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# Protecting and Restoring America's Watersheds

Status, Trends, and Initiatives in Watershed Management

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# Introduction

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**Watershed:** the land area that drains to a body of water such as a stream, lake, wetland, or estuary

**W**e call the earth the water planet because water covers 70 percent of its surface. In the United States, rivers, lakes, estuaries, and wetlands are among the Nation's most precious resources. Americans depend on clean water to drink, to irrigate their crops, and to run their industries. Water resources provide opportunities for recreation such as fishing and swimming, and wetlands even provide protection from floods. Rivers, lakes, estuaries, and wetlands also provide critical habitat for both aquatic and land-based wildlife. For example, estuaries serve as birthplace and nursery for most saltwater fish and shellfish.

The nation's water resources have immeasurable value. However, in monetary terms, clean water plays a staggering role in the nation's economy. Each year, nearly \$200 billion of food and fiber, \$60 billion of manufactured products, and over \$40 billion of tourism depend on clean water and healthy watersheds.

The nation has improved the quality of its water resources in recent decades, but it has not sufficiently protected and restored all waters. Today, approximately 40 percent of the nation's major watersheds have water quality and habitat-related problems. The sources of these problems are widespread and complex.

Our nation cannot solve the majority of these problems by further regulating discharges from factories and sewage treatment plants. Existing programs and regulations have greatly improved the nation's water—industries and municipalities have cleaned their pollutant discharges at great expense with technological solutions. These long-standing programs will continue to be a critical element of watershed management. Newer requirements that address other pollutant sources (e.g., stormwater runoff) will further improve conditions. However, the government does not regulate or control many ongoing activities that impact watersheds.



*Clean water is a critical component of food production.*

To address the water quality problems that remain, our nation has needed a more comprehensive approach—one that considers all threats to a watershed. The “watershed approach” addresses natural resource issues that cross jurisdictions and political boundaries. It integrates concerns about water quality and water quantity and coordinates insights from the natural and social sciences. A successful watershed approach includes the support, participation, and leadership of local stakeholders and land users. Their decisions and lifestyles profoundly impact the nation's waters. In recent years, governments, non-profit organizations, businesses, and citizens have used a watershed approach to refocus their efforts to protect and restore the nation's waters. These refocused efforts have brought widespread positive results.

This report considers challenges to watershed health, recent successes of the watershed approach, and obstacles that remain. It was developed by a federal interagency

team that worked with local, state, and tribal partners. The report's descriptions and recommendations represent the opinions of local watershed practitioners, combined with suggestions from studies and reports by academic evaluators and governments. These stakeholders presented their views in roundtable discussions held throughout the country in 1999 and 2000. These Regional Watershed Roundtables, building blocks to a National Watershed Forum in the summer of 2001, provided opportunities for dialogue about issues, an exchange of information, and collaboration on watershed protection and restoration projects. As of December 31, 2000, more than 1,000 people had participated in regional roundtable discussions at more than 20 locations.

The report will explore the advantages of a watershed approach in greater detail in the next section, “Why Watersheds?” The third section of the report, “How are Watersheds Impaired?” identifies major threats to the nation's watersheds. For example, it discusses how toxic chemicals, invasive species, runoff with excessive levels of nutrients and sediments, and habitat loss and modification harm watersheds. Most importantly, this third section describes how human activities generate these threats. Automobile use contributes to polluted runoff from roads and the deposition of airborne pollutants in watersheds. Environmentally insensitive housing developments and farming techniques can compromise wetlands and forests and increase sediment delivery to rivers. Demands for energy and minerals have blocked rivers with dams, polluted waters with mine tailings, and fouled air and water with pollutants released from coal-burning power plants. These examples suggest that watershed health will only improve significantly with changes to individual land use and lifestyles and the implementation of cleaner technologies.

The fourth section of this report, “How is the Watershed Approach Working?” discusses local, state, tribal, and federal efforts to address the threats identified in the previous section. This section highlights the successes and shortcomings of these efforts. The watershed approach



*Power generation and many other industries depend on large volumes of useable water.*

has addressed many threats to watersheds, but the nation has not fully committed to its use. The fifth section, “What Can be Done to Improve Progress?” recommends refinements to the implementation of the watershed approach. Table 1 summarizes these recommendations, the most important feature of this report. Both the fourth and fifth sections reflect input from local watershed practitioners, academic researchers, and local, state, tribal, and federal partners. Their input can guide efforts to improve the watershed management process.

The discussion in the fourth and fifth sections of this document is organized by seven key themes of the watershed approach. These themes—education and awareness; partnerships and coordination; monitoring and research; planning and prioritization; funding and technical assistance; implementation; and evaluation—provide a useful framework for considering watershed management. A glossary and links to relevant websites at the end of the document should help readers understand and use the report.

Watershed protection and restoration efforts will take time. Population growth, organizational inertia, limited financial resources, gaps in knowledge, and natural

events impede effective and lasting solutions. However, this document can move watershed efforts in promising directions—it identifies successes that watershed efforts should emulate and obstacles that they must overcome. As watershed practitioners develop detailed plans of action to address weaknesses in the nation’s watershed management, the recommendations in this report can influence their work. Local citizens can explore how they can provide better leadership and support for watershed management efforts. Governments can explore how they can better coordinate and enhance their technical and financial support of local watershed efforts.

The federal government will need to continue to advance watershed management. For example, federal agencies’ expertise and resources will improve watershed monitoring practices across the country. Federal agencies will also facilitate and fund many state and local watershed-related activities. Effective federal actions will be a critical ingredient for successful watershed protection and restoration. Working together, citizens, businesses, watershed organizations, and government agencies can address their shared responsibility for protecting and restoring our nation’s waters.

*Future generations will enjoy the benefits of healthy watersheds.*







**TABLE 1: RECOMMENDATIONS FROM WATERSHED PRACTITIONERS**

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**Education and Awareness**

- Ensure that key groups receive environmental education, especially local decision-makers
- Use modern technology, multi-media campaigns, and person-to-person approaches to enhance education and awareness programs

**Partnerships and Coordination**

- Continue to develop broad partnerships for watershed protection and restoration
- Foster greater coordination across government agencies by implementing the Unified Federal Policy on Watershed Management
- Continue supporting regional and local watershed partnerships with Federal Coordination Teams (also known as Regional Watershed Coordination Teams)
- Improve the delivery of information and support to local watershed efforts

**Monitoring and Research**

- Increase coordination of existing and new watershed monitoring programs
- Ensure data consistency amongst all monitoring groups
- Incorporate new indicators, such as indices of biological integrity, into watershed monitoring programs
- Provide meaningful and timely watershed information to decision-makers and the public
- Expand research in watershed management, especially efforts that evaluate environmental outcomes and improve predictive models

**Planning and Prioritization**

- Encourage consideration of watershed health in local planning and decision-making
- Refine and coordinate national watershed assessments by integrating new and enhanced monitoring and assessment data and by prioritizing actions and assistance programs

**Funding and Technical Assistance**

- Increase financial and technical assistance from all sources to watershed protection and restoration efforts
- Enhance program flexibility by expanding funding eligibilities, relaxing grant-making requirements, and addressing priority needs
- Develop education campaigns that inform watershed groups about financial and technical assistance tools

**Implementation**

- Pursue both watershed protection and restoration activities
- Ensure that watershed plans lead to action
- Follow up projects with appropriate monitoring, maintenance, and evaluation activities
- Provide adequate enforcement of watershed laws and regulations

**Evaluation**

- Establish science-based indicators for watershed programs and projects
- Incorporate outcome-oriented measures into assistance programs
- Develop common federal indicators for assessing watershed health and common measures for tracking and reporting performance
- Track results at local, regional, and national watershed scales



# Why Watersheds?

*Watershed*  
Charity Scott  
Age 16  
Good Shepherd School  
Baltimore, Maryland



## What Is A Watershed?

**N**o matter where you live, you live in a watershed. A watershed is the land area that drains to a single body of water such as a stream, lake, wetland, or estuary. Hills or ridgelines often bound watersheds; interior valleys collect precipitation in streams, rivers, and wetlands. These physical boundaries define the movement of water and delineate the watershed. Watersheds, also known as catchments or basins, describe geography at many different scales: a few acres may drain to a small stream or wetland; a few large rivers may drain into an estuary where fresh and salt water mix; about 40 percent of the U.S. land area in the lower 48 states drains to the Mississippi River. Watersheds are thus “nested”—larger watersheds such as the Mississippi River basin encompass many smaller watersheds. Figure 1 depicts a typical watershed.

**FIGURE 1.** The area hydrologically defined by a watershed is affected by many processes and issues. A “watershed approach” coordinates their management.



erations into decision-making. It considers local stakeholder input and national and state goals and regulations. A watershed approach recognizes needs for water supply, water quality, flood control, navigation, hydropower generation, fisheries, biodiversity, habitat preservation, and recreation; and it recognizes that these needs often compete. It establishes local priorities in the context of national goals and coordinates public and private actions. A watershed approach offers a blueprint for water resource management.

A comprehensive watershed approach improves on the fragmented approach the nation has used in the past. The United States has developed separate laws for clean water, clean air, fertile soils, productive fisheries, healthy forests and robust communities. It created separate agencies to administer those laws at federal, state, and local levels and on public and private lands. These agencies have different missions, authorities, and modes of operation. The property boundaries of landowners and the political boundaries of states, tribes, counties, and municipalities are often unrelated to watershed boundaries. As a result, when citizens or governments have tried to coordinate water resource protection or restoration efforts, they have often found it difficult to do so. Evidence suggests that the watershed approach improves collaboration and information sharing among diverse partners and leveraging of resources.

## What is the Watershed Approach and Why are We Using It?

A “watershed approach” uses hydrologically defined areas (watersheds) to coordinate the management of water resources. The approach is advantageous because it considers all activities within a landscape that affect watershed health. Ideally, a watershed approach will integrate biology, chemistry, economics, and social consid-

## Watershed Protection and Restoration

In 1890, John Wesley Powell, second director of the U.S. Geological Survey suggested that the federal government organize the western United States into watershed units. These watershed units would be governing bodies and would facilitate an integrated approach to natural resource management. Although the government did not implement his plan, Powell’s perspective underscores the importance of our relationship with the land and the need to consider it as we protect and restore aquatic resources.

## Watershed Protection and Restoration

This document frequently uses the terms protection and restoration. Watershed protection measures reduce

“When we try to pick out anything by itself,  
we find it hitched to everything else in the universe.”

*John Muir*

impacts to waterbodies and prevent degradation. Protection measures include both voluntary and legally mandated actions. Paying farmers to set aside conservation easements, for example, ensures that some lands have limited human impacts, while water quality permits limit pollutant releases into waterbodies. Watershed protection measures that prevent degradation before it occurs typically cost less and succeed more often than watershed restoration measures implemented after watersheds are impaired. Protected watersheds are more likely to be healthier watersheds.

Watershed restoration is more difficult to define. The Wetlands Subcommittee of the Federal Geographic Data Committee defined wetland restoration to provide a standard for federal agency reports of their restoration activities. This group defined restoration as “the manipulation of... physical, chemical, or biological characteristics... with the goal of returning natural/historic functions.” Similarly, in the 1992 report “Restoration of Aquatic Ecosystems,” the National Research Council defined restoration as the “return of an ecosystem to a close approximation of its condition prior to disturbance.” That report also states, “The term restoration means the re-establishment of pre-disturbance aquatic functions and related physical, chemical, and biological characteristics.” In summary, restoration activities seek to restore healthy aquatic communities and provide clean waters for recreation, irrigation, and public consumption. For a more detailed discussion of watershed restoration principles, visit the Environmental Protection Agency’s “River Corridor and Wetland Restoration” webpage ([www.epa.gov/owow/restore](http://www.epa.gov/owow/restore)).

Watershed restoration can be challenging. Most restoration efforts do not show immediate results. Some restoration

activities can even unintentionally harm the environment. All restoration efforts require a long-term commitment.

## Addressing Watershed Problems

A watershed approach highlights relationships among land management decisions, everyday actions, and watershed health. The next section of this report discusses threats to watershed health such as pathogens, chemical pollutants, and invasive species. Most are caused by commonplace activities: clearing forested lands for new housing developments; paving new roads and driveways for transportation; over-applying fertilizers and pesticides to lawns; overworking farmlands and timberlands; or postponing maintenance to home septic tanks. Only by understanding these problems and reducing our impacts can we assure healthy watersheds for our use and enjoyment.



*Streambank stabilization projects restore vegetation to stream corridors, reducing stream temperatures and erosion and benefiting aquatic and terrestrial species in the watershed.*



# How are Watersheds Impaired?



*Seeing the Pond from the Pipe*  
Emily Forbes  
Kindergarten  
Kennesaw, Georgia  
Lewis Elementary School

**B**oth natural events and human activities affect watersheds. Natural events such as storms, fires, and droughts can suddenly alter watershed conditions at large scales. While some natural events have negative impacts, these events are often critical for long-term ecological health. For example, a fire may damage a forest, but it also rejuvenates the forest by spreading seeds of key species and adding necessary nutrients to the forest floor. Individual human activities typically have smaller and more predictable impacts, but their cumulative impact can be far greater. Increases in population, land development, and economic activity increase demands for water, waste disposal, and raw materials. These activities increase pollutant releases to water and air and degrade or fragment natural habitats. Without appropriate management, these changes can seriously compromise watershed health.



Assessments of watershed conditions often measure physical, biological, and chemical watershed variables, such as soil stability, plant and animal diversity, and water quality. Assessments can also measure watershed functions such as nutrient cycling, temperature control, and water availability. This section briefly describes the condition of the nation's watersheds in the context of threats to watershed health. The remainder of the report describes the successes and obstacles of watershed approaches that address these threats.

## The National View

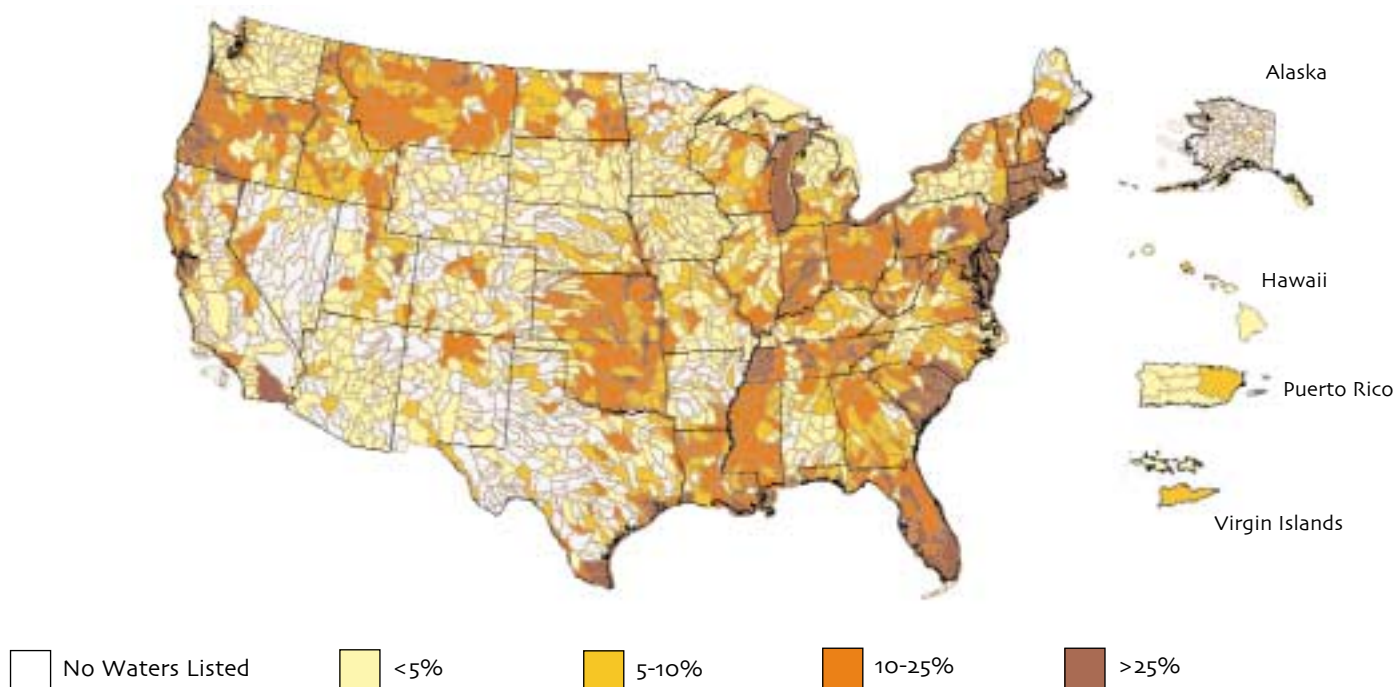
As required by the Clean Water Act, states, tribes, territories, and interstate commissions develop biennial assessments of streams, lakes, wetlands, and estuaries for a National Water Quality Inventory Report to Congress. In 1998, these parties reported that about 40 percent of their assessed streams, lakes, and estuaries were not clean

enough to support uses such as fishing and swimming (see Figure 2).

Although these parties assessed only 23 percent of the nation's streams and rivers in 1998, they reported that more than 291,000 miles of rivers and streams do not fully support aquatic life, fish consumption, swimming, and drinking water uses. Most of the United States' population, more than 218 million people, live within ten miles of an impaired waterbody.

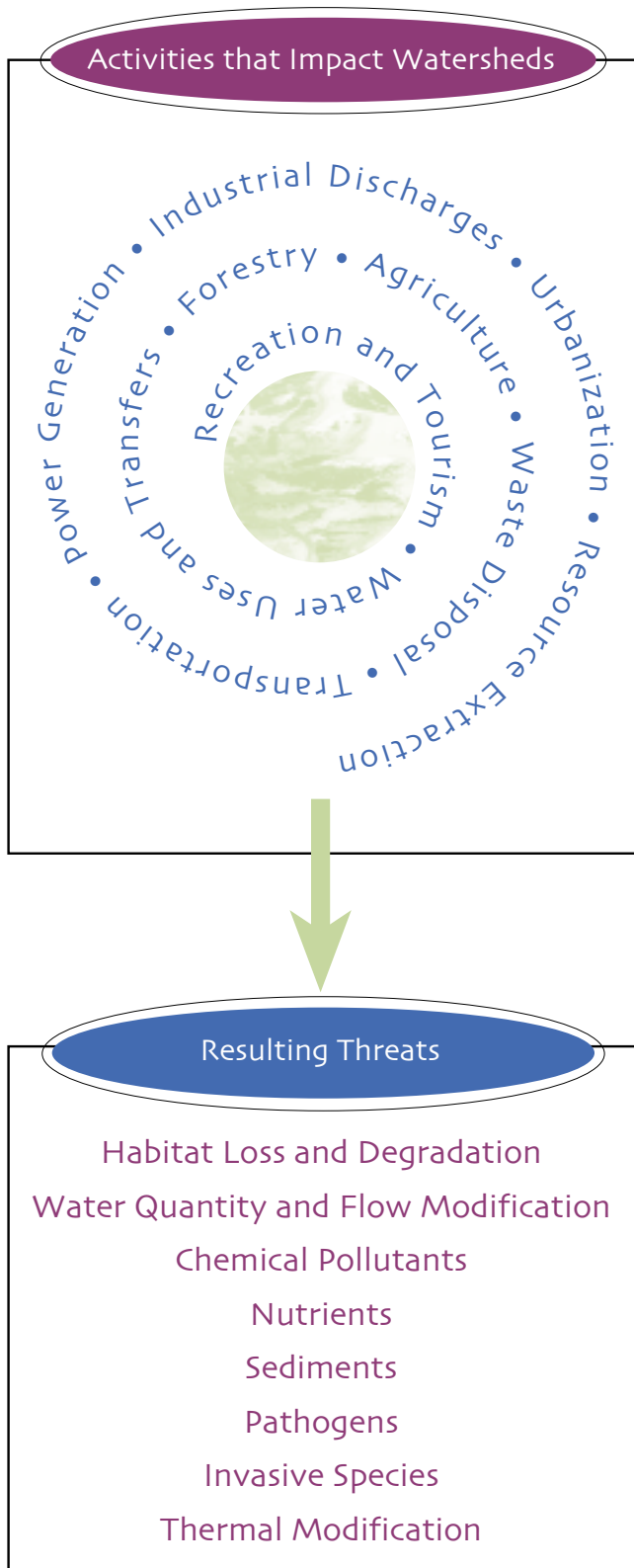
Figure 3 outlines the major activities that impact watersheds and the threats that result. The remainder of this section describes the threats in greater detail. Most watersheds are impacted by more than one activity, and many watersheds are impacted by all activities outlined in Figure 3. Successful watershed approaches address many threats to watershed health with a coordinated and comprehensive strategy.

FIGURE 2. 1998 Impaired Waters-National Summary



The colors in this figure show the percentage of waters threatened within watersheds, divided by the total number of water miles in those watersheds.

FIGURE 3. Threats to Watershed Health



## Habitat Loss and Modification

Historically, this nation has not fully appreciated its dependence on healthy ecosystems. From coastal estuaries to mountain forests, human activities such as residential and commercial development, recreation, and resource extraction have changed, fragmented, and destroyed natural habitats.

Habitat loss has severe impacts and can be permanent. For example, coastal wetlands converted to commercial or residential uses provide neither nursery habitat for estuarine fish nor protection from hurricane storm surges. Wetland losses have also contributed to significant declines in waterfowl populations. Forest losses impact many plant and animal species in both aquatic and terrestrial habitats. Forest and wetland losses increase overland flow and reduce filtration of sediments and pollutants, increasing the likelihood that pollutants will reach streams, rivers, and estuaries.

Habitat modification is less obvious, but it is detrimental nonetheless. For example, when communities build roads over streams, they modify the stream habitat. Road culverts prevent fish passage and seriously impact fish populations. Anadromous fish, species that migrate from freshwater to saltwater and back to freshwater, cannot breed successfully if culverts block their migration routes. Anadromous species may have value for recreational and commercial fishermen or they may provide a critical food supply for commercially valuable fish.

Urban streams often provide good examples of habitat modification. When communities straighten and channelize urban streams and line them with concrete, they modify the vegetative and physical structure of the riverine habitat, increase river velocities during rainstorms, and decrease river volumes during dry periods. Straightened and channelized streams also carry more sediments and chemical pollutants to their receiving waters.

The examples of road construction and stream urbanization demonstrate how habitat modification can affect flow



rates, stream ecology, and the characteristics of the waterbody itself. Appropriate engineering techniques and other mitigating measures that consider the natural structure and function of watersheds can reduce these impacts.

## Water Quantity & Flow Modification

People, plants, and animals depend on sufficient water flows in rivers and streams. If stream flows are low, fluctuating, or blocked by physical barriers, these changes can affect many plant and animal species. These changes can also affect recreational opportunities. American rivers suffer from these problems because our citizens have devised many methods to capture, control, store, and divert water. These alterations support drinking water supplies, hydropower, irrigation, flood control, manufacturing uses, and recreation.

For example, in the last century the United States has led the world in dam construction to block and harness rivers. Few human actions have more significant impacts on a river system than dam construction. Dams change upstream and downstream habitats, water temperatures, water quality, and sediment movement. They also block or slow the movement of materials and organisms throughout a watershed.

## Chemical Pollutants

When chemical compounds are introduced into a watershed, they can compromise drinking water systems, contaminate fish, and degrade water quality. Chemicals reach waterbodies from many sources, including factories, wastewater treatment plants, cars, boats, lawns, and crop fields. For example, insecticide concentrations in urban and suburban waters commonly exceed guidelines for aquatic life protection. Homeowners, commercial properties, and golf courses most commonly apply these insecticides.

Acid mine drainage from abandoned mine lands threatens natural resources, public health, and community vitality.

### *How are Watersheds Impaired?*

In the nation's coal fields and hard rock mining areas, sulfur-bearing minerals in abandoned mines and refuse piles contaminate adjacent and downstream waters with acidic and metal-laden waters. The contamination often eliminates all aquatic life and compromises drinking waters.

Mercury contamination prevents human consumption of fish in many

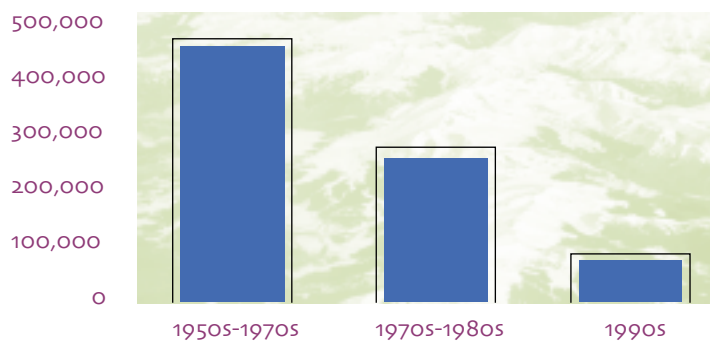


*If coastal rivers and streams are dammed or otherwise altered by human activities, anadromous fish cannot swim upstream to reproduce.*

## WETLAND LOSS RATES

The lower 48 states have lost more than 50 percent of their wetlands (over 100 million acres) since 1780. The U.S. Fish and Wildlife Service recently estimated that the United States still loses over 50,000 acres of wetlands each year. States and tribes most often identify road construction, residential development, and the conversion of lands for agricultural use as the leading reasons for loss. Although the nation is far from its goal of gaining 100,000 acres of wetlands annually, the annual rate of loss has been decreasing in the last five decades as indicated by the adjacent chart.

FIGURE 4. Wetland Acres Lost Annually







*Waters downstream of abandoned mines and refuse piles can be contaminated with acids and metals. In this photograph, the orange color of the water dramatically identifies this contamination.*

lakes, streams, rivers, and coastal areas. Fish consumption advisories for mercury have more than doubled in number from 1993 to 1998, affecting nearly 2000 waterbodies nationwide. In January 2001, the Food and Drug Administration issued a nationwide advisory recommending pregnant women and women of childbearing age not eat certain kinds of marine fish, including shark, swordfish, and some mackerel due to high levels of methyl mercury found in these species. Coal-burning power plants and urban runoff are significant sources of mercury.

Our nation has effectively managed discrete point sources of chemical pollution, but widespread nonpoint sources of chemical inputs to waterbodies from property owners, resource users, and everyday activities continue to threaten watershed health.

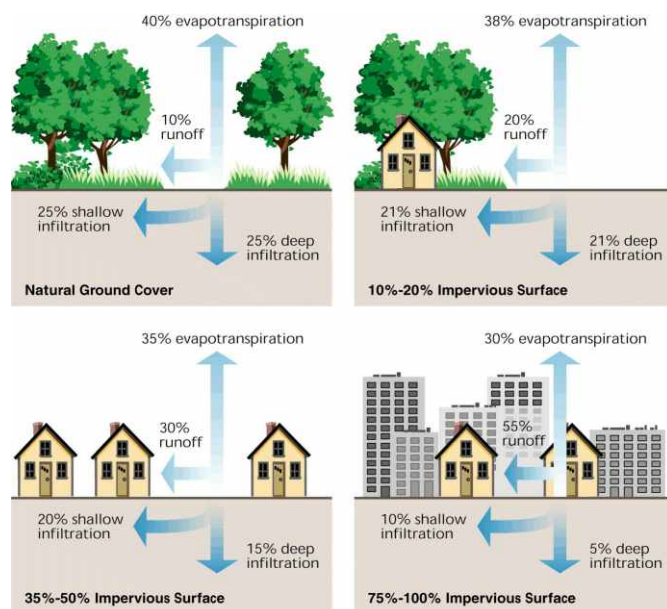
## Nutrients

Healthy marine and freshwater environments require the nutrients nitrogen and phosphorus. However, human activities can contribute excessive amounts of these nutrients to a waterbody, causing overwhelming aquatic plant growth. The plant growth consumes large amounts of oxygen and prevents sunlight penetration of the water column. This process, eutrophication, threatens all water

organisms. It reduces oxygen, impairs water clarity, and displaces key species. Excessive nutrients can also spur harmful algae blooms that can kill fish and potentially harm people. For example, *Pfiesteria* outbreaks and some red tides can introduce toxins that poison fish and shellfish and threaten the health of humans that come in contact with affected waters.

The U.S. Geological Survey's National Water Quality Assessment indicates that streams and groundwater in agricultural or urban areas almost always contain levels of nitrogen and phosphorus that can cause excessive plant growth. The 1998 National Water Quality Inventory lists nutrients as a leading cause of water pollution. States reported that excessive nutrients have degraded more than 3.4 million acres of lakes and reservoirs and 84,000 miles of rivers and streams. The National Oceanic and Atmospheric Administration's National Estuarine Eutrophication Survey found moderate to high eutrophic

**FIGURE 5. Impervious cover and Surface Runoff**



Impervious surfaces increase surface runoff and accompanying volumes of sediments, nutrients, and chemicals.





conditions in 65 percent of the estuaries in the survey. In agricultural areas, runoff containing fertilizers and manure elevates nutrient levels, while in urban areas nutrients typically come from failing septic systems and the excessive fertilization of suburban lawns, golf courses, and commercial developments. In some estuaries, air deposition of nitrogen contributes a significant portion of the nitrogen found in the water. Nitrogen is released into the air by the combustion of fossil fuels in cars, power plants, and factories, and returns to the watershed in rainwater and air currents.

Excessive nutrients in our coastal waters are a leading cause of hypoxic zones—areas with little or no oxygen. A hypoxic zone in the Gulf of Mexico has eliminated most aquatic life in an area averaging 5,000 square miles during the summers from 1996-2000. In Long Island Sound, another hypoxic area may have killed millions of shellfish in the summer of 2000.

Nutrient contamination can also impact drinking water resources. Excessive nutrient concentrations can cause unpleasant tastes and odors, increase drinking water treatment costs, and violate drinking water standards.

## Sediments

Sediments are eroded soils transported by wind and water. Excessive volumes of sediments entering waterbodies can diminish water clarity, alter habitats, impair fish spawning success, and increase drinking water treatment costs. Timber harvesting, mining, agriculture, and construction can introduce excessive sediments if improperly managed. These activities remove vegetation and manipulate soils, allowing wind or water to carry loosened sediments to nearby waterbodies.

Increases in impervious surfaces exacerbate this problem (see Figure 5). Impervious surfaces include buildings, concrete sidewalks, and asphalt driveways and roads. Increases in impervious surfaces decrease infiltration of

## FOREST LAND ROAD TRENDS

Improperly managed forest land roads can erode and increase sedimentation in watersheds. In 1998, the Forest Service constructed only 215 miles of new roads, one-tenth of the construction in 1988. In addition, the Forest Service has decommissioned 25,000 miles of roads in the past decade.

The Forest Service receives only about 20 percent of the funds necessary to fully maintain Forest Service roads and meet intended safety, service, and environmental standards. As of December 2000, the Forest Service estimates it has a road maintenance and repair backlog of approximately eight billion dollars.

rainwater into soils and increase surface runoff. Increases in surface runoff increase soil erosion and sediment transport to streams, rivers, lakes, and estuaries.

## Pathogens

Pathogens are microorganisms that cause disease. Pathogens in freshwater and estuarine environments include both bacteria and viruses. Citizens can be exposed to aquatic pathogens when they drink water, eat fish or shellfish, or come into contact with surface waters during work or recreation. Gastroenteritis, hepatitis, and cholera are examples of diseases associated with waterborne pathogens. The Centers for Disease Control and Prevention estimate that waterborne microbial infections cause up to 940,000 illnesses and 900 deaths each year in the United States.

Potentially harmful bacteria can enter waters from sewage treatment plant discharges, stormwater outflows, boat discharges, malfunctioning septic systems, and runoff from poorly managed animal feeding operations. Once released in the water, pathogens disperse, contaminating the water column, bottom sediments, and aquatic life. Although



*Concentrated animal feeding operations are large agricultural enterprises that keep and raise animals in confined situations. Poorly managed concentrated animal feeding operations can threaten watersheds with pathogens, excessive nutrients, and chemical pollutants.*

some communities regularly monitor shellfish harvesting areas and bathing beaches, communities cannot detect all pathogen outbreaks before the public is at risk. Enhanced prevention provides the only practical solution.

## Invasive Species

Species are considered invasive if their presence in an ecosystem will cause environmental harm, economic harm, or harm to human health. Invasive species can displace native species, alter predator-prey relationships, destroy crops, and decrease ecosystem resiliency. Invasive species are usually non-native species, and they are often exotic species from another part of the world. Native species can also be characterized as invasive if they dominate their ecosystem due to human induced changes to that ecosystem.

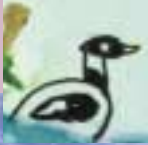
When species are moved outside their normal range into a new region, they can create havoc. Species are unintentionally transported in cargo bays, in ballast waters, and

### INVASIVE SPECIES: HOW BIG IS THE PROBLEM?

- Scientists have linked invasive species to 70 percent of this century's extinctions of native aquatic species.
- By one recent estimate, invasive species cost private landowners more than \$100 billion per year in treatment costs and lost productivity. This estimate does not consider public costs of wildlife loss, displacement of threatened and endangered species, and reduced opportunities for fishing, hunting, camping, and other recreation.
- Invasive species control has been considered one of the top priorities of the U.S. Fish and Wildlife Service since 1999.
- Five hundred scientists recently asked political leaders to make aquatic nuisance species control a priority issue.



*Zebra mussels introduced from Europe have invaded the waters of 20 states in the U.S. since 1988. They have overwhelmed pipes used for municipal and industrial water supply, and studies suggest that their invasion may severely impact native mussel populations.*



on the clothes of tourists, or they are intentionally imported and exported for landscaping, aesthetics, animal control, and recreation. Not all non-native species become pests in new locations, but the gypsy moth, nutria, zebra mussel, hydrilla, sea lamprey, and kudzu are examples of non-native invasive species that have caused massive economic and ecological losses. When their new ecosystem lacked the natural controls of their native ecosystems, these invasive species overran millions of acres of rangelands, forestlands, riparian areas, and waterbodies.

## Thermal Modification

Many activities can cause thermal modification, or temperature change. Industrial sites or power generation plants often discharge warm water. The removal of streambank or aquatic vegetative cover reduces shade and increases stream temperatures. Dams may increase or decrease water temperatures depending on their design and operation. For example, a large dam with a deep storage reservoir and deep release point may discharge cool waters, while a dam with multiple release points may discharge mixed warm and cool waters. Stormwater management programs can also cause temperature changes by altering the volume and timing of stormwater delivery to waterbodies.

Increased or fluctuating temperatures can harm fish and other aquatic organisms whose life cycles and breeding success are inextricably linked to water temperature. Thermal modification has eliminated many fish species and other aquatic organisms from streams across the nation.

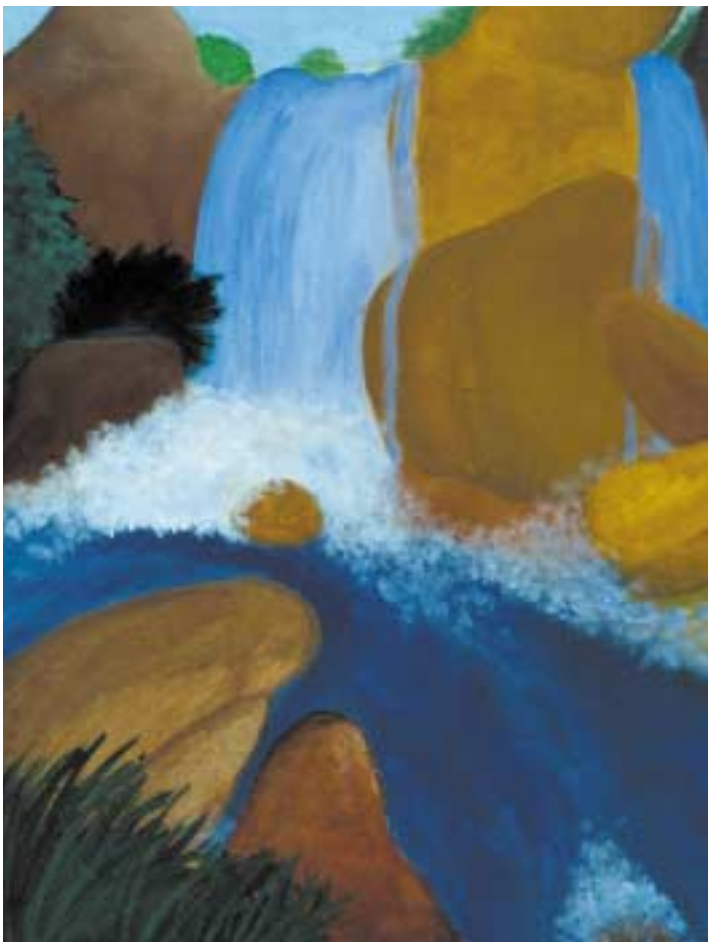
## What Can Be Done to Address These Problems?

The threats discussed in this section impair a significant percentage of the nation's watersheds. What can be done to address these problems?

Water resource management has traditionally focused on specific sources of pollution such as sewage discharges, certain chemical pollutants such as dioxins or heavy metals, or narrowly defined water resources such as a river segment or wetland. While these approaches have successfully addressed many specific problems and should receive continued support, they often fail to address widespread problems that degrade watersheds.

In the past decade, many water resource practitioners have increased emphasis on watershed approaches to address land and water resource problems. They have considered the human activities that generate threats to watershed health. These practitioners have tried to integrate appropriate scientific, programmatic, and political perspectives to remedy these problems. The next section of this report describes progress of these watershed approaches.

# How is the Watershed Approach Working?



*Waterfall*  
Jennie Fong  
Grade 11  
Archbishop Mitty High School  
San Jose, California

This section examines local, state, tribal, and federal use of the watershed approach to address the threats presented in the previous section. How well is the watershed approach working? This section reports the successes and shortcomings of selected local watershed efforts and governmental programs to date.

Many perspectives inform this report. The information and opinions in this chapter and the next reflect comments from local watershed stakeholders and studies from university scholars and state, tribal, and federal governments. Two groups deserve special recognition for contributing ideas to this report. A series of Regional Watershed Roundtable discussions has provided invaluable insights from diverse groups of watershed stakeholders. These roundtable discussions, building blocks to a National Watershed Forum in the summer of 2001, provide opportunities for dialogue about issues, an exchange of information, and collaboration on watershed protection and restoration projects. As of December 31, 2000, more than 1,000 people had participated in Regional Watershed Roundtable discussions at more than 20 locations.

The second group, a Watershed Reinvention workgroup, identified opportunities to orient federal programs and processes on a watershed basis and make these programs





more flexible, collaborative, and innovative. Federal watershed practitioners from all agencies and departments that impact water quality participated in the workgroup. The workgroup’s recommendations highlight opportunities for flexibility, collaboration, and innovation in watershed management efforts. The federal watershed practitioners developed their recommendations after considering the experiences of the workgroup participants, analyzing agency programs, and evaluating recent studies from private organizations and academic institutions.

Although local watershed stakeholders, government agencies, and academia consider the watershed approach from different perspectives, they make similar recommendations for national watershed protection and restoration efforts.

## Seven Themes of Watershed Management

Seven themes of watershed management are commonly found in local watershed efforts and can frame a discussion of watershed approaches (see Figure 6). The seven themes are the following:

- Increasing public education and awareness
- Developing new partnerships and coordinating efforts
- Collecting necessary information through monitoring and research
- Establishing appropriate plans and priorities
- Obtaining funding and technical assistance
- Implementing solutions
- Evaluating the results

Assessing the results of watershed management efforts in the United States remains more subjective than quantitative. Therefore, this report highlights examples of successes and shortcomings for each of the seven themes of watershed management using input from multiple sources.

FIGURE 6. Seven Themes of Watershed Management



## Education and Awareness

Education and awareness efforts inform citizens, corporations, and governments about watershed health and also about management activities that address watershed threats. Education programs inform the public about the impacts of individual, daily decisions on watershed health. They help citizens understand connections between watershed health and their quality of life.

Many watershed education programs have been very successful. For example, the Blackfoot Challenge education program and Project NEMO (Nonpoint Education for Municipal Officials), highlighted in this section, are excellent examples of watershed education efforts that influence behavior.

Watershed practitioners believe that peer education programs are the most effective way to change local land management practices. Many programs, including the Department of Agriculture’s Natural Resource Conservation Service extension program (the nation’s largest conservation technical assistance program), rely on

“The way we perceive the nation as individual resource users, researchers and decision-makers has a direct and major impact on how we perceive problems and solutions.”

*New Strategies for America's Watersheds*

**DESIGNING EDUCATION EFFORTS WITH MULTIPLE COMPONENTS**  
**THREATS: SEDIMENTS, NUTRIENTS, THERMAL MODIFICATION**

Private land use practices in the Blackfoot River watershed (Montana) have increased sedimentation, nutrient loads, and temperatures in the river. In response, stakeholders in the Blackfoot watershed designed a comprehensive collection of education and awareness programs.

The Blackfoot Challenge, a grassroots organization, sponsors teacher education programs that demonstrate how teachers can blend watershed resource education activities into their existing curricula. The organization also hosts workshops on weed management and alternative ranch income (e.g., ecotourism and guest ranching) for private landowners in the watershed. Wildlife management experts hold meetings about threatened and endangered species in the watershed such as grizzly bears, wolves, bull trout, and west slope cutthroat trout. These education programs have helped to change land use habits in the watershed, improving watershed health.

person-to-person interaction to educate landowners and implement projects that improve watershed health.

The federal government increasingly uses advanced technologies to distribute information and services for watershed management. For example, the Watershed Information Network ([www.epa.gov/win](http://www.epa.gov/win)) organizes infor-



*Education programs inform landowners about the impacts of individual, daily decisions on watershed health.*

mation and services for watershed practitioners. The network provides information about major laws governing water resources and links to watershed partners, including federal and state agencies and local watershed groups. It provides descriptions, application procedures, and deadlines for funding and technical assistance programs. In addition, the network provides information about on-line and in-person training. For example, the network contains links to the Environmental Protection Agency's Watershed Academy ([www.epa.gov/owow/watershed/wacademy](http://www.epa.gov/owow/watershed/wacademy)), an educational resource that offers many on-line training modules. Individuals can use the modules at their own pace to learn about topics including ecology, watershed planning, and best management practices.



These efforts notwithstanding, watershed roundtable discussions consistently note that watershed education programs are still needed for citizens, watershed groups, corporations, local governments, and government officials. In a 1998 poll sponsored by the Roper Center for Public Opinion Research, nearly half of the people surveyed thought that factories were still the leading cause of water pollution and did not know how to do more to protect the environment. Only 22 percent of Americans knew that nonpoint source pollution is now the nation's leading water quality challenge and that changes in their everyday actions could have a positive effect. While watershed education programs have had many successes in recent years, this poll suggests that Americans still do not know the causes of watershed health impairments and therefore watershed education programs need still greater emphasis.

## Partnerships and Coordination

Watershed practitioners consistently say that effective partnerships provide the foundation for watershed protection or restoration activities. Local partnerships drive most watershed activities. In addition, since governments own land, regulate activity, and provide assistance, coordination within and among government agencies also benefits watershed health. Coordinating the actions of local watershed groups with government agencies increases efficiency.

### Local Watershed Partnerships

Watershed partnerships can include any person or group interested in watershed health. Typical partnerships include many watershed stakeholders:

- Landowners
- Elected officials
- Representatives of federal, tribal, state, and local government agencies
- Agricultural organizations
- Business organizations

*How is the Watershed Approach Working?*

## EDUCATING MUNICIPAL OFFICIALS ABOUT NONPOINT SOURCE POLLUTION

### THREATS: NUTRIENTS, SEDIMENTS, CHEMICAL POLLUTANTS

Project NEMO (Nonpoint Education for Municipal Officials) educates local government decision-makers in Connecticut about land uses that cause nonpoint source pollution. The program makes technical presentations to town engineers, planners, and commissioners and recommends a three-tiered planning strategy based on natural resources, site design, and stormwater best management practices. The University of Connecticut Cooperative Extension System developed the NEMO project in partnership with two other units of the university: the Department of Natural Resources Management and Engineering and the Connecticut Sea Grant Program. The University of Connecticut Cooperative Extension System manages the NEMO program with the assistance of the Environmental Protection Agency, the Connecticut Department of Environmental Protection, the Connecticut chapter of the Nature Conservancy, and EnviroGraphics, Inc.

## BANKING GRASSLANDS TO ENHANCE RANCHING IN NEW MEXICO


### THREAT: HABITAT MODIFICATION

The Valle Grande Grass Bank is a partnership of ranchers, environmentalists, and Forest Service personnel that rehabilitates hard-used rangelands in northern New Mexico. Ranchers that overuse rangelands can increase erosion and displace native species. The grass bank provides alternative grazing lands so that ranchers can rest and restore their home pastures. The Conservation Fund, a nonprofit organization, manages the grass bank. Ranchers deliver their cows to the grass bank and plant their overused lands with desired vegetation. Ranchers usually participate in the grass bank for several growing seasons to allow the new vegetation to become established and resilient.

- Environmental organizations
- Student groups and senior citizen organizations

By including many interest groups, local watershed partnerships tap the varied skills of different partners, increase credibility, reduce duplication of effort, and maximize results from limited funds.





## PROTECTING LAKE KEOWEE IN SOUTH CAROLINA THREATS: NUTRIENTS, CHEMICAL POLLUTION, SEDIMENTS, PATHOGENS

The Friends of Lake Keowee Society (FOLKS) is a 3,000-member organization dedicated to protecting regional lakes in South Carolina. The all-volunteer group has a diverse membership that includes retirees, scientists, farmers, realtors, and boat dealers. Every realtor and boat dealer in the region provides new homeowners and boat owners with free memberships to FOLKS. The organization believes that homeowners and boat owners that use the lake have a vested interest in a healthy lake.

Since the early 1970's, population growth rates in this region of South Carolina have increased four-fold. Increased urban runoff and septic system failure have accompanied this rapid growth. These changes threaten the lake's ability to provide drinking water for local municipalities and attract tourism and recreation. FOLKS volunteers have worked with state agencies, Clemson University, and the Appalachian Council of Governments to secure aerial surveys and maps of lakes, coordinate sediment and siltation monitoring, and assist with volunteer water monitoring. This broad coalition is working vigorously to maintain watershed health in the Lake Keowee region.

In recent years, local watershed partnerships have grown in number. The Environmental Protection Agency's Adopt Your Watershed program ([www.epa.gov/adopt](http://www.epa.gov/adopt)) and River Network ([www.rivernet.org](http://www.rivernet.org)), a national nonprofit organization, both recognize over 3,000 local watershed groups. Citizens increasingly participate in these efforts because they are increasingly aware of watershed health, and state and federal governments increasingly support watershed groups. States such as Washington, Oregon, and New Jersey encourage watershed planning by supporting the establishment of local watershed councils. All states provide varied funding and technical assistance for watershed planning efforts.

Various federal agencies also encourage local watershed efforts with financial and technical support. Local watershed efforts often receive federal funding indirectly from state and tribal grant programs, but they also receive direct support from federal grant programs. For example, the Environmental Protection Agency supports local partnerships with Watershed Assistance Grants. These small grants provide seed money for fledgling watershed groups. The city of Alpine, TX received \$25,000 from the Watershed Assistance Grant program to form a community partnership for the restoration of Alpine Creek. The restored creek will serve as an urban wildlife refuge and an important flood control channel. Other federal agencies support similar programs, such as the Clean Streams Initiative sponsored by the Office of Surface Mining. Without such support, local watershed residents may not have enough capacity to sustain long-term restoration efforts.

### Partnerships in Government

State and federal governments own land, regulate activities, and provide assistance, and therefore governmental coordination on these issues benefits watershed health. Historically, responsibilities for watershed management have been very fragmented. In recent years, state and federal programs have reorganized governmental water programs to adopt a more unified approach. The following paragraphs identify many recent improvements to partnerships in government. However, multiple forums have observed that governmental coordination needs further improvement.

The federal government issued the *Unified Federal Policy for Ensuring a Watershed Approach to Federal Land and Resource Management* in October 2000. The policy guides management across federal lands and water resources. It calls for federal agencies to use a watershed approach; to assess watersheds on federal lands with a common, science-based method; to focus federal funding and resources in jointly selected watersheds; and to enhance collaboration with tribes, states, and interested stakeholders.



To further coordinate federal resources, regional offices of federal government agencies established Federal Coordination Teams, also known as Regional Watershed Coordination Teams, in twelve large river basins. On these teams, regional directors of federal agencies work with federal staff, state and tribal representatives, as well as nonprofit organizations to improve interagency coordination and leverage resources. For example, the Mid-Atlantic Federal Coordination Team signed an agreement to coordinate government programs to address sprawl (highlighted in this section).

The Five Star Restoration Grant Program is another example of federal coordination. The Environmental Protection Agency and National Marine Fisheries Service, along with the National Fish and Wildlife Foundation, National Association of Counties, National Association of Service and Conservation Corps, and the Wildlife Habitat Council have jointly developed this program that supports stream-bank and wetland restoration. The program provides challenge grants and technical support to community-based restoration projects. Each project involves five or more partners—“five stars”—in the restoration effort. Project partners include local government agencies, elected officials, community groups, businesses, schools, and environmental organizations. Each partner contributes funding, land, technical assistance, workforce support or other services to match the federal assistance.

### Coordinating Government Assistance with Local Watershed Actions

State and federal governments coordinate with local watershed efforts in many ways. The following paragraphs highlight a few examples.

The Tennessee Valley Authority’s Watershed Teams are an excellent example of federal government coordination with local watershed efforts. The twelve teams help local watershed coalitions build capacity, identify priorities, and implement restoration and protection activities. Each team serves a specific watershed, learning about local

### MID-ATLANTIC FEDERAL COORDINATION TEAM SIGNS MEMORANDUM OF AGREEMENT TO ADDRESS SPRAWL

Seven federal agencies committed to protect vital resources by coordinating federal programs and helping state and local governments implement 25 pilot projects in the mid-Atlantic region to manage growth. The pilot projects will use innovative approaches to achieve the following objectives:

- Provide positive incentives for environmentally sensitive development and the conservation and management of natural lands.
- Furnish technical assistance to state and local governments in understanding and addressing the impacts of development practices on the environment, natural resources, and working resource lands.
- Encourage appropriate revitalization of urban residential communities and redevelopment of abandoned commercial, industrial, and brownfields sites.
- Eliminate programmatic incentives to harmful sprawl development.
- Reinforce state and local leadership and objectives in managing growth, creating livable communities, and protecting natural resources.

The Environmental Protection Agency, Department of Agriculture, Department of Transportation, Department of the Army, Department of Commerce, Department of the Interior, and Department of Housing and Urban Development signed this agreement.



*The mid-Atlantic region has lost significant forested and wetland areas to environmentally insensitive suburban development.*



## RESTORING ESTUARINE WETLANDS WITH A FIVE-STAR PARTNERSHIP

### THREAT: HABITAT LOSS

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People for Puget Sound, a nonprofit organization in Seattle, Washington, organized a diverse partnership to restore estuarine habitat for wild Chinook salmon. This partnership includes volunteer organizations, businesses, urban youth corps, the Student Conservation Association, the Environmental Protection Agency, the Army Corps of Engineers, and the International Marine Association for Protection of Aquatic Life. The Five Star Restoration Grant Program awarded a grant to the partnership to restore previously altered parkland to tidal influence. The restored wetlands will provide mudflat and salt marsh habitat for wild Chinook salmon and other estuary-dependent species.

resource issues and building community trust. The Watershed Teams facilitate coalitions among government agencies, businesses, and community organizations, and they supply environmental assessments and monitoring data that help local coalitions establish priorities for watershed restoration and protection actions. The twelve teams have helped more than 100 stakeholder groups in the Tennessee Valley, including many groups founded with Watershed Team assistance. The Watershed Teams measure their performance by considering improvements to watershed health and local success in obtaining public and private contributions.

In addition to coordinating federal government activities (discussed under the heading “Partnerships in Government”), Federal Coordination Teams have also helped local watershed efforts. For example, the Southeast Federal Coordination Team provided technical expertise in environmental assessment, monitoring, and restoration to the Hiawassee River Watershed Coalition for a project in Brasstown Creek in western North Carolina. As a result of the Federal Coordination Team support, the Hiawassee River Watershed Coalition successfully applied for nearly two million dollars in funding for this project from the

North Carolina Clean Water Management Trust Fund. The Federal Coordination Teams have also convened the previously mentioned regional roundtables to facilitate coordination among watershed stakeholders from public, private, and nonprofit sectors. Roundtable participants have shared information about successful projects and explored new ideas. More than twenty regional roundtables have been conducted, and the National Watershed Forum in June 2001 will bring together regional participants and perspectives.

Local watershed groups recognize the efforts of governments to assist them, but many practitioners suggest that governments can still better organize their support for local actions. For example, watershed data, technical assistance, and financial assistance remain disorganized within state and federal departments, and organization across departments is rare. In addition, many government programs lack an effective point of contact for watershed groups.

## Assessing Partnership Success

While watershed practitioners suggest that partnerships are the most important element of any watershed effort, their progress in forming and successfully utilizing partnerships may be gradual. Stakeholders often hold different views, interests, and responsibilities, so trust and mutual understanding may be slow to develop. Even after watershed stakeholders form functioning, sustainable partnerships, the partnerships may not produce immediate, tangible environmental results. Because the process of improving watershed health is usually a gradual one, it is difficult to assess the success of watershed partnerships. Nonetheless, most evaluations of watershed partnerships suggest that their efforts can improve coordination, use resources more efficiently, and make decisions more effectively.

## Monitoring and Research

Watershed monitoring and research provide information about watershed health, watershed function, and the





impacts of human actions. Watershed monitoring evaluates the chemical, physical, and biological characteristics of watersheds. Water chemistry monitoring is the most traditional and common monitoring program. Monitoring of physical watershed characteristics such as sediment loading or channel stability is more rare. Biological monitoring is most rare. Biological monitoring evaluates the diversity of living organisms and is considered by many experts to be the most complete measure of watershed health. All three methods of monitoring help to identify specific impairments and threats to watershed health. Watershed groups use this information to understand threats to watersheds and prioritize their efforts.

Watershed research explains how watershed ecosystems work and how they can vary. Research also assesses the results of watershed protection and restoration activities. Ideally, this research informs future watershed actions.

Monitoring programs organized by local watershed groups, states, tribes, and federal agencies contribute valuable information to watershed management efforts. For example, the Environmental Protection Agency collects water quality data from states and synthesizes the data for the biannual National Water Quality Inventory and the List of Impaired Waters. The U.S. Geological



*Volunteer monitoring programs contribute valuable information to watershed management efforts.*

Survey's National Water Quality Assessment program makes selected measurements of water quality in sixty river basins and aquifer systems. The breadth and consistency of this monitoring program allow for nationally consistent assessments. The National Water Quality Assessment program recently released a report assessing pesticide and nutrient levels in these sixty watersheds and will soon release further assessments. The Fish and Wildlife Service has developed National Wetland Inventory maps for more than 90 percent of the contiguous United States. The maps are available for wetland trend analysis and watershed planning. The Natural Resources Conservation Service inventories resources on private lands. The Forest Service monitors the size, health, and location of the nation's forests and woodlands.



*Water chemistry monitoring is the most traditional and common type of monitoring performed.*

The U.S. Geological Survey also works with states, local governments, and tribes to collect watershed data and develop research projects. Projects have delineated drinking water source areas; assessed water quality in lakes, rivers, and estuaries; monitored best-management practices; and identified sources of microbial contamination. In a separate program, the U.S. Geological Survey has established research partnerships with 51 universities.

Improved water quality models provide an interesting intersection of watershed monitoring and research. The U.S. Geological Survey's National Water Quality



## MONITORING SOURCE WATER FOR HERBICIDE CONTAMINATION IN PENNSYLVANIA

### THREAT: HERBICIDES

The Philadelphia Suburban Water Company intakes water in the lower Neshaminy Creek watershed in eastern Pennsylvania. The watershed is largely suburban, but approximately 15 percent of the watershed remains agricultural. The water company works with the Bucks County Conservation District and the Penn State Cooperative Extension Service to reduce levels of herbicides occurring in peak spring runoff.

This partnership is trying to quantify the problem with a concentrated monitoring program. Philadelphia Suburban tests samples hourly at the treatment plant after significant rainfall events between May 15 and June 30. The water company also collects grab samples from key sites in the watershed. The Bucks County Conservation District and the Penn State Cooperative Extension Service organize forums at which the water company shares this information with local farmers. The information encourages farmers to follow herbicide application instructions and adopt relevant best management practices.

Assessment program is developing promising models of nationwide surface water quality. The Environmental Protection Agency is testing models that predict pesticide occurrence in streams and reservoirs.

Despite the many national monitoring programs, more and better data are needed. Watershed practitioners find that data are often incomplete because of limitations and differences in various local, state, tribal, and federal monitoring programs. For example, the Environmental Protection Agency's 1998 *National Water Quality Inventory* reflected state, tribal, and territory monitoring of only 23 percent of the nation's rivers and streams, 42 percent of the nation's lakes, ponds, and reservoirs, and five percent of the nation's ocean shoreline miles. The new "Coastal Research and Monitoring Strategy" a cooperative product of the National Oceanic and Atmospheric Administration,

the U.S. Geological Survey, the Department of Agriculture, and the Environmental Protection Agency, notes that coastal waters lack consistent, comprehensive monitoring data. Many watersheds lack data about habitat quality. Few monitoring programs consider biological indicators of watershed health.

Also, many national and state monitoring programs provide data for watersheds that encompass hundreds of square miles, whereas local actions require data related to an individual town or a specific stream reach. The existing watershed data are often uncoordinated and inconsistent. Local monitoring data, state monitoring data, and federal monitoring data may be incompatible. As a result, watershed groups may be unable to analyze trends in watershed health.

Watershed research, too, has significant gaps. For example, research is just beginning to explore linkages among watershed components—rivers, wetlands, floodplains, upland areas, groundwater, and the atmosphere. Because watershed management requires an interdisciplinary approach, more research is needed to explore integrating biology, chemistry, and physics with the social sciences.

Also needed is greater understanding of the public health and environmental impacts of chemical mixtures, chemical degradation products, and emerging contaminants such as endocrine disruptors and pharmaceuticals. Watershed models with greater accuracy and reliability would be very useful for this purpose and many others. Models can serve to reduce the overall costs of performing monitoring.

Practitioners ultimately need research that assesses individual projects. Such research could help practitioners understand the long-term effects of restoration and protection projects and the factors that most influence project success or failure.

## Planning and Prioritization

Watershed planning and prioritization activities guide public and private actions in a watershed. They ensure



that restoration actions are focused, coordinated, and efficient. State, federal, and tribal governments often establish broad plans and priorities. Local land use and watershed planning efforts address smaller-scale issues.

In 1998 and 1999, states, tribes, and territories developed Unified Watershed Assessments that identified watersheds most in need of restoration. The Unified Watershed Assessments were developed quickly with available information. Since these state, tribal, and territorial assessments required collaboration and agreement across government programs, their compilation is the nation's most comprehensive statement of watershed priorities. In developing Unified Watershed Assessments, participants used resources such as state lists of impaired and threatened waters, federal and state lists of endangered species, and data from nonprofit organizations. States, territories, and tribes determined that 60 percent of the nation's watersheds do not meet clean water and other natural resource goals requiring restoration action. They also determined that 15 percent of the watersheds need preventive action to sustain water quality and aquatic resources. Participants are developing watershed restoration action strategies for many of their highest priority watersheds. These comprehensive watershed plans allow governments to target funding and technical assistance to watersheds with the greatest needs.

The National Estuary Program's Comprehensive Conservation and Management Plan process provides a model of regional watershed planning and priority setting. Representatives of government, industry, and public interest groups work together to develop comprehensive plans for estuary activities. These plans reflect the priorities of estuary stakeholders. They strive to conserve and enhance the natural, cultural, recreational, social, and economic resources of each watershed.

Local planning increasingly considers an array of environmental issues. Local ordinances have always addressed traditional issues such as building density and land use, but in the past they have not reflected environmental concerns. Zoning decisions impact watersheds by

## RESEARCHING THE MANAGEMENT OF FRESHWATER INPUTS TO ROOKERY BAY

### THREAT: PHYSICAL BARRIERS

The 25 reserves in the National Oceanic and Atmospheric Administration's National Estuarine Research Reserve System monitor estuarine trends in 21 states and territories. The Rookery Bay Reserve (Florida) is studying how freshwater inflows affect fish species and how these inflows can be mitigated. Research by the Florida Department of Environmental Protection indicates that Hurricane Andrew and other major storm events altered the estuary's freshwater inflows, damaging habitats within the reserve. These alterations had immediate and long-term impacts on the food chain by harming species eaten by commercially and recreationally important fish.


Human impacts, such as dam or weir construction, alter the flow of freshwater and nutrients into estuaries. When storms threaten upstream flooding, freshwater is released downstream. The National Oceanic and Atmospheric Administration's National Marine Fisheries Service awarded funding to the Rookery Bay Reserve to restore natural freshwater inflow patterns during storm events. The reserve proposes to computerize a weir on Henderson Creek to allow for more natural flow of freshwater into the estuary. The reserve hopes that this project will enable other water management districts to manage water flow similarly.

## FOUR ADVANTAGES OF THE UNIFIED WATERSHED ASSESSMENT APPROACH

### PROVIDED BY THE MARYLAND DEPARTMENT OF THE ENVIRONMENT

1. Allowed the state to build on an existing analytical framework that it had been developing.
2. Gave the state an opportunity to go beyond traditional water quality issues and perform a truly integrated assessment of its watersheds, including habitat, landscape, and human-related factors.
3. Encouraged the state to bring together a truly diverse group of agencies and individuals that historically had not collaborated on management efforts.
4. Focused restoration in an integrated, watershed-based manner.





influencing the location of commercial, residential, and industrial buildings in communities. For example, construction in a floodplain often reduces wetland acreage, and environmentally oriented zoning plans attempt to prevent or mitigate these impacts. Local land trusts and national land conservation organizations preserve open space in watersheds benefiting species, water quality, and the community. In these examples and many more, local planning has important consequences for the health of local watersheds and economies. The Environmental Protection Agency has posted model ordinances on the webpage “Model Ordinances to Protect Local Resources” ([www.epa.gov/owow/nps/ordinance](http://www.epa.gov/owow/nps/ordinance)).

#### **MANAGING THE SAN MIGUEL WATERSHED THROUGH COMPREHENSIVE ASSESSMENT THREATS: FLOW MODIFICATION, SPECIES LOSS, NUTRIENTS, SEDIMENTS**

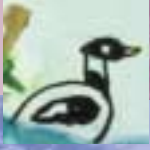
Stakeholders in the San Miguel Watershed in southwest Colorado began a comprehensive watershed management approach in 1990. Numerous studies, including rare plant and animal surveys, instream flow studies, a fish survey, a land health assessment, a hazardous waste inventory, water quality studies, and river restoration studies assessed the condition of the watershed. A broad coalition of partners used information from the studies and public meetings to draft a watershed management plan. This plan will conserve and enhance the natural, cultural, recreational, social, and economic resources of the watershed.

The management plan strives to reduce impacts to the watershed from large-scale development. Large-scale development can cause excessive nutrient inputs, heavy sedimentation, and erosion. As a result of accompanying population increases, communities often over-appropriate water and reduce instream flows. To address this problem, the San Miguel Board of County Commissioners has placed new stipulations on construction, sewage disposal, fertilizer use, blasting, and new roads in the watershed. These stipulations helped San Miguel County earn an Environmental Protection Agency Outstanding Achievement Award and a National Association of Counties Award for community-based ecosystem protection.

Despite many successful planning and prioritization efforts nationwide, watershed activities remain difficult to organize and integrate. Various government agencies and stakeholder groups address different issues at different scales.

For example, it is not clear that the Unified Watershed Assessment process has improved coordination within state and federal governments. Although these assessments are state-wide, multi-program statements of watershed priorities, many government funding and technical assistance programs have not used them to target their resources. Federal agencies do not consistently integrate voluntary programs (e.g., the Environmental Protection Agency’s nonpoint source management program, the Department of Agriculture’s Environmental Quality Incentives Program) or regulations (e.g., regulations for Concentrated Animal Feeding Operations) in the identified priority watersheds. In addition, stakeholders in high priority watersheds have not consistently implemented restoration action strategies. These priority watersheds need greater attention from watershed practitioners and these practitioners may require more financial and technical assistance to successfully implement the restoration action strategies. The process of developing statewide water quality and habitat assessments has, however, fostered greater collaboration between state agencies and amongst all decision-makers. The process may therefore serve as the starting point for the development of comprehensive natural resource assessments in the future.

Many local planning efforts and land use ordinances still need revision. For example, at a roundtable meeting for southeastern states, seven of nine state delegations identified land use planning and zoning as their highest priorities. They found that existing planning efforts and zoning ordinances often fail to protect watersheds and sometimes encourage watershed degradation. Many zoning laws unintentionally encourage urban sprawl and discourage investment in inner cities. For watershed management to be effective, these local issues must be addressed.



## Funding and Technical Assistance

Funding and technical assistance provide local watershed groups with the means to protect and restore watersheds. Watershed management requires that work be done and materials and services be purchased. Watershed actions require both human and financial resources. Governmental, nonprofit, or private sources provide this support.

The federal government has many funding programs that support watershed actions. The Environmental Protection Agency's recent revision of the *Catalog of Federal Funding Sources for Watershed Protection* ([www.epa.gov/win/resources/html](http://www.epa.gov/win/resources/html)) identifies 69 federal grant or loan programs from twelve federal departments and agencies. The catalog indexes the programs by name, agency, and keyword. These funding opportunities are critical, but many are limited to specific purposes, recipients, or geographic areas, and some offer minimal funding.

The array of funding resources for watershed management can overwhelm watershed groups. However, environmental finance centers at nine universities provide publications, analyses of financing alternatives, training, and technical assistance. The environmental finance centers at the University of Maryland and Boise State



*The Natural Resources Conservation Service provides direct technical assistance to farmers across the nation.*

### PLANNING FOR IMPROVED WATER QUALITY WITH NEW GRADING ORDINANCES IN MAUI, HAWAII THREATS: SEDIMENTS, NUTRIENTS

Maui County includes the islands of Maui, Molokai, and Lanai. Hawaii's Department of Health considers the waters of West Maui, Kahului Harbor, and the South Molokai Shoreline to be impaired because they often exceed nutrient and turbidity standards. The county has identified construction and grading projects as a primary source of water quality problems.

In August 1998, the Maui County Council revised its grading ordinances. The county now requires that all grading work use erosion control and sediment best management practices. The county informed the public, the construction industry, general contractors, government officials and inspectors, and Soil and Water Conservation District officials about the new ordinance, effective erosion control plans, and new technologies. This program has inspired other counties in the state to consider similar ordinances.

University develop workshops for local governments that discuss watershed financing alternatives. The Environmental Protection Agency's National Estuary Program is also conducting workshops that discuss financing alternatives for estuary plan implementation activities. These programs help watershed practitioners identify and exploit creative financing opportunities.

The federal government recently enhanced some financial assistance programs for watershed protection and restoration activities. The Department of Agriculture's Conservation Reserve Program now provides greater financial incentives to farmers that retire environmentally sensitive cropland. These incentives include rental payments, cost-share payments for best management practices, and technical assistance. The recent Transportation Equity Act for the 21st Century provides billions of dollars for transportation improvements, including environ-

## RESTORING WETLANDS WITH TRANSPORTATION FUNDS IN MISSISSIPPI

### THREAT: WETLAND LOSS

In 1990, the Mississippi Department of Transportation purchased State Line Bog and Dead Dog Bog, two wetlands on 360 acres in southeast Mississippi. The Department of Transportation used Transportation Equity Act grant funds to work with the Mississippi Chapter of The Nature Conservancy and the Mississippi Department of Wildlife, Fisheries, and Parks to restore the bogs. The restoration project is designed to offset unavoidable wetland impacts that will occur during the construction of Mississippi highways. Paper companies had owned these properties and degraded the habitat by draining the bogs and harvesting their trees.

Project partners backfilled drainage ditches to restore wetland hydrology and used periodic prescribed burns to gradually remove logging debris and create an appropriate vegetative structure. These changes are restoring



the insectivorous pitcher plant communities that once dominated the bogs.

*The Mississippi Department of Transportation used Transportation Equity Act grant funds to restore wetlands with rare insectivorous pitcher plant communities.*

mental protection and restoration projects. This act and an earlier act, the Intermodal Surface Transportation Efficiency Act, have created and protected many acres of wetlands with mitigation projects. In the last four years, states have restored or created 2.4 acres of wetlands for each acre that has been unavoidably impacted by transportation projects.

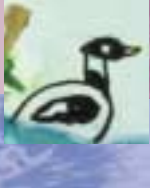
In the same period, the Department of the Interior's Office of Surface Mining has more than doubled its funding for the Appalachian Clean Streams Initiative. This program addresses acid mine drainage, nonpoint source pollution from abandoned coal mines. The program has provided \$20 million as seed money for 99 projects in 11 states. In the last few years, the Environmental Protection Agency's nonpoint source grants program has doubled its assistance to states and tribes to nearly \$240 million. The Agency's Clean Water State Revolving Fund provides loans for many types of watershed protection and restoration projects, including wastewater, stormwater, nonpoint source, and estuary protection projects. The program manages more than \$34 billion in assets.

While the federal government has enhanced and expanded existing funding programs, it has also developed entirely new programs. For example, the federal government developed both the Five-Star Restoration Grant program and the Watershed Assistance Grants program in 1998. The Environmental Protection Agency's Watershed Assistance Grants program supports local watershed partnerships during their development and contributes to watershed protection and restoration actions. In 1999 and 2000, the program awarded more than one million dollars to 60 projects. The demand for these grants far exceeds available resources: in 2000 alone, 400 proposals from local groups in 46 states requested nearly nine million dollars.

One source of technical information for watershed efforts is the *Stream Corridor Restoration Handbook* ([www.usda.gov/stream\\_restoration](http://www.usda.gov/stream_restoration)). The document presents current knowledge of stream corridors and stream corridor restoration. Fifteen federal agencies and other watershed groups developed this document to address many stream corridor restoration scenarios.

Other technical assistance programs support private landowners. The Natural Resources Conservation Service provides direct technical assistance programs to farmers across the nation. The U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program works with





landowners to restore watersheds by planting native species, removing invasive species, improving wetland hydrology, and reconstructing in-stream aquatic habitat. Landowner interest in the Partners for Fish and Wildlife program exceeds the program's resources.

The financial assistance programs highlighted in these paragraphs will help to protect and restore watershed health, but further assistance is still needed. Recent studies by the Environmental Protection Agency suggest that communities will need billions of dollars over the next twenty years to upgrade and maintain their wastewater treatment infrastructure.

Watershed practitioners at the Regional Watershed Roundtables suggest that, compared to watershed needs, watershed assistance programs are modest. Many of these practitioners suggest that substantial increases in funding and technical assistance are necessary, including additional grant and loan programs. The watershed practitioners noted that technical assistance programs cannot meet the demand for on-the-ground implementation of protection and restoration measures. Most federal agencies lack field-level, watershed-based personnel. Private practitioners increasingly provide technical assistance, but local stakeholders cannot always secure assistance when they need it most. Practitioners at the roundtables asked for expanded federal and state programs that are less restrictive and provide more financial and technical support for local watershed efforts.


In addition, watershed practitioners note that specific elements of watershed management are typically overlooked in assistance programs. Watershed groups struggle to secure funding for staff salaries, monitoring and research, and project evaluation and maintenance because many assistance programs are restricted from supporting these activities. While federal laws place restrictions on some programs, many agencies develop other restrictions themselves. Federal, tribal, and state assistance programs do not effectively coordinate their efforts to target priority watershed problems. Multiple mandates and conflicting

## RESTORING BOTTOMLAND HARDWOOD WETLANDS IN ARKANSAS WITH THE WETLANDS RESERVE PROGRAM THREAT: WETLAND LOSS

The Raft Creek Bottoms in northeast Arkansas was once an extensive tract of bottomland hardwood forest. Bottomland hardwood forests are especially valuable for wildlife breeding, nesting, and habitat. In the 1960s and 1970s, landowners converted most of the Raft Creek Bottoms to cropland. In recent years, landowners have worked to reverse these actions.

With the help of the Department of Agriculture's Wetlands Reserve Program, landowners have restored the 3,000 acres in the Raft Creek Bottoms. Landowners planted bottomland hardwoods in approximately 70 percent of the area while creating the largest manmade herbaceous wetland in Arkansas on the remaining 30 percent of the tract. Waterfowl by the thousands now visit the bottomlands in the winter. Shorebirds and water birds that recently were rarely seen are now common sights on these tracts.

The Department of Agriculture's Wetland Reserve Program is a voluntary program that offers landowners financial incentives to protect, restore, and enhance wetlands on their property. Landowners that participate in the program may sell a conservation easement to the Department of Agriculture—the landowner limits future use of the land, yet retains private ownership. Landowners may also receive cost-share funding from the Department for wetlands restoration activities. In this case, landowners and the Natural Resources Conservation Service developed plans for wetland restoration and protection. Landowners continue to control access to the land and may lease the land for hunting, fishing, and other undeveloped recreational activities. The program has enrolled 915,000 acres nationally since 1996.



scientific evidence stymie attempts to focus limited funding and technical outreach. Further coordination of governmental assistance opportunities will help local watershed groups navigate their way through the many programs in many offices of many departments that have different eligibilities, requirements, and application schedules.

## Implementation

In this report, implementation describes actions that beneficially impact watershed health. Citizen stakeholders, the private sector, and government agencies implement these actions. Implementation includes pollution prevention, wastewater treatment, wetland restoration, enforcement, invasive species control, and critical habitat protection.

### **STOPPING THE SPREAD OF THE TAMARISK ON THE MOJAVE RIVER, CALIFORNIA** **THREAT: INVASIVE SPECIES**

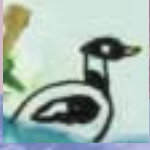
The Mojave River flows above ground year-round in the Afton Canyon of the southern California Desert. The above ground flow provides riparian wildlife habitat amid the desert. However, the salt cedar, or tamarisk, has invaded this habitat, drastically reducing wildlife populations near the river. A native of the Mediterranean region, the salt cedar creates an environment that is too salty for California's native plants. It has replaced much of the native vegetation and offers little food or shelter to wildlife. The salt cedar also consumes large volumes of water, reducing the amount available to other plants, fish, and wildlife.

Working with local conservation districts, the Natural Resources Conservation Service, the Army Corps of Engineers, and other partners, the Bureau of Land Management is removing salt cedar and replacing it with native vegetation. To date, the Bureau of Land Management has treated more than 300 acres of tamarisk and planted over 7,000 native willows and cottonwoods along the Mojave River. Native wildlife is returning to the banks of the Mojave River after a decade's absence.

This report frequently mentions “watershed protection and restoration.” National watershed health depends on both watershed protection and watershed restoration. However, watershed practitioners note that watershed protection (the prevention of degradation) is more cost-effective and more likely to succeed than watershed restoration. Practitioners also note that “restored” watersheds are rarely as ecologically valuable as protected watersheds. Nonetheless, watershed restoration is necessary because many of the nation's watersheds are already degraded.

Federal agencies account for watershed protection and restoration actions in many ways. For example, the Fish and Wildlife Service estimates that it has protected or restored more than 325 million acres of wetlands as part of the North American Waterfowl Management Plan. The Service estimates that in the last five years it has also helped to protect more than 160,000 acres of coastal habitat and reopen more than 2,200 miles of streams to anadromous fish. The Department of Agriculture reports that in the last four years it has created nearly one million miles of conservation buffers and restored nearly one million acres of wetlands. Working with state agencies and other partners, the Bureau of Land Management, the Forest Service, the Environmental Protection Agency, and the U.S. Geological Survey are restoring 120 abandoned mine sites in 12 states as part of the Interdepartmental Abandoned Mine Land Watershed Cleanup Initiative.

While new programs often command attention, long-standing programs are more important than ever for watershed health. For example, the National Pollutant Discharge Elimination System requires that states and regional offices of the Environmental Protection Agency issue permits to effluent dischargers, providing a baseline of protection for waterbodies everywhere. Even as watershed efforts do more to alleviate nonpoint source pollution, watershed health depends on permits that manage point sources. However, some Watershed Roundtable stakeholders suggest that governments do not sufficiently enforce regulatory programs. The *Green Gauge 2000*, an



annual survey tracking the American public’s attitudes on environmental issues, confirmed stakeholder concerns by noting that public support for strengthening environmental regulations has been increasing over the past decade. In 2000, nearly half of the surveyed population agreed with the statement, “environmental regulations do not go far enough.” Compliance and enforcement activities are necessary to prevent watershed degradation and to identify violations of environmental laws.

Three exemplary projects are highlighted among these paragraphs about implementation. Many other watershed projects deserve similar recognition. Other documents, such as *Watershed Success Stories* ([www.cleanwater.gov/success](http://www.cleanwater.gov/success)) offer more examples of successful implementation projects.

Not all watershed protection and restoration efforts are successful. Watershed stakeholders often do not fully implement solutions to watershed problems for many years, if at all. Partnerships can break down, priorities can change, and funding can cease, causing implementation to be stymied. Sometimes watershed efforts are adversely affected by droughts or storms. Even when successfully completed, many restoration projects are poorly maintained, negating their previously positive impact.

## CONTROLLING SALINITY IN THE COLORADO RIVER BASIN

### THREAT: SALINITY

The Colorado River and its tributaries provide municipal and industrial water for more than 23 million people in seven states and irrigation water for nearly 4 million acres of land. The threat of salinity is a major concern to agricultural, municipal, and industrial users in both the United States and the Republic of Mexico. Damages in Mexico are not quantified, but damages in the United States typically range between \$500 million and \$750 million per year. In the Colorado River Basin Salinity Control Program, the Bureau of Reclamation, the Bureau of Land Management, the Natural Resources Conservation Service, and seven states are implementing salinity control projects that cost-effectively remove salt from river water. The program constructs desalination plants, intercepts groundwater before it flows through saline formations, implements water conservation measures, establishes more stringent control measures at oil and gas development sites, seals flowing saline wells, and provides technical and financial assistance to land users for salinity reduction practices. Control measures are preventing approximately 500,000 tons of salt from entering the river system.

## RESTORING DEGRADED STREAMBANKS ON CHEROKEE LANDS IN NORTH CAROLINA

### THREATS: HABITAT LOSS, EROSION

Increased erosion, sedimentation, and habitat degradation caused by development, recreation, and urbanization have impaired the Oconaluftee and Ravens Fork Rivers in western North Carolina. The watershed is a popular area for tourists and is also an important source of revenue for local communities, especially the Eastern Band of the Cherokee Indians.

The Cherokee Tribe has worked with the Environmental Protection Agency and the Department of Agriculture’s Natural Resources Conservation Service to plan, design, and implement best management practices for stream restoration, and to educate area landowners about watershed protection techniques. The Tennessee Valley Authority and Western Carolina University have collected and analyzed sedimentation data to identify restoration sites. Work has begun on restoration projects and on implementing a new Erosion Control Ordinance and an Integrated Resource Management Plan.

Restoration activities on the Oconaluftee and Ravens Fork Rivers have already yielded results. For example, at one site restoration actions have slowed stream flow near the riverbanks, and they are rebuilding naturally. The river has deposited six inches of new sediment along the banks and riparian vegetation is thriving.



## EVALUATING DRINKING WATER PROTECTION MEASURES IN IOWA

### THREATS: PATHOGENS, SEDIMENTS, NUTRIENTS

Lake Fisher is the primary source of drinking water for Bloomfield, Iowa. Excessive inputs of sediments and nutrients are reducing lake capacity and increasing drinking water treatment costs. To address this situation, landowners have treated 900 acres of land in the watershed with a combination of terraces, water and sediment control basins, ponds, and constructed wetlands. Septic system improvements have also reduced bacterial inputs to the lake. Preliminary results for this project have been striking. Agricultural best management practices have reduced the sediment load reaching Lake Fisher by 60 percent. Nutrients, pesticides, and organic materials flowing into the lake have been reduced by 50 percent. Septic system improvements have reduced bacteria flowing to the lake by 50 percent.

## EVALUATING RIPARIAN RESTORATION IN COYOTE CREEK, CALIFORNIA

### THREAT: HABITAT LOSS

The San Francisco Bay Bird Observatory at the south end of San Francisco Bay uses mist-netting, point counts, area searches, and nest-finding to evaluate riparian corridor restoration projects. The program monitors bird use of these managed riparian corridors by comparing data from their long-term reference site (Coyote Creek Field Station) to other restoration sites. The Observatory uses these bird data in conjunction with vegetation data to assess the success of the restoration sites, to make management recommendations, and to study the use of urban riparian sites. The program plans to monitor the reference site for at least the next 40 years. It will document changes in the avian populations over time as the site matures.



*The San Francisco Bay Bird Observatory is studying bird populations (e.g. Rufous Hummingbird) as an indicator of the success of riparian corridor restoration projects.*

## Evaluation

Watershed practitioners evaluate implementation actions to assess their effectiveness. Evaluations can consider the environmental impact of individual projects, watershed-wide efforts, state initiatives, or national programs.

Proper evaluation ensures that watershed efforts duplicate effective projects and programs and eliminate or modify less effective projects and programs. Watershed efforts that continually evaluate their work tend to achieve more positive results and can objectively demonstrate those results. Unfortunately, project-level and watershed-level evaluations of the environmental impacts of restoration efforts are not common. Some projects, however, including the two highlighted in this section, provide excellent exceptions.

At larger scales, some states and regional organizations produce useful and innovative environmental performance scorecards. For example, Florida recently developed a water quality and natural resource performance report ([www.dep.state.fl.us/ospp/report](http://www.dep.state.fl.us/ospp/report)) that the Florida Department of Environmental Protection issues on a quarterly basis. The report tracks environmental trends that are directly impacted by Florida's environmental programs. Florida's Department of Environmental Protection expects that the report will help it enhance and replicate successful efforts and change those that are not working as intended.

Federal agencies and departments are also increasingly evaluating their efforts with objective, environmentally focused measures. For example, the Tennessee Valley Authority's Watershed Teams monitor water quality ratings in the 603 watersheds managed by the Tennessee Valley Authority. In recent years, water quality ratings have improved in 210 of the 603 watersheds.

Despite this progress, many existing measurement tools and environmental indicators are complex and have only indirect linkages to on-the-ground changes. Efforts to improve these tools often have to overcome organizational inertia to replace traditional measurement approaches. Improved evaluation techniques are needed to objectively demonstrate the success or failure of watershed protection and restoration efforts.



## INTEGRATING THE THEMES OF WATERSHED MANAGEMENT: THE AMD&ART PROJECT THREATS: CHEMICAL POLLUTANTS, HABITAT LOSS

Acid mine drainage (AMD) is the most widespread and damaging environmental problem for Appalachia, as well as one of the region's worst economic and social problems. AMD&ART, a small non-profit organization, develops watershed treatment systems that are also recreational sites, art parks, educational centers, and historical exhibits. Their projects reach people, restore nature, and clean water. The "ART" in AMD&ART is not an acronym. It represents the art of blending disciplines in the design process and orchestrating citizens, contributors, and governmental agencies.

This example highlights all seven components of the watershed approach discussed in this report.



*The Vintondale Site Plan: (1) History Wetlands; (2) Community Recreation; 3) AMD Treatment System and Litmus Garden*

A pilot project in Vintondale, Pennsylvania is designing a community park to fulfill environmental, recreational, and educational needs. This project is developing new partnerships and increasing coordination. More than 10 percent of the Vintondale population has gathered for regular meetings with AMD&ART artists, historians, and scientists to discuss project planning and prioritization. The resulting design proposal incorporates ideas from everyone that contributed to the process. Participation in the process is increasing public awareness of economic and environmental issues. The project has initiated school education programs and

service projects for students of all ages in surrounding communities. Diverse partners such as the Environmental Protection Agency, the Pennsylvania Department of Transportation, AmeriCorps, and private foundations have contributed technical support and more than \$400,000 in funding to the project. Monitoring and research efforts include volunteer water quality monitoring, AMD&ART staff-conducted biological surveys, and university-conducted surveys of community attitudes, knowledge, and behavior. Twenty-five percent of the town's population gathered for the project's groundbreaking—the symbolic beginning of implementation efforts. Many aspects of project implementation have already begun, including the development of a 35-acre site that includes a wetlands treatment system for acid mine drainage. Evaluation efforts are measuring environmental change and social and economic benefits. These results will allow other communities with similar discharges and environmental conditions to build upon Vintondale's successes. The AMD&ART project is a model for a new partnership between the Department of the Interior's Office of Surface Mining and the National Endowment for the Arts. This partnership will remediate acid mine drainage with similar artful, community-driven approaches throughout eastern coal country.

# What Can be Done to Improve Progress?

*Quick as my Thought*  
Rachel Rees  
Age 8  
Submitted Independently  
Susanville, California



**T**his last section summarizes ideas and actions to improve watershed management from roundtable participants, reinvention team members, academic evaluators, and government-sponsored studies and reports. The section organizes these recommendations with the same seven themes used by the previous section. Implementation of these recommendations will require the collaboration of diverse stakeholders in the public and private sectors. A more detailed discussion of potential actions follows each set of recommendations.

## Education and Awareness

### Recommendations

Ensure that key groups receive environmental education:

- Local decision-makers, such as municipal officials, mayors, and county councilpersons
- Students
- Real estate, agricultural, and industrial organizations

Use modern technology and multi-media campaigns to enhance education and awareness programs

### Discussion

As noted in the fourth section of this report, most Americans do not understand how watershed health is threatened and degraded. Many others do not under-





stand how they can improve watershed health. As a result, the collective actions of individuals significantly impair our nation's water resources.

Education and awareness efforts should build on previous successes. Many programs attempt to reach a broad audience, but education and awareness programs should give special attention to a few key groups. Education and awareness programs should target local decision-makers because they can change local land use policies.

Watershed groups should develop peer education programs for agricultural stakeholders, real estate developers, and industrial organizations because these programs have proven to be effective.

Student education programs are a long-term investment in an environmentally aware citizenry. State and federal agencies should expand efforts to encourage use of environmental curricula; many excellent and proven curricula are rarely used. Teachers need training, and schools should consider flexible, interdisciplinary learning approaches. Studies suggest that thematic, action-oriented environmental education can improve academic achievement in many subjects, reduce discipline problems, and motivate students.

Education programs should continue to use modern technology. The Watershed Information Network organizes information about watershed resources in one location on the internet. Its sponsors are expanding the network and improving the accuracy and comprehensiveness of the information presented. Watershed education campaigns should increase their use of computer imaging technology. For example, television weather reports can use watershed maps to depict floods and droughts, and related features can demonstrate how common activities such as fertilizing a lawn impact watershed health (highlighted in this section). These types of projects can expand public awareness of how watersheds function.

## USING MODERN TECHNOLOGY DURING WEATHER REPORTS

The National Environmental Education and Training Foundation hopes to advance public awareness of watershed issues through television weather reports. It is anticipated that in 2001 the weather report on WRC-TV NBC4 in Washington, DC will depict events such as oil spills, plumes of polluted runoff, floods, and droughts with three-dimensional maps of the Chesapeake Bay and Potomac River watersheds. An accompanying website will link viewers to real-time water quality monitoring data, volunteer monitoring data, and tips on reducing water pollution. If the program is successful, the National Environmental Education and Training Foundation will reproduce it in major cities around the country.

## Partnerships and Coordination

### Recommendations

Continue to develop broad partnerships for watershed protection and restoration:


- Enhance university-based service-learning networks to connect students and educators with local watershed groups

Foster greater coordination of government agencies for watershed protection and restoration:

- Implement the Unified Federal Policy
- Continue to facilitate government assistance to state, tribal, and local watershed practitioners with Federal Coordination Teams

Improve the delivery of information and support to local watershed efforts:

- Establish points of contact for federal, tribal, and state agencies
- Expand and enhance the Watershed Information Network
- Convene a federal-level workgroup to discuss further opportunities for improvement



## Discussion

The nation has supported many watershed partnerships in recent years. And yet, because governments have traditionally divided watershed management responsibilities, partnership and coordination efforts may still provide the greatest opportunities for improvements to watershed management.

Many stakeholders participate in local watershed efforts, and state and federal governments should continue to encourage and support these partnerships. Universities can play a larger role in watershed management efforts. Academic institutions should assist watershed efforts with relevant research, monitoring, assessment, planning, priority-setting, implementation, and education programs. Federal agencies should support service-learning networks that link skilled students and faculty with watershed groups.

Government coordination efforts should build on recent successes. Federal Coordination Teams should continue to integrate government funding and technical assistance programs and to support the implementation of these programs by local watershed practitioners. The Unified Federal Policy on Watershed Management should promote a consistent, cost-effective watershed approach for federal land and resource management. Agencies should continue model programs such as the Five-Star Restoration Program.

Many watershed practitioners note that government agencies can improve the delivery of informational, technical, and financial support to watershed efforts. Individual government agencies should designate reliable, responsive, and knowledgeable points of contact to answer questions and support watershed management. Government agencies should coordinate information about water quality data, technical assistance, and financial assistance in one location. The Watershed Information Network supports this goal; its sponsors are updating this network to address all of these issues. Federal agency representatives suggest that a federal-level workgroup could consider further coordinating federal support for watershed efforts.

Senior career personnel that manage watershed issues would participate in the workgroup. The workgroup would develop strategies to promote mutual understanding of programs and policies, to identify and resolve inter-agency inconsistencies or misunderstandings, and to implement actions (such as memoranda of understanding) that foster and support coordination at regional, state, tribal, and local levels.

## Monitoring and Research

### Recommendations

Increase coordination of watershed monitoring programs:

- Develop a national watershed monitoring network to consider trends in watershed health
- Increase coordination among federal, tribal, state, and local governments and volunteer monitoring groups to ensure that volunteer data are accurate, complete, and compatible with government monitoring efforts
- Implement the Coastal Research and Monitoring Strategy recommendations

Incorporate new indicators into watershed monitoring programs:

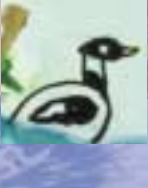
- Monitor physical and biological characteristics
- Monitor emerging chemical contaminants such as pharmaceuticals and endocrine disruptors

Provide meaningful and timely watershed information to decision-makers and the public:

- Provide data at scales useful for decision-making
- Use the internet to display and distribute visual, understandable data

Expand research in watershed management:

- Explore linkages among watershed components—rivers, wetlands, floodplains, upland areas, groundwater, and the atmosphere
- Explore the integration of the natural and social sciences
- Improve and verify models that can predict watershed properties



Increase research efforts that evaluate environmental outcomes, such as research that evaluates best management practices

### Discussion

Monitoring and research direct watershed protection and restoration activities. Many watershed monitoring and research programs operate at local, state, tribal, and federal levels. Increasingly, volunteers and nonprofit organizations are also collecting and analyzing watershed indicators.

Watershed monitoring programs lack consistency and comprehensiveness. The federal government should develop a national watershed monitoring program with standard protocols. This program should be coordinated with monitoring programs run by tribal, state, and local governments, as well as with volunteer groups. A consistent national program would reveal trends in watershed health. These coordinated sources of watershed monitoring data should provide information that the federal government can use at larger scales to make national policy decisions, and local watershed decision-makers can use for smaller-scale assessments.

Watershed monitoring programs should incorporate resource indicators that have not been traditionally measured. Monitoring programs should consider physical characteristics, such as wetland structure and streambank stability, and emerging chemical contaminants, such as pharmaceuticals. The federal government should continue to develop and disseminate wetlands tracking and assessment tools. Monitoring programs should incorporate biological indicators of watershed health, such as species diversity and population levels. These programs should also monitor previously neglected areas. For example, federal agencies with coastal responsibilities should lead the implementation of the “Coastal Research and Monitoring Strategy” to address deficiencies in coastal zone monitoring. Watershed management efforts need nationally consistent monitoring programs that cover a variety of watershed resources.

Watershed monitoring programs should provide timely data to the public. The data should be easily accessible

and understandable. Monitoring programs should use the internet to display and transfer large volumes of data.

Research programs should study linkages in watershed function. Researchers should investigate the linkages between watershed components—rivers, wetlands, floodplains, upland areas, groundwater, and the atmosphere. Researchers should also investigate linkages of natural sciences, such as biology, chemistry, and physics, with social sciences, such as economics, sociology, and psychology. For example, watershed actions that protect lands, reduce pollution, or manage species can profoundly affect individual and community attitudes and economics.

Researchers should also develop models that are more accurate and more reliable. For example, watershed models are needed to predict pollutant inputs or pollutant movement in watersheds. These models would reduce monitoring costs and suggest watershed protection and restoration actions.

Perhaps most importantly, research efforts should investigate the long-term successes and failures of protection and restoration activities. Researchers should investigate why similar actions cause different results in different watershed situations. This research would be invaluable in guiding future watershed projects.

## Planning and Prioritization

### Recommendations

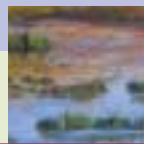
Encourage consideration of watershed health in local planning:

- Provide incentives for ecologically sensitive planning activities

Refine and coordinate national watershed assessments:

- Provide incentives to prioritize actions within watersheds at a smaller scale
- Coordinate federal assistance (financial and technical) across programs to maximize improvement opportunities
- Integrate new and enhanced monitoring and assessment data into planning and prioritization activities





## Discussion

Watershed stakeholders should organize and integrate watershed activities to ensure that they use resources efficiently. For example, local planning and zoning requirements for residential, commercial, and industrial development should reflect broader regional watershed conditions and management priorities. Many local governments already consider water quality issues in planning, but they should increase and broaden these efforts. State and federal governments should encourage local efforts with education campaigns and financial incentives.

States and tribes should continue to update and refine their comprehensive watershed assessments. Revised assessments could consider watersheds at smaller scales that would be more useful for local watershed efforts. State and federal governments should use these improved assessments to coordinate funding and technical assistance. Coordination of protection and restoration activities will maximize their efficiency.

## Funding and Technical Assistance

### Recommendations

Increase financial and technical assistance from all sources to watershed protection and restoration efforts

Increase program flexibility to address high priority needs:

- Re-evaluate funding needs and funding programs to ensure that programs sustainably support areas of greatest need
- Expand funding eligibilities
- Relax grant-matching requirements for selected assistance recipients

Expand citizen knowledge and understanding of watershed funding and technical assistance tools:

- Develop an internet-based clearinghouse of watershed assistance tools
- Develop education campaigns that inform watershed groups about financial and technical assistance tools

## Discussion

Participants at the Regional Watershed Roundtables suggested that existing watershed management assistance programs are insufficient. In particular, participants suggested that federal and state governments should increase their financial and technical assistance to watershed management efforts. Assistance programs should also add field staff to work with private landowners and managers to make on-the-ground improvements.

Watershed practitioners suggest that government funding and technical assistance programs should support high priority activities. Governments should expand program eligibilities or develop new programs to support chronically under-funded needs such as watershed monitoring and research, staffing, and project evaluation and maintenance. Since watershed implementation projects often require long-term efforts, they require sustainable sources of funding. Grant programs should ease match requirements for smaller projects or for nonprofit organizations with limited capital.

Watershed practitioners recommend that technical assistance programs expand their use of on-the-ground partnerships that teach landowners about best management practices and water efficiency techniques and assist landowners with their implementation. Because watersheds cannot be restored without the participation of private landowners, technical assistance programs will critically impact the success of governmental watershed efforts.

The federal government should furnish an internet-based clearinghouse to help watershed groups navigate an overwhelming number of public and private services and funding sources. A clearinghouse of this sort would also aid inter-agency coordination. Finally, the federal government should inform citizens and organizations about available watershed resources through educational campaigns.



## Implementation

### Recommendations

Pursue both watershed protection and restoration activities

Display patience and perseverance with implementation efforts:

- Recognize that successful implementation of watershed protection and restoration actions takes place over decades
- Ensure that watershed plans lead to action
- Follow up projects with appropriate monitoring, maintenance, and evaluation activities

Provide adequate enforcement of watershed laws and regulations

Incorporate the latest technologies to restore, protect, and monitor watershed health

### Discussion

Watershed practitioners should implement actions that both protect and restore watersheds. Many local stakeholders recognize that protecting remaining undeveloped watershed areas is preferable to restoring degraded areas. Federal agencies with competing authorities and legislative mandates will need to cooperate with each other to balance protection and restoration efforts.

Project implementers should exercise both patience and perseverance. Watershed protection and restoration programs often gain momentum slowly. However, watershed plans must eventually lead to action. Watershed practitioners should also maintain restoration projects appropriately to retain environmental gains.

Governments should provide adequate resources to their programs for effective implementation. Watershed management programs should be able to provide reasonable deterrents against activities that adversely impact watershed health, decisive actions against violators, and efficient on-the-ground actions.

*What Can be Done to Improve Progress?*

## Evaluation

### Recommendations

Establish science-based indicators for watershed programs and projects:

- Improve indicators for chemical, physical, and biological properties of watersheds
- Incorporate outcome-oriented measures into assistance programs—and provide funds for evaluating these measures
- Fund research to evaluate varying treatment and restoration techniques
- Develop common federal indicators for assessing watershed health and common measures for tracking and reporting performance

Measure results against established goals


Make results widely available to watershed practitioners:

- Track results at local, regional, and national watershed scales
- Post results on the internet

### Discussion

The complexity of watershed approaches has limited objective and empirical evaluations of success or failure. Watershed protection and restoration efforts often involve many scientific and social issues that practitioners can only assess in a subjective and piecemeal fashion. At the same time, many functional watersheds need immediate protection and many degraded watersheds need immediate restoration. Therefore, watershed practitioners should learn as much they can from their actions, and these lessons should inform future actions.

Watershed projects and programs should develop and use indicators that reflect resource-level changes—quantifiable chemical, physical, or biological results. Federal agencies should establish common watershed health indicators and track and report performance of both projects and programs. For an effort like this to be successful, individual projects must track results against established goals and



government programs must keep better inventories of these watershed restoration projects. Federal agencies should require that applicants for federal assistance establish quantifiable resource-level goals. Governments should also provide financial support for the monitoring and measurement of project results.

Governments should track results with databases that cross agency and political borders. These databases should consider watershed progress at many scales and should be accessible via the internet.



# Conclusion

*All Paths Lead to Light*  
Natalie Hamill  
Age 17  
Stuart Country Day School  
Princeton, New Jersey

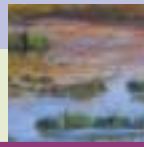


**T**his report provides information about local, regional, and national efforts to protect and restore the health of the nation's water resources. It reflects three major concepts used in managing the nation's watersheds:

- The watershed approach offers the best hope for protecting and restoring the nation's watersheds.
- Local citizens should provide both leadership and active support for watershed management efforts.
- State and federal governments provide significant support to local watershed efforts, but they should coordinate and enhance this support to make it more effective.

## The Watershed Approach

Healthy watersheds are some of the nation's most precious resources, but Americans contribute to water quality and habitat degradation with their actions in small ways every day. Our industries, our farms, our neighborhoods,



and our cars—many elements intrinsic to our lives—affect our water resources. Because the sources of impairment are so diffuse, a watershed approach to water resource protection and restoration is most appropriate.

## Local Leadership and Engagement

Citizens are leading the drive to reverse impacts to watershed health. Community groups are recognizing watershed problems and taking the responsibility to address them. These local efforts are educating the greater public, building new and unique partnerships, and improving knowledge of how watersheds are threatened and impaired. They are establishing plans and priorities, securing financial and human resources, taking action to restore and protect watershed health, and evaluating their successes.

## Governmental Collaboration and Support

Local watershed groups are not facing this challenge alone. State and federal agencies significantly support watershed efforts. These government agencies are coordinating their activities and improving their support so that it is more accessible, valuable, and conducive to on-the-ground and in-the-water results.

\* \* \* \* \*

These three concepts offer a blueprint for success. Building on these broad concepts and the specific recommendations for action in the last chapter, the nation's watershed protection and restoration efforts can gain momentum and make significant progress. The United States established a goal in 1972 to restore and maintain the chemical, physical, and biological integrity of all its waters. We have yet to meet that goal. Through the efforts of watershed groups nationwide, that day will yet come.



# Websites and Resources

Links to watershed-related websites of federal agencies and other organizations.

## Interagency Watershed Information

### Watershed Information Network

[www.cleanwater.gov/win](http://www.cleanwater.gov/win)

## Federal Government Watershed Websites

### U.S. Department of Agriculture

[www.usda.gov](http://www.usda.gov)

#### Natural Resources Conservation Service

[www.nrcs.usda.gov](http://www.nrcs.usda.gov)

#### Forest Service

[www.fs.fed.us](http://www.fs.fed.us)

#### Forest Lands Inventory

[fia.fs.fed.us](http://fia.fs.fed.us)

### Army Corps of Engineers

[www.usace.army.mil](http://www.usace.army.mil)

#### Research and Development

[www.erdc.usace.army.mil](http://www.erdc.usace.army.mil)

#### Institute for Water Resources

[www.wrsc.usace.army.mil](http://www.wrsc.usace.army.mil)

### Bonneville Power Administration, Fish and Wildlife

[www.efw.bpa.gov](http://www.efw.bpa.gov)

### United States Department of Commerce

[www.doc.gov](http://www.doc.gov)

#### National Oceanic and Atmospheric Administration

[www.noaa.gov](http://www.noaa.gov)

#### National Ocean Service

[www.nos.noaa.gov](http://www.nos.noaa.gov)

#### Office of Ocean and Coastal Resource Management

[www.ocrm.nos.noaa.gov](http://www.ocrm.nos.noaa.gov)

#### National Marine Fisheries Service

[www.nmfs.noaa.gov](http://www.nmfs.noaa.gov)

### United States Environmental Protection Agency

[www.epa.gov](http://www.epa.gov)

#### Office of Water

[www.epa.gov/ow](http://www.epa.gov/ow)

#### Office of Wetlands, Oceans, and Watersheds

[www.epa.gov/owow](http://www.epa.gov/owow)

#### Watershed Restoration

[www.epa.gov/owow/restore](http://www.epa.gov/owow/restore)

#### Watershed Academy

[www.epa.gov/watershed/wacademy](http://www.epa.gov/watershed/wacademy)

#### Funding Sources

[www.epa.gov/watershed/wacademy/fund.html](http://www.epa.gov/watershed/wacademy/fund.html)

#### Model Ordinances

[www.epa.gov/owow/nps/ordinance](http://www.epa.gov/owow/nps/ordinance)

#### Surf Your Watershed

[www.epa.gov/surf](http://www.epa.gov/surf)

### U.S. Department of Interior

[www.doi.gov](http://www.doi.gov)

#### Bureau of Land Management

[www.blm.gov](http://www.blm.gov)



**Office of Surface Mining, Reclamation and Enforcement**

[www.osmre.gov](http://www.osmre.gov)

**Appalachian Clean Streams Initiative**

[www.osmre.gov/acsihome.htm](http://www.osmre.gov/acsihome.htm)

**Bureau of Reclamation**

[www.usbr.gov](http://www.usbr.gov)

**U.S. Fish and Wildlife Service**

[www.fws.gov](http://www.fws.gov)

**Ecosystems**

[ecosystems.fws.gov](http://ecosystems.fws.gov)

**Wetlands**

[wetlands.fws.gov](http://wetlands.fws.gov)

**U.S. Geological Survey**

[www.usgs.gov](http://www.usgs.gov)

**National Water Quality Assessment Program**

[water.usgs.gov/nawqa](http://water.usgs.gov/nawqa)

**Tennessee Valley Authority**

[www.tva.gov](http://www.tva.gov)

**Water Information**

[www.tva.gov/environment/water/index.htm](http://www.tva.gov/environment/water/index.htm)

**Department of Transportation**

[www.dot.gov](http://www.dot.gov)

**Federal Highway Administration**

[www.fhwa.dot.gov](http://www.fhwa.dot.gov)

**Transportation Equity Act of the 21st Century**

[www.fhwa.dot.gov/tea21/index.htm](http://www.fhwa.dot.gov/tea21/index.htm)

**Environmental Issues**

[www.fhwa.dot.gov/environment/genlenv.htm](http://www.fhwa.dot.gov/environment/genlenv.htm)

**Wildlife Crossings**

[www.fhwa.dot.gov/environment/wildlifecrossings/main.htm](http://www.fhwa.dot.gov/environment/wildlifecrossings/main.htm)

**Non-Government Watershed Websites**

**Adopt-A-Watershed**

[www.adopt-a-watershed.org](http://www.adopt-a-watershed.org)

**AMD&ART**

[www.amdandart.org](http://www.amdandart.org)

**American Rivers**

[www.americanrivers.org](http://www.americanrivers.org)

**Center for Watershed Protection**

[www.cwp.org](http://www.cwp.org)

**Clean Water Network**

[www.cwn.org](http://www.cwn.org)

**Conservation Technology Information Center (CTIC)**

[www.ctic.purdue.edu/CTIC/CTIC.html](http://www.ctic.purdue.edu/CTIC/CTIC.html)

**National Institute for Water Resources**

[wri.nmsu.edu/niwr](http://wri.nmsu.edu/niwr)

**Nonpoint Education for Municipal Officials (NEMO)**

[nemo.uconn.edu](http://nemo.uconn.edu)

**River Network**

[www.rivernetwork.org](http://www.rivernetwork.org)

**River of Words**

[www.riverofwords.org](http://www.riverofwords.org)

**Save Our Streams (Izaak Walton League)**

[www.iwla.org/SOS/index.html](http://www.iwla.org/SOS/index.html)

**Terrene Institute**

[www.terrene.org](http://www.terrene.org)

**Water Environment Federation**

[www.wef.org](http://www.wef.org)

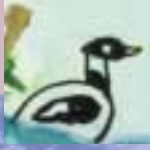
**Watershed Education for Teachers**

[www.projectwet.org](http://www.projectwet.org)

**Watershed Management Council**

[watershed.org](http://watershed.org)





# Glossary

## **Acid Mine Drainage**

Acidic water that flows from areas that have been mined for coal or mineral ores. The acidity is caused by the exposure of sulfur-bearing minerals to oxidizing conditions. Acid mine drainage is toxic to aquatic organisms.

## **Air (or Atmospheric) Deposition**

Process by which pollutants are released into the air, carried by wind patterns away from their place of origin, and deposited on the land or in waterbodies. These pollutants come from man-made and natural sources. Any chemical that is emitted into the air can become an air deposition problem.

## **Algae**

Simple rootless plants that grow in sunlit waters in proportion to the amount of available nutrients. They are food for fish and small aquatic animals. Excessive amounts of algae can adversely affect water quality by lowering the dissolved oxygen in the water.

## **Algal Blooms**

Sudden spurts of algae growth, which can adversely affect water quality and indicate potentially hazardous changes in local water chemistry.

## **Anadromous**

Ascending rivers from the sea, at certain seasons, for breeding. For example, salmon and shad are anadromous fish.

## **Aquifer**

An underground geological formation or group of formations containing water. Aquifers are sources of groundwater for wells and springs.

## **Bacteria**

Microscopic living organisms that can aid in pollution control by metabolizing organic matter in sewage, oil spills, or other pollutants. However, certain bacteria in soil, water, or air can also cause human, animal, and plant health problems.

## **Basin**

The area of land that drains water, sediment, and dissolved materials to a common outlet such as a stream, lake, or estuary. Often used as a synonym for watershed or catchment.

## **Best Management Practice**

Methods, measures, or practices that prevent or reduce water pollution. Best management practices may include treatment requirements, operating procedures, schedules of activities, prohibition of practices, maintenance procedures, or other management practices which control runoff, spillage, leaks, sludge or waste disposal, or drainage from various sites and operations.

## **Biodiversity**

The variety of organisms found within a specified geographic region.

## **Catchment**

A structure, such as a basin or reservoir, that collects or drains water. Often used as a synonym for watershed or basin.

## **Channelization**

Human engineering of river channels to enlarge, straighten, embank, or protect existing channels, create new channels, or protect adjacent structures.



### Clean Water Act

National environmental legislation designed to protect and restore the nation's water resources passed by Congress in 1972 in response to growing public concern for serious and widespread water pollution. The Clean Water Act is the primary federal law that protects our nation's waters, including lakes, rivers, aquifers, and coastal areas.

### Concentrated Animal Feeding Operation

Agricultural enterprise that keeps and raises animals in confined situations. Concentrated animal feeding operations congregate animals, feed, manure and urine, dead animals, and production operations on a small land area. These operations bring food to the animals rather than allowing the animals to graze or otherwise seek food in pastures, fields, or on rangeland. There are approximately 361,000 animal feeding operations in the United States, of which 5-10 percent are considered concentrated animal feeding operations.

### Conservation Easement

Legal agreement that restricts landowners to uses that are compatible with conservation and environmental values. Easements are generally governed by state laws; thus states administer easements in various ways.

### Ecosystem

A system defined by the interaction of a community of organisms with their physical environment. Ecosystems can be considered at many different scales.

### Erosion

The wearing away of land surface by wind or water, intensified by land-clearing practices related to farming, residential or industrial development, road building, or logging.

### Estuary

A wide lower course of a river near the sea where fresh and salt water mix.

### Eutrophic

Having waters rich in mineral and organic nutrients that promote a proliferation of plant life, especially algae, that reduces the dissolved oxygen content and often causes the death of other organisms.

### Evapotranspiration

The combined processes of evaporation and transpiration. It is the sum of water used by vegetation and water lost by evaporation.

### Groundwater

Water beneath the earth's surface that supplies wells and springs.

### Habitat

The living and non-living environment where a population (e.g., human, animal, plant, microorganism) lives. Habitat includes all things an organism needs to survive—food, water, space, and protection from predators.

### Hydrology

The study of the occurrence, distribution, and circulation of the natural waters of the earth.

### Impervious Surfaces or Impervious Cover

Hard surfaces within a watershed including rooftops, parking lots, streets, sidewalks, and driveways that do not allow rainfall to infiltrate underlying soils.

### Infiltration

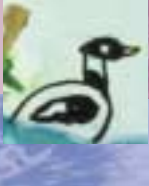
The flow of a fluid into a substance through pores or small openings.

### Insecticide

A chemical compound specifically used to kill or prevent the growth of insects.

### Invasive Species

With respect to a particular ecosystem, any animal or plant that is not native to that ecosystem whose introduction does or is likely to cause economic or environmental harm, or harm to human health.



### **Irrigation**

The controlled application of water to arable lands to supplement water requirements not satisfied by rainfall.

### **Mitigation (of wetlands)**

Restoration, creation, enhancement, or preservation of wetlands that expressly compensates for unavoidable wetland losses due to development actions.

### **Native Species**

An animal or plant that originated in a particular place or region.

### **National Pollutant Discharge Elimination System**

The Environmental Protection Agency's permitting system to control and monitor all point sources of pollution. Primary regulated entities are industrial facilities and publicly owned water treatment facilities.

### **Nonpoint Source Pollution**

Pollution, unlike pollution from industrial and sewage treatment plants, that comes from many diffuse sources. Nonpoint source pollution is usually caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and even our underground sources of drinking water. Atmospheric deposition, hydromodification, and failing septic systems are other sources of nonpoint source pollution.

### **Nutrient**

A substance necessary for the growth of living organisms. Nitrogen and phosphorous, for example, are required nutrients for algae growth.

### **Overland Flow**

The flow of rainwater or snowmelt over the land surface toward a waterbody. After an overland flow enters a stream, it is called runoff.

### **Precipitation**

The discharge of water, in liquid or solid state, out of the atmosphere, generally upon a land or water surface. Precipitation includes rainfall, snow, hail, and sleet.

### **Pathogens**

Microorganisms that can cause disease in humans, animals, plants, or other organisms. Pathogens include bacteria, viruses, and parasites and can be found in sewage, runoff from animal farms, and wild animals. Fish and shellfish contaminated by pathogens, or the pathogens themselves, can cause serious illnesses.

### **Point Source Pollution**

Pollution discharged by any discernible, confined, and discrete conveyance, including any pipe, ditch, channel, tunnel, conduit, well, discrete fixture, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel, or other floating craft.

### **Reservoir**

A pond, lake, or basin, either natural or artificial, for the storage, regulation, and control of water.

### **Riparian Zone / Riparian Buffer**

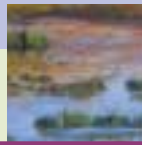
The land adjacent to streams, rivers, and lakes that actively interfaces with the waterbody through physical and chemical processes. Healthy riparian zones filter nutrients and sediments, increase streambank stability, and provide shade that reduces stream temperatures.

### **Runoff**

Precipitation, snow melt, or irrigation water that runs off the land into surface water. Runoff can carry pollutants from the air and land into the receiving waters.

### **Sediment**

Fragmental material that originates from weathering of rocks and is transported by, suspended in, or deposited by water or air.



### **Stakeholder**

One who has a share or an interest in an issue.

### **Virus**

The smallest form of microorganisms capable of causing disease. Viruses of fecal origin are infectious to humans by waterborne transmission.

### **Water Quality Standard**

A law or regulation that consists of the beneficial use or uses of a waterbody, the numeric and narrative water quality criteria that are necessary to protect the use or uses of that particular waterbody, and an anti-degradation statement.

### **Watershed**

The land area that drains into a single body of water such as a stream, river, lake, or wetland. Large watersheds may be composed of several smaller nested watersheds. Also known as a catchment or basin.

### **Watershed Approach**

A coordinating framework for environmental management involving diverse stakeholders and utilizing sound science to focus resources on high priority issues within hydrologically defined areas.

### **Watershed Management**

The process of using and supporting the watershed approach to manage land and water resources. The term often describes the implementation of watershed approaches by governmental agencies.

### **Watershed Practitioner**

One who practices an occupation or technique related to the management of watersheds. Practitioners can include local citizens, government employees, landowners, business leaders, and representatives of non-profit organizations.

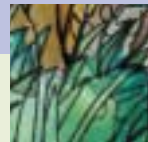
### **Watershed Restoration**

The manipulation of physical, chemical, or biological characteristics of watersheds with the goal of returning natural or historic functions. Also, the return of a watershed to a close approximation of its condition prior to disturbance.

### **Wetlands**

An area that is inundated or saturated by surface water or groundwater with a frequency and duration sufficient to support, and under normal circumstances supporting, vegetation adapted for life under those soil conditions. Swamps, bogs, fens, and marshes are examples of wetlands.





# References

AMD&ART. *Transforming Environmental Liabilities into Community Assets: An Interdisciplinary Initiative Re-creating Place*. Johnstown, Pennsylvania. November 1999.

Bricker, S.B., C.G. Clement, D.E. Pirhalla, S.P. Orlando, and D.R.G. Farrow. *National Estuarine Eutrophication Assessment: Effects of Nutrient Enrichment in the Nation's Estuaries*. National Ocean Service, National Oceanic and Atmospheric Administration. Silver Spring, MD. 1999.

Center for Watershed Protection. *Rapid Watershed Planning Handbook: A Comprehensive Guide for Managing Urbanizing Watersheds*. Ellicott City, Maryland. October 1998.

Clinton, W. *Executive Order 13112 on Invasive Species*. 64 FR 6183. The White House. February 3, 1999.

Coastal Research and Monitoring Strategy Workgroup of the Clean Water Action Plan. *Coastal Research and Monitoring Strategy*. September 2000.

Cronk, Q., and J. Fuller. *Plant Invaders: The Threat to Natural Ecosystems*. Chapman & Hall. New York. 1995.

Ecological Society of America. Committee on Land Use. "Ecological Principles and Guidelines for Managing the Use of Land." *Ecological Applications*. Vol. 10, No. 3. June 2000.

Environmental Law Institute. *Building Capacity to Participate in Environmental Protection Agency Activities: A Needs Assessment and Analysis*. ISBN 0-911937-96-X. June 1999.

Glenn Lozar, J. *Environment-based Education: Creating High Performance Schools and Students*. The National Environmental Education & Training Foundation (NEETF). Washington, DC. 2000.

Federal Agencies. *Clean Water Action Plan: Restoring and Protecting America's Waters*. ISBN 0-16-049536-9. February 1998.

– *Unified Federal Policy for a Watershed Approach to Federal Land and Resource Management*. Federal Register. Vol. 65, No. 202, Pages 62566-72. October 18, 2000.

Florida Department of Environmental Protection. *Secretary's Quarterly Performance Report*. Vol. 2, No. 4. September 1999.

Kenney, D. *Arguing About Consensus: Examining the Case Against Western Watershed Initiatives and Other Collaborative Groups Active in Natural Resources Management*. Natural Resources Law Center, University of Colorado School of Law. 2000.

– *Assessing the Effectiveness of Watershed Initiatives: The Current State of Knowledge*. Natural Resources Law Center, University of Colorado School of Law. 2000.


Lewicki, C., and T. Younos, eds. "Integrating Universities' Knowledge and Student Service-Learning into Community-Based Watershed Management Programs." *Water Resources Update*. Vol. 119. February 2001.

Lieberman, G. and L. Hoody. *Closing the Achievement Gap: Using the Environment as an Integrating Context for Education*. State Environmental Education Roundtable. 1998.

National Academy of Public Administration. *Environment.Gov: Transforming Environmental Protection for the 21st Century*. ISBN 1-57744-083-8. Washington, D.C. 2000.

National Association of Counties. Watershed Management Advisory Committee. *Leadership in Watershed Management: The County Role*. Washington, D.C. June 1999.

National Conference of State Legislatures. *Watershed Protection: The Legislative Role*. Denver, Colorado. December 1998.



National Research Council. *New Strategies for America's Watersheds*. National Academy Press. Washington, D.C. 1999.

— *Restoration of Aquatic Ecosystems*. National Academy Press. Washington, D.C. 1992.

Pimentel, D. "Environmental and Economic Costs Associated with Non-indigenous Species in the United States." AAAS Conference. Anaheim, California. January 24, 1999.

Reinvention Workgroup of the Clean Water Action Plan. *Watershed Reinvention Opportunities*. June 27, 2000.

Scurlock, M., and J. Curtis. *Maximizing the Effectiveness of Watershed Councils: Policy Recommendations from Pacific Rivers Council and Trout Unlimited*. Pacific Rivers Council. Eugene, Oregon. 2000.

The Meridian Group. (DRAFT) *Summary of the Regional Watershed Roundtable Reports*. January 9, 2001.

The President's Council on Sustainable Development. *Sustainable America: A New Consensus for Prosperity, Opportunity, and a Healthy Environment for the Future*. ISBN 0-16-018429-0. February 1996.

U.S. Department of Agriculture, Natural Resources Conservation Service. *A Geography of Hope*. Program Aide 1548. December 1996.

— *National Engineering Handbook*. Vol. 210-VI, *Stream Corridor Restoration: Principles, Processes, and Practices*. August 1998.

U.S. Department of Agriculture. Forest Service. *Water & The Forest Service*. FS-660. January 2000.

U.S. Department of the Interior. *People, Land & Water*. Vol. 6, No. 2. March/April 1999.  
— *People, Land & Water*. Vol. 7, No. 5. July/August 2000.

U.S. Department of Transportation. Federal Highway Administration. *Critter Crossings: Linking Habitats and Reducing Roadkill*. Washington, D.C. February 2000.

U.S. Environmental Protection Agency. Office of Wetlands, Oceans, and Watersheds. *Atlas of America's Polluted Waters*. EPA840-B-00-002. May 2000.

U.S. Environmental Protection Agency. *Four Years of Progress: Meeting our Commitment for Wetlands Reform*. 1997.

U.S. Environmental Protection Agency. Office of Water. *National Water Quality Inventory: 1998 Report to Congress*. EPA-841-R-00-001. June 2000.

U.S. Environmental Protection Agency. National Estuary Program. *Successful Coastal Management Solutions*. February 2000.

U.S. Environmental Protection Agency. Office of Water. *Introduction to Water Quality Standards*. EPA-823-B-95-004. September 1994.

U.S. Environmental Protection Agency. Office of Water. *Liquid Assets 2000: America's Water Resources at a Turning Point*. EPA-840-B-00-001. May 2000.

U.S. Environmental Protection Agency. Office of Wetlands, Oceans, and Watersheds. *Top 10 Watershed Lessons Learned*. EPA-840-F-97-001. October 1997.

U.S. Environmental Protection Agency. Office of Water. *Watershed Approach Framework*. EPA-840-S-96-001. June 1996.

U.S. Geological Survey. *The Quality of Our Nation's Waters - Nutrients and Pesticides*. U.S. Geological Survey Circular 1225. 1999.

Westbrooks, R. *Invasive Plants - Changing the Landscape of America: Fact Book*. Federal Interagency Committee for the Management of Noxious and Exotic Weeds. Washington, DC. 1998.

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## Illustrations—the River of Words Project

Each section of this report presents artwork from the River of Words Project. River of Words is an international poetry and art program created to promote literacy and environmental stewardship by helping children to develop respect for and understanding of the natural world. River of Words helps children explore and interpret their watersheds through a multidisciplinary curriculum that combines science, history, geography, math, language, and the arts. Affiliated with the Library of Congress Center for the Book and co-founded in 1995 by United States Poet Laureate (1995-1997) Robert Hass and writer Pamela Michael, River of Words conducts an annual poetry and art contest on the theme of “watersheds” designed to help children fall in love with language, the arts, and the earth. Thousands of American and international schoolchildren in kindergarten through 12th grade have participated in River of Words.

Further information about the project can be found at [www.riverofwords.org](http://www.riverofwords.org) or by calling 510-548-POEM (7636).

"We need to bring alive the necessity for clean water so all Americans act as stewards of their water resources....  
For safe, clean, abundant water—in our homes, rivers, lakes, and streams—is one of our planet's greatest treasures."

*Senator John H. Chafee*

