John H. McShane, Yellowstone National Park

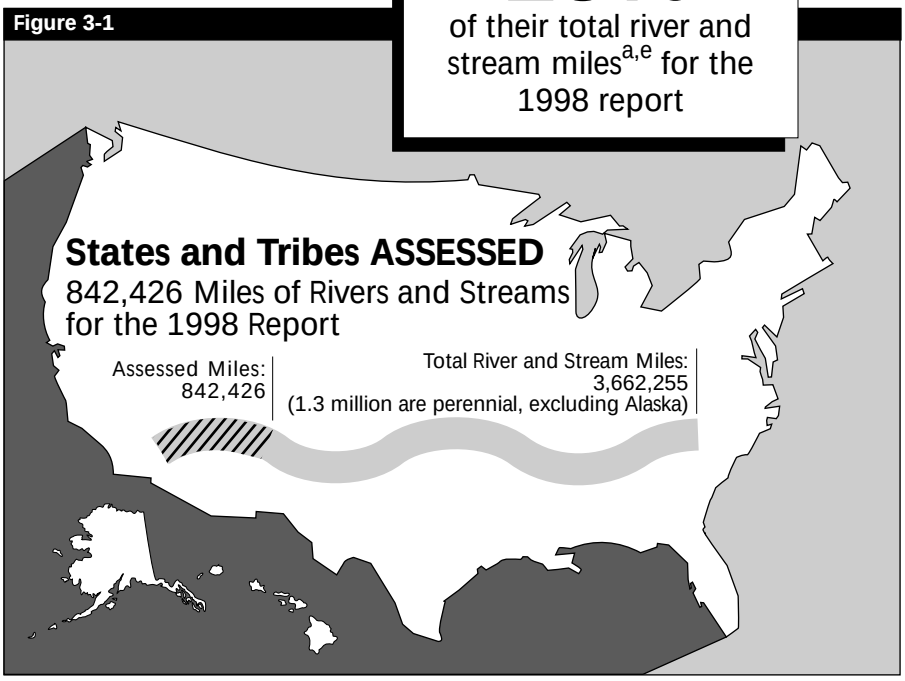
Rivers and Streams

All 50 states, 2 interstate river commissions, Puerto Rico, the District of Columbia (collectively referred to as states in the rest of this chapter), and 9 American Indian tribes rated river water quality in their 1998 Section 305(b) reports (see Appendix A, Table A-1, for individual state and tribal information). These states and tribes assessed conditions in 842,426 miles of rivers and streams or 23% of the total miles of all rivers and streams in the country (Figure 3-1). Most of the assessed rivers and streams are perennial waterbodies that flow all year. Some assessments included nonperennial streams that flow only during wet periods.

Altogether, the states and tribes assessed 148,519 more river and stream miles in 1998 than 1996. This is a 21% increase over the 693,905 miles assessed in 1996. The states of Alaska, Idaho, and Oregon, which did not provide assessment information in 1996, collectively reported on more than 66,000 river and stream miles in

States and Tribes
ASSESSED
23%
of their total river and stream miles[a,e] for the 1998 report

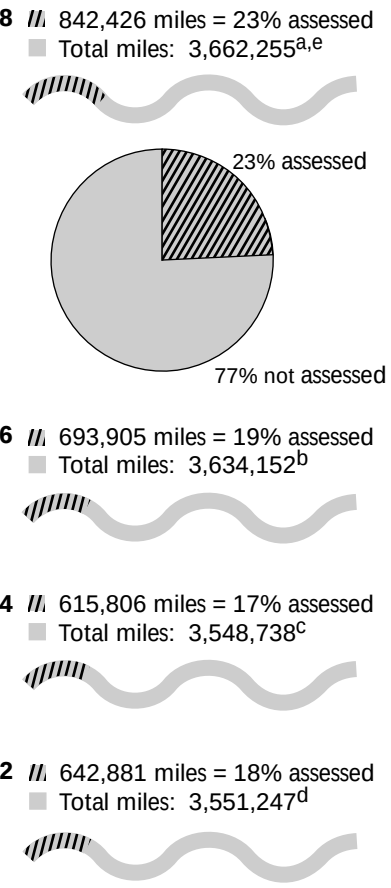
Figure 3-1



This figure compares the total miles of rivers and streams (combination of perennial and intermittent) with the subset that were assessed by states for the 1998 water quality report.

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

River and Stream Miles Assessed by States and Tribes



[a]Source: 1998 state and tribal section 305(b) reports.
[b]Source: 1996 state and tribal section 305(b) reports.
[c]Source: 1994 state and tribal section 305(b) reports.
[d]Source: 1992 state and tribal section 305(b) reports.
[e] The total number of river and stream miles reported by the states increased between 1996 and 1998 due primarily to Pennsylvania's switch to atlas values based on a higher resolution hydrography database.

1998. Other states reported significant increases in assessed river and stream miles because of changes in their monitoring program or assessment process.

For example, Delaware more than doubled the number of assessed river and stream miles in the state, representing an increase of more than 1,600 miles, due to more comprehensive coverage of the state's waters using the rotating basin approach.

The states and tribes used recent monitoring data to assess 43% of their assessed river and stream miles (see Appendix A, Table A-2, for individual state and tribal information). Evaluated assessments, based on qualitative information or monitoring information more than 5 years old, were used for 45% of the assessed river and stream miles. States did not specify whether the remaining 12% of assessed river and stream miles were monitored or evaluated. Compared to the 1996 reporting cycle, states are using monitoring data for a smaller percentage of their assessments. In 1996, states used monitoring data in 51% of their river and stream assessments.

The summary information presented in this chapter applies strictly to the portion of the nation's rivers assessed by the states and tribes. EPA cannot make generalizations about the health of all of our nation's rivers based on data extracted from the 305(b) reports.

The primary reason the assessment results cannot be used to characterize nationwide water quality is that states have not achieved comprehensive assessment of all rivers and streams. Another factor is the monitoring design used to collect data. Very few states or tribes use a statistical design to randomly select water sampling sites that represent a cross section of water quality conditions in their jurisdictions. Instead, many states and tribes direct their limited monitoring resources toward waters with suspected problems.

However, more than half of the states are working to achieve comprehensive assessments. See the highlight on page 24 for a description of some of the approaches used. One approach, called rotating basins, involves intensive monitoring in different selected basins each year. Another approach, called probability-based monitoring, involves statistical design that provides statewide characterization. Some states, such as West Virginia, use both approaches. See the highlight on page 54 for a description of West Virginia's approach for achieving comprehensive assessments.

National data from other federal agencies, such as those described in Chapter 2, and private organizations will also clarify national water quality trends. In fact, the U.S. Geological Survey recently published a report comparing nutrient and pesticide levels in natural, agricultural, and urban streams in 20 study units across the country. See the highlight on page 66 for a brief description of these findings.

Water Quality Assessment

States and tribes rate water quality by comparing data to standards. Water quality standards include narrative and numeric

criteria that support specific designated uses. Standards also specify goals to prevent degradation of good quality waters.

States and tribes use their numeric and narrative criteria to evaluate whether the designated uses assigned to the waterbodies are supported. Designated uses reflect the goals of the Clean Water Act. They aim to protect human health and the biological integrity of aquatic ecosystems. The most common designated uses are

- Aquatic life support
- Drinking water supply
- Recreation such as swimming, fishing, and boating
- Fish consumption.

After comparing water quality data to standards, states and tribes classify the waters into the following categories:

- **Good/Fully Supporting:** Good water quality supports a diverse community of fish, plants, and aquatic insects, as well as the array of human activities assigned to a river by the state. These waters meet applicable water quality standards, both criteria and designated use.

- **Good/Threatened:** Good water quality currently supports aquatic life and human activities in and on the river. These waters are currently meeting water quality standards, but states and tribes are concerned they may degrade in the near future. These concerns are based on a trend of increasing pollution or land use changes that may threaten future water quality.

- **Fair/Partially Supporting:** Fair water quality supports aquatic communities with fewer species of fish, plants, and aquatic insects and/or pollution occasionally interferes with human activities. These waters are meeting water quality standards most of the time, but exhibit occasional exceedances. For example, occasional siltation problems may reduce the population of some aquatic species in a river although other species are not affected.

- **Poor/Not Supporting:** Poor water quality does not support a healthy aquatic community and/or prevents some human activities on the river. These waters are not meeting water quality standards. For example, persistent PCB contamination in river sediments (originating from discontinued industrial discharges) may contaminate fish and make the fish inedible for years.

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

65% OF ASSESSED river and stream miles have good water quality.

Summary of Use Support

Most states and tribes rate how well a river supports individual uses (such as swimming and aquatic life) and then consolidate individual use ratings into a summary table. This

State Progress Toward Comprehensive Assessments: West Virginia Example

For the 1998 305(b) cycle, states began developing plans to achieve more comprehensive assessments of their waters. The EPA Guidelines made several recommendations on promising techniques. States were encouraged to build on these suggestions and to pursue other promising strategies. Some key concepts are to

- Fit monitoring and survey work within rotating basin assessment and management plans
- Seek partnerships among other natural resources agencies and support from locally based volunteer monitoring groups
- Leverage resources among different programs through state Performance Partnership Agreements (PPAs)
- Organize site-specific survey work to support development of environmental indicators for different spatial scales ranging from small watersheds to an entire state
- Consider innovative new techniques such as probability-based surveys.

The experiences of West Virginia illustrate how states are working to implement sound approaches for more comprehensive assessments.

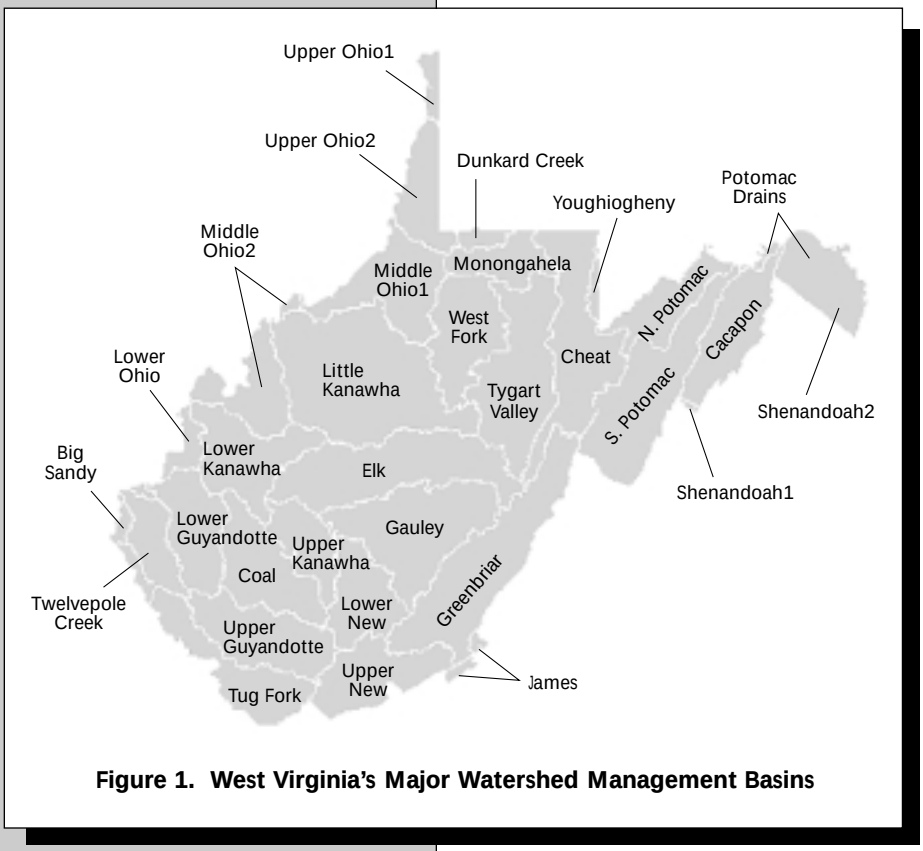


Figure 1. West Virginia's Major Watershed Management Basins

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West Virginia's Watershed Management Framework

The foundation of West Virginia's assessment program is their Watershed Management Framework (WMF), which includes a rotating basin monitoring approach. The major steps in the West Virginia rotating basin system depend on reliable assessment information to define watershed management objectives within each of their major basins. As management plans are developed and implemented, an iterative process then applies new assessments to document progress and to make any needed mid-course adjustments. To ensure involvement from all major stakeholders, an Interagency Watershed Steering Committee (IWMSC) was created composed of representatives from 12 state and federal agencies. A Citizens Stream Monitoring initiative seeks grass-roots involvement from volunteer persons in local watershed groups. This program was assisted through a "Save Our Streams" grant from EPA and technical support through the Izaak Walton League. In addition to valuable assessment inputs, the West Virginia Citizen Stream Monitoring activities help ensure public participation in all phases of the rotating basin management system.

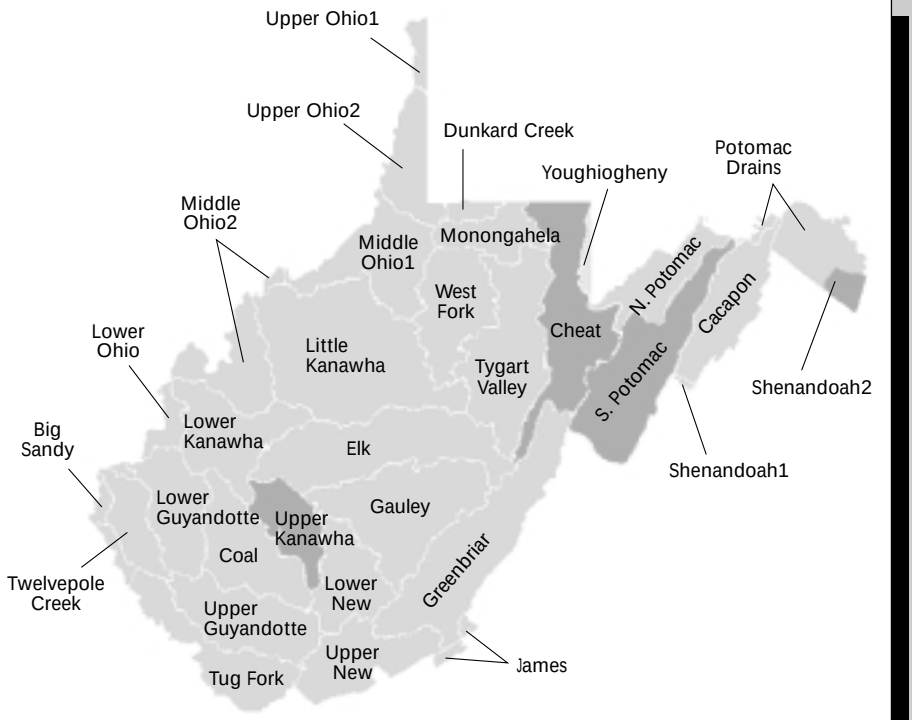


Figure 2. Shaded Basins Were Surveyed and Included in West Virginia's 1998 305(b) Report

The first results from West Virginia's new rotating basins approach are reflected in their 1998 305(b) report. For the Cheat River, the Shenandoah River, the South Branch of the Potomac River, the Upper Kanawah River, the Upper (North) Ohio River, and the Youghiogheny River, major new sampling efforts were undertaken applying rigorous quality assurance and bioassessment techniques to document the status of aquatic life support.

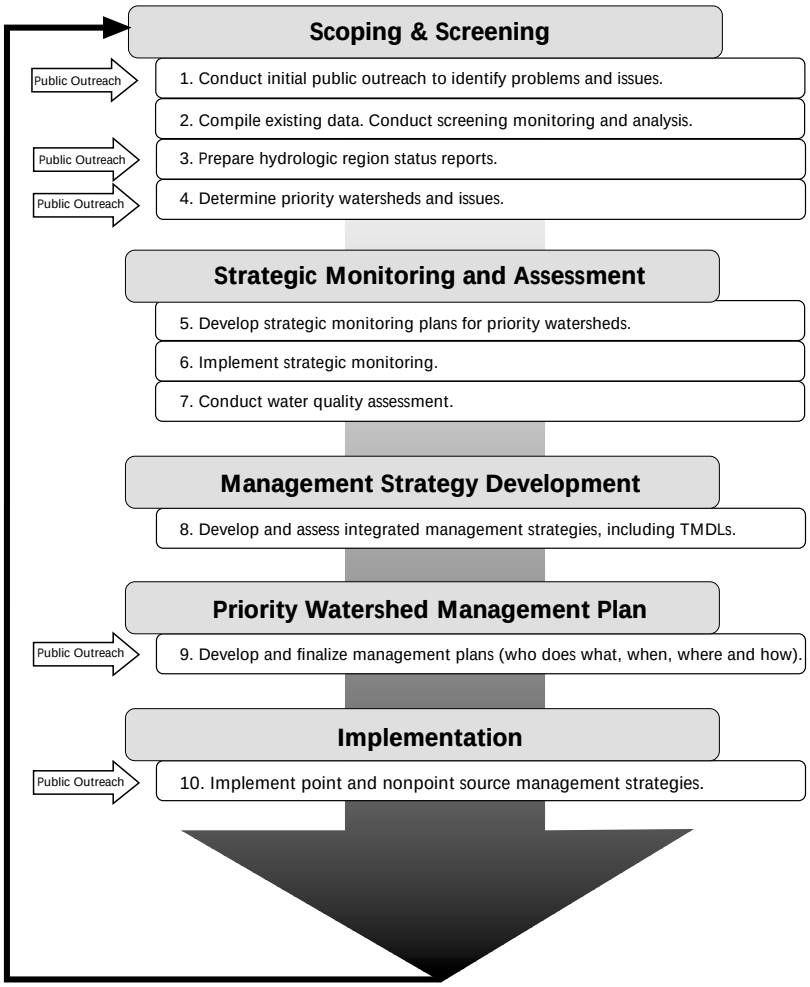


Figure 3. Steps in West Virginia's Rotating Basins Watershed Management Cycle

Probability-Based Monitoring in West Virginia

To improve the reliability of their assessments, West Virginia is also incorporating probability-based sampling techniques into their rotating basin surveys. A major attraction is the potential to document more precisely the extent and severity of acid mine drainage problems. These concerns can impact both larger rivers and smaller tributary streams but are most commonly encountered in upland areas on small headwater streams. West Virginia is working with EPA's Office of Research and Development to prototype a stratified random sampling approach aimed at providing a baseline for all streams but also for a special subpopulation of the smaller headwater streams. This is a particularly appropriate application of randomized surveys since it is not feasible to expect sampling for each of the thousands of headwater streams in the state. Within a few years, West Virginia will be able to compare the

HIGHLIGHT HIGHLIGHT HIGHLIGHT

findings from its traditional nonrandomized site surveys with the new random surveys to develop statistically reliable estimates of conditions on both watershed and statewide spatial scales.

Conclusion

West Virginia is implementing key components needed to achieve comprehensive assessments of its water resources through

- Increased interagency cooperation
- Constructive involvement of grassroots watershed organizations and other stakeholders
- Application of new monitoring approaches
- A more flexible application of conventional assessment techniques through their rotating basin system.

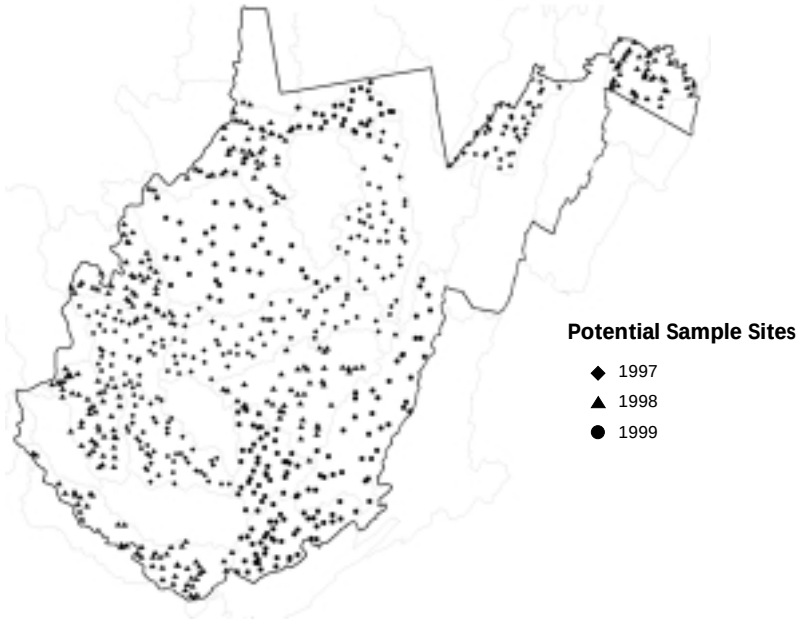


Figure 4. West Virginia Stream Samples – Rotating Basins

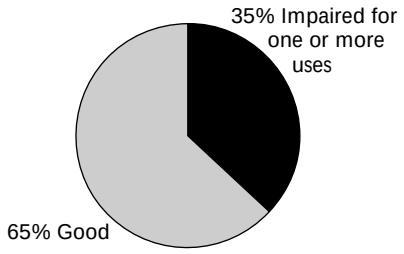
Assessed Waters

Total rivers and streams = 3,662,255 miles[a]
Total assessed = 842,426 miles

Of the assessed miles:

- 43% were monitored
- 45% were evaluated
- 12% were not specified

Summary of Assessed Water Quality



[a]Source: 1998 state and tribal Section 305(b) reports.

table divides assessed rivers into those miles that are

- **Good** – Fully supporting all of their uses or fully supporting all uses but threatened for one or more uses
- **Impaired** – Partially or not supporting one or more uses
- **Not attainable** – Not able to support one or more uses.

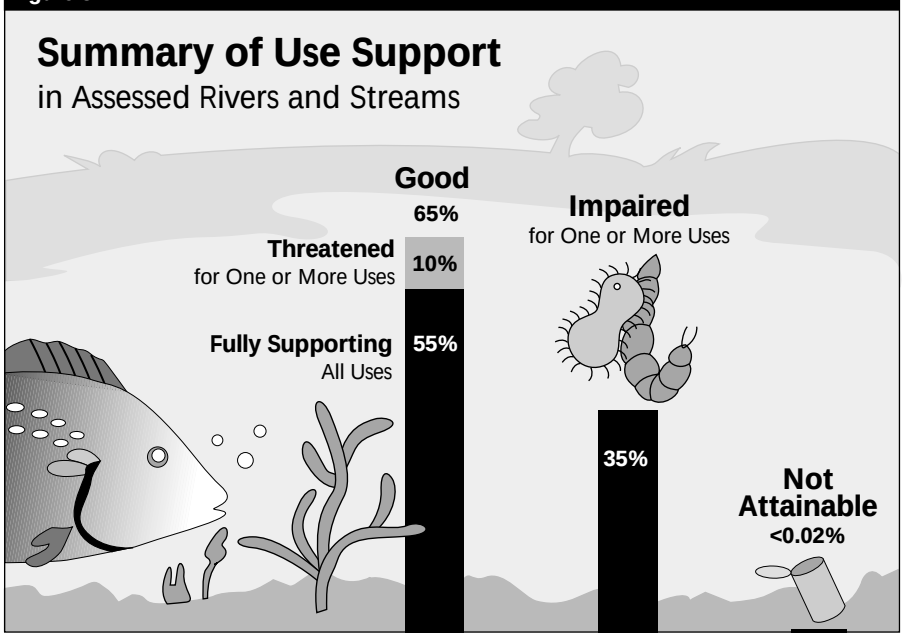
Forty-seven states, eight tribes, two interstate commissions, Puerto Rico, and the District of Columbia reported summary use support status for rivers and streams in their 1998 Section 305(b) reports (see Appendix A, Table A-2, for individual state and tribal information). Another three states and four tribes reported individual use support status but did not report summary use support status. In such cases, EPA used either aquatic life or swimming use support status to represent summary water quality conditions in the state's or tribe's rivers and streams.

In addition, the Susquehanna River Basin Commission provided use support information that was not included in the totals presented here because the waters in their jurisdiction overlap with waters in New York, Pennsylvania, and Maryland.

It is important to note that nine states did not include the effects of statewide fish consumption advisories for mercury when calculating their summary use support status in rivers and streams. Connecticut, Indiana, Maine, Massachusetts, New Hampshire, New Jersey, North Carolina, and Vermont excluded the impairment associated with statewide mercury advisories in order to convey information that would have been otherwise masked by the fish consumption advisories. Because Ohio's summary of use support was based only on aquatic life use support data, it does not include the effect of the state's statewide mercury advisory either. If these advisories had been included, all of the states' rivers and streams would have received an impaired rating. (See the discussion of mercury in Chapter 4.)

New York also excluded the effect of a statewide PCB/chlordane/mirex/DDT fish consumption advisory for rivers and streams in its summary data.

Figure 3-2



This figure presents the status of the assessed miles of rivers and streams. Of the more than 800,000 miles of rivers and streams assessed, 65% fully support their designated uses and 35% are impaired for one or more uses. Ten percent of the assessed waters are fully supporting uses but threatened.

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

Altogether, states and tribes reported that 65% of 840,402* assessed river and stream miles fully support all of their uses. Of the assessed waters, 55% fully support designated uses and 10% fully support all uses but are threatened for one or more uses. These threatened waters may need special attention and additional monitoring to prevent further deterioration (Figure 3-2). Some form of pollution or habitat degradation impairs the remaining 35% of the assessed river and stream miles.

Individual Use Support

Individual use support assessment provides important detail about the nature of water quality problems in our nation's surface waters. The states establish specific designated uses for waterbodies through their water quality standards. The states consolidate their more detailed uses into six general use categories so that EPA can present a summary of the state and tribal data.

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

Only four states did not report individual use support status of their rivers and streams (see Appendix A, Table A-3, for individual state and tribal information). The reporting states and tribes assessed the status of aquatic life and swimming uses most frequently (see Figure 3-3) and identified more impacts on aquatic life and swimming uses than on the other individual uses. These states and tribes reported that fair or poor water quality impacts aquatic life in 216,881 stream miles (30% of

*This value does not equal the 842,426 assessed miles because every state did not account for all assessed river and stream miles in the Summary of Use Support.

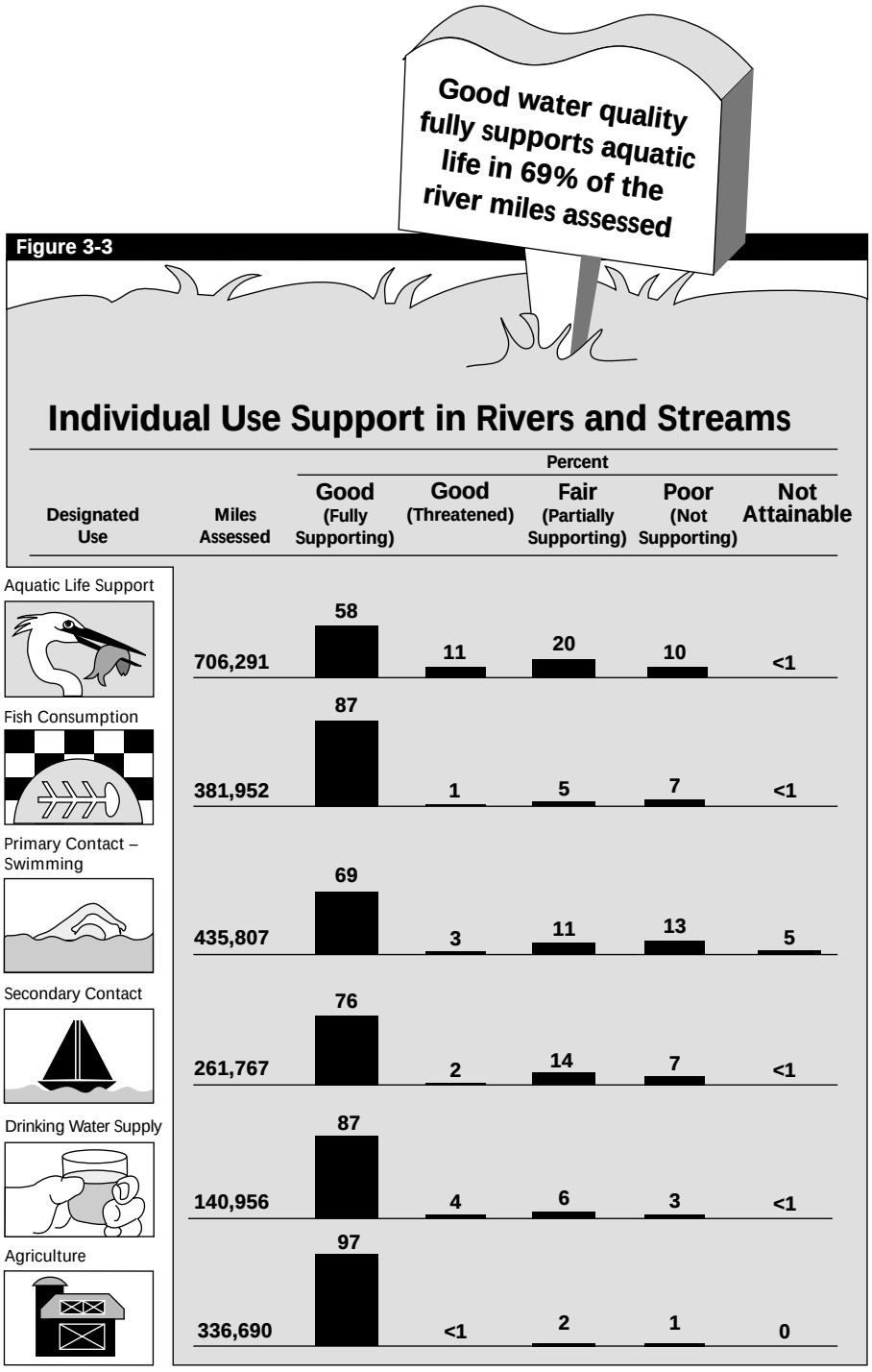


Figure 3-3

This figure presents a tally of the miles of rivers and streams assessed by states for each category of designated use. For each category, the figure presents a summary of the proportion of the assessed waters rated according to quality.

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

the 706,291 miles assessed for aquatic life support). Fair or poor water quality conditions also impair swimming activities in 101,210 miles (24% of the 435,807 miles assessed for swimming use support).

Many states and tribes did not rate fish consumption use support because they have not included fish consumption as a use in their standards. EPA encourages the states to designate fish consumption as a use in their waterbodies to ensure this use is protected and to promote consistency in future reporting. Most states report information on fish consumption advisories to EPA (see Chapter 8). Fish consumption advisories identify the species or size of fish that should not be eaten or limit the quantities of fish that should be eaten.

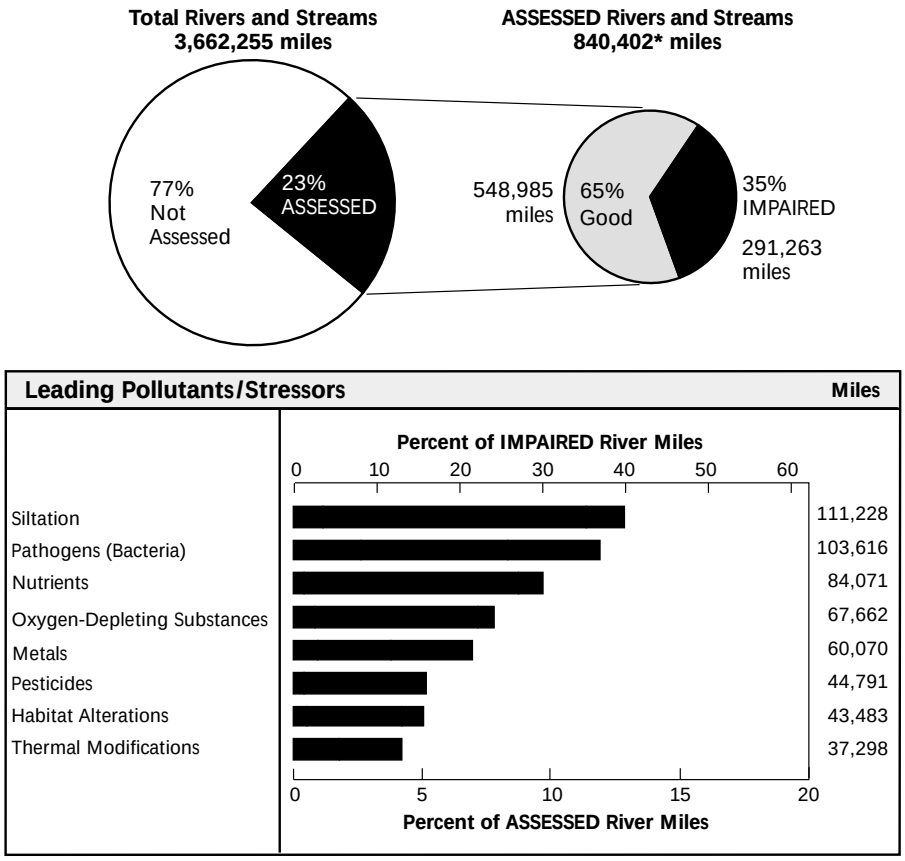
Water Quality Problems Identified in Rivers and Streams

When states and tribes rate waters as impaired, they also attempt to identify the causes and sources of impairment. Figures 3-4 and 3-5 identify the pollutants and sources of pollutants that impair the most river and stream miles.

The following sections describe the leading pollutants and sources of impairment in rivers as identified by the states and summarized by EPA. It is important to note that the information about pollutants and sources is incomplete because the states do not identify the pollutant or source of pollutants responsible for every impaired river segment.

Figure 3-4

Leading POLLUTANTS in Impaired Rivers and Streams



States assessed 23% of the total miles of rivers and streams for the 1998 report. The larger pie chart on the left illustrates this proportion. The smaller pie chart on the right shows that, for the subset of assessed waters, 65% are rated as good and 35% as impaired. When states identify waters that are impaired, they describe the pollutants or processes causing or contributing to the impairment. The bar chart presents the leading causes and the number of river and stream miles impacted. The percent scales on the upper and lower x-axis of the bar chart provide different perspectives on the magnitude of the impact of these pollutants. The lower axis compares the miles impacted by the pollutant to the total ASSESSED miles. The upper axis compares the miles impacted by the pollutant to the total IMPAIRED miles.

Based on data contained in Appendix A, Table A-4.

*Includes miles assessed as not attainable.

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

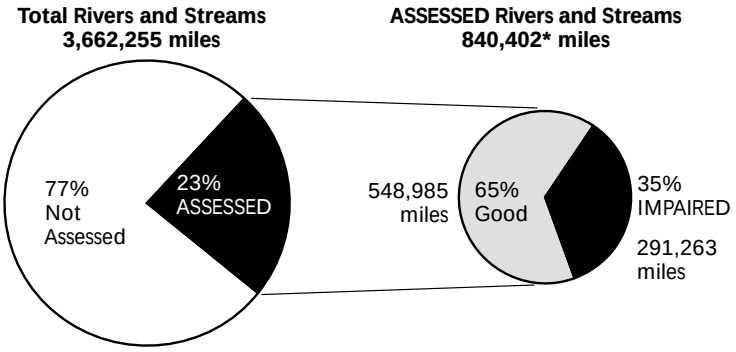
The pollutants/processes and sources shown here may not correspond directly to one another (i.e., the leading pollutant may not originate from the leading source). This may occur because a major pollutant may be released from many minor sources. It also happens when states do not have the information to determine all the sources of a particular pollutant/stressor.

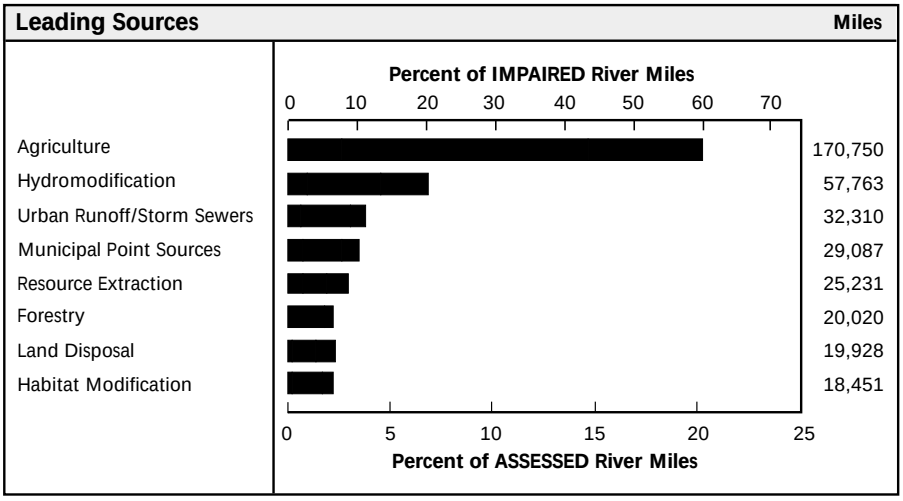
SILTATION is the most common pollutant affecting assessed rivers and streams. Siltation

- Is found in 13% of the assessed rivers and streams (see Figure 3-4).
- Contributes to 38% of reported water quality problems in impaired rivers and streams.

Figure 3-5

Leading SOURCES of River and Stream Impairment†





States assessed 23% of the total miles of rivers and streams for the 1998 report. The larger pie chart on the left illustrates this proportion. The smaller pie chart on the right shows that, for the subset of assessed waters, 65% are rated as good and 35% as impaired. When states identify waters that are impaired, they also describe the sources of pollutants associated with the impairment. The bar chart presents the leading sources and the number of river and stream miles they impact. The percent scales on the upper and lower x-axis of the bar chart provide different perspectives on the magnitude of the impact of these sources. The lower axis compares the miles impacted by the source to the total ASSESSED miles. The upper axis compares the miles impacted by the source to the total IMPAIRED miles.

Based on data contained in Appendix A, Table A-5.

†Excluding unknown and natural sources.

*Includes miles assessed as not attainable.

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

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

- Affect 20% of the assessed rivers and streams
- Contribute to 59% of reported water quality problems in impaired rivers and streams (see Figure 3-5).

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

Pollutants and Stressors Impacting Rivers and Streams

A total of 60 tribes and states reported the number of river and stream miles impacted by individual pollutants and stressors, such as invasive species (see Appendix A, Table A-4, for individual state and tribal information).

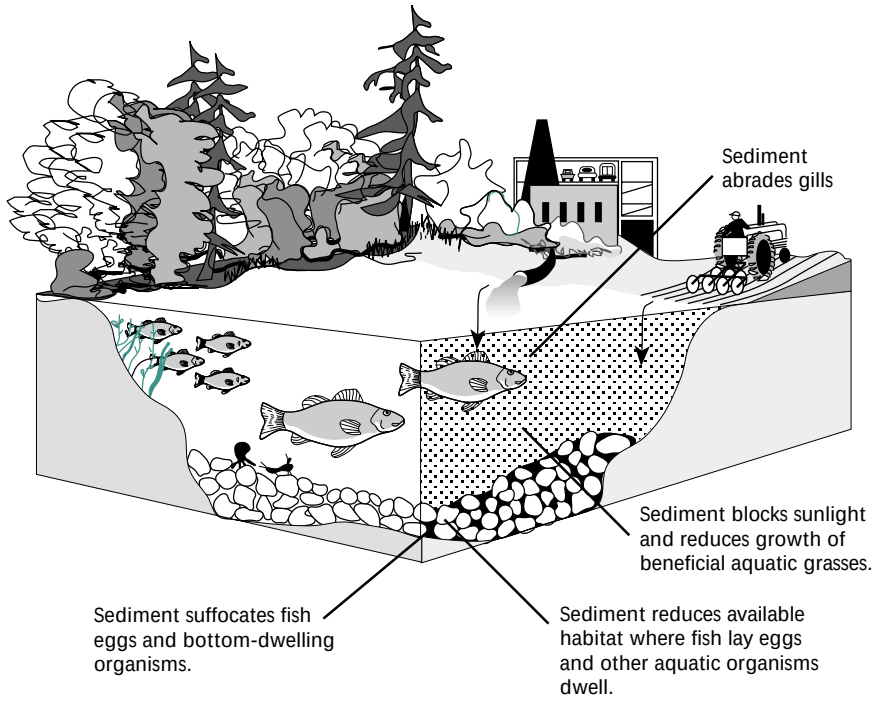
The states and tribes report that siltation, composed of tiny soil particles, remains one of the most widespread pollutants impacting assessed rivers and streams. Siltation impaired 111,228 river and stream miles (13% of the assessed river and stream miles and 38% of the impaired river and stream miles). Siltation alters aquatic habitat and suffocates fish eggs and bottom-dwelling organisms (see Figure 3-6). Aquatic insects live in the spaces between cobbles, and their habitat is destroyed when silt fills in these spaces. The loss of aquatic insects adversely impacts fish and other wildlife that eat these insects. Excessive siltation can also interfere with drinking water treatment processes and recreational use of a river. Sources of siltation include agriculture, urban runoff, construction, and forestry.

The states and tribes report that bacteria (pathogens) pollute 103,616 river and stream miles (12% of the assessed river and stream miles and 36% of the impaired river and stream miles). Bacteria provide evidence of possible fecal contamination that may cause illness if the public ingests the water. States use bacterial indicators to determine if rivers are safe for swimming and drinking. Bacteria commonly enter surface waters in inadequately treated sewage, fecal material from wildlife, and runoff from pastures, feedlots, and urban areas.

Nutrient pollution was also reported as a significant cause of

Figure 3-6

The Effects of Siltation in Rivers and Streams



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

Identifying Sources Is a Challenge

It is relatively easy to collect a water sample and identify pollutants causing impairments, such as fecal coliform bacteria indicating pathogen contamination. However, detecting and ranking sources of pollutants can require monitoring pollutant movement from numerous potential sources, such as failing septic systems, agricultural fields, urban runoff, municipal sewage treatment plants, and local waterfowl populations. Often, states are not able to determine the particular source responsible for impairment. In these cases, many states report the source of impairment as "unknown." In the 1998 305(b) reports, states reported unknown sources impairing 30,499 river and stream miles (4% of the assessed river and stream miles).

water quality impairment in the 1998 305(b) reports, with states and tribes reporting impacts to 84,071 river and stream miles (10% of the assessed river and stream miles and 29% of the impaired river and stream miles). While nutrient pollution has been an ongoing problem in the nation's lakes and ponds (see Chapter 4), it is getting increased attention because of its effects on rivers and streams, particularly those that flow to sensitive estuarine and coastal waters (see Chapter 5). Excessive levels of nitrogen and phosphorus may accelerate growth of algae and underwater plants, depleting the water column of dissolved oxygen necessary to maintain populations of fish and desirable plant species. Nutrients may enter rivers and streams from municipal and industrial wastewater treatment discharges and runoff from agricultural lands, forestry operations, and urban areas.

In addition to siltation, bacteria, and nutrients, the states and tribes also reported that oxygen-depleting substances, metals, pesticides, habitat alterations, and thermal modifications impact more miles of rivers and streams than other pollutants and stressors. Often, several pollutants and stressors impact a single river segment. For example, the removal of shoreline vegetation may accelerate erosion of sediment and nutrients into a stream. In such cases, the states and tribes count a single mile of river under each pollutant and stressor category that impacts the river mile. Therefore, the river and stream miles impaired by each pollutant or stressor do not add up to 100% in Figure 3-4.

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

Sources of Pollutants Impacting Rivers and Streams

A total of 59 tribes and states reported sources of pollution related to human activities that impact some of their rivers and streams (see Appendix A, Table A-5, for individual state and tribal information). These states and tribes reported that agriculture is the most widespread source of pollution in the nation's assessed rivers. After agriculture, the states and tribes reported that hydromodification, urban runoff and storm sewers, and municipal discharges are the most common sources of impairment to rivers and streams.

■ Agriculture – Agriculture is listed as a source of pollution for 170,750 river and stream miles, or about 20% of assessed river and stream miles (Figure 3-5). While this number is significant, it must be viewed in light of the magnitude of the

agricultural sector in the United States. According to the 1997 Census of Agriculture, 41% of the continental United States, about 900 million acres, is used for agricultural production. Cropland accounts for about 46% of the agricultural land. Pasture and range land make up another 43%.

Of the 53 states and tribes that reported impairment from agriculture, 28 reported the number of river and stream miles impacted by specific types of agricultural activities:

- Nonirrigated Crop Production – crop production that relies on rain as the sole source of water.
- Irrigated Crop Production – crop production that uses irrigation systems to supplement rainwater.
- Range Grazing – land grazed by animals that is seldom enhanced by the application of fertilizers or pesticides, although land managers sometimes modify plant species to a limited extent.
- Pasture Grazing – land upon which a crop (such as alfalfa) is raised to feed animals, either by grazing the animals among the crops or harvesting the crops. Pasture land is actively managed to encourage selected plant species to grow, and fertilizers or pesticides may be applied more often on pastureland than rangeland.
- Animal Feeding Operations – either Concentrated Animal Feeding Operations (permitted point source) or Animal Feeding Operations (nonpoint source).
  - – Concentrated Animal Feeding Operations (permitted point source) – facilities in which animals are confined, fed, and maintained for some period of time throughout the year where discharges are regulated through the National Pollutant Discharge Elimination System.
  - – Animal Feeding Operations (nonpoint source) – facilities in which animals are confined, fed, and maintained for some period of time throughout the year that are considered nonpoint sources according to the Clean Water Act.

The 28 states and tribes that reported the number of river and stream miles impacted by specific types of agricultural activities identified the most miles impaired by nonirrigated crop production. These states and tribes report that nonirrigated crop production degrades 46,484 miles (27% of the 170,750 miles impaired by agriculture). Following nonirrigated crop production, the states and tribes report that irrigated crop production degrades 31,156 miles (18% of the 170,750 miles impaired by agriculture). The states and tribes also report that animal feeding operations pollute 27,751 miles (16% of the 170,750 miles impaired by agriculture), range grazing degrades 19,469 miles (11% of the 170,750 miles impaired by agriculture), and pasture grazing degrades 10,597 miles (6% of the 170,750 miles impaired by agriculture).

Runoff from irrigated and nonirrigated cropland may contain nutrients (nitrogen and phosphorus), pesticides, and soil particles.

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

Nutrients in Streams: Findings of the U.S. Geological Survey NAWQA Program

As described in Chapter 2, Congress established the National Water Quality Assessment (NAWQA) Program in 1991. The U.S. Geological Survey (USGS) implements this program to examine water quality patterns and trends across the United States. USGS recently released a report analyzing the results of water quality monitoring at 20 study units across the country (USGS, 1999, *The Quality of Our Nation's Waters—Nutrients and Pesticides: U.S. Geological Survey Circular (1225)*).

Nutrient levels in streams affected by different land use activities were one aspect of the USGS report. For this report, USGS looked at data from streams on concentrations of total nitrogen and total phosphorus. It compared the concentrations found in agricultural areas, urban areas, and undeveloped areas. Summaries of these data are presented in Figures 1 and 2.

The highest total nitrogen and phosphorus concentrations were found in streams draining watersheds with large amounts of agricultural and urban land uses. These data support the growing understanding of the contribution of human activities, including the amounts and timing of fertilizer and manure applications and land- and water-management practices, on levels of nitrogen and phosphorus in streams.

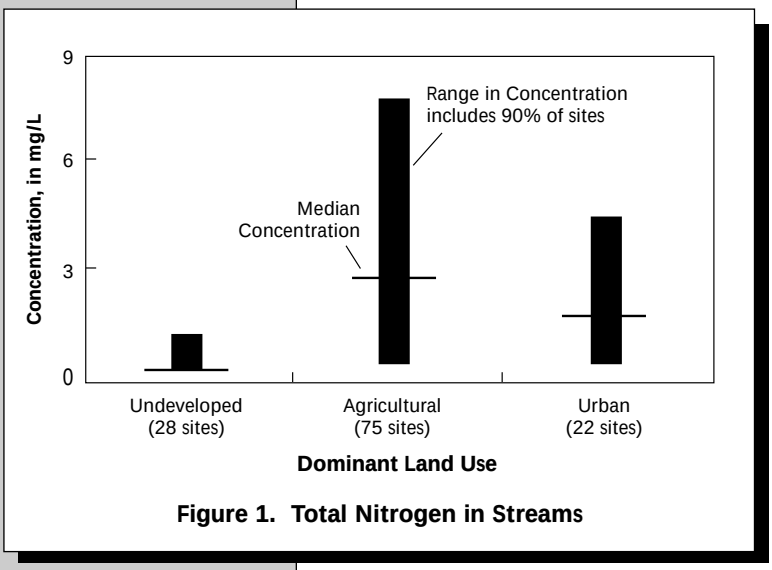


Figure 1. Total Nitrogen in Streams

Nitrogen

In more than half of sample streams, total nitrogen concentrations were above background levels. High concentrations of nitrogen in streams in agricultural watersheds correlated with nitrogen inputs from fertilizer and manure applications and from livestock wastes. Elevated levels of nitrogen in urban streams are probably due

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to a combination of sources including fertilizers used on lawns and golf courses, emissions from vehicles and power plants, and discharges from municipal wastewater treatment plants.

Phosphorus

Total phosphorus levels were above background levels in most streams sampled. About half of the urban streams sampled had average annual concentrations that ranked among the highest in the study. This was especially evident in the semiarid western and southwestern regions where discharges from wastewater treatment plants contribute a large portion of streamflow. However, phosphorus concentrations have decreased during the last 10 years as a result of reductions in the use of phosphate detergents and upgrades to wastewater treatment plants.

The USGS report concluded that human activities have increased nutrient levels above background concentrations in streams. In most cases, enrichment of streams with nutrients occurred in small watersheds and/or regions dominated by agricultural or urban land use.

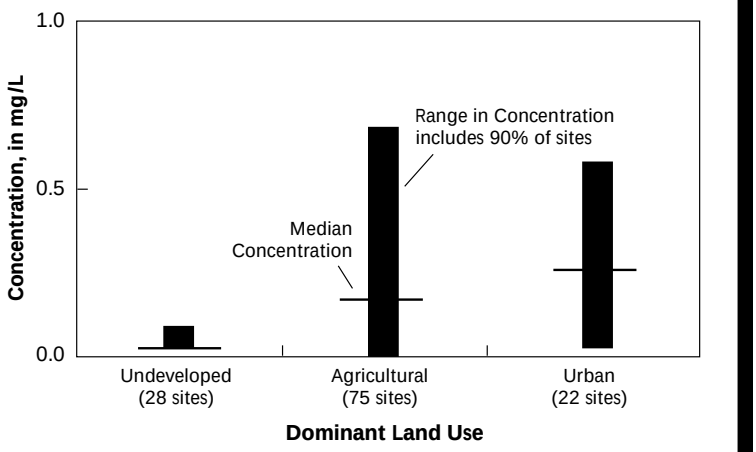

Figure 2. Total Phosphorus in Streams

Agricultural Water Quality Accomplishments

Agriculture is recognized in watersheds across the country as a source of nonpoint source pollution. On the other hand, agricultural land use is recognized in many areas as a "preferred" use for environmental, social, and economic purposes. Addressing problems caused by various agricultural activities while maintaining the overall, long-term sustainability of the environment and the industry presents special challenges.

The agricultural community, through voluntary incentive-based approaches, has been responsive to the growing national concern over degradation of our nation's waters. Technical assistance and financial incentives through U.S. Department of Agriculture (USDA) programs such as the Conservation Reserve Program, the Environmental Quality Incentive Program (EQIP), and the Wildlife Habitat Incentive Program, along with numerous conservation programs at the state and local levels, have helped landowners to become better stewards of the nation's natural resources while meeting the demands of today's markets. Financial assistance provided through these programs has been especially effective in encouraging voluntary adoption of new, more environmentally sensitive practices.

Since the mid-1980s, farmers and ranchers have adopted conservation practices, also referred to as Best Management Practices (BMPs), aimed at reducing nonpoint source pollution at an ever increasing rate. For example, Lake Washington in Mississippi was severely degraded with nutrients and sediments from agricultural lands. The landowners in the watershed, working through the local soil and water conservation district, with technical assistance from the USDA's Natural Resources Conservation Service, developed a watershed management plan to address the water quality problems. In this project, landowners planned and applied BMPs to the land surrounding the lake to reduce sediment and nutrients entering the lake. Monitoring was conducted on several practices by the Mississippi Department of Environmental Quality to see how these practices affected the quality of water in the lake. As a result of BMPs installed in the project area, soil loss was reduced from more than 9.2 tons per acre per year to 2 tons per acre per year on 17,700 acres in the Lake Washington watershed. Monitoring also

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indicated that the installation of BMPs reduced total suspended solids entering the lake from agricultural fields by 50%, total phosphorous was reduced by 83%, and total nitrogen was reduced by 45%.

Farmers and ranchers in Medina, Uvalde, and Bandera counties in Texas are using the EQIP to protect water quality and quantity in the Edwards Aquifer. The Aquifer provides drinking water for 1.5 million people in the San Antonio area and irrigation water for 100,000 acres of farmland. Through the EQIP, crop producers have installed improved irrigation systems that save up to 50,000 gallons of water per acre per year. Ranchers have applied conservation practices to 120,000 acres of grazing land. Water yields on some grazing lands have increased by as much as 40,000 gallons per acre per year. Vegetated buffers and filter strips have been planted on 600 acres, and improved management is being practiced on 500 acres of riverbanks. As a result, sediment loading into streams, rivers, and the Edwards Aquifer has declined by 300,000 tons; pesticide and nutrient loading has declined by 545,000 pounds.

Another shining example of the agricultural community taking voluntary proactive steps to address the issue of water quality is evident in Utah. In 1991, the landowners, water users, and resource managers became alarmed that Chalk Creek was the major source of sediment delivery to the Weber River, which supplies water to Ogden and other Wasatach Mountain Range communities. To address this environmental concern, the interested parties began working together on the Chalk Creek Nonpoint Source Water Quality Project. Most of the agricultural land in the Chalk Creek watershed is in rangeland, with just 2,000 acres of cropland. By 1994, a coordinated watershed resource plan had been developed and a local Technical Advisory Committee had been formed to oversee implementation of the watershed management plan. By 1997, most of the major landowners in the watershed, working with the Summit Soil and Water Conservation District and other agencies, had begun designing resource management system plans for their own land. Through this local initiative, the community is realizing its goal of reduced sedimentation into the Weber River.

Nutrients occur naturally in the soil but are also added in the form of chemical fertilizers and manure. Rainwater and irrigation carry excess nutrients to surface waters and shallow ground water. The transport of nutrients, pesticides, and sediments from cropland can be prevented or reduced by ensuring the proper use and application of chemicals, encouraging the infiltration of water and discouraging runoff, and minimizing soil disturbance.

Sources of pollution from animal feeding operations include facilities that are treated as both point and nonpoint sources. Animal waste from these operations can introduce pathogens, nutrients (phosphorus and nitrogen), and organic matter to nearby rivers and streams. Pollution from animal facilities can be prevented through the proper siting and management of the operation. Many facilities implement a comprehensive plan for handling, storing, and using all wastes produced. For more information on animal feeding operations, see the highlight on the Unified National Strategy for Animal Feeding Operations on page 78.

Improper grazing practices on range and pasture can introduce both soil particles and animal waste into receiving streams. Implementing a comprehensive grazing management plan helps reduce contributions of pollutants by

- Maintaining sufficient soil cover
- Protecting riparian areas from trampling
- Minimizing the direct deposition of wastes into streams.

Range grazing may generate both soil erosion and animal waste runoff. Land used for pasture grazing usually has good ground cover that protects the soil from eroding, but pasture grazing can become a source of animal waste runoff if animals graze on impermeable frozen pastureland during winter.

While agriculture was the leading source associated with impaired river and stream miles, the states and tribes identified a number of other sources. The top-ranked sources are listed below:

■ Hydrologic Modifications – Hydrologic modifications (or hydromodifications) include flow regulation and modification, channelization, dredging, and construction of dams. These activities may alter a river's habitat in such a way that it becomes less suitable for aquatic life. For example, dredging may destroy the river-bottom habitat where fish lay their eggs. The states and tribes report that hydrologic modifications degrade 57,763 river and stream miles (7% of the assessed miles and 20% of the impaired miles).

■ Urban Runoff and Storm Sewers – In urban areas, runoff from impervious surfaces may include sediment, bacteria (e.g., from pet waste), toxic chemicals, and other pollutants. Development in urban areas can increase erosion that results in higher sediment loads to rivers and streams. Storm sewer systems may also release pollutants to rivers and streams, particularly during wet weather events. The states and tribes report that urban runoff and storm sewers pollute 32,310 river and stream miles (4% of the assessed miles and 11% of the impaired miles).

■ Municipal Wastewater Treatment Plants (WWTPs) – Municipal WWTPs treat incoming wastewater from domestic sources and frequently wastewater inputs from industrial and commercial establishments. Although municipal WWTPs treat this waste before discharging to rivers and streams, discharges may still contain toxic chemicals, nutrients, and other pollutants. In some cases, during wet weather events, municipal WWTPs discharge untreated wastewater because of operation and maintenance problems. The states and tribes report that municipal sewage treatment plants pollute 29,087 river and stream miles (3% of the assessed miles and 10% of the impaired miles).

■ Resource Extraction – Activities such as mining and oil and gas production may have adverse effects on water quality. For example, changes in the technology used for surface mining have resulted in much larger areas of land being affected by the mining operations. The runoff associated with these activities is often high in acidity and toxic metals, which can degrade rivers and streams, creating conditions that are harmful to aquatic life. Mining can continue to cause water quality impairments even after activities have ceased. The states and tribes report that resource extraction pollutes 25,231 river and stream miles (3% of the assessed miles and 9% of the impaired miles).

■ Forestry Activities – Commercial forestry activities such as harvesting of trees, application of fertilizer and pesticides, and construction of logging roads may impair water quality by degrading habitat and introducing pollutants to rivers and streams. For example, tree harvesting can cause erosion that increases runoff. Trees harvested near stream courses can reduce the supply of large woody debris important in creating fish habitat in streams. Loss of riparian area timber can also reduce shade and raise water temperature. As the temperature of water increases, it can hold less dissolved oxygen, which is needed by aquatic organisms. The states and tribes report that forestry activities degrade 20,020 river and stream miles (2% of the assessed miles and 7% of the impaired miles).

■ Land Disposal of Wastes – Various forms of land-based waste disposal, such as septic tanks, landfills, and application of sludge, may result in the runoff of pollutants to rivers and streams. These pollutants can include bacteria, hazardous wastes, organic materials, and sediment. The states and tribes report that land disposal of wastes pollutes 19,928 river and stream miles (2% of the assessed miles and 7% of the impaired miles).

■ Habitat Modifications – Changes to a river's habitat, such as removal of riparian vegetation, riverbank modification, and drainage and filling of wetlands, can make it less suitable for the organisms inhabiting it, create conditions favorable to invasion by species not present prior to the changes, or limit its ecosystem function. The states and tribes report that habitat modifications degrade 18,451 river and stream miles (2% of the assessed miles and 6% of the impaired miles).

The states and tribes also report that "natural" sources impair over 33,000 miles of rivers and streams. Natural sources include soils with natural deposits of arsenic or salts that leach into waterbodies, waterfowl (a source of nutrients), and drought, which causes low-flow conditions and elevated water temperatures.

Sources such as mining and forestry activities can play a more significant role in degrading water quality at a regional or local level than at the national level. For example, resource extraction (including acid mine drainage) contributes to the degradation of 43% of the impaired river and stream miles in the coal belt states of Kentucky, Maryland, Ohio, Pennsylvania, and West Virginia. These states report that resource extraction impairs about 5,800 miles of rivers and streams. Yet, at the national level, resource extraction contributes to the degradation of only 9% of all the impaired river and stream miles in the nation. At the local level, streams impacted by acid mine drainage are devoid of fish and other aquatic life due to low pH levels and the smothering effects of iron and other metals deposited on stream beds. The primary sources of acid mine drainage are abandoned coal refuse disposal sites and surface and underground mines.

In the Pacific Northwest states of Oregon and Washington, water quality managers identify forestry activities as responsible for almost a fifth (19%) of the impaired river and stream miles, but, at the national level, states report that forestry activities contribute to the degradation of only 7% of the impaired river and stream miles identified. Forestry activities include harvesting timber, constructing logging roads, and stand maintenance. California, Mississippi, Montana, and West Virginia also report that forestry activities degrade over 1,000 miles of streams in each state.

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

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

Through the Eyes of Morning

The long
complicated
elements of morning
drape themselves across the dew touched meadow
as if they are
lace
from the intricate garments of a queen
who has chosen
this moment
to blow a frosty kiss to her people through the fog–
so intensely ghost white
that if you look deep enough
you can see yourself.
And so I look.
Deep.
Hoping that if something as simple
yet intense,
as young
yet ancient,
as morning
knows who I am, maybe I will too.

But I only see the dew.
And the fog.

And who is anyone
through the distorted eyes of
morning?

River of Words 1999 Grand Prize Winner (Poetry, Grades 7-9)
Anne Atwell-McLeod, Age 13, ME

River of Words 1999 Grand Prize Winner (Art, Grades 7-9)
Naomi Celmo, *Wild and Free - The River and Me*, Age 15, FL

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Restoring the Mississippi River Ecosystem

The Mississippi River and the basin it sustains are an integral part of the history, culture, economy, and environment of the United States. The main stem of the river and its tributaries drain 40% of the land in the lower 48 states. This area includes parts of 26 states and parts of 6 of the 10 EPA Regions and is home to almost a third of the U.S. population (see figure below). The river is an extremely important resource. It is a drinking water supply for tens of millions of people, it transports barges bearing billions of dollars worth of cargo, and, together with its remaining wetlands, it is habitat to large and valuable populations of waterfowl, fish, and shellfish. In addition, billions of dollars are spent on recreation associated with the river.

In recent years, there has been growing concern about water quality in the Mississippi River and the Gulf of Mexico into which it drains. In response, EPA and other concerned agencies have launched programs to restore water quality. The Mississippi River Initiative addresses point source pollution, while a nutrient task force and basin teams work to control nonpoint sources in the Mississippi River Basin.

Figure 1. The Mississippi River Basin System

Condition of the Resource

Activities on the land that constitute the Mississippi River's huge watershed affect the quality of the river and the Gulf of Mexico. The river receives runoff laden with fertilizers and other chemicals and direct discharges of treated

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wastewater from cities and factories. The engineering that has been undertaken to control floods and enhance navigation has taken a toll as well. Separating the river channel from the floodplain through flood control and land use conversion measures has reduced the ability of the river to cleanse itself of nutrients and has starved the marshes of Louisiana of sediment needed to offset subsidence and sea-level rise.

Compounding these problems, the Gulf of Mexico, which is strongly correlated with nutrient discharges from the mouth of the Mississippi River, is suffering from hypoxia. Hypoxia is an absence of oxygen reaching living tissues. In coastal waters, it is characterized by levels of dissolved oxygen so low that not enough is available to support fish and other aquatic species. Eutrophication or the overabundance of nutrients, such as nitrogen and phosphorus, causes hypoxia. Excess nutrients may come from a wide range of sources: runoff from developed land, atmospheric deposition, soil erosion, and agricultural fertilizers. Sewage and industrial discharges also contribute nutrients.

The Mississippi River Initiative

The Mississippi River Initiative began as a way to address the unprecedented amount of pollution currently contaminating the river. In September 1997, representatives from affected U.S. Attorneys' offices met in St. Louis for 2 days with officials from the Justice Department to discuss the state of the river and how best to work together to stop point source pollution and clean up the river. The Initiative has developed into a comprehensive, coordinated federal effort to keep illegal pollution, ranging from raw sewage to industrial waste, out of the river and to restore the river and surrounding communities to their historic grandeur. To stop illegal point source pollution from entering the river, the Initiative employs the cooperative efforts of the Department of Justice, EPA's civil and criminal enforcement groups, the U.S. Customs Service, other U.S. Attorneys, the U.S. Coast Guard, the U.S. Fish and Wildlife Service, state attorneys general, state environmental agencies, the Federal Bureau of Investigation, and other state and local leaders.

Mississippi River/Gulf of Mexico Watershed Nutrient Task Force

EPA, together with representatives from federal, state, and tribal agencies and organizations, formed the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force during the fall of 1997. The Task Force was established to study the causes and effects of excessive nutrient runoff to the Mississippi River Basin and to coordinate and implement nutrient reduction activities to alleviate hypoxia in the Gulf of Mexico. To date, the Task Force has initiated a two-track effort to respond to the nutrients issue. The first is an ecosystem/watershed management track to develop and implement nutrient reduction strategies in the basin. The second track is to assess the state of scientific knowledge and understanding of hypoxia.

Task Force activities include coordinating and supporting nutrient management activities from all sources, restoring habitats to trap and assimilate nutrients, and supporting other hypoxia-related activities in the Mississippi River and Gulf of Mexico watersheds.

The Mississippi River Basin System Teams

In December 1997, EPA representatives from the Gulf of Mexico program, Office of Water, and EPA Regions of the Mississippi River Basin met in St. Louis to review the issues and needs in the Basin. One outcome of this meeting was the creation of EPA teams for each major segment or tributary system of the Mississippi River. The following teams were organized:

- Missouri River Tributary Team
- Upper Mississippi Segment Team
- Arkansas-Red-White River
- Tennessee River Tributary Team
- Ohio River Tributary Team
- Lower Mississippi River Segment Team.

The purpose of the teams is to build upon and complement the work of state, tribal, regional, and local efforts to address the public health and environmental issues in the Mississippi River Basin. In particular, the teams work to enhance

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EPA's support for a number of existing multistate, multistakeholder organizations and efforts. These include the Upper Mississippi River Basin Association (UMRBA), the Ohio River Valley Sanitation Commission (ORSANCO), the Corps of Engineers' Environmental Management Program for the Upper Mississippi River, and the state of Illinois' Illinois River Initiative.

River of Words 1999 Finalist, Jennifer Strand, Age 14, *Breezy Night*, PA

Unified National Strategy for Animal Feeding Operations (AFO) (March 9, 1999)

The USDA-EPA Unified National Strategy for AFOs was one of more than 100 actions President Clinton requested in the Administrator's Clean Water Action Plan. Animal feeding operations, or AFOs, are livestock-raising operations, such as hog, cattle, dairy, and poultry farms, where animals are kept and raised in confined situations. When not properly managed, animal waste from these operations can run off into nearby waterbodies. Since the 1970s, factors such as the growing concentration of animals at larger feeding operations, the availability of new waste and runoff controls, and increasing water pollution problems have heightened awareness that more should be done to control agricultural waste.

The AFO strategy addresses the water quality problems resulting from ineffective waste management. These problems include runoff polluted by excess nitrogen, phosphorus, pathogens, and other compounds. Elevated concentrations of these pollutants have been associated with the contamination of drinking water, crops, and animal feed and adverse impacts to fish and shellfish.

The draft strategy proposes a variety of voluntary and regulatory approaches. It is designed to help AFO owners and operators remain financially strong while reducing threats to public health and water quality. This draft strategy contains a section encouraging industry leadership to provide education, financing, and advice for pollution control plans. The strategy establishes an expectation that all animal feeding operations develop and implement comprehensive nutrient management plans by the year 2009. These plans include manure handling and storage, application of manure to the land, recordkeeping, feed management, integration with other conservation measures, and other manure utilization options.

As part of the strategy, USDA and EPA estimate that 95% of the 450,000 animal feeding operations will implement voluntary comprehensive nutrient management plans. An estimated 15,000 to 20,000 livestock operations will be required to develop comprehensive nutrient management plans as part of permits under the Clean Water Act.

To date, approximately 2,000 permits have been issued to concentrated animal feeding operations under the authority of the Clean Water Act. The EPA program intends to focus permitting and

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enforcement activities on three types of facilities:

- The largest concentrated AFOs (or CAFOs, those with 1,000 or more animal units [1 animal unit = 1 steer weighing 1,000 pounds])
- AFOs with unacceptable conditions such as direct discharge into waterways
- AFOs that are significant contributors to water quality impairment within a watershed.

Earl Scales, Weirsdale, FL