Part II

Along the American River

CHAPTER ONE

Along the American River

America's rivers are an integral part of the nation's heritage and wealth. They are simultaneously sources of water for drinking, irrigation, and industry; conduits to move people and products; nurturers of both aquatic and terrestrial biodiversity; and treasure troves of scenic, historic, and recreational pleasure.

From the nation's birth through about the 1950s, the story of the American river is largely about taming its force. Public and private efforts were aimed at reducing the risks of floods, providing assured supplies of water for cities and industry, and bringing water to the vast, largely arid West.

In the 1930s and 1940s, many of the nation's rivers were little more than handy receptacles for municipal waste and industrial toxins. They had become putrid stews carrying waterborne disease, threatening human health, and destroying plant and animal resources. Partly in response to the damage done to the nation's waters in the first half of the 20th Century, the national focus began to shift to water quality in the 1950s. Over the next four decades, a massive investment was made to reduce point-source pollution and improve the quality of the nation's rivers.

In the 1990s, truly remarkable and exciting changes are taking place in the nation's collective thinking about rivers.

- People and institutions increasingly think about rivers in holistic terms, either in the context of watersheds or as interconnected systems that may span hundreds and even thousands of miles from headwaters streams to river's end in estuaries and oceans. The old adage that "we all live downstream" has never been more relevant.

- Massive floods in recent years have underscored the complexity of river systems and the need for comprehensive planning. Responding to problems such as catastrophic flooding reveals the complexity of environmental problems: there are many sources of stress, and many, varied solutions.

- Escalating costs of highly engineered structures and the federal balanced budget imperative have created new opportunities for locally led initiatives. Instead of driving top-down solutions, federal agencies now promote collaborative planning with early inclusion of all interested parties at the local and state level. Broader involvement of all interested groups often leads to more creative, more informed, and more cost-effective solutions. Groups that traditionally didn't communicate are now finding common interests.

The extent of watershed-level activity is remarkable. From Rivers Unlimited in Ohio and Idaho Rivers United to the Alabama Rivers Alliance and Amigos Bravos in New Mexico, citizen groups across the country are adopting watersheds as their organizing principle. Some 3,000 river and watershed organizations are listed in the *1996-97 River and Watershed Conservation Directory*. Watershed '96, a conference sponsored by the U.S. Environmental Protection Agency and others, drew 2,000 participants in the spring of 1996.

National groups such as River Network, Know Your Watershed, Pacific Rivers Council, American Rivers, Trout Unlimited, the Appalachian Mountain Club, Restore America's Rivers and others are playing diverse roles as advocates, communicators, and teachers.

States have moved forcefully. Florida, Wisconsin, Massachusetts, New York, Texas, and Maryland have passed legislation or established specific programs to deal with clean water and other issues at the watershed level.

North Carolina's "whole basin approach" to water quality protection focuses on coordinating and integrating all program activities for each of the state's 17 major river basins.

Resources are mobilized to assess all waters in a basin and develop a management plan that targets priority problems and pollutant sources. These plans provide a basis for management decisions such as National Pollutant Discharge Elimination System (NPDES) permit renewals, enforcement, and monitoring.

At the national level, numerous efforts are underway to look more broadly at environmental problems. After the tragic 1993 floods in the Midwest, the administration created a Floodplain Management Task Force that produced a multivolume report, paving the way for numerous subsequent changes in the federal approach to floodplain management. An Interagency Ecosystem Management Task Force also produced a massive review of the opportunities and impediments to implementing an ecosystem approach to environmental management.

Federal agencies now recognize the need to work together as well as with state and local governments and the private sector. For example, Coastal America—a partnership of 11 federal agencies and the White House Council on Environmental Quality—helps build partnerships among federal agencies, the states, and non-governmental organizations.

This edition of *Environmental Quality* uses "The American River" as an extended metaphor to describe environmental problems and opportunities along the course of a river. While the focus is on rivers as an organizing tool, a broad range of other environmental issues will be considered.

A few cautionary notes are in order:

- In chapters 3-6, the discussion is organized in terms of the distinctive segments of a river, beginning with headwaters and ending with estuaries and coasts. The placement of subjects in these chapters is only illustrative; it is not meant to imply that such activities occur only in these segments of a river.

- The lines between "urban" and "rural" are increasingly blurred; most watersheds today are characterized by a mix of land uses, some predominantly "urban" and some predominantly "rural."

Though much of the discussion considers the impacts of human activities on water quantity and quality, the real point of this report is to think broadly about the complexity of environmental problems, about the many groups that have an interest in environmental problems, and about challenges posed by indirect and cumulative effects that are not easily understood.

Watersheds and their component parts—upland drainage areas, rivers, streams, lakes, and estuaries—are a useful focal point because they integrate nearly all aspects of the environment. In assessing any particular development, governments must consider a broad array of potential effects on a stream, including impacts on water quality and quantity, riparian forests, wetlands, wildlife corridors, and aquatic habitat, to name just a few. Environmental managers also recognize that watersheds are often the units that actually define a problem, and are more relevant than state or national boundaries when considering natural resources management.

The well-known phase, "Think Globally, Act Locally," has a great deal of merit. This report is a reminder that acting locally is a vital part of our efforts to protect the environment, and that much new thinking and acting is occurring at the local, state, and regional level. As we learn more about environmental problems, it is also a reminder that the gap between local, regional, national, and global thinking and action is not as wide as we may think.

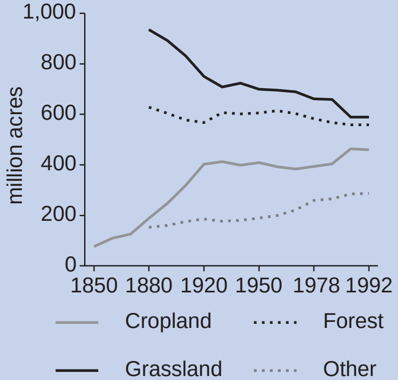
FROM DEVELOPMENT TO STEWARDSHIP

The state of America's rivers reflects our national and political history, not to mention the many thousands of years of natural history that preceded the arrival of the first settlers from Europe.

As settlers moved from east to west across the United States in the 18th and 19th centuries, rivers were the principal routes of movement, and riverbanks were the first places to be settled.

Steamboats, needing wood for fuel, were responsible for much of the early loss of riparian forests. Soon thereafter, early settlers began clearing forests for agriculture (Figure 1.1). This historic land-use pattern permanently changed the environment in much of the Midwest, but proved more transitory in other regions of the country. In the Northeast, for example, extensive clearing was common until the mid-1800s, when farming became unprofitable and farms were increasingly abandoned. In Petersham Township in central Massachusetts, nearly 85 percent of the land was cleared by 1850; today, forests have returned to

Figure 1.1 Major Uses of Land in the Contiguous United States, 1850-1992



Source: Daugherty, A.B., *Major Uses of Land in the United States, 1992* (USDA, ERS, Washington, DC, 1995) and earlier reports.

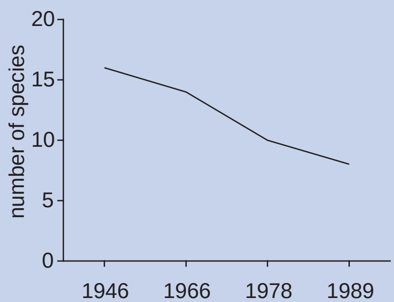
about 90 percent of the township, and most of the cleared land is devoted to residential development.

The historic pattern of clearing forest land along rivers has remained a relatively common feature of the American landscape until recently. Prior to settlement, woody riparian vegetation covered an estimated 30-40 million hectares in the contiguous United States; by the early 1970s, at least two thirds of that area had been converted to non-forest land uses and only 10-14 million hectares remained wooded. In much of the arid West, the Midwest, and the Lower Mississippi River valley, riparian forests have been reduced by more than 80 percent.

Along the Willamette River in Oregon, for example, the streamside forest in 1850 extended up to 3 kilometers on both sides of a river characterized by multiple channels, sloughs, and backwaters. By 1967, government-sponsored programs for forest clearing, snag removal, and channelization had reduced the Willamette to a single uniform channel that had lost more than 80 percent of its forest and land-water edge habitats. Agriculture, logging, and urbanization all had important environmental impacts, increasing runoff of silt, nutrients, and pollutants into rivers and lakes. Increased silt and nutrients, in turn, began a process of euthrophication that killed many desirable plants and encouraged the growth of nuisance plants and algae. The loss of native plants and chemical changes in the water subsequently led to a loss of animal species, including fish and waterfowl.

In the region around Lake Mendota, Wisconsin, the conversion to agriculture was largely complete by the 1870s. By the 1880s, large blooms of blue-green algae

Figure 1.2 Aquatic Plants in University Bay, Lake Mendota, Wisconsin, 1946-1989



Source: Nichols, S.A., R.C. Lathrop, and S.R. Carpenter, "Long-term vegetation trends: a history," in Kitchell, J.F. (ed.), *Food Web Management: A Case Study of Lake Mendota, Wisconsin* (Springer-Verlag, New York, 1992).

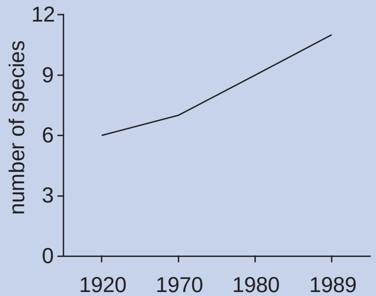
were common. By 1989, roughly a century later, about half the lake's species of aquatic plants were gone (Figure 1.2). The beds of wild celery that once supported canvasback ducks and other migratory waterfowl and the native pondweeds that were vital nursery and rearing habitat for many fishes had also disappeared. These beneficial plants were largely replaced by coontail and an exotic, Eurasian watermilfoil, both of which have low food value for fish and wildlife. Deep-water insect populations began to decline around 1950. Native fish populations have declined by about one third (Figure 1.3); the causes include overfishing, habitat loss, the disappearance of native aquatic plants, and the stocking of the lake with predatory fish for game purposes.

The loss of native plants and animals has been especially severe in our lakes, rivers, and other waters. By 1989, in spite of conservation and restoration efforts, over 100 species of freshwater fishes were added to the threatened or endangered list and more than 250 were in danger of disappearing.

The Changing Federal Role

The early history of water resources development in the United States has two focal points: the effort to reduce the risks to human life and settlements posed by floods, through the construction of dams, levees, and other measures; and the effort to take greater advantage of the economic benefits of water, by providing an assured supply of water for irrigation, industry, and public consumption.

Figure 1.3 Cumulative Loss of Native Fish from Lake Mendota, Wisconsin, 1920-1989



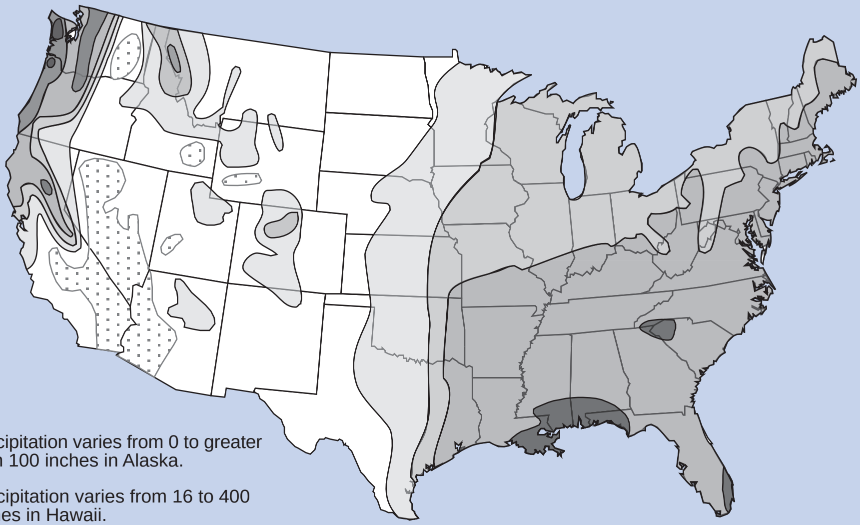
Source: Magnuson, J.J. and R.C. Lathrop, "Historical changes in the fish community," in Kitchell, J.F. (ed.), *Food Web Management: A Case Study of Lake Mendota, Wisconsin* (Springer-Verlag, New York, 1992).

In both cases, the nub of the problem was the unpredictability of precipitation and water supply in much of the nation, and particularly in the states west of the 100th Meridian. The area east of the Mississippi River typically receives more than twice as much annual rainfall as the area west of the Rocky Mountains (Figure 1.4) (Box 1.1).

The federal authority to regulate water stems from an 1824 Supreme Court case, *Gibbons vs. Ogden*, in which the court confirmed the federal government's power to protect and promote navigation under the commerce clause. The navigation authority became the constitutional foundation for federal regulation of water use.

Congress and the Supreme Court historically interpreted the commerce clause quite broadly, citing it as the federal authority to develop water resources for irrigation, hydropower, flood control, and municipal and industrial water use, as well as to prevent environmental degrada-

Figure 1.4 Mean Annual Precipitation in the United States



Precipitation varies from 0 to greater than 100 inches in Alaska.

Precipitation varies from 16 to 400 inches in Hawaii.

Precipitation, in inches

0 to 10
11 to 20
21 to 30
31 to 40
41 to 60
61 to 100
Greater than 100

Source: Adapted from National Climatic Data Center, *Climatography of the United States No. 81.*

tion or restore past environmental damage.

After the turn of the century, the federal government assumed a much larger role in water resources development. The Reclamation Act of 1902 gave the federal government a major role in the development of a vast infrastructure of dams, canals, and other structures to support irrigated agriculture in the West, generate power, and provide water for municipal and industrial usage. The New Deal transformed the Bureau of Reclamation's program into a regional water development program, building large storage reservoirs to support irrigated agriculture and urban growth. Hoover Dam, which was built to augment supplies for California's Imperial Valley and for Los Angeles' growing needs, became the model for more large multiple-purpose projects that began during the Depression and continued in the 1960s. In all, the Bureau of Reclamation constructed some 133 water projects in the West.

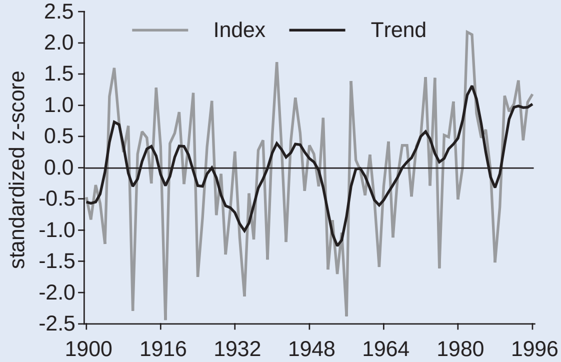
At about the same time, the Army Corps of Engineers began to expand its flood control mission. The Corps builds, operates, and maintains navigation channels, reservoirs and levees for flood control and incidental uses such as hydroelectric power generation. The Corps' navigation authority also became a limited form of river basin management, as flood control and navigation objectives required the Corps to plan and manage

Box 1.1
Trends in Precipitation

In an average year, about 9 percent of the contiguous United States is unusually dry and about 9 percent is unusually wet. But there is considerable variation in these numbers. In 1983, 36 percent of the country experienced unusually wet weather. In the Dust Bowl year of 1934, almost half the country—48.8 percent—was extremely dry. (See Part III, Table 6.2)

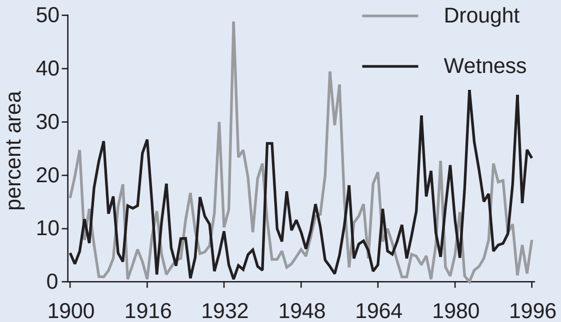
For the nation as a whole, precipitation trends have been generally above normal during the 1970-96 period, especially since 1992 (Box Figure 1.1). In both 1995 and 1996, roughly one fourth of the country experienced unusually wet weather (Box Figure 1.2). In addition, much of the country has been struck by natural disasters in the past few years. During July and August 1993, devastating floods hit the lower Missouri River, the upper Mississippi River, the Illinois River, and many of their tributaries. Thirty-eight lives were lost, and estimated damages were between $10 billion and $16 billion.

Box Figure 1.1 Precipitation Index, 1900-1996



Source: See Part III, Table 6.1.

Box Figure 1.2 Severe to Extreme Wetness and Drought, 1900-1996



Source: See Part III, Table 6.2.

on a basinwide scale. The Department of Agriculture also had a dam-building role through its Soil Conservation Service (now the Natural Resources Conservation Service), which financed small dams on the upper reaches of watersheds.

The reclamation program was originally envisioned as a way to support the development of small farms in the West. That program limited water deliveries to 160-acre tracts (320 acres when both a husband and wife held title), with project costs to be repaid in 10 years by the beneficiaries. But most projects could not meet the repayment obligation, so repayment periods were progressively extended and the costs of project water and power were subsidized in various ways. The subsidies included interest-free repayment charges and the use of an "ability-to-pay" standard for cost recovery, which allowed Reclamation to shift some of the repayment obligations from irrigators to hydroelectric power generation. The acreage limitation policy and subsidies have long been criticized as economically inefficient and environmentally unsound.

The generation of hydropower also emerged as a major part of the federal role in water development. Several controversies over hydropower developed over the course of many decades. One key issue concerned whether the federal government or private utilities would capture the benefits of prime dam sites. The Federal Power Act of 1920 allowed private access to hydroelectric sites subject to a federal license. Since then, power generation has evolved into a mixed system of privately and publicly generated power.

Rivers and coastal waters are also important for waterborne commerce. The water transportation system includes harbors, ports, channels, wharves, locks and dams. Some commercial water facilities are constructed and maintained under federal programs, while others are local or private. For example, the Coast Guard operates the "aids-to-navigation" system, enforces safety and pollution prevention regulations for the design and operation of vessels and marine facilities along coastal waters, and, with EPA, coordinates response to oil and hazardous materials spills.

Other federal agencies also have an important role in water issues. The Fish and Wildlife Service (FWS) and the National Marine Fisheries Service administer the Endangered Species Act and the Fish and Wildlife Coordination Act, to protect species threatened by a federal activity or where private actions may harm species when water is removed from stream channels.

The era of building large dams for traditional needs such as flood control, water supply, and irrigation is now essentially complete, though the nation will continue to develop its water resources for recreation, some additional water supply, environmental enhancement, navigation, and probably some low-head hydro. The nation has about 75,000 dams, including some 2,600 large dams that each store more than 6 million cubic meters of water. Water storage in reservoirs increased to 445 million acre-feet. (Figure 1.5).

The Emerging Federal Conservation Role

The rise of the conservation movement and of federal conservation programs has had an important impact on water resources development.

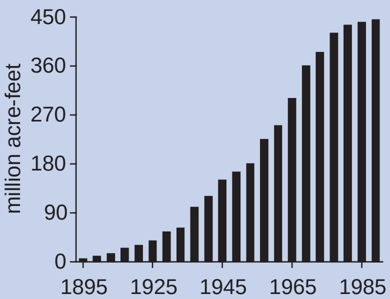
In the first half of the century, fish and wildlife impacts were generally a minor issue in the construction of federal reclamation projects. Early responses included authorizing agencies to construct fish ladders and hatcheries, create wildlife refuges, and operate reservoirs in a manner consistent with fish and wildlife protection. Until 1958, fish and wildlife protection was generally a permissible but minor use of water. The 1958 Fish and Wildlife Coordination Act mandated that fish and wildlife receive "equal consideration" with other project purposes, and the National Environmental Policy Act of 1969 (NEPA) became a major new vehicle for the evaluation of fish and wildlife impacts in pending federal projects. The Endangered Species Act of 1973 required federal agencies or licensees to take all necessary steps to preserve endangered species.

The original focus of the Wild and Scenic Rivers Act of 1968 was to preserve prime undammed rivers. Since then, the program has broadened its focus to river and corridor protection generally. About 10,000 river miles are protected by the Wild and Scenic Rivers Act.

Watershed protection also has been a focus of federal activities since the late 19th Century. The 1897 Organic Administration Act, which provided management authority and direction for the forest reserves, expressed the congressional intent that forest reserves be managed for both timber production and watershed protection. The Multiple-Use, Sustained-Yield Act of 1960 included watersheds as one of the specific multiple uses, along with outdoor recreation, range, timber, and fish and wildlife. The National Forest Management Act of 1976 directed that guidelines for the creation of forest plans consider watershed protection, and that no harvesting should take place in areas where irreversible watershed damage could occur. Forest Service regulations require planners to evaluate hazardous watershed conditions, provide instructions to avoid or mitigate damage at specific sites, and give special attention to 100-foot wide riparian zones along perennial streams, lakes, and other water bodies.

The Bureau of Land Management (BLM) operates under generally similar mandates. The Federal Land Policy and Management Act of 1976 included

Figure 1.5 Reservoir Storage in the United States, 1895-1990



Source: Ruddy, B.C. and K.J. Hitt, *Summary of Selected Characteristics of Large Reservoirs in the United States and Puerto Rico* (USGS, Reston, VA, 1988) with updates by W.B. Solley, USGS, 1997.

resources dependent on watershed protection as part of BLM's multiple-use mandate. The Public Rangelands Improvement Act of 1978 recognized the serious deterioration of public rangelands and directed BLM to take rehabilitative measures to restore viable ecological systems. BLM is paying increasing attention to the protection of riparian areas and stream ecosystems. The agency has the authority to exlude livestock from sensitive riparian areas, but is not required to do so.

The National Park Service (NPS) has a strong watershed protection mandate, but has limited authority to deal with impacts to park resources that arise outside of park boundaries.

By the 1950s, the importance of managing land uses to achieve water supply and quality goals was understood. While plans were being approved for major flood control works, agricultural forces argued for a program of flood control upstream in small watersheds. The concept combined structures for flood control with the idea of reducing erosion, runoff, flooding, and sedimentation.

The Watershed Protection and Flood Control Act of 1954 established a mechanism for the Soil Conservation Service (now the Natural Resources Conservation Service) to work on small watersheds of no more than 250,000 acres. The goals of the Small Watershed Program include flood prevention, watershed protection, and water management. Projects include a combination of land treatment, structural, and nonstructural measures to enhance natural resource management and improve economic and social conditions in watersheds. Local groups, organized into legally recognized bodies, are central to the development and success of these projects. Groups provide land, easements, rights of way, and operations and maintenance inputs. With strong local involvement, projects reflect community priorities and serve to bring together disparate interests to solve mutually identified problems.

Today, the concept of watershed protection to address water supply issues has returned to the fore of water resource management approaches. The primarily structural approaches characterizing the earlier part of this century are giving way to more holistic approaches, incorporating nonstructural approaches and other conservation practices that enhance watershed function. The approach is based on a simple premise—that managing precipitation where it falls is the most effective and efficient solution to taming the river.

A comprehensive flood management strategy could include nonstructural approaches such as maintaining or restoring wetlands to hold precipitation, returning parts of watersheds to native vegetation, and increasing the moisture-holding capacity of soils. Healthy wetlands are particularly efficient at cycling moisture and contribute to a favorable distribution of water—absorbing water when it is plentiful and releasing it gradually.

The many efforts underway to manage water more efficiently also are paying off in terms of recent reductions in total national water withdrawals (Box 1.2).

Box 1.2
Trends in Water Withdrawls

During the period from 1950 to 1980, water use rose faster than the rate of population growth, increasing from about 184 billion gallons per day in 1950 to 445 billion gallons daily by 1980 (Box Figure 1.3). Over half of the 1980 total was used for industrial purposes—primarily thermoelectric power—and another third was used for irrigation, including water applied both to agricultural crops and pastures and to recreational lands such as golf courses. Public water supplies represented only about 8 percent of total national water withdrawals. Between 1980 and 1995, the nation's total water withdrawals declined nearly 10 percent to 400 billion gallons per day, including an 11 percent decline in irrigation water use, an 11 percent decline in thermoelectric use, and a 39 percent decline in commercial and other industrial use (Box Figure 1.4). While U.S. population continued to grow steadily, the downturn in water withdrawals suggests some improvements in water-use efficiency, though other factors such as variations in annual precipitation also affect such measures. (See also Part III, Table 6.3)

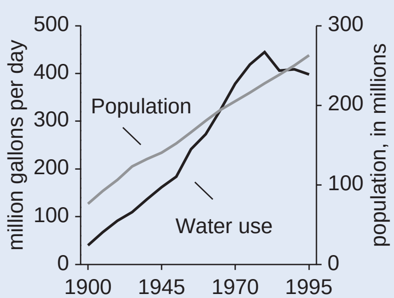
In the case of agriculture, for example, irrigators are using water more efficiently. Nationally, average water rate applications have dropped 14 percent since 1970. Between 1982 and 1992, 11 million more irrigated acres were managed with water conservation systems. Cropping techniques such as terracing can increase the water available for use in a watershed. Conservation plantings can promote infiltration of rainfall, capturing more water for use by agriculture and communities.

Another factor is the decline in irrigation in the West and increase in the East, where irrigation water tends to be used as a supplement.

Groundwater is one of the nation's most important natural resources. About 40 percent of the nation's public water supply and more than 30 percent of the water used for irrigation is provided by groundwater. Groundwater provides 96 percent of the self-supplied domestic freshwater use in the United States. It is the nation's principal reserve of freshwater and represents much of the nation's future water supply.

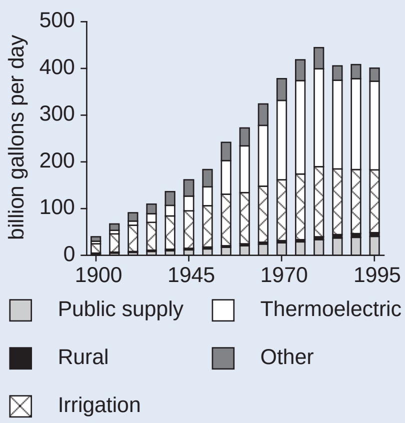
Depletion of groundwater in some regions has reached significant proportions. Moreover, increases in withdrawals from the nation's groundwater systems are expected to occur in future years as a result of increased irrigation in certain regions, water needs for industry and growing urban areas, limited new surface reservoir capacity, and the desire to establish water supply systems that are not easily affected by droughts.

Box Figure 1.3 Population Growth and Water Use in the United States, 1900-1995



Source: See Part III, Table 1.1 and Table 6.3 .

Box Figure 1.4 U.S. Water Use by Sector, 1900-1995



Source: See Part III, Table 6.3.

Water Rights

State law usually governs who has the right to use water and how those rights are administered. In the East, where water is generally abundant, the riparian doctrine is used, which entitles stream-side owners to make reasonable use of the water flowing past their land provided that their use does not unreasonably interfere with the use of others.

Under the prior appropriation doctrine in the West, the right to use water is established by putting the water to a beneficial use. When there is not enough water for everyone, users under the riparian doctrine will share reductions proportionately, while those under the prior appropriation doctrine will be apportioned water under the principle of "first in time is first in right."

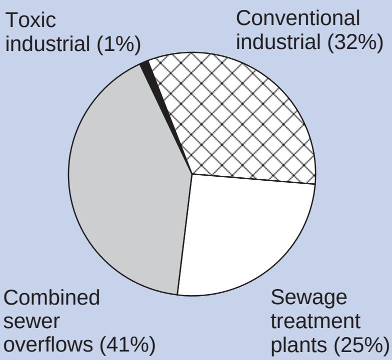
Federal reserved water rights are a special case. The Supreme Court has held that when the United States withdraws land from public domain and reserves it for a federal purpose, by implication it reserves sufficient water to accomplish reservation purposes. The doctrine has its roots in the context of water rights on Indian Reservations, but was later extended to other federal reservations, such as National Parks and Forests.

The Federal Role in Water Quality

The Clean Water Act's National Pollution Discharge Elimination System (NPDES) provides a permitting mechanism to limit the amount of pollution that can be discharged into receiving waters from industrial and sewage treatment plants, as well as from other sources that can affect water quality (Figure 1.6). Technology-based performance requirements have been issued for over 50 kinds of industries; collectively, they reduce pollution loadings from industries by about 90 percent. Municipal sewage treatment plants in most areas are required to provide at least secondary treatment, to assure that 85 percent of conventional pollutants flowing through these plants, such as organic waste and sediment, are removed.

Water quality standards are set by the states for every body of water, subject to EPA approval. These include a designated use (such as drinking water or recreation), specific criteria to protect those

Figure 1.6 Point Source Discharges, circa 1992-1995



Source: U.S. Environmental Protection Agency, Permit Compliance System, unpublished.
Note: Totals include: sewage treatment plants, 3,318 million pounds in 1992; combined sewer overflows, 5,340 million pounds in 1992; toxic industrial, 146 million pounds in 1995; and conventional industrial, 4,170 million pounds in 1995.

uses, and provisions to prevent degradation of water.

The law also provides funding to help states and local governments protect and improve water quality. The original 1972 act established a construction grants program, in which the federal government agreed to pay up to 75 percent (later reduced to 55 percent) of the construction and design cost for municipal treatment plants. From 1972 to 1990, the program provided nearly $54 billion in federal assistance; state and local governments contributed over $20 billion.

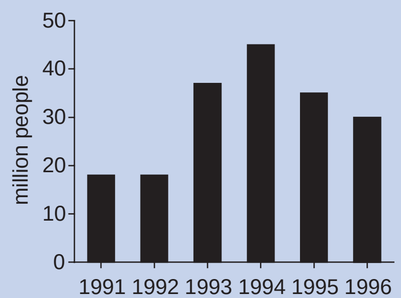
Amendments to the act in 1987 began a transition from grants to loans through state revolving funds. Localities now must repay the cost of construction financing. Federal contributions (83 percent) to the funds are matched by states (17 percent of total capitalization). Although loan support under this program has focused on financing municipal sewage treatment, loans may now be used for stormwater management, wetlands protection, and projects that reduce agricultural and urban runoff, if they are part of a state's Nonpoint Source Pollution Plan.

The transition from grants to loans has meant a substantial increase in the share of wastewater treatment expenditures borne by local governments. The program has also been an effective way to leverage limited dollars. Over a 20-year period, an initial federal investment can result in the construction of up to four times as many projects as a one-time federal grant. With new streamlined requirements, state revolving loan fund projects are completed about 30 percent faster than those funded with grants. The typical cost of a state revolving fund loan is about 30 to 50 percent less than the cost of the same project funded through the commercial bond market. For more on point-source pollution controls, see Chapter Five.

Under the Safe Drinking Water Act, which mandates national primary drinking water regulations, EPA and the states regulate about 55,000 public community drinking water systems that serve over 247 million people. In 1996, 83 percent of the population were served by community systems with no reported violations of drinking water standards, 12 percent were served by systems with one or more violations of maximum contaminant levels (MCL), and 5 percent were served by systems with violations of water treatment technique standards (Figure 1.7).

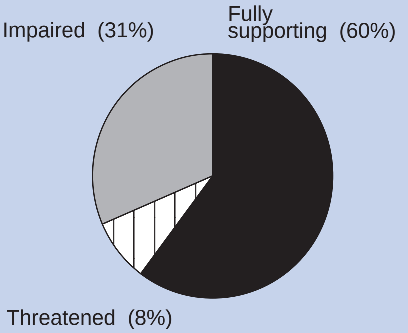
Water quality remains a significant problem in the nation's rivers, lakes, and estuaries. According to the 1996 EPA National Water Quality Inventory, which

Figure 1.7 Population Served by CWSs with Violations of Health-based Standards, 1991-1996



Source: U.S. Environmental Protection Agency, Safe Drinking Water Information System, 1997.
Note: CWS = Community Water System.

Figure 1.8 Overall Use Support in U.S. Rivers and Streams, 1996



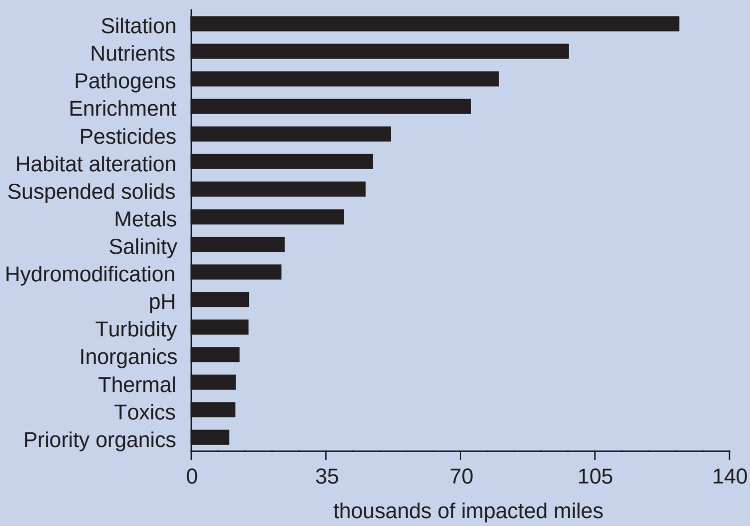
Source: See Part III, Table 6.4.
Note: Based on an assessment of 18% of U.S. river and stream miles.

surveyed about 18 percent of the nation's 3.6 million miles of rivers and streams, about 60 percent of surveyed rivers and streams showed good water quality and supported their designated use and 8 percent were in good condition but threatened. About 30 percent were impaired—supporting their designated uses only partially or not at all (Figure 1.8).

One or more sources may impair any given river or stream. Siltation and nutrients were the pollutants most often found in surveyed rivers and streams, each affecting 18 percent and 14 percent, respectively, of all surveyed river miles (Figure 1.9). Agricultural activities were the most widespread source of pollution, generating pollutants that degraded aquatic life or interfered with public use in 25 percent of the surveyed river miles (Figure 1.10).

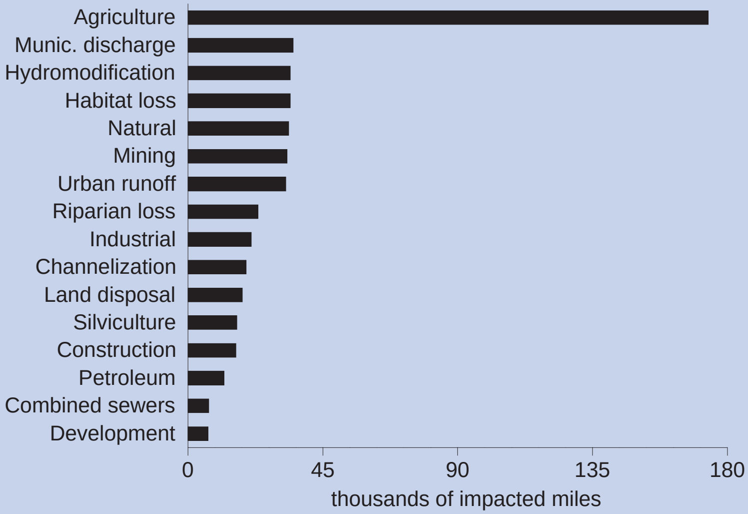
Nonpoint Pollution. It is generally agreed that the framework of pollution

Figure 1.9 Leading Causes of Pollution in U.S. Rivers and Streams, 1996



Source: U.S. Environmental Protection Agency, Office of Water, *National Water Quality Inventory: 1996 Report to Congress*, Table A4 (EPA, OW, Washington, DC, 1998).

Figure 1.10 Leading Sources of Pollution in U.S. Rivers and Streams, 1996



Source: U.S. Environmental Protection Agency, Office of Water, *National Water Quality Inventory: 1996 Report to Congress*, Table A5 (EPA, OW, Washington, DC, 1998).

control standards, technical tools, and financial assistance provided by the Clean Water Act has greatly reduced water pollution from industries, sewage treatment plants, and other point sources, but for a variety of reasons has been considerably less successful in reducing pollution from nonpoint sources. Other approaches have been effective in reducing nonpoint pollution, but have not been widely implemented. Conservation activities, for example, have generated substantial benefits for water resources by reducing runoff, sediment loads, erosion, and nutrient use.

A wide variety of federal programs are intended to reduce nonpoint pollution. Sources of nonpoint pollution include air deposition, cropland, livestock, urban runoff, storm sewers, construction sites, mining, logging, and drainage from waste disposal sites.

Under the Clean Water Act, EPA has provided over $570 million through fiscal 1997 in grants to states, which are passed through to farmers, ranchers, small businesses and local governments to support the design and implementation of practical measures to address polluted runoff. The Clean Water state revolving fund program is also a significant source of funding for nonpoint pollution control projects, providing $659 million since 1988, with the potential to fund a much larger share.

The Department of Agriculture also has numerous programs that address nonpoint pollution. The 1996 farm bill merged the Agricultural Conservation Program (ACP), Great Plains Conservation Program, Colorado Basin Salinity Control Program, and Water Quality Incentive Projects into the Environmental Quality Incentives Program (EQIP). EQIP funding is capped at $200 million for each year through 2002. The program is available to farmers and ranchers in priority areas identified through the locally led conservation process and where there are significant threats to water and soil and related natural resources.

CASE STUDIES

The causes of environmental change have varied from river to river, and have included urbanization, industrial development, agriculture, and the construction of dams and canals. In general, it appears that for many rivers pollution was most severe in the 1930 to 1950 period, with gradual improvement or restoration since then. The Delaware River and Bay, the South Florida ecosystem, and the San Francisco Bay-Delta ecosystem provide three contrasting examples.

Case Study: The Delaware River and Bay

Several studies, including a 1975 CEQ report and a study by Ruth Patrick, have described the environmental history of the Delaware River.

Arriving in the Delaware Valley in 1678, the first Quaker settlers built tanneries, brickyards, and glassworks. These were soon followed by forges and furnaces to smelt and shape iron ore and grain mills to grind corn, wheat, and rye. Lumbering became an important industry, with communities on the Bay supplying wood to shipyards and papermills near Wilmington. Commercial fishing and oystering thrived.

By the time of the first Continental Congress in 1774, there was noticeable water pollution in the Delaware. The first water quality survey in 1799 reported that the main sources of pollution were in the Philadelphia area. But the volume of waste was small enough to be assimilated by the river; the water continued to be drinkable and fisheries prospered.

During the 1800s, many large manufacturers chose sites along the river to take advantage of the water and the inexpensive transportation provided by the river and newly built canals. In the early 1800s, E. I. Du Pont, a French chemist, established the first gunpowder mills in the nation on the Brandywine Creek just above Wilmington. The availability of large amounts of water was vital to the success and growth of these enterprises.

The fishing industry continued throughout the century, but many species—shad, striped bass, and sturgeon—began to decline. Catfish almost completely vanished and the population of oysters also declined. Overfishing and dam construction, which prevented upstream migration, probably were the main factors in the decline, but water pollution almost certainly played a role.

By the 1850s, the city of Philadelphia began building sewers to carry wastewater away from city streets, and other communities soon followed suit. But the volume of sewage and industrial waste contaminated water supplies, causing typhoid and other waterborne diseases that preyed on

Philadelphians through the end of the century.

To deal with this public health threat, Philadelphia in 1899 began construction of the world's largest sand filtration plant. Other cities such as Trenton also built filtration plants, but Camden abandoned the Delaware as its source of water and in 1897 drilled over 100 wells into the aquifers underlying southern New Jersey.

During the first decades of the 20th Century, modest attempts at pollution control were overwhelmed by continued municipal and industrial growth. Water quality sunk to probably its lowest level in the period from 1930 to 1950. Only about 20 percent of the total sewage from Camden and Philadelphia was treated; most smaller communities were discharging raw sewage directly into the river. Industrial dischargers were adding to the problem; over 200 industries in Philadelphia alone were annually discharging some 90,000 tons of solid and semisolid wastes into the river or into the sewer system. As dissolved oxygen was depleted, noxious hydrogen sulfide gases were formed, causing waterfront residents in Philadelphia to complain to President Roosevelt as early as 1934. During World War II, fumes of hydrogen sulfide corroded the metal used for naval radar equipment while it was still on the assembly line.

Fishing declined drastically, with annual finfish catches after 1930 dropping to one tenth of the 1900 catch or less. Commercial shad fishing virtually disappeared, and oyster harvests sank to less than one fifth of their former size. The water in the estuary was so dirty that it clogged ships' engines, requiring expensive repairs.

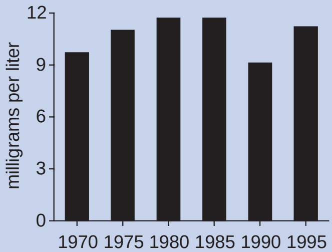
In 1936, the Interstate Commission on the Delaware River Basin was created to encourage the cleanup of the Delaware. Though it had no authority to compel action, this cooperative effort—managed by the states of New York, New Jersey, Delaware, and Pennsylvania—succeeded in recommending minimum water quality standards that all of the member states eventually ratified. Between 1936 and 1942, communities along the river spent more than $10 million to build sewage collection and treatment plants, and by 1946 Philadelphia had embarked on an $80 million sewer improvement and treatment program.

In 1937, Pennsylvania passed the Clean Streams Law, which brought industrial wastes under control. By 1961, 71 percent of Pennsylvania's industries were treating their wastes before discharging them to rivers, compared to just 8 percent in 1941.

By 1964, helped by federal and state funds, all municipalities along the Delaware River Estuary had at least primary treatment. The river's dissolved oxygen content improved, though other indices showed no significant improvement in water quality. Further tightening of water quality standards followed in 1967.

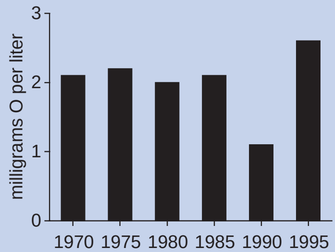
Over the past 40 years, water quality in the Delaware has improved substantially, with the most significant progress since 1980 (Figures 1.11a-1.11f). Though the Delaware is still the site of an enormous concentration of industry—including petroleum refining and petrochemical

Figure 1.11a Mean Annual DO Concentrations in Delaware River, 1970-1995



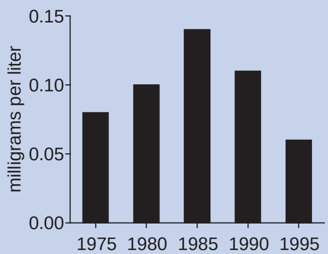
Source: Organization for Economic Cooperation and Development, *Environmental Data Compendium 1997* (OECD, Paris, 1997).
Note: DO = Dissolved oxygen.

Figure 1.11b Mean Annual BOD Concentrations in Delaware River, 1970-1995



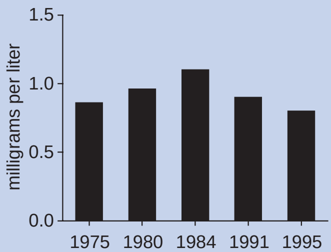
Source: Organization for Economic Cooperation and Development, *Environmental Data Compendium 1997* (OECD, Paris, 1997).
Note: BOD = Biochemical oxygen demand.

Figure 1.11c Mean Annual Phosphorus Concentrations in Delaware River, 1975-1995



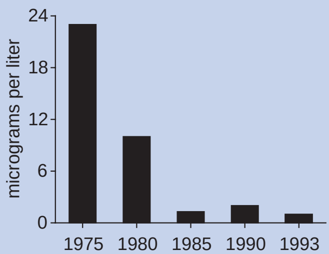
Source: Organization for Economic Cooperation and Development, *Environmental Data Compendium 1997* (OECD, Paris, 1997).

Figure 1.11d Mean Annual Nitrate Concentrations in Delaware River, 1975-1995



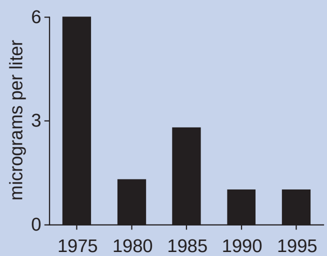
Source: Organization for Economic Cooperation and Development, *Environmental Data Compendium 1997* (OECD, Paris, 1997).

Figure 1.11e Mean Annual Chromium Concentrations in Delaware River, 1975-1993



Source: Organization for Economic Cooperation and Development, *Environmental Data Compendium 1997* (OECD, Paris, 1997).

Figure 1.11f Mean Annual Lead Concentrations in Delaware River, 1975-1995



Source: Organization for Economic Cooperation and Development, *Environmental Data Compendium 1997* (OECD, Paris, 1997).

plants, papermaking, chemical manufacturing, metal processing, and food processing—the dissolved oxygen level has improved enough to maintain aquatic life in all sections of the river. Commercial fishing, including a resurgence of the shad fishery, is continuing. The Delaware is extensively used as a recreational resource. Greenway trails are being established, and public access to the Delaware Estuary has increased as a result of new public parks in the watershed.

Although there have been dramatic improvements in the water quality in the river, problems still exist. For example, water quality does not meet the standard for swimming in the Philadelphia and Camden sections of the river, primarily due to bacteria. Despite increased numbers, levels of some anadromous fish have not reached historic levels due to habitat perturbations and lack of coordinated management plans. Elevated levels of toxics have been detected in sediments, water column, and tissues of organisms, and fish consumption advisories exist in all three states. Heavy use of surface and groundwater places a significant demand on the long-term water supply in the watershed. Sprawl development causes habitat fragmentation and consumes large amounts of natural habitat.

The Delaware Estuary Program was established in 1988 under the Clean Water Act to address these and other issues affecting the Delaware watershed. The program brought together stakeholders from all three states to identify the most important issues and develop a plan of action. In 1996, the Comprehensive Conservation and Management Plan (CCMP) for the Delaware Estuary was signed by the three governors and EPA. Implementation of the plan is currently underway.

Case Study: South Florida Watershed

South Florida—the vast watershed beginning at the headwaters of the Kissimmee River, passing through Lake Okeechobee and the Everglades, and spilling out into Florida Bay—provides an interesting contrast to the history of the Delaware Basin.

Much more so than the Delaware, the south Florida watershed has a long history of attempts to physically modify the rivers and ecosystem to accomodate regional development. Changes began in 1882, with the channelization of the Caloosahatchee River and its connection to Lake Okeechobee, resulting in a new westward outflow from the lake. Four canals were cut from the lake southeast through the Everglades to the Atlantic. In 1916, a fifth canal was constructed from the lake due east to the ocean, and the southern rim of the lake was diked and leveed for agriculture.

Flood control and mosquito control were the two primary reasons for the diking, draining, and channeling of the Kissimmee River, Lake Okeechobee, and the Everglades. Major drainage control systems were built between the late 1930s and the 1960s as a result of the very damaging hurricanes of 1926, 1928, 1947, and 1948. The 1928 hurricane was especially destructive, causing Lake Okeechobee to overflow and killing some 2,500 people.

These disasters spearheaded the heightening of the levee around Lake Okeechobee, improving the linkage of the lake with the Caloosahatchee River, digging the St. Lucie Canal, channelizing the Kissimmee River, constructing the eastern perimeter levee, and creating the Central and Southern Flood Control District (later to become the South Florida Water Management District).

All of these changes had unforseen environmental consequences, including uncontrolled drainage that threatened freshwater supplies, inadequate flood control in wet years, huge muck fires in dry glades, and saltwater intrusion. To deal with these new problems, Congress in 1948 authorized a massive new project that included a 100-mile levee to protect lands to the east of the Everglades from flooding and saltwater intrusion. The project also created an agricultural area and three water conservation areas separated by levees and regulated by canals and pump stations. The water conservation areas provide water to Everglades National Park, which was authorized in 1934 and established in 1947.

The reshaping continued in the 1960s. The Kissimmee River, which in its natural state included 103 miles of meandering river and 35,000 acres of wetlands, was reduced to a canal 56 miles long. Transportation projects such as Alligator Alley and the Tamiami Trail blocked the southward movement of water.

These massive changes had an enormous environmental impact. The wading bird population in the ecosystem may have declined by as much as 90 percent since the turn of the century. South Florida now has 56 federally listed endangered and threatened species—notably including the Florida panther—and 29 candidate species.

The growth of agriculture, which brings nutrient discharges into a nutrient-poor ecosystem, has caused severe water quality problems and changes in vegetation; nutrient over-enrichment is considered the main pollutant in the ecosystem. Native vegetation in many areas has given way to dense stands of cattails, resulting in further decreases in populations of local wading birds and other native species. Hydrological changes and agricultural practices also are affecting Florida Bay, where massive seagrass die-offs, algal blooms, and declines in populations of fish, mangroves, and other species have been documented. Explanations range from hypersalinity (due to diverted freshwater flows) and pollution to the natural impacts of hurricanes and drought.

Exotic species, including Australian melaleuca and Brazilian pepper, are proving to be a formidable long-term problem. Melaleuca was introduced intentionally for its ability to dry up marshes, and both it and Brazilian pepper tend to form dense stands that crowd out native species.

The effort to restore the Everglades ecosystem, which began in 1983 and is continuing today, is described in Chapter Six.

Case Study: The Sacramento-San Joaquin River System

San Francisco Bay and the Delta combine to form the West Coast's largest estuary. The estuary conveys the waters of the Sacramento and San Joaquin rivers to the Pacific Ocean. It encompasses roughly 1,600 square miles, drains over 40 percent of the state (60,000 square miles), and contains about five million acre-feet of water.

The estuary watershed provides drinking water to 20 million Californians and irrigates 4.5 million acres of farmland. It also hosts a rich diversity of aquatic life. Each year, two thirds of the state's salmon pass through the Bay and Delta, as do nearly half of the waterfowl and shorebirds migrating along the Pacific Flyway. In addition, the estuary's water enables the nation's fourth-largest metropolitan region to pursue many activities, including shipping, fishing, recreation, and commerce.

Before western water development began, about 40 percent of California's runoff converged into the Sacramento-San Joaquin Delta on its way to San Francisco Bay and the Pacific Ocean. A series of reservoirs, canals, and pump stations now capture winter rains and snowpack for diversion to Southern California, the San Joaquin Valley, and parts of the Bay area via the massive State Water Project (SWP) and Central Valley Project (CVP). The water delivered through these huge systems has enabled the state's semiarid Central Valley to become one of the nation's prime agricultural areas and has provided water to the rapidly growing population in Southern California.

These North-South transfers have come at a price for the North. For example, Delta fishery resources have been devastated. Fewer than 500 wild winter run salmon have returned to spawn in the Upper Sacramento in recent years, compared to 80,000 annually 20 years ago. Causes of these dramatic declines include overfishing, loss of habitat, water pollution, dams, levees, obstructions, and drought.

Water quality in the Delta also is at risk. Concerns include salinity intrusion into the western Delta from San Francisco Bay, wastewater discharges that contain chemical pollutants, and the inflow of agricultural drainage water that may contain pesticide residues and other toxic agents. The state is legally required to provide an adequate amount of freshwater to the Delta, but this requirement may conflict with water transfers and local consumptive uses. This is especially true during drought, when there may not be enough water to fulfill all demands.

The conflict between water requirements in the Delta and the transfer of water supplies to the southern part of the state has proved to be one of the most controversial water problems in the West. In 1982, California voters defeated a referendum to build the "Peripheral Canal" around the Delta to improve the system's efficiency. Northern Californians overwhelmingly rejected the proposal, apparently fearing that the Delta environment would not be adequately protected and that populous Southern California was attempting another "water grab." Although there was more support in Southern California, many in that part of the state feared the project's high cost.

In 1987, as part of the National Estuary Program, EPA launched a San Francisco Estuary Project (SFEP). After five years, the project's public-private partnership approach reached its initial goal of developing a Comprehensive Conservation and Management Plan (CCMP) for the estuary. The CCMP addresses five critical issues: the decline of biological resources; pollutants; freshwater diversions and altered flow regime; dredging and waterway modification; and intensified land use. For each of these areas, the CCMP defines the problem, evaluates the existing management structure, identifies goals for correcting the problem, provides a broad recommended approach for achieving the goals, and provides specific actions and objectives for carrying out the recommended approach.

However, many aspects of the San Francisco Estuary Project were not implemented. Thus, in 1993, state and federal agencies were being forced to make regulatory decisions regarding implementation of the Clean Water Act and the Endangered Species Act. In December 1994, representatives from the state and federal government signed the Bay-Delta Accord, specifying how state and federal agencies would meet their regulatory obligations until a joint state-federal comprehensive water management and ecosystem restoration program could be developed. The accord led to creation of the CALFED Bay-Delta Program.

Specific concerns addressed by this program include: water quality for both drinking and agriculture; the reliability of water supplies; the deterioration of fish and wildlife populations and habitat; and the Delta levee system, which is now vulnerable to natural disaster as a result of neglect and a lack of financial resources for needed maintenance. A federally chartered Bay-Delta Advisory Council, with 34 members from throughout the state, provides regular guidance and is one of many avenues for public input.

The CALFED Bay-Delta Program is carrying out a three-phase process to achieve broad agreement on comprehensive solutions for the Bay-Delta system. During Phase I in 1995 and 1996, the program worked to clearly define the fundamental problems in the Bay-Delta ecosystem, developed a mission statement and general goals, and developed an initial set of alternative actions.

During Phase II, in compliance with the National Environmental Policy Act and the California Environmental Quality Act, the program is preparing a program-level environmental impact statement to identify impacts associated with the various alternatives. After selection of a preferred alternative, the third phase begins with a site-specific environmental review. During Phase III, which will begin in early 1999 and continue for perhaps 20 to 30 years, the preferred alternative will be implemented.

THE RIVER RUNS DRY

Across much of the nation, droughts and water scarcity are always a risk.

During the extreme drought in the Mississippi watershed in 1988, for example, the barge system was severely tested. The Mississippi-based barge industry is one of the nation's major conveyors of bulk commodities. Some 300 tow and barge companies haul nearly half of the entire Midwestern grain crop plus about 40 percent of the nation's petroleum and 20 percent of its coal. All told, the industry earns about $1 billion per year.

The drought began in the winter of 1987 and continued through the following summer. By mid-June, 83 percent of the river basin was experiencing a severe drought. On June 8, a barge ran aground near St. Louis, marking the first in a series of navigational disruptions.

Fully loaded barges require minimum water levels of 9 feet to operate safely. In 1988, even carefully controlled and timed water releases by the Army Corps of Engineers could not maintain such levels.

Under such circumstances, river managers had to fall back on other strategies, including dredging the blocked areas, limiting the number and weight of the barges pulled by a towboat, releasing more water from upstream dams, or using alternate navigation routes or modes of transportation.

In 1988, managers drew on all of these strategies and more. In addition to periodic dredging, some barge traffic was diverted to the Tennessee-Tombigbee Waterway. Some grain shipments were shifted to alternate ports and routes on the Great Lakes instead of the Mississippi. By the time of the closing of the Ohio River on June 14, 700 barges were backed up at Mound City, a major grain port. With the barges not running and no empty barges arriving, grain piled up at the port. More than $1 million worth of corn was simply stored on city streets because there was no more room in the grain elevators.

At one point, the Governor of Illinois proposed to triple the normal water releases from Lake Michigan for a limited time to help restore Mississippi River levels. Governors of four Great Lakes states threatened court action over the move, and the Canadian Ambassador delivered a formal protest to the U.S. State Department. In the end, the Governor of Illinois dropped the proposal.

All told, the economic losses due to disrupted barge transportation may have reached $1 billion.

For much of the area west of the Mississippi, water scarcity is a fact of life that has had an important impact on the region's development.

In February 1991, after four years of severe drought in California, Governor Pete Wilson established a Drought Water Bank to help deal with the water shortage. The bank's charge was to purchase water from willing sellers and sell it to entities with critical needs.

Water for the bank was acquired through land fallowing (i.e., not planting or irrigating a crop), using groundwater instead of surface water, and transferring water stored in local reservoirs. Most of the 351 contracts negotiated were for fallowing land, but the largest acquisition came from transferring stored water. Of the 820,000 af purchased by the bank, about 400,000 af were disbursed for critical needs and about 260,000 af were carried over into 1992. Some of the excess water acquired was lost in conveyance or was used to maintain water quality standards in the Delta. The Water Bank initiative continued through 1993.

A nearly dried up stock pond in Brackettsville, Texas, in August 1980.

Photo Credit:
USDA—95CS2427

Overall, the California Water Bank was considered an effective effort to reallocate water. The adverse economic impacts were minimal, and the Bank created substantial gains for California's agriculture and economy. But the effort was not without criticism. Some local communities worried about the possible impact on their tax base, and some rural communities feared that water banking could accelerate their demise. Many were concerned that urban areas could use the Water Bank as an excuse for avoiding water development, conservation, or reclamation programs.

Elsewhere in the water-short West, supplies have been augmented through the transfer of water from one river basin to another by canal, aqueduct, or pipeline. For example, more than 802 million cubic meters of water are transferred annually from the basins of the Colorado, San Juan and Colorado rivers on the Western Slope across the Continental Divide to the Eastern Slope of the Colorado, where 80 percent of the state's population resides.

Groundwater has been one answer to the water supply problem in the West. About 30 percent of the groundwater used for irrigation in the United States is pumped from the High Plains aquifer, which underlies parts of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming. In 1990, 15.6 million acre-feet of water was withdrawn from the aquifer to irrigate approximately 14 million acres. This intense use has led to significant declines from pre-development water levels in many areas (Figure 1.12). In the central and the southern High Plains, declines have exceeded 100 feet. Smaller, less extensive declines have occurred thus far in the northern High Plains, where irrigation has been practiced for a shorter time.

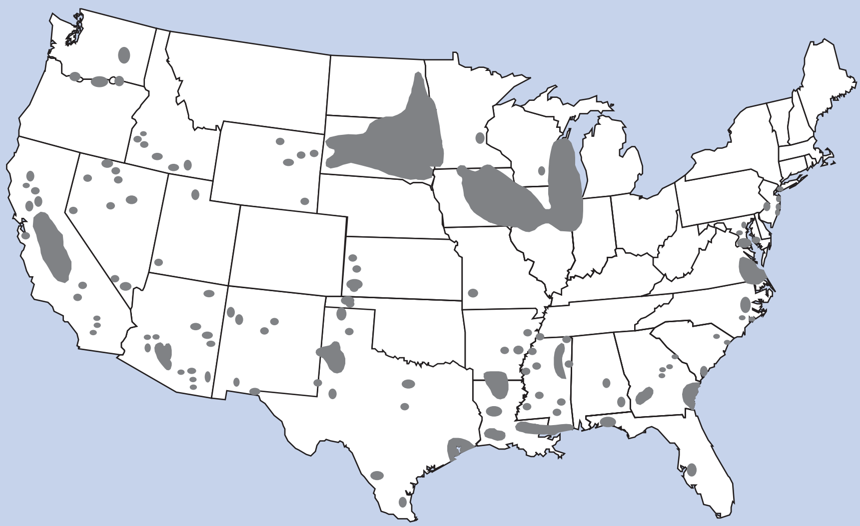
The Southwest also faces a fundamental imbalance between water supplies and demand. In an average year, there is insufficient precipitation to meet demand (Figure 1.13). These areas use more than 100 percent of their annual average precipitation and either import water from other watersheds or mine groundwater to meet annual demand. Water use conflicts have existed in these areas for decades, but the conflicts have intensifed as demands have increased.

Where water demand exceeds 75 percent of available precipitation, water use conflicts are just beginning to emerge and will likely escalate if development should increase demand. Much of the East and parts of the Northwest have abundant freshwater supplies, but even these areas have experienced water use conflicts and more may arise. Continued growth will require some combination of importing more water and/or managing water more efficiently.

Case Study: Water Conflicts in the South

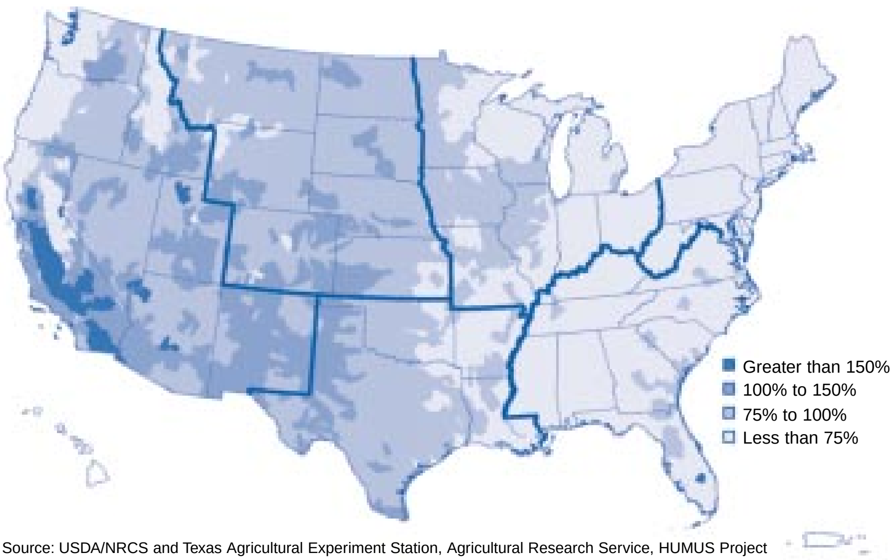
Even in the eastern region of the nation, where water is relatively abun-

Figure 1.12 Areas of Water Table Decline in the United States



Source: U.S. Geological Survey.

Figure 1.13 Freshwater Consumption as a Percentage of Local Average Precipitation



Source: USDA/NRCS and Texas Agricultural Experiment Station, Agricultural Research Service, HUMUS Project #RWH.1576, 1996.

dant, increasing demand and pressures to manage water for a wider array of uses can lead to conflicts.

In the late 1980s, for example, the Corps of Engineers asked the Congress for permission to reallocate 120 million gallons of water daily from Lake Lanier to meet metro Atlanta's growing water needs. The state of Alabama, worried about the impact of this proposal, filed suit in 1990 in U.S. District Court to bar the reallocation. Florida, which shared Alabama's concerns, later became a party to the suit.

In 1992, the Corps and the governors of Georgia, Alabama, and Florida signed a Memorandum of Agreement (MOA) that preserved the status quo while the states negotiated a formal agreement about how much water each state can take from the Chattahoochee and Flint rivers. In the meantime, the states embarked on a comprehensive study, including both the Apalachicola-Chattahoochee-Flint and the Alabama-Coosa-Tallapoosa river basins. The research effort includes studies of the demand for water resources over the next several decades, the historic and present availability of surface and groundwater, future trends in population and employment, the environmental needs of the basins, navigation-related water needs, and recreation-related water needs. The goal is to develop strategies to guide water management decisions and a mechanism for coordination of those decisions.

In March 1997, Georgia agreed to enter into two interstate compacts that will divide water from the region according to an allocation formula. A compact with Alabama and Florida will divide the waters of the Chattahoochee, Flint, and Apalachicola rivers. Another compact with Alabama will divide the waters of the Alabama, Coosa, and Tallapoosa rivers. The compacts must be approved by the state legislatures and ratified by Congress.

In order to prevent delays in implementation, the allocation formulas will be worked out by the members of the compact commission after the legislation is passed. The goal of the allocation effort is to establish an equitable allocation of the available water for various uses, including drinking, navigation, power generation, recreation, industry, and other purposes, and to find a reasonable balance between upstream interests such as metro Atlanta and downstream interests such as farming and fishing industries.

THE RIVER RUNS OVER

An important thread of the nation's history deals with efforts to tame the uncontrollable nature of rivers through the construction of dams, channels, levees and dikes. Now highly regulated and controlled, rivers nevertheless are still capable of overflowing all such structures and inflicting much suffering on surrounding communities.

The Great Flood of 1993 in the upper Mississippi and Missouri rivers revived a national debate about floodplain management and federal policies that dates back many decades (Box 1.3).

The debate has many facets, including whether the construction of an extensive system of federal and non-federal levees and dikes along the river has actually worsened the severity of the flood by reducing available floodplain area; whether federal policies promote excessive floodplain development; and whether people choosing to live on floodplains should bear a greater share of the risk inherent in that decision.

The private and uncontrolled construction of levees and dikes along the river in its early history raised some difficult questions. Every such structure built

Box 1.3
What is a Floodplain?

Floodplains are the relatively low and periodically inundated areas adjacent to rivers, lakes, and oceans. Floodplain lands and adjacent waters combine to form a complex, dynamic physical and biological system that supports a multitude of water resources, living resources, and societal resources. Floodplains provide the nation with natural flood and erosion control, water filtering processes, a wide variety of habitats for flora and fauna, places for recreation and scientific study, and historic and archeological sites.

Estimates of the extent of the nation's floodplains vary. In 1977, the U.S. Water Resources Council estimated that floodplains comprise about 7 percent, or 178.8 million acres, of the total area of the United States and its territories.

Source: *Sharing the Challenge*.

along one shore could increase the volume and speed of flows on the opposite shore or at sites downstream, thus creating a situation in which the effort to protect one community might worsen the damage for others.

The need for greater coordination became dramatically evident after the monumental Mississippi River flood of 1927, which demonstrated the inadequacy of the flood control efforts that began in the early 18th Century and that had grown over the years to an uncoordinated amalgam of public and private systems (Box 1.4). In response, the 1928 Flood Control Act and the 1936 Flood Control Act codifed a federal interest in the coordinated development and installation of flood damage reduction measures.

Starting in 1936, the Corps focused on major rivers and the development of congressionally approved plans for reservoirs, levees, channelization, and diversions. In the upper Mississippi River basin, the Corps constructed 76 reservoirs controlling a drainage area of almost 370,000 square miles and containing a total flood storage volume of 40 million acre-feet of water. In addition, the Corps constructed over 2,200 miles of levees in the upper Mississippi basin. River communities also were protected by an estimated 5,800 miles of non-federal levees.

Did the federal effort help reduce the damages during the 1993 flood? The June 1994 report of the Interagency Floodplain Management Review Committee concluded that the federal system had worked essentially as designed and thus significantly reduced the damages to population centers, agriculture, and industry. The Committee estimated that reservoirs and levees built by the Corps stored 22.2 million acre-feet of water during the period of peak flooding and that federally constructed levees had prevented substantial damages to communities such as St. Louis, Kansas City, and the low-lying areas of Rock Island and Moline, Illinois. All told, the committee estimated that Corps-built reservoirs and levees prevented more than $19 billion in damages, and that watershed projects built by the Soil Conservation Service (now NRCS) saved an estimated additional $400 million.

Levees can cause problems in some critical reaches by backing water up on other levees or lowlands, but the Committee concluded that flooding in 1993 would have covered much of the floodplains of the main stem lower Missouri and upper Mississippi rivers whether or not levees were there. A modeling analysis estimated that if all the non-urban levees were absent, the peak stage at St. Louis in 1993 would have been reduced by 2.5 feet. Even at that level, the flood would have been more than 17 feet above flood stage and almost 4 feet higher than the previous known maximum level recorded during the flood of 1973.

The Committee concluded that “levees did not cause the 1993 flood. During large events such as occurred in 1993, levees have minor overall effects on floodstage but may have significant localized effects.”

The Committee, however, did conclude that the uncoordinated development of private and other non-federal levees throughout the Upper Mississippi

Box 1.4
The Great Mississippi Flood of 1927

In *Rising Tide,* author John M. Barry writes eloquently of the Great Mississippi River flood of 1927, which devastated a vast area and forced over a million people out of their homes.

Greenville, Mississippi, was protected from direct assault by the river by a large levee. The major break in the levee occurred north of Greenville, long before the flood waters described reached the city. The city was also protected by a smaller, local levee. A break in this smaller levee is described here by Barry. The flooding in Greenville began on April 21, 1927.

"The Greenville protection levee stood eight feet high. The water paused briefly, then ripped the levee apart as smootly as if unzipping it.

"Then came the chaos. Water roared and hissed, the fire whistle blasted, church bells clanged, animals barked and neighed and bellowed in terror. In Newtown, the black neighborhood closest to the protection levee, hundreds of families began to wade through the rising water to the Mississippi levee, the highest ground in the Delta.

"Rescuers were depositing thousands of refugees from all over the Delta on the levee, to join the city's own thousands already there. Farmers moved cattle, mules, horses, and pigs to the levee as well. The Mississippi River lay on one side, the flood on the other. The levee crown was only 8 feet wide, its landslide slope an additional 10 to 40 feet wide before touching water. A line of people already stretched north from downtown for more than a mile.

"Martial law solved little. Virtually the entire county was underwater, as much as 20 feet of water. The current everywhere was ferocious. People took shelter in railroad boxcars, in the upper stories of cotton gins, oil mills, houses, and barns. Thousands clung to roofs or trees, or sat on the levee awaiting pickup.

Weeks after the levee broke, water was still pouring through both the Mounds Landing break and the city's protection levee."

Source: Barry, John M., *Rising Tide: The Great Mississippi Flood of 1927 and How it Changed America* (Simon and Schuster, New York, 1997).

Basin failed to provide a soundly engineered flood-damage reduction system for the basin. It also noted that levees provide only a fixed level of protection and are subject to overtopping during larger floods, a fact that many in the basin had failed to understand.

A second issue in the debate is whether federal policies are actually creating incentives for development in floodplains. Critics point to the fact that there were some 10 million homes in the 100-year flood plain and to cases like that in Chesterfield, Missouri, where an industrial park sited behind an agricultural levee suffered extensive damage during the 1993 flood. All told, about $390 billion in property was thought to be at risk.

While some federal programs did indeed seem to reduce the risk of floodplain development, it was apparent that many of those at risk failed to participate in those programs. For example, the Committee found that only 20-30 percent of eligible homeowners and local governments were enrolled in the National Flood Insurance Program. They concluded that the fact that communities

Residents of Louisa County in Muscatine, Iowa, wade through a flooded-out neighborhood in July 1993.

Photo Credit:
USDA—93CS0380

choosing not to participate still received substantial disaster assistance was one of the factors explaining the low enrollment. "Provision of major federal disaster assistance to those without insurance creates a perception with many floodplain residents that purchase of flood insurance is not a worthwhile investment," the Committee found. Critics also noted that there were many other federal post-disaster assistance programs available. These include grants and Small Business Administration loans for homeowners struck by catastrophic flooding, compensation to farmers under the crop insurance program for the value of crop losses, and federal public assistance grants to local governments to rebuild damaged public buildings and infrastructure.

The Committee concluded that "individual citizens must adjust their actions to the risk they face and bear a greater share of the economic costs." They recommended that the federal government improve its marketing of flood insurance and enforce lender compliance rules, and "reduce the amount of post-disaster support to those who were eligible to buy insurance but did not to that level needed to provide for immediate health, safety, and welfare."

The report also suggested that the administration "give full consideration to all possible alternatives for vulnerability reduction, including permanent evacuation of floodprone areas" and "creation of additional artificial and natural storage."

In short, the priorities should be: first, avoiding inappropriate use of the floodplain; second, minimizing vulnerability to damage through both structural and nonstructural means; and third, mitigating flood damages when they do occur.

In the wake of the flood and the interagency report, the Clinton administration made substantial revisions to federal floodplain management policies and programs. The emphasis of the reforms is to reduce the loss of life and property caused by floods and to restore the natural resources and functions of flood plains.

In September 1994, Congress and the administration agreed on a package of amendments to the National Flood Insurance Program. The reforms extended the waiting period that applies before flood insurance coverage becomes effective from 5 to 30 days, increased the dollar amount of flood insurance coverage available for residences from $180,000 to $250,000, and prohibited post-disaster support to those who could have purchased flood insurance but did not. The amendments also incorporated the protection of natural resources and functions of floodplains into the program's community rating system, as an incentive to reduce insurance premiums in communities with exemplary floodplain management programs.

The Administration and Congress also agreed in 1994 on reforms to the crop insurance program that provided for catastrophic crop insurance protection. Other 1994 legislation required communities to develop and implement floodplain management plans in association with the construction of a Corps of Engineers flood damage reduction project.

The Administration implemented a marketing strategy called "Cover America," designed to improve participation in the flood insurance program. In less than two years, the new strategy contributed to a 22 percent increase in the number of households signed up for the program.

To encourage responsible rebuilding in the floodplain in the aftermath of the 1993 Midwest floods, the federal government provided funds to acquire, relocate, or elevate over 12,000 flood-damaged properties in about a dozen states. In some cases, entire communities, such as Valmeyer, Illinois, were relocated. Over 40 towns asked for at least some real estate to be bought by the relocation program. Several communities in the Midwest that flooded again in 1995 were spared repetitive and expensive flood damage as a result of the relocation and buy-out program. Most of the funding came from the Department of Housing and Urban Development's Community Development Block Grant program. The flexibility of the CBDG program allows it to play a major role in repair and restoration efforts, as well as in acquisition, relocation, and replacement of damaged properties.

The Department of Interior's Fish and Wildlife Service (FWS), through its National Wildlife Refuge land acquisition and Partners for Wildlife programs, also is participating in the new floodplain initiatives. To restore and protect fish and wildlife habitats of national importance, FWS made extensive use of voluntary cooperative agreements with private landowners, local soil and water conservation districts, The Nature Conservancy, Ducks Unlimited, and other organizations.

To respond to landowners and levee districts who sought alternatives to restoring flood-damaged lands to pre-flood conditions or repairing levees, the Administration has taken several steps. First, it implemented the Emergency Wetlands Reserve Program. In situations where the cost of levee repair and land restoration was greater than the agricultural value of the land, landowners could now choose to restore the lands as wetlands, instead of trying to rehabilitate the lands for agricultural production. This option not only gave the landowners direct benefits in helping to extricate them from flood-prone lands, but benefited the surrounding areas by adding more wetlands and reducing the region's vulnerability to flooding. Since the 1993 Midwest floods, NRCS has restored and acquired easements on about 86,000 acres in the Mississippi and Missouri river basins. NRCS will be enrolling an estimated additional 5,800 acres in 1996, bringing the total to 92,000 acres.

In 1996, the Administration broadened its authority under emergency flood control repair and restoration law to allow consideration of non-structural alternatives to levee repairs. After a flood has damaged levees, the Corps of Engineers can now assist landowners in exploring the most efficient way to reduce future flood risk instead of being limited strictly to rebuilding to pre-flood conditions.

Civilian volunteers and National Guard personnel build a sandbag levee at Valley Junction, Iowa, trying to stop flooding of the Raccoon River in July 1993.

Photo Credit:
USDA—93CS0295

The Administration has created interagency task forces that meet after a flood to coordinate in planning structural and non-structural levee repairs and associated restoration. These task forces pool expertise from throughout the government to advise and assist landowners.

In the 1996 farm bill, some of the Administration's initiatives on floodplain management were made permanent and broadened. For example, the Emergency Wetlands Reserve program's option to retire lands voluntarily with a floodplain easement was added to the Emergency Watershed Protection program. The bill also created a new Flood Risk Reduction program, in which farmers could request that USDA offer them their projected future farm program benefits up-front for farm acreage located within the floodplain. The goal of the program is to remove any incentives created by USDA programs that may encourage intensive new row-crop production in floodplains. In this way, farmers can easily move to more suitable lands located in less vulnerable areas.

The Administration also adopted a number of measures to accelerate assistance, response, and recovery. These measures include pre-deploying material and supplies in anticipation of a flood; allowing the Corps of Engineers to implement a "quick repair option" for severely damaged levees, to provide short-term protection while the larger restoration is under planning and design; and expediting the Federal Highway Administration's procedures to provide the states with the funds necessary to begin repairs to Federal-aid roads and bridges damaged by disasters.

The 1993 flood led to significant changes in floodplain management, decreasing incentives for floodplain development, providing new alternatives for floodplain use, increasing enrollment in the National Flood Insurance Program, and expediting federal assistance and recovery programs. The Administration is continuing to refine its flood and floodplain management efforts.

In short, American rivers formed the backbone on which we built a nation. From our early days as a country, the importance of water and waterways was clear, but only recently did we understand that development and pollution could devalue and destroy these precious resources. Today, a shift to thinking about rivers in a much broader context, both environmentally and in terms of governance, has created not only new attitudes but new institutions and mechanisms for decision-making. Broader participation characterizes these new approaches. Chapter Two looks at some of these efforts.

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