United States
Environmental Protection
Agency

Office of Water
Washington, D.C. 20460

EPA 503/9-92/006
April 1992

EPA

National Water Quality Inventory

1990 Report to Congress

503992006

This report was prepared pursuant to Section 305(b) of the Clean Water Act, which states:
"(b)(1) Each State shall prepare and submit to the Administrator by April 1, 1975, and shall bring up to date by April 1, 1976, and biennially thereafter, a report which shall include—

"(A) a description of the water quality of all navigable waters in such State during the preceding year, with appropriate supplemental descriptions as shall be required to take into account seasonal, tidal, and other variations, correlated with the quality of water required by the objective of this Act (as identified by the Administrator pursuant to criteria published under section 304(a) of this Act) and the water quality described in subparagraph (B) of this paragraph;

"(B) an analysis of the extent to which all navigable waters of such State provide for the protection and propagation of a balanced population of shellfish, fish, and wildlife, and allow recreational activities in and on the water;

"(C) an analysis of the extent to which the elimination of the discharge of pollutants and a level of water quality which provides for the protection and propagation of a balanced population of shellfish, fish, and wildlife and allows recreational activities in and on the water, have been or will be achieved by the requirements of this Act, together with recommendations as to additional action necessary to achieve such objectives and for what waters such additional action is necessary;

"(D) an estimate of (i) the environmental impact, (ii) the economic and social costs necessary to achieve the objective of this Act in such State, (iii) the economic and social benefits of such achievement; and (iv) an estimate of the date of such achievement; and

"(E) a description of the nature and extent of nonpoint sources of pollutants, and recommendations as to the programs which must be undertaken to control each category of such sources, including an estimate of the costs of implementing such programs.

"(2) The Administrator shall transmit such State reports, together with an analysis thereof, to Congress on or before October 1, 1975, and October 1, 1976, and biennially thereafter."

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, D.C. 20460

THE ADMINISTRATOR

Honorable Thomas S. Foley
Speaker of the House of
Representatives
Washington, D.C. 20515

Dear Mr. Speaker:

As required by Section 305(b) of the Federal Water Pollution Control Act, I am transmitting to the Congress the 1990 National Water Quality Inventory Report. This biennial report is the eighth in a series of national water quality assessments published since 1975. It is based primarily on reports submitted by the States in 1990. In some cases, State-reported information has been supplemented by data developed by the U.S. Environmental Protection Agency (EPA). Although EPA has analyzed and summarized the water quality information in the State reports, the views and recommendations presented are those of individual States, not those of EPA or the Administrator.

Generally, this report indicates that most of the Nation's waters are of good quality. However, this finding is based on an assessment of less than half of the Nation's freshwater surface waterbodies. In addition, the report indicates that a significant number of waterbodies remain impaired or have become so.

The 1990 State 305(b) reports were more comprehensive than ever before. About 36 percent of the total river miles, 47 percent of the total lake acres (excluding the Great Lakes), and 75 percent of the total estuarine square miles in the U.S. were assessed by the States. This represents a seven percent increase in the number of river miles assessed over 1988, and a six percent increase in the number of lake acres assessed. Because of the change in number of waters assessed, and variations among States in assessment methodologies and water quality standards, direct comparisons should not be drawn between these figures and those reported in 1988.

Of assessed waters, most are reported to be supporting the beneficial uses for which they have been designated by the States, but a significant number are not. These uses, such as drinking water supply, swimming, and the propagation of aquatic life, were found to be supported in 70 percent of assessed river miles, 60 percent of assessed lake acres, and 67 percent of assessed estuarine square miles. Some of these waters may be considered threatened because States indicate they could become impaired if pollution control actions are not taken.

According to the States, various conventional pollutants of primarily nonpoint origin (such as runoff from agricultural lands) are the most commonly reported problems in impaired waters. Nutrients are among the top two contributors to impairment in all types of surface waters. Excess levels of nutrients contribute to oxygen deficiencies and organic enrichment of water, also reported among the top causes of impairment. Other widespread pollutants include siltation, pathogens, and metals. Agriculture is the leading source of pollution in rivers and lakes, and ranks in the top four sources in estuaries. Other leading sources include municipal dischargers, storm sewers/runoff, hydrologic/habitat modifications (e.g., channelization), and land disposal (e.g., septic tanks).

States provided more information on the status of wetlands in 1990 than in previous years, but reporting remains uneven. The States reported that major sources of wetland loss include land development for residential or commercial purposes, agricultural and resource extraction activities, impoundments, and highway construction. Sediment, salinity, and metals were cited as leading water quality problems affecting wetlands.

Although generally the quality of the Nation's ground water resources is good, States report an increasing number of pollution incidents. The sources of contamination most frequently cited include underground storage tanks, septic systems, municipal landfills, agricultural activities, and abandoned hazardous waste sites. Leading contaminants in ground water include nitrates, metals, pesticides, petroleum products, and volatile organic compounds.

In addition to presenting the results of State water quality assessments, this report discusses the Nation's programs to control pollution in both surface and ground water. States report that most major point source dischargers to surface waters are meeting their permit limits. However, 15 percent of major municipalities and 13 percent of major industries are in significant noncompliance. Most (83 to 86 percent) of significant industrial users of sewage treatment facilities are reported to be meeting pretreatment requirements. However, 39 percent of municipalities required to do so have not fully implemented their pretreatment programs. All States have approved nonpoint source assessments, and all have approved management programs in place, although only 44 of these programs are complete. A variety of innovative nonpoint source management projects have been initiated across the country by States, localities, community groups, and EPA Regional Offices. The States have adopted a variety of activities to address ground water contamination, including implementing ground water protection strategies, enacting comprehensive ground water protection legislation, and establishing Wellhead Protection Programs.

EPA is continuing to work with the States to improve the quality and scope of the Section 305(b) assessments. Problems with inconsistent reporting among States and over time are being addressed through improved technical guidance developed by a State-EPA workgroup. State adoption of EPA's Section 305(b) Waterbody System, a computerized data system designed to manage assessment data and facilitate State reporting, should also lead to dramatic improvements in the process. Future reports in this series should continue to reflect these improvements.

Sincerely,

William K. Reilly

William K. Reilly

Acknowledgments

This report is based primarily on water quality assessments submitted to the U.S. Environmental Protection Agency by the States, Territories, and Interstate Commissions of the United States. The EPA wishes to thank the authors of these assessments for the time and effort spent in preparing these reports and reviewing the draft of this national assessment. Additional thanks go to the water quality assessment coordinators from all ten EPA Regions who work with the States.

The project manager and editor of this document was Alice Mayio of the Assessment and Watershed Protection Division, Office of Wetlands, Oceans and Watersheds. Key contributions were also made by the following individuals in other EPA program offices: Richard McDermott, Ground Water Protection Division; Kathryn Smith, Permits Division; Doreen Robb, Wetlands Division; Mary Lou Sóscia, Oceans and Coastal Protection Division; and Brett Snyder, Office of Policy, Planning and Evaluation.

Data analysis and technical assistance were provided by Versar Incorporated under Contract No. 68-D9-0166. Technical assistance, editorial support, design, typesetting, and graphics were provided by Research Triangle Institute under Contract No. 68-C9-0013.

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Introduction

Patricia Cunningham

Executive Summary

This report summarizes water quality assessment information submitted by the States to the U.S. Environmental Protection Agency (EPA) in 1990 under Section 305(b) of the Clean Water Act. The States based their water quality assessments on data collected in 1988 and 1989 using physical, chemical, and "evaluative" approaches such as sending questionnaires to fisheries biologists and analyzing land use data.

In their water quality assessments, States reported on a variety of water quality measures. Leading measures include

- The extent to which assessed rivers, lakes, estuaries, and other waters meet their intended (i.e., designated) uses;
- Pollutants and pollutant sources responsible for impairment in surface and ground waters not meeting uses;
- The extent to which "fishable and swimmable" water quality has been attained in the assessed surface waters;
- The extent of various pollution impacts such as fishing restrictions, fish kills, and areas of sediment contamination;
- Actions under way at the State and Federal levels to control water pollution; and
- State recommendations for further or continued action.

State reporting of water quality assessments is more comprehensive with each Section 305(b) reporting cycle. In part this is because water resource managers are recognizing the value of

assessment data in setting priorities for control actions. For example, as this and previous national water quality assessments note, nontraditional sources of pollution such as runoff from agricultural fields and urban areas are clearly the leading reason for impairment in surface waters. Increased management attention is therefore being focused at the Federal, State, and local levels on identifying waters with nontraditional source impacts, implementing management plans to mitigate those impacts, and developing monitoring programs to study the effects of nontraditional mitigation measures.

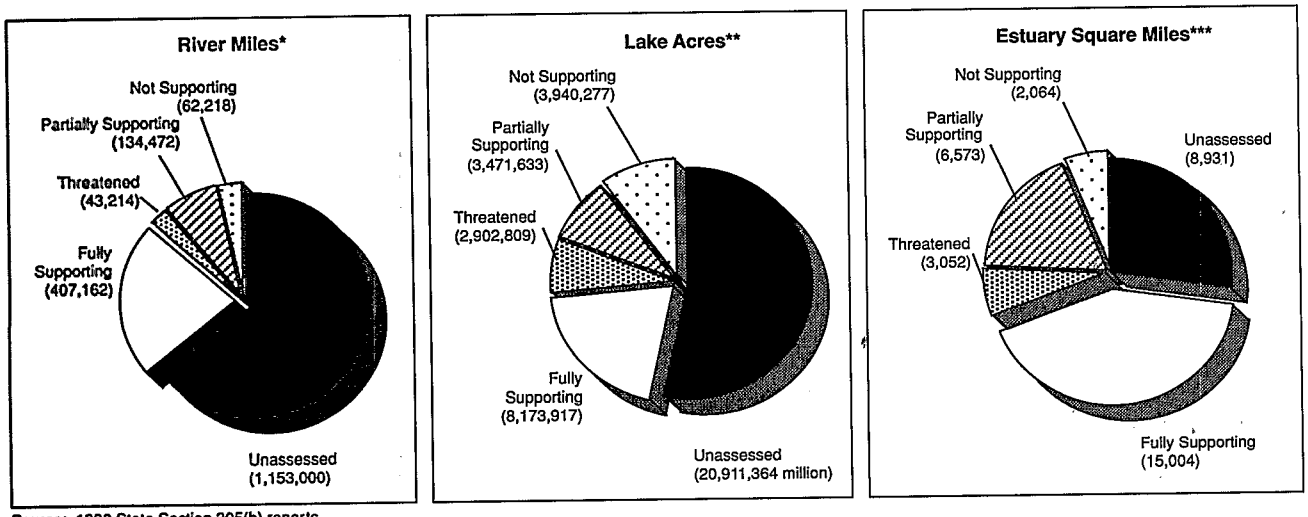
The reader should note that about one-third of the Nation's river and stream miles, one-half of its lake acres, and two-thirds of its estuarine square miles were assessed by the States in 1990. This is an improvement over previous reporting cycles. However, many waters remain unassessed because States are generally constrained by diminishing resources and competing needs to monitor most often in those waters with known or suspected problems. This report should therefore be seen primarily as a "snapshot" of conditions in those areas that have been assessed by the States.

It is also important to note that the data upon which this document is based were collected and reported by States with differing monitoring capabilities, water quality standards, and assessment approaches. (See the Introduction to this report for further discussion of the limitations of these data.) Progress is being made in introducing consistency in assessment approaches to the 305(b) reporting process. Statistically valid information on water quality status and trends in the Nation's waters will be collected in coming years by scientifically designed, broad-scale monitoring programs sponsored by EPA and other Federal agencies.

What Do the States Report on the Quality of Their Rivers?

More than 647,000 river miles were assessed by 51 States, Territories, and Jurisdictions in 1990. This reflects 36 percent of the total river miles in the United States, or 53 percent of the total river miles in the States that reported. This is an increase of 127,000 miles over the number of river miles assessed in 1988. States assessed their waters with chemical and biological monitoring data as well as with other types of data such as surveys of fisheries biologists, predictive water quality models, and information from citizen volunteer monitors.

The States designated their waterbodies for specific



Source: 1990 State Section 305(b) reports.

*Estimate of total river miles (1.8 million miles) based on State-reported information in *America's Clean Water: The States' Nonpoint Source Assessment*, ASIWPCA, 1985.
**Estimate of total lake acres (39,400,000 acres) based on State-reported information in *America's Clean Water: The States' Nonpoint Source Assessment*, ASIWPCA, 1985.
***Total estuary square miles (35,624 square miles) based on 1990 State-reported Section 305(b) data and excluding Alaska, New Jersey, Pennsylvania, and Island Territories.

Figure ES-1. Degree of Designated Use Support in the Nation's Waters

uses (such as drinking water supply, contact recreation, and warm and cold water fisheries) as part of their EPA-approved water quality standards. Among the States that reported on support of these designated uses, a combined total of 407,162 river miles were found to support designated uses, or 63 percent of the river miles assessed in these States (see Figure ES-1). An additional 7 percent of assessed stream miles (43,214 miles) currently support uses but are threatened by pollution. Including unassessed waters, it might alternatively be stated that 23 percent of the Nation's total river miles are known to support uses, 2 percent are threatened, 7 percent partially support uses, 3 percent do not support uses, and the remaining 64 percent were not assessed. These numbers should be interpreted with care and should not be compared to those of previous reporting cycles because States may have revised their assessment criteria over time.

The most extensive causes of impairment in the Nation's rivers were siltation (affecting 36 percent of impaired river miles), nutrients (affecting 28 percent), organic enrichment/low dissolved oxygen (affecting 26 percent), and pathogens (affecting 19 percent). Agricultural runoff was by far the most extensive source of pollution, affecting 60 percent of impaired river miles. Other sources include municipal discharges (affecting 16 percent of impaired waters), hydrologic/habitat modification, and resource extraction (each affecting 14 percent) (see Table ES-1).

What Do the States Report on the Quality of Their Lakes?

About 18.5 million lake acres (excluding the Great Lakes) were assessed by 46 States, Territories, and Jurisdictions in 1990. This reflects 47 percent of the total lake acres in the U.S., or 69 percent of the total lake acres in the States reporting. This is an increase of about 2.2 million lake acres over the number assessed in 1988.

Among the States that reported on support of designated uses, a combined total of more than 8 million lake acres were found to support those uses, or 44 percent of the assessed lake acres in those States (see Figure ES-1). An additional 16 percent (about 3 million acres) currently support uses but are threatened by pollution. Nineteen percent (about 3.5 million acres) partially support uses, and the remaining 21 percent (about 4 million acres) do not support designated uses. Including unassessed waters, about 21 percent of the Nation's total lake acres are known to support uses, 7 percent are threatened, 9 percent partially support uses, 10 percent do not support uses, and the remaining 53 percent were not assessed.

The most extensive causes of use impairment in lakes were metals (affecting 48 percent of impaired acres), nutrients (affecting 32 percent), organic enrichment/low dissolved oxygen (affecting 19 percent), and

Table ES-1. Leading Causes and Sources of Impairment

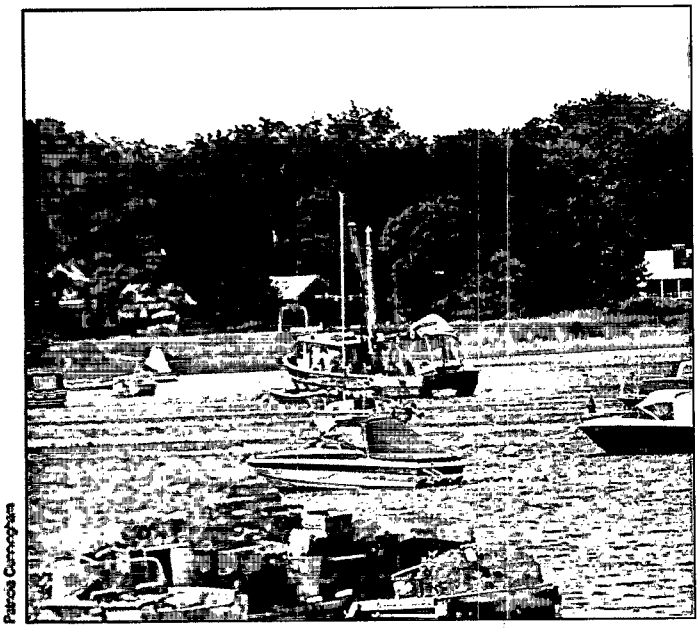
Type of Waterbody	Rivers	Lakes	Estuaries
Leading Causes of Impairment*	Siltation Nutrients Organic Enrichment/ Low Dissolved Oxygen Pathogens	Metals Nutrients Organic Enrichment/ Low Dissolved Oxygen Suspended Solids	Nutrients Organic Enrichment/ Low Dissolved Oxygen Pathogens Priority Organics
Leading Sources of Impairment*	Agriculture Municipal Discharges Hydrologic/Habitat Modification Resource Extraction	Agriculture Hydrologic/Habitat Modification Storm Sewers/Runoff Land Disposal	Municipal Discharges Storm Sewers/Runoff Land Disposal Agriculture

*Determined by size affected.

Source: 1990 State Section 305(b) reports.

suspended solids (affecting 13 percent) (see Table ES-1). It should be noted that cause data for lakes were skewed by data from one State that changed its assessment approach in 1990 and reported a large number of lake acres affected by mercury from atmospheric deposition. When data from that State are excluded, metals rank sixth and nutrients are by far the leading cause of use impairment. Nutrients are the main cause of cultural eutrophication–a major alteration of lake ecology characterized by the excessive growth of aquatic weeds and algae. The States reported that about half of all lakes assessed for trophic status were classified as eutrophic. The most extensive sources of pollution in lakes were agriculture (affecting 57 percent of impaired lake acres), hydrologic/habitat modification (affecting 40 percent), storm sewers/runoff (affecting 28 percent), and land disposal (affecting 24 percent) (see Table ES-1).

About 4,800 Great Lakes shoreline miles were assessed by six of the eight Great Lakes States in 1990. This reflects 94 percent of the total Great Lakes shoreline miles in the U.S. and all the shoreline miles in these six States. A combined total of about 85 Great Lakes shoreline miles were found to support designated uses, only 1.4 percent of assessed shoreline miles. This low rate of use support is attributed largely to fish consumption restrictions in place throughout nearshore waters of the Great Lakes. The most extensive causes of nonsupport were organic chemicals, pesticides, and metals. Significant sources of impairment include land disposal, contaminated sediments, and atmospheric deposition.



Patricia Cunningham

Huntington Harbor, North Shore of Long Island, New York.

What Do the States Report on the Quality of Their Estuaries and Coastal Waters?

About 26,700 square miles of estuaries were assessed by 22 States, Territories, and Jurisdictions in 1990. This reflects about 75 percent of the total estuarine area in these States.

Among the States that reported on support of designated uses, a combined total of about 15,000 square miles were found to support uses, or 56 percent of estuarine square miles assessed in those States (see Figure ES-1). Including unassessed waters, 42 percent of total estuarine square miles in these States were known to support designated uses, 8 percent support uses but are threatened by pollution, 18 percent partially support uses, 6 percent do not support uses, and the remaining 25 percent were not assessed.

The most extensive causes of use impairment in estuaries were nutrients (affecting 55 percent of impaired square miles), organic enrichment (affecting 31 percent of impaired square miles), pathogens (affecting 30 percent), and priority organics (affecting 15 percent). The most extensive sources of pollution in estuaries, as cited by the States, were municipal discharges (affecting 35 percent of impaired estuarine square miles), storm sewers/runoff (affecting 30 percent), land disposal (affecting 19 percent), and agriculture (affecting 18 percent) (see Table ES-1).

Coastal shoreline water quality was reported separately from estuarine water quality in the State reports. Over 4,200 coastal shoreline miles were assessed by 13 States and Territories in 1990. This reflects about 22 percent of the Nation's 19,200 miles of ocean coastline, and 33 percent of the coastline miles in these States. Among the States that reported on support of designated uses, a combined total of 3,775 miles were found to fully support uses, or 89 percent of coastline miles assessed in these States.

What Do the States Report on the Status of Their Wetlands?

State reporting on wetlands status increased in 1990, but remained uneven. Most of the States and Territories provided information on wetlands acreage, causes of loss, wetlands legislation, and State programs. However, few States reported on wetlands quality (i.e., support of designated uses).

The States cited land development for residential or commercial purposes, agricultural and resource extraction activities, impoundments, mining, and highway construction as causes of current wetlands losses. Agriculture was reported as a major historical cause of wetlands loss but currently appears to be less of a threat.

A variety of State wetlands protection legislation and programs were discussed by the States.

What Public Health/Aquatic Life Impacts Are Reported by the States?

In general, the information reported by the States shows that toxic substances affect less area than other types of pollution problems such as siltation and nutrients. However, where they occur, toxic substances can cause or contribute to locally severe public health and aquatic life impacts.

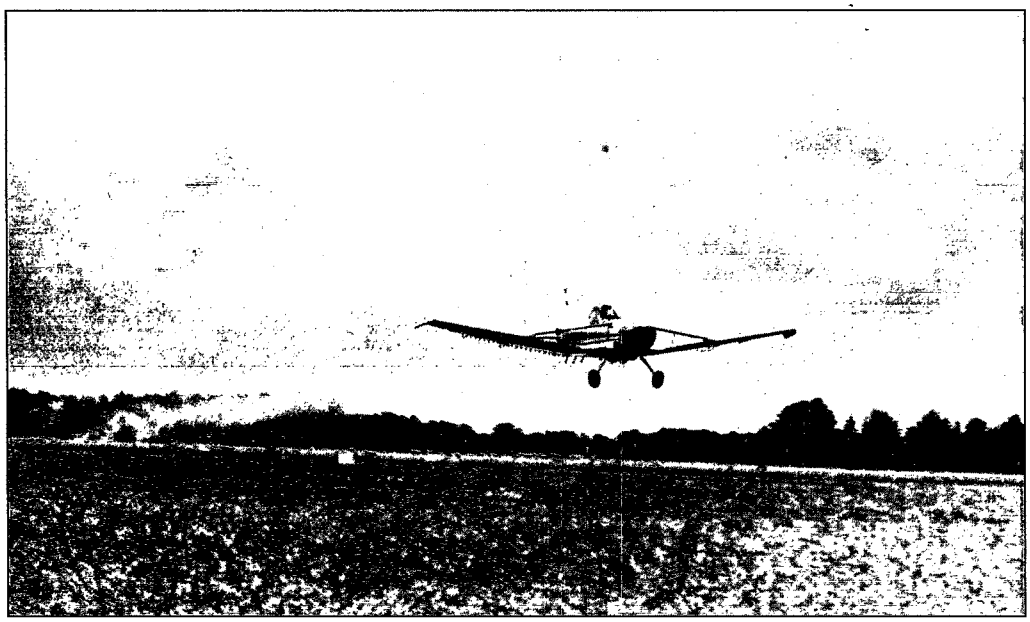
Our understanding of the prevalence of toxic substances, exposure routes, and levels of concern is limited by the difficulty and expense of monitoring and conducting long-term health effects studies. Nevertheless, States have gained considerable experience over the last decade in monitoring for toxic substances and in targeting monitoring to areas most likely to be contaminated. In 1990, the number of States providing data on toxic substances in their waters increased substantially compared to previous reporting cycles.

The States reported elevated concentrations of toxics in 15 percent of monitored river miles, 39 percent of monitored lake acres, 19 percent of monitored estuarine waters, and 7 percent of monitored ocean shoreline miles. Over 98 percent of Great Lakes shoreline miles were reported as having elevated concentrations of toxics.

Forty-seven States and Territories reported 998 waterbodies with fishing advisories and 50 waterbodies with fishing bans in place during the reporting period. PCBs, pesticides, dioxin, mercury, organics, and other heavy metals were the most commonly cited causes; industrial discharges, urban runoff/storm sewers, and nonpoint sources such as agricultural or resource extraction activities were the most common sources of contamination leading to fishing restrictions.

Sediment contamination by toxics was discussed by 29 States. Five States reported that sediment contamination was not a problem, but 24 States identified 384 incidents of sediment contamination. Incidents were caused primarily by heavy metals, PCBs, pesticides, and dioxin.

More than a thousand



Jim Turner

Drift from aerial application of pesticides can contribute to localized public health or aquatic life impacts in adjacent surface waters.

pollution-caused fish kills were reported by 42 States during the 1988-90 reporting period, with roughly 26 million fish killed. Pesticides, biochemical oxygen-demanding substances/low levels of dissolved oxygen, oil and gas, chlorine, temperature changes, and ammonia were leading causes cited by the States. Commonly cited sources include industrial discharges, agriculture, municipal discharges, spills, and resource extraction activities.

Shellfish harvesting restrictions, also resulting from fecal coliform or viral contamination of coastal and estuarine waters, were reported by 20 States. Twelve States provided information on a total of 340 incidents, and 11 States provided information on the geographic extent of the shellfish closures for a total of 2,108 square miles of estuarine waters. The most commonly reported sources of the restrictions were municipal wastewater treatment facilities, urban runoff/storm sewers, onsite wastewater systems, marinas, and industrial dischargers.

Information on contact recreational restrictions due to pollution was reported by 23 States. In 3 States, no restrictions were reported; in the remaining 20 States, 301 incidents were reported, most of short-term duration and attributed to pathogen indicators such as fecal coliform bacteria from sewage treatment plants, combined sewer overflows, urban runoff, and spills.

Eleven States provided information on closure of surface water drinking supplies. Of these States, 10 reported 34 closure incidents. Toxic pollutants entering waterbodies (primarily rivers) from accidental spills and industrial discharges were the primary reasons for closure. Most closures were of short duration.

Table ES-2. Leading Sources and Contaminants in Ground Water

Leading Sources*	Leading Contaminants*
Underground Storage Tanks	Nitrates
Septic Systems	Metals
Municipal Landfills	Pesticides
Agricultural Activities	Petroleum Products
Abandoned Hazardous Waste Sites	Volatile Organic Compounds

*Determined by number of States reporting.

Source: 1990 State Section 305(b) reports.

What Do the States Report on Ground-Water Quality?

Ground water is a vital natural resource. In many areas of the country, it is the only reliable source of drinking water or irrigation water; it is also widely used for industrial uses and livestock watering.

Although generally the quality of the Nation's ground water is good to excellent, an increasing number of pollution incidents affecting both public water supplies and private wells have been reported throughout the country. The sources of contamination most frequently cited by the States in 1990 were underground storage tanks, septic systems, municipal landfills, agricultural activities, and abandoned hazardous waste sites (see Table ES-2).

The States also identified the most prevalent contaminants in ground water. Leading contaminants were nitrates (identified by 37 States), metals (33 States), pesticides (32 States), petroleum products (31 States), and volatile organic compounds (31 States).

EPA's Office of Ground Water Protection has developed a set of indicators to measure progress and set priorities in ground-water protection efforts. In 1990, 32 States provided some quantitative information on one or more of these indicators. EPA plans to move toward inclusion of these indicators in future 305(b) reports.

What Is the Status of Ground-Water Protection Programs?

The States are currently involved in a number of activities to address ground-water contamination and sources of contaminants. These activities include

- Adopting and implementing State ground-water protection strategies (44 States);
- Establishing Wellhead Protection Programs under the Safe Drinking Water Act of 1986 (17 States with approved programs, 29 States with programs under development);
- Enacting legislation specifically aimed at developing comprehensive ground-water protection programs (37 States);

- Promulgating ground-water protection regulations (36 States);
- Developing protective ground-water quality standards (41 States);
- Developing ground-water monitoring programs (35 States);
- Adopting ground-water classification and mapping programs (39 States);
- Developing special source controls for contaminating sources such as landfills and septic systems (24 States); and
- Developing plans to coordinate ground-water protection programs among different State agencies (23 States).

EPA carries out ground-water protection activities under the Safe Drinking Water Act, the Clean Water Act, the Resource Conservation and Recovery Act, the Comprehensive Environmental Response, Compensation, and Liability Act ("Superfund"), and the Federal Insecticide, Fungicide, and Rodenticide Act. Programs initiated by EPA under these authorities include the National Pesticide Survey, the Pesticides in Ground-Water Strategy, the Ground-Water Protection Strategy, and the Ground-Water Task Force.

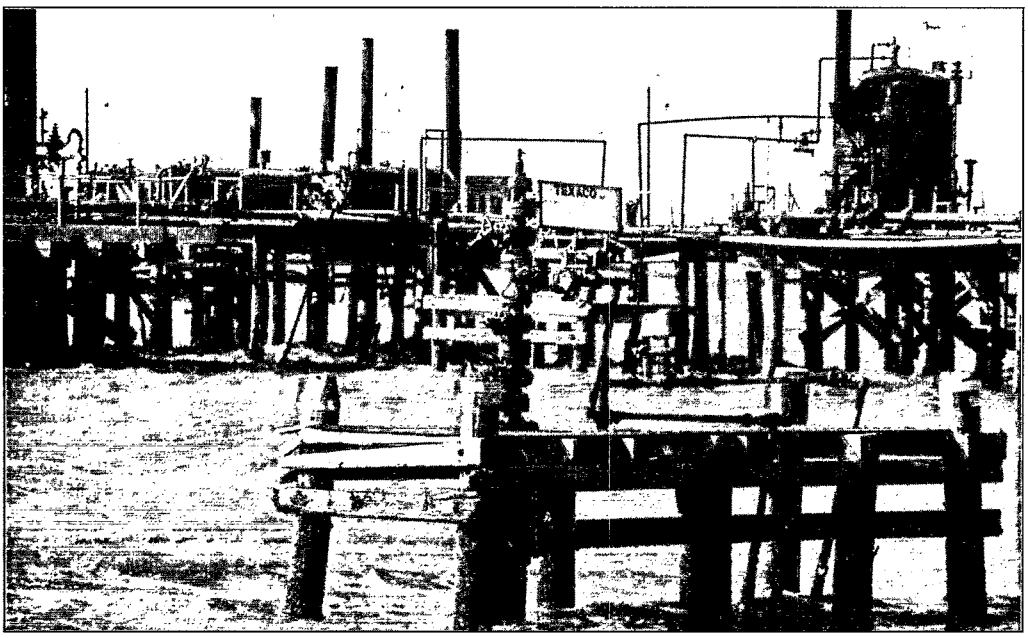
Are the Nation's Surface Water Pollution Control Programs Working?

The Clean Water Act (CWA) of 1972 (revised by amendments in 1977, 1981, and 1987) provides the basic framework for Federal and State programs to control point and nonpoint sources of pollution.

Point sources of pollution (except discharges of dredged or fill material regulated by the Corps of Engineers) are regulated through permits issued by either EPA or the States. These permits specify limits on the amount and types of pollutants that may be discharged. As of October 1990, most major point sources were meeting their permit limits: 15 percent of major municipal plants and 13 percent of directly discharging industrial facilities were in significant noncompliance with applicable permit conditions.

To help control pollution from municipal dischargers, the CWA authorized EPA to provide grants and loans to the States. Expenditures under the construction grants program have resulted in significant expansion of wastewater treatment. Although the construction grants program is being phased out under the provisions of the 1987 Clean Water Act, a State revolving loan fund has been established to ensure continued financing of wastewater treatment and to provide a new source of funding to control nonpoint source pollution and stormwater discharges.

The Clean Water Act requires EPA to establish uniform, nationally consistent guidelines limiting pollutants in industrial effluents. At this time, EPA has established guidelines for 28 major categories of industries and 15 additional secondary industries. An additional 12 industry categories are



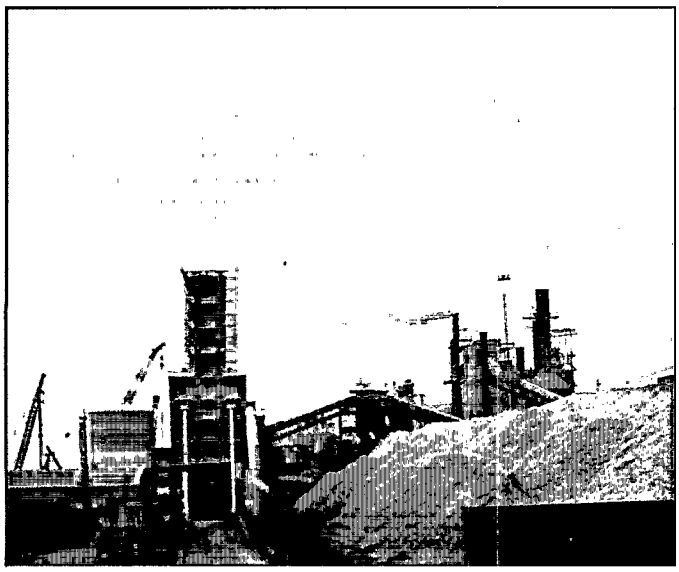
Doreen Robb, EPA Wetlands Division

Oil platform in Terrebonne Bay, Louisiana.

under study for future guidelines development.

States are making progress in developing the capability to assess and regulate toxic discharges using biological techniques. As of June 1990, 67 percent of States were using whole effluent toxicity testing in their permitting process.

The National Pretreatment Program is designed to protect municipal wastewater treatment plants and the environment from the impacts of toxic waste discharges into sewers from industrial sources. The pretreatment program currently regulates about 30,000 significant industrial users. About 14 to 17 percent of these are in significant noncompliance with pretreatment requirements. In addition, about 39 percent of sewage treatment facilities are failing to implement at least one component of their approved pretreatment programs. EPA has developed a report to Congress on the effectiveness of the pretreatment program as required under Section 519 of the Clean Water Act.



Georgia Mirnich

A pulp and paper mill, Chesapeake Bay.

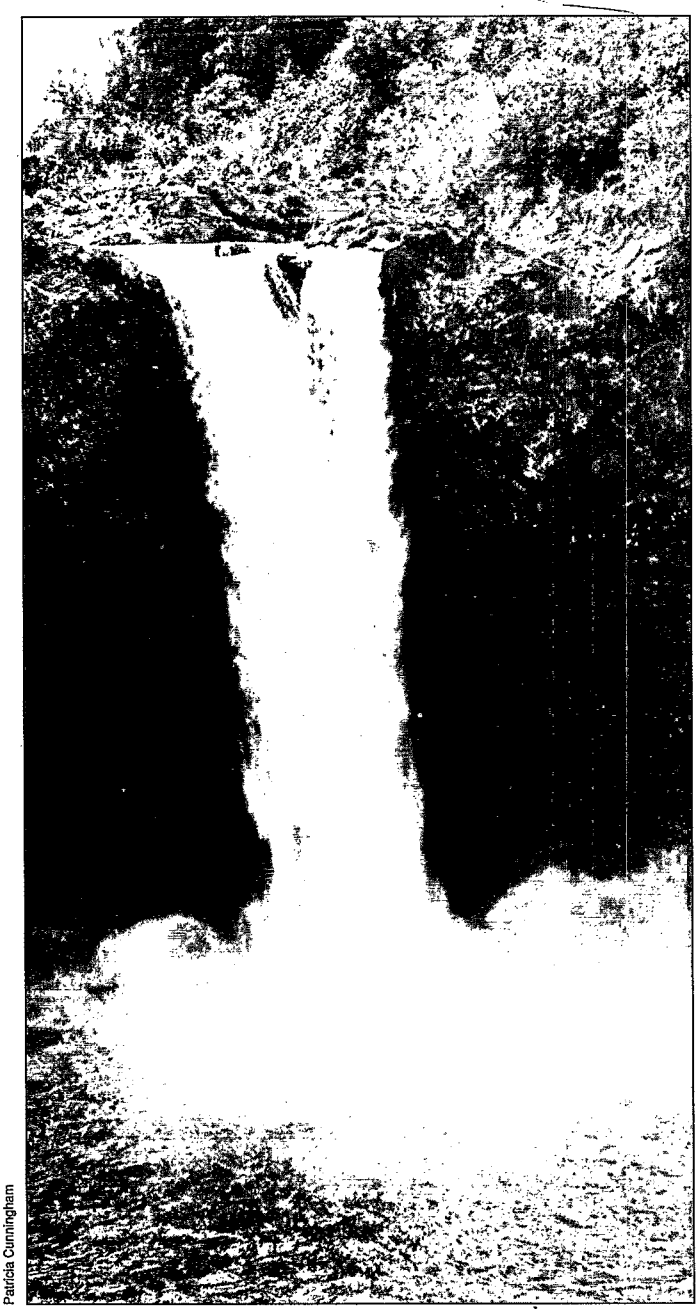
New initiatives in point source control include implementation of the National Combined Sewer Overflow Strategy and promulgation of requirements for discharges from municipal separate storm sewer systems serving populations of 100,000 or more and for stormwater discharges associated with industrial activity.

Nonpoint sources of pollution are primarily addressed through programs at the State and local levels of government. Nonpoint source (NPS) management activities focus primarily on pollution prevention, as opposed to restoration. Approaches range from land use management to the implementation of structural and cultural practices designed to reduce the environmental impacts of human activities. Examples of NPS management activities include preserving wetlands, managing nutrients and pesticides on farms, creating wet detention basins in urban areas, controlling stream acidification caused by abandoned coal mines, protecting salmonid fisheries from sediment entering streams from logging areas, and protecting and reestablishing riparian habitats. These activities may be imposed through regulatory or voluntary programs and are generally developed and applied on a site-specific basis.

In 1987, Congress enacted Section 319 of the Clean Water Act to establish a comprehensive nonpoint source pollution control program. Section 319 reflects increased Congressional and public awareness of the scope and diversity of nonpoint sources of pollution. A three-stage national program was created by Section 319, granting States primary authority and responsibility to develop nonpoint source assessment reports, adopt nonpoint source management programs, and carry out those management programs. Section 319 also establishes an EPA grant program to assist States in implementing their approved management programs.

As of October 1990, all States had EPA-approved nonpoint source assessments. EPA also fully approved 44 State nonpoint source management programs and has approved portions of all remaining State management programs. EPA issued final guidance on the award and management of grants for nonpoint source control in February 1991.

New initiatives in nonpoint source control include the 1990 Farm Bill, which contains strong water quality provisions and offers new opportunities to link EPA and U.S. Department of Agriculture water quality programs in the States, and the Coastal Zone Management Reauthorization Amendments of 1990, which require coastal States to develop coastal nonpoint pollution control programs. A variety of innovative nonpoint source management projects have been initiated across the country by States, localities, community groups, and EPA Regional offices.



Patricia Cunningham

Introduction

Background

Since 1972, Federal and State regulatory efforts to protect the Nation's surface water resources have been driven by the Clean Water Act. The objective of the Clean Water Act is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The Act establishes an interim goal to attain this objective: that, "wherever attainable . . . water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983."

Water pollution control programs have since been evolving in response to the mandates of the Clean Water Act and its amendments. In the 1970s and early 1980s, the focus of pollution control activities was on the most blatant and easily controlled sources of pollution: traditional point sources, such as discharges from industrial facilities and municipal sewage treatment plants. Increasingly stringent levels of industrial and municipal treatment were established as part of the point source permitting process, and a construction grants program was established to provide financial assistance to municipalities to upgrade existing sewage treatment plants and build new facilities.

Important progress was made in reducing the impacts of conventional (i.e., nontoxic) pollutants from traditional point sources as a result of these efforts. As this report will point out, although these sources continue to cause localized water quality problems in our waters, they are no longer leading sources of pollution in the Nation as a whole. Instead, we are finding that pollution from nontraditional sources such as farmlands, city streets, storm sewers, construction sites, and mines adversely affects more U.S. waters. Toxic pollutants—hard and expensive to detect and control—also continue to

impair our water resources.

The 1987 amendments to the Clean Water Act, which will be referenced frequently in this report, were designed to address many of the Nation's remaining water quality problems. Key aspects of the amendments include a strengthening of the nonpoint source management program; a phased expansion of the permitting program to address stormwater discharges; requirements that waters impaired by toxicants be identified and control strategies be implemented; and a strengthening of the Nation's programs to protect and restore estuarine and coastal waters. Many of the programs implemented under the 1987 amendments are discussed in this report.

The overall approach of the Nation's pollution control efforts has begun to evolve in response to these new programs and to our increased knowledge of how the environment works. Increasingly, new control activities are being designed to address entire ecosystems or watersheds—the physical and chemical quality of waters; the health, diversity, and abundance of the animals and plants that live in the waters; the integrity of the habitats they occupy; and the uses and abuses of the land surrounding those waters. Many of these programs are just beginning, and it may take years to fully assess their effectiveness. Future reports in this series will attempt to do just that as our ability to monitor, assess, and report on aquatic conditions continues to improve.

Methodology

Section 305(b) of the Clean Water Act requires States to report to EPA on the extent to which their surface waters are meeting the goals of the Act and to recommend how the goals can be achieved. EPA, in turn, analyzes these reports and transmits them and this national report to Congress. This report to Congress summarizes the States' 1990 reports, which contain data collected in 1988 and 1989.

A number of variables are involved in defining water quality, collecting monitoring data, and compiling and reporting on that information. EPA seeks to establish consistency among these variables by preparing guidelines for States' use in reporting water quality information. For example, for surface waters, these guidelines promote the use of a water quality measure based on the degree to which a waterbody is in compliance with the State water quality standards established for that waterbody. State water quality standards consist of the water quality objective, expressed as the "designated use," numeric and narrative "criteria" designed to ensure maintenance of the designated use, and an antidegradation provision. EPA's Section 305(b) reporting guidelines require that States report on water quality in terms of the degree that designated uses are supported. Degree of use support is divided into four categories: fully supporting, fully supporting but threatened, partially supporting, and not supporting uses. Limited criteria for defining these categories have been developed, but States have considerable discretion in determining exactly how decisions about the degree of use support are made.

Another method of defining surface water quality, as mentioned above, is by determining progress toward the goals of the CWA—that waters be of fishable and swimmable quality. EPA guidelines encourage reporting on this measure and seek to establish baseline definitions of fishability and swimmability.

Ideally, the State assessments should contain two types of water quality information: waterbody-specific and summary. This dual approach allows the State reports to serve various functions. The identification of specific problem areas and pollutants increases the usefulness of the reports in determining State management needs and pollution control priorities; summary data permit a "big picture" of State and national water quality to be drawn. In general, it is the State summary information that has been extracted and analyzed for this 1990 *National Water Quality Inventory*. In future 305(b) reporting cycles, considerably more emphasis will be placed on waterbody-specific information.

Some of the major surface water data elements that were used in this report include the following:

- Total sizes of assessed waterbodies (in river miles, lake acres, estuarine square miles, and coastal and Great Lake shoreline miles) per

State that are fully, partially, or not supporting designated uses and those that are threatened;

■ Major causes of use impairment (i.e., pollutants or processes such as siltation causing degradation);

■ Sources of pollution in those waters not fully supporting their uses;

■ Number of waters adversely affected by toxic pollutants.

Although most States have provided most or all of the summary data requested in the guidelines, others have not. For example, out of the 55 States, Territories, and Jurisdictions that submitted water quality assessments in 1990 in time for their inclusion in this report:

■ 51 States provided information that could be used to derive the overall degree of designated use support for 647,066 stream miles, or 53 percent of the stream miles in these States;

■ 46 States provided information on designated use support for 18,488,636 acres of lakes and reservoirs, 70 percent of lake acres in these States;

■ 22 out of 27 coastal States provided information on designated use support for 26,693 square miles of estuaries, 75 percent of the estuarine area in the reporting States;

■ 45 States provided information on their existing wetland acreage and State wetland programs, and five States assessed designated use support in their wetlands;

■ 47 States reported on causes of nonsupport in impaired rivers, 35 reported on causes in impaired lakes, and 16 reported on causes in impaired estuarine waters;

■ 42 States reported usable information on sources of pollution in impaired rivers, 35 reported on sources in impaired lakes, and 15 reported on sources in impaired estuaries;

■ 41 States provided data on the total number of river miles affected by toxics, 33 reported on the number of lake acres affected by toxics, and 16 reported on the number of estuarine square miles affected by toxics.

However, despite incomplete reporting, the continuing effort to improve and better manage water quality data is succeeding. In 1990, the States provided more data on many topics of concern than in previous years. The number of waters assessed by the States has risen significantly. Current State and EPA initiatives to further improve water monitoring and reporting include implementing a computerized water quality data system to manage State information on the causes, sources, and magnitude of degradation in individual waterbodies and developing more cost-effective monitoring techniques. EPA is also in the process of examining EPA and State monitoring efforts as part of planned revisions to program guidance for monitoring.

Jimmy Crawford

The number of waters assessed by the States has risen significantly.

Nevertheless, the absence of data for some States limits EPA's ability to analyze the data over time and creates gaps in our understanding of water quality conditions nationwide. Another obstacle arises because of inconsistencies among States in how these data were generated. These inconsistencies are themselves the result of different approaches to monitoring, different pollution problems and program needs, incomplete and varying water quality criteria, and the lack of generally accepted assessment methodologies.

For example, as mentioned previously, the standard measure for evaluating water quality is the degree to which designated uses are supported in a given waterbody. Determining the degree of use support involves a considerable amount of best professional judgment. It also may involve going beyond examination of the specific chemical criteria contained in State water quality standards. Such criteria are designed to support the use but are often incomplete compared to the range of potential pollutants and phenomena that adversely affect water quality and, ultimately, the degree of use support.

A wide degree of variation is evident among States in the number of river miles, lake acres, and estuarine square miles assessed for designated use support (see Table I-1). Some States provided rather low estimates of their total number of waters; therefore, their percentages of total waters assessed may appear high by comparison with other States. Some States actually assessed a very high percentage of their waters because they used best professional judgment, information from citizens and other State agencies, and computer modeling to supplement actual chemical, biological, and physical monitoring data. Other States assessed a smaller percentage of their total stream miles because they preferred to rely almost exclusively on actual water quality monitoring data such as chemical and biological information from fixed stations and special surveys and may have excluded supplemental sources of information.

Why do State monitoring strategies vary? Clearly, some States have more funds than others for these activities, just as some have more waters to deal with and some have more severe water quality problems. States heavily affected by diffuse and difficult-to-locate nonpoint sources may have to rely on other than traditional fixed-station monitoring of chemical pollutants to determine water quality conditions.

On the other hand, States with high concentrations of industries and cities may find it more effective to rely on biological surveys and various chemical monitoring methods to assess water quality. Traditionally, then, each State weighs its needs and judges how it can best use its monitoring resources.

One drawback of this approach is that it results in a relatively small percentage of the Nation's waters being assessed. We assume that since States generally focus their monitoring resources on waters most likely to have problems— e.g., urban waters or those that are intensively used for recreational purposes—the remaining unassessed waters may be of better quality. EPA is encouraging increased water quality assessment to verify this and gain a more accurate picture of the Nation's waters as a whole. EPA has also asked States to identify which of their waterbodies were assessed using biological or chemical data (termed "monitored") and which were assessed using other types of data (termed "evaluated").

In addition to the problem of variations in the number of waters assessed, there are basic inconsistencies involving how support of designated uses is determined. Variability exists among States in defining the characteristics a waterbody must

Patrice Cunningham

Biologists monitor the health of fish populations off the southern California coast.

Table I-1. Percentage of Waters Assessed for Rivers, Lakes, and Estuaries*

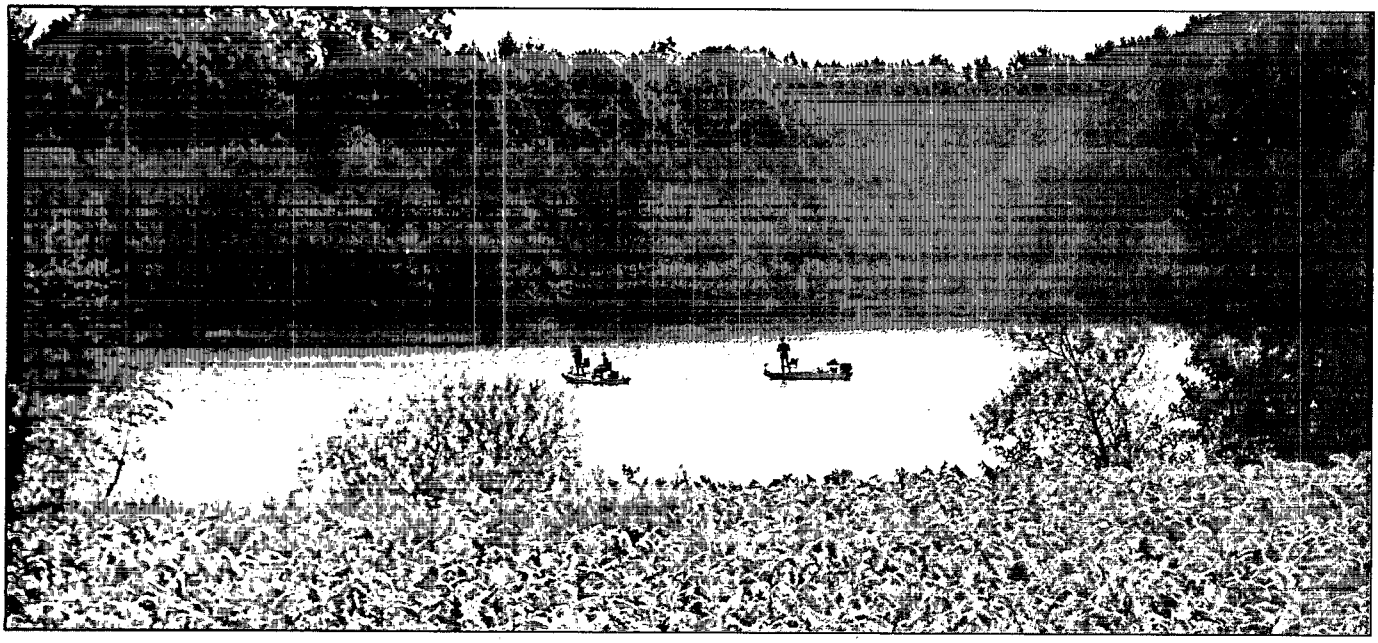
	Rivers		Lakes		Estuaries	
State	Total Miles	Percent Assessed	Total Acres	Percent Assessed	Total Sq. Miles	Percent Assessed
Alabama	40,600	30	504,721	100	625	16
Alaska	—	—	—	—	—	—
Arizona	17,537	30	127,372	95	NA	NA
Arkansas	11,310	42	355,063	100	NA	NA
California	26,970	45	1,417,540	82	1,598	50
Colorado	31,470	97	265,982	55	NA	NA
Connecticut	8,400	11	82,900	28	601	100
Delaware	643	100	4,499	56	—	—
Delaware River Basin	206	100	—	—	866	100
District of Columbia	40	95	376	63	6	100
Florida	12,659	62	2,085,120	46	4,298	63
Georgia	20,000	100	417,730	100	594	100
Hawaii	349	100	—	—	134	100
Idaho	—	—	—	—	NA	NA
Illinois	14,080	93	305,847	68	NA	NA
Indiana	20,000	25	106,203	92	NA	NA
Iowa	18,300	39	80,670	99	NA	NA
Kansas	13,295	91	173,602	98	NA	NA
Kentucky	18,490	52	228,385	94	NA	NA
Louisiana	14,180	92	866,646	99	7,656	71
Maine	31,672	100	994,560	96	1,633	100
Maryland	17,000	100	32,583	64	2,523	100
Massachusetts	8,053	20	151,173	42	177	77
Michigan	36,350	100	840,960	58	NA	NA
Minnesota	91,944	6	3,411,200	83	NA	NA
Mississippi	15,839	100	500,000	100	133	100
Missouri	21,064	100	287,543	100	NA	NA
Montana	51,212	100	740,086	85	NA	NA
Nebraska	24,000	30	145,800	60	NA	NA
Nevada	7,500	19	425,400	47	NA	NA
New Hampshire	14,544	9	152,788	99	—	—
New Jersey	—	—	—	—	—	—
New Mexico	3,500	89	132,690	87	NA	NA
New York	70,000	100	750,000	89	1,564	100
North Carolina	37,222	94	305,367	100	3,194	100
North Dakota	11,868	77	619,088	99	NA	NA
Ohio	43,917	17	—	—	NA	NA
Ohio River Valley	981	100	—	—	NA	NA
Oklahoma	19,791	22	1,041,884	42	NA	NA
Oregon	90,000	31	610,808	83	206	—
Pennsylvania	50,000	48	149,000	0	NA	NA
Puerto Rico	5,373	100	11,146	100	—	—
Rhode Island	724	86	16,683	100	193	100
South Carolina	9,900	35	525,000	41	2,155	17
South Dakota	9,937	40	1,598,285	43	NA	NA
Tennessee	19,124	54	538,504	100	NA	NA
Texas	80,000	20	3,065,600	50	1,990	100
Utah	11,779	75	481,638	28	NA	NA
Vermont	5,266	100	229,146	99	NA	NA
Virgin Islands	—	—	—	—	6	100
Virginia	27,240	40	161,290	100	2,529	100
Washington	40,492	12	613,582	28	2,943	37
West Virginia	28,361	62	23,460	80	NA	NA
Wisconsin	43,600	31	957,288	14	NA	NA
Wyoming	19,437	100	427,219	100	NA	NA
Totals	1,216,219	53	26,962,427	69	35,624	75

*Based on State estimates of total waters. — Not reported. NA = Not applicable. Source: 1990 State Section 305(b) reports.

have to be fully, partially, or not supporting its uses and even what those uses should be. In part, this variability arises from the range of methods the States use to assess water quality. In many cases, biological, chemical, and evaluative data must all be weighed before a use support decision can be made. However, not all States have biological monitoring capabilities; fixed-station chemical monitoring networks range widely in geographic coverage and scope; and State approaches to the use of evaluative data vary. Other factors contributing to inconsistencies include widely divergent natural conditions among States and vast differences in the States' monitoring capabilities and resources.

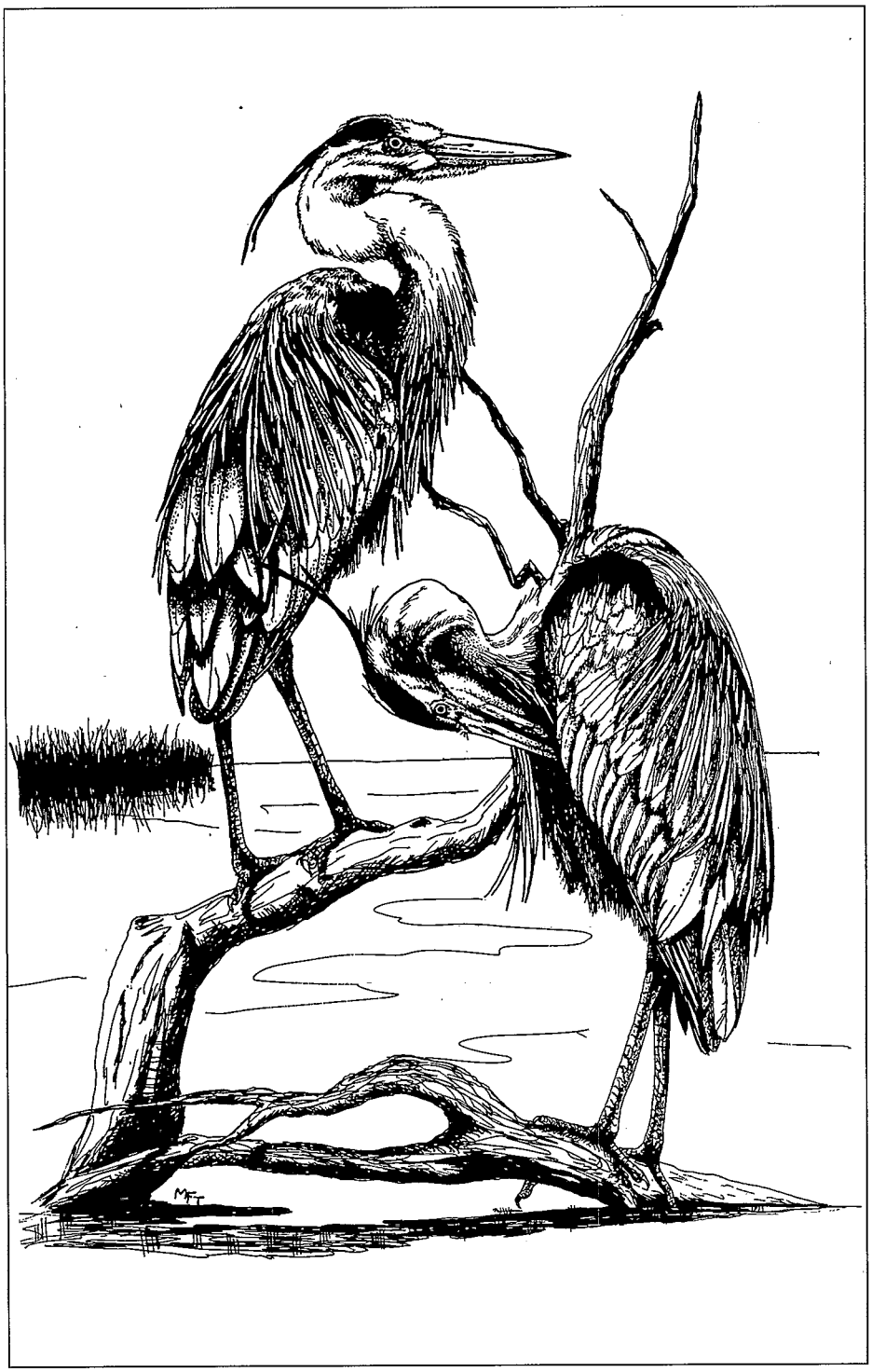
To address these problems, EPA is working with the States to develop improved guidance on making use support decisions. This guidance distinguishes among the various designated uses States assess (such as fish consumption and swimming) and the different types of waters assessed (rivers vs. lakes); takes into account new developments in specifications for the duration and frequency of exceedances of toxic chemical criteria; and encourages the use of additional indicators such as fishing restrictions and drinking water supply closures in making use support decisions. Efforts to further improve this assessment guidance will continue for future 305(b) reporting cycles. This guidance should greatly increase the consistency of State assessments of water quality. Other EPA activities include developing a consistent and accepted baseline of total State waters and encouraging the use of the Section 305(b) reporting process as a tool in managing toxicants, nonpoint sources, and lake/estuary/wetland protection programs.

To further improve the Section 305(b) reporting process and to manage the various new assessments required by the Water Quality Act of 1987, EPA has developed a data system for managing water quality information for specific waterbodies. Design of the system—called the Section 305(b) Waterbody System (WBS)—began in 1986. In 1990, the WBS was widely used by States for organizing and analyzing their assessment information, developing summary tables on key water quality measures, and preparing waterbody listings required by the Water Quality Act.



Randy Dodd

Recreational fishing on Tar River Reservoir.



Surface Water Quality

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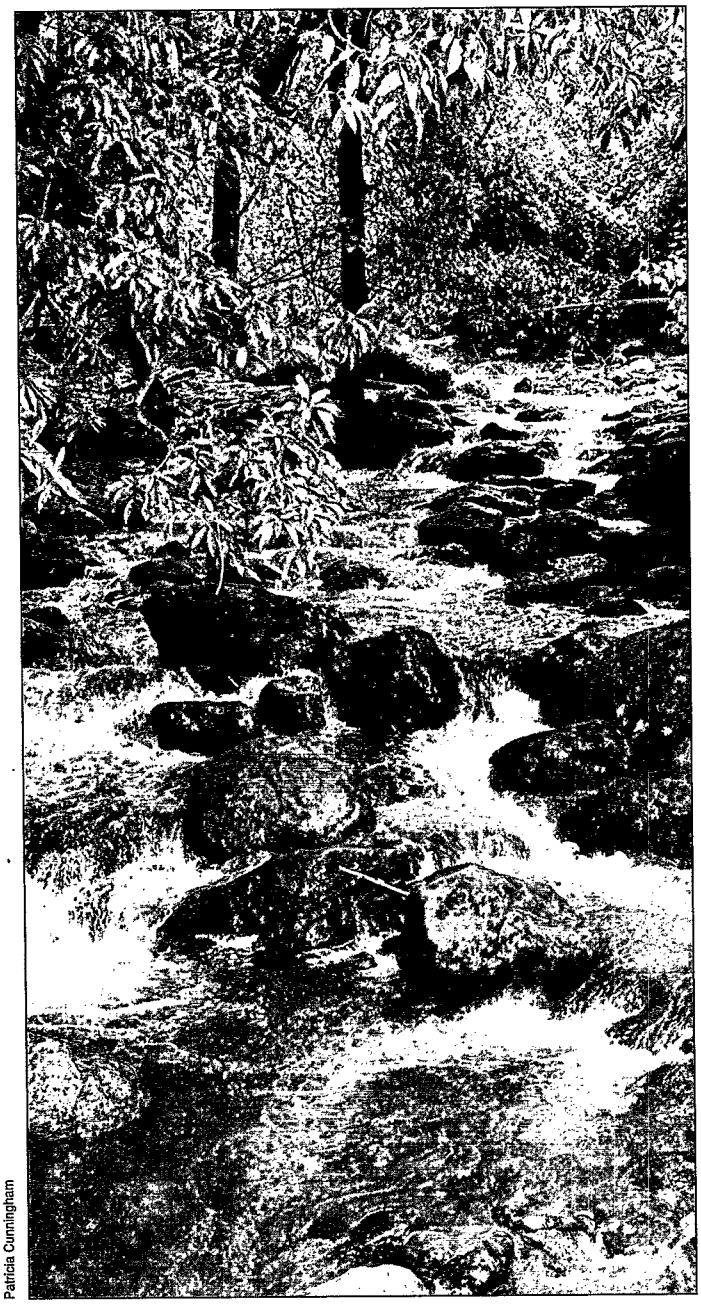


Patricia Cunningham

Rivers and Streams

Support of Designated Uses

The standard measure of water quality reported by the States is the degree to which waters support the uses for which they have been designated, such as high-quality cold water fishery, contact recreation, or drinking water supply. In their 1990 State Section 305(b) reports, 51 States, Territories, Jurisdictions, and Interstate Commissions (hereafter referred to as States) provided use support information for rivers and streams (see Table 1-1). These States assessed a total of 647,066 river miles, 127,653 more miles than were assessed in 1988. These miles represent 53 percent of the total stream miles estimated for these States and 36 percent of the Nation's estimated 1.8 million stream miles.*

Of those assessed waters, 407,162 miles (63 percent) were found to be fully supporting their designated uses. An additional 7 percent (43,214 miles) were identified as threatened waters that currently support their designated uses but could soon become impaired if pollution control actions are not taken. Twenty-one percent of assessed waters, or 134,472 miles, were reported as partially supporting uses, and 10 percent, or 62,218 stream miles, were reported as not supporting uses (see Figure 1-1). Forty-nine States specified the basis of their assessment decisions. In these States, 63 percent of

*Estimate from ASIWPCA, *America's Clean Water: The States' Nonpoint Source Assessment*, 1985.

Table 1-1. Designated Use Support in Rivers and Streams

State	Total River Miles	Miles Assessed			Miles Fully Supporting	Miles Threatened	Miles Partially Supporting	Miles Not Supporting
		Total	Percent Evaluated	Percent Monitored				
Alabama	40,600	12,016	69	31	8,783	159	2,003	1,071
Arizona	17,537	5,185	72	28	206	1,120	2,142	1,717
Arkansas	11,310	4,713	54	45	1,636	—	539	2,538
California	26,970	12,122	30	70	4,612	—	5,920	1,590
Colorado	31,470	30,582	72	28	27,662	974	1,221	725
Connecticut	8,400	893	40	60	420	190	229	54
Delaware	643	643	11	89	132	15	94	402
Delaware River Basin	206	206	—	—	0	199	0	7
District of Columbia	40	38	0	100	0	0	3	35
Florida	12,659	7,908	37	63	4,890	258	1,863	897
Georgia	20,000	20,000	66	34	19,395	—	556	49
Hawaii	349	349	28	72	265	0	80	4
Illinois	14,080	13,122	20	80	5,522	179	7,263	158
Indiana	20,000	4,917	46	54	2,570	416	1,143	788
Iowa	18,300	7,156	94	6	0	90	6,552	514
Kansas	13,295	12,144	1	99	345	0	1,078	10,721
Kentucky	18,490	9,556	55	45	6,429	130	1,268	1,729
Louisiana	14,180*	13,101	65	35	3,290	5,420	3,053	1,338
Maine	31,672	31,672	75	25	31,107	0	0	565
Maryland	17,000	17,000	85	15	15,657	0	1,218	125
Massachusetts	8,053	1,624	15	85	475	94	467	588
Michigan	36,350	36,350	37	63	34,989	—	—	1,361
Minnesota	91,944	5,316	12	88	1,425	—	517	3,374
Mississippi	15,839	15,839	87	13	7,663	480	7366	330
Missouri	21,064	21,064	65	35	11,220	—	9827	17
Montana	51,212	51,212	95	5	34,808	3,194	11,944	1,266
Nebraska	24,000	7,331	8	92	4,025	—	1,914	1,392
Nevada	7,500	1,447	4	96	405	45	362	635
New Hampshire	14,544	1,348	36	64	20	839	339	150
New Mexico	3,500	3,125	20	80	0	8	2,843	274
New York	70,000	70,000	95	5	63,771	1,439	3,582	1,208
North Carolina	37,222	35,234	67	33	12,766	10,928	9,440	2,100
North Dakota	11,868	9,173	54	46	180	6,709	2,284	0
Ohio	43,917	7,444	—	—	2,231	437	1,540	3,236
Ohio River Valley	981	981	21	79	0	0	981	0
Oklahoma	19,791	4,400	55	45	269	2,305	1,826	0
Oregon	90,000	27,738	87	13	12,546	—	8,497	6,695
Pennsylvania	50,000	23,832	53	47	19,137	—	1,982	2,713
Puerto Rico	5,373	5,373	80	20	2,078	567	1,207	1,521
Rhode Island	724	626	10	90	201	287	29	109
South Carolina	9,900	3,493	0	100	2,758	0	275	460
South Dakota	9,937	4,028	17	83	673	551	1,764	1,040
Tennessee	19,124	10,247	62	38	4,652	1,872	2,620	1,103
Texas	80,000	16,184	3	97	13,548	0	0	2,636
Utah	11,779	8,874	0	100	1,544	238	5,658	1,434
Vermont	5,266	5,266	91	9	3,140	1,194	720	212
Virginia	27,240	10,809	46	54	8,862	—	1,468	479
Washington	40,492	4,897	13	87	1,548	562	1,319	1,468
West Virginia	28,361	17,456	62	38	7,160	0	9,180	1,116
Wisconsin	43,600	13,595	80	20	6,878	1,504	4,946	267
Wyoming	19,437	19,437	67	33	15,269	811	3,350	7
Totals	1,216,219	647,066	63	37	407,162	43,214	134,472	62,218
Percent of Assessed Waters					62.9%	6.7%	20.8%	9.6%

— Not reported.

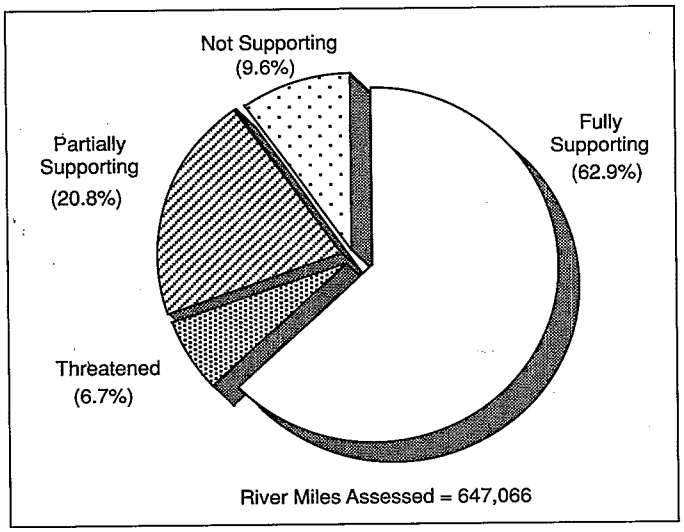
*U.S. EPA Reach File Version 1 estimate (1982).

Source: 1990 State Section 305(b) reports.

assessed waters were evaluated using mathematical models, citizen complaints, questionnaires, etc., and 37 percent were monitored using ambient chemical and biological data (see *Highlight–Water Quality Assessment Data* for further discussion).

Reporting consistency improved during the 1990 reporting cycle. More States provided use support information than in any previous reporting cycle; and all but four States submitted use support information in a usable format. In addition, individual States assessed a higher percentage of their river and stream miles in 1990.

Despite these improvements, the Section 305(b) assessment and reporting process continues to have limitations, and stream data in this chapter should not be compared between States or within States over time. As mentioned in the Introduction to this report, States have adopted different water quality criteria, water quality standards, and assessment methodologies. State capabilities to monitor water quality, fish tissue, and biological integrity also vary. These inconsistencies, rather than dramatic differences in water quality, probably account for the wide range in percentage of waters supporting uses among the States. Furthermore, changing assessment methods within a given State may appear to indicate water quality trends where none actually exist. States may assess different waterbodies from year to year, improve their monitoring capabilities, or adopt new assessment criteria and evaluation procedures.



Source: 1990 State Section 305(b) reports.

Figure 1-1. Designated Use Support in Assessed Rivers and Streams

Causes of Impairment

States were asked to identify the causes of nonsupport in waters not fully supporting uses. Causes of nonsupport are pollutants (such as pesticides or nutrients) or pollution processes (such as habitat destruction) that impair waterbodies. In 1990, 47 States provided data on the number of stream miles affected by different causes of nonsupport (see Table 1-2).

Because any given stream mile can be affected by many different causes, States were asked to include each impaired stream mile under every cause category contributing to its impairment. Therefore, a single river mile affected by multiple causes is counted under several cause categories. The values reported are the total number of river miles affected by a particular cause of impairment, according to whether the cause is a major or moderate/minor contributor to impairment. (Data from States that did not specify degree of impact are included under the "major" heading in Table 1-2.) The relative extent of each cause of nonsupport can be determined by dividing the total number of miles affected by each cause category by the total miles impaired (see Figure 1-2).

Siltation, the smothering of stream beds by sediments (usually from accelerated soil erosion), is the most commonly reported cause of nonsupport in the Nation's rivers and streams, affecting 36 percent of impaired river miles. Nutrients, the second most commonly reported cause, affect 28 percent of impaired river miles and most often consist of phosphorus and nitrogen compounds such as those used in agricultural fertilizers. Both siltation and nutrients are predominantly from diffuse nonpoint sources.

Nutrients can stimulate the growth of algae, which often deplete dissolved oxygen concentrations. The next most common cause of impairment is organic enrichment/low dissolved oxygen, affecting 26 percent of impaired river miles. This cause may be closely linked to sewage treatment plants and feedlots.

Fecal coliform bacteria are organisms commonly monitored as indicators of possible pathogen contamination of waters. Pathogen contamination (cited as the fourth

Table 1-2. Impaired River Miles Affected by Causes of Pollution

State	Total Impaired Waters*	Siltation		Nutrients		Organic Enrichment		Pathogens		Metals	
		Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
Alabama	3,074	232	950	128	1,184	141	1,259	14	363	24	385
Arizona	3,859	1,385	1,746	76	636	26	569	44	805	589	1,482
Arkansas	3,077	619	30	32	—	39	283	1,963	368	—	—
Colorado	1,946	—	—	—	—	21	—	176	505	527	1,294
Connecticut	283	2	37	21	80	61	71	114	48	73	22
Delaware	496	—	—	7	30	38	11	436	30	23	17
Delaware River Basin	7	—	—	—	—	—	—	7	—	—	—
District of Columbia	38	—	—	—	—	10	14	21	3	5	17
Florida	2,760	—	—	290	618	573	807	96	359	—	125
Georgia	605	—	—	—	—	28	36	11	370	6	100
Illinois	7,421	170	6,420	979	6,206	156	1,337	147	237	23	1,036
Iowa	7,066	6,553	510	70	6,981	52	71	394	28	432	14
Indiana	1,931	—	15	—	—	180	130	—	—	71	93
Kansas	11,799	3	—	507	195	7,894	3,344	—	—	64	—
Kentucky	2,997	406	18	222	32	500	23	1,424	—	249	146
Louisiana	4,391	210	1,386	147	2,667	614	2,752	442	3,148	16	258
Maine	565	—	—	—	—	100	73	58	84	—	20
Maryland	1,343	50	952	—	724	64	76	20	625	7	—
Massachusetts	1,055	—	—	62	324	118	276	415	465	92	77
Michigan	1,361	239	34	33	94	88	—	132	—	148	62
Minnesota	3,891	—	—	—	1,478	111	1,494	326	1,849	220	1,521
Mississippi	7,696	268	6,360	641	6,720	86	5,813	9	2,294	87	514
Missouri	9,844	4	7,128	—	—	2	52	—	—	18	—
Montana	13,210	285	6,032	104	5,497	42	805	—	1,609	446	3,326
Nebraska	3,306	—	—	—	—	365	236	158	1,109	—	—
Nevada	997	—	204	180	201	72	126	21	—	101	—
New Hampshire	489	—	—	—	—	44	27	150	339	—	—
New Mexico	3,117	921	1,040	110	1,406	35	248	100	211	566	1,472
New York	4,790	126	59	8	150	69	121	15	144	11	88
North Carolina**	11,540	—	—	—	—	902	—	670	—	—	—
North Dakota	2,284	691	1,129	759	1,118	10	219	—	608	—	348
Ohio	4,776	634	1,130	32	63	2,619	754	—	—	596	734
Ohio River Valley	981	—	981	—	—	—	—	402	—	—	877
Oregon**	15,192	1,260	—	745	—	603	—	885	—	—	—
Pennsylvania**	4,695	—	—	565	—	302	—	148	—	1,931	—
Puerto Rico	2,728	—	—	65	447	33	156	295	430	12	61
Rhode Island	138	—	—	—	27	17	18	53	20	87	13
South Carolina	735	—	—	280	94	280	94	450	86	—	—
South Dakota	2,804	110	275	—	232	16	179	424	1,103	—	—
Tennessee	3,723	1,674	1,028	256	1,170	432	1,413	534	862	101	575
Texas	2,636	—	—	34	—	60	54	1,502	71	57	618
Utah	7,092	—	—	1,202	1,545	1,135	1,613	378	1,245	353	1,555
Vermont	932	393	328	217	246	104	301	52	240	10	47
Washington	2,787	542	352	612	384	376	543	1,310	587	285	756
West Virginia	10,296	1,034	4,576	253	927	410	2,267	47	189	759	2,330
Wisconsin	5,213	2,627	1,278	987	647	388	664	72	529	88	220
Wyoming	3,357	—	2,623	—	—	—	—	—	273	7	—
Totals	185,323	20,438	46,621	9,624	42,123	19,216	28,329	13,915	21,236	8,084	20,203
Combined Totals			67,059		51,747		47,545		35,151		28,287
Percent of Impaired Waters			36.2%		27.9%		25.7%		19.0%		15.3%

* The sum of partially and nonsupporting river miles (Table 1-1).

** These States did not specify the degree of impact (i.e., Major or Moderate/Minor); river miles were placed in the "Major" column for national reporting purposes.

— Zero or not reported.

Source: 1990 State Section 305(b) reports.

Salinity		Habitat Modification		Pesticides		Suspended Solids		Flow Alteration		pH		Thermal Modification	
Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
—	—	14	120	—	436	—	—	14	242	27	385	—	—
71	334	—	—	—	366	—	—	—	—	76	231	—	—
32	—	—	—	—	—	—	—	—	—	34	—	—	15
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	6	94	—	—	—	32	1	—	—	—	—	—
—	—	—	—	11	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	4	—	—
—	—	—	—	—	—	97	244	—	—	—	—	—	—
—	2	—	—	—	—	—	—	—	—	1	1	—	—
—	119	352	1,230	—	50	60	489	27	725	5	162	—	—
—	—	13	4	199	6,535	—	—	1	9	82	—	—	—
—	12	—	—	212	220	19	155	18	—	18	152	—	—
5,314	766	—	—	130	—	—	—	—	—	—	—	—	—
164	20	98	55	—	—	35	—	—	—	261	13	—	—
36	1,251	8	200	—	2,285	563	3,323	—	539	—	116	12	43
—	—	—	—	—	—	—	36	4	—	—	—	—	—
—	—	—	15	—	—	—	—	2	—	82	238	—	25
3	15	—	—	—	20	12	29	—	—	—	5	—	—
330	—	24	—	—	—	26	—	274	—	5	5	2	—
10	607	—	—	—	—	—	995	—	—	18	467	—	—
5	214	—	—	87	6,668	48	436	—	—	—	23	—	—
—	—	4,498	—	206	—	—	—	—	—	11	11	—	—
394	5,347	274	4,547	—	—	327	6,646	584	6,516	40	673	125	2,401
—	—	154	67	30	175	28	130	8	171	—	—	—	—
163	133	126	—	—	—	—	344	—	118	126	388	—	132
—	—	—	—	—	—	—	—	—	—	—	—	—	—
16	332	174	1,569	—	204	—	—	290	750	46	274	75	308
9	13	—	—	5	47	—	—	56	94	60	—	103	10
—	—	—	—	—	—	—	—	—	—	—	—	—	—
176	494	—	—	—	65	—	—	—	89	—	—	—	36
—	—	607	914	53	36	—	—	392	280	291	56	—	—
—	981	—	—	490	491	—	—	—	—	—	—	—	—
—	—	1,480	—	52	—	—	—	1,355	—	455	—	1,320	—
33	—	—	—	164	—	597	—	—	—	307	—	37	—
—	—	33	5	14	102	35	229	263	34	1	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	6	—	—	—	—	—	—	70	—	—
50	988	—	—	—	—	700	1,817	—	—	135	473	—	1,576
8	11	120	202	33	205	1,053	784	234	377	144	420	14	39
587	542	—	—	—	218	—	—	18	—	—	—	—	—
110	1,223	—	—	—	—	—	—	—	—	142	616	—	—
—	—	217	230	—	4	32	21	174	150	9	10	96	337
—	58	473	153	132	139	441	218	234	117	242	102	754	905
3	127	56	302	—	277	—	—	106	126	725	1,111	95	217
—	—	207	876	68	136	325	493	259	567	—	19	—	293
—	811	—	741	—	130	—	—	—	347	—	—	—	—
7,514	14,400	8,934	11,324	1,892	18,809	4,398	16,421	4,314	11,251	3,343	6,025	2,633	6,337
	21,914		20,258		20,701		20,819		15,565		9,368		8,970
	11.8%		10.9%		11.2%		11.2%		8.4%		5.1%		4.8%

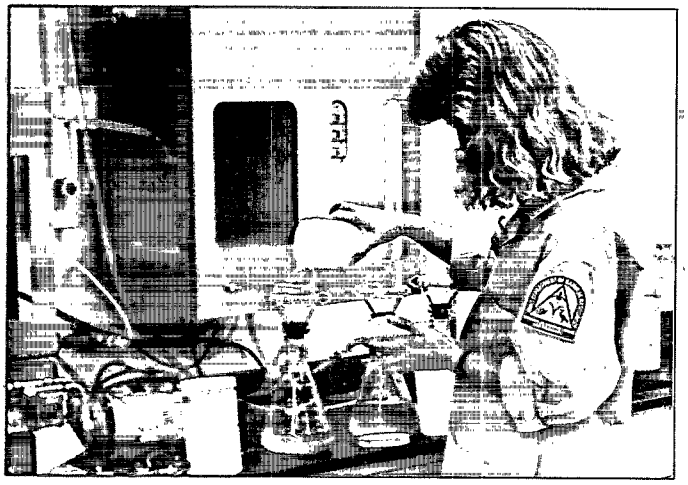
Water Quality Assessment Data

States collect a broad range of information on conditions in their rivers, lakes, and estuaries. EPA requests that States report conditions based on two categories of assessment data. **Monitoring data** can be provided by networks of chemical or biological sampling stations located near dischargers or at other strategic points along waterbodies. Monitoring data also encompass short-term or one-time intensive or special surveys designed to provide water quality "snapshots" for discrete areas or to answer questions about specific problem sources or conditions. The data collected may be chemical (e.g., the concentration of a given pollutant in water, sediment, or fish/shellfish tissue) or biological (e.g., counts of the number of certain indicator species in a given sample or tests of the toxicity of river or wastewater samples). Their common elements are that they are scientifically collected by the State pollution control agency, local governments, or Federal authorities using quality control procedures and involve actual observations of the water, sediments, fish tissue, or aquatic organisms.

Evaluative data, on the other hand, are collected from a variety of sources that may not use quality control procedures or involve site-specific sampling. Examples of this type of data include reports of pollution-caused fish kills, predictive modeling based on knowledge of sources, land use types, etc., surveys of fisheries personnel, and certain kinds of volunteer monitoring.

The degree to which States use these different types of data varies greatly. Some States rely almost exclusively on fixed-station chemical monitoring data or a combination of fixed-station and intensive survey data. Other States may use rotating basin surveys in which a limited number of basins are studied intensively using biological, chemical, and toxicological approaches. Others with limited monitoring resources may find that their evaluative data provide a more realistic picture of water quality conditions than does a small network of infrequently sampled stations. Most States use a combination of data types to reach their assessment decisions.

Designated use support information for rivers shows that in the 49 States that specified data types, 639,416 stream miles were assessed, 37 percent using monitoring data and 63 percent using evaluative approaches. Of the 404,931 miles supporting uses in these States, 67 percent were evaluated and 33 percent were monitored. However, nearly the reverse of this applies in the 58,975 miles not supporting uses: 41 percent of waters were evaluated and 59 percent were monitored. Two different conclusions could be drawn from these findings: that States concentrate their monitoring efforts in their most degraded waters or that States tend to find problems where they monitor. Many States have indicated that the former argument is true. Faced with diminishing resources for monitoring, States have traditionally focused monitoring stations and intensive surveys on those areas most likely to have problems. Nevertheless, perhaps a combination of the two may apply, since reliance on models, questionnaires, and citizen complaints may fail to reveal certain types of water quality problems. In any case, EPA continues to support both types of assessment activities as the best available and most practical way to expand coverage of the Nation's waters.



Doreen Robb, EPA Wetlands Division

States use a wide variety of chemical and biological methods to monitor their waters.

leading cause of impairment nationwide) may impair drinking water supply and contact recreation uses. Such contamination may come from inadequately treated sewage or runoff from pastures, feedlots, and urban areas. These pathogen indicators were found to affect 19 percent of impaired waters.

The fifth and sixth most commonly reported causes of impairment are metals (such as lead, copper, and mercury) and salinity. Other significant causes include habitat modification, pesticides, suspended solids, flow alteration, pH, and thermal modification.

Forty-four States specified the degree of impact (i.e., major or moderate/minor) of the causes affecting their rivers and streams. For all categories of causes, there were more waters in which the cause was a moderate/minor contributor to impairment than a major contributor. Causes with a high percentage of major impact include organic enrichment (major impact in 37 percent of affected waters), pathogens (major impact in 35 percent), and siltation (major impact in 29 percent).

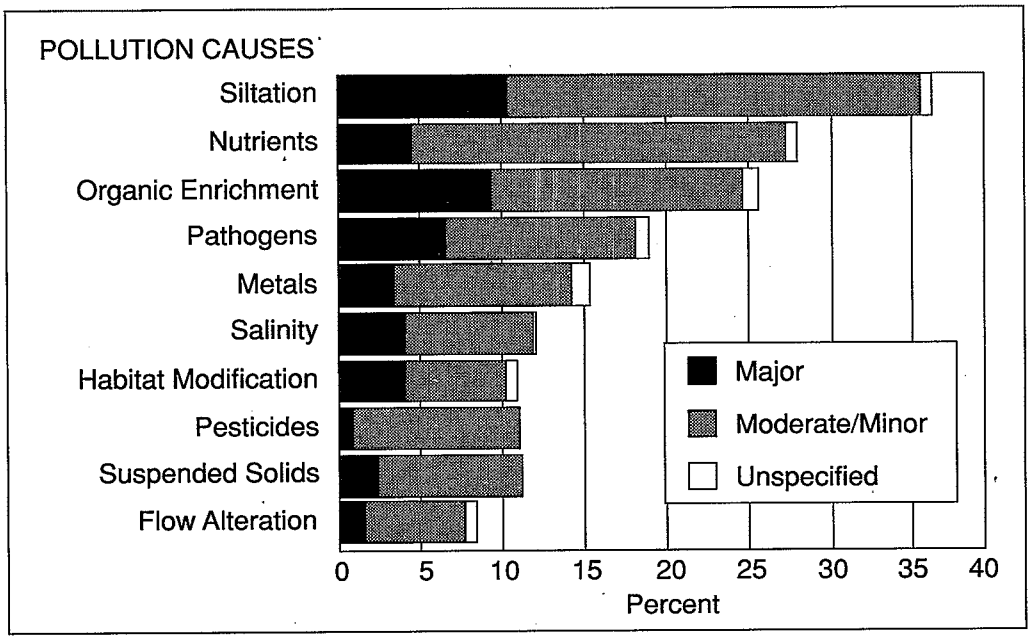
Sources Of Impairment

In their 1990 State Section 305(b) reports, 42 States provided information on the various sources of pollution contributing to use impairment in rivers. Sources of impairment, such as municipal discharges and agricultural runoff, contribute pollutants or result in harmful processes such as siltation (see *Highlight–Sources of Pollution Reported by the States*). Table 1-3 displays the categories of sources and the size of waters affected by each.

As with causes of impairment, any given stream mile can be affected by many different sources. Therefore, States were asked to include each stream mile under each source category contributing to its impairment. As a result, a single river mile affected by multiple sources is counted under several categories. The values reported are the total number of river miles affected by a particular source of impairment according to whether the source is a major or moderate/minor contributor to impairment. (Data from States that did not specify degree of impact are included under the "major" column heading in Table 1-3.) The relative extent of each source of nonsupport can be determined by dividing the total number of miles affected by each source category by the total miles impaired (see Figure 1-3).

Table 1-3 reveals that the most extensive source of pollution reported for the Nation's rivers is agricultural runoff, which affects 60 percent of impaired river miles. Other extensive sources include municipal dischargers, affecting 16 percent; hydrologic/habitat modification, affecting 15 percent; resource extraction, affecting 14 percent; storm sewers/runoff, affecting 11 percent; and industrial dischargers and silviculture, each affecting about 9 percent of impaired river miles.

Thirty-eight States specified the degree of impact (i.e., major or moderate/minor) of the pollution sources



Source: 1990 State Section 305(b) reports.

Figure 1-2. Percent of Impaired River Miles Affected by Causes of Pollution

affecting their rivers. Major impacts outweigh moderate/minor impacts for agriculture, silviculture, and combined sewers.

Attainment of the Clean Water Act Goals

The Clean Water Act (CWA) states, "It is the national goal that, wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved . . ." Most U.S. waters are classified to reflect these benchmarks, which are commonly referred to as the fishable and swimmable goals of the Clean Water Act. Support of CWA goals is considered a separate and independent criterion from the degree of designated use support.

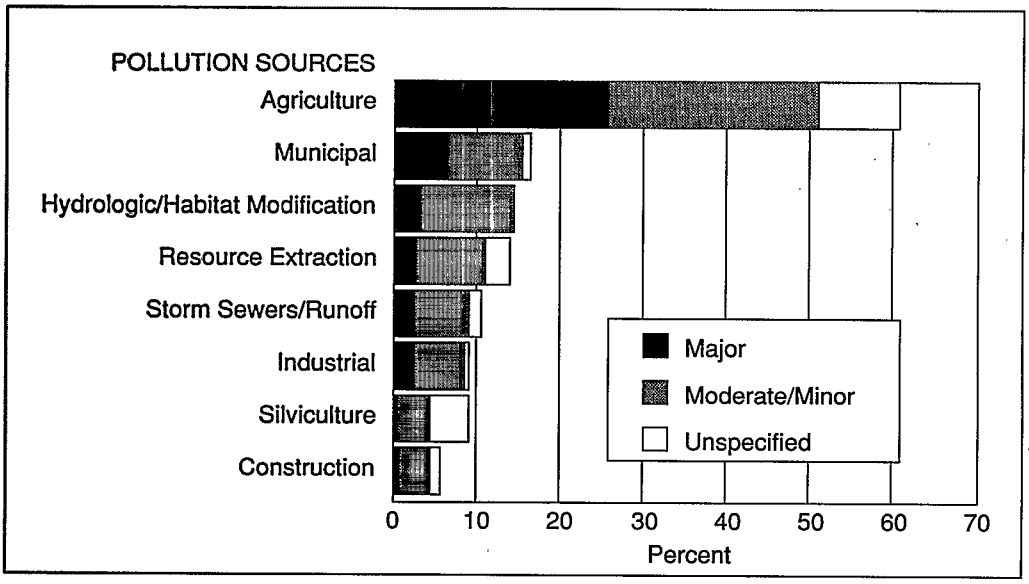
Fishing advisories, consumption bans, and high incidences of fish abnormalities indicate that waters are not supporting healthy aquatic populations and do not support the fishable goal. Swimmable goals are most often impaired by beach closures due to elevated bacteria levels but can be affected by algal blooms or elevated toxic concentrations.

In some cases, physical constraints, irrevocable water quality impacts, and severe socioeconomic impacts prevent the achievement of the CWA goals. In these cases, States may establish water quality standards that exclude the fishable or swimmable goal based on the results of a special use attainability study. Thus, there are four possible outcomes for any waterbody when CWA goal support is assessed:

- Fishable and/or swimmable goals are supported;
- Fishable and/or swimmable goals are partially supported;
- Fishable and/or swimmable goals are not supported but are attainable; and
- State water quality standards do not include fishable and/or swimmable uses (i.e., the CWA goals are not attainable).

In their 1990 water quality assessments, 52 States provided data on the attainment of the fishable and swimmable CWA goals in their rivers and streams (see Table 1-4). A total of 656,804 river miles were assessed for the fishable goal; 80 percent were found to be attaining the goal, 14.5 percent were partially attaining, 5 percent were currently not attaining but could in the future, and less than 1 percent were determined to be "not attainable" (see Figure 1-4).

Progress toward the CWA swimmable goal was assessed in 586,386 stream miles. Seventy-five percent were found to be attaining the swimmable goal, 8 percent were partially attaining, 7 percent were currently not attaining the swimmable goal but could in the future, and 10 percent were categorized as "not attainable" (see Figure 1-4). Fewer waters were assessed for the swimmable goal than for the fishable goal, at least in part because some States do not include swimming uses in their standards.



Source: 1990 State Section 305(b) reports.

Figure 1-3. Percent of Impaired River Miles Affected by Sources of Pollution

Sources of Pollution Reported by the States

Point and nonpoint source categories of pollution are not clearly defined in all cases: many source categories have significant point and nonpoint elements. For example, storm sewers/runoff and resource extraction are sources that may be addressed both via point source control measures (i.e., permits) or nonpoint source best management plans. The following categories were used in the analysis of State data and are not intended as legal definitions.

Point Sources

- Discharge into waterways via a discrete "point" such as a pipe or ditch
- Are subject to permits issued by the State or EPA that limit allowable amounts of pollutants
- Are also subject to enforcement action if their permit limits are violated

Nonpoint Sources

- Enter waterways generally as runoff from widespread (i.e., "nonpoint") areas
- Are addressed via voluntary controls, best management practices, incentive programs, demonstration programs, and, to some extent, by regulatory programs at State or local level, particularly in the Coastal Zone

John Thelgard

Runoff from storm sewers, city streets, and lawns can carry pollutants to surface waters.

Source Categories Used in This Report

Industrial (e.g., pulp and paper mills, chemical manufacturers, steel plants, textile manufacturers, food processing plants)

Municipal (e.g., publicly owned sewage treatment plants, including plants that may receive indirect discharges from factories or businesses)

Combined Sewers (storm and sanitary sewers combined, which may exceed capacity and discharge untreated wastes during storms)

Storm Sewers/Runoff (runoff from streets, paved areas, lawns, etc., that enters a sewer, pipe, or ditch before discharge)

Agricultural (e.g., crop production, pastures, rangeland, feedlots)

Silvicultural (e.g., forest management, harvesting, road construction)

Construction (e.g., highway building, land development)

Resource Extraction (e.g., mining, petroleum drilling, runoff from mine tailing sites)

Land Disposal (e.g., leachate or discharge from septic tanks, landfills, hazardous waste disposal sites)

Hydromodification (e.g., channelization, dam construction, streambank modification)

Table 1-3. Impaired River Miles Affected by Sources of Pollution

State	Total Impaired Waters*	Agriculture		Municipal		Hydrologic/ Habitat Mod		Resource Extraction		Storm Sewers/ Runoff	
		Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
Alabama	3,074	554	502	388	192	80	125	513	155	12	261
Arizona	3,859	—	3,034	—	670	—	1,264	—	1,847	—	396
Arkansas**	3,077	2,597	—	182	—	—	—	200	—	15	—
Connecticut	283	—	47	133	113	6	50	—	42	1	136
Delaware	496	78	352	13	61	—	—	—	—	9	163
Delaware River Basin	7	—	—	7	—	—	—	—	—	—	—
District of Columbia	38	—	—	1	—	—	3	—	—	16	22
Florida	2,760	188	1,648	35	642	20	887	—	438	84	1,779
Georgia	605	—	—	41	54	—	—	—	—	3	385
Illinois	7,421	2,065	—	405	—	202	—	20	—	9	—
Iowa	7,066	6,825	213	170	406	4	29	2	85	172	1,082
Indiana	1,931	1,338	208	646	1,030	—	—	29	—	7	—
Kansas	11,799	7,725	3,261	949	298	—	—	118	64	664	24
Kentucky	2,997	1,046	185	1,151	25	153	—	833	34	219	42
Louisiana	4,391	1,182	1,355	212	2,624	123	2,823	111	3,400	196	1,472
Maine	565	72	47	8	63	—	4	—	1	3	12
Maryland	1,343	22	912	—	—	2	1	87	45	—	—
Massachusetts	1,055	11	60	138	229	—	—	—	—	288	538
Michigan	1,361	203	118	459	134	189	31	6	—	182	262
Mississippi	7,696	723	6,436	128	916	—	19	—	230	57	208
Missouri	9,844	7,137	—	10	36	1	3,669	15	40	188	—
Montana	13,210	502	10,671	46	1,077	300	5,198	239	2,158	—	106
Nebraska	3,306	2,423	526	605	831	333	53	—	—	189	528
Nevada	997	441	218	—	—	175	247	101	—	—	139
New Hampshire	489	—	—	140	131	—	—	—	—	—	—
New Mexico	3,117	2,403	345	55	288	93	620	145	179	33	4
New York	4,790	33	28	160	156	97	41	1	24	10	113
North Carolina**	11,540	5,502	—	172	80	—	—	—	—	922	—
Ohio	4,776	635	1,415	1,945	732	645	1,037	594	265	275	885
Oregon**	15,192	7,605	—	1,062	—	—	—	2,280	—	1,675	—
Pennsylvania**	4,695	624	—	432	—	30	—	2,548	—	57	—
Puerto Rico	2,728	172	608	60	60	46	—	—	14	312	119
Rhode Island	138	36	5	21	31	—	13	—	—	36	83
South Carolina	735	282	161	194	46	—	6	—	—	93	110
South Dakota	2,804	1,275	1,097	11	43	—	—	—	62	47	215
Tennessee	3,723	1,590	1,515	511	1,028	1,312	1,328	350	763	173	822
Texas	2,636	5	44	1,360	110	18	—	—	—	94	—
Utah	7,092	1,306	4,562	65	509	216	—	293	—	—	—
Vermont	932	227	239	39	135	195	210	51	35	71	95
Washington	2,787	576	549	152	1,250	715	595	83	77	650	216
West Virginia	10,296	390	2,359	323	1,446	144	585	1,019	3,595	300	558
Wyoming	3,357	2,192	734	6	110	569	378	54	770	10	282
Totals	171,008	59,985	43,454	12,435	15,559	5,668	19,216	9,692	14,323	7,072	11,057
Combined Totals			103,439		27,994		24,884		24,015		18,129
Percent of Impaired Waters			60.5%		16.4%		14.6%		14.0%		10.6%

* The sum of partially and nonsupporting river miles (Table 1-1).

** These States did not specify the degree of impact (i.e., Major or Moderate/Minor); river miles were placed in the "Major" column for national reporting purposes.

— Zero or not reported.

Source: 1990 State Section 305(b) reports.

Industrial		Silviculture		Construction		Unknown		Land Disposal		Combined Sewers	
Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
70	130	64	132	15	102	22	—	—	35	—	23
—	242	—	166	—	527	—	1,303	—	617	—	—
124	—	261	—	15	—	—	—	81	—	—	—
70	22	—	—	—	42	—	6	9	91	107	11
22	55	—	—	—	—	—	—	—	—	—	16
—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	1	—	—	—	6	11	1
104	430	—	142	21	823	119	—	15	1,027	—	—
5	117	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	—	—	—	14	—	103	—
78	31	—	—	—	37	—	—	2	117	—	—
208	73	—	—	—	—	—	—	42	—	625	83
—	17	—	—	—	—	6	—	—	—	—	—
182	30	—	—	2	—	204	—	75	50	—	—
368	2,325	17	1,322	7	528	—	1,627	22	855	20	169
103	197	—	—	—	7	—	1	43	13	1	21
—	—	—	—	21	2	—	—	245	74	—	—
87	50	—	—	—	29	—	—	71	90	187	51
80	157	5	8	78	16	197	127	18	3	317	62
136	834	—	405	—	—	—	286	5	58	—	—
4	—	—	—	—	—	—	—	1	—	—	—
—	339	—	1,690	—	1,267	—	—	—	340	—	—
186	208	—	—	—	—	334	252	—	—	—	—
—	—	—	40	—	—	59	—	22	—	—	—
29	—	—	—	—	—	—	11	2	6	40	17
—	—	34	130	25	205	66	314	10	99	—	—
28	90	—	38	—	41	94	16	62	141	36	78
102	1,226	—	—	564	—	—	—	—	—	—	—
745	515	6	12	7	62	232	79	144	526	102	60
368	—	7,580	—	1,420	—	—	—	—	—	—	—
250	—	—	—	—	—	110	—	103	—	32	—
37	124	—	—	17	23	—	16	203	527	2	—
—	74	—	—	15	18	19	—	33	39	6	6
72	26	—	—	1	—	216	26	—	—	—	—
11	—	—	—	—	26	—	—	—	26	—	—
218	353	76	66	153	928	18	62	14	187	62	70
28	—	—	—	—	—	26	681	44	—	—	—
65	509	161	—	—	—	—	—	—	—	—	—
10	56	22	66	137	73	—	2	6	132	—	4
165	476	171	136	414	105	135	846	262	357	1	39
966	1,413	198	2,388	209	607	650	1,104	56	168	190	283
334	169	58	65	362	858	—	—	—	—	—	—
5,280	10,288	8,653	6,806	3,483	6,327	2,507	6,759	1,604	5,584	1,842	994
	15,568		15,459		9,810		9,266		7,188		2,836
	9.1%		9.0%		5.7%		5.4%		4.2%		1.7%

Table 1-4. Attainment of Clean Water Act Goals in Rivers and Streams

	Fishable Goal (miles)					Swimmable Goal (miles)				
State	Assessed	Meeting	Partially Meeting	Not Meeting	Not Attainable	Assessed	Meeting	Partially Meeting	Not Meeting	Not Attainable
Alabama	11,857	8,703	1,669	1,049	436	11,857	8,703	1,669	1,049	436
Arizona	5,296	662	2,312	2,061	260	5,296	1,810	566	645	2,275
Arkansas	11,310	9,426	1,535	349	—	11,310	9,236	0	2,074	—
California	11,448	9,069	1,492	887	—	10,463	7,947	1,620	896	—
Colorado	28,770	28,105	—	572	93	31,377	9,062	—	254	22,061
Connecticut	893	664	170	57	2	893	679	94	118	2
Delaware	643	498	71	74	0	643	98	56	365	124
Delaware River Basin	206	206	0	0	0	206	199	0	7	0
District of Columbia	39	10	3	26	0	38	0	3	35	0
Florida	7,950	6,750	268	897	35	7,950	6,750	268	897	35
Georgia	20,000	19,395	556	49	0	0	—	—	—	—
Hawaii	349	349	—	0	0	349	349	—	0	0
Illinois	13,123	11,476	1,101	546	0	4,525	1,144	2,003	424	954
Indiana	4,994	2,986	1,143	788	77	2,304	138	153	2,013	0
Iowa	7,155	90	6,620	428	17	7,155	158	1,456	223	5,318
Kansas	12,079	8,838	2,265	976	0	11,942	627	1,546	9,769	0
Kentucky	9,339	6,914	1,702	723	—	3,595	1,481	576	1,538	—
Louisiana	8,535	6,510	1,553	472	—	8,535	5,670	2,055	810	—
Maine	31,672	31,282	0	390	0	31,672	31,506	0	166	0
Maryland	17,000	15,618	1,281	101	0	17,000	16,998	0	2	0
Massachusetts	1,623	1,061	208	354	0	1,624	682	620	319	3
Michigan	36,350	35,632	—	718	0	36,350	36,086	—	264	0
Minnesota	6,079	2,292	681	2,306	800	5021	2,045	548	1,628	800
Mississippi	15,839	8,023	7,350	350	116	15,839	13,086	2,126	511	116
Missouri	21,063	11,216	9,830	17	0	21,069	5,370	—	0	15,699
Montana	51,212	38,474	11,565	1,173	0	51,211	46,096	4,536	579	0
Nebraska	7,330	5,131	1,773	426	0	12,011	1,035	606	1,034	9,336
Nevada	1,559	793	583	83	100	1,574	735	560	57	222
New Hampshire	1,347	1,294	3	50	0	1,390	859	339	150	42
New Jersey	1,719	1,315	307	97	—	592	91	48	453	—
New Mexico	3,117	2,851	—	266	0	3,117	3,117	—	0	0
New York	70,000	69,300	—	0	700	70,000	69,200	—	800	0
North Carolina	37,293	23,820	12,551	922	—	37,293	23,820	12,551	922	—
North Dakota	9,204	8,548	656	0	—	9,204	8,489	715	0	—
Ohio	7,688	2,524	1,482	2,868	814	0	—	—	—	—
Ohio River Valley	981	434	547	0	0	981	579	64	338	0
Oklahoma	3,778	2,161	1,258	359	0	3,633	2,148	412	515	558
Oregon	27,739	26,197	—	1,542	—	27,739	26,773	—	966	—
Pennsylvania	23,832	19,137	1,982	2,713	—	23,832	19,137	1,982	2,713	—
Puerto Rico	5,373	2,757	2,048	566	2	5,373	2,738	1,737	483	415
Rhode Island	626	512	0	24	90	626	512	0	24	90
South Carolina	3,594	3,230	54	310	0	3,438	2,010	388	1,040	0
South Dakota	3,964	3,085	—	879	0	802	396	—	406	0
Tennessee	11,081	10,857	—	224	—	11,081	10,420	—	661	—
Texas	16,203	16,044	—	159	—	16,203	14,435	—	1,768	—
Utah	11,779	1,303	10,476	0	0	4,320	120	4,164	36	0
Vermont	5,266	4,468	608	190	0	5,265	4,854	13	140	258
Virginia	10,809	8,862	1,468	479	—	10,809	8,862	1,468	479	—
Washington	5,141	2,873	1,084	1,184	—	4,928	3,441	311	1,176	—
West Virginia	19,818	17,969	506	1,343	0	19,812	18,415	0	1,397	0
Wisconsin	13,302	8,272	4,334	220	476	13,192	8,235	4,269	212	476
Wyoming	19,437	19,430	—	7	0	947	947	0	0	0
Totals	656,804	527,416	95,095	30,274	4,018	586,386	437,288	49,522	40,356	59,220
Percent of Assessed Waters		80.3%	14.5%	4.6%	0.6%		74.6%	8.4%	6.9%	10.1%

— Not reported.

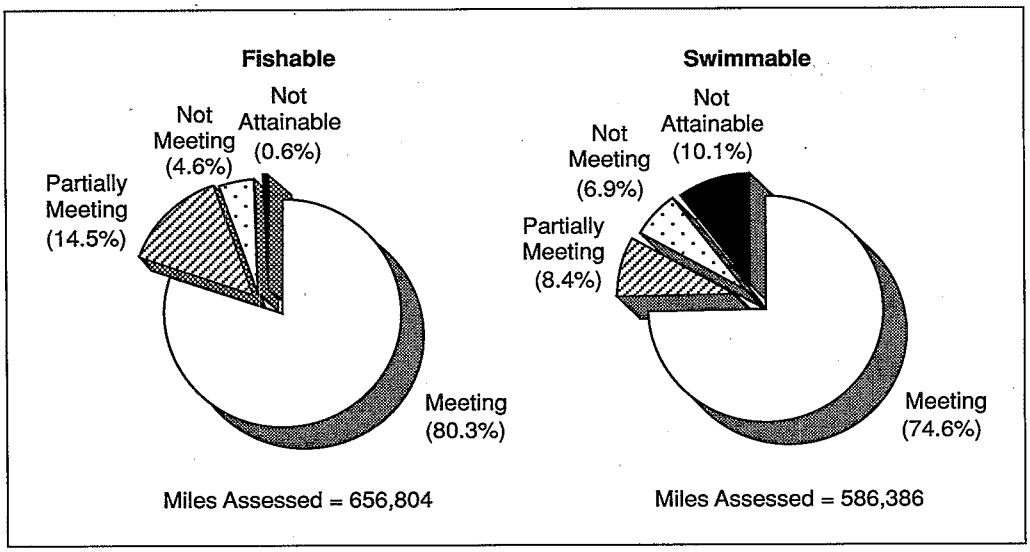
Source: 1990 State Section 305(b) reports.

Fifteen States reported that the fishable goal was not attainable in 4,018 stream miles, and 20 States found the swimmable goal not attainable in 59,220 miles. Reasons cited include naturally occurring physical limitations, such as intermittent flow and salinity, and extensive land uses such as row crop agriculture that would be prohibitively expensive to control.

The percentage of waters meeting CWA goals ranges from zero to 100 percent among the reporting States. This variability occurs because the States use different definitions of CWA goal attainment. For example, some States do not adhere to EPA's definition of fishability and consider waters fishable if they support aquatic life (thereby excluding fish consumption considerations). EPA is refining the definitions of CWA goal attainment for future reporting.

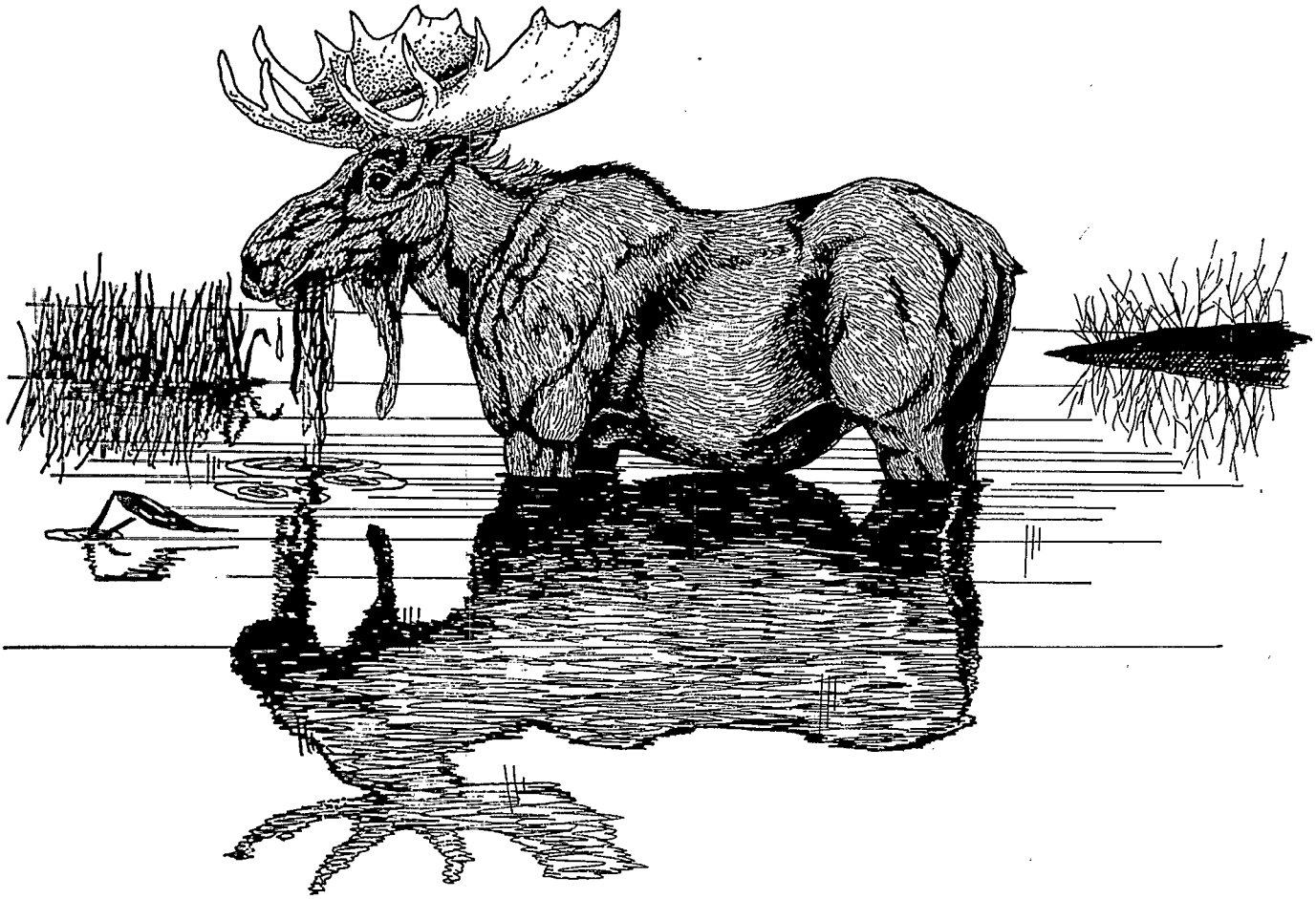
Jim Turner

Agriculture is the largest single source of pollution affecting rivers and streams.



Source: 1990 State Section 305(b) reports.

Figure 1-4. Attainment of Clean Water Act Goals in Assessed Rivers and Streams



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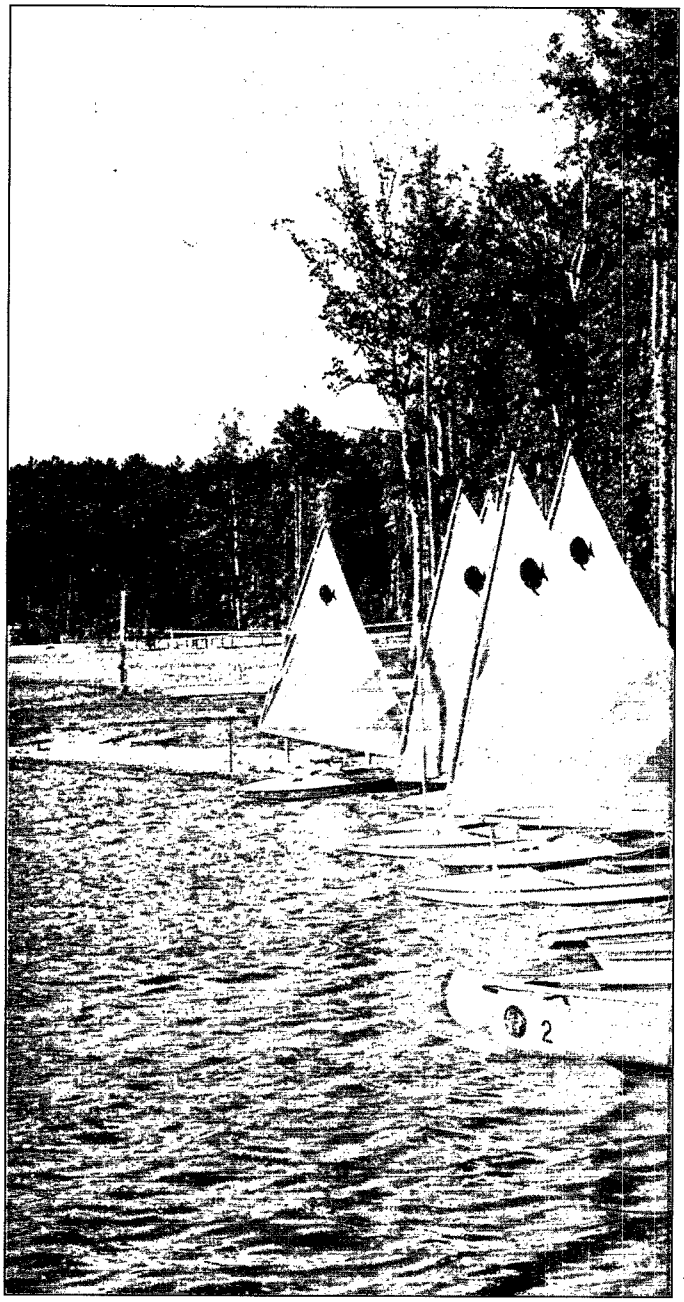


Patricia Cunningham

Lakes and Reservoirs

Support of Designated Uses

In their 1990 State Section 305(b) reports, 46 States, Territories, and Jurisdictions (hereafter referred to as States) provided information on support of designated uses in their lakes and reservoirs (see Table 2-1). A total of 18,488,636 acres were assessed, about 2 million more than were assessed in 1988. These assessed acres represent 69 percent of the lake acres estimated for these States and 47 percent of the Nation's total 39,400,000 lake acres. Great Lakes are not included in this assessment (see Chapter 3 for information on the Great Lakes).

Of those assessed lake acres, 8,173,917 acres (44 percent) were found to be fully supporting their designated uses. An additional 2,902,809 acres (16 percent) are threatened (i.e.,may not fully support uses in the future if action is not taken to control pollution sources). Nineteen percent of assessed lake acres, or 3,471,633 acres, partially support uses, and 21 percent, or 3,940,277 acres, do not support uses (see Figure 2-1).

All 46 States specified the basis of their lake assessment decisions. Seventy-four percent of the assessed waters were monitored and the remaining 26 percent were evaluated. (See *Water Quality Assessment Data.*)

These data should be interpreted with caution and should not be compared to those of previous 305(b) reporting cycles. Changes in assessment criteria and evaluation procedures, rather than actual changes in water quality, often account for variation between

Table 2-1. Designated Use Support in Lakes and Reservoirs

State	Number of Lakes	Acres of Lakes	Acres Assessed: Total	Acres Assessed: Percent Evaluated	Acres Assessed: Percent Monitored	Acres Fully Supporting	Acres Threatened	Acres Partially Supporting	Acres Not Supporting
Alabama	43	504,721	504,721	0	100	296,284	147,035	300	61,102
Arizona	182	127,372	121,388	64	36	1,195	92,052	22,343	5,798
Arkansas	77	355,063	355,063	0	100	355,063	—	0	0
California	4,955	1,417,540	1,159,160	19	81	170,652	—	357,130	631,378
Colorado	4,069	265,982	145,305	86	14	132,057	12,276	972	0
Connecticut	6,000	82,900	23,179	33	67	1,858	15,369	5,952	0
Delaware	63	4,499	2,541	31	69	1,263	30	811	437
District of Columbia	8	376	238	0	100	0	0	108	130
Florida	7,712	2,085,120	957,120	17	83	302,336	9,856	533,888	111,040
Georgia	175	417,730	417,730	0	100	404,704	—	13,000	26
Illinois	85,305	305,847	209,036	60	40	595	22,997	101,457	83,987
Indiana	575	106,203	97,536	65	35	97,372	—	63	101
Iowa	264	80,670	80,306	92	8	7,075	35,446	36,820	965
Kansas	235	173,602	170,602	9	91	0	37,598	114,011	18,993
Kentucky	99	228,385	214,861	0	100	100,910	94,839	15,362	3,750
Louisiana	101	866,646	854,331	69	31	548,841	146,858	158,632	0
Maine	5,785	994,560	960,418	22	78	714,028	57,824	188,566	0
Maryland	190	32,583	21,002	100	0	11,463	5,791	3,640	108
Massachusetts	2,871	151,173	64,019	27	73	4,281	15,278	17,803	26,657
Michigan	35,000	840,960	489,433	5	95	50,168	391,904	—	47,361
Minnesota	12,034	3,411,200	2,849,689	22	78	687,064	—	49,817	2,112,808
Mississippi	—	500,000	500,000	51	49	280,389	58,969	160,596	46
Missouri	362	287,543	287,543	15	85	282,905	—	4,564	74
Montana	3,956	740,086	632,705	21	79	31,313	137,627	449,114	14,651
Nebraska	415	145,800	87,267	7	93	60,764	12,245	14,258	0
Nevada	384	425,400	198,725	72	28	129,642	0	54,283	14,800
New Hampshire	1,300	152,788	152,788	71	29	133,943	6,826	7,992	4,027
New Mexico	175	132,690	115,959	15	85	0	—	115,959	0
New York	7,500	750,000	668,000	0	100	377,892	26,942	238,343	24,823
North Carolina	144	305,367	305,355	2	98	195,562	97,442	1,940	10,411
North Dakota	216	619,088	611,075	20	80	13,127	343,132	33,082	221,734
Oklahoma	224,948	1,041,884	441,092	49	51	33,653	193,308	214,131	0
Oregon	6,095	610,808	504,928	85	15	374,303	—	58,918	71,707
Puerto Rico	38	11,146	11,146	20	80	3,433	112	3,598	4,003
Rhode Island	117	16,683	16,683	17	83	1,860	13,592	301	930
South Carolina	1,418	525,000	217,368	0	100	133,180	0	71,068	13,120
South Dakota	799	1,598,285	682,033	2	98	0	548,000	6,885	127,148
Tennessee	117	538,504	538,322	61	39	375,808	53,707	59,456	49,351
Texas	5,700	3,065,600	1,543,898	3	97	1,351,278	7,263	0	185,357
Utah	3,008	481,638	134,201	0	100	0	0	134,201	0
Vermont	604	229,146	227,755	3	97	19,403	158,772	38,611	10,969
Virginia	247	161,290	160,640	70	30	143,856	—	16,784	0
Washington	808	613,582	175,184	1	99	20,112	34,959	39,358	80,755
West Virginia	17,800	23,460	18,870	0	100	8,171	1,775	7,194	1,730
Wisconsin	15,000	957,288	132,202	56	44	9,182	33,102	89,918	0
Wyoming	2,629	427,219	427,219	85	15	306,932	89,883	30,404	0
Totals	459,523	26,813,427	18,488,636	74	26	8,173,917	2,902,809	3,471,633	3,940,277
Percent of Assessed Waters						44.2%	15.7%	18.8%	21.3%

— Not reported.

Source: 1990 State Section 305(b) reports.

States and within States over time.

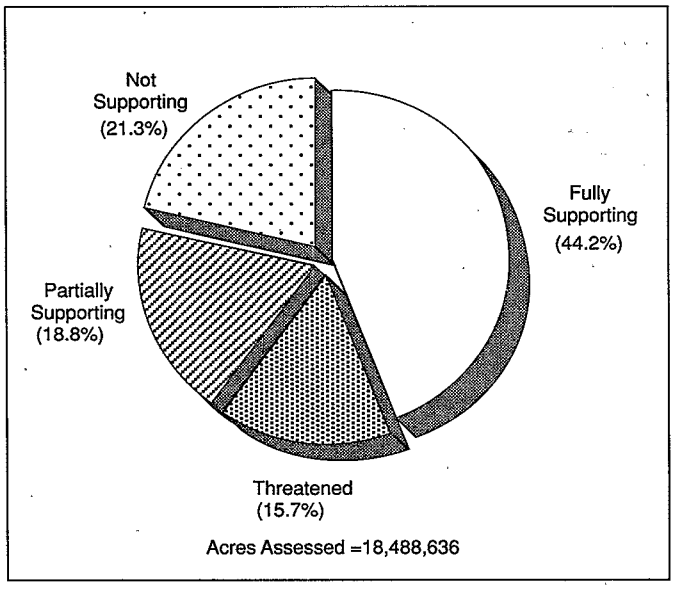
Causes of Impairment

In 1990, 35 States provided data on the causes of nonsupport in their lakes (see Table 2-2). As described in Chapter 1 for rivers, any given acre of lake can be affected by many different causes (i.e., specific pollutants or pollutant processes). Therefore, States were asked to include any given lake acre under each of the cause categories that contributes to impairment. This allows a single lake acre to be counted more than once if it is affected by multiple causes. The values reported are the total number of lake acres affected by a particular cause of impairment, according to whether the cause is a major or moderate/minor contributor to impairment. (Data from States that did not specify this degree of impact are included under the "major" column heading in Table 2-2.) The relative extent of each cause of nonsupport can be determined by dividing the total number of acres affected by each cause category by the total acres impaired (see Figure 2-2).

Metals and nutrients are the most commonly reported cause of use impairment in lakes, affecting 48 percent and 32 percent of impaired lake acres, respectively. Although these statistics indicate that metals impair more lake acres, nutrients are listed by 32 of the 35 States reporting causes of lake impairment. In contrast, 23 States report lake acres impaired by metals, and almost three-quarters of the lake acres adversely affected by metals are concentrated in one State, Minnesota.

Nutrients can lead to organic enrichment and low levels of dissolved oxygen, which were identified as affecting 19 percent of impaired lake acres. Suspended solids, noxious aquatic plants, and siltation affect 13 percent each, and flow alteration affects 12 percent. Priority organics, salinity, pH, pathogens, and taste and odor affect less than 5 percent of impaired lake acres.

Table 2-2 reveals that certain States account for a large proportion of the impacts from individual causes of impairment, which influences the relative significance of the causes. For example, as mentioned above, Minnesota alone accounts for 73 percent of the lake acres affected by metals. Minnesota attributes this



Source: 1990 State Section 305(b) reports.

Figure 2-1. Designated Use Support in Assessed Lakes and Reservoirs

Patricia Cunningham

One of the leading causes of lake pollution is nutrients.

Table 2-2. Impaired Lake Acres Affected by Causes of Pollution

State	Total Impaired Waters*	Metals		Nutrients		Organic Enrichment		Suspended Solids		Noxious Aquatic Plants	
		Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
Arizona	28,141	4,055	11,345	—	—	5	503	—	—	553	699
Delaware	1,248	—	—	—	150	—	—	—	—	—	—
District of Columbia	238	—	103	—	—	103	—	—	—	—	—
Florida	644,928	—	1,600	2,368	282,176	320	82,816	25,408	196,608	—	—
Georgia	13,026	—	—	26	13,000	—	—	—	—	—	—
Illinois	185,444	4,300	20,207	45,452	122,701	66,318	99,047	73,058	102,303	28,728	96,040
Indiana	164	—	45	122	12	59	63	—	—	—	—
Iowa	37,785	—	—	8,521	28,357	145	4,682	—	—	—	—
Kansas	133,004	9,040	73,664	523	10,261	—	—	—	—	—	—
Kentucky	19,112	5,314	—	8,748	—	—	—	4,517	—	—	—
Maine	188,566	—	—	2,463	42,156	136,492	36,783	—	—	—	—
Maryland	3,748	—	—	2,406	397	6	—	—	—	—	226
Massachusetts	44,460	25,448	—	4,208	3,092	22	40	503	230	10,633	8,287
Michigan	47,361	20,367	2,659	2,957	—	2,476	—	—	—	—	—
Minnesota	2,162,625	1,908,762	51,513	215,951	29,738	—	—	—	—	—	—
Missouri**	4,638	—	—	1,153	—	1,910	—	—	—	—	—
Montana	463,765	—	306,242	—	319,316	—	257,022	—	310,845	—	306,019
Nevada	69,083	14,800	6,100	21,200	—	40,005	950	—	—	14,800	38,800
New Hampshire	12,019	—	—	3,728	938	—	—	—	—	—	4,562
New Mexico	115,959	15,000	60,326	25,243	22,261	4,000	2,361	—	—	308	11,763
New York	263,166	326	7,597	106,353	27,762	306	61,103	—	—	—	—
North Carolina**	12,351	9,263	—	618	—	—	—	—	—	1,853	—
North Dakota	254,816	—	—	7,374	6,294	1,608	29,032	—	—	—	—
Oregon**	130,625	1,139	—	106,774	—	69,147	—	—	—	9,191	—
Puerto Rico	7,601	4	87	340	902	1,194	646	145	—	210	93
Rhode Island	1,231	99	—	293	192	174	—	—	—	—	—
South Carolina	84,188	—	—	63,713	—	63,713	—	—	—	—	—
South Dakota	134,033	—	—	112,742	6,885	130	28	359	593	102,468	17,941
Tennessee	108,807	—	21,457	35,308	35,642	34,647	43,861	383	17,041	4,565	23,859
Texas	185,357	—	43	—	—	—	—	—	—	—	—
Vermont	49,580	—	—	19,604	1,595	2,442	11,882	—	—	21,678	8,009
Virginia	16,784	—	6,462	—	15,536	—	10,483	—	—	—	—
Washington	120,113	—	80,000	4,897	—	4,905	72	—	—	—	—
West Virginia	8,924	1,695	3,365	35	2,790	—	630	—	—	38	—
Wyoming	30,404	—	—	—	17,749	—	53	—	—	—	—
Totals	5,583,294	2,019,612	652,815	803,120	989,902	430,127	642,057	104,373	627,620	195,025	516,298
Combined Totals			2,672,427		1,793,022		1,072,184		731,993		711,323
Percent of Impaired Waters			47.9%		32.1%		19.2%		13.1%		12.7%

* The sum of partially and nonsupporting lake acres (Table 2-1).

** These States did not specify the degree of impact (i.e., Major or Moderate/Minor); lake acres were placed in the "Major" column for national reporting purposes.

— Zero or not reported.

Source: 1990 State Section 305(b) reports.

Siltation		Flow Alteration		Priority Organics		Salinity		pH		Pathogens		Taste and Odor	
Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
4,424	12,095	—	—	356	—	—	350	48	1,483	—	—	—	95
—	—	—	—	158	—	—	—	—	—	1,098	150	—	—
—	103	—	—	—	103	—	—	—	136	103	136	—	—
—	—	—	—	—	72,448	—	—	—	—	—	448	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—
67,552	110,066	10	67	2,041	2,546	—	—	—	—	1,808	1,661	—	97,149
—	—	—	—	12	—	—	—	30	—	45	77	—	—
18,680	13,191	—	—	—	—	—	—	1	—	10,738	—	—	—
410	42,382	259	7,788	—	—	9,230	18,897	—	—	9,550	—	—	—
—	—	—	—	—	—	—	—	219	—	—	—	—	—
—	47,779	—	30	—	—	—	—	—	—	—	—	—	4,197
104	2,690	—	—	—	—	—	—	—	952	3	23	—	2,400
28	—	—	—	—	—	—	—	—	—	18	268	—	—
—	—	—	—	12,462	—	—	—	292	7	3	—	—	—
—	—	—	—	2,960	25,260	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	74	—	1,120	—
—	79,142	—	363,221	—	—	12,900	12,595	5,600	—	1,399	9,532	—	—
—	—	—	—	—	—	6,100	—	—	950	—	—	—	—
—	—	—	—	—	—	—	—	474	3,242	—	—	—	—
59,001	25,147	—	—	—	1,240	—	—	—	2,252	—	—	—	—
—	3,507	33,877	600	102,060	434	—	2,944	16,569	—	3,189	23,720	—	—
247	—	—	—	370	—	—	—	—	—	—	—	—	—
1,970	158	221,568	—	—	—	—	1,854	—	—	—	—	—	—
15,594	—	—	—	—	—	—	—	81,365	—	13,248	—	—	—
—	—	—	—	210	—	340	—	141	—	381	504	141	159
—	—	—	—	—	—	—	—	—	—	523	34	—	—
—	—	—	—	—	—	—	—	—	55,645	20,475	50	—	—
88,102	10,117	—	7,868	—	—	—	—	—	—	—	—	—	—
21,074	30,425	167	24,905	18,508	6,149	—	—	—	11,924	—	20,730	16	11
3,588	23	25	—	—	—	72,295	105,510	—	—	7,206	5	—	—
2,301	19,211	7,519	89	—	—	—	—	114	—	794	160	—	—
—	3,199	—	—	—	—	—	—	—	6,766	—	1,084	—	—
—	—	—	—	—	—	—	—	—	—	49	—	—	—
338	7,290	—	—	—	—	8	—	1,791	2,152	—	—	—	—
—	12,919	—	9,420	—	—	—	459	—	—	—	—	—	—
283,413	419,444	263,425	413,988	139,137	108,180	100,873	142,609	106,644	85,509	70,704	58,582	1,277	104,011
	702,857		677,413		247,317		243,482		192,153		129,286		105,288
	12.6%		12.1%		4.4%		4.4%		3.4%		2.3%		1.9%

problem to mercury in fish tissues from atmospheric deposition. Without the Minnesota data, metals would be the sixth most significant cause of lake impairment.

Thirty-two States specified the degree of impact of the various causes of nonsupport in their lakes and reservoirs. For most cause categories, there are more lake acres in which the cause is a moderate/minor contributor to impairment than a major contributor. Of the leading causes, only the metals category shows more major than minor impacts: in 75 percent of the lake acres affected by metals, their impact was considered major. Among the other causes of use impairment, those with the greatest percentage of major impacts are priority organics (major impact in 56 percent of affected acres), salinity (major impact in 41 percent), and nutrients (major impact in 45 percent).

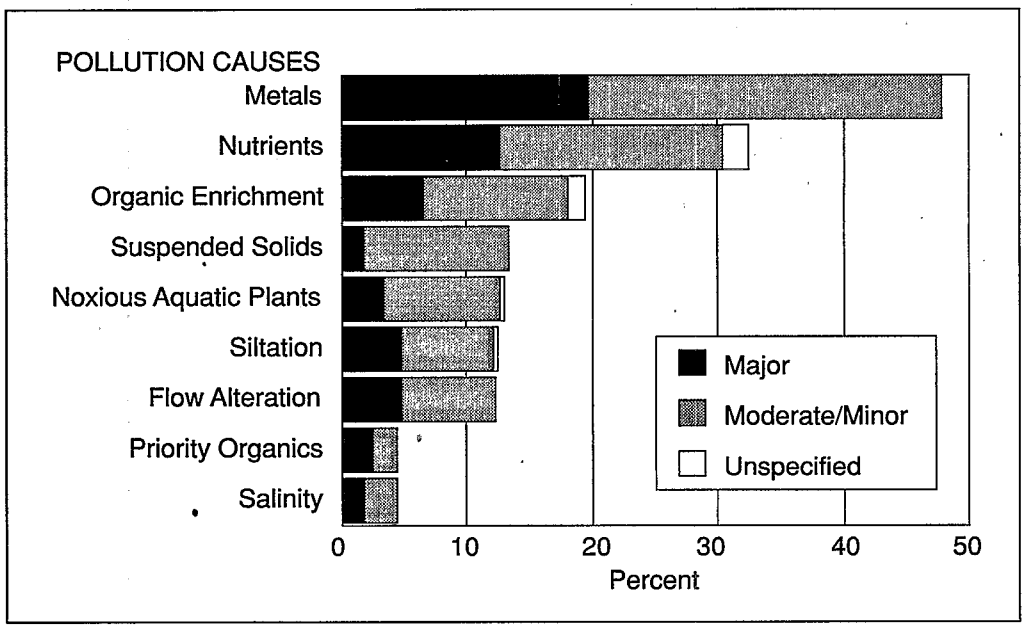
Sources of Impairment

Information on the various sources of pollution contributing to use impairment in lakes and reservoirs was provided by 35 States. Table 2-3 displays the categories of sources and the size of waters affected by each.

Because an acre of lake can be affected by many sources of pollution, States were asked to include any given lake acre under each of the source categories that contribute to impairment. This allows a single lake acre to be counted more than once if it is affected by multiple sources. The values reported are the total number of lake acres affected by a particular source of impairment, according to whether the source is a major or moderate/minor contributor to impairment. The relative extent of each source of nonsupport can be determined by dividing the total number of acres affected by each source category by the total acres impaired (see Figure 2-3).

Agricultural runoff is reported as the most extensive source of pollution, affecting 57 percent of impaired lake acres. Other leading sources in lakes include hydrologic/habitat modification (affecting 40 percent of impaired lake acres), storm sewers/runoff (affecting 28 percent), land disposal (affecting 24 percent), and municipal dischargers (affecting 17 percent).

These numbers should also be interpreted with care. Certain States predominate



Source: 1990 State Section 305(b) reports.

Figure 2-2. Percent of Impaired Lake Acres Affected by Causes of Pollution

in the number of lake acres reported as affected by the various sources of pollution, which can skew the source rankings. For example, Florida alone accounts for 66 percent of the total number of lake acres affected by storm sewers/runoff and 70 percent of the lake acres affected by land disposal.

Thirty-three States specified the degree of impact (i.e., major or moderate/minor) of pollution sources in their lakes. The number of acres with major impacts exceeds those with moderate/minor impacts for industrial discharges, combined sewers, and "unknown" sources.

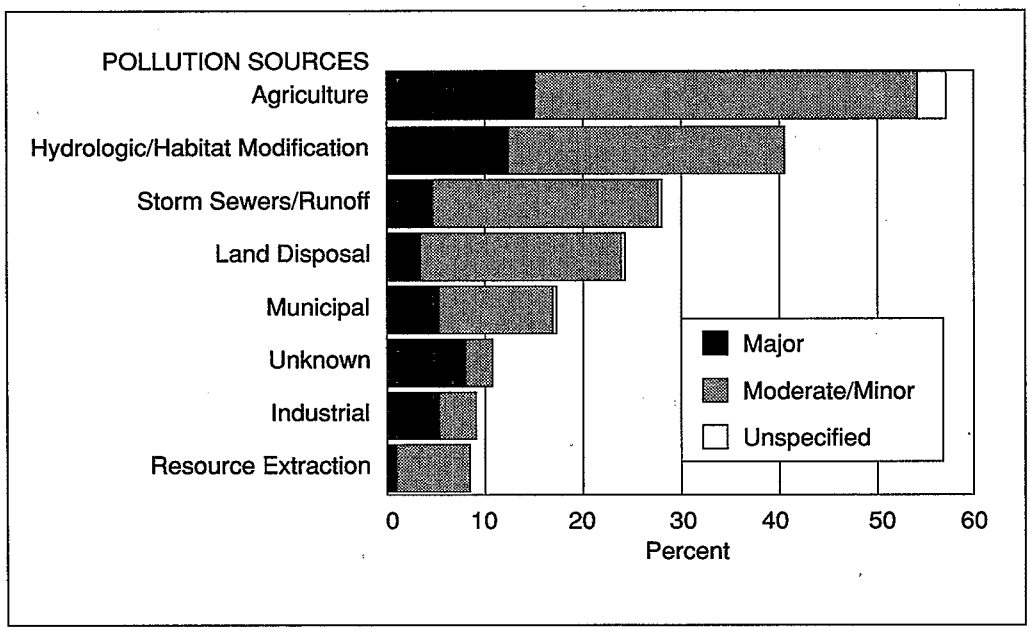
Attainment of the Clean Water Act Goals

In 1990, 46 States assessed the ability of their lakes and reservoirs to support fishing and swimming activities, the basic goals of the Clean Water Act (see Table 2-4). Of the 17,633,217 lake acres evaluated for attainment of the fishable goal, 70 percent fully meet, 11 percent partially meet, and 19 percent do not meet the fishable goal. Less than 1 percent (6,276 acres) were determined to be "not attainable" (i.e., suffering from irrevocable impacts and/or not designated for fishable use).

Eighty-two percent of the assessed lake acres fully meet the swimmable goal, 10 percent partially meet the goal, and 7 percent do not meet the goal. Less than 1 percent (69,020 acres) were categorized as "not attainable" (see Figure 2-4). The States report higher levels of attainment of the CWA goals than of designated uses. This may be because the CWA goals reflect attainment of only two uses among multiple uses designated to an individual waterbody. A waterbody may not be supporting other uses such as drinking water use and still meet the swimmable and fishable goals.

Trophic Status of Lakes and Reservoirs

Lakes evolve naturally over time, filling with sediments and organic matter that alter many basic characteristics such as depth, biological productivity, oxygen levels, and water transparency. This natural aging process is known as eutrophication. Human activities can accelerate eutrophication by increasing the loadings of nutrients and organic



Source: 1990 State Section 305(b) reports.

Figure 2-3. Percent of Impaired Lake Acres Affected by Sources of Pollution

Table 2-3. Impaired Lake Acres Affected by Sources of Pollution

State	Total Impaired Waters*	Agriculture		Hydrologic/ Habitat Mod		Storm Sewers/ Runoff		Land Disposal		Municipal	
		Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
Arizona	28,141	—	12,474	—	—	—	805	—	390	—	622
Connecticut	5,952	109	3,203	88	916	—	—	23	638	3,203	80
Delaware	1,248	162	812	—	—	186	321	—	—	—	—
District of Columbia	238	—	—	—	103	103	27	—	—	—	—
Florida	644,928	2,304	622,912	—	446,400	576	638,841	—	591,488	1,216	252,480
Georgia	13,026	—	—	—	—	6	1,690	—	—	20	11,310
Illinois	185,444	132,647	52,734	32,018	141,445	3,621	49,984	1,871	33,006	4,925	87,023
Indiana	164	12	—	—	40	—	—	—	—	59	63
Iowa	37,785	20,881	15,421	220	—	16,535	6,890	7	—	12	10,400
Kansas	133,004	607	46,774	—	5,824	8,042	2,334	—	—	—	—
Kentucky	19,112	8,182	—	—	—	—	—	169	—	6,041	455
Maine	188,566	1,794	58,722	—	7,865	31,613	67,476	—	1,999	—	4,845
Maryland	3,748	—	—	—	—	—	104	—	—	—	—
Massachusetts	44,460	272	354	—	—	1,332	1,022	1,337	3,008	1,031	—
Michigan	47,361	28	—	—	—	—	906	—	—	5,279	—
Missouri	4,638	3,778	—	1,730	—	1,270	—	—	—	65	—
Montana	463,765	14,299	364,149	—	299,629	—	546	—	9,708	—	5,100
Nevada	69,083	14,800	6,100	40,005	950	—	—	—	—	6,400	—
New Hampshire	12,019	20	—	25	—	74	34	—	—	3,490	142
New Mexico	115,959	99,037	1,535	—	196	5	—	—	98	—	—
New York	263,166	33,462	93,991	33,877	—	1,347	3,720	2,844	50,086	15,302	8,816
North Carolina**	12,351	445	—	—	—	—	—	—	—	815	—
North Dakota	254,816	4,354	12,830	221,568	579	—	22	—	—	—	2,701
Oregon**	130,625	98,145	—	—	—	10,866	—	13,129	—	485	—
Puerto Rico	7,601	826	1,825	—	—	621	—	—	828	—	—
Rhode Island	1,231	47	—	—	25	844	167	323	109	—	—
South Carolina	84,188	4,570	—	—	—	25	—	—	—	20,450	—
South Dakota	134,033	118,455	7,016	1,339	7,868	90	—	13,560	9,272	—	—
Tennessee	108,807	15,500	50,213	4,789	31,559	20	19,081	—	7,800	14,600	9,556
Texas	185,357	3,624	—	—	—	—	—	—	35	6,640	5
Utah	134,201	15,128	6,518	98,234	3,530	96,932	—	99,715	5,428	97,584	21
Virginia	16,784	—	7,291	—	—	—	4,935	—	21	—	548
Washington	120,113	—	—	—	—	—	—	—	—	—	—
West Virginia	8,924	48	2,184	—	—	39	—	—	—	—	3,434
Wyoming	30,404	28,513	7,665	—	27,005	—	25	—	—	—	8,300
Totals	3,511,242	622,049	1,374,723	433,893	973,934	174,147	798,930	132,978	713,914	187,617	405,901
Combined Totals			1,996,772		1,407,827		973,077		846,892		593,518
Percent of Impaired Waters			56.9%		40.1%		27.7%		24.1%		16.9%

* The sum of partially and nonsupporting lake acres (Table 2-1).

** These States did not specify the degree of impact (i.e., Major or Moderate/Minor); lake acres were placed in the "Major" column for national reporting purposes.

— Zero or not reported.

Source: 1990 State Section 305(b) reports.

Unknown		Industrial		Resource Extraction		Construction		Silviculture		Combined Sewers	
Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
—	26,543	—	350	—	6,832	—	152	—	1,084	—	—
—	—	—	1,900	23	—	—	975	—	—	—	—
158	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	64,320	—	31,872	—	42,176	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	6,602	2,636	8,891	1,088	127,811	26	5,515	75	229	—	25
—	—	—	—	30	—	—	—	—	—	22	23
—	—	—	—	—	—	71	—	1	—	—	—
—	—	—	—	190	50	—	—	—	—	—	—
—	—	—	—	4,862	—	—	—	—	—	—	—
73,007	18,432	—	4,288	—	—	32	1,344	3,442	45,831	—	—
—	—	—	—	—	952	—	—	—	—	—	—
11,460	28,205	45	—	—	—	—	—	—	—	—	—
34,236	2,588	1,780	—	—	2,659	—	—	—	—	1	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	1,600	—	15,122	—	36,292	—	—
—	—	—	—	20,900	—	—	—	—	—	—	—
83	4,562	3,490	—	—	—	—	—	—	—	—	—
—	19,250	—	—	—	—	—	6,136	244	2,475	—	—
101,094	10,730	—	7,800	—	—	—	35	—	3,180	2,944	—
5,138	—	2,618	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	895	—	—	—	—	—	2,755	—	—	—
—	672	—	291	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
59,143	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	162	1,698	—	—
—	—	—	40,391	1,924	—	—	10,950	—	4,550	—	—
500	543	—	—	—	—	—	—	—	—	—	—
—	—	96,900	21	2,815	684	2,826	8,532	671	—	—	—
—	—	—	630	—	—	—	875	—	2,028	—	—
41	—	80,000	—	—	80,000	—	—	—	—	—	—
86	7	1,200	—	2,711	4,875	111	14	149	1,636	—	—
—	—	—	—	—	9,520	—	11,506	—	—	—	—
284,946	118,134	189,564	128,882	34,543	266,855	3,066	103,332	7,499	99,003	2,967	48
	403,080		318,446		301,398		106,398		106,502		3,015
	11.5%		9.1%		8.6%		3.0%		3.0%		0.1%

Table 2-4. Attainment of Clean Water Act Goals in Lakes and Reservoirs

	Fishable Goal (acres)					Swimmable Goal (acres)				
State	Assessed	Meeting	Partially Meeting	Not Meeting	Not Attainable	Assessed	Meeting	Partially Meeting	Not Meeting	Not Attainable
Alabama	488,426	286,039	133,635	63,548	5,204	488,426	286,039	133,635	63,548	5,204
Arizona	121,394	17,747	96,224	7,398	25	121,376	113,179	6,742	120	1,335
Arkansas	355,063	355,063	0	0	—	355,063	355,063	0	0	—
California	1,038,845	538,832	54,931	445,082	—	1,037,225	619,089	70,519	347,617	—
Colorado	148,396	146,494	—	1,862	40	145,055	112,539	—	0	32,516
Connecticut	23,179	20,304	2,875	0	0	23,179	23,179	0	0	0
Delaware	2,542	2,384	0	158	0	2,543	1,294	969	280	0
District of Columbia	238	108	27	103	0	238	0	0	238	0
Florida	957,120	845,696	384	111,040	0	957,120	845,696	384	111,040	0
Georgia	417,730	404,704	13,000	26	0	0	—	—	—	—
Illinois	209,036	160,402	20,920	27,714	—	209,035	136,436	59,765	12,834	—
Indiana	97,536	97,372	63	101	0	97,524	97,372	63	89	0
Iowa	80,306	42,856	26,332	11,115	3	80,306	42,787	29,706	5,586	2,227
Kansas	173,602	173,236	0	366	0	173,602	173,199	0	403	0
Kentucky	214,861	214,642	219	0	0	214,861	214,642	219	0	0
Louisiana	592,869	455,869	137,000	0	—	592,869	434,237	137,960	20,672	—
Maine	960,583	796,394	164,189	0	0	960,583	911,493	49,090	0	0
Maryland	21,002	17,255	3,641	106	0	21,001	20,999	0	2	0
Massachusetts	64,018	37,706	569	25,663	80	64,017	44,893	17,952	1,080	92
Michigan	489,433	472,587	—	16,846	0	489,433	489,433	—	0	0
Minnesota	2,190,320	225,838	0	1,964,482	0	1,536,185	1,290,496	68,088	177,601	0
Mississippi	500,000	339,358	160,596	46	0	500,000	492,453	7,501	46	0
Missouri	287,543	285,074	—	2,469	0	287,543	260,376	—	79	27,088
Montana	632,705	226,475	392,977	13,253	0	632,704	288,934	332,619	11,151	0
Nevada	308,125	149,042	159,083	0	0	308,125	43,075	264,100	950	0
New Hampshire	153,516	149,776	3,270	470	—	155,463	146,442	5,293	3,728	—
New Mexico	115,598	115,598	—	0	0	115,598	115,598	—	0	0
New York	750,000	560,000	—	190,000	0	750,000	678,000	—	72,000	0
North Carolina	305,345	295,221	—	10,124	—	305,355	303,134	—	2,221	—
North Dakota	611,073	367,484	21,855	221,734	—	610,749	376,767	12,248	221,734	—
Ohio	26,015	24,879	865	271	—	102,731	20,953	75,722	6,056	—
Oklahoma	448,776	219,855	200,493	28,428	0	434,431	285,197	123,310	25,924	0
Oregon	504,928	504,928	0	0	0	504,928	504,928	0	0	0
Puerto Rico	11,146	7,627	1,124	2,395	0	11,146	6,791	1,960	2,395	0
Rhode Island	16,683	15,553	100	487	543	16,683	15,553	100	487	543
South Carolina	260,902	175,069	72,713	13,120	0	217,667	197,142	20,525	0	0
South Dakota	682,034	682,034	—	0	0	682,034	682,034	—	0	0
Tennessee	540,030	483,675	—	56,355	—	538,322	521,473	—	16,849	—
Texas	1,543,898	1,543,884	—	14	—	1,543,898	1,536,346	—	7,552	—
Utah	133,754	0	133,754	0	0	133,754	2,329	131,425	0	0
Vermont	225,740	221,525	1,877	1,957	381	41,820	40,636	331	838	15
Virginia	160,640	150,158	10,482	0	—	160,640	160,640	—	0	—
Washington	182,848	62,551	5,277	115,020	—	182,807	180,512	660	1,635	—
West Virginia	18,870	12,988	4,152	1,730	0	18,870	18,870	0	0	0
Wisconsin	139,330	42,284	89,918	7,128	0	139,330	42,284	89,918	7,128	0
Wyoming	427,219	427,219	0	0	0	245,311	245,311	0	0	0
Totals	17,633,217	12,373,785	1,912,545	3,340,611	6,276	16,209,550	13,377,843	1,640,804	1,121,883	69,020
Percent of Assessed Waters		70.2%	10.8%	18.9%	0.0%		82.5%	10.1%	6.9%	0.4%

— Not reported.

Source: 1990 State Section 305(b) reports.

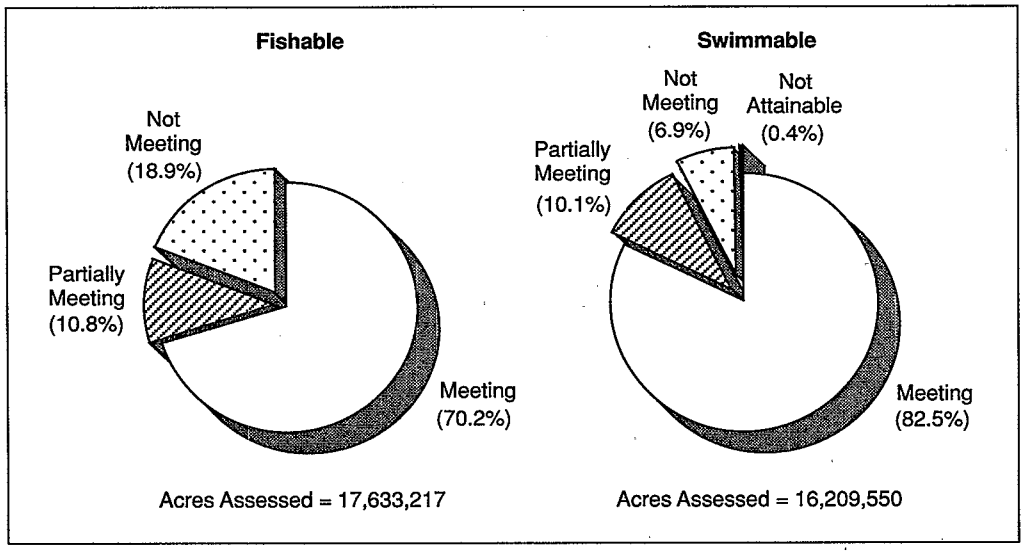
substances entering lakes through runoff, sewage discharges, septic tank leachate, and similar sources. These substances can overstimulate algae and aquatic plant growth, creating conditions (e.g., low dissolved oxygen concentrations and algal scum on the lake surface) that adversely affect swimming, boating, and the health and diversity of indigenous fish populations. Such major, and generally undesirable, changes in lake ecology are known as *cultural* eutrophication.

The eutrophication progression is commonly described by a series of trophic states:

- Oligotrophic—clear waters with little organic matter or sediment and minimal algal and plant productivity;
- Mesotrophic—waters containing more nutrients and therefore exhibiting more biological productivity;
- Eutrophic—waters extremely rich in nutrients, with high biological productivity; and
- Hypereutrophic—murky, highly productive waters, closest to the wetlands status.

Dystrophic is also a lake classification but is not necessarily a part of the eutrophication progression. Dystrophic systems are often low in nutrients yet are highly colored with dissolved humic matter. Lakes found in areas with peat bogs or other types of wetlands are sometimes dystrophic systems. Table 2-5 displays the general characteristics of lakes in the various trophic classifications.

Trophic status concepts can also be applied to reservoirs or to such natural waterbodies as oxbow lakes found along large alluvial rivers. For these waterbodies, the succession of trophic states may take place more quickly than for natural, glacially derived lakes. The sequence may also begin with conditions associated with the mesotrophic or even eutrophic states. Especially for newly impounded reservoirs, there may be an initial highly productive period called the "trophic upsurge." This will be followed by a less productive state and a subsequent more lengthy series of trophic changes dependent on site-specific watershed conditions. In many cases, an impounded reservoir will exhibit different trophic states at the same time in different locations in the reservoir. For example, oligotrophic conditions may be present near the dam while the riverine portion of the same reservoir could be eutrophic. Despite these complexities, trophic classifications can be useful in characterizing general water quality and in making management decisions to



Source: 1990 State Section 305(b) reports.

Figure 2-4. Attainment of Clean Water Act Goals in Assessed Lakes and Reservoirs

control cultural eutrophication.

Although changes in lake water quality may be tracked by monitoring for trophic state, the trophic state of a lake does not always define its use. For example, fishing may be better in a eutrophic lake than an oligotrophic lake. User perceptions are also important to consider in assessing support of uses: a lake with chemical, physical, and biological data indicating eutrophic conditions may be typical for its region and perceived by its users as fully supporting recreational activities.

Section 314 of the Water Quality Act of 1987 requires States to identify their significant publicly owned lakes by trophic status in their Section 305(b) reports. Table 2-6 displays the results of the State evaluations of trophic status. Thirty-eight States reported that 50 percent of the 8,347 lakes assessed for trophic status were either eutrophic or hypereutrophic, 39 percent were mesotrophic, 10 percent were oligotrophic, and less than 1 percent were dystrophic. Lakes classified by States using categories not consistent with the format of the table are listed under "other."

As with other results reported by the States, the trophic status summary data may be biased if the lakes were assessed in response to a problem or public complaint or because of their easy accessibility. It is likely that more remote and/or pristine lakes are underrepresented in some State assessments.

Water Quality Trends in Lakes

Because the trophic status of a lake may change over time—often due to purely natural factors—it is useful to establish long-term trend monitoring procedures to help detect these historical changes, especially when they are associated with undesirable cultural eutrophication. Section 314 of the Clean Water Act requires States to report on trends in their lakes. To help States enhance trend detection capabilities, special grant and technical assistance programs have been supported by EPA's Clean Lakes Program since 1989. These long-term lake monitoring programs will also help assess trends for other types of pollutants, including toxic substances and lake acidification. A few States have made trend estimates using best professional judgment based on limited observations. Currently, however, 35 States (77 percent of those for which information is available) indicate they have inadequate databases to make reliable trend assessments.

In their 1990 305(b) reports, several States expressed interest in determining land use trends that could adversely affect lake water quality. Two States (Maine and Vermont) noted that they were interested in identifying watersheds where rapid land use changes (usually from residential or commercial development) posed the threat of impacts to lakes unless protection measures could be instituted promptly. Maine developed a special Lake Vulnerability Index and is as much concerned with "future" trends as historic patterns. Many States indicate an interest in increasing their attention to pollution prevention as the most cost-effective way to protect lakes: lake management and protection, although costly, is

Table 2-5. General Characteristics of Traditional Lake Trophic Status Classifications

Characteristics	Oligotrophic	Mesotrophic	Eutrophic
Nutrient Level	Low	Medium	High
Organic Matter Content	Low	Medium	High
Biological Productivity	Low	Medium	High
Lake Age	Young	Medium	Old
Water Transparency	High	Medium	Low
Oxygen Depletion Hypolimnion	No	Yes	Yes
Average Depth	Deep	Moderate	Shallow

Source: *Report to Congress: Water Quality of the Nation's Lakes, 1989.* Nonpoint Sources Branch, OWRS.

Table 2-6. Trophic Status of the Nation's Lakes

State	Total Number of Lakes Assessed	Oligo-trophic	Meso-trophic	Eutro-phic	Hyper-eutrophic	Dys-trophic	Other
Alabama	35	2	22	6	0	0	5
Colorado	65	8	25	32	0	0	0
Connecticut	204	38	95	29	11	0	31
Delaware	30	0	0	30	0	0	0
District of Columbia	3	0	2	1	0	0	0
Florida	104	63	18	23	0	0	0
Illinois	278	3	17	136	122	0	0
Iowa	114	0	0	114	0	0	0
Kansas	217	0	56	97	64	0	0
Kentucky	99	12	31	56	0	0	0
Louisiana	101	0	0	101	0	0	0
Maine	1,882	154	1,075	653	0	0	0
Maryland	62	2	15	45	0	0	0
Massachusetts	414	28	124	202	59	1	0
Michigan	684	99	357	228	0	0	0
Minnesota	1,563	202	529	539	293	0	0
Mississippi	33	0	0	33	0	0	0
Missouri	103	8	36	56	3	0	0
Montana	48	6	21	16	0	0	5
Nebraska	45	0	2	31	12	0	0
New Jersey	21	0	0	21	0	0	0
New Mexico	55	5	9	31	0	1	9
North Carolina	120	27	28	44	9	12	0
North Dakota	149	0	12	58	79	0	0
Ohio	125	0	30	69	26	0	0
Oklahoma	67	8	17	35	7	0	0
Oregon	202	59	72	61	10	0	0
Pennsylvania	53	1	39	13	0	0	0
Puerto Rico	18	4	2	12	0	0	0
Rhode Island	56	5	21	14	0	0	16
South Carolina	40	0	4	36	0	0	0
South Dakota	129	0	8	121	0	0	0
Tennessee	109	19	33	50	7	0	0
Utah	62	10	36	15	1	0	0
Vermont	184	28	104	38	0	14	0
Virginia	219	23	65	130	0	1	0
West Virginia	76	18	29	29	0	0	0
Wisconsin	578	16	332	230	0	0	0
Total Number of Lakes	8,347 (100%)	848 (10.2%)	3,266 (39.1%)	3,435 (41.2%)	703 (8.4%)	29 (<1%)	66 (<1%)

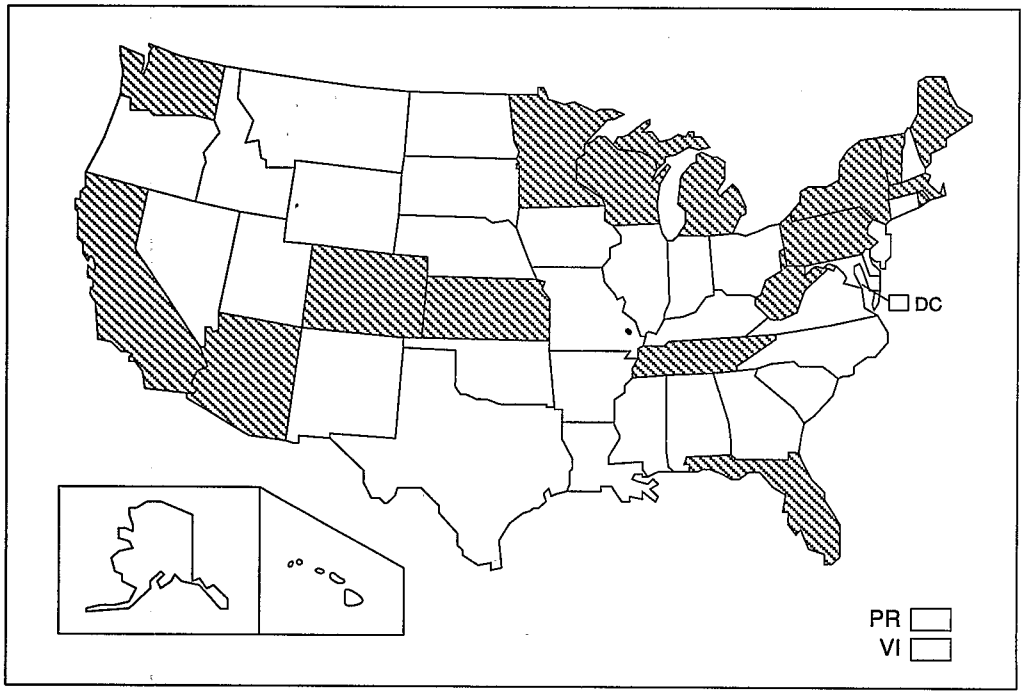
generally less expensive than lake restoration. The ability to predict where land use will require prompt planning and management attention to avoid pollution problems is a type of trend analysis that will likely find increasing use in State lake programs.

Lake Acidity

With the 1987 reauthorization of the Clean Water Act, changes to Section 314 emphasize monitoring lakes for a number of significant features in addition to traditional trophic status parameters. Many States have expanded their lake monitoring efforts to detect potential impacts of acid deposition, acid mine drainage, and toxic substances. Monitoring lake acidity and monitoring toxic substance impacts are often closely coordinated because pollution that can increase a lake's acidity can also increase the solubility of toxicants or magnify their deleterious effects.

Acidic lakes are generally found in areas where the watershed soils have limited buffering capacities. In these lakes, acidic sources such as acid rain from the combustion of fossil fuels and acid outflows from abandoned mines can significantly depress a lake's pH level. An increase in lake acidity can radically alter the community of fish and plant species residing in a lake. Fish, in particular, are sensitive to fluctuations in lake acidity. Small increases in acidity depress reproduction of many sport fish species. Large increases in acidity can entirely eliminate fish populations in a lake.

Many States are building monitoring databases to identify acidified lakes and to distinguish between lakes in which acidification results from natural conditions and those in which it is influenced by human activities. States are also beginning to identify lakes that are sensitive to anthropogenic acidification because of low natural acid-neutralizing capacities. State monitoring programs have benefited from EPA-sponsored initiatives such as the National Acid Precipitation Assessment Program (NAPAP). NAPAP has suggested important parameters to include in a lake or watershed acidification monitoring program. Several States have adopted these monitoring approaches as part of work being carried out



Source: 1990 State Section 305(b) reports.

Figure 2-5. States Reporting Acid Deposition Concerns

through Section 314 Lake Water Quality Assessment grants.

Figures 2-5 and 2-6 summarize information from the 1990 Section 305(b) reports on States' concerns about acid deposition and acid mine drainage. In most instances, the States feel more monitoring is needed to distinguish between vulnerability to impacts (e.g., from low acid-neutralizing capacities) and actual adverse impacts to aquatic life or other designated uses.

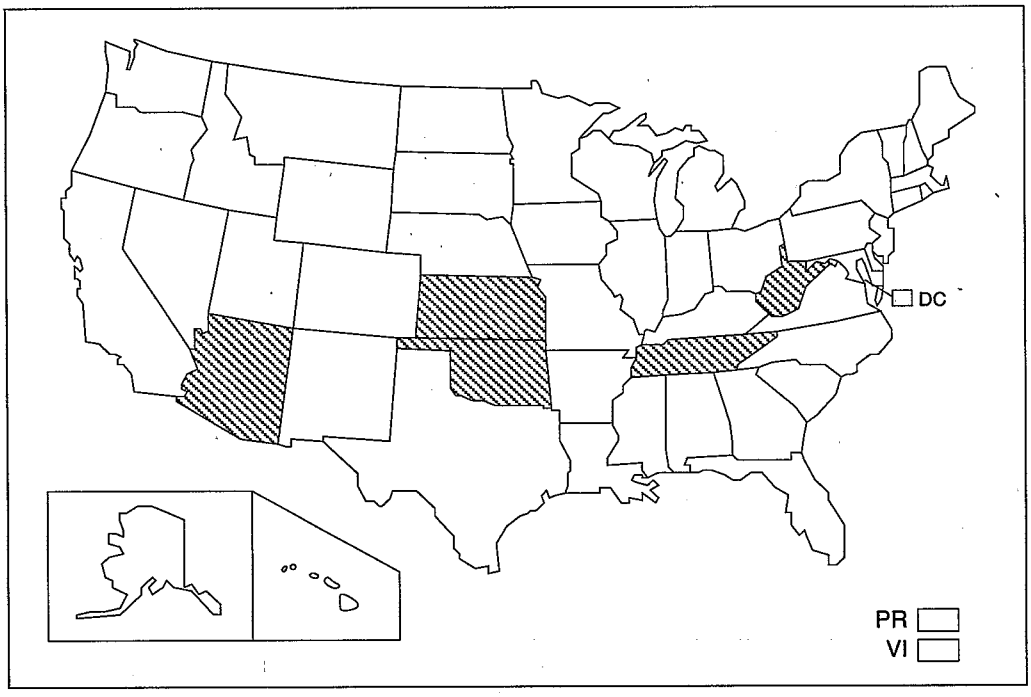
Controlling Acidification and Toxicant Impacts

For conventional pollutants (e.g., oxygen-demanding substances, nutrients, or sediment) and for toxics problems associated with active point source discharges, States have developed a variety of control and rehabilitation techniques for lakes and their watersheds. For acidification problems and the toxic substance concerns often related to acidification effects, the management challenges can be highly complex.

Often, effectively addressing the causes and sources of increased acidity in lakes requires a multimedia approach. For example, the causes for acid deposition impacts are often located outside a lake's watershed and involve air pollution factors. The ultimate solutions to such intermedia issues will depend on controls initiated through programs related to the Clean Air Act. In the case of acid mine drainage, ground-water resources as well as surface water may be impaired.

The addition of limestone or other alkaline materials to lake waters is the most common rehabilitation technique, even though this is often only a temporary solution to acidification problems. A variant is to inject alkaline materials into lake sediments. These techniques have been used in Europe for some time and are being applied on a limited basis in such States as Massachusetts, New York, West Virginia, and Michigan. In some cases, more lasting benefits are possible from liming the land surfaces in a reservoir's watershed. Maryland is undertaking experiments to evaluate the effectiveness of watershed liming.

Especially for small lakes, acidic runoff may be



Source: 1990 State Section 305(b) reports.

Figure 2-6. States Reporting Acid Mine Drainage Concerns

associated with rainfall events during specific times of the year when meteorologic conditions introduce weather systems from areas of high air pollution and, hence, increased levels of acidity. Several States in the Midwest have documented this pattern and are considering ways to divert runoff from small lakes or reservoirs during these critical seasons.

The Section 314 Clean Lakes Program

From its inception in 1972, the Clean Lakes Program has encouraged coordination with other Federal, State, local, and "grass-roots" programs. Jurisdiction over a lake and its watershed will often involve several units of government. Pollutants may come from point sources, requiring attention under the National Pollutant Discharge Elimination System (NPDES) program. Nonpoint sources of pollution may involve residential developments, road construction, agriculture, or other land use factors. Addressing nonpoint source concerns may require participation from a variety of State agencies, Federal agencies such as the U.S. Department of Agriculture (USDA), and, of course, local property owners.

Building the institutional framework required to involve all pertinent parties in a lake's management needs is a major objective of Section 314. States have been encouraged to develop their own legislation to give focus to their specific lake management agendas, and several grants offered through the EPA Clean Lakes Program are designed to assist these State efforts. Through the exchange of information on lake management techniques and using a variety of cooperative agreements with the States, EPA has provided support for integrated approaches to lake management, involving assessment, planning, restoration, and protection.

The States may enter into four types of cooperative agreements with EPA under the Section 314 Clean Lakes Program:

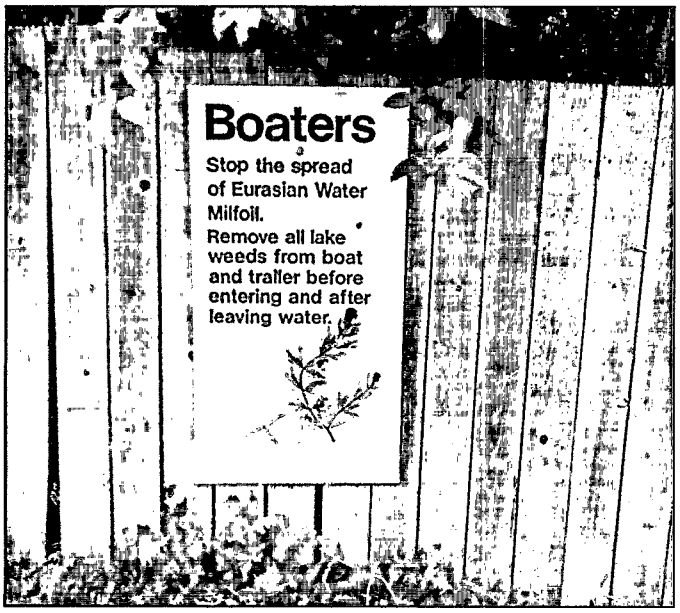
- State Lake Water Quality Assessments enable States to gather information required under Section 314(a)(1) of the Clean Water Act and establish lake programs within State agencies.
- Phase I - Diagnostic/Feasibility Studies are performed on individual lakes to determine necessary protection and restoration measures.
- Phase II - Restoration/Implementation Projects fund implementation of the recommendations proposed in the Phase I study.
- Phase III - Post-Restoration Monitoring Studies determine the longevity and effectiveness of the restoration measures implemented under the Phase II projects.

The integrated approach central to the Clean Lakes Program stresses interagency cooperation to build strong local support for lake projects. This approach provides a solid platform from which to pursue the challenges that confront efforts to protect and restore the Nation's lake resources. Over time, many States have developed the institutional foundations—in legislation, in funding sources, and in local support—for self-sustaining lake programs, often modeled after EPA's Clean Lakes initiatives.

Restoration and Control Methods

Background on Lake Management Methods

Lake management for water quality improvements may include in-lake treatment techniques to reduce existing nutrient or toxic contamination problems and watershed management



Randy Dodd

Introduced water plants have caused degradation of water quality in some lakes and reservoirs.

practices aimed at reducing additional inputs of nutrients and other contaminants. Usually, a combination of watershed improvement to reduce pollution that enters a lake and application of in-lake restoration techniques is used to upgrade the quality of a lake or reservoir. The following discussion highlights State restoration and control methods. Subsequent sections provide more detailed coverage for special topics such as toxic substances and acidity.

States, often with assistance from EPA's Clean Lakes Program, have developed a wide variety of techniques to address problems affecting recreational and other important lake uses. Lake rehabilitation techniques can be categorized based on typical pollution problems and restoration objectives. Objectives include: (1) controlling nuisance algae; (2) alleviating problems from excessive shallowness and loss of lake capacity; (3) controlling nuisance water plants; (4) improving the condition of the fish community; (5) mitigating the impacts of acidity; and (6) removing toxic substances. Commonly encountered rehabilitation measures associated with these management objectives are summarized in Table 2-7.

Control measures are directed at the actual sources of pollution. Point sources are usually controlled through wastewater treatment and permit programs. Since the early 1970s, the NPDES program has provided a mechanism for State and Federal scrutiny of the impacts of municipal or industrial discharges to lakes and reservoirs. Nonpoint sources, because they are diffuse by nature, are best controlled through watershed management. Especially with the addition of Section 319 to the Clean Water Act in 1987, a number of initiatives have taken place in State programs to focus nonpoint source management efforts on improving lake water quality.

All States use general surface water standards to guide management decisions affecting lakes, especially concerning NPDES permitting issues. Many States have also adopted special turbidity standards for lakes. The following examples describe approaches already in use in a variety of States and provisions that will likely be adopted in the near future.

Table 2-7. Lake Rehabilitation Techniques by Restoration Objectives

	Restoration Objectives					
Technique	**Control Nuisance Algae**	**Eliminate Excessive Shallowness**	**Remove Rooted Plants**	**Improve Fisheries**	**Acid Mitigation**	**Toxics Removal**
Phosphorus Precipitation Inactivation	●					
Sediment Removal/Dredging	●	●				●
Dilution/Flushing	●					●
Biological Controls	●		●			
Introduction of Non-Native Species				●	●	
Aquatic Macrophyte Harvesting	●		●			
Artificial Circulation	●			●		
Hypolimnetic Aeration	●			●		
Food Chain Manipulation	●			●		
Chemical Controls	●		●	●	●	●
Diversion	●	●				
Sediment Basin/Trap		●				
Drawdown/Water Level Management			●		●	
Shading/Sediment Cover			●			●
Sediment Oxidation	●		●			
Hypolimnetic Withdrawal	●					
Nutrient Addition					●	

Source: CLP Report to Congress EPA-440/5-89-003.

■ Colorado has adopted lake-specific phosphorus standards for Dillon, Cherry Creek, and Chatford Reservoirs. The State has then encouraged a system of tradeoffs between point and nonpoint source loadings as an efficient means of achieving site-specific controls to meet the standards targets.

■ Delaware plans to use a trophic state index (Porcella's Lake Evaluation Index) to trigger management attention on nutrient control if a lake's trophic status rises beyond the upper mesotrophic to lower eutrophic range.

■ Georgia plans to develop lake-specific standards (involving such parameters as pH, fecal coliforms, chlorophyll *a*, total nitrogen, total phosphorus, and surface dissolved oxygen) for several high-priority lakes. The State will also consider nutrient standards for streams feeding these lakes.

■ Illinois has standards to keep phosphorus levels below 50 parts per billion on lakes with surface areas of 20 acres or more. Point source dischargers for communities with more than 2,500 adults may have stringent phosphorus limits added to discharge permits if lake phosphorus levels exceed the standards criterion.

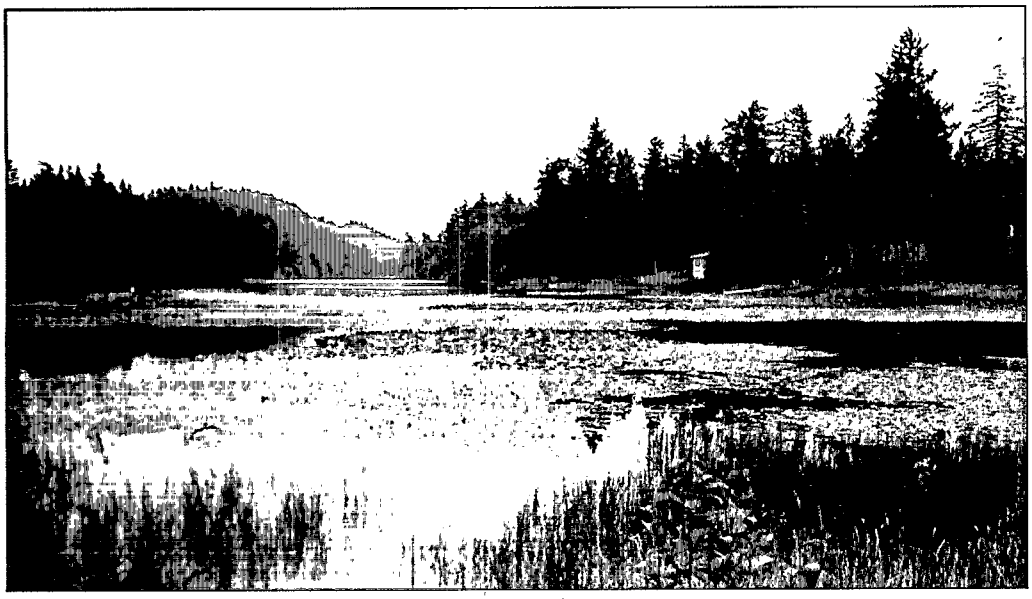
■ Minnesota is exploring use of ecoregion concepts to define regional reference conditions for use in applying antidegradation policies to lakes.

■ Oklahoma has defined special designations for lakes deemed high-quality waters or used as public drinking water supplies. Such designations prevent additional pollutant loading from permitted point source discharges. If water quality problems are documented, such lakes are also recommended as high-priority candidates for nonpoint source management attention.

■ Vermont has narrative standards for phosphorus loadings that lead to eutrophic conditions in small lakes. Under such circumstances, nutrient permit limits would be considered for point source dischargers. Vermont is also working on numeric phosphorus criteria for 12 segments of Lake Champlain.

■ Virginia has provisions in its standards for designating a lake or watershed as a "Nutrient Enriched Water." Such an action would focus management attention on phosphorus control in point source permit decisions.

For many categories of pollution from diffuse sources—especially agriculture or silviculture—implementing best management practices (BMPs) in lakeshore and watershed areas is the primary control strategy. Most States approach BMP implementation using voluntary approaches and cost-share incentives combined with educational and technical assistance efforts. State water quality agencies have shown considerable flexibility in setting up cooperative efforts with other State natural resource agencies, with Federal agencies, and with local government agencies to target work on specific lakes or watersheds and to use available technical expertise and funding resources



Randy Dodd

Excessive growth of nuisance algae and rooted aquatic vegetation are two symptoms of eutrophication.

efficiently. A number of States have highlighted specific BMPs they feel should be given priority in evaluating lake nonpoint source management needs.

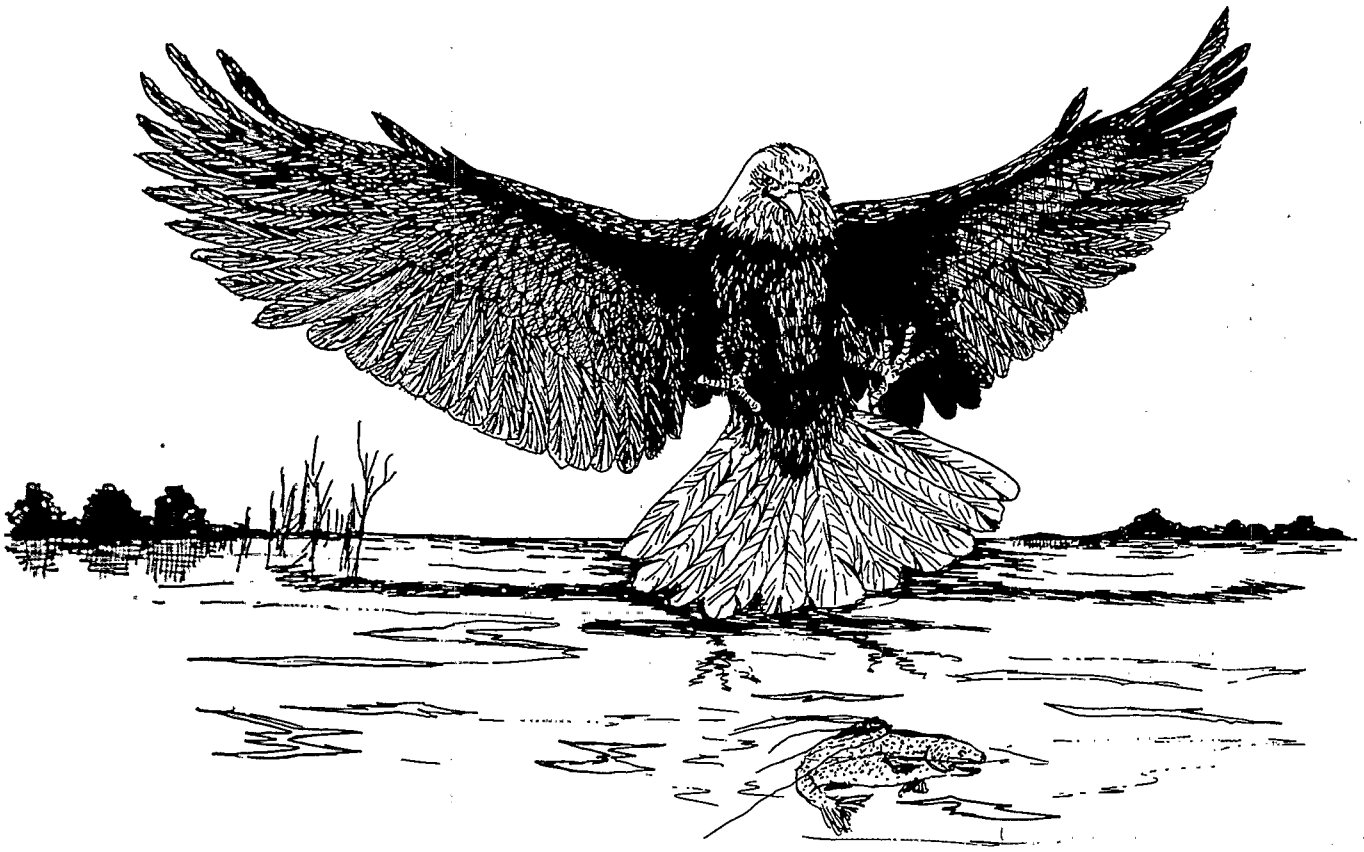
Other types of nonpoint source controls lend themselves to land use ordinances or regulations, especially urban nonpoint source runoff and construction-related concerns that involve land development or road construction. Many States have set up active technical assistance and education programs encouraging local government to adopt ordinances or permitting policies that address urban nonpoint and stormwater sources that contribute to lake problems. State water quality agencies have also initiated a variety of cooperative arrangements with State departments of transportation to promote the use of sound management practices on State and Federal highway projects.

The 1987 reauthorization of the Clean Water Act provided additional tools to improve lake water quality. Some States have taken steps to integrate their lake programs with activities associated with their Section 319 nonpoint source management programs. Many lakes have become the focus of targeted watershed demonstration projects supported through EPA nonpoint source grants or through other innovative funding mechanisms. For example, Illinois' Lake Management Act and Washington's Centennial Clean Water Fund are programs with a strong nonpoint source emphasis. Additionally, the new permit requirements for stormwater discharges under the NPDES are also expected to play a significant role in controlling pollutants from these sources and improving lake water.

In recent years, attention has focused on the need for improved management at dams to maintain recreational and aquatic life designated uses. Especially in older reservoirs built for hydroelectric power, navigation, drinking water supplies, irrigation water, or flood control, sizable fluctuations in lake water levels may impede access to marinas and boat launching areas and may seriously affect the reproductive success of fishes that lay eggs in the littoral areas. Lake level fluctuations and water releases from hydrostructures may also adversely impact the water quality of tailwater fisheries below the dams. State water quality agencies, often in cooperation with State wildlife conservation departments, tourism agencies, Federal agencies, and power companies, have made significant progress in working with the operators of reservoir hydrostructures to define operating rules to improve water quality.

In addition to a technical foundation of lake rehabilitation and pollution control methods, successful lake programs usually require strong local support and cooperation from natural resource agencies at the local, State, and Federal levels. Many States have made great progress in establishing these types of institutional frameworks, which are essential ingredients in managing the nonpoint source pollutants. The control of pollutants from diffuse sources is clearly the major unfinished business facing our Nation's lake managers.

Patricia Cunningham



3

The Great Lakes

Support of Designated Uses

The Great Lakes, containing one-fifth of the world's fresh water, are stressed by a wide range of pollutant sources. Traditional sources of contamination include municipal and industrial discharges, combined sewer overflows, urban runoff, and hazardous waste sites associated with the urban centers located on the shoreline. These urban areas include Chicago, Detroit, Gary, Toledo, Toronto, and Buffalo. Increasingly, atmospheric deposition and in-place sediment contaminants are also cited as sources of pollution in the Great Lakes. The diffuse origins of these sources hinder control efforts.

In their 1990 State Section 305(b) reports, six of the eight Great Lakes States provided information on the extent to which their Great Lakes shoreline miles attain their designated uses (see Table 3-1). A total of 4,857 miles were assessed—all of the shoreline miles in the reporting States or 94 percent of the total 5,169 Great Lakes shoreline miles in the United States. Of the assessed shoreline, 2 percent (85 miles) fully support uses. Another 1 percent (69 miles) fully support uses but are threatened. Twenty-nine percent of assessed miles (1,415 miles) partially support uses, and 68 percent (3,288 miles) do not support uses (see Figure 3-1). All of the waters not supporting their designated uses are in Michigan.

The use support figures are difficult to interpret because the States use a variety of assessment and reporting methodologies. For

Table 3-1. Designated Use Support in Great Lakes

State	Great Lake Shore Miles	Shore Miles Assessed: Total	Shore Miles Assessed: Percent Evaluated	Shore Miles Assessed: Percent Monitored	Miles Fully Supporting	Miles Threatened	Miles Partially Supporting	Miles Not Supporting
Illinois	63	63	0	100	0	54	9	0
Indiana	43	43	0	100	—	—	43	—
Michigan	3,288	3,288	0	100	0	—	—	3,288
New York	577	577	100	0	85	15	477	0
Ohio	236	236	—	—	0	—	236	0
Wisconsin	650	650	100	0	0	0	650	0
Totals	4,857	4,857			85	69	1,415	3,288
Percent of Assessed Waters					1.8%	1.4%	29.1%	67.7%

— Not reported.

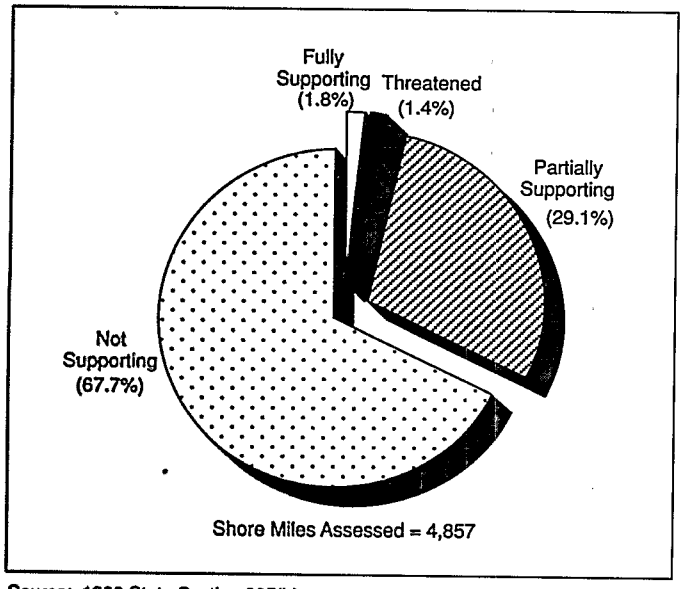
Source: 1990 State Section 305(b) reports.

example, most States classify waters subject to fish consumption advisories as partially supporting designated uses. But Michigan does not have a partial support classification. As a result, Michigan is the only Great Lakes State reporting that its shoreline does not support designated uses, even though it has the same fish consumption restrictions as do the other State shorelines.

It should also be noted that it is the nearshore waters of the Great Lakes that are most likely to be degraded; Table 3-1 does not address water quality conditions in the deeper, cleaner, less stressed central waters of the Great Lakes.

Causes and Sources of Impairment

Six States reported causes of use impairment for 4,772 shoreline miles (see Table 3-2). Priority organics remain the most extensive cause of use impairment on the Great Lakes (see Figure 3-2). Priority organics,



Source: 1990 State Section 305(b) reports.

Figure 3-1. Designated Use Support in Assessed Great Lakes

Table 3-2. Impaired Great Lake Shore Miles Affected by

State	Total Impaired Waters*	Priority Organics: Major	Priority Organics: Mod/Min	Pesticides: Major	Pesticides: Mod/Min
Illinois	63	63	—	—	—
Indiana	43	—	43	—	43
Michigan**	3,288	3,288	—	—	—
New York	492	463	29	29	—
Ohio	236	4	186	—	—
Wisconsin	650	650	—	—	650
Totals	1,484	1,180	258	0	693
Combined Totals	4,772		4,726		693
% of Impaired Waters			99.0%		14.5%

*The sum of partially and nonsupporting shore miles (Table 3-1); threatened waters are included in this column for Illinois and New York.

**This State did not specify the degree of impact (i.e., Major or Moderate/Minor); shoreline miles were placed in the "Major" column for national reporting purposes.

Source: 1990 State Section 305(b) reports.

primarily PCBs, affect 99 percent of the impaired shoreline miles. Pesticides impair 14 percent and metals affect 5 percent. Metals are a major cause of impairment in Ohio, where elevated concentrations of copper and cadmium affect aquatic life uses. Organic enrichment, nutrients, pH, pathogens, and siltation are also reported causes of use impairment.

Only four States reported shoreline miles impaired by individual sources (see Table 3-3 and Figure 3-3). The reported information suggests that landfills and contaminated sediments are the leading sources impairing the Great Lakes. However, this information is misleading because it pertains to less than 21 percent of the impaired Great Lakes shoreline. Significant sources are not fully represented in the summary information because Michigan, which reported 69 percent of the impaired shoreline miles, failed to specify shoreline mileages affected by source categories. Michigan did state that atmospheric transport and deposition are a major source of critical pollutants in the Great Lakes. Two other States, Illinois and Indiana, also cited atmospheric deposition as a source of impairment on their Great Lakes shorelines.

Attainment of Clean Water Act Goals

Five States provided information on the degree to which their Great Lakes shoreline waters meet the fishable and swimmable goals of the Clean Water Act (see Table 3-4). A total of 1,569 shoreline miles were assessed. Only 5 percent of these waters (85 miles) are reported to be fully supporting the fishable goal (see Figure 3-4). Another 59 percent are partially supporting the fishable goal, and 35 percent are not supporting the fishable goal. The fishable goal is considered attainable throughout the Great Lakes shoreline.

The fishable goals are not met because of fish consumption advisories issued to protect the public from elevated concentrations of priority organics and mercury in fish tissues. A uniform fish advisory jointly issued by the Great Lakes States and the Province of Ontario in 1987 remains in effect for all of the Great Lakes. The advisory pertains primarily to bottom-dwelling fish with elevated tissue residues of PCBs, mercury, and chlordane.

More than half of the assessed shoreline miles (57 percent) are fully supporting the swimmable goal,

Causes of Pollution

Metals		Organic Enrichment		Nutrients		pH		Pathogens		Siltation	
Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
—	2	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	15	29	—	—	—	1	15	—	14
86	129	—	46	—	4	—	35	—	—	—	—
—	20	—	—	—	20	—	—	—	—	—	—
86	151	0	61	29	24	0	35	1	15	0	14
	237		61		53		35		16		14
	4.9%		1.3%		1.1%		0.7%		0.3%		0.3%

Table 3-3. Impaired Great Lake Shore Miles Affected by Sources of Pollution

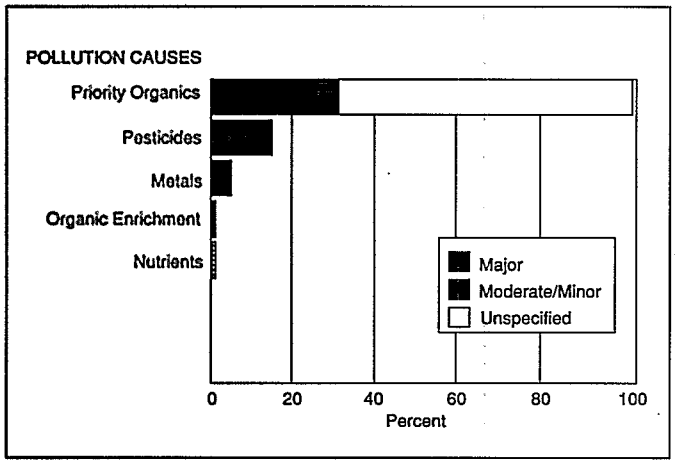
State	Total Impaired Waters*	Land Disposal		Contaminated Sediments		Atmospheric Deposition		Combined Sewers		Municipal	
		Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
Illinois	63	—	—	4	—	63	—	—	16	—	—
Indiana	43	—	—	—	—	—	43	—	43	—	43
New York	492	15	492	463	29	—	—	—	14	1	—
Wisconsin	650	—	—	—	—	—	—	—	20	—	40
Totals	1,248	15	492	467	29	63	43	0	93	1	83
Combined Totals			507		496		106		93		84
% of Impaired Waters			40.6%		39.7%		8.5%		7.4%		6.7%

*The sum of partially and nonsupporting shore miles (Table 3-1); threatened waters are included in this column for Illinois and New York.
** Zero or not reported.
Source: 1990 State Section 305(b) reports.

Table 3-4. Attainment of Clean Water Act Goals in the Great Lakes

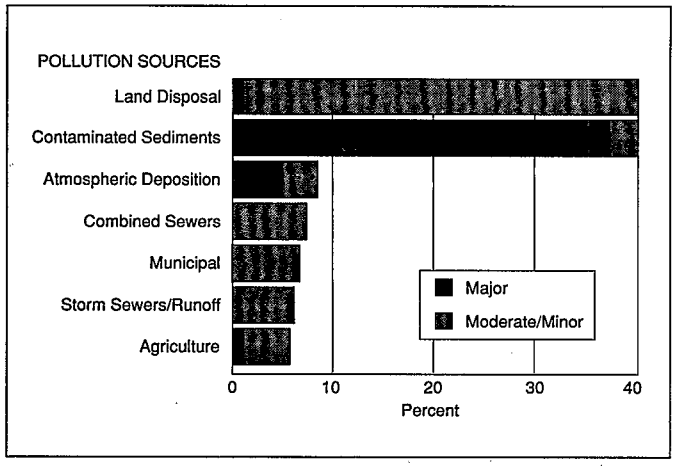
State	Fishable Goal (shore miles)					Swimmable Goal (shore miles)				
	Assessed	Meeting	Partially Meeting	Not Meeting	Not Attainable	Assessed	Meeting	Partially Meeting	Not Meeting	Not Attainable
Illinois	63	0	0	63	0	63	63	0	0	0
Indiana	43	—	43	—	—	43	43	—	—	—
New York	577	85	—	492	0	577	563	—	14	0
Ohio	236	0	236	0	—	236	231	5	0	—
Wisconsin	650	0	650	0	0	650	0	650	0	0
Totals	1,569	85	929	555	0	1,569	900	655	14	0
Percent of Assessed Waters		5.4%	59.2%	35.4%			57.4%	41.7%	0.1%	

— Not reported.
Source: 1990 State Section 305(b) reports.



Source: 1990 State Section 305(b) reports.

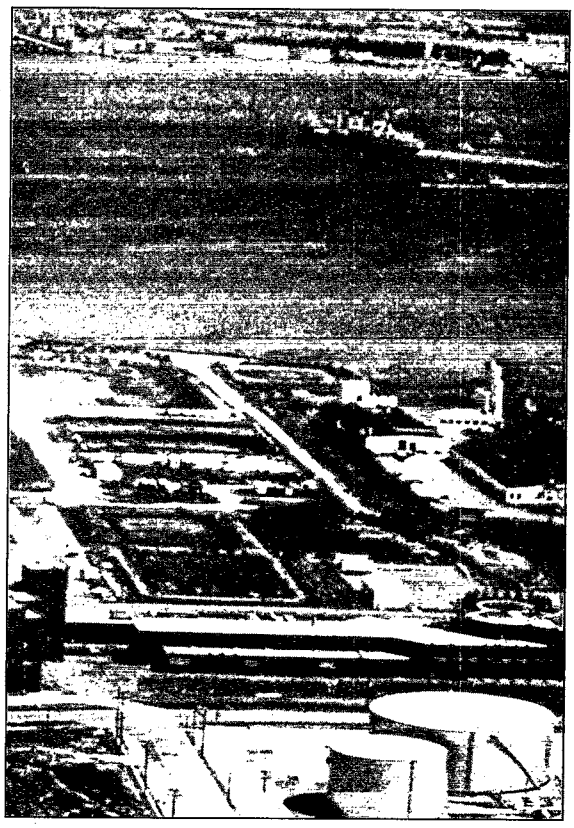
Figure 3-2. Percent of Impaired Great Lakes Shore Miles Affected by Causes of Pollution

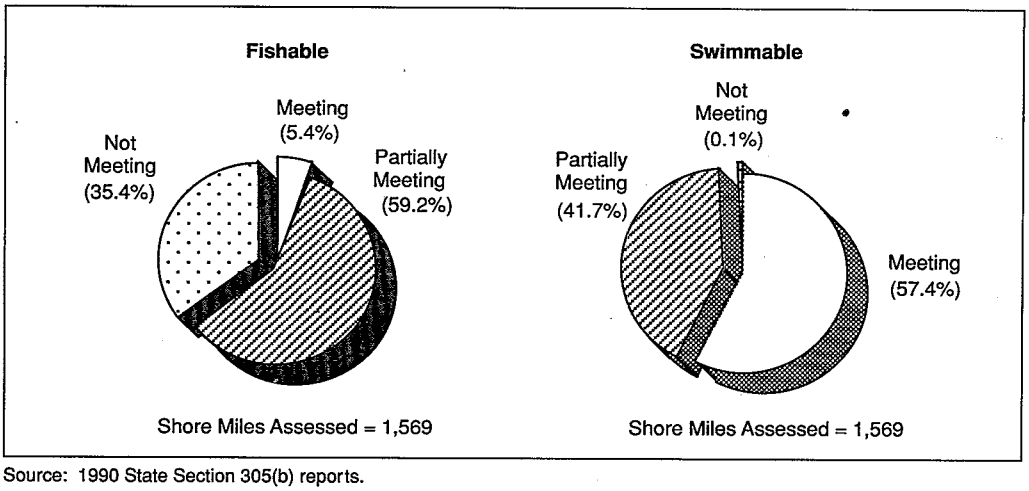


Source: 1990 State Section 305(b) reports.

Figure 3-3. Percent of Impaired Great Lakes Shore Miles Affected by Sources of Pollution

Storm Sewers/Runoff		Agriculture		Industrial		Construction	
Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
—	63	—	—	—	—	—	—
—	—	—	43	—	43	—	—
—	14	14	15	—	—	—	14
—	—	—	—	—	—	—	—
0	77	14	58	0	43	0	14
	77		72		43		14
	6.2%		5.8%		3.4%		1.1%





Source: 1990 State Section 305(b) reports.

Figure 3-4. Attainment of Clean Water Act Goals in Assessed Great Lakes

42 percent are partially supporting, and less than 1 percent of the assessed shoreline is not supporting the swimmable goal. The swimmable goal was considered attainable for all assessed shoreline miles. The States did not report reasons for not attaining the swimmable goal.

Water Quality Management

The Great Lakes are cooperatively managed by the U.S. and Canada under the Great Lakes Water Quality Agreement of 1978, as amended in 1987. The 1978 Agreement outlined programs and practices necessary to reduce pollutant discharges into the Great Lakes system. The 1987 amendments strengthened toxic reduction features of the Agreement. The Clean Water Act, as amended in 1987, applies to the U.S. waters of the Great Lakes, incorporating the Great Lakes Water Quality Agreement by reference.

The International Joint Commission (IJC), established by the 1909 Boundary Waters Treaty, is responsible for identifying actions needed to maintain the integrity of the Great Lakes ecosystems. The Commission's two boards, the Great Lakes Water Quality Board and the Science Advisory Board, identify problem areas, plan programs to reduce pollution, and publish reports on issues and findings.

Since 1973, the IJC has identified 42 Areas of Concern in the Great Lakes basin where environmental quality is degraded and designated uses are impaired. The Areas of Concern consist primarily of harbors, bays, and river mouths. In 1985, the Great Lakes States and Canadian provinces agreed to develop and implement a Remedial Action Plan (RAP) for each Area of Concern. The RAP process includes preparation of a Phase I report that identifies impaired uses, and a Phase 2 report that examines restoration options and determines responsibility for implementation.

Several Areas of Concern are discussed in the narrative assessments for each Great Lake: the St. Louis River and Bay in Lake Superior; the Saginaw River in Lake Huron; the Cuyahoga River, the Ashtabula River, and the Black River in Lake Erie; and the Niagara River and the Connecting Channels of the Upper Great Lakes. Other Areas of Concern are discussed in detail in the 1990 State Section 305(b) reports.

Both chemical and bacterial contamination can result in closures of recreational swimming areas.

The Great Lakes: A Narrative Assessment

Because of a lack of new data, the States did not change their Great Lakes water quality assessments substantially from 1988 to 1990. As a result, there is little change in the general conclusions drawn from the 1988 and 1990 Section 305(b) reports.

■ The Great Lakes' trophic status is improving. The Great Lakes States continue to report declining phosphorus concentrations but increasing nitrate concentrations.

■ Toxic contamination persists in fish tissues and lake sediments. Previously declining trends in fish tissue concentrations of PCBs, DDT, and mercury have slowed and even reversed in some fish species. Atmospheric deposition and sediment contamination from previous activities (e.g., industrial discharges) are thought to be significant sources of persistent toxic contamination in fish.

■ Sediment contamination continues to be a major problem, particularly in nearshore waters and harbors. No improvement is noted for contaminated sediments. Remediation efforts have been stalled pending approval of dredge disposal plans.

■ The States have made progress in designing Remedial Action Plans for numerous Areas of Concern, but few have reached the implementation stage because of a lack of funds.

All eight of the Great Lakes States provide narrative information on the Great Lakes in the 1990 State Section 305(b) reports. The information is summarized here for each of the Great Lakes.

Lake Superior

Lake Superior, the largest of the Great Lakes, lies in a sparsely populated watershed and is classified as oligotrophic. The water quality of Lake Superior is generally very good with only a few problem areas associated with urban centers concentrated along the shoreline. The lake's water quality surpasses established objectives, standards, and criteria for all contaminants except PCBs.

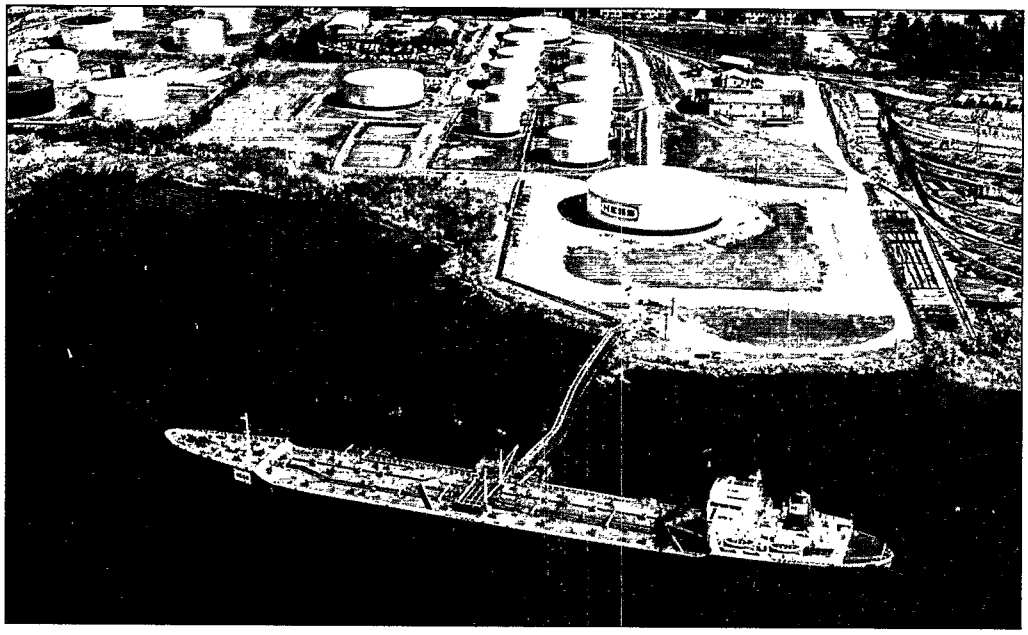
Atmospheric deposition, however, may be a significant source of pesticides, nitrates, and PCBs. Lindane, dieldrin, DDT, HCB, chlordane, endrin, aldrin, and PCBs continue to be found in Lake Superior rainwater. Lake Superior is highly susceptible to atmospheric inputs of contaminants because of its large surface area, long water retention time, low biological productivity, and low sedimentation rate.

Minnesota reports that all fish species except coho salmon contained detectable amounts of PCBs in a survey of five Lake Superior sites. Wisconsin, Michigan, and Minnesota maintain fish consumption advisories for PCBs along the entire Lake Superior shoreline.

■ The St. Louis River and Bay near Duluth, MN, have been identified as an Area of Concern by the IJC. Sediments in the river and bay contain elevated concentrations of mercury, PCBs, and coal tars. Fish consumption advisories have been issued and dredge spoil disposal is currently restricted. A Remedial Action Plan is in preparation. A citizens advisory committee and several technical committees have investigated concerns about toxics, water quality, sedimentation, habitat, and biota. The committees will identify designated uses impaired by pollution, propose goals and objectives to restore the uses, and recommend solutions.

Lake Michigan

The open waters of Lake Michigan are classified as oligotrophic. Data collected in 1987 indicate that overall phosphorus concentrations continue to decline in Lake Michigan. However, nearshore waters in Green Bay and along the southern portion of the lake continue to suffer from noxious algal blooms during the summer. To address the persistent eutrophication problems, the Green Bay Remedial Action Plan calls for a 40 to 50 percent reduction in phosphorus loading. Significant sources of phosphorus, sediments, BOD, and bacteria include animal wastes, municipal dischargers, urban runoff, construction sites, upstream contamination in Lake Winnebago, cropland and stream bank erosion, and industrial dischargers.



Traditional sources of pollution in the Great Lakes include discharges from industrial and municipal facilities.

Wisconsin reports that aquatic plant communities and fish populations have improved owing to increased clarity, tighter control of commercial fishing and, to some extent, water quality improvements. However, Wisconsin is concerned about habitat modifications resulting from bulkhead construction, dredging, and filling for marina development. Wisconsin is investigating the environmental effects associated with marina operations, including sampling for tributyltin.

The status of fish contamination could not be updated because of a lack of data.

Lake Huron

Lake Huron is classified as oligotrophic, but contains one eutrophic area—Saginaw Bay. Water quality is generally better in the northern half of the lake, but improvements in Saginaw Bay's water quality have contributed to an overall improvement in southern Lake Huron's water quality.

Michigan reports that water quality in open areas of Lake Huron continues to show an upward trend in nitrate concentrations but no significant trends for total phosphorus, chloride, or chlorophyll *a* concentrations. Pesticides and PCBs have been detected in open water samples, but at low concentrations; detected pesticides include dieldrin, endrin, chlordane, DDE, and endosulfan.

Michigan noted an increase in PCB concentrations in lake trout, reversing former trends of declining fish tissue PCB concentrations. However, on a lakewide basis, PCBs have not affected the Lake Huron fishery to the extent that the fisheries of Lake Michigan and Lake Superior have been affected. Lake trout DDT residues continued to fluctuate but remained below concentrations observed during the 1970s. Selenium and arsenic concentrations in top predator species and rainbow smelt continue to be higher in Lake Huron than in other Great Lakes fish species, but natural sources are suspected.

■ The Lower Saginaw River, an Area of Concern, is one of five sites selected for the Assessment and Remediation of Contaminated Sediments (ARCS) program conducted by EPA and the U.S. Army Corps of Engineers. ARCS is a 5-year study and demonstration project investigating control and removal of toxic pollutants in the Great Lakes. Removal of toxic materials from bottom sediments is a program priority. Sediment sampling of the Saginaw River began in 1989, but the results are not yet available.

Lake Erie

Michigan reports that Lake Erie's water quality has improved dramatically in the last two decades. Once declared "dead" because excess nutrients overfertilized the lake and decaying algae depleted large regions of oxygen, Lake Erie now supports the largest walleye sport fishery on the Great Lakes. However, Lake Erie is still classified as eutrophic and nearshore contamination problems persist. Lake Erie is more susceptible to nutrient enrichment problems because of its shallow depths and warm water temperatures.

The western basin of Lake Erie exhibits the most serious symptoms of eutrophication as well as the highest levels of toxic contamination. Concentrations of many compounds, particularly PCBs, lindane, and 1,4-dichlorobenzene, are highest in the western basin. Of 17 pesticides, PCBs, and chlorobenzenes detected in open waters of Lake Erie, only PCBs and α-BHC were found at significant concentrations throughout the lake.

Michigan reported no change in contaminant residues in walleye fish tissues. Mercury levels remain below Food and Drug Administration (FDA) action levels and concentrations of other contaminants are relatively low. Concentrations of PCBs,

Doreen Robb, EPA Wetlands Division

Establishing a sampling station along a Lake Erie coastal wetland.

DDT, and other organic toxics do not exhibit any trends and have not declined significantly since monitoring began in 1977.

A fish advisory for carp and channel catfish remains in effect along Pennsylvania's Lake Erie shoreline due to elevated concentrations of PCBs and chlordane. Pennsylvania notes that trout and salmon collected in Lake Erie do not exhibit unsafe contaminant concentrations.

The status of Ohio's Lake Erie shoreline has not changed since the 1988 report. Elevated cadmium and copper concentrations persist in the water column. A lakewide fish advisory for PCBs in carp and channel catfish remains in effect. Ohio reports that point sources are still responsible for the majority of impairments on its Great Lakes' shoreline.

Ohio is developing cost-effective alternatives to open lake disposal of dredged sediments. The State also intends to develop biocriteria for rivermouth areas entering Lake Erie and believes the biocriteria approach could be applied to nearshore and open lake waters if appropriate evaluations are selected and calibration is established.

■ The RAP process for the Cuyahoga River, initiated in 1987, has generated a 3-year fish tissue monitoring program and a fecal coliform bacteria survey.

■ The Ashtabula River RAP process has accelerated implementation of remedial actions and enhanced local citizen participation. Monitoring activities include a biological survey of the river performed in 1989. The draft Phase 1 report was reviewed during 1989 and is currently under revision. Phase 2 will select remedial actions and funding mechanisms. Much of the remedial work on the Ashtabula River involves expensive dredging and disposal of highly contaminated sediments. Until the sources and extent of pollution are better defined, responsibility for the cleanup cannot be delegated.

■ At the Black River, USX Steel is dredging sediments contaminated with polyaromatic hydrocarbons (PAHs), and wastewater treatment plant construction and upgrades are underway to eliminate bypasses at the eastside Lorain plant.

Lake Ontario

New York reports that bioaccumulation of toxic chemicals in fish flesh is the primary problem on Lake Ontario. Toxics from the entire upper Great Lakes system drain into Lake Ontario. Past discharges from the chemical industry concentrated on the New York shoreline and Canada's Hamilton Harbor industrial complex have also contributed to the toxics problem.

The Lake Ontario Toxics Management Plan, completed in 1989, requires the NY Department of Environmental Conservation, EPA, the Ontario Ministry of the Environment, and Environment Canada to explore additional measures to reduce toxic contamination. The goal of the Management Plan is to reduce toxic contamination to levels that provide clean drinking water and fish that are safe for unlimited consumption. Lake water quality should also support reproduction of the most sensitive native species. The Management Plan commits the agencies to implementing specific controls and monitoring activities and improving the effectiveness of existing programs.

Niagara River

Programs implemented during the early 1980s reduced priority pollutant loads into the Niagara River from point sources by 80 percent. Load reductions resulted from permit revisions, remediation at hazardous waste sites, criteria development, and enhanced monitoring. The current Niagara River Management Plan, initiated in 1987, targets both point and nonpoint sources for an additional 50 percent reduction in toxics over a 10-year period.

Upper Great Lakes Connecting Channels

Lakes Superior, Michigan, and Huron are referred to as the upper Great Lakes. They are connected by the St. Mary's, St. Clair, and Detroit Rivers and Lake St. Clair. Heavy urban and industrial development along the channels and their use as transportation corridors have produced long-term water quality degradation. Mercury contamination in Lake St. Clair and phenol contamination in the St. Mary's River were first identified in the 1940s. Heavy

metals, organochlorine pesticides, and PCBs remain in the fish, sediment, and waters of the connecting channels.

The St. Mary's River delivers the outflow of Lake Superior over 68 miles to Lake Huron. The St. Mary's River exhibits good water quality overall, but industrial and municipal effluents have degraded the area near Sault St. Marie, Ontario. Contaminants of concern include heavy metals, oil and grease, phenols, ammonia, and bacteria.

The St. Clair River flows 39 miles from Lake Huron to Lake St. Clair. Sediments are contaminated with PCBs, oil and grease, mercury, and other metals. Fisheries are impacted by PCBs and mercury. Recent surveys indicate that the benthic community is impaired in the immediate vicinity of a petrochemical complex at Sarnia, Ontario. The sediments near Sarnia are also contaminated with pollutants characteristic of the petrochemical industry, including hexachlorobenzene, hexachlorobutadiene, carbon tetrachloride, and hexachloroethane. However, the zone of impairment has decreased from a distance of 27 miles in 1968 to 7.5 miles in 1985. The improvements reflect reductions of effluent contamination concentrations implemented during the 1970s and 1980s.

Lake St. Clair receives most of its inflow from the St. Clair River. There are no direct point source discharges into Lake St. Clair and the water quality is good, especially in the northern portion. Thermal stratification does not occur and oxygen concentrations remain near saturation concentrations throughout the lake. Lake St. Clair is the only connecting channel that is not classified as an Area of Concern. However, the lake does receive contaminants from upstream sources and atmospheric deposition, and mercury contamination of fish is a primary concern.

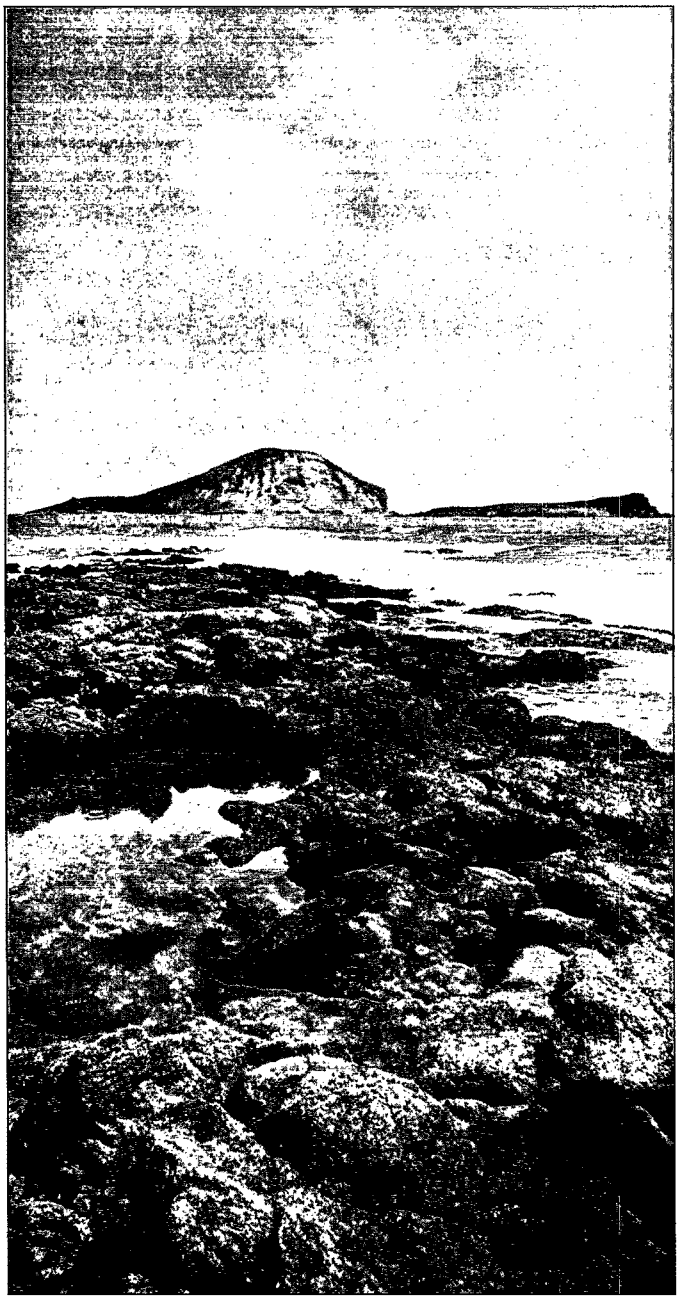
The Detroit River connects Lake St. Clair to Lake Erie. The Detroit watershed is one of the world's most heavily industrialized areas, and it suffers from the most severe environmental problems of the upper Great Lakes connecting channels. Improvements have been made in controlling point source discharges of oil and grease, phosphorus, ammonia, chloride, and phenols, but sediment contamination persists. Remaining problems include elevated concentrations of PCBs, oil and grease, PAHs, mercury, and other heavy metals in sediments, bacterial contamination, and fish consumption advisories. Contaminants originate from numerous municipal and industrial outfalls, urban runoff, combined sewer overflows, atmospheric deposition, and contaminated tributaries.

Remedial Action Plans for the connecting channels are in the initial stages of development. Recent completion of the IJC's Upper Great Lakes Connecting Study should expedite RAP preparation.

Roger Thoms

Mercury and PCB contamination in sport fish such as trout and salmon is a lingering problem in the Great Lakes.

4



Patricia Cunningham

Estuaries and Coastal Waters

Estuaries

Support of Designated Uses

Twenty-two States, Jurisdictions, and Interstate Commissions (hereafter referred to as States) provided use support information on their estuarine waters in their 1990 State Section 305(b) reports (see Table 4-1). A total of 26,693 square miles were assessed, 75 percent of the estuarine waters in these States.

Of these assessed waters, 15,004 square miles, or 56 percent, were found to fully support designated uses. An additional 11 percent (3,052 estuarine square miles) currently support uses but are threatened by pollution and could become impaired if control actions are not taken. Twenty-five percent of assessed estuarine waters (6,573 square miles) partially support uses, and 8 percent (2,064 square miles) do not support their designated uses (see Figure 4-1). Twenty-one States specified the basis of their assessment decisions for 25,827 square miles. These States based 66 percent of their estuarine assessments on monitoring data and 34 percent on evaluative methods, such as mathematical models or fisheries surveys.

Although estuarine reporting appears fairly comprehensive, eight estuarine States failed to provide summary information on designated use support in their estuarine waters. Thirteen States claim that they assessed all of their estuarine waters in 1990, and, of these, five report that their assess-

Table 4-1. Designated Use Support in Estuaries

State	Estuary Square Miles	Square Miles Assessed: Total	Square Miles Assessed: Percent Evaluated	Square Miles Assessed: Percent Monitored	Sq. Miles Fully Supporting	Sq. Miles Threatened	Sq. Miles Partially Supporting	Sq. Miles Not Supporting
Alabama	625	103	12	88	65	35	3	0
California	1,598	799	26	74	267	—	39	493
Connecticut	601	601	4	96	363	4	229	5
Delaware River Basin	866	866	—	—	0	855	0	11
District of Columbia	6	6	0	100	0	0	0	6
Florida	4,298	2,712	27	73	1,639	25	861	187
Georgia	594	594	83	17	584	—	8	2
Hawaii	134	134	0	100	40	0	94	0
Louisiana	7,656	5,445	86	14	1,862	1,953	1,630	0
Maine	1,633	1,633	88	12	1,473	0	36	124
Maryland	2,523	2,523	15	85	109	10	2,312	92
Massachusetts	177	136	18	82	18	0	17	101
Mississippi	133	133	90	10	120	6	7	0
New York	1,564	1,564	0	100	1,140	11	150	263
North Carolina	3,194	3,194	0	100	2,894	8	290	2
Oregon	206	61	0	100	4	—	57	0
Rhode Island	193	193	26	74	142	17	18	16
South Carolina	2,155	364	0	100	244	0	2	118
Texas	1,990	1,990	0	100	1,505	0	0	485
Virginia	2,529	2,529	25	75	2,158	—	368	3
Virgin Islands	6	6	0	100	4	1	1	1
Washington	2,943	1,106	7	93	373	127	451	155
Totals	35,624	26,692	66	34	15,004	3,052	6,573	2,064
Percent of Assessed Waters					56.2%	11.4%	24.6%	8.0%

— Not reported.

Source: 1990 State Section 305(b) reports.

Table 4-2. Impaired Estuary Square Miles Affected by Causes of Pollution

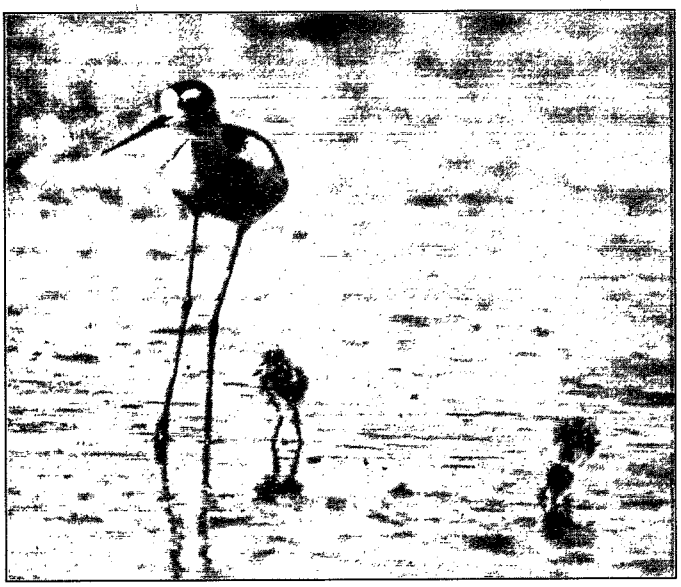
State	Total Impaired Waters*	Nutrients: Major	Nutrients: Mod/Min	Organic Enrichment: Major	Organic Enrichment: Mod/Min	Pathogens: Major	Pathogens: Mod/Min	Priority Organics: Major	Priority Organics: Mod/Min	Suspended Solids: Major	Suspended Solids: Mod/Min
District of Columbia	6	—	1	1	—	1	5	—	—	—	—
Florida	1,048	216	583	1	40	—	45	—	44	68	362
Georgia	10	—	—	2	4	—	—	—	—	—	—
Hawaii	94	—	46	—	—	—	—	—	—	—	—
Maine	160	—	—	1	—	38	—	3	—	—	—
Maryland	2,404	1,033	1,159	957	283	87	113	—	—	—	—
Massachusetts	118	1	14	2	16	95	16	15	18	—	28
New Jersey	143	70	—	—	—	142	—	70	—	—	—
New York	413	—	102	12	101	244	123	145	268	—	—
North Carolina**	292	—	—	226	—	35	—	—	—	—	—
Oregon**	57	—	—	—	—	57	—	—	—	—	—
Rhode Island	34	—	14	7	—	28	2	—	—	—	—
South Carolina	120	24	13	24	13	112	—	—	—	—	—
Texas	485	—	—	—	—	329	22	—	—	—	—
Virgin Islands	2	—	1	—	1	—	1	—	—	—	1
Washington	605	2	0	152	33	209	77	56	298	0	8
Totals	5,991	1,346	1,933	1,385	491	1,377	404	289	628	68	399
Combined Totals			3,279		1,876		1,781		917		467
Percent of Impaired Waters			54.7%		31.3%		29.7%		15.3%		7.8%

* The sum of partially and nonsupporting estuary square miles (Table 4-1).

** These States did not specify the degree of impact (i.e., Major or Moderate/Minor); estuary square miles were placed in the "Major" column for national reporting purposes.

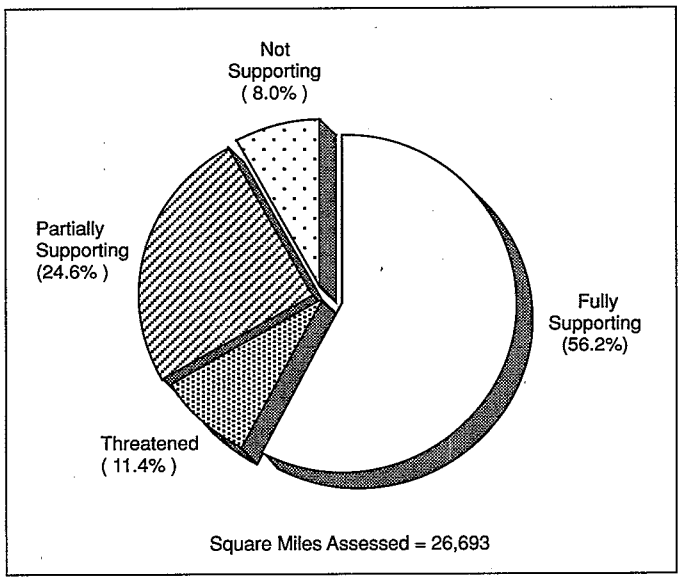
— Zero or not reported.

Source: 1990 State Section 305(b) reports.



US Fish and Wildlife Service

Black-necked stilt and chicks.



Source: 1990 State Section 305(b) reports.

Figure 4-1. Designated Use Support in Assessed Estuaries

Metals		Siltation		Pesticides		Unknown		Ammonia		pH		Oil and Grease	
Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
—	6	1	—	—	—	—	—	—	2	—	1	—	—
—	208	—	—	—	—	—	68	—	—	—	—	—	—
—	3	—	—	—	—	—	—	—	—	—	—	—	—
—	3	—	46	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	19	20	—	—	—	—	—	—	16	—	—
14	24	—	—	—	—	—	—	32	10	—	—	—	6
—	—	140	—	70	—	—	—	—	—	—	—	—	—
—	33	—	—	—	—	—	—	—	1	—	—	—	27
8	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—	—
7	8	—	—	—	—	—	—	—	1	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	14	—	—
3	58	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—
43	9	2	104	11	4	41	—	—	12	—	5	1	2
79	352	143	169	101	4	41	68	32	26	0	36	1	35
	431		312		105		109		58		36		36
	7.2%		5.2%		1.8%		1.8%		1.0%		0.6%		0.6%

ments were based entirely on monitoring data. As with rivers and lakes, the area of estuarine waters found to be fully supporting uses varied from zero to 98 percent of assessed waters, with only three States reporting that over 90 percent of their assessed estuarine waters fully support designated uses.

Causes of Impairment

For their estuarine waters, 16 States provided information on the causes of nonsupport (see Table 4-2). States were asked to provide the number of estuarine square miles under each cause category that contribute to impairment and to assign a degree of impact of major or moderate/minor. Therefore, any given square mile may be counted under several categories if it is affected by a number of causes. The values reported are the total number of estuarine square miles affected by a particular cause of impairment, according to whether the cause is a major or moderate/minor contributor to impairment. The relative extent of each cause of nonsupport is determined by dividing the number of square miles in each cause category by the total square miles impaired (see Figure 4-2).

Nutrients are reported by the States as the leading cause of nonsupport in estuaries, affecting 55 percent of total impaired square miles. Organic enrichment/low dissolved oxygen was found to affect 31 percent of impaired waters. Pathogens are the third leading cause of impairment, affecting 30 percent of assessed estuarine areas. These findings indicate that eutrophication (caused by excessive amounts of nutrients) and high concentrations of bacteria—which can lead to restrictions in shellfishing waters—are the leading threats to the Nation's estuaries.

Other causes identified by the States were priority organics, affecting 15 percent of impaired waters; suspended solids affecting 8 percent; metals, affecting 7 percent; and siltation, affecting 5 percent.

These figures should be interpreted with care because almost half of the States with estuarine waters did not provide information on causes of pollution. As a result, regional problems may be overlooked for areas where States failed to report

Table 4-3. Impaired Estuary Square Miles Affected by Sources of Pollution

State	Total Impaired Waters*	Municipal		Storm Sewers/ Runoff		Land Disposal		Agriculture		Construction	
		Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
District of Columbia	6	—	1	1	2	—	—	—	—	—	—
Florida	1,048	—	767	3	948	—	589	1	550	—	485
Georgia	10	—	—	—	—	—	—	—	—	—	—
Maine	160	117	6	—	—	—	—	—	—	—	—
Maryland	2,404	—	—	65	45	47	19	22	53	—	—
Massachusetts	118	50	28	20	83	2	20	—	7	—	12
New Jersey	143	140	—	140	—	—	—	70	—	140	—
New York	413	57	200	102	71	5	68	—	4	—	—
North Carolina**	292	46	—	28	—	12	—	130	—	—	—
Oregon**	57	57	—	27	—	57	—	53	—	—	—
Rhode Island	34	7	25	15	17	2	7	—	—	—	—
South Carolina	120	—	—	50	—	—	—	5	—	—	—
Texas	485	257	22	—	—	—	—	—	—	—	—
Virgin Islands	2	—	—	—	1	—	—	—	—	—	—
Washington	605	65	193	40	132	218	91	166	13	—	3
Totals	5,897	796	1,242	491	1,299	343	794	447	627	140	500
Combined Totals			2,038		1,790		1,137		1,074		640
Percent of Impaired Waters			34.6%		30.4%		19.3%		18.2%		10.9%

* The sum of partially and nonsupporting estuary square miles (Table 4-1).
** These States did not specify the degree of impact (i.e., Major or Moderate/Minor); estuary square miles were placed in the "Major" column for national reporting purposes.

— Zero or not reported.

Source: 1990 State Section 305(b) reports.

causes of impairment. Also, the significance of causes affecting large estuaries such as the Chesapeake Bay may be exaggerated and may overshadow problems affecting smaller estuarine systems. This is reflected by the fact that Maryland alone accounts for 67 percent of those estuarine waters affected by nutrients and for 66 percent of the estuarine waters impacted by organic enrichment.

Fourteen States specified the degree of impact (i.e., major or moderate/minor) of the causes of degradation in their estuarine waters. Among these, major impacts far outweighed moderate/minor impacts for a variety of pollutants including organic enrichment, pathogens, and pesticides. For example, in 74 percent of waters impaired by organic enrichment, the impact was considered major, as was the impact of pathogens in 77 percent of affected waters.

Sources of Impairment

In their 1990 State Section 305(b) reports, 15 States provided information on the various sources of pollution contributing to use impairment in their estuarine waters (see Table 4-3). States provided the total number of square miles under each of the source categories that contribute to impairment and, in most cases, assigned a degree of impact of major or moderate/minor.

As discussed earlier, any given square mile may be counted under several categories if it is affected by a number of sources. The values reported are the total number of estuarine square miles affected by a particular source of pollution, according to whether the source is a major or moderate/minor contributor to impairment. The relative extent of each source of nonsupport is determined by dividing the number of square miles in each source category by the total square miles impaired (see Figure 4-3).

Table 4-3 illustrates a somewhat different water quality picture for estuaries than for inland waters. The most extensive source of pollution cited by the States in their estuarine waters is municipal discharges (affecting 35 percent of impaired square miles), followed by storm sewers/runoff (affecting 30 percent), land disposal (affecting 19 percent) agriculture (affecting 18 percent), construction (affecting 11

Industrial		Combined Sewers		Hydrologic/ Habitat Mod		Unknown		Resource Extraction		Silviculture	
Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
—	—	3	—	—	1	—	—	1	—	—	—
15	390	—	—	—	200	4	—	—	90	—	34
2	8	—	—	—	—	—	—	—	—	—	—
—	—	—	1	—	1	—	—	—	—	—	—
—	—	—	3	—	—	—	—	—	—	—	—
8	28	44	15	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	19	115	78	—	—	—	—	—	—	—	—
15	—	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—
—	30	30	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	67	—	—	—	14	—
—	—	—	—	—	—	5	54	—	—	—	—
1	—	1	1	—	—	—	—	—	—	—	—
59	22	55	13	104	1	41	18	—	—	41	—
118	497	248	111	104	203	117	72	1	90	55	34
	615		359		307		189		91		89
	10.4%		6.1%		5.2%		3.2%		1.5%		1.5%

percent), and industrial discharges (affecting 10 percent).

These figures may create an inaccurate impression of the leading sources of estuarine impairment because Louisiana did not report the sources of impairment for its estuarine waters (a significant portion of total impaired estuarine waters). Maryland also reported large areas of impaired estuarine waters (2,404 square miles) but identified sources affecting only 254 square miles of impaired estuarine waters. As a result, sources affecting large estuarine tracts in these States, such as resource extraction in Louisiana, are not adequately reflected in the ranking of leading sources.

Thirteen states specified the degree of impact of pollution sources in their estuarine waters. Moderate/minor impacts outweigh major impacts in waters affected by all sources except combined sewers, silviculture, and "unknown" sources.

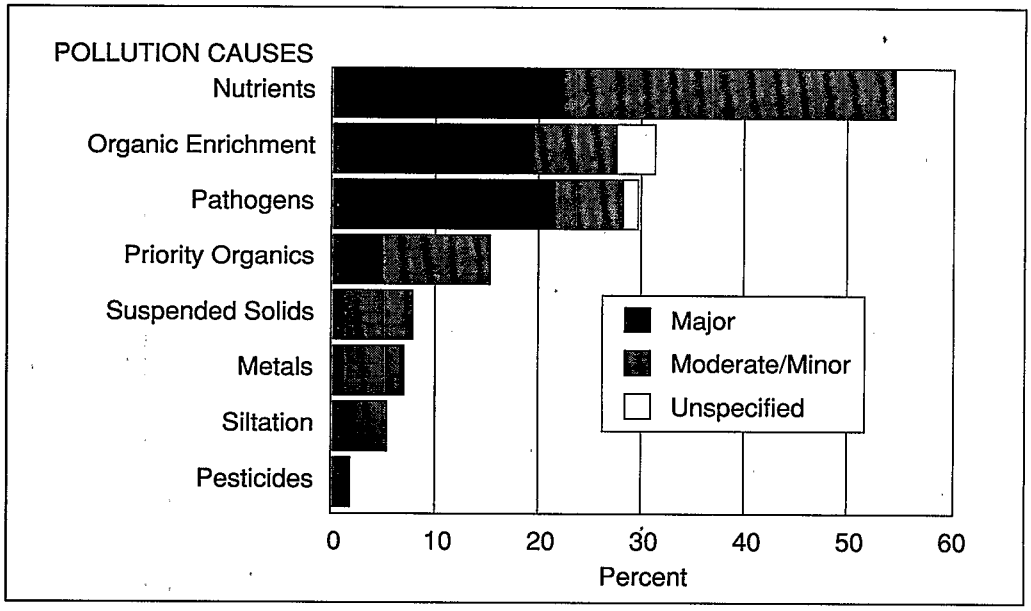
Attainment of the Clean Water Act Goals

The basic goals of the Clean Water Act—that waters be clean enough to support fishing and swimming—apply to the Nation's estuaries as well as to its rivers and lakes. Twenty-one States provided information on CWA goal attainment in estuarine waters (see Table 4-4).

A total of 22,572 estuarine square miles were assessed for the fishable goal of the CWA. Of these, 77 percent attain fishing uses, 16 percent partially attain fishing uses, 7 percent do not currently attain fishing uses but might in the future, and less than 1 percent (12 square miles) are "not attainable" (i.e., affected by irrevocable impacts or not designated by the State for fishing uses).

Nearly the same number of estuarine square miles were assessed for the swimmable goal of the CWA. A higher percentage of waters—88 percent of the 21,986 square miles assessed—attain the swimmable goal. Eight percent partially meet the goal, 5 percent do not currently attain the goal, and less than 1 percent (21 square miles) are not attainable. Figure 4-4 illustrates progress toward attainment of the CWA goals in the Nation's estuaries.

More waters meet the swimmable goal than the fishable goal for several reasons. First, bacterial standards are generally less restrictive for contact recreation than for shellfish harvesting; therefore, more



Source: 1990 State Section 305(b) reports.

Figure 4-2. Percent of Impaired Estuary Square Miles Affected by Causes of Pollution

waters are likely to be impaired for fishing. Second, more measures have been developed to evaluate fishable use impairments, such as fish consumption advisories and various habitat modifications (e.g., loss of submerged aquatic vegetation or deposition of sediments on cobbled spawning areas). In contrast, bacterial standards are the only quantitative measure frequently used to determine attainment of the swimmable goal.

Ocean Coastal Waters

Support of Designated Uses

Eleven States and two Territories (hereafter referred to as States) reported on the degree to which their ocean coastal waters support the uses for which they have been designated (see Table 4-5). These States assessed 4,230 coastal miles, 33 percent of their total miles and only about 22 percent of the Nation's estimated 19,200 miles of ocean coastline.*

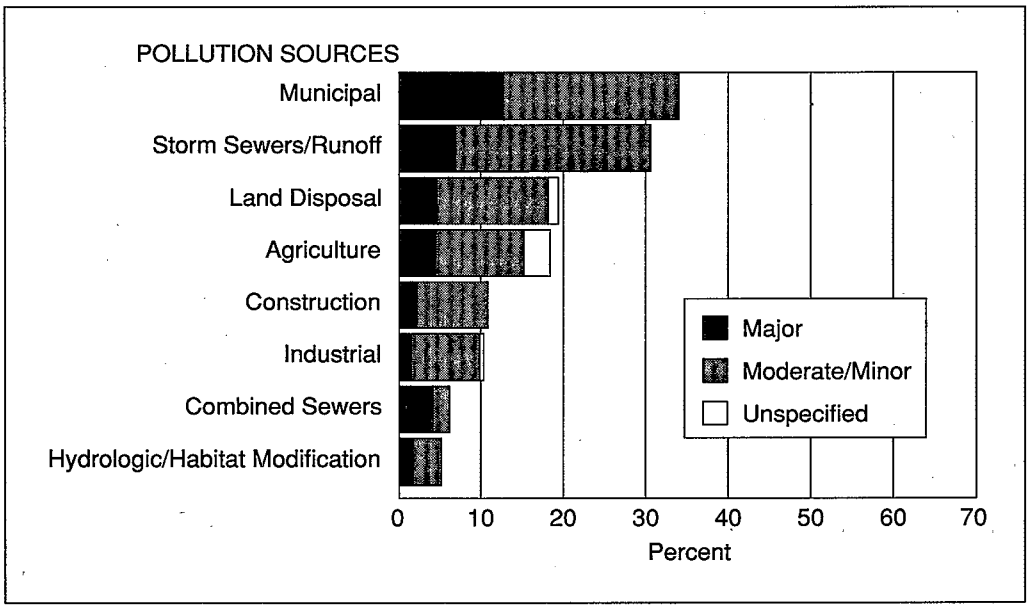
Of the assessed coastal miles, 3,775 miles (89 percent) were found to fully support their designated uses. An additional 1 percent (49 miles) support uses but are threatened and likely to become impaired if pollution control actions are not taken. Seven percent of assessed coastal miles (290 miles) partially support uses, and 3 percent (116 miles) do not support uses (see Figure 4-5). All 13 States specified the basis of their assessment decisions (i.e., whether monitored data or evaluative information was used). In these States, 48 percent of the miles were assessed using evaluative information and 52 percent using monitoring data.

Although these figures may satisfactorily portray coastal conditions in these 13 States, they are not necessarily representative of the Nation as a whole because they apply to so few waters. Inconsistent reporting and assessment methodologies also make it difficult to draw conclusions on a national scale.

Causes and Sources of Impairment

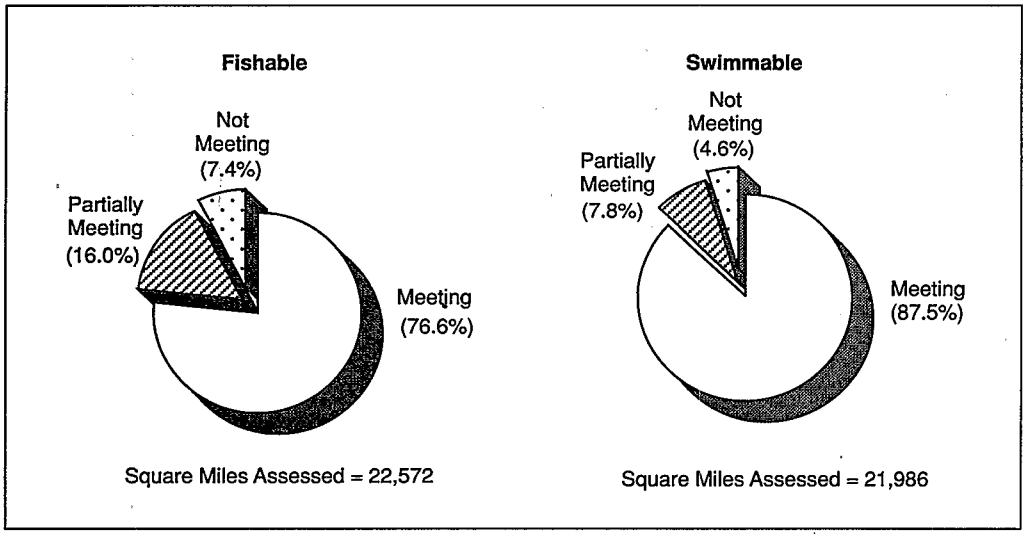
Only five States provided information on the causes and sources of nonsupport in ocean coastal waters not

*Estimate excludes figures for Connecticut, Rhode Island, and Alaska.



Source: 1990 State Section 305(b) reports.

Figure 4-3. Percent of Impaired Estuary Square Miles Affected by Sources of Pollution



Source: 1990 State Section 305(b) reports.

Figure 4-4. Attainment of Clean Water Act Goals in Assessed Estuaries

Table 4-4. Attainment of Clean Water Act Goals in Estuaries

	Fishable Goal (square miles)					Swimmable Goal (square miles)				
State	Assessed	Meeting	Partially Meeting	Not Meeting	Not Attainable	Assessed	Meeting	Partially Meeting	Not Meeting	Not Attainable
Alabama	103	100	3	0	0	103	100	3	0	0
California	799	306	2	491	—	795	349	0	446	—
Connecticut	600	366	218	16	0	600	554	16	30	0
Delaware River Basin	866	802	4	60	0	866	855	0	11	0
District of Columbia	6	0	0	6	0	6	0	0	6	0
Florida	2,730	2,410	133	187	0	2,730	2,410	133	187	0
Georgia	594	584	8	2	0	0	—	—	—	—
Hawaii	40	40	—	0	0	40	40	—	0	0
Louisiana	4,684	4,432	252	0	—	4,685	3,535	1,078	72	—
Maine	1,633	1,475	36	122	0	1,633	1,631	0	2	0
Maryland	2,522	107	2,283	132	0	2,522	2,520	0	2	0
Massachusetts	137	78	13	46	0	137	53	46	38	0
Mississippi	133	126	7	0	0	133	132	1	0	0
Oregon	61	4	57	0	—	61	61	0	0	—
New York	1,569	1,229	—	335	5	1,578	1,487	—	77	14
Rhode Island	193	182	0	4	7	193	182	0	4	7
South Carolina	364	338	25	1	0	364	320	18	26	0
Texas	1,991	1,933	—	58	—	1,990	1,990	—	0	—
Virginia	2,529	2,158	368	3	—	2,529	2,158	368	3	—
Virgin Islands	6	4	1	1	0	5	3	1	1	0
Washington	1,012	605	210	197	—	1,016	860	49	107	—
Totals	22,572	17,279	3,620	1,661	12	21,986	19,240	1,713	1,012	21
Percent of Assessed Waters		76.6%	16.0%	7.4%	0.0%		87.5%	7.8%	4.6%	0.0%

— Not reported.

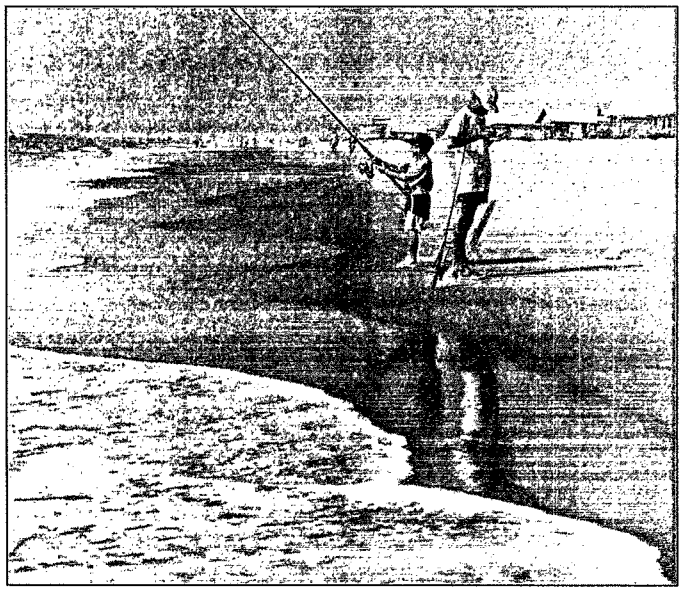
Source: 1990 State Section 305(b) reports.

Table 4-5. Designated Use Support in Oceans

State	Ocean Square Miles	Coastal Miles Assessed			Miles Fully Supporting	Miles Threatened	Miles Partially Supporting	Miles Not Supporting
		Total	Percent Evaluated	Percent Monitored				
Alabama	50	50	100	0	50	0	0	0
California	1,840	1,118	48	52	1,046	—	49	23
Delaware	25	25	100	0	25	0	0	0
Florida	8,460	880	37	63	832	0	36	12
Hawaii	824	824	62	38	824	0	0	0
Maryland	32	32	0	100	32	0	0	0
Mississippi	81	81	0	100	0	10	60	11
New York	130	130	0	100	60	0	70	0
Puerto Rico	434	434	72	28	252	38	75	69
Texas	367	367	0	100	367	0	0	0
Virginia	112	112	100	0	112	—	0	0
Virgin Islands	173	14	0	100	12	1	0	1
Washington	165	163	100	0	163	0	0	0
Totals	12,693	4,230	48	52	3,775	49	290	116
Percent of Assessed Waters					89.2%	1.2%	6.9%	2.7%

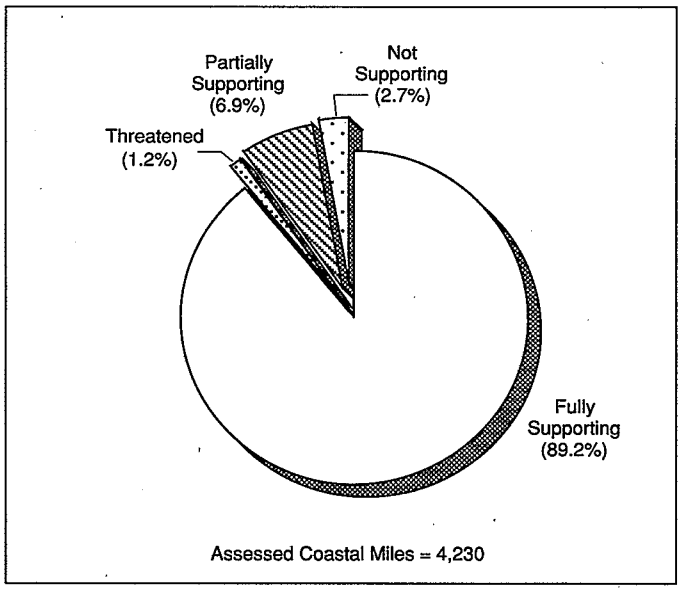
— Not reported.

Source: 1990 State Section 305(b) reports.



Julie Dufin

Recreational fishing at Topsail Beach, North Carolina.



Source: 1990 State Section 305(b) reports.

Figure 4-5. Designated Use Support in Assessed Oceans

Table 4-6. Impaired Ocean Coastal Miles Affected by Causes of Pollution

State	Total Impaired Waters*	Pathogens		Priority Organics		Nutrients		Unknown		Habitat Modification	
		Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
Florida	48	—	—	—	—	17	12	—	19	—	—
Mississippi	71	36	35	—	—	—	—	—	—	—	—
New York	70	12	—	—	70	—	—	—	—	—	—
Puerto Rico	144	1	32	—	3	—	26	—	12	3	21
Virgin Islands	1	—	—	—	—	—	—	—	—	—	1
Totals	334	49	67	0	73	17	38	0	31	3	22
Combined Totals			116		73		55		31		25
Percent of Impaired Waters			34.7%		21.9%		16.5%		9.3%		7.5%

*The sum of partially and nonsupporting coastal miles (Table 4-5).

— Zero or not reported.

Source: 1990 State Section 305(b) reports.

Table 4-7. Impaired Ocean Coastal Miles Affected by Sources of Pollution

State	Total Impaired Waters*	Storm Sewers/ Runoff		Land Disposal		Agriculture		Contaminated Sediments		Municipal	
		Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
Florida	48	—	28	—	28	—	47	—	—	—	—
Hawaii	0	—	—	—	—	—	41	—	—	—	3
Mississippi	71	—	71	—	61	—	—	—	—	—	10
New York	70	—	—	—	—	—	—	—	70	—	12
Puerto Rico	144	4	16	1	32	—	0	—	—	7	17
Totals	333	4	115	1	121	0	88	0	70	7	42
Combined Totals			119		122		88		70		49
Percent of Impaired Waters			35.7%		36.6%		26.4%		21.0%		14.7%

*The sum of partially and nonsupporting coastal miles (Table 4-5).

— Zero or not reported.

Source: 1990 State Section 305(b) reports.

fully supporting uses (see Tables 4-6 and 4-7). Because these cause and source data include only a small proportion (2 percent) of the Nation's total ocean coastal waters, they may not be representative of coastal pollution influences.

Attainment of the Clean Water Act Goals

Thirteen States provided information on the extent to which their ocean coastal waters attain the fishable and swimmable goals of the Clean Water Act. Table 4-8 displays this information.

Figure 4-6 reveals that 92 percent of the 4,184 assessed coastal miles attain the fishable goal, 5 percent partially attain the goal, 3 percent do not currently attain the goal but might in the future, and less than 1 percent (4 miles) are not attainable—that is, are irrevocably affected by pollution or are not designated for fishing.

Ninety-two percent of the 4,165 miles assessed attain the swimmable goal, 4 percent partially attain the goal, 2 percent of the miles do not meet the goal, and 2 percent cannot attain the swimmable goal (see Figure 4-6). All of the waters unable to attain the swimmable goal are located in Puerto Rico, which did not identify the reason for nonattainability in its coastal waters.

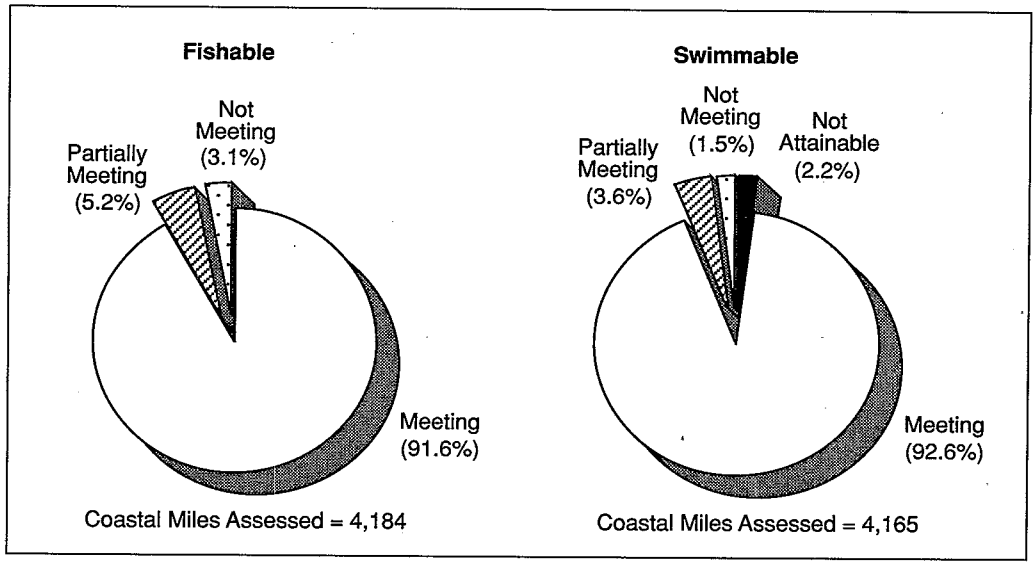
New Initiatives in Estuarine and Coastal Waters

The National Estuary Program

Authorized by Congress in 1985 and formally established in 1987 by amendments to the Clean Water

Unknown Toxicity		Suspended Solids		Organic Enrichment		Oil and Grease		Nonpriority Organics		Metals	
Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
—	—	—	—	—	12	—	—	—	—	—	—
—	10	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
5	8	—	18	1	4	—	3	—	3	—	2
—	—	—	—	—	—	—	—	—	—	—	—
5	18	0	18	1	16	0	3	0	3	0	2
	23		18		17		3		3		2
	6.9%		5.4%		5.1%		0.9%		0.9%		0.6%

Habitat Modification		Industrial		Construction		Combined Sewers		Unknown	
Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
—	47	—	—	—	17	—	—	—	—
—	—	—	31	—	—	—	—	—	—
—	—	—	10	—	—	—	—	—	—
—	—	—	—	—	—	12	—	—	—
—	—	8	—	—	—	—	—	—	6
0	47	8	41	0	17	12	0	0	6
	47		49		17		12		6
	14.1%		14.7%		5.1%		3.6%		1.8%



Source: 1990 State Section 305(b) reports.

Figure 4-6. Attainment of Clean Water Act Goals in Assessed Oceans

Act, the National Estuary Program (NEP) adopts a geographic, basin-wide approach to environmental management. The EPA Administrator selects estuaries for NEP participation from among candidate estuaries nominated by State governors. There must be a likelihood for success in chosen estuaries, as well as evidence of institutional, financial, and political commitment to finding solutions.

This national demonstration program also aims to communicate its lessons to the more than 150 estuaries in the U.S. Among the environmental problems addressed in the NEP estuaries are: loss of aquatic habitat; toxic contamination of estuarine sediments; increased nutrient levels; bacterial contamination; and hypoxia. Seventeen estuaries are currently part of the NEP (see Figure 4-7).

For approved estuaries, the Administrator convenes Management Conferences (groupings of interested Federal, Regional, State, and local governments; affected industries; scientific and academic institutions; and citizen organizations) to define program goals and objectives, identify problems, and design pollution prevention/control and resource management strategies. Each Management Conference creates and begins implementation of a Comprehensive Conservation and Management Plan (CCMP) to protect and restore the estuary.

To encourage and test early management actions, Action Plan Demonstration Projects have been funded in each of the NEP sites. These projects allow the Management Conference to test, on a small scale, actions intended for long-term protection of the estuary; to take early action rather than wait for the completion of the CCMP; to build support for control actions; and to more specifically define the likely cost of the actions. Thirty-eight such demonstration protects are currently underway in NEP estuaries.

In addition, EPA's Office of Wetlands, Oceans, and Watersheds is working with the National Oceanic and Atmospheric Administration (NOAA) and State coastal zone management agencies to implement the provision of the Federal Coastal Zone Management Act of 1972 and its amendments. Under this law, NOAA awards grants to States to develop and administer management programs for coastal zones. In September 1988, EPA and NOAA signed an agreement integrating the Coastal Zone Management and National Estuary Programs. Specific areas of coordination are identified, and mechanisms are established at the national level to facilitate coordination and oversight of both programs.

Table 4-8. Attainment of Clean Water Act Goals in Oceans

	Fishable Goal (coastal miles)					Swimmable Goal (coastal miles)				
State	Assessed	Meeting	Partially Meeting	Not Meeting	Not Attainable	Assessed	Meeting	Partially Meeting	Not Meeting	Not Attainable
Alabama	50	50	0	0	0	50	50	0	0	0
California	1,061	1,000	49	12	—	1,044	1,034	0	10	—
Delaware	25	25	0	0	0	25	25	0	0	0
Florida	892	861	19	12	0	892	861	19	12	0
Hawaii	824	824	—	0	0	824	824	—	0	0
Maryland	32	32	0	0	0	32	32	0	0	0
Mississippi	81	10	60	11	0	81	10	71	0	0
New York	130	60	—	70	0	130	130	—	0	0
Puerto Rico	434	319	88	23	4	434	238	60	41	95
Texas	367	367	—	0	—	367	367	—	0	—
Virgin Islands	13	12	0	1	0	11	10	0	1	0
Virginia	112	112	0	0	—	112	112	0	0	—
Washington	163	163	0	0	0	163	163	0	0	0
Totals	4,184	3,835	216	129	4	4,165	3,856	150	64	95
Percent of Assessed Waters		91.6%	5.2%	3.1%	0.0%		92.6%	3.6%	1.5%	2.2%

— Not reported.

Source: 1990 State Section 305(b) reports.

The Near Coastal Waters Program

The Near Coastal Waters (NCW) Program arose out of EPA's first strategic planning process in 1986. Through this process, EPA, with the assistance of the States and other Federal agencies, formulated a 10- to 15-year blueprint for improving the Agency's environmental management of near coastal waters and for raising the level of coordination among Federal, State, and local program managers.

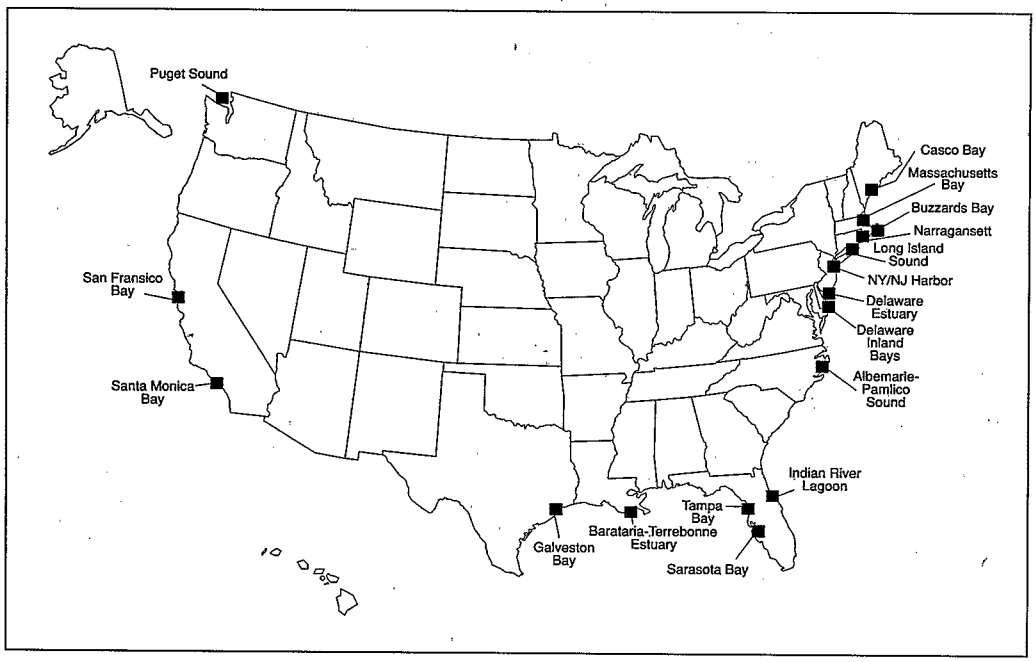
The strategic plan recognized that the multiple threats to the Nation's near coastal waters come from varied sources and require management from a waterbody perspective. Ever-increasing coastal development imposes increased stresses on natural aquatic systems. The NCW program focuses on a geographically targeted waterbody approach that parallels the approach adopted for the 17 estuaries of the NEP but moves beyond that approach to protect all near coastal waters. These may include bays, lagoons, coves, 1,600-mile-long freshwater Great Lakes coasts, and other coastal waterbodies. To date, the program has focused on a limited number of demonstration projects and, in 1990 and 1991, the development of Regional strategies to protect near coastal waters. The NCW Program builds on insights gained in the NEP, Chesapeake Bay, Great Lakes, and other programs; develops new management techniques; and offers flexibility to apply this knowledge as needed across the Nation's vast coastline.

NCW Regional strategies are currently being developed and implemented by the EPA Regions to target geographic areas for special protection. This targeting will allow the focus and enhancement of existing water-quality-based programs for increased coastal protection. Implementation projects include wetlands restoration, training for permit writers, increased enforcement initiatives, and nonpoint source best management practices. As the strategies continue to be developed and improved, they will provide a framework for increased Federal and State protection activities. These strategies will form an important model for the Agency's new Watershed Initiative.

The EPA National Coastal and Marine Policy

In response to the critical threats to our coastal ecosystems, in January 1989, Administrator Lee Thomas signed EPA's National Coastal and Marine Policy (NCMP)—a consolidated statement of EPA goals and objectives for protecting and improving coastal and marine environments. The general policy statement is as follows:

> The Environmental Protection Agency will protect, restore, and maintain the Nation's coastal and marine waters to protect human health and sustain living resources. We will take action to further reduce



Source: 1990 State Section 305(b) reports.

Figure 4-7. Estuaries Participating in the National Estuary Program

pollution of these waters and limit the effects of increasing coastal populations.

The goals of EPA's National Coastal and Marine Policy include

■ Recovery of full recreational use of shores, beaches, and water by reducing sources of bacterial and other contamination, plastics, floatables, and debris;

■ Restoration of the Nation's shellfisheries and saltwater fisheries and protection of marine mammals and living resources by controlling pollution and causes of habitat destruction and loss;

■ Minimization of the use of coastal and marine waters for waste disposal by strictly limiting ocean dumping, tightening controls on land-based sources, and establishing aggressive programs to reduce the amount of waste generated by our society;

■ Greater understanding of the effects of pollution on complex coastal and marine ecosystems by expanding scientific research and monitoring programs and developing new technology;

■ Leadership by the U.S. in protecting the world's oceans by aggressively promoting international efforts to stop pollution and protect critical marine habitats and living resources.

An Agency-wide Standing Committee consisting of Assistant and Regional Administrators was established in August 1989 to oversee EPA's implementation of its NCMP. Action plans were developed that commit the Agency to undertake activities, within EPA's regulatory and nonregulatory capabilities, that will increase our ability to protect coastal and marine areas.

Coastal America

EPA has joined in a partnership with the U.S. Department of the Interior, the U.S. Army Corps of Engineers, and the Department of Commerce's NOAA to protect, restore, and maintain the Nation's coastal living resources. Coordinated by the President's Council on Environmental Quality, Coastal America is intended to lay the groundwork for this effort, building on existing Federal capabilities and authorities to

■ Ensure comprehensive coastal living resource protection and management;

■ Provide a strong national capability to respond quickly and effectively to State and regional needs;

■ Serve as a catalyst to forge similar governmental alliances at the State and local level;

■ Empower States and local governments through outreach and training programs to educate the public on the value of species and habitat, and the effects of land use practices and urban and agricultural runoff and to encourage the public to protect and restore coastal living resources.

Coastal America will support protective environmental projects in coastal areas around the country. The projects will focus on protection/prevention, restoration, and remediation. Within each Region, Federal, State, and local partners will identify critical resource problems and set priorities for action. Within each Region, site-specific coastal resource problems will be addressed on a watershed basis through cooperative efforts. These actions include implementing best management practices, demonstrating and evaluating watershed management strategies, testing alternative mitigation measures, and restoring degraded habitats. Coastal America projects provide an excellent opportunity to implement management actions to protect living resources.

Bill Richards

Controlling pollution and habitat loss is a key goal of EPA's National Coastal and Marine Policy.

5

Patricia Cunningham

Wetlands

Wetlands are either inundated or saturated by water for varying periods of time during the growing season. In all wetlands, the presence of water creates conditions that favor the growth of specially adapted plants (hydrophytes) and promote the development of characteristic hydric soil properties. Wetlands are valuable water resources (see *Highlight–Understanding Wetlands*), and States are making progress in assessing their wetlands problems and threats and developing wetlands protections programs.

Water Quality Standards for Wetlands

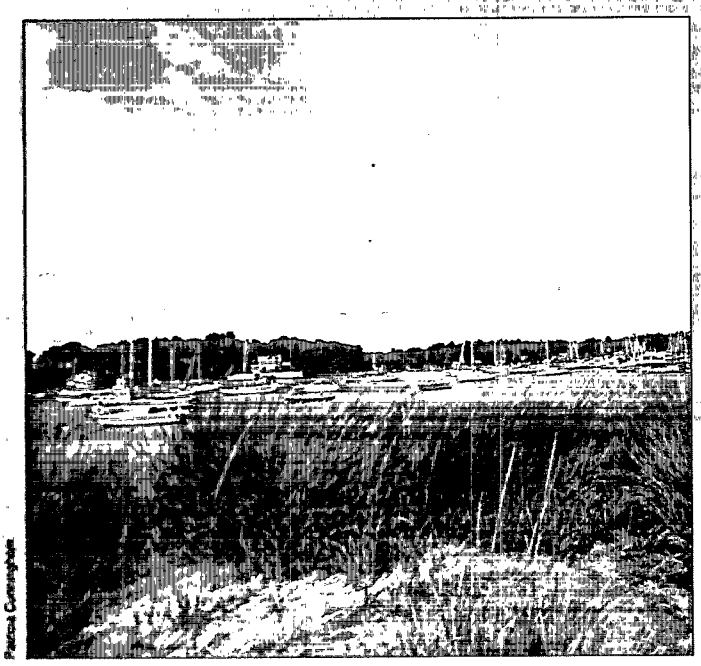
In July of 1990, EPA issued guidance to States for the development of water quality standards for wetlands by the end of fiscal year 1993. Water quality standards for wetlands are necessary to ensure that the provisions of the Clean Water Act applied to other surface waters are also applied to wetlands. Although Federal regulations implementing the CWA include wetlands in the definition of "waters of the U.S." and therefore require water quality standards, a number of States have not developed standards for wetlands and have not included wetlands in their definitions of "State waters." Applying water quality standards to wetlands is part of an overall effort to protect and enhance the Nation's wetlands resources and provides a regulatory basis for a variety of programs to meet this goal. Standards provide the foundation for a broad range of water quality management activities including, but not

Understanding Wetlands

A wide variety of wetlands have formed across the country as the result of regional and local differences in hydrology, vegetation, water chemistry, soils, topography, climate, and other factors. Wetlands type is primarily determined by local hydrology, the unique pattern of water flow through an area. In general, two broad categories of wetlands are recognized: coastal wetlands and inland wetlands.

With the exception of the Great Lakes coastal wetlands, coastal wetlands are closely linked to estuaries, where seawater mixes with fresh water to form an environment of varying salinity and fluctuating water levels (due to tidal action). Coastal marshes dominated by grasses and halophytic (salt-loving) plants are particularly abundant along the Atlantic and Gulf coasts due to the gradual slope of the land. Mangrove swamps, dominated by halophytic shrubs or trees, are common in Hawaii, Puerto Rico, and in 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 and herbs, shrub swamps, and wooded swamps dominated by trees, such as bottomland hardwood forests along 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, prairie potholes of Minnesota and the Dakotas, vernal pools of California, playa lakes of the Southwest, cypress-gum swamps of the South, and wet tundra of Alaska.



Patricia Cunningham

Marina development in a coastal salt marsh in Huntington, New York.

Wetlands Values

In their natural condition, wetlands may provide many benefits including food and habitat for fish and wildlife, flood protection, shoreline erosion control, natural products for human use, water quality improvement, and opportunities for recreation, education, and research. Each wetlands works as part of a complex, integrated system. An assessment of any specific wetlands must take this critical interrelationship into account.

Fish and Wildlife Habitat

Wetlands are critical to the survival of a wide variety of animals and plants, including numerous rare and endangered species. For many species such as the wood duck, muskrat, cattail, and swamp rose, wetlands are primary habitats. For others, wetlands provide important seasonal habitats where food, water, or cover are plentiful.

Altogether, wetlands are among the most productive natural ecosystems in the world. Wetlands produce great volumes of food as leaves and stems break down in the water to form detritus. This enriched material is the principal food for many small aquatic invertebrates, various shellfish, and forage fish that are food for larger commercial and recreational fish species such as bluefish and striped bass.

Flood Protection

Wetlands function like natural tubs, 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 floodwaters. 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, since urban development increases the rate and volume of surface water runoff, thereby increasing the risk of flood damage.

Shoreline Erosion Control

Wetlands are often located between rivers and high ground and are therefore able to buffer shorelines against erosion. Wetlands bind soil, dampen wave action, and reduce current velocity through friction.

Natural Products

Wetlands produce a wealth of natural products, including timber, fish and shellfish, wildlife, wild rice, and furs. Much of the Nation's fishing and shellfishing industry harvests wetlands-dependent species. For example, in the Southeast, 96 percent of the commercial catch and over 50 percent of the recreational harvest are fish and shellfish that depend on the estuary-coastal wetlands system. Waterfowl hunters spend over $300 million annually to harvest wetlands-dependent birds.

Water Quality Improvement

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.

Recreation and Aesthetics

Wetlands provide endless opportunities for popular recreational activities such as hiking, birdwatching, fishing, and boating. An estimated 50 million people spend nearly $10 billion each year observing and photographing wetlands-dependent birds alone.

Patricia Cunningham

Information contained in this highlight was drawn from a brochure developed by the EPA Office of Wetlands Protection, *America's Wetlands: Our Vital Link Between Land and Water*, February 1988, OPA-87-016. For copies or further information, contact U.S. EPA, Office of Wetlands Protection (A-104F), Washington, DC 20460.

limited to, monitoring under Section 305(b), permitting under Sections 402 and 404, water quality certification under Section 401, and the control of nonpoint source (NPS) pollution under Section 319.

Definition

The first, and most important, step in applying water quality standards to wetlands is to ensure that wetlands are legally included in the scope of States' water quality standards programs. States may accomplish this by adopting a regulatory definition of "State waters" at least as inclusive as the Federal definition of "waters of the U.S." and adopting an appropriate definition for "wetlands." States may also need to remove or modify regulatory language that explicitly or implicitly limits the authority of water quality standards over wetlands.

Use Designation

At a minimum, all wetlands must have uses designated that meet the goals of Section 101(a)(2) of the CWA by providing for the protection and propagation of fish, shellfish, and wildlife and for recreation in and on the water, unless the results of a use-attainability analysis show that the CWA goals cannot be achieved. When designating uses for wetlands, States may choose to use their existing general and water-specific classification system or they may set up an entirely different system for wetlands reflecting their unique functions. Two basic pieces of information are useful in classifying wetlands uses: (1) the structural types of wetlands and (2) the functions and values associated with such types of wetlands. Generally, wetlands functions directly relate to the physical, chemical, and biological integrity of wetlands. The protection of these functions through water quality standards also may be needed to attain the uses of waters adjacent to, or downstream of, wetlands.

Criteria

The Water Quality Standards Regulation (40 CFR 131.11(a)(1)) requires States to adopt criteria sufficient to protect designated uses, which may include general statements (narrative) and specific numerical values (i.e., concentrations of contaminants and water quality characteristics). Most State water quality standards already contain many criteria for various water types and designated use classes that may be applicable to wetlands.

Narrative criteria are particularly important in wetlands because many wetlands impacts cannot be fully addressed by numeric criteria. Such impacts may result from the discharge of chemicals for which there are no numeric criteria in State standards, nonpoint sources, and activities that may affect the physical and/or biological, rather than the chemical, aspects of water quality (e.g., discharge or dredged and fill material). Narratives should be written to protect the most sensitive designated use and to support existing uses under State antidegradation policies. In addition to other narrative criteria, narrative biological criteria provide a further basis for managing a broad range of activities that impact the biological integrity of wetlands and other surface waters, particularly physical and hydrologic modifications. Narrative biological criteria are general statements of attainable or attained conditions of biological integrity and water quality for a given use designation. EPA has published national guidance on developing biological criteria for all surface waters.

Antidegradation

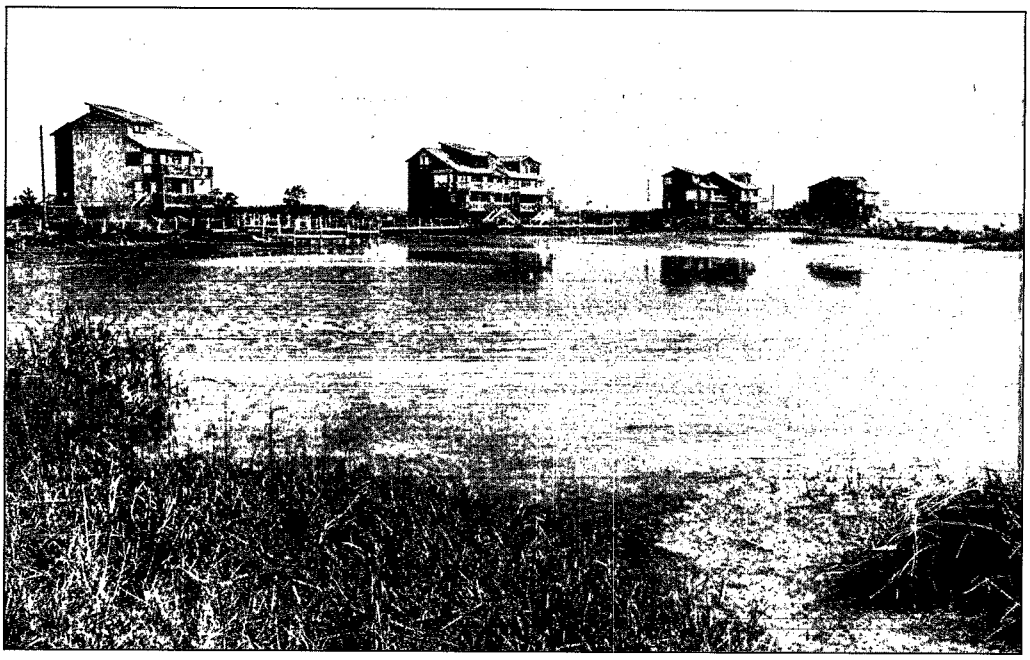
All State water quality standards contain antidegradation policies that protect designated uses and prevent lowering of water quality. These policies provide a powerful tool for the protection of wetlands and can be used by States to regulate point and nonpoint source discharges to wetlands in the same way as other surface waters. In conjunction with designated uses and narrative criteria, antidegradation can be used to address impacts to wetlands that cannot be fully addressed by chemical criteria, such as physical and hydrologic modifications. With the inclusion of wetlands as "waters of the State," State antidegradation policies and their implementation methods will apply to wetlands.

Implementation

Implementing water quality standards for wetlands will require a coordinated

effort between related Federal and State agencies and programs. Many States have begun to make more use of CWA Section 401 certification to manage certain activities that impact their wetlands resources on a physical and/or biological rather than just a chemical basis. Section 401 gives the States the authority to grant, deny, or condition certification of Federal permits or licenses that may result in a discharge to "waters of the U.S." Such action is taken by the State to ensure compliance with various provisions of the CWA, including the State's water quality standards. Violation of water quality standards is often the basis for denials or conditioning through Section 401 certification.

Water quality standards for wetlands can prevent the misuse and overuse of natural wetlands for treatment through adoption of proper uses and criteria and application of State antidegradation policies. The Water Quality Standards Regulation (40 CFR 131.10(a)) states that, "in no case shall a State adopt waste transport or waste assimilation as a designated use for any 'waters of the U.S.'" Certain activities involving the discharge of pollutants to wetlands may be permitted. However, as with other surface waters, the State must ensure, through ambient monitoring, that permitted discharges to wetlands preserve and protect wetlands functions and values as defined in State water quality standards. For municipal discharges to natural wetlands, a minimum of secondary treatment is required and applicable water quality standards for the wetlands and adjacent waters must be met.



Bill Richards

Expansion of urban development in the coastal zone threatens saltwater wetlands.

Many wetlands, through their assimilative capacity for nutrients and sediment, also serve an important water quality control function for nonpoint source pollution effects on waters adjacent to, or downstream of, the wetlands. Section 319 of the CWA requires the States to complete assessments of NPS impacts to State waters, including wetlands, and to prepare management programs to control them. Water quality standards for wetlands can form the basis for these assessments and management programs for wetlands.

In addition, States can address physical and hydrologic impacts to wetlands quality through the application of narrative criteria to protect existing uses and through application of their antidegradation policies. The States should provide a linkage in their water quality standards to the determination of "significant degradation" as required under EPA guidelines (40 CFR 230.10(c)) and other applicable State laws affecting the disposal of dredged or fill materials in wetlands.

Finally, water quality management activities, including the permitting of wastewater and storm water discharges, the assessment and control of NPS pollution, and waste disposal activities (sewage sludge, Comprehensive Environmental Response, Compensation and Liability Act [CERCLA], and Resource Conservation and Recovery Act [RCRA]) require sufficient monitoring to ensure that the designated and existing uses of "waters of the U.S." are maintained

and protected. The inclusion of wetlands in water quality standards provides the basis for conducting both wetlands-specific and status and trend monitoring of State wetlands resources. Monitoring of activities impacting specific wetlands may include several approaches, including biological measurements (i.e., plant, macroinvertebrate, and fish) that have shown promise for monitoring stream quality. The States are encouraged to develop and test the use of biological indicators.

Support of Designated Uses

Summary of State Information

Most States have not designated specific uses for their wetlands. In their 1990 Section 305(b) reports, however, five States (California, Hawaii, Iowa, Kansas, and Nevada) reported on use support in some of their wetlands (see Table 5-1). The use support data submitted by these States are not representative of national wetlands conditions for several reasons. First, the submitted information applies to a small fraction of the Nation's wetlands. The reporting States assessed only 218,076 acres of wetlands, or less than two-tenths of 1 percent of the 103 million acres of wetlands in the conterminous States (U.S. Fish and Wildlife Service, 1991, unpublished data). Second, the reporting States are concentrated in the western region of the country, an area with stresses and disturbances not representative of those found elsewhere. Despite these limitations, the use support information does provide an initial indication of problems stressing some of the Nation's wetlands, primarily in the western and midwestern States. The submitted use support information is summarized briefly as follows:

- California assessed 10,355 acres of inland wetlands, representing a small fraction of the State's total wetlands acreage. California wetlands are designated for fishable use and both contact and noncontact recreational use. Four percent of the assessed wetlands fully support designated uses, 4 percent partially support uses, and 93 percent do not fully support uses. Almost all impairments were attributed to toxic contaminants from nonpoint sources. Use support of coastal wetlands could not be determined because California combined use support information for estuaries and coastal wetlands.

- Hawaii assessed all of its reported 110,807 acres of wetlands, which are designated for recreational use and fish and wildlife habitat. All but 1,000 acres support designated uses. The causes of impairment include nutrients and salinity. Urban runoff is the only identified source.

- Iowa assessed 72 percent (26,489 acres) of their 36,852 total wetlands acres. Four percent of the assessed acres fully support designated uses, 31 percent support uses but are threatened, 51 percent partially support uses, and 14 percent do not support uses. Siltation, nutrients, and pesticides are the most common causes of impairment in Iowa's wetlands. Major sources include agriculture, affecting 90 percent of impaired wetlands, and hydrologic modification (e.g., channelization and construc-

Table 5-1. Designated Use Support in Wetlands

State	Total Wetland Acres	Wetland Acres Assessed			Acres Fully Supporting	Acres Threatened	Acres Partially Supporting	Acres Not Supporting
		Total	Percent Evaluated	Percent Monitored				
California	90,172	10,355	12	88	382	—	387	9,586
Hawaii	110,807	110,807	100	0	109,807	0	1,000	0
Iowa	36,852	26,489	100	0	969	8,215	13,665	3,640
Kansas	34,256	34,256	43	57	0	4,560	29,696	0
Nevada	136,650	36,169	33	67	0	0	12,000	24,169
Totals	408,737	218,076			111,158	12,775	56,748	37,395
Percent of Assessed Waters					51.0%	5.9%	26.0%	17.1%

— Not reported.

Source: 1990 State Section 305(b) reports.

tion of wing dams and revetments), affecting 23 percent. Land disposal and urban runoff reportedly affect less than 6 percent of the impaired wetlands.

■ Kansas assessed all of its 34,256 acres of wetlands. Kansas designates its wetlands for noncontact recreation and aquatic habitat uses. Thirteen percent of the assessed wetlands support uses but are threatened; the remaining 87 percent partially support designated uses. Thirty-nine percent of the use impairments are due to dewatering, 33 percent to sedimentation, and 28 percent to chronic metal concentrations. Agriculture accounts for 52 percent of use impairments, hydrologic regime alterations (often linked to irrigation practices) account for 28 percent, and 20 percent of wetlands impairments are due to natural mineral intrusion.

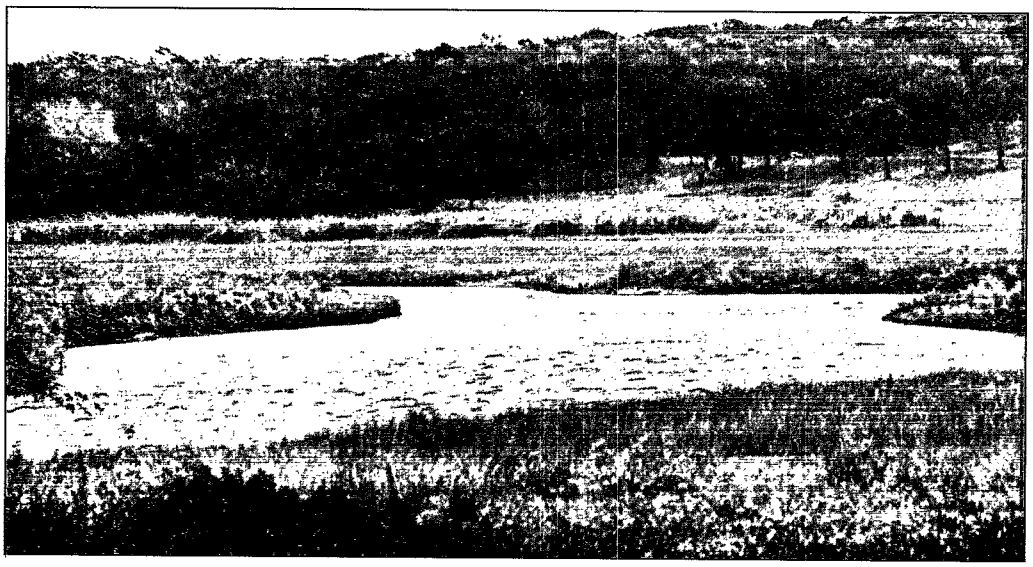
■ Nevada classified and assessed 36,169 acres, or 26 percent of its wetlands. One-third of the assessed wetlands, or 12,000 acres, partially support designated uses, and the remaining 24,169 acres do not support designated uses. Metals are the leading cause of impairment, followed by salinity and organic enrichment/low dissolved oxygen concentrations. The leading sources are irrigated crops, flow regulation, mill tailings, and natural sources.

In summary, the reporting States found that 51 percent of their assessed acres support designated uses, 6 percent support uses but are threatened, 26 percent partially support uses, and 17 percent do not support designated uses. However, it should be emphasized that conclusions cannot be drawn from these figures, which are based on such a small percentage of the Nation's total wetlands.

Causes and Sources of Impairment

Only four States (Hawaii, Iowa, Kansas, and Nevada) reported causes of nonsupport in wetlands. Causes of nonsupport are the pollutants (such as nutrients or pesticides and processes (such as habitat destruction) that impair waterbodies. An individual acre of wetlands can be affected by many causes of nonsupport. Therefore, States were asked to report each wetlands acre under each cause category contributing to its impairment. As a result, a single acre affected by multiple causes is included under several cause categories. The values reported are the total number of wetlands acres affected by a particular cause according to whether the cause is a major or moderate/minor contributor to impairment (Table 5-2). The leading causes of wetlands impairment in the four reporting States are metals (affecting 55 percent of impaired wetlands), siltation (affecting 32 percent), salinity (affecting 30 percent), and flow alteration (affecting 22 percent) (see Table 5-2). These States also reported that nutrients, pesticides, organic enrichment, and habitat modification impair wetlands.

Four States also reported sources of wetlands impairments (Table 5-3). A single



Patricia Cunningham

Coastal salt marsh wetlands near Northport, Long Island, New York.

Table 5-2. Impaired Wetlands Acres Affected by Causes of Pollution

State	Total Impaired Waters*	Metals		Siltation		Salinity		Flow Alteration		Nutrients	
		Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
Hawaii	1,000	—	—	—	—	—	1,000	—	—	—	1,000
Iowa	17,305	—	—	10,112	5,355	—	—	—	—	5,773	7,374
Kansas	29,696	—	19,456	—	11,505	—	—	13,461	4,700	—	—
Nevada	36,169	26,169	—	—	—	—	24,169	—	—	—	—
Totals	84,170	26,169	19,456	10,112	16,860	0	25,169	13,461	4,700	5,773	8,374
Combined Totals			46,625		26,972		25,169		18,161		14,147
Percent of Impaired Waters			55.3%		32.0%		29.9%		21.6%		16.8%

*The sum of partially and nonsupporting wetland acres (Table 5-1).

— Zero or not reported.

Source: 1990 State Section 305(b) reports.

acre of wetlands can be affected by multiple sources of pollution, such as mining leachate and agricultural runoff. The States were asked to report any given wetlands acre under each of the course categories contributing to impairment. This allows a single acre of wetlands to be counted more than once if it is affected by multiple sources.

In Iowa, Kansas, and Nevada, agriculture is the predominant source of wetlands degradation followed by habitat modification (see Table 5-3). Resource extraction is a major source of wetlands pollution in Nevada, and storm sewers and urban runoff impair wetlands in Hawaii. These figures do not represent national trends, however, because so few States reported sources of impairment.

Attainment of the Clean Water Act Goals

The CWA goals seek to achieve water quality that "provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water . . ." These goals, commonly referred to as the fishable and swimmable goals, can be applied to wetlands as well as to rivers, lakes, and estuaries. Although wetlands seldom support swimming uses, they often are utilized for boating, fishing, and canoeing.

California, Hawaii, Iowa, Kansas, and Nevada assessed attainment of the Clean Water Act fishable and swimmable goals in some of their wetlands (see Table 5-4). The States reported dramatic differences in attainment of the goals. Fishable goal attainment ranged from 3 percent in California's assessed wetlands to 100 percent attainment in Hawaii and Kansas. Hawaii also reported full attainment of the swimmable goal. In contrast, none of the assessed wetlands in Kansas or Nevada attain the swimmable goal. Due to the variability in reported goal attainment, national trends cannot be drawn.

Wetlands Resources

A National Perspective

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 losses have taken place, with many of the original wetlands drained and converted to farmland. Today, less than half of our original wetlands remain (see Figure 5-1 and Table 5-5). This amounts to an area equal to the size of California. An additional 170 million acres of wetlands are estimated to exist in Alaska—covering slightly more than half the State; Hawaii has approximately 50,000 acres. Next to Alaska, Louisiana and Florida have the largest wetlands acreage in the U.S.

Two basic types of data collection efforts can be used to track the quantity of wetlands: (1) detailed maps and (2) status and trends reports. Detailed maps provide site-specific information on wetlands. Status and trends

Pesticides		Organic Enrichment		Habitat Modification		Unknown Toxicity		Ammonia	
Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
—	—	—	—	—	—	—	—	—	—
—	10,262	—	—	4,006	—	—	1,570	109	—
—	—	—	—	—	—	—	—	—	—
—	—	10,000	—	—	—	—	—	—	—
0	10,262	10,000	0	4,006	0	0	1,570	109	0
	10,262		10,000		4,006		1,570		109
	12.2%		11.9%		4.8%		1.9%		0.1%

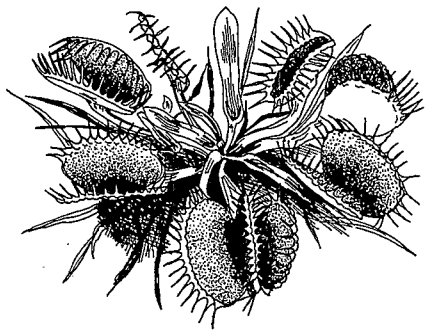


Table 5-3. Impaired Wetlands Acres Affected by Sources of Pollution

State	Total Impaired Waters*	Agriculture		Habitat Modification		Other		Resource Extraction		Storm Sewers/ Runoff		Land Disposal	
		Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min	Major	Mod/Min
Hawaii	1,000	—	—	—	—	—	—	—	—	—	1,000	—	—
Iowa	17,305	15,575	—	4,006	—	—	—	—	—	—	570	—	1,000
Kansas	29,696	13,461	16,205	13,461	4,700	—	19,456	—	—	—	—	—	—
Nevada	36,169	34,169	—	34,169	—	—	24,169	26,169	—	—	—	—	—
Totals	84,170	63,205	16,205	51,636	4,700	0	43,625	26,169	0	0	1,570	0	1,000
Combined Totals			79,410		56,336		43,625		26,169		1,570		1,000
Percent of Impaired Waters			94.3%		66.9%		51.8%		31.1%		1.9%		1.2%

*The sum of partially and nonsupporting wetland acres (Table 5-1).

— Zero or not reported.

Source: 1990 State Section 305(b) reports.

Table 5-4. Attainment of Clean Water Act Goals in the Wetlands

State	Fishable Goal (acres)					Swimmable Goal (acres)				
	Assessed	Meeting	Partially Meeting	Not Meeting	Not Attainable	Assessed	Meeting	Partially Meeting	Not Meeting	Not Attainable
California	9,889	316	0	9,573	—	8,566	313	0	8,253	—
Hawaii	110,807	110,807	—	0	0	110,807	110,807	—	0	0
Iowa	26,702	9,184	13,665	3,640	213	26,702	491	4,081	1,693	20,437
Kansas	34,256	34,256	0	0	0	34,256	0	0	0	34,256
Nevada	36,169	10,000	2,000	0	24,169	36,169	0	0	2,000	34,169
Totals	217,823	164,563	15,665	13,213	24,382	216,500	111,611	4,081	11,946	88,862
Percent of Assessed Waters		75.5%	7.2%	6.1%	11.2%		51.6%	1.9%	5.5%	41.0%

— Not reported.

Source: 1990 State Section 305(b) reports.

Table 5-5. Wetlands Losses in the United States, 1780s to 1980s

State	Total Surface Area (acres)*	Wetlands: Estimates of Original Wetlands circa 1780s	Percent of Surface Area	Estimates of Existing Wetlands circa 1980s	Percent of Surface Area	Percent of Wetlands Lost
Alabama	33,029,760	7,567,600	22.9	3,783,800	11.5	50
Arizona	72,901,760	931,000	1.3	600,000	0.8	36
Arkansas	33,986,560	9,848,600	29.0	2,763,600	8.1	72
California	101,563,520	5,000,000	4.9	454,000	0.4	91
Colorado	66,718,720	2,000,000	3.0	1,000,000	1.5	50
Connecticut	3,205,760	670,000	20.9	172,500	5.4	74
Delaware	1,316,480	479,785	36.4	223,000	16.9	54
Florida	37,478,400	20,325,013	54.2	11,038,300	29.5	46
Georgia	37,680,640	6,843,200	18.2	5,298,200	14.1	23
Idaho	53,470,080	877,000	1.6	385,700	0.7	56
Illinois	36,096,000	8,212,000	22.8	1,254,500	3.5	85
Indiana	23,226,240	5,600,000	24.1	750,633	3.2	87
Iowa	36,025,600	4,000,000	11.1	421,900	1.2	89
Kansas	52,648,960	841,000	1.6	435,400	0.8	48
Kentucky	25,852,800	1,566,000	6.1	300,000	1.2	81
Louisiana	31,054,720	16,194,500	52.1	8,784,200	28.3	46
Maine	21,257,600	6,460,000	30.4	5,199,200	24.5	20
Maryland	6,769,280	1,650,000	24.4	440,000	6.5	73
Massachusetts	5,284,480	818,000	15.5	588,486	11.1	28
Michigan	37,258,240	11,200,000	30.1	5,583,400	15.0	50
Minnesota	53,803,520	15,070,000	28.0	8,700,000	16.2	42
Mississippi	30,538,240	9,872,000	32.3	4,067,000	13.3	59
Missouri	44,599,040	4,844,000	10.9	643,000	1.4	87
Montana	94,168,320	1,147,000	1.2	840,300	0.9	27
Nebraska	49,425,280	2,910,500	5.9	1,905,500	3.9	35
Nevada	70,745,600	487,350	0.7	236,350	0.3	52
New Hampshire	5,954,560	220,000	3.7	200,000	3.4	9
New Jersey	5,015,040	1,500,000	29.9	915,960	18.3	39
New Mexico	77,866,240	720,000	0.9	481,900	0.6	33
New York	31,728,640	2,562,000	8.1	1,025,000	3.2	60
North Carolina	33,655,040	11,089,500	33.0	5,689,500	16.9	49
North Dakota	45,225,600	4,927,500	10.9	2,490,000	5.5	49
Ohio	26,382,080	5,000,000	19.0	482,800	1.8	90
Oklahoma	44,748,160	2,842,600	6.4	949,700	2.1	67
Oregon	62,067,840	2,262,000	3.6	1,393,900	2.2	38
Pennsylvania	29,013,120	1,127,000	3.9	499,014	1.7	56
Rhode Island	776,960	102,690	13.2	65,154	8.4	37
South Carolina	19,875,200	6,414,000	32.3	4,659,000	23.4	27
South Dakota	49,310,080	2,735,100	5.5	1,780,000	3.6	35
Tennessee	27,036,160	1,937,000	7.2	787,000	2.9	59
Texas	171,096,960	15,999,700	9.4	7,612,412	4.4	52
Utah	54,346,240	802,000	1.5	558,000	1.0	30
Vermont	6,149,760	341,000	5.5	220,000	3.6	35
Virginia	26,122,880	1,849,000	7.1	1,074,613	4.1	42
Washington	43,642,880	1,350,000	3.1	938,000	2.1	31
West Virginia	15,475,840	134,000	0.9	102,000	0.7	24
Wisconsin	35,938,560	9,800,000	27.3	5,331,392	14.8	46
Wyoming	62,664,960	2,000,000	3.2	1,250,000	2.0	38
Subtotal (Conterminous U.S.)	1,934,198,400	221,129,638	11	104,374,314	5	53
Alaska	375,303,680	170,200,000	45.3	170,000,000	45.3	0.1
Hawaii	4,115,200	58,800	1.4	51,800	1.3	12
Total U.S.	2,313,617,280	391,388,438		274,426,114	11.9	30

*Note: Surface area includes both land and water surface area. There are some discrepancies between the total surface area of States. These differences are probably due to shifting river channels forming State borders. The area given is that presented by the U.S. Geological Survey, National Atlas of the United States, 1970.

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. These estimates are based on the latest information available and may differ from estimates reported by the States in 1990.

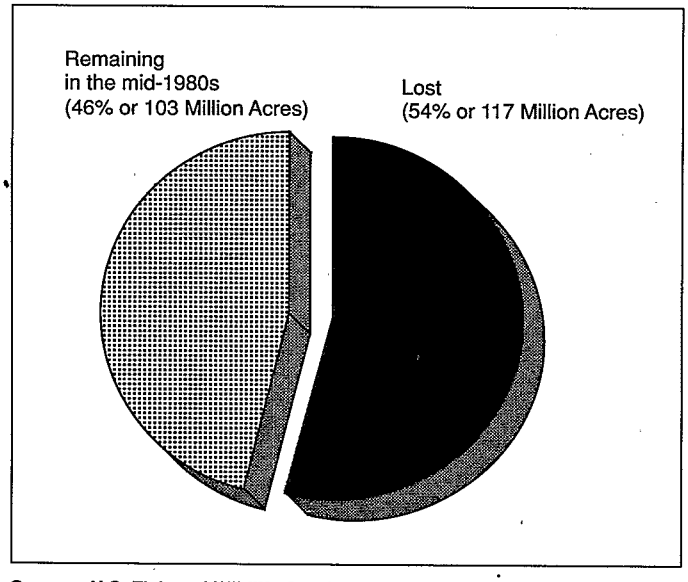
information is used to evaluate changes to the resource over time. The FWS has been involved extensively in these two areas over the last several years.

The first complete national assessment of the changes in the quantity of U.S. wetlands resources over time is provided in *Wetlands of the United States: Current Status and Recent Trends* (U.S. FWS, 1984). This report assesses the changes in the national wetlands resource from the mid-1950s to the mid-1970s. Estimates of wetlands loss are based on the evaluation of wetlands acreage within thousands of 4-square-mile plots located across the U.S. The number and locations of the plots were chosen to provide a given statistical precision when the information was extrapolated to the entire United States.

Based on these data, the FWS estimates that the Nation's wetlands are being lost at an alarming rate. Between the mid-1950s and mid-1970s alone, about 11 million acres of marshes and swamps were destroyed, an area three times the size of New Jersey. The average annual loss was 458,000 acres (440,000 acres of inland wetlands and 18,000 acres of coastal wetlands) during this period.

Agricultural activities affecting wetlands, including drainage, filling, and road construction, were responsible for 87 percent of losses between the mid-1950s and mid-1970s (see Table 5-6). Agricultural activities had the greatest impact on forested wetlands, inland marshes, and wet meadows. Urban development and other development were responsible for 8 percent and 5 percent of wetlands losses, respectively. Urban development was the major cause of coastal wetlands losses outside of Louisiana, while submergence of Louisiana's coastal marshes by Gulf waters was the leading factor in that State. In addition to the direct physical destruction of wetlands, these habitats are also threatened indirectly by chemical contamination and other pollution.

The FWS has recently updated the status and trends report to cover the time span between the mid-1970s and the mid-1980s (*Report to Congress: Wetlands Status and Trends in the Conterminous U.S., Mid-1970's to Mid-1980's*, September 1991). Although the average annual loss has decreased from 458,000 acres, wetlands are still being lost at a significant rate, totalling a net loss of 2.6 million acres over the 9-year study period. Freshwater wetlands accounted for 98 percent of the loss and, by the mid-1980s, an estimated



Source: U.S. Fish and Wildlife Service, 1991, unpublished data.

Figure 5-1. Original and Remaining Acreages of Wetlands in Lower 48 States

Table 5-6. Major Causes of Wetlands Loss and Degradation

Human Impacts
Drainage
Dredging and stream channelization
Deposition of fill material
Diking and damming
Tilling for crop production
Grazing by domestic animals
Discharge of pollutants
Mining
Alteration of hydrology
Natural Threats
Erosion
Subsidence
Sea level rise
Droughts
Hurricanes and other storms
Overgrazing by wildlife

Source: 1990 State Section 305(b) reports.

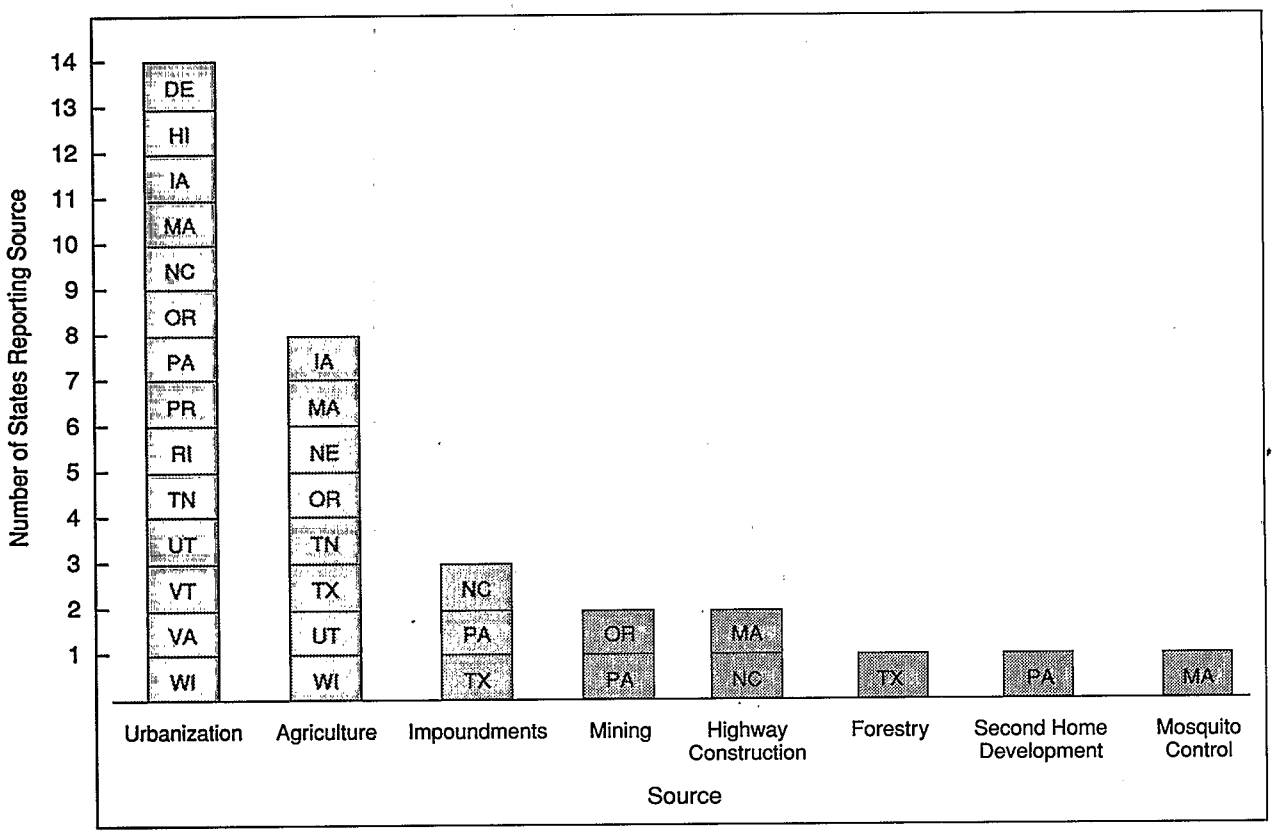
97.8 million acres of freshwater wetlands and 5.5 million acres of coastal wetlands remained. By far, the most significant wetlands losses occurred in the inland forested wetlands category, which lost approximately 3.4 million acres during the study period. This loss occurred primarily in the southern U.S.

During the mid-1970s to mid-1980s study period, 54 percent of the wetlands loss was attributed to agriculture and 5 percent to urban land uses; the remaining 41 percent was attributed to "other" land uses. These direct losses of physical wetlands habitat are serious; however, this is only one measure of wetlands loss. We still do not have the capability to measure loss and degradation of wetlands function. The Environmental Monitoring and Assessment Program (EMAP) (see *Highlight–The EMAP Wetlands Program*) is working with the FWS to coordinate efforts in mapping and assessing wetlands extent as well as wetlands function.

The FWS also has the capability to produce regional and State inventories. The FWS prepared a report for the Mid-Atlantic Region of the U.S. (*Mid-Atlantic Wetlands: A Disappearing National Treasure*, June 1987), as well as a report for California's Central Valley (*Wetlands of the California Central Valley: Status and Trends, 1939 to mid-1980s, June 1989*). The FWS is moving toward more State-specific wetlands inventories such as the inventory produced for Oregon (*Oregon Wetlands: Wetlands Users Guide*, August 1990).

Overview of State Reporting

The number of States reporting on the status of their wetlands increased



Note: This figure includes only those States that clearly identified *current* sources of wetlands losses. Sources of historic wetlands losses are not included.

Figure 5-2. Current Sources of Direct Wetlands Losses

dramatically during the 1990 reporting cycle. Forty-five States provided information on their wetlands resources, compared to 14 States in the previous cycle. The increase in State reporting reflects improvements in EPA's 305(b) guidelines as well as the growing awareness of wetlands value across the Nation.

The majority of information submitted by the States in their 1990 State Section 305(b) reports focused on the quantity of their wetlands resources and certain State programs. For the first time, several States addressed the impact of chemical contaminants and other stresses on the quality of existing wetlands. Despite these improvements, information on the quality of existing wetlands is generally not available because of the lack of State and Federal resources to monitor wetlands quality.

Inconsistent reporting of wetlands acreage and State programs is the result of several factors. First, there is a general lack of appropriate databases and related tools to track the quantity and quality of wetlands resources on consistent statewide or national scales. The FWS National Wetlands Inventory (NWI) is one such tool relied on by some States for this purpose. However, the NWI has not been completed for all States. Although many State estimates of wetlands acreage are based on NWI information, others are independent estimates.

Second, wetlands are a complex, fragmented, and in some areas widely distributed water resource. The effort required to identify and assess all State wetlands biennially is enormous. Third, in the past, EPA has not issued specific guidance on wetlands reporting. Guidance issued by EPA in 1988 has enabled a shift toward more consistent and complete State reporting on the quantity and quality of wetlands nationwide.

In 1990, many States revised wetlands inventory procedures by standardizing their definition of wetlands and consolidating wetlands inventories previously maintained by numerous agencies. Several States also initiated new inventories or were able to reference updated NWI figures. At least one State, Illinois, reports a substantial increase in wetlands acreage since the 1988 Section 305(b) reporting cycle. The reported growth in wetlands estimates is probably due to improved inventory methods rather than actual increases in wetlands acreage.

Fifteen States and Puerto Rico provided narrative descriptions of activities currently causing wetlands losses (Figure 5-2). Although many historic wetlands losses were due to agricultural conversion, more of the

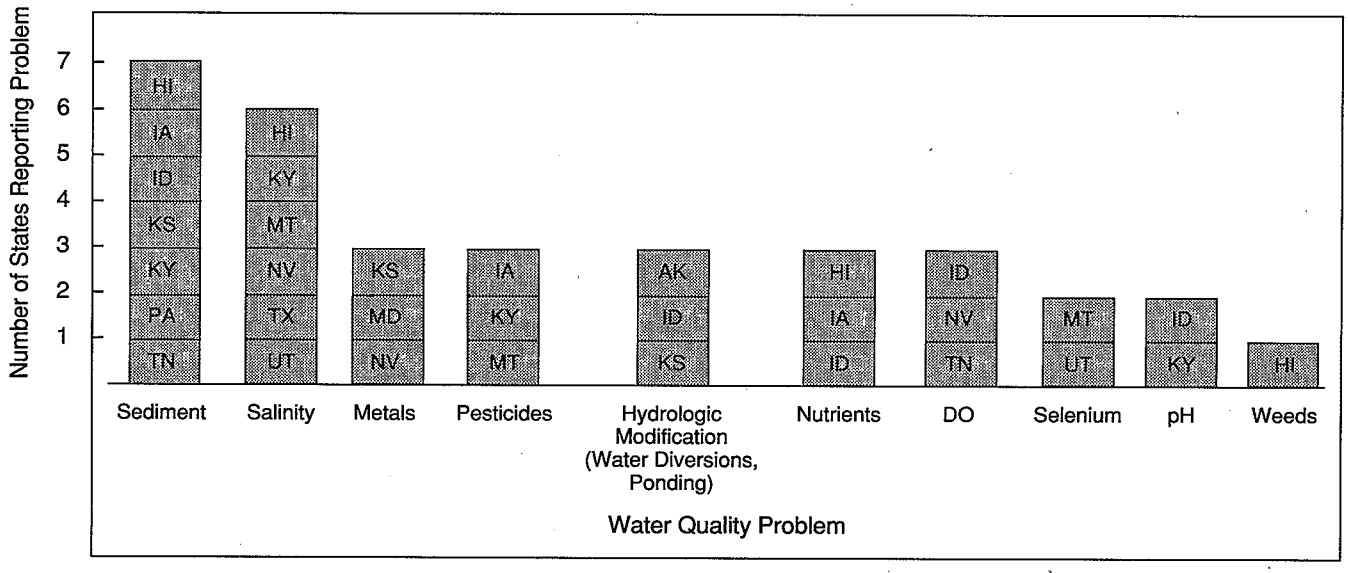


Figure 5-3. Water Quality Problems Affecting Wetlands

The EMAP Wetlands Program

The Environmental Monitoring and Assessment Program (EMAP) is a new EPA initiative aimed at assessing and reporting the status and trends of ecological conditions in wetlands, near coastal waters, forests, inland surface waters, Great Lakes, agroecosystems, and arid lands of the United States. The goals of the EMAP-Wetlands program are to provide a quantitative assessment of the current status and long-term trends in wetlands conditions on regional and national scales.

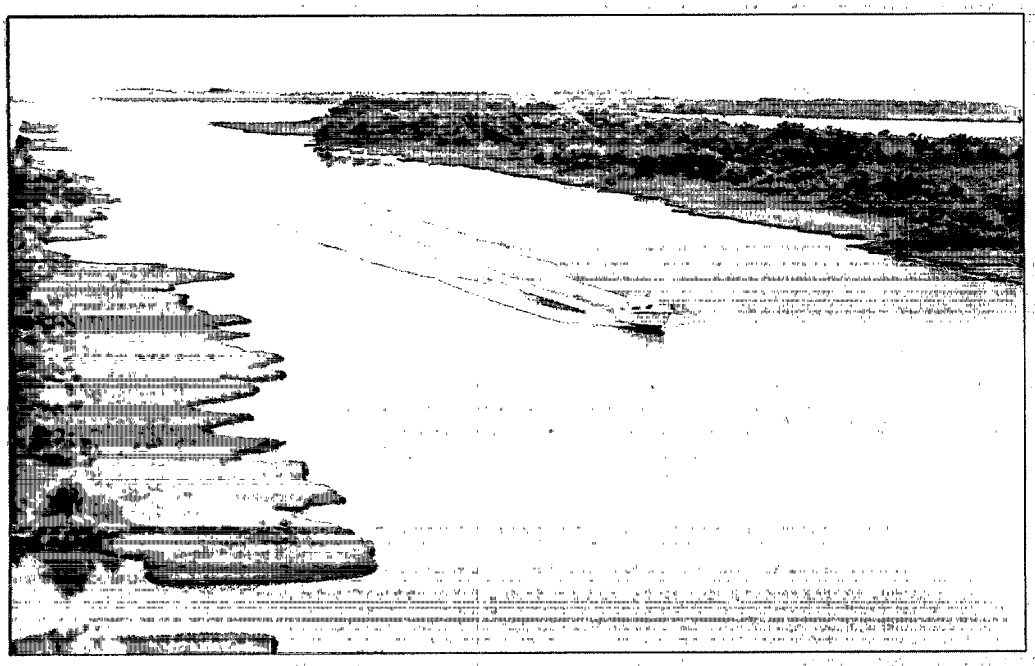
The objectives of the EMAP-Wetlands program are to

- Quantify the regional status of wetlands by measuring both indicators of ecological condition and the threats to the resource;
- Monitor changes through time, on a regional scale, in the condition of wetlands and in hydrology, pollution exposure, and other factors that influence or stress wetlands;
- Identify plausible causes for degraded or improved wetlands conditions;
- Assess the effectiveness of drainage and pollution control actions and other environmental policies on the condition of wetlands on a regional and national scale; and
- Provide annual statistical summaries and periodic interpretive assessments of wetlands status and trends.

In the short term, the EMAP-Wetlands program will provide standardized protocols for measuring and describing wetlands conditions, provide estimates of wetlands conditions in several regions, and develop formats for reporting program results.

The main thrusts of the EMAP-Wetlands program approach are to develop and evaluate a sampling strategy to derive regional and national estimates of wetlands conditions and to evaluate indicators of wetlands conditions. The EMAP-Wetlands program has been working closely with U.S. Fish and Wildlife Service's National Wetlands Inventory personnel to develop and evaluate the appropriate sampling strategy and classification for EMAP-Wetlands. Ultimately, the EMAP-Wetlands program will field-sample 3,200 wetlands and report on eight distinct wetlands types.

The selection of indicators to evaluate wetlands conditions is deemed an iterative process. Initially, the following indicators will be measured:



Bill Pacheco

Wetlands may be disturbed by dredging to keep waterways navigable.

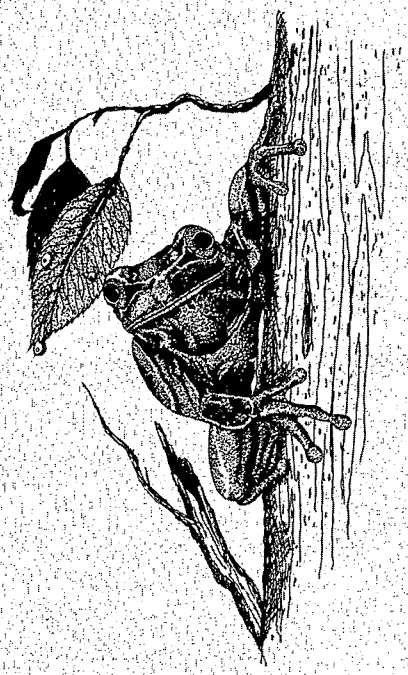
- Wetlands extent and type diversity;
- Landscape indicators—including patch size and ratios of open water to vegetation;
- Indicators of hydrology—water level and flood duration and frequency;
- Sediment characteristics—including sedimentation rates, bulk density, and organic matter content;
- Vegetation species composition and abundance;
- Vertebrate and macroinvertebrate community composition and abundance;
- Chemical contaminants in sediments; and
- Nutrients in sediment or vegetative tissues.

The first five indicators will be field-tested in a pilot project in Louisiana to determine whether they can be used to clearly distinguish salt marshes in good condition from salt marshes in degraded condition. If these indicators are successful in the 1991 pilot project, they will be used in the first demonstration project in 1992. Regional demonstration projects are field studies conducted on a statistically large enough number of sites to enable EPA to distinguish the condition of one wetlands class in one region. The 1992 demonstration project is proposed for the salt marshes in the southeast United States.

The EMAP-Wetlands program will report on the proportion of the Nation's wetlands that are healthy and sustainable and those that are unhealthy. These data will be a critical tool with which EPA and Congress can assess and influence current wetlands management decisions and policy. These data can also be used to evaluate the success of efforts to achieve the "no net loss" goals and proposed water quality criteria for wetlands. EMAP data could be used by State and Federal managers to both (1) establish "designated use" classes and regional biocriteria for wetlands and (2) identify sensitive wetlands classes that need special regulatory consideration to be preserved with "no net loss."

Doreen Robb, EPA Wetlands Division

Collecting water samples in Sandusky Bay wetlands, Ohio.



reporting States now attribute current wetlands losses to commercial and residential development.

Fourteen States reported that expanding urbanization threatens remaining wetlands, while only eight States reported that agriculture and irrigation projects continue to destroy wetlands. Three States listed impoundments as a source of wetlands loss. Mining and highway construction were cited by two States each, and forestry, second home development, and mosquito control were each reported by one State.

In addition to direct physical losses, wetlands are threatened by water quality degradation. Wetlands functions can be altered by excessive sediment and/or nutrient inputs, which can accelerate filling and invasion by exotic plant species. Organic enrichment can deplete dissolved oxygen concentrations, creating intolerable conditions for aquatic organisms including juvenile fish. Hydrologic modifications in wetlands, such as surface ponding or drying out, can result from upstream dams, irrigation return flows, diversions, ground-water depletion, and diking. Changes in the quantity and seasonality of flow can also alter biotic communities in wetlands.

Thirteen States, including four States that assessed designated use support, discussed water quality problems in their wetlands (see Figure 5-3). Siltation is the most frequently reported problem, cited by seven States. Six States reported that salinity, from either saltwater intrusion or soil salts, threatens wetlands. Three States reported that metals degrade their wetlands, and two States cited elevated selenium levels. Pesticides, hydrologic modifications, nutrients, and low dissolved oxygen concentrations were listed by three States; pH was reported by two States; and aquatic weeds were reported by one State.

Twelve States and Puerto Rico provided narrative discussions of sources of wetlands water quality problems (see Figure 5-4). The leading sources of wetlands contamination in these States are agriculture (reported by eight States), urban and industrial runoff (reported by five States), and development (reported by four States). Irrigation, channelization, forestry, and mining were reported by three States. Two western States also reported that irrigation return-flows elevate selenium levels in receiving wetlands, and Kansas reported that irrigation withdrawals dewater wetlands.

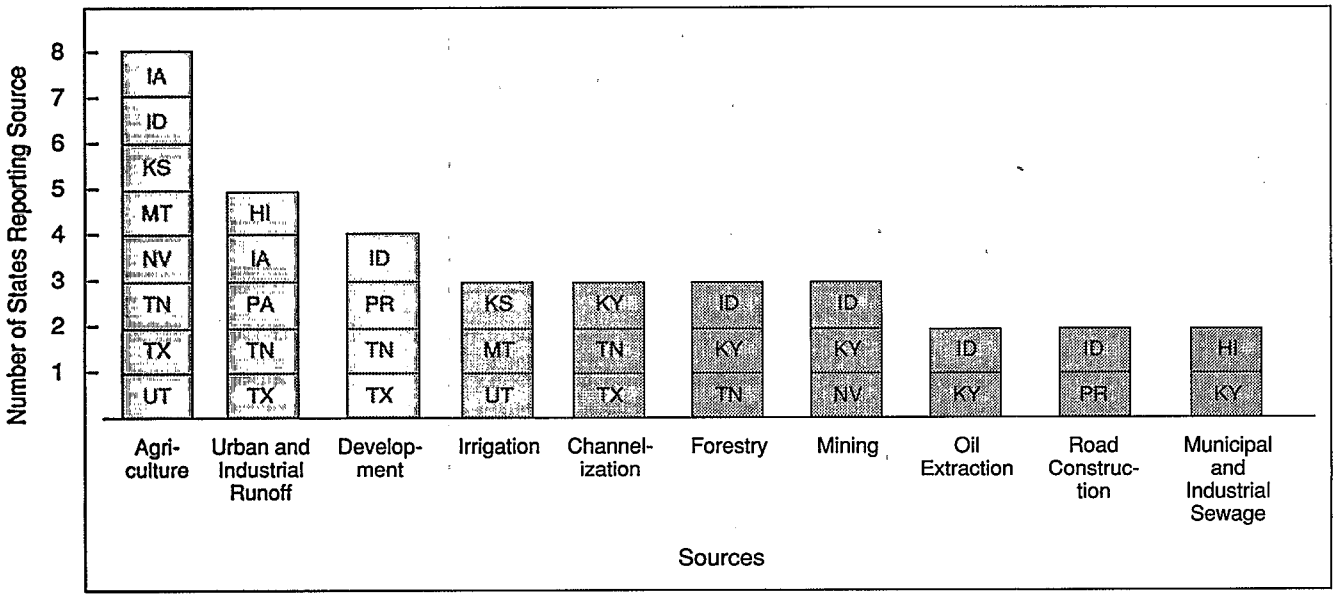


Figure 5-4. Sources of Water Quality Problems in Wetlands

Oil extraction, road construction, sewage discharges, landfills, and natural sources were each listed by two States. Other sources, reported only by Idaho, include onsite sewage systems and recreational activities.

The following discussion highlights the status of wetlands in several States. Additional information on wetlands status within individual States is included in Appendix A, State Summaries.

■ Arizona—Riparian areas were once common along the State's drainageways, but now are Arizona's most rare and threatened natural community. River impoundments, channelization, ground-water pumping, surface water diversions, and agricultural development severely reduced wetlands and riparian areas.

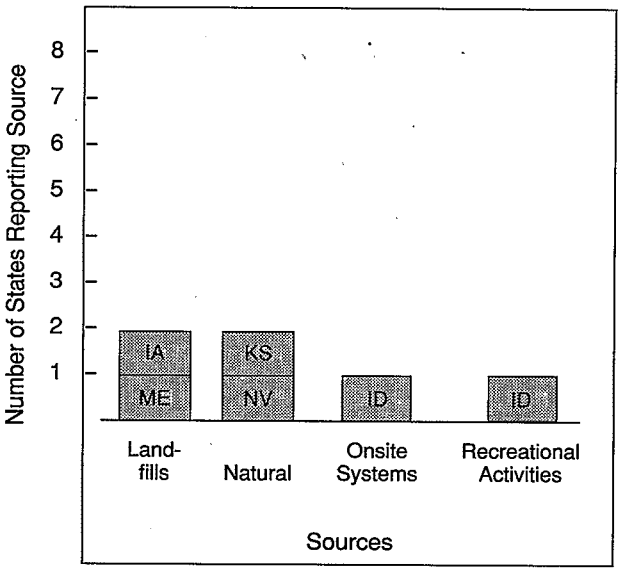


Figure 5-4. (continued)

■ Hawaii—Construction of the Hyatt Waikoloa Hotel on the island of Hawaii resulted in the destruction of approximately 20 percent of the total number of anchialine ponds in the State. Anchialine ponds are a unique type of low salinity wetlands fed by ground water near the Hawaiian coast. The wetlands losses prompted the State to expand their Section 401 certification program to prevent further disturbances of anchialine ponds and other wetlands. The State also reports that hillside runoff, sedimentation, and sewage effluent generate nutrient enrichment problems and excessive vegetative growth in marshes.

■ Idaho—The State reports a high incidence of impacts from nonpoint sources in wetlands, but only several incidents where designated uses are impaired. Agriculture (especially range activities), forest practices, mining (especially placer mining), road or bridge construction, and recreational activities are the most frequently reported sources of impairment. These activities generate sediment, nutrients, pH fluctuations, organic enrichment, and hydrologic and other habitat alterations that impair salmonid spawning and recreational uses of Idaho's wetlands.

■ Kentucky—The Kentucky State Nature Preserve Commission estimates that 58 percent of the State's original 1,566,000 acres of wetlands were drained by 1978. Only 20 percent of Kentucky's wetlands remain forested, which reflects a dramatic decline in bottomland hardwood forests. The Kentucky Department of Fish and Game estimates the annual rate of wetlands loss at 3,600 acres. Nearly all remaining wetlands are degraded by pesticides, acid mine drainage, siltation, brine water, or domestic and industrial sewage. Coal mining, oil extraction, logging, channelization, and impoundments have significantly altered wetlands in the western region of the State.

■ Maine—The historic loss of approximately 20 percent of Maine's wetlands is attributed to commercial, residential, and urban development, road construction, navigation projects, hydropower and water storage projects, peat mining, timber harvesting, and agricultural conversion. Maine also reports that some remaining wetlands are adversely affected by landfills and hazardous waste disposal practices. The State is also concerned with the secondary effects of development adjacent to wetlands (e.g., urban runoff).

■ North Dakota—Most recent estimates indicate that North Dakota's wetlands loss rate has declined from 20,000 to 10,000 acres annually. The decline in loss rate is attributed to State and Federal legislation, the diminishing wetlands base, and the increasing cost of draining wetlands.

■ Oklahoma—The State has lost 85 to 90 percent of its historic wetlands acreage. Currently, the FWS estimates that 1 percent of bottomland hardwoods and

2 percent of floodplain wetlands are lost annually. Previous losses are due to reservoir construction, agricultural clearing, ranching, clear cutting, and conversion of the hardwood forests to pine plantations. Upstream dams and flood control structures have also altered hydrologic regimes and damaged wetlands.

■ Utah—It is difficult to assess wetlands trends in Utah because fluctuating climatic effects on the Great Salt Lake shoreline have a dominant effect on losses and gains. For example, high precipitation during 1983-84 caused the Great Salt Lake to rise and destroyed 300,000 acres of wetlands. During the ensuing dry period, lake levels receded and some of the wetlands returned. Approximately 700 acres may be lost annually due to residential and commercial development, agricultural activities, and livestock practices. Remaining wetlands water quality is degraded by irrigation return flows containing elevated concentrations of soil salts and selenium.

■ Wisconsin—As of 1985, 5.3 million acres of wetlands remained in the State. Records indicate that Section 404 permits were issued to fill 9,247 wetlands acres between 1982 and 1989. Cranberry operations accounted for 54 percent of the wetlands losses. Other agricultural operations, development, and ditch excavation each affected 10 percent of the lost wetlands acreage.

Wetlands Protection Programs

Summary of Federal Programs

The Section 404 Permit Program

Section 404 of the Clean Water Act gives the U.S. Army Corps of Engineers authority to issue permits for "the discharge of dredged or fill material into the navigable waters [of the United States] at specified disposal sites." Section 404 also gives EPA a number of responsibilities to ensure that the environment is sufficiently protected from the adverse impacts of these discharges. Although States may be granted the authority to assume 404 permitting, to date only Michigan has assumed that responsibility. Since 1972, the 404 program has developed into the most important Federal regulatory program for the protection of wetlands.

Project applications under Section 404 and Section 10 of the Rivers and Harbors Act are processed by the Corps of Engineers. EPA reviews and evaluates applications using its Section 404(b)(1) guidelines, which contain the environmental criteria for Section 404 permit decisions. The FWS and the National Marine Fisheries Service also influence the Section 404 permitting process through their review of applications. After receiving comments from these agencies, the States, and other interested parties, the Corps of Engineers makes its permit decisions.

Section 319 Nonpoint Source Program

Section 319 of the 1987 CWA created a comprehensive program to integrate Federal and State programs aimed at controlling NPS water pollution. The physical location of wetlands between water and land links wetlands protection with control of NPS contamination and water quality improvements in adjacent waters. In 1990, EPA published guidance on the coordination of State and Federal NPS control programs and wetlands programs. The guidance discusses the implementation of activities that can benefit both NPS and wetlands programs.

Summary of State Programs

The States protect their wetlands with a variety of permitting programs, coastal management programs, wetlands acquisition programs, and natural heritage programs. In their 1990 Section 305(b) reports, 42 States reported on State programs to protect their wetlands, representing a dramatic increase in State reporting over previous years (see Table 5-4). Several general conclusions can be drawn from the information provided:

■ Freshwater wetlands receive minimal protection;

■ Most States rely upon the Section 401 certification process to protect inland wetlands;

- Most inland wetlands programs (other than 401 programs) are delegated to local or regional government entities;

- Few States have established specific water quality standards or criteria for wetlands; and

- More States are adopting no net loss policies and requiring replacement of filled wetlands.

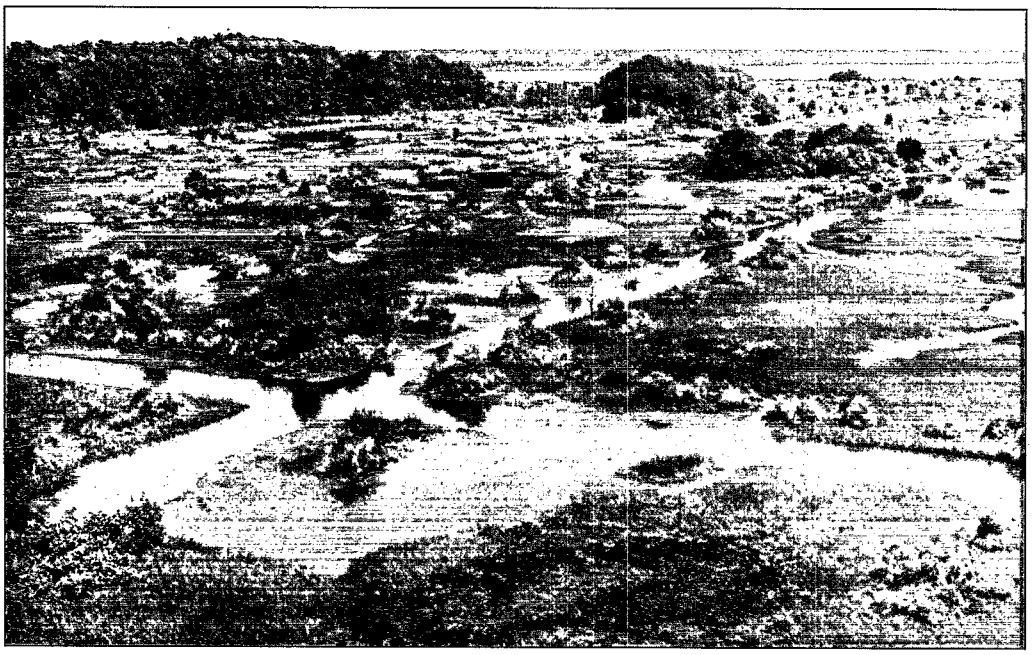
Section 401 of the CWA gives broad statutory authority to the States to grant, condition, or deny certification of federally permitted or licensed activities that result in a discharge to waters of the U.S., including wetlands. Although the 401 certification can be a powerful tool, it should be used to augment other State programs because it applies only to projects requiring Federal permits (i.e., Sections 9 and 10 of the Rivers and Harbors Act, and Sections 402 and 404 of the CWA). Activities exempt from Section 404, such as certain draining activities, are not reviewed under Section 401.

Thirty-five States reported that they use their Section 401 authority to protect wetlands; of these, 17 States report that the Section 401 process is their primary mechanism for protecting freshwater wetlands. Several States also reported that inadequate staffing and funding restricted the effectiveness of their Section 401 certification programs.

Only 14 States describe inland wetlands protection programs in addition to their Section 401 programs. In eight States these programs are delegated to local or regional governments. Many of these freshwater programs are limited because they apply only to wetlands over a specific size (e.g., 10 acres in Maine) and exempt agricultural and silvicultural activities, which can cause significant wetlands losses.

Although many States define wetlands as waters of the State, few States have developed water quality standards for wetlands, which are vital to an effective Section 401 program. The Section 401 certification program can stop projects that degrade wetlands only if water quality standards including antidegradation policies, will be violated (e.g., if existing uses will be eliminated by the project now or in the future). None of the States reported criteria for assessing use support in wetlands.

In contrast, most coastal States have permit programs to regulate loss of estuarine and marine wetlands. Coastal permit programs exist in 18 of the 26 coastal States and Territories (the term "coastal" includes the Great Lakes States) reporting on wetlands protection programs. These programs have been encouraged and supported with Federal financial assistance since enactment of the 1972 Coastal Zone Management Act. The State permit programs have significantly reduced the rate of coastal wetlands conversions. For example, in Delaware the rate of coastal wetlands losses declined from 444 acres to 20 acres per year following enactment of its coastal permit program.



Bill Richards

Drainage and navigation channels degrade wetlands habitat.

Table 5-7. Summary of Reported State Wetlands Protection Programs

State	Coastal Permit Program	Freshwater Nontidal Program	Comprehensive Coastal and Inland Program	Formal Policy, Regulation, or Guidelines for Issuing 401 Certification for Wetlands
Alabama	●	—	—	●
Alaska	—	—	—	●
Arizona	NA	—	—	●
Arkansas	NA	—	—	—
Connecticut	NA	—	●	●
Delaware	●		—	—
Florida	●	■	●	●
Georgia	●	—	—	—
Hawaii	—	—	—	●
Illinois	—	—	▲	—
Indiana	—	—	—	●
Iowa	NA	—	—	●
Kansas	NA	—	—	●
Kentucky	NA	—	—	●
Louisiana	●	—	—	●
Maine	●	■	●	—
Maryland	●	▲	—	●
Massachusetts	●	■	●	●
Michigan	●	■	●	●
Minnesota	—	—	—	●
Mississippi	●	—	—	●
Missouri	NA	—	—	●
Nebraska	NA	—	—	●
Nevada	NA	—	—	●
New York	●	■	●	●
North Carolina	●	—	—	●
North Dakota	NA	—	—	—
Ohio	—	—	—	●
Oklahoma	NA	—	—	●
Oregon	●	●	●	●
Pennsylvania	●	■	●	●
Puerto Rico	—	—	—	●
Rhode Island	●	●	—	●
South Carolina	●	—	—	●
South Dakota	NA	■	—	—
Tennessee	NA	●	—	●
Texas	—	—	—	●
Vermont	NA	●	●	●
Virginia	●	—	—	●
Washington	—	—	—	●
West Virginia	NA	—	—	●
Wisconsin	●	■	●	—

● Program in place.
▲ Program in place; legislation enacted but not yet implemented; regulations to be developed.
■ Program in place; can be delegated to local or regional authorities.
— No data.

State-Reported Information

More States reported on wetlands protection programs in their 1990 Section 305(b) reports than ever before. The following information highlights several State wetlands protection programs. Additional information on State wetlands programs is provided in Table 5-7 and in Appendix A, State Summaries.

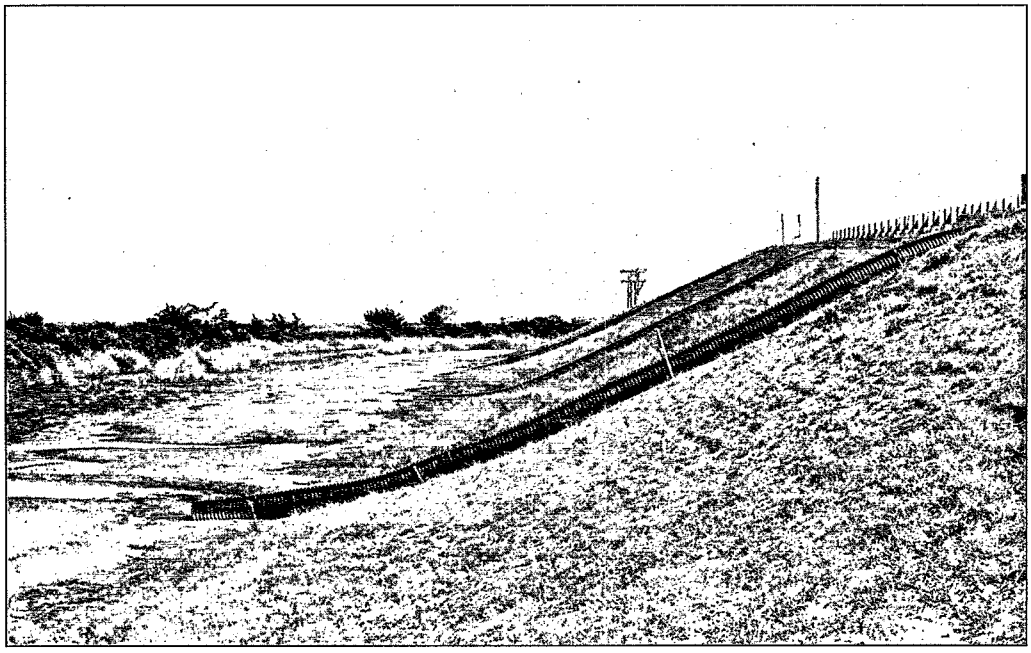
■ Indiana—Wetlands are waters of the State and the discharge of dredge spoil or fill into wetlands constitutes water pollution. The State determines if the discharge would violate water quality standards that include wetlands. Most wetlands fills would violate one or more sections of Indiana's State laws and regulations, and Section 401 certification is usually denied for Section 404 projects unless extensive mitigation is proposed. Drainage of wetlands is not regulated.

■ Maine—The Natural Resources Protection Act of 1988 requires a permit for most alteration activities adjacent to protected areas, including wetlands. Proposed activities must not interfere unreasonably with existing scenic, aesthetic, or recreational uses; cause soil erosion; harm wildlife or aquatic habitat; lower water quality; or increase flooding unless alternatives with fewer impacts do not exist. Regulations to implement the Act are under preparation.

Maine's Mandatory Shoreland Zoning Act, amended in 1989, requires municipalities to establish land use controls for all land areas within 250 feet of coastal wetlands, tidal waters, and freshwater wetlands that are 10 acres or larger. The State imposed a model ordinance on communities not implementing their own controls. The model ordinance includes numerous standards for shoreland development (e.g., minimum lot size and frontage requirements, clearing limitations, and erosion and sedimentation control rules). All land use activities, including those not requiring a permit, must comply with land use standards in the local or model ordinances.

■ Oregon—Oregon's Senate Bill 3, passed in 1989, is primarily intended to promote wetlands protection. It requires the Division of State Lands (DSL) to compile a wetlands inventory; defines wetlands; establishes areas and criteria for filling or removing material in wetlands; authorizes the DSL director to approve wetlands conservation plans and estuary management plans; requires notice to DSL of changes in wetlands status; and requires DSL to develop a public information program about wetlands, analyze voluntary wetlands protection incentives, and adopt rules to implement the Act. The bill also allows the creation, restoration, or enhancement of wetlands in exclusive farm-use zones. DSL is drafting administrative rules to implement the requirements of Senate Bill 3.

Oregon's Removal-Fill Law requires a permit for removal, fill, or alteration involving 50 cubic yards or



Randy Dodd

Highway runoff into a coastal salt marsh.

more of material in any waters of the State, including wetlands. The law is more restrictive than the Section 404 program administered by the Corps of Engineers. Oregon's Division of Environmental Quality reviews Section 404 permit applications to determine if wetlands functions will be altered.

■ Pennsylvania—Local wetlands protection efforts were enhanced by the 1988 revisions of the Municipal Planning Code. The revisions specify that wetlands preservation is a valid zoning purpose. The Commonwealth is distributing a handbook to local governments that provides strategies for protecting wetlands through land use regulations, easements, tax incentives, and acquisition programs.

■ Texas—In 1989, the Texas Legislature passed Senate Bill 1206 establishing a single statewide definition of wetlands. The State's Strategic Plan aims for no net loss of existing wetlands. The State will deny 401 certification to projects that adversely impact wetlands until lost wetlands are replaced.

Texas wetlands are considered waters of the State and are protected from deterioration by the Antidegradation Policy. The State may impose wastewater treatment levels, facility operations, or project requirements on proposed activities that might impair high-priority wetlands. If wetlands destruction is unavoidable, wetlands will be replaced one-for-one with similar habitat and hydrology. At present, wetlands resources are identified and protected on a site-specific basis.

■ Vermont—In 1990, the Water Resources Board adopted the Vermont Wetlands Rules to implement the 1986 Wetlands Act. The rules establish standards and restrict activities that could potentially degrade the function and value of significant wetlands. In addition, the State Development Control Law (Act 250) requires a permit for every major land development and subdivision in the State. Several permit criteria protect wetlands, but most agricultural and silvicultural activities are exempt, as are small- scale industrial, commercial, and residential projects. The State also reviews Section 404 permits through the Section 401 certification program.

New Initiatives

State Wetlands Program Development Grants

EPA has long recognized the crucial role States can play in protecting the Nation's wetlands and has worked with States to develop their interest, authority, and capability to protect wetlands. This effort has been hampered by the lack of direct Federal funding to support State wetlands protection programs. States have been able to use Section 106 or 205 funds for wetlands programs, but this has generally not been a realistic option because of full allocation of those funds to other State water quality programs.

The State grants awarded in FY90 covered a wide range of activities to support development of new programs or refinement and enhancement of existing State wetlands protection programs. The demand for funding exceeded the $1 million appropriated for FY90. EPA received approximately 50 applications for funding—from 35 States, 4 Native American Indian Tribes, 1 Territory, and 1 local community. The funds requested by these applications totaled approximately $3 million in Federal funding for $5 million of total project costs.

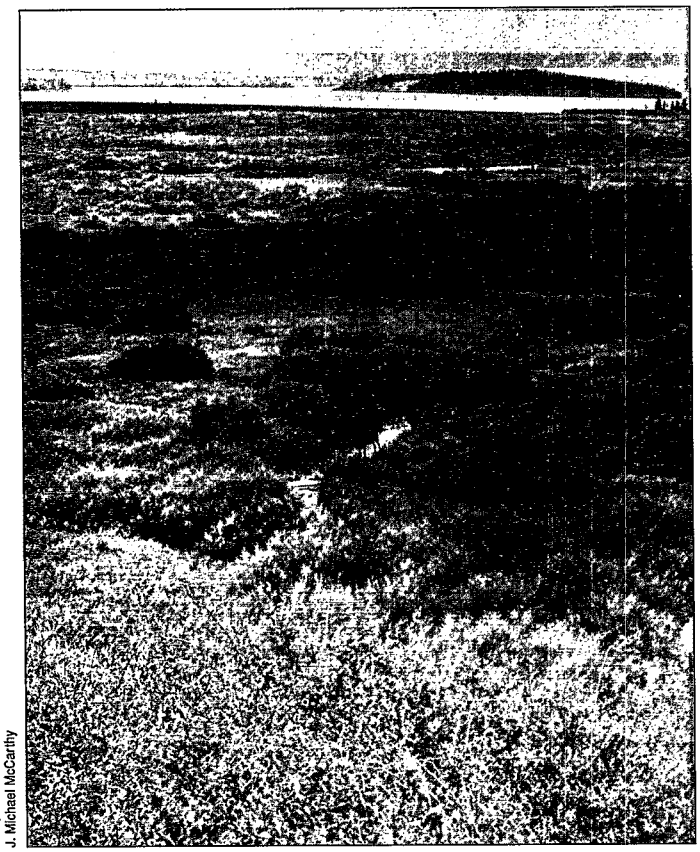
States that have active programs for wetlands protection looked upon the wetlands program development grants as an opportunity to increase and build upon their programs. However, other States that currently are not active in the wetlands protection arena saw the grants as a chance to assess existing authorities, to develop recommendations for new programs and legislation, to consider how to fit wetlands into existing programs, to develop public support for wetlands protection, and to move toward additional protection for the resource.

The agricultural community has been particularly concerned about wetlands protection. The State of Delaware used this grant opportunity to demonstrate the multiple use value of wetlands to the agricultural community. Wisconsin is enhancing their wetlands

protection program by streamlining and targeting the delivery of essential program information to specific audiences. Vermont is using the grant program to develop a pilot project to demonstrate the potential of coordinating State agencies, regional planning commissions, and municipal governments in planning for local resources. The project will serve as a guide to other municipalities interested in pursuing local wetlands protection efforts.

Several States (Michigan, South Carolina, and Oregon) are using wetlands grants to develop their wetlands water quality standards and to improve their Section 401 water quality certification programs to include wetlands. New Hampshire and Connecticut are acquiring and implementing Geographic Information System (GIS) capability to better track permit applications to monitor statewide trends in wetlands development and losses, to conduct long- and short-term analysis of wetlands impacts on a statewide basis as well as within a particular geographic region of the State, and to target specific areas for increased local assistance or basin planning.

While each of these projects will help the specific State better protect wetlands resources, each project will also serve as a model that can be used by other States. The projects funded this first year just begin to tap the imagination and creativity of the States in developing ways to better protect their valuable resources.

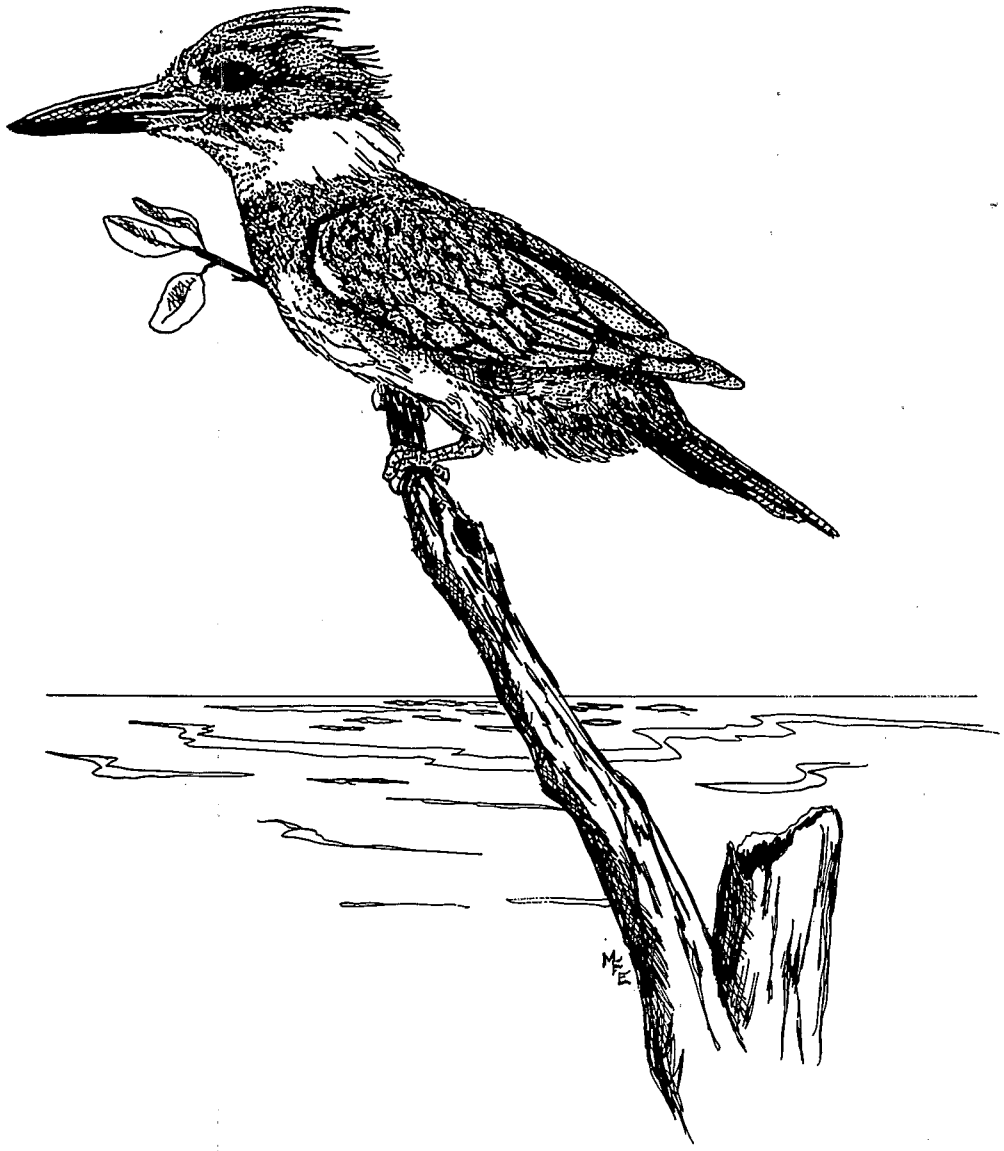


J. Michael McCarthy

Wetlands, Jackson Lake, Wyoming.

Patricia Cunningham

Cypress swamp in coastal North Carolina.



6

Paul Goetz

Public Health/ Aquatic Life Concerns

In 1990, States were asked to report specifically on pollution problems affecting public health and aquatic life. Among the topics they were to address were fish and shellfish consumption advisories and bans, pollution-caused fish kills, problems related to toxic contamination of sediments, contact recreation restrictions, and closures of surface drinking water supplies due to pollution. Many of these impacts result from toxic pollutants. Examples of toxic pollutants include heavy metals, pesticides, dioxin, and PCBs.

Although any pollutant may produce toxic effects if found at a high enough concentration, a number of pollutants appear to have adverse and long-term effects at extremely low concentrations. These toxic substances may be synthetic or naturally occurring, may persist in the environment for long periods of time or dissipate quickly, and may have a variety of different effects on aquatic life and public health.

Our knowledge of the health effects of many toxic pollutants in water and fish and shellfish tissue is still limited. We know that some are linked to human health problems such as cancer, kidney ailments, neurological disorders, and birth defects. Some chronic health effects result only after long-term exposure; others develop years after a short period of exposure. Exposure routes from the aquatic environment to humans include consumption of contaminated drinking water; consumption of contaminated fish, shellfish, and waterfowl tissue; and direct contact

with contaminated water at recreation sites such as swimming beaches.

In addition to public health problems, toxic pollutants can damage aquatic ecosystems by directly eliminating sensitive species or indirectly causing increased incidence of disease in the remaining species. Some toxicants may persist in the environment for decades, posing a continuing threat to humans, aquatic organisms, birds, and other wildlife. This is clearly the case with organochlorine pesticides such as DDT, aldrin, chlordane, and mirex, which have been removed from use for a decade or more yet continue to be found in water, soil, sediment, and tissues of fish, birds, mammals, and humans.

To a large extent, our understanding of the prevalence of toxic substances, exposure routes, and levels of concern is limited by the difficulty and expense of monitoring and conducting long-term health effects studies. The Federal government has developed 62 numeric human health criteria and 25 numeric aquatic life criteria for toxic pollutants against which sampled water concentrations can be measured. Many more toxic substances affect the aquatic environment, however, and State adoption of existing criteria is not universal. Because of the lack of universal criteria, toxic contamination can be discussed only in terms of the "elevated" levels reported by the States. These elevated levels are defined as exceedances of State water quality standards, criteria developed by EPA under Section 304(a) of the Clean Water Act, Water Quality Advisories developed by EPA, or "levels of State concern" where numeric criteria do not exist.

Julie Dubin

Although no longer used, some toxicants such as DDT and chlordane may persist in water, sediments, and fish tissue.

Total Size of Waters Affected by Toxics

Reporting on the extent of toxic contamination of waters was more comprehensive in the 1990 State Section 305(b) reports than in previous years. In general, there appears to be a substantial increase in the total waters affected by toxic pollutants over previous years. One reason for this increase is that more States provided information in 1990. In addition, increased monitoring activity by the States may have led to the detection of more toxics problems. Table 6-1 summarizes this reporting by State for all waterbody types. Highlights of the table include the following:

■ Rivers and streams– 41 States reported that they monitored for toxic substances in 182,611 river miles and found approximately 15 percent of these waters to be affected. Louisiana did not provide data on the number of river miles they monitored for toxic pollutants, but reported that an additional 37 stream miles are affected by elevated concentrations of toxic pollutants.

■ Lakes and reservoirs– 33 States reported that they monitored for toxic pollutants in 9,204,721 acres of lakes and found roughly 39 percent of lakes to be affected. Louisiana did not report on the number of lake acres they monitored for these substances, but reported that 9,118 lake acres

are affected by elevated concentrations of toxic pollutants.

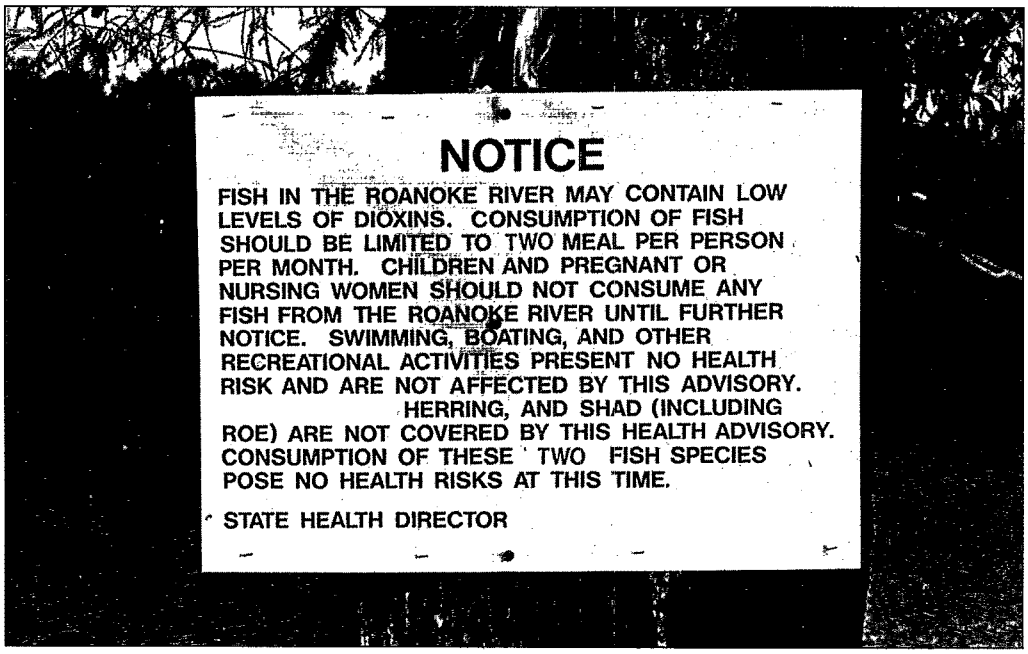
■ Estuaries–17 States reported that 10,159 square miles of their estuaries were monitored for toxic substances, and 19 percent were found to be affected by elevated toxics concentrations.

■ Coastal waters–Six States reported that they monitored 1,837 coastal shoreline miles and found 7 percent to be affected by elevated concentrations of toxic substances.

■ Great Lakes–Six States reported that 4,893 of their Great Lakes shoreline miles were monitored for toxic pollutants, and over 98 percent were found to be affected.

In some States the percentage of monitored waters found to have elevated concentrations of toxic substances appears high. Monitoring for toxic substances is an expensive, resource-intensive process, and States are most likely to direct monitoring efforts toward those waters suspected or known to have toxics problems (e.g., waters with multiple industrial dischargers or waters with known sediment contamination problems). EPA and the States have gained considerable experience over the last decade in monitoring for toxic substances and in targeting monitoring to areas most likely to be contaminated.

Because we cannot always predict where contamination is likely to occur, monitoring for toxic compounds must also be conducted in previously unmonitored waters. States are making progress in identifying these waters.



Randy Dodd

State fishing advisories are posted to warn recreational fishermen of potential risks of consuming chemically contaminated fish.

Fish Consumption Advisories and Bans

Toxic chemicals discharged to rivers, lakes, and estuaries may be absorbed or ingested by aquatic organisms that are, in turn, consumed by larger predators such as fish. Toxic pollutants can bioaccumulate in the tissues of fish and shellfish, which poses a potential health hazard to people who eat them. Various methodologies (e.g., FDA "action levels," Water Quality Criteria, or levels of State concern) have been used by the States to impose fish and shellfish consumption restrictions. To determine whether the degree of fish tissue contamination could be harmful to the public, some States have considered local factors such as consumption rates for general consumers, sportsmen, or subsistence fishermen; species of fish consumed; and size of the fish consumed.

In 1990, 31 States reported finding concentrations of toxic contaminants in fish tissue exceeding FDA action levels or other levels of concern in localized areas. Many States responded to the finding of elevated concentrations of toxic substances by imposing fishing bans or fish consumption advisories. Advisories typically recommend limiting consumption of certain fish species from given waterbodies to a few meals per week or month and differentiate between the general population of consumers and more sensitive subpopulations of consumers (e.g., pregnant women, nursing

Table 6-1. Size of Surface Waters Affected by Toxic Substances

State	Rivers (miles)			Lakes (acres)		
	Total Waters	Monitored for Toxics	Elevated Toxics	Total Waters	Monitored for Toxics	Elevated Toxics
Alabama	40,600	783	140	507,421	230,379	30,200
Arizona	17,537	1,806	942	127,372	61,899	21,995
Arkansas	11,310	410	91	355,063	—	—
California	26,970	12,123	2,286	1,417,540	1,159,961	730,336
Colorado	31,470	4,600	1,294	265,982	10,355	262
Connecticut	8,400	599	182	82,900	8,754	2,875
Delaware	643	161	63	4,499	253	158
Delaware River Basin	206	120	10	—	—	—
District of Columbia	40	38	16	376	238	103
Florida	12,659	4,098	168	2,085,120	812,864	94,080
Georgia	20,000	446	156	417,730	52,663	0
Hawaii	349	200	0	1,125	—	—
Illinois	14,080	4,574	1,635	305,847	80,598	28,530
Indiana	90,000	2,531	1,140	104,540	23,500	815
Iowa	18,300	1,449	490	80,670	32,015	10,400
Kansas	13,295	12,280	295	173,602	166,667	18,028
Louisiana	14,180	—	37	713,719	—	9,118
Maine	31,672	865	296	944,560	38,106	400
Maryland	17,000	1,944	—	21,001	3,036	—
Massachusetts	8,053	1,188	325	151,173	29,771	25,550
Michigan	36,350	22,800	748	840,960	110,255	29,255
Minnesota	91,944	1,856	1,734	3,411,200	2,190,320	1,964,482
Mississippi	15,839	1,290	188	500,000	43,093	46
Montana	51,212	35,461	2,279	740,086	459,580	302,247
Nebraska	24,000	1,849	340	145,800	111,466	300
Nevada	7,500	1,574	47	425,400	69,925	3
New York	70,000	3,400	505	750,000	668,000	141,572
North Dakota	11,868	5,826	255	619,088	437,671	0
Ohio	43,917	6,100	2,070	117,361	—	—
Pennsylvania	50,000	4,314	2,192	149,000	—	—
Puerto Rico	5,373	1,063	154	11,146	6,678	210
Rhode Island	724	537	99	16,683	4,970	99
South Carolina	9,900	2,514	4	525,000	354,114	0
South Dakota	9,937	3,080	163	1,598,285	548,000	0
Susquehanna River Basin	21,100	1,196	885	—	—	—
Tennessee	19,124	2,550	433	538,504	305,119	43,421
Texas	80,000	11,854	769	3,065,600	902,960	532
Utah	11,779	8,874	2,335	481,638	135,179	0
Washington	40,492	1,571	1,150	613,582	132,867	112,684
West Virginia	28,361	4,128	1,466	23,460	13,465	2,302
Wisconsin	43,600	8,886	532	957,288	—	—
Wyoming	19,437	1,673	346	—	—	—
Totals	1,069,221	182,611	28,260	23,290,321	9,204,721	3,570,003

— Not reported.

Source: 1990 State Section 305(b) reports.

Estuaries (sq. miles)			Oceans (coastal miles)			Great Lakes (shore miles)		
Total Waters	Monitored for Toxics	Elevated Toxics	Total Waters	Monitored for Toxics	Elevated Toxics	Total Waters	Monitored for Toxics	Elevated Toxics
625	85	35	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
1,598	800	495	1,840	1,118	62	—	—	—
—	—	—	—	—	—	—	—	—
600	558	185	—	—	—	—	—	—
—	—	—	25	—	—	—	—	—
866	53	25	—	—	—	—	—	—
6	6	4	—	—	—	—	—	—
4,298	1,883	252	8,460	63	0	—	—	—
594	56	4	—	—	—	—	—	—
134	34	0	—	—	—	—	—	—
—	—	—	—	—	—	63	63	63
—	—	—	—	—	—	43	43	43
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
7,656	—	—	—	—	—	—	—	—
1,633	10	10	3,500	—	—	—	—	—
2,522	2,042	—	32	0	—	—	—	—
177	107	78	1,519	—	—	—	—	—
—	—	—	—	—	—	3,288	3,288	3,288
—	—	—	—	—	—	272	272	272
133	7	0	81	40	0	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
1,564	1,564	750	130	130	70	577	577	492
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	231	—	—
—	—	—	—	—	—	40	—	—
—	—	—	434	119	5	—	—	—
193	101	7	420	—	—	—	—	—
2,155	319	0	190	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
1,990	1,959	20	367	367	0	—	—	—
—	—	—	—	—	—	—	—	—
2,943	575	85	165	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	650	650	650
—	—	—	—	—	—	—	—	—
29,687	10,159	1,950	17,163	1,837	137	5,164	4,893	4,808

Table 6-2. Fishing Restrictions Reported by the States

State	Number of Waterbodies with Restrictions		Areas Affected			
	Advisories	Bans	River Miles	Lake Acres	Estuary Square Miles	Great Lake Shore Miles
Alabama	1	0	157	—	—	—
Alaska	1	5	—	—	—	—
Arizona	0	2	—	550	—	—
Arkansas	2	1	—	—	—	—
California	6	0	—	—	—	—
Colorado	7	—	—	—	—	—
Connecticut	5	0	65	—	—	—
Delaware	5	—	39	158	—	—
Delaware River Basin	5	0	—	—	22	—
District of Columbia	1	—	—	—	6	—
Florida	25	0	—	—	—	—
Georgia	3	1	34	—	—	—
Illinois	10	0	361	20,298	—	63
Indiana	21	0	687	—	—	43
Iowa	3	0	—	—	—	—
Kansas	1	—	10	—	—	—
Kentucky	3	—	116	—	—	—
Louisiana	9	1	62	8,964	—	—
Maine	5	0	256	—	—	—
Maryland	3	1	—	—	—	—
Massachusetts	12	1	—	—	—	—
Michigan	35	16	579	10,880	—	3,288
Minnesota	446	—	1,734	1,964,482	—	272
Mississippi	5	4	36	—	—	—
Missouri	19	0	831	9,968	—	—
Montana	1	—	20	—	—	—
Nebraska	1	0	—	—	—	—
Nevada	2	—	60	14,800	—	—
New Hampshire	1	—	15	—	—	—
New Jersey	11	7	—	—	—	—
New Mexico	0	1	—	—	—	—
New York	52	1	505	141,572	750	492
North Dakota	1	0	—	—	—	—
Ohio	15	—	—	—	—	—
Ohio River Valley	13	0	317	—	—	—
Oklahoma	2	0	—	—	—	—
Oregon	3	—	—	—	—	—
Pennsylvania	18	2	—	—	—	—
Rhode Island	2	1	—	—	—	—
South Carolina	3	—	—	—	—	—
Tennessee	16	0	108	54,647	—	—
Texas	1	3	62	500	58	—
Utah	1	—	—	—	—	—
Vermont	2	0	7	127,629	—	—
Virginia	5	0	430	—	—	—
West Virginia	7	0	435	—	—	—
Wisconsin	208	3	300	135,386	—	650
Totals	998	50	7,226	2,489,834	836	4,808

— Not reported.

Source: 1990 State Section 305(b) reports.

Table 6-3. Pollutants Associated with Fishing Restrictions

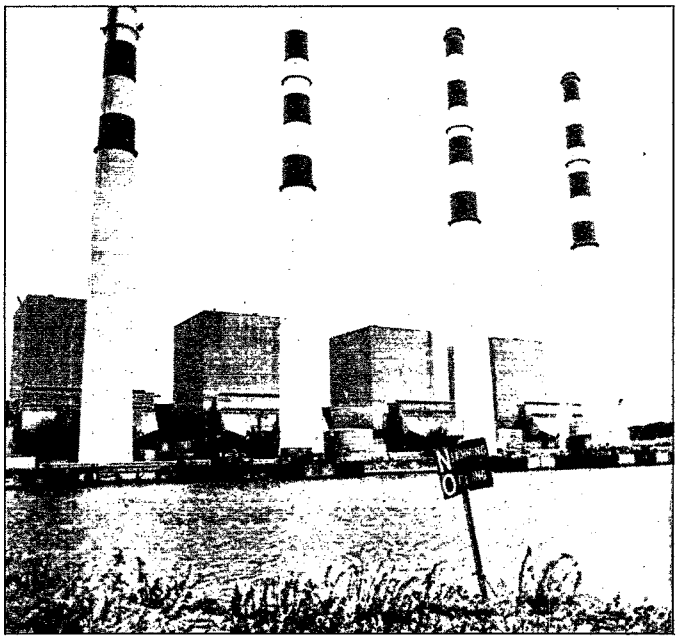
Pollutant	Number of States Reporting
PCBs	30
Pesticides	23
Dioxin	16
Mercury	16
Organics	8
Metals	5

Source: 1990 State Section 305(b) reports.

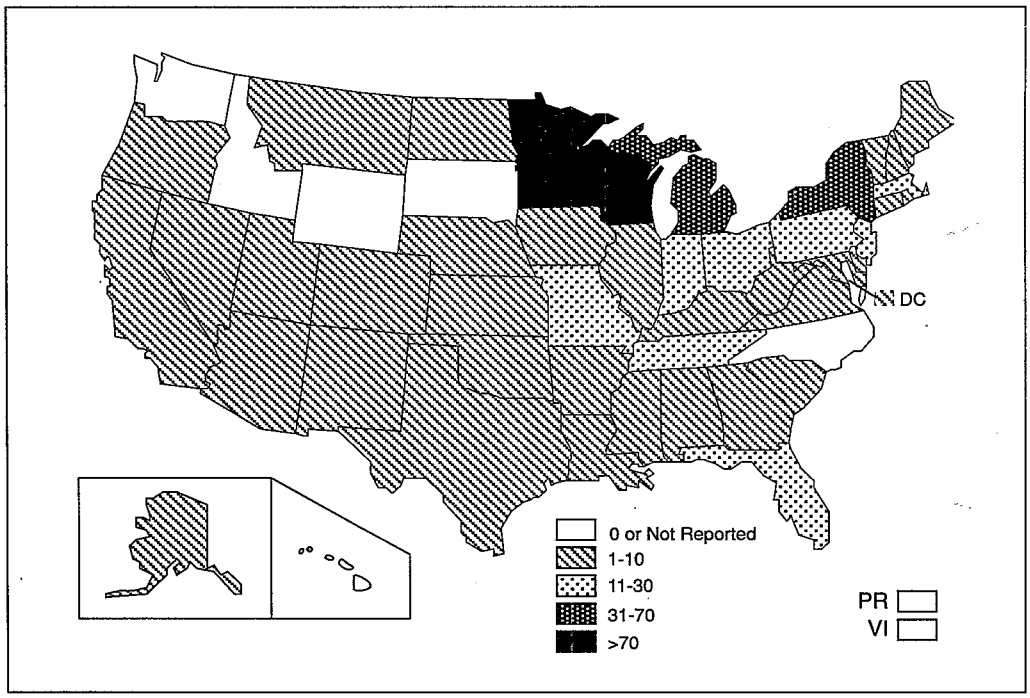
Table 6-4. Sources Associated with Fishing Restrictions

Source	Number of States Reporting
Industrial	12
Urban Runoff/Storm Sewers	8
Agriculture	4
Resource Extraction	4

Source: 1990 State Section 305(b) reports.



Patricia Cunningham



Source: 1990 State Section 305(b) reports.

Figure 6-1. Number of Fish Consumption Restrictions Nationwide

mothers, and children). Fishing bans generally prohibit any consumption of one or more fish species and apply to all potential consumers.

National statistics on fishing advisories and bans are incomplete. Definitions for advisories and bans are not consistent nationwide, making it difficult to track the number of advisories and bans accurately. EPA just completed development of a national database on State fish and shellfish advisories and bans based on information provided by all 50 States. This database contains information on the pollutant that triggered the consumption restriction, the status of the restriction (commercial fish ban, advisory, partial ban, or ban), the fish

species named in the advisory or ban, the waterbody for which the restriction was issued and the geographic extent of the waters covered by the restriction. By the Fall of 1991, EPA will make the database available to States and the public on an electronic bulletin board.

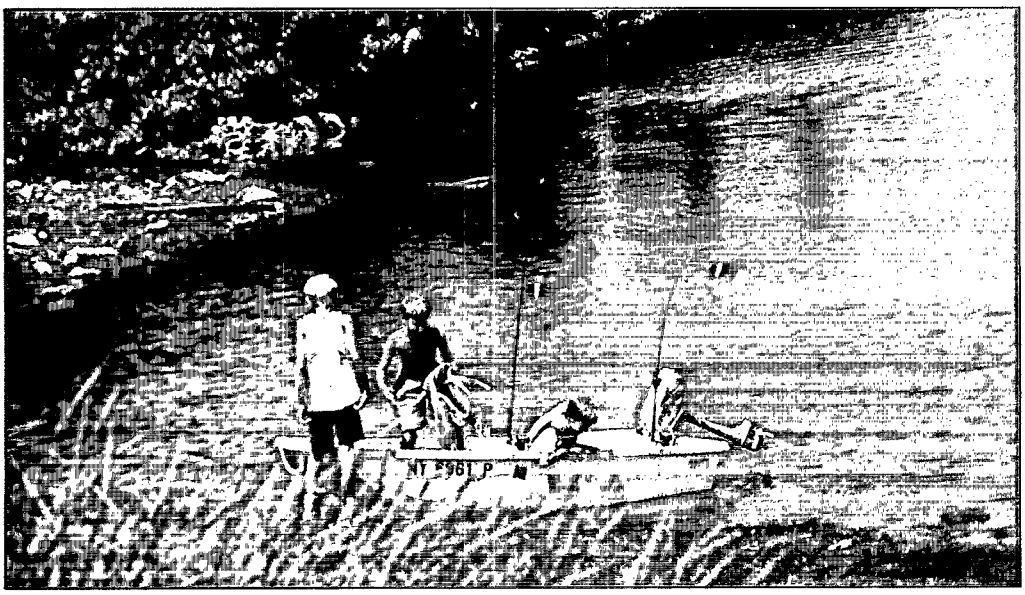
In their 1990 State Section 305(b) reports, 47 States, Jurisdictions, and Interstate Commissions (hereafter referred to as States) provided information on fishing advisories and bans in their waters. All of these States reported that some fishing restrictions were in place in their waters during the 1988-90 reporting period. Table 6-2 summarizes this information by State. Figure 6-1 illustrates the national distribution of fishing advisories and bans combined. Forty-five States reported a total of 998 waterbodies with fishing advisories, and 16 States reported 50 waterbodies with fishing bans (The definition of waterbody may vary from State to State). The pollutants most commonly identified as causing advisories or bans are PCBs, pesticides, dioxin, mercury, organics, and other heavy metals. Table 6-3 summarizes the number of States that cite fishing restrictions for various pollutants.

General categories of sources contributing these contaminants include industrial dischargers, urban runoff/storm sewers, and nonpoint sources such as agricultural and resource extraction activities. Table 6-4 indicates the number of States attributing fishing restrictions to these sources.

In addition to reporting on the number, causes, and sources of restrictions, States were asked to report on the area affected by fishing advisories and bans. Twenty-five States reported that 7,226 stream miles were affected, 13 States reported that 2,489,834 lake acres were affected, and 4 States reported that 836 estuarine square miles were affected. Six States reported that 4,808 Great Lakes shoreline miles were affected by fishing restrictions.

These numbers summarizing fishing advisories and bans should be interpreted with caution and should not be compared with the findings of previous State Section 305(b) reports until standardized and complete reporting is in effect. Bans and advisories, once imposed, tend to remain in force for a number of years because of the persistence of many of the chemicals involved. Thus, a large apparent change in the number of bans and advisories reported by the States over a 2-year period is more likely the result of increasingly comprehensive monitoring and reporting rather than actual water quality changes. In addition, for any given waterbody, a combination of advisories and bans may be imposed for different fish species or may apply differently to different segments of the waterbody or to different consuming populations (e.g., pregnant women, nursing mothers, and children). Last, a great deal of variability is evident among States in the criteria used to impose fishing restrictions and the programs in place to monitor, analyze, assess, and report fish tissue data.

Therefore, the high numbers of restrictions reported by some States is more likely attributable to the criteria and procedures used to set restrictions and to sophisticated, well-established fish tissue monitoring programs



Patricia Cunningham

Forty-seven States reported some fishing restrictions in effect.

in those States rather than to unusually degraded water quality conditions. By the same token, States with no data or with only a few fishing restrictions may not have extensive monitoring programs to detect fish tissue contamination.

The following examples cited by the States in 1990 help illustrate the variety of pollutants and sources responsible for fish tissue contamination and subsequently for the issuance of fish consumption restrictions.

■ Florida issued its first fish consumption advisory in early 1989 in response to elevated concentrations of mercury found in largemouth bass collected in the Everglades Water Conservation Areas. Subsequently, increased monitoring resulted in advisories being issued for nine areas in Florida for a total of 25 streams and lakes. The Governor issued an executive order forming a task force to deal with the issue of mercury in fish and wildlife. At present, fish tissue sampling is continuing and plans are being made for additional sampling of estuarine species and to address specific questions pertaining to the sources, movement, and toxicity of mercury.

■ Louisiana reported that in February 1989 a revised advisory was issued to ban the sale and consumption of speckled and white trout from the Calcasieu Estuary. The State believes that the chlorinated hydrocarbons and PCBs found consistently in these predator fish present a risk to public health. The State is continuing its seafood sampling program and will revise the existing health advisory as needed.

■ West Virginia has experienced an increase in impacts to public health and aquatic life during this reporting period. In addition to the existing advisory for dioxin on a portion of the Kanawha River and several tributaries, fish consumption advisories have been issued for the Ohio River (chlordane and PCBs), Shenandoah River (PCBs), and portions of the North Branch of the Potomac River (dioxin) and Potomac River main stem (dioxin). Risk assessment information and FDA action levels were taken into consideration when developing these advisories.

■ In September 1988 the State of Utah issued a health advisory recommending limited consumption of fish and waterfowl from Stewart Lake. The advisory was issued in response to high concentrations of selenium detected in fish and waterfowl from the lake.

■ In 1988, the Maine Legislature established the Maine Dioxin Monitoring Program to collect more data to assess the extent of the State's dioxin problem. This program required the State to collect sludge and fish samples below 12 industrial or municipal wastewater discharges, analyze them for dioxin and furan, and report the results to the State Legislature by December 1990. Subsequent analyses of bass and trout fillets and whole suckers from Maine rivers showed dioxin concentrations of up to 45.7 parts per trillion (three times the amounts reported previously). The State toxicologist warned in March 1990 that pregnant women should avoid eating fish from the Androscoggin River, Kennebec River below Skowhegan, Penobscot River below Lincoln, Presumpscot River below Westbrook, and the West Branch of the Sebasticook River below Hartland. The general public was advised to eat no more than two meals of fish per year from the Androscoggin River and five meals from the Kennebec River. The State and EPA are currently drafting wastewater discharge permits that will control the discharge of dioxin and furan to acceptable levels by June 1992.

■ A fish consumption advisory issued in August 1987 for PCB contamination in lake trout from Lake Champlain was revised by the Vermont Department of Health in 1989. Since 1987 the State has collected fish of 10 different species at several locations in Lake Champlain and analyzed them for PCBs and other contaminants. Analysis of the additional lake trout data has resulted in the current consumption advisory being limited to lake trout longer than 25 inches. Contaminant concentrations in the other fish species have been found to be low, and no additional advisories have been issued.

■ During 1989, Virginia conducted a special study of PCBs in the Front Royal area at 11 collection sites. The State placed an advisory

against the consumption of fish caught between the lower reaches of the North and South Forks of the Shenandoah River and the State line. The source of PCB contamination was determined to be the Avtex Fibers, Inc., plant located in Front Royal, Virginia. Avtex's Virginia Pollution Discharge Elimination Permit was revoked in November 1989 and the plant was subsequently shut down.

Current Initiatives

Efforts are under way at EPA to improve consistency among State fish advisory programs. Current EPA activities include the development of a fish sampling and analysis guidance document, the establishment of an electronic bulletin board system for fish advisory information, an evaluation of fish consumption survey methodologies, and the development of a methodology to predict population exposure from the consumption of contaminated fish.

Fish Sampling and Analysis: A Guidance Document

In an effort to improve and promote consistency among State and Federal fish monitoring programs, EPA established a workgroup of representatives from 14 States and several Federal agencies to develop guidance on how to sample and analyze fish tissue. The objective of the guidance is to recommend a cost-effective procedure to collect data for the development of protective fish consumption advisories.

The guidance document reviews existing sampling and analytical procedures, recommends a two-tiered sampling strategy (general screening to locate problem areas, and intensive surveys to determine extent and magnitude of contamination), recommends target fish species and contaminants for analysis, and recommends specific analytical methods and quality control procedures. The document is expected to be completed in 1992.

State Fish Advisory Bulletin Board

In response to a clear need for improved communication about fishing advisories, EPA is establishing an electronic mail bulletin board system. The bulletin board will include a listing of all fish consumption advisories in the U.S. and a bibliography of State and Federal risk assessments of fish consumption. The bulletin board is designed to promote the exchange of fish advisory information among Federal agencies, State health departments, State fish and game services, State water pollution control agencies, and the public. The bulletin board is scheduled to be operable by the Fall of 1991.

Analysis of Population at Risk from the Consumption of Dioxin-Contaminated Fish Caught Near Bleached Pulp and Paper Mills: A Pilot Study

As a result of increasing concern about the possible human health impacts of consuming fish caught near industrial effluent discharges, EPA is currently developing a methodology for estimating the number of people at potential risk. The methodology involves determining the size of the area within reasonable traveling distance of a contaminated

Randy Dodd

Industrial facilities were cited by the States as the leading source of contaminants responsible for fishing restrictions.

waterbody and estimating the environmental exposures and associated health risks for various age, sex, and ethnic/race groups living within this area. The methodology is designed to use readily available information to estimate the potential for cancer and noncancer risks within specific subpopulations.

A Review and Analysis of Fish Consumption Survey Methods and Approaches

Recent studies have noted the paucity of accurate data on fish consumption among subsistence and sport fishermen. In an effort to address this need, EPA is planning to conduct an evaluation of survey methods best suited for obtaining information on fish consumption rates for recreational and subsistence fishermen. The evaluation will discuss how surveys can be used to identify the species of fish consumed and the preparation procedures used by subsistence and recreational fishermen. In addition, methods will be identified for examining relationships between socioeconomic variables and fish consumption rates. This report is expected to be completed by October 1991.

Sediment Contamination

Contamination of stream, lake, and estuarine sediments by toxic substances has been identified as a growing environmental concern by an increasing number of States. Although some contaminants are degraded by bacteria in sediments, others remain unaltered in sediment for many years even after the pollutant source has been eliminated or modified; these may serve as a continuing source of toxics to the water column and to aquatic organisms. Bottom-dwelling animals such as estuarine worms, may ingest sediment contaminants as part of their feeding activities and may themselves serve as food for animals higher in the food chain that, in turn, ultimately serve as food for humans.

In addition to potential impacts on water column and benthic biota, sediment contamination can pose obstacles to the maintenance dredging of harbors and navigation channels. Disposal of dredge spoil can become a difficult issue if the spoil contains unacceptable concentrations of PCBs, mercury, dioxin, and similar toxic chemicals. Methods of disposal such as open water dumping, confinement in diked containment areas, and spreading in coastal areas, wetlands, and "reclaimed lands" may create new—and possibly more severe—environmental problems. Resuspension of toxics into the water column also may occur when dredging takes place. Because it may be necessary to dredge harbors simply to keep them open for navigation purposes, the States face difficult decisions where sediment contamination is a concern.

Three approaches are typically used to assess sediment quality: (1) conduct a field survey of benthic communities; (2) conduct bioassays using sediment samples and test organisms; and (3) determine the concentrations of individual chemicals in sediment samples and compare these concentrations to the levels of these chemicals known to cause adverse effects in aquatic life.

Procedures for assessing benthic communities, for performing acute bioassays, and for *analyzing* individual chemicals in sediments are relatively well developed. However, there are currently no national criteria for assessing the effects of individual chemicals in sediments. EPA plans to release draft sediment criteria for nonpolar organic pollutants in late 1991 for public comment; a method for deriving sediment quality criteria for metals is being developed.

Currently, many States do not have the analytical tools and resources for sediment monitoring and analyses; others may not have reported on available chemical data as there are no criteria against which to screen sediment data. Therefore, the following discussion of State-reported information on sediment contamination is limited and probably understates the extent of the problem. As methodologies and criteria are developed and more emphasis is placed on reporting, the comprehensiveness of State data will undoubtedly improve.

Thirty-three States provided some information on sediment contamination in their waters. Twenty-nine of these States indicated that instances of sediment contamination exist in their waters; five States reported

Table 6-5. Sediment Contamination Reported by States

State	Number of Sites	Contaminants Identified
Alaska	1	Aromatic hydrocarbons
Arizona	6	Pesticides, metals (boron, chromium, selenium), radiochemicals
California	1	Mercury
Connecticut	6	Lead, polychlorinated biphenyls (PCBs), organic chemicals, and other metals
Delaware	2	Metals
DC	—	Lead, cadmium, zinc, chlordane, DDT
Florida	—	—
Hawaii	1	Arsenic
Illinois	—	Heavy metals, DDT, PCBs, heptachlor epoxide
Indiana	8	Metals, polynuclear aromatic hydrocarbons (PAHs), cyanide, other organics
Iowa	1	PCBs
Kentucky	1	PCBs
Louisiana	7	Priority organics, creosote, metals, oil and grease, PCBs
Maine	7	Dimethyl formamide, toluene, trichloroethane, chlorinated solvents, tris(2,3-dibromopropyl) phosphate, PCBs, copper, cadmium
Maryland	—	Nickel, zinc, PAHs, non-DDT chlorinated pesticides, pesticides, DDT, PCBs and other metals
Massachusetts	13	Metals, priority organics, oil and grease
Michigan	13	Mercury, alkylated lead, PCBs, dioxin, benzo(a)pyrene, hexachlorobenzene [HCB], DDT, dieldrin, toxaphene, mirex
Minnesota	1	Mercury, PCBs, coal tars
Nevada	7	Mercury and other metals
New York	21	Priority organics, metals, pesticides
Ohio	193	Arsenic, cadmium, chromium, copper, lead, zinc
Oklahoma	10	Mercury, lead, zinc, chlordane, hydrocarbons, PCBs
Oregon	14	Arsenic, cadmium, chromium, copper, lead, nickel, zinc, DDT, PAHs, PCBs, phthalates, cyanide, volatile organic compounds, phenanthrene, pentachlorophenol
Rhode Island	—	—
South Carolina	2	PCBs, chromium, mercury
South Dakota	4	Mercury
Virginia	31	Selenium, chromium, arsenic, iron, manganese, nickel, cadmium, zinc, copper, mercury, lead
Virgin Islands	10	Mercury, copper, selenium, cadmium, nickel, zinc
Wisconsin	24	PCBs, dioxin, mercury, pentachlorophenol, arsenic, cadmium, chromium, zinc, oil and grease, pesticides, PAHs
Total	384	

— Not reported.

Source: 1990 State Section 305(b) reports.

no problems. A total of 384 separate instances of sediment contamination are reported by 24 of the 29 States (Table 6-5). Leading pollutants associated with sediment contamination include heavy metals (e.g., arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc), PCBs, pesticides (e.g., DDT, chlordane, heptachlor, toxaphene, mirex, and dieldrin), and dioxin.

The following examples from the 1990 State Section 305(b) reports serve to illustrate the variety of pollutants and sources contributing to sediment contamination problems.

■ Maine reported that, during 1988-1989, sediments contaminated by toxic pollutants were identified in three waterbodies. Approximately 400 acres of Annabessacook Lake are contaminated with dimethyl formamide, toluene, and trichloroethane from a Superfund site. Sediments in a 6-mile stretch of Quiggle Brook were contaminated by chlorinated solvents from another Superfund site. Tris(2,3-dibromopropyl)-phosphate and other organic compounds from a textile mill were responsible for contaminating 1.5 miles of sediments in the Piscataquis River.

■ Iowa reported that sediments in the Mississippi River at Davenport contain relatively high concentrations of PCBs. Recent studies show that concentrations are significantly higher offshore of local industrial dischargers.

■ Louisiana reported on sediment contamination in Sibley Lake, a large freshwater impoundment located near Natchitoches that serves as the source of public drinking water and as a recreational area. In August of 1988, Tennessee Gas Pipeline Company (TGPC) notified the State that analysis of wastewater from one of their outfalls revealed the presence of PCBs. The State issued a compliance order and imposed civil penalties against TGPC for this excursion. The compliance order required TGPC to sample lake sediments, fish tissue, effluent, and lake water and to take any and all measures necessary to cease discharge of wastewater containing PCBs. TGPC has since ceased direct discharge of their wastewater and has rerouted the wastewater through an activated carbon treatment system prior to discharge into Sibley Lake. During 1989, TGPC sampling results indicated no detectable amounts of PCBs in lake water; however, PCBs were found in lake sediment and fish. In February 1990, TGPC agreed to conduct an intensive study of the sediment around their outfall to help the State determine what remediation plan, if any, is necessary.

■ South Dakota reported a potential problem of toxic pollutants in the sediment of Whitewood Creek, the Belle Fourche River, the Cheyenne River, and Lake Oahe of the Missouri River system. Homestake Mining Company in Lead had used mercury in its gold recovery process for many years. High concentrations of mercury were discharged into Whitewood Creek and presumably were transported downstream as far as Lake Oahe.

■ Alaska reported that the 1989 *Exxon Valdez* oil spill in Prince William Sound caused extensive contamination of intertidal sediments by floating crude oil, resulting in mortality of intertidal organisms. Sediments contaminated by aromatic hydrocarbons have been found in Port Valdez.

New Initiatives

Efforts are under way at EPA to provide States with better tools to assess and control toxics problems.

■ Development of EPA's sediment management strategy to focus the Agency's resources on preventing, remediating, and managing the dredged disposal of contaminated sediments;

■ Further development of sediment criteria; and

■ Development of acute and chronic bioassays for sediments using sensitive species.

Fish Kills Caused by Pollution

One obvious and important indicator of water quality problems is the occurrence of fish kills caused by pollution. Information on fish kills is incomplete; the information reported by the States in 1990 most probably underestimates the extent of the problem for several reasons.

Table 6-6. Fish Kills Caused by Pollution*

State	No. of Fish Kills	No. of Fish Killed	Kills Caused by Toxic Pollutants		Kills Caused by Conventional Pollutants		Kills Due to Unknown/ Unspecified Causes	
			No. Kills	No. Fish	No. Kills	No. Fish	No. Kills	No. Fish
Alabama	7	3,231	3	3,060	3	100	1	71
Alaska	5	2,700	1	2,700	4	—	—	—
Arizona	2	—	2	—	0	—	0	—
Arkansas	9	143,142	0	0	0	0	9	143,142
California	13	—	11	—	2	—	—	—
Connecticut	6	1,948	3	743	1	225	2	980
Delaware	5	—	0	—	1	—	4	—
District of Columbia	2	500	0	0	0	0	2	500
Florida	—	210,952	—	70,640	—	140,312	—	—
Hawaii	8	—	8	—	—	—	—	—
Illinois	51	842,487	—	—	—	—	51	842,487
Indiana	75	454,222	—	—	—	—	75	454,222
Iowa	21	1,076,293	11	1,069,914	3	2,024	7	4,355
Kansas	49	244,713	5	4,047	28	181,297	16	59,369
Kentucky	35	364,015	7	55,862	17	229,926	11	78,227
Maine	7	1,625	0	0	3	600	4	1,025
Maryland	322	—	13	—	213	—	96	—
Massachusetts	2	—	2	—	—	—	0	—
Michigan	25	54,163	6	2,724	13	51,439	6	—
Minnesota	106	148,523	0	0	35	11,519	71	137,004
Mississippi	23	115,301	7	107,801	7	2,600	9	4,900
Montana	3	—	3	—	0	—	0	—
Nebraska	42	228,233	—	—	—	—	42	228,233
Nevada	4	10,000	2	—	1	10,000	1	—
New Hampshire	1	—	1	—	—	—	—	—
New Mexico	4	8,000	1	—	0	0	3	8,000
New York	58	163,770	17	75,330	20	60,640	21	27,800
North Carolina	93	—	3	—	63	—	27	—
Ohio	135	613,575	17	54,581	81	528,978	37	30,016
Oklahoma	80	477,160	4	8,973	34	14,126	42	454,061
Oregon	6	104,230	2	375	4	103,855	0	0
Puerto Rico	4	150	0	0	1	—	3	150
Rhode Island	2	—	—	—	1	—	1	—
South Carolina	10	9,030	7	2,530	2	4,500	1	2,000
South Dakota	2	35,000	2	35,000	0	0	0	0
Tennessee	17	—	—	—	—	—	17	—
Texas	56	11,193,610	12	2,350,657	26	5,260,998	18	3,581,955
Utah	28	12,306	6	2,768	16	9,421	6	117
Vermont	7	16,000	3	16,000	1	—	3	—
Virgin Islands	5	—	—	—	5	—	—	—
West Virginia	27	9,364,951	4	6,150	15	9,316,919	8	41,882
Wisconsin	8	47,758	2	37,318	5	3,700	1	6,740
Totals	1,365	25,947,588	165	3,907,173	605	15,933,179	595	6,107,236
Percent of Total Fish Kills			12.0%	15.1%	44.3%	61.4%	43.6%	23.5%

*During 1988-1990 reporting period only; excludes kills due to natural causes when a breakout was possible.

— Not reported.

Source: 1990 State Section 305(b) reports.

Table 6-7. Pollutants Associated with Fish Kills

Pollutant	Number of States Reporting
Pesticides	19
BOD/DO	17
Oil and Gas	16
Chlorine	14
Temperature	10
Ammonia	9
Organics	7
Acidity	6

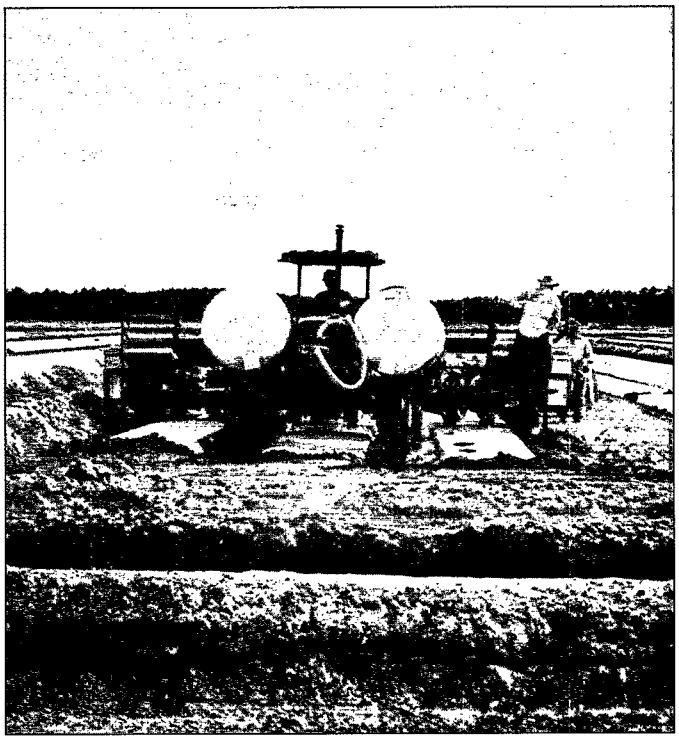
BOD/DO = Biological oxygen demand/dissolved oxygen.

Source: 1990 State Section 305(b) reports.

Table 6-8. Sources Associated with Fish Kills

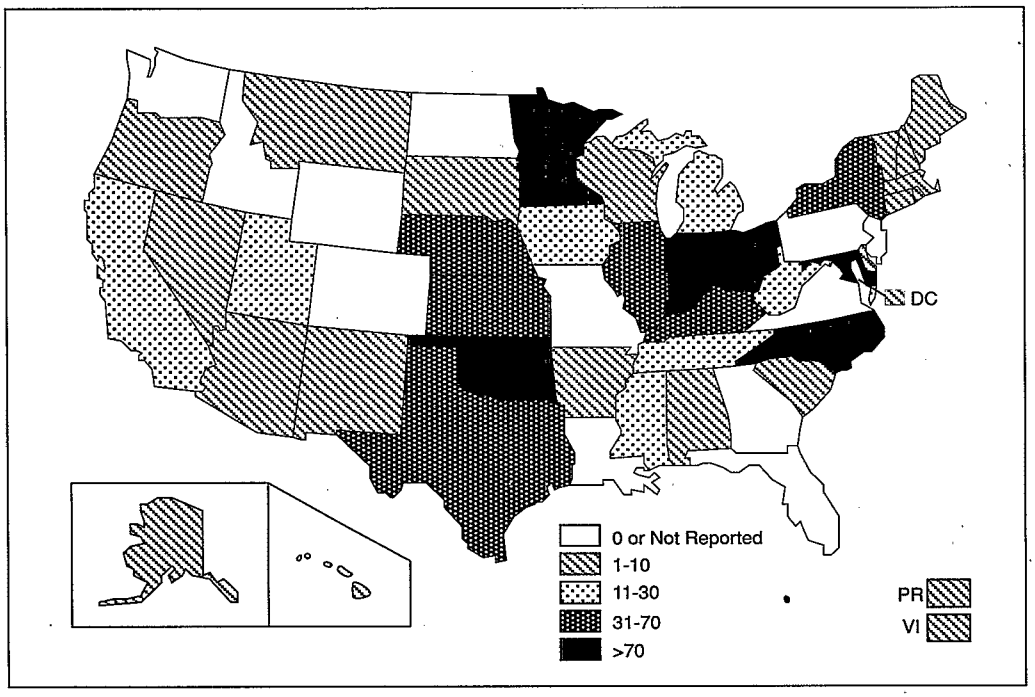
Source	Number of States Reporting
Industrial	21
Agriculture	19
Municipal	18
Spills	15
Resource Extraction	9
Hydromodification	6
Urban Runoff/Storm Sewers	5

Source: 1990 State Section 305(b) reports.



Jim Turner

Pesticides were the leading cause of fish kills.



Source: 1990 State Section 305(b) reports.

Figure 6-2. Number of Fish Kills Nationwide

In many cases it is the public—fishermen, boaters, and hikers—who first notice fish kills and report them to fish and game wardens or other State officials. Many fish kills may go undetected or unreported; others may be difficult to investigate. (Dead fish may be carried quickly downstream, for example, or may be difficult to count because of turbid conditions.) Reporting on pollution-caused fish kills is new to the State Section 305(b) process, and a number of States did not provide data, did not present a comprehensive number of kills, or did not specify the cause and/or magnitude of the fish kills. Available data reported by the States are presented in Table 6-6.

Table 6-6 shows that 42 States provided some information on the occurrence of pollution-caused fish kills during the 1988-1990 reporting period:

- All of these States indicated that pollution-caused kills occurred in their waters.

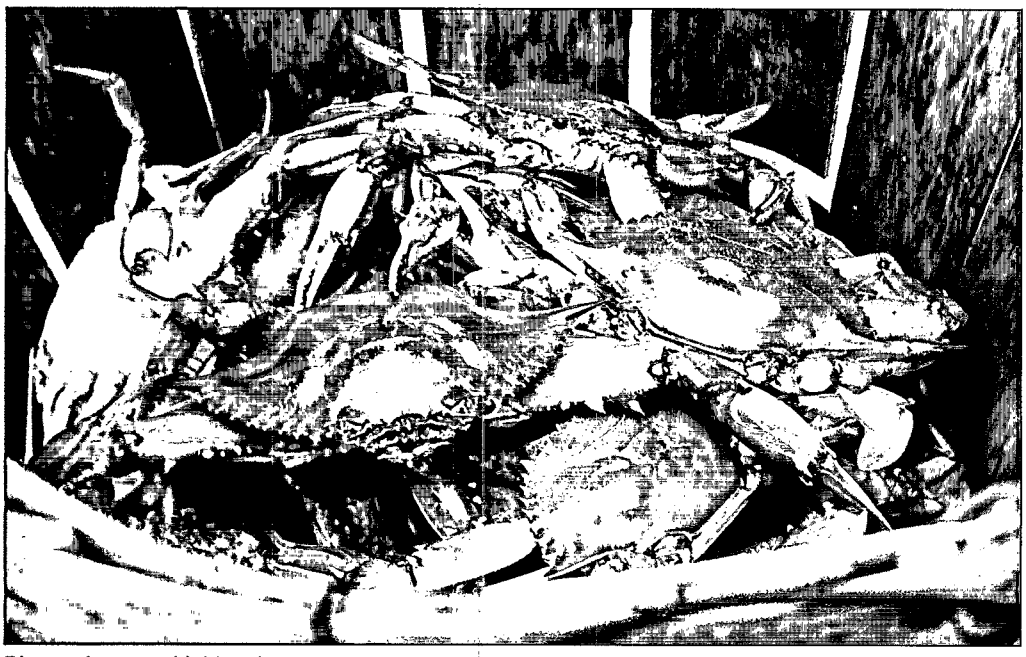
- Forty-one States provided information on the number of kills, for a total of 1,365 incidents (see Figure 6-2).

- In the 30 States that indicated the number of fish killed, almost 26 million fish were reported killed. Almost 80 percent of that total was contributed by two States: Texas (43 percent) and West Virginia (36 percent).

- About three and a half times more fish kills were attributed to conventional pollutants (44 percent) than to toxic substances (15 percent) in those States that specified the distinction. Forty-four percent of the fish kills (595) were attributed to unknown causes.

- The States reported that leading identified causes of fish kills include pesticides, biochemical oxygen demand/low dissolved oxygen, oil and gas, chlorine, temperature changes, ammonia, organics, and acidity (Table 6-7).

- The most commonly reported sources of fish kills are industrial dischargers, agriculture, municipal sewage treatment plants, spills, resource extraction, hydromodification, and urban runoff/storm sewers (Table 6-8).



George Mirsch

Blue crabs are a highly prized fishing resource of the Chesapeake and Delaware Bays.

Shellfish Harvesting Restrictions

In addition to seafood consumption restrictions related to toxic pollutants, many coastal States report restrictions on shellfish harvesting related to pathogenic bacterial or viral contamination of estuarine waters. Shellfish, particularly oysters, clams, and mussels, are filter-feeders that extract their food (plankton) as well as waterborne bacteria and viruses from the water column and accumulate them on their gills and mantle and in their digestive systems. Contaminated shellfish are a serious human health concern particularly when shellfish are consumed raw; proper cooking is the most effective method for killing many microorganisms.

States currently analyze water samples from shellfish harvesting areas to measure the most probable number (MPN) of total coliform and fecal coliform bacteria. Fecal coliform bacteria are found in the digestive systems and waste products of several avian and mammalian species. These bacteria, although nonpathogenic, serve as environmental indicators for the presence of potentially pathogenic sewage-associated microorganisms (bacteria such as *Salmonella, Vibrio, Shigella,* and viruses) that can cause such diseases as gastroenteritis, dysentery, cholera, and infectious hepatitis. The States restrict shellfish harvesting to those areas that maintain total and fecal coliform levels below certain

Table 6-9. Shellfish Harvesting Restrictions Reported by States*

State	Number of Restrictions	Estuarine Sq. Miles Affected
California	2	—
Connecticut	6	—
Delaware	9	—
Delaware River Basin	2	42
Florida	—	—
Georgia	—	178
Louisiana	—	—
Maryland	—	92
Massachusetts	7	78
Maine	120	158
Mississippi	—	—
New Hampshire	2	3
New Jersey	—	126
New York	63	294
North Carolina	—	—
Oregon	—	—
Rhode Island	43	52
South Carolina	57	274
Texas	10	721
Virginia	19	—
Total	340	2,018

*All States listed indicated shellfish harvesting restrictions were in effect during reporting cycle but several did not provide quantitative data on the restrictions.

— Not reported.

Source: 1990 State Section 305(b) reports.

Table 6-10. Sources Associated with Shellfish Harvesting Restrictions

Source	Number of States Reporting
Municipal Wastewater Facilities	8
Urban Runoff/Storm Sewers	4
Onsite Wastewater Systems (Septic)	3
Recreational Activities (Marinas)	2
Industry	2

Source: 1990 State Section 305(b) reports.

statistical limits (e.g., the fecal coliform [MPN] median does not exceed 14/100 mL of seawater and 10 percent of the water samples do not exceed 43/100 mL). Data reported by the States are presented in Table 6-9.

Table 6-9 shows that 20 States reported that shellfish harvesting restrictions were in effect for their estuarine and coastal waters during the 1988-90 reporting period:

- Twelve States provided information on the number of restrictions for a total of 340 incidents, and over one-third of the restrictions were reported by the State of Maine.

- Eleven States provided information on the geographic extent of the shellfish closures for a total of 2,018 square miles of estuarine waters.

- The most commonly reported sources of shellfish closures are municipal wastewater treatment facilities, urban runoff/storm sewers, onsite wastewater systems (septic systems), marinas, and industrial dischargers (Table 6-10).

Although these numbers summarizing shellfish harvesting restrictions represent 80 percent of all States having estuarine harvesting areas, they should be interpreted with some caution. A great deal of variability exists among States in the bacteriological criteria used to impose shellfishing restrictions; the various restriction categories for shellfish harvesting (e.g., approved, conditionally approved/seasonal, conditionally approved, restricted and prohibited); and the State programs in place to monitor, analyze, assess, and report bacteriological contamination data. As with fish and shellfish consumption restrictions, the high number of shellfish closures reported by some States is more likely attributable to the bacteriological criteria and procedures used to set the restrictions rather than to unusually degraded water quality conditions. Similarly, States with little or no data on shellfish closures may not have extensive surveillance programs to evaluate bacterial contamination of their shellfish harvesting areas.

Contact Recreation Restrictions

Information reported by the States on contact recreation restrictions such as the closure of bathing areas is limited. The information is reported in a variety of formats, and different bacterial criteria are used to restrict contact recreation activities. Most States' criteria are based on fecal coliform bacterial counts; however, some States are currently using *Enterococcus*, a form of fecal streptococcus bacteria. As for some other types of information in this section, contact recreation restrictions are often the responsibility of State health agencies and local governments (i.e., cities and counties) that may not coordinate reporting with pollution control agencies preparing the State Section

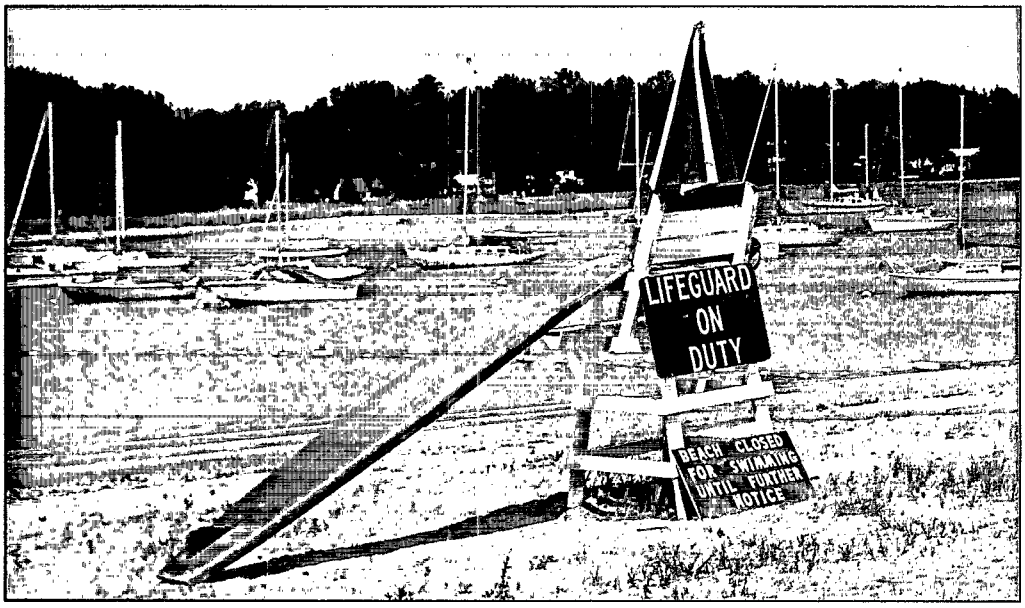
305(b) reports. Thus, comprehensive summaries of contact recreation restrictions are not yet available because many States do not present quantitative summaries of restrictions.

Twenty-three States provided some information on contact recreation restrictions during the 1988-90 reporting period. In 3 States, no closures were reported to have occurred; in the remaining 20 States, 301 incidents of contact recreation restrictions were reported (Table 6-11). Most of these restrictions involved beach closures that were of short duration and were attributed primarily to fecal coliform bacteria. High concentrations of these bacteria in the water column may indicate the presence of pathogenic microorganisms from malfunctioning municipal sewage treatment plants, combined sewer overflows, onsite wastewater systems (septic systems), urban runoff, marinas, and raw sewage spills. Gastroenteritis, ear infections, and skin infections (e.g., swimmer's itch) are some of the common illnesses experienced from contact recreation in sewage-contaminated waters. Although the primary reason for most restrictions was the presence of fecal coliform bacteria, the presence of toxic pollutants (e.g., priority organics, hydrocarbons, and heavy metals from spills or industrial discharges), medical wastes, pathogenic microorganisms (*Shigella*), and the avian parasite that causes swimmer's itch (*Schistosoma*) was also cited.

Closure of Surface Drinking Water Supplies

The use of surface water supplies for drinking water varies greatly among the States and Territories. As with contact recreation and shellfish harvesting restrictions, State health agencies and local governments (i.e., cities) are most often responsible for issuing restrictions and may not report this information to the pollution control agencies preparing the State Section 305(b) reports. A comprehensive summary of surface drinking water restrictions issued nationwide is not currently available.

In this reporting period, 11 States provided information on closures of surface water drinking supplies. Of these States, 10 reported closure of surface drinking water supplies in 34 closure incidents (Table 6-12). Mississippi reported that closures have occurred but did not specify the number of closures. It should be noted that several States indicated that no closures to surface water drinking supplies had occurred during the reporting cycle, yet they reported that the public was told to boil water before consumption in some communities. Toxic pollutants entering waterbodies from accidental chemical spills and industrial dischargers were the primary reasons for closure. Conventional pollutants such as fecal coliform bacteria, siltation, and ash from a large forest fire were other reasons reported for closures. Most States with closures indicated that the closures were of short duration and pumping was resumed after the pollutant had moved downstream of the water intakes. These States also reported that storage capacity was generally adequate so that water supplies to users were not disrupted.



Patricia Cunningham

Recreational use of many beaches can be severely restricted by fecal coliform contamination.

Table 6-11. Contact Recreation Restrictions Reported by the States

State	Number of Sites with Contact Recreation Restrictions*	Reason for Restriction
Alaska	5	Fecal coliform, diesel fuel spill, swimmer's itch
Arizona	3	Fecal coliform, dioxin, swimmer's itch
California	29	Toxic and conventional polllutants
Connecticut	12	Fecal coliform from sewage treatment plant failure
Delaware	7	Fecal coliform
DC**	—	Fecal coliform
Florida	23	Fecal coliform
Hawaii	3	Oil spills, fecal coliform from sewage spills
Illinois	3	Fecal coliform
Kentucky	3	Fecal coliform
Louisiana	4	Priority organics, metals, fecal coliform
Maryland	26	Fecal coliform
Michigan	27	Fecal coliform, medical wastes, *Shigella*
Mississippi	1	Fecal coliform from sewage overflow
New Jersey	—	Fecal coliform
New York	77	Fecal coliform from sewage overflow, medical wastes
Ohio	19	Fecal coliform, high water
Rhode Island	3	Fecal coliform, oil spill
South Carolina	1	*Shigella*
Tennessee	45	Fecal coliform, organic chemicals, mercury
Vermont	9	Fecal coliform
Virgin Islands	—	Fecal coliform
Wisconsin	1	Fecal coliform
Total	301	

*Some waterbodies/beaches were closed more than once during the reporting period; however, each site was counted only once for consistency in reporting.
** All waters in the District of Columbia are closed to contact recreation.

— Not reported.

Source: 1990 State Section 305(b) reports.

Table 6-12. Closure of Surface Drinking Water Supplies Reported by States

State	Number of Closures	Reason for Closure
Alaska	1	Diesel fuel spill
California	11	Toxic pollutants, conventional pollutants
Connecticut	5	Color and turbidity, siltation, oil spill
Maine	1	Tris(2,3-dibromopropyl)phosphate contamination
Massachusetts	2	Oil spill, leaking storage tank
Michigan	4	Chemical spills
Mississippi	—	Fecal coliform
Nebraska	1	Ash from forest fire clogged
Nevada	1	Unspecified effluent
Ohio	5	Chemical spill, sewage discharge
West Virginia	3	Fire retardant, diesel fuel gasoline
Total	34	

— Not reported.

Source: 1990 State Section 305(b) reports.

Census of State Fish/Shellfish Consumption Advisory Programs

The primary mechanism used by States to alert consumers about the health risks of eating contaminated fish or shellfish is the consumption advisory; however, consumption advisory practices vary greatly from State to State. At the request of EPA, the American Fisheries Society (AFS) conducted a census in November 1989 to determine State fish consumption advisory practices. AFS sent questionnaires to the chiefs of health departments, fisheries agencies, and water quality/environmental management departments in all 50 States and the District of Columbia. Officials in all States and the District responded to the questionnaire that covered advisories in both coastal marine and inland fresh waters. *Results of the 1989 Census of State Fish/Shellfish Consumption Advisory Programs* (1989 Census) was prepared for the Office of Water Regulations and Standards in August 1990 and provides a current description of State fish/shellfish consumption advisory responsibilities and practices nationwide.

In their biennial 305(b) reports, States generally provide information on the number of fishing restrictions, the waterbodies affected, the contaminants of concern, the size or geographic extent of the contamination and, in some cases, the specific fish/shellfish species for which the restriction is issued. Lacking, however, is information on the procedures and processes used by the States that culminate in the issuance of a fish consumption advisory or ban. The primary focus of the census report was to quantify the use of various sample collection, sample analysis, and data interpretation techniques (including use of risk assessment methodologies) in State fish advisory programs. State agency responsibility for each aspect of the fish advisory process was also identified.

The 1989 Census was a first step by EPA to identify differences and similarities among State programs, to evaluate the effectiveness of the consumption advisories process, to identify State information needs, and to design and develop appropriate Federal assistance that will promote consistency and accuracy among State advisories.

Roger Thomas

Sample collection, analysis, and data interpretation techniques in fish advisory programs vary widely among States.

State Agency Responsibilities

According to the 1989 Census, collection of fish and shellfish tissue data used in advisory development in the States is normally a multiagency effort and may include various combinations of environmental, fisheries, and health agencies.

In contrast, State health departments are the sole agencies responsible for interpreting data, assessing human health risks, and issuing consumption advisories in nearly half the States, and they play a major role in most other States. Furthermore, health departments play a principal role in communicating advisories to the public in 11 States and share this responsibility primarily with environmental and fisheries agencies in 27 States.

Sample Collection Procedures

Respondents to the 1989 Census reported on sample collection procedures used to assess fish and shellfish contamination. They indicated the types of monitoring programs used to obtain data for advisories, the types and

numbers of waterbodies sampled, and the collection criteria used, including fish species sampled, size range of fish/shellfish collected, and frequency of sampling.

Intensive surveys or special studies were reported by 37 States as a frequent or principal source of tissue residue data used for developing advisories. Routine surface water monitoring programs and monitoring in response to emergencies (e.g., fish kills, chemical spills) were cited as the second and third most frequent sources of data used by 29 and 11 States, respectively.

The number of waterbodies surveyed annually for tissue contamination varied widely among the States. Eighteen States typically survey less than 10 waterbodies annually (Figure 1). Only five States survey more than 50 waterbodies annually and Wisconsin surveys over 100 waterbodies annually.

Forty-one States identify freshwater rivers and 35 States identify lakes as the primary waterbodies surveyed. Of 23 States with estuarine and coastal waters, 20 States and 14 States, respectively, report that fish/shellfish are frequently collected from these waters.

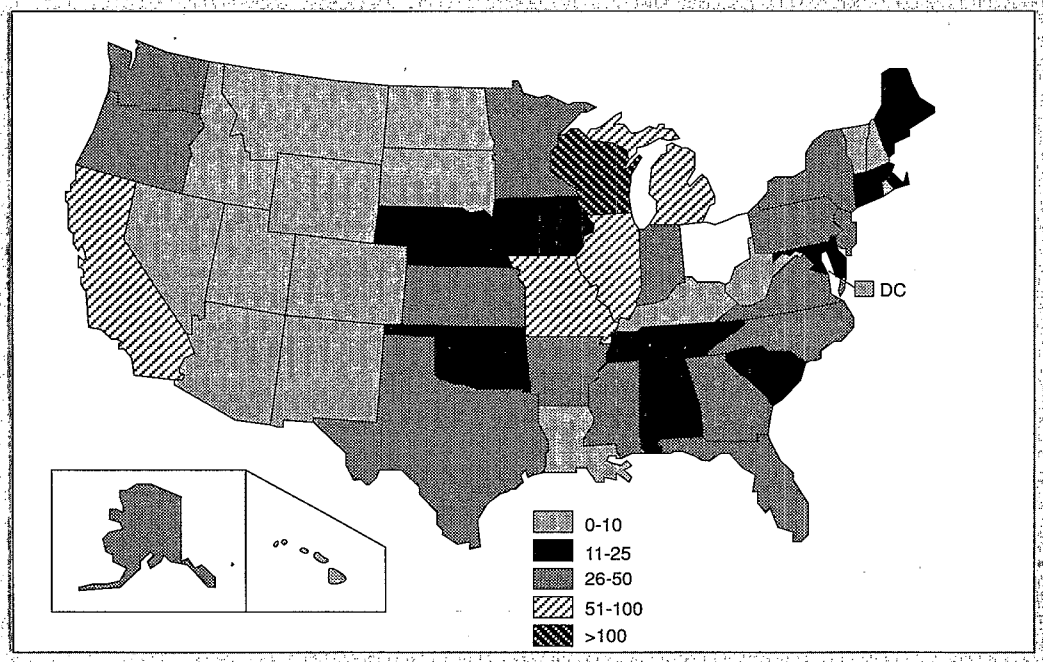
States were asked to identify the fish/shellfish species most commonly used as a basis for consumption advisories. Approximately 60 fish/shellfish species were identified and are categorized by family in Figure 2. The predominant families include Ictaluridae (catfish), used by 32 States; the Centrarchidae (sunfish), used by 30 States; the Cyprinidae (carp), used by 22 States; and the Salmonidae (salmon and trout), used by 20 States. Approximately nine species of shellfish, including molluscs (clams, oysters, mussels, and scallops) and crustaceans (crab, shrimp, and lobster), were identified.

Sample Analysis Procedures

The 1989 Census surveyed States on procedures used in chemical analysis of contaminated fish/shellfish tissues including the portion of the fish/shellfish analyzed, pollutants analyzed, analytical methods commonly used, types of laboratories conducting the analyses, and number of samples analyzed annually by the State.

For fish, the edible portion with skin on is used for residue analyses in 23 States; an equal number of States analyze the edible portion with the skin removed. Sixteen States report that the whole fish is frequently analyzed. For shellfish, 14 States report that only the edible portion is analyzed; 7 States analyze the whole shellfish.

A majority of States (34) indicate that metals and PCBs/pesticides are the two pollutant groups most frequently analyzed for in fish/shellfish tissue. The *EPA Interim Methods for Sampling and Analyses of Priority Pollutants in Sediments and Fish Tissue* (EPA-600/4-81-055) is the standard analytical procedure most commonly used by



Source: P. A. Cunningham, J. M. McCarthy, D. Zietland, *Results of the 1989 Census of State Fish/Shellfish Consumption Advisory Programs,* Prepared for Office of Water Regulations and Standards, 1990.

Figure 1. Number of Waterbodies Surveyed Annually for Fish/Shellfish Tissue Contamination

31 States; 15 States reported using the U.S. Food and Drug Administration *Pesticides Analytical Manual* (1978); and 17 States reported using a variety of other methods.

Almost all States (41) indicated that State-operated laboratories are frequently used to analyze chemical residues in fish/shellfish tissue. Other types of laboratories commonly used by the States include contract, EPA, and other Federal laboratories.

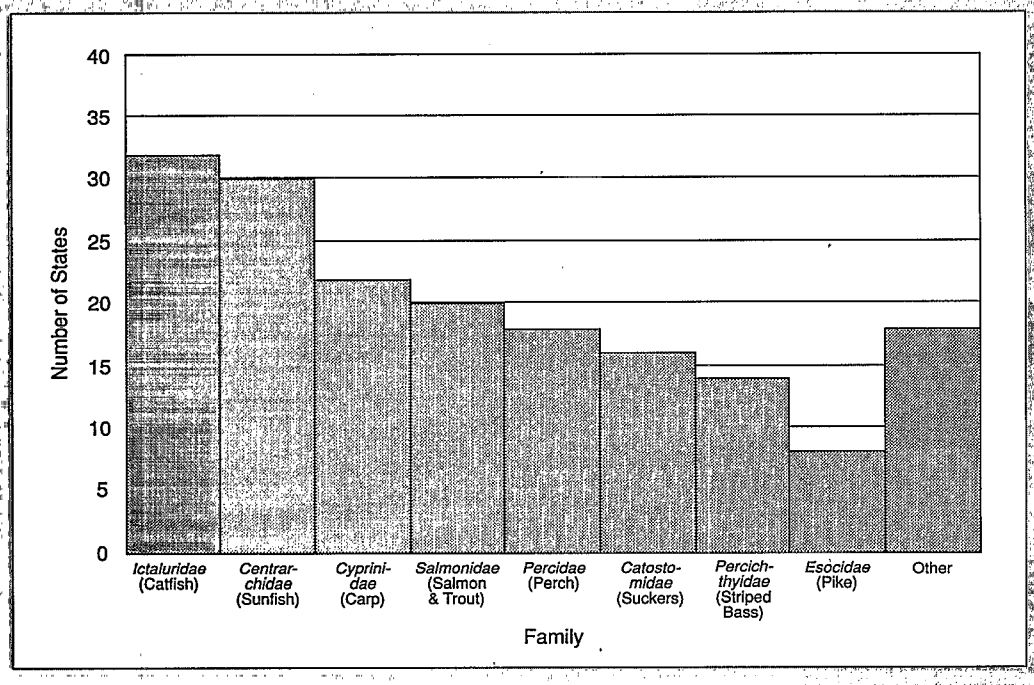
Data Interpretation

The greatest inconsistency in the advisory process reported in the 1989 Census was associated with data interpretation procedures used to evaluate the health risk of consuming contaminated fish/shellfish. Although the majority of States (34) reported frequently using FDA action levels for deriving the levels of concern, other methods, such as EPA's Cancer Potency Factor or Reference Doses, were also used. Multiple methods for deriving the level of concern were used depending on the contaminant and risk assessment policy considerations.

Another area of disagreement among the States was the issuance of fish/shellfish advisories based on risk assessment results. Eleven States reported that all advisories are based on results of a risk assessment, 10 States use a risk assessment approach only when contaminants without FDA action levels are detected, and 9 States are considering use of a risk assessment approach. Ten States do not plan to use a risk assessment approach, and the State position on using a risk assessment approach was unclear for 11 States.

In calculating the human health risk of eating contaminated fish/shellfish, States varied widely in their use of the following variables:

- Consumption rate
- Maximum risk considered acceptable for carcinogens
- Average body weight assumed for a typical consumer
- Meal size.



Source: P. A. Cunningham, J. M. McCarthy, D. Zietland, *Results of the 1989 Census of State Fish/Shellfish Consumption Advisory Programs*, Prepared for Office of Water Regulations and Standards, 1990.

Figure 2. Major Fish Families Representing Species Used in Consumption Advisories

Advisory Development

Nationally, 24 contaminants were identified by the States in the 1989 Census as having been detected at concentrations requiring issuance of fish/shellfish consumption advisories (Figure 3). PCBs, pesticides, metals, and dioxins are the four pollutant groups most often identified as triggering advisories. The four contaminants individually identified by the most States as resulting in the issuance of advisories are PCBs (33 States), mercury (21 States), chlordane (21 States), and dioxin/dibenzofurans (21 States).

Thirty-seven States reported having waterbodies under advisories that restrict consumption of fish/shellfish; an equal number reported having advisories that prohibit consumption. Eight States have more than 10 waterbodies under advisories restricting consumption; 6 States have more than 10 waterbodies under advisories prohibiting consumption.

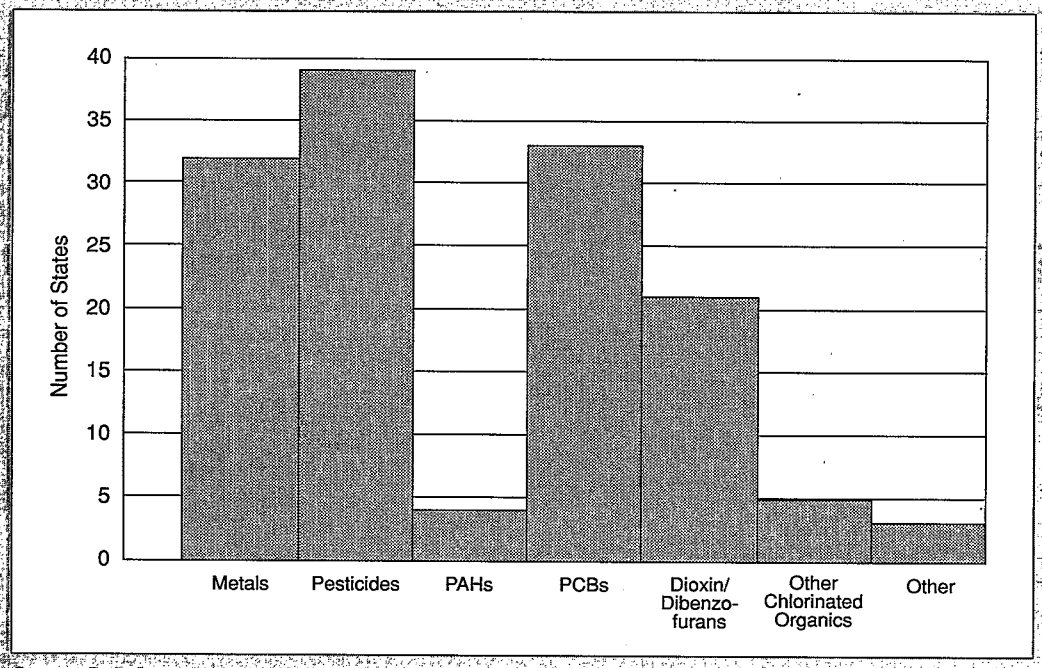
The majority of States (36) reported that advisories are generally issued for an indefinite period of time. Thirteen States reported issuing advisories for a 1-year period; no States reported issuing advisories for less than 1 year.

Major methods used by the States to disseminate fish/shellfish advisory information include newspaper notices, posting signs at the affected waterbody, fishing licenses, TV/other media, and posting notices in public buildings (Figure 4).

State Concerns and Recommendations

According to the 1989 Census, States were most concerned about the lack of agreement on safe consumption levels, lack of consistent risk assessment methodology, the need for increased monitoring of toxics in fish and shellfish, and the need for improved information transfer on consumption advisory issues.

States recommended that the Federal government provide additional training or guidance on consumption

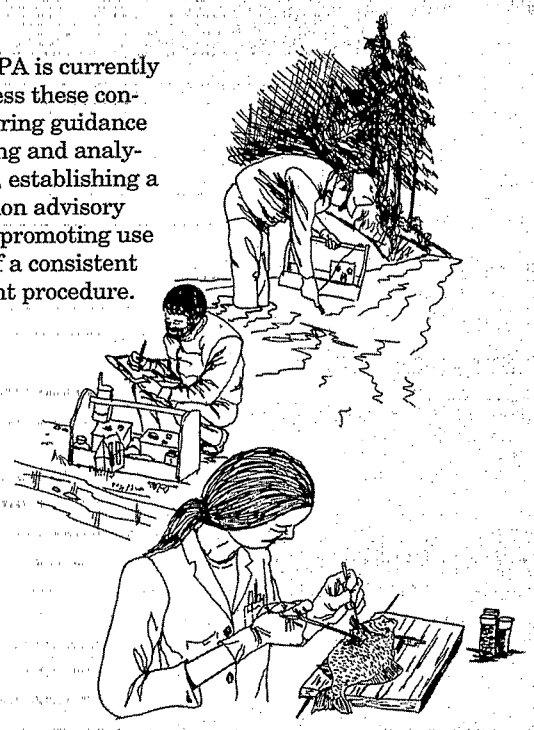


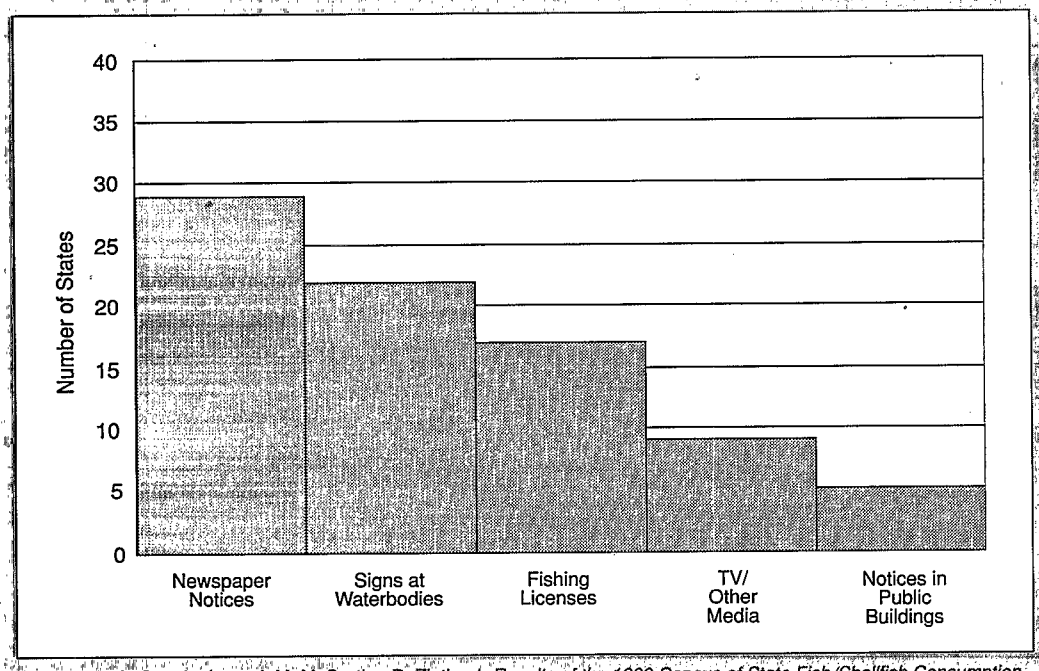
Source: P. A. Cunningham, J. M. McCarthy, D. Zietland, *Results of the 1989 Census of State Fish/Shellfish Consumption Advisory Programs*, Prepared for Office of Water Regulations and Standards, 1990.

Figure 3. Major Groups of Contaminants Detected at Concentrations Requiring Issuance of Consumpton Advisories

advisory development (43 States); data interpretation, particularly risk assessments (35 States); and methods of communicating advisories to the public (32 States).

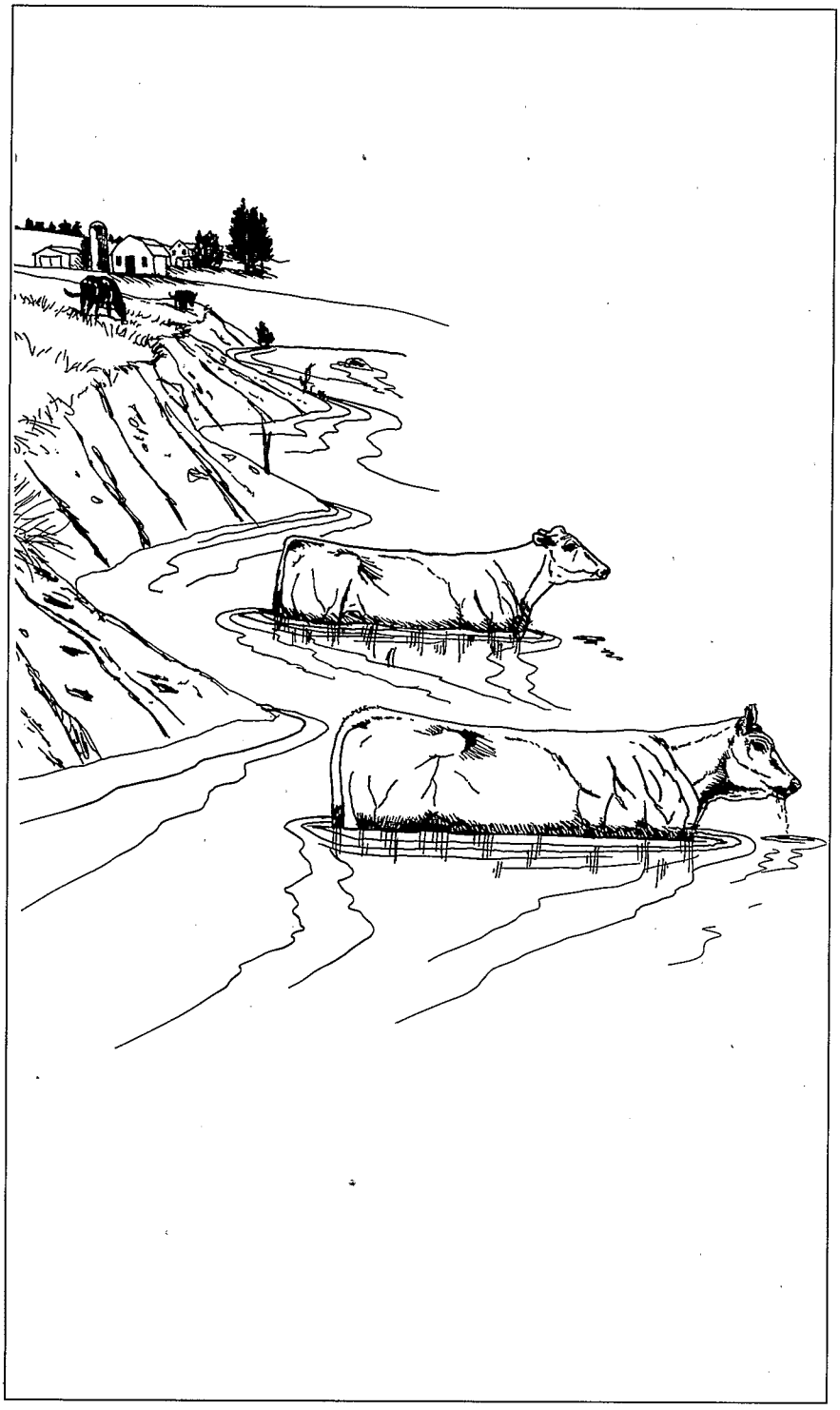
In response to these recommendations, the EPA held a Federal-State forum on fish advisories at the 1990 AFS meeting and sent representatives in all States an information package including a summary of current EPA activities and a draft short-term Federal Action Plan for review by the States. Two of the short-term action items addressed in the plan involved (1) resolving differences between the EPA and FDA risk assessment methods and (2) the need for an exchange of information on risk assessment methods and procedures. EPA is currently trying to address these concerns by preparing guidance on fish sampling and analysis procedures, establishing a fish consumption advisory database, and promoting use by all States of a consistent risk assessment procedure.





Source: P. A. Cunningham, J. M. McCarthy, D. Zietland, *Results of the 1989 Census of State Fish/Shellfish Consumption Advisory Programs*, Prepared for Office of Water Regulations and Standards, 1990.

Figure 4. Major Means by Which the Public is Notified of Fish/Shellfish Consumption Advisories



Ground-Water Quality and Protection

7

Paul Goetz

Ground-Water Quality

Introduction

Ground water is a vital natural resource that is withdrawn for domestic use, irrigation, industrial use, and livestock. In many parts of the United States, ground water is the only reliable source of drinking water or irrigation water. However, this vital resource is quite vulnerable to contamination. An increasing number of pollution incidents affecting both public water supplies and private wells have been reported throughout the country. As a result of a growing awareness of the importance of this resource and its vulnerability, many States and Territories (hereafter referred to as States) are developing and expanding upon legislation, regulations, and programs to protect ground water.

Ground-water protection is especially important because of the difficulty and expense involved in remediating contaminated aquifers, providing alternative water supplies, or adding treatment to public water systems. The States have identified a broad range of contaminants and contamination sources, such as underground storage tanks, septic systems, and landfills. Controlling these sources of contamination has become a primary focus of State ground-water protection programs.

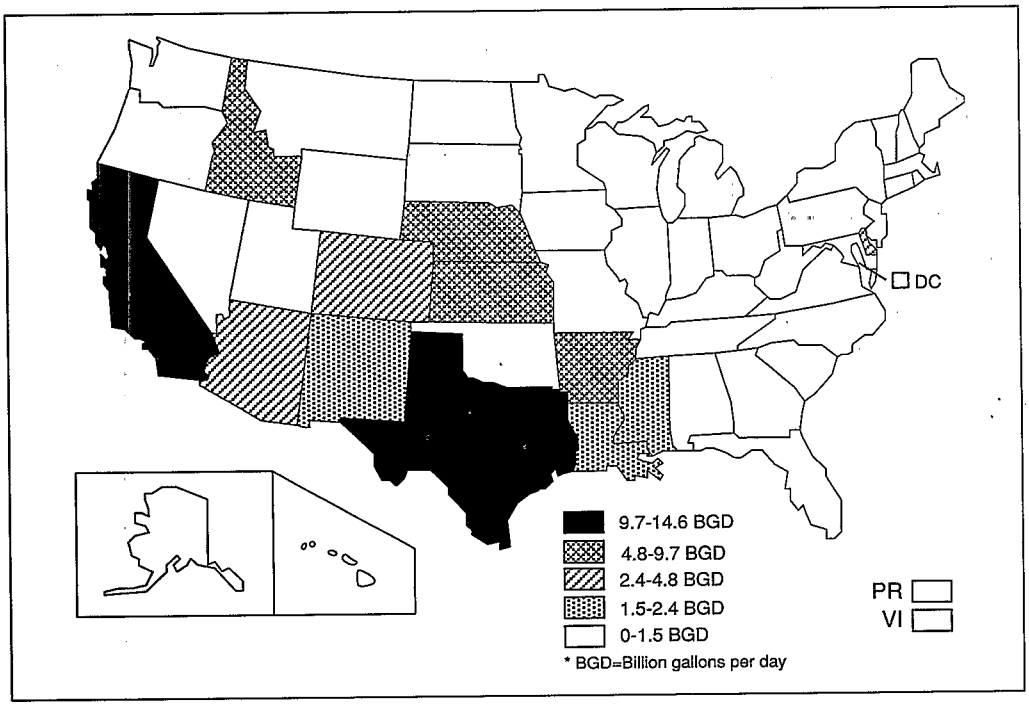
EPA compiled the information reported in this chapter primarily from 1990 305(b) State Water Quality Reports. EPA requested that each State provide information concerning its ground-water protection program, the sources of ground-water contamination identified in the State, and the contami-

nants observed in the State's ground water in their 305(b) reports.

The Agency remains committed to working with States and others in the ground-water community to develop indicators that could be used to measure trends in ground-water quality. To date, EPA has developed a preliminary set of ground-water quality protection indicators, which includes maximum contaminant level violations in water supplies, extent of contamination from hazardous waste sites, ambient volatile organic compound and nitrate levels in ground water, and the extent of agricultural pesticide use. Several States have expressed interest in using indicators as part of Section 305(b) reporting in place of, or in addition to, current ground-water information reporting. Because not all States had data readily available to provide indicator information for the 1990 report, EPA proposed that this information be voluntary for 1990 and that the States begin reporting of indicator information for inclusion in 1992. In addition, EPA requested that States voluntarily report additional data indicating ground-water protection activities. This chapter summarizes the data provided by 46 States and 2 Territories and the District of Columbia; data were not available for 4 States and 2 Territories.

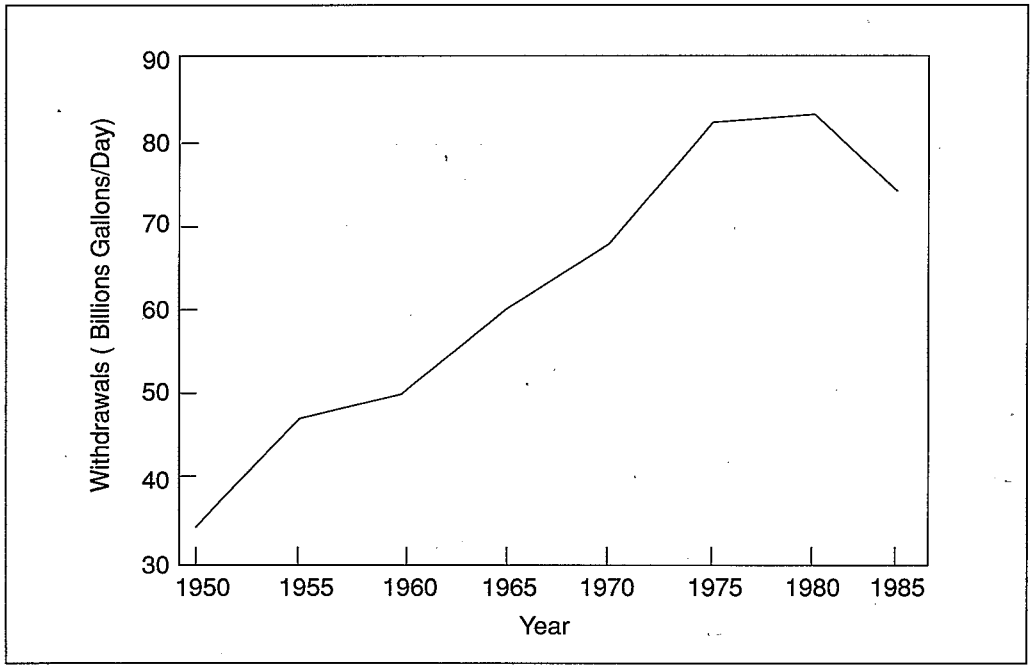
In addition to the data from the State 305(b) reports, this chapter reports supplemental ground-water use data from the U.S. Geological Survey *1986 National Water Summary* and *1988 Open File Report 88-112*. The Agency also consulted reports prepared by the U.S. EPA Office of Ground-Water Protection, including The 1989 Urban Institute's *State Management of Ground Water: Assessment of Practices and Progress* and the 1990 Environmental Law Institute's *Survey and Analysis of State Ground-Water Classification Systems and Program Operations*.

This chapter consists of three sections that summarize the following information: ground-water withdrawals and use, ground-water quality, and ground-water protection indicators.



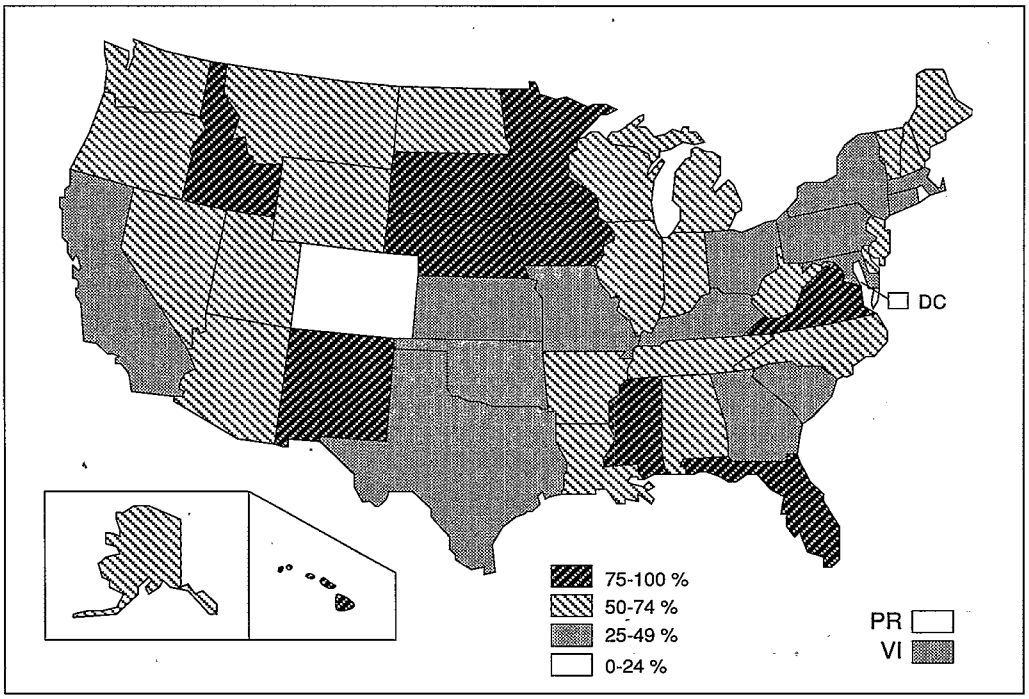
Source: 1990 State Section 305(b) reports and 1986 USGS National Water Summary.

Figure 7-1. National Distribution of Ground-Water Withdrawals by State/Territory



Source: 1988 U.S. Geological Survey Open-File Report 88-112.

Figure 7-2. National Withdrawals of Ground Water, 1950-1985



Source: 1990 State Section 305(b) reports and 1986 USGS National Water Summary.

Figure 7-3. Ground Water as a Source for Domestic Supply (as a Percentage of State Population)

Current Ground-Water Use

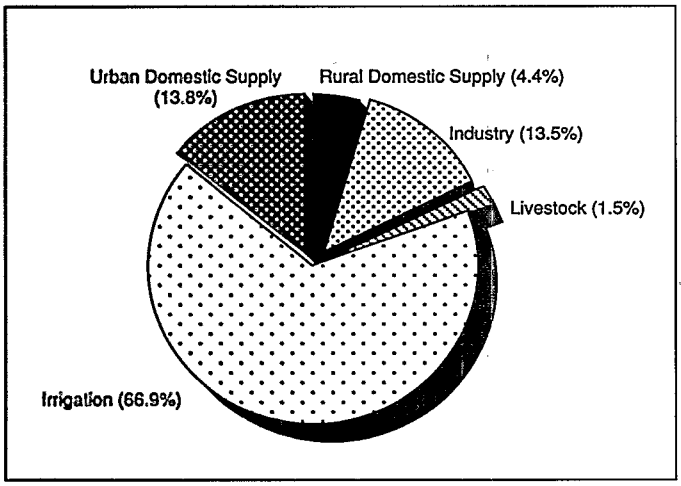
In 1985, ground-water withdrawals in the United States totaled 80 billion gallons per day. As can be seen in Figure 7-1, the majority of these withdrawals were concentrated in a small number of States. California and Texas both withdrew more than 10 billion gallons per day and account for greater than one-quarter of the Nation's total withdrawals. Four other States—Arkansas, Idaho, Kansas, and Nebraska—each withdrew more than 4-1/2 billion gallons of ground water per day.

The national use of ground water has grown significantly over the last 40 years. Figure 7-2 shows that ground-water withdrawals increased steadily between 1950 and 1980 from 34 billion gallons per day to 83 billion gallons per day. Then, withdrawals declined somewhat between 1980 and 1985 from 83 to 73 billion gallons per day.

Nationally, about 51 percent of the U.S. population relies to some extent on ground water as a source of drinking water. Figure 7-3 depicts the geographic distribution of the Nation's reliance on ground water for domestic supply. This reliance varies considerably across States. Nine States—Florida, Hawaii, Idaho, Minnesota, Mississippi, Nebraska, New Mexico, South Dakota, and

Virginia— depend on ground water to supply drinking water for 75 percent or more of their populations. The vast majority of the rural population in nearly all the States relies on potable or treatable ground-water sources to provide economical supplies of water for domestic use. Only Colorado, the District of Columbia, Rhode Island, and Puerto Rico rely on ground water as a drinking water supply for less than 25 percent of their populations.

Ground water is also used for irrigation, industrial purposes, and watering livestock. As shown in Figure 7-4, 67 percent of all ground-water withdrawals in the United States are used for irrigation, 14 percent are consumed by industry, and less than 2 percent are used for watering livestock. The percentage of ground-water withdrawals for uses other than drinking water varies considerably among the States. In the East and South, withdrawals are used primarily for industrial and domestic purposes; in the West, most ground water is withdrawn for irrigation.



Source: 1986 USGS National Water Summary.

Figure 7-4. National Uses of Ground Water

Ground-Water Quality

The 1990 Section 305(b) State Water Quality Reports indicate that, overall, the Nation's ground-water quality is good to excellent. Twenty-four States made some judgment concerning the quality of their ground water: 9 States judged their ground-water quality to be excellent, 14 judged their ground-water quality to be good, and 1 reported that its overall water quality was poor. Generally, ground-water degradation has occurred only in local problem areas.

Many States are engaging in studies to better understand the quality of their ground water, to identify potential sources of contamination, and to determine the vulnerability of the resource to pollution. Thirty-four States reported that they have conducted broad ground-water quality studies, with an average of two to five studies reported by each State. Since 1988, the number of studies conducted has generally increased by one or two per State.

One type of study conducted by the States involved investigations of point source impacts on ground water, such as from underground storage tanks, septic systems, or surface impoundments. In addition, nonpoint source contamination by pesticides or nitrates was an area of particular concern to the States—22 States report having conducted at least one study dealing with this type of contamination.

An example of a nonpoint source study is the Pesticide Pilot Study initiated by Washington State to determine whether pesticides migrate into ground water under conditions of normal agricultural usage. Out of the 81 wells sampled in the study, pesticides were detected in 23, with roughly a third of those detections exceeding recommended criteria. Nitrates were detected in 61 wells, with roughly a third of these detections also exceeding the drinking water standard.

Other types of studies include inventories of ground-water contamination incidents or potential contamination sources, ground-water sampling surveys, land use studies, and studies of regional contamination problems. Rhode Island's Private Well Survey was initiated to investigate the effects of eight land uses that could potentially contaminate ground water. In this survey, private wells were sampled for volatile organic compounds (VOCs) and pesticides. VOCs were detected in 27 percent of the wells sampled, and pesticides were detected in 11 percent.

Some States conducted aquifer studies, ground-water quality characterization and classification, or studies that identified and evaluated sources of data on ground water. An example of an aquifer study is Utah's project to define and describe in three dimensions the aquifers in western Kane County, to identify aquifer

recharge areas, and to provide the maps necessary to begin classification of the ground water in these aquifers.

Overview of Contamination Sources

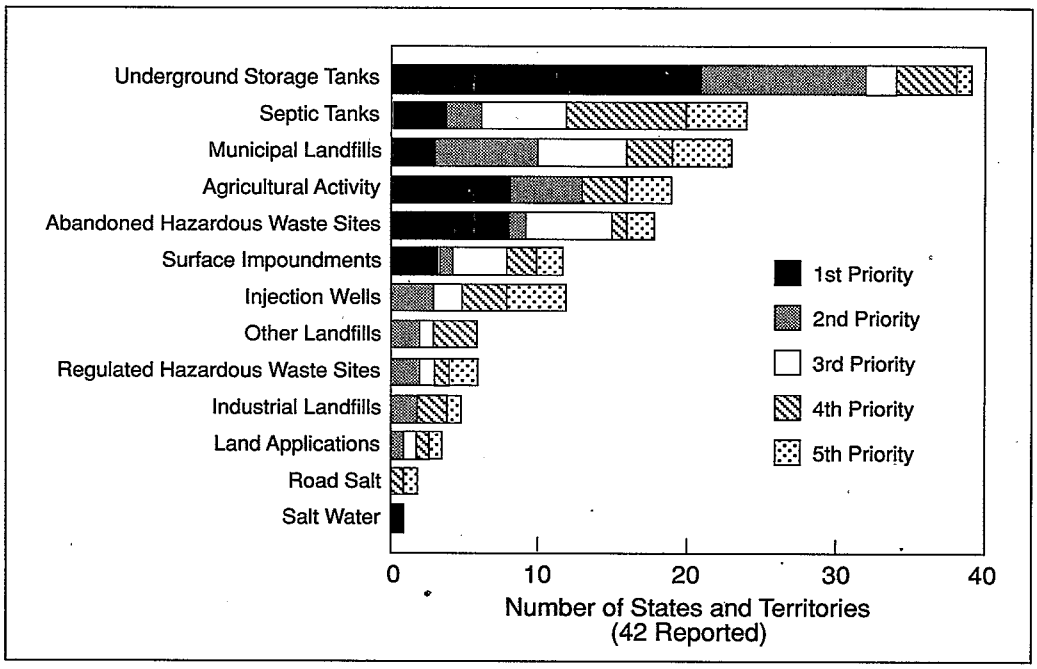
EPA requested that the States identify and rank the severity of sources of ground-water contamination in their States. Of the 57 States, 42 ranked sources of contamination. The most frequently cited sources of contamination were underground storage tanks, septic systems, municipal landfills, agricultural activities, and abandoned hazardous waste sites. Road salting and saltwater intrusion were the sources cited least often by the States. In addition to the sources listed in Figure 7-5, the States noted contamination from urban and storm-water runoff, hazardous material spills, and mining activities as potential sources.

Figure 7-5 illustrates the States' rankings of the severity of the threat to ground-water quality from these sources of contamination. Underground storage tanks were by far the most frequently ranked contamination source (39 times) as well as the source most frequently ranked most important (21 times). Septic systems were ranked second (24 times), although they were ranked as the most important source by only four States. Municipal landfills were ranked third (23 times), and agricultural activities were fourth (19 times). Agricultural activities and abandoned hazardous waste sites were each ranked as the most important source of contamination by eight States.

Since 1986, there have been only minor differences in the sources ranked as priority concerns by the States. Underground storage tanks, septic systems, municipal landfills, agricultural activities, abandoned hazardous waste sites, and surface impoundments have continued to be the sources of ground-water contamination most often noted as concerns by the States.

Overview of Contaminants

The States were also asked to identify the most prevalent contaminants observed in their ground water (see



Source: 1990 State Section 305(b) reports.

Figure 7-5. Priority Ranking of Ground-Water Contamination Sources by Number of States and Territories Reporting

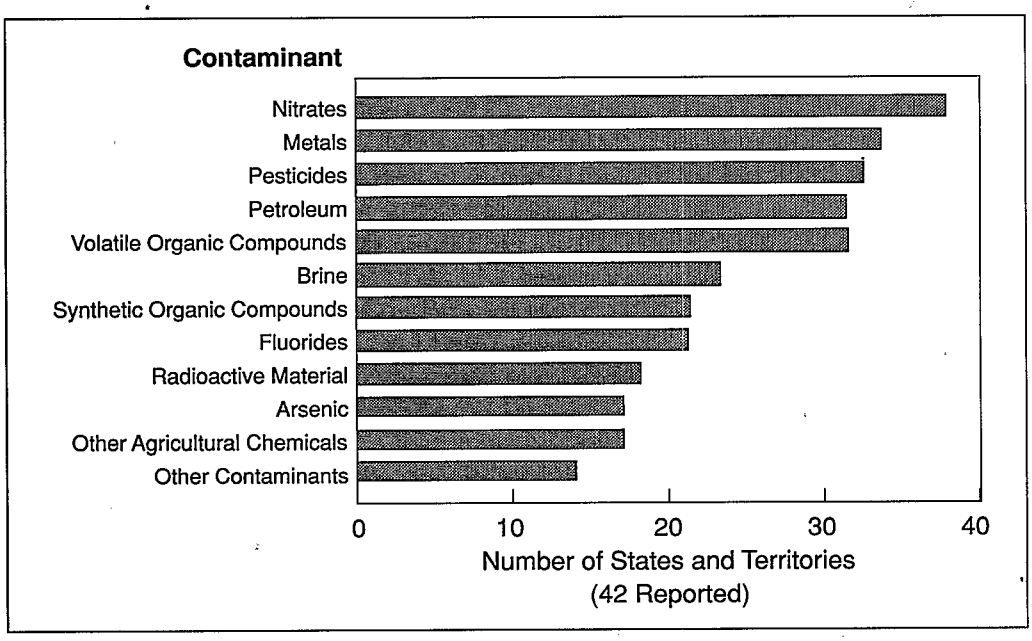
Figure 7-6). Nitrates were identified as a contaminant by 37 States, metals by 33 States, pesticides by 32 States, and both petroleum products and VOCs by 31 States. Brine, synthetic organic chemicals, fluorides, and radioactive contaminants were reported by 23, 21, 21, and 18 States, respectively. Arsenic, other agricultural chemicals, and other contaminants (e.g., bacteria and solvents) were the contaminants reported least often (reported by 17, 17, and 14 States, respectively).

Between 1986 and 1990 the number of States reporting sewage contamination problems decreased while detections of pesticides increased to become one of the most pressing sources of concern. In 1988, the most important sources of contamination were nitrates, pesticides, VOCs, petroleum products, metals, and brine. The same contaminants were reported most often in 1990. The only significant change between 1988 and 1990 was an increase in the number of States reporting fluoride detections, from 14 States to 21.

Indicators of Ground-Water Protection Activities

Developing the ability to measure trends in ground-water quality was one of the key recommendations of EPA's 1986 Ground-Water Strategy. In response to this recommendation, the Office of Ground-Water Protection has developed a set of indicators that the EPA and the States can use to track progress and set priorities in ground-water protection efforts. The set of ground-water indicators includes

- Maximum contaminant level (MCL) violations in public drinking water systems supplied by ground water, which provides an indication of the risk to populations supplied by ground water;
- Extent of onsite and offsite contamination at hazardous waste sites and the populations at risk from exposure to contamination;
- Ambient VOC levels in ground water;
- Ambient nitrate levels in ground water; and



Source: 1990 State Section 305(b) reports.

Figure 7-6. Most Frequently Observed Ground-Water Contaminants by Number of States and Territories Reporting

■ Extent of agricultural pesticide use.

These indicators are assessed based on existing data and/or data that can be readily collected by the States over time. The indicators also lend themselves to graphic display to convey trends in ground-water quality and vulnerability.

In its guidelines for preparation of the 1990 State 305(b) reports, the EPA encouraged the States to use one or more of the indicators, where data were available, as part of their 1990 305(b) reporting. However, not all States had data readily available to provide indicator trends. Therefore, the use of indicators as part of the 1990 reporting process was voluntary and not required for the State 305(b) report. Nonetheless, 32 States provided some quantitative data characterizing one or more indicators, as summarized in Table 7-1. Thirty-one of the reporting States provided nitrate or pesticide* data collected from regional or local studies and 23 of the 32 States and Territories provided VOC data. However, few of the States were able to provide data characterizing statewide ground-water quality conditions. MCL data were provided by 15 States; these reports included both the total number of MCL violations and constituent-by-constituent summaries. A few of these States provided data describing the population at risk from MCL violations or contaminated ground water. Only 10 States reported information characterizing waste sites.

Several other indicator parameters reported by a few of the States were salinity levels, bacteria concentrations, radioactivity levels, and heavy metal concentrations.

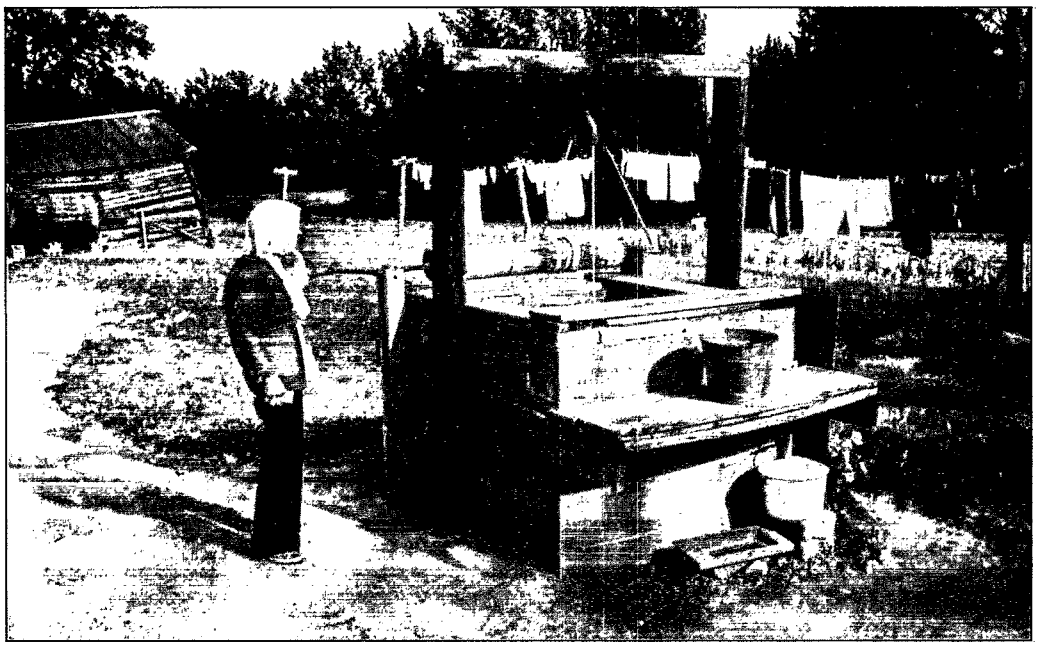
The range of ground-water indicator information reported by the States is exemplified by the following approaches.

Arizona provided data describing the number of RCRA and CERCLA sites in each of its ground-water basins. Populations relying on ground water in those basins in 1985 and population estimates for the year 2000 were also provided. In addition, Arizona reported the number of samples and detections for major contaminant types within the basins including MCL exceedances, VOC concentrations, and nitrate and pesticide data between 1987 and 1989. Arizona also conducted several studies, such as ground-water quality assessments for Phoenix and Tucson, that have supported hydrologic and policy documents.

Vermont reported on a Department of Agriculture study assessing ground-water sources in proximity to, and downgradient from, field corn plots as a means of assessing ground-water contamination in worst case settings. The study found that approximately half of the wells sampled had nitrate levels above 0.5 mg/L, but 34 of 355 (10.4 percent) were above the 10-mg/L drinking water limit for nitrate, which is the nitrate MCL.

Nebraska provided VOC data for 96 public water

*Most pesticide data were reported in terms of detections in ground water, rather than usage levels.



Scott Guthrie

Rural water supply for a farm family.

Table 7-1. Summary of States and Territories Reporting Ground-Water Indicators

	EPA Indicators						
	MCLS		Waste Sites				
State	MCL Summary	MCLS by Contaminant	RCRA	CERCLA	VOCs	Nitrates	Pesticides
Alabama	—	—	—	—	●	●	●
Alaska	—	—	—	—	—	—	—
Arizona	●	●	●	●	●	●	●
Arkansas	—	—	—	—	—	●	—
California	—	—	—	—	—	—	—
Colorado	—	—	—	—	—	—	—
Connecticut	—	—	—	—	●	●	●
Delaware	—	—	—	—	—	—	—
District of Columbia	—	—	—	—	—	—	—
Florida	—	—	—	—	—	—	—
Georgia	—	—	—	—	●	—	●
Hawaii	—	—	—	—	●	—	●
Idaho	—	—	—	—	●	●	●
Illinois	—	●	—	—	●	—	●
Indiana	—	—	—	—	—	—	—
Iowa	—	—	●	—	—	●	●
Kansas	—	—	—	—	●	●	●
Kentucky	—	—	—	—	—	—	—
Louisiana	—	●	●	●	●	●	—
Maine	—	—	●	●	—	●	●
Maryland	—	—	—	—	—	—	—
Massachusetts	—	—	—	—	—	—	—
Michigan	—	—	●	●	—	●	●
Minnesota	—	●	—	—	●	●	●
Mississippi	—	—	—	—	—	—	—
Missouri	—	●	—	—	●	●	●
Montana	—	—	—	—	—	—	—
Nebraska	—	●	—	—	●	●	●
Nevada	—	—	—	—	—	—	—
New Hampshire	—	—	—	—	—	—	—
New Jersey	●	●	●	●	●	●	●
New Mexico	—	●	—	●	●	●	—
New York	—	—	—	—	●	●	●
North Carolina	—	—	—	—	—	—	—
North Dakota	—	●	—	—	●	●	●
Ohio	—	●	—	—	●	●	●
Oklahoma	—	—	—	—	●	●	—
Oregon	—	—	—	—	—	—	—
Pennsylvania	●	●	—	—	—	●	—
Rhode Island	—	●	—	●	●	●	●
South Carolina	—	—	—	—	—	—	—
South Dakota	●	●	—	—	●	●	●
Tennessee	—	—	—	—	—	—	—
Texas	—	—	—	—	—	—	—
Utah	—	—	—	—	—	—	—
Vermont	—	—	—	—	—	●	●
Virginia	—	—	—	—	—	—	—
Washington	—	—	—	●	—	●	●
West Virginia	—	—	—	—	—	—	—
Wisconsin	—	●	—	●	●	●	●
Wyoming	—	—	—	—	—	—	—
American Samoa	—	—	—	—	—	—	—
Guam	●	●	—	—	—	●	—
Puerto Rico	—	—	—	—	●	●	—
Virgin Islands	—	—	—	—	●	●	—
Total	5	15	6	9	23	28	23

Other Indicators

Salinity	Bacteria	Radio-activity	Metals
●	●	—	●
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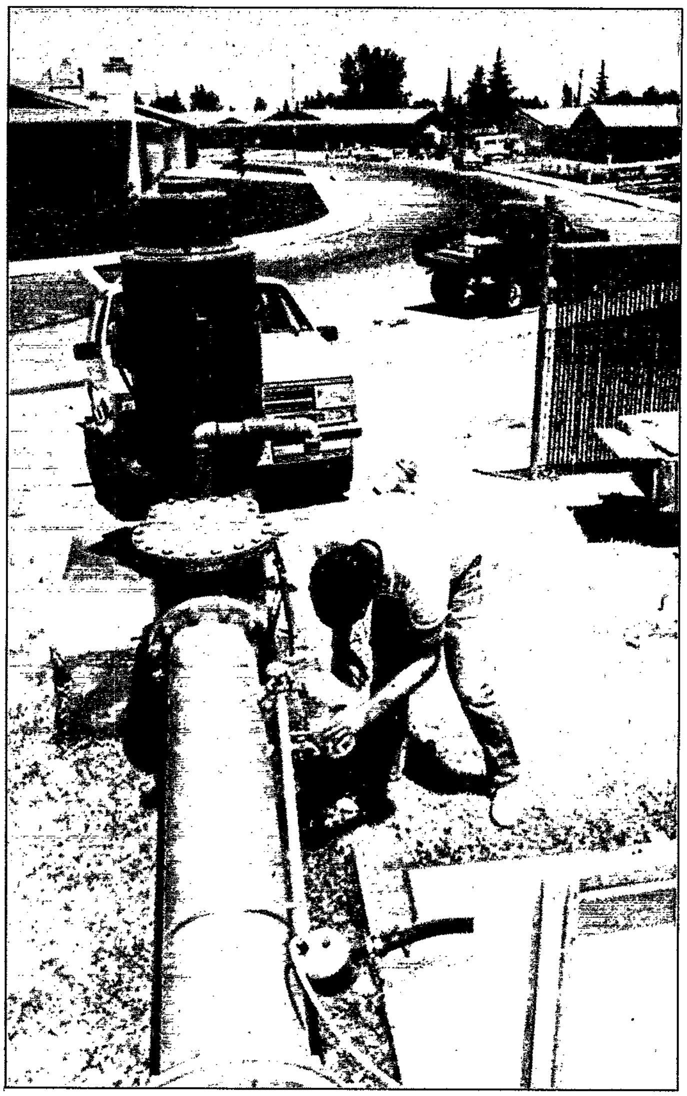
10	10	9	9



Richard Pratt

Monitoring ground-water quality from a community well.

supply systems analyzed between 1981 and 1989. Five of those municipal systems that were known to be in violation of MCLs for VOCs served a population of 74,000 people. Nebraska also identified portions of 24 counties where ground water is reported to be impaired by agricultural activities.

Ohio reported that annual tests of community well systems found that 156 of 1,300 wells (12 percent) had detectable VOC levels and slightly over 1 percent of the wells tested exceeded one or more MCLs. Over the past 4 years, more than 10,000 rural wells were tested for nitrates. Nearly 3 percent of the sampled wells exceeded the MCL for nitrate. In a 1988 study, Ohio EPA sampled 35 wells in residential areas for sludge effluent. Elevated nitrate levels were reported, although there was little or no organic contamination.

Kansas reported data from its ground-water monitoring network. The wells in the network have been analyzed for heavy metals, VOCs, pesticides, nitrates, and radionuclides. During 1988-1989, 113 ground-water supply wells in Kansas were sampled for 19 commonly used pesticides. Fifteen percent of the wells tested had pesticides above detection levels. The most commonly detected pesticides were atrazine, alachlor, metolachlor, metribuzin, and bromacil. These same pesticides appeared in significant amounts in wells sampled from 1986 to 1987. The number of wells exceeding EPA's Health Advisory Level (HAL) rose threefold between 1986 and 1989, from 4 to 12. As a result, the State reported that, following the 1988-89 pesticide monitoring activities, two wells exceeding the HAL were removed from use, one was plugged, several are on standby status, and four are still in use.

Wisconsin monitored approximately 3,700 wells for nitrates in 1988 because nitrates represent a statewide cause of contamination, and the State perceives nitrate data as ideal to evaluate long-term trends in ground-water quality. Additionally, the Department of Agriculture, Trade, and Consumer Protection (DATCP) sampled for nitrates at 534 randomly selected wells on Wisconsin Grade A dairy farms between 1988 and 1989. This study found that 255 wells (48 percent) had nitrate concentrations above the Preventive Action Limit (PAL) of 2 mg/L, and 55 wells (10 percent) had nitrate concentrations exceeding the Enforcement Standard (ES) of 10 mg/L. The DATCP study and other statewide studies have led Wisconsin to estimate that 10 percent of domestic wells, or 70,000 of the 700,000 wells in the State, have nitrate concentrations above the drinking water standard of 10 mg/L.

Wisconsin also reported on the population at risk from contamination at Superfund sites in the State. At Wisconsin's 34 National Priorities List (NPL) sites, the total population at risk within 1 mile of these sites totals 104,294; within 2 miles of these sites, 261,129; and within 3 miles, 648,223.

Although ground-water indicator information was optional for the 1990 reports, EPA plans to move toward inclusion of ground-water indicators as a major element in the 1992 305(b) report and will work with State representatives to select the indicators to be used for this reporting.

Joe Neander

Leaking underground storage tanks can cause ground-water contamination.

8

Jimmy Crawford

State and Federal Ground-Water Protection Programs

State Programs

States are currently involved in a number of activities to address ground-water contamination and sources of contaminants. These activities include: adopting and implementing State Ground-Water Protection Strategies; enacting legislation aimed at the development of comprehensive ground-water protection programs and promulgating protection regulations; adopting ground-water classification and mapping programs; establishing Wellhead Protection Programs; developing ground-water quality standards and monitoring systems; developing special source controls for contaminating sources; and establishing procedures to enhance coordination of ground-water protection programs among State agencies. This chapter summarizes State activity in these areas, describes components of several States' programs, and briefly outlines Federal ground-water protection activities.

The status of State ground-water protection programs is further summarized in Table 8-1. The table identifies

- Ground-Water Strategies adopted by the State or under development;
- Wellhead Protection Programs that have been submitted, approved, or reviewed by EPA;
- Specific legislative authority to develop and implement ground-water programs and/or regulations;
- Any regulation specifically aimed at protecting ground water;

Table 8-1. Ground-Water Programs

State	Ground-Water Strategy	Wellhead Protection Program	Ground-Water Legislation	Ground-Water Regulations	Ground-Water Protection Standards	Ground-Water Monitoring System
Alabama	●	○	—	—	—	●
Alaska	●	○	—	●	●	—
Arizona	●	▲	●	●	●	●
Arkansas	●	◐	—	—	—	—
California	●	▼	●	—	●	—
Colorado	●	○	●	—	●	—
Connecticut	●	◐	●	●	●	—
Delaware	—	◐	—	●	●	—
District of Columbia	—	▼	—	—	—	—
Florida	●	▲	●	●	●	●
Georgia	●	○	●	●	●	●
Hawaii	●	○	—	●	—	●
Idaho	●	○	●	●	●	▼
Illinois	●	◐	●	●	●	●
Indiana	●	○	●	—	●	—
Iowa	●	○	●	—	●	▼
Kansas	●	▲	●	—	●	●
Kentucky	●	▲	—	▼	●	▼
Louisiana	●	◐	●	●	—	●
Maine	●	◐	●	●	●	●
Maryland	●	●	●	●	●	●
Massachusetts	●	◐	—	●	●	—
Michigan	●	○	●	—	●	●
Minnesota	●	○	●	●	●	●
Mississippi	●	▼	●	●	—	●
Missouri	●	▲	●	●	●	—
Montana	—	▼	●	●	●	—
Nebraska	●	◐	●	●	●	●
Nevada	●	○	—	—	—	●
New Hampshire	—	◐	—	●	●	—
New Jersey	●	▲	●	●	●	●
New Mexico	●	●	●	●	●	●
New York	●	◐	●	●	●	—
North Carolina	●	○	—	●	●	●
North Dakota	●	▲	—	—	—	●
Ohio	●	○	—	—	—	●
Oklahoma	—	◐	—	●	●	●
Oregon	—	○	●	●	—	●
Pennsylvania	●	○	●	●	—	●
Rhode Island	●	◐	●	●	●	●
South Carolina	●	▲	●	●	●	●
South Dakota	●	▲	●	●	●	●
Tennessee	●	○	●	—	—	●
Texas	●	◐	●	●	●	●
Utah	●	▲	—	●	●	●
Vermont	●	●	●	●	●	●
Virginia	●	▼	●	●	●	●
Washington	●	○	●	—	●	●
West Virginia	●	▲	—	●	—	—
Wisconsin	—	○	●	●	●	●
Wyoming	—	▼	—	●	●	—
American Samoa	—	▼	●	—	—	—
Guam	—	▼	●	—	●	●
Northern Mariana	—	▼	—	—	—	—
Puerto Rico	●	◐	●	—	●	●
Virgin Islands	—	▼	—	—	●	—
Totals	44	17 Approved	37	36	41	35

—Not reported.
● Program in place.
○ Program under development.
▲ Program in revision or review.
▼ No program.

Classification/ Mapping Program	Special Source Controls	Interagency Coordination
▼	—	●
●	—	▼
●	●	—
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39	24	23

■ Numeric or narrative ground-water protection standards;

■ Ground-water monitoring programs consisting of a network of wells periodically sampled and analyzed for specific parameters;

■ Classification or mapping programs;

■ Special controls that feature innovative methods to control specific contamination sources; and

■ A plan, committee, or advisory group established to coordinate interagency ground-water protection programs.

Ground-Water Protection Strategies

Of a total of 56 States and Territories (hereafter referred to as States), 44 have adopted, or are in the process of developing, ground-water protection strategies. At least 30 of these States directly referenced their strategy in their State 305(b) reports. The general content of these strategies includes: selection of goals and objectives for the ground-water problems in the State; development of a ground-water classification system; program coordination mechanisms for local, State, and Federal ground-water protection activities; public education and/or involvement; development of an interagency ground-water data collection system; legislative recommendations pertaining to the regulation of contaminating sources; development of a ground-water monitoring system; establishment of a Wellhead Protection Program; improvement of existing State ground-water protection programs; and development of statewide standards for

Julie Duffin

An old hand pump provides drinking water when the electric pump fails.

ground-water quality. Two examples of State strategies that employ the ground-water protection mechanisms identified above are discussed here.

The Texas Ground-Water Protection Strategy, published in 1988, is intended to be a flexible outline of the Texas Ground-Water Protection Committee's goals, with recommendations for implementation. The Strategy identifies opportunities to improve existing programs as they apply to ground water and suggests where coordination programs would provide needed or added protection. In addition, the Strategy outlines goals, needs, and recommendations in six important areas: interagency coordination, hazardous and nonhazardous materials management, public water supply, rural water supply, research, and legislation. Also included is the expansion of coordination with local governments and increased efforts to educate the public on ground-water issues.

Missouri published its Ground-Water Protection Strategy in 1987. New initiatives included in the strategy are: initiation of a formal interagency ground-water data collection system; development and use of a computer-assisted data management system; development of a classification system; promotion of a bill allowing the State to regulate underground storage tanks (USTs); and increasing educational activities related to ground water.

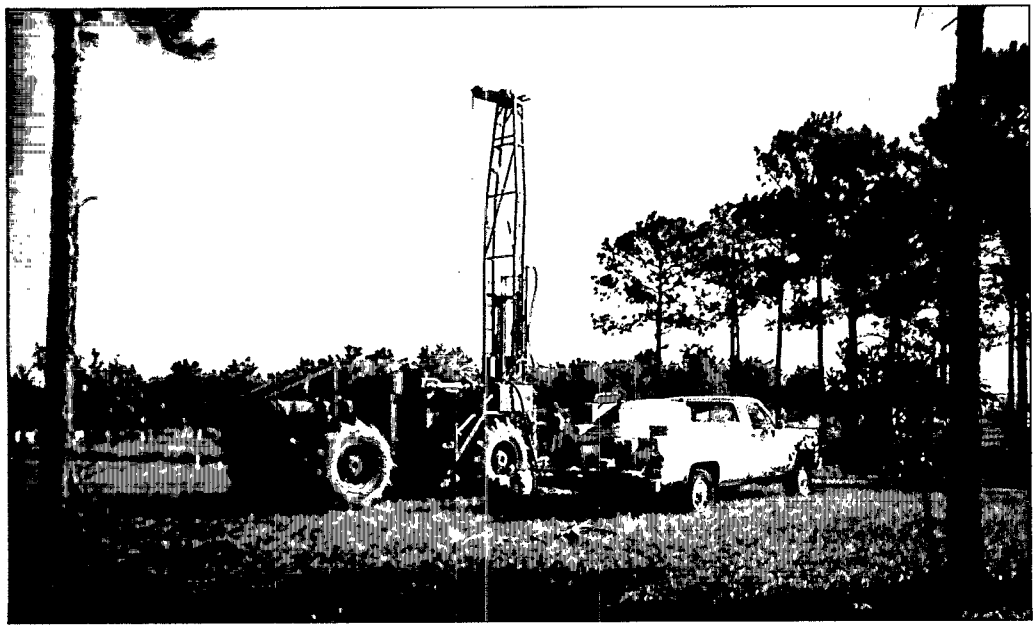
To achieve the goals of their Strategies, many States have enacted comprehensive ground-water protection legislation and/or have developed regulatory programs aimed at controlling contamination sources. This section describes State ground-water protection legislation and regulations and summarizes State programs currently in place.

Ground-Water Protection Legislation

Although most of the States can claim authority to develop ground-water protection programs under general clean water statutes, at least 37 of the 56 States report some form of current or pending legislation geared specifically to ground-water protection. Generally, legislation focuses on the need for increased data collection, public education activities, and program development; and many mandate strict technical controls such as discharge permits, UST registration, and protection standards. Additionally, some States have enacted legislation establishing a State policy to restore and maintain ground-water quality and remediate pollution that has already occurred.

For example, Idaho enacted the Ground-Water Protection Act in 1989, which established a Ground-Water Quality Council consisting of agency, citizen, and industry representatives. The Council's task is to develop a statewide comprehensive plan for protection of ground-water quality. In addition, one priority topic for Council consideration is development of a ground-water monitoring program.

South Dakota's Centennial Environmental Protection Act of 1989 includes statutory authority for ground-water protection activities that include: development of a voluntary Wellhead Protec-



Scott Guthrie

Exploratory soil boring operation for the placement of a ground-water monitoring well.

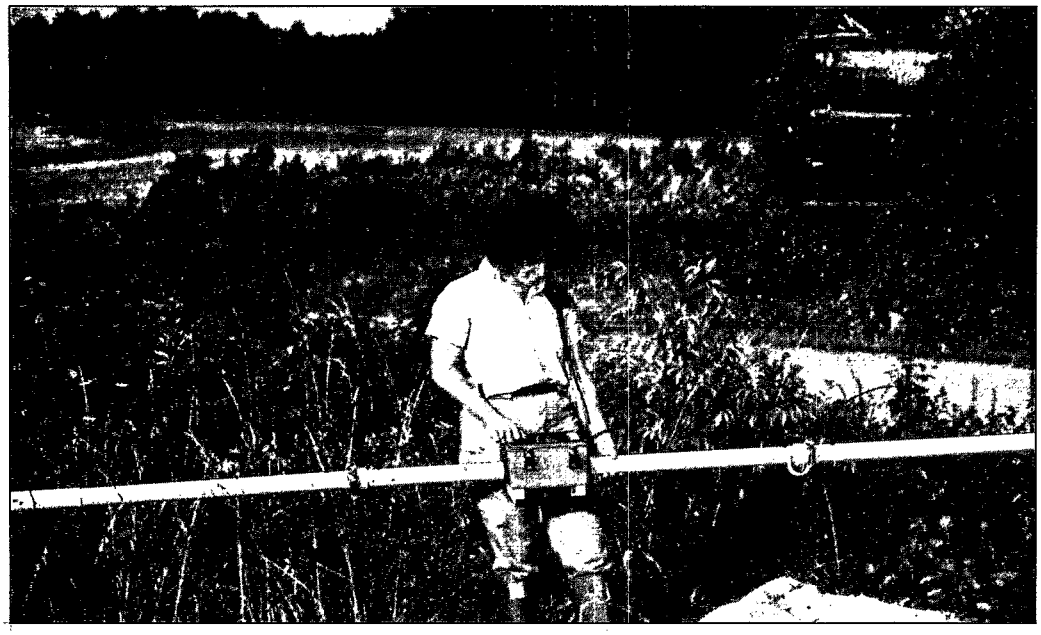
tion Program; water quality analysis for new domestic wells; certification of small onsite wastewater disposal system installers; pesticide and agricultural chemical management plans to protect water quality; establishment of a ground-water protection fund for the development and implementation of ground-water management and protection programs designated by the Legislature; regulation of all bulk chemical storage with potential to contaminate public water supplies; establishment of a 5-year State ground-water research and education program and fund for specific projects; and establishment of an advisory group to direct the research and education program.

Ground-Water Protection Regulations

Of the 56 States responding, 36 report that they have established regulations specifically to protect ground water. In general, the State's ground-water protection regulations stipulate controls for the management of specific sources of contamination and standards for ground-water quality protection. These standards may be used to apply limits on the allowable discharges from contamination sources or to set contaminant concentration targets or threshold levels for ground-water cleanup.

In 1989, Oregon adopted Statewide Ground-Water Quality Protection Rules, which provided the State Department of Environmental Quality with an overall strategy for protecting ground-water quality. The Rules require prevention of contamination of ground water through the use of best available technology. They also establish mandatory minimum ground-water quality protection requirements for permitted sources whose treatment and disposal of wastes and wastewater could affect ground water.

New Mexico adopted a comprehensive set of State ground-water protection regulations that are designed to protect all ground waters with total dissolved solids (TDS) concentrations of 10,000 mg/L or less for current and potential use as domestic and agricultural water supply. Also, the regulations establish 47 numeric ground-water quality standards and require discharge plans applying to dischargers to surface impoundments and leach fields, application of wastes to land, and well injection.



Joe Alexander

Electromagnetic surveying is used to delineate geometry of a ground-water contaminant plume.

Ground-Water Protection Standards

Ground-water protection standards can involve either narrative standards describing nondegradation goals or numeric standards that set threshold health-based concentrations for specific compounds in ground water. Forty-one States report that they have adopted either narrative or numeric protection standards. Of those States, at least 26 have indicated that they have numeric standards and some may have both. Arizona's Department of Health Services is currently developing health-based guidance levels for 223 chemicals including

pesticides, organics, metals, and other inorganics. The new guidance levels are intended to replace the existing standards.

Wisconsin has adopted numerical standards for 74 substances including 24 VOCs, nitrates, certain pesticides, and radium. Both preventive action levels and enforcement standards have been established. The preventive action levels are set as a percentage of the ground-water quality standard or background concentration so that problems can be recognized, addressed, and corrected before the standard is exceeded. Other States have used Federal primary and secondary MCLs as a means for early warning and differential protection of ground water.

Wellhead Protection Programs

Since the reauthorization and amendments of the Safe Drinking Water Act in 1986, many States and local governments are actively moving to develop and implement Wellhead Protection (WHP) Programs. Section 1428 of the Act specifies that each State must prepare a WHP Program and submit it to EPA. To date, EPA has approved Wellhead Protection Programs in 14 States and is working with 32 States to develop a program or revise a previously submitted program. Rhode Island's approved program provides a mechanism for increased protection of ground water supplied by public systems through efforts at the State and local level. The program sets a high priority for source controls and remediation efforts in Wellhead Protection Areas and provides technical information and administrative tools to local governments and suppliers. Texas is currently implementing a cooperative WHP program designed to address and mitigate contamination in specific geographic areas surrounding public supply wells or wellfields. The Texas Water Commission, in cooperation with several other State agencies, is working to develop a statewide agricultural chemicals and agricultural agents management plan. The plan will address aquifer vulnerability, agricultural chemical contamination potential, specific pesticide management plans, and interagency coordination.

In addition, EPA provides State and local governments with extensive assistance for developing Wellhead Protection Programs, including technical assistance documents, workshops, training sessions, and pilot projects.

Ground-Water Classification/ Mapping Programs

Thirty-eight States report active programs to classify or map vulnerable ground-water supplies. Of these 38 States, 22 have a formal system for designating ground-water classes. The States have incorporated elements of the Federal Ground-Water Classification Guidelines, such as ground-water use, ground-water quality, and hydrogeology; however, no State has relied totally on the Federal guidelines. Instead, State classification programs are tailored to specific needs and problems of the individual State.

For example, Montana has established a ground-water classification system based on specific conductance (100 μmho/cm to 15,000 μmho/cm at 25 °C) and suitability for various beneficial uses. Connecticut designates four classes of ground water in terms of ground-water use or quality and permissible discharges. Minnesota has a statewide ground-water susceptibility mapping program that delineates various levels of ground-water contamination susceptibility. The project uses mapped data from several sources on soil, vadose zone and aquifer material, and recharge potential as input data. A newly funded mapping project will develop guidelines for mapping geologic sensitivity at a county scale in an effort to further develop ground-water susceptibility information.

Ground-Water Monitoring Programs

Thirty-four States report having active monitoring programs of some kind to assess ground-water quality. Monitoring ranges from limited sampling of existing drinking water wells to periodic analyses of wells installed for the purpose of long-term monitoring. For example, Ohio maintains a statewide ambient ground-water quality network consisting of 130 stations, which includes public water supply wells and industrial/commercial wells. The network characterizes ambient ground-water quality for each of

Ohio's major aquifer systems. The monitoring program also measures the quality of ground water used for drinking water and identifies regional or local ground-water impacts from diffuse or nonpoint sources of contamination.

Other States require all community water systems to be tested periodically for contaminants, such as organics. Florida tests community water systems for 118 organic contaminants including most of the priority pollutants as well as certain pesticides known to be used in the State and suspected to be polluting ground water.

Special Controls on Specific Contamination Sources

At least 23 States have established some type of special control on specific contamination sources, such as landfills, septic systems, and underground injection wells. In addition, States have adopted specific controls on other minimally regulated sources of contamination. For example, Idaho has established a building moratorium in an area of the State where central sewers are not available. In addition, the State adopted new regulations that require that hazardous waste facilities be sited in locations where the risk of ground-water contamination is minimal.

In 1989, Arizona implemented the Aquifer Protection Permit system, which requires permits for most discharge activities and requires BMPs for agricultural activities. Maine requires that sand-salt mixtures be stored in watertight storage buildings. Also, Rhode Island has banned the use of septic system cleaners that use organic solvents and acids, but this provision is difficult to enforce.

Craig Whitaker

Measurement of ground-water levels in a Resource Conservation and Recovery Act ground-water monitoring well.

Coordination of Protection Programs Among State Agencies

Historically, ground-water protection programs have been overseen by many different agencies within the States, making coordination difficult for those programs. Coordinating the activities of these agencies to ensure an effective ground-water protection program has become a top priority in many States. Twenty-two States report having developed a plan to coordinate ground-water protection programs among the State agencies.

In particular, Louisiana established the Ground-Water Advisory Group, whose members represent State and local governmental agencies that have regulatory authority and technical expertise applicable to ground-water protection and their cooperating agencies. The Group's purpose is to coordinate members' efforts, review State agency plans of action, and assist in coordinating resources toward implementation of the State's Ground-Water Protection Strategy.

The Illinois State Environmental Protection Agency, Department of Energy and Natural Resources, Department of Public Health, and Department of Agriculture cooperated in the development of a ground-water education program. In Virginia, the Ground-Water Data Management Task Force will implement an interagency-

shared data system in 1990. Also, the Texas Ground-Water Protection Committee has responsibilities including improving interagency coordination and publishing an interagency ground-water report.

EPA Programs

The Federal Government has instituted a number of laws and programs to protect the Nation's ground water. As shown in Table 8-2, these include both Federal statutes that mandate certain other ground-water protection activities and EPA programs that deal specifically with the control and study of contaminant sources activities conducted under the authority of Federal statutes.

Legislation

The **Safe Drinking Water Act (SDWA)** and its 1986 amendments created three programs to protect ground water—the Underground Injection Control Program, the Sole Source Aquifer Program, and the Wellhead Protection Program. The Underground Injection Control Program establishes technical criteria and standards for the construction, operation, monitoring, and testing of wells to control the underground injection of wastes. Many States reported enforcing their own underground injection control programs. The Sole Source Aquifer Program authorizes EPA to undertake a special review of possible ground-water impacts from federally funded projects in designated areas that receive Federal financial assistance. The Wellhead Protection Program provides assistance to States to develop programs to protect the wellhead area of all public water systems from ground-water contaminants that may adversely affect human health. EPA has published guidelines to assist the States in developing their Wellhead Protection Programs.

The **Clean Water Act (CWA)** authorizes two programs directly relevant to ground-water protection—the CWA Section 106 Grant Program and the Nonpoint Source Control Strategies. The CWA Section 106 Grant Program supports State programs to improve institutional capabilities through the development of State ground-water protection strategies. The Nonpoint Source Management Programs are required from the States by the 1987 CWA Amendments. Under CWA Section 319, States must describe strategies to identify best management practices and identify appropriate State and local nonpoint source control programs to implement the best manage-

Table 8-2. EPA Ground-Water Protection Programs and Statutes

Statutes

- Safe Drinking Water Act (SDWA)
- Clean Water Act (CWA)
- Resource Conservation and Recovery Act (RCRA)
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or "Superfund")
- Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

Programs

- National Pesticide Survey
- Pesticides in Ground-Water Strategy
- Ground-Water Protection Strategy
- Ground-Water Task Force

Jim Turner

Toxic agricultural chemicals are tank-mixed in preparation for application by tractor-driven sprayer.

ment practices. In addition, under Section 319(i), the EPA Administrator may make grants to States to conduct ground-water quality protection activities that will advance the State toward implementing a comprehensive nonpoint source pollution control program.

The **Resource Conservation and Recovery Act (RCRA)** established a number of programs that provide for ground-water protection and cleanup. These programs emphasize prevention of releases to ground water and other environmental media through management standards and cleanup requirements. Most States are currently managing or developing new programs derived from the following major sections of RCRA: Subtitle C, Hazardous Waste; Subtitle D, Solid Waste; and Subtitle I, Underground Storage Tanks. Subtitle C requires design, operating, and closure standards for all hazardous waste treatment, storage, and disposal facilities. It also requires post-closure care and ground-water monitoring for land disposal facilities. Subtitle D requires minimum national management standards for municipal solid waste landfills to be adopted and implemented by States. Subtitle I requires EPA to develop a comprehensive program for managing certain categories of underground storage tanks containing petroleum and chemical substances.

The **Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)** and the **Superfund Amendments and Reauthorization Act of 1986 (SARA)** created several programs currently operated by EPA and States that act to protect or clean up contaminated ground water. Using its emergency response authority under "Superfund," EPA responds to releases of hazardous substances into the environment, thereby removing those hazardous substances before they have the opportunity to contaminate ground water. In a Superfund remedial action, EPA undertakes long-term efforts to provide a permanent remedy to existing releases of hazardous wastes that pose a serious, but not immediate, danger to public health. Remedial actions often involve cleaning up contaminated ground water. The "Title III" Emergency Planning and Community Right-to-Know Act (a free-standing act created as part of SARA) requires industry and Federal, State, and local governments to work together in developing emergency plans, emergency release notification procedures, "community right-to-know" reporting, and toxic chemical release reporting.

The **Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)** protects ground water indirectly by controlling the use of pesticides through registration and certification procedures. EPA may deny registration for a pesticide if its normal use will result in unreasonable adverse effects on the environment, including ground-water contamination.

National Programs

The National Pesticide Survey is jointly sponsored by EPA's Offices of Drinking Water and Pesticide Programs. It is a national statistical survey designed to determine the presence of pesticide residues in two distinct populations of drinking water wells: public water system wells and private domestic drinking water wells. Over 1,300 wells have been analyzed for over 100 pesticides specifically selected for their propensity to leach and their degradation products. Each well was also analyzed for nitrate. Based on the results of the survey, EPA estimates that at least half of the Nation's drinking water wells contain detectable amounts of nitrate, with only a small percentage at concentrations higher than EPA's regulatory and health-based limits for drinking water (1.2 percent of community water system wells and 2.4 percent of rural domestic wells). Based on the survey, EPA estimates that about 10 percent of the 94,600 community water system wells in the United States contain one or more pesticides. Of the 10.5 million rural domestic wells, EPA estimates that 4.2 percent contain one or more pesticides.

The Pesticides in Ground-Water Strategy was released by the EPA Office of Pesticides and Toxic Substances in October 1991. The Strategy's goal is to determine the current status of pesticides in ground water and to evaluate the agricul-

tural activities with potential to affect ground water. The key component of the Strategy is the development of State Management Plans (SMPs) for controlling pesticide leaching to ground water. Each State will develop an SMP to control pesticides that pose an unreasonable risk to health or the environment.

The **Ground-Water Protection Strategy** was developed in 1984 by EPA and provides an approach to integrating source-specific control and cleanup programs into a comprehensive policy and institutional framework for protecting the resource. The Strategy is aimed at strengthening State ground-water programs and internal ground-water organizations and coping with unaddressed ground-water problems. The Strategy outlined a three-tiered classification system for ground water as a policy framework for EPA programs.

A **Ground-Water Task Force** was established in 1989 by EPA to expand upon the 1984 Ground-Water Protection Strategy. The Task Force was given a mandate to review the Agency's ground-water protection program and to develop concrete principles and objectives to ensure effective and consistent decisionmaking in all Agency activities that affect ground water. This was necessitated by a general understanding among EPA managers and the States that, despite the progress made since 1984, gaps still remained in the Nation's efforts to protect the ground-water resource comprehensively.

The final Task Force report addressed five aspects of the Agency's ground-water protection program:

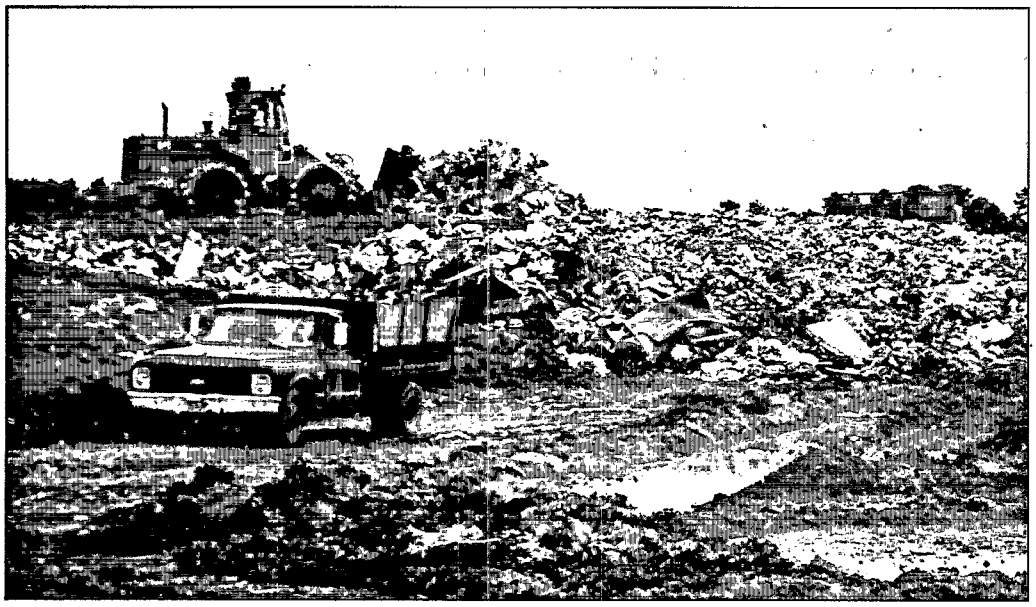
- *EPA's Ground-Water Protection Principles*—prevents adverse effects to human health and the environment.

- *The Federal / State Relationship in Ground-Water Protection*— encourages the States to develop ground-water protection programs.

- *Agency Policy on EPA's Use of Quality Standards in Ground-Water Prevention and Remediation Activities*—describes how EPA will use maximum contaminant levels under the Safe Drinking Water Act and water quality standards under the Clean Water Act as "reference points" in carrying out ground-water programs and describes how these reference points will be applied differently in prevention and remediation activities.

- *Data Management Recommendations*—will result in recommendations for improved ground-water data availability, accessibility, and utilization.

- *Office of Research and Development's Ground-Water Research Plan*—examines research activities to ensure that they support the needs of Agency programs.



John Thelgard

Leaching of toxic chemicals from landfill sites is one of the many sources of ground-water contamination.

Water Pollution Control Programs

9

Patricia Cunningham

Point Source Control Program

Treating Municipal Wastewater

Municipal treatment facilities receive wastewater from residential sources, as well as from industry, groundwater infiltration, and stormwater runoff. The array of pollutants that may be associated with these sources includes suspended solids, organics, heavy metals, nutrients, acids, viruses, and bacteria.

Adequate treatment of municipal wastewater is important for the protection of the Nation's water resources and public health. Without adequate treatment, this pollution poses a potentially serious threat to fish, shellfish, and macroinvertebrate communities, recreational opportunities, surface water drinking supplies, ground-water drinking supplies, and the general health and stability of many of the Nation's stream, river, lake, estuarine, and coastal ecosystems.

The Clean Water Act requires municipalities to achieve treatment levels based on technology performance. The 1981 CWA amendments extended the deadline for eligible treatment plants to achieve "secondary treatment" to July 1, 1988. Secondary treatment removes at least 85 percent of several key conventional pollutants. If secondary treatment is not enough to meet water quality standards, the Clean Water Act mandates additional treatment, as necessary.

Historically, under the Clean Water Act, EPA has been authorized to help municipalities solve their wastewater treatment problems by providing grants for construction. For this purpose,

$18 billion was originally appropriated to the construction grants program. Funding has continued since the initial appropriation in 1972, and the Federal investment in municipal wastewater treatment to date is $56 billion through FY92.

Through the 1987 amendments to the Clean Water Act, the State Revolving Fund Program was established to follow the phaseout of the construction grants program. Under this program, the Agency provides grants to States to capitalize the establishment of State-run loan programs. This is a major step in restoring the responsibility for financing wastewater treatment to States and municipalities.

Congress appropriated $6.0 billion through fiscal year 1991 for State Revolving Funds (SRFs). In addition, Congress has authorized a total of $1.8 billion for 1993 and 1994. States must provide a 20 percent match as part of their commitment toward establishing their SRFs. In addition to providing loans for construction of wastewater treatment facilities, State Revolving Funds allow funding for activities not previously eligible under the construction grants program.

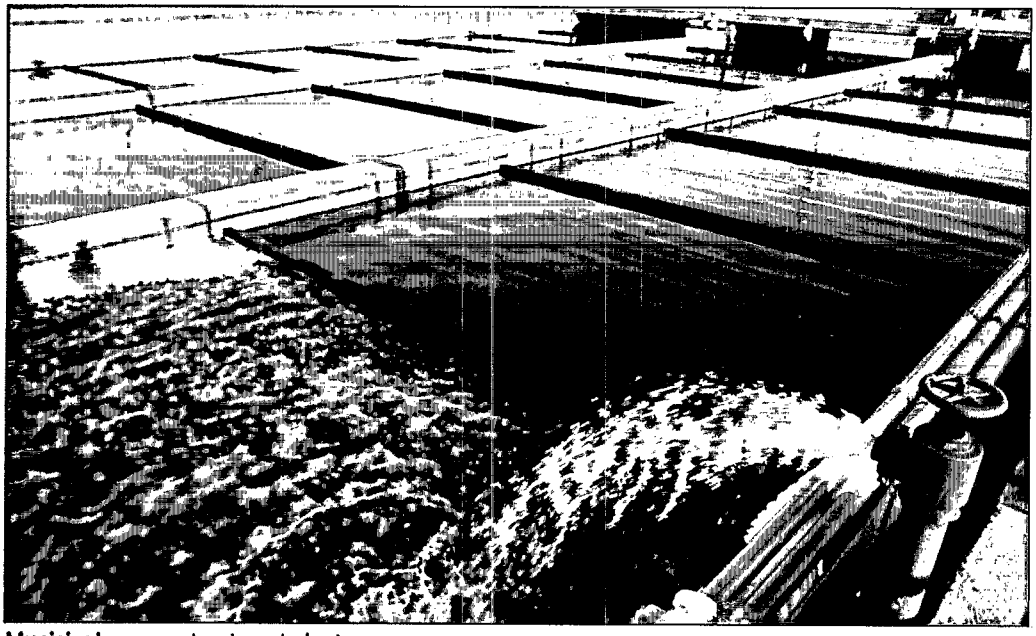
The amendments of 1987 expanded eligibilities and also led to the promulgation of new rules related to new enforceable requirements. The major categories of new eligibilities are nonpoint source control and programs for the protection of ground water and estuaries. The primary programs with new enforceable requirements are those dealing with stormwater, toxic discharges, and sludge use and disposal.

The SRF loan program provides States with more discretion than ever before in selecting projects for funding. States are now able to finance projects they may consider to be of higher priority, such as nonpoint source, estuarine, combined sewer overflow, or stormwater control projects. All States and Puerto Rico had approved SRF programs in place as of September 1990.

The States, in their 1990 Section 305(b) reports, provided some examples of water quality improvements due to municipal construction and upgrading. For example:

■ Arkansas reported that the new Fayetteville treatment plant eliminated chronic violations of dissolved oxygen standards and reduced instream phosphorus concentrations by almost 50 percent in the White River. Strict phosphorus restrictions were included in the plant's NPDES permit to protect Beaver Reservoir from further degradation. The State also observed significant improvements in Bayou Meto following construction of a new sewage treatment plant in Jacksonville during 1988. Dissolved oxygen concentrations increased and downstream BOD concentrations decreased after the new plant began operating.

■ In Kentucky, 21 municipal wastewater projects were completed in 1988-1989, and an additional 20 projects were in various stages of construction. Discharge monitoring reports indicated significant reductions in pollutants discharged following replacement of old facilities with new plants.



Municipal sewage treatment plant.

■ Minnesota reported that $177 million was spent to improve the State's municipal wastewater treatment facilities during the reporting period. As a result, new facilities have been completed or are under construction for all but 100 communities with an identified need for facility improvements. Less than 1 percent of the served population reside in the 100 communities that have not addressed upgrade needs.

■ Missouri reports a 50 percent reduction in the number of stream miles affected by point sources since 1984. The improvements in stream quality are attributed to the replacement of multiple old plants with single regional facilities and enhanced performance at existing plants resulting from compliance activities, operator training, and minor plant upgrades.

■ In North Dakota, the quality of municipal wastewater discharges has substantially improved since 1981. Data indicate that the mean annual 5-day biological oxygen demand (BOD) concentration dropped from 22 mg/L in 1981 to 13 mg/L in 1988. Similarly, the mean concentration of suspended solids declined from 44 mg/L to 24 mg/L in 1988.

■ Virginia reports that the construction of new treatment plants decreased the total quantity of pollutants entering the State's waters although the total discharge volume increased during this time. Average annual discharge almost doubled between 1976 and 1989; however, the amount of BOD material and suspended solids discharged was cut almost in half. The new treatment plants provide a higher degree of treatment to a greater portion of the State's population.

Funding Needs for Wastewater Treatment

The Needs Survey, a biennial report to Congress, is the primary mechanism for assessing municipal wastewater treatment needs nationwide. The 1990 Needs Survey presented cost estimates for needs eligible under the construction grant and SRF programs. However, the scope of this latest survey was scaled down from previous efforts. EPA adjusted the documented 1988 cost estimates for Federal grants and loans awarded, and inflated the results to 1990 dollars, to report needs traditionally eligible for construction grants. States reported needs eligible under SRF that *supplement* and reflect either an increase or decrease in EPA's estimate of needs for the traditional eligibilities. As a result, the cost estimates reported in the 1990 Needs Survey and summarized here are not directly comparable to those reported in prevous years.

Table 9-1. Needs for Publicly Owned Wastewater Treatment Facilities (January 1990 Dollars, in Billions)

Needs Category		Needs for Traditional Eligibilities		Supplemental State Estimates
		Current	Design Year	
I	Secondary Treatment	18.5	24.9	12.4
II	Advanced Treatment	3.6	4.7	6.6
IIIA	Infiltration/Inflow Correction	2.8	2.8	0.8
IIIB	Replacement/Rehabilitation	3.6	3.6	0.7
IVA	New Collector Sewers	10.9	13.8	3.2
IVB	New Interceptor Sewers	9.1	14.1	3.3
V	Combined Sewer Overflows	16.5	16.5	3.2
Categories I-V		65.0*	80.4	30.2

*Current needs to meet construction needs of facilities in significant noncompliance is approximately $12.0 billion, as reported in the State Revolving Funds Final Report to Congress.

Source: U.S. EPA, *1990 Needs Survey Report to Congress.*

The capital investment necessary to satisfy all categories of need for the traditional eligibilities and supplemental State estimates is presented in Table 9-1. This table indicates that

- An estimated $65 billion is needed to satisfy the current or existing population. Of this amount, approximately $12 billion is needed to meet the construction needs of municipal wastewater facilities in significant noncompliance with the CWA requirements, as reported in the SRF Final Report to Congress.

- An estimated $80.4 billion is required to satisfy needs for the traditional eligibilities for an approximate 20-year design life for municipal facilities.

- An estimated $30.2 billion in design year needs is required to satisfy the States' supplemental estimates of SRF eligible needs. These estimates are incremental to the traditional eligibilities and reflect newly identified needs, revised cost estimates due to changed plans, the addition of reserve capacity, and the satisfaction of previously identified needs through State and local financing that did not involve Federal assistance.

The 1990 Needs Survey invited the reporting of new types of eligible needs under SRF (e.g., nonpoint source pollution control and groundwater, estuarine, and wetlands protection), as well as needs resulting from new enforceable requirements (e.g., control of toxicants, sludge use and disposal, and stormwater). States included needs for the control of toxics and sludge use and disposal as part of their supplemental estimates for Categories I and II, and these needs are reported. Only a few States submitted needs for the newer types of eligibilities, including stormwater, as States indicated estimates are still being developed. Therefore, EPA did not report any of these estimates to avoid misrepresentation of these needs.

Table 9-2. Status of Permit Issuance

	Major Permits	Minor Permits
Total Facilities	7,102	56,791
EPA-Issued:		
Total	2,021	7,412
Expired	204	3,033
Percent	10%	41%
State-Issued:		
Total	5,081	49,379
Expired	1,046	15,821
Percent	21%	32%

Source: Permit Compliance System, October 1990.

Treating Industrial Wastewater

The Clean Water Act required EPA to establish uniform, nationally consistent effluent limitation guidelines for industrial discharges. At this time, EPA has established Best Available Technology Economically Achievable (BAT) and Best Conventional Pollutant Control Technology (BCT) guidelines for about 28 industrial categories. EPA has also promulgated technology-based guidelines for approximately 15 additional secondary industries that represent Best Practicable Control Technology Currently Available (BPT) levels. EPA is studying an additional dozen industries for future guideline development.

In addition to these technology-based requirements, in 1984 EPA issued a policy on the water-quality-based control of toxic pollutants discharged by point sources. In 1985, a technical guidance document was issued to support the national policy. Both the policy and guidance recommend using overall toxicity as a measure of adverse water quality impact and as a regulatory parameter. The use of toxicity testing as a regulatory tool is a relatively new concept; however, coupled with chemical testing for pollutants that are hazards through bioaccumulation, it provides a powerful means of detecting and controlling toxic problems.

Permitting, Compliance, and Enforcement

Establishing rigorous permit conditions is the basis on which point source control is achieved for industrial and municipal dischargers.

During the early 1980s, the rate of permit issuance fell behind the rate of permit expiration, and large backlogs of unissued permits developed. Efforts to remedy these backlogs have been largely successful. Table 9-2 illustrates the status of permit issuance as of October 1990.

Once the permit is established, compliance with these conditions is essential for achieving water quality improvements. Despite examples of water quality improvements associated with upgrading municipal facilities, 15 percent of major municipal treatment plants are in significant noncompliance with applicable permit conditions. Industrial permittees have historically achieved a higher rate of compliance, but as of October 23, 1990, 13 percent of direct discharging industrial facilities were in significant noncompliance with their permit conditions.

EPA and States with approved NPDES programs are responsible for ensuring that municipal and industrial facilities comply with the terms of their discharge permits. Currently, 39 States have approval from EPA to administer their own NPDES programs. This responsibility includes issuing permits, conducting compliance inspections and other compliance monitoring activities, and enforcing compliance. EPA has the lead implementation responsibility in the remaining States. EPA and the States evaluate compliance by screening self-monitoring reports submitted by the permitted facility. Facilities that are determined to be in noncompliance are subject to Federal as well as State enforcement action.

Table 9-3 illustrates rates of significant noncompliance based on statistics maintained by EPA from June 1984 through October 1990. It should be noted that significant noncompliance rates for municipals and industrial facilities jumped in FY90 primarily because, for the first time, EPA calculated noncompliance directly from its automated database. Therefore, if data are not entered into the Permit Compliance System in a timely manner (e.g., failure to enter the receipt of a required

Table 9-3. National Composite Rates of Facilities in Significant Noncompliance (percent)

Quarter Ending	Nonmunicipals	Municipals
12/31/83	8	19
03/31/84	10	20
06/30/84	6	14
09/30/84	6	13
12/31/84	5	12
03/31/85	5	13
06/30/85	5	10
09/30/85	5	9
12/31/85*	8	14
03/31/86*	8	16
06/30/86*	8	15
09/30/86*	7	14
12/31/86*	7	14
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06/30/88*	7	14
09/30/88*	6	12
12/31/88	6	12
03/31/89	7	13
06/30/89	7	12
09/30/89	5	10
12/31/89	6	10
10/23/90	13	15

*Reflects NPDES Rule Change.

report within 30 days), the system will automatically determine that the facility is not in compliance. EPA is continuing to refine its tracking of compliance with permit conditions to better reflect instances of noncompliance by the regulated community.

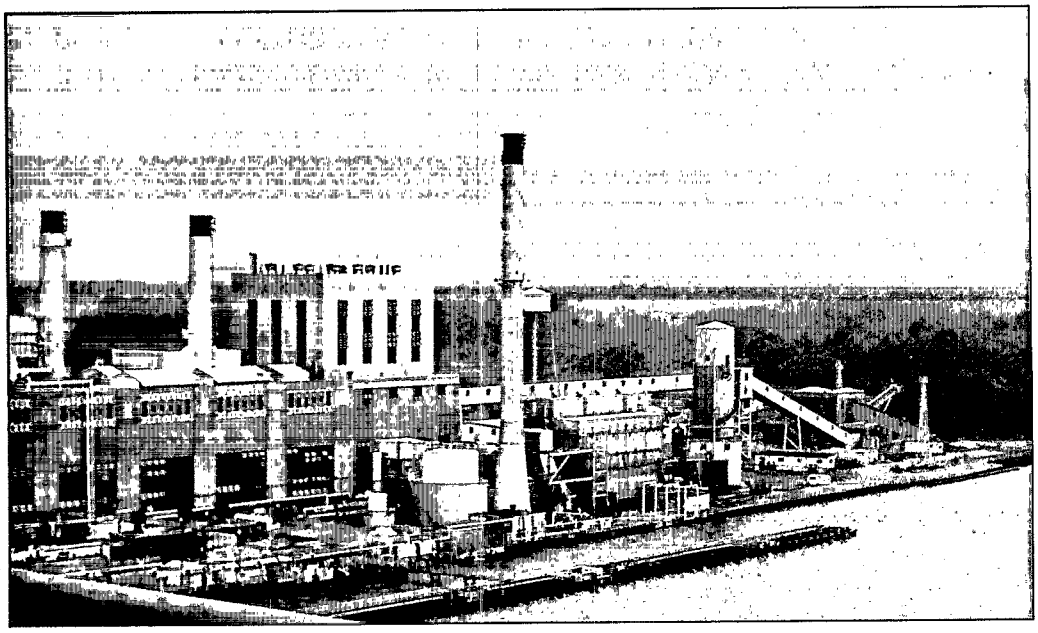
National Municipal Policy

Due to the generally poor municipal compliance record, and because of Congressional concern over the performance of treatment works built substantially with Federal funds, EPA developed the National Municipal Policy (NMP) to address the failure of POTWs to meet treatment levels required for compliance with the CWA. On January 23, 1984, the EPA Administrator signed the NMP into effect. The NMP clarified and emphasized EPA's resolve to ensure that municipalities comply with the Clean Water Act as quickly as possible, regardless of whether Federal grant assistance was available for treatment plant construction. The deadline established for full compliance with the Clean Water Act was July 1, 1988. By this date all municipal treatment facilities were to be in compliance with the secondary treatment requirement of Section 301(b)(1)(B) of the CWA or with more stringent limitations established to meet State water quality standards. Of the total universe of 3,731 major municipal facilities, 1,478 facilities were identified as requiring construction to meet the 1988 deadline. By July 1, 1988, all but 423 municipal facilities achieved compliance with the requirements. Since the 1988 deadline, 188 facilities have come into compliance, and, of the remaining 235 facilities, all but 50 have been placed on enforceable compliance schedules. EPA is continuing to track the progress of these facilities in meeting the requirements of the CWA.

In the 1987 Water Quality Act Amendments to the CWA, EPA was given authority to seek administrative penalties from permittees in noncompliance with the Act's requirements. EPA issued guidance and delegated the authority for issuing these orders to the regional level in August 1987. The first Administrative Penalty Order (APO) was issued in September 1987. Through October 1990, 396 APOs have been issued assessing a total of $7.5 million in penalties. These orders have been an effective tool in expeditiously addressing violations of the CWA and represent an integral component of EPA's overall enforcement strategy.

Controlling Toxicants

The 1987 amendments to the Clean Water Act reinforced both the water-quality-based and technology-based approaches to point source control, requiring EPA to develop and update technology-based standards and adding specific direction as to how water-quality-based limits should be used to achieve additional improvements. One of the Act's primary emphases lay in strengthening the Nation's toxics control program.



Paul Goetz

Chemical manufacturing facility along the lower Delaware River.

Identifying Waters Impaired by Toxicants

Section 304(l) of the CWA requires States to develop lists of impaired waters, identify point sources and the amounts of pollutants they discharge that cause toxic impacts, and develop an individual control strategy for each such point source. These individual control strategies are National Pollutant Discharge Elimination System permits with new or more stringent limits on the priority pollutants of concern. The individual control strategies must be accompanied by supporting documentation to show that the permit limits are sufficient to meet water quality standards as soon as possible but no later than 3 years after establishment of the individual control strategy. The general effect of Section 304(l) is to immediately focus national surface water quality protection programs on addressing known water quality problems due entirely or substantially to point source discharges of Section 307(a) toxic pollutants. Controls for these pollutants must be established as soon as possible but no later than the statutory deadlines set forth in Section 304(l).

EPA has been implementing control measures for all toxic pollutants as part of its ongoing surface water program. Section 304(l) emphasizes the importance of the water-quality-based and technology-based approaches in protecting surface waters from priority toxic pollutants and establishes a number of one-time requirements. After the Section 304(l) deadlines pass, EPA will continue identifying impaired waters and controlling the discharge of toxic and other pollutants through existing reporting, standards setting, and permitting programs.

In developing lists of impaired waters, States used a variety of available data sources (including State Section 305(b) reports). At a minimum, dilution analyses were conducted based on existing or readily available data. EPA asked States to assemble data quickly to report preliminary lists of waters, point sources, and amounts of discharged pollutants by April 1, 1988, in their Section 305(b) reports. These lists were then to be refined and expanded by the statutory deadline of February 4, 1989.

Section 304(l) encourages the States and EPA to address problems identified through review of existing and readily available data. The States and EPA Regions will continue to collect new water quality data to fill existing data gaps and ensure that changes in water quality are identified.

NC Division of Environmental Management

The Clean Water Act requires States to identify waters impaired by toxics, dischargers to those waters, and the pollutant causing toxic impacts.

Status of 304(l) Implementation (as of March 1991)

EPA's notice of approval or disapproval of States' lists submitted in June 1989 was followed by a 120-day public comment period that allowed interested persons to comment on the listed waters and identified sources and to petition EPA to list additional waters. The public comment period closed on October 4, 1989, after which EPA provided responses to all comments and petitions. After close of the public

comment period, and by June 4, 1990, EPA (in most cases) provided its final decisions on the listed waters and sources. Upon taking into consideration all the comments and petitions received, EPA prepared its final decisions, including any additions or deletions to the June 1989 lists as submitted by the States.

As of March 1991, 529 waterbodies had been identified as being impaired primarily by point source discharges of Section 307(a) toxic pollutants. In addition, 686 point sources were listed as being responsible for impairing the quality of those waters. There are also 18,770 waters on the "long" list that include all waters impaired by any pollutant from either point sources or nonpoint sources. The long list will be used for long-term planning and setting of priorities for monitoring, total maximum daily load (TMDL) development, nonpoint source controls, and permit revisions.

EPA Regions and the States continue to work on implementing 304(l) requirements. As of October 1990, final listing decisions had been made in 50 of the 56 States and U.S. territories, and approximately 76 percent of the Individual Control Strategies (ICSs) required were in place as EPA-approved draft or final NPDES permits.

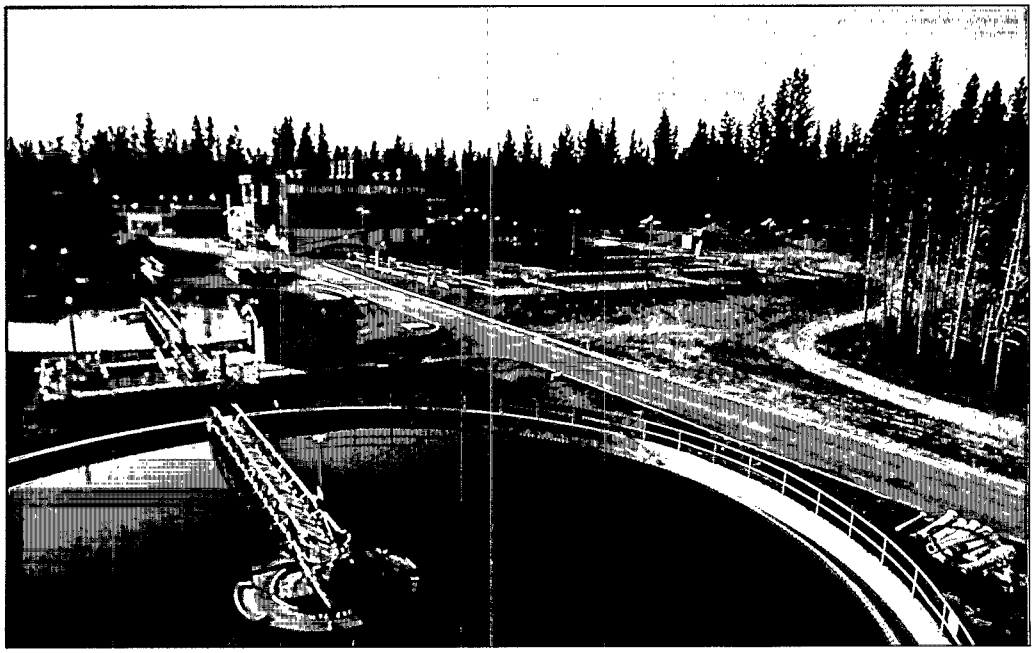
Toxicity Testing

EPA's *Technical Support Document for Water Quality-based Toxics Control* urges the use of an integrated toxics control strategy with both whole effluent toxicity-based assessment procedures and chemical-specific and biological assessment procedures to uphold State water quality standards.

The States and EPA Regional offices are incorporating toxicity limits and toxicity testing requirements into permits. When toxicity testing shows a permittee's discharge contains toxicity at unacceptable levels, permit limitations and conditions require the permittee to reduce toxicity so that no unacceptable effects occur instream.

Toxicity reduction evaluations (TREs) identify and implement whatever actions are needed to reduce effluent toxicity to the levels specified in the permit. TREs combine toxicity testing, chemical analyses, source investigations, and treatability studies to determine either the actual causative agents of effluent toxicity or the control methods that will reduce effluent toxicity. EPA is currently documenting successful TREs conducted by permittees, States, and EPA researchers. Methods and procedures for conducting TREs are described in several EPA guidance documents.

States are making progress in developing the capability to assess and regulate toxic discharges using these biological techniques. As of June 1990, 67 percent of the States are using the whole effluent approach in permitting as part of their water-quality-based toxics control program. For industrial permits, 58 percent of the States require acute whole effluent toxicity testing and 33 percent require acute whole effluent toxicity permit limitations. Forty-two percent of the States require chronic whole



Sewage treatment facility settling basin.

effluent toxicity testing and 28 percent require chronic whole effluent toxicity permit limitations. For municipal permits, 49 percent of the States require acute whole effluent toxicity testing and 18 percent require acute whole effluent toxicity permit limitations. Thirty-three percent of the States require chronic whole effluent toxicity testing and 14 percent require chronic whole effluent permit limitations. Also, EPA estimates that 77 percent of the States are currently incorporating ambient biosurveys into their toxics control programs.

The National Pretreatment Program

The primary goal of the National Pretreatment Program is to protect municipal wastewater treatment plants and the environment from the adverse impact that may occur when toxic, hazardous and concentrated conventional wastes are discharged into sewer systems from industrial sources. To achieve this goal, the EPA has promulgated National Pretreatment Standards for pollutants that: (1) interfere with the operation of a publicly owned treatment works (POTW), including interference with its use or disposal of municipal sludge; or (2) pass through the POTW and contaminate the receiving stream or are otherwise incompatible with the operation of the treatment works. In addition, the program is intended to improve opportunities to recycle and reclaim municipal and industrial wastewaters and sludges. The prevention of interference, the prevention of pass-through, and the improvement of opportunities to recycle wastewater and sludge are the three regulatory objectives of the National Pretreatment Program. These objectives are accomplished through a pollution control strategy with three elements:

■ **National Categorical Standards**: National technology-based standards developed by EPA Headquarters reflecting BAT in establishing effluent limits for the 126 "priority pollutants" as well as for conventional and nonconventional pollutants for specific industrial categories.

■ **Prohibited Discharge Standards**:

General Prohibitions — National regulatory prohibitions established by EPA against pollutant discharges from *any* nondomestic user that cause pass-through or interference at the POTW.

Specific Prohibitions — National regulatory prohibitions established by EPA against pollutant discharges from *any* nondomestic user that cause: (1) fire or explosive hazard, (2) corrosive structural damage, (3) interference due to obstruction, (4) interference due to flow rate or concentration, (5) interference due to heat, (6) interference from petroleum-based oil, and (7) acute worker health and safety problems from toxic gases.

■ **Local Limits**: Enforceable local effluent limitations developed by POTWs on a case-by-case basis to reflect site-specific concerns and implement the Federal general and specific prohibited discharge standards as well as State and local regulations.

To ensure the success of the pretreatment program, EPA also issues guidance documents and has conducted scores of training seminars to assist POTWs in developing, implementing, and enforcing effective pretreatment programs.

The primary focus for pretreatment implementation is at the local level, since the POTW is in the best position to regulate its industrial users. States may become involved in pretreatment implementation through a formal approval process in which the Federal Government transfers its oversight responsibilities to the State. The Federal Government, through the EPA, is involved in pretreatment through standard setting, policy development, and oversight of program implementation by approved States and POTWs in States without approved pretreatment programs. At present, 27 States have received approval from EPA to administer the pretreatment program, including five States that have chosen to directly regulate the industrial community in their States in lieu of local program approval and implementation. In addition, 1,442 local programs have been approved by either EPA or approved States, and another 100

programs are under development. The pretreatment program currently regulates approximately 30,000 significant industrial users (SIUs).

On July 24, 1990, the EPA promulgated the Domestic Sewage Study (DSS) final rule, which implements the recommendations made in the DSS. Specifically, the rule is designed to improve the control of hazardous wastes discharged to POTWs as well as strengthen the enforcement of pretreatment program requirements. In addition, the rule requires that POTWs conduct toxicity testing of their effluents. A continuing task will be to integrate the implementation of these requirements into the normal operations of the POTW's pretreatment program.

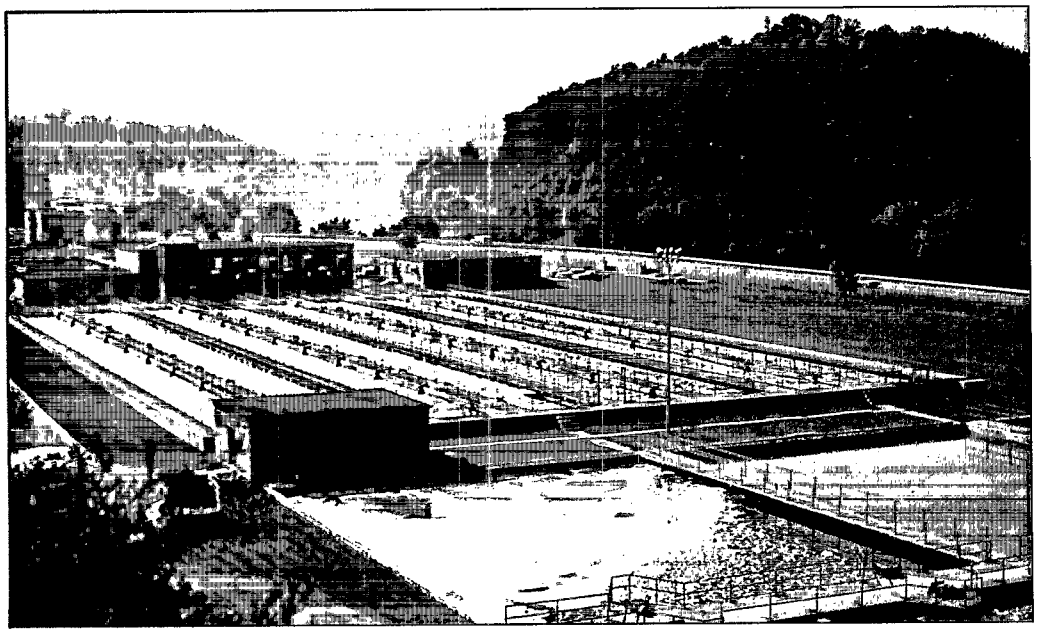
The environmental accomplishments of the National Pretreatment Program have been significant. Nationwide, EPA estimates that toxic pollutant loadings to POTWs have decreased by up to 75 percent through pretreatment. In many cases, the effects on surface water and sludge have been dramatic. Between 1975 and 1985, for example, 15 POTWs discharging to San Francisco Bay decreased their overall metals loadings by 80 percent, despite a 15 percent increase in POTW flows. In Wisconsin, 14 of 24 POTWs reported marked decreases in average total metals concentrations in their sludge after approval of their local pretreatment programs.

The compliance status of industrial users and POTWs is an indicator of the programmatic success of pretreatment implementation. Based on data reported by POTWs or States, approximately 14 to 17 percent of significant industrial users are in significant noncompliance with pretreatment requirements. This compares with a rate of 13 percent significant noncompliance for the major industries in the NPDES program, which discharge directly to waterbodies. According to data in EPA's national database, 39 percent of POTWs are failing to implement at least one significant component of their approved pretreatment programs.

EPA has focused its oversight and enforcement resources on ensuring that local municipalities properly implement their approved programs. Toward that end, on October 4, 1989, EPA announced the National Pretreatment Enforcement Initiative against cities for failure to adequately implement their approved pretreatment programs. In this action, EPA joined with several States in bringing civil judicial suits or administrative penalties against 61 cities. This effort was designed to alert cities as to their requirements under the pretreatment program and to ensure adequate implementation of the program. A followup announcement was made on May 1, 1991, containing 755 additional actions against both POTWs and significant industrial users.

EPA has developed a report to Congress on the effectiveness of the pretreatment program as required under Section 519 of the CWA. This report analyzes the major strengths and weaknesses of the program and provides direction for improving the program.

EPA is expected to promulgate sludge standards in 1992 for the safe disposal



CMI Haas

EPA is developing regulations for each of the major uses and disposal options for sewage sludge.

and beneficial use of municipal sludge. The application of increasingly stringent discharge standards governing toxic pollutants to municipal treatment plants is also expected. Where industrial or other nondomestic wastes are limiting a municipal treatment plant's sludge management practices or compliance with its discharge permit, the plant's pretreatment program will be the vehicle for achieving the necessary pollutant reductions.

Managing Sludge

The need for effective sludge management is continuous and growing. In the United States, the quantity of municipal sludge produced annually has almost doubled since 1972. Municipalities currently generate approximately 7.6 million dry metric tons of wastewater sludge per year, or approximately 32 kilograms per person per year. Improper sludge management could lead to significant environmental degradation of water, land, and air, as well as adverse human health conditions.

Prior to the 1987 amendments to the Clean Water Act, the authorities and regulations related to the use and disposal of sewage sludge were fragmented and did not provide States and municipalities with adequate guidelines on which to base sludge management decisions. There was no single legislative approach or framework for integrating the various Federal laws to ensure that sludge would be used or disposed of in a consistent or environmentally acceptable manner. Although the Clean Water Act, the Clean Air Act, the Resource Conservation and Recovery Act, the Marine Protection, Research and Sanctuaries Act, and the Toxic Substances Control Act all regulate some aspect of sludge management, coverage is uneven, and the requirements are based on different methodologies and approaches.

Section 406 of the Water Quality Act of 1987, which amends Section 405 of the Clean Water Act, for the first time sets forth a comprehensive program for reducing the environmental risks and maximizing the beneficial uses of sludge. The program is based on the development of technical requirements for sludge use and disposal and the implementation of such requirements through permits.

Pursuant to Section 405, EPA is developing regulations for each of the major use and disposal options for sewage sludge. These options include land application, incineration, landfilling, distribution and marketing, and surface disposal sites. EPA will ensure that these regulations also comply with other relevant statutes such as the Solid Waste Disposal Act. The first set of regulations, addressing 28 pollutants in sewage sludge, was proposed in February 1989. Development of a comprehensive set of disposal option regulations will give the States and municipalities a basis for making environmentally appropriate and cost-effective sludge management decisions. The final regulations are scheduled to be promulgated in early 1992.

Before the technical disposal criteria in the comprehensive rules are promulgated, EPA is implementing the Sewage Sludge Interim Permitting Strategy. The Interim Strategy sets forth EPA's policy on fulfilling the CWA mandate that EPA place sludge conditions in permits or take other measures necessary to protect the public health and environment from adverse effects of sewage sludge. To complement the Interim Strategy, EPA has also developed the *Guidance for Writing Case-by-Case Permit Requirements for Municipal Sewage Sludge*, which provides technical information and assistance to permit writers in developing interim sludge requirements. In addition, EPA has begun coordinating EPA/State permitting activities, which EPA anticipates will provide the foundation for EPA-approved State sludge programs. Fifteen States currently have agreements with EPA detailing each State's permitting responsibilities under the Interim Program.

In May 1989, EPA promulgated regulations for including sludge management conditions in NPDES permits and for issuing sludge-only permits. These rules also outline the requirements for State sludge management programs that seek EPA approval to implement the new statutory requirements. In addition, regulations that address sewage sludge disposal in municipal solid waste landfills were proposed in August 1988 and

are scheduled to be promulgated in late 1992.

New Initiatives in Point Source Control

Combined Sewer Overflow Control

Large projects to mitigate the water quality impacts of combined sewer overflow (CSO) discharges have been undertaken in a number of municipalities. However, most CSO discharges are currently not addressed or are inadequately addressed in NPDES permits. In recognition of this, EPA issued the National CSO Control Strategy in August 1989. The objectives of the strategy are to ensure that CSO discharges occur only as a result of wet weather; to bring all wet weather CSO discharge points into compliance with the technology-based requirements of the CWA and applicable State water quality standards; and to minimize water quality, aquatic biota, and human health impacts from wet weather overflows. The National CSO Control Strategy called upon States to develop statewide permitting strategies by January 15, 1990, for the development and implementation of measures to reduce pollutant discharges from CSOs.

Since EPA issued the National CSO Control Strategy, there has been significant progress in its implementation. In response to the national strategy, 30 States submitted CSO Permitting Strategies and 20 States declared that they did not require a strategy because their communities did not have combined sewer systems or, if they did, there were no overflows from the systems. Of the 30 strategies that were submitted, EPA Regions have approved 19. Three strategies were conditionally approved; EPA is currently working with these States to resolve the outstanding concerns and issues as soon as possible. Twelve strategies have not been approved; EPA is still reviewing these plans and continuing to discuss them with the appropriate States.

As a result of these strategies, EPA estimates that there are approximately 1,049 communities with combined sewer systems having 10,764 CSO discharge points.

As a result of working with the States to implement the national strategy and the State permitting strategies, EPA has identified a number of significant issues that have to be addressed. These issues concern compliance with both technology-based and water-quality-based NPDES permit requirements as well as monitoring and compliance considerations. To address these issues, EPA formed the CSO Task Force in August 1990. The Task Force had its initial meeting on September 26, 1990. Task Force members include representatives from a number of EPA's Office of Water program areas, from EPA Regional Offices, and from the States of New York, Michigan, and Washington.

To assist EPA and State NPDES permit writers in drafting and issuing technically and legally defensible permits for CSO discharges, EPA is developing a guidance manual for permit writers. EPA expects that a

John Thelgard

Most combined sewer overflow discharges are not currently addressed by the NPDES permit system.

draft of this manual will be available in the fall of 1992.

NPDES Stormwater Controls

Since 1972, State and EPA efforts under the NPDES program have traditionally focused on controlling pollutant discharges from POTWs and industrial process wastewaters. As these sources of pollution came increasingly under control, the need for controlling pollutants in stormwater point source discharges became more critical to efforts to achieve the goals of the CWA. As reflected in this report, stormwater discharges from a variety of sources, including storm sewers discharging urban runoff, feedlot runoff, construction site runoff, runoff from resource extraction activities, and runoff from land disposal sites are major sources of use impairment. In addition, man-made stormwater drainage systems can directly or indirectly cause hydromodification impacts.

Prior to enactment of the Clean Water Act amendments of 1987, EPA had promulgated effluent guideline limitations for stormwater discharges from a number of industrial categories, including petroleum refineries, certain mining activities, and large feedlots. Section 405 of the CWA amendments established a timetable and framework for EPA to address other stormwater discharges under the NPDES program by adding Section 402(p) to the CWA. On November 16, 1990, EPA promulgated permit application requirements for discharges from municipal separate storm sewer systems serving populations of 100,000 or more and for stormwater discharges associated with industrial activity. In the November 1990 notice, EPA initiated permitting activities for stormwater discharges from a number of industrial sources, including manufacturing facilities, mining activities, oil and gas facilities, certain construction activities, and land disposal sites that received hazardous and/or industrial wastes. EPA is required to develop two stormwater reports to Congress. The first should identify stormwater discharges and determine, to the maximum extent practicable, the nature and extent of pollutants in such discharges. The second study should establish procedures and methods to control stormwater discharges to the extent necessary to mitigate impacts on water quality. Based on the two studies, EPA is required to issue regulations no later than October 1, 1992. These regulations are to designate additional stormwater discharges to be regulated to protect water quality and establish a comprehensive program to regulate such designated sources, including requirements for State stormwater management programs.

The November 16, 1990, regulations subject a wide variety of stormwater discharges to the NPDES program. Sources addressed by these regulations correlate well with a number of major pollution sources identified in this report. Major classes of diffuse sources that include, in part, stormwater point source discharges are: urban runoff conveyances, construction sites, resource extraction sites, and land disposal facilities. EPA is evaluating additional stormwater discharges in the context of the two stormwater studies, including additional municipal separate storm sewer systems (which contribute to urban runoff) and animal feedlots (which contribute to agricultural runoff). The ability of this new program to address priority sources will depend on a number of factors, including funding to EPA and authorized NPDES States.

Control of Bioconcentratable Contaminants

Bioconcentratable contaminants can cause adverse human health and aquatic life impacts. In response, EPA has developed draft guidance to identify and, where necessary, control bioconcentratable organic compounds that may be present in effluents, nonpoint source runoff, receiving waters, sediments, dredged material, and the tissues of aquatic organisms.

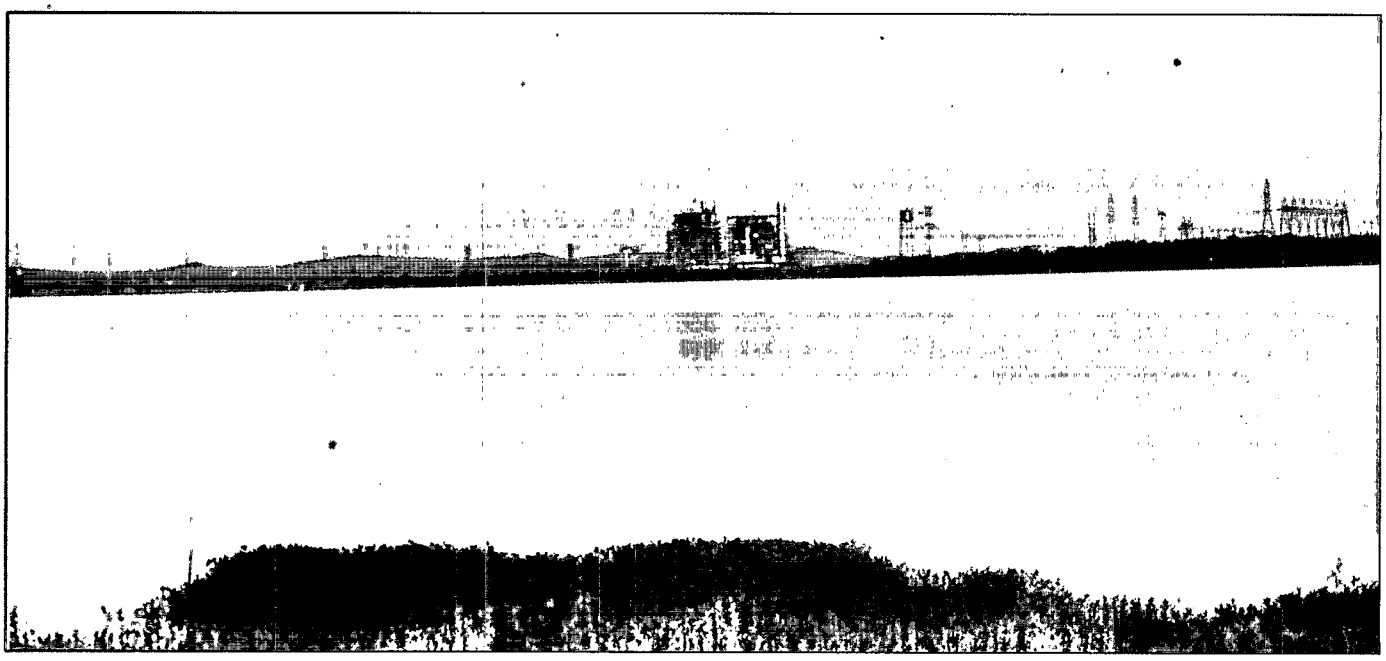
The approach outlined in EPA's draft guidance is designed to assist regulatory authorities in discovering the presence, identity, and concentration of specific organic compounds in complex mixtures and to make more informed decisions with regard to controlling these substances. EPA's approach provides: a comprehensive screen for organic chemicals that are likely to bioconcentrate, procedures for assess-

ing and controlling complex mixtures, a standardized assessment methodology, and triggers for regulatory action and control development. EPA's new draft guidance focuses principally on the development and implementation of point source limitations on bioconcentratable organic compounds.

Pollution Prevention

EPA has established an Office of Pollution Prevention that works with other program offices to improve pollution prevention activities within the Agency. For example, an Agency pollution prevention policy is being developed, and a strategy to address pollution prevention in manufacturing and chemical use has been drafted. Future strategies will focus on the municipal water and wastewater, agricultural, energy, and transportation sectors. A subcommittee comprising representatives from EPA Headquarters and Regions has been formed to develop an Agency-wide training strategy to ensure that pollution prevention concepts are integrated into all Agency activities.

In terms of the point source control program, the Agency's draft pollution prevention strategy recognizes the importance of permitting and enforcement activities and will continue support for a strong program in these areas. Training is being provided to familiarize NPDES permit writers with pollution prevention opportunities, how their permit decisions can affect other media, and how to effectively communicate the concept of pollution prevention to industrial managers.



Craig Whitaker

Electric power plant on Lake Graham, Texas.

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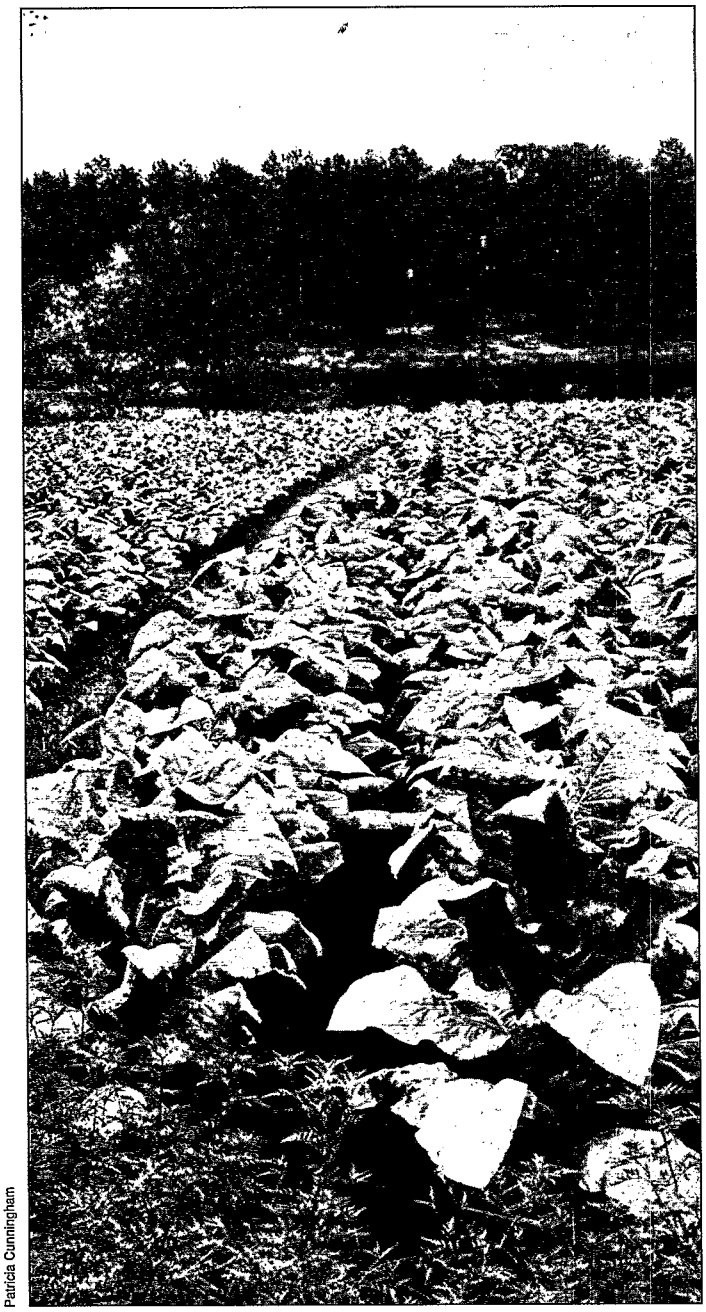


Patricia Cunningham

Nonpoint Source Control Program

Background

Nonpoint source pollution generally results from land runoff, atmospheric deposition, drainage, or seepage of contaminants. Major sources of nonpoint pollution include agricultural runoff, runoff from urban areas, and runoff from silvicultural operations. Siltation and nutrients are the pollutants responsible for most of the nonpoint source impacts to the Nation's surface waters. These diffuse sources are often harder to identify, isolate, and control than traditional point sources. As a result, from 1972 to 1987, EPA and the States placed primary focus on addressing the obvious problems due to municipal and industrial discharges: permitting point source discharges, then inspecting, monitoring, and enforcing those permits to ensure that point sources met the Clean Water Act's requirements.

Sections 208 and 303(e) of the Clean Water Act of 1972 established the initial framework for addressing nonpoint sources of pollution. Funds provided by EPA under Section 208 were used by States and local planning agencies to analyze the extent of NPS pollution and develop water quality management programs to control it. Best management practices were evaluated, assessment models and methods were developed, and other types of technical assistance were made available to State and local water quality managers.

The National Section 319 Program

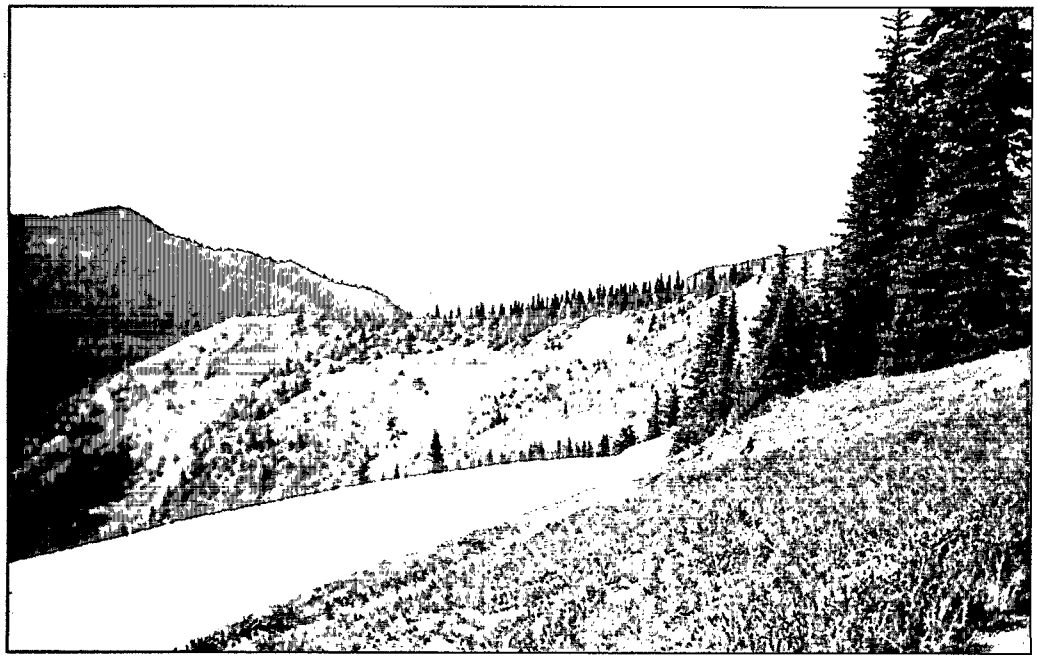
In 1987, Congress enacted Section 319 of the Clean Water Act and in so doing established a national program to control nonpoint sources of water pollution. Section 319 created a three-stage national program to be implemented by the States with Federal approval and assistance. States are to address nonpoint source pollution by (1) developing nonpoint source assessment reports; (2) adopting nonpoint source management programs; and (3) carrying out the management programs.

All States now have EPA-approved nonpoint source assessments. EPA has also fully approved 44 State nonpoint source management programs and has approved portions of all remaining State management programs. Section 319 also provides for the issuance by EPA of grants to States to assist them in implementing the management of EPA-approved programs. Congress first appropriated $40 million in Section 319 grant funds in FY90. This was reduced to about $38 million after budget reductions mandated by the Gramm-Rudman-Hollings Act. In December 1990, EPA issued interim guidance on nonpoint source management, including an allocation formula for awarding grant funds to States. For FY91, Congress appropriated $51 million to carry out the nonpoint source program. This was an increase of one-third over FY90.

EPA issued final guidance on the award and management of these funds in February 1991. The guidance encourages States to focus Section 319 funds on high-priority activities including

- Addressing nationally significant, high-risk nonpoint source problems and focusing implementation activities in priority watershed or ground-water areas;
- Comprehensively integrating existing programs to control nonpoint source pollution;
- Providing for monitoring and evaluation of program effectiveness including using water quality monitoring protocols;
- Emphasizing pollution prevention mechanisms;
- Protecting particularly sensitive and ecologically significant waters (wetlands, estuaries, wild and scenic rivers);
- Promoting comprehensive watershed management.

To improve technical understanding of nonpoint pollution and the effectiveness of various nonpoint source control technologies, the final Section 319 grants guidance establishes requirements for a standardized water quality monitoring program for representative watersheds across the country. The guidance requires each of EPA's 10 Regional offices to award supplementary funds to support more intensive water quality monitoring of selected watershed projects.



Randy Dodd

Upper Big Thompson River watershed, Colorado.

The 1990 Report to Congress on Section 319

The Report to Congress on Section 319 of the Clean Water Act—Managing Nonpoint Source Pollution—provides the most current and comprehensive information, as of October 1, 1990, on nonpoint source programs at the national, State, and local levels. Included are findings of State nonpoint source assessments; related activities of EPA, other Federal agencies, and other entities; achievements to date in controlling NPS pollution; and EPA's recommendations for future directions in controlling NPS pollution.

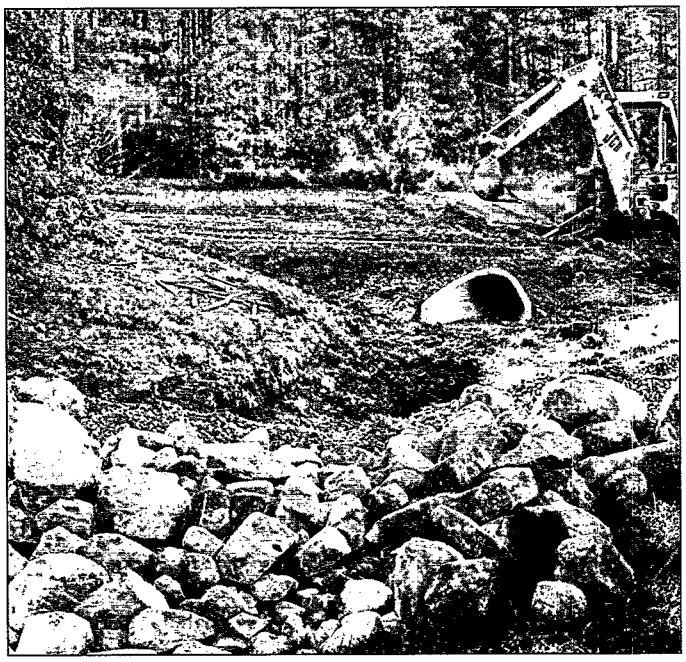
National NPS Agenda

In January 1989, EPA developed the *Nonpoint Source Agenda for the Future*. This Agenda is designed to assist EPA in defining the goals of the NPS program and the means to achieve those goals.

The goal of the Agenda is to protect and restore the quality of U.S. waters through strong national leadership and by helping State and local governments overcome barriers to the successful implementation of NPS measures. Among these barriers are (1) inadequate public awareness of the nonpoint source problem, (2) inadequate knowledge or inadequate transfer of knowledge about successful solutions to nonpoint source problems, and (3) inadequate incentives to correct nonpoint source pollution.

EPA developed five approaches to pursue the goals of the Agenda. These include raising public awareness of nonpoint source pollution, providing States and local governments with information on nonpoint source solutions and with incentives for their implementation, helping States and localities improve their regulatory capabilities (e.g., by developing water quality criteria and monitoring protocols specifically designed to evaluate control activities), and developing tools needed by States and localities to establish sound water-quality-based nonpoint source control programs.

EPA has made progress in attaining the goals of the Agenda. For example, EPA has initiated the first phase of its public awareness program: a nonpoint source brochure and poster were printed in early 1990, and EPA's *Nonpoint Source Newsnotes* now serves as the primary vehicle for sharing State and local success stories on nonpoint control. EPA also began operation of an electronic bulletin board to support information transfer on issues relating to nonpoint pollution. In addition, in early 1991, EPA's Office of Research and Development established a research agenda to support nonpoint source control efforts.



Jimmy Crawford

Preventing erosion is a major concern during construction activities.

Nonpoint Source Management Programs and Implementation

Many innovative projects have been initiated across the Nation by States, local governments, community groups, and EPA regions to manage nonpoint source pollution problems. The following examples exemplify the diversity of approaches that have been applied to NPS pollution control. In some cases, control is only beginning. In other situations, control measures have been in place long enough to show significant results.

- **Buttermilk Bay, Massachusetts**

Urban runoff poses significant water quality problems for confined estuaries and embayments because of the concentration and variety of pollutants discharging into shellfishing and recreational waters. Development of an urban runoff program was prompted by shellfish closings of Buttermilk Bay.

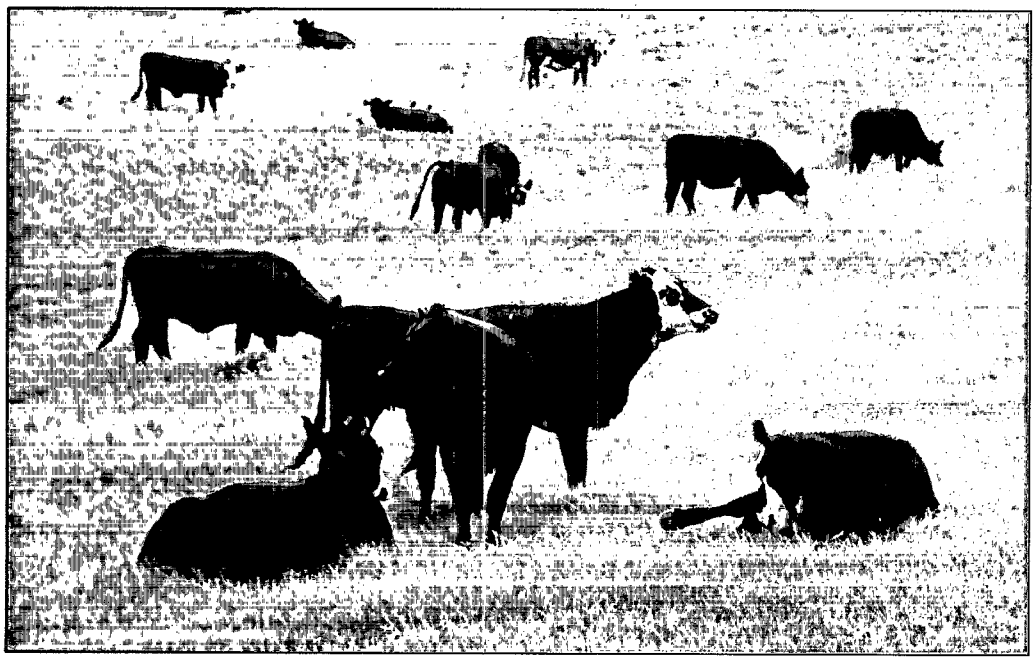
The overall watershed management strategy was

built around the concept of citizen education; that is, information on septic system maintenance, pet control, and proper litter and household waste disposal was distributed. EPA developed a plan for treating storm runoff from the watershed that involved modifying existing catch basin systems and installing an exfiltration system to remove bacteria and other contaminants from the stormwater. Observations suggest that these systems have reduced runoff to the Bay and are successfully removing bacteria from the runoff.

■ **Mammoth Cave/ Karst Area, Kentucky**

A long-range water quality project was started to protect the cave system in Mammoth Cave National Park from agricultural and other sources of nonpoint source pollution. The cave system is threatened by both point and nonpoint pollution that may harm rare cave-dwelling organisms including one federally designated endangered species.

The project was formed at a meeting of State and Federal agency and university representatives in September 1989. Local sponsors subsequently formed a Project Oversight Committee, which in turn established a Technical Advisory Committee. The latter committee selected a target groundwater drainage basin for monitoring and BMP implementation. Near-term activities include establishing a water quality monitoring network, establishing two demonstration farms, and planning and conducting educational activities in the entire project area. The project is partially funded by a USDA grant to install BMPs.



Patricia Cunningham

Cattle grazing at South Point, Hawaii.

■ **Clam River, Michigan**

The Clam River and its tributaries receive significant nonpoint source pollution from nutrients in animal waste, sediments from rural soil erosion, and various contaminants from urban runoff.

The project provides cost-sharing and technical assistance for the implementation of such BMPs as no-till planting, strip cropping, and filter strips. Landowner participation in the cost share program has been excellent. An aggressive information and education program was also implemented. The key to the project's success has been interagency cooperation. The Michigan Clean Water Incentives Program, the Northwest Michigan Council of Governments, and the Northwest Michigan Resource Conservation and Development Council played a significant role in establishing the project. The link to local agencies is provided by the project Steering Committee.

■ **Morrison Lake, Michigan**

The Morrison Lake Project includes a watershed management plan to reduce phosphate loading in the lake by 25 percent over 3 years. The project will identify pollution sources, implement BMPs to reduce sources, and measure BMP efficiency. Conservation plans were prepared for more than 60 percent of the cropland in the district and applied to 15 percent.

Project managers met individually with farmers to provide information and assistance. Project

newsletters stressed the importance of the project to the community and the local newspaper featured the story in several articles.

■ **Minnesota River, Minnesota**

The project is a cooperative local, State, and Federal effort. It will identify those streams that receive the most nonpoint source loading. That information will enable planners to estimate the load reductions necessary to achieve water quality goals and the money needed to achieve these goals. The Minnesota River Assessment Project received a funding commitment of $700,000 for 2 years from the Minnesota Legislature.

■ **Big Springs Basin, Iowa**

The Big Springs Demonstration Project tracks the fate of agricultural chemicals and devises methods to prevent or reduce their movement to ground water and surface water. A consortium of Federal, State, and local government agencies, universities, and agribusiness firms developed the project proposal, and a core group manages and tracks the project activities.

Several State and Federal agencies fund the project. Funds are available under the Iowa Groundwater Protection Act for the Big Spring Basins Project. EPA has funded the project since 1986 and provides support to project areas not covered by State funding.

Over the past 3 years, on-farm demonstrations have shown that the cost of farm inputs can be reduced by $3,000 to $4,000 per year. In early 1989, 52 percent of the farmers involved in the project reported reductions in the use of nitrogen, phosphorus, and potassium fertilizer (39 percent) and a 23 percent reduction in pesticide use. Significantly, these reductions were accomplished with an increase in crop yields.

■ **Oakwood Lakes, South Dakota**

The Poinsett Rural Clean Water Project (RCWP) is the first major national groundwater nonpoint source study to include soil and groundwater monitoring. The 10-year effort, begun in 1981, will determine the effects of agricultural BMPs on ground water and surface water. The emphasis on studying ground-water effects makes the project unique.

BMPs employed in the 106,000-acre watershed consist mainly of conservation tillage, fertilizer management, and pesticide management. These practices focus on the major water quality problems in the watershed, including eutrophication of surface waters and contamination of the aquifer by nitrates and pesticides.

Although a comprehensive report will be developed this year, several earlier findings of the study have resulted in recommendations for action. Three geological settings were related to consistently high concentrations of nitrate as N: (1) shallow sand and gravel with thin topsoil, (2) sand/silt alternating layers, and (3) shallow weathered till. Concentrations of nitrates as N in water samples were greater under farmed sites than under unfarmed sites. Although the fate of pesticides has not been established, there are signs of rapid

Iowa Rural Clean Water Project

Prairie Rose Lake, Iowa.

degradation or dilution below detection levels. Almost 75 percent of the pesticides were detected at the time of, or shortly after, application.

As a result of these findings, the project recommended against combining high fertilization and no-till management in areas where thin soils overlie shallow, unconfined aquifers used for domestic drinking water. To reduce the contamination of shallow aquifers, the project recommends use of fertilizer management systems in areas where there are sand and gravel aquifers overlain by weathered till or thin topsoil.

■ Echo Creek Watershed, Utah

A tributary of the Weber River, which supports a cold water fishery and supplies water to over 500,000 people, Echo Creek is the only uncontrolled stream in the Weber basin. It contributes 70 percent of the sediment entering the Weber River. Extensive hydrologic modification from road and rail construction and poor rangeland condition has resulted in significant erosion. This sediment adversely affects the fishery and drinking water supplies. The USDA, the Utah Department of Transportation, and the Union Pacific Railroad have funded various studies and corrective actions. These have included streambank stabilization, redesign of highway segments, and rangeland improvements.

■ Newport Bay Watershed Management Program, California

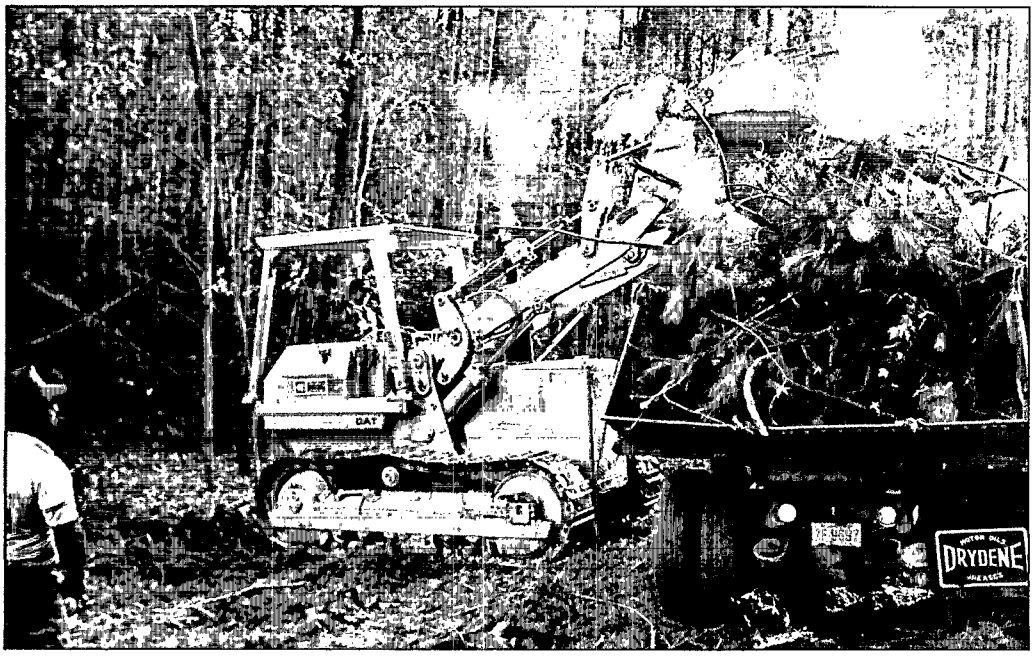
Newport Bay is the largest of Southern California's remaining coastal wetlands. Urban and agricultural runoff is threatening the Bay, which is a designated State ecological reserve.

The Santa Ana Regional Water Quality Control Board has worked closely with other State and Federal agencies to implement a management program that includes construction of vessel pump-out facilities; enactment of ordinances to address marine sanitation in Newport Harbor; dredging controls; creation of an 85-acre sedimentation basin using State, local, and private funding; agricultural erosion controls; channel stabilization; and enactment of more effective erosion control ordinances by the three major local jurisdictions.

■ Truckee River Strategy, Nevada

The Truckee River provides water for numerous uses including: municipal and industrial use in the Reno-Sparks area, power generation, irrigation, and spawning habitat for the endangered Cuiui and the Lahontan cutthroat. The river drains into Pyramid Lake, a major sports fishery and source of income to the Pyramid Lake Paiute Tribe.

The Truckee water quality issues are many and complex and involve a number of Federal, State, and local governments, private firms, and individual water users. The Truckee is listed as water quality limited for nitrogen, nitrite, phosphorus, and fecal coliform on several of its reaches. EPA has required the State to perform a wasteload allocation and determine total maximum daily loads for these constit-



Jimmy Crawford

Deforestation from increasing urban construction can result in sediment runoff into surface waters.

uents. The sources of the loadings are disputed and a strategy has been devised to document the sources and allocate loading reductions fairly among the affected parties.

The strategy involves calibration of the Truckee River model, collection and evaluation of data, evaluation of sources and loads using monitoring data, and amendment of the Washoe County 208 plan to include a new nonpoint source assessment in Truckee Meadows. Other actions include updating of the Sparks and Washoe County land use plans, evaluation of projected urban stormwater loadings and agricultural runoff wasteloads, construction of a pond system for flood control and stormwater detention, and channel improvements at Brookside Golf Course to reduce nonpoint source pollution.

New Initiatives in NPS Control

The 1990 Farm Bill

The Food, Agriculture, Conservation and Trade Act of 1990 (1990 Farm Bill), enacted by Congress on October 25, 1990, contains strong water quality provisions and offers new opportunities to link USDA and EPA water quality programs in the States. The bill, hailed by many as the most environmentally sound agricultural legislation ever passed by Congress, builds on existing USDA and EPA efforts, broadens the applicability of the Conservation Reserve Program (CRP) to environmentally sensitive areas and establishes a new Wetland Reserve Program (WRP) and Water Quality Incentives Program (WQIP).

The CRP, created by the 1985 Farm Bill, has paid producers to remove highly erodible cropland from production for a 10-year period to protect and improve soil and water resources. The 1990 Farm Bill expands the land eligibility requirements to include not only highly erodible land, but also other cropland areas that reduce water quality impairments or improve wellhead protection. Priority will also be given in the bid evaluation process to producers offering filterstrips, sod waterways, shelterbelts, and contour grass strips, which increase water quality benefits under the CRP.

The Act also established a Wetland Reserve Program with an enrollment goal of up to 1 million acres. Land accepted into the WRP would be removed from production through easements.

The WQIP is another feature of the 1990 Farm Bill that addresses nonpoint source pollution and supports State ground-water programs. The WQIP allows the USDA to provide technical assistance and up to $3,500 in incentive payments to individual producers to develop and implement farm-level water quality plans. An additional $1,500 in cost-share payments is available to individual farmers to implement some practices.

Lands identified by States under the Wellhead Protection provisions (Section 1428) of the Safe Drinking Water Act and Section 319 of the Clean Water Act are explicitly targeted under the WQIP. Other areas targeted are endangered or threatened species habitat areas and areas of karst topography, which are particularly vulnerable to seepage of contaminants.

In addition to the WQIP and CRP, the Farm Bill contains provisions for coordinating USDA programs with State water quality programs, greater flexibility to allow crop rotations, an environmental easement provision, and sustainable agriculture research and education programs. Other environmental features include modifications to swampbuster, pesticide recordkeeping for certified applicators, and an organic food certification program.

The Coastal Zone Management Reauthorization Amendments of 1990

Congress also enacted the Coastal Zone Management Reauthorization Amendments (CZMARA) of 1990, which contain a new Section 6217 entitled *Protecting Coastal Waters*. Section 6217 requires each coastal State (including the Great Lakes States) with an approved Coastal Zone Management Program to develop a new Coastal Nonpoint Pollution Control Program.

These programs will become amendments to both the State's existing Coastal Zone Management Program (prepared pursuant to the Coastal Zone Management

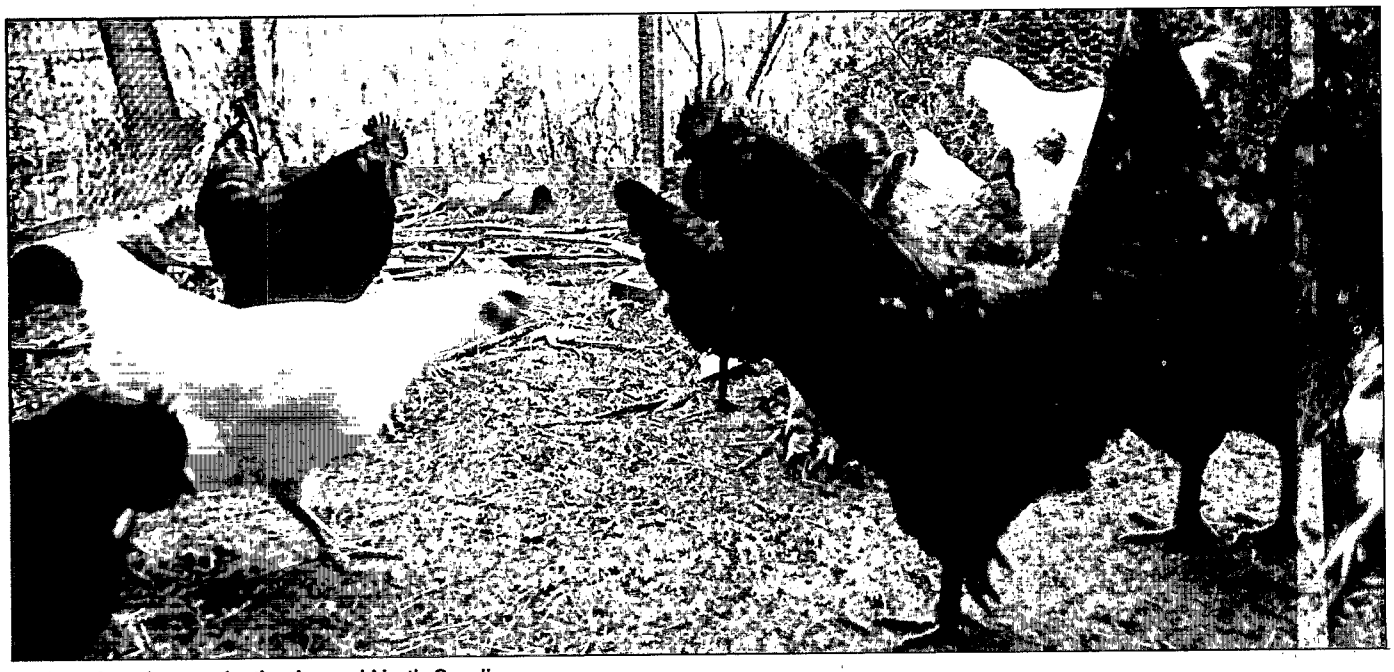
Act) and the Nonpoint Source Management Program (prepared under Section 319 of the Clean Water Act).

The CZMARA legislation further provides that States' Coastal Zone Management Programs must contain enforceable policies and mechanisms to implement the applicable requirements of the States' Coastal Nonpoint Pollution Control Programs.

A key provision of the legislation is the requirement that State Coastal Nonpoint Pollution Control Programs *"develop and implement management measures for nonpoint source pollution to restore and protect coastal waters working in close conjunction with other state and local authorities."* Guidance "for specifying management measures" will be prepared by EPA, in consultation with the National Oceanic and Atmospheric Administration of the Department of Commerce, the Fish and Wildlife Service of the Department of the Interior, and other Federal agencies. The proposed guidance was issued in May 1991 (56 *Federal Register* 27618).

Proposed technical guidance will form the basis for management measures required by Section 6217 of CZMARA. Based on comments received on the proposed guidance, EPA will issue final management guidance in May 1992.

EPA and NOAA will issue joint guidance to assist the States in developing coastal nonpoint pollution control programs that incorporate management measures in conformity with those specified in EPA's technical guidance. Coastal nonpoint control programs must be submitted by the States to NOAA and EPA for approval by both agencies within 30 months of issuance of the management measures guidelines. Draft program guidance was published in October 1991.



Julie Dufflo

Backyard poultry production in rural North Carolina.

11

NC Division of Environmental Management

Surface Water Monitoring

Introduction

Under various sections of the Clean Water Act (primarily Sections 106, 204(j), 314, 319, and 320), States receive Federal grants to conduct water monitoring and report the results of their monitoring activities to EPA. EPA, in turn, establishes national policy on monitoring, provides technical guidance and support to the States, sponsors special studies on issues of concern, and reports to Congress on the findings of the State monitoring efforts. Other Federal agencies such as the U.S. Geological Survey (USGS) and NOAA also conduct surface water monitoring and maintain networks of sampling stations. The roles and objectives of the various agencies engaged in water monitoring are discussed here, along with the challenges facing water monitoring in the 1990s, and new initiatives underway or planned to meet those challenges.

What Is Monitoring?

There are essentially two major types of water monitoring: source monitoring and ambient monitoring.

Source monitoring involves assessing the composition of effluents from industrial or municipal dischargers and of the mixing zones where effluents merge with receiving water. Source monitoring includes self-monitoring by dischargers, compliance sampling inspections that check on discharger self-monitoring, and characterization studies used by EPA to determine typical constituents of specific types of industrial dischargers.

Ambient monitoring

involves assessing the quality of the aquatic environment beyond the immediate influence of the discharge. It can include sampling of water chemistry, biology, habitat, sediment, or fish tissue and may be conducted through networks of fixed sampling stations, localized intensive surveys, or statistically designed special studies. In their ambient monitoring programs, States most often combine fixed-station networks with intensive surveys.

Roles and Objectives

Surface water monitoring serves different purposes, depending on the needs of the individual agencies that conduct or sponsor it.

State monitoring activities funded by EPA have traditionally focused on

- Characterizing the quality of State water resources and identifying problem waters (such as waters that do not meet standards or waters threatened by nonpoint source pollution);

- Supporting the development of water quality management priorities, plans, and programs (including developing water quality standards and providing data for nonpoint source management plans and wasteload allocation modeling); and

- Evaluating the effectiveness of control programs (such as "before-and-after" studies to document the impacts of wastewater treatment plant construction and upgrade, or watershed monitoring to determine the effects of nonpoint source management practices).

State monitoring capabilities vary, but most States sample the water column and fish tissue and conduct biological surveys; fewer States conduct sediment monitoring.

USGS operates a national network of fixed stations concentrated at the mouths of large rivers. The objectives of this program, called the National Stream Quality Accounting Network, or NASQAN, are to assess water quality trends and determine mass loadings of selected constituents in the water column. USGS has also developed the National Water Quality Assessment Program (NAWQA) to conduct status and trends assessments for 60 surface and ground-water systems.

NOAA maintains a 10-year status and trends network for toxics in estuaries and coastal waters. The program monitors sediments, fish tissue, and mollusks for trace elements, organochlorine compounds, and aromatic hydrocarbons.

The U.S. Fish and Wildife Service conducts the National Contaminant Biomonitoring Program aimed at determining status and trends in contaminant levels for fish and wildlife. Fish and bird tissue is monitored for trace elements, pesticides, and some industrial compounds.

An Evolving Program

Today's surface water monitoring program is evolving in response to a variety of new challenges and data needs.

First, as this report notes,

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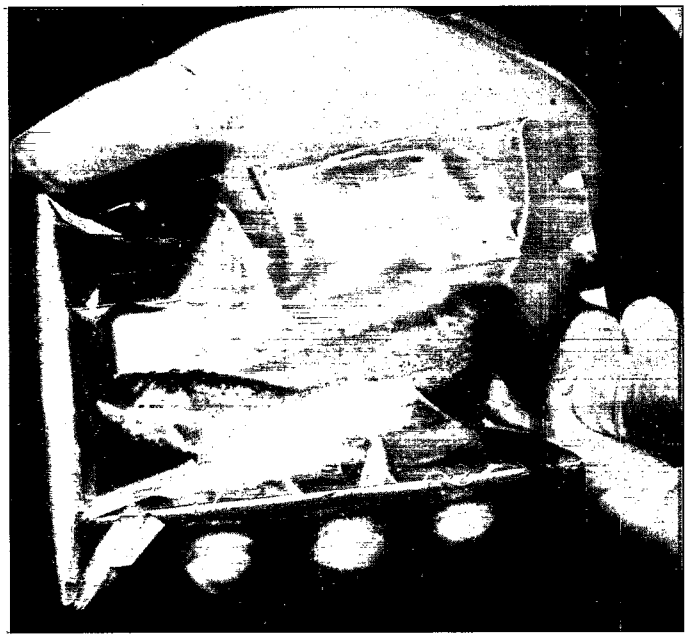
State pollution control biologists seine a creek to evaluate a representative sample of the aquatic life.

the water pollution problems in the U.S. have changed as we have made progress in cleaning up conventional pollutants from sewage treatment facilities and industries. Pollution from diffuse sources such as agricultural runoff, construction activities, and urban areas is now the predominant concern in waters across the country, and today's monitoring program must adapt and develop new approaches to address this concern.

Second, while demands for information are up, monitoring resources at the State level are down. States must juggle competing priorities and increasingly limited funds to carry out their water pollution control activities; in many cases, monitoring programs are being scaled back or directed toward new, more cost-effective activities. It is clear that improved, integrative assessment methods and data management approaches such as biological monitoring, habitat assessments, and geographical information systems are of benefit to today's monitoring programs.



J. W. Crawford

Chemical assessments of fish tissue are a key tool in identifying pollution due to toxicants.

Third, current monitoring activities overseen by the EPA are limited in their ability to provide information on national status and trends and program effectiveness. Monitoring data reported by the States and incorporated into this National Water Quality Inventory report are best seen as providing a snapshot of water quality conditions in individual States. Valid national conclusions are difficult to make, and comparisons between States or trend evaluations over time are virtually impossible to develop. This situation results in large part from the design of State monitoring programs—of necessity biased toward identifying problem areas, and reflecting the capabilities and objectives of individual States. Although various monitoring programs managed by other Federal agencies collect data that can be used for status and trends, a lack of coordination between agencies at all levels of government creates difficulties in developing programs that will support one another and share data.

To meet these challenges, EPA is working in cooperation with States and other Federal agencies to forge a new direction for surface water monitoring. Activities underway can be grouped into the following five categories.

1. Defining a mission and establishing policy on monitoring and the use of monitoring data. Statements of policy provide focus to the wide range of State and Federal monitoring activities, guide the development of new methods, and encourage their implementation. The following statements of policy are currently being developed by EPA's Office of Water:

■ *Surface Monitoring Mission Statement:* EPA is developing a Monitoring Mission Statement to provide an overall framework or vision for the surface water monitoring program. Development of the Mission Statement began in response to a decline in monitoring resources and a need for better coordination of water monitoring activities. The Mission Statement will describe the three overall objectives of monitoring, set out optimal program designs for each objective, describe the status of current monitoring activities, and present potential solutions.

■ *Policy on Biological Assessments and Criteria:* To help restore and maintain the biological integrity of the Nation's waters, EPA has established a statement of policy endorsing the use of biological assessments and urging their integration with toxicity testing and chemical assessment methods. This policy recognizes that each approach provides a unique and valid assessment of designated use impairment and should be applied independently in water quality assessments. The value,

application, and conduct of biological surveys are discussed. In addition, the policy supports the development and implementation of biological criteria in State water quality standards.

2. Developing and implementing technical monitoring methods (e.g., for biological assessments) and technical guidance on monitoring program design. In its role of providing technical assistance and guidance on surface water monitoring, EPA's Office of Water has developed the following documents:

■ *Rapid Bioassessment Protocols*: In 1989, EPA's Office of Water issued protocols providing States with biological monitoring methods to supplement traditional, instream chemical analyses. The key concept underlying these protocols is the comparison of the structure and function of the aquatic community at a given stream study site to that of an ecological reference site. On the basis of this comparison, a water quality assessment can be made. The protocols also include methods for assessing the quality of the aquatic habitat at the stream site.

EPA has provided technical support and training to States to encourage the implementation of the rapid bioassessment protocols. Supplemental guidance is being developed to aid States in adapting the river protocols to fit the variety of ecological regions in the U.S. In addition, rapid bioassessment methods are being developed for estuarine waters.

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Rapid bioassessment protocols provide States with methods to compare the structure of aquatic communities at a given stream site with an ecological reference site.

■ *National Estuary Program Monitoring Guidance:* EPA is developing guidance on the design, implementation, and evaluation of estuary monitoring programs required under Section 320 of the Clean Water Act. The guidance document identifies the major steps involved in developing and implementing estuary monitoring programs, documents existing monitoring methods, and describes their use in monitoring the effectiveness of estuarine management actions. Case studies of existing programs are included.

■ *Section 305(b) Reporting Guidelines:* EPA has established a State-EPA 305(b) Consistency Workgroup to evaluate problems of consistency in water quality assessment and reporting under the Section 305(b) process. In 1991, this workgroup recommended specific improvements to the biennially issued reporting guidelines to States. Guidelines for the 1992 305(b) reporting cycle contain these recommendations, including specific guidance on the interpretation of chemical monitoring data and the use of additional measures such as fishing restrictions and trophic status data for lakes.

■ *Guidance on Planning and Implementing Volunteer Monitoring Programs:* In recognition of the value of volunteer water monitoring and to encourage the development of carefully planned volunteer programs that work in conjunction with State water quality agencies, EPA developed a volunteer water monitoring guide for State managers. This guide provides specific steps for planning, implementing, and maintaining a volunteer water monitoring program, and includes sections on quality assurance/quality control (QA/QC), data management and presentation, and funding.

■ *Nonpoint Source National Monitoring Program:* EPA is developing a national monitoring database designed to provide information on the success of nonpoint source pollution control activities. To be included in the database, projects must have ambient monitoring of chemical, physical, and/or biological/habitat conditions; the monitoring must be part of a rigorous nonpoint source abatement program with well-defined goals and objectives. Each of the 10 EPA

Regions are to allocate a portion of the Section 319 grant funds for these projects. Data provided through this program will document the effects of well-developed nonpoint source pollution control efforts, provide better understanding of management programs and results, and provide a model for adjusting best management practices, where necessary, to achieve better results.

3. Coordinating and developing programs to determine status/trends and program effectiveness. New long-term monitoring programs and tools are being developed by the EPA and USGS to provide improved water quality information of value to decisionmakers. Coordination among Federal agencies and State water resource managers will help ensure that these programs meet data needs, are not duplicative, and effectively reflect water quality conditions.

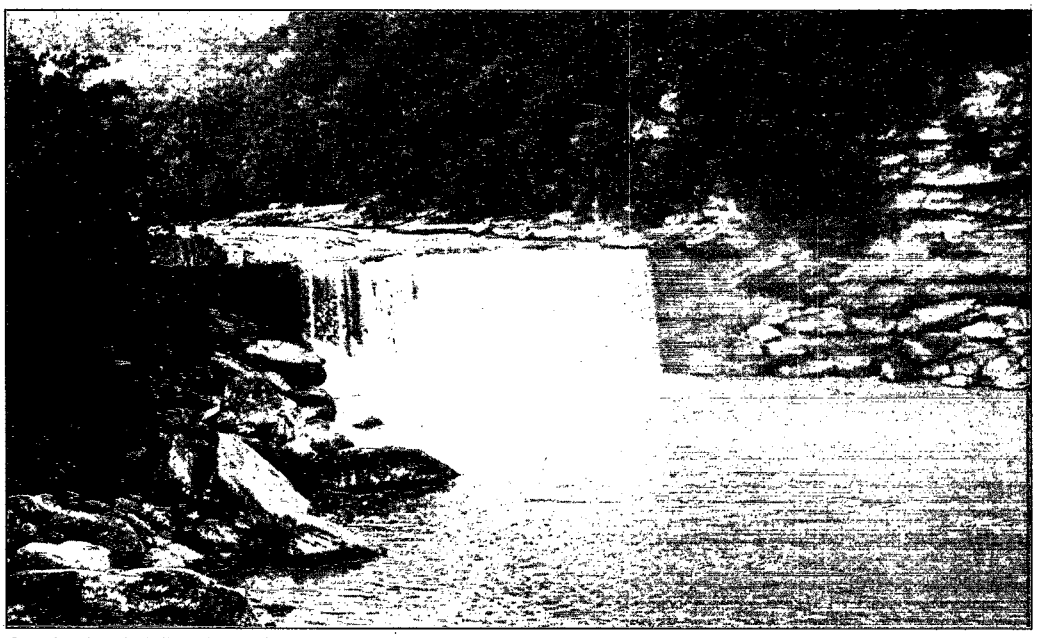
■ *EPA's Environmental Monitoring and Assessment Program:* EPA's Office of Research and Development has initiated a program designed to monitor indicators of the condition of specific ecological resources on a regional basis nationwide. It will describe the current status, extent, and geographic distribution of ecological resources; identify trends in the quality of those resources; identify the likely causes of degradation; and determine the impact of pollution control programs. EMAP is based on a statistical sampling design and adopts a long-term, multiple ecosystem approach. It is also designed to respond to monitoring issues and perspectives that might arise in the future.

■ *USGS NAWQA Program:* The U.S. Geological Survey has developed a multiyear status and trend assessment program. Its goals are to provide nationally consistent descriptions of water quality, provide a baseline for evaluating past and future trends, promote understanding of the factors influencing water quality, and establish the basis for forecasting water quality change and effects of remedial actions. It is concerned with both ground- and surface-water quality; ultimately 60 watershed areas will be monitored intensively under this program.

■ *Environmental Indicators:* EPA is researching and testing a proposed set of environmental indicators to be incorporated into water quality monitoring and assessment programs. The goal of this project is to promote the use of indicators that measure environmental progress, highlight remaining areas of concern, and characterize the range of impacts in the Nation's waters.

4. Modernizing and improving data management capabilities of State and Federal agencies. A variety of water quality data systems are available to State and Federal agencies for data storage, analysis, management, and reporting. A continuing effort is underway to ensure that these data systems are modernized and best meet the needs of the user community.

■ *EPA Section 305(b) Waterbody System:* This data management tool was



Roger Thoma

Cumberland Falls, Kentucky.

designed to track the results of State ambient water quality assessments and to assist States in the reporting of those assessments under Section 305(b) of the Clean Water Act. The Waterbody System (WBS) has been enhanced twice since its development for the 1988 reporting cycle. These enhancements reflect recommendations made by a workgroup of State and EPA WBS users. Over 40 States, Territories, and Interstate Commissions are currently using the WBS in preparing their biennial Section 305(b) reports.

■ *Water Quality Data Systems Steering Committee:* EPA's Office of Water has organized a Steering Committee for Water Quality Data Systems composed of representatives from EPA's Office of Water, Office of Information Resources Management, Regional offices, and various Federal agencies. The Steering Committee was called together in response to recommendations of an internal EPA 1987 study of the surface water monitoring program. Its purpose is to guide management and development of STORET, EPA's storage and retrieval database for water quality data; oversee Office of Water water quality data management systems; and ensure that EPA and State data management needs are met. The principal functions of the Steering Committee are to facilitate communication, cooperation, and coordination among the various EPA offices, Regions, and other agencies.

5. Increasing available assessment information, encouraging information exchange, and involving the public. EPA encourages States to explore all available sources of water quality information, integrate new sources into their assessment reports where feasible, exchange data and report findings, and engage the public in water quality protection. Many strides have already been made in this area, primarily as part of the nonpoint source and estuarine management programs under Sections 319 and 320 of the Clean Water Act.

■ *Volunteer Water Monitoring:* A 1988 survey of existing citizen volunteer monitoring programs provided ample evidence that volunteer programs can deliver reliable water quality data. EPA supports the development of volunteer monitoring programs that cooperate or work with State water quality agencies and that maintain stringent QA/QC protocols. EPA sees particular value in the use of volunteer-collected data as a screening tool to detect potential problems and as baseline information in waters otherwise unmonitored by States. Volunteer monitoring also serves to educate the public and engage citizens in water quality protection.

As mentioned, an EPA guide for State managers has been developed, and two methods manuals for lake and stream volunteer monitoring are in preparation. EPA also sponsors a volunteer monitoring newsletter, a biennial national symposium, and regional workshops. A number of EPA Regions provide technical assistance to States and groups engaged in volunteer monitoring.

■ *Information Clearinghouses:* Several clearinghouses, electronic bulletin boards, and information updates on water quality activities have been developed by EPA for use by State and local governments, Federal agencies, and the public. These include the Clean Lakes Clearinghouse, a bibliographic database of lake restoration, protection, and management resources; the Nonpoint Source Bulletin Board, designed to provide State and local agencies and the public with timely, relevant nonpoint source information, a forum for open discussion, and the ability to exchange computer text and program files; and a fish advisory bulletin board that will promote information exchange among Federal agencies, various State agencies, and the public. Information updates on State and EPA nonpoint source control activities and water quality monitoring and assessment activities are also available.

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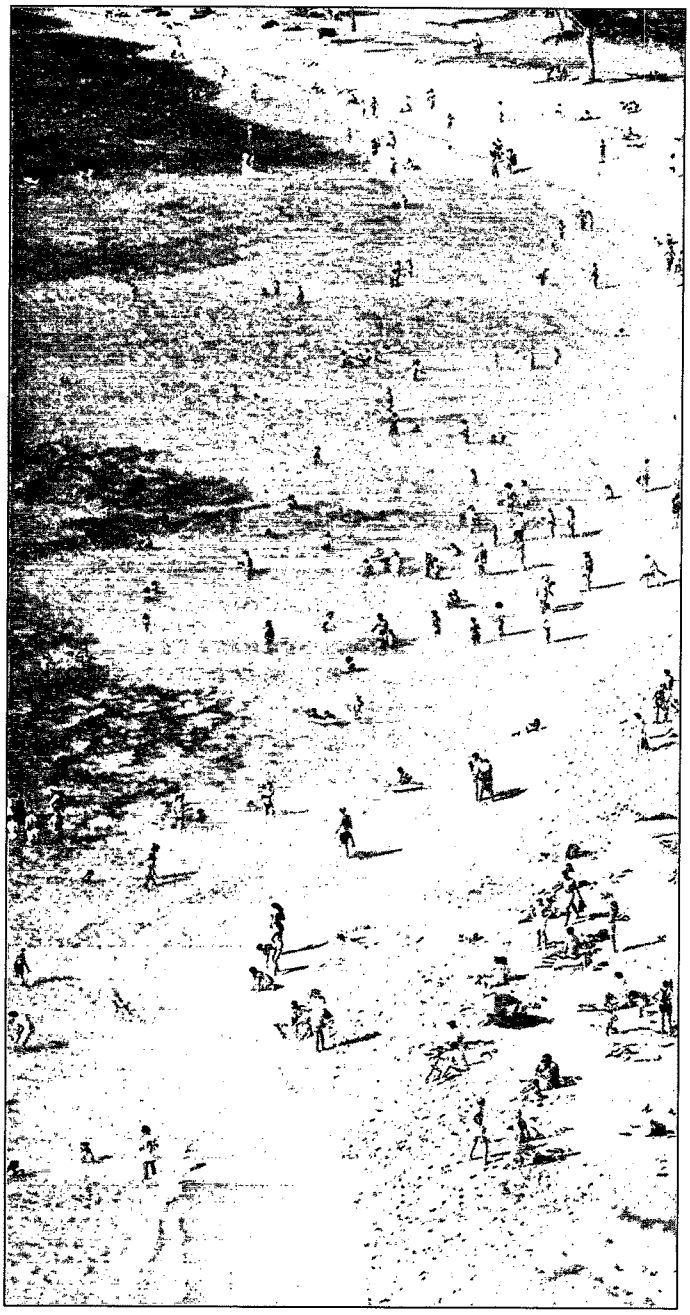


Patricia Cunningham

Costs and Benefits of Pollution Control

Section 305(b) of the Clean Water Act calls for States to prepare estimates of the economic and social costs necessary to achieve the objectives of the Act. States are also asked to report on the economic and social benefits of achieving these objectives. This section draws upon the information submitted by States and Federal agencies concerning the benefits and costs of water pollution control.

This description of benefits and costs is incomplete for a variety of reasons. Information is lacking on the changes in water quality attributable to State water quality programs that might contribute to economic benefits, and information on economic activity associated with changes in water quality is inadequate or nonexistent. Although significant steps have been taken by government and academic institutions to fill these gaps, more information is needed.

An economic framework can prove useful in presenting information on the consequences of actions taken to protect water quality conditions. Using this type of framework, information from disparate sources can be organized and presented so that it will be useful in developing new environmental policies or evaluating the economic efficiency of existing policies.

However, a well-designed economic analysis can require a substantial amount of effort and resources. For example, an analysis for a relatively small watershed, if complete in its characterization of the economic benefits and costs of efforts undertaken to achieve defined water quality standards, can be expensive to conduct and

prepare. For this reason, the EPA and the States have, to date, relied upon existing studies that describe the benefits and costs of pollution control.

Costs

Estimates of the economic costs of water quality programs include expenditures for equipment and personnel used to reduce and treat discharges to waterbodies and governmental expenditures for developing and enforcing water quality regulations. National cost estimates prepared by the EPA are presented in Table 12-1. Only a few States reported their economic costs in their Section 305(b) reports, so there is no breakdown of costs by State or other geopolitical region.

As displayed in Table 12-1, the costs for water pollution control programs constitute the largest portion of water quality expenditures at present (92 percent as of 1987). Surface water quality program costs are those associated with actions taken to meet the Marine Protection, Sanctuaries and Research Act of 1972 and the Clean Water Act as amended in 1987. Water quality programs address both point sources and nonpoint sources of pollution. Point source expenditures are those incurred to control pollutant discharges from industrial and municipal facilities. Nonpoint source expenditures are those incurred to control pollution from sources such as precipitation, land runoff, drainage, and seepage, including agricultural runoff, irrigation return flows, and urban storm drainage. The costs for drinking water programs shown in Table 12-1 are for treating drinking water supplies to improve their quality for human consumption as required under the Safe Drinking Water Act as amended in 1986. The costs of transporting drinking water to consumers is a quantity issue, not a quality issue, so these costs are not included in the table.

Total annual water pollution control costs have increased steadily over time, from about $9.9 billion in 1972 to $37.5 billion in 1987 (in 1986 dollars). The majority of historical point source control costs are public expenditures for sewage services and wastewater treatment and private expenditures for control of industrial effluents and the pretreatment of wastewater discharges to municipal treatment facilities. Annual costs are projected to reach $58 billion by the year 2000 given existing rates of change. However, the value shown in Table 12-1 shows that, to achieve full implementation of the Acts, costs will increase to $64 billion in the year 2000. Most of the increase in the expenditure rate is attributable to additional drinking water regulations and the need to construct additional municipal wastewater treatment facilities.

Economic costs associated with other environmental protection programs can

Table 12-1. Total Annualized Costs of Water Pollution Control in the United States (millions of 1986 dollars)

	Year				
Program	**1972**	**1980**	**1987**	**1995**	**2000**
Water Quality Total	9,110	22,763	34,421	48,193	57,563
Point Source	8,543	22,116	33,642	47,300	56,604
Nonpoint Source	567	647	779	893	959
Drinking Water Total	802	1,982	3,111	5,350	6,571
Total Water	9,912	24,745	37,532	53,543	64,134

Source: Table 3-3, page 3-3, in *Environmental Investments: The Cost of a Clean Environment – A Summary*, USEPA, Office of Policy, Planning and Evaluation, December 1990.

contribute to changes in water quality conditions. For example, improvements in air quality controls can reduce the effects of acidic deposition on affected waterbodies. Measures taken to reduce runoff and leakage from landfills and underground storage facilities can prevent the contamination of surface and ground-water supplies. The regulation of toxic pesticides and herbicides can prevent the deterioration of natural ecosystems and enhance recreational and commercial fisheries. Table 12-2 presents the total annualized cost of environmental protection in the United States. The proportion of these costs that can be directly or otherwise related to water quality improvements has not been computed.

Table 12-3 presents information on water pollution control costs for North Carolina as an example of costs incurred by an individual State. North Carolina was the only State that provided a reasonably broad (though not comprehensive) summary of the costs of its water pollution control activities. Several other States, notably West Virginia and Nebraska, described in some detail the costs of State-administered programs but did not include information on private expenditures. The expenditures in North Carolina are not necessarily representative of expenditures in other States, but the presentation can serve as a useful illustration of the variety of Federal, State, local, and privately funded and administered activities aimed at protecting water quality. An evaluation of the costs listed in the table suggests that the majority of documented costs are municipal and industrial treatment costs (both primarily point sources), whereas agriculture (nonpoint source) and administrative costs are an order of magnitude smaller.

Benefits

The States' 1990 submissions to the EPA have not fully described the economic benefits associated with water quality improvements. States continue to focus their presentations on measurable physical, chemical, and biological changes in water quality and estimated changes in physical loadings from point and nonpoint sources of pollution. Few States have used this information as input into economic models that translate changes in water quality conditions into economic activities (see *Highlight–Economic Analysis of Marine Sportfishing*). Fewer States go the next step and attach

Table 12-2. Total Annualized Costs of Environmental Protection in the United States (millions of 1986 dollars)

	Year				
Program	**1972**	**1980**	**1987**	**1995**	**2000**
Air and Radiation Total	7,934	17,854	27,006	37,151	44,944
Water, Total	9,912	24,745	37,531	53,543	64,134
Land, Total	8,436	13,612	19,092	37,158	46,148
Chemicals, Total	92	889	819	2,472	2,892
Multimedia, Total[a]	108	868	842	2,102	2,298
Total Costs	26,482	57,968	85,290	132,426	162,425
Percent of GNP[b]	0.88%	1.58%	1.92%	2.56%	2.83%

[a]Includes costs not attributable to individual media programs (e.g., EPA management and support, Emergency Planning and Community Right-to-Know Act, and undesignated non-EPA Federal costs).
[b]GNP = Gross National Product, using GNP implicit price index.

Source: Table 2-1, pp. 2-2, 2-3, in *Environmental Investments: The Cost of a Clean Environment – A Summary*, USEPA, Office of Policy, Planning and Evaluation, December 1990.

Economic Analysis of Marine Sportfishing

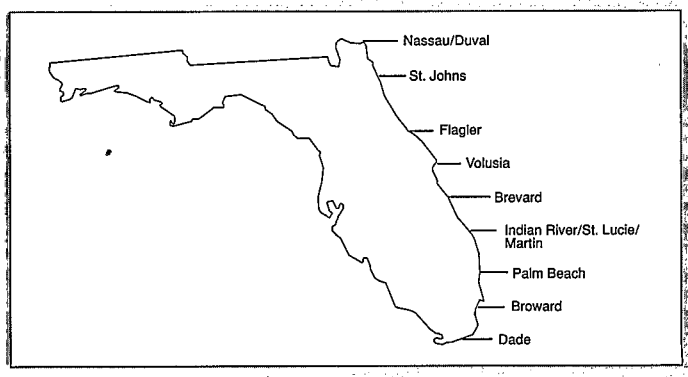
EPA is currently supporting a study with the University of Maryland to develop a database and a methodology for assessing the economic value of access to marine sportfishing and the economic value of changes in the catch rates of various species and species groups. The survey data cover the region from New York south along the coast to south Florida (excluding the Florida Keys). This area encompasses nearly 80 percent of East Coast marine sportfishing participants. It is also an area with active pollution control policies and several management plans involving recreational fisheries. To analyze the effects on recreational fishing decisions of policies to control water pollution, for example, it must be assumed that the policies will first alter fish catch rates (i.e., by improving fish stock size). Fishermen will then respond to the changes in catch rates by altering where they fish, what species they fish for, their fishing mode, and perhaps how often they fish. These behavioral changes can then be linked to dollar measures of the benefits to recreational fishermen of the improved fishing conditions.

The preferred method of analysis adopted in this research is based on the random utility model, which was developed in earlier work under a cooperative agreement with the EPA.[1] In one paper,[2] the model is applied only to Florida fishing sites. This model assumes the decision to go fishing at a site on Florida's east coast and predicts which site the fisherman will select on the basis of the relative attractiveness of the alternatives. These sites are pictured in the figure below.

Using data from the National Marine Fisheries Service (NMFS) survey on species caught, aggregate catch rates are constructed for three fishing categories: big game fish (e.g., billfish, marlin, and tuna), small game fish (e.g., bluefish, mackerel, and sea trout), and bottomfish (e.g., sheepshead, snapper, and grouper). Catch rate is defined as the mean number of fish of a species group caught per trip at the site. The catch rates vary by time of year and by fishing mode (i.e., shore or boat).

Dollar benefit estimates were calculated for three distinct scenarios. The first involved an increase in the small game fish catch rates for both modes and all sites by 20 percent. This would increase the sample average benefits associated with each fishing occasion by $0.33. A similar increase in catch rates for bottomfish by boat fishermen would be $1.27 per choice occasion. Finally, the average dollar benefit from a 20 percent increase in the catch rates of big game fish would be $1.56 per trip.

The more detailed report, which is forthcoming from the University of Maryland, will include all of the regions covered by the survey. Thus, it will permit additional regional analyses such as the one discussed here, but the more detailed model will also demonstrate, for example, how changes in the Florida fishery affect fishing behavior in the Chesapeake Bay region.



Recreational Fishing Sites Modeled for Florida.

[1] N. E. Bockstael, W. M. Hanemann, and I. E. Strand, 1989. Measuring the Benefits of Water Quality Improvements Using Recreation Demand Models, Vol. 2 of *Benefits Analysis Using Indirect or Imputed Market Methods*, EPA Report #230-10-89-069 and NTIS #PB-90-134669.

[2] N. E. Bockstael, K. E. McConnell, and I. E. Strand, 1989. A Random Utility Model for Sportfishing: Some Preliminary Results for Florida, *Marine Resource Economics*, 6:245-260.

Table 12-3. Costs of Water Pollution Control Activities in North Carolina[a]

Category of Expenditures/Source of Funds (where available)	Years Data Available (thousands of dollars)	
MUNICIPAL COSTS	**FY1988**	**FY1989**
– Capital Investment in Municipal Wastewater Treatment Facilities		
– Total Federal funds (EPA and other Federal agencies)	52,800	444,500
– Total State funds (Water Bond Acts and Revolving Loan and Grant Act sources)	3,890	8,800
– Total local funds (matching funds and other sources)	84,700	50,000
INDUSTRIAL COSTS	**FY1986**	
– Capital Expenditures for Manufacturing Firms of 20 or More Employees		
– End-of-line treatment	13,900	
– Change in production process	1,700	
– Operating Costs for Manufacturing Firms of 20 or More Employees		
– Water pollution abatement operating costs	90,000	
– Payments to government units for sewerage services	35,800	
AGRICULTURAL COSTS	**FY1988**	**FY1989**
– Best Management Practices		
– State funds granted to farmers	6,060	6,456
– Estimated minimum matching funds invested by farmers	2,000	2,132
– Technical Assistance		
– State funds granted to local governments	483	970
– Estimated minimum matching funds from local governments	1,712	3,057
ADMINISTRATIVE COSTS	**FY1988**	**FY1989**
– Department of Environment, Health and Natural Resources		
– Division of Environmental Management		
• Surface Water Quality Section	6,410	7,327
• Groundwater Section	2,446	2,771
• Construction Grants and Loans Section	1,636	1,473
• Laboratory Section (Surface and Groundwater)	1,363	1,339
– Division of Land Resources (includes Sedimentation and Erosion Control budget and most of Mining Branch)	1,500	1,500
– Division of Soil and Water Conservation		
• Agricultural Cost-Share Program Section	154	218
• Watershed Planning Section	86	90
• Wetlands Inventory Section	34	36
– Pollution Prevention Program	388	488
– Division of Environmental Health (onsite sewage collection, treatment and disposal program)	420	420
– Division of Water Resources		
• Aquatic Weed Control Program	63	66
• Stream Watch Program	22	23
• In-stream Flow Studies	39	41

[a]As noted by the authors, these figures do not represent a comprehensive list of all water pollution control expenditures in North Carolina. Some major categories excluded include operation and maintenance expenditures for municipal wastewater and treatment; capital and operating expenditures for drinking water treatment; other State environmental programs supporting water quality protection; and other Federal, State, local, and private initiatives.

Source: Adapted from tables on pp. 140-143 in Chapter Three, *1988 North Carolina State 305(b) Report,* 1990.

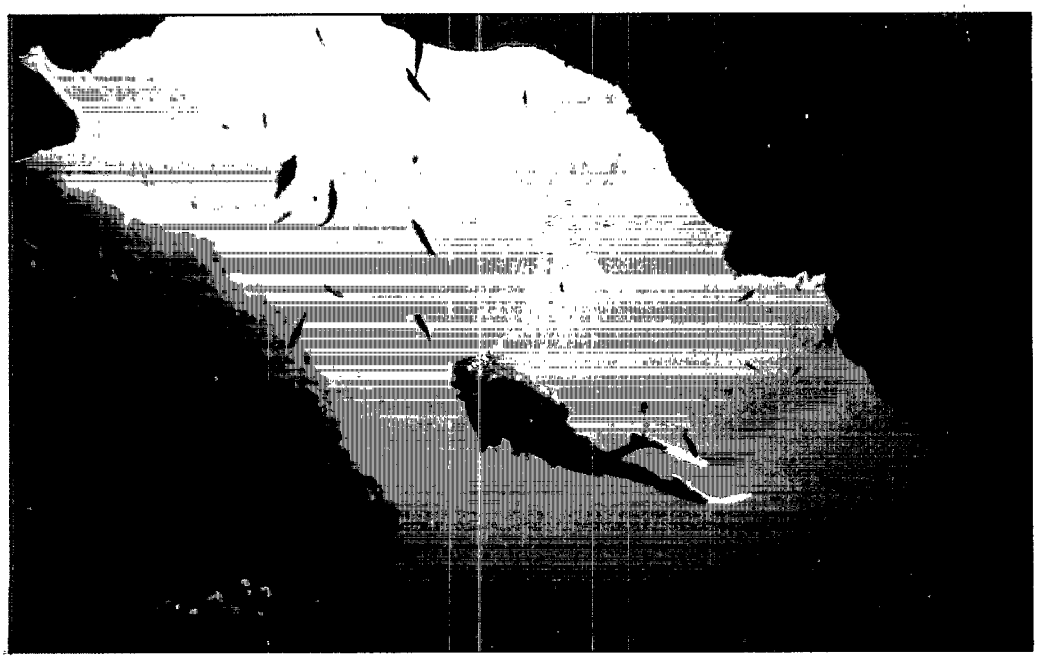
values to these economic activities in a manner that allows for a comparison between the economic costs and benefits.

States reporting on economic benefits limited their discussions to selected local projects involving a single pollutant source or class of sources. This information was typically prepared in support of a local policy decision or as a case study for some larger regional or national issue. As a result, there were no comprehensive economic benefit estimates prepared by an individual State for any category of benefits.

Figure 12-1 attempts to characterize the universe of economic benefit categories associated with water quality conditions. Using this categorization scheme, benefits are divided into two distinct groups: (1) benefits that are not related to current uses by individuals, and (2) benefits associated with current uses by individuals. The first category is designed to capture intrinsic economic values that may arise from bequest or stewardship motivations, for example. To illustrate, individuals may wish to secure a satisfactory level of water quality in a lake for their use in the future. Thus, they may be willing to pay to maintain the water quality of the lake. Similarly, individuals may be willing to pay to secure the lake's water quality for persons other than themselves, which may extend beyond the existing population and include future generations.

The second category describes the benefits associated with current uses of waterbodies and includes both direct and indirect contributions of water quality to the individual's consumption patterns. Examples of direct effects include the effect of water quality on changes in water-based recreational activities, drinking water supplies, and the supply of commercial fishery stocks. Indirect factors affected by water quality conditions include such items as agricultural irrigation and industrial processes using water as an input to production. In addition, naturally occurring ecosystem processes provide services that both directly and indirectly influence the economic behavior of individuals. Little information has been cataloged on the contribution of ecosystems to the well-being of humans or to productive outputs, but this area of research is likely to grow.

Ideally, State and Federal water quality program benefits should be analyzed and displayed concisely and comprehensively (see Figure 12-1). In fact, few studies succeed in cataloging the full array of benefits associated with water quality programs. Some benefit categories have been the focus of significant theoretical and empirical research, notably recreation, commercial, and municipal drinking water services. Consequently, policymakers' efforts to evaluate the economic benefits of these categories can yield tenable results (although these procedures continue to have their detractors and limitations). Other benefit categories have only recently begun to be explored in depth. As the need to identify the environmental results of government regulations becomes a greater concern, more will be done to extend the current



Paul Goetz

A diver enjoys the pristine beauty of the underwater world, Kona Coast, Hawaii.

I. **INTRINSIC BENEFITS**

A. **No Current Use by the Individual.**

1. **Community Benefits** – Biocentric satisfaction of knowing that an ecological community is sustained for its own sake.

2. **Existence Benefits** – Vicarious enjoyment from the knowledge that other individuals are now using the resource. Stewardship interest in providing a future opportunity for other individuals to use the resource.

B. **Potential Future Use by the Individual**

1. **Option Benefits** – Interest in securing option to participate in an activity or use a resource at some point in the future (i.e., participate in any categories listed below under "**CURRENT BENEFITS**").

II. **CURRENT BENEFITS**

A. **Indirect Use by the Individual (limited physical contact with water or recognition of contribution to environmental conditions).**

1. **Aesthetic Benefits** – Conditions enhance characteristics of current adjoining fixed amenities (e.g., lakeside commercial and residential property).

2. **Recreational Benefits** – Conditions enhance characteristics of current adjoining transitory activities (e.g., hiking, picnicking, birdwatching, and photography).

3. **Structural Ecosystem Benefits** – Conditions maintain functional ecosystem processes (e.g., stable climate, purification of air, land, and water, storm protection).

B. **Direct Use by the Individual (extensive contact with water, and consumption of goods where water is an input to production of the good).**

1. **Recreational Benefits** – Conditions enhance characteristics of current water-contact activities (e.g., commercial and private boating, swimming, and fishing).

2. **Commercial Benefits** – Conditions enhance characteristics of current production processes and activities.

a. **Extractive Commercial Uses** – Production practices where water is a medium for other goods (e.g., commercial fishing, chemical industries, medical industries).

b. **Commercial Navigation** – (e.g., dams, locks, canals, ports).

c. **Agricultural Irrigation** – Water used as input to production of agricultural crops.

d. **Industrial Processes** – Water itself is used as input to production (e.g., processing, cooling, waste disposal, and steam generation).

e. **Municipal Water** – (e.g., water used for drinking, washing, and fire protection).

Source: Adapted from Figure 3-1, page 3-2, in *Benefit-Cost Assessment Handbook for Water Programs, Volume 1*, Research Triangle Institute, prepared for the USEPA, Economic Analysis Division, April 1983.

Figure 12-1. Classification of Economic Benefits Related to Water Quality Conditions

state of knowledge on economic theories and methods useful for calculating benefits.

In the 1990 State 305(b) reports, several States elected to report on water quality improvements and the economic benefits achieved as a result of their efforts. The following examples are intended to demonstrate how States have responded to requests for information on the economic benefits of their programs. These examples are not intended to be representative of conditions within or across individual States during the period 1988-1990. The order of presentation is designed to show a spectrum of sophistication in the use of information and economic theory in the preparation of State benefit analyses. The first examples contain a limited amount of economic information on costs and benefits, whereas the last example makes use of state-of-the-art applied economic techniques to arrive at economic benefits attributable to improvements in water quality. It is hoped that these examples will assist States in preparing future Section 305(b) reports.

■ The Ohio River Commission examined long-term trends in monitoring data for total suspended solids (TSS) and total Kjeldahl nitrogen (TKN) and their relationship with wastewater treatment dollars spent through the Construction Grants Program. In Table 12-4, the category of dollars spent refers to monies allocated from 1977 through 1989 for publicly owned treatment works discharging directly into the Ohio River. The dollar amount may include additional State and local funds as well as monies spent for project planning,

Table 12-4. Wastewater Treatment Systems Expenditures and Ohio River Water Quality Improvements

Ohio River Mile Points	Dollars Spent on Improvement Along Segment ($ million)	Long-Term Trends in Decreasing Concentrations (mg/L/yr)	
26.5 to 40.2	4.5	TSS = 0.04,	TKN = 0.08
43.3 to 86.8	39.8	TSS = no trend,	TKN = 0.06
94.0 to 126.4	56.5	TSS = no trend,	TKN = 0.05
138.2 to 161.8	5.9	TSS = 0.04,	TKN = 0.07
171.0 to 203.9	40.7	TSS = 0.06,	TKN = 0.07
243.0 to 260.0	6.2	TSS = 0.08	TKN = 0.08
269.7 to 279.2	3.9	TSS = 0.07,	TKN = 0.07
308.3 to 350.7	89.3	TSS = 0.03,	TKN = 0.05
356.0 to 408.5	3.4	TSS = no trend,	TKN = NA
417.1 to 462.8	9.2	TSS = no trend,	TKN = NA
464.5 to 490.0	73.3	TSS = 0.03,	TKN = NA
506.0 to 531.5	0.5	TSS = no trend,	TKN = NA
605.2 to 625.2	31.4	TSS = 0.07,	TKN = 0.03
724.0 to 791.5	13.7	TSS = 0.07,	TKN = 0.02
792.5 to 846.0	11.4	TSS = no trend,	TKN = NA
891.5 to 918.5	1.2	TSS = no trend,	TKN = NA
944.0 to 952.3	2.8	TSS = 0.06,	TKN = 0.02

TSS = Total suspended solids.
TKN = Total Kjeldahl nitrogen.
NA = Not available due to insufficient data.

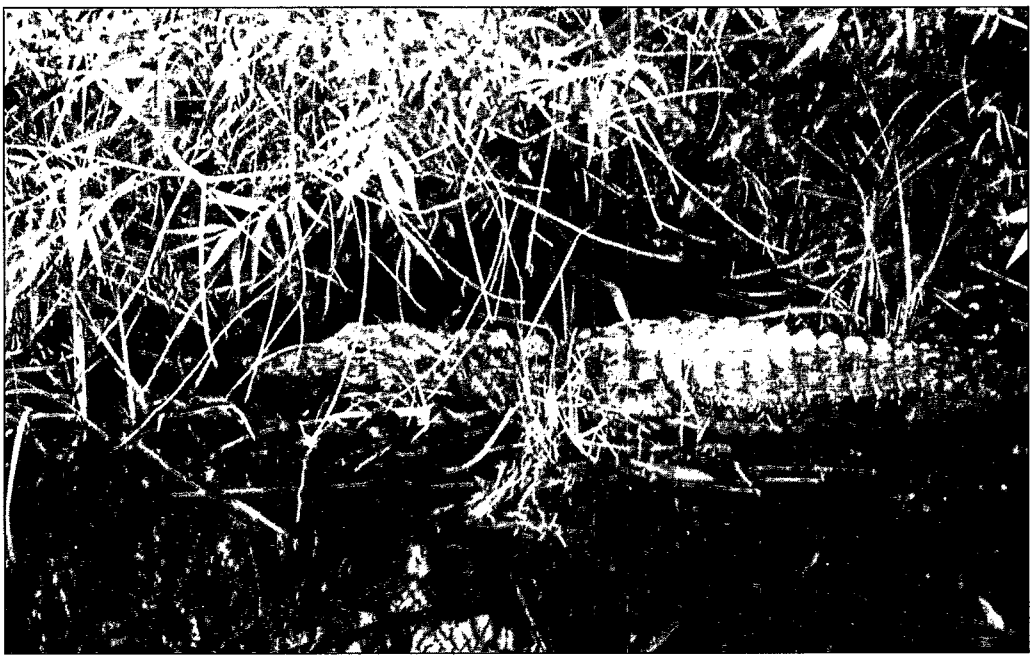
Source: Adapted from Table 30, pages 6-12 to 6-15, *Ohio 1988 Section 305(b) Report*, Ohio EPA, 1990.

collection system improvements, and other areas not directly resulting in improved effluent quality. Further, some monies allocated during this period may not have been spent, while monies allocated prior to 1977 are not reported but may have been spent during the report period. The trend data refer to median decreases in TSS and TKN concentrations measured using the Commission's monitoring program. The table suggests that there may be a relationship between construction expenditures for wastewater treatment systems and Ohio River water quality improvements. However, additional information is needed to prepare a more conclusive statement about the relationship between these expenditures and water quality conditions in the Ohio River.

■ Missouri prepared estimates on the benefits and costs of several different wastewater treatment projects. In this comparison, they elected not to assign dollar values to the environmental benefits, but simply to list them. In most cases, the benefits were described as protecting stream miles, some of which are classified by the State. For the 44 small watershed soil conservation projects, substantial soil conservation benefits resulted. Included were a reduction in sedimentation rates in 11 small drinking water reservoirs and a reduction in concentrations of agricultural chemicals in these same reservoirs. For six coal mine reclamation projects, 20 miles of classified streams were protected and 1,000 acres of land were returned to production.

■ In the District of Columbia, discernible water quality improvements have led to increased use of the Potomac River by the local population. In the 1960s, summer water quality conditions in the Potomac River were unable to support recreational and aesthetic uses. By contrast, the number of boating and water sports events (e.g., rowing, wind surfing) and commercial development along the Potomac today are indicative of the value this resource is capable of delivering. Surveys conducted by the fisheries management program have shown that fishing activity and the number of anglers have increased greatly. In 1988, the District began to require that anglers purchase a license to fish in District waters. In 1989, fishing license registration doubled and is projected to increase an additional 25 percent in 1990.

■ An attempt to analyze the costs and benefits of restoring lake water quality and recreational value through implementation of in-lake restoration practices (e.g., Clean Lakes Program) was undertaken for three project areas in Illinois. Benefits were expected to accrue as a result of better recreational experiences and an increase in the extent of one or more uses. A procedure for calculating increased economic benefit, based on potential "visitor day" estimates, was recommended for use by the U.S. Water Resources Council. The procedure called for assigning points to five general recreation criteria,



Roger Thoma

An alligator in the Florida Everglades.

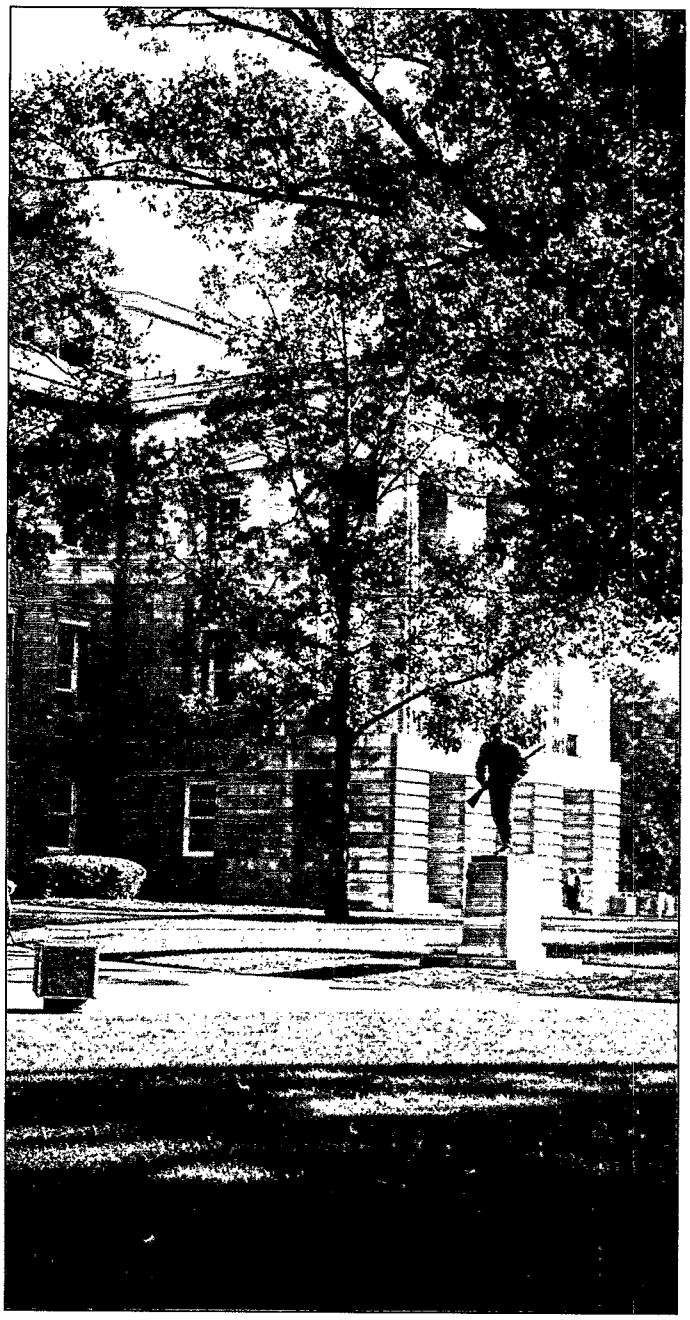
comparing pre- and post-implementation conditions. Criteria included recreational activities, availability of other nearby lakes, carrying capacity, accessibility, and aesthetics. Assigned points were then converted into dollar values. Annual benefits and cost-benefit ratios were calculated. For these three projects, using current discounted cash flow estimates over a 10-year period, the analyses suggested that all three restoration projects had strongly positive benefit-cost ratios.

■ A study was performed for North Carolina's Albemarle and Pamlico Sounds on the economic benefits of recreational fishing due to improvements in estuarine water quality. The researchers employed a travel cost method (a random-utility maximization model) of estimating demands for fishing in the Pamlico Sound and Outer Banks regions separately. The travel cost method uses information on the travel expenditures of recreationists and the characteristics of sites, including water quality, for the unpriced water quality improvements. The research concluded that a 25 percent increase in the fish catch rate (a site characteristic related to water quality) would increase the value to a fisherman of a typical fishing trip by between $10 and $71 (in 1981 dollars). The authors note that the site-specific nature of the analysis, and the nature of economic benefit estimation, warrant additional research before such information can be used in comparison with costs of specific water pollution control programs by State decisionmakers.

Roger Thoma

Boating and other water sports are important recreational benefits resulting from good water quality management.

13



John Thallgard

State Recommendations

In their 1990 reports, 41 States and Territories discussed recommended program actions needed to make additional progress toward the Clean Water Act's goal of fishable and swimmable waters. These recommendations encompass a range of actions at the Congressional, Federal, State, and local levels and are often expressed in terms of State objectives or continuing needs. It should be emphasized that the recommendations discussed here were reported by the States themselves in 1990; this discussion does not attempt to assess their merits. Nor should this discussion be construed as an EPA or Administration endorsement of any State recommendations. Many of the State recommendations for action do, however, reflect current EPA program concerns and priorities.

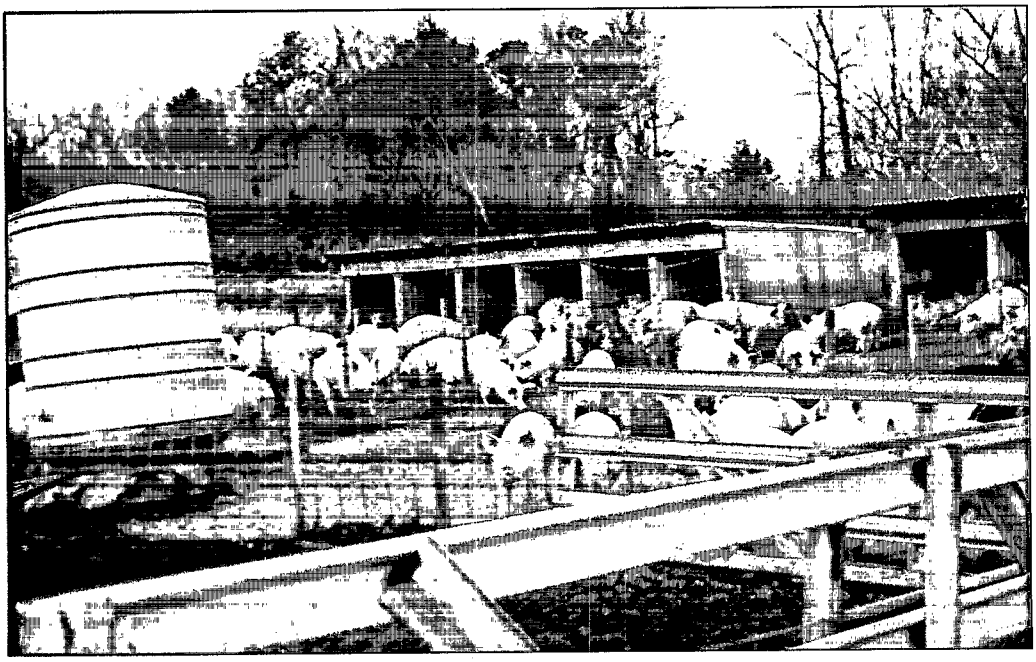
A recurring theme in almost all State recommendations is the need for continued, and in many cases additional, funding to implement ever-expanding State water quality protection responsibilities. For example, Mississippi's 305(b) report includes the following:

> To adequately assess the quality of the State's surface waters and groundwaters requires a significant commitment of human and monetary resources. The ambient surface water monitoring program has historically been focused on conventional physical, chemical, and biological parameters. However, the number of sampling sites, sampling locations, and sampling frequencies are not adequate,

nor are toxic parameters being adequately addressed. In addition, the surface water monitoring needs of programs addressing agricultural nonpoint source pollution, urban stormwater runoff, water quality and sediment contamination below point discharges, and lakes can now only be minimally met, if at all. The State simply does not have the resources to upgrade the monitoring program at present funding and staffing levels.

In general, State recommendations fall into nine major categories. Ranked by the frequency with which they are reported, these categories are nonpoint source abatement, toxics identification and control, water quality monitoring, lake protection, water quality criteria and standards, municipal facilities, ground-water protection, data management/coordination, and wetlands protection. Other toxics less frequently cited by the States include combined sewer overflows and urban stormwater runoff, permitting and enforcement, and estuaries.

Nonpoint Source Abatement: Recommendations most often cited by the States concern the identification, prevention, and control of nonpoint sources of pollution. Most commonly, States cite the need for additional funding for development of better monitoring and assessment methods to detect NPS, assess their impacts, and determine the effectiveness of NPS controls. Identification and regulation of urban runoff was most often cited by States as the NPS area needing additional financial support. (Note that much of urban runoff is discharged in a conveyance that is legally considered a point source and is subject to NPDES stormwater requirements.) Several States also indicate that funding is needed to implement NPS Management Plans and establish action plans for priority watersheds. A number of States cite increased public education on the nature of NPS pollution and NPS controls as a mechanism for encouraging BMP implementation and NPS program funding. Several States suggest EPA should take specific actions with respect to NPS programs ranging from issuing loading limits for NPS pollutants and recommending adoption of more stringent nutrient standards to developing numeric criteria for NPS pollutants.



Virginia Rural Clean Water Project

Feedlots often drain animal waste into nearby streams.

Identification and Control of Toxic Substances: The States strongly recommend expanding efforts to gather data on toxic pollutants and to develop or implement State toxic control programs. Specific recommendations for data collection on toxics emphasize two areas: bioaccumulation of toxics in fish and shellfish tissue and sediment contamination. The States cite a need for the Federal government to provide national guidance on bioaccumulation of toxics in fish tissue including standardizing analytical methods, establishing national risk assessment methodology, and developing standardized procedures for the issuance of consumption

advisories to the public. Funding is requested by several States to initiate or expand their current fish tissue monitoring programs. With respect to sediment contamination, almost half of the States recommend that EPA actively pursue development of a nationwide in-place pollutant program designed to provide both technical guidance and dedicated Federal financial support for expansion of sediment monitoring programs and remediation efforts. In addition, States cite the need for EPA to refine and/or develop national sediment criteria for toxics, particularly heavy metals.

Water Quality Monitoring: Beyond expressing a general need to expand water quality monitoring activities and evaluate them to be certain they are providing needed data, a prominent theme of State monitoring recommendations is to increase the emphasis on instream biological monitoring as an indicator of pollution and pollution abatement. Specifically, States recommend the expanded use of rapid bioassessment techniques and development of biocriteria for making use support determinations. Other monitoring recommendations include seeking increased EPA and State support to expand fish tissue and sediment toxics monitoring programs as well as lake and NPS monitoring efforts.

Lake Protection: The States overwhelmingly recommend that Congress appropriate funds to support the Clean Lakes Program. While about half of the States cite the need for funding to support *ongoing* lake quality assessment programs and restoration efforts, the remainder cite the need for funding simply to *initiate* a viable lake water quality monitoring program. Particularly for these latter States, efforts to collect monitoring data on lake water quality, establish a database for implementation of Phase I and II Clean Lakes Studies, and develop a long-term lake water quality management program have been hampered by lack of available State and/or Federal funding. Overall, the States cite the need for additional data on lake water quality conditions and trends and the increasing vulnerability of lakes to intense development pressures, effects of nutrient enrichment, toxics (particularly heavy metals and pesticides), pathogenic bacterial contamination, and acid deposition as primary reasons for needing strong lake protection programs.

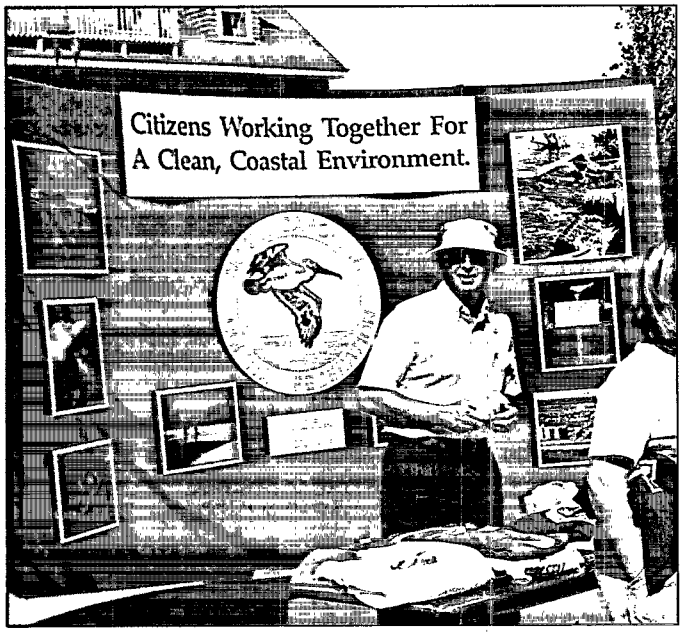
Water Quality Criteria and Standards: The States' ability to assess water quality conditions depends heavily on criteria for specific pollutants established by the States and approved by EPA. When these criteria are violated, designated uses may not be met. Together with an antidegradation policy, the criteria and the uses they protect form the State's water quality standards. A number of States recommend updating their standards by taking such actions as strengthening numerical criteria for toxics (particularly priority organics and heavy metals), adopting new standards for NPS pollutants and wetlands protection, or developing more specific classifications such as nutrient-sensitive or high-quality waters. Federal leadership is urged in finalizing criteria for sediment contamination and continuing to refine and develop criteria for substances causing risks to human health with specific emphasis on fish and shellfish consumption advisories. EPA is also encouraged to promote greater interstate consistency in all water quality standards.

Municipal Facilities: Continued funding for the maintenance, upgrade, and construction of municipal sewage treatment facilities remains a leading recommendation of the States. Several States express concerns about the State

NC Division of Environmental Management

Electrofishing is used to sample fisheries resources in small streams.

Revolving Fund Program, which replaces the Construction Grants Program terminated in 1990. The State Revolving Fund Program transfers funding responsibility for wastewater treatment construction from the Federal Government to the States. Several States voice concerns that adequate money is not available to provide a smooth transition from the Construction Grants Program to the State Revolving Fund Program. Several States express concerns about acquiring matching funds required to initiate State Revolving Fund Programs in their States. Two other municipal concerns that were cited by many States involved pretreatment and CSO mitigation problems. States feel there should be more emphasis by EPA on municipalities to implement and enforce their approved pretreatment programs. Federal funding is urged to support inspections, audits of industrial uses, enforcement, and more research on the effectiveness of pretreatment in reducing toxics in effluent. Special appropriations are also needed for CSO mitigation projects, and, because of excessive costs, States recommend Federal assistance be provided to implement the projects in a timely manner.



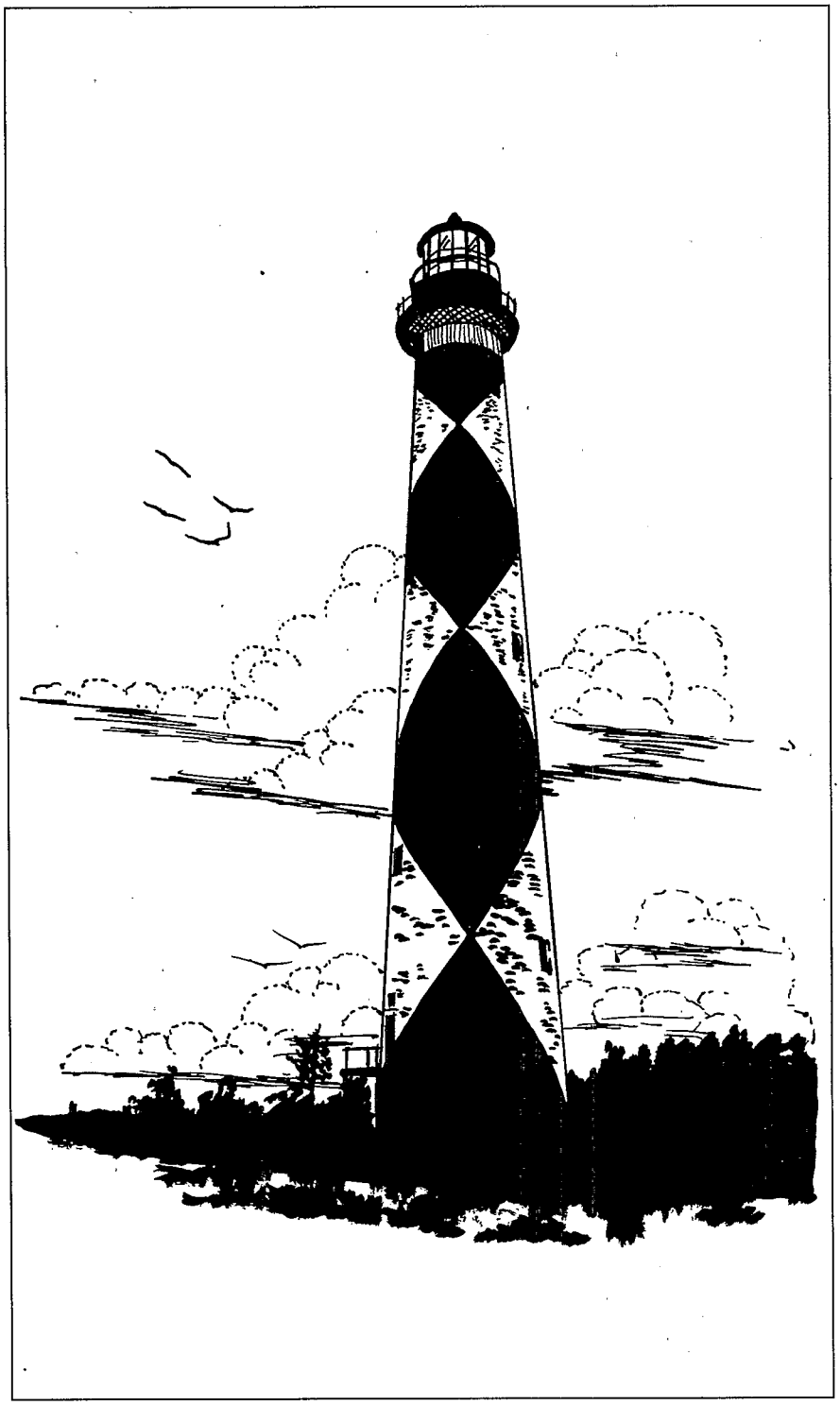
Randy Dodd

Citizen action groups work to strengthen existing State protection efforts.

Ground-Water Protection: Clear priorities many States and Territories express include gaining a better understanding of the quality of their ground-water resources, identifying and mapping these resources using the Geographic Information System, identifying potential sources of contamination, and determining the vulnerability of their ground-water resources to various pollution sources. Several States recommend continued collection and analysis of ground-water data. Their recommendations include more Federal funding to expand ground-water monitoring and management programs, development of a national concept for ground-water protection including establishment of minimum ground-water quality standards, and greater coordination of ground-water protection activities among various Federal, State, and local programs.

Data Management/ Coordination: EPA and the States are actively engaged in developing computerized data management systems to handle a wide range of water quality and program information. A common State recommendation is to integrate and enhance these various databases. Integration of State surface and ground-water quality data into the Geographic Information System and expanded use of the National Waterbody System PC reach file capabilities are cited. States also urge more effective coordination among State, local, and Federal agencies to better address diverse or cross-media environmental problems such as NPS pollution (including hazardous waste disposal, agricultural runoff, and acid deposition) and wetlands and ground-water protection.

Wetlands Protection: Several States call for increased Federal efforts in protecting valuable wetlands resources. Specific recommendations include the need for additional Federal appropriations to identify and quantify wetlands acreage and to strengthen existing State protection efforts. In addition, a number of States cite the need for additional Federal guidance to States in developing water quality standards and designated use classification for wetlands or, in lieu of that, the need for establishing national minimum water quality standards for wetlands to be incorporated into State regulations.



Appendix

Alabama

To obtain a copy of the Alabama 1990 305(b) report, contact:

Alabama Department of Environmental Management
Planning and Projects Branch
1751 Cong. W. L. Dickinson Drive
Montgomery, AL 36130

Surface Water Quality

During the reporting period, Alabama assessed 12,016 miles of streams, 504,721 acres of lakes, 103 square miles of estuaries and 50 coastal miles. Of these assessed waters, approximately 74 percent fully support their designated uses, 16 percent fully support but with a possibility of being threatened without some means of corrective action, 5 percent partially support uses, and 5 percent do not support uses.

Alabama also assessed the extent to which its waters support the fishable/swimmable goal of the Clean Water Act. Of the assessed waters, 82 percent meet the fishable/swimmable goals, 11 percent partially meet the goals, 6 percent do not meet the CWA goals, and less than 1 percent are not capable of attaining the goals because they are classified less stringent than fishable/swimmable.

The main causes of nonsupport of designated uses are excessive levels of nutrients and organic enrichment leading to depleted levels of dissolved oxygen. Inadequately treated effluents from municipal discharges, industrial discharges, and nonpoint source runoff appear to be leading sources of pollution in the State.

Based on available data and using Water Quality Report guidance, 59 percent of Alabama's total reservoir surface acreage is determined to be supporting all uses, 29 percent is use-threatened, and 12 percent is unable to fully support all intended uses.

Funding available through the Clean Lakes Program has allowed the initial development of a uniform database for all Alabama reservoirs. Alabama says that continued funding of the Clean Lakes Program is important to continue needed monitoring activities in the State.

Wetlands are included as waters of the State in the Alabama Water Pollution Control Act (AWPCA) by definition but, to date, are not defined or protected for their inherent value. ADEM strives to achieve a "no net loss" of wetlands and areas deemed of greatest ecological value. Particularly, wetlands and submerged aquatic vegetation are protected, and development is diverted whenever possible. In ADEM's regulations, wetlands and submerged grassbeds are identified as coastal resources on which impacts from any regulated use must be considered. Dredge and fill activities in freshwater wetlands are regulated solely by ADEM's authority to issue 401 Water Quality Certification under the Clean Water Act (CWA).

During the 1988-1989 reporting period, 19 public wastewater treatment facilities were completed through the construction grants program at a cost exceeding $120 million. Since the enactment of the CWA, Alabama has reduced the discharge of primary treated wastewater from 65 MGD to 0 MGD and the volume of raw discharge from 2.5 MGD to 0 MGD.

ADEM monitors the surface waters of the State by means of a fixed-station ambient monitoring network, water quality demonstration studies, intensive surveys and compliance monitoring of effluent discharges.

Ground-Water Quality

The State of Alabama has a diverse and complex geologic environment that provides for an abundant ground-water resource. The diversity of the geology serves to protect many deep aquifers from surficial point source and nonpoint source contamination. The same geology provides for relatively fast surficial recharge to some shallow aquifers, which are also highly susceptible to contamination from surface sources.

Overall ground-water quality in Alabama public water supply systems is good due to the maintenance of drinking water and well construction standards. The Alabama Geological Survey monitoring well network indicates relatively good overall ground-water quality. The number of known sources, releases, and events of ground-water contamination has increased significantly in the past year due to better reporting under the underground storage tank (UST) program and increased public knowledge of ground-water issues.

Alaska

To obtain a copy of the Alaska 1990 305(b) report, contact:

Alaska Department of Environmental Conservation
Division of Environmental Quality
Water Quality Management Section
P.O. Box O
Juneau, AK 99811-1800

Surface Water Quality

Alaska's waters are vast. There are an estimated 3,000,000 lakes, 365,000 miles of rivers and streams, 170,000,000 acres of wetlands, and 36,000 coastal shoreline miles. Only a fraction of 1 percent of the total number of waterbodies are assessed. Most waters are remote from population centers and are presumed to be in pristine condition. Water pollution problems are centered in urban and industrial areas.

Impaired rivers and streams number 29, with 122 listed as suspected. Timber harvest, placer mining, and urban runoff are the major sources of impaired rivers and streams. Urban devel-

opment is the major source of pollution of lakes (fuel and chemical leaks and spills, septic systems, erosion, pesticides, fertilizers, and animal wastes). Thirteen lakes are identified as impaired, and 34 as suspected. Alaska's estuaries and coastal waterbodies are affected by urban and harbor activities, oil and gas development and transportation, industrial sources, municipal sewage treatment plants, and timber harvest and processing. Sixteen estuaries are listed as impaired and 16 as suspected. No coastal waterbodies are identified as impaired or suspected.

The most significant event affecting water quality in Alaska in the past 2 years clearly was the Nation's largest oil spill, caused by the grounding of the Exxon Valdez on Bligh Reef in Prince William Sound on March 24, 1989. The 10.9-million-gallon spill of crude oil affected hundreds of square miles of estuaries and coastal waters. Over 100 miles of shoreline remain moderately to heavily oiled, with oil residues frequently embedded in intertidal substrates. The six coastal waterbodies listed as impaired are Cook Inlet, Katmai National Monument, Kenai Peninsula, Prince William Sound, Shelikof Strait, and Western Gulf of Alaska. A major effort to assess natural resource damages from the Exxon Valdez oil spill is continuing with many State, Federal, industry, and local cooperators.

Wetlands constitute an estimated 150,000,000 to 223,000,000 acres, or 41 to 61 percent of the State's total land area. Portions of Alaska's wetlands are assessed as impaired as a result of oil and gas development on the North Slope and Kenai Peninsula. One wetland area is listed as suspected due to urban development. It is estimated that 80,000 acres of wetlands have been filled in Alaska from all activities, or 0.05 percent of the State's total wetland acreage. The extent of hydrologic modification of wetlands is thought to be considerable but is not quantified.

Ground-Water Quality

The State is faced with an increasing number of sites with contaminated ground water. The major source of contamination is leaking underground fuel tanks; other sources are failing septic systems, hazardous substances, and landfill leachate. Forty-six ground-water sites are assessed as impaired, and four as suspected. Ground-water contamination often is discovered through periodic testing of well water or citizen complaints. Systematic and routine efforts are needed to screen for ground-water contamination.

To address ground-water issues, ADEC completed a draft statewide Ground-water Quality Protection Strategy in September 1988 that identified 120 ground-water sites contaminated by various pollutants but not necessarily in violation of water quality standards. ADEC also has prepared an Oil and Hazardous Substance Site report identifying approximately 277 sites potentially contaminated with hazardous materials and maintains a drinking water database for all public water supplies statewide.

The great majority of Alaska's waterbodies meet high quality standards, yet significant and widespread water pollution problems remain that interfere with existing and attainable uses of water under regulation. Uses most often compromised include drinking, recreation, and growth and propagation of fish, shellfish, and wildlife.

The intensity of water resource use is increasing as population increases. The 1990 assessment of water quality in Alaska is intended to promote agency and citizen action toward full attainment of national and State water quality goals.

Arizona

To obtain a copy of the Arizona 1990 305(b) report, contact:

Arizona Department of
Environmental Quality
2005 North Central Avenue
Phoenix, AZ 85004

Surface Water Quality

During water years 1988-1989, 5,185 river miles were assessed in Arizona, 30 percent of the estimated 17,537 stream miles. Of the river miles assessed, 74 percent have impaired support of designated uses and 18 percent are impaired by elevated levels of toxics.

An assessment was also completed on 52 of the 182 lakes included in the new Clean Lakes Program. Of the 121,388 lake acres assessed, 23 percent have impaired support of designated uses and 18 percent are impaired because of elevated levels of toxics. Monitoring data were available on 16 lakes; however, only 7 of the lakes assessed had sufficient samples to provide a "monitored" assessment.

Arizona identifies its principal surface water quality problems to be contamination of the lower Salt River and middle Gila River by toxic chemicals; contamination of the Puerco River by radiochemicals; untreated wastewater in Nogales Wash; contamination of San Pedro Creek with metals, turbidity, and ammonia; and acid mining contamination of Boulder Creek, and headwaters of Sonoita Creek.

Much of Arizona is a fragile desert, very slow to revegetate, and, once the desert crust is disturbed, quick to blow into dust storms or wash away with a rainstorm. This desert landscape is significantly impaired because of historically poor rangeland management, mining operations, and recent explosive urban development.

Concern about the protection and management of Arizona's wetlands and riparian areas has escalated in the past few years resulting in the formation of the Riparian Habitat Task Force established by Executive Order of the Governor in June 1989.

A total of 728 wastewater treatment systems are regulated in Arizona. In 1988, 491 (67 percent) were in full or substantial compliance with regulatory requirements. Of the 158 facilities in Arizona holding National Pollution Discharge Elimination System (NPDES) permits, 17 (11 percent) are not in compliance with the conditions of their permits due to failure to adequately report effluent discharges and 55 (35 percent) are not in compliance due to the discharge of effluent of substandard quality or due to substandard treatment efficiency.

Arizona is currently conducting a triennial review of its surface water quality standards and proposing significant changes.

Arizona's Nonpoint Source Program integrates both regulatory and nonregulatory components. Best Available Demonstrated Control Technology (BADCT) guidance documents have been prepared for mining, landfills, municipal wastewater, and septic tanks. Best Management Practices (BMPs) for agricultural activities have been recommended and are to undergo field verification. Potentially mobile and persistent pesticides will be monitored and regulated through the Pesticide Contamination Prevention Program. BMPs for rangeland management are being developed, and a BMP handbook for stormwater has been drafted. Nine demonstration projects have been nominated for funding or have preliminary approval for funding.

Ground-Water Quality

Ground water throughout the State generally meets mandated drinking water standards. Problems can be found, however, at several localities, particularly the pollution by organic chemicals in Phoenix and Tucson. Most contamination is related to land use: leachates from landfills, mining operations, and disposal of toxic wastes; petroleum products emanating from leaking underground storage tanks; and septic tanks. Irrigation recirculates salts within the aquifer and may introduce pesticides, nitrates, and other compounds associated with fertilizers into the ground water. Urban runoff can increase the levels of petroleum hydrocarbons and metals in the ground water. Because ground water is slow moving, most such problems tend to be localized and are thus more amenable to study and to eventual remediation.

Arkansas

To obtain a copy of the 1990 Arkansas 305(b) report, contact:

Arkansas Department of Pollution Control and Ecology
Water Division
8001 National Drive
Little Rock, AR 72209

Surface Water Quality

For this reporting period, Arkansas assessed 4,713 miles of streams, or 42 percent of the State's total river miles. Approximately 35 percent of assessed river miles fully support their designated uses.

In its 1990 305(b) report, the State provided regional assessments of water quality. Water quality in the Delta Region is significantly influenced by agricultural runoff. The vast majority of waterways in this region have been channelized for agricultural development and therefore have impaired uses. The Gulf Coastal Region exhibits site-specific impacts due to resource extraction. Silviculture is the predominant land use in the Ouachita Mountains Region; the region is characterized by exceptionally high water quality although concerns have been voiced about the effects of harvesting practices. In the Arkansas River Valley Region, zero flows are common during summer critical conditions. During peak runoff events, contaminants enter the Region's streams from agricultural sources. The Boston Mountains Region is highly used for recreational purposes and has extremely good water quality. Potential water quality degradation is of concern because of conversion of hardwoods to pasturelands, expansion of confined animal operations, timber management practices, and localized natural gas production. Last, in the Ozark Highlands Region, water quality problems are directly related to the high rate of animal management activities such as chicken, swine, and cattle operations. The waste from this animal production is generally land-applied and therefore has the potential to contaminate both surface and ground waters.

During the past 2 years, 204 locations have been evaluated for potential toxics contamination. Investigations included fish flesh analyses for heavy metals, pesticides, and other bioaccumulative compounds; sediment sampling for similar compounds; rapid bioassessment for aquatic life support; and acute and chronic toxicity testing. Potential toxics problems were addressed through the NPDES permitting process including the Toxicity Identification/Reduction Evaluation procedures.

During the summer of 1989, baseline data were gathered from 77 significant publicly owned lakes. No substantial use impairment was found on any of these lakes although the water quality variations among the lakes were dramatic. The wetlands program continues to be driven by the Section 404 process and the requirement for Section 401 water quality certification. Such certification is determined on the basis of protection of designated uses, specifically those associated with the fishery uses.

Ground-Water Quality

Use of ground water in the 1980s has varied between 4 and 5 billion gallons per day.

About 93 percent was for agricultural use, 2 percent for industrial use, 2 percent for municipal use, 2 percent for rural domestic use, and 1 percent for thermoelectric energy. Fifty-five percent of the population depends upon ground water for drinking water and domestic use.

Contamination of shallow domestic wells and springs by human and animal wastes is the most prominent ground-water problem in the State, as evidenced by high nitrate concentrations. Some surficial aquifers have been contaminated by industrial wastes, which include both heavy metals and organic chemicals; some of these are being monitored under the Superfund and RCRA programs.

Contamination of fresh ground water by saline water has occurred in several places due to large-scale pumping. In some areas, the occurrence of saline water appears to be of natural origin and not the result of human activity. Some salt-water contamination in south Arkansas is due to oil and gas exploration, production, and disposal practices.

Ground-water problems continue to be centered around areas of excessive withdrawals that exceed recharge rates and cause significant declines in ground-water levels. Additionally, salt water intrusion is occurring in some of these areas. Potential ground-water problems are found statewide. Potential threats to ground water include a large number of waste impoundments, landfills, and open dumps, especially those located in moderate to high aquifer recharge zones. Contamination from waste impoundments, storage tanks, and dumps has occurred. Hazardous substances transported by vehicles and trains have been involved in accidents resulting in ground-water contamination. However, Arkansas' public ground-water supply compliance with the Safe Drinking Water Act standards is excellent. Compliance with bacterial limits in these waters exceeds the national goal.

California

To obtain a copy of the 1990 California 305(b) report, contact:

California State Water
Resources Control Board
Division of Water Quality
901 P Street
Sacramento, CA 95801

Surface Water Quality

Over three-fourths of California's assessed stream miles and half its lake acres are classified as having water quality that generally supports designated uses. Some of the largest waterbodies not supporting uses in the State include harbors, bays, and lagoons in the San Diego Region (15,300 acres); Clear Lake in Lake County (44,000 acres); and the Salton Sea (220,000 acres).

Pollution sources in streams not fully supporting uses include agriculture, abandoned and active mines, and other nonpoint sources such as urban runoff, erosion, individual disposal systems, and animal grazing. The remaining stream pollution sources consist of point sources and natural or unknown causes.

Lakes are mostly affected by natural causes and agricultural return flows. Municipal and industrial point sources are prohibited from discharging directly to lakes in California.

Major pollutants affecting waters of the State include bacteria, nutrients, dissolved solids, pesticides, herbicides, other toxic organics, and metals. Toxic substances are now recognized as a constantly expanding threat to water quality. Toxic substances have been, and probably still are, dumped illegally into community sewer systems, municipal landfills, vacant lands, and surface waters. California is moving aggressively to address the toxic pollution issue with new legislation, more severe penalties, and new programs.

The State identifies the following as statewide issues of concern: ground-water pollution, hazardous waste disposal sites, pollution of harbors and bays, agricultural impacts on water quality, and mine drainage.

Colorado

To obtain a copy of the Colorado 1990 305(b) report, contact:

Colorado Department
of Health
Water Quality Division
4210 East 11th Street
Denver, CO 80220

Surface Water Quality

Colorado assessed 97 percent of its 31,470 stream miles during the 1990 reporting period. Of the assessed miles, 90 percent fully support designated uses, 3 percent support uses but are threatened, and only 6 percent are impaired. The major causes of use impairment include metals, pathogens, effluent toxicity, ammonia, and low dissolved oxygen concentrations. Agricultural activities, resource extraction, and municipal and industrial discharges are major sources of water quality degradation in Colorado's rivers and streams.

Lake assessments received less attention than rivers and streams because of a lack of data. Only 82 lakes over 25 acres in size were assessed, primarily with limited data. Of the 145,305 acres assessed, 91 percent fully support designated uses, 8 percent support uses but are threatened, and only 1 percent are impaired. Approximately half of the assessed lakes are classified as eutrophic. Impairments are caused by nutrients, organic contaminants, and metals. The major sources degrading Colorado's lakes are agricul-

tural activities, construction and urban runoff, municipal and industrial discharges, silvicultural activities, and land disposal.

Colorado also identified five lakes impacted by toxics, three of which are located on the Rocky Mountain Arsenal and are impacted by organic contaminants. Mercury concentrations exceed standards in the other two lakes. Fish consumption is banned or restricted at all five lakes.

Colorado presented water quality information for seven basins in their 1990 305(b) report. The Platte River Basin has a larger population and faces more critical water quality problems than any basin in Colorado. Important recreational reservoirs are threatened by accelerated eutrophication from urbanization, nitrates exceed drinking water standards in municipal wells, and past mining activities degrade several tributaries with metals and minerals.

Large-scale irrigated agriculture and livestock feeding operations also have the potential to affect water quality adversely. The Arkansas River Basin continues to be affected by inactive and current mining activities. Agricultural, municipal, and industrial withdrawals also concentrate total dissolved solids (salts), which impair downstream water quality. Elevated nitrate concentrations affect drinking water supplies for several communities.

The Upper Colorado River Basin has maintained good water quality through the investment of substantial fiscal resources for advanced wastewater treatment and nonpoint source controls. Additional funding will be needed to address persistent problems from inactive mines. For example, construction of a treatment plant for effluent from the inactive Keystone mine has reduced metal concentrations and restored aquatic life in receiving streams. Other projects are underway to reduce salt loading from agricultural activities into surface waters.

Metals from past mining activities impair several streams in the Rio Grande River Basin and the San Juan River Basin. No water quality problems were identified in the Republican and Green River Basins.

Connecticut

To obtain a copy of the Connecticut 1990 305(b) report, contact:

Connecticut Department of
Environmental Protection
Water Compliance Unit
122 Washington Street
Hartford, CT 06106

Surface Water Quality

As of 1990, 420 of Connecticut's 893 assessed miles of major rivers and streams fully support water-quality goals. Another 190 miles fully support but are threatened. An additional 229 miles partially support goals. The remaining 54 miles do not support most water uses, other than perhaps limited aquatic habitat use, navigation, and industrial activities.

The primary pollutants impairing water quality are bacteria, ammonia, metals, PCBs, and organic enrichment, which depletes oxygen concentrations. The major sources of contamination, in descending order of relative impact, are municipal and industrial discharges, combined sewer overflows, urban runoff and storm sewers, and in-place contaminants.

Of the 23,179 assessed lake acres, 8 percent fully support designated uses, another 66 percent fully support uses but are threatened by pollution, and 26 percent are partially supporting uses. Nutrients, noxious aquatic plants, and priority organics are the most prevalent causes of impairment. Numerous sources contribute to lake impairment, including municipal and industrial discharges, in-place contaminants, agricultural activities, highway runoff, instream impoundments, and natural conditions.

Urbanized harbors and tidal portions of major tributary rivers are the most heavily impacted estuaries in the State. Approximately 234 of the 601 square miles assessed are suspected of having water quality problems caused primarily by nutrients, priority organics, pathogens, and organic enrichment/low dissolved oxygen. The sources of pollution are municipal sewage treatment plants and industrial discharges, combined sewer overflows, and nonpoint sources such as urban runoff and in-place contamination.

Municipal regulatory programs appear to be achieving considerable success in stemming wetlands losses. The State's Council on Environmental Quality reported in 1988 that annual permitted losses under the 1969 Tidal Wetland Act average 0.5 acre.

Ground-Water Quality

Approximately 32 percent of the population depends on ground water for potable water supply. Over 90 percent of the State's ground-water resources is presumed to be suitable for drinking without treatment. Impacts from improper solvents handling and disposal, leaking underground petroleum storage tanks, landfill leachate, pesticides (EDB), and improper road salt storage have resulted in the contamination of 1,368 public and private water supply wells in the past decade.

Delaware

To obtain a copy of the Delaware 1990 305(b) report, contact:

Delaware Department of
Natural Resources and
Environmental Control
89 Kings Highway
P.O. Box 1401
Dover, DE 19903

Surface Water Quality

Twenty-one percent of Delaware's river waters fully support all designated uses,

50 percent of the lakes assessed fully support all designated uses, and 100 percent of the coastal waters fully support all designated uses. The percentage of waters meeting the Clean Water Act Fishable Goal are 77 percent of river waters, 94 percent of the lake waters, and 100 percent of coastal waters. The percentage of waters meeting the Swimmable Goal are 15 percent of river waters (where primary contact recreation is a designated use), 50 percent of the lake waters assessed, and 100 percent of coastal shore waters. Nonattainment of swimmable water quality to support primary contact recreation is the most widespread problem in the inland waters, and nonattainment of fishable water quality is the major problem in estuarine waters.

The most widespread water quality problem contributing to nonattainment of designated uses and goals is the elevated contributions of bacteria, which serve as indicators of pathogenic organisms. The State's water quality standards for primary contact recreation are based on concentrations of *Enterococcus* bacteria. Other indicators of pathogens, such as total coliform bacteria, are used by the Division of Public Health to determine areas where shellfish harvesting is not permitted. The presence of pathogen indicators is the most widespread problem affecting swimmable water quality for the inland waters and fishable water quality for the estuarine waters.

Although pathogen indicators may be the most widespread contaminant in Delaware's waters, the presence of toxics may represent the most serious threat to human health and aquatic life. Approximately 10 percent of all river waters, 6 percent of all lake waters assessed, and 10 percent of the estuary waters, including portions of the Delaware River and Indian River Bay, are anticipated to be impacted by elevated levels of toxics.

Other pollutants of concern include nutrients, ammonia, and organic enrichment leading to dissolved oxygen problems. Approximately 15 percent of all river waters are impacted by these constituents. It is anticipated that studies conducted through the Clean Lakes Program and National Estuary Programs will assess nutrient impacts on lakes and estuaries in greater detail.

Determination of the sources of these contaminants is very difficult. Through the development of the 304(l) lists as required by the Clean Water Act, the State identified waters that were anticipated to be impacted by point source discharges of priority pollutants. Runoff from agricultural and urban areas is a significant source of nutrient and pathogenic indicator contamination.

Ground-Water Quality

Approximately two-thirds of Delaware's population rely on ground-water supplies for domestic needs. All of the fresh water for farm use and most of the water used for irrigation and self-supplied industrial use is also derived from ground water. Approximately 38 billion gallons are withdrawn each year for all uses.

Delaware's ground water is generally of good quality. Dissolved iron is a common constituent that may cause aesthetic concern, and elevated nitrate contamination is a concern in agricultural areas in Kent and Sussex County. Salt water intrusion is a problem in the coastal areas. Synthetic organic compounds have also been detected in some areas, primarily in the industrialized areas of New Castle County. The major sources of contamination are identified as underground storage tanks, agricultural activities, landfills, septic system disposal areas, and abandoned hazardous waste sites.

Delaware River Basin

To obtain a copy of the Delaware River Basin Commission's 1990 305(b) report, contact:

Delaware River Basin
Commission
P.O. Box 7360
West Trenton, NJ 08628

Surface Water Quality

Delaware River and Bay constitute part of the boundary of four States: Delaware, New Jersey, New York, and Pennsylvania. From Hancock, NY, to the mouth of the Delaware Bay, the Delaware River flows 330 miles, draining 0.4 percent of the U.S. land area. Almost 10 percent of the Nation's population rely on the waters of the Delaware River Basin for potable and industrial water.

The Delaware River Basin Commission (DRBC) reports that 97 percent of the 206 assessed river miles in the Delaware River Basin support designated uses. In the Delaware Bay, uses are supported in 99 percent of the 866 square miles of estuarine waters assessed. However, frequent spills and discharges from combined sewers threaten use support in all basin waters.

Major river and estuarine impairments are attributed to pathogen indicators, organic enrichment, and low dissolved oxygen concentrations. Toxic substances (including organics, metals, and conventional contaminants) also impair estuarine portions of the basin, but to a lesser extent. The primary sources identified include municipal and industrial discharges, storm sewers, combined sewer overflows, and urban runoff.

The DRBC also conducted an assessment of its waters relative to their support of the fishable/swimmable goal of the Clean Water Act. This assessment revealed that 100 percent of the assessed river miles and 93 percent of assessed estuary square miles meet the fishable goal, and approximately 97 percent of the assessed river miles and 99 percent of the assessed estuary square miles meet the swimmable goal.

The protection of water quality from growth-related impacts (both point and nonpoint) will be essential to maintain high quality reaches of the river and the water quality improvements achieved over the last 40 years. Recreational use of the Delaware River is intense and increasing in both the nontidal river and the estuary; this increased use makes the maintenance of water quality a key concern. An unanswered concern is the impact of the recreational use itself on the river's quality.

Water quality in 1988-89, however, reflects substantial water quality improvements as the result of water pollution control efforts extending back 40 years.

District of Columbia

To obtain a copy of the District of Columbia 1990 305(b) report, contact:

Department of Consumer & Regulatory Affairs
Water Hygiene Branch
Suite 203, 2100 Martin Luther King, Jr. Ave., SE
Washington, DC 20020
Attn: Hamid Karimi

Surface Water Quality

For 1990, the District of Columbia assessed 100 percent of its estuarine waters, 95 percent of its small streams, and 63 percent of its lakes and impoundments. By using rapid bioassessment data, the District increased significantly the number of streams assessed.

Most of the District's surface waters do not support all of their designated uses. Exceptions are the Washington Ship Channel, several Rock Creek tributaries, and the Tidal Basin. Most of the District's surface waters designated for use as raw water sources for industrial and public water supplies meet these particular uses.

In the District, causes of nonsupport are typical for an urban area. Fecal coliform contamination is a principal cause of nonsupport of designated uses. In the Anacostia River, low dissolved oxygen levels are a leading cause of nonsupport of uses. High metals concentrations are also a concern, particularly in many of the District's smaller streams. Other causes of nonsupport include oil and grease, high pH, and priority organics.

Urban runoff, whether from storm sewers, combined sewer overflows (CSOs), or surface runoff, is a principal source of pollution to District surface waters. Currently, combined sewers serve 35 percent of Washington, DC. Discharges of untreated sewage after a rainstorm result in high fecal coliform, high biological oxygen demand, and low dissolved oxygen. Storm sewers/runoff add sediment, heavy metals, road salts, oil, and other toxics to receiving waters.

Wastewater treatment plant effluent discharges are a major source of nutrients to the Potomac estuary. Implementation of advanced wastewater treatment processes at the Blue Plains Wastewater Treatment Plant has significantly reduced nutrient loads to District waters. Still of concern are nutrient inputs from fall line points, particularly the upper Potomac watershed.

Other pollution sources are more site specific. These sources include leachate from landfills, runoff from industrial yards, leaks from underground storage tanks, and breaks in sanitary sewer lines.

Ground-Water Quality

Reliable information on the quality of the ground water in the District of Columbia is essentially nonexistent. This is because virtually all of the City's water supply needs have been satisfied by the Potomac River. To fill this information void, the District established a Ground Water Protection Program in January 1989. One of the first tasks of this program has been to conduct a ground-water assessment. Upon completion, the District should know the actual quality of its ground water.

Florida

To obtain a copy of the Florida 1990 305(b) report, contact:

Florida Department of Environmental Regulation
Standards Monitoring Section
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Surface Water Quality

Most of Florida's waters are of good quality; the distribution of problem areas closely follows the distribution of Florida's population. Water quality problems in the State are evident around the densely populated, major urban areas including Jacksonville, Orlando, Tampa, the Cape Kennedy area, and the southeastern Florida Coast. The sparsely populated northwest and west central sections of the State have very good water quality.

Historically, Florida has not been highly industrialized. Thus, difficult and persistent industrial types of pollution are not widespread. However, Florida has undergone an extensive population growth in the past two decades, which has resulted in more pollution sources associated with development.

Florida reports that it assessed 62 percent of its stream miles, and, of these, 62 percent fully support designated uses. Fifty percent of the State's lake acres were assessed. Thirty-one percent of assessed lake acres fully support uses, 56 percent partially meet uses, and 12 percent do not support uses. (This lower degree of use support for lakes is attributed to the fact that two lakes—Lake Okeechobee and Lake George—account for almost half of the assessed lake areas in the State and are partially meeting uses.)

Sixty-three percent of the State's estuarine area was reported as assessed, with 60 percent meeting uses. Of the

State's ocean coastal area, 10 percent was reported as assessed and 95 percent of assessed ocean square miles meet uses.

In previous years, most water quality problems in the State were caused by point sources. Recently, however, nonpoint sources accounted for the majority of the State's water quality problems. This is because point source treatment processes have improved and there has been an increase in the acreage of agricultural and urban developed land. Major water quality problems in Florida include urban stormwater, agricultural runoff, domestic wastewater, pulp and paper mills, and hydrologic modification.

Georgia

To obtain a copy of the Georgia 1990 305(b) report, contact:

Water Quality Management Program
Georgia Environmental Protection Division
270 Washington Street, SW
Atlanta, GA 30334

Surface Water Quality

Georgia is rich in water resources with good water quality. An assessment of the State's rivers, lakes, and estuaries indicates that the vast majority support designated water uses. Of the 20,000 stream miles assessed, 97 percent support designated uses, 3 percent partially support uses, and less than 1 percent do not support designated uses. This evaluation is based on predictive modeling, 25 years of trend monitoring, intensive surveys, and special studies, as well as the judgment of professional staff members.

Of the 417,730 acres of lakes assessed, 97 percent fully support uses, 3 percent partially support uses, and less than 1 percent do not support designated uses. Of the 594 square miles of estuaries, 98 percent fully support uses, 1 percent partially support uses, and less than 1 percent do not support designated uses.

Municipal and industrial discharges and urban runoff are cited as the most common sources of use impairment in Georgia rivers, lakes, and estuaries. Generally, the causes of most concern are dissolved oxygen, nutrients, toxic substances, turbidity, and fecal coliform bacteria. Metals, particularly zinc, copper, cadmium, and lead, also impair streams and rivers.

Georgia continued its strong permitting and enforcement programs in 1988-1989. Ninety-three percent of major municipal dischargers and 98 percent of major industrial dischargers maintained consistent permit compliance in 1988-1989. However, improperly treated discharger, spills, and erosion/sedimentation problems resulted in monetary penalties totaling $819,215 being levied by the Georgia Environmental Protection Division.

In 1989, Georgia adopted numeric standards for toxic substances to protect aquatic life and human health. The State also adopted more stringent fecal coliform criteria for contact recreational uses. The new toxic substance standards are reflected in the 1990 water quality assessments, but the new fecal coliform standards will not influence use support assessments until the next reporting cycle (1992).

Ground-Water Quality

Ground water is extremely important to the life, health, and economy of Georgia. In 1987, ground water provided 24 percent of the public water supply, 95 percent of the rural use, 69 percent of the irrigation use, and almost half of the industrial use of water in the State. Outside the larger cities of the Piedmont, ground water is the dominant source of water.

Except where they may become saline at lower depths, all of the aquifers can be considered as potential sources of drinking water. For the most part, these aquifers are underutilized and generally free of contamination. Water from most of the aquifers may be safely consumed without treatment, and, except for occasional curtailment of lawn sprinkling, water has not been rationed.

The most extensive contamination of Georgia's aquifers is from naturally occurring mineral salts (i.e., high total dissolved solids). Another natural source of contamination is from radioactive minerals that are common rock constituents in many Georgia aquifers. Although naturally occurring radioactivity may occur anywhere in Georgia, the most significant problems have occurred at sporadic locations near the Gulf Trough in the Coastal Plains.

Radon, a radioactive gas produced by the radioactive minerals mentioned above, also occurs in variable amounts in wells, particularly in the Piedmont region. In addition to natural sources, business and industry, agriculture, and homes (e.g., septic systems) may also contaminate ground water.

Widespread testing of 818 public water supply wells for volatile organic chemicals (VOCs, which include solvents and hydrocarbons) identified only eight contaminated wells. The most common sources of the VOCs were improper disposal of solvents by nearby businesses, leaking underground fuel-storage tanks located near wells, and inactive nonpermitted abandoned landfills.

Ground-water protection from leaking underground storage tanks was enhanced with enactment of the Georgia Underground Storage Act of 1988. Under this Act, the Department of Natural Resources promulgated rules to establish a financial assurance trust fund and instituted corrective action requirements to clean up leaking underground tanks. In its first year of operation, investigation and corrective procedures were initiated at 125 sites.

Additional ground-water protection is provided by regulations to implement a ground-water recharge area

protection program approved by the Georgia General Assembly in 1990. One of these rules requires that any landfill constructed within 2 miles of a significant recharge area have a synthetic liner and a leachate collection system. The rules also give significant recharge areas highest priority for cleanup of existing pollution.

Hawaii

To obtain a copy of the Hawaii 1990 305(b) report, contact:

Hawaii Department of Health
P.O. Box 3378
Honolulu, HI 96801

Surface Water Quality

The overall quality of waters in Hawaii is excellent. Surface water quality problems with toxics are practically nonexistent. The majority of the State's nearshore waters are pristine and meet water quality standards that are the most stringent in the Nation.

All ocean waters, bays, estuaries, lakes, and rivers in the State fully support beneficial uses. Channelized streams and drainage structures within urban areas may not be swimmable due to elevated levels of pathogenic indicators.

Embayments and nearshore waters are primarily impacted by nonpoint source pollution. The major contributing factors include stormwater runoff, construction and agricultural activities, and natural erosion. Point source contributions are minor.

The aquatic ecosystems of streams and rivers in the State are subject to greater human impacts than the marine environment. Streams in urban areas have been concrete-lined and straightened for flood control. Man-made drainage structures, such as the Ala Wai Canal are the only waterbodies in the State that are not swimmable due to the levels of pathogenic organisms contained in urban runoff. These waters do, however, support aquatic life and are fishable. One impounded stream system, creating Wahiawa Reservoir on Oahu, is eutrophied due to the discharge of treated municipal wastewater. This discharge is scheduled to be eliminated.

Wetlands in the State provide important refuges and habitats for many native Hawaiian birds, including rare and endangered species of birds and native plants. Wetlands and marshes near residential districts are threatened by habitat alterations due to urban growth and development. A growing concern is the possibility of runoff from golf courses, which may contain pesticides and fertilizers. Conversely, the last municipal wastewater discharge to a wetland (and only point source) will be eliminated in 1990.

The State water management program has been successful in maintaining the high quality of Hawaii's waters through careful regulation of point source discharges to prevent degradation and by strict enforcement of environmental laws. In 1989, the State established procedures and began including limitations for preventing toxicity in NPDES discharges.

In addition, the State more than doubled its budget for water quality monitoring in 1989. Also in 1989, the State proposed the Nation's most stringent standards for protecting marine recreational waters from pathogenic contamination and proposed new standards for 97 toxic pollutants. These standards were adopted by the Governor on January 18, 1990. In January 1990, the U.S. EPA, Region IX, approved Hawaii's Nonpoint Source Assessment Report and Management Plan. Controls on urban runoff will be enhanced through the permitting of industrial and large municipal storm sewer systems.

Ground-Water Quality

The State's ground-water sources of drinking water meet drinking water standards although there are instances of contamination below action levels. Ground-water concerns have focused attention on certain domestic water supplies contaminated at low levels by man-made organic pollutants. Probably the application of agricultural pesticides over decades has ultimately percolated to ground-water aquifers.

In areas impacted by nutrients, phosphorus levels are declining. Areas impacted by nonpoint sources of sediment have remained unchanged. Discharges of municipal wastewaters to inland waters are minor and are being eliminated. The Governor of Hawaii adopted an antidegradation Ground-water Protection Strategy on March 12, 1990.

Idaho

To obtain a copy of the Idaho 1990 305(b) report, contact:

Idaho Department of the Environment
450 W. State Street
Boise, ID 83720

Surface Water Quality

Over 16,000 stream miles were assessed for nonpoint source pollution impacts, or approximately 50 percent of the total stream miles in the State. Over 12,000 miles of streams experience some type of nonpoint source impact; in half of these stream miles, at least one designated use is not fully supported.

Agriculture is the primary nonpoint source activity impacting designated uses in Idaho streams. The second most significant nonpoint source is hydrologic or habitat modification. Other nonpoint source activities affecting Idaho waters are forest practices, construction, and mining. The extent of impacts from these activities varies by region. Agricultural activities affect more streams in the central and southern regions, while forest practices are more significant in the northern region.

Idaho has over 2,800 named freshwater lakes covering more than 700,000 surface acres. Lake conditions range from pristine in high alpine lakes to overproductive in developed reservoirs. Signs of deteriorating water quality are most notable in the developed recreational lakes in the panhandle region. Although few are classified as eutrophic, there is a strong public perception of declining water quality in these lakes. Statewide, a total of 727,202 acres were assessed for trophic status. Thirty-one percent of the assessed lake acres were classified as oligotrophic, 58 percent as mesotrophic, 10 percent as eutrophic, and 1 percent could not be classified.

Agriculture is the primary nonpoint source activity reported to be impacting lake water quality, especially in the southern and central regions of the State. Ironically, most of Idaho's reservoirs were constructed to provide irrigation water for agricultural activities, which, in turn, generate excessive nutrient and sediment loadings from irrigation return flows and agricultural runoff. As a result, many reservoirs are experiencing eutrophication problems. Reservoir drawdowns, primarily for irrigational use, also adversely impact lake water quality.

Other nonpoint sources are more prevalent in the northern regions of the State, where shoreline development and silvicultural activities are more extensive. These sources include construction, urban runoff, subsurface sewage disposal, mining, and forest practices.

Of 149 priority wetland areas in Idaho, 66 have nonpoint source impacts. Statewide, these impacts are primarily the result of agricultural activities, especially rangeland. In the northern region of the State, however, forestry activities are the primary impact on wetlands.

Ground-Water Quality

Idaho ranks in the top five states in the United States for volume of ground-water used. The major use is for irrigation, although over 90 percent of Idaho's drinking water comes from its aquifers. The quality of most ground water in Idaho is good. Most is suitable for drinking, agricultural, and industrial uses, although naturally occurring contaminants such as dissolved solids, fluoride, and hardness restrict water use in some areas. Contamination from both point and nonpoint sources is localized, ranging from a few acres up to several square miles. Where water supply wells have been impacted, the contamination is generally limited to a small number of wells.

The most common point sources of ground-water contamination are above- and below-ground petroleum storage, leaks and accidental spills of industrial chemicals, and land application of wastewater. The relative importance of nonpoint sources versus point source impacts is not known.

Septic systems can impact ground water when the water table is shallow, soil conditions are inappropriate for the system design, or system density is excessive. Impacts on ground water from infiltration or injection of urban runoff water are poorly investigated in Idaho. However, in the Spokane Valley in neighboring Washington, 30 percent of the total dissolved solids delivered to the aquifer and 60 percent of the toxic metal loading to the aquifer are estimated to be derived from urban runoff. Improved storm drainage practices are particularly important where population centers are situated over vulnerable aquifers such as the Rathdrum Prairie and the Boise Valley.

Illinois

To obtain a copy of the Illinois 1990 305(b) report, contact:

Illinois Environmental Protection Agency
Division of Water Pollution Control
2200 Churchill Road
Springfield, IL 62706

Surface Water Quality

Rivers and streams in Illinois total 14,080 river miles (13,200 interior river miles; 880 border river miles). Of the 13,122 river miles assessed in this reporting period, 42 percent fully support their designated uses. The major causes of use impairment are siltation, nutrients, habitat/flow alteration, organic enrichment/low dissolved oxygen, ammonia, and suspended solids. The major sources of use impairment are agriculture, point sources, hydrologic/habitat modification, urban runoff, and resource extraction. Eighty-seven percent of assessed stream miles meet the fishable goal of the Clean Water Act (CWA). Almost 25 percent of the 4,525 miles assessed meet the swimmable goal.

The State assessed 442 lakes covering 209,036 acres and representing 68 percent of the acreage of inland lakes in Illinois. Eleven percent of assessed lake acres support uses, 49 percent partially support uses, and the remaining 40 percent do not support uses. Additionally, 77 percent and 65 percent of these assessed waters meet the fishable and swimmable goals of the CWA, respectively.

The primary causes of use impairment for lakes are suspended solids, siltation, organic enrichment/dissolved oxygen deficiencies, and nutrients. Six inland lakes covering 20,298 acres have sport fish consumption advisories and are impaired as a result of above-average chlordane or dieldrin concentrations in the sediment. Sources affecting the greatest number and acreage of lakes are agriculture (primarily row crops), in-place contaminants (deposited sediment with associated nutrients and pollutants), lake/stream bank erosion, resource extraction, and municipal point sources.

Sixty-three miles of the Lake Michigan shoreline form the northeastern portion of Illinois' border. Nine

shoreline miles partially support designated uses with minor impairment; the remaining shoreline miles are fully supporting uses but threatened. The causes for less than full support include phenols and arsenic in water column samples and priority organics based on the lakewide sport fish advisory. Major sources are atmospheric deposition and in-place contaminants. Due to a sport fish health advisory, Illinois' portion of Lake Michigan is considered to not be fully attaining the fishable goal of the CWA. All shoreline miles meet the swimmable goals of the Act.

Ground-Water Quality

Ground-water monitoring and assessment information to date indicate that statewide ground-water quality is generally good. However, many activities, past and present, contribute to ground-water contamination in Illinois. Major sources of identified contamination in the State include leaking underground storage tanks, abandoned hazardous waste sites, agricultural chemical operations, and municipal and industrial landfills. Contaminants include organic and inorganic chemicals, metals, pesticides and other agricultural chemicals, arsenic, brine, and petroleum products.

The Illinois Ground-Water Protection Act, signed into law September 24, 1987, will help direct new program initiatives through numerous agencies to protect the State's ground-water resources from future degradation and to avoid difficult and expensive remedial cleanup efforts.

Indiana

To obtain a copy of the Indiana 1990 305(b) report, contact:

Indiana Department
of Environmental
Management
105 South Meridian Street
Indianapolis, IN 46225

Surface Water Quality

During the reporting period, Indiana assessed 4,917 miles of streams, 97,536 acres of lakes, and 43 Great Lake shoreline miles. Of the waters assessed, 60 percent of the river and stream miles and over 99 percent of the total inland lake and reservoir acreage fully support their designated uses. All of Indiana's portion of Lake Michigan is considered as partially supporting designated uses due to the lakewide fish consumption advisory for certain species.

Of the stream miles assessed, it was estimated that the swimmable goal is supported in 6 percent and the fishable goal is supported in 60 percent. Although both the fishable and swimmable goals are supported in over 99 percent of the total lake and reservoir acres assessed, many are considered threatened by point and/or nonpoint sources of pollution. All of Lake Michigan governed by Indiana supports the "swimmable" goal but is not considered to support the "fishable" goal due to the lakewide fish consumption advisory.

The major causes of nonsupport of uses are fecal coliform bacteria, organic enrichment, pesticides, priority organic compounds, and ammonia. The sources of substances most often contributing to nonsupport of uses are: industrial and municipal/semipublic point sources, combined sewer overflows, and agricultural nonpoint sources. Nonpoint sources were most often considered to have major impacts.

Although much of Indiana's wetland resource has been lost, there are an estimated 750,000 acres of wetlands remaining, mostly in the northern part of the State. No formal water quality assessment has been made of these areas; however, the State is unaware of any wetland problems related to point source discharges. The main concern regarding wetlands is preventing the future loss of these areas through draining and filling.

One area of special concern for Indiana is toxics control and monitoring. Increased monitoring of fish tissue and sediments for toxics and bioconcentrating materials has occurred in Indiana over the past 2 years.

Over 2,500 stream miles and approximately 23,500 inland lake and reservoir acres were monitored in some way for toxics. Of the river and stream miles monitored, about 45 percent were considered to have elevated levels of toxic substances because of the occurrence of fish consumption advisories or the presence of sediment contamination at medium to high levels of concern. Pesticides, PCBs, and metals were the substances most often causing these problems. Only about 3 percent of the inland lake and reservoir acres monitored were found to have toxic substances (primarily metals) in sediments at levels of medium to high concern. No fish tissue samples from lakes or reservoirs have been found to contain toxic substances at levels above Food and Drug Administration Action Levels. All of Indiana's portion of Lake Michigan is considered to be affected by toxics due to the lakewide fish consumption advisory.

Ground-Water Quality

Indiana's plentiful ground-water resource serves 60 percent of its population for drinking water and fills many of the water needs of businesses, industry, and agriculture. Although most of Indiana's ground water has not been shown to have been adversely affected by man's activities, over 590 sites of ground-water contamination have been documented. These problems affect over 1,720 individual wells and several hundred thousand people.

The substances most frequently detected as well water contaminants in the State are chlorinated volatile organic chemicals, petroleum products, heavy metals, and nitrate. Monitoring wells at waste disposal sites most

often indicate ground-water pollution from inorganic chemicals. The sources of ground-water contamination most commonly reported in the State are hazardous material spills, leaking underground storage tanks, and waste disposal activities.

Some geographic areas of concern in the State for prevention, detection and correction of ground-water quality impacts are areas geologically vulnerable to contamination, priority public supply well fields, and potential sole source aquifers.

In 1987, Indiana completed a comprehensive Ground Water Protection Strategy that addresses information needs and solutions. Implementation of the 160 recommendations in this plan is an important goal for increased effort to safeguard the resource. The Indiana Ground Water Protection Act of 1989 formalizes an Inter-Agency Ground Water Task Force to coordinate the actions of five State agencies in this regard. The Act also authorizes a number of ground-water protection activities and mandates the accomplishment of several key initiatives from the Ground Water Strategy.

Iowa

To obtain a copy of the Iowa 1990 305(b) report, contact:

Iowa Department of Natural Resources
Wallace State Office Building
Des Moines, IA 50319

Surface Water Quality

Of the 7,156 miles of streams assessed during 1988 and 1989, about 8 percent are not supporting the uses for which they were designated in the State's water quality standards and about 92 percent are partially supporting those uses. For lakes, 53 percent of the 80,306 assessed acres support designated uses, about 46 percent partially support, and the remaining do not support uses. Thirty-five percent of 26,489 assessed wetlands acres fully support designated uses, about 51 percent partially support, and about 14 percent do not support.

Of the four flood control reservoirs assessed, approximately 52 percent are fully supporting/threatened and 48 percent are partially supporting designated uses.

The failure of the assessed waterbodies of all types to fully support their designated uses is attributed primarily to nonpoint sources of pollution (mainly agriculture and urban runoff). Point sources, however, are identified as water quality impacts on approximately 10 percent of impaired stream miles. Although direct discharge of wastewater to lakes in Iowa is prohibited, one lake of 12 acres is impacted by a municipal point source. Impacts to water quality of all wetlands and flood control acres are attributed to nonpoint sources.

Most of Iowa's lake water quality problems can be attributed to agricultural nonpoint source pollution. Siltation from soil erosion is the primary concern. Since 1979, projects to control watershed soil erosion and improve lake water quality have been initiated for at least 19 Iowa lakes. Urban runoff, construction site runoff, land disposal of wastes, and hydrologic or habitat modification also pose threats to lake water quality in Iowa, though to a lesser degree.

Thirty-five fish kills were reported from October 1988 through September 1989. Most fish kills resulted from naturally occurring conditions, such as low dissolved oxygen, high levels of ammonia, or high water temperatures.

Sources of ammonia and oxygen-demanding substances include urban runoff, farm feedlots, and other nonpoint sources. One fish kill was attributed to ammonia from a possible spill.

Fish consumption advisories were issued for two waterbodies in 1989 due to high levels of chlordane or polychlorinated biphenyls (PCBs) in bottom- feeding fish. An existing advisory for a privately owned urban impoundment remained in effect.

Special studies conducted in 1988 and 1989 found that sediments in a portion of the Mississippi River near Davenport were contaminated with PCBs.

No surface drinking water supplies, bathing areas, or incidence of waterborne disease were reported.

Ground-Water Quality

Ground-water withdrawals account for nearly 85 percent of the total water uses in Iowa, with approximately 80 percent of all Iowa's drinking water coming from ground-water aquifers. The quality and quantity of Iowa aquifers vary throughout the State.

Major ground-water concerns in Iowa center around human activities and resultant ground-water contamination. Agricultural chemicals, landfills, underground storage tanks, agricultural drainage wells, livestock wastes, and improper management of hazardous substances all contribute to some degree to ground-water degradation. Several studies in northeastern Iowa have focused primarily on contamination involving nitrates, pesticides, and other manmade organic chemicals. High levels of nitrates have been detected in ground-water drinking water supplies throughout the State. Nitrogen fertilizer usage, animal wastes, and lagoons all contribute to elevated nitrate levels in ground water. Studies in several regions of Iowa have detected low levels of various pesticides in ground water. Runoff into agricultural drainage wells and sinkholes, as well as infiltration through soils, are believed to be the sources of pesticide contamination. The concentrations of pesticides found are thought to pose no immediate threat to public health. However, little is known about the effects of long-term exposure to low concentrations of

many of these chemicals or their breakdown products.

Synthetic organic compounds have also been detected in Iowa ground water. In several instances, concentrations have been detected that are high enough to be considered a health concern for long-term exposure.

Kansas

To obtain a copy of the Kansas 1990 305(b) report, contact:

Kansas Department of Health and Environment
Water Quality Assessment Section
Bureau of Water Protection
Forbes Field
Topeka, KS 66620

Surface Water Quality

During Water Years 1988-1989, Kansas assessed 12,144 miles of streams and 170,602 acres of lakes. Of the river miles assessed, 3 percent fully support designated uses. The primary cause (57 percent) of nonsupport is organic enrichment and the predominant source (54 percent) is runoff from nonirrigated crop land. Mineral intrusion from natural sources also impairs uses extensively.

Assessment of Kansas waters relative to their support of fishable/ swimmable goals of the Clean Water Act revealed that nearly 100 percent of assessed lake acres meet both the fishable and swimmable goals. Seventy-three percent of the river miles assessed meet the fishable goal, 19 percent partially meet the fishable goal, and 8 percent do not attain the fishable goal because of exceedances of FDA action levels for chlordane. Only 5 percent meet the swimmable goal, 13 percent partially meet the goal, and 82 percent of the assessed miles do not attain the swimmable goal based on exceedances of State standards for fecal coliform bacteria.

For lakes, the main causes of use impairment appear to be metals and nutrients. Agriculture and storm sewers/runoff are the leading sources of use impairment in the lakes.

Designated uses for wetlands in Kansas are limited to noncontact recreation and aquatic life support. Out of the 34,256 acres of wetlands assessed, 73 percent fully support and 27 percent partially support noncontact recreation use. Aquatic life is fully supported in 13 percent of this total acreage and is partially supported in 87 percent. The primary causes of impairment are dewatering, sedimentation, and metals. Agricultural activities are the leading source of wetlands impairment.

Ground-Water Quality

Kansans rely on groundwater resources for public, rural, industrial, and irrigation water supplies. Approximately 85 percent of all water used in Kansas is supplied from ground water. Irrigation continues to be the largest user of ground water. In rural areas, ground water supplies 85 percent of the drinking water.

Ground-water quality problems in Kansas are generally localized. More than 300 isolated groundwater pollution problems are known and are generally the result of human activities. Pesticide contamination of ground water is a site-specific problem; more analysis is needed to determine the extent of contamination. The Kansas Groundwater Quality Monitoring Network, established in 1976, is the principal statewide monitoring effort. The Kansas Department of Health and Environment has established a Bureau of Environmental Remediation to respond to State contamination cleanup needs. In 1988-89, 272 public water supply wells were screened. Fifteen percent of the wells sampled had levels of atrazine, alachlor, bromacil, metolachlor, or metribuzin above detection limits.

Kentucky

To obtain a copy of the Kentucky 1990 305(b) report, contact:

Kentucky Division of Water
Water Quality Branch
18 Reilly Road
Frankfort Office Park
Frankfort, KY 40601

Surface Water Quality

During the reporting period, Kentucky assessed 9,556 miles of streams and 214,861 acres of lakes. Approximately 69 percent of assessed river miles fully support their designated uses, as do 90 percent of assessed lake acres.

The major causes of use nonsupport in rivers are fecal coliform contamination, affecting primary contact recreation use, and organic enrichment and siltation, impairing warm-water aquatic habitat use. The major sources of the fecal coliform contamination are municipal wastewater treatment plant discharges and agricultural nonpoint sources. Municipal point sources are responsible for organic enrichment, and surface mining and agricultural nonpoint sources are the major sources of siltation.

Nutrients are the greatest cause of use nonsupport and affected the largest number of lakes. Municipal discharges and nonpoint sources, including agriculture, are the principal sources of nutrients. Iron and manganese are the second greatest cause of use nonsupport in lakes. Natural sources, surface mining, and unspecified nonpoint sources account for the greatest impacts to lakes.

A statistical trend analysis showed improvements in water quality, particularly an increase in dissolved oxygen in South Fork Elkhorn Creek, which was attributed to increased treatment of wastewater at the City of Lexington's Town Branch wastewater treatment plant. A trend in the Nolin River showed a deterioration in water quality that may be the result of the City of Elizabethtown's

municipal discharges into Valley Creek, which flows into the Nolin River.

Several trends were detected statewide, although specific causes were not readily apparent. Chloride increased at 14 of the 47 sites tested. The pH is increasing at many sites and decreasing at none. Total recoverable lead is decreasing at 16 sites and increasing at three sites. Degradation due to priority pollutants has occurred in some of the State's streams.

Forty-two fish kills totaling over 541,000 fish were reported in the past 2 years, affecting over 153 miles of streams. The number of fish kills reported and the number of waterbodies affected were lower than those reported over the past 10 years, but the number of miles affected and the number of fish killed were higher. Fish kills were most commonly attributed to sewage discharges. Bacteriological surveys were conducted on seven stream drainages. Municipal sewage treatment plant discharges were found to be a major source of recreational use impairment.

Ground-Water Quality

Underground storage tanks, septic tanks, abandoned hazardous waste sites, improper well construction, and oil and gas brine pits are estimated to be the top five sources of ground-water contamination in Kentucky. Lack of basic monitoring data prevents an assessment of the magnitude of the problem caused by these sources. Pilot wellhead protection studies have been initiated to gain experience in methods to detect and evaluate contamination of ground water.

Major concerns are protection of ground water for public water supplies, lack of consistent data gathering in a usable format by agencies involved in ground-water monitoring, and contamination from oil and gas exploration.

Louisiana

To obtain a copy of the Louisiana 1990 305(b) report, contact:

Louisiana Department of Environmental Quality
Water Quality Management Division
Planning and Assessment Section
P.O. Box 82215
Baton Rouge, LA 70884-2215

Surface Water Quality

Louisiana contains a plentiful supply of water resources comprising an estimated 290,000 river and stream miles, 866,646 lake/reservoir acres, and 7,656 square miles of estuaries. Of the 13,101 total river miles assessed, 66 percent are fully supporting designated uses, 23 percent are partially supporting designated uses, and 11 percent are not supporting designated uses. Eighty-one percent of the State's 854,331 assessed lake acres are fully supporting their designated uses, and 19 percent are partially supporting their designated uses. Of the 5,445 square miles of estuaries assessed, 70 percent are fully supporting their designated uses, and 30 percent are partially supporting designated uses.

The most frequently cited pollutants identified as causes of use impairment are oxygen-demanding substances, fecal coliform bacteria, nutrients, suspended solids, and oil and grease. The most commonly cited sources of pollutants are inadequately treated sewage discharges from municipalities, discharges and spills from petroleum activities, hydrologic modification, and agricultural runoff. At this time, nonpoint sources appear to be the predominant sources contributing to water quality problems in the State.

Ground-Water Quality

The quality of water in the State's major aquifer systems remains excellent. The deeper aquifers remain free from contamination. Of specific concern in Louisiana, however, are the shallow aquifers and the water-bearing zones that are not used as major sources of water. These strata, which have been shown to contribute significantly to the water balance of the deeper aquifers, are becoming increasingly threatened. This threat is two-fold. Site-specific contamination of these shallow strata presents a direct threat to the major aquifers by means of leakage through well bores, stratigraphic interconnections, and fractures. In addition, individual wells are located in these shallow strata and may become directly contaminated.

To address this growing problem, the Department of Environmental Quality now has a Ground Water Protection Division within the Office of Water Resources. In addition to enforcing State and Federal ground-water protection programs, the new Division has developed a State ground-water protection strategy concerning the safeguarding of all potential sources of drinking water from contamination. Proposed studies include continued baseline monitoring of industries in the New Orleans-Baton Rouge industrial corridor and the Calcasieu area, the determination of the effect of nonpoint source pollution on shallow and deep aquifer systems, and the Wellhead Protection Program (WHPP) focused on the inventory of potential contamination sources around drinking water wells.

Maine

To obtain a copy of the Maine 1990 305(b) report, contact:

Maine Department of Environmental Protection
State House Station No. 17
Augusta, ME 04333

Surface Water Quality

During Water Years 1988-1989, 31,672 river miles, 960,418 lake acres, and 1,633 square miles of estuary were assessed. This represents close to 100 percent of the total waterbodies in the State. Of the assessed waters, 98 percent of river miles, 80 percent of lake acres, and 90 percent of estuary square miles fully support their designated uses.

In the more populated areas of Maine, water quality is affected by a combination of point sources such as industrial and municipal effluents and nonpoint sources such as urban and suburban stormwater runoff, combined sewer overflows, agriculture, construction-related runoff, and waste disposal practices. Most of the larger municipal and industrial effluents now receive the equivalent of best practicable treatment. This has led to improved water quality in the State's major rivers in the past 20 years. Given the difficulties of controlling nonpoint sources, the low number of remaining untreated point sources, and the emergence of ground-water quality and hydropower as major concerns, it is doubtful that water quality improvements will continue at the same rate as in the past.

Ground-Water Quality

More than 60 percent of Maine households draw their drinking water from ground water supplied from private wells, public wells, or springs. In addition, approximately 60 percent of the water needs of Maine livestock are derived from ground water. Industrial ground-water use is slightly less.

Ground water in significant areas of the 11 percent of Maine that is not forested may be threatened by contamination. During the past decade, numerous wells in Maine have been made unpotable by nonpoint source pollution. Because of slow ground-water flow rates and low biological activity, ground-water contaminants are extremely persistent. Centuries may be required for natural processes to restore contaminated ground water to potable standards. Major sources of ground-water contamination in the State are leaking underground storage tanks, agricultural activities, municipal landfills, salt storage/road deicing, and septic systems.

In 1989, the State adopted the Maine Groundwater Management Strategy and, in 1990, formulated its Nonpoint Source Pollution Management Plan, which identifies the major sources of nonpoint source pollution to Maine ground water and surface water and proposes to implement pollution prevention programs during the next 4 years of the program.

Public misconceptions about ground water are probably the major factor contributing to degradation of this resource. Other impediments to effective ground-water protection in Maine are lack of an accurate ground-water quality database, lack of data to quantify nonpoint pollution source impacts, and inadequate State and Federal funding.

Maryland

To obtain a copy of the Maryland 1990 305(b) report, contact:

Maryland Department of the Environment
Chesapeake Bay & Special Projects Program
2500 Broening Highway
Baltimore, MD 21224

Surface Water Quality

The State's surface waters are of good quality and exhibit stable trends even though many problems still exist and new ones have been identified. The most serious of these problems is the continuing accumulation of nutrients in estuaries and impoundments. Suspended sediments continue to be a problem in both free-flowing and tidal waters. Locally elevated bacterial levels are found throughout the State and have resulted in some areas being closed to recreational bathing or shellfish harvesting. Acid mine drainage from many abandoned coal mines in western Maryland remains a long-standing, difficult problem to solve. Toxic metal and organic compounds, due to agricultural and urban runoff and industrial and municipal discharges, accumulate in sediments and in tissues of aquatic organisms and have led to a selective fish consumption advisory in the urban Baltimore area.

Of the 17,000 miles of rivers and streams assessed in Maryland, 92 percent fully support their designated uses, 7 percent partially support uses, and about 1 percent do not support their designated uses. Of the 21,002 acres of large public lakes assessed in the State, 55 percent fully support their intended uses, 27 percent fully support but are threatened, 17 percent partially support uses, and less than 1 percent do not support their intended uses. Of the 2,523 square miles of estuarine waters in the State, only 118.6 square miles (4.7 percent) fully supported their designated uses. No water quality impacts were noted along 32 miles of the open ocean coast.

Nutrients, sediments, and bacteria are the three major causes of use impairment in the State. These problems occur statewide and in all waterbody types. Organic enrichment and low dissolved oxygen levels are also a major problem, particularly in the Chesapeake Bay. Other causes of water quality impacts include high acidity, thermal modification, and salinity. Leading sources of impairment include agricultural and urban runoff, mining, construction, municipal discharges, and land disposal (failing septic systems and raw sewage input).

Ground-Water Quality

Ground-water resources in Maryland are an abundant natural resource. Although it

constitutes only 13 percent of the total water used in the State, ground water is of substantial cultural and economic importance. For example, ground water constitutes up to 97 percent of the total water used in some Eastern Shore counties. Approximately 15 percent of the State's population uses ground water as a drinking water supply; other major uses of ground water include livestock water supply, irrigation, and industrial uses.

On the whole, the State's ground waters are of acceptable quality. However, a number of localized instances of ground-water contamination exist. Locally serious impacts occur as a result of excess nitrates, bacteria, salt, toxic compounds, and petroleum products. In some cases, water supply wells have been closed.

Existing or potential sources of ground-water contamination in the State include septic systems, landfills and dumps, underground storage tanks, saltwater intrusion, agricultural activities, surface impoundments, injection wells, spills and improper storage, and land application of sewage sludge and wastewater.

Massachusetts

To obtain a copy of the Massachusetts 1990 305(b) report, contact:

Massachusetts Division of
Water Pollution Control
1 Winter Street, 8th Floor
Boston, MA 02108

Surface Water Quality

Water quality in Massachusetts has not changed significantly since 1988. The State reports that water quality impacts from point sources appear to be declining as a result of the construction and upgrading of wastewater treatment plants. Nonpoint sources, however, continue to degrade water quality and are more apparent now that control of point sources has improved.

Data for this reporting period indicate that 35 percent of the 1,624 river miles assessed fully support their designated uses, 29 percent partially support uses, and 36 percent do not support their uses. The most common cause of nonattainment is pathogen indicators and the most prominent source is urban runoff.

Over 40 percent of the State's lake and pond acres were assessed. Of the acres assessed, 31 percent fully support, 28 percent partially support, and 41 percent do not support designated uses. Major causes of nonattainment include nutrients and excessive aquatic plant growths. The major sources of these problems are unknown but are believed to be various nonpoint sources.

Of the State's marine waters assessed, 13 percent fully support, 13 percent partially support, and 74 percent do not support designated uses. The leading sources of the impairment of designated uses are combined sewer overflows and municipal sewage treatment plants.

Monitoring data indicate that 65 percent of the State's river miles meet the fishable goal of the Clean Water Act, 13 percent partially meet the fishable goal, and 22 percent do not meet the goal. Of the State's lake waters, 59 percent are fishable, 1 percent have fish consumption advisories, and 39 percent are under fishing bans. Of marine waters, 57 percent meet CWA fishable goals, 10 percent partially meet the goals, and 33 percent do not meet the goals. Priority organics and heavy metal contamination are the cause of fish consumption advisories and bans in the State.

Ground-Water Quality

In addition to municipal and privately owned wastewater treatment facilities, over 650,000 individual subsurface sewage disposal systems (septic systems) operate in the Commonwealth serving approximately 30 percent of the population, mostly in rural areas. Wastewater treatment, even on the level of the individual home system, must be designed and regulated to protect ground-water resources.

Currently, the protection of ground water from point sources of pollution is accomplished through the Department of Environmental Protection's Ground Water Discharge Permit Program administered by the Division of Water Pollution Control. All dischargers of pollutants into the ground waters require a wastewater discharge permit. Since adoption of the 1983 regulations, the Department has received 502 permit applications and has taken final action on approximately 360.

An integral part of the ground-water discharge permit program is the permit review process, which encompasses all the divisions within the Department. The review process ensures that the environmental concerns particular to each division within the Department are considered and addressed.

The majority of ground-water discharge permits issued to date are for sanitary sewage discharged to the ground by small privately owned sewage treatment facilities. The total discharge flow rate is approximately 13.5 million gallons per day. Industrial discharges account for 28 ground-water discharge permits with permitted flows in excess of 200,000 gallons per day.

Michigan

To obtain a copy of the Michigan 1990 305(b) report, contact:

Michigan Department of
Natural Resources
Surface Water Quality
Division
P.O. Box 30028
Lansing, MI 48909

Surface Water Quality

Water quality in Michigan's lakes and streams is generally quite good. The inland waters of the upper peninsula and the

northern half of the lower peninsula are of excellent quality and generally contain diverse aquatic communities. In the southern part of the State, lakes and streams have been affected by surface water runoff from agricultural land and urban centers and by municipal and industrial discharges.

During the reporting period, Michigan assessed 36,350 miles of streams, 489,433 acres of lakes, and 3,288 Great Lake shoreline miles. Designated uses were supported in 96 percent of the assessed river miles and 90 percent of assessed lake acres. Since all Michigan waters of the Great Lakes have public health fish consumption advisories in place for at least one species due to elevated levels of toxic materials in their tissue, the State's Great Lakes waters are considered to be not fully supporting their designated uses.

Four of the five Great Lakes border Michigan. Three of these lakes—Superior, Michigan, and Huron—are considered to be oligotrophic and of good quality. Water quality in Saginaw Bay of Lake Huron has improved considerably in recent years and has contributed to improved water quality conditions in Lake Huron. Conditions in Lake Erie have also improved. Lake Erie is still considered to be eutrophic, but biological communities are becoming more balanced and there are fewer problems with low dissolved oxygen levels. Michigan is currently preparing or implementing Remedial Action Plans for several Great Lakes nearshore Areas of Concern to improve water quality conditions in these historically degraded areas.

Over the past 20 years, pollution abatement efforts have reduced water quality problems in many Michigan waters. Eutrophication problems in particular have been substantially reduced due to major point source reductions in phosphorus and organic material loads. The State is now increasing its efforts at determining the magnitude of nonpoint source nutrient loads and implementing nonpoint source control programs.

Toxic contaminants continue to have a major impact on water resources in several areas of the State. Michigan implemented an industrial pretreatment program, promulgated new rules on the discharge of toxic materials, and regulated hazardous waste disposal facilities to control the discharge of these substances. However, many problems are due to in-place pollutants that have accumulated in bottom sediments from historical discharges. At present, little is known about the interaction of these materials with the aquatic environment, the extent of contamination in problem areas, the specific chemical compounds involved, or toxic material resuspension and transport rates.

Ground-Water Quality

Ground water is readily available at most locations in Michigan, although there are some places in the western upper peninsula and southern Michigan where yields are low. Most of the State's ground water is of exceptional quality and is used for a variety of purposes including domestic consumption, crop irrigation, food processing, and industrial processes. Approximately half of Michigan's residents, or about 4.6 million people, depend on ground water as their sole source of drinking water. The withdrawal of ground water for public consumption is the largest use of this resource in Michigan.

Certain aquifers have become contaminated by toxic materials leaking from waste disposal sites, businesses, or government facilities. Actual or potential ground-water contamination has been identified at 1,689 sites in Michigan. At this time, 65 of these sites are also on the Federal Superfund list and another 15 are proposed for inclusion.

At least 35 Michigan municipal well systems are known to have been affected by toxic contaminants and over 950 private residential wells are known to be contaminated. Even greater numbers of public and private wells are potentially affected by known contamination sites.

Various steps are being taken to protect the State's ground water including the cleanup of hazardous waste sites and contaminated aquifers, the regulation of activities that could potentially impact ground-water supplies, and monitoring ground-water quality. An interagency ground-water management and protection program is being implemented.

Minnesota

To obtain a copy of the Minnesota 1990 305(b) report, contact:

Minnesota Pollution Control Agency
Water Monitoring and Data Management Unit
520 Lafayette Road
St. Paul, MN 55155

Surface Water Quality

Of 91,944 total river miles in the State, 5,316 miles (approximately 6 percent) were assessed. Twenty-seven percent of the assessed river miles support designated uses, 10 percent partially support uses, and 63 percent do not support uses. Thirty-seven percent of the assessed miles fully meet the fishable goal of the Clean Water Act, and 41 percent fully meet the swimmable goal. Where these goals are not met, nonpoint source pollution has caused three times as many river miles to be out of compliance with the Clean Water Act as point source pollution. The most frequent pollutants encountered in streams were high levels of nutrients and fecal coliforms, low levels of dissolved oxygen, and mercury and PCBs in fish tissue.

Of the 12,034 lakes in Minnesota, 1,573 have been assessed for swimmable use. These assessments show 1,135 lakes (or 72 percent) support swimming. Assessment of fishable use in lakes is based on fish consumption advisories issued because of contaminants found in fish tissue. Over half of the

State's large lakes (34 of 62) have been sampled for contaminants in fish. Of these, four lakes have no fish consumption advisory, 29 lakes have advisories recommending no more than one meal per week or one meal per month for some sizes and species of fish, and one lake has an advisory recommending no consumption of some sizes or species of fish. Nonsupport in large lakes is primarily due to mercury contamination. Of the State's 11,972 smaller lakes, 233 have been sampled for contaminants in fish. Of these lakes, 13 have no fish consumption advisories, 218 have advisories recommending no more than one meal per week or one meal per month for some sizes and species of fish, and two lakes have advisories recommending no consumption of some sizes and species of fish. Generally, lakes in Minnesota are most often affected by nonpoint source pollution. In south and central regions of the State where agriculture is the predominant land use, nutrient loading from runoff is the major factor. Increased nutrient loadings to lakes cause algal blooms that interfere with swimming and aesthetic enjoyment of the lakes. In the northeastern part of the state, a recently completed study determined conclusively that mercury found in lakes and streams is predominantly due to atmospheric disposition. Mercury, as well as PCBs and dioxin, accumulates in fish, making them unsafe to eat.

While the rate of wetlands destruction in Minnesota appears to be slowing, the controlling factors are unclear. Wetlands have been incorporated into the assessment and management plans required by Section 319 of the Clean Water Act and into the local water management plans being developed by Minnesota's counties. The antidegradation policy that governs discharges to the State's waters includes discharges to wetlands.

Ground-Water Quality

At least 75 percent of all Minnesotans rely on ground water for their drinking water supply. Water use within the State is divided into five major categories: public water supply, irrigation, thermoelectric power generation, self-supplied industrial use, and heating and cooling. Data for rural domestic and livestock use, a significant part of ground-water use, were unavailable. Public water supply accounts for 40 percent of the ground water withdrawn, which was more than 267 billion gallons in 1988.

The MPCA's Ambient Ground Water Monitoring Program, established in 1979, has evaluated 1,100 samples, representing 487 monitoring points in the 14 principal aquifers. Samples included analyses for volatile organic carbons (VOCs) and pesticides in geologically sensitive areas. VOCs were detected in one-fourth of the 30 wells tested and one or more pesticides were detected in 39 percent of 725 wells. Elevated nitrate concentrations were commonly found in surficial aquifers and in areas of intense agricultural use. The MPCA is working with other State agencies to conduct a study of nitrate concentrations in Minnesota's ground water.

Through the efforts of the MPCA and the Environmental Protection Agency in attaining the goals of the Clean Water Act, control of point source pollution has vastly improved. As land use increases and intensifies, the adverse impact of nonpoint source pollution and toxic contamination presents an increasing challenge to the State to protect the quality of Minnesota's water. Cooperation among Federal, State and local levels of government, as well as citizen involvement, will be required to cope with the challenges of the future.

Mississippi

To obtain a copy of the Mississippi 1990 305(b) report, contact:

The Mississippi Department of Environmental Quality
Office of Pollution Control
P. O. Box 10385
Jackson, MS 39289-0385

Surface Water Quality

Of the State's 15,839 miles of rivers, approximately 48 percent fully support designated uses, 3 percent fully support uses but are threatened, 46 percent partially support uses, and 2 percent do not support uses. Approximately 50.5 percent of the stream miles meet the fishable goal of the Clean Water Act, 46.5 percent partially meet the goal, and 2 percent do not meet the goal. Approximately 83 percent of the State's rivers meet the swimmable goal of the Act. This assessment is significantly different from that reported in the 1988 Water Quality Report. Many more miles of rivers are shown as partially supporting designated uses and partially attaining the fishable goal of the Clean Water Act. Water quality in the State has not declined during the past 2 years. However, knowledge of the water quality of the State's rivers has expanded.

The most significant impacts on the State's streams were due primarily to nutrients and siltation and to a lesser degree to pesticides, priority organics, metals, chlorine, organic enrichment, low dissolved oxygen, suspended solids, and salinity. The major source of these pollutants is agricultural nonpoint sources. It is anticipated that with implementation of Best Management Practices, all streams classified for Fish and Wildlife or higher uses could potentially attain support of the fishable/swimmable goal.

Approximately 56 percent of the State's 500,000 acres of lakes fully support designated uses, 12 percent fully support designated uses but are threatened, while 32 percent are partially supporting of designated uses. Approximately 68 percent of the State's lakes meet the fishable goal of the Clean Water Act and 32 percent partially meet the fishable goal of the Act. Approxi-

mately 98 percent of the State's lakes meet the swimmable goal of the Act. Lakes rated as partially supporting their use classification are impacted by nonpoint sources primarily from agricultural activities.

Of the 133 square miles of estuaries assessed, 119.75 square miles fully support designated uses, 6.5 square miles fully support use but are threatened, and 6.75 square miles partially support uses. Approximately 95 percent of the estuaries meet the fishable/swimmable goal of the Clean Water Act.

Of the 81 coastal miles, 10 miles fully support designated uses but are threatened, 60 miles are partially supporting, and 11 miles are not supporting uses. Tidal streams were assessed independently of rivers. Of the 215.8 miles assessed, 71.2 miles fully support uses, 67.1 miles fully support uses but are threatened, 72.5 miles partially support uses, and 5 miles do not support uses. Municipal and industrial discharges along with runoff from nonpoint sources and septic tanks account for the impacts on coastal waters and tidal streams.

Of the 1,290 miles of rivers monitored for toxics, 188 miles were found to have elevated levels of pesticides, PCBs and/or dioxin in fish. In the past, toxics of concern had been identified at 25 of the 36 fish tissue sampling stations. However, only three of these stations were considered elevated. An apparent increase in DDT levels seen during this period is attributed to improved sampling, preparation, extraction, and analytical techniques. Historically, no elevated levels of toxics have been found in completed analyses for estuaries, coastal waters, or tidal streams, with the exception of dioxin in the Escatawpa River near Moss Point. However, recent data indicate significant declines in dioxin levels at this site. At present, four fish consumption advisories and three commercial fishing bans are in effect in Mississippi. The advisories and bans are due to PCBs, dioxin, or both.

Water quality improvements continue to result from implementation of regional wastewater treatment plants. Plant construction and expansion eliminated poorly treated discharges into several waterbodies. During 1988 and 1989, 45 municipalities, with a total of 57 facilities, upgraded their existing wastewater treatment to meet final effluent limits. Numerous private systems were also eliminated as a result of construction of regional systems, especially along the Mississippi Gulf Coast.

Ground-Water Quality

The ground-water quality in Mississippi is good; however, minor ground-water quality problems exist in some areas such as low pH, excessive iron, excessive dissolved solids, and excessive color. These natural ground-water quality problems reflect geochemical reactions with minerals and organic matter within the aquifers. Localized problems have been found near RCRA-regulated sites, industrial sites, and oil exploration areas. The Mississippi State Department of Health administers the Federal Safe Drinking Water Act for the State. New legislation in 1987 authorizes the Department of Environmental Quality, Ground-Water Division, and the Department of Agriculture to monitor impacts on ground water due to agricultural chemicals and establish standards for ground-water quality. Mississippi is currently working on a Ground-Water Classification and Quality Standards document based on recommendations made in the Ground-Water Protection Strategy.

Missouri

To obtain a copy of the Missouri 1990 305(b) report, contact:

Missouri Department of
Natural Resources
Division of Environmental
Quality
P.O. Box 176
Jefferson, MO 65102

Surface Water Quality

During 1988-1989, Missouri assessed 21,064 miles of rivers and 287,543 acres of lakes. Of the State's rivers and streams, 53 percent are fully supporting uses and 47 percent are partially supporting their uses. Most impaired waters are affected by extensive land uses, especially row crop agriculture. Of the State's lakes and reservoirs, 98 percent are fully supporting their designated uses.

The number of stream miles affected by point sources in Missouri has been dropping since 1984 as the result of sewage treatment plant construction and a statewide assessment program that has targeted projects of greatest need. Nonpoint source control efforts, however, have lagged behind. The most successful program to date has been the reclamation of abandoned coal mine lands. State-funded programs to address soil erosion are very small compared to the size of the problem and the area affected. Impacts from abandoned lead-zinc mining areas are highly amenable to treatment but are not being addressed because of lack of funds.

Another leading concern in the State is the continuing channelization (e.g., realignment, straightening) of streams, which reduces the quantity and quality of aquatic habitat, increases water temperature, and increases erosion and sedimentation. Also of concern are chronic water shortages in the northern and western part of the State and heavy residential development around Lake of the Ozarks.

Ground-Water Quality

The State has identified 17 areas of known ground-water contamination. These areas have been contaminated by a variety of compounds such as organic chemicals, pesticides, heavy metals, and nitrates.

Public and private wells are at risk or have been affected at a number of these sites. In addition, nitrates and bacteria from septic tanks and local surface contaminants are a problem statewide.

Ground-water protection activities include assumption of regulatory activities for a new State underground storage tank law as well as continuing programs in wellhead protection, sealing abandoned wells, closing hazardous waste sites, and large increases in ground-water and unsaturated soils monitoring. Educational programs for those involved with application of farm chemicals, transporters of hazardous material, and the general public will also be needed.

Montana

To obtain a copy of the Montana 1990 305(b) report, contact:

Montana Water Quality Bureau
Department of Health and Environmental Sciences
Cogswell Building
Helena, MT 59620

Surface Water Quality

Montana used the EPA Waterbody System (WBS) and the EPA Reach File for the first time to prepare their 1990 Section 305(b) water quality assessments. With these tools, the State improved the accuracy of stream mile estimates and conducted more systematic assessments of designated use support.

Montana assessed all 51,212 of its stream miles in the EPA Reach File (version 2). Of these, 68 percent fully support designated uses, 6 percent fully support uses but are threatened, 23 percent partially support designated uses, and 3 percent do not support designated uses.

Flow alteration, much of which results from dam releases and withdrawals for irrigation, is the leading cause of impairment in Montana's streams. Suspended solids, silt, dissolved solids (salinity), nutrients, habitat alteration, metals, thermal modification, and bacteria are other significant causes of impairment.

Point sources of pollution, primarily municipal and industrial discharges, contribute to less than full support in 11 percent of the State's impaired stream miles. The majority of stream impairments are attributed to nonpoint sources including agriculture, natural conditions, habitat/hydrologic modification, resource extraction, forest practices, and construction.

Of the 632,705 lake acres assessed, 5 percent fully support designated uses, 22 percent fully support uses but are threatened, 71 percent partially support designated uses, and 2 percent do not support designated uses.

Lake level alteration in water storage reservoirs is the leading cause of use impairment in Montana's lakes. Other significant causes include nutrients, suspended solids, metals, noxious aquatic plants, and organic enrichment. Each of these causes affects at least half of the assessed lake acres. The leading sources of lake impairment are agriculture, natural sources, habitat/hydrologic modification, and forest practices.

Only about 2 percent of Montana's lake acres and stream miles do not meet the fishable goal of the Federal Clean Water Act. An even smaller percentage of lake acres and stream miles do not meet the swimmable goal. According to Department water quality specialists, fishing and swimming are attainable in all waters that currently do not support these uses.

Elevated concentrations of toxic pollutants have been measured in approximately 40 percent of Montana's lake acres and 5 percent of stream miles. The principal causes of toxic contamination in surface waters are heavy metals from mill tailings and natural geothermal sources in Yellowstone National Park. In recent years, three Montana streams have experienced fish kills due to metals and pesticides, and one fishing advisory has been issued for 20 miles of Silver Creek.

Ground-Water Quality

The principal sources of ground-water contamination in Montana are underground storage tanks, injection wells, septic tanks, spills, abandoned hazardous waste sites, road salting, and agricultural activities. Principal substances contaminating ground water are metals, cyanide, volatile organic chemicals, nitrates, pesticides, and petroleum products.

Nebraska

To obtain a copy of the Nebraska 1990 305(b) report, contact:

Nebraska Department of Environmental Control
Box 94877
State House Station
Lincoln, NE 68509

Surface Water Quality

Very few significant water quality trends have been detected in Nebraska's streams over the past 10 years. Of Nebraska's 7,331 assessed stream miles, 55 percent fully support designated uses, 26 percent partially support uses, and 19 percent do not support designated uses.

Agricultural runoff is the principal source of use impairment in Nebraska. Other sources of use impairment are domestic point sources, habitat/hydrologic modifications, industrial discharges, and natural conditions. All of these sources impact the biotic integrity of affected streams.

About 60 percent of all publicly owned lake surface acres in Nebraska were assessed for support of designated uses. Of those lake acres assessed, 84 percent fully support all assigned uses. Aquatic life uses are impaired in those lakes not fully supporting their uses.

Agricultural runoff and the inherent characteristics of the lakes appear to be responsible for the high productivity and low dissolved oxygen levels in these lakes.

Data from 1979 through 1989 were available to determine water quality trends for 13 lakes representing 37,665 surface acres. Water quality showed no significant changes in four lakes covering 1,770 acres. These trends indicate that 95 percent improved, almost 5 percent maintained their water quality, and less than 1 percent showed degrading trends.

Nebraska notes a number of water-quality-related issues that are of concern. These include recreational use support, nonpoint source pollution, the lack of information on toxic pollutants, the need to redirect monitoring and data gathering activities, unlicensed landfills, and hazardous waste.

Ground-Water Quality

It is estimated that about 1,875,000,000 acre-feet of ground water lie in storage under Nebraska's surface. Ground water is an extremely important resource to Nebraska, supplying about 67 percent of the water used for irrigation and about 77 percent of the public water supplies.

Although Nebraska's natural ground-water quality is good, many areas have experienced degradation from human activities. Hundreds of cases of ground-water contamination have been documented, with numbers increasing each year. Major sources are agricultural activities, industrial facilities, leaking underground storage tanks, oil or hazardous substance spills, solid waste landfills, wastewater lagoons, brine disposal pits, and septic systems. The most commonly detected contaminants in Nebraska's ground water are nitrates and pesticides.

The Nebraska Ground-Water Quality Protection Strategy was recently updated. It puts forward a plan for ground-water quality protection that emphasizes the prevention of contamination. Many of the elements of this plan have been implemented.

Nevada

To obtain a copy of the Nevada 1990 305(b) report, contact:

Nevada Division of
Environmental Protection
Capitol Complex, Room 221
Carson City, NV 89710

Surface Water Quality

Of the 7,500 miles of rivers, streams, and creeks identified in Nevada, 3,359 miles have been classified by the State. Of the total, 3,354 miles are designated under the Clean Water Act (CWA) Goal as fishable and 2,915 miles are designated swimmable. The remaining waters, 4,141 miles, are unclassified.

Designated uses are assigned to classified waters in Nevada but not all waters have the same uses applied to them. These designated uses include aquatic life, wildlife propagation, recreation involving water contact, recreation not involving water contact, municipal drinking supply, stock watering, irrigation, and industrial supply.

Of the 1,447 river miles assessed, 31 percent fully support uses, 25 percent partially support uses, and 44 percent do not support uses. The fishable goal is attained in 51 percent of assessed river miles, and the swimmable goal is attained in 47 percent.

Sixty-five percent of the 198,725 assessed lake acres fully support designated uses, 27 percent partially support uses, and 7 percent do not support uses.

Of the lake acres assessed, 183,925 acres (93 percent) are fully or partially supporting their uses. For wetlands, 24,169 acres are not supporting the beneficial uses.

Since Nevada is a water-poor State, the water that is available is under great demand and is heavily used. The major users are agriculture and municipal and industrial sources. The impacts on water quality from the municipal and industrial sources have been reduced greatly over the last few years with most point source polluters eliminated from direct discharges or stringently controlled.

Nonpoint source pollution directly related to irrigation, grazing, and flow regulation practices has the greatest impact on the waters of Nevada. Temperature, pH, nutrients, dissolved solids, and dissolved oxygen are the main pollutants of concern and are being targeted in the Nonpoint Source Program.

Water quality has improved over the past 2 years because of the removal of point sources and the implementation of more stringent standards on the remaining point sources. Most exceedances are seasonal and natural, for example, pH and temperature. The Nonpoint Source Program will help to further improve water quality by promoting better grazing and irrigation practices.

The water quality standards adopted for Las Vegas Bay/Lake Mead for chlorophyll *a* and un-ionized ammonia are not being achieved because the City of Las Vegas Wastewater Treatment Plant and Clark County Sanitation District discharge into the Las Vegas Wash, which flows 11 miles to Las Vegas Bay. Ammonia and phosphorus are the pollutants of concern entering the bay.

The Truckee River continues to show improvement due to phosphate and nitrogen removal from the Reno/Sparks Wastewater Treatment Plant. In 1988 total nitrogen was exceeded in 100 percent of the samples collected; in 1989 there was only a 9 percent exceedance rate.

The Carson River water quality standard for total phosphates was exceeded for about two-thirds of its reaches. Total phosphates and pH and temperature exceedances occur during the summer months at low flows and can be attributed to nonpoint sources in Carson Valley, a major agricultural

area. A fish consumption health advisory has been issued for portions of the Carson River and Lahontan Reservoir since 1985 because of high levels of mercury. The area is now under consideration by EPA as a Superfund Site.

The Walker River has seen marked improvement in nitrates and phosphates with no violations reported during 1988 and 1989. However, pH and solids continue to be a problem mainly because of the low flows that occurred during this time.

The Humboldt River continues to have water quality problems because of very low flows during this time, which resulted in high TDS and turbidity levels. The river normally has a highly variable flow with a major irrigation/recreation reservoir on the lower end of the system (Rye Patch Reservoir) and a terminal sink. Major point sources have all but been eliminated.

Agricultural and rangeland nonpoint sources are contributing the large sediment and nutrient loads to the waters of the State. Urban drainage systems contribute nutrients, heavy metals and organic loads to the nonpoint source load. The Nonpoint Source Program should achieve reductions of these nonpoint source loads in the 1990s. Point sources are being eliminated where possible and their effects on water quality have been greatly reduced. These point sources have a major impact in only a very few river miles of the State.

Ground-Water Quality

Approximately 50 percent of Nevada's total population relies on ground water. Since surface waters are either fully allocated or overallocated, Nevada's future growth must rely heavily on untapped ground-water aquifers. Thus, protecting present and potential (i.e., untapped) ground-water aquifers is a high priority of the State.

Nevada initiated this protection effort by completing the "Ground Water Protection Strategy for Nevada" in June of 1989. The Strategy delineated Nevada's short- and long-term goals, recognizing both the priorities and limited resources available.

Major sources of ground-water contamination in the State include mining, underground storage tanks, injection wells, septic tanks, and landfills. Substances contaminating ground water include volatile organic chemicals, nitrates, petroleum products, radioactive material, fluorides, arsenic, and brine/salinity.

New Hampshire

To obtain a copy of the New Hampshire 1990 305(b) report, contact:

Water Supply and Pollution Control Division/DES
Water Quality Section
6 Hazen Drive
P.O. Box 95
Concord, NH 03301

Surface Water Quality

During 1988 and 1989, New Hampshire assessed 1,348 miles of its estimated 14,544 total river miles. Of the assessed river miles, 1 percent fully support designated uses, 63 percent currently support uses but are threatened, 25 percent partially support uses, and 11 percent do not support designated uses. Pathogen indicators, organic enrichment, low dissolved oxygen concentrations, and priority organics cause most of the impairments. Municipal and industrial point sources, as well as combined sewer overflows continue to be the major sources of impairment in New Hampshire's mainstem waterbodies. Onsite sewage disposal and other nonpoint sources contribute to use impairment to a lesser extent.

Of the 152,788 acres of lakes assessed, 88 percent fully support their designated uses and 4 percent fully support but are threatened. However, about 5 percent of the assessed waters only partially support designated uses and 3 percent do not support uses. Acidification and nutrient impacts are cited as the primary causes of nonattainment.

Industrial and municipal discharges are the major source of lake impairments. Moderate and minor effects from acid rain and natural acidity are also widespread. A recent survey found that 85 percent of New Hampshire's lakes and ponds are sensitive to acid rain, and only 50 percent of the State's lakes have satisfactory pH values during winter.

In March of 1989, New Hampshire issued the only fish advisory in effect. Currently, fishing is restricted on 15 miles of the Androscoggin River below Berlin due to dioxin discharges from the James River Corporation. Shellfish harvesting continues to be restricted in Great Bay and Hampton Harbor because of elevated bacteria concentrations generated by municipal treatment plants and nonpoint sources.

New Jersey

To obtain a copy of the New Jersey 1990 305(b) report, contact:

New Jersey Department of Environmental Protection
Bureau of Water Resources Management Planning
P.O. Box CN-029
Trenton, NJ 08625

Surface Water Quality

Approximately 76 percent of New Jersey's 1,719 assessed river and stream miles meet the fishable goal of the Clean Water Act. The swimmable goal is attained in only 15 percent of the 592 river miles assessed. All of New Jersey's public lakes are classified as threatened for attainment of clean water goals. The most frequent pollution problems are nutrients, siltation, depressed dissolved oxygen, and excess primary productivity.

Nonpoint source pollution is cited as the principal source of contaminants.

Pollutants commonly found in State waters include fecal coliform bacteria, nutrients, reduced dissolved oxygen levels, siltation, road salts, and oil and grease. Toxic substances in water, sediments, shellfish and fish tissue are generally found in low amounts in the State. Other types of known or suspected water quality problems are thermal modification/elevated stream temperatures, habitat alterations, pH fluctuations, and chlorine levels. Point sources affect every major waterway in the State. Nonpoint sources are also a major contributor to water quality degradation, but very little monitoring data exist to quantify their extent. Impacts are suspected from stormwater outfalls, construction, urban and agricultural runoff, land disposal practices, and hydrologic/habitat modification.

Ground-Water Quality

Currently, about half of the State's population relies on ground water for drinking water. Ground-water quality is considered naturally good in the State; however, treatment for some undesirable constituents of natural origins is warranted in some areas owing to the physical/chemical nature of the geologic materials housing the aquifer. The most common of these naturally occurring contaminants are iron, dissolved solids, sulfate, and hardness. Other less common yet significant contaminants are radium, lead, and barium.

As of December 1989, 3,086 ground-water pollution investigations had been performed. The most common pollutants found were volatile organic compounds, metals, base neutrals, acid extractables, and PCBs/pesticides. Other contaminants included miscellaneous landfill contaminants, undifferentiated petroleum hydrocarbons, gasoline, and fuel oil.

Underground storage tanks account for the largest percentage of ground- water pollution sources. Other common sources are land disposal sites, accidental spills and leaks, and unknown sources. The NJ Department of Environmental Protection recently formulated a strategy to coordinate the many ground-water management programs to upgrade overall effectiveness of resource management.

New Mexico

To obtain a copy of the New Mexico 1990 305(b) report, contact:

New Mexico Water Quality
Control Comission
Division Water Quality
Planning Section
1190 St. Francis Drive
Santa Fe, NM 87503

Surface Water Quality

Attainable or designated uses are not fully supported in 3,117 assessed river miles and 115,959 assessed lake acres. Fifty-four of the river miles are impaired largely due to discharges from 10 wastewater treatment plants. The remainder of the impaired river miles and all of the impaired lake acreage are solely or primarily impacted by a variety of nonpoint sources. The level of pollution is such that several of the State's designated uses (all subcategories of fishery uses, secondary contact recreation, irrigation, livestock and wildlife watering and domestic water supply uses) are not attained in almost 274 river miles; the CWA fishable goal is not attained in 266 of these miles. Pollution in these rivers and streams is so severe that the uses are seasonally or permanently precluded. None of the assessed lakes are impacted to the extent that the CWA fishable/swimmable goals or the State's designated uses are precluded.

The 3,117 river miles and 115,599 lake acres impaired represent a dramatic increase from the 576 miles of rivers and 47,308 lake acres reported as impaired in 1988. The primary reason for this difference is the result of the interagency nonpoint source assessment required under Section 319 of the Federal Clean Water Act. The additional river miles largely reflect ongoing, long-term nonpoint source problems and are only secondarily the result of new pollutant sources. Where point sources have been identified as causes of water quality impairments, actions have already been taken or are under way to solve the identified problems.

Available data indicate that New Mexico has been largely successful in reducing point source impacts on the State's rivers. Nonpoint sources now predominate. Heavy metal contamination, siltation, habitat alteration, and hydrologic modification are the predominant causes of use impairment in New Mexico's rivers and streams.

In the State's lakes, heavy metals, siltation, nutrients, and habitat destruction are major causes of use impairment. Agriculture and recreation are the major sources of these impacts. Point sources are not known to significantly affect attainment of designated uses in lakes.

New Mexico notes two issues of special concern: nonpoint source pollution and toxic substances. Ninety-eight percent of all water quality impairment of surface waters is due to nonpoint source water pollution. In addition, further investigation is needed of surface water quality impacts of toxic substances.

Ground-Water Quality

Approximately 88 percent of the total population of New Mexico depends on ground water for drinking water. Of those whose water comes from public water systems, 86 percent are supplied from ground-water sources. Overall, the quality of these waters is good, although there are significant pollution problems known to affect limited areas throughout the State.

Since the mid-1970s the State has been inventorying

incidents, causes, and sources of ground-water contamination around the State. At least 1,493 incidents of ground-water contamination have been documented. Ground-water contamination most frequently occurs in vulnerable aquifer areas where the water table is shallow. Slightly more than half of all cases have been caused by nonpoint source pollution, principally household septic tanks and cesspools.

The principal point sources of ground-water pollution have been leaking underground storage tanks, oil and gas production activities, mining and milling, sewage (including septage) disposal, dairies, and miscellaneous industrial sources.

Many population centers and mineral resource development areas have been established in vulnerable aquifer areas, with resultant ground-water quality problems. For example, the Albuquerque South Valley, located in the shallow water table zone along the Rio Grande, has problems with ground-water contamination from a variety of sources including septic tanks and industrial sources. The Espanola area is also located in the Rio Grande Valley and has ground-water contamination from septic tanks and leaking underground storage tanks.

The Ogallala Formation, in Lea County, is the principal freshwater aquifer in the region. Numerous instances of contamination by oil-field activities have been identified since the early 1950s. Nitrate contamination from septic tanks has also occurred in several areas of the county.

The Grants Mineral Belt in Cibola and McKinley Counties has been a major uranium-producing region of the United States. Seepage from active and inactive mill tailings ponds plus the long-term impacts of previously unregulated discharges and potential contamination from abandoned spoils piles constitute a continuing ground-water quality problem.

The San Juan Basin is second only to southeastern New Mexico as a petroleum producing region and produces most of the State's natural gas. Ground-water quality in the Basin has been impacted by oil and gas production activities and by landfills.

In Dona Ana County, ground-water contamination problems have been caused by disposal of dairy wastes.

New York

To obtain a copy of the New York 1990 305(b) report, contact:

New York State Department of Environmental Conservation
Bureau of Monitoring & Assessment
Division of Water
50 Wolf Road
Albany, NY 12233-3503

Surface Water Quality

During Water Years 1988-1989, New York assessed 70,000 miles of streams, 668,000 acres of lakes, 1,564 square miles of estuaries, 577 Great Lake shoreline miles, and 130 ocean coastal miles. Approximately 91 percent of its rivers and streams were found to fully support their designated uses, along with 57 percent of lake, pond, and reservoir acres, 73 percent of estuary square miles, 15 percent of Great Lake shoreline miles, and 46 percent of ocean coastal miles.

For approximately 237 river miles, 128,000 lake acres, and 145 square miles of estuary, toxic pollutants are a major impact. An estimated 70 miles of ocean coastline and 463 miles of Great Lakes shoreline are affected by toxics as well. Contaminated sediments are responsible for virtually all of this use impairment; together with other nonpoint sources, they constitute the major sources of water use impairment in the State. Industrial and municipal point sources are relatively minor contributors to use impairment.

Other areas of concern are: acid precipitation; PCB contamination of lakes; estuarine water quality, particularly in Long Island Sound and the New York City area of the Lower Hudson estuary; and contaminated runoff from urban storm sewers.

Ground-Water Quality

Approximately 6 million people in New York State use ground water as a source of water. Half of these people are on Long Island and the remainder are in upstate New York. The Department of Health has reported 275 public water supplies affected by toxic organic contamination of ground water. Of these, 126 water supplies on Long Island and 37 in upstate New York remain closed or abandoned.

Contamination by synthetic organic chemicals is the most significant threat to ground-water quality statewide. The three major categories of organic contaminants that are detected most frequently in ground water are

- Industrial/commercial synthetic organic solvents and degreasers, primarily 1,1,1-trichloroethane, trichloroethylene, and tetrachloroethylene;
- Gasoline and other petroleum products that contain the compounds benzene, toluene, and xylene; and
- Agricultural pesticides and herbicides, primarily aldicarb and carbofuran.

The primary sources of ground-water contamination by organic chemicals are spills, leaks, and improper handling at industrial and commercial facilities.

Petroleum contamination is also a significant ground-water quality problem. Sixty-five percent of the reported private well contamination in upstate New York is petroleum-related, and over 75 percent of spills recently reported in Nassau and Suffolk counties were due to inland spills or leaks of underground storage tanks. Ground-water cleanup operations are often marginally effective and are particularly difficult and expensive in the sandy soils encountered on Long Island.

Pesticide contamination, primarily by aldicarb, is a particular problem on Long Island, where it was used on potato fields. It has also been detected in ground water in upstate New York. A sampling survey of 330 wells in eastern Long Island detected aldicarb in concentrations exceeding the Department of Health's recommended guideline in 23 percent of the wells.

Nitrate contamination has been noted in two upstate public water supply wells. It is a more serious problem on Long Island, where nitrate concentrations are increasing in the major public water supply aquifers for most of the developed and agricultural areas. Primary sources of nitrate are agricultural and domestic use of fertilizer, subsurface disposal of sewage, and leaking sewer lines.

North Carolina

To obtain a copy of the North Carolina 1990 305(b) report, contact:

NC Division of Environmental Management
Water Quality Planning Branch
P.O. Box 29535
Raleigh, NC 27626-0535

Surface Water Quality

Of North Carolina's 37,222 miles of freshwater streams and rivers, 64 percent support their uses, 25 percent partially support uses, 6 percent do not support designated uses, and 5 percent were not evaluated. River basins located in the mountains tend to have the highest percentage of high quality streams, while more heavily developed piedmont or coastal plain basins have more stream mileage with use impairment.

Nonpoint sources account for use impairment in 85 percent of degraded streams. Major sources include agriculture, unspecified nonpoint sources, municipal wastewater treatment plants (WWTPs), and urban runoff. Sediments are the most widespread cause of stream impact. In the past the State has emphasized control of point sources; while this emphasis has had great positive benefit, effective nonpoint source control is more difficult to implement and continued progress in pollution control will probably be slower.

Overall, 96 percent of the surface area of lakes and reservoirs in North Carolina support their designated uses, 1 percent partially support uses, and 3 percent do not support their uses. The largest cause of use nonsupport has been coal-fired power plant discharges to two lakes (Hyco and Belews), which have resulted in excessive selenium levels in these lakes. Belews Lake no longer receives coal ash basin effluent, and Hyco Lake will no longer be receiving effluent in the near future. These actions should restore biota in both lakes. In addition, extensive efforts are underway to control eutrophication in two relatively new lakes, Falls and Jordan. The major sources of use impairment in lakes are in-place contaminants, industrial WWTPs, and agriculture. Major causes of lake problems are metals (primarily selenium) and aquatic macrophytes.

Of the State's 3,194 square miles of estuaries and sounds, 90 percent fully support their designated uses while 9 percent partially support uses (because of closed shellfish areas or areas of excessive algal growth) and less than 1 percent do not support their designated uses. Major sources of impairment in estuarine waters are agriculture, municipal WWTPs, septic tanks, and urban runoff. Major causes of impacts in estuaries are chlorophyll *a* and nutrients, and bacteria. Several new or expanded efforts are underway to protect estuarine waters including expanded control of stormwater runoff to surface waters, nutrient control measures in several coastal watersheds, and protection of primary nursery areas.

Ground-Water Quality

About half of the people in North Carolina use ground water as their primary water supply. Ground-water quality is generally good statewide. The major source of ground-water contamination is leaking underground storage tanks; spills, lagoons, and septic tanks are also important sources. Comprehensive programs are underway to (1) assess potential contamination sites and (2) develop a comprehensive ground-water protection strategy for the State.

Over the past few years the following issues have emerged as critical to the long-term protection of ground water in North Carolina:

- Identification of leaking underground storage tanks
- Remediation of ground-water contamination sites
- Assessment of pesticide impacts on ground water
- Management of, and access to, information
- Setting permit conditions to protect ground water
- Improved understanding of basic hydrogeologic processes.

Finding solutions to these problems has shaped the development of North Carolina's Groundwater Protection Program over the past 2 years.

The State has three fundamental strategies for managing ground-water resources. First, the State establishes and enforces construction, monitoring, and reporting guidelines for facilities that generate or treat waste that can pollute ground water. Second, where ground water has been contaminated or is threatened, action is required to control the pollution and restore the ground water to the extent feasible. Third, the resource must be prudently managed to ensure adequate ground-water quality and availability to support present and future growth and development. These fundamental strategies form the foundation of the State ground-water program and have been incorporated into the following program goals:

- Prevent pollution of

ground-water resources

- Respond to contamination incidents and restore the resource
- Wisely manage the ground-water resource.

Over the past 2 years, incident response capabilities have been significantly increased with the addition of 52 staff to implement Federal and State leaking underground storage tank (LUST) trust funds. Other major initiatives include the following:

1. A State-funded, interagency, comprehensive study to determine whether pesticides are impacting ground water in the State.
2. DRASTIC mapping of the State on a county-by-county basis. Several Federal and State programs will support this effort.
3. An Ambient Ground-water Monitoring Strategy to establish environmental indicators of ground-water quality and improve understanding of natural processes.
4. A long-term project for the mapping of recharge and discharge areas across the State.

North Carolina is currently in the process of implementing a basinwide management program. This effort will involve the coordination of many aspects of North Carolina's water quality management program, including wasteload allocations, monitoring, permitting, compliance, planning, and other activities. The objective of this program is to develop consistent and effective water quality management strategies, including the equitable distribution of assimilative capacity. Basin plans will be prepared at the end of each cycle and, it is hoped, will serve to meet many of EPA's reporting requirements, including those for Sections 305(b), 303(d), 314, and 319 of the Clean Water Act.

North Dakota

To obtain a copy of the North Dakota 1990 305(b) report, contact:

North Dakota Department of Health and Consolidated Laboratories
Division of Water Supply and Pollution Control
1200 Missouri Avenue
P.O. Box 5520
Bismarck, ND 58502-5520

Surface Water Quality

Of the 9,173 miles of assessed rivers and streams in North Dakota, 1,350 miles are moderately to slightly impaired by point source pollution and all assessed miles are impacted to some degree by nonpoint source pollution. Of the assessed river miles, 75 percent are fully supporting their designated uses and 25 percent are partially supporting uses. No river or stream segment is identified as not supporting designated uses. The major pollutants causing some impairment to streams in the State are nutrients and siltation. The primary source of these pollutants is nonpoint source pollution, primarily in the form of runoff of nonirrigated cropland, pasture land, and feedlots. Other nonpoint sources of pollution are loss of riparian vegetation and wetland drainage.

Of the 611,075 lake acres assessed, 221,734 acres do not support designated use. This nonsupport is caused by the severe drought of 1988 and 1989, compounded by a policy of reservoir drawdown for downstream river uses at the expense of the beneficial uses of the reservoirs. An additional 33,082 lake acres partially meet designated uses. The major cause of partial use support is periodic fish kills caused by low dissolved oxygen concentrations resulting from the decomposition of accumulated organic matter. Major sources of pollutants are nutrients from agricultural runoff and internal nutrient cycling from the sediments. Sedimentation or siltation is the major pollutant threatening lakes and reservoirs. Toxic pollutants of concern are trace metals, primarily chromium, copper, lead, and arsenic. The source of these metals is believed to be a result of the highly erosive soils in that area compounded by nonpoint source pollution activities such as overgrazing and oil exploration and extraction activities.

North Dakota has approximately 2 million wetlands acres. The loss of wetlands in the State is estimated at 20,000 acres per year since 1986. With the advent of legislation designed to eliminate Federal subsidy payments to producers who drain wetlands, the annual loss of wetlands appears to have been reduced to approximately 10,000 acres per year. Drainage continues to be the greatest threat to wetlands; however, nonpoint source pollution problems such as siltation and pesticide contamination are gaining recognition as significant threats.

Ground-Water Quality

Ground water is one of North Dakota's most precious resources. Nearly the entire rural population and many municipalities obtain their water from ground-water supplies. Sixty percent of the State's population relies on ground water for its drinking water source.

North Dakota is primarily an agricultural State with limited industrial development. As a result, it has experienced relatively minor ground-water contamination problems in comparison to heavily industrialized States. The majority of ground-water contamination incidences reported to date are associated with hydrocarbon spills or leaks. Other sources of ground-water contamination are agricultural chemicals (e.g., pesticides and fertilizers), storage tanks and pipelines, wastewater impoundments, solid waste disposal sites, oil and gas exploration activity, and septic systems.

North Dakota's ground-water protection strategy is the core of its ground-water program. The strategy reviews current State and Federal ground-water protection programs and addresses issues such as standards, classification, monitoring, and data management.

Other programs that provide ground-water protection are the point and nonpoint source pollution control programs, the public water supply program, the underground injection control program, the construction grants program, the solid waste management program, and the hazardous waste management program.

Ohio

To obtain a copy of the Ohio 1990 305(b) report, contact:

Ohio Environmental Protection Agency
Division of Water Quality Monitoring and Assessment
P.O. Box 1049
Columbus, OH 43266-1049

Surface Water Quality

Of the total 7,444 assessed stream miles in Ohio, 30 percent are attaining their aquatic life use designations, 6 percent are currently supporting uses but are threatened, 21 percent are partially attaining those uses, and 43 percent are not attaining aquatic life uses. Since the State's sampling program is necessarily biased toward stream segments in problem areas, the actual percentage of total stream miles attaining their aquatic life uses in Ohio is probably higher.

The proportion of stream and river miles fully supporting aquatic life uses is less than reported in 1988, but not because of reductions in water quality. In fact, continued reductions are evident in point source loadings. Changes in use support are largely the result of the adoption of ecoregional biological criteria in Ohio, and a reassessment of all stream segments for which biological data were available. Two new indices and the use of reference sites to set biocriteria have resulted in more sensitive aquatic life criteria for Ohio's waters.

Municipal (including combined sewers) and industrial point source discharges accounted for impacts in 41 percent of stream miles. Nonpoint sources were contributors in 32 percent; habitat/flow modification in 17 percent; and natural conditions, in-place pollutants, and other or unknown in the remainder. Most waterbody segments were affected by multiple sources. Leading causes of nonattainment include low dissolved oxygen/organic enrichment, siltation, habitat degradation, metals, and ammonia.

Trend analyses of data from 11 Ohio rivers indicate a sharp improvement where the biota had been affected by municipal discharges and less improvement where industrial discharges, residual toxic impacts, and extensive habitat degradation have been affecting the biological community. Overall, Ohio has made dramatic improvements in rivers that were grossly polluted 20 to 30 years ago. Many miles are still impaired, but it is estimated that their impairment is not nearly as severe as in the past. However, fish tissue data are conspicuously lacking for many areas of the State. Results that are available for PCB content in fish tissue show a substantial number of areas with concentrations at levels of concern.

In Ohio's inland lakes and reservoirs, on average, 8 percent of assessed acres fully support uses and Clean Water Act goals, 65 percent partially support uses, and 2 percent do not support uses. The remaining 25 percent is considered to be attaining but threatened. Agricultural nonpoint sources, point sources, and urban runoff and septic tanks were major sources of use impairment in lakes. Leading causes were identified as sedimentation and corresponding loss of volume, nuisance macrophite growths, nutrient enrichment, and general aesthetics.

The Lake Erie assessment has not been updated since 1988 because no new data were available. Thus, use statistics have not changed. All 236 of Ohio's Lake Erie shoreline miles are considered partially supporting due to a lakewide fishing advisory for carp and channel catfish and to criteria exceedances for copper and cadmium.

Assessment of the Ohio River resource focused on the level of support of its designated uses and the level of achievement of the Clean Water Act fishable and swimmable goals. An overall evaluation of beneficial uses indicated full use and goal support for about 30 percent of the river's 981 miles, partial use and goal support for about 60 percent, and nonsupport of uses and goals for about 10 percent. Major sources of partial support and nonsupport are combined sewer overflows, urban runoff, and municipal discharges. Causes of partial and nonsupport are elevated levels of volatile organic compounds, violations of the fecal coliform criterion, and elevated levels of PCBs and chlordane in the tissue of certain fish species.

Ground-Water Quality

NOTE: Information for this section is contained in Volume IV of Ohio's 305(b) report, which was unavailable.

Ohio River

To obtain a copy of the Ohio River 1990 305(b) report, contact:

Ohio River Valley Water Sanitation Commission
49 East Fourth Street
Suite 815
Cincinnati, OH 45202

Surface Water Quality

The Ohio River Valley Water Sanitation Commission (ORSANCO) coordinates water pollution control efforts for the 981 river miles of the Ohio River. All river miles were assessed, and all are partially supporting their designated uses.

The fishable goal of the Federal Clean Water Act is met in 434 miles and partially met in 547; the swimmable goal is met in 579 miles, partially met in 64 miles, and not met in 338. The issuance of fish

consumption advisories by Pennsylvania, West Virginia, Ohio, and Kentucky in 1989 led to the large increase of river miles not fully attaining the fishable goal as compared to water years 1986 and 1987. The fish consumption advisories were issued due to levels of PCBs and chlordane in fish tissue of certain species (primarily catfish and carp) above action levels established by the U.S. Food and Drug Administration. The causes of nonattainment of the swimmable goal are combined sewer overflows, urban runoff, and municipal discharges.

The primary causes of use impairment are concentrations of copper and lead, which frequently exceed stream criteria developed for the protection of aquatic life. The major sources of these metals are nonpoint sources (mine drainage, urban runoff and agriculture), industrial point sources, and combined sewer overflows.

The multiple uses of the Ohio River are at times in conflict and create special challenges to water pollution control efforts. Concerns have arisen over maintaining water quality for all uses as required by the Ohio River Valley Water Sanitation Compact. The following specific areas require attention:

■ Spills and Accidental Discharges. During water years 1988 and 1989, there were several large spills to the Ohio River that caused the closure of public water supply intakes and the number of spills reported to the Commission increased markedly. The Commission is addressing this concern with increased communication and coordination of spill prevention and response personnel in the Ohio River basin.

■ 1988 Drought Conditions. Low-flow conditions experienced during 1988 impacted water utilities using the Ohio River. Increased sodium concentration in the water led to the issuance of health advisories. The low-flow/high-temperature conditions also caused severe taste and odor problems for most of the water utilities.

■ Biological Resources Characterization. A characterization of the biological resources in the Ohio River would provide more concrete information for water quality assessments, which are currently based primarily upon chemical monitoring data.

■ Hydropower Development. The proposal to operate hydroelectric power generation facilities at all dams on the Ohio River and at many dams on tributaries raises the concern of the potential loss of aeration at the dams. The Commission will be actively involved with State and Federal agencies and project developers in monitoring water quality and identification of impacts due to hydropower development.

■ Combined Sewer Overflows. During periods of rainfall, the combined sewer systems of communities along the Ohio River overflow and discharge untreated sewage directly to the Ohio River. This problem was pronounced during the unusually wet spring and summer of 1989. There are two major concerns: (1) any discharge of untreated sewage represents a violation of the Commission Pollution Control Standards and (2) these discharges are a threat to recreational use of the Ohio River.

Ground-Water Quality

Over 130 communities along the Ohio River rely on the aquifer as their public water supply. These communities deliver potable water to almost one million people. Because of this use and the potential for much greater use there is a need for aggressive protection efforts for this resource.

The Commission's major concern is monitoring, assessing, and protecting surface waters in the Ohio River Basin. As part of this effort, the Commission will be assessing the impact of ground-water contamination as a nonpoint source of pollution to the Ohio River. The alluvial aquifer associated with the main stem of the Ohio River is vulnerable to contamination due to extensive industrial development along the Ohio River. Major sources of ground-water contamination are surface impoundments, industrial spills and leaks, and regulated hazardous waste sites. Contaminants include volatile and synthetic organic chemicals, metals, and petroleum products.

Oklahoma

To obtain a copy of the Oklahoma 1990 305(b) report, contact:

Oklahoma Department
of Pollution Control
P.O. Box 53504
Oklahoma City, OK 73152

Surface Water Quality

During the 1988-1990 reporting period, Oklahoma constructed a waterbody-specific computer database for tracking assessment information. As a result of implementing the new program, the State assessed fewer stream miles (4,400 miles) for the 1990 Section 305(b) report than in previous years. Of the assessed stream miles, 6 percent fully support designated uses, an additional 52 percent currently support uses but are threatened, and 42 percent partially support their designated uses. None of the States' waters were found not to be supporting designated uses.

A total of 441,092 lake acres were also assessed. Of these, 8 percent fully support designated uses, 44 percent fully support uses but are threatened unless pollution control actions are taken, and 48 percent partially support designated uses. The State did not report any lake acres as not supporting their designated uses. Nutrients, suspended solids, and turbidity are the most commonly reported problems in Oklahoma's lakes. Agriculture, urban runoff, and resource extraction are the primary sources of concern.

The State also rated the trophic status of 67 "major" lakes with a surface area exceeding 100 acres and/or a high degree of public use. Eight lakes were classified as hypereutrophic, 35 as eutrophic, 17 as mesotrophic, and 7 were classified as oligotrophic.

In 1990, Oklahoma initiated an ambient toxicity testing program in conjunction with EPA Region 6. Biotoxicity tests are performed quarterly on sediment and/or water samples collected from waterbodies with suspected toxics concerns. Currently, 11 sites are included in the toxicity testing program.

The toxicity program and waterbody tracking system are examples of Oklahoma's efforts to improve problem detection and source identification. The State intends to develop and implement solutions to their water quality problems as additional assessment information is incorporated into the waterbody system and sources are identified.

Ground-Water Quality

Ground water is an important natural resource in Oklahoma, particularly in the western half of the State. Twenty-two major aquifers are used as sources of community drinking water and countless more minor aquifers are used as drinking water sources by individuals. Relatively speaking, little ground-water contamination has been documented and the pollution that is known is localized and being remediated. The Oklahoma State Department of Agriculture (OSDA) surveyed community drinking water wells to identify those wells potentially at risk from the use of agricultural chemicals. No problems were detected and those wells that were felt to have some potential for problems have been advised on best management practices that should be followed to ensure a continued safe drinking water supply.

The Oklahoma Water Resources Board (OWRB) maintains a ground-water quality network in 21 major ground-water basins in Oklahoma. The network, established in 1983 and reorganized in 1986, consists of approximately 184 domestic, irrigation, stock, and municipal water wells. Wells are sampled each year during July and August and samples are analyzed for approximately 19 inorganic constituents.

The Oklahoma State Department of Health (OSDH) routinely monitors community drinking water wells for nitrates, coliform bacteria, and other basic drinking water quality parameters. OSDH is also sampling all community drinking water wells for volatile organic compounds.

There are several sites of ground-water contamination directly attributable to anthropogenic sources. The Town of Cyril must abandon its ground-water-based drinking water supplies because of saltwater contamination. The contamination is believed to be caused by improper disposal of brine during past oil and gas production activities. In the communities of Miami, Vici, and Frederick, leaking underground storage tanks have contaminated shallow ground-water-containing formations but pose no serious threat to drinking water supplies. It is expected that more localized sites of ground-water contamination will be discovered as more intensive surveys are conducted. Leaking underground storage tanks and improperly operated septic tanks are examples of the types of sources of localized ground-water contamination that may be distributed across the State.

Oregon

To obtain a copy of the Oregon 1990 305(b) report, contact:

Oregon Department of
Environmental Quality
Water Quality Division
811 Southwest Sixth Avenue
Portland, OR 97204

Surface Water Quality

During the reporting period, Oregon assessed 27,738 miles of streams and 504,928 acres of lakes. Of the assessed river miles, 45 percent fully support designated beneficial uses, 31 percent partially support uses, and 24 percent do not support their designated uses. Of the assessed lake acres, 74 percent fully support uses, 12 percent partially support uses, and 14 percent do not support their designated uses.

Major causes of nonsupport in rivers include dissolved oxygen, bacteria, nuisance aquatic growth and nutrients, solids, habitat alterations, flow alterations, and thermal modifications. Major sources of impairment in rivers include point sources, agriculture, range, silviculture, urbanization, and recreational activities. In lakes, major causes of nonsupport include nutrients, pH, and organic enrichment (low oxygen). Major sources of impairment for lakes include agriculture, land disposal, and storm sewers/runoff.

The State is in the process of establishing Total Maximum Daily Loads (TMDLs) for 11 "water quality limited" stream segments where water quality standards are not being met. This process reflects a major program change from technology-based permitting with a greater emphasis on the receiving waterbody.

Oregon has 21 major estuaries, with a total of 131,844 acres of intertidal and subtidal estuarine habitat. The total of Oregon's nearshore submerged and submersible lands is over 800,000 acres. Knowledge of the water quality in Oregon estuaries is very limited. The monitoring in estuaries is predominantly related to fecal coliform monitoring in commercial shellfish growing areas. Monitoring for other conventional pollutants such as nutrients or priority pollutants such as heavy metals and pesticides is not being conducted.

Although the extent of wetlands remaining in Oregon has not been fully evaluated, intensive

wetlands-inventory projects are now in progress at several Federal and State agencies. Preliminary estimates for existing wetlands are 131,844 acres of estuarine wetlands and 30,000 acres of inland freshwater marsh. Historically, there has been a steady decline in wetlands throughout the State and, despite some relatively recent efforts at mitigation, there continues to be a net loss of wetlands.

Major point source issues of concern in Oregon are

- Discharges of dioxin from pulp mills that use chlorine for bleaching their pulp
- Potential water quality degradation from cyanide heap leaching processes used in mining
- The need for improved waste handling facilities at confined animal feeding operations
- Discharge of irrigation runoff from container nurseries
- Potential ground-water problems resulting from the use of disposal wells.

Ground-Water Quality

In Oregon an estimated 1.6 million persons (about 60 percent of Oregon's population) depend on ground water for all or part of the daily water needs. An average of 1.1 billion gallons per day of ground water were withdrawn in Oregon during 1980. Of this amount, 75 percent was for irrigation use, 12 percent for rural domestic and livestock use, 7 percent for industrial use, and 6 percent for public water use. Ground-water use is expected to increase in the future because the State's population is growing and because summertime flow in many streams is inadequate to meet present and future demand.

The number of known ground-water contamination sites in the State has increased to over 200, and is rising steadily, in part due to increased assessment activities. To date, ground-water contamination resulting from industrial activities has been discovered at approximately 75 sites in Oregon. The types of industries that have been found to be causing ground-water pollution include chemical manufacturing, metals plating, wood treatment, oil/gas storage and refueling areas, electronics, food processing, aluminum plants, and pulp and paper mills. Among the contaminants from these industries are organic chemicals, dissolved metals, nitrates, cyanide, and total dissolved solids. Other sources of ground-water contamination in Oregon include landfills, onsite sewage disposal, municipal sewage treatment facilities, and agricultural activities.

The State Groundwater Protection Act was passed in 1989 to address nonpoint source ground-water contamination problems such as those resulting from agricultural practices. The Act requires an interagency strategy for resolving existing inconsistencies or conflicts between programs dealing with nonpoint sources of ground-water pollution. It focuses on management and protection of ground water through assessment activities, research, education, and demonstration projects. The Act also requires a statewide ambient monitoring program, the establishment of a data repository, hydrologic characterizations, research, and establishment of Best Management Practices, and criteria for setting ground-water standards. DEQ, as the lead agency in implementing the Groundwater Act, is working with the Agriculture Department, Oregon State University, the Agriculture Extension Service, the Water Resources Department, and the State Health Division in establishing a ground-water program in Oregon.

Pennsylvania

To obtain a copy of the Pennsylvania 1990 305(b) report, contact:

Pennsylvania Department of Environmental Resources
Bureau of Water Quality Management
P.O. Box 2063
Harrisburg, PA 17120

Surface Water Quality

A total of 23,832 miles out of approximately 50,000 total miles of rivers and streams were assessed for this report. This represents an increase of 10,590 miles assessed over the 1988 report. Approximately 80 percent of the miles assessed fully support designated stream uses, 8 percent partially support, and 11 percent do not support uses.

The most extensive causes of water quality degradation in Pennsylvania streams are low pH, heavy metals, and turbidity/suspended solids from abandoned coal mine drainage. Although some funding is available for abatement of abandoned mine drainage, the immensity of the problem and difficulties associated with control have severely hampered abatement and treatment projects. These difficulties are expected to continue. Other major causes of use impairment are reduced oxygen concentrations due to oxygen-consuming materials and nutrients; increased nutrient loads and turbidity/suspended solids associated with cropland, pasture land runoff, and livestock in streams; and organics, metals, and dissolved solids.

In addition to abandoned mine drainage, major sources of reported degradation are agriculture, municipal point sources, other nonpoint sources, industrial point sources, natural conditions, undetermined sources, and onsite wastewater systems. Each of these sources affects more than 100 stream miles.

Pennsylvania assessed trophic status in 53 significant publicly owned lakes. Of these, 13 are eutrophic. Designated uses are classified as threatened in 29 and impaired in portions of 4 publicly owned lakes. Toxic pollutants have become a source of concern and action in recent years. Assessment records indicate that, excluding impacts due to heavy metals from abandoned mine drainage, approximately 375 stream miles are reported as impacted by toxics.

Pennsylvania is receiving the most acidic precipitation in the Nation. It is a long-term problem that is adversely affecting water quality. Limited available data indicate that precipitation pH values are relatively uniform across the State, with lower values in western Pennsylvania and slightly higher values in the east. Recent studies have indicated that the water quality impacts are occurring in small headwater streams on poorly buffered watersheds and in vulnerable Pocono Mountain lakes.

Ground-Water Quality

Ground water is one of Pennsylvania's most valuable natural resources. It supplies the drinking water needs of approximately 50 percent of the State's population through public and domestic water supplies. In many rural areas, it is the only available source of water supply. It also provides sustaining baseflow to the State's 50,000 miles of surface water during dry weather.

Ground-water quality is believed to be generally acceptable for drinking with only minor treatment. However, in some areas of the State, some form of water treatment may be required due to natural or man-induced conditions. Coal mining has contributed high concentrations of iron, potential acidity, sulfate, dissolved solids, noncarbonate hardness, and manganese in portions of western Pennsylvania and in the hard coal areas in the eastern part of the State. High chloride, dissolved solids, strontium, barium, iron, and magnesium concentrations may be encountered in oil- and gas-producing areas of western and northern Pennsylvania. Carbonate hardness and nitrate problems are generally limited to the carbonate aquifers in the central and southeastern part of the State.

The major source of ground-water contamination in Pennsylvania is leaking underground storage tanks. Other sources include coal mining (abandoned and active sites), surface impoundments, land application of animal waste, municipal waste landfills, and chemical plants. The major pollutant cause statewide is petroleum and/or its byproducts. Other causes include organic and inorganic chemicals, radionuclides, pesticides, and fertilizer.

Ground-water protection has become a priority issue in Pennsylvania in recent years. A draft Ground Water Protection Strategy, completed in December 1989, protects ground-water quality through the application of best demonstrated control technologies for permitted activities, the use of BMPs in other activities, and the application of antidegradation strategies and program measures to protect unique ground-water resources. In addition, ground-water monitoring and data assessment programs are being implemented by the Bureau of Water Quality Management.

Pennsylvania's Storage Tank and Spill Prevention Act, effective August 5, 1989, addresses ground-water contamination from storage tanks. The law provides for permitting of all regulated tanks and cleanup of release/spill sites.

Puerto Rico

To obtain a copy of the Puerto Rico 1990 305(b) report, contact:

Puerto Rico Environmental Quality Board
Water Quality Area
P.O. Box 11488
Santurce, PR 00910-1488

Surface Water Quality

Puerto Rico has approximately 5,373 stream miles. Of these, 39 percent fully support designated uses and 11 percent fully support but are threatened. Twenty-two percent partially support uses and 28 percent do not support uses. Pathogens, nutrients, and flow alteration are the leading causes of use impairment in streams; leading sources include agricultural activities (feedlots and crops), land disposal (landfills and wastewaters from communities), and urban runoff.

Thirty-one percent of Puerto Rico's 11,146 acres of lakes and lagoons support designated uses and 1 percent support but are threatened. Principal causes of nonsupport in lakes include organic enrichment/reduced dissolved oxygen levels, nutrients, and pathogens, primarily from nonpoint sources.

Of 434 coastal shoreline miles, 58 percent fully support designated uses and 9 percent support but are threatened. Major causes of impairment include pathogens, nutrients, and suspended solids. Sources of impairment in coastal waters include urban runoff and municipal and industrial discharges.

Lakes, lagoons, estuaries, and wetlands were identified as special concerns because of their value as critical habitats. In order to more accurately assess their problems and water quality status, a need for better monitoring strategies for these waters was noted.

Ground-Water Quality

The principal uses of ground water in Puerto Rico include potable water supply, industrial processing, and agricultural activities. Ground water is used extensively and provides about 24 percent of the total water used islandwide. However, dependence on ground water varies throughout the island; a number of municipalities draw 50 percent or more of their public water supply from ground-water sources.

Because of the importance of ground-water as a major source of public water supply, EQB has developed the Groundwater Protection Strategy, which was approved by EPA in October of 1988, to protect ground-water quality and ensure its availability for current and future uses.

Within the scope of this strategy, wells in the north-

east of Puerto Rico were sampled to determine water quality. Results indicate that 10 wells were contaminated with volatile organic compounds. As a result, EQB initiated a second round of monitoring of these wells and wells in adjacent areas.

Major sources of ground-water contamination include abandoned hazardous waste sites, municipal landfills, underground storage tanks, injection wells, and septic tanks.

Rhode Island

To obtain a copy of the Rhode Island 1990 305(b) report, contact:

Rhode Island Department of Environmental Management
Division of Water Resources
291 Promenade Street
Providence, RI 02908-5767

Surface Water Quality

An assessment of overall surface water quality in Rhode Island indicates that 78 percent of the State's rivers and streams, 93 percent of lakes, and 82 percent of estuaries/oceans support designated uses. Changes from the 1988 assessment are a result of the increased water quality monitoring data available for this report.

Of those waters assessed for support of Clean Water Act goals, 82 percent of river and stream miles are fishable/swimmable, as are 93 percent of lakes, and 95 percent of estuaries/oceans.

The most significant causes of nonsupport in rivers and streams are heavy metals, priority organics, coliforms, low dissolved oxygen, and nutrients. In lakes and ponds, the major causes of nonsupport are coliforms, nutrients, heavy metals, and low dissolved oxygen. In estuaries and coastal waters, the major causes of nonsupport are coliforms, heavy metals, nutrients, and low dissolved oxygen. In rivers and estuaries, major sources include industrial and municipal point sources and nonpoint sources such as urban runoff and failed septic systems, while lakes/ponds are affected by nonpoint sources, primarily septic systems.

State concerns include: funding constraints on municipal wastewater treatment facility construction, municipal facilities operation and maintenance, combined sewer overflows, septage management, increasing water quality monitoring coverage for surface waters, nonpoint source pollution management, reorganization of RIDEM, and the State Clean Water Strategy outlining surface water problems and solutions.

Ground-Water Quality

Ground water is a locally abundant and widely used resource in Rhode Island. Twenty-four percent of the State's population depends on ground water for its water supply.

Rhode Island's principal aquifers are extremely vulnerable to contamination from a wide variety of pollution sources. Over 90 contaminants have been detected in Rhode Island's ground water, the most common being organic solvents, the pesticide aldicarb (Temik), and petroleum products. Most ground-water contamination problems are localized. Significant pollution sources include landfills, hazardous and industrial waste disposal sites, road salt storage sites, surface impoundments, leaking underground fuel storage tanks, and chemical and oil spills.

In addition, roughly 2,600 underground storage tank facilities with about 6,400 tanks have been registered with the DEM. Nonpoint sources have also been recognized as contributing to ground-water quality degradation, particularly septic systems, fertilizer and pesticide applications, and road salt applications. Approximately 90 percent of the State's ground-water resources are considered impacted or threatened due to nonpoint pollution.

In order to protect the State's ground-water resources from the many potential sources of contamination, the DEM is continuing to develop and implement a comprehensive ground-water protection program. The Rhode Island Groundwater Protection Strategy, which identifies existing and needed State initiatives, will guide the ground-water protection efforts in Rhode Island.

South Carolina

To obtain a copy of the South Carolina 1990 305(b) report, contact:

South Carolina Department of Health and Environmental Control
Bureau of Water Pollution Control
Division of Water Quality
2600 Bull Street
Columbia, SC 29201

Surface Water Quality

South Carolina has approximately 9,900 miles of rivers, 525,000 acres of lakes, and 2,155 square miles of estuaries. Physical, chemical, and biological data were available for 3,493 miles of rivers, 217,368 acres of lakes, and 364 square miles of estuaries. Of the assessed river miles, 79 percent fully support their designated uses, 8 percent partially support uses, and 13 percent do not support their designated uses. Of the assessed lake acres, 61 percent fully support their designated uses, 33 percent partially support uses, and 6 percent do not support designated uses. Of the assessed estuary square miles, 67 percent fully support uses, less than 1 percent partially support uses, and 32 percent do not support their designated uses.

Nonpoint sources were the leading contributors to use impairment in South Carolina's rivers and estuaries (fecal coliform contamination was the most frequent cause of use impairment). In lakes,

sources of pollution were largely unknown, but the leading causes of impairment were organic enrichment, nutrients, and low dissolved oxygen concentrations. Of the State's coastal waters classified for shellfish growing, about 85 percent are unconditionally approved for harvesting.

The State notes that industrial waste pretreatment programs have improved water quality by reducing toxic discharges. Most point source agricultural waste discharges have been eliminated through the issuance of State construction permits that require alternate nondischarging treatment systems.

Ground-Water Quality

The overall quality of ground water in South Carolina is excellent. The Department has made an effort to educate the public about ground water and provide protection to prevent future contamination through its permitting process and by requiring the licensing of well drillers, establishing well construction standards, and regulating underground storage tanks.

Nevertheless, the State cites approximately 590 instances of localized ground-water contamination. Substances contaminating ground water include organic chemicals, inorganic chemicals, metals, radioactive material, pesticides and other agricultural chemicals, and petroleum products.

Sources of contamination are diverse and include leaking underground petroleum storage tanks, surface impoundments, above-ground storage tanks, chronic spills and leaks, onsite industrial landfills, and unpermitted waste disposal.

These sources are not restricted to any particular areas of the State, but are more concentrated in the three major urban/industrial centers: Greenville/Spartanburg, Columbia, and Charleston. An additional concentration of ground-water contamination problems has been associated with high water-table areas in Horry, Beaufort, and Florence Counties.

South Dakota

To obtain a copy of the South Dakota 1990 305(b) report, contact:

South Dakota Department of Water and Natural Resources
Joe Foss Building
523 East Capitol
Pierre, SD 57501

Surface Water Quality

South Dakota has a total of 9,937 miles of rivers and streams. Of these, 4,028 miles have been assessed for water quality. Currently, 30 percent of these assessed waters are fully supporting their assigned beneficial uses, 44 percent are partially supporting their uses, and 26 percent are not supporting their uses. Nonsupport of designated uses is primarily caused by agricultural nonpoint sources introducing suspended solids and pathogens (fecal coliforms). Other pollutant sources include inadequate municipal wastewater treatment, industrial discharges, and natural causes. Water quality trends in rivers were generally maintained.

South Dakota has 799 lakes and reservoirs (including Missouri River mainstem reservoirs) totalling 1,598,285 acres. Roughly 80 percent of the 682,033 lake acres assessed are considered to support their designated uses; however, all of these acres are threatened. Only 1 percent of total lakes partially support uses, and 19 percent do not support uses. Approximately 98 percent of use nonsupport for lakes can be attributed to nonpoint sources.

Most lakes in the State are characterized as eutrophic to hypereutrophic. Runoff carrying sediments and nutrients from agricultural land is the major nonpoint pollution source. Smaller lakes are more severely affected by nonpoint sources than are larger lakes.

Ground-Water Quality

Approximately 453 million gallons of water are used daily by South Dakotans; of this, nearly 50 percent is from ground-water sources.

Ground-water quality is highly variable in South Dakota but is generally suitable for domestic, industrial, and agricultural uses. However, numerous localized incidents of ground-water degradation have occurred. Documented or suspected sources of ground-water contamination include leaking artesian wells; wastewater treatment lagoons; landfills; septic systems; inadequate well design, construction, and placement; feedlots; and petroleum and other chemical spills or leaks. These pollution problems have remained consistent through the years, although reported spills or leaks of petroleum and other chemicals have increased. Many of these contamination problems result from improperly locating or constructing wells, septic systems, treatment lagoons, and other sources.

Generally, over the past 10 years there has been an increase in reported incidents of potential ground-water contamination. And in the past 2 years, reported spills of oil and hazardous substances increased significantly. This is primarily the result of increased public awareness and new reporting requirements under the underground storage tank (UST) regulation.

South Dakota is aggressively addressing ground-water pollution. Ongoing State ground-water projects include the Oakwood/Poinsett Rural Clean Water Project, assumption of the Underground Injection Control, RCRA, and AST programs; cleanup activities from hazardous materials spills; wellhead protection program activities; and a ground-water discharge permit program.

Tennessee

To obtain a copy of the Tennessee 1990 305(b) report, contact:

Tennessee Department
of Environment
and Conservation
Division of Water Pollution
Control
T.E.R.R.A. Building
150 Ninth Avenue, North
Nashville, TN 37243-1534

Surface Water Quality

Of the 19,124 stream miles in Tennessee, 10,247 were assessed for this report. Forty-five percent of the assessed miles fully support designated uses, 18 percent fully support uses but are threatened, 26 percent partially support designated uses, and 11 percent do not support designated uses.

Of the 538,504 publicly owned lake acres in the State, 80 percent fully support designated uses, 11 percent partially support designated uses, and 9 percent do not support designated uses.

During the reporting period, Tennessee assessed 11,081 river miles, and 540,030 lake acres for the fishable/swimmable goals of the Clean Water Act. Of the assessed river miles, 98 percent meet the fishable goal and 94 percent meet the swimmable goal. Of the assessed lake acres, 90 percent meet the fishable goal and 97 percent meet the swimmable goal.

The largest causes of nonsupport in streams are siltation and suspended solids, fecal coliforms, low dissolved oxygen, nutrients, and flow alteration. Major sources of these causes are agriculture, hydrologic modification (channelization), municipal discharges, mining activities, upstream impoundment, industrial discharges, urban runoff, and construction activities.

In lakes, the largest causes of nonsupport are nutrients, low dissolved oxygen, siltation and priority organics. Major sources are agricultural activities, municipal discharges, upstream impoundments, hydromodification, and mining activity.

Ground-Water Quality

More than half the population of Tennessee relies on ground water for drinking water supplies. Groundwater constitutes 21 percent of the water withdrawn in the State (exclusive of water withdrawn for thermoelectric use). In West Tennessee, nearly all public supplies, industries, and rural residents use ground water; Memphis, the largest city, is completely supplied by ground water.

Many pollutants are known or thought to be contaminating ground water. These pollutants include metals, petroleum products, pesticides and other agricultural chemicals, and radioactive materials. In addition, volatile or synthetic organic materials, plus inorganic chemicals such as nitrates, have been detected in some samples.

Leading sources of groundwater contamination include septic/sewage and water treatment plant sludge, illegal dumps, septic tanks, wastewater pits, ponds and lagoons, sanitary landfills, underground storage tanks and pipelines, and abandoned hazardous waste sites.

Ground-water protection in Tennessee has become a major concern. In an effort to define and protect this finite resource, the Tennessee Department of Environment and Conservation has developed a Ground-Water Management Strategy that would assemble the many pieces of relevant information into a comprehensive whole. Some of the recommendations contained in this Strategy will require legislative action by the General Assembly, while others can be accomplished by coordination of existing programs through the establishment of the Ground Water Management Council.

Texas

To obtain a copy of the Texas 1990 305(b) report, contact:

Texas Water Commission
Water Quality Standards
and Evaluation Section
P.O. Box 13087
Capitol Station
Austin, TX 78711-3087

Surface Water Quality

Of the State's 16,203 assessed stream miles, less than 1 percent are not meeting fishable uses and approximately 11 percent are not swimmable. Eighty-four percent of the stream miles assessed support their designated water uses. The majority of impaired stream miles are affected by dissolved oxygen depletion and elevated fecal coliform levels caused by discharges of treated domestic wastewater. Approximately 65 percent of the 1,537 stream miles not suitable for fishing and swimming are affected by major metropolitan areas: Fort Worth-Dallas, San Antonio, Houston, and cities in the Lower Rio Grande Valley.

Only 14 of the State's 1,543,898 acres of reservoirs currently do not meet the fishable goals. Less than 1 percent of lake acres do not meet the swimmable goal. The cause of nonsupport is exceedance of chloride, sulfate, and total dissolved solids; the sources of this pollution include tributaries transporting treated domestic wastewater and urban runoff. Approximately 87.5 percent of reservoirs support uses, approximately 0.5 percent support but are threatened, and approximately 12 percent do not support designated uses.

Estuary assessment indicates 76 percent of estuary waters fully support their uses while 24 percent do not support shellfish harvesting use due to elevated fecal coliform bacteria contamination. Offshore coastal waters are meeting their uses. All 1,933 square miles of estuarine and 3,879 square miles of ocean waters within the State's jurisdiction meet the Clean Water Act fishable/swimmable goals.

Eutrophication in reservoirs and estuaries may cause problems not specifically addressed by the desig-

nated uses and numerical criteria of the State's surface water quality standards. Rita Blanca Lake receives treated domestic wastewater from the City of Dalhart and is the State's most eutrophic lake. Estuaries exhibiting the highest degree of eutrophication are the Neches River Tidal, Armand Bayou Tidal, and the Arroyo Colorado Tidal.

Ground-Water Quality

Approximately 61 percent of the total water used by Texans for domestic, municipal, industrial, and agricultural purposes is supplied by ground-water sources. A major form of ground-water contamination is saltwater intrusion from natural sources. Saline conditions are sometimes aggravated by ground-water withdrawals. In the past, oil and natural gas extraction activities were suspected of causing saline contamination in some areas. Improvements in brine disposal, well-plugging, and underground injection procedures have reduced these problems in recent petroleum operations.

Nevertheless, expanded development of the State's water resources and pressures to meet supply needs have created local, regional, and statewide problems of varying intensity. While surface water quality continues to be a major concern, ground-water overdraft and quality degradation are particularly troublesome because of expanding economic activities that are ground-water dependent.

Several State agencies are involved in the protection of ground-water resources. An interagency committee, funded by the EPA Ground-Water Grant, was established in 1985 to improve coordination of ground-water protection activities and develop a comprehensive ground-water protection strategy. A ground-water protection strategy was developed in 1987 and implementation began in 1988. The strategy addresses interagency coordination, improvement of existing programs, development of new program areas, and needs for funding and new legislation.

Utah

To obtain a copy of the Utah 1990 305(b) report, contact:

Bureau of Water Pollution Control
Division of Environmental Health
P.O. Box 16700
Salt Lake City, UT 84145

Surface Water Quality

Of the 8,874 miles of rivers and streams assessed in 1988-89, 20 percent support their designated uses, 64 percent partially support their uses, and 16 percent do not support their designated uses. Of the 63 (134,201 acres) lakes, reservoirs, and ponds assessed, 100 percent partially support their designated uses. These 63 waterbodies represent only 30 percent of the total number of lake surface acres in Utah.

The most frequently cited pollutants are metals and dissolved solids (salinity). Total dissolved solids and iron cause a large portion of the exceedances of the State's water quality criteria. Nutrients, including total phosphorus, are the most frequently cited causes for partial support in lakes and reservoirs.

Surface water quality is affected by both natural and man-made point and nonpoint sources of pollution. Most of the water quality problems in Utah's surface waters result from nonpoint sources rather than point sources. Nonpoint sources in the State include natural geologic formations, agriculture, failing individual wastewater disposal systems, urban stormwater systems, recreation, silviculture, and resource extraction activities. The majority of the water allocated in Utah is for agricultural use. Consequently, agriculture is one of the primary sources of nonpoint source pollution. Irrigation return flows to rivers and lakes from croplands and pastures add nutrients, sediments, and salts to these waterbodies. Runoff from overgrazed noncropland areas also contributes high concentrations of these pollutants.

During the reporting period, new national water quality criteria were adopted in the State of Utah. The Water Quality Management Section in the Bureau also implemented a Lake Water Quality Assessment Program to monitor the lakes and reservoirs in the State to determine water quality trends for those waterbodies. The Section has also continued to effectively implement a nonpoint source program in cooperation with the Utah Department of Agriculture to address this statewide pollution problem.

Water quality concerns facing the State of Utah include effective control of widespread nonpoint source pollution, the reduction in the ability to fund wastewater projects in the State, the continued oversight of wastewater dischargers, lack of a State policy to protect valuable wetlands, and continued assessment of lakes and reservoirs.

Ground-Water Quality

Ground water is a critically important source of fresh water for domestic use, industry and agriculture in Utah. Because of the combined effects of low population, climate, limited heavy industry and effective regulation, the ground water quality has been maintained at a high level over most of the State. However, increased reliance on ground-water sources by industry, agriculture and a growing population and the near complete utilization of surface sources suggest that effective regulation will be more important in the future to the maintenance of a high-quality ground-water resource.

Although ground water in Utah is generally good in quality, degradation has occurred in several areas because of the effects of irrigation, urbanization, infiltration of leachate from landfills, and mine and mill

tailings. Contaminants include metals, petroleum products, organic chemicals, radioactive materials, and pesticides and other agricultural chemicals.

During the 305(b) reporting period, the Bureau of Water Pollution Control developed and implemented a comprehensive ground-water quality protection regulation and created a management group, the Groundwater Section, within the Bureau to oversee this important program.

Vermont

To obtain a copy of the Vermont 1990 305(b) report, contact:

Vermont Department of Environmental Conservation
Water Resources Planning
103 S. Main Street
Waterbury, VT 05676

Surface Water Quality

The water quality of Vermont's rivers and lakes is generally excellent. Continued progress is noted in the cleanup or elimination of point source discharges, particularly from wastewater treatment plants. Of the 5,266 miles of rivers and streams in Vermont, 60 percent fully support the uses for which they are designated; 23 percent fully support use but are threatened. Of the 227,755 assessed acres of lakes and ponds in Vermont, 78 percent fully support designated uses; 69 percent of these lake acres are threatened. The largest portion of this threat to lake use is associated with Lake Champlain, where toxic substances have been found in the tissue of one fish species.

Vermont reports that nonpoint sources are the most widespread contributors to use impairment. The four most common water quality impairments due to nonpoint sources in rivers are siltation/turbidity, habitat alterations, nutrient enrichment, and flow alterations. Other common problems include thermal modifications and pathogens. The highest ranked sources of these impairments are agricultural runoff, hydromodifications below hydropower dams, and erosion from construction sites.

Point source discharges were responsible for repeated beach closures on Lake Champlain. Public beaches in the Burlington area were closed frequently during the summers of 1988 and 1989, primarily as the result of combined sewer overflows which are now being corrected.

On other lakes, most of the water quality impairments are caused by nonpoint sources and excessive plant growth. Only two lakes receive point source discharges. The major impairments are nuisance aquatic plants such as Eurasion milfoil and algae; nutrient enrichment from nonpoint sources; pathogens; and siltation/turbidity. Threats to lake water quality include erosion from development, acid precipitation, and, in the case of Lake Champlain, a preliminary indication of the contamination of fish tissue by toxic substances.

Ground-Water Quality

Ground-water quality appears to remain good to excellent throughout Vermont, except for vicinities of a few contaminating activities. All of the State's ground water is presently classified as Class III, suitable for individual drinking water supply. In most cases, randomly located domestic wells produce enough drinkable ground water to meet household needs.

The major sources of ground-water contamination in Vermont include petroleum pollution from leaking underground storage tanks and accidental spills; leachate from landfills; leachate from onsite sewage systems; and application and storage of salt and salted sand.

Vermont is making good progress with its program to replace older, unprotected steel underground storage tanks (USTs). Since September 1987, all new Category One USTs require secondary containment provisions. Tanks within water well (wellhead) protection areas or Class II ground-water areas have more stringent monitoring requirements. The UST regulations, when fully implemented, should prevent most ground contamination by petrochemicals. Leachate from landfills will be virtually eliminated by the State's program to close out existing, unlined landfills and replace them with fewer regional, lined landfills with leachate collection and treatment. The process of selecting sites for these new regional facilities is underway in most solid waste management districts.

The most obvious problems with ground-water management are the lack of data about the resource and the absence of a statewide, interagency ground-water data management system. The first problem is a reflection of the low level of concern due to the generally high quality and abundance of the resource. The second problem is being addressed as data and computer resources become available.

Virginia

To obtain a copy of the Virginia 1990 305(b) report, contact:

Virginia State Water Control Board
Office of Water Resources Management
2111 North Hamilton Street
Richmond, VA 23230

Surface Water Quality

Water in Virginia is generally of good quality except in relatively few areas. During the reporting period, Virginia assessed 10,809 miles of streams, 160,640 lake acres, 2,529 estuary square miles, and 112 ocean coastal miles. Of the assessed river miles, 82 percent fully support CWA goals and designated uses, 14 percent partially support goals, and 4 percent do not support CWA goals.

Of the State's assessed lake acres, 90 percent fully support designated uses and 10 percent partially support goals and uses. Of the assessed estuary square miles, 85 percent fully support designated uses, 15 percent partially support uses, and 0.1 percent do not support their designated uses. All of the State's assessed ocean coastal miles fully support their designated uses.

The major causes of nonsupport in Virginia's rivers include fecal coliform bacteria; the major source of these pollutants is agricultural runoff.

Of the minor problems noted in lakes, the most commonly cited problem was eutrophication, as indicated by nutrient levels and dissolved oxygen concentrations.

The dominant cause of impairment in Virginia's estuaries is eutrophication as indicated by nutrient, dissolved oxygen, and ammonia concentrations.

Ground-Water Quality

Ground water accounts for approximately 22 percent of the water used in Virginia for purposes other than hydroelectric and thermoelectric uses. Eighty percent of Virginians use ground water either as their only water supply or as part of their supply.

Contamination of major aquifers in Virginia is not a serious problem. Most ground-water pollution incidents contaminate finite areas near the spill or accident. During this reporting period, 559 new cases of contamination have been documented; 79 percent of the complaints are due to leaking underground tanks and associated piping. The State lists underground storage tanks, landfills (municipal, onsite industrial, and others), surface impoundments, septic tanks, and agricultural activities as the major sources of ground-water contamination. Volatile and synthetic organic chemicals, pesticides, nitrates, fluorides, brine/salinity, metals, and petroleum products are the contaminants of concern.

Specific ground-water program activities in Virginia include formation of an interagency Ground-Water Protection Steering Committee, implementation of an underground storage tank program, ground-water quality monitoring, long-range study of saltwater intrusion, and investigations of pollution complaints and proposed landfill sites.

Virgin Islands

To obtain a copy of the Virgin Islands 1990 305(b) report, contact:

Virgin Islands Department of Conservation and Cultural Affairs
Division of Natural Resource Management
P.O. Box 4340
Charlotte Amalie, St. Thomas
Virgin Islands 00801

Surface Water Quality

Water quality in the Virgin Islands is generally good but is declining due to an increase in nonpoint sources such as vessel wastes and uncontrolled runoff. Of the approximately 6 square miles of assessed bays, harbors, and estuaries, 65 percent fully support designated uses, 14 percent partially support designated uses, 8 percent do not support uses, and 13 percent are threatened. Major sources of use impairment are municipal/domestic point sources and nonpoint sources. Nonpoint source pollution has increased with the rapid rate of construction along the coastlines, increasing boat activities, and Hurricane Hugo. Of the 14 ocean coastal miles assessed, 85 percent support designated uses, 7 percent do not support designated uses, and 7 percent are threatened.

Ground-Water Quality

The major ground-water contaminant in the Virgin Islands is high salinity due to rainfall containing high salt concentrations from sea-spray-laden air. This is further increased by locally high evapotranspiration rates. Excessive withdrawals and to a much lesser extent leaking saltwater mains, cause saltwater intrusion problems. During past periods of low rainfall several wells required reductions in withdrawal rates, others have had water level declines, and some have gone dry.

The volcanic rock aquifer has the lowest concentration of dissolved solids, but nitrate levels exceed the USEPA National Interim Drinking-Water Regulations maximum concentration of 10 mg/L. Sewage effluent discharged to intermittent streams, leaking municipal sewer pipes, and septic tanks have caused nitrate and bacterial contamination in several areas.

Volatile organic compounds have been detected recently in the Turpentine Run aquifer near the Tutu well field on St. Thomas. As a result, several leaking underground storage tanks were identified and replaced and a ground-water cleanup program is in effect.

As a result of an assessment report documenting hydrocarbon releases to soils and ground water from a solid waste management unit at the Hess Oil refinery, three areas of ground-water contamination within the refinery were identified. Hess Oil is conducting a hydrocarbon recovery and ground-water monitoring program and is lining underground pipes suspected of leaks. The Hess Oil ground-water monitoring program has not detected any hydrocarbon contamination outside the refinery complex.

A cooperative ground-water control program between EPA, USGS, and DPNR is needed to institute ground-water monitoring and permitting. USGS is currently compiling an inventory of existing wells documenting their current use status, water levels, and water quality. Periodic water level measurements and water quality sampling data

are needed for selected aquifers for control of withdrawal rates to prevent saltwater intrusion.

DPNR and the Department of Health need to better regulate discharges of sewage effluent and septic tank construction and maintenance. DPNR currently has an underground storage tank program in place requiring permitting and testing of all tanks in use now as well as new contruction.

Washington

To obtain a copy of the Washington 1990 305(b) report, contact:

Washington Department of Ecology
Water Quality Program
PV-11
Olympia, WA 98504

Surface Water Quality

During the reporting period, Washington assessed 4,897 river miles, 175,184 lake acres, 1,106 estuary square miles, and 163 ocean coastal miles. Of the assessed river miles, 32 percent fully support designated uses, 11 percent fully support but are threatened, 27 percent partially support uses, and 30 percent do not support their designated uses. Of the assessed lake acres, 11 percent fully support designated uses, 20 percent support but are threatened, 23 percent partially support uses, and 46 percent do not support their designated uses. Of the State's assessed estuary square miles, 34 percent fully support designated uses, 11 percent support but are threatened, 41 percent partially support uses, and 14 percent do not support their designated uses. All of the assessed ocean coastal miles fully support their designated uses.

The primary causes of impaired surface waters in the State are fecal coliform bacteria, temperature problems, organic enrichment and dissolved oxygen problems, nutrients, and habitat/flow alterations. Contamination by metals, priority organics, and pesticides are serious problems in certain waterbodies. The primary sources of water quality impairment in Washington are municipal and industrial point sources, storm sewers, runoff from pasture land and irrigated agricultural lands, onsite wastewater disposal, urban runoff, flow regulation, vegetation removal, and natural causes. Natural causes include such things as glacial runoff, poor circulation in estuaries, and low streamflow during summer months.

Ground-Water Quality

Washington lacks a comprehensive ground-water monitoring program, so it is difficult to assess the extent of existing contamination. Available data, however, suggest that contamination may be more widespread than previously believed. This is a concern because more than 70 percent of the State's population relies on ground water for drinking water; among rural residents, that figure is over 90 percent. In some counties, virtually all of the population relies on ground water for domestic use.

Of the major sources of ground-water contamination, the greatest threat to ground-water quality is agricultural activities. Activities include pesticide application and concentrated animal feeding operations, which generate nutrient and fecal coliform contamination. Misuse, poor storage practices, and improper mixing or container disposal account for a portion of the contamination of ground water from pesticides. In some cases, application of leachable pesticides to field crops in accordance with recommended procedures has resulted in ground-water contamination. Nutrients, particularly nitrates, from commercial fertilizers and animal manures have contaminated ground water.

The second greatest threat to ground water is land application and land treatment of wastes. This includes land application of municipal sludges, municipal wastewater, and wastes from food processing.

The third most serious threat, municipal landfills, is regulated under the State's Minimum Functional Standards for Solid Waste Handling, yet many landfills have not come into compliance with the liner design requirements and the current standards are now believed to be inadequate. Many of the landfills are producing uncontrolled leachate (metals, volatile and synthetic organic compounds) that is contaminating ground water. Wood waste landfills also contribute tanins, lignins, and tropolons to the ground water. A number of landfills are nominated to the National Priorities List under CERCLA/SARA or are on the State's contaminated sites list. Remedial action has been or will be taken at these sites, which have localized impacts to the ground water.

Domestic septic systems (private and community) rank fourth as a contributor to ground-water contamination. The contaminants of concern range from nitrates and pathogenic bacteria and viruses to metals and synthetic organic compounds (e.g., solvents) used in households.

Underground storage tanks rank as the fifth greatest threat to ground water.

West Virginia

To obtain a copy of the West Virginia 1990 305(b) report, contact:

West Virginia Department of Water and Natural Resources
Water Resources Division
694 Winfield Road
St. Albans, WV 25177

Surface Water Quality

Of the approximately 28,000 stream miles in West Virginia, 19,818 miles were assessed for fishable/swimmable goals using informa-

tion and data from various sources. The Clean Water Act fishable/swimmable goal was attained by approximately 93 percent of the total miles assessed. Of the 17,456 miles assessed for use support, only 6 percent do not support their designated uses, 53 percent partially support their uses and 41 percent fully support their uses.

Of the 18,870 lake acres assessed, 9 percent do not support designated uses, 38 percent partially support, and 53 percent fully support or fully support but are threatened. The major causes of nonsupport in streams and lakes are siltation, mine drainage, and nutrients. There has been very little change in water quality during the reporting period. An increase in fully supporting waters is a result of the increase in waters assessed.

Elevated levels of toxics were noted in 1,466 miles of total assessed streams. Mine drainage contributed toxics to an additional 2,427 stream miles. Elevated levels of toxics were also noted in 2,302 lake acres. Many of these reported elevated toxic levels are due to exceedances of the State water quality standard for iron.

West Virginia's wetlands (102,000 acres) constitute less than 1 percent of the State's total acreage. The State's management of these areas is geared toward protection of wetlands either by regulatory proceedings or acquisition.

Specific State water quality concerns are as follows:

- Abandoned mine drainage is the most serious water quality problem facing the State, affecting at least 477 streams totaling 2,427 miles.
- Some rural areas of the State, particularly those with extremely depressed economies, remain unsewered. The result is the improper disposal of domestic sewage into the surface and ground water.
- The Division's laboratory is inadequately funded and unable to meet the analytical needs of the numerous water-quality-related programs.
- Development in small watersheds must be carefully controlled to ensure that receiving waters are capable of assimilating any resulting wastewater.
- Unpermitted wood treatment plants are using highly toxic chemicals that may impact both surface and ground water.
- Approximately 65 facilities have sludge disposal needs that are not currently approved under the Division's sludge management program.

The Federal Energy Regulatory Commission has issued licenses for 16 hydroelectric projects on the upper Ohio basin. The potential consequences of the development and operation of the hydropower projects could cause a decline in water quality and a reduction in the wasteload assimilation capabilities of the river.

Ground-Water Quality

Approximately half of West Virginia's citizens (53 percent) depend directly upon the State's ground water as a sole source of water. The remainder depend upon it indirectly as it supplies stream flow during dry weather and is also the primary source of over 1,600 noncommunity public water supplies (schools, hospital, restaurants, campgrounds, etc.).

There have been no substantial changes in the quality of West Virginia's ground water during the reporting period; however, available information from a limited portion of the State has been reevaluated, resulting in the acknowledgment that West Virginia's vital ground-water resource has been degraded in many areas of the State and may not be characterized as of "adequate quality." Such a conclusion is not based on a dramatic increase in contamination during the current reporting period.

It is possible that 15 to 20 percent of the supplies of the State's nearly 1 million ground-water consumers have been impacted in quality and/or quantity by coal mining. And over 40 percent of Preston County's ground-water-dependent residents are drinking water containing some level of bacteria. These data may or may not be applicable to the rest of the State.

Wisconsin

To obtain a copy of the Wisconsin 1990 305(b) report, contact:

Wisconsin Department
of Natural Resources
Water Quality Evaluation
Section
P.O. Box 7921
Madison, WI 53707

Surface Water Quality

Wisconsin is rich in surface water resources with over 43,000 miles of rivers and streams, nearly 15,000 inland lakes, 650 miles of Great Lakes shoreline, and approximately 5.3 million acres of wetlands. During 1988-1989, overall water quality was reported for streams from 183 of the 331 (55 percent) delineated watersheds and 14 major river mainstems, 578 lakes (132,202 acres), and 650 miles of Great Lakes shoreline.

Of the 13,595 assessed stream miles, approximately 62 percent fully meet the CWA goals and 36 percent partially meet CWA goals. Almost 2 percent are not meeting the goals and about 4 percent are not capable of attaining CWA goals. All 650 miles of Wisconsin's Great Lakes shoreline are partially meeting CWA fishable/swimmable goals.

The primary water quality problems in impaired waterbodies are from pollution due to agricultural practices. There are major agricultural source impacts on 28 percent of the assessed stream miles; whereas industrial and municipal point sources are

currently responsible for major impacts on only 2 percent of the assessed stream miles. In Wisconsin, there are generally very few improvements yet to be made to control point source water-quality-related problems, and those improvements are necessary to control toxic substances. On the other hand, although there has been some progress in controlling nonpoint source pollution, there is still a long way to go before water quality improvements are evident throughout the State.

Elevated concentrations of toxicants are evident in 6 percent of the assessed stream miles, primarily in the form of fish tissue and sediment contamination. Based on current information, 10 stream reaches in the State still exceed acceptable toxicant levels due to point source discharges.

The entire 650 miles of Great Lakes shoreline is affected by elevated concentrations of toxic substances found primarily in fish tissue samples. Additional toxic substances may be introduced by migrating fish that were exposed to PCB contamination in other areas of the Great Lakes outside of Wisconsin's jurisdiction.

Fishing and swimming are designated uses for all Wisconsin Lakes. Ninety-five percent of the assessed lake acres partially or fully support those uses and meet the CWA goals. Metals, nutrients, organic enrichment/dissolved oxygen, and noxious aquatic plants are the major causes of nonsupport of designated uses and CWA goals within the selected lakes. The most significant toxics problem in lakes is the presence of elevated mercury in predator fish.

Of the 35 million acres of land in Wisconsin, approximately 10 million acres were originally wetlands. As of 1985, 5.3 million acres of wetlands remained in the State. Recent assessments show that 9,247 wetland acres were lost or adversely impacted from 1982 through August 1989. Wetlands water quality standards are being drafted to provide criteria and consistency in review of projects affecting wetlands.

Ground-Water Quality

Sixty-seven percent of Wisconsin's residents use ground water for drinking water supplies. Many of the State's industrial and agricultural activities also depend on ground-water sources.

The five leading sources of ground-water contamination in Wisconsin are agricultural activities, municipal landfills, underground storage tanks, abandoned hazardous waste sites, and spills. The application, storage, and handling of nitrogen-based chemical fertilizers and animal wastes have resulted in extensive nitrate contamination. Nitrate is the contaminant most often found to exceed ground-water quality standards.

Volatile organic compounds (VOCs) are the most significant contaminating substances associated with municipal landfills, underground storage tanks, abandoned hazardous waste disposal sites, and spills.

In addition to VOCs, improper handling and storage of pesticides are sources of ground-water contamination. The pesticide sampling program has identified atrazine and alachlor as the two most extensively used and commonly found pesticides.

☆U.S. GOVERNMENT PRINTING OFFICE: 1992-617-003/67012

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Washington, DC 20460

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