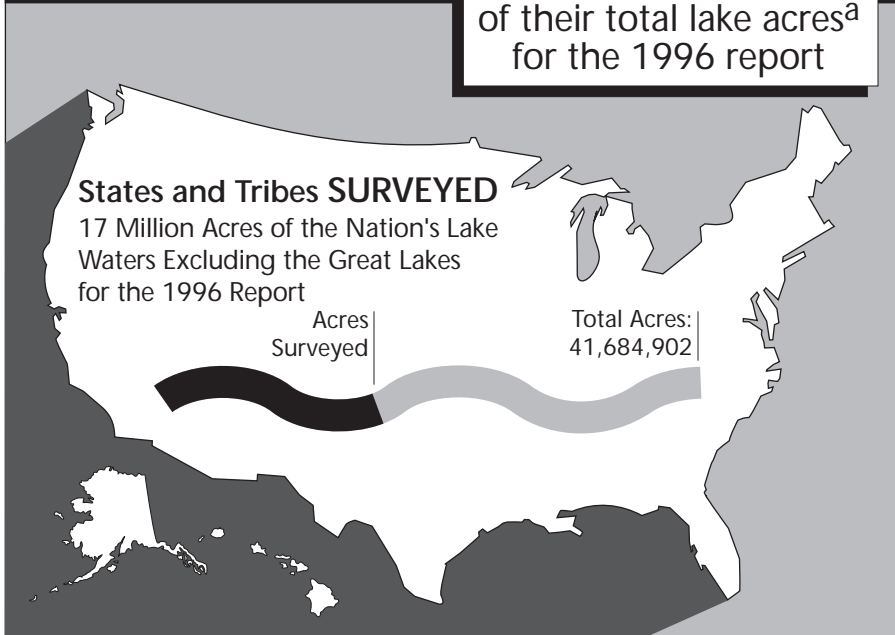
of the surveyed lake acres were monitored or evaluated.^a

The number of surveyed lake acres declined from 17.1 million acres to 16.8 million acres between 1994 and 1996. Although California surveyed almost 300,000 additional lake acres in 1996 due to refined lake size estimates and new monitoring, a number of States, including Nevada, Washington, and Wisconsin, surveyed significantly fewer lakes. Funding issues forced Nevada to limit lake sampling to

THE STATES SURVEYED nearly 17 million acres of lakes for 1996.

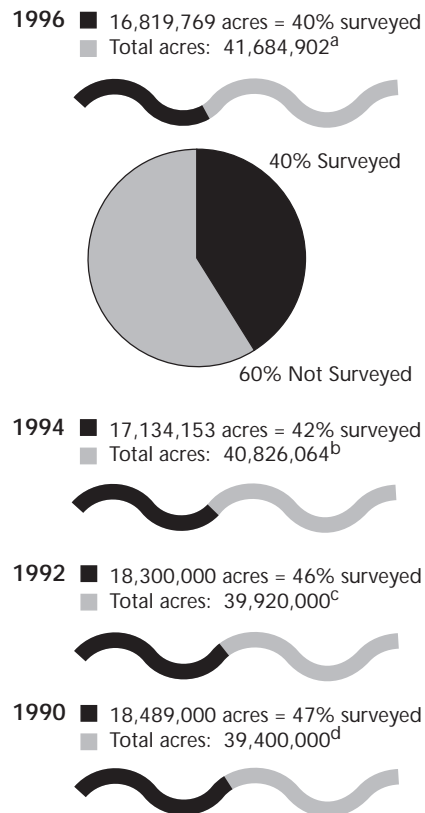
States and Tribes SURVEYED 40%
of their total lake acres^a
for the 1996 report

Figure 3-1



Based on data contained in Appendix B, Table B-1.

Lake, Reservoir, and Pond Acres Surveyed by the States and Tribes



^aSource: 1996 State and Tribal Section 305(b) reports.
^bSource: 1994 State and Tribal Section 305(b) reports.
^cSource: 1992 State and Tribal Section 305(b) reports.
^dSource: *National Water Quality Inventory: 1990 Report to Congress*, U.S. EPA, 1992.

Note: Figures do not add to 100% due to the rounding of individual numbers.

**61% OF SURVEYED
lake acres have good
water quality.**

only those lakes near routine sampling locations on rivers and streams. Due to staffing concerns, Washington State was only able to use water quality data collected internally at the Department of Ecology. In previous years the State incorporated data from other agencies into their 305(b) reports. Wisconsin now surveys its lakes as part of the State's 5-year basin planning cycle. Although the number of lakes assessed varies from year to year, Wisconsin surveys almost all the lakes in its monitoring program over the 5-year cycle.

Differences in State survey methods undermine comparisons of lake information submitted by individual States. Lake data should not be compared among States, which devote varying resources to monitoring biological integrity, water chemistry, and toxic pollutants in fish tissues. The discrepancies in State monitoring and survey methods, rather than actual differences in water quality, often account for the wide range in water quality ratings reported by the States.

The summary information presented in this chapter applies strictly to the portion of the Nation's lakes surveyed by the States and Tribes. EPA cannot make generalizations about the health of all of our Nation's lakes based on data extracted from the 305(b) reports because most States and Tribes rate their waters with information obtained from water monitoring programs designed to detect degraded waterbodies. Very few States or Tribes randomly select water sampling sites to represent a cross section of water quality conditions in their jurisdiction. Instead, many States and Tribes

direct their limited monitoring resources toward waters with suspected problems. As a result, the surveyed lakes probably contain a higher percentage of polluted waters than all of the Nation's lakes.

Summary of Use Support

The States and Tribes rate whether their water quality is good enough to fully support a healthy community of aquatic organisms and human activities, such as swimming, fishing, and drinking water use. The States and Tribes designate individual lakes for specific activities, termed "individual designated uses." EPA and the States use the following terminology to rate their water quality:

- **Good/Fully Supporting:** Good water quality supports a diverse community of fish, plants, and aquatic insects, as well as the array of human activities assigned to a lake by the State.
- **Good/Threatened:** Good water quality currently supports aquatic life and human activities in and on the lake, but changes in such factors as land use threaten water quality, or data indicate a trend of increasing pollution in the lake.
- **Fair/Partially Supporting:** Fair water quality supports aquatic communities with fewer species of fish, plants, and aquatic insects, and/or occasional pollution interferes with human activities. For example, runoff during severe thunderstorms may temporarily elevate fecal coliform bacteria densities and indicate that swimming is not

safe immediately following summer storms.

■ **Poor/Not Supporting:** Poor water quality does not support a healthy aquatic community and/or prevents some human activities on the lake. For example, lake waters may be devoid of fish for more than a month each summer because excessive nutrients from runoff initiate algal blooms that deplete oxygen concentrations.

■ **Not Attainable:** The State has performed a use-attainability analysis and demonstrated that use support of one or more designated beneficial uses is not attainable due to one of six specific biological, chemical, physical, or economic/ social conditions (see Chapter 1 for additional information).

Most States and Tribes rate how well a lake supports individual uses (such as swimming and aquatic life) and then consolidate individual use ratings into a summary table. This table divides lake acres into those fully supporting all of their uses, those fully supporting all uses but threatened for one or more uses, and those impaired for one or more uses (see Chapter 1 for a complete discussion of use support).

Forty-two States, one Tribe, Puerto Rico, and the District of Columbia reported summary use support status for lakes in their 1996 Section 305(b) reports (see Appendix B, Table B-2, for individual State and Tribal information). Another four States reported individual use support status but did not report summary use support status. In such cases, EPA used aquatic life use support status or

swimming use support status to represent general water quality conditions in the State's lakes.

It is important to note that four States did not include the effects of statewide fish consumption advisories for mercury when calculating their summary use support status. New Hampshire, Michigan, South Carolina, and Vermont excluded the impairment associated with statewide mercury advisories in order to convey information that would have been otherwise masked by the fish consumption advisories. If these advisories had been included, all of the States' waters would receive an impaired rating. (See discussion of mercury in "Pollutants Impacting Lakes, Reservoirs, and Ponds" on page 55.)

The States and Tribes reported that 61% of their surveyed 16.8 million lake acres have good water quality (Figure 3-2). Waters with

Surveyed Waters

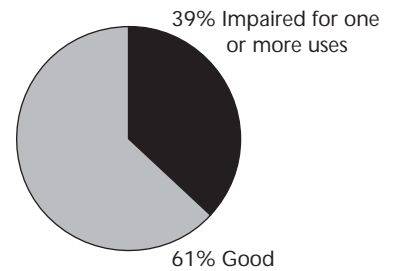
Total lakes = 41,684,902 acres^a
 Total surveyed = 16,819,769 acres^b



Of the surveyed acres:^c

- 20% were monitored
- 74% were evaluated
- 7% were not specified

Surveyed Water Quality

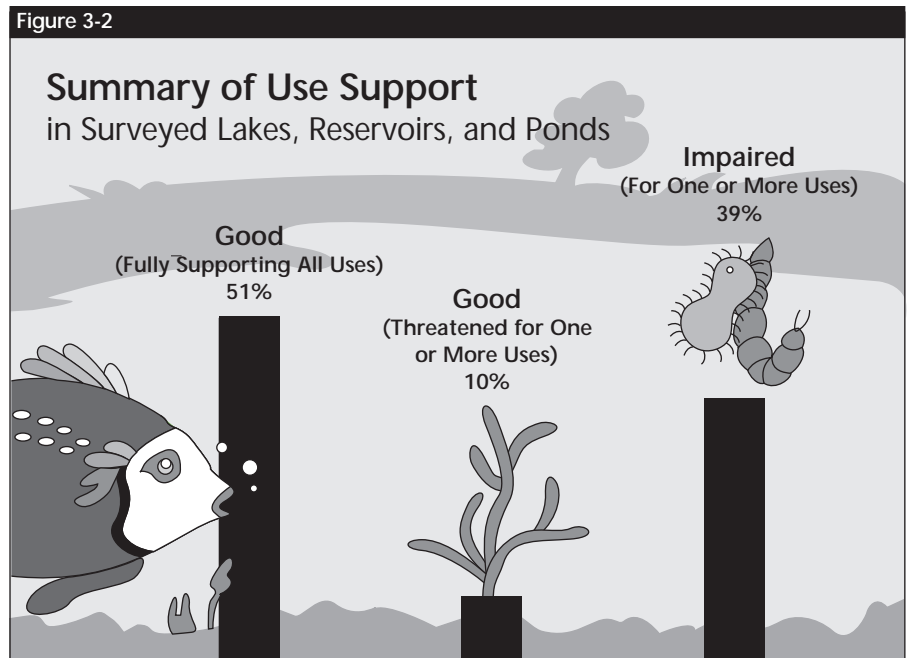


^aSource: 1996 State and Tribal Section 305(b) reports.

^bDoes not include acres assessed as not attainable (<0.01% of total lakes).

^cFigures may not add to 100% due to rounding.

Figure 3-2



Based on data contained in Appendix B, Table B-2.

**39% OF SURVEYED
lake acres are
impaired for one
or more uses**

good quality include 51% of the surveyed lake acres that fully support all uses and 10% of the surveyed lake acres that fully support all uses but are threatened for one or more uses and might deteriorate if we fail to manage potential sources of pollution. Some form of pollution or habitat degradation impairs the remaining 39% of the surveyed lake acres.

Individual Use Support

Individual use support information provides additional detail about water quality problems in our Nation's surface waters. The States and Tribes are responsible for designating their lakes for specific uses, but EPA requests that the States and Tribes rate how well their lakes support six standard uses so that EPA can summarize the State and Tribal data. The standard uses consist of aquatic life support, fish consumption, primary contact recreation (such as swimming and diving), secondary contact recreation (such as boating), drinking water supply, and agricultural use (see Chapter 1 for a description of each individual use).

Forty-two States, one Tribe, Puerto Rico, and the District of Columbia reported individual use support status of their lakes, reservoirs, and ponds (see Appendix B, Table B-3, for individual State and Tribal information). The reporting States and Tribes rated aquatic life use and swimming use in more lakes and identified more impacts on aquatic life use and swimming use than the other individual uses (Figure 3-3). These States and

governments reported that fair or poor water quality impacts aquatic life in over 4.4 million lake acres (31% of the 14.2 million acres surveyed for aquatic life support), and swimming criteria violations impact 3.8 million lake acres (24% of the 15.4 million acres surveyed for swimming use support).

Many States and Tribes did not rate fish consumption use support because they have not codified fish consumption as a use in their standards. Some of these States consider fishing use as a component of aquatic life use—lakes that provide a healthy habitat for fish support fishing activities even though anglers may not be able to eat their catch in these States. EPA encourages the States to designate fish consumption as a separate use in their waterbodies to promote consistency in future reporting.

Water Quality Problems Identified in Lakes, Reservoirs, and Ponds

Figures 3-4 and 3-5 identify the pollutants/stressors and sources of pollutants that impair (i.e., prevent from fully supporting designated uses) the most acres of lakes, as reported by the States. The two figures are based on the same data (contained in Appendix B, Tables B-4 and B-5), but each figure provides a different perspective on the extent of impairment attributed to individual pollutants/stressors and sources. Figure 3-4 shows the relative impact of the leading pollutants/stressors and sources in all surveyed lakes. Figure 3-5 presents

the relative impact of the leading pollutants/stressors and sources in lakes with identified problems (i.e., impaired lakes), a subset of surveyed lakes.

The following sections describe the leading pollutants/stressors and sources of impairment identified in lakes. It is important to note that the information about pollutants/stressors and sources is incomplete because the States do not identify the pollutants/stressors or source of pollutants impairing every impaired lake. In some cases, a State may recognize that water quality does not fully support a designated use, but the State may not have adequate data to document that a specific pollutant or stressor is responsible for the impairment. Sources are even more difficult to identify than pollutants and stressors.

Pollutants Impacting Lakes, Reservoirs, and Ponds

Forty-one States, the District of Columbia, and Puerto Rico reported the number of lake acres impacted by individual pollutants and processes, such as invasions by noxious aquatic plants (see Appendix B, Table B-4, for individual State and Tribal information). EPA measures the impact of each pollutant or process by summing the total lake acres impaired (i.e., not fully supporting designated uses) by each pollutant or process. EPA ranks the pollutants and processes by the extent of their impacts on aquatic life and human activities rather than actual pollutant loads in lakes. This approach targets the pollutants and processes causing the most harm to aquatic life and public use of our

waters rather than the most abundant pollutants in our lakes, reservoirs, and ponds.

The States, District of Columbia, and Puerto Rico identified more lake acres polluted by nutrients and metals than any other pollutants or processes (Figures 3-4 and 3-5). They

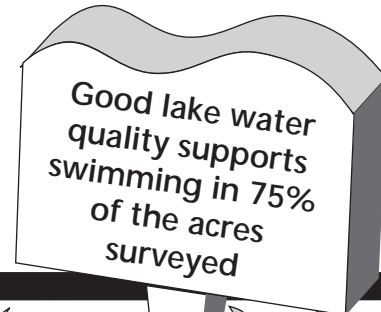
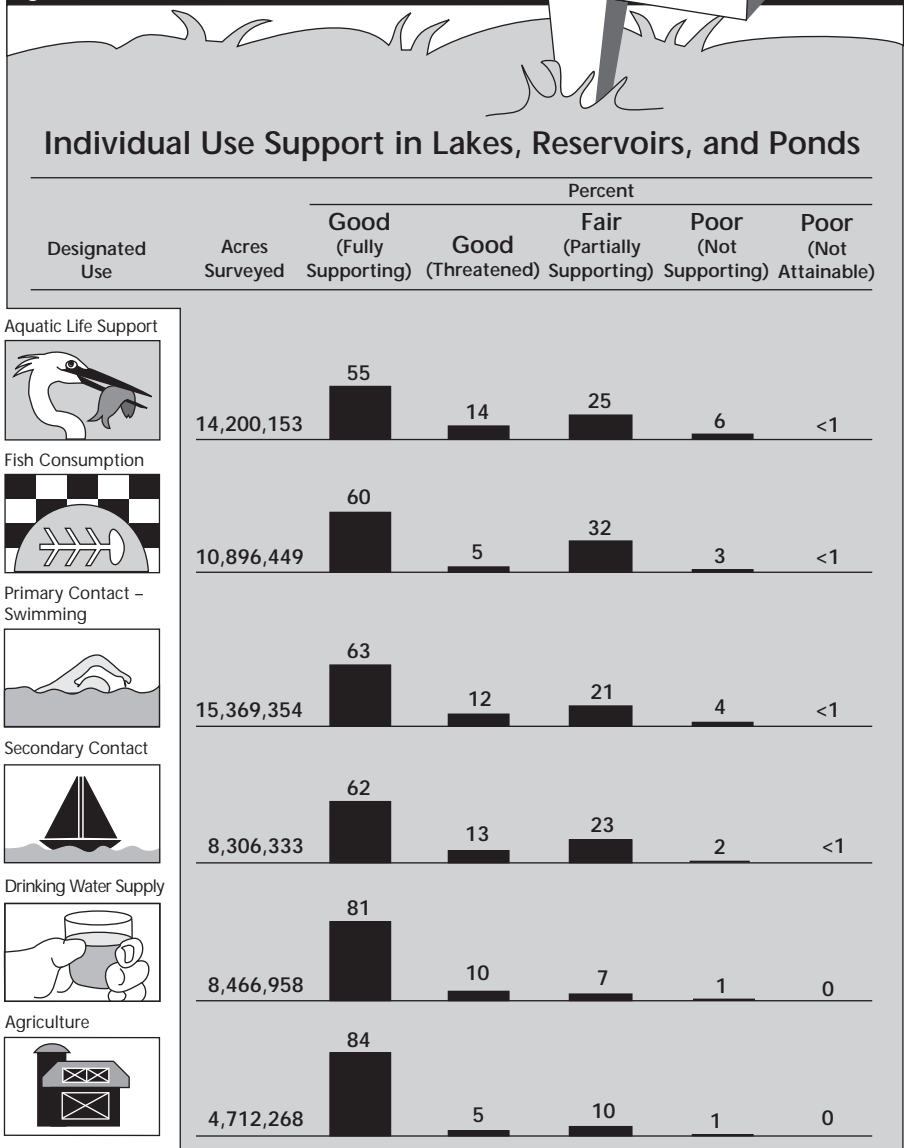


Figure 3-3



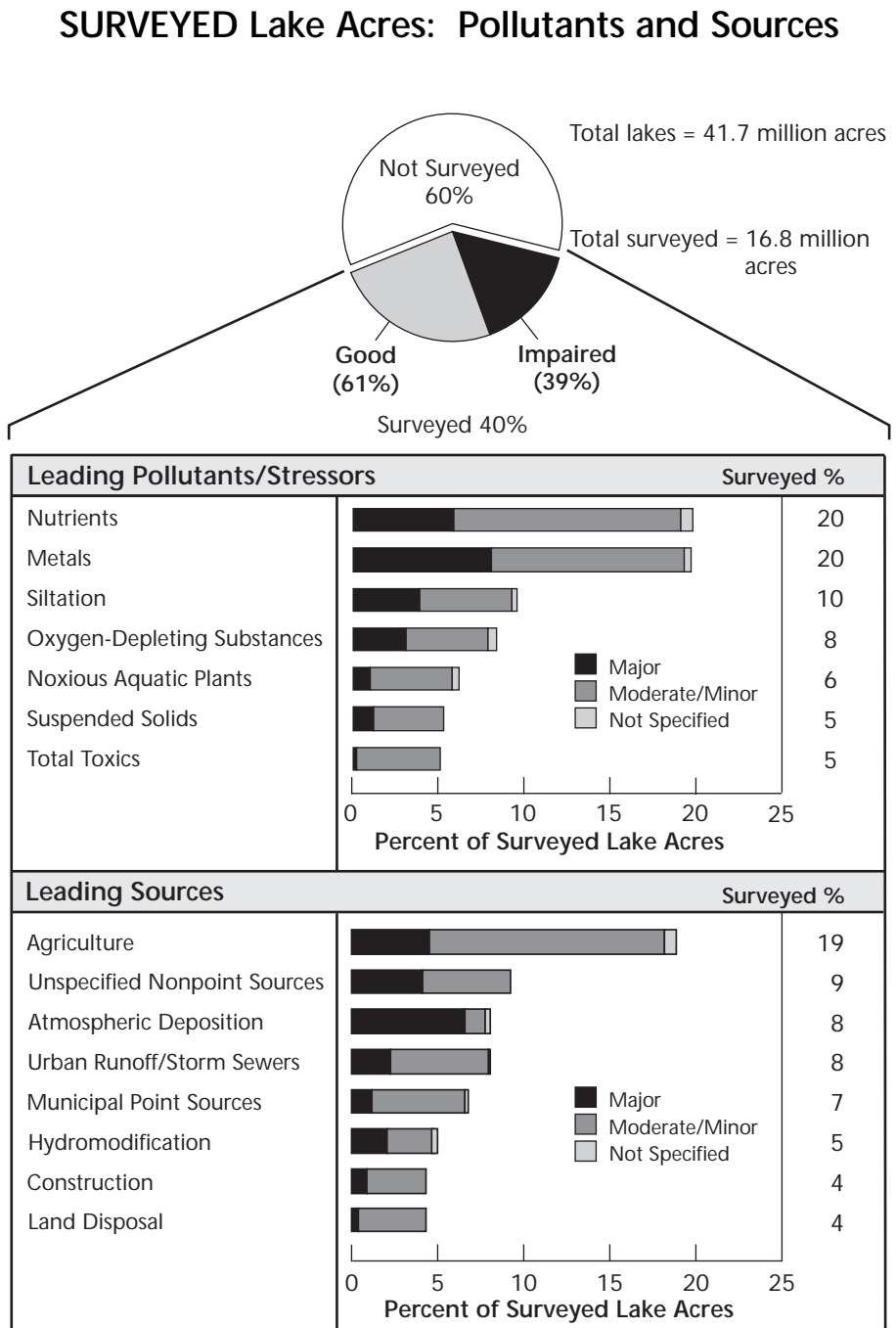
Based on data contained in Appendix B, Table B-3.

Figure 3-4

The pollutants/processes and sources shown here may not correspond directly to one another (i.e., the leading pollutant may not originate from the leading source). This may occur for a number of reasons, such as a major pollutant may be released from many minor sources or States may not have the information to determine all the sources of a particular pollutant/stressor.

AGRICULTURE is the leading source of pollution in surveyed lakes. According to the States, agricultural pollution problems

- affect 19% of all lakes surveyed, and
- contribute to 49% of all water quality problems identified (see Figure 3-5).

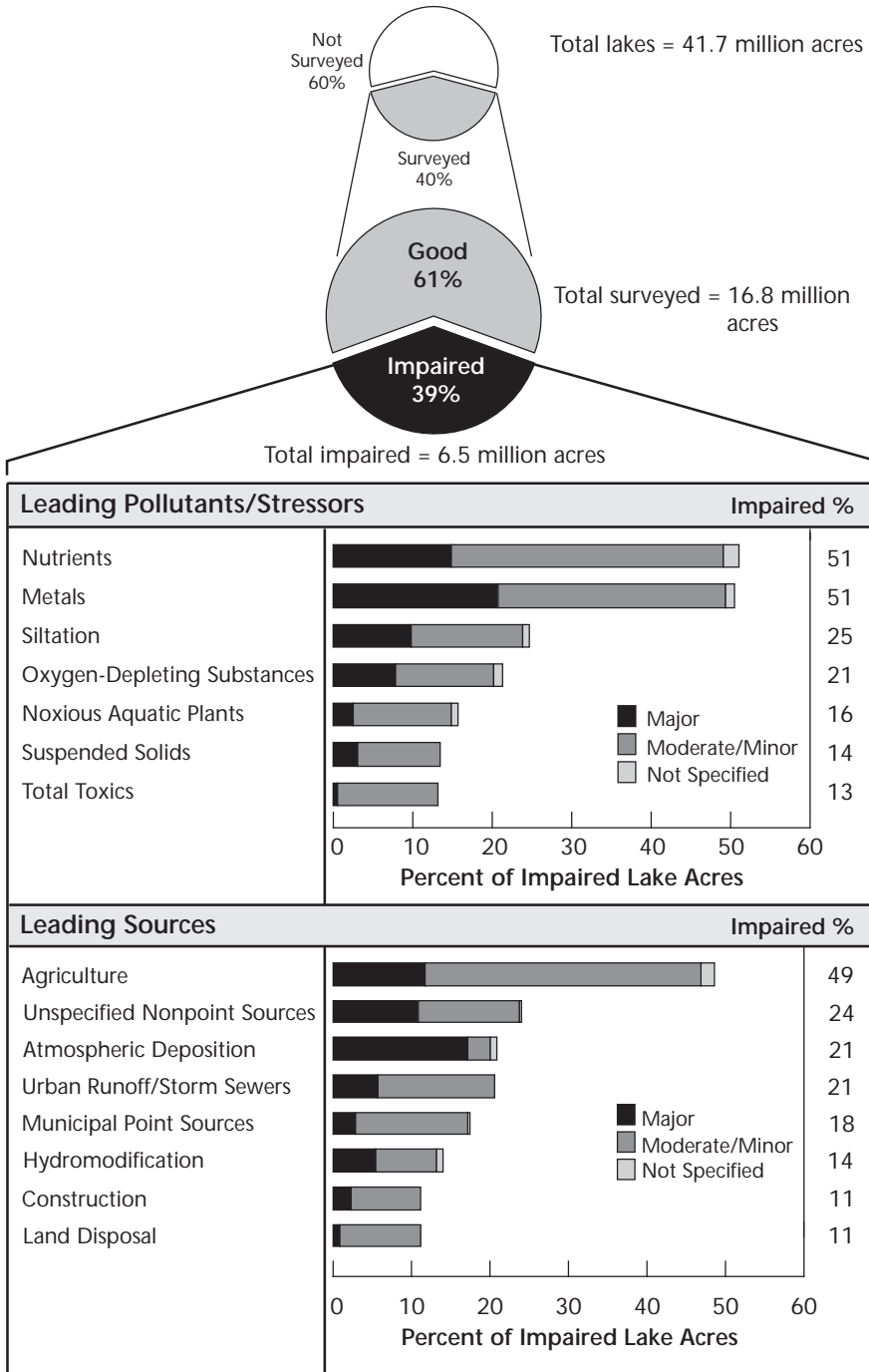


Based on data contained in Appendix B, Tables B-4 and B-5.

Note: Percentages do not add up to 100% because more than one pollutant or source may impair a lake.

Figure 3-5

IMPAIRED Lake Acres: Pollutants and Sources



NUTRIENTS AND METALS are the most common pollutants affecting surveyed lakes. Nutrients and metals

- are found in 20% of all lakes surveyed (see Figure 3-4), and
- contribute to 51% of all the water quality problems identified in lakes.

Note: Percentages do not add up to 100% because more than one pollutant or source may impair a lake.

Based on data contained in Appendix B, Tables B-4 and B-5.

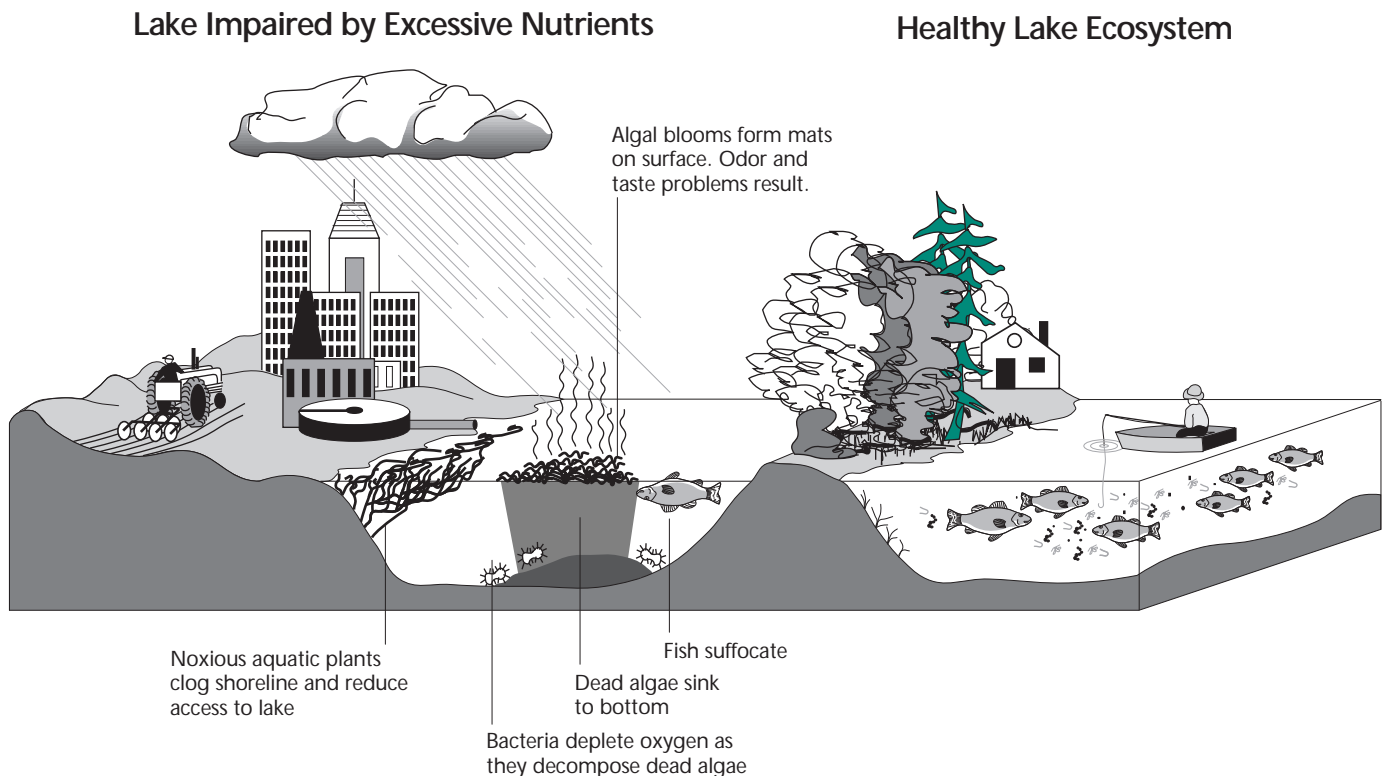
reported that metals and excess nutrients pollute 3.3 million lake acres (which equals 20% of the surveyed lake acres and 51% of the impaired lake acres).

Healthy lake ecosystems contain nutrients in small quantities from natural sources, but extra inputs of nutrients (primarily nitrogen and phosphorus) unbalance lake ecosystems (Figure 3-6). When temperature and light conditions are favorable, excessive nutrients stimulate population explosions of undesirable algae and aquatic weeds. The algae sink to the lake

bottom after they die, where bacteria consume the available dissolved oxygen as the bacteria decompose the algae. Fish kills and foul odors may result if dissolved oxygen is depleted.

States consistently report metals as a major cause of impairment to lakes. This is mainly due to the widespread detection of mercury in fish tissue samples. It is difficult to measure mercury in ambient water so most States rely on fish samples to indicate mercury contamination, since mercury bioaccumulates in tissue. States are

Figure 3-6



Nutrients cause nuisance overgrowth of algae as well as noxious aquatic plants, which leads to oxygen depletion via plant respiration and microbial decomposition of plant matter. If not properly managed and controlled, sources such as agriculture, industrial activities, municipal sewage, and atmospheric deposition can contribute to excessive nutrients in lakes.

actively studying the extent of the mercury problem, which is complex because it involves atmospheric transport from power-generating facilities and other sources.

In addition to nutrients and metals, the States, Puerto Rico, and the District of Columbia report that siltation pollutes 1.6 million lake acres (10% of the surveyed lake acres), enrichment by organic wastes that deplete oxygen impacts 1.4 million lake acres (8% of the surveyed lake acres), and noxious aquatic plants impact 1.0 million acres (6% of the surveyed lake acres).

Often, several pollutants and processes impact a single lake. For example, a process such as removal of shoreline vegetation may accelerate erosion of sediment and nutrients into a lake. In such cases, the States and Tribes count a single lake acre under each pollutant and process category that impacts the lake acre. Therefore, the lake acres impaired by each pollutant and process do not add up to 100% in Figures 3-4 and 3-5.

Most States and Tribes also rate pollutants and processes as major or moderate/minor contributors to impairment. A major pollutant or process is solely responsible for an impact or predominates over other pollutants and stressors. A moderate/minor pollutant or stressor is one of multiple pollutants and stressors that degrade aquatic life or interfere with human use of a lake. The States report that metals are the most widespread major cause of impairment in lakes.

Currently, EPA ranks pollutants and stressors by the geographic extent of their impacts (i.e., the number of lake acres impaired by

each pollutant or process). However, less abundant pollutants or processes may have more severe impacts than the leading pollutants listed above. For example, extreme acidity (also known as low pH) can eliminate fish in isolated lakes, but acid impacts on lakes are concentrated in northeastern lakes and mining States and are not widespread across the country as a whole. The individual State 305(b) reports provide more detailed information about the severity of pollution in specific locations.

Sources of Pollutants Impacting Lakes, Reservoirs, and Ponds

Forty-one States, the District of Columbia, and Puerto Rico reported sources of pollution related to human activities that impact some of their lakes, reservoirs, and ponds (see Appendix B, Table B-5, for individual State information). These States and Puerto Rico reported that agriculture is the most widespread source of pollution in the Nation's surveyed lakes (Figures 3-4 and 3-5). Agriculture generates pollutants that degrade aquatic life or interfere with public use of 3.2 million lake acres (19% of the surveyed lake acres).

The States and Puerto Rico also reported that unspecified nonpoint sources pollute 1.6 million lake acres (9% of the surveyed lake acres), atmospheric deposition of pollutants impairs 1.4 million lake acres (8% of the surveyed lake acres), urban runoff and storm sewers pollute 1.4 million lake acres (8% of the surveyed lake acres), municipal sewage treatment plants pollute 1.2 million lake acres

(7% of the surveyed lake acres), and hydrologic modifications degrade 924,000 lake acres (6% of the surveyed lake acres). Many more States reported lake degradation from atmospheric deposition in 1996 than in past reporting cycles. This is due, in part, to a growing awareness of the magnitude of the atmospheric deposition problem. Researchers have found significant impacts to ecosystem and human health from atmospherically delivered pollutants. See the "Great Waters Program" section of

Chapter 12 for additional information on atmospheric deposition.

The States, the District of Columbia, and Puerto Rico listed numerous sources that impact several hundred thousand lake acres, including construction, land disposal of wastes, industrial point sources, onsite wastewater systems (including septic tanks), forestry activities, habitat modification, flow regulation, contaminated sediments, highway maintenance and runoff, resource extraction, and combined sewer overflows.



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Tidal Estuaries and Ocean Shoreline Waters

Rivers meet the oceans, Gulf of Mexico, and the Great Lakes in coastal waters called estuaries. This chapter describes conditions in tidal estuaries, where tides mix fresh water from rivers with saline water from the oceans and the Gulf of Mexico. Fresh water estuaries around the Great Lakes are discussed in Chapter 12.

Estuarine waters include bays and tidal rivers that serve as nursery areas for many commercial fish and most shellfish populations, including shrimp, oysters, crabs, and scallops. Most of our Nation's fish and shellfish industry relies on productive estuarine waters and their adjacent wetlands to provide healthy habitat for some stage of

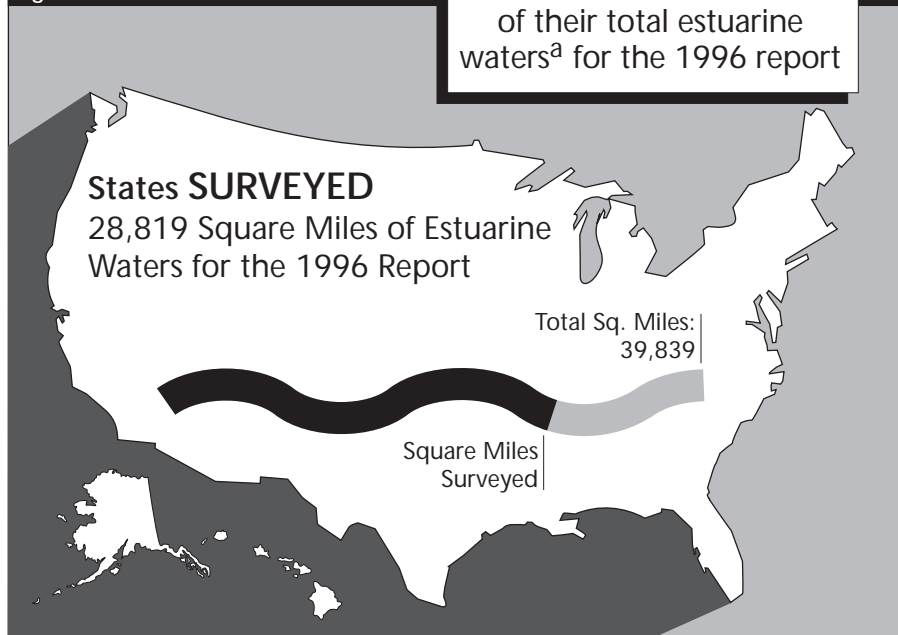
fish and shellfish development. Recreational anglers also enjoy harvesting fish that reproduce or feed in estuaries, such as striped bass and flounder.

Estuaries

Twenty-three of the 27 coastal States and other government entities (hereafter collectively referred to as States) rated general water quality conditions in some of their estuarine waters (Appendix C, Table

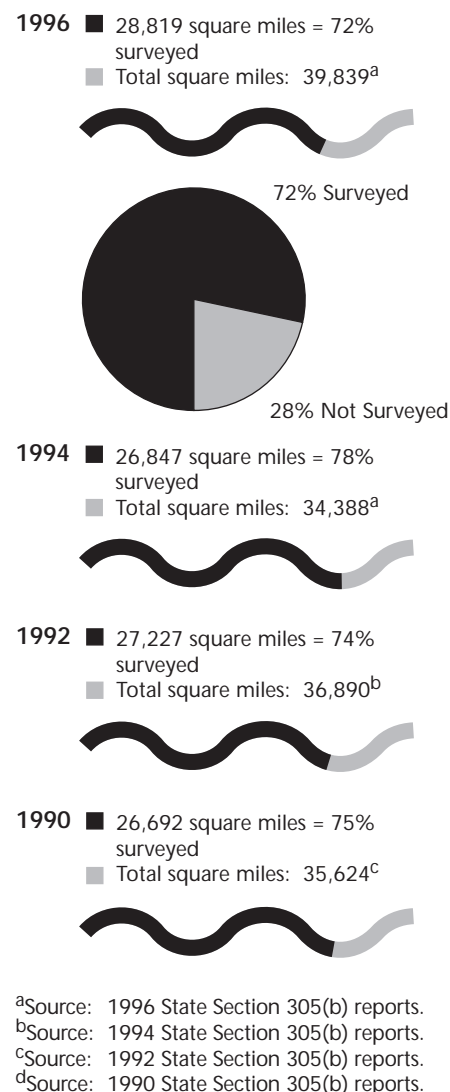
States
SURVEYED
72%
of their total estuarine
waters^a for the 1996 report

Figure 4-1



Based on data contained in Appendix C, Table C-1.

Estuaries Surveyed by States and Territories



**62% OF SURVEYED
estuaries have good
water quality.**

C-2, contains individual State data). In addition, Delaware reported individual use support status in estuarine waters but did not summarize general water quality conditions. The EPA used aquatic life use support status to represent general water quality conditions in Delaware's estuarine waters.

Altogether, these States surveyed 28,819 square miles of estuarine waters, which equals 72% of the 39,839 square miles of estuarine waters in the Nation (Figure 4-1). The States based 49% of their survey on monitored data and evaluated 35% of the surveyed estuarine waters with qualitative information (including best professional judgment by water quality managers). The States did not specify whether 16% of the surveyed estuarine waters were monitored or evaluated.

The States constantly revise their survey methods in an effort to improve their accuracy and precision. These changes limit the comparability of summary data presented herein and summary data presented in previous Reports to Congress. Similarly, discrepancies in State survey methods undermine comparisons of estuarine information submitted by individual States. Estuarine data should not be compared among States, which devote varying resources to monitoring biological integrity, water chemistry, and toxic pollutants in fish tissues. The discrepancies in State monitoring and survey methods, rather than actual differences in water quality, often account for the wide range in water quality ratings reported by individual States.

Summary of Use Support

EPA directs the States to rate whether their water quality is good enough to fully support a healthy community of aquatic organisms and human activities such as swimming, fishing, and drinking. The States designate individual estuaries for specific activities, termed "individual designated uses." EPA and the States use the following terminology to rate their water quality:

- **Good/Fully Supporting:** Good water quality supports a diverse community of fish, plants, and aquatic insects, as well as the array of human activities assigned to an estuary by the State.
- **Good/Threatened:** Good water quality currently supports aquatic life and human activities on the estuary, but changes in such features as land use threaten water quality, or data indicate a trend of increasing pollution in the estuary.
- **Fair/Partially Supporting:** Fair water quality supports aquatic communities with fewer species of fish, plants, and aquatic insects, and/or occasional pollution interferes with human activities. For example, runoff during severe thunderstorms may temporarily elevate fecal coliform bacteria densities and indicate that shellfish are not safe to harvest and eat immediately after summer storms.
- **Poor/Not Supporting:** Poor water quality does not support a healthy aquatic community and/or

prevents some human activities on the estuary. For example, estuarine waters may be devoid of fish for short periods each summer because excessive nutrients from runoff initiate algal blooms that deplete oxygen concentrations.

■ **Not Attainable:** The State has performed a use-attainability analysis and demonstrated that use support of one or more designated beneficial uses is not attainable due to one of six specific biological, chemical, physical, or economic/ social conditions (see Chapter 1 for additional information).

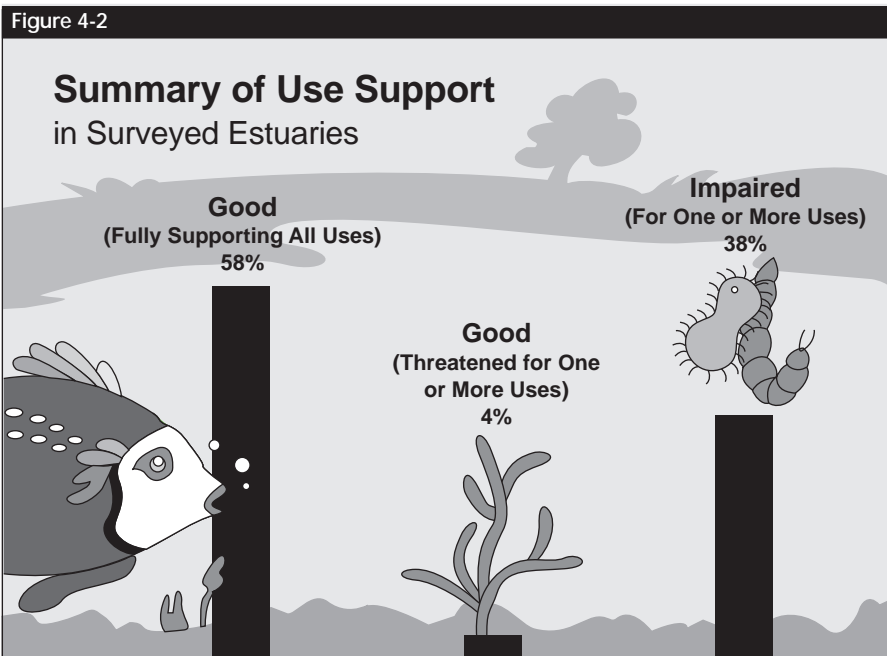
Most States rate how well an estuary supports individual uses (such as swimming and aquatic life) and then consolidate individual use ratings into a summary water quality rating. This table divides estuaries into those fully supporting all of

their uses, those fully supporting all uses but threatened for one or more uses, and those impaired for one or more uses (see Chapter 1 for a complete discussion of use support).

The States reported that 62% of the surveyed estuarine waters have good water quality that fully supports designated uses (Figure 4-2). Of these waters, 4% are threatened and might deteriorate if we fail to manage potential sources of pollution. Some form of pollution or habitat degradation impairs the remaining 38% of the surveyed estuarine waters.

Individual Use Support

Individual use support information provides additional detail about water quality problems in our



Based on data contained in Appendix C, Table C-2.

Surveyed Waters

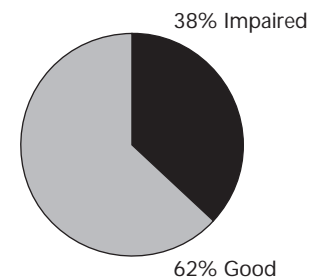
Total estuaries = 39,839 square miles^a
 Total surveyed = 28,819 square miles^b

- 72% surveyed
- 28% not surveyed

Of the surveyed estuarine waters:

- 49% were monitored
- 35% were evaluated
- 16% were not specified

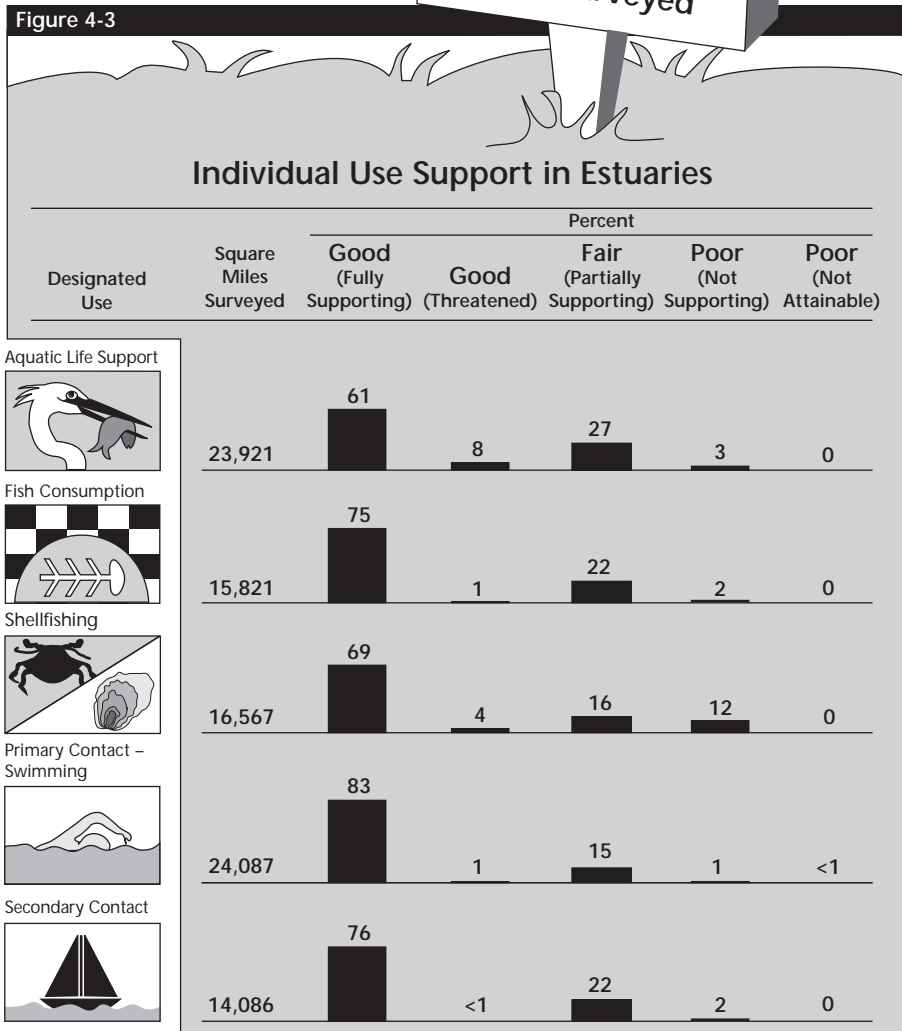
Surveyed Water Quality



^aSource: 1996 State Section 305(b) reports.

^bDoes not include square miles assessed as not attainable (<0.1% total estuaries).

Good water quality supports shellfishing in 74% of the waters surveyed



Based on data contained in Appendix C, Table C-3.

Nation's surface waters. The States are responsible for designating their estuaries for State-specific uses, but EPA requests that the States rate how well their estuaries support five standard uses so that EPA can summarize the State data. The standard uses are aquatic life support, fish consumption, shellfish harvesting, primary contact recreation (such as swimming and diving), and secondary contact recreation (such as boating) (see Chapter 1 for a description of each individual use). Few States designate saline estuarine waters for drinking water supply use and agricultural use because of high treatment costs.

Nineteen States reported the individual use support status of their estuarine waters (see Appendix C, Table C-3, for individual State information). Most often, these States examined aquatic life conditions and swimming use in their estuarine waters (Figure 4-3). The States reported that pollutants impact aquatic life in 7,358 square miles of estuarine waters (31% of the 23,920 square miles surveyed for aquatic life support) and violate shellfish harvesting criteria in 4,509 square miles of estuarine waters (27% of the 15,794 square miles surveyed for shellfishing use support). Pollutants also violate swimming criteria in 3,839 square miles of estuarine waters (16% of the 24,087 square miles surveyed for swimming use support).

Water Quality Problems Identified in Estuaries

Figures 4-4 and 4-5 identify the pollutants and sources of pollutants that impair (i.e., prevent from fully supporting designated uses) the most square miles of estuarine waters, as reported by the States. The two figures are based on the same data (contained in Appendix C, Tables C-4 and C-5), but each figure provides a different perspective on the extent of impairment attributed to individual pollutants and sources. Figure 4-4 shows the relative impact of the leading pollutants and sources in surveyed estuarine waters. Figure 4-5 presents the relative impact of the leading pollutants and sources in estuaries with identified problems (i.e., impaired estuaries), a subset of surveyed estuarine waters.

The following sections describe the leading pollutants and sources of impairment identified in estuaries. It is important to note that the information about pollutants and sources is incomplete because the States cannot identify the pollutant or source of pollutants impairing every estuarine waterbody. In some cases, a State may recognize that water quality does not fully support a designated use, but the State may not have adequate data to document that a specific pollutant or stressor is responsible for the impairment. Sources of impairment are even more difficult to identify than pollutants and stressors.

Pollutants and Processes Impacting Estuaries

Twenty-one States reported the number of estuarine waters impacted by individual pollutants and stressors such as habitat alterations (see Appendix C, Table C-4, for individual State information). EPA ranks the pollutants and stressors by the geographic extent of their impacts on aquatic life and human activities (measured as estuarine square miles impaired by each pollutant or process) rather than actual pollutant loads entering estuaries. This approach targets the pollutants and stressors causing the most harm to aquatic life and public use of our waters, rather than the most abundant pollutants in our estuaries.

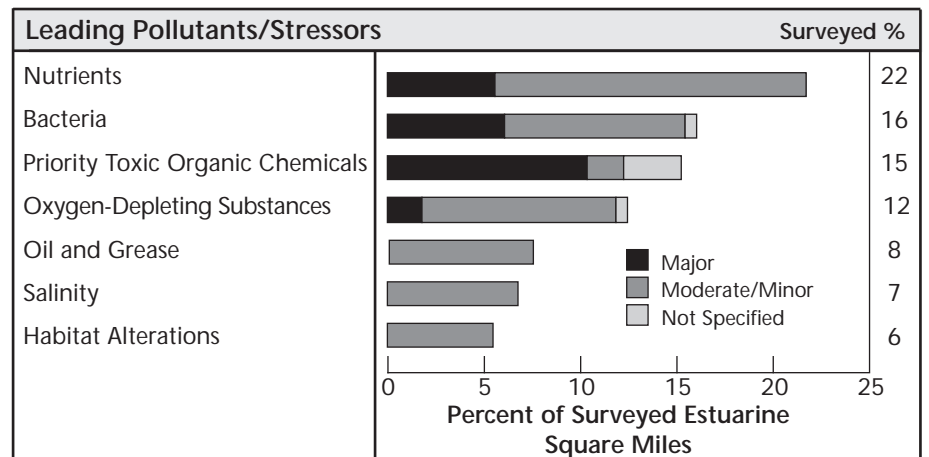
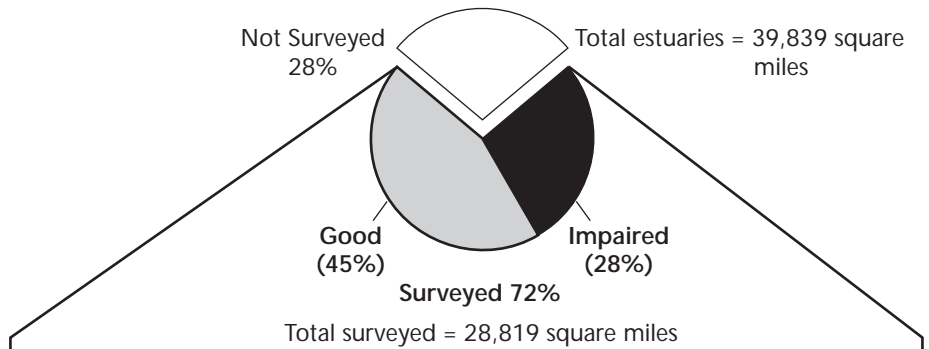
Often, more than one pollutant or stressor impacts a single estuarine waterbody. In such cases, the States and other jurisdictions count a single square mile of estuary under each pollutant or stressor category that impacts the estuary. Therefore, the percentages of estuarine waters impaired by all the pollutant and process categories do not add up to 100% in Figures 4-4 and 4-5.

The States identified more square miles of estuarine waters polluted by nutrients than any other pollutant or stressor (Figures 4-4 and 4-5). Eleven States reported that extra nutrients pollute 6,254 square miles of estuarine waters (22% of the surveyed estuarine waters). As in lakes, extra inputs of nutrients destabilize

Figure 4-4

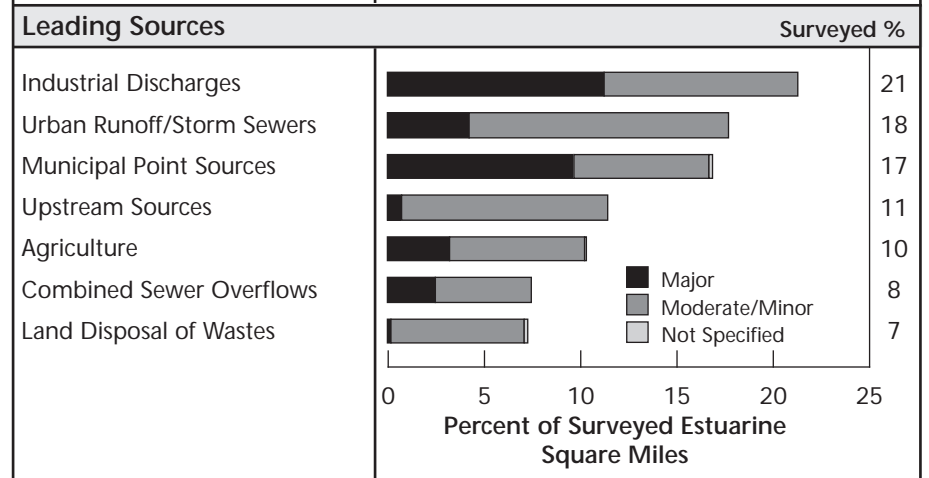
SURVEYED Estuaries: Pollutants and Sources

The pollutants/processes and sources shown here may not correspond directly to one another (i.e., the leading pollutant may not originate from the leading source). This may occur for a number of reasons, such as a major pollutant may be released from many minor sources or States may not have the information to determine all the sources of a particular pollutant/stressor.



NUTRIENTS are the most common pollutants affecting surveyed estuaries. Nutrients

- are found in 22% of all estuaries surveyed, and
- contribute to 57% of all the water quality problems (see Figure 4-5).

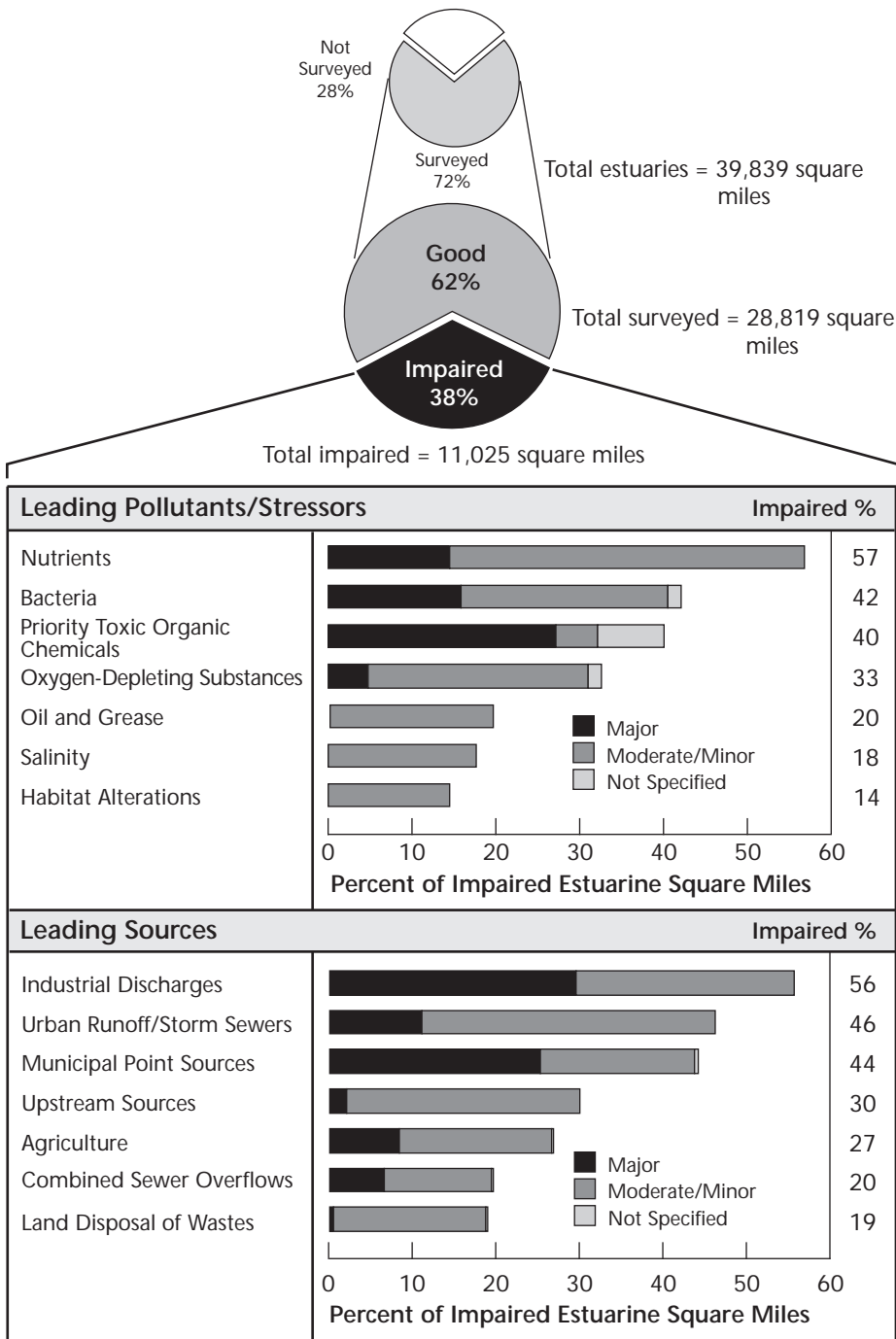


Based on data contained in Appendix C, Tables C-4 and C-5.

Note: Percentages do not add up to 100% because more than one pollutant or source may impair an estuary.

Figure 4-5

IMPAIRED Estuaries: Pollutants and Sources



INDUSTRIAL DISCHARGES are the leading source of pollution in surveyed estuaries. According to the States, industrial discharges

- affect 21% of all estuaries surveyed (see Figure 4-4), and
- contribute to 56% of all water quality problems identified.

Note: Percentages do not add up to 100% because more than one pollutant or source may impair an estuary.

Based on data contained in Appendix C, Tables C-4 and C-5.

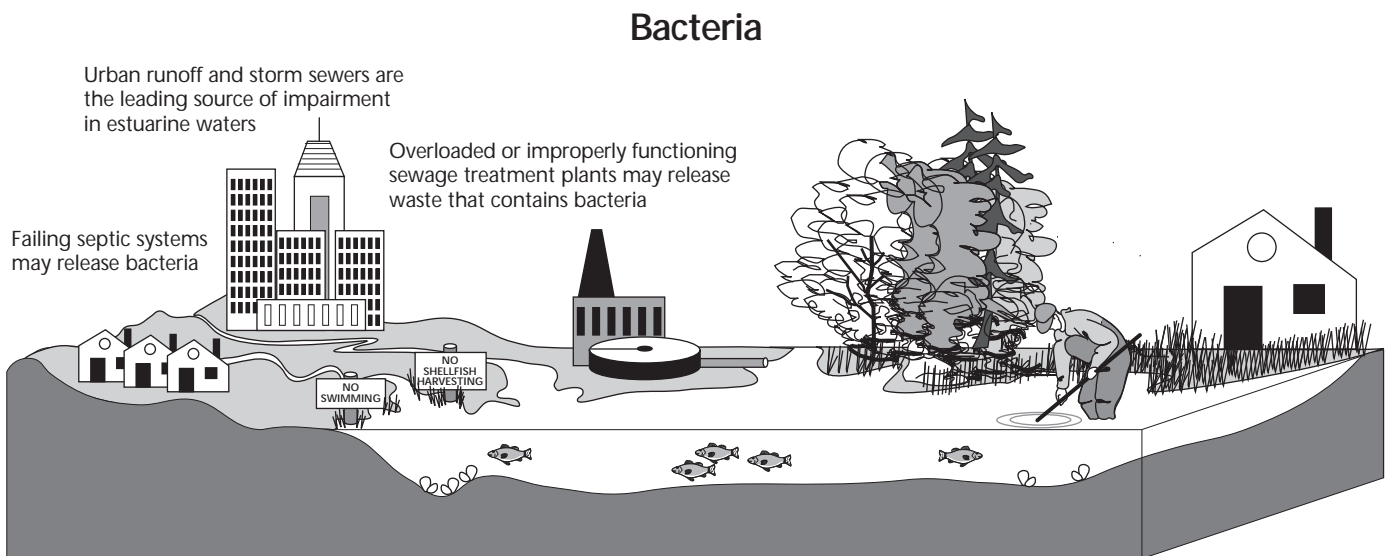
estuarine ecosystems. When temperature and light conditions are favorable, excessive nutrients stimulate population explosions of undesirable algae. Decomposition of dead algae depletes oxygen, which may trigger fish kills and foul odors. Explosive growth of algal populations can reduce light penetration and inhibit growth of beneficial aquatic plants. Submerged aquatic plants provide critical habitat for desirable shellfish, such as scallops.

Twenty-one States reported that bacteria pollute 4,634 square miles of estuarine waters (16% of the surveyed estuarine waters). Most States monitor harmless bacteria, such as *Escherichia coli*, that inhabit the digestive tracts of humans and other warm-blooded animals and populate sewage in

high densities. Such bacteria provide evidence that an estuary is contaminated with sewage that may contain numerous viruses and bacteria that cause illness in people. Most States monitor the indicator bacteria rather than run multiple tests to detect the numerous harmful viruses and bacteria in sewage.

Pathogenic viruses and bacteria seldom impact aquatic organisms such as fish and shellfish. However, shellfish can accumulate bacteria and viruses from contaminated water and cause illness when ingested. Therefore, the Food and Drug Administration and the States restrict the harvest and sale of shellfish grown in waters polluted with indicator bacteria. Bacteria also interfere with recreational activities because some pathogens can be

Figure 4-6



Some bacteria, such as fecal coliforms, provide evidence that an estuary is contaminated with fecal material that may contain pathogenic bacteria and viruses harmful to people. Often, the pathogenic viruses and bacteria do not adversely impact aquatic life such as fish and shellfish. However, shellfish may accumulate bacteria and viruses that cause human diseases when ingested. Therefore, officials restrict shellfish harvesting in contaminated waters to protect public health. Bacteria also impair swimming uses because some pathogenic bacteria and viruses can be transmitted by contact with contaminated water.

transmitted by contact with contaminated water or ingestion during swimming (Figure 4-6).

The States also report that priority organic toxic chemicals pollute 4,398 square miles (15% of the surveyed estuarine waters), oxygen depletion from organic wastes impacts 3,586 square miles (12% of the surveyed estuarine waters), oil and grease pollute 2,170 square miles (8% of the surveyed estuarine waters), salinity, total dissolved solids, and/or chlorides impact 1,944 square miles (7% of the surveyed estuarine waters), and habitat alterations degrade 1,586 square miles (6% of the surveyed estuarine waters). Priority organic toxic chemical pollution and dissolved oxygen depletion are widespread problems reported by more than 15 States. In contrast, only two States (Florida and Louisiana) reported extensive impacts from habitat alterations and oil and grease.

Most States rate pollutants and stressors as major or moderate/minor contributors to impairment. A major pollutant or stressor is solely responsible for an impact or predominates over other pollutants and stressors. A moderate/minor pollutant or stressor is one of multiple pollutants and stressors that degrade aquatic life or interfere with human use of estuarine waters.

The States report that nutrients have a major impact on more estuarine waters than any other pollutant or stressor. The individual State 305(b) reports provide more detailed information about the severity of pollution in specific locations.

Sources of Pollutants Impacting Estuaries

Twenty-one States reported sources of pollution related to human activities that impact some of their estuarine waters (see Appendix C, Table C-5, for individual State information). These States reported that industrial discharges are the most widespread source of pollution in the Nation's surveyed estuarine waters. Pollutants in industrial discharges degrade aquatic life or interfere with public use of 6,144 square miles of estuarine waters (21% of the surveyed estuarine waters) (Figure 4-4).

The States also reported that pollution from urban runoff and storm sewers impacts 5,099 square miles of estuarine waters (18% of the surveyed estuarine waters), municipal sewage treatment plants pollute 4,874 square miles of estuarine waters (17% of the surveyed estuarine waters), upstream sources pollute 3,295 square miles of estuarine waters (11% of the surveyed estuarine waters), agriculture pollutes 2,971 square miles of



Key Management Issues for the National Estuary Programs

ANEP is a newly organized not-for-profit organization whose purpose is to promote responsible stewardship and a common vision for the preservation of our Nation's bays and estuaries.

What are the most common problems facing the 28 estuaries in the National Estuary Program (NEP), and what should the public and decision-makers know about those problems? These questions were the focus of the NEP Key Management Issues Workshop held in San Francisco, California, February 26-28, 1997. Cosponsored by EPA and the Association of National Estuary Programs (ANEP), the purpose of the workshop was to begin a national dialogue to define the key issues and identify themes that should be conveyed in an upcoming *Citizens' Report to the Nation*.

The workshop employed an interactive format, where over 125 representatives from the local NEPs and EPA convened to exchange ideas and experiences concerning issues facing the NEPs. Attendees included NEP directors, scientists, outreach coordinators, citizens, business representatives, local government officials, and EPA Headquarters and Regional managers and staff.

Common Management Issues

Toxic Chemicals

Changing the normal balance of chemical concentrations in an ecosystem can jeopardize the health and reproductive capacity of the organisms in that ecosystem. In the marine environment, toxics of the greatest concern are polycyclic aromatic hydrocarbons (PAHs), toxic metals, polychlorinated biphenols (PCBs), and pesticides. Several classes of toxic chemicals collect in sediments, where bottom-dwelling organisms can be exposed to them and pass the toxicity on through the food web.

NEPs from every region of the United States identified chemicals as an important water quality management issue. A variety of management approaches are being undertaken by NEPs, including promotion of best management practices (BMPs), public education and outreach, wasteload allocations, numerical criteria, and discharge permits.



Alteration of Natural Flow Regimes

Alteration of the natural flow regimes in tributaries can have significant effects on the water quality and health and distribution of living resources in the receiving estuaries. Reduced inflow can reduce the total productivity and economic value of an estuary.

A number of NEPs identified flow alterations as a highly significant issue. The majority of these NEPs were in the Southeast and Gulf and Caribbean regions. Management approaches being undertaken include establishment of minimum flows, promotion of BMPs, wastewater reuse, and promotion of more efficient use of limited water supplies.

Declines in Fish and Wildlife Populations

The distribution and abundance of fish and wildlife depend on factors such as light, turbidity, nutrient availability, temperature, salinity, habitat and food availability, as well as natural and human-induced events that disturb or change environmental conditions.

Most of the NEPs from across all regions identified declines in fish and wildlife as either a high or

medium program priority. Management approaches to protect living species include the purchase of ecologically valuable lands, pollutant reduction, habitat restoration, and augmentation of existing populations.

Pathogens

Pathogens commonly found in marine waters include those causing gastroenteritis, salmonellosis, and hepatitis A. Pathogen contamination, as suspected from indicator organisms, results in the closure of shellfishing areas and bathing beaches.

A majority of NEPs from every region of the United States identified pathogens as a water quality management issue. Management approaches include stormwater runoff and combined sewer overflow mitigation, land use controls for new developments, BMP implementation, reduction of raw or inadequately treated sewage discharges, development of information clearinghouses, septic tank inspections, maintenance of sewer lines, and establishment of "no discharge" zones.

For more information, see the NEP section in Chapter 12.



Introduced Species

Intentional or accidental introductions of invasive species may often result in unexpected ecological, economic, and social impacts to the marine environment. These species may now constitute the largest single threat to the biological diversity of the world's coastal waters.

Management approaches include planting of native vegetation, development of regulatory permitting processes for mariculture operations, and public outreach and education.

Nutrient Overloading

Although nutrients occur naturally in animal wastes, soils, and even the atmosphere, land use practices and a growing population have greatly increased the amount of nutrients entering estuaries, resulting in nuisance algal conditions and low dissolved oxygen.

A large number of NEPs from across the United States identified the impacts of nutrient overloading as either a high or medium priority. Management approaches include promotion of BMPs, land use controls, local education and outreach, dissolved oxygen targets, advanced wastewater treatment standards, septic tank replacement, point/non-point source trading, and improving riparian buffer areas.

Habitat Loss and Degradation

The continued health and biodiversity of marine and estuarine systems depends on the maintenance of high-quality habitat. The same areas that often attract human development also provide essential food, cover, migratory corridors, and breeding and nursery areas for a broad array of coastal and marine organisms.

A majority of the NEPs in all regions of the United States identified habitat loss and degradation, including reduced or changed submerged aquatic vegetation, habitat alteration, and reduced or degraded wetlands, as a high-priority management issue. Management approaches include habitat restoration and management, wetlands protection, acquisition of ecologically valuable habitat, management of future growth, fisheries management practices, and public education.

Natural Resource Valuation

An understanding of the economic value of natural resources is critical in gaining the support of citizens, industry, and government in the preservation of the natural environment. Natural resource valuation can help demonstrate to local communities the benefits of investments in management actions to sustain or improve the health of the ecosystem.



Many of the NEPs are beginning to collect natural resource valuation information. For example, researchers have estimated that the Tampa Bay estuary supports more than \$1 billion in economic benefits to residents, local governments, and businesses through recreational and commercial fishing, boating, wastewater disposal, enhanced property values, savings in shipping costs, and power plant cooling.

Looking to the Future

Although these challenges are being dealt with locally, management approaches have national implications and applicability. Collectively, the NEPs have a significant knowledge base and wealth of experience in dealing with the serious problems that threaten the

health of these nationally significant estuaries.

The NEP workshop identified not only solutions, but also some of the obstacles to successful implementation of management actions. The need for long-term commitment, support, and coordination at all levels of government, and strong public participation was identified as a critical component for NEP success in developing and implementing management actions.

For More Information

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State and Federal Partners in Integrated Estuarine Monitoring in the Mid-Atlantic (1997 & 1998)

Background

The Mid-Atlantic Integrated Assessment (MAIA) began as a partnership between EPA's Region 3 and the Office of Research and Development (ORD) Environmental Monitoring and Assessment Program (EMAP) to develop and respond to the best available information on the condition of various ecological resources and to adapt environmental management over time, based on careful monitoring of environmental indicators and related new information. Additional partnerships have been developed with other Federal and State environmental organizations. MAIA has implemented an Assessment Framework that begins by defining realistic environmental goals and related environmental assessment questions. MAIA then strives to answer the assessment questions and to characterize ecological resource conditions based on exposure and effect information.

MAIA is producing assessments at four levels of integration: (1) single resource assessments which determine the status and trends in the condition of individual ecological resources (e.g., estuaries); (2) within-resource associations for a

single resource group; (3) determining landscape condition and the associations between resource condition and landscapes; and (4) determining relationships among multiple resources at various spatial scales.

Initial efforts are ongoing for individual resources (e.g., estuaries, surface waters, forests, and agriculture) between the Region, EMAP, other Federal agencies, and States. The *Condition of the Mid-Atlantic Estuaries Report*, written by ORD/Atlantic Ecology Division has been reviewed and is in final production. This report responded to specific assessment questions developed by the MAIA Estuaries Team, which fall into the following broad areas: (1) Is there a problem? (2) Where is the problem located? What is the magnitude, extent, and distribution? (3) What is the cause of the problem? (4) Are things changing? (5) What does it mean to the community? (6) What can we do about it?

The data sources underlying this report were the ORD's Environmental Monitoring and Assessment Program (EMAP) and related monitoring efforts (e.g., Regional-EMAP (REMAP) and other special ORD monitoring efforts in the MAIA



geographic area), State programs on the coastal and estuarine resource area, the Chesapeake Bay Program (CBP) and National Estuary Program (NEP) efforts.

Although the report answers many of the assessment questions, data gaps remained—either because there has not been adequate monitoring in some geographic areas (i.e., additional monitoring is required) or because there are no environmental indicators available to adequately answer the question (i.e., additional research is required).

Development of an Integrated Monitoring Program

In 1997, MAIA began a coordinated monitoring effort of the mid-Atlantic estuaries to respond to the data gaps identified during the development of the *Condition of the Mid-Atlantic Estuaries Report*.

The integrated monitoring program built upon existing monitoring activities conducted by the National Oceanographic and Atmospheric Administration (NOAA), the Chesapeake Bay Program (CBP), the National Park Service (NPS), the Delaware Estuary Program, and the States, using a suite of common core indicators or measurements. Monitoring will be conducted in large estuarine systems, large tidal rivers, and small estuarine systems.

The goal of the integrated estuarine monitoring in MAIA is to assess the environmental condition

of large estuarine systems in the Mid-Atlantic such as the Chesapeake Bay and the Delaware Bay including specific attention to their large river components such as the Susquehanna, Potomac, James, and Delaware. The monitoring will assess the condition of smaller estuarine systems as a whole with specific attention to 10 small systems such as Virginia Coastal Bays, Pocomoke River, and Salem River. To reach this goal, existing monitoring programs will be guided, integrated, and leveraged to improve spatial coverage and strengthen their capabilities to assess environmental condition through use of a core list of indicators. Field validation will be conducted of new indicators and the feasibility assessed of merging alternative monitoring designs such as probabilistic (EMAP) and targeted (Chesapeake Bay Program) monitoring programs.

MAIA partners participated fully in the planning and execution of the Integrated Estuarine Monitoring. The partners are:

- EPA, Region 3
 - Office of Research and Development, EMAP, Atlantic Ecology Division
 - Office of Research and Development, EMAP, Gulf Ecology Division
- Chesapeake Bay Program
- National Oceanographic and Atmospheric Administration
- National Park Service – Assateague Island

HIGHLIGHT HIGHLIGHT



- Delaware River Basin Commission
- Maryland Department of Natural Resources
- Virginia Department of Environmental Quality

Process

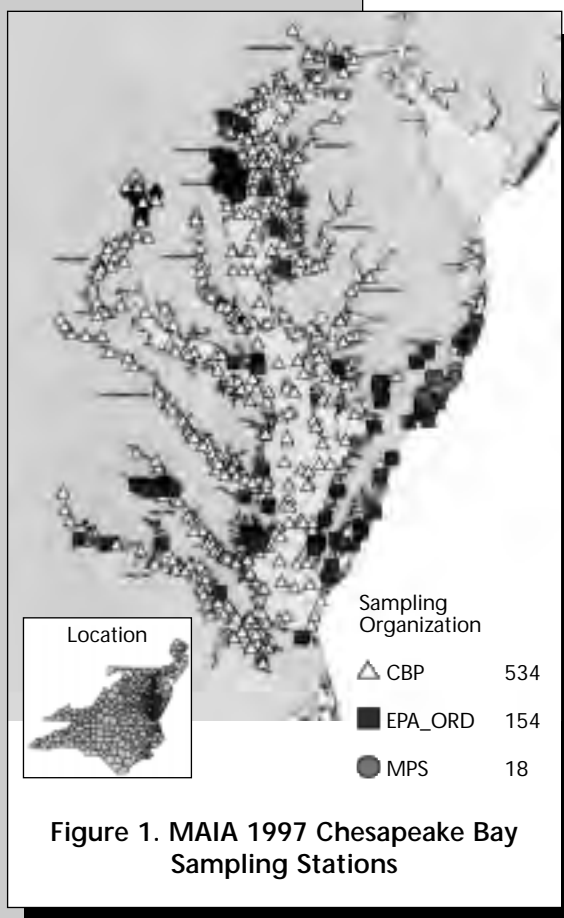
The concept of using Integrated Estuarine Monitoring was developed by the joint EPA Region 3/ORD/EMAP Team. Representatives of the various Federal and State monitoring programs participated in

a series of workshops in Annapolis, MD, to discuss how to integrate estuarine monitoring efforts. The purpose of integrating monitoring efforts was to better characterize estuaries across the Region and to design a monitoring program that also responded to the information needs at all scales from regional to smaller, local scales. Other issues addressed include how the EMAP design could be linked to regional and intensive sites and whether a core set of indicators can be identified that all groups could agree on.

The programs agreed to work together and to approach integration through the assessment process, not by comparing monitoring designs. Using the draft *Condition of the Mid-Atlantic Estuaries Report* as a starting point, they were able to identify assessment questions that would help characterize the condition of the estuaries. In addition, they identified questions that could not be answered because indicators had not yet been developed or field-verified.

The group agreed to develop a set of core existing indicators that would be monitored by all parties. They determined the ideal set of indicators would cover the food chain, water quality, habitat quality, eutrophication, and chemical contamination.

The ORD Gulf Ecology Division (GED), with input from the partners, developed a comprehensive integrated monitoring design that met the various goals identified. The final design consists of more than 700 stations throughout the mid-Atlantic estuaries (see Figures 1, 2, and 3). The partners agreed to provide summary tables of water quality and sediment monitoring, including methods, maps, outlines, measurements, and schedules and to provide recent summary reports of their own monitoring activities. This information will be compiled by ORD/Atlantic Ecology Division (AED) into a summary overview of the MAIA integrated estuaries monitoring program, which will be put on the EMAP homepage.





ORD/AED also provided a central Information Management clearinghouse, which includes a directory, catalog, and summary data sets. Formats and file specifications for transmission of summary data, including metadata requirements, were provided to the collaborators in the *MAIA-Estuaries 1997 Data Transfer and Format Manual*.

Using a Core List of Indicators

Selected parameters shown to be key indicators of overall environmental quality are measured by the various monitoring programs. These indicators are quantifiable and clearly related to ecological condition.

The partners developed a list of core indicators. Each partner initially presented the suite of indicators being used in their monitoring program. Detailed discussions about the choice of

indicators and the protocols for collection followed. The ultimate result of these discussions was a detailed list of core indicators (see Figure 4) for which all partners would monitor. It was agreed that all partners would monitor these core indicators but could monitor additional indicators as required by their individual program. It was also agreed that, when monitoring for these core indicators, all partners would use the same protocols.

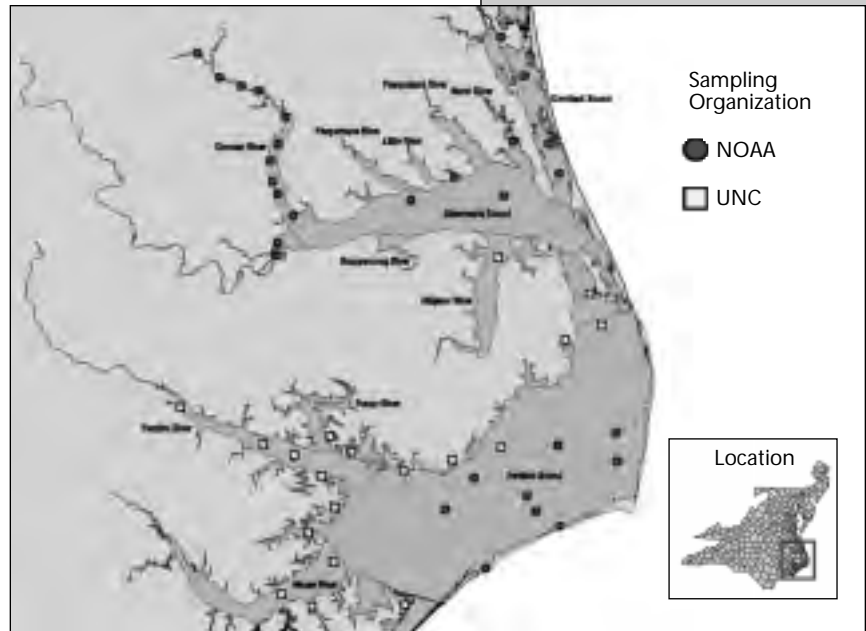


Figure 2. MAIA 1997 Albermarle / Pamlico Sound Sampling Stations

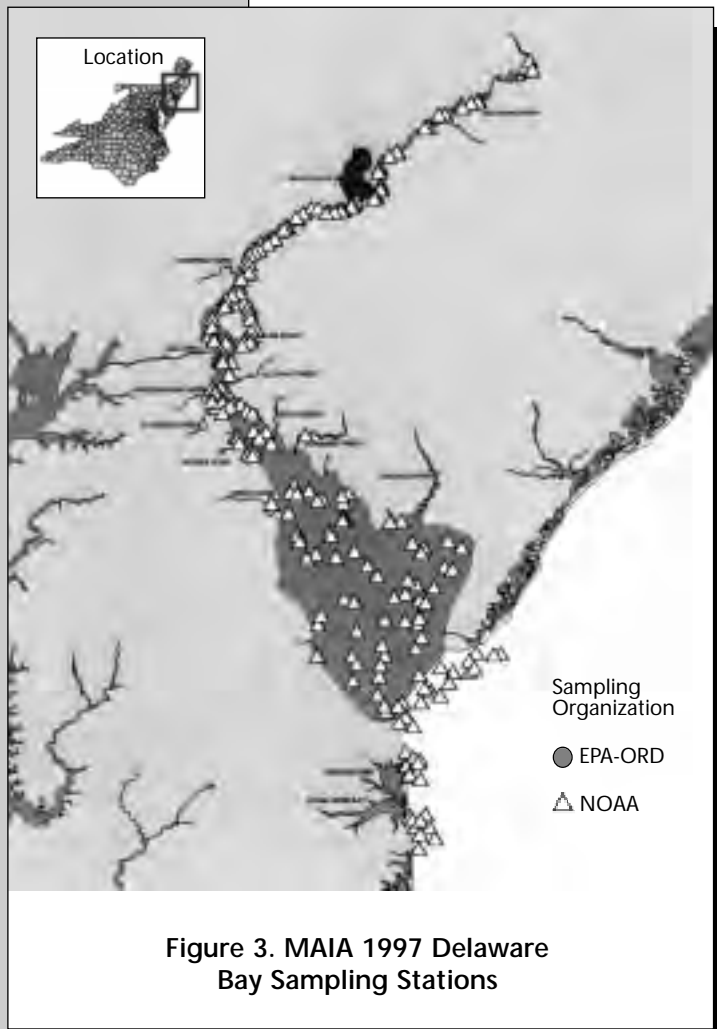
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The partners will be collecting the field data at over 700 sites during July, August, and September of 1997. Data and assessment reports are scheduled to be available in 1998.

For Further Information

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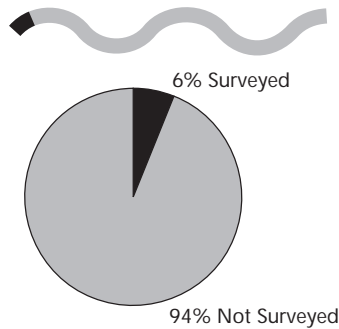
- Location (latitude and longitude)
- Time and Date of Sampling
- Depth of Water Column
- Water Column Measurements
 - Physical measurements (at surface and bottom; water column profiles at some stations): Temperature, Salinity, Dissolved oxygen, pH, Conductivity
 - Water Clarity (Secchi disk or turbidity) (measured once per station)
 - Water Column Chemistry (Chesapeake Bay Program Protocol) (surface and bottom): Dissolved silica (SI), Dissolved ammonia (NH_4), Dissolved nitrite and nitrate ($\text{NO}_{2,3}$), Dissolved nitrite (NO_2), Particulate organic nitrogen (PON), Total dissolved nitrogen (TDN), Total dissolved phosphorous (TDP), Dissolved orthophosphate (PO_4F), Total particulate phosphorous (PHOSP), Particulate organic carbon (POC), Total suspended solids (TSS), Chlorophyll *a* (CHLA), Pheophytin (PHEA)
 - Sediment Measurements
 - (1) Benthic macroinvertebrates: Species composition and enumeration, Biomass, Silt-clay content (%silt/clay)
 - (2) Observational SAV (in conjunction with benthic gap)
 - (3) Sediment chemistry (first year only): NOAA NS&T contaminants, acid volatile sulfides (AVS) and simultaneously extractable metals (SEM), silt-clay content (%silt/clay), total organic carbon
 - (4) Sediment bioassay (first year only): Pore Water Concentrations of Ammonia and Hydrogen Sulfide, Microtox, *Ampelisca*, On a subsample of stations (MD initiative)– *Leptocheirus plumulosus* and *Cyprinodon variegatus*
 - Fish Measurements (second year only)
 - Fish tissue contaminants
 - Fish community
 - External pathology
 - Macrophage aggregates

Figure 4. Core Indicators (EMAP Protocol Unless Otherwise Specified)

Ocean Shoreline Waters Surveyed by States

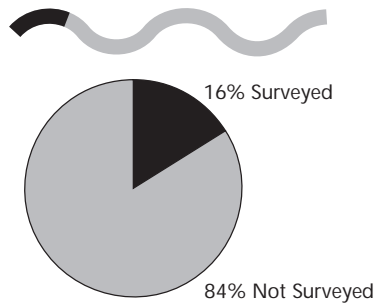
Including Alaska's Ocean Shoreline

1996 ■ 3,651 miles = 6%
 ■ Total ocean shoreline miles: 58,585^a



Excluding Alaska's Ocean Shoreline

1996 ■ 3,651 miles = 16% surveyed
 ■ Total ocean shoreline miles: 22,585^a



Of the surveyed ocean shoreline miles:

- 54% were monitored
- 42% were evaluated
- 4% were not specified

1994 ■ 5,208 miles = 9%
 ■ Total ocean shoreline miles: 58,421^b



1992 ■ 3,398 miles = 17% surveyed
 ■ Total ocean shoreline miles: 20,121^c



1990 ■ 4,230 miles = 22% surveyed
 ■ Total ocean shoreline miles: 19,200^d



^aSource: 1996 State Section 305(b) reports.
^bSource: 1994 State Section 305(b) reports.
^cSource: 1992 State Section 305(b) reports.
^dSource: 1990 State Section 305(b) reports.
^eNote: Figures may not add to 100% due to rounding.

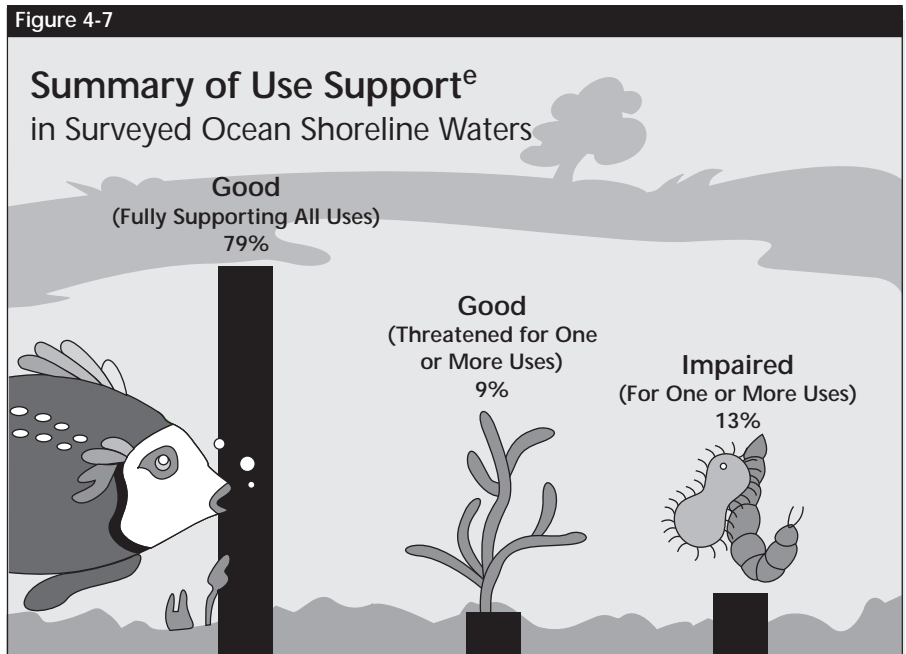
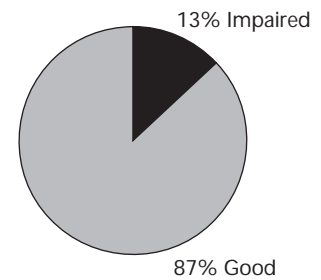
estuarine waters (10% of the surveyed estuarine waters), pollution from combined sewer overflows impairs 2,163 square miles of estuarine waters (8% of the surveyed estuarine waters), and land disposal of wastes pollutes 2,093 square miles (7% of the surveyed estuarine waters). Urban sources contribute more to the degradation of estuarine waters than does agriculture because urban centers are located adjacent to most major estuaries. Upstream sources of pollution are sources across State lines or along a river upstream of an estuary.

waters represent 6% of the Nation's coastline (including Alaska's 36,000 miles of coastline), or 16% of the 22,585 miles of national coastline excluding Alaska (see Appendix C, Table C-6, for individual State information). Most of the surveyed waters (3,185 miles, or 87%) have good quality that supports a healthy aquatic community and public activities (Figure 4-7). Of these waters, 315 miles (9% of the surveyed shoreline) are threatened and may deteriorate in the future. Some form of pollution or habitat

Ocean Shoreline Waters

Ten of the 27 coastal States and Territories rated general water quality conditions in 3,651 miles of ocean shoreline. The surveyed

Surveyed Water Quality



Based on data contained in Appendix C, Table C-6.

degradation impairs the remaining 13% of the surveyed shoreline (467 miles).

Individual Use Support

EPA requests that the States rate how well their ocean shoreline waters support five standard uses so that EPA can summarize the State data. The standard uses consist of aquatic life support, fish consumption, shellfish harvesting, primary contact recreation (such as swimming and diving), and secondary contact recreation (such as boating) (see Chapter 1 for a description of each individual use). Few States designate saline ocean waters for drinking water supply use and agricultural use because of high treatment costs.

The States provided limited information on individual use support in ocean shoreline waters (Appendix C, Table C-7, contains individual State information). Eight States rated aquatic life support and nine rated swimming use in their ocean shoreline waters, but fewer States rated their ocean waters for support of shellfishing, fish consumption, and secondary contact recreation. General conclusions cannot be drawn from information representing such a small fraction of the Nation's ocean shoreline waters (Figure 4-8).

Water Quality Problems Identified in Ocean Shoreline Waters

Only six of the 27 coastal States identified pollutants and sources of pollutants degrading ocean shoreline waters (Appendix C, Tables C-8 and C-9, contain individual State information). General conclusions cannot be drawn from this limited

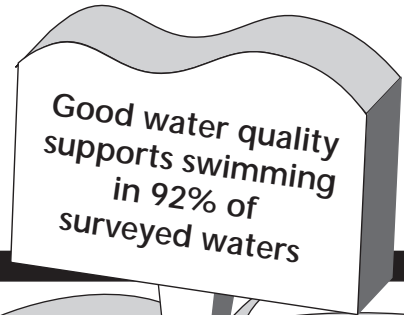
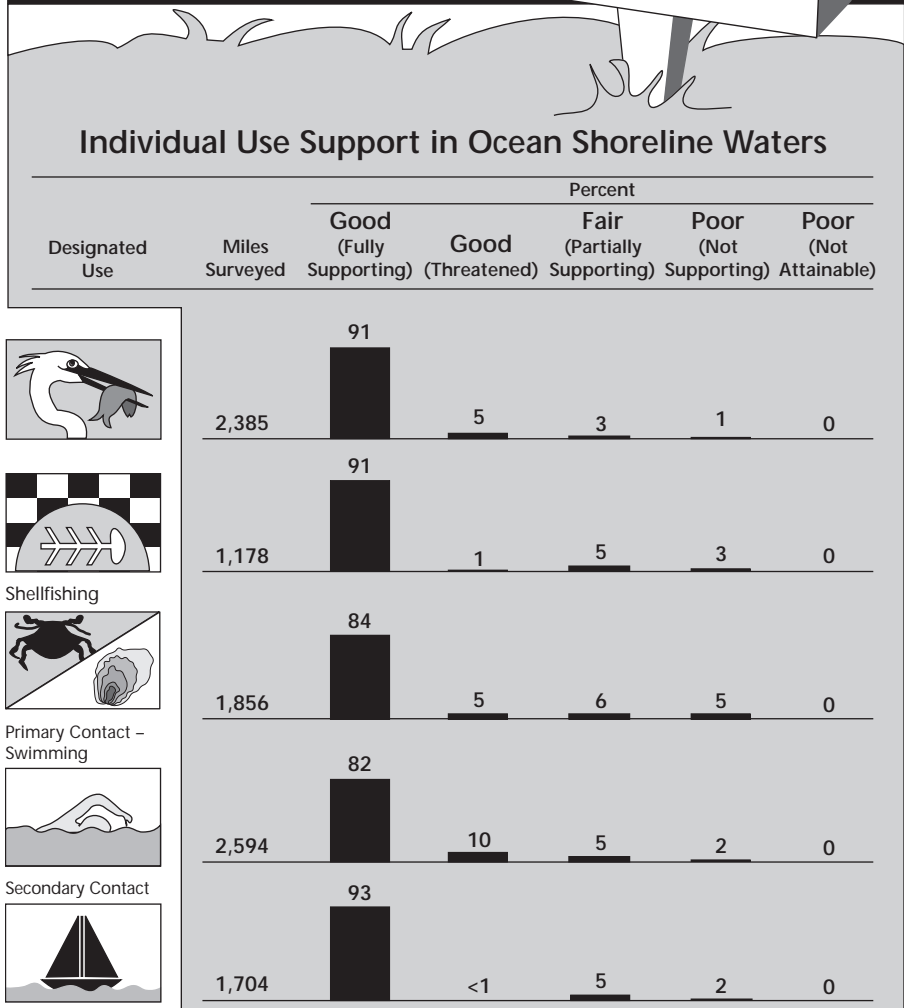


Figure 4-8

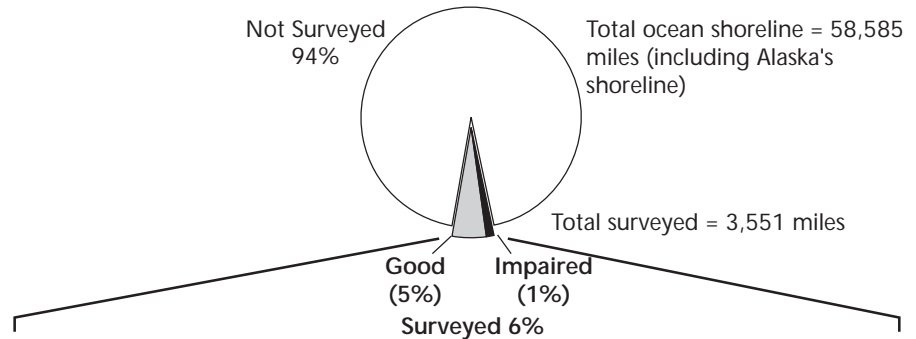


Based on data contained in Appendix C, Table C-7.

The pollutants/processes and sources shown here may not correspond directly to one another (i.e., the leading pollutant may not originate from the leading source). This may occur for a number of reasons, such as a major pollutant may be released from many minor sources or States may not have the information to determine all the sources of a particular pollutant/stressor.

Figure 4-9

SURVEYED Ocean Shoreline: Pollutants and Sources



Leading Pollutants/Stressors	Surveyed %
Bacteria	12
Turbidity	3
Nutrients	2
Oxygen-Depleting Substances	2
Suspended Solids	2
pH	1
Oil and Grease	1
Metals	1

Percent of Surveyed Shoreline Miles

Legend: Major (Black), Moderate/Minor (Grey), Not Specified (White)

Leading Sources	Surveyed %
Urban Runoff/Storm Sewers	7
Septic Systems	5
Municipal Sewer Discharges	4
Industrial Point Sources	4
Land Disposal of Wastes	3
Marinas	3
Recreational Activities	3

Percent of Surveyed Shoreline Miles

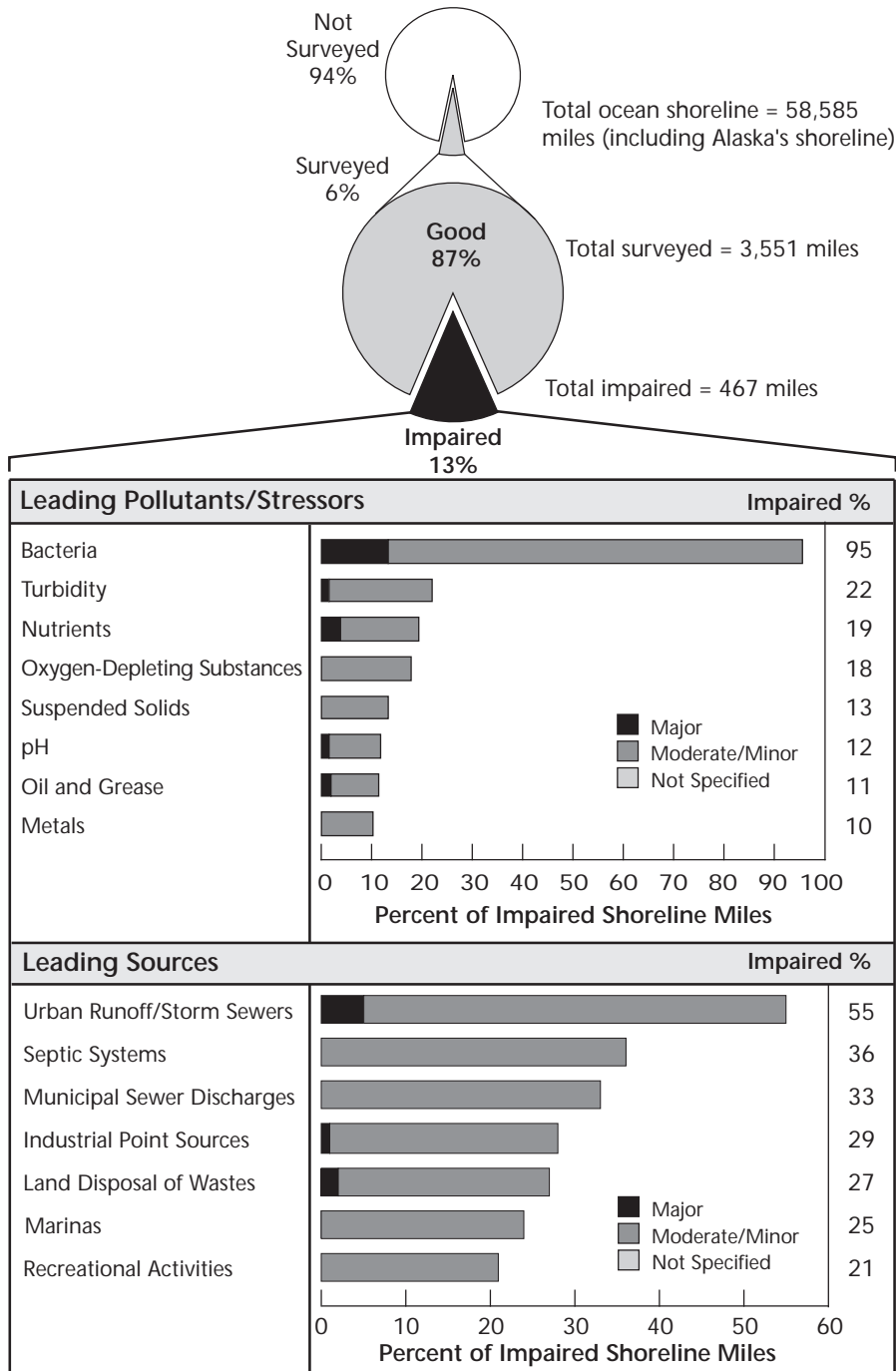
Legend: Major (Black), Moderate/Minor (Grey), Not Specified (White)

Based on data contained in Appendix C, Tables C-8 and C-9.

Note: Percentages do not add up to 100% because more than one pollutant or source may impair a segment of ocean shoreline.

Figure 4-10

IMPAIRED Ocean Shoreline: Pollutants and Sources

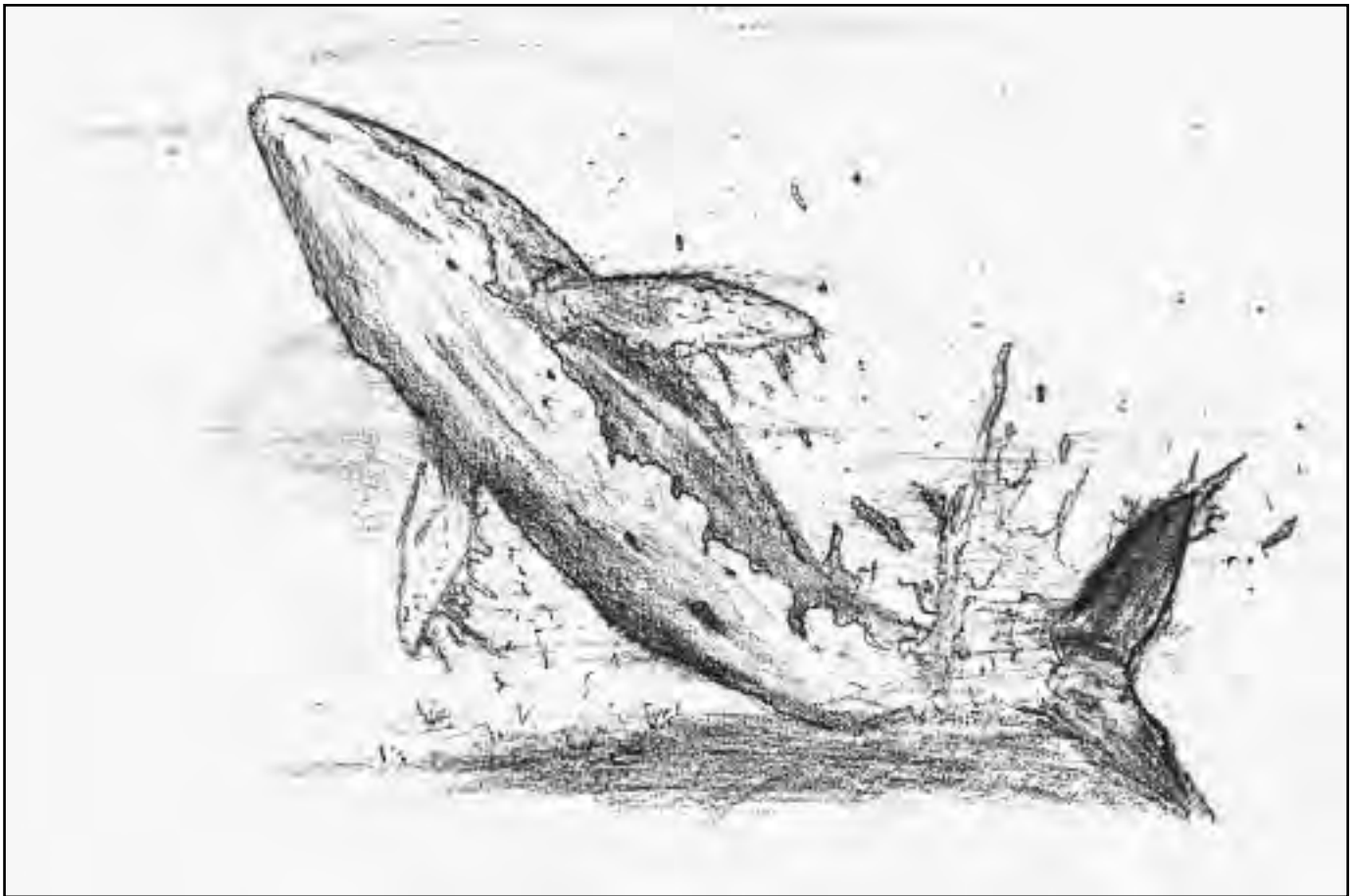


Note: Percentages do not add up to 100% because more than one pollutant or source may impair a segment of ocean shoreline

Based on data contained in Appendix C, Tables C-8 and C-9.

source of information. The six States identified impacts in their ocean shoreline waters from bacteria, turbidity, nutrients, oxygen-depleting substances, suspended solids, acidity (pH), oil and grease, and metals (Figures 4-9 and 4-10). The six States reported that urban

runoff and storm sewers, septic systems, municipal sewer discharges, industrial discharges, land disposal of wastes, marinas, recreational activities, and spills and illegal dumping pollute their coastal shoreline waters (Figures 4-9 and 4-10).



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Wetlands

Introduction

Wetlands are areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support (and that under normal circumstances do support) a prevalence of vegetation typically adapted for life in saturated soil conditions (Figure 5-1). Wetlands generally include swamps, marshes, bogs, and similar areas. This is the definition of wetlands as it appears in the regulations jointly issued by the Army Corps of Engineers (COE) and the U.S. EPA (33 CFR Part 328.3(b), 40 CFR Part 232.2 (r), and 40 CFR Part 230.3(t)).

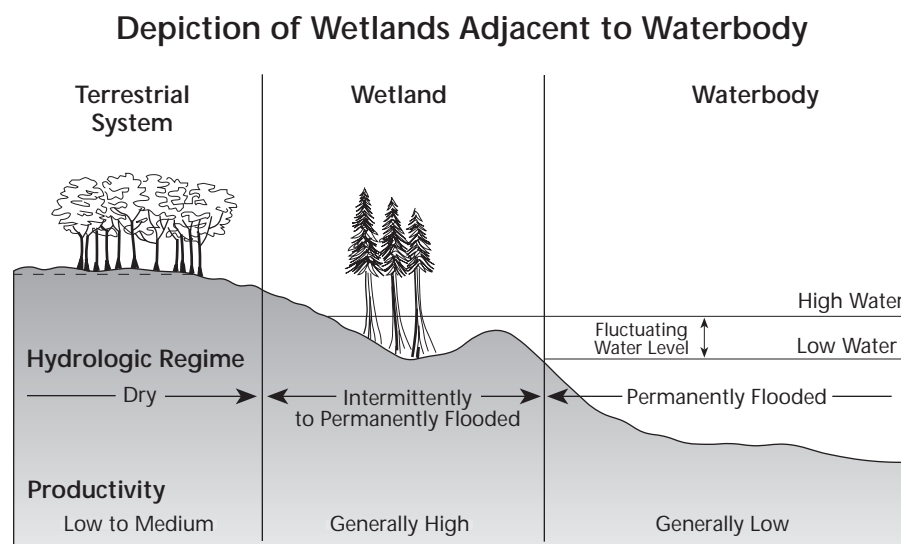
A wide variety of wetlands exists across the country because of regional and local differences in hydrology, vegetation, water chemistry, soils, topography, climate, and other factors. Wetlands type is determined primarily by local hydrology, the unique pattern of water flow through an area. In general, there are two broad categories of wetlands: coastal and inland wetlands.

With the exception of the Great Lakes coastal wetlands, coastal wetlands are closely linked to estuaries, where sea water mixes with fresh water to form an environment of varying salinity and fluctuating water levels due to tidal action. Coastal marshes dominated by grasses, sedges, and rushes and halophytic (salt-tolerant) plants are generally located along the Atlantic

and Gulf coasts due to the gradual slope of the land. Mangrove swamps, which are dominated by halophytic shrubs and trees, are common in Hawaii, Puerto Rico, Louisiana, and southern Florida.

Inland wetlands are most common on floodplains along rivers and streams, in isolated depressions surrounded by dry land, and along the margins of lakes and ponds. Inland wetlands include marshes and wet meadows dominated by grasses, sedges, rushes, and herbs; shrub swamps; and wooded swamps dominated by trees, such as hardwood forests along

Figure 5-1



Wetlands are often found at the interface between dry terrestrial ecosystems, such as upland forests and grasslands, and permanently wet aquatic ecosystems, such as lakes, rivers, bays, estuaries, and oceans.

Reprinted with modifications, by permission, from Mitsch/Gosselink: *Wetlands 1986*, fig. 1-4, p. 10. ©1986, Van Nostrand Reinhold.

floodplains. Some regional wetlands types include the pocosins of North Carolina, bogs and fens of the northeastern and north central States and Alaska, inland saline and alkaline marshes and riparian wetlands of the arid and semiarid West, vernal pools of California, playa lakes of the Southwest, cypress gum swamps of the South, wet tundra of Alaska, the South Florida Everglades, and prairie potholes of Minnesota, Iowa, and the Dakotas.

Functions and Values of Wetlands

In their natural condition, wetlands provide many benefits, including food and habitat for fish and wildlife, water quality improvement, flood protection, shoreline erosion control, ground water exchange, as well as natural

products for human use and opportunities for recreation, education, and research.

Wetlands are critical to the survival of a wide variety of animals and plants, including numerous rare and endangered species. Wetlands are also primary habitats for many species, such as the wood duck, muskrat, and swamp rose. For others, wetlands provide important seasonal habitats where food, water, and cover are plentiful.

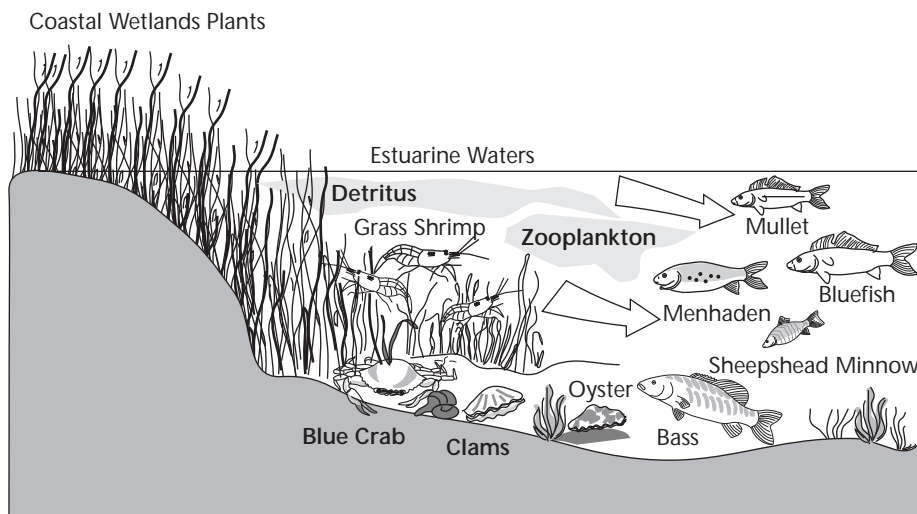
Wetlands are among the most productive natural ecosystems in the world. They produce great volumes of food, such as leaves and stems, that break down in the water to form detritus (Figure 5-2). This enriched material is the principal food for many aquatic invertebrates, various shellfish, and forage fish that are food for larger commercial and recreational fish species such as bluefish and striped bass.

Wetlands help maintain and improve water quality by intercepting surface water runoff before it reaches open water, removing or retaining nutrients, processing chemical and organic wastes, and reducing sediment loads to receiving waters (Figure 5-3). As water moves through a wetland, plants slow the water, allowing sediment and pollutants to settle out. Plant roots trap sediment and are then able to metabolize and detoxify pollutants and remove nutrients such as nitrogen and phosphorus.

Wetlands function like natural basins, storing either floodwater that overflows riverbanks or surface water that collects in isolated depressions. By doing so, wetlands help protect adjacent and downstream property from flood damage. Trees and other wetland

Figure 5-2

Coastal Wetlands Produce Detritus that Support Fish and Shellfish



vegetation help slow the speed of flood waters. This action, combined with water storage, can lower flood heights and reduce the water's erosive potential (Figure 5-4). In agricultural areas, wetlands can help reduce the likelihood of flood damage to crops. Wetlands within and upstream of urban areas are especially valuable for flood protection, since urban development increases the rate and volume of surface water runoff, thereby increasing the risk of flood damage.

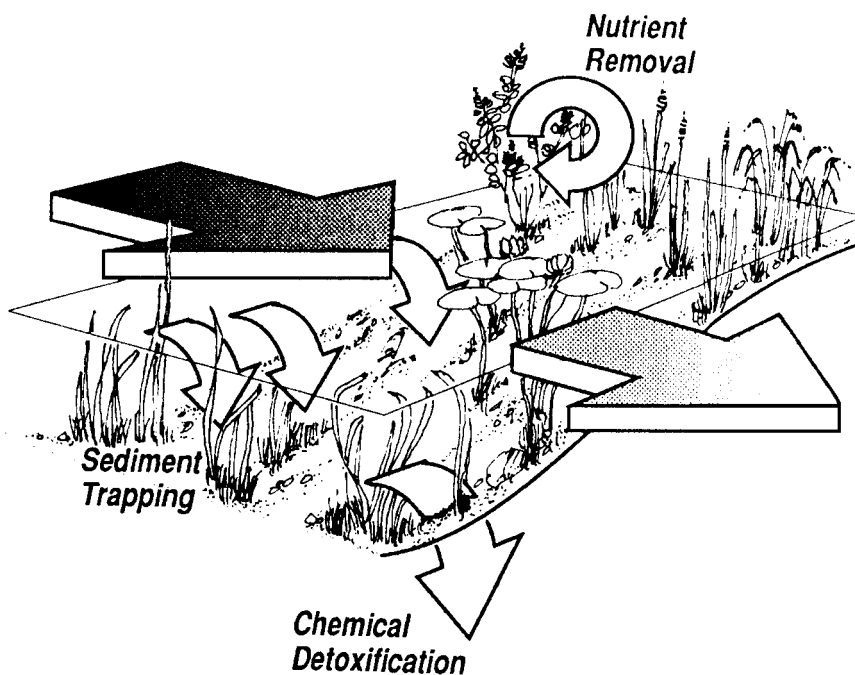
Wetlands are often located between rivers and high ground (called uplands) and are therefore able to store flood waters and reduce channel erosion. Wetlands bind soil, dampen wave action, and

reduce current velocity through friction. These properties are very valuable for stabilizing shorelines (Figure 5-5).

Wetlands water storage capacity also allows recharge of ground water, which may be used as sources of water for drinking or agricultural uses (Figure 5-6). Elevated ground water tables and water stored in wetlands are also important for maintaining stream base-flows. Water entering wetlands during wet periods is released slowly through ground water or as runoff, moderating stream flow volumes necessary for the survival of fish, wildlife, and plants that rely on the stream (Figure 5-7).

Figure 5-3

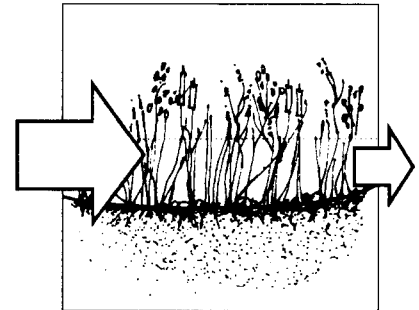
Water Quality Improvement Functions in Wetlands



Source: Washington State Department of Ecology.

Figure 5-4

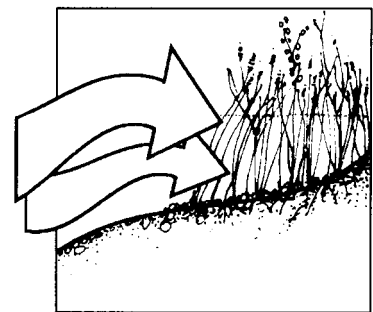
Flood Protection Functions in Wetlands



Source: Washington State Department of Ecology.

Figure 5-5

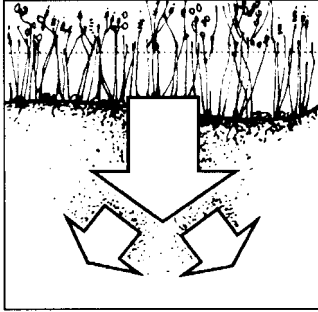
Shoreline Stabilization Functions in Wetlands



Source: Washington State Department of Ecology.

Figure 5-6

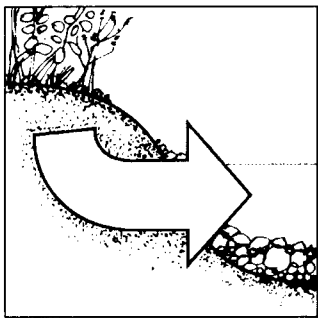
Ground Water Recharge Functions in Wetlands



Source: Washington State Department of Ecology.

Figure 5-7

Streamflow Maintenance Functions in Wetlands



Source: Washington State Department of Ecology.

Wetlands produce a wealth of natural products, including fish and shellfish, timber, wildlife, and wild rice. Much of the Nation's fishing and shellfishing industry harvests wetlands-dependent species. A national survey conducted by the U.S. Fish and Wildlife Service (FWS) in 1991 illustrates the economic value of some of the wetlands-dependent products. Over 9 billion pounds of fish and shellfish landed in the United States in 1991 had a direct dockside value of \$3.3 billion. This served as the basis of a seafood processing and sales industry that generated total expenditures of \$26.8 billion. In addition, 35.6 million anglers spent \$24 billion on freshwater and saltwater fishing. It is estimated that 71% of commercially valuable fish and shellfish depend directly or indirectly on coastal wetlands.

The abundant wildlife in wetlands also attracts outdoor recreationists. Visits by outdoor recreationists to national wildlife refuges (NWR), which often protect extensive wetlands, bring millions of dollars and many jobs to adjacent communities. The FWS estimated that in 1994, bird watchers and other outdoor recreationists spent \$636,000 in the communities around the Quivara NWR in Kansas, \$3.1 million around the Salton Sea NWR in California, and over \$14 million around the Santa Ana NWR in Texas.

Consequences of Wetlands Loss and Degradation

The loss or degradation of wetlands can lead to serious consequences, including increased flooding; species decline, deformity, or extinction; and declines in water quality. The following discussion describes several examples of the consequences of wetlands loss and degradation.

Floods continue to seriously damage the property and livelihoods of thousands of Americans despite expenditures of billions of local, State, and Federal dollars over the years to reduce flooding. Loss or degradation of wetlands intensifies flooding by eliminating their capacity to absorb peak flows and gradually release flood waters.

- In Massachusetts, the U.S. Army Corps of Engineers estimated that over \$17 million of annual flood damage would result from the destruction of 8,422 acres of wetlands in the Charles River Basin. For this reason, the COE decided to preserve wetlands rather than construct extensive flood control facilities along a stretch of the Charles River near Boston. Annual benefits of the preservation project average \$2.1 million while annual costs average \$617,000.

- The Minnesota Department of Natural Resources estimated that it costs the public \$300 to replace the water storage capacity lost by development of 1 acre of wetlands

that holds 12 inches of water. The cost of replacing 5,000 acres of wetlands would be \$1.5 million, which exceeds the State's annual appropriation for flood control.

- In 1988, DuPage County, Illinois, found that 80% of all flood damage reports came from owners whose houses were built in converted wetlands. The county spends \$0.5 to \$1.0 million annually to correct the problem.

Another consequence of wetlands loss or degradation is decline, deformity from toxic contamination, or extinction of wildlife and plant species. Forty-five percent of the threatened and endangered species listed by the Fish and Wildlife Service rely directly or indirectly on wetlands for their survival. The Nature Conservancy estimates that two-thirds of freshwater mussels and crayfishes are rare or imperiled and more than one-third of freshwater fishes and amphibians dependent on aquatic and wetlands habitats are at risk.

- The destruction of wetlands around Merritt Island and St. John's Island in Florida has been identified as a major contributor to the extinction of the Dusky Seaside Sparrow. The sparrow's habitat was diked and flooded in an attempt to control mosquitos, then drained and burned to promote ranching. The last Dusky Seaside Sparrow died in captivity on June 16, 1987.

- Overlogging of mature bottomland hardwood forests is believed to have caused the extinction of the Ivory Billed Woodpecker in the

United States. The clearing of bottomland hardwood forests has also affected the Louisiana Black Bear, or swamp bear, by destroying the bear's habitat. With its population plummeting from the thousands to several hundred, the Fish and Wildlife Service recently listed the Louisiana Black Bear as "threatened" under the Endangered Species Act.

- Populations of Mallard Ducks and Northern Pintail Ducks in North America declined continually between 1955 and the early 1990s. In 1990, the number of Mallard Ducks in the prairies of the United States declined 60% from the number counted in 1989 to the lowest population figures on record. The well-being of waterfowl populations is tied to the status and abundance of wetlands. As waterfowl populations are squeezed into the remaining wetlands, confined conditions favor outbreaks of avian cholera and other contagious diseases in waterfowl. In 1996, breeding duck populations reached their highest levels since 1979 because of consecutive years of abundant precipitation and continued public and private efforts to maintain and restore wetlands habitats.

- The Arizona Game and Fish Department estimates that 75% or more of all of Arizona's native wildlife species depend on healthy riparian systems during some portion of their life cycle.

Wetlands loss and degradation also reduce water quality purification functions performed by wetlands.

STATES REPORT that residential development and urban growth are the leading sources of recent wetlands loss.

- The Congaree Bottomland Hardwood Swamp in South Carolina provides valuable water quality services, such as removing and stabilizing sediment, nutrients, and toxic contaminants. The total cost of constructing, operating, and maintaining a tertiary treatment plant to perform the same functions would be \$5 million.
- Forested riparian wetlands play an important role in reducing nutrient loads entering the Chesapeake Bay. In one study, a riparian forest in a predominantly agricultural watershed removed about 80% of the phosphorus and 89% of the nitrogen from the runoff water

before it entered a tributary to the Bay. Destruction of such areas adversely affects the water quality of the Bay by increasing undesirable weed growth and algae blooms.

- A study of two similar sites on the Hackensack River in New Jersey demonstrated the increase in erosion that results from the destruction of marshlands. In the study, marsh vegetation was cut at one site and left undisturbed at the other site. The bank at the cut site eroded nearly 2 meters (more than 6 feet) in 1 year while the uncut site exhibited negligible bank erosion.

These examples illustrate the integral role of wetlands in our ecosystems and how wetlands destruction and degradation can have expensive and permanent consequences. By preserving wetlands and their functions, wetlands will continue to provide many benefits to people and the environment.

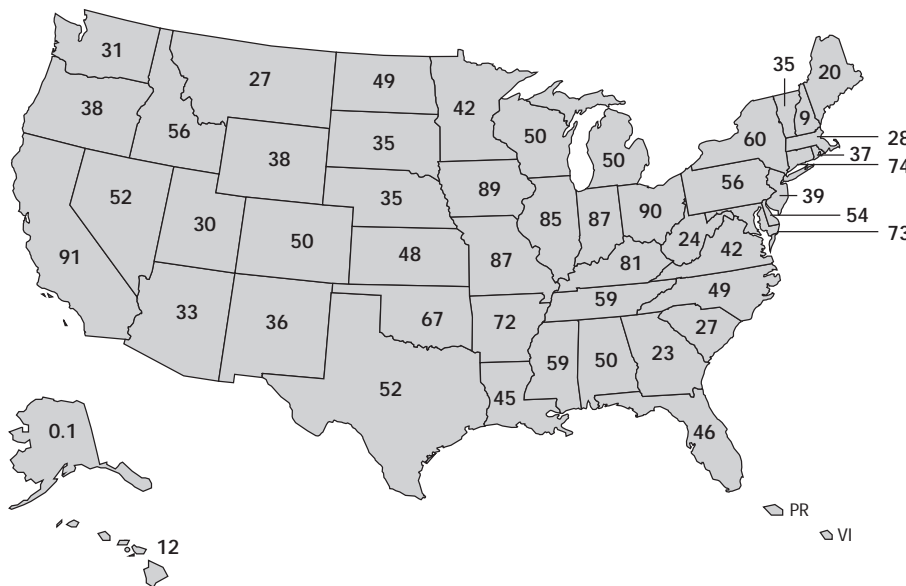
Extent of the Resource

Wetlands Loss in the United States

It is estimated that over 200 million acres of wetlands existed in the lower 48 States at the time of European settlement. Since then, extensive wetlands acreage has been lost, with many of the original wetlands drained and converted to farmland and urban development. Today, less than half of our original wetlands remain. The losses amount to an area equal to the size of California (see Figure 5-8). According to the U.S. Fish and Wildlife Service's *Wetlands Losses in the United States 1780's to 1980's*, the three States

Figure 5-8

Percentage of Wetlands Acreage Lost, 1780s-1980s



Twenty-two States have lost at least 50% of their original wetlands. Seven of these 22 (California, Indiana, Illinois, Iowa, Missouri, Kentucky, and Ohio) have lost more than 80% of their original wetlands.

Source: Dahl, T.E., 1990, *Wetlands Losses in the United States 1780's to 1980's*, U.S. Department of the Interior, Fish and Wildlife Service.

that have sustained the greatest percentage of wetlands loss are California (91%), Ohio (90%), and Iowa (89%).

According to FWS status and trends reports, the average annual loss of wetlands has decreased over the past 40 years. The average annual loss from the mid-1950s to the mid-1970s was 458,000 acres, and from the mid-1970s to mid-1980s it was 290,000 acres. Agriculture was responsible for 87% of the loss from the mid-1950s to the mid-1970s and 54% of the loss from the mid-1970s to the mid-1980s. These estimates are based on aerial photographs.

A more recent estimate of wetlands losses from the National Resources Inventory (NRI), conducted by the Natural Resources Conservation Service (NRCS), indicates that 792,000 acres of wetlands were lost on non-Federal lands between 1982 and 1992 for a yearly loss estimate of 70,000 to 90,000 acres. This net loss is the result of gross losses of 1,561,300 acres of wetlands and gross gains of 768,700 acres of wetlands over the 10-year period. The NRI estimates, although they are based on hydric soils, are consistent with the trend of declining wetlands losses reported by FWS. Although losses have decreased, we still have to make progress toward our interim goal of no overall net loss of the Nation's remaining wetlands and the long-term goal of increasing the quantity and quality of the Nation's wetlands resource base.

The decline in wetlands losses is a result of the combined effect of several trends: (1) the decline in profitability in converting wetlands for agricultural production; (2) passage of Swampbuster in the 1985,

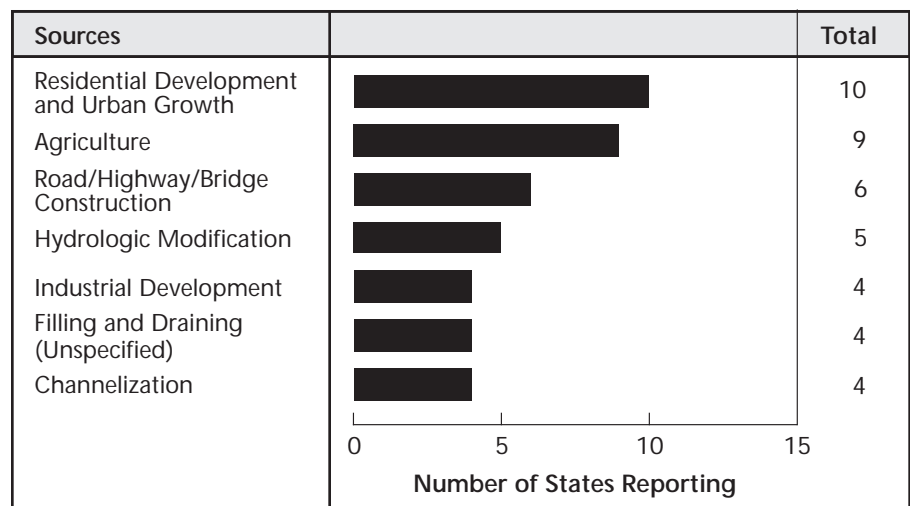
1990, and 1996 Farm Bills; (3) presence of the CWA Section 404 permit programs as well as development of State management programs (see Chapter 17); (4) greater public interest and support for wetlands protection; and (5) implementation of wetlands restoration programs at the Federal, State, and local level.

Twelve States listed sources of recent wetlands loss in their 1996 305(b) reports (Figure 5-9). Residential development and urban growth were cited as the leading sources of current losses (see Appendix D, Table D-1, for individual State information). Other losses were due to agriculture; construction of roads, highways, and bridges; hydrologic modifications; filling and/or draining; channelization; and industrial development.

Several States and the District of Columbia reported on efforts to

Figure 5-9

Sources of Recent Wetlands Losses (12 States Reporting)



Based on data contained in Appendix D, Table D-4.

More States are monitoring unimpacted wetlands to define baseline conditions in healthy wetlands.

inventory wetlands. Some of the programs are designed to augment the FWS's National Wetlands Inventory (NWI), while others are designed to produce independent status and trend information. Some of the programs have already been completed and others have been authorized but not funded.

- Alabama is evaluating and mapping wetlands habitats in a portion of the Lower Mobile-Tensaw River Delta and Mobile Bay. With funding from USEPA's Gulf of Mexico Program, Alabama is digitizing wetlands habitats based on aerial photography from 1955, 1979, and 1988, using the NWI methodology.
- Delaware is currently mapping wetlands area in the State based on 1992 aerial photography.
- In 1996, the District of Columbia completed mapping of its wetlands based on a 1994 estimate of total wetlands acreage generated by applying the Planogrid method to aerial NWI maps. The finer detail and resolution of the new methodology almost doubled previous estimates of wetlands acreage.
- New Hampshire recently completed a wetlands mapping project that translated LANDSAT digital imagery into a geographic information system (GIS) format. The project included extensive field verification and soils mapping in 7 of the 10 counties. The GIS mapping system revealed many small wetlands that were overlooked by previous surveys. As a result, New Hampshire's estimate of total wetlands acreage climbed from 200,000 acres to between 400,000

and 600,000 acres of nontidal wetlands and 7,500 acres of tidal wetlands.

- In 1996, New York completed county maps of fresh water wetlands for all counties outside of the Adirondack Park. In addition, New York has completed its tidal wetlands inventory that shows tidal wetlands on Long Island, in New York City, and in certain counties along the southern reaches of the Hudson River.
- In 1996, Georgia finished an analysis of landcover based on LANDSAT TM imagery. Georgia reported acreage of 15 landcover classes for each county. Based on these data, Georgia estimates that 13% of its land area, nearly 5 million acres, is wetlands.
- The Ohio Department of Natural Resources (DNR) is conducting a statewide inventory of wetlands as part of its Remote Sensing Program with cooperation from numerous agencies. The program utilizes digital data from the LANDSAT Thematic Mapper, digitized soils data, low level aerial photographs, and topographic maps to identify and map different types of wetlands, including farmed wetlands. DNR plans to update the maps every 5 years.

Monitoring Wetlands Functions and Values

Wetlands monitoring programs are critical to the achievement of important national goals, such as no overall net loss of wetlands functions and values. With States and

Tribes developing water quality standards for their wetlands, State and Tribal monitoring programs are critical for determining if wetlands are meeting their existing and designated uses. Monitoring programs are also needed to prioritize wetlands for protection and restoration and to develop performance standards for successful mitigation and restoration efforts.

Monitoring programs can provide the data needed to identify degradation of functions and values in wetlands and sources of that degradation, but specific wetlands monitoring programs are still in their infancy. Currently, no State is operating a statewide wetlands monitoring program, although several States include some wetlands in their ambient monitoring programs. A growing number of States are implementing monitoring projects at selected reference wetlands that are relatively free from impacts. These States will use the data collected from reference wetlands to define baseline conditions in healthy wetlands and to create standards to protect wetlands.

■ Minnesota initiated the Reference Wetlands Project in 1993 to develop a basis for assessing the biological and chemical integrity of wetlands. This project included 32 relatively undisturbed wetlands and three impacted wetlands to calibrate biological metrics. In 1995, Minnesota began a second wetlands project in depressional wetlands. In the Impacted Wetland Project, 20 known impacted wetlands and six least-disturbed wetlands were sampled. In the Impacted Wetland Project the focus

was on calibrating biological metrics across a gradient of disturbance. The disturbance gradient was represented by two primary stressors, conventional agricultural practice and storm water discharges. Both projects characterized the invertebrate community, vegetation, amphibians, water, and sediment chemistry. This information will provide the basis for determining use support status and evaluating depressional wetlands health in Minnesota.

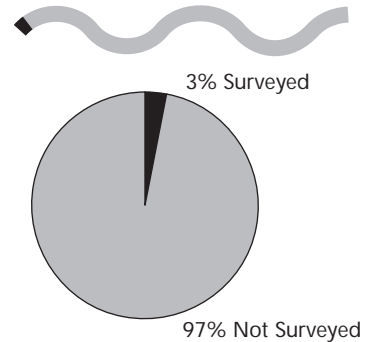
■ Montana sampled 80 wetlands throughout the State during 1993 and 1994 to develop bioassessment protocols. Wetlands were sampled for water column and sediment chemistry, macroinvertebrates, and diatoms. To partition natural variability between wetlands types, Montana developed a classification system to group reference wetlands by ecoregion and hydrogeomorphology. Montana used a multi-metric approach to develop a macroinvertebrate index to assess wetlands water quality. Preliminary results indicate detection of impairments caused by metals, nutrients, salinity, sediment, and fluctuating water levels.

■ North Dakota initiated a project in 1995 to develop biocriteria and water quality standards for wetlands. North Dakota began sampling water chemistry, sediments, macroinvertebrates, phytoplankton, and vegetation in reference wetlands of the prairie pothole region. Based on continued field sampling, North Dakota plans to develop biological criteria for specific wetlands classes.

Wetlands Acres Surveyed by States and Tribes

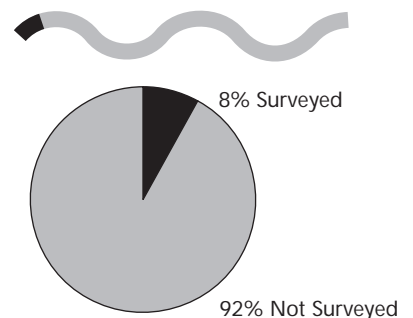
Including Alaska's Wetlands

- 8,405,875 acres = 3% surveyed
- Total acres (including Alaska) = 277 million^a



Excluding Alaska's Wetlands

- 8,405,875 acres = 8% surveyed
- Total acres (excluding Alaska) = 107 million



^aFrom Dahl, T.E. 1990. *Wetlands Losses in the United States 1780's to 1980's*. U.S. Department of the Interior, Fish and Wildlife Service.

Source: 1996 Section 305(b) reports submitted by States, Tribes, Territories, and Commissions.

■ Ohio initiated a project in 1994 to develop biocriteria for wetlands. Ohio is applying the same approach to wetlands that it used to develop its stream biocriteria program. Methodologies to assess vegetation, macroinvertebrates, and amphibian assemblages are under development. As with streams, Ohio is defining the biological integrity of wetlands based on a framework of least-impacted reference sites. Ohio will use wetland biocriteria to define the attainable condition for a class of wetlands in a given region.

■ Every 3 years, Kansas collects water quality samples from seven wetlands (covering 25,069 acres) owned by the State or the Federal government. The State monitors one station per wetland for nutrients, minerals, heavy metals, clarity, suspended solids, pesticides, bacteria, algae, temperature, and dissolved oxygen.

■ Kentucky added several wetlands to its reference reach monitoring program to characterize chemical water quality, sediment quality, fish tissue concentrations of contaminants, habitat conditions, and general biotic conditions in each physiographic region of the State. The information will be used to develop designated uses and biological criteria for wetlands.

Designated Use Support in Wetlands

The States, Tribes, and other jurisdictions are making progress in developing specific designated uses

and water quality standards for wetlands, but many States and Tribes still lack specific water quality criteria and monitoring programs for wetlands. Without criteria and monitoring data, most States and Tribes cannot evaluate use support. To date, only nine States and Tribes reported the designated use support status for some of their wetlands (see Appendix D, Table D-1). Only Kansas used quantitative data as a basis for use support decisions.

■ California reported that 12% of the 124,178 acres of surveyed wetlands fully supports aquatic life use and 88% of the acres are impaired due to metals, nutrients, oxygen depletion, and salinity. Sources impacting wetlands include municipal wastewater treatment plants, urban runoff and storm sewers, and hydrologic and habitat modifications.

■ The Coyote Valley Band of Pomo Indians in northern California classified all 1.6 acres of their wetlands as partially supporting uses for wildlife and use as a riparian buffer. The use support analysis was based on reconnaissance surveys rather than monitoring in the wetlands. The wetlands are impaired by exotic species, filling and draining, and other habitat alterations.

■ The Hoopa Valley Tribe in northern California reported that all of its 3,200 acres of surveyed wetlands are impaired for aquatic life use, religious use, wildlife habitat use, and use as a riparian buffer. Filling and draining, flow alterations, other habitat alterations, and exotic species impair the wetlands.

Agriculture, forestry, construction, hydrologic modifications, and unknown sources have degraded wetlands on the Hoopa Valley Reservation.

■ Iowa used best professional judgment to determine the use support of 26,062 wetlands acres during 1994 and 1995. The State reported that 35% of the assessed wetlands fully supported designated uses, of which 32% are threatened for one or more uses. The nonsupporting acres are impaired by pesticides, ammonia, nutrients, siltation, and habitat alterations. Sources of impairment include agriculture, urban runoff and storm sewers, land disposal of wastes, and hydro-modification.

■ Kansas assessed and determined the use support of 35,597 wetlands acres during this reporting cycle. Of the 35,597 acres, 10,458 acres were of unknown use support. Of the remaining 26,139 acres, 9% fully support uses now but are threatened and 91% are impaired and exceed chronic aquatic life support criteria. Kansas used monitoring data to determine use support in nine publicly owned wetlands (covering 25,069 acres) and qualitative information to assess one wetland (covering 70 acres).

■ Louisiana assessed use support in over 1 million acres of its 8.7 million total acres of wetlands. The State reported that 92% of the assessed wetland acres fully support uses and 8% are impaired because of bacteria, siltation and suspended solids, and hydrologic modifications. Sources of impairment include

channelization, dredging, flow regulation, drainage and filling, recreational activities, upstream sources, and natural sources.

■ Michigan assessed use support for 10 acres of wetlands. All 10 acres are impaired and do not support designated uses because of nickel contamination.

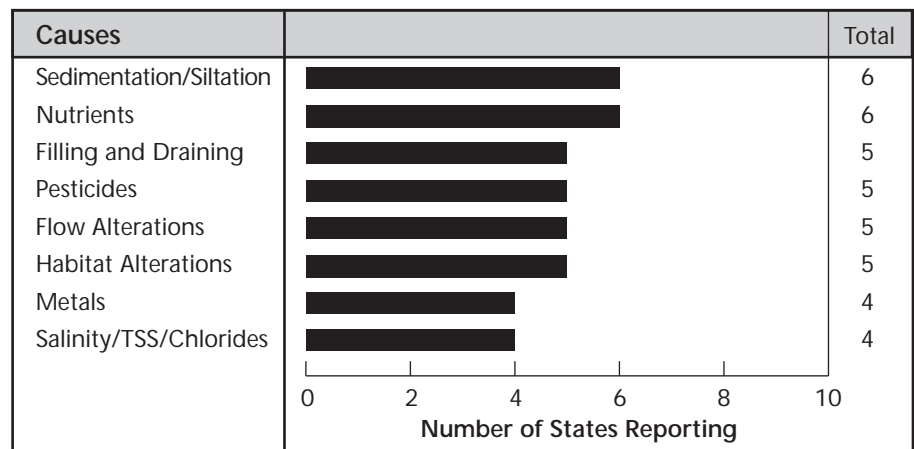
■ Nevada surveyed use support in 19,326 acres (25%) of its 136,650 total acres of wetlands. Nevada reported that all of the surveyed wetlands fully supported designated uses.

■ North Carolina used aerial photographs and soil information from a 1992-1993 survey to rate use support by current land use. North Carolina rated wetlands on hydric soils with natural tree cover as fully supporting uses. Partially supporting wetlands have modified

More information on wetlands can be obtained from EPA's Wetlands Hotline at 1-800-832-7828, between 9 a.m. and 5 p.m. Eastern Standard Time.

Figure 5-10

Causes Degrading Wetlands Integrity (10 States Reporting)



Based on data contained in Appendix D, Table D-2.

cover and hydrology but still retain wetlands status and support most uses. For example, pine plantations still retain value for wildlife habitat, flood control, ground water recharge, nutrient removal, and aquatic habitat, although the modified wetlands support these uses less effectively than undisturbed wetlands. Wetlands converted to agriculture or urban land use are classified as not supporting original wetlands uses. The State used this methodology to survey use support in over 7 million acres of wetlands. The State reported that 66% of the surveyed wetlands fully support uses and 34% are impaired for one or more uses.

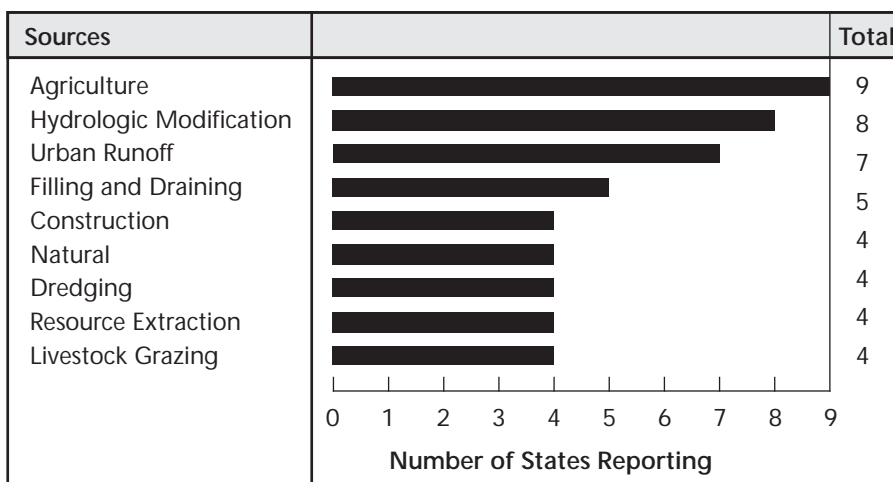
EPA cannot draw national conclusions about water quality conditions in all wetlands because the States used different methodologies

to survey only 3% of the total wetlands in the Nation. Summarizing State wetlands data would also produce misleading results because two States (North Carolina and Louisiana) contain 98% of the surveyed wetlands acreage. More States and Tribes will assess use support in wetlands as they develop standards for wetlands. Many States are still in the process of developing wetlands water quality standards, which provide the baseline for determining beneficial use support (see Chapter 13). Improved standards will also provide a firmer foundation for assessing impairments in wetlands in those States already reporting use support in wetlands.

The States have even fewer data to quantify the extent of pollutants degrading wetlands and the sources of these pollutants. Although most States cannot quantify wetlands area impacted by individual causes and sources of degradation, nine States identified causes and sources known to degrade wetlands integrity to some extent (Figures 5-10 and 5-11). These States listed sediment and habitat alterations as the most widespread causes of degradation impacting wetlands, followed by draining and nutrients. Agriculture and hydrologic modifications topped the list of sources degrading wetlands, followed by urban runoff, construction, and draining (see Appendix D, Tables D-3 and D-4, for individual State information).

Figure 5-11

Sources Degrading Wetlands Integrity (9 States Reporting)



Based on data contained in Appendix D, Table D-3.

Summary

Currently, most States are not equipped to report on the integrity of their wetlands. Only six States and Tribes reported attainment of designated uses for wetlands in 1996. National trends cannot be

drawn from this limited information. This is expected to change, however, as States adopt wetlands water quality standards and enhance their existing monitoring programs to more accurately assess designated use support in their wetlands.



Jeff Reynolds, Raleigh, NC



Ground Water Quality

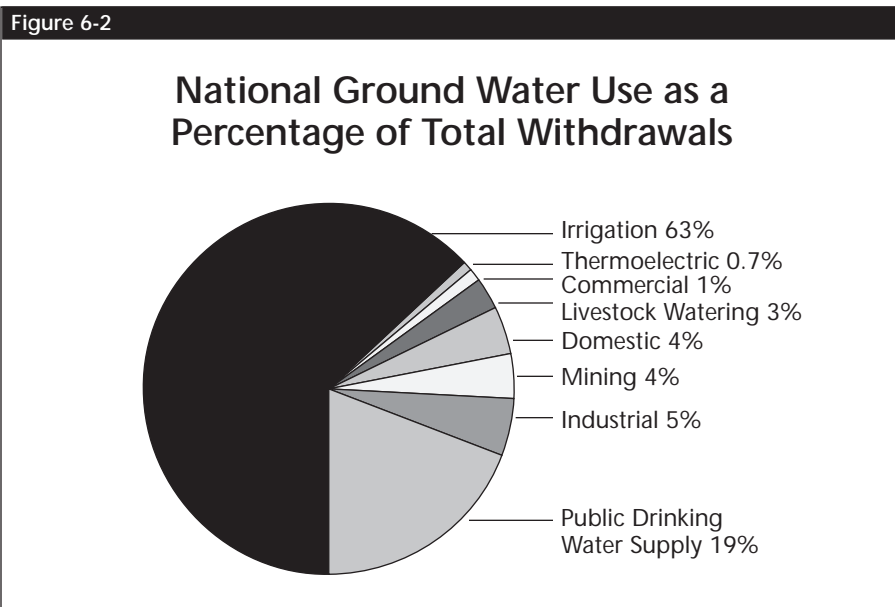
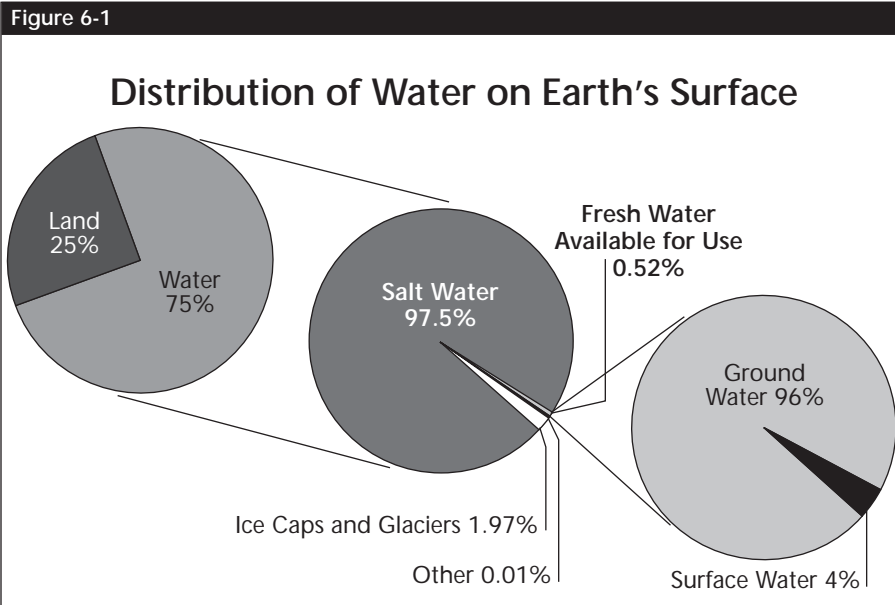
Ground water is a vital national resource that is used for myriad purposes. It is used for public and domestic water supply systems, for irrigation and livestock watering, and for industrial, commercial, mining, and thermoelectric power production purposes. In many parts of the Nation, ground water serves as the only reliable source of drinking and irrigation water. Unfortunately, this vital resource is vulnerable to contamination, and ground water contaminant problems are being reported throughout the country.

To ascertain the extent to which our Nation's ground water resources have been impacted by human activities, Section 106(e) of the Clean Water Act requests that each State monitor ground water quality and report the findings to Congress in their 305(b) State Water Quality Reports. Evaluation of our Nation's ground water quality is complex and early efforts to provide a National assessment of ground water quality relied on generalized overviews presented by the State resource managers. These overviews were most frequently based on known or suspected contamination sites and on finished water quality data from public supply systems. Unfortunately, these early assessments did not always provide a complete or accurate representation of ambient ground water quality conditions. Nor did they provide an indication of the extent and severity of ground water contamination problems.

EPA recognized that an accurate representation of our Nation's ambient ground water quality conditions required developing a set of guidelines that would ultimately yield quantitative data for specific hydrogeologic units within a State. EPA, in partnership with interested States, developed guidelines for assessing ground water quality that took into account the complex spatial variations in aquifer systems, the differing levels of sophistication among State programs, and the expense of collecting ambient ground water data. It was these guidelines that were used by States for reporting the 1996 305(b) ground water data.

The most significant change for 1996 was the request that States provide ground water information for selected aquifers or hydrogeologic settings (e.g., watersheds) within the State. The focus on specific aquifers or hydrogeologic settings provides for a more quantitative assessment of ground water quality than was possible in previous reporting cycles.

State response to the revised ground water guidelines was excellent. Forty States, one Territory, and two Tribes used the new guidelines to assess and report ground water quality data in 1996. Each of these reporting entities (hereafter referred to as States) used the data that was available to them and, as a consequence, there was wide variation in reporting style. This variation was anticipated by EPA and States involved in developing the guidelines as it is a direct reflection



Source: Open-File Report 92-63, U.S. Geological Survey.

of the administrative, technical, and programmatic diversity among our States. This variation is expected to decrease in future 305(b) reporting cycles as many States have indicated they are developing plans to improve their data management to provide better coverage. Still other States indicated that the 1996 Guidelines provided incentive to modify their ground water programs to enhance their ability to provide more accurate and representative information.

Despite variations in reporting style, the 1996 305(b) State Water Quality Reports represent a first step in improving the assessment of State ambient ground water quality. For the first time, States provided quantitative data describing ground water quality. Furthermore, States provided quantitative information pertaining to contamination sources that have impacted ground water quality. This chapter presents the results of data submitted by States in their 1996 305(b) Water Quality Reports.

Ground Water Use in the United States

Although 75% of the earth's surface is covered by water, less than 1% is fresh water available for our use. It has been estimated that approximately 96% of the world's available fresh water reserve is stored in the earth as ground water. Figure 6-1 helps put these numbers into perspective.

In the United States, ground water is used for agricultural, domestic, industrial, and commercial purposes. Ground water provides

water for drinking and bathing, irrigation of crop lands, livestock watering, mining, industrial and commercial uses, and thermoelectric cooling applications. Figure 6-2 illustrates how ground water is used among these various categories. As shown, irrigation (63%) and public water supply (19%) are the largest uses of ground water withdrawals.

In 1990, the United States Geological Survey reported that ground water supplied 51% of the Nation's overall population with drinking water. In rural areas of the Nation, ground water supplied 95% of the population with drinking water. So our Nation's dependence on this valuable resource is obvious. In their 305(b) Water Quality Reports, States emphasized the importance of ground water as a drinking water resource.



Idaho is one of the top five States in the country for the volume of ground water used. Idahoans use an average of 9 billion gallons per day of ground water. Sixty percent of this water is used by agriculture for crop irrigation and stock animals. Thirty-six percent is used by industry, and 3% to 4% is used for drinking water. Even though the volume of ground water used for drinking water is relatively small in comparison to total ground water use, more than 90% of the population in Idaho rely on ground water for their drinking water supply. Currently, approximately 70% of the State's population is served by public systems regulated under the Safe Drinking Water Act (see description in Chapter 18); the remaining 30%

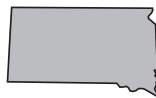
obtain their drinking water through private systems typically represented by private wells.



Approximately 95% of the 11.5 million people in Illinois rely on public water supplies as a source of drinking water. About 4.1 million people use ground water as a source of public water supply. Furthermore, an estimated 400,000 residences in Illinois are served by private wells.



Kansas relies on ground water resources for public, rural-domestic, industrial, irrigation, and livestock water supplies. Over 90% of all water used within Kansas is supplied by ground water. Although irrigation continues to be by far the largest user of ground water, ground water provides approximately 85% of the drinking water in rural areas. A total of 637 community public water supplies are dependent on ground water, either solely or in combination with surface water sources. These supplies serve a total of 1,717,464 people.



South Dakota is heavily dependent on ground water to meet the needs of its population. More than 75% of the population use ground water for domestic needs. Over 80% of the State's public water supply systems rely on ground water and virtually everyone not supplied by the public water supply systems is dependent on ground water.

In 1990, the United States Geological Survey reported that ground water supplied 51% of the Nation's overall population with drinking water. In rural areas of the Nation, ground water supplied 95% of the population with drinking water. So our Nation's dependence on this valuable resource is obvious. In their 305(b) Water Quality Reports, States emphasized the importance of ground water as a drinking water resource.



Ground Water Use

State	Uses of Ground Water Specific to Drinking Water	Other Uses
Alabama		40% of water is obtained from ground water
Alaska	85% of public drinking water systems in the State use ground water as their source	Ground water is the major source of fresh water for public and private drinking water supply systems, industry, and agricultural development
Arkansas	47.2% of total ground water withdrawals are used for drinking water	Between 1975 and 1980, ground water use increased from 2,596 to 4,056 million gallons per day (a 56% increase); it increased from 4,056 to 4,708 million gallons per day between 1980 and 1990 (a 16% increase)
Colorado	59 of 63 counties use ground water for drinking water; 29 of these counties rely solely on ground water	Ground water supplies approximately 18% of total water withdrawals; 96% is used for irrigation
Delaware	67% of the State's population is dependent upon public and private wells for domestic needs; Kent and Sussex Counties rely 100% on ground water for drinking water	Overall, ground water use increased 13.31%, whereas overall surface water use decreased 18.87%
Georgia	In 1990, ground water made up 24% of the public water supply and 92% of rural drinking water sources; for all practical purposes, ground water is the dominant source of drinking water for areas outside the larger cities of the Piedmont	In 1990, ground water made up 60% of irrigation use and 51% of the industrial and mining use



State	Uses of Ground Water Specific to Drinking Water	Other Uses
Indiana	Nearly 60% of the population uses ground water for drinking water and other household purposes; approximately 50% of the population served by public water supplies depends on ground water; over 0.5 million homes have private wells	Industry withdraws an average 190 million gallons/day; irrigation consumes 200 million gallons/day during the crop production season; and livestock depend on an average of 45 million gallons/day
Kentucky	Approximately 14% of the population (500,000 people) rely on private wells for drinking water; there are 362 public water supply systems using ground water as principal, partial, or supplemental supplies	Large ground water withdrawals (>10,000 gallons/day) increased from 37.8 million gallons/day in 1980 to 320 million gallons/day in 1995
Maine	More than 60% of all households draw their drinking water from ground water supplied from private or public wells; ground water is the source of approximately 98% of all water used by households with private supplies	Nearly 60% of water needed for livestock is supplied by ground water; ground water also supplies more than 60% of industrial needs
Maryland	Ground water supplied 450 public water supply systems in 1995, serving a population of 960,000	
Missouri	Ground water is the main source of drinking water in the Ozarks and Southeast Lowlands for both public and private supplies; the cities of Independence, Columbia, and St. Charles use ground water adjacent to the Missouri River	

HIGHLIGHT  HIGHLIGHT HIGHLIGHT

State	Uses of Ground Water Specific to Drinking Water	Other Uses
New York	Approximately 6,000,000 people use ground water as a source of drinking water; 50% of these people are on Long Island and the remainder are in upstate New York	
South Carolina	Ground water is a source of drinking water for more than 60% of the population	
Tennessee	More than 50% of the population relies on ground water for drinking water supplies (one in five of these households relies on a private well or spring); community public water systems withdraw approximately 243 million gallons/day	
Texas	About 41% of municipal water is derived from ground water resources	In 1992, approximately 56% of the water used for domestic, municipal, industrial, and agricultural purposes was derived from ground water
Utah	Ground water is a major source of public drinking water supplies with almost 67% of the population dependent upon this resource	
Vermont	Approximately 60% of the population depend on ground water to meet their drinking water needs; in rural communities, ground water dependence is nearly 100%	
Virginia	Ground water is used solely or in part to supply 80% of the population with drinking water	Ground water accounts for approximately 22% of the water used exclusively for hydroelectric and thermo-electric purposes
Wisconsin	Ninety-seven percent of Wisconsin's villages and cities use ground water for drinking water, and 70% of the State's residents rely on ground water for their water supply	



Ground water is the source of drinking water for 60% to 70% of the population of Washington State. In large areas east of the Cascade Mountain Range, 80% to 100% of available drinking water is obtained from ground water resources. As a whole, over 95% of Washington's public water supply systems use ground water as their primary water source.

Ground water is also often directly connected to rivers, streams, lakes, and other surface waterbodies, with water flowing back and forth from one resource to the other. In some areas of the country, ground water contributes significantly to the water in streams and lakes.

The volume of ground water that is discharged to surface waterbodies, thereby maintaining streamflow during periods of low flow or drought conditions, was previously unrecognized and unquantified. This volume, estimated at 492 billion gallons per day, is measured using special instruments or estimated using stream gaging and hydraulic gradient data. When ground water contributing to stream baseflow maintenance is included with the other ground water uses, it becomes evident just how important it can be. As shown in Figure 6-3, stream baseflow maintenance accounts for 54% of ground water discharges. This baseflow contributes to maintaining healthy aquatic habitats in surface water.

With ground water playing such an important part in maintaining water flow in streams and lakes, the quality of the ground water can have an important effect on the

overall condition of the surface water. Surface waters can become contaminated if the ground water serves as a means to transport contaminants to the surface water (and vice versa). This could affect drinking water supplies drawn from surface water, fish and wildlife habitats, swimming, boating, and fishing.

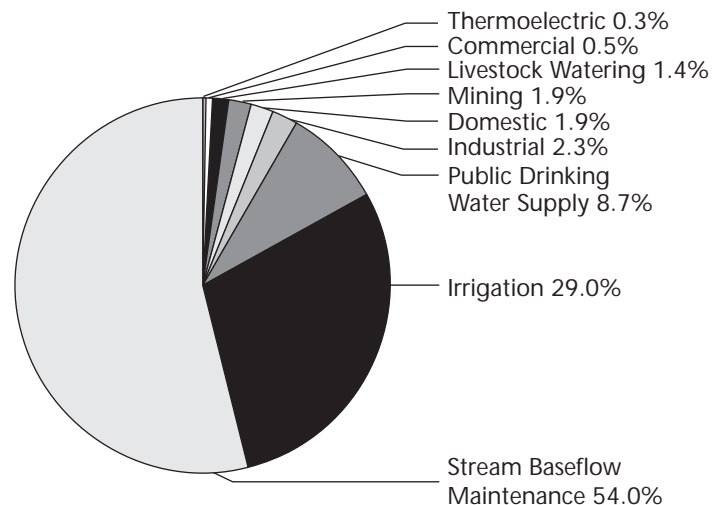
Thus, it is evident that ground water is a very important natural resource. Preserving the quality of our ground water resources ensures that our needs as a Nation will be met now and into the future.

Ground Water Quality

The evaluation of our Nation's ground water quality is complex. In evaluating ground water quality

Figure 6-3

Withdrawal and Discharge of Ground Water as a Percentage of Contribution



Source: Open-File Report 92-63, U.S. Geological Survey, and *National Water Summary 1986, Hydrologic Events and Ground-Water Quality*, U.S. Geological Survey, Water-Supply Paper 2325.



Ground Water/Surface Water Interactions

Nationwide, many water quality problems may be caused by ground water/surface water interactions. Substantial evidence shows that it is not uncommon for contaminated ground water to discharge to and contaminate surface water. In other cases, contaminated surface water is seeping into and contaminating ground water. In their most recent reports on water quality, several states reported ground water/surface water interactions leading to contamination of one medium by the other. A few examples follow:

- The Arkansas Department of Health (ADH) is investigating cases of ground water contaminated by microscopic organisms normally found in surface water. Because surface water carries disease-causing protozoa and other organisms resistant to the chlorination used to disinfect most public wells, the ADH must determine if public drinking water wells are supplied by sources of ground water under the direct influence (GWUDI) to surface water.

The ADH has developed an objective method to determine if a well is supplied by GWUDI. Water quality information is used to determine the potential for contamination and then possible pathways of contamination are identified by evaluating

the well's conformance to established construction standards. Two primary defects in well construction that provide possible pathways for surface water contamination are: (1) unsuitable below-ground construction, particularly shallow casings and insufficient grout; and (2) well sites characterized by poor drainage, high soil infiltration rate, and highly permeable outcrops.

Arkansas has more than 1,700 public drinking water supply wells. In the 3 years since the GWUDI program began, the ADH has used the above method to determine that 900 of these wells are not supplied by sources of ground water under the influence of surface water. For many of the wells evaluated, the ADH has recommended simple, above-ground construction repairs or site maintenance procedures that effectively closed the pathways of surface water contamination.

- In South Carolina, ground water serves to recharge most of the streams; thus, contaminated ground water impacts surface waters more often than surface waters impact ground water. In the State's Ground Water Contamination Inventory, 79 cases of contaminated ground water discharging from surficial aquifers to surface water have been noted.



Detailed information on contaminant concentrations in both the aquifer and surface water is not available. However, in most of these cases, dilution of the contaminated ground water by uncontaminated surface water reduces the contaminant concentrations in the surface water to low or not detectable levels.

■ No single program addresses the water quality concerns that arise from ground water/surface water interactions in Maine. However, contamination, or potential contamination, of surface water through baseflow of contaminated ground water is being evaluated at several locations. At an egg production facility in Turner, Maine, past practices that included excessive land spreading of chicken manure, hen carcass disposal, and septage disposal resulted in nitrate contamination of large areas of a sand and gravel aquifer. The majority of the shallow ground water at the site discharges to streams on the east and west sides of the property. Monitoring

points have been established on these streams to evaluate the effects of past practices and current wastewater disposal on surface water quality. To date, surface waters within the property and along the property boundary show evidence of nitrate contamination.

■ A similar situation occurs in Delaware. Past land-use practices, such as high septic system density and poultry houses, have contributed to nitrate contamination of ground water. This nitrate-contaminated groundwater discharges into the Rehoboth and Indian River bays contributing to eutrophication and algal bloom problems. In fact, it is estimated that certain subbasins within the Indian River Bay watershed contribute, through direct ground water discharge, almost 50% of the total nitrogen load that enters the bay. Furthermore, poultry-producing subbasins were found to be the source of greater nitrate loading than non-poultry-producing basins.

under Section 305(b) of the Clean Water Act, our goal is to assess if the resource has been adversely impacted or degraded as a result of human activities.

Not too long ago, it was thought that soil provided a protective "filter" or "barrier" that immobilized the downward migration of contaminants released on the land surface and prevented ground water resources from being adversely impacted or contaminated. The discovery of pesticides and other contaminants in ground water demonstrated that ground water resources were indeed vulnerable to contamination resulting from human activities. The potential for a contaminant to affect ground water quality is dependent upon its being introduced to the environment and its

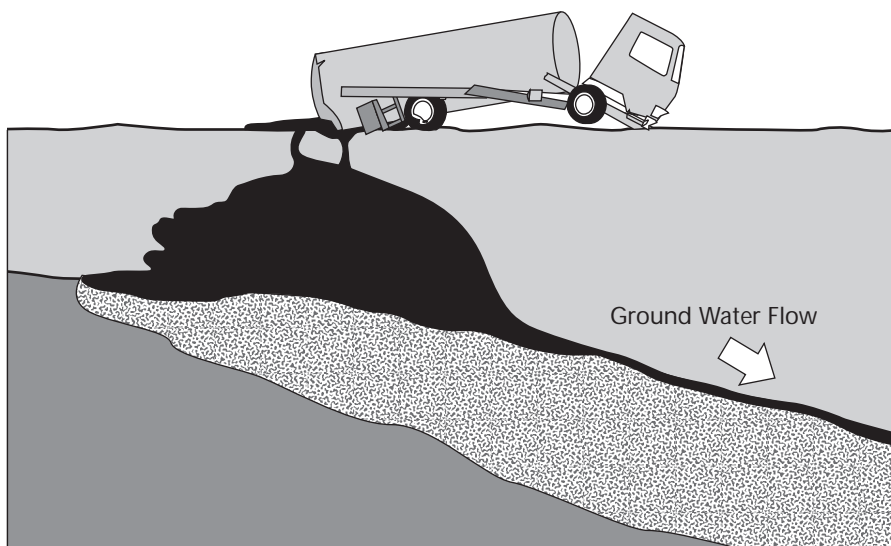
ability to migrate through the overlying soils to the underlying ground water resource. Figure 6-4 illustrates a petroleum spill onto the ground surface and the subsequent migration of the petroleum through the soils to the underlying ground water.

Ground water contamination can occur as relatively well defined, localized plumes emanating from specific sources such as leaking underground storage tanks, spills, landfills, waste lagoons, and/or industrial facilities (Figure 6-5). Contamination can also occur as a general deterioration of ground water quality over a wide area due to diffuse nonpoint sources such as agricultural fertilizer and pesticide applications, septic systems, urban runoff, leaking sewer networks, application of lawn chemicals, highway deicing materials, animal feedlots, salvage yards, and mining activities. Ground water quality degradation from diffuse nonpoint sources affects large areas, making it difficult to specify the exact source of the contamination.

Ground water contamination is most common in highly developed areas, agricultural areas, and industrial complexes. Frequently, ground water contamination is discovered long after it has occurred. One reason for this is the slow movement of ground water through aquifers, which, for finer-grained aquifers may be less than 1 foot per day. Contaminants in the ground water do not mix or spread quickly, but remain concentrated in slow-moving, localized plumes that may persist for many years. This often results in a delay in the detection of ground water contamination. In

Figure 6-4

Ground Water Contamination as a Result of Petroleum Spillage



some cases, contaminants introduced into the subsurface more than 10 years ago are only now being discovered. This also means that the practices of today may have effects on water quality well into the future.

Shallow, unconfined aquifers are especially susceptible to contamination from surface activities. Ground water contamination in the surficial aquifers can also affect ground water quality of the underlying confined aquifers. Confined aquifers are most frequently susceptible to contamination when low-permeability confining layers are thin or absent, thus enabling the unretarded downward migration of contaminants. Recent studies in southern New Castle County of Delaware have demonstrated the long-term susceptibility of the underlying aquifers to contamination. In Delaware, stream

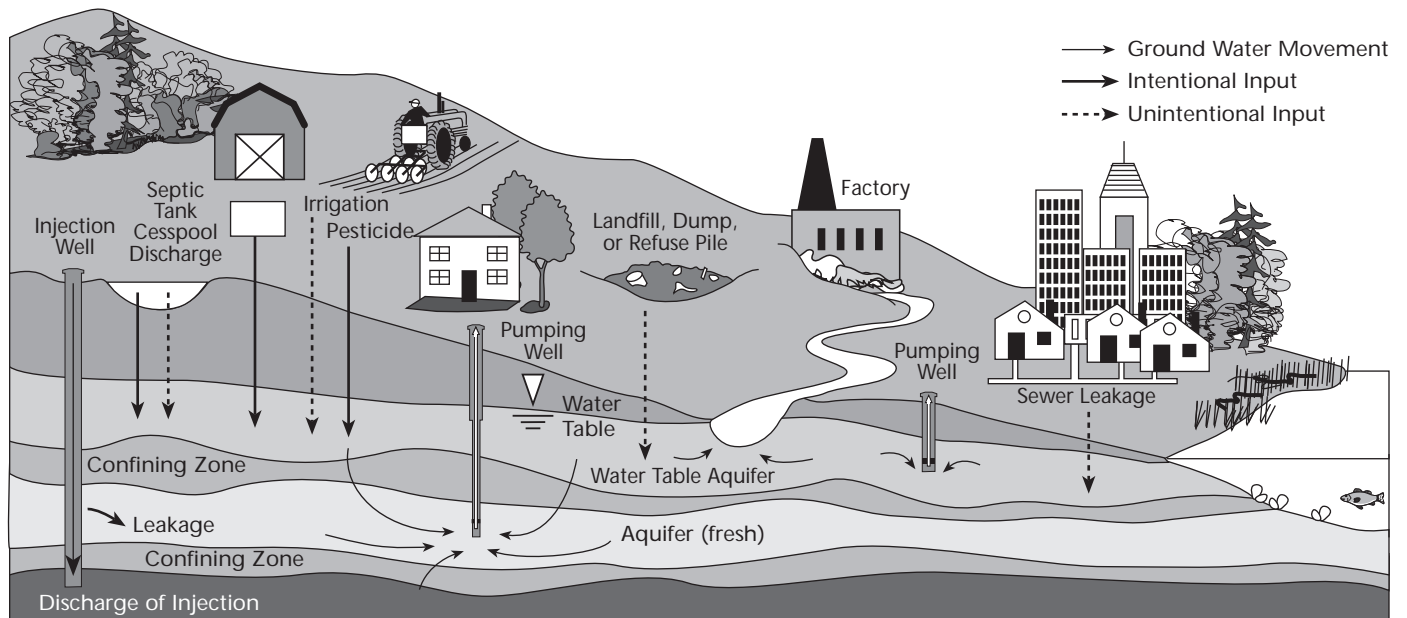
channels have cut down through confining layers at periods of low sea level. When sea level rose, the stream channels were filled with sand and gravel. These highly permeable channels can act as conduits for contaminant migration.

Ground water contaminant problems are frequently serious and can pose a threat to human health and/or result in increased costs to consumers. In the 1996 Guidelines, States were asked to indicate the major uses (e.g., public water supply, private water supply, irrigation, industry, livestock watering) for water withdrawn from aquifers or hydrogeologic settings within the State. States were also asked to relate water use to uses that may have been affected by ground water contamination.

Although this information was considered optional, 20 States

Figure 6-5

Sources of Ground Water Contamination





Ground Water Along Our Nation's Coasts

Communities along the U.S. coast have been attracting new residents and more industry at an ever-rising rate during the past two or so decades. This growth has been beneficial for the economy and tax base of these areas. However, now we are seeing the beginning of what could be unwelcome, even dangerous, effects on these communities and the environment. In fact, coastal communities may face critical water supply issues within the decade if ground water protection and conservation are not aggressively pursued.

EPA is forming a partnership between its internal Offices of Ground Water and Drinking Water and Wetlands, Oceans, and Watersheds, the Ground Water Protection Council, and the State of Florida to begin a water supply study in Florida. The results of this study will form the basis of research to characterize current national water quality and quantity in coastal areas.

The problem will be framed in terms of current drinking water needs, human health, and economic impact. EPA plans to share the results of this research with coastal

communities through public outreach. Beginning with the most affected localities and in partnership with local and community organizations, EPA will inform coastal communities about the possible problems coming their way and how to avoid them. EPA will develop methods to help communities protect their source waters and drinking water and provide assistance to communities in putting these methods in place.

The problems of protecting coastal source water and drinking water have been neglected for too long—so long that real problems are arising. EPA hopes this project will significantly benefit ground water and drinking water quality all along the coast through improved characterization of ground water in coastal areas and better watershed management. Public education about problems in the coastal environment and how to solve them will encourage public involvement. Better management of resources—environmental, financial, and human—will lead to new and needed environmental improvements.

responded with information for a total of 66 aquifers or hydrogeologic units. Of these, 43 units reportedly supplied water for PWS, 45 units supplied water for private use, and 32 units supplied water for irrigation. Other important uses of the water included commercial (12 units), livestock (19 units), and industry (10 units).

When evaluating the different uses for ground water that have been affected by water quality problems, water supply for public and private use were the most frequently affected. Water supply to PWS was affected in 19 units (almost 45%) and water supply to private wells was affected in 23 units (>50%). Irrigation, commercial, livestock, and industry uses were less frequently affected. This may reflect lower water quality standards for these uses.

Ground Water Contaminant Sources

Ground water quality may be adversely impacted by a variety of potential contaminant sources. EPA developed a list of potential contaminant sources for the 1996 305(b) Guidelines and requested each State to indicate the 10 top sources that potentially threaten their ground water resources. The list was not considered comprehensive and States added sources as was necessary based on State-specific concerns. Factors that were considered by States in their selection include the number of each type of source in the State, the location of the various sources relative to ground water

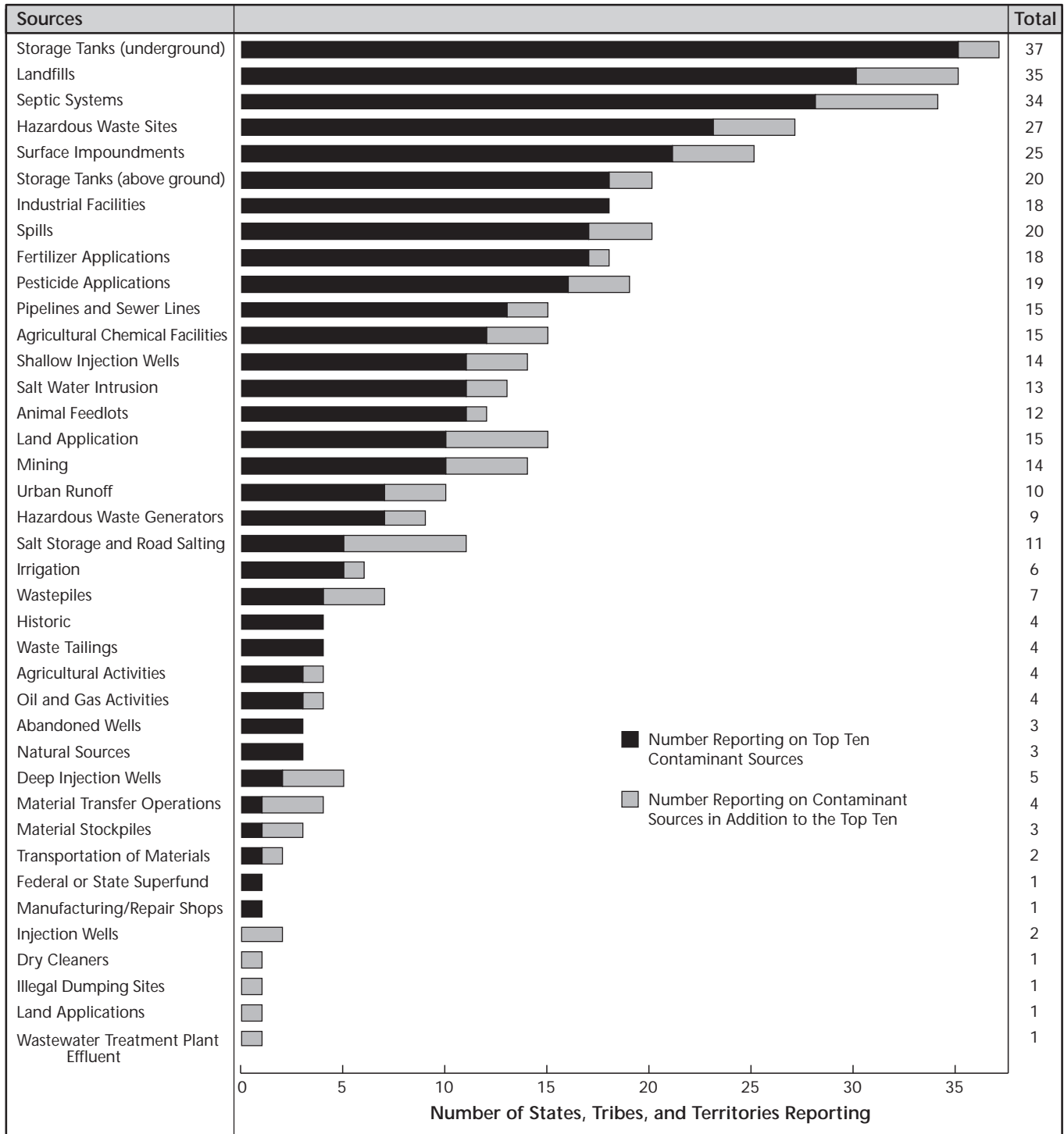
used for drinking water purposes, the size of the population at risk from contaminated drinking water, the risk posed to human health and/or the environment from releases, hydrogeologic sensitivity (the ease with which contaminants enter and travel through soil and reach aquifers), and the findings of the State's ground water protection strategy and/or related studies. For each of the indicated contaminant sources, States were also asked to identify the contaminants impacting ground water quality.

Thirty-seven States provided information related to contaminant sources. As requested in the 1996 Guidelines, most States indicated the 10 top contaminant sources threatening ground water quality. In some cases, they not only specified the 10 top sources, but provided additional information on sources of lesser, but still notable, importance. In a few other cases, they provided information on the majority of sources threatening ground water quality within the State.

Figure 6-6 illustrates the sources most frequently cited by States as a potential threat to ground water quality. As shown, leaking underground storage tanks (USTs) were specified by 35 out of 37 States as one of the top 10 potential sources of ground water contamination. Two other States noted that leaking USTs were a source of ground water contamination. Landfills, septic systems, hazardous waste sites, and surface impoundments were the next most frequently cited sources of concern.

Figure 6-6

Major Sources of Ground Water Contamination



Underground Storage Tanks

Leaking USTs were cited as the highest priority contaminant source of concern to States in 1996 (Figure 6-6). The high priority assigned to leaking USTs in 1996 is consistent with information reported by States during previous 305(b) cycles.

Although USTs are found in all populated areas, they are generally most concentrated in the more heavily developed urban and suburban areas of a State. USTs are primarily used to hold petroleum products such as gasoline, diesel fuel, and fuel oil. Because they are buried underground, leakage can be a significant source of ground water contamination that can go undetected for long periods of time (Figure 6-7).

States report that the organic chemicals associated with petroleum products are one of the most common ground water contaminants. Petroleum-related chemicals have adversely affected ground water quality in aquifers across the Nation. The most significant affects generally occur in the uppermost aquifer, which is frequently shallow and often used for domestic purposes. Petroleum-related chemicals threaten the use of ground water for human consumption because some (e.g., benzene) are known to cause cancer even at very low concentrations.

The primary causes of leakage in USTs are faulty installation and corrosion of tanks and pipelines. As of March 1996, more than 300,000 releases from USTs had been confirmed. EPA estimates that nationally 60% of these leaks have impacted ground water quality and, in some

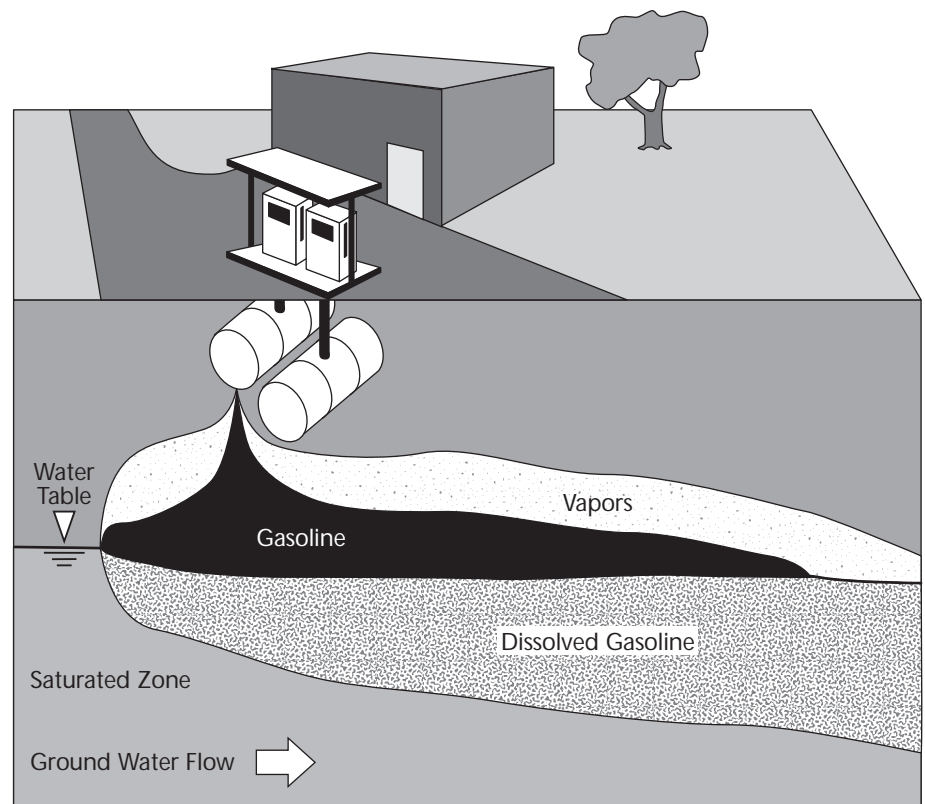
States, the percentage is as high as 90%.

In general, the threat from USTs was determined primarily based on the sheer number of leaking USTs.

- There were almost 61,000 facilities containing 155,308 registered USTs in Texas in 1994. During that same year, 4,894 cases of ground water contamination were documented as being under enforcement by the Texas Natural Resource Conservation Commission. Fifty-two percent of the contamination cases are within the 10 most populous

Figure 6-7

Ground Water Contamination as a Result of Leaking Underground Storage Tanks





Frequently Considered Factors

When identifying a contaminant source as a potential threat to ground water quality, States may consider a number of different factors such as

- Number of each type of source in the State
- Location of various sources relative to ground water used for drinking water purposes
- Size of the population at risk from contaminated drinking water
- Risk posed to human health and/or the environment from releases
- Hydrogeologic sensitivity (the ease with which contaminants enter and travel through soil and reach aquifers)
- Findings of the State's ground water protection strategy and/or related studies. States were asked in the *1996 Guidelines* to specify the factors they considered in reporting contaminant sources.

Number of States Reporting a Contaminant Grouping in Association with the Specified Source

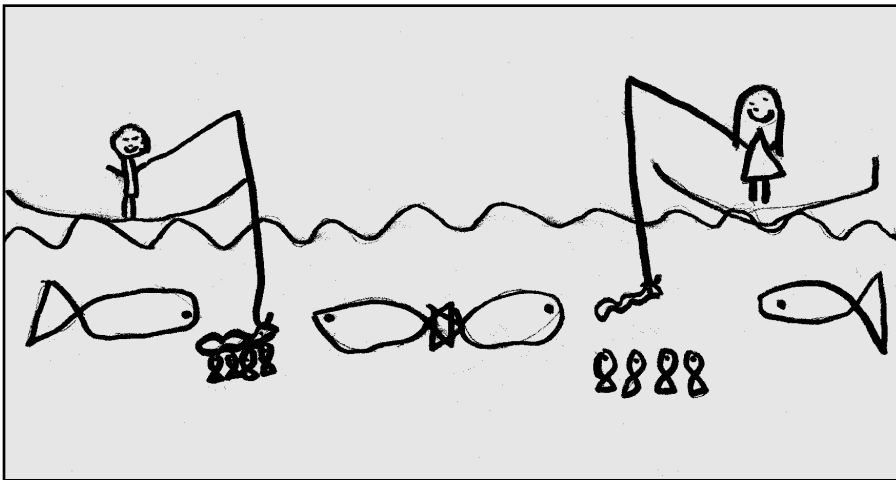
Source	Leaking USTs	Landfills	Septic Systems
Petroleum Compounds	31	18	
Halogenated Solvents	9	19	5
Organic Pesticides	5	12	
Metals	3	20	
Nitrate		8	22
Bacteria		10	17
Inorganic Pesticides		10	
Protozoa			9
Viruses		5	15



Unquestionably, human health and the environment, the number and/or size of the contaminant sources, and the location of a source relative to a drinking water source were the most important factors considered. These three factors are reflected in the high priority assigned to leaking USTs, landfills, and septic systems (see Figure 6-7 of this report). Large numbers of each of these three contaminant sources have been documented in the States. Adverse impacts to drinking water as a result of releases from these three sources have also been

reported. Releases are frequently known to be hazardous to human health.

The table shows the contaminants that States specified in association with leaking USTs, landfills, and septic systems. As shown, petroleum compounds were most frequently associated with leaking USTs. Nitrate, bacteria, and protozoa were most frequently cited in association with septic systems. The variability in contaminants associated with landfills reflects the diversity in disposed materials.



Jesse Xiong, 1st grade, Estes Hills Elementary, Chapel Hill, NC

counties in Texas. Furthermore, leakage from storage tanks has been documented in 223 of 254 counties in the State and either has affected, or has the potential to affect, virtually every major and minor aquifer in the State.

■ As of August 1996, the State of Arizona was tracking approximately 8,960 facilities having 30,000 USTs. Of these 30,000 USTs, 5,935 have reported leaks and 917 have or may have contaminated ground water.

■ In the State of Delaware, there are over 9,000 regulated USTs (3,516 of which are currently in use) located at over 2,000 facilities. Over the period 1994-1995, 586 sites had confirmed releases with 80 having confirmed ground water releases.

■ As of December 31, 1995, a total of 41,795 USTs have been registered at approximately 14,000 facilities in the State of Kentucky. Approximately 400 of these registered sites have ground water contamination at levels above the maximum contaminant levels for drinking water. On average, about 20 new USTs per year manifest ground water contamination above allowable limits.

The "registered USTs" and "facilities" described above represent tanks used for commercial and industrial purposes. Hundreds of thousands of household fuel oil USTs are not included in the numbers presented above. Many of these household USTs, installed 20-to-30 years ago as suburban communities were developed across the country, have reached or surpassed their normal service lifespans. Some of these

tanks are undoubtedly leaking and threatening ground water supplies. Because household tanks are not regulated as commercial facilities are, however, it is not possible to determine the extent to which ground water quality is threatened by them. In addition, since the cost of replacing leaking USTs would be borne by the homeowner, there is little incentive for the homeowner to investigate the soundness of his/her home oil tank.

Recognizing the need to address and control the leaking UST situation, States across the Nation have taken action. One excellent example is Maine. In 1985, the Maine Legislature passed a law to regulate all underground petroleum storage tanks. This law required that all tanks be registered with the Maine Department of Environmental Protection (DEP) by May 1, 1986, regardless of size, use, or contents. This law also established procedures for abandonment of tanks and prohibited the operation, maintenance, or storage of petroleum in any storage facility or tank that is not constructed of fiberglass, cathodically protected steel, or other noncorrosive material.

To date, approximately 39,850 tanks have been registered, with only an estimated 4,000 tanks pending registration. Since 1986, approximately 27,750 inactive or old tanks have been removed from the ground. Figures 6-8 and 6-9 illustrate the effectiveness of this program. In Figure 6-8, the number of drinking water supply wells contaminated by leaking USTs has dropped dramatically. At the same time, as shown in Figure 6-9, the number of nonconforming USTs has

decreased while the number of protected replacement USTs has increased. It is estimated by the Maine DEP that \$3 of cleanup and third-party damage claim costs are avoided for every \$1 spent on preventive measures.

Landfills

Landfills were cited by States as the second highest contaminant source of concern in 1996 (Figure 6-6). Landfills have consistently been cited as a high-priority source of contamination by the States. Landfills may be used to dispose of sanitary (municipal) and industrial wastes.

Municipal wastes, some industrial wastes, and relatively inert substances such as plastics are disposed of in sanitary landfills. Resulting contamination may be in the form of high dissolved solids, chemical and biochemical oxygen demand, and some volatile organic compounds.

Industrial landfills are site specific as to the nature of the disposed material. Common materials that may be disposed of in industrial landfills include plastics, metals, fly ash, sludges, coke, tailings, waste pigment particles, low-level radioactive wastes, polypropylene, wood, brick, cellulose, ceramics, synthetics, and other similar substances. Contamination from these landfills may be in the form of heavy metals, high sulfates, and volatile organic compounds. States indicated in their 1996 305(b) Water Quality Reports that the most common contaminants associated with landfills were metals, halogenated solvents, and petroleum compounds. To a lesser extent, organic and inorganic

pesticides were also cited as a contaminant of concern.

Landfills of all types have long been used to dispose of wastes. In the past, little regard was given to the potential for ground water contamination in site selection. Landfills were generally sited on land considered to have no other uses. Unlined

Figure 6-8

Number of Private Drinking Water Supply Wells Contaminated by Leaking Underground Petroleum Storage Facilities in Maine (1986-1993)

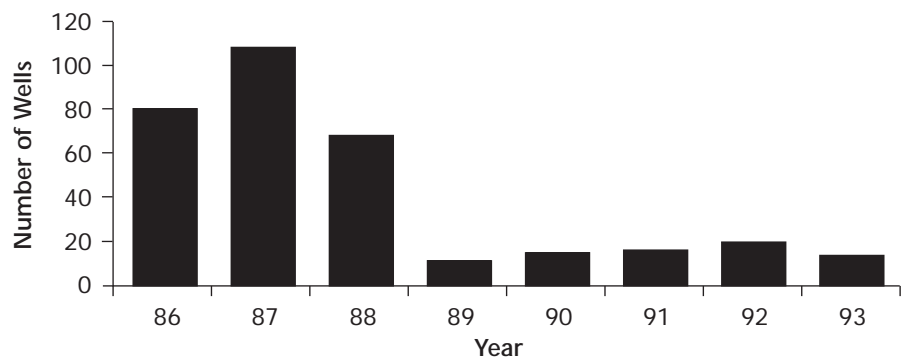
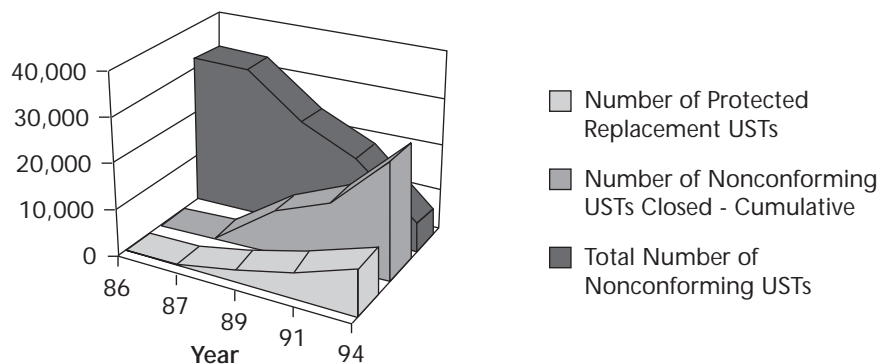


Figure 6-9

Changes in the Makeup of the Maine UST Population



abandoned sand and gravel pits, old strip mines, marshlands, and sinkholes were often used. In many instances the water table was at, or very near the surface, and the potential for ground water contamination was high (Figure 6-10). Although regulations involving the siting, construction, and monitoring of landfills have changed dramatically, past practices continue to cause a threat to ground water quality.

For example, although there are no currently active or operational solid waste disposal sites in the District of Columbia, historic records indicate that about 80 sites within the District of Columbia had been used as either a landfill or an open dump. Historic landfill sites continue to be discovered during routine environmental assessments and construction excavations. The exact location and materials disposed of are frequently unknown. Landfill sites that remain undiscovered have the potential to continue affecting

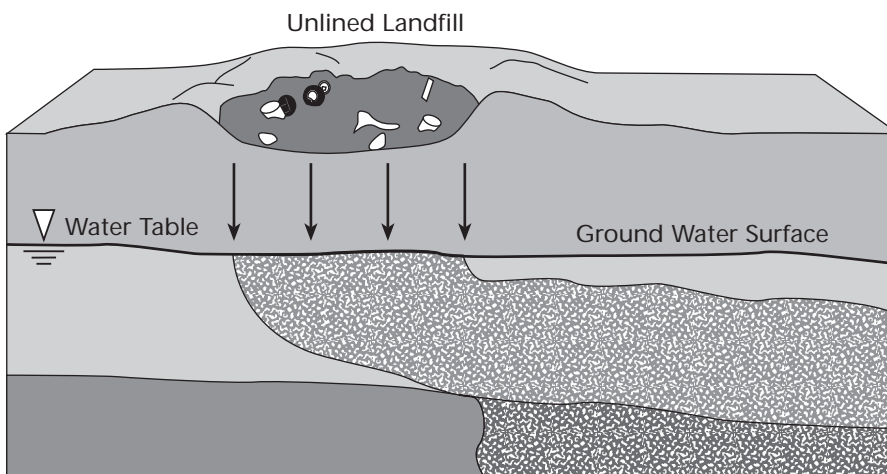
ground water quality. Past handling and disposal practices cause concern because soil properties in the District of Columbia are unfavorable for use as a landfill. Specifically, soils are characterized by a relatively high permeability. In addition, the shallow depth to bedrock, high seasonal ground water level, and susceptibility to flooding make the area even more unsuitable.

To better govern municipal landfills, the State of Texas established a regulatory program in 1969 and began permitting new sites in 1975. From 1977 to 1981, previously existing landfills were either closed, permitted as grandfathered sites, or considered illegal/unauthorized sites. Records indicate from 1981 until 1994, 1,343 previously existing landfills (dumps), 1,810 permitted and grandfathered landfills, and 2,549 illegal/unauthorized sites have been closed. As a rule, ground water monitoring is not required at these 5,702 sites. In 1994, there were 360 active landfills operating under the jurisdiction of the Texas Natural Resource Conservation Commission. Of these sites, 196 were conducting ground water monitoring, 27 of which had documented ground water contamination.

A total of 391 municipal landfills have been identified in the State of Maine. As of December 1995, 206 landfills have been closed and capped. Seventeen landfills are partially closed with 168 yet to be closed. Of these 168 landfills, 45 are currently active sites and 123 are inactive sites that are no longer receiving solid waste. In all:

Figure 6-10

Ground Water Contamination as a Result of Unlined Landfill Disposal



- 184 landfill sites are situated on sand and gravel aquifers and ground water contamination has been documented at 46 of these sites
- 60 other sites have contaminated surface water and/or ground water and are considered to be substandard; 37 of these sites have serious ground water contamination.
- Hazardous substances in the ground water are confirmed or suspected at 41 municipal landfills. Public or private water supplies are threatened at 13 of these sites. Public water supplies appear to be threatened by hazardous contaminants at three sites. Contaminants at the remaining 10 sites appear to threaten private water supplies.

Recognizing the problems associated with old, inactive landfill sites, States are taking action to ensure that current and future landfills are less of a threat. In the State of Maine, active landfills are required to be licensed by the Department of Environmental Protection. Currently 57 landfills are licensed to operate in Maine. Eight of these are licensed to accept municipal solid waste only; 22 are licensed to accept special wastes (nonhazardous waste generated by sources other than domestic and typical commercial establishments), and 27 are approved to accept only construction and demolition debris. The landfills licensed to accept municipal solid waste and/or special wastes are secure landfills with leachate collection systems and treatment, thereby greatly reducing the risk of ground water contamination.

Septic Systems

As shown in Figure 6-6, septic systems were cited by 29 out of 37 States as a potential source of ground water contamination. States based their decisions most heavily on three factors, including the location of septic systems relative to sources of drinking water, the large number of residential septic tank systems, and human health. These findings are consistent with previous 305(b) reporting cycles in which septic systems were consistently ranked among the top five sources of ground water contamination.

Septic systems include buried septic tanks with fluid distribution systems or leachfields. Septic systems are designed to release fluids or wastewaters into constructed permeable leach beds, if present, and then to the shallow soil. Wastewaters are then expected to be attacked by biological organisms in the soil and/or degraded by other natural processes over time. Ground water may be contaminated by releases from septic systems when the systems are poorly designed (tanks are installed in areas with inadequate soils or shallow depth to ground water); poorly constructed or sealed; are improperly used, located, or maintained; or are abandoned.

A variety of wastewaters are disposed of in septic systems and, as a consequence, a variety of different chemicals may be present in the system. States stressed that one of the more common uses is for disposal of domestic sewage and liquid household wastes. Typical contaminants from household septic systems include bacteria, nitrates, viruses, phosphates from detergents, and

other chemicals that might originate from household cleaners.

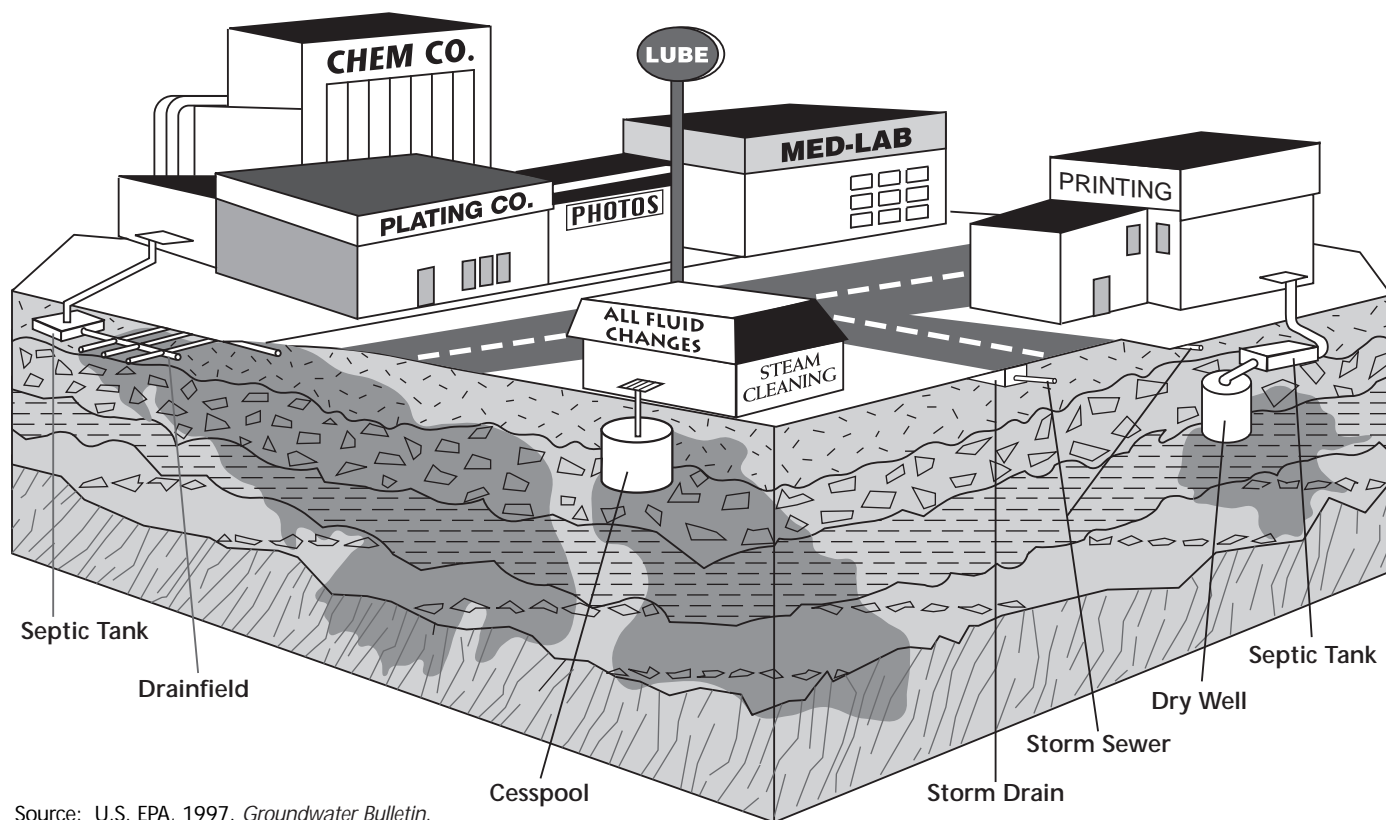
Septic systems are generally found in rural areas of the Nation. For example, Vermont is characterized by a large rural population. Due to the rural setting, homes and industries outside municipal service areas lack access to sewers. Septic systems are now and probably will remain a significant nonpoint source of contamination with approximately 220 indirect discharge sites. These sites represent discharges to the subsurface of over 6,500 gallons of sewage per day.

American households dispose of an estimated 3.5 billion gallons of liquid waste into these systems each day. Although the use of domestic septic systems is difficult to control, many States are initiating permitting processes. In addition, the local sale of products that pose a threat to ground water quality may be discouraged. Support of local collection programs may be encouraged through the increase in public awareness.

Although States most frequently cited domestic septic systems as a threat to ground water quality,

Figure 6-11

Ground Water Contamination as a Result of Commercial Septic Systems



Source: U.S. EPA, 1997. *Groundwater Bulletin*.

similar systems are also used by commercial and industrial facilities to dispose of process wastewaters (Figure 6-11). The most misused septic systems are those used by the automotive repair/service businesses that dispose of engine fluids, fuels, and cleaning solvents. As much as 4 million pounds of waste per year are disposed of by commercial sites into septic systems that have affected the drinking water of approximately 1.3 million Americans. The costs needed to clean up the contamination and supply new sources of drinking water have ranged from \$30,000 to \$3.8 million. States are currently enforcing waste management programs requiring businesses to properly dispose of their chemical waste.

State Overview of Contaminant Sources

For the first time in 1996, States were asked to provide information on the types and numbers of contaminant sources within a specified reporting area. Reporting contaminant source information for specific areas within States is new and not all States track this information in an easily accessible format. Of the States that do, 29 provided this information. The information is tabulated on a nationwide basis in Table 6-1.

Requesting this type of information served two purposes. First, it was possible to determine what contaminant sources have the greatest potential to impact ground water quality based on the sheer number of such sites in a given area. Second, it was possible to determine how many of these sites actually impacted ground water quality.

As shown in Table 6-1, leaking USTs represent the highest number of potential sources. Over 100,000 leaking UST sites have been identified in 80 different areas of the Nation. Of these, over 17,000 have confirmed releases of ground water contamination. The next big category of potential contaminant sources are septic systems. States reported the presence of 10,656 sources in a total of eight areas. Of these, 10,594 have confirmed releases. The next highest category were State sites, with a total of 2,614 confirmed ground water contamination incidents.

Ground Water Assessments

For the first time in 1996, States were asked to report data for aquifers or hydrogeologic settings (e.g., watersheds) within the State. Reporting data for specific aquifers or hydrogeologic settings within States is new. EPA recognized that not every State would be able to report ground water data on an aquifer-specific basis.

EPA also anticipated that there would be wide variation in reporting style. The information reported by States in their 1996 State Water Quality Reports reflects the diversity of our Nation's individual ground water management programs.

Due to the diversity in reported data, evaluation of ground water quality on a national basis for 1996 is not possible at this time. However, the positive

Table 6-1. Summary of Contaminant Source Type and Number

Source Type	Units for Which Information Was Reported	Sites Reported Nationwide	Sites Listed and/or with Confirmed Releases Nationwide	Sites with Confirmed Ground Water Contamination Nationwide	Site Investigations Nationwide	Sites that are Stabilized or with Source Removed Nationwide
Leaking UST	80	100,921	40,363	17,827	22,362	9,367
UST Sites (no releases found)	21	2,210	—	—	—	—
Septic Systems	8	10,656	10,594	—	—	—
State Sites	65	7,017	5,751	2,614	5,348	2,935
Underground Injection	49	5,006	1,077	911	116	62
CERCLIS (non-NPL)	54	2,399	1,332	645	1,154	374
RCRA Corrective Action	74	2,114	283	289	54	37
MN Dept of Agriculture	1	600	164	50	119	—
DOD/DOE	77	404	234	166	115	53
Miscellaneous	55	229	905	514	72	40
Nonpoint Sources	17	171	190	62	32	27
NPL	63	167	250	204	57	22
Landfills	4	149	78	74	136	3
Wastewater Land Application	21	116	—	24	24	—

CERCLIS = Comprehensive Environmental Response, Compensation, and Liability Information System

DOD/DOE = Department of Defense/Department of Energy

MN = Minnesota

NPL = National Priority List (or Superfund)

RCRA = Resource Conservation and Recovery Act

UST = Underground Storage Tank

— = Not available

response from States showed they welcomed the changes made in 1996 and are developing and implementing plans to report more aquifer-specific information in the future.

Diversity of Reporting Units

Thirty-three States reported data summarizing ground water quality. In total, data were

reported for 162 specific aquifers and other hydrogeologic settings. States that were unable to report ground water quality data for specific aquifers assessed ground water quality using a number of different hydrogeologic settings or "reporting units," including statewide summaries, reporting by county, watershed, basin, and sites or areas chosen for specific reasons such as potential vulnerability to contamination.

Sites with Corrective Action Plans Nationwide	Sites with Active Remediation Nationwide	Sites with Cleanup Completed Nationwide
6,143	6,301	19,379
—	—	—
—	—	—
791	1,216	3,166
32	28	204
41	21	49
37	79	52
—	—	—
26	22	39
12	5	32
3	21	36
25	38	24
—	—	0
7	5	0

Figure 6-12 presents an overview of the States that were able to provide ground water quality data for specific or "differentiated hydrogeologic units" within the State. A brief description of several ground water assessment methods and their rationale follows.

Florida – Very Intense Study Area

Florida's Very Intense Study Area (VISA) Network, consisting of about 450 wells, began operating in 1990. The VISA Network monitors the effects of various land uses on ground water quality in specific aquifers in selected areas. The major land uses represented are

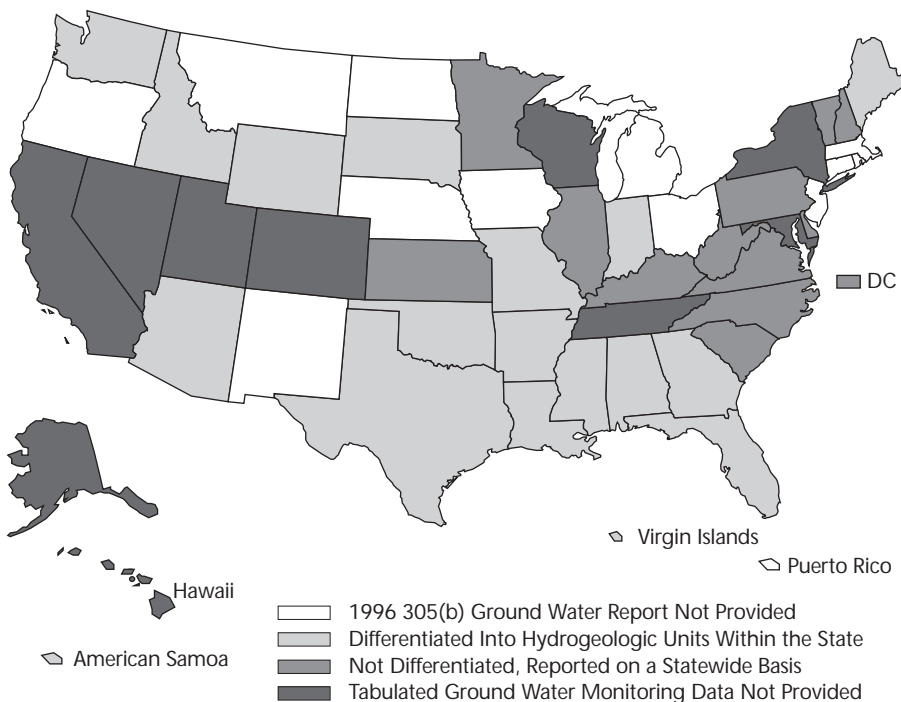
intensive agriculture, mixed urban/suburban, industrial, and low impact. The VISAs were chosen based on their relative susceptibility to contamination. Currently, Florida has data on 23 VISAs and is in the process of analyzing the results of the first two rounds of sampling.

Wells in the VISA and Florida's background networks are sampled in the same year for various water chemistry indicators and groups of contaminants. By comparing VISA and background results in the same aquifer system, lists of contaminants commonly associated with different kinds of land use can be developed. This process helps Florida to plan for and regulate land uses that are a threat to ground water quality.

For the 1996 report, Florida chose to present information for the North Lake Apopka VISA (Figure 6-13), which consists of 36 square miles in the Lake Apopka Basin. The vulnerability to contamination of the surficial and Floridian aquifers and Lake Apopka was an important consideration in choosing the study area. Because land use in the Lake Apopka Basin is over 50% agricultural, this VISA helps Florida evaluate the impacts of intensive agricultural growing, processing, and packing on ground water quality.

Figure 6-12

Summary of How Ground Water Data Were Reported



Arkansas – Ambient Ground Water Monitoring Program

The Arkansas Department of Pollution Control and Ecology initiated an Ambient Ground Water Monitoring Program in 1986 in order to gather background, ground-water quality data from various aquifers in the State. Samples are collected every 3 years and analyzed for general water quality indicators, including metals, petroleum hydrocarbons, and pesticides. Three rounds of sampling and analysis have been completed in some areas since inception of this program.

For 1996, Arkansas presented information for the nine currently active monitoring areas (Figure 6-14). The areas are in different counties covering the diverse geologic, hydrologic, and economic regimes within the State. Each area was chosen for a particular reason and with particular objectives in mind. For example, one area is characterized by the largest community using ground water to meet all of its needs and one objective of the monitoring program is to monitor water quality within an area of the underlying aquifer that is affected by public and commercial well use.

Figure 6-13

Locations and Descriptions of Very Intense Study Areas (VISA) in Florida

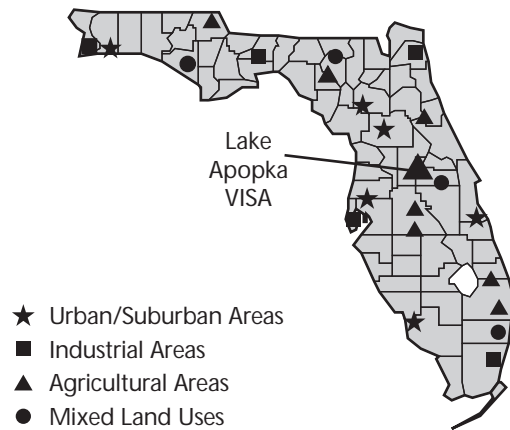
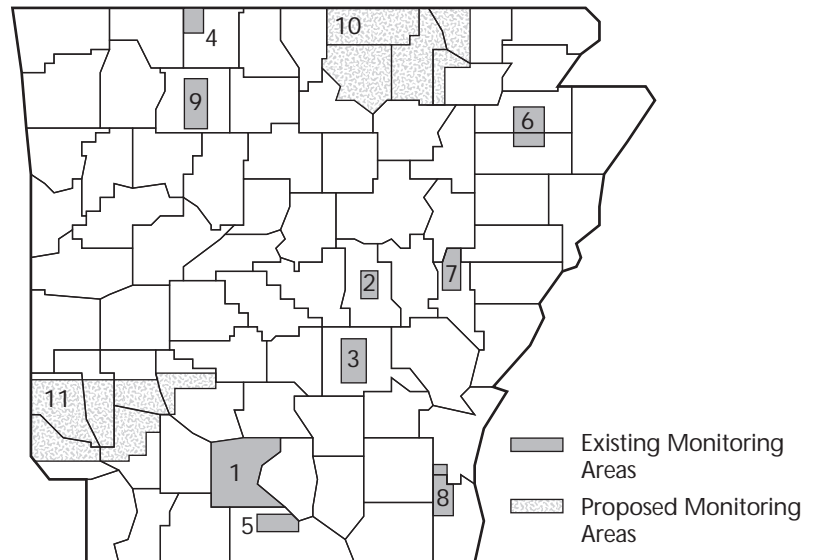


Figure 6-14

Arkansas Ambient Ground Water Monitoring Program



Existing monitoring areas include Ouachita (1), Lonoke (2), Pine Bluff (3), Omaha (4), El Dorado (5), Jonesboro (6), Brinkley (7), Chicot (8), and Buffalo River Watershed (9). Expansion areas will include Hardy (10) and Athens Plateau (11).

Wyoming – County Summary

In 1992, the Wyoming Department of Environmental Quality, Water Resources Center and the State Engineer’s Office implemented a prioritized approach for assessing aquifer sensitivity and ground water vulnerability at the county level on a statewide basis. Goshen County was selected as a pilot project area based on (1) the existence of recent studies and reports on ground water quality and aquifer characteristics; (2) Federal, State, and local interest in ground water and wellhead protection programs; and (3) the

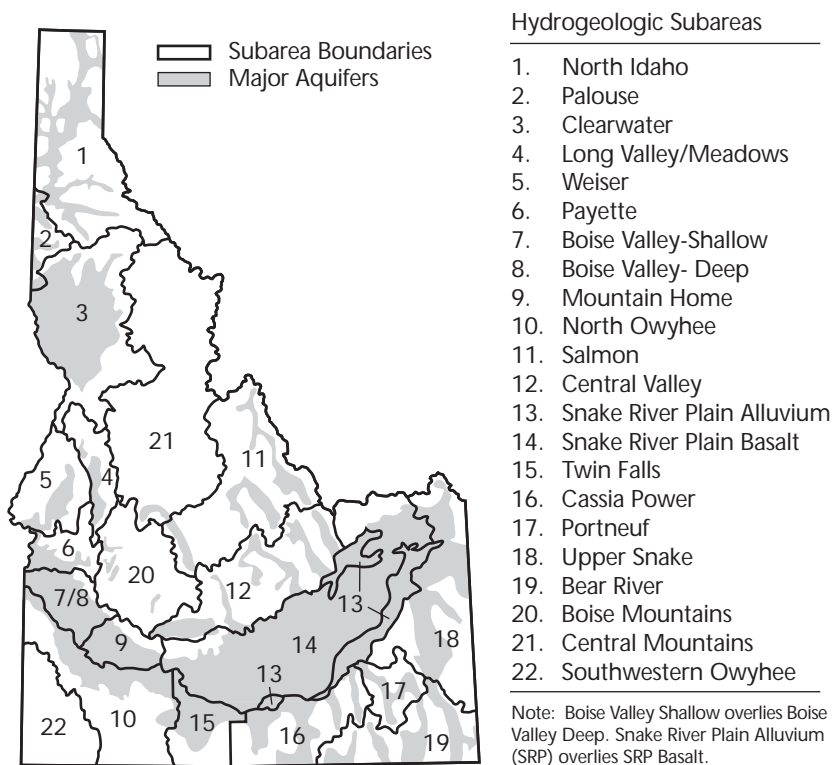
amount of related data and information available to complete sensitivity and vulnerability maps. Goshen County also ranked fourth out of 23 counties in overall vulnerability to contamination from pesticides. For 1996, Wyoming focused ground water assessment on the North Platte River alluvial aquifer located in Goshen County.

Indiana – Hydrogeologic Setting

To avoid the evaluation of ground water quality data across similar political boundaries, Indiana developed a system that allows for data to be analyzed according to similar surface and subsurface environments. This was achieved by first producing a document that describes all the hydrogeologic settings found in Indiana. These hydrogeologic settings provide a conceptual model to interpret the sensitivity to contamination of ground water in relation to the surface and subsurface environments. For ground water quality data for 1996, the State of Indiana selected five hydrogeologic settings considered to be highly vulnerable to contamination (i.e., principally outwash deposits or fans of glacial origin) and occurring in largely populated areas (i.e., areas of greatest water demand).

Figure 6-15

Idaho’s Hydrogeologic Subareas



Idaho – Hydrogeologic Subareas

The State of Idaho is divided into 22 hydrogeologic subareas (Figure 6-15) for Statewide monitoring purposes. These subareas represent geologically similar areas and generally encompass one or more of the 70 major ground water flow systems identified within the State. Each flow system includes at least one major aquifer, with some systems being comprised of several aquifers that may be interconnected.

Idaho reported ground water quality data for 20 of the 22 hydrogeologic subareas. Subareas 21 and 22 were not included in 1996 because the ground water in these subareas is used by few people and the aquifer systems are isolated from other major aquifers.

Arizona – Watershed Zone

Arizona presented ground water quality data for all 10 “watershed zones” within the State (Figure 6-16). The watershed zones are delineated along USGS Hydrologic Unit boundaries and correspond to the State’s 13 surface water basins. A few surface water basins were combined and one was split to form the 10 watershed zones. Each watershed zone is characterized in terms of several

features, including size, population base, hydrologic provinces, ecoregions, ground water basins, hydrology, and geology. Investigations of potential ground water contamination problems have led to site remediation efforts through various State and Federal programs.

Figure 6-16

Arizona Watersheds



Alabama – Tuscumbia Fort Payne Aquifer

Alabama provided ground water quality data for the Tuscumbia Fort Payne Aquifer outcrop area located in northern Alabama adjacent to the Tennessee River (Figure 6-17). This area is underlain by the Tuscumbia Limestone and the Fort Payne Chert geologic formations. It is considered to be a unique karst area that is highly susceptible to contamination from surface sources. Surface and ground water interaction is fairly rapid due to recharge through sinkholes and other karst features. Because the

area is heavily farmed and pesticides associated with farming are used, the Alabama Department of Environmental Management has accumulated ground water monitoring data for this area.

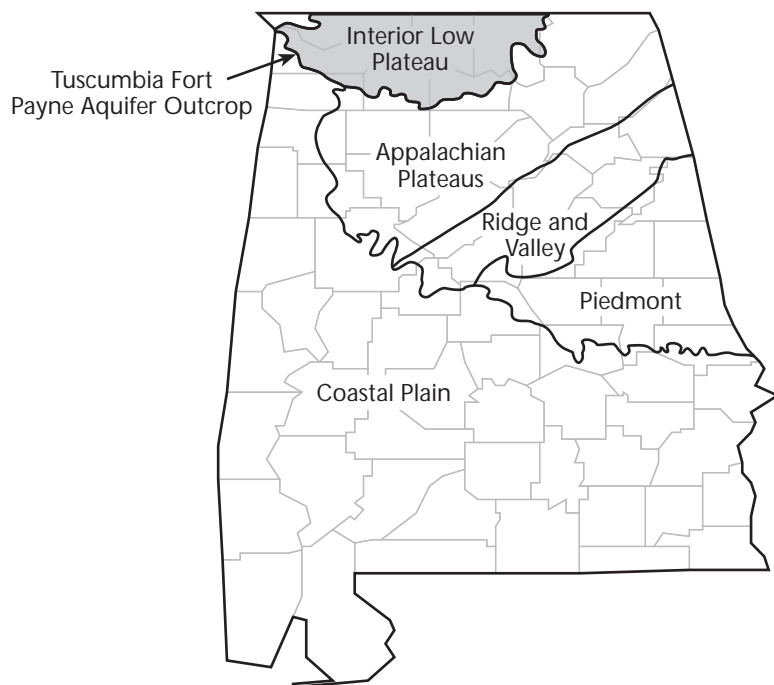
Texas – Trinity and Dockum Aquifers, Rio Grande Alluvium, and Laredo Formation

Ambient ground water quality monitoring is conducted continuously and extensively throughout the State of Texas. As a consequence, boundaries and various characteristics of all the State's major and minor aquifers have been identified, including water availability, recharge, and geologic formation. In addition, major entities using ground water have been identified within each river basin and the aquifer(s) used, the quality of water being developed, and the quantity of water needed for a 50-year planning period.

For 1996, Texas selected the Trinity and Dockum Aquifers, Rio Grande Alluvium, and Laredo Formation for assessment. These selections represent one major, one minor, and two undifferentiated/local aquifers, respectively. The main selection criterion was to select a range of recently monitored aquifers and to develop an initial methodology for the assessment of the aquifers. The refinement of the assessment methodology for subsequent 305(b) reporting cycles is of primary importance.

Figure 6-17

Alabama Physiographic Provinces



Extent of Coverage

States were encouraged to report ground water data for selected aquifers or hydrogeologic settings as part of the 1996 305(b) reporting cycle. EPA recognized that this was not always plausible and as a consequence, recommended that State ground water resources be assessed incrementally over time.

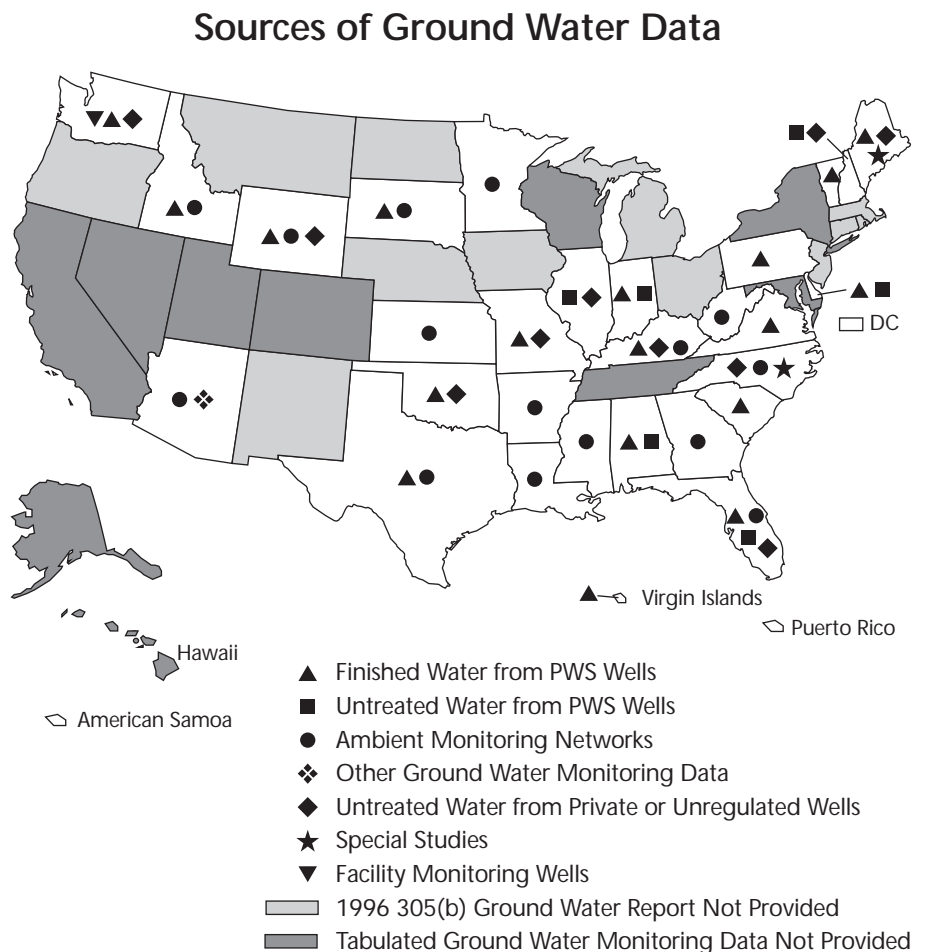
The extent of State coverage will increase as individual States develop and implement plans to assess ground water quality on an aquifer-specific basis. Greater quantities of ground water monitoring data will also become available as States complete source water delineations and source inventory/susceptibility analyses for public water supplies under the Source Water Assessment Program (see Chapter 18).

Ground Water Quality Data Sources

EPA recognizes that data collection and organization varies among the States, and that a single data source for assessing ground water quality does not exist for purposes of the *1996 Report to Congress*. As a consequence, EPA suggested several types of data that could be used for assessment purposes (e.g., ambient ground water monitoring data, untreated water from private or unregulated wells, untreated water from public water supply wells, and special studies).

States were encouraged to use available data that they believe best reflects the quality of the resource. Depending upon data availability and the judgment of the State ground water professionals, one or multiple sources of data were used in the assessments. The majority of the States opted to use multiple sources of data. As shown in Figure 6-18, States used data collected from ambient monitoring networks, public water supply systems, private and unregulated

Figure 6-18



wells, facility monitoring wells, and special studies.

Finished water quality data from public water supply systems were the most frequently used source of data (Figure 6-19). Ambient monitoring networks and untreated water quality data from private and unregulated wells were the next frequently used sources of data.

States used a variety of data sources to report on ground water quality. Although there was a strong reliance on finished water quality data from public water supply systems, these data were frequently reported in conjunction with other sources of data to provide a more meaningful assessment of ground water quality than was possible in previous reporting cycles.

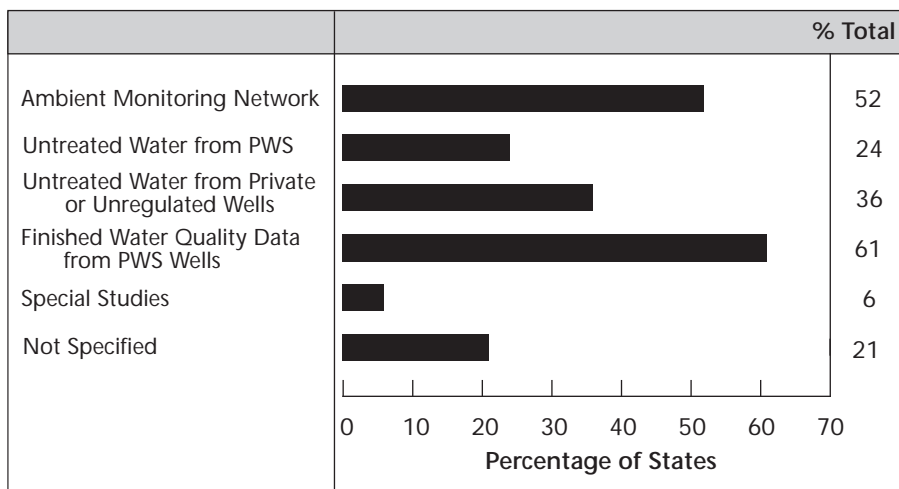
Parameter Groups/Analytes

The primary basis for assessing ground water quality is the comparison of chemical concentrations measured in ground water to water quality standards. For 1996, EPA suggested that States consider using maximum contaminant levels (MCLs) defined under the Safe Drinking Water Act. In general, most States used the MCL concentrations for comparison purposes. Exceptions occurred when State-specific standards were available.

It was not possible for States to sample and analyze ground water for every known constituent. For ease of reporting, EPA suggested that the ground water quality data be summarized into parameter groups. Parameter groups

Figure 6-19

Aquifer Monitoring Data



Note: Percentages based on a total of 33 States submitting data. Some States utilized multiple data sources.

recommended in the 1996 Guidelines include volatile organic compounds (VOCs), semivolatile organic compounds (SVOC), and nitrate. These three groups were recommended because they are generally indicative of contamination originating as a result of human activities. States were also encouraged to report data for any other constituents of interest.

Nationally, more States reported data for VOCs, SVOCs, nitrates, and metals than any other constituent or group of constituents. Parameter groups and individual constituents identified by States in their 1996 305(b) reports are summarized in Table 6-2.

As shown, States reported data for a wide variety of constituents. Organic as well as inorganic and microbial constituents were included in the ground water assessments depending upon State interests and priorities. Although the greatest quantity of data was reported for nitrate and VOCs, it was clear that States were also concerned with SVOCs, pesticides, metals, and bacteria.

Ground Water Quality Data

Ground water quality data reported by States in 1996 represent different sources, often with different monitoring purposes. As a consequence, national

comparisons are not appropriate. Rather, ground water quality assessments are performed using comparable data groupings. Data most closely approximating actual ground water quality conditions (e.g., untreated ground water) are given special consideration in these assessments. Specifically, this report focuses on nitrate, VOCs, SVOCs, pesticides, bacteria, and metals. These parameter groups/constituents were selected as they are indicative of ground water degradation as a result of human activities.

Table 6-2. Summary of Parameter Groups/Constituents Reported by States in 1996

Nitrate		
VOC		
SVOC		
Bacteria		
Pesticides		
Radioactivity		
Metals		
Arsenic	Lead	Mercury
Iron	Antimony	Copper
Manganese	Beryllium	Zinc
Barium	Nickel	Strontium
Selenium	Thallium	Vanadium
Cadmium	Cobalt	Silver
Chromium	Molybdenum	Sodium
Inorganics		
Chloride	Magnesium	Boron
Fluoride	Potassium	Hardness
TDS	Aluminum	Silica
Alkalinity	Bromide	Bicarbonate
Calcium	Lithium	Specific Conductivity
Other		
Nutrients	Orthophosphorous	TOC

Nitrate

States reported data for nitrate more frequently than for any other parameter or parameter group. It was the second most frequently cited ground water contaminant after petroleum compounds. Twelve States specifically referenced nitrate as a widespread and significant cause of ground water contamination in their 1996 State Water Quality Reports.

The focus on nitrate as a ground water contaminant is justified. It is soluble in water, and consequently, is easily transported from the soil surface to the underlying ground water resource. Extensive application of nitrate in fertilizer to agricultural lands, residential lawns, and golf courses has resulted in widespread degradation of ground water resources. The misuse of septic systems and

improper disposal of domestic wastewater and sludge have also caused ground water contamination. At exposures greater than 10 milligrams per liter, its presence in water can lead to methemoglobinemia or "blue-baby syndrome" (an inability to fix oxygen in the blood). It is also an environmental concern as a potential source of nutrient enrichment in coastal waters.

Table 6-3 presents ground water quality information for nitrate. As shown, 15 States reported nitrate data for ambient monitoring networks. Nitrate was measured at concentrations exceeding the MCL of 10 milligrams per liter in 8 of the 15 States for a total of 26 units and 267 wells impacted by nitrate. Thus, approximately 50% of the reporting States indicated elevated levels of nitrate in ground water collected from

Table 6-3. Nitrates

Monitoring Type	States Reporting	States Reporting MCL Exceedances	Units Impacted by MCL Exceedances	Wells Impacted by MCL Exceedances	Highest Number of Wells That Exceeded the MCL within a Single Unit	Average Number of Wells That Exceeded the MCL within a Single Unit
Ambient Monitoring Network	15	8	26	267	81 out of 681	10
Untreated Water from PWS	7	5	5	85	38 out of 346	17
Untreated Water from Private/Unregulated Wells	10	9	10	2,233	2,000 out of 250,000	23
Finished Water from PWS	18	11	18	230	101 out of 2,806	13
Special Studies	2	2	4	309	288 out of 9,000	No meaningful average

ambient monitoring networks. This percentage is even higher for States reporting data for untreated water from PWS and from private/unregulated wells (i.e., nitrate levels exceeding the MCL were reported by five out of seven States for untreated water from PWS and by nine out of ten States for untreated water from private/unregulated wells).

VOC/SVOCs/Pesticides

VOCs and SVOCs (including pesticides) were cited by States as among the top five contaminants of concern. This is not unexpected given that the number of identified man-made organic compounds totaled near 2 million in 1977 and

was believed to be growing at a rate of about 250,000 new formulations annually.*

Organic compounds can be released to the environment through a number of different avenues. Generally, organic compounds are released to ground water via pesticide applications, disposal practices, and spills. As reported in their 1996 State Water Quality Reports, it was disposal practices that generated the most concern among States. Disposal practices that were cited as having the potential to adversely impact ground water quality included landfills, hazardous waste sites, surface impoundments, and shallow injection wells.

* Giger, W., and P.V. Roberts. 1977. Characterization of refractory organic carbon. In *Water Pollution Microbiology*, Volume 2, Ralph Mitchell (ed.). New York: Wiley-Interscience.

Table 6-4. VOCs

Monitoring Type	States Reporting	States Reporting MCL Exceedances	Units Impacted by MCL Exceedances	Wells Impacted by MCL Exceedances	Highest Number of Wells That Exceeded the MCL within a Single Unit	Average Number of Wells That Exceeded the MCL within a Single Unit
Ambient Monitoring Network	10	7	16	30	5 out of 113	2
Untreated Water from PWS	6	5	5	77	51 out of 80	15
Untreated Water from Private/Unregulated Wells	3	2	5	96	52 out of 80	20
Finished Water from PWS	17	6	13	152	114 out of 603	12
Special Studies	1	1	2	19	9 out of 720	5

The organic compounds that pose the greatest threat to ground water quality are those that are relatively soluble, not easily converted to the vapor state, and not subject to chemical or biological degradation. Their presence in ground water is becoming increasingly pervasive and a cause for national concern due to the carcinogenic effects of many of the organic compounds.

Tables 6-4 through 6-6 present data related to VOCs, SVOCs, and pesticides. As shown, more States reported information for VOCs than for either SVOCs or pesticides. This is consistent with the fact that VOCs are the most frequently detected class of organic

priority pollutants and they are the most frequently detected **individual** compounds impacting ground water quality at RCRA and CERCLA sites.*

Based on the information presented in Tables 6-4 through 6-6, it appears that ground water contamination by VOCs is indeed more prevalent than either SVOCs or pesticides. Seventy percent of the reporting States (i.e., 7 out of 10 States) indicated that VOCs were measured at levels exceeding MCL values in ground water collected from ambient monitoring networks as opposed to 43% (3 out of 7 States) for SVOCs and 25% (2 out of 8 States) for pesticides. Furthermore, VOCs were

* Plumb, R.H. 1985. Disposal site monitoring data: observations and strategy implications. In *Proceedings: Second Canadian/American Conference on Hydrogeology, Hazardous Wastes in Ground Water: A Soluble Dilemma*, June 25-29, 1995, Banff, Alberta, Canada.

Monitoring Type	States Reporting	States Reporting MCL Exceedances	Units Impacted by MCL Exceedances	Wells Impacted by MCL Exceedances	Highest Number of Wells That Exceeded the MCL within a Single Unit	Average Number of Wells That Exceeded the MCL within a Single Unit
Ambient Monitoring Network	7	3	3	5	3 out of 27	2
Untreated Water from PWS	4	3	3	10	7 out of 305	3
Untreated Water from Private/Unregulated Wells	3	1	2	4	2 out of 27	2
Finished Water from PWS	14	3	3	18	14 out of 10,985	6
Special Studies	0	0	0	0	0	0

measured at levels exceeding MCL values in a total of 16 units and 30 wells. Again, this can be compared to SVOCs impacting three units and five wells and pesticides impacting two units and five wells.

As was noted with nitrates, elevated levels of VOCs were found more frequently in untreated ground water collected from PWS and private/unregulated wells. Although VOCs were measured at levels exceeding MCL levels in ground water collected from PWS and private/unregulated wells in only five and two States, respectively, a total of 77 and 96 wells were impacted (Table 6-4). The same pattern was not observed for SVOCs (Table 6-5). Although elevated levels of pesticide were measured in untreated ground water collected from private/unregulated

wells, these data include one area known to have been heavily contaminated by pesticide usage (Table 6-6).

Metals

States identified metals as the fourth highest contaminant of concern with respect to ground water degradation. As shown in Table 6-7, metals comprise a broad category of individual constituents that may be present in ground water singularly or in combination, depending on the contaminant source. Although normal background ground water conditions may be characterized by elevated metal concentrations in some parts of the Nation (e.g., southwestern United States), metals are generally considered an indicator of ground

Figure 6-6. Pesticides

Monitoring Type	States Reporting	States Reporting MCL Exceedances	Units Impacted by MCL Exceedances	Wells Impacted by MCL Exceedances	Highest Number of Wells That Exceeded the MCL within a Single Unit	Average Number of Wells That Exceeded the MCL within a Single Unit
Ambient Monitoring Network	8	2	2	5	3 out of 26	3
Untreated Water from PWS	2	1	1	2	2 out of 353	2
Untreated Water from Private/Unregulated Wells	5	4	4	101	76 out of 330	25
Finished Water from PWS	1	0	0	0	0	0
Special Studies	1	1	1	0	1 out of 42	1

water contamination resulting from human activities.

Metals are present in numerous commercial and industrial process and waste streams. Depending on handling and disposal practices, metals can be released to the environment and can impact ground water quality. Because metals are not easily broken down, they tend to be persistent and can affect ground water quality for long periods of time.

Ground water contamination by metals most frequently occurs as a result of improper operation and/or inappropriate design of landfills, disposal of liquid or solid mining wastes or tailings, or ineffective containment of nuclear wastes. States cited landfills,

hazardous waste sites, surface impoundments, shallow injection wells, land application, industrial facilities, and mining as prime sources of metal contamination in ground water.

Table 6-7 presents the information reported by States for metals. Metals were most frequently tested and detected in ground water collected from ambient monitoring networks. Eleven States reported metal data for ambient monitoring networks. Metals were measured at concentrations exceeding MCL values in 7 of the 11 States for a total of 33 units and 195 wells impacted by metal contamination. Thus, approximately 65% of the reporting States indicated elevated levels of metals in ground water collected from ambient monitoring networks.

Figure 6-7. Metals

Monitoring Type	States Reporting	States Reporting MCL Exceedances	Units Impacted by MCL Exceedances	Wells Impacted by MCL Exceedances	Highest Number of Wells That Exceeded the MCL within a Single Unit	Average Number of Wells That Exceeded the MCL within a Single Unit
Ambient Monitoring Network	11	7	33	195	42 out of 419	6
Untreated Water from PWS	2	2	4	100	88 out of 272	25
Untreated Water from Private/Unregulated Wells	1	1	3	13	7 out of 26	4
Finished Water from PWS	6	4	10	175	135 out of 706	17
Special Studies	0	0	0	0	0	0

Metals were less frequently tested in ground water collected from either PWS or private/unregulated wells. Still, a total of 100 wells were found to exceed MCL values for metals in untreated ground water collected from PWS wells.

Bacteria

The sixth most common ground water contaminant cited in the 1996 State Water Quality Reports was bacteria. One of the most common sources of bacteria in ground water is septic systems. Other important sources include landfills, animal feedlots, surface impoundments, and pipelines and sewers.

High concentrations of disease-causing bacteria in ground water

may be a source of human health problems. The most common diseases spread by these pathogenic bacteria are related to the consumption of contaminated drinking water (e.g., gastroenteritis, campylobacteriosis, and hepatitis).

For purposes of their 1996 State Water Quality Reports, States focused less on bacteria than on other contaminant groupings. Still, one out of the three States reporting data on bacteria indicated levels that exceeded MCL values. As shown in Table 6-8, ground water was impacted by bacteria in 10 ambient monitoring wells. In a special study conducted in the Boise River Valley by the State of Idaho, total coliform bacteria were detected at levels exceeding MCL values in 95 out of 720 samples.

Figure 6-8. Bacteria

Monitoring Type	States Reporting	States Reporting MCL Exceedances	Units Impacted by MCL Exceedances	Wells Impacted by MCL Exceedances	Highest Number of Wells That Exceeded the MCL within a Single Unit	Average Number of Wells That Exceeded the MCL within a Single Unit
Ambient Monitoring Network	3	1	1	10	10 out of 27	10
Untreated Water from PWS	1	1	1	1	1 out of 102	1
Untreated Water from Private/Unregulated Wells	1	0	0	0	0	0
Finished Water from PWS	3	3	3	404	381 out of 3,854	Meaningless
Special Studies	1	1	2	101	95 out of 720	50

This study focused on some of the more densely populated areas in Idaho and documented the threat to shallow ground water resources from historic and current land and water use practices.

Conclusion

Assessing the quality of our Nation's ground water resources is no easy task. An accurate and representative assessment of ambient ground water conditions ideally requires a well planned and well executed monitoring plan. Such plans are expensive and may not be compatible with State administrative, technical, and programmatic initiatives. As a consequence, EPA and interested States developed guidelines for the assessment of ground water quality that took into account the complex spatial variations in aquifer systems, the differing levels of sophistication among State programs, and the expense of collecting ambient ground water monitoring data. The newly developed guidelines incorporated the flexibility necessary to accommodate differences in State programs.

State response to the new guidelines was excellent. Thirty-three States reported ground water quality data for 162 aquifers and other hydrogeologic settings. From this response, it was evident that States welcomed the changes made in 1996. It was also evident that the flexibility purposely incorporated into the 1996 Ground Water Assessment Guidelines yielded a diversity in reported data. This diversity presented a challenge in assessing ground water quality.

Some of the more challenging aspects were highlighted in this report. Following are changes that are expected to occur over time to improve our picture of ground water quality:

- State reporting styles varied significantly in 1996. Although this variability was expected, final data interpretation was challenging because data compilations required the use of a single defined data structure. When State data did not exactly conform to this structure, some interpretation on the part of EPA was necessary. With more specific directions and definitions in the Guidelines, States' ability to respond in a more structured reporting style will improve and the need for outside interpretation will lessen.
 - As the direction and focus of ground water assessments becomes clearer, State response will grow and more accurate characterization of ground water quality will be possible.
 - Because ground water monitoring is expensive, few States have access to ambient ground water quality data. EPA suggested a number of data sources that could be used in the absence of ambient ground water monitoring data. Although finished water quality data from PWS were one of those sources, these data do not provide the most accurate representation of ground water quality. As States continue to develop new sources of ground water data, the reliance on finished water quality data will decrease. Furthermore, it is
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expected that the variability in data sources and types will decrease as States continue program development.

As the direction and focus of ground water assessment in the

305(b) program becomes clearer, State response will grow and more accurate characterization of ground water quality will result. The 1996 305(b) State Water Quality Reports were the first step toward that goal.

