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National Management Measures to Protect and Restore Wetlands and Riparian Areas for the Abatement of Nonpoint Source Pollution

Appendix F: Index of Case Studies Organized by State, Territory, and Tribe

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Assessment and Watershed Protection Division
Office of Water
U.S. Environmental Protection Agency

Appendix F
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STATES

Alabama

Gulf Oak Ridge

The Alabama Department of Conservation and Natural Resources will acquire 588 acres of Gulf Oak Ridge, the only remaining globally imperiled maritime forest in Alabama. The area will be included in Gulf State Park. Six rare plant species occur on the site, and a large number of neotropical migratory birds use the area as their first and last staging area in spring and fall. The federally endangered red-cockaded woodpecker, Mississippi sandhill crane, and jaguarundi and federally threatened indigo snake are likely inhabitants of the Gulf Oak Ridge.

Source: U.S. Fish and Wildlife Service (USFWS). 1998b. *1998 Coastal Wetlands Conservation Grant*. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC.

Water Watch

Alabama Water Watch is dedicated to developing Citizen Volunteer Monitoring of Alabama's lakes, streams, and wetlands. The program, which is funded in part by a grant from EPA and the Alabama Department of Environmental Management, educates citizens about water issues, both statewide and worldwide, and trains them to measure water quality conditions at sites of concern. The program challenges citizens to make a difference and potentially improve environmental policy by actively participating in determining long-term water quality trends.

Source: Auburn University. 1995. *Alabama Water Watch*. Auburn University, Auburn, AL.

Alaska

Eagle River Watershed Wonders

The Anchorage School District and partners are collaborating to restore riparian habitat along the habitat banks of the Eagle River, which supports all five species of Pacific salmon in addition to resident populations of rainbow trout. The project is bringing together the fourth-grade students from Ravenwood Elementary School with experts from Chugach Sate Park, the Anchorage Waterways Council, federal resource agencies, and others to promote stewardship of the Eagle River Watershed through the restoration projects. As part of their involvement, students learn scientific methods for collecting water samples and monitoring fish populations, as well as gaining an ecological understanding of human activities that affect the health of the watershed. Partial funding for this grant is being provided by the National Marine Fisheries Service Community-based Restoration Program.

Source: U.S. Environmental Protection Agency, *River Corridor and Wetland Restoration: Projects Funded by Five Star Restoration Program in FY00*. <www.epa.gov/owow/wetlands/restore/5star/fy00grants.html>. Accessed January 2003.

Local Wetland Management Plans

The municipalities of Anchorage and Juneau have implemented wetlands management plans that identify sensitive wetlands, specify practices for protection and restoration of high-value wetlands, and contain enforceable policies requiring compensation for wetland damages from development. Similar plans for wetlands management and conservation are anticipated for other populated areas of the state's coastal region.

Source: State of Alaska. 1995. *Alaska Coastal Clean Water Plan*. Draft. Alaska Coastal Management Program, Anchorage, AK.

Arizona

Chaparral Watershed

The effect of upstream shrub control on the establishment of riparian vegetation was evaluated on a chaparral watershed in central Arizona. The response of riparian vegetation to increased water yield through shrub control treatments was evaluated. Studies indicated that the continuity of flow had a greater effect on enhancing the riparian zones than did total streamflow increases.

Source: Debano, L., J. Brejda, and J. Brock. 1984. Enhancement of riparian vegetation following shrub control in Arizona chaparral. *Journal of Soil and Water Conservation*, September-October, pp. 317-320.

Ramsey Canyon

The Nature Conservancy acquired an in-stream water rights certificate for its Ramsey Canyon Preserve in the Huachuca Mountains. The certificate gives the Arizona Nature Conservancy the legal right to maintain in-stream flows in the stretch of Ramsey Creek along their property, which in turn preserves in-stream and riparian habitat and wildlife.

Source: Andy Lorenzi, The Nature Conservancy. 1992. Personal Communication.

Tres Rios Project

The Tres Rios Demonstration Constructed Wetlands Project was originally initiated to meet current and future NPDES discharge requirements for the 91st Avenue wastewater treatment plant (WWTP) in Phoenix. For 60 months, 12 acres of wetland system were created and monitored. This project has been underway since 1995. The use of constructed wetlands for wastewater treatment is preferred because the cost of initial upgrades to existing WWTP facilities to meet future NPDES charges were estimated at $625 million, and wetland treatment is estimated at $82 million. Other benefits would include habitat; environmental education; flood control; aesthetics; and reduction in vandalism, dumping, and nuisance conditions in the river corridor.

Source: International City/County Management Association and National Association of Counties (ICMA and NACO). 1999. *Protecting Wetlands, Managing Watersheds...Local Government Case Studies.* International City/County Management Association and National Association of Counties, Washington, DC.

Arkansas

Bottomland Hardwood Study

A long-term study was conducted to determine chemical and hydrological functions of bottomland hardwood wetlands along the Cache River. Hydrologic gauging stations were established at inflow and outflow points on the river, and more than 25 chemical constituents were measured. Preliminary results for the 1988 water year indicated that total and inorganic suspended solids and nitrate were retained in the wetlands, and organic suspended solids, total and dissolved organic carbon, inorganic carbon, total phosphorus, soluble reactive phosphorus, ammonia, and total Kjeldahl nitrogen were exported. All measured constituents were exported during low water when there was limited contact between the river and the wetlands and retained when the Cypress-Tupelo part of the floodplain was inundated.

Source: Kleiss, B.A., E.E. Morris, J.F. Nix, and J.W. Barko. 1989. Modification of Riverine Water Quality by an Adjacent Bottomland Hardwood Wetland. In *Proceedings of Wetlands: Concerns and Successes,* ed. D.W. Fisk, Tampa, Florida, September 17-22, 1989, pp. 429-438. TPS 89-3. American Water Resources Association, Bethesda, MD.

Cache River

The USACE studied a 20-mile stretch of the Cache River where floodplain deposition was shown to reduce suspended solids by 50%, nitrates by 80%, and phosphates by 50%.

Source: Stuart, G., and J. Greis. 1991. *Role of Riparian Forests in Water Quality on Agricultural Watersheds*. U.S. Department of Agriculture, Forest Service, Washington, DC.

Cache River Wetland

Suspended sediment dynamics were measured in a hardwood wetland adjacent to the Cache River during the 1988-1990 water years. A suspended sediment mass balance was calculated using depth-integrated, flow-weighted daily measurements at wetland inflow and outflow points. Measurements of sediment accretion were made at 30 sites in the wetland. Multiple regression was used to relate sedimentation rates to several biological factors. A combination of distance to the river, flood duration, and tree basal area accounted for nearly 90% of the variations in sedimentation rates.

Source: Kleiss, B.A. 1996. Sediment retention in a bottomland hardwood in eastern Arkansas. *Wetlands* 16:321-333.

Landowner's Guide

The purpose of the guide is to assist private landowners in the conservation and management of Arkansas' wetlands and associated agricultural lands. The guide contains information on voluntary programs that provide technical and/or financial assistance for wetland and riparian habitat restoration and agricultural land management activities.

Source: U.S. Environmental Protection Agency (USEPA). 1995-1996. *Landowner's Guide to Voluntary Wetland Programs in Arkansas*. U.S. Environmental Protection Agency, Washington, DC.

California

Nature Conservancy

The Nature Conservancy brought together a dozen public partners to acquire 5,000 acres critical to the Cosumnes River Preserve, which now covers 12,000 acres. The Cosumnes watershed supports significant natural communities, such as vernal pool grasslands, streamside forests, and wetlands, that are used by thousands of migratory birds.

Source: The Nature Conservancy. 1998b. *The Nature Conservancy Magazine*. January/February 1998. The Nature Conservancy, Arlington, VA.

Huichica Creek Vineyard

The Napa County Resource Conservation District of Napa, California, received a loan from the SRF for the Huichica Creek Vineyard Sustainable Agricultural Demonstration Project. The project will be an outdoor classroom designed to encourage the adoption of best management practices in perennial crops in California. The SRF loan will be used to install surface drainage improvements; restore wetland areas between vineyard blocks, which includes constructing a weir, planting native vegetative species, and developing the necessary habitat structures for waterfowl and raptors; and stabilize the creekbed and restore riparian vegetation. The overall project includes incorporating best management practices and low input viticulture techniques that include long-term monitoring of water quality, soil nutrition, insect pest populations, and biodiversity changes.

Source: U.S. Environmental Protection Agency (USEPA). 1998b. *Wetlands Projects Funded by the Clean Water State Revolving Fund (CW-SRF)*. U.S. Environmental Protection Agency, Office of Wastewater, Washington, DC.

Tahoe Conservancy

The Tahoe Conservancy is charged with preserving and enhancing the unique ecological and recreational values of the Tahoe basin. The Conservancy's work with private owners of wetland property comes primarily through its acquisition program. It focuses on obtaining conservation easements, development rights, and full titles to lands that contain wetlands, meadows, or riparian areas. The Conservancy offers 95% of what the property would bring on the open market .

Source: California Environmental Resources Evaluation System. 1995. CWIS, Tahoe Conservancy. Programs. California Environmental Resource Evaluation System, Sacramento CA.

Carmel River

A study was conducted that linked Mediterranean climate and ground water extraction with the decline of riparian vegetation and subsequent severe bank erosion on the Carmel River. Ground water is closely coupled with streamflow to maintain water supply to riparian vegetation, particularly where precipitation is seasonal.

Source: Groenveld, D.P., and E. Griepentrog. 1985. Interdependence of Groundwater, Riparian Vegetation, and Streambank Stability: A Case Study. In *Proceedings of Riparian Ecosystems and their Management: Reconciling Conflicting Issues*, Tucson, Arizona, April 16-18, 1985, pp. 44-48. GTR RM-120. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Little Lost Man Creek

Nitrate retention was evaluated in a third-order stream under background conditions and during four intervals of modified nitrate concentration caused by nutrient amendments or storm-enhanced discharge. Measurements of stream response to nitrate loading and storm discharge showed that nitrate was exported from the subsurface (11% greater than input) under normal background conditions. With increased nitrate input, there was an initial 39% reduction followed by a steady state reduction of 14%. Subsurface measurements taken during a storm event showed a 6% increase in exported nitrate.

Source: Triska, F.J., V.C. Kennedy, R.J. Avanzino, G.W. Zellweger, and K.E. Bencala. 1990. In situ retention-transport response to nitrate loading and storm discharge in a third-order stream. *Journal of North American Benthological Society* 9(3):229-239.

Lake Tahoe

A wetland was constructed near Lake Tahoe to determine the potential for treating urban runoff in sub-Alpine regions of the United States. The purpose of the project was to determine the effectiveness of the wetland in removing nitrate, phosphorus, iron, suspended solids, and other constituents from runoff. Nitrate concentrations were decreased by the wetland by 85%-90%. Particulate phosphorus concentrations decreased by 47%, soluble phosphorus decreased by 20%, iron was reduced by 84%, and turbidity and suspended solids were reduced by 85% by the wetland.

Source: Reuter, J.E., T. Djohan, and C.R. Goldman. 1992. The use of wetlands for nutrient removal from surface runoff in a cold climate region of California: Results from a newly constructed wetland at Lake Tahoe. *Journal of Environmental Management* 36(1):35(19).

Redwood City

Wetland loss near the port of Redwood City, California, is believed to be responsible for damage to shipping channels. The USACE recently spent $2.8 million on a dredging project there.

Sources: McAliney, M., ed. 1993. *Arguments for Land Conservation: Documentation and Information Sources for Land Resources Protection*. Trust for Public Land, Sacramento, CA.

U.S Army Corps of Engineers (USACE). 2001. *Annual Report to Congress on the Status of the Harbor Maintenance Trust Fund for Fiscal Year 1999*. IWR-Report 00-R-7.

San Luis Rey and San Diego Rivers

A restoration project was conducted to create and restore riparian habitat for the endangered least Bell's vireo. The most important aspects of restoration planning were found to include careful analysis of species composition, density, community structure, and arrangement, and ground water and soil characteristics.

Source: Baird, K. 1989. High quality restoration of riparian ecosystems. *Restoration & Management Notes* 7(2):60-64.

Stevinson Ranch

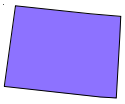
The Stevinson Ranch golf course has achieved Signature Status from Audubon International through the Audubon Cooperative Sanctuary Program for Golf Courses (see New York Audubon Golf Course Program). At Stevinson, great care has been taken to protect existing wetlands, and more than 100 acres of additional wetlands have been added.

Source: GolfWeb. 1997. *Golfing with Mother Nature at Stevinson Ranch.*

Wetland Conservation Guide

The guidebook describes the financial advisory and technical assistance available to private property owners who choose to create, protect, or enhance wetlands on their land. It also explains benefits that can be derived from having wetlands on private property and from making use of this assistance. All options presented in the program are voluntary.

Source: Heasley, P. 1994. *Options for Wetland Conservation: A Guide for California Landowners*. California Coastal Conservancy, Oakland, CA.



Colorado

Boulder Creek Restoration

Boulder reduced potential wastewater treatment costs significantly by deciding to restore Boulder Creek rather than construct a nitrification tower. Discharge effluent at the wastewater treatment plant met water quality standards; however, farther downstream ammonia concentrations exceeded the allowable level. Downstream the creek previously had been channelized and degraded. Through revegetation, terracing, construction of aeration structures, and other improvements, the stream was restored. The natural functions of the stream would then cool and reaerate the water to convert the ammonia. Restoration of Boulder Creek would also improve wildlife habitat, particularly fisheries.

Source: Barnett, J., Greenways Coordinator, City of Boulder. 1990. Personal communication.

Fort Collins

A laboratory study was conducted by the Crops Research Laboratory in Fort Collins using a rainfall simulator to evaluate how buffer zone length and vegetation height influence runoff and sediment yield. Results showed not only that sediment was filtered from the runoff by vegetation, but also that most sediment was deposited upslope from the vegetated buffer strips as a sediment wedge. The sediment wedge developed outside the vegetation zone and then progressed into the vegetation as time passed.

Source: Pearce, R., M.J. Trlica, W.C. Leiniger, J.L. Smith, and G.W. Frasier. 1996. *Efficiency of Grass Buffer Strip Length and Vegetation Height on Sediment Filtration in Laboratory Rainfall Simulations*. USDA National Agricultural Library.

Landowning Colorado Style

The booklet offers information about natural and man-made laws in Colorado. Riparian area and wetland functions along with regulatory policies are discussed.

Source: U.S. Environmental Protection Agency (USEPA). No date. *Landowning Colorado Style*. Environmental Protection Agency, Washington, DC.

Shop Creek Pond

The Shop Creek Pond/wetland system was evaluated to determine ability to remove suspended solids and phosphorus species from stormwater runoff. Suspended solid removals for 66 storms averaged 78% in Shop Creek Pond and 36% in the wetlands. Total phosphorus removals for the same storm events averaged 47% in Shop Creek Pond and 10% in the wetland. The Shop Creek Pond/wetland system was capable of removing about 52% of the total phosphorus load entering the system.

Source: Kunkel, J.R., T.D. Steele, B. Urbonas, and J. Carlson. 1992. Chemical-Constituent Load Removal Efficiency of an Urban Detention Pond/Wetlands System in the Denver Metropolitan Area, Colorado. In *Proceedings of Environmental Engineering: Saving a Threatened Resource in Search of Solutions*, Baltimore, Maryland, August 2-6, 1992.

Connecticut

Barn Island

Impoundment of the Barn Island tidal marsh in the 1940s for waterfowl management following ditching for mosquito control and harvesting of salt meadow hay greatly impacted and altered habitat in the system. Prior to restoration efforts the impoundment consisted primarily of phragmites and narrow-leafed cattails. Several attempts at restoring salt marsh vegetation to the site have been made with varying degrees of success. The restoration has proceeded significantly toward restoring salt marsh communities following reestablishment of tidal influx.

Source: Myers, J. 1996. The ongoing salt marsh restoration at Stonington, Connecticut. In *Restoration and Reclamation Review*. University of Minnesota, Department of Horticultural Science, St. Paul, MN.

Coastal Embayments

In 1991 the Connecticut Department of Environmental Protection requested a study be conducted by Coastal America to identify salt marshes that have been degraded as a result of tidal flow restrictions caused

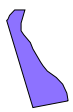
by the placement of transportation facilities. This study provided an initial assessment of all degraded salt marshes between New Haven and the Connecticut-Rhode Island border. Ten sites were selected for further study, and six were found to be experiencing degradation as a result of tidal flow restrictions. As a result, the Connecticut congressional delegation drafted legislation to provide for a comprehensive examination of degraded coastal wetlands.

Source: Coastal America Partnership. 1997. *Wetlands Protection and Restoration.* Coastal America, Washington, DC.

Wetland Protection

Connecticut requires a permit for dredging or filling activities in tidal and inland wetlands. Permit applications for new projects are reviewed for impacts on water quality, water circulation, aquatic life, and wetlands. Soil erosion and sediment controls are also required for construction adjacent to wetlands, thereby reducing sediment impacts in wetlands from development in adjacent upland areas. Local authorities frequently incorporate mandatory setbacks from wetlands into zoning regulations to provide added protection against effects from upland areas on wetlands.

Source: *Connecticut CZARA Program.* 1996. Connecticut Department of Environmental Protection, Hartford, CT.



Delaware

PSE&G's Estuary Enhancement Program:

The Public Service Electric & Gas Co. (PSE&G) is conducting a restoration program under the New Jersey Department of Environmental Protection and the Delaware Department of Natural Resources and Environmental Control. Of the land slated for restoration, 12,500 acres are in New Jersey and 8,000 are in Delaware. Nearly 17,000 acres will be restored as salt marshes, making this the largest endeavor of its kind. PSE&G purchased land and made agreements with landowners to gain access to land.

Source: Richman, M. 1996. Utility restores salt marshes in large wetlands enhancement program. *Water Environment Federation* 1(1, June).

Wetlands Rehabilitation Program

The Northern Delaware Wetlands Rehabilitation Program was established by the Department of Natural Resources and Environmental Control to bring together civic and business leaders, scientists, resource managers, and property owners to develop strategies to restore close to 10,000 acres of wetlands in 31 distinct sites along the Christina and Delaware rivers in New Castle County. The program seeks to improve water quality; increase wildlife populations; control nuisance plants, mosquitoes, and flooding; reduce shoreline erosion; and improve recreational and educational opportunities in designated marshes.

Source: Delaware Department of Natural Resources and Environmental Control. 1998. *Wetlands Rehabilitation Program*. Delaware Department of Natural Resources and Environmental Control, Dover, DE.

Florida

Agrico Swamp

This evaluation of the success of restoring phosphate mined lands involved comparisons between natural and reclaimed sites over a 4-year period. Species richness, percent cover, and the survival and growth of vegetation were measured. Restored sites were determined to improve water quality to levels consistent with state water quality standards.

Source: U.S. Geological Survey (USGS), Northern Prairie Science Center. 1997a. *Riparian Ecosystem Creation and Restoration: A Literature Summary*. *Case Studies: Agrico Swamp.* U.S. Geological Survey, Reston, VA.

Banana Lake

The Banana Lake project was conducted as compensation for impacts on wetlands from a highway construction project. Objectives of the restoration project included improving the surface water quality, eliminating localized flooding, restoring pre-mining drainage and functions of the headwater system, and restoring a hardwood wetland. The restored wetland was shown to reduce nitrate, ammonia, Kjeldahl nitrogen, total nitrogen, orthophosphate, and total

phosphorus in comparison to adjacent unrestored wetlands.

Source: Powers, R.M., and J.F. Spence. 1989. Headwater Restoration: The Key Is Integrated Project Goals. In *Proceedings of Wetlands: Concerns and Successes*, ed. D.W. Fisk, Tampa, Florida, September 17-22, 1989, pp. 269-279. TPS 89-3. American Water Resources Association, Bethesda, MD.

Buffer Zone Guidelines

The East Central Florida Regional Planning District has developed guidelines for determining buffer zones for water, wetlands, and wildlife.

Source: Brown, M.T., J. Schaefer, and K. Brandt. 1990. *Buffer Zones for Water, Wetlands, and Wildlife in East Central Florida*. Publication no. 89-07 and Florida Agricultural Experiment Station Journal Series no. T-00061. Center for Wetlands, University of Florida, Gainesville, FL.

Emerson Point Park

The Emerson Point Park restoration project is part of a larger estuary watershed restoration program through the Tampa Bay National Estuary Program. Emerson Point is one of 26 habitat restoration and enhancement projects. In 1995 Manatee County began planning the restoration project. A $1.5 million budget was secured through the integral financial commitment of local, regional, state, and federal agencies and several nonprofit and corporate donators. So far, $475,000 of $828,000 budgeted for restoration has been spent. The project has helped increase community awareness and appreciation of the Tampa Bay environment.

Source: International City/County Management Association and National Association of Counties (ICMA and NACO). 1999. *Protecting Wetlands, Managing Watersheds...Local Government Case Studies.* International City/County Management Association and National Association of Counties, Washington, DC.

Kissimmee Prairie Watershed

Through the efforts of the Florida Department of Environmental Protection's Division of Recreation and Parks, Florida's Conservation and Recreation Lands Program, the South Florida Water Management District, the National Audubon Society, and the Nature Conservancy, 48,000 acres in the 100,000-acre Kissimmee Prairie Watershed were acquired. The Kissimmee Prairie Watershed is an area of more than 100,000 acres in northern Okeechobee and southern Osceola counties. Habitats in the watershed consist of wet and dry prairie, pine flatwoods, scrub, oak hammock, marsh, and hardwood swamp, as well as native and improved rangeland. The watershed, therefore, provides prime habitat for several federally listed threatened and endangered birds.

Source: International City/County Management Association and National Association of Counties (ICMA and NACO). 1999. *Protecting Wetlands, Managing Watersheds...Local Government Case Studies.* International City/County Management Association and National Association of Counties, Washington, DC.

Kissimmee River

Total phosphorus and total nitrogen mass balance equations were calculated for Boney Marsh, a subtropical constructed freshwater wetland in the floodplain of the Kissimmee River in South Florida. River water was diverted through the marsh for 9 years. Nutrient retention was influenced primarily by nutrient loading rates. The Boney Marsh mean annual total phosphorus removal efficiency was 72%. Total phosphorus removal efficiencies were consistently higher than total nitrogen removal efficiencies at all times. Unlike wetlands in temperate latitudes, Boney Marsh was a net positive sink for total phosphorus year-round but not for total nitrogen.

Source: Moustafa, M.D., T.D. Fontaine, and M.J. Chimney. 1995. The Response of a Freshwater Wetland to Long-term Low-level Nutrient Loads. In *National Interagency Workshop on Wetlands*, USACE Waterways Experiment Station, New Orleans, LA, April 5-7, 1997.

Lake Jackson

A sediment filtration plant and artificial wetland were constructed to remove suspended solids and nutrients from stormwater runoff prior to discharge into Lake Jackson. Water samples collected during storm events were analyzed for a wide range of particulate and dissolved parameters including suspended solids and various nitrogen and phosphorus species. Results from the first year of study indicated that under normal operating conditions, the facility was capable of removing about 95% of the suspended solid load. All other parameters measured showed reductions of from 35% to 90%.

Source: Tuovila, B.J., T.H. Johengen, P.A. LaRock, J.B. Outland, D.H. Esry, and M. Franklin. 1987. An Evaluation of the Lake Jackson (Florida) Filter System and Artificial Marsh on Nutrient and Particulate Removal from Stormwater Runoff. In *Aquatic Plants for Water Treatment and Resource Recovery*. University of Arizona, Tucson, AZ.

Orange County

The efficiency of a detention pond and wetland temporary storage system in reducing constituent loads in runoff was determined in a study conducted in an urban area of west Orlando. Regression efficiencies, which relate the amount of constituent load into the wetland versus the amount exported, were used to quantify the removal effectiveness. The detention pond generally reduced suspended constituent loads. The pond had regression efficiencies of 65% for suspended solids, 41% for suspended lead, 37% for suspended zinc, 17% for suspended nitrogen, and 21% for suspended phosphorus. The wetland was generally effective in reducing both suspended and dissolved constituent loads. Regression efficiencies for suspended constituents were 66% for solids, 75% for lead, 50% for zinc, 30% for nitrogen, and 19% for phosphorus. Regression efficiencies for dissolved constituents were 38% for solids, 54% for lead, 75% for zinc, 13% for nitrogen, and 0% for phosphorus. The detention pond/wetland system achieved appreciable reduction of loads for most constituents. System regression efficiencies were 55% for total solids, 83% for total lead, 70% for total zinc, 36% for total nitrogen, and 43% for total phosphorus.

Source: Martin E.H., and J.L. Smoot. 1986. *Constituent Load Changes in Urban Stormwater Runoff Routed Through a Detention Pond-Wetlands System in Central Florida*. Prepared in cooperation with the Florida Department of Transportation. USGS Water Resources Investigation Report 85-4310.

Orlando

An urban stormwater treatment system consisting of a detention pond and a wetland was constructed to receive runoff from a four-lane roadway and adjacent areas. Water quality monitoring at the pond inlet, pond outlet, and wetland outlet was conducted to determine the effectiveness of the pond, the wetland, and the system in treating stormwater runoff. The detention pond reduced suspended constituent concentrations and loads of solids, lead, and zinc. The wetland was found to be more effective at reducing constituent concentrations and loads than the detention pond. By utilizing two treatment units in series, a variety of physical and biological processes acted to improve water quality. The system achieved appreciable reductions in the loads of solids, lead, zinc, and, to a somewhat lesser degree, loads of nutrients. Total solids, lead, and zinc efficiencies ranged between 55% and 83%. Total nitrogen and phosphorus efficiencies were 36% and 43%, respectively.

Source: Martin, E.H. 1988. Effectiveness of an urban runoff detention pond-wetlands system. *Journal of Environmental Engineering* 114(4).

Palm Beach Gardens

A system of man-made wetlands (36 ha) and a natural wetland retention impoundment (120 ha) were used to treat stormwater runoff from a residential/golf course development (947 ha). The wetland system was designed to improve water quality, restore destroyed wetlands, provide habitat for fish and wildlife, and add natural aesthetics. All water quality parameters monitored were improved by the wetland treatment system. The wetland system removed 71% of nitrite, 68% of turbidity, 62% of total phosphate, and 50% of total suspended solids. Water discharged from the development met state potable water standards.

Source: Blackburn, R.D., P.L. Pimentel, and G.E. French. 1986. *Treatment of Stormwater Runoff Using Aquatic Plants: The Use of Wetlands for Controlling Stormwater Pollution,* ed. E.W. Strecker, J.M. Kersnar, and E.D. Driscoll. Woodward-Clyde Consultants, Portland, Oregon. Prepared for U.S. EPA, Region 5, Water Division, Watershed Management Unit. EPA/600 February 1992.

Tampa

A wet detention pond built as part of a parking lot expansion in Tampa was studied to assess its ability to remove pollutants from urban runoff. The pond, which has a wetland vegetation coverage of 90%, was measured for pollutant removal efficiencies from flows generated by 18 storm events over the summer of 1989. Measurements taken at pond inflow and outflow points showed reductions of 44% for ammonia nitrogen, 75% for nitrate and nitrite, 56% for orthophosphate, 47% for total phosphorus, and 71% for total suspended solids. Organic nitrogen was not removed.

Source: Rushton, B.T., and C.W. Dye. 1990. Tampa Office Wet Detention Stormwater Treatment. In *Annual Report for Stormwater Research Program Fiscal Year 1989-1990*, pp. 39-74. Southwest Florida Water Management District, Brooksville, FL.

Wetland Protection

Florida requires a permit for dredging or filling activities in waters of the state, including wetlands. Permit applications are reviewed for impacts on water quality, habitat, and the functions of wetlands as NPS pollution filters. Stormwater regulations require the placement of BMPs to reduce or eliminate pollutants entering wetlands from upland developments. Further protection of wetlands and riparian areas is achieved through the Surface Water Improvement and Management Program, which identifies point and nonpoint sources of water pollution in individual watersheds and develops strategies for restoration and protection of river corridors and wetland systems with the goal of bringing all sources of surface water pollution into compliance with state water quality standards.

Source: *Florida Coastal Nonpoint Source Pollution Control Program.* 1995. Florida Coastal Management Program, Tallahassee, FL.

Georgia

Little River

A study was conducted on riparian forests located adjacent to agricultural uplands to test their ability to intercept and utilize nutrients (nitrogen, phosphorus, potassium, calcium) in agricultural runoff. Tissue nutrient concentrations, nutrient accretion rates, and production rates of woody plants on the sites were compared to control sites. Data from the study provide evidence that young (bloom state) riparian forests within agricultural ecosystems absorb nutrients lost from agricultural uplands.

Source: Fail, J.L., Jr., B.L. Haines, and R.L. Todd. No date. Riparian forest communities and their role in nutrient conservation in an agricultural watershed. *American Journal of Alternative Agriculture* II(3):114-120.

Tifton

A mixed hardwood riparian forest located in an agricultural watershed was shown to be effective in retaining nitrogen (67%), phosphorus (25%), calcium (42%), and magnesium (22%). Nitrogen was removed from subsurface water by plant uptake and microbial processes. Riparian land use was also shown to affect the nutrient removal characteristics of the riparian area. Forested areas were more effective in nutrient removal than pasture areas, which were more effective than croplands.

Source: Lowrance, R.R., R.L. Todd, and L.E. Asmussen. 1983. Waterborne Nutrient Budgets for the Riparian Zone of an Agricultural Watershed. *Agriculture, Ecosystems and Environment* 10:371-384.

Nutrient Cycling in an Agricultural Watershed

Processes within a riparian area apparently converted primarily inorganic nitrogen (76% nitrate, 6% ammonia, 18% organic nitrogen) into primarily organic nitrogen (10% nitrate, 14% ammonia, 76% organic nitrogen).

Source: Lowrance, R.R., R.L. Todd, and L.E. Asmussen. 1984. Nutrient cycling in an agricultural watershed: Phreatic movement. *Journal of Environmental Quality* 13(1):22-27.

Riparian Restoration

The study evaluated the effectiveness and feasibility of restoring a riparian wetland and using it as a bioremediation site for nutrients moving downslope from an animal waste application site. Short-term effectiveness of the restored wetland in enhancing water quality was monitored. Water sampling design and procedures are presented in detail.

Source: Vellidis, G., R. Lowrance, M.C. Smith and R.K. Hubbard. 1993. Methods to assess the water quality impact of a restored riparian wetland. *Journal of Soil and Water Conservation* 48(3):223(8).

Hawaii

Hamakau Wetlands

The Hamakau Wetlands restoration project, funded through the National Coastal Wetlands Conservation Grant Program, was completed in the spring of 1995. The project was designed to restore a 22.7-acre

wetland in Honolulu County that had been donated to the state by Ducks Unlimited. The parcel was donated to Ducks Unlimited by a private landowner, the Kaneohe Ranch. The wetland is connected to the Kawainiu Marsh, which at 800 acres is the largest wetland in Hawaii. An important goal of this project was to restore habitat to benefit endangered birds. Critical to the restoration of the wetlands was removal of nonnative plants and animals species. In addition to the direct benefits to wildlife, the Hamakua Wetlands is important as a model for the multi-partner approach to wetland conservation projects in Hawaii. Finally, its high profile in the urban setting of the city of Kailua in Honolulu County provides excellent public education opportunities on the importance of conserving and restoring wetlands.

Source: U.S. Fish and Wildlife Service (USFWS). 1998a. *Case Studies—U.S. Fish and Wildlife Service*. U.S. Department of Interior, Fish and Wildlife Service, Washington, DC.

Idaho

Teton River Basin

The National Wildlife Refuge System has provided funding for the acquisition of 1,000 acres of wetland habitat in Teton County. The site, which consists of several wetlands and associated uplands, provides migratory, nesting, feeding, and resting habitat for waterfowl, raptors, shorebirds, and wading birds, as well as several rare, threatened, and endangered plant and animal species. The project will be managed by the Teton Valley Land Trust.

Source: U.S. Fish and Wildlife Service (USFWS). 1998e. Wetlands Projects Approved for 19 States. Fish and Wildlife Service News List Server. Listed April 30, 1998. U.S. Department of Interior, Fish and Wildlife Service, Washington, DC.

Illinois

Des Plaines River

The Des Plaines River Wetlands Demonstration Project was designed to improve water quality in the river through the use of constructed wetlands. Four wetlands were constructed to improve water quality affected by agricultural and urban runoff. The four wetlands were found to reduce total suspended solids by 86% to 90%, nitrogen by 61% to 92%, and phosphorus by 65% to 78%.

Source: U.S. Environmental Protection Agency (USEPA). 1993a. *Constructed Wetlands for Wastewater Treatment and Wildlife Habitat.* EPA832-R-93-005. USEPA, Office of Wastewater Management, Washington, DC.

East St. Louis

The East St. Louis Action Research Project evaluated the economics of wetland development in areas where wetlands had formerly been located to improve surface water quality, to create recreational spaces, to create habitat, and to alleviate flooding. Many benefit assumptions were made to estimate the amount of benefit that can be derived from the reintroduction of a wetland. This analysis took into account only the money that the wetland would bring in by people using it for recreation and education. Lodging will be provided in the wetlands and is included in the cost and benefit analysis. The total recreational benefit comes to $371,350 per year. The true benefits of the wetland will be seen by the surrounding area and its various populations. The indirect monetary benefits of wetlands were not estimated for East St. Louis. However, the following list is being considered in addition to the direct benefits from recreation alone.

- It is likely that the residents get their water supply from these wetlands, as opposed to ground wells. Wetlands recharge the water table over time by trapping and holding snowmelt and rainfall. The benefits from increased water will be felt by farms bordering the wetland, which may discover increased yields.

- The large size of this wetland will provide flood protection to large areas lower in the drainage basin, increasing property values.
- The wetlands and their surrounding vegetation will help to capture and filter runoff water of pesticide residue, nutrients from crop fertilizer, animal waste, and organic matter. After this occurs, the particles can be converted to less harmful forms or remain buried, helping to improve water quality. This puts less demand on treatment facilities.

Source: Sperl, R., A. Davis, and B. Scheidecker. 1996. Wetland Development: Economic Evaluation. *East St. Louis Action Research Project*. University of Illinois at Urbana-Champaign, Champaign, IL.

Embarras River

Studies were conducted on forested and grassed VFS in central Illinois. It was found that both types of VFS reduced nitrate-nitrogen concentrations up to 90% in shallow ground water. On an annual basis, the forested VFS was more effective at reducing nitrate-N than the grass VFS, but it was less efficient at retaining total and dissolved phosphorus.

Source: Osborne, L.L., and D.A. Kovacic. 1993. Riparian vegetated buffer strips in water quality restoration and stream management. *Freshwater Biology* 29:243-258.

Iroquois County

Iroquois County, Illinois, is using the Natural Resources Conservation Service's (NRCS) Conservation Reserve Program (CRP) to establish VFS along the many miles of creeks, streams, rivers, and drainage ditches throughout the county. An NRCS district representative helps farmers register for the program, which has provided about $26,000 worth of switchgrass seed to the participants. The VFS will remove chemicals and sediment and lead to improved water quality. NRCS is also working to obtain easements for those areas currently enrolled in the program, so that the land does not return to production after the CRP contract ends. In addition, the Illinois Department of Natural Resources, through its Conservation 2000 fund, is acquiring easements on key floodplains, many of which are in or adjacent to continuous CRP buffers.

Source: Natural Resources Conservation Service (NRCS). 2000c. *Illinois-Water Quality, Flood Protection, State Program*. U.S. Department of Agriculture, Washington, DC.

Prairie Wolf Slough Restoration Project

The Prairie Wolf Slough Restoration Project was an Urban Resources Partnership-funded program that involved 13 different local, private, state, and federal agencies. There was a desire among partners to demonstrate wetland restoration techniques and the benefit of wetlands in urban and suburban areas. The restored wetlands were shown to help improve water quality and control stormwater flooding. During storm events in 1996, the site flooded and stored water that would normally have moved downstream.

Source: Urban Resources Partnership. 1997. Prairie Wolf Slough—A Chicago Wetland/Prairie Restoration Project. In *WHC 1997 Wildlands Conference "Beyond-the-Case-Study" Workshops*. United Nations Educational, Scientific, and Cultural Organization, World Heritage Committee, Paris, France.

Agricultural Watersheds

Small streams in agricultural watersheds in Illinois were shown to have water temperature problems following the removal of trees. Loss of shade increased water temperatures by 10 to 15 degrees Fahrenheit. Slight increases in water temperature over 60 degrees caused a significant increase in phosphorus release from sediments.

Source: Karr, J.R., and I.J. Schlosser. 1977. *Impact of Nearstream Vegetation and Stream Morphology on Water Quality and Stream Biota. Ecological Research Series*. EPA-600/3-77-097. U.S. Environmental Protection Agency, Washington, DC.

Heron Pond

A riparian forested wetland adjacent to the Cache River in southern Illinois was studied to determine its ability to serve as a nutrient and sediment trap. The 30-ha alluvial cypress wetland, dominated by bald cypress and water tupelo, was estimated to retain about 0.4% of the total annual phosphorus flux of the river and approximately 3% of the sediments passing through the system.

Source: U.S. Environmental Protection Agency (USEPA). 1993b. *Created and Natural Wetlands for Controlling Nonpoint Source Pollution*. Office of

Research and Development and Office of Wetlands, Oceans, and Watersheds. CRC Press Inc., Boca Raton, FL.

Meredosia Wetland Complex Project

In March 1998 the Migratory Bird Conservation Commission, as authorized under the North American Wetlands Conservation Act, approved $524,556 in funding for the Meredosia Wetland Complex Project in Brown, Cass, and Morgan counties. This act is non-regulatory and calls for voluntary partnerships to develop and implement the projects. Partners will acquire 1,160 acres (a $2 million value) of farmland from John Hancock Mutual Life Insurance Company as part of a larger project that is protecting and restoring areas along the Illinois River. Restoration of this property could provide a significant increase in waterfowl hunting, birdwatching, and nature exploration.

Source: U.S. Fish and Wildlife Service (USFWS). 1998c. *Illinois.* U.S. Department of Interior, Fish and Wildlife Service, Washington, DC.

Wetland Assessment

The synoptic assessment approach is being applied to develop maps for use in ranking riparian wetlands for restoration according to their potential for water quality improvements. The approach is being used to identify areas where wetland restoration would provide the greatest benefit from reduced nitrogen levels to human water supply and to non-degraded fish communities.

Source: USEPA. 1992a. A Synoptic Approach to Cumulative Impact Assessment - A Proposed Methodology. EPE/600/R-92/167.

Wetlands Conservation Strategy

The Illinois Wetland Conservation Strategy is a comprehensive plan to guide the development and implementation of Illinois's wetland programs and protection initiatives. It is an organizational tool used to identify opportunities for making programs work better. The goal of the Illinois Wetland Conservation Strategy is to ensure that there will be no net loss of wetlands or their functions in Illinois.

Source: Baum, S. 1995. *Illinois Wetland Strategy*. Illinois Natural History Survey, Champagne, IL.

University of Illinois

Four vegetative filters were installed on feedlots in central and northern Illinois. Two configurations were used: channelized flow and overland flow. Filters removed as much as 95% of nutrients and oxygen-demanding materials from the applied runoff on a weight basis and 80% on a concentration basis. Removal was directly related to two variables: flow distance and contact time with the filter. Channelized flow with greater flow depths required either greater contact time or longer flow distance than shallow overland flow to achieve the same level of treatment.

Source: Dickey, E.C., and D.H. Vanderholm. 1981. Vegetative filter treatment of livestock feedlot runoff. *Journal of Environmental Quality* 10(3):279-284.

Indiana

Center for Alternative Agricultural Systems

Purdue University Center for Alternative Agricultural Systems began a study in 1990 to determine the feasibility of offsetting the costs of converting productive land into VFS by planting certain tree and shrub species. Pussy willow, red twigged dogwood, and corkscrew willows were planted as wind breaks in buffer strips. Two years after planting, researchers sold harvested branches to florists for gains equivalent to $5,500 per acre. Erosion from the test fields was dramatically reduced, and corn stubbles and soil that would normally have washed into ditches and drain tiles were trapped by the shrubs.

Sources: Perkins, A. 1997. 4a Indiana. Perdue University, West Lafayette, IN.

Purdue Agriculture Experiment Station. 1997. *Purdue Makes Money Grow on Filter-Strip Bushes*. Purdue University, West Lafayette, IN.

Kosciusko County

A 1-acre wetland was constructed downstream of a dairy farm and monitored to determine the water quality effects of the system on surface water runoff from the dairy. The effects of the wetland on water quality were determined by monitoring the chemical composition of the surface water, nutrient load, and

plant and animal dynamics. Significant reductions were seen in fecal coliform, phosphates, total phosphorus, ammonia, suspended solids, total nitrogen, and conductivity. Year-round routine operation and maintenance were determined to be required for successful treatment.

Source: U.S. Environmental Protection Agency (USEPA). 1997d. *The Water Monitor*. EPA 841-N-97-005.U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds. August-September 1997.

Purdue University

A project was conducted to develop a VSF system with familiar native herbaceous and tree species that would not inhibit tree establishment and growth, would provide beneficial wildlife habitat, and would provide necessary erosion control. Three VSF plots composed of mixed native weeds and grasses, ladino clover, and orchard grass were established with seedlings of oak, walnut, and ash. VSF cover, wildlife, and erosion control were monitored monthly throughout a 4-year period. The native species control plot performed better than the planted clover and orchard grass plots. Wildlife habitat use and browsing statistics indicated an increase in biodiversity due to VSF use. Tree planting within the VSF system was shown to diversify land use objectives to include hardwood production and wildlife habitat enhancement without restricting tree growth or VSF effectiveness in meeting water quality improvement objectives.

Source: Gillespie, A.R., B.K. Miller, and K.D. Johnson. 1995. *Effects of Ground Cover on Tree Survival and Growth in Filter Strips of the Cornbelt Region of the Midwestern US.* Texas A&M Blackland Research Center.

Southern Lake Michigan

A $1 million grant through the National Wildlife Refuge System will be used to help purchase more than 1,200 acres of critical habitat for migrating waterfowl, raptors, shorebirds, and neotropical birds in Lake, Porter, and LaPorte counties along southern Lake Michigan.

Source: U.S. Fish and Wildlife Service (USFWS). 1998e. Wetlands Projects Approved for 19 States. Fish and Wildlife Service News List Server. Listed April 30, 1998. U.S. Department of Interior, Fish and Wildlife Service, Washington, DC.

Iowa

Allamakee County

Since the Conservation Reserve Program was initiated in Allamakee County, 1,700 acres of continuous land have been enrolled. In addition, buffers on 40 miles of stream have been enrolled. One contract is on Vernon and Sandra Gavles' dairy farm, which has 44 acres in the CRP. A state-owned, stocked trout stream runs across their property. Practically the entire corridor they own is in buffers, with 29.2 acres of woody riparian zone and 14.6 acres of grass filter. The CRP rent is approximately $150/acre for a total of $6,600. The Gavles have also installed 6,870 feet of exclusionary fencing to keep their cattle out of the stream. All of these efforts will help protect and improve water quality. Without the 50 percent cost share, they would not have been able to make these changes.

Source: Natural Resources Conservation Service (NRCS). 2000a. *Iowa Conservation Reserve Program (CRP), Bottomland*. U.S. Department of Agriculture, Washington, DC.

Iowa River Corridor Project

The Iowa River Corridor Project uses a voluntary approach to wetland restoration, gives landowners economic alternatives for frequently flooded farmland, and is intended to improve water quality and wildlife habitat. It is sponsored by the Iowa Natural Resources Conservation Service. The farmers can choose to continue farming as they have, sell an easement and have a wetland restored, sell an easement and title to the FWS, or try some alternative farming practices.

Source: Zinkand, D. 1996. Wetlands restoration project to look like giant buffer strip. *Iowa Farmer Today.* Iowa Farmer Today Publications, Cedar Rapids, IA.

Iowa State University

Studies at Iowa State University have shown that vegetated buffer strips are 35% to 40% effective in reducing runoff volumes. Vegetated buffer strips removed, on average, 26% to 50% of the atrazine, metolachlor, and cyanazine from runoff from test fields. Heavier rainfall meant a lower percentage reduction in runoff. Plots with a 15-to-1 drainage

area-to-buffer strip area ratio had an average 40% runoff reduction, while plots with a 30-to-1 ratio had a 35% reduction.

Source: Wood, G. 1997. BMPs make the grade. *Farm Journal*, February.

Middle Raccoon Watershed Partnership

Farmers in Carroll County, Iowa, have been encouraged to participate in CRP to reduce soil erosion, improve water quality, enhance wildlife habitat, and improve the aesthetic qualities of their farms. By the third year of the CRP program, the 420-square mile Middle Raccoon watershed outside Des Moines, Iowa, had about 75 miles of stream buffers averaging approximately 100 feet wide. Also, four constructed wetlands have been installed on farms in the watershed through an EPA and Iowa Department of Natural Resources Section 319 grant.

The city of Des Moines, Iowa, may also join the collaborative watershed protection effort in the Middle Raccoon watershed. Since the city receives its drinking water from the Raccoon River, it is investigating the impact of the stream buffers on water quality in the Raccoon River. The CEO and General Manager of the Water Works Department, L.D. McMullen, is researching whether the stream buffers have made enough difference in the water quality to avoid having to alter or expand the city's water treatment system. He stated that currently it costs $1,000 per day to run the system's nitrate reducer after a severe rainstorm and hopefully the installation of stream buffers will enable the city to save that money.

Sources: Natural Resources Conservation Service (NRCS). No date. *Iowa–Middle Raccoon Watershed Partnership, Conservation Reserve Program (CRP), City of Des Moines drinking water*. U.S. Department of Agriculture, Washington, DC.

Raccoon River Watershed Project. 1999. *Partner Initiatives of the Raccoon River Watershed Project: Constructed Wetland Project.* Raccoon River Watershed Project, Urbandale, IA.

Wetland Restoration Program

The Wetland Science and Watershed Science Institutes, in cooperation with the Social Sciences Institute, the Natural Resources Conservation Service (Iowa State Office), and the USFWS, are implementing a watershed-scale wetland restoration project in Winnebago County, Iowa. Winnebago County is in the heart of the southern prairie pothole region, and all of the wetlands in the project watershed have been impacted to some degree by agricultural drainage. The overall purpose of this project is to determine where wetland restoration would create the greatest benefits and give deference to those wetlands in the Wetland Restoration Program sign-up. Landowners with wetlands identified for restoration are being given assurance that their lands would be accepted into the program.

Source: U.S. Geological Survey (USGS). 1998. *Watershed Scale Wetland Restoration.* U.S. Geological Survey, Reston, VA.

Kansas

Johnson County Streamway Park System

Leaders in Johnson County, Kansas, expected to spend $120 million on stormwater control projects. Instead, voters passed a $600,000 levy to develop a county-wide streamway park system. Development of a greenways network along streambeds will address some of the county's flooding problems, as well as provide a valuable recreation resource. This greenway network will save Johnson County over $119 million if it is implemented, and no additional stormwater controls are necessary.

Source: International City/County Management Association and National Association of Counties (ICMA and NACO). 1999. *Protecting Wetlands, Managing Watersheds...Local Government Case Studies.* International City/County Management Association and National Association of Counties, Washington, DC.

Water Quality Assessment

Every 3 years, Kansas assesses water quality conditions in seven state or federally owned wetlands covering 25,069 acres. Data collected at these wetlands are compared against baseline wetland conditions. The data will be used to define standards to protect wetlands.

Source: U.S. Environmental Protection Agency (USEPA). 1995b. *National Water Quality Inventory: 1994 Report to Congress*. EPA841-R-95-005. U.S.

Environmental Protection Agency, Office of Water, Washington, DC.

Kentucky

Reference Reach Monitoring Program

Kentucky has added several wetlands to its reference reach monitoring program to characterize general wetland conditions in each of the physiographic regions of the state. The assessments will be used to develop designated uses and biological criteria for wetlands.

Source: U.S. Environmental Protection Agency (USEPA). 1995b. *National Water Quality Inventory: 1994 Report to Congress*. EPA841-R-95-005. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Louisiana

Atchafalaya Basin

Overflow areas in the Atchafalaya Basin had large areal net exports of total nitrogen (predominantly organic nitrogen) and dissolved organic carbon but acted as a sink for phosphorus. Ammonia levels increased dramatically during the summer. The Atchafalaya Basin floodway acted as a sink for total organic carbon mainly through reductions in particulate organic carbon.

Source: Lambou, V.W. 1985. Aquatic Organic Carbon and Nutrient Fluxes, Water Quality, and Aquatic Productivity in the Atchafalaya Basin, Louisiana. In *Proceedings of Riparian Ecosystems and Their Management: Reconciling Conflicting Issues*, Tucson, Arizona, April16-18, 1985, pp. 180-185. GTR RM-120. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Barataria-Terrebonne Estuary

Several economic studies have shown that the value of Barataria-Terrebonne Estuarine System (BTES) wetlands for tertiary wastewater treatment ranges from $82 to $157 per acre for municipal wastewater. The value for industrial wastewater is as high as $4,626 per acre. The costs to replace wetlands in the BTES area ranges from $368 to $2,204, depending on the type of creation. For dredged material placement, the costs range from $502 to $1,250; for uncontrolled sediment diversion, $368; and for controlled sediment diversion, $1,004 to $2,204. In addition to the commercial activity that is dependent on the estuary, the resource provides area residents and visitors with a number of valuable non-market services, such as recreational opportunities. The most significant activities are fishing, hunting, swimming, and boating. The economic benefits were estimated to be between $3.3 million and $1 billion per year for these activities. Estimates were also developed for recreational benefits per acre of wetland within the study area. Fishing was the highest-valued activity at between $96 and $1,213 per acre of wetland.

Source: Barataria-Terrebonne National Estuary Program. No date. Economic Value Assessment of the Barataria-Terrebonne Estuarine System. Published Research Report 26. Nicholls State University Campus, Thibodaux, LA.

Coastal Wetlands

Louisiana's coastal swamps constitute about 40% of the entire coastal wetland resources of the U.S. (Bergstrom et al., 1990). These wetlands are of great importance for the recreational, commercial harvest, and ecological service benefits they provide. A case study involved an attempt to value several of the key direct and indirect uses of Louisiana's coastal wetlands within a total valuation framework (Farber and Costanza, 1987; Costanza et al., 1989). Since the population of the region has been growing rapidly, the researchers incorporated a 1.3% annual increase into their benefit estimates to take this into account.

The estimated value of commercial fisheries in the coastal wetlands of Louisiana is between $317 and $846 per acre. The value for trapping is estimated to be between $151 and $401 per acre. The value placed on recreation in these wetlands is between $46 and $181 per acre. The highest value is found in stormwater protection, estimated to be between $1,915 and $7,549 per acre. These values were obtained from Costanza et al. (1989) and are in 1983 dollars, shown for both an 8 percent and 3 percent discount rate.

Source: Costanza, R., S.C. Farber, and J. Maxwell. 1989. Valuation and management of wetland ecosystems. Ecological Economics 1: 335-361.

Marsh Terracing

In response to critical coastal land loss, this pilot project was launched to test a technique for restoring wetlands in an area where sediment inflow is minimal. Bay bottom terracing uses existing sediment to form a baffle system of ridges or "terraces" at marsh elevation, after sedimentation. Data analyzed from aerial photography, on-site surveys, and readings from satellite-linked data collection platforms have shown that the technique was a success and that the marsh is coming back strongly. The terraces were quickly and completely vegetated, shoreline retreat was reversed, and annual primary productivity was increased.

Source: U.S. Environmental Protection Agency (USEPA). 1994a. *Innovations in Coastal Protection: Searching for Uncommon Solutions to Common Problems*. EPA 842-F-94-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Maine

St. Agatha

A constructed wetland-pond treatment system was installed on Long Lake to test its effectiveness in removing phosphorus and sediments from agricultural runoff. The 1-acre treatment system, which consists of an initial sedimentation basin, a grass filter strip, a constructed wetland, and a deep detention pond, removed 92% of total phosphorus and 95% of total suspended solids over a 150-day study period.

Source: Jolley, J.W. 1990. The Efficiency of Constructed Wetlands-Pond Systems in the Reduction of Phosphorus and Sediment Discharges from Agricultural Watersheds. Thesis in Civil Engineering, University of Maine.

Long Lake

Agricultural runoff was determined to be the largest pollutant source to Long Lake. The NRCS designed treatment systems called Nutrient/Sediment Control Systems to improve the quality of runoff entering the lake. Four systems, consisting of sediment basins, grass filters, constructed wetlands, and pond components, were installed in the Long Lake watershed. The system approach incorporated design ideas based on the ecology of wetlands, in addition to design parameters already reported in the literature on the individual performance of ponds, filter strips, and wetlands. Monitoring data for 1989 and 1990 showed annual removal efficiencies of 82% to 91% for total phosphorus, 96% to 97% for total suspended solids, and 92% to 94% for volatile suspended solids. Monitoring for both years ended in mid-November when the systems froze over. Although the annual removals were good, seasonal removals varied considerably, with spring (April to May) flows exporting more phosphorus and sediment from the system than was imported.

Source: Moshiri, G.A. 1993. *Constructed Wetlands for Water Quality Improvement*. CRC Press, Inc., Boca Raton, FL.

Wetland Conservation Plan

The State Planning Office, in cooperation with other state agencies and a diverse task force, is developing a State Wetland Conservation Plan (WCP). The plan will include an inventory and assessment of state wetland resources, implementation of a conservation strategy, recommendations for regulatory changes, and a monitoring program.

Source: *Maine Coastal Nonpoint Source Control Program.* 1996. Maine State Planning Office, Coastal Program, Augusta, ME.

Maryland

Anacostia Restoration Plan

In Maryland and the District of Columbia, a basinwide plan for the restoration of the Anacostia River and associated tributaries considered in detail the impacts of wetland creation and riparian plantings within the watershed.

Source: USACE. 1990. *Anacostia River Basin Reconnaissance Study*. U.S. Army Corps of Engineers, Baltimore District; Baltimore, MD.

Chesapeake Bay

Simulated rainfall and bare plots were used to determine the effectiveness of 4.6- and 9.2-meter-long

VFS in removing nutrients and sediments from agricultural runoff. Total suspended solids, total nitrogen, and total phosphorus in surface runoff were reduced by 66%, 0%, and 27%, respectively, by the 4.6-meter VFS. Nutrient removals appeared to be greater with longer filters but decreased as the number of runoff events increased.

Source: Magette, W.L., R.B. Brinsfield, R.E. Palmer, and J.D. Wood. 1989. Nutrient and sediment removal by VFSs. *Transactions of the American Society of Agricultural Engineers* 32(2):663-667.

Chesapeake Bay

Riparian forest buffers have been used to treat stormwater in the Chesapeake Bay watershed. According to a study found in the *Chesapeake Bay Riparian Handbook*, the costs of engineered stormwater BMPs that incorporate natural systems, such as grassed swales and bioretention areas, is less expensive than the construction of storm drain systems. These engineered stormwater BMPs cost $500 to $10,000 per acre.

Sources: Palone, R.S. and A.H. Todd (eds). 1998. *Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers*, NA-TP-02-97. U.S. Department of Agriculture, Forest Service, Washington, DC.

U.S. Environmental Protection Agency (USEPA). 1997b. *Protecting Wetlands: Tools for Local Governments in the Chesapeake Bay Region.* EPA 903-R-97-008. Prepared for Chesapeake Bay Program by U.S. Environmental Protection Agency, Washington, DC.

Forest Buffer Legislation

Baltimore County, Maryland, has adopted legislation to protect the water quality of streams, wetlands, and floodplains. The legislation requires forest buffers for any activity that is causing or contributing to pollution, including NPS pollution, of the waters of the state. Baltimore County has also developed management requirements for the forest buffers, including those located in wetlands and floodplains, that specify limitations on alteration of the natural conditions of these resources. The provisions call for public and private improvements to forest buffers to abate and prevent water pollution, erosion and sedimentation of stream channels, and degradation of aquatic and riparian habitat.

Source: Chesapeake Bay Program. 1997a. *Chesapeake Bay Watershed Riparian Buffer/Local Case Studies.* U.S. Environmental Protection Agency, Chesapeake Bay Program, Annapolis, MD.

GIS

Since the early 1980s, Prince George's County has been using GIS technologies. The Department of Environmental Resources found GIS to be the most cost-effective means to continue its flood management and water quality programs. In 1992 the county completed a 15-year effort modeling the watershed, covering approximately 85% of the county. Recognizing the need to update the data, the county determined that it could cost $4 million by traditional methods. As an alternative, the county developed Geo-STORM, a flood management model, and WPS, a water quality model. These models automatically perform much of the necessary data analysis and provide alternative solutions. The final part of the program was a Wetland Banking System using GIS. The total cost of this program was $450,000 and is part of the county's stormwater management funding, provided through ad valorem taxes, surplus, interest income, permit fees, a fee-in-lieu program, and miscellaneous budgeting items.

Source: International City/County Management Association and National Association of Counties (ICMA and NACO). 1999. *Protecting Wetlands, Managing Watersheds...Local Government Case Studies.* International City/County Management Association and National Association of Counties, Washington, DC.

Nontidal Wetlands Protection Act

Maryland's Nontidal Wetlands Protection Act encourages development of comprehensive watershed plans for addressing wetlands protection, mitigation, and restoration issues in conjunction with water supply issues.

Source: State of Maryland. 1989. Maryland Code, Annotated. Natural Resources. Nontidal Wetlands Protection Act Sections 8-1201–8-1211.

Rhode River 1

A case study focusing on the hydrology and below-ground processing of nitrate and sulfate was conducted on a riparian forested wetland. Nitrate and sulfate entered the wetland from cropland ground water drainage and from direct precipitation. Data

collected over a 3-year period showed that an average of 86% of nitrate and 25% of sulfate inputs were removed in the wetland. Annual removal of nitrates varied from 87% in the first year to 84% in the second year, and sulfate removal varied from 13% in the second year to 43% in the third year. Nitrate removal was always highest in the fall (average of 96%) when input fluxes were lowest and lowest in the winter (average of 81%) when input fluxes were highest.

Source: Correll, D.L., and D.E. Weller. 1989. Factors Limiting Processes in Freshwater: An Agricultural Primary Stream Riparian Forest. In *Freshwater Wetlands and Wildlife*, ed. R.R. Sharitz and J.W. Gibbons, pp. 9-23. U.S. Department of Energy, Office of Science and DOE Symposium Series no. 61. Technology Information, Oak Ridge, TN.

Rhode River 2

A riparian deciduous hardwood forest in the Rhode River watershed was shown to remove over 80% of nitrate and total phosphorus in overland flows and about 85% of the nitrate in shallow ground water drainage from cropland.

Source: Correll D.L., T.E. Jordan, and D.E. Weller. 1992. Nutrient flux in a landscape: Effects of coastal land Use and terrestrial community mosaic on nutrient transport to coastal waters. *Estuaries* 15(4, December):431-442.

Riparian Forest Buffer Demonstration Sites

A restoration effort in the Chapel Point State Park, located in the town of Marbury, has been made possible by funds from the Maryland Greenways Program. Excess sediment from erosion of agricultural land is of primary concern. The main objectives of the restoration effort are improved water quality and establishment of forested buffer strips along the Port Tobacco River. Riparian forest buffer demonstration sites have already been established along the Port Tobacco River in the Chapel Point State Park.

Source: Chesapeake Bay Program. 1998. *Riparian Forest Buffer Demonstration Sites: Chapel Point State Park, MD.* U.S. Environmental Protection Agency, Chesapeake Bay Program, Annapolis, MD.

Sligo Creek

Wet Ponds were constructed to filter stormwater entering Sligo Creek, a tributary to the Anacostia River. The Sligo Creek watershed is highly urbanized, which has resulted in the creek's poor water quality and limited habitat. Before the stormwater ponds were constructed, there were only three species of fish and no amphibians living in the creek. The Wheaton Branch stormwater detention pond project is one of 12 stormwater projects. It captures runoff from a commercial area and filters it through a retrofitted and expanded three-celled extended detention wet pond. Hand stones were placed to stabilize the channel. In 1993 vernal ponds were dug to help repopulate fish and amphibians.

Source: Chesapeake Bay Program. 1997a. *Chesapeake Bay Watershed Riparian Buffer/Local Case Studies.* U.S. Environmental Protection Agency, Chesapeake Bay Program, Annapolis, MD.

In the Maryland Department of Transportation, the Environmental Programs Division (EPD) is responsible for the preparation of plans, specifications, and estimates for wetland mitigation and stream restoration projects; ensuring compliance with all applicable environmental regulations; and ensuring that all natural, cultural, and socioeconomic commitments made during the planning phase are met during final design of all SHA capital projects.

Source: Jacobs, Susan M., Maryland Department of Transportation. No date. Personal communication.

Wye Island

Changes in nitrate concentrations in ground water between an agricultural field planted in tall fescue (*Festuca arundinacea*) and riparian zones vegetated by leguminous or nonleguminous trees were measured to determine the effectiveness of riparian vegetation management practices. Analysis of shallow ground water samples indicated that nitrate concentrations beneath nonleguminous riparian trees decreased toward the shoreline, and removal of the trees resulted in increased nitrate concentrations. Nitrate concentrations did not decrease below leguminous trees, and removal of the trees resulted in decreased ground water nitrate concentrations.

Source: James, B.R., B.B. Bagley, and P.H. Gallagher. 1990. Riparian Zone Vegetation Effects on Nitrate Concentrations in Shallow Groundwater. Submitted for publication in the *Proceedings of the 1990 Chesapeake Bay Research Conference.* University of Maryland, Soil Chemistry Laboratory, College Park, MD.

Rhode River Subwatershed

Phosphorus export from a riparian forest was shown to be nearly evenly divided between surface runoff (59%) and ground water flow (41%) for a total phosphorus removal of 80%. The mean annual concentration of dissolved total phosphorus changed little in surface runoff. Most of the concentration changes occurred during the first 19 meters of the riparian forest for both dissolved and particulate pollutants. Dissolved nitrogen compounds in surface runoff also declined. Total reductions of 79% for nitrate, 73% for ammonium nitrate, and 62% for organic nitrate were observed. Changes in mean annual ground water concentrations decreased significantly (90% to 98%), while ammonium nitrate concentrations increased by more than threefold. Again, most of the nitrate loss occurred in the first 19 meters of the riparian forest. It appears that the major pathway of nitrogen loss from the forest was in subsurface flow (75% of the total nitrate) with a total removal efficiency of 89% for total nitrate.

Source: Peterjohn, W.T., and D.L. Correll. 1984. Nutrient dynamics in an agricultural watershed: Observations on the role of a riparian forest. *Ecology* 65(5):1466-1475.

Wetlands Assistance Guide

The *Private Landowner's Wetland Assistance Guide* is a comprehensive guide to federal, state, and private/nonprofit programs offering technical and/or financial assistance to private wetland owners within the state of Maryland.

Source: State of Maryland. 1992. *Private Landowner's Wetlands Assistance Guide: Voluntary Options for Wetlands Stewardship in Maryland*. U.S. Environmental Protection Agency, Region 3, Philadelphia, PA.

Massachusetts

Cape Cod Coastal Embayments

In 1990 the Massachusetts Department of Environmental Protection initiated a $100,000 study to examine the potential restoration of 500 to 1000 acres of salt marsh cut off from tidal influence by transportation infrastructure. It is anticipated that, by designing culverts to provide tidal flows that more closely approximate natural conditions and by constructing larger channels in and around transportation facilities, the productivity of these marshes will be restored.

Source: Coastal America Partnership. 1997. *Wetlands Protection and Restoration*. Coastal America, Washington, DC.

Natural Storage in the Charles River Valley

The Charles River basin drains approximately 307 square miles in the Boston, Massachusetts, area. It is the most densely populated river watershed in New England. Severe flooding in 1955 due to Hurricane Diane caused more than $5 million in damages to the watershed. The USACE studied the area to identify a solution for future flooding. In 1984 the USACE unveiled a plan entitled "The Charles River Natural Valley Storage Project." Instead of structural controls, the project relied mainly on preserving wetlands. The plan identified 6,930 acres of land in 17 existing wetlands within the river basin as essential and stated that they would be protected. Protection is a result of purchasing the land outright or purchasing easements, which prevent current and future owners from interfering with natural water storage. A portion of the land protected is uplands and fringe wetlands.

The USACE decided on the measures in the Charles River Natural Valley Storage Project because "wetlands provide a prudent and least-cost solution to future flooding." By preserving the wetlands, costly structural controls were avoided. Purchasing the land and easements had cost $10 million, only 10 percent of the estimated $100 million cost of constructing a dam for the same purpose. The USACE also estimated that in 1987 an additional $3.2 million in damages was prevented by controlling severe spring flooding in the land purchased as part of the Charles River Natural Valley Storage Project. It has been further estimated that the city of Boston has realized annual savings of $17 million in flood damage from the project.

In addition to maintaining the natural hydrology of the area, the preservation of the wetlands also benefits the aesthetic and ecological quality of the floodplain. Further benefits are seen in the local property values. Statistical analysis in the Charles River Natural Valley Storage Project area has confirmed a 1.5 percent premium added to the property values of homes next to the wetlands. Realtors in the area have also noted

an undeniable advantage to selling the land adjacent to the wetlands.

Sources: National Audubon Society. No date b. *What's a Wetland Worth?* National Audubon Society, New York, NY.

Natural Resources Defense Council (NRDC). 1999. *Reports: Stormwater Strategies—Community Responses to Runoff Pollution*. Natural Resource Defense Council, New York, NY.

Wetland Protection

Massachusetts requires a permit for activities involving dredge-and-fill, or other alterations, within a wetland area or within a 100-foot buffer zone around a wetland area. The Wetlands Protection Act (Massachusetts General Laws Chapter 131, Section 40) provides jurisdiction for activities outside wetland areas and their buffer zones once a wetland has been altered as a result of an activity. Regulations have explicit criteria for the protection of water quality and aquatic habitat functions of wetlands, which are addressed in the review of permit applications. The Commonwealth's Stormwater Initiative also helps to protect wetlands by requiring the best practical method of treatment of new stormwater discharges to wetlands. Other practices to protect wetland functions, such as acquisition efforts, local bylaws, and increased buffer zones, are achieved through planning processes at the town meeting level.

Source: *Massachusetts Coastal Nonpoint Pollution Control Plan*. 1995. Massachusetts Office of Coastal Zone Management, Boston, MA.

Michigan

Peterson Wetland Restoration

The project successfully restored 14 ha of wetlands drained by a county tax ditch. Project goals included restoration of the 14-ha wetland, reduction of siltation and water volume entering the county drain and the Looking Glass River, increased flood storage, improved water quality, and creation of habitat for wetland wildlife. Wetland vegetation, waterfowl usage, and water retention increased. Because of the increase in water retention, the restored wetland now provides excellent wildlife habitat in addition to reducing sedimentation, erosion, and flooding. Water quality and siltation data are not available due to the absence of an adequate monitoring and assessment program.

Source: Eitniear, T. 1995. Peterson Wetland Restoration Project. In *Methods of Modifying Habitat to Benefit the Great Lakes Ecosystem,* ed .J.R.M. Kelso and J.H. Hartig, pp. 282-286 CISTI Occas. Paper No.1. Natural Research Council of Canada, Research Press, Ottawa, ON, Canada.

Grand Traverse Bay Watershed Initiative

The Grand Traverse Bay Watershed Initiative in Michigan represents an effort on the part of local organizations and agencies to manage resources in a five-county area in the state's lower peninsula. The program considers wetlands, riparian areas, and other environmental issues related to water quality within the bay watershed in a manner that balances economic growth with environmental protection.

Source: Wright, C. 1997. Grand Traverse Bay Watershed Initiative. Traverse City, MI.

Landowner's Guide

Living with Michigan's Wetlands is a comprehensive guide designed to help landowners understand wetlands, their benefits, basic techniques and options for wetland management, and the economic benefits of various protection methods. Wetland regulatory policies affecting landowners and sources for information and assistance are included. The document also provides information to help landowners make decisions regarding protection of wetlands and other natural resources while meeting economic needs and personal goals.

Source: U.S. Environmental Protection Agency (USEPA). 1996-1997. *Living with Michigan's Wetlands: A Landowner's Guide.* U.S. Environmental Protection Agency, Washington, DC.

Meadows Golf Club

The Meadows Golf Club, which finished its first year of operation in 1994, was designed to model sound environmental practices. Wetlands located on the course are used as biological filters. In addition, vegetated buffer zones, established around sensitive wetland areas, aid in reducing nutrient runoff into the waterways. Water quality monitoring indicates a

steady decline in the amount of nitrates, phosphates, suspended and dissolved solids, and ammonia exported from golf course wetlands.

Source: U.S. Environmental Protection Agency (USEPA). 1995c. *Nonpoint Source News-Notes*. August/September, issue no. 42. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Michigan Wildlife Habitat Foundation

The Michigan Wildlife Habitat Foundation (MWHF) is focused on restoring and improving wildlife habitat, and it has an active program for wetland restoration on private lands. The landowner must provide a match of at least $100 per acre and must sign an agreement that land uses on the site will not change for 10 years. The remaining restoration costs are covered by MWHF.

Source: Michigan Wildlife Habitat Foundation. 1997. *Saginaw Bay Watershed: A Strategy for Wetland Restoration*. Consortium for International Earth Science Information Network.

Wetland Protection

Michigan has implemented the Clean Water Act §404 Program since 1984. Water quality impacts are considered in the permit review process, and §404 permits are not issued for activities that would result in a violation of state water quality standards. The Goemaere-Anderson Wetland Protection Act, the Inland Lakes and Streams Act, and the Great Lakes Submerged Lands Act are also used to protect wetlands and riparian areas from the effects of new activities.

Source: *Michigan Coastal Nonpoint Source Program*. 1996. Michigan Department of Environmental Quality, Lansing, MI.

Watershed Initiative Program

Michigan's Watershed Initiatives program implements management measures to protect nonpoint source functions within wetlands and riparian areas. Existing conditions within the wetlands, as well as the effects of activities upstream in the watershed, are addressed. This is accomplished on a targeted basis through the Watershed Initiatives, which identify priority areas for wetland protection and restoration in selected watersheds. The state utilizes funds and technical assistance provided through Clean Water Act §319 and Coastal Zone Management Act grants to encourage local governments and communities to implement best management practices on a watershed basis for wetland protection and restoration.

Source: *Michigan Coastal Nonpoint Source Program*. 1996. Michigan Department of Environmental Quality, Lansing, MI.

Wetland Acquisition

Michigan's wetland protection approach is supplemented by a program of state acquisition of wetlands, state encouragement of wetland easements, state designation of Environmental Areas to protect coastal wetlands and adjacent uplands, and encouragement of private wetland acquisition efforts. Instruments such as tax reversion and land exchange are used to maximize acquisition efforts.

Source: *Michigan Coastal Nonpoint Source Program*. 1996. Michigan Department of Environmental Quality, Lansing, MI.

Minnesota

Clear Lake

Clear Lake, a 257-ha body of water in south central Minnesota, is a heavily used recreational area. The lake has become eutrophic because of inflow of nutrient-rich runoff from the adjacent city of Waseca. In 1981, 50% of the hydraulic load and 55% of the phosphorus load to the lake was diverted into a 21.4-ha marsh system. Between 1981 and 1986, the wetland reduced the annual phosphorus load to Clear Lake by 39%. In 1986 construction was completed on a second marsh system designed to filter urban and agricultural runoff carrying 20% of the phosphorus load into the lake.

Source: Barten, J.M. 1987. Stormwater runoff treatment in a wetland filter: Effects on the water quality of Clear Lake. *Lake and Reservoir Management* 3:297-305.

Conservation Reserve Enhancement Program

In February 1998 Minnesota and the Federal Government approved the Minnesota River Conservation Reserve Enhancement Program (CREP). CREP will combine state funds with the federal Conservation

Reserve Program to restore 190,000 acres of floodplain marshes and forests around the Minnesota River.

Source: Environmental Defense Fund. 1998. EDF Praises Minnesota River Conservation Reserve Enhancement Program. News release, February 19, 1998.

Economic Efficiency of Wetland Mitigation in Minnesota's Red River Valley

The economic efficiency of wetland mitigation in Minnesota's Red River Valley was examined using the Minnesota Routine Assessment Method on 10 wetland case studies to rate the functions of impacted and replacement wetlands. Secondary sources were used to assign dollar values to wetland functions of impacted and replacement wetlands. Estimated annual social values ranged from $207 to $1,027 per acre for impacted wetlands and from $268 to $927 per acre for replacement wetlands. The social values of replacement wetlands exceeded the social values of impacted wetlands in seven cases. Values of replacement wetlands were 1.8 to 4 times greater than the values of impacted wetlands due to 2-to-1 replacement ratios.

Source: Detenbeck, N.E., C.A. Johnson, and G.J. Niemi. 1993. Wetland effects of lake water quality in the Minneapolis/St. Paul metropolitan area. *Landscape Ecology* 8:39-61.

Fish Lake

An urban lake in the Minneapolis-St. Paul area was found to retain sediment and nutrient loads in runoff routed through the wetland. Comparison of annual loads entering and leaving the wetland showed the retention of incoming loads in the wetland was 97% of nonvolatile suspended solids, 76% of volatile suspended solids, 48% of total phosphorus, 4% of dissolved phosphorus, 3% of dissolved nitrite plus nitrate nitrogen, 1% of total ammonia nitrogen, and 47% of total organic nitrogen.

Source: Brown, R.G. 1985. Effects of an urban wetland on sediment and nutrient loads in runoff. *Wetlands*, 4(1):147-158.

Lake McCarrons

A combined detention/wetland stormwater treatment facility was constructed upstream of Lake McCarrons to decrease phosphorus loads in stormwater entering the lake and to restore a degraded wetland. Nutrient removal effectiveness of the pond was determined based on mass inflows and outflows from rainfall and snowmelt events summed over the entire period of the study. Samples were analyzed for a wide range of particulate and dissolved constituents including suspended solids and various nitrogen and phosphorus species. Removal of total suspended solids was greater that 90%, total phosphorus was reduced by over 78%, and total nitrogen was reduced by greater than 74%. The goal to reduce the total phosphorus load to the lake by 75% was achieved.

Source: Oberts, G.L., and R.A. Osgood. 1991. Water-quality effectiveness of a detention/wetland treatment system and its effect on an urban lake. *Environmental Management* 15(1):131-138.

The Minnesota Department of Natural Resources

The Minnesota Department of Natural Resources computed the average cost to replace an acre-foot of floodwater storage to be $300. In other words, if development eliminates 1-acre of wetland that naturally stores a 12-inch depth of water during a storm, it would cost the public $300 to replace the water storage. The cost to replace 5,000 acres of wetlands lost annually in Minnesota would be $1.5 million.

Source: Floodplain Management Association. 1994. Economic benefits of wetlands. *FMA News: The Newsletter of the Floodplain Management Association* (July).

Minnesota USGS

The USGS conducted a study to determine the effectiveness of two VSF for reducing chemical loads in feedlot runoff and to investigate how infiltration from the VSF affects ground water. Water samples were analyzed for concentrations of nitrate, ammonium, organic nitrogen, phosphorus, chloride, sulfate, fecal coliforms, and chemical oxygen demand. Ground water samples were analyzed for dissolved oxygen, pH, specific conductance, and temperature. A report is being prepared that will summarize the discharge and chemical data collected, information about the effectiveness of VSF for treating feedlot runoff, and information about the impacts of infiltration from VSF on ground water.

Source: U.S. Geological Survey (USGS). 1997b. Summary of Project MN14702: Effectiveness of

Vegetated Filter Strips for Remediating Feedlot Runoff in Minnesota. U.S. Geological Survey, Reston, VA.

Reference Wetlands Project

Minnesota initiated the Reference Wetlands Project to develop a basis for assessing the biological and chemical health of wetlands. The assessment of 32 relatively undisturbed and three disturbed wetlands will be used to provide a basis for determining use support status and will help the state determine if restored wetlands can achieve conditions comparable to natural wetlands.

Source: U.S. Environmental Protection Agency (USEPA). 1995b. *National Water Quality Inventory: 1994 Report to Congress*. EPA841-R-95-005. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Stevens County

Vegetated buffer strips were evaluated to determine pollution control efficiencies for feedlot runoff. Buffer strips were planted in corn, sorghum, sudan grass, or oats. Runoff and total solids transported from the feedlot were reduced by 67% and 79%, respectively. Total nitrogen was reduced by an average of 84% and total phosphorus by an average of 83%.

Source: Young, R.A., T. Huntrods, and W. Anderson. 1980. Effectiveness of vegetated buffer strips in controlling pollution and feedlot runoff. *Journal of Environmental Quality* 9(3):483-487.

Wetland Conservation Plan

The Conservation Plan was developed to improve management and conservation of wetlands. The plan was designed to use existing wetland policies as a starting point to improve policies and enhance information for decision making. The plan addresses regional differences in the state based on their ecology and general landscape, watershed features, major land use patterns, and wetland characteristics.

Source: Minnesota Department of Natural Resources. 1997. *Minnesota Wetland Conservation Plan, Version 1.0.* Minnesota Department of Natural Resources, St. Paul, MN.

Mississippi

Coastal Preserves

The Mississippi Department of Marine Resources will acquire 2,500 acres of Grand Bay savannah and coastal marshes within the Grand Bay Bioreserve in the Grand Bay/Bangs Lake area of Jackson County. Only 3% of the rare and biologically significant coastal savannah remains. It is the largest and least disturbed wet pine savannah in the nation. The area includes estuarine, marsh, and scrub shrub wetlands. The preserve is one of Mississippi's three largest estuarine wetland ecosystems and is a vital nursery area for estuarine and marine fish and shellfish species.

Source: U.S. Fish and Wildlife Service (USFWS). 1998b. *1998 Coastal Wetlands Conservation Grant*. U.S. Department of Interior, Fish and Wildlife Service, Washington, DC.

Pearl River Basin

The synoptic assessment approach is being used in the Pearl River Basin to provide information on cumulative impacts for use in the 404 permit review process. The assessment approach evaluates wetland losses from conversion and the effects of the losses on hydrologic function.

Source: U.S. Environmental Protection Agency (USEPA). 1992a. *A Synoptic Approach to Cumulative Impact Assessment: A Proposed Methodology.* EPE/600/R-92/167. U.S. Environmental Protection Agency, Washington, DC.

Missouri

Missouri Department of Conservation

The Ralph and Martha Perry Memorial Conservation Area Wetlands Restoration program created 737 acres of wetlands in three counties located along the Blackwater River. The project will enable the Missouri Department of Conservation to better manage the habitat by controlling the flow of water to and from the land in ways that simulate natural processes. This is one of only 24 projects nationwide that re-

ceived funding in 1995 from the North American Wetlands Conservation Council.

Source: Missouri Department of Conservation. 1998. *Ralph and Martha Perry Memorial Conservation Area.* Missouri Department of Conservation, Jefferson City, MO.

Bay Island, Hannibal

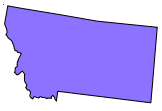
Sedimentation resulting from high flow levels in the Upper Mississippi River has resulted in deterioration and loss of riverine forested wetland habitat. Restoration of wetland functions in the Bay Island Complex included construction of low-level levees, water level management, and planting of mast tree species. Water level management during critical times of the year provides valuable resting and feeding habitat for migratory waterfowl and wintering bald eagles. Shorebirds, furbearers, and other wildlife species also benefit from restoration of prime wetland habitat. Planting of mast tree species provides important food resources for wood ducks and adds diversity to the bottomland hardwood forest that currently exists in the area.

Source: USACE, Great Lakes Regional Headquarters. 1997. *Environmental Management Program: Bay Island Wetland Habitat Rehabilitation and Enhancement*. USACE, Great Lakes Regional Headquarters, Chicago, IL.

Operation Green Stripe

Through Operation Green Stripe, Future Farmers of America (FFA) chapters recruit farmers to establish vegetative buffers between their fields and surface water supplies. Cooperating agriculture retailers provide free grass seed for the strips, and Monsanto provides educational grants to FFA chapters based on the number of farmers the students recruit.

Source: Monsanto. 1997. *Operation Green Stripe*. Monsanto, St. Louis, MO.



Montana

Pine Butte Swamp

The Nature Conservancy's Pine Butte Swamp Preserve is an 18,000-acre area consisting of a large fen, native foothills prairie, and rocky ledges of limber pine and creeping juniper. The preserve includes the largest wetland complex along the Rocky Mountain Front and represents the grizzly bear's last stronghold on the plains. Studies have been completed on the area's hydrology, vegetation, and wildlife, and the Conservancy has developed a long-range management plan for the fen, the grizzly bear, and the surrounding foothill prairie. Cooperative efforts with local agencies and neighboring landowners enhance the integrity of the ecosystem.

Source: The Nature Conservancy. 1998c. *Pine Butte Swamp Preserve.* The Nature Conservancy, Arlington, VA.

Ronan Spring Creek

Located in northwestern Montana, about 50 miles north of Missoula, Ronan Spring Creek is only 4 miles long. It is a tributary to Crow Creek, which flows to the Flathead River and eventually drains into the Columbia River. Farming practices, urbanization, and grazing activities had led Ronan Spring Creek to be 200 feet wide but only a few inches deep. In 1996 the Confederated Salish and Kootenai Tribes, Bill Edelman (who owns the creek), and the NRCS began to contact neighbors along the creek, local groups, and state and federal natural resource agencies to create a large partnership. Money for the restoration effort was provided through a grant by the state Fish, Wildlife and Parks Department's Future Fisheries program, the Ronan State Bank, and Pheasants Forever. Approximately $5,000 was used for shrubs. Harriman Trout Farms donated fish, and the Confederated Salish and Kootenai Tribes offered staff time and expertise. In the end, the creek was restored to 8 feet wide and 4 feet deep, which will help to bring back fish habitat and backwaters for waterfowl.

Source: Natural Resources Conservation Service (NRCS). 2000b. *Erosion Control, Water Management, Local Partnerships, Wildlife Habitat*. U.S. Department of Agriculture, Washington, DC.

Stream Management Guide

The *Stream Management Guide for Landowners, Managers, and Stream Users* provides helpful background information for landowners and managers, resource professionals, state and local decision makers, recreationists, and others interested in streams. The document discusses the characteristics of streams and restoration of degraded streams and

riparian areas, and it presents examples of stream and riparian area problems that might be encountered.

Source: Montana Department of Environmental Quality. 1995. *The Stream Management Guide for Landowners, Managers and Stream Users*. Color World, Bozeman, MT.

Nebraska

Heron Haven Wetland Restoration

Monitoring of water quality is being conducted (as of 1997) on this highly urbanized wetland to determine the appropriate best management practices to be applied in restoration efforts. Restoration efforts are being directed at protecting the wetland from NPS impacts and improving water quality and habitat characteristics. Quarterly monitoring was begun in December 1995, and some impacts of urban runoff to the wetland have been assessed. A report on restoration efforts to date is being prepared for the project.

Source: University of Nebraska–Lincoln. 1997a. *Heron Haven Wetland Restoration Project*. Water Center Environmental Programs Unit. University of Nebraska, Lincoln, NE.

Ithica

A series of studies and demonstrations are being conducted at the Agricultural Research and Development Center near Ithica to develop and demonstrate regionally relevant VFS designs in large-scale riparian plots, compare and demonstrate the efficacy of several VFS designs with different vegetation compositions and widths, and to evaluate the overall contribution of riparian VFS in NPS abatement on a realistic subwatershed scale. The overall aim of the program is to better define the most effective VFS for the Midwest and promote their use as BMPs in Nebraska.

Source: University of Nebraska–Lincoln. 1997b. Riparian Buffer Strips (RBS). Water Center Environmental Programs Unit. University of Nebraska, Lincoln, NE.

Private Lands Wetlands Initiative Program

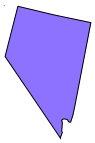
The Nebraska Game and Parks Commission (NGPC) funds a two component program that provides for wetland development and financial incentives to participate in the water bank program. The intent of the program is to pay for the landowner's actual costs for restoring, enhancing, or creating shallow wetlands and adjacent upland habitat for the benefit of waterfowl and other wildlife. The NGPC will reimburse the landowner for 100% of the costs. It will also provide landowners a one-time lump sum incentive for enrolling existing wetlands in the USDA's Water Bank Program or for extending their existing contract.

Source: Nebraska Game and Parks Commission. 1997. *Programs for Restoring, Creating, and Enhancing Wetlands on Private Lands in Nebraska*. Nebraska Game and Parks Commission, Lincoln, NE.

Tiburon Golf Course

The Wehrspann Lake Watershed Project has organized several Water Quality Opens at a local golf course in Omaha. Participants enjoy 18 holes of golf while learning about measures the golf course is taking to preserve water quality on the course and other steps being taken to preserve water quality and habitat elsewhere in the watershed. A unique educational feature of the tournament lies in the fact that people from all walks of life are brought together in a casual environment that is conducive to learning about nonpoint source pollution. The tournaments also help to stimulate discussions between the golfers and the golf course managers about management practices, such as the nonpoint source treatment functions of wetlands.

Source: U.S. Environmental Protection Agency (USEPA). 1998a. *Top Ten Watershed Lessons Learned.* EPA 840-F-97-001. U.S. Environmental Protection Agency, Office of Water, Washington, DC.



Nevada

Lake Tahoe

A 3-year study in Lake Tahoe of nitrate removal in an undisturbed headwater watershed showed that riparian forests and wetlands were capable of removing over 99% of the incoming nitrate nitrogen. Wetlands and riparian areas in the watershed appeared to be capable of "cleaning up" nitrate-containing waters with a very high degree of efficiency and for providing a major value as natural pollution controls for sensitive waters.

Source: Rhodes, J., C.M. Skau, D. Greenlee, and D. Brown. 1985. Quantification of Nitrate Uptake by Riparian Forests and Wetlands in an Undisturbed Headwaters Watershed. In *Proceedings of Riparian Ecosystems and Their Management: Reconciling Conflicting Issues*, Tucson, Arizona, April 16-18,1985, pp. 175-179. GTR RM-120. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Walker River Paiute Tribe

The purpose of the Walker River Paiute Riparian Management Plan (Walker River Paiute Tribe) is to protect and improve riparian areas and water quality on the reservation.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog*. 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

New Hampshire

Wetland Water Quality Standards

In New Hampshire, monitoring of a variety of parameters at five wetlands throughout the state will provide baseline data for developing specific wetland water quality standards.

Source: U.S. Environmental Protection Agency (USEPA). 1995b. *National Water Quality Inventory: 1994 Report to Congress*. EPA841-R-95-005. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

New Jersey

Agricultural Experiment Station

The New Jersey Agricultural Experiment Station has developed a five-zone model for determining buffer widths for the protection of surface waters from NPS pollution.

Source: Nieswand, G.H., B.B. Chavooshian, R.M. Hordon, T. Shelton, S. Blarr, and B. Brodeur. 1989. *Buffer Strips to Protect Water Supply Reservoirs and Surface Water Intakes: A Model and Recommendations*. Prepared for the New Jersey Department of Environmental Protection by Cook College Department of Environmental Resources.

Freshwater Protection Act Rules

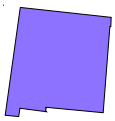
The Freshwater Protection Act Rules (New Jersey Administrative Code 7:7A) require ecological transition areas adjacent to wetlands of exceptional or intermediate value. Wetlands of ordinary resource value, which constitute approximately 5% of the state, do not require buffers. The standard width of the transition area for wetlands of exceptional value is 150 feet, and for freshwater wetlands of intermediate value, it is 50 feet. Wetlands of exceptional value include those which discharge into FW-1 or FW-2 trout waters or their tributaries (FW-1 and FW-2 are water quality rankings for fresh surface waters in New Jersey) or those which provide habitat for threatened or endangered species. Freshwater wetlands of ordinary resource value are those which do not exhibit the characteristics above, are isolated wetlands that are more than 50% surrounded by development, and are less than 5,000 square feet in size, including, but not limited to drainage ditches, swales, and detention facilities. Freshwater wetlands of intermediate value include those which are not defined as either exceptional or ordinary. Activities within buffers are limited based on the determined wetland value and guidelines established at New Jersey Administrative Code 7:7A-6.2.

Source: New Jersey Department of Environmental Protection and Energy. 1992. *Freshwater Wetlands Protection Act Rules, New Jersey Administrative Code 7:7A*. New Jersey Department of Environmental Protection, Trenton, NJ.

Green Acres Program

The New Jersey Green Acres Program provides funding for state, county, municipal, and nonprofit organization acquisition of open lands, including wetlands, for the purpose of conservation. The program also provides funding for the development of recreational facilities that offer public access and use of wetlands and riparian areas.

Source: *New Jersey Coastal Nonpoint Pollution Control Program*. 1995. New Jersey Department of Environmental Protection, Trenton, NJ.



New Mexico

Partners Project

Kimberly de Castro of Santa Fe, a participant in the U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program, received the Environmental Law Institute's National Wetlands Award in the Land Stewardship and Development category. The award recognizes her commitment to habitat restoration and her devotion to educating youth about having respect for the land. Ms. de Castro dedicated her entire 50-acre property to wildlife, restoring two wetlands and planting more than 5,000 plants. The restored land has also become an outdoor learning center. Since 1987, Partners for Fish and Wildlife has funded more than 17,900 landowner agreements and helped restore 397,000 acres of wetlands and 1,400 miles of riparian and in-stream habitat.

Source: U.S. Fish and Wildlife Service (USFWS). 1998d. New Mexico Partners Project Wins National Wetlands Award. Press release, April 22, 1998. U.S. Department of Interior, Fish and Wildlife Service, Washington, DC.

Riparian Preserve

The Gila Riparian Preserve protects a prime example of Southwest riparian habitat along the Gila River, New Mexico's last major free-flowing river. Regular flooding facilitates the germination of seedlings in beds created by high river flows.

Source: The Nature Conservancy. 1997. *Gila Riparian Preserve*. The Nature Conservancy, Arlington, VA.

New York

Audubon Golf Course Program

The Audubon Society of New York State teamed with the U.S. Golf Association to establish the Audubon Cooperative Sanctuary Program for Golf Courses. Objectives include enhancement of wildlife habitat and protection of natural resources on golf courses. Active participation in conservation programs by golf course superintendents, course officials, golfers, and the public is encouraged. Participants in the program develop a plan of action to enhance habitat and improve management practices. A course may become certified in the following areas: environmental planning, wildlife and habitat management, public involvement, integrated pest management, water conservation, and water quality management. More than 1900 golf courses nationwide have joined the program since its inception.

Source: U.S. Golf Association. 1998. *An Overview of U.S. Golf Association Environmental Research*. U.S. Golf association, Far Hills, NJ.

Buffalo River and Cazenovia Creek Model

The Buffalo River and Cazenovia Creek Model Wetlands and Watershed Stewardship Program is part of the Erie County Department of Environment and Planning's program to assist municipalities with planning issues at a watershed level. The project was first proposed in 1997 as a demonstration project, which was very successful and cost-effective. It aims to create a heightened sense of community awareness and encourages environmental stewardship for three new natural parks along the Buffalo River. It also provides an educational work experience and real job training for youth. The project cost $10,450 and was supplemented by a grant from EPA and the U.S. Department of Labor. NACO provided funding to implement and document the program. The county estimates that other counties that wish to implement a similar project should expect a cost of $10,000 to $15,000.

Source: International City/County Management Association and National Association of Counties (ICMA and NACO). 1999. *Protecting Wetlands, Managing Watersheds...Local Government Case Studies.* International City/County Management Association and National Association of Counties, Washington, DC.

Monroe County Wetland Education Program

Through a $20,000 grant from EPA, $5,000 of in-kind services from the county Health Department, and at least $4,000 of in-kind services from the Environmental Management Council, Monroe County hired an intern to advance wetland education efforts in schools and with public officials. The wetland education activities were developed by the intern and other county staff. This effort focuses on watersheds in

Monroe County, but participants from adjoining municipalities that share common watersheds with Monroe County have participated in the wetland workshops.

Source: International City/County Management Association and National Association of Counties (ICMA and NACO). 1999. *Protecting Wetlands, Managing Watersheds...Local Government Case Studies.* International City/County Management Association and National Association of Counties, Washington, DC.

The Salt Marsh Restoration Team (SMRT)

The SMRT has received the American Rivers 1997 Urban Hometown River Award, a GOLD award for Special Achievement in Scientific/Engineering Breakthrough. SMRT is restoring and enhancing a critical salt marsh on the western shore of Staten Island and on the islands of Arthur Kill and Kill Van Kull that were damaged by a 567,000-gallon oil spill. The restoration focused on restoring smooth cordgrass. Cordgrass stabilizes the shoreline against the massive erosion that is occurring in the absence of the plant community, replaces lost habitat, and accelerates the rate of reduction for petroleum contaminants left from the spill. SMRT has successfully restored over 1.25 miles of shoreline, amounting to over 6 acres of hand-planted nursery-grown grasses. Rapid erosion of shoreline has been halted in this area.

Source: American Rivers. 1998. American Rivers 1997 Urban Hometown River Award. American Rivers, Washington, DC.

Skaneateles Lake

Chris and Rick Fesko own a 1,200-acre farm on the hillside east of Skaneateles Lake. With the help of the Onondaga Soil and Water Conservation District and the Skaneateles Lake Watershed Agricultural Program, the Feskos plan to add more BMPs to those already existing on their property. The costs for these new efforts are estimated at $150,000, which will be contributed by the Feskos, NRCS, Farm Service Agency, EPA, New York State, and the city of Syracuse.

Source: Natural Resources Conservation Service (NRCS). 2000b. *Erosion Control, Water Management, Local Partnerships, Wildlife Habitat*. U.S. Department of Agriculture, Washington, DC.

Staten Island Bluebelt Project

Staten Island is the least populated and least developed of New York City's five boroughs. In the 1970s, the city zoned 672 acres as "Open Space Network," an undevelopable, environmentally sensitive area. In the 1980s, the state began regulating freshwater and tidal wetlands, which allowed for more wetland protection on Staten Island. In the 1990s, the DEP started the storm sewer construction and maintenance system in South Richmond, Staten Island. The system uses existing, natural drainage systems (including streams, ponds, and wetlands) as the main part of the stormwater system. The system covers 11 watersheds consisting of 6,000 acres. Additions to the system will include constructed wetlands, settling ponds, and sand filters (NRDC, 1999). Freshwater and tidal wetlands on Staten Island were acquired for use as stormwater treatment systems. Beginning in the 1970s, the New York State Department of Environmental Conservation delineated rivers and wetlands of important nonpoint source abatement functions. A cost/benefit study indicated that the Bluebelt project saves about $50 million over the conventional trunk sewer line approach! Constructed wetlands might be incorporated into the Bluebelt System (Gumb, D., et al., 1996). The Bluebelt is 265.5 acres.

Sources: Gumb, D., J. Vokral, R. Smith, S. Mehrotra. 1996. Staten Island Bluebelt Project: New York City's Watershed Approach with Multiple Benefits. In *Watershed '96 Proceedings*. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Natural Resources Defense Council (NRDC). 1999. *Reports: Stormwater Strategies—Community Responses to Runoff Pollution*. Natural Resource Defense Council, New York, NY.

Wetland Protection

New York requires permits for activities within a tidal or nontidal wetland or regulated adjacent area, generally extending a distance of 100 to 300 feet landward from the wetland boundary. New York also establishes cooperative agreements with local governments and municipal governments for the purpose of preserving, maintaining, or enhancing wetlands. The State Environmental Quality Review evaluates impacts on

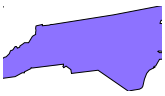
wetlands and riparian areas from activities outside the wetland or regulated adjacent area.

Source: *New York Coastal Nonpoint Program Submission*. 1995. New York Department of Environmental Conservation, Albany, NY.

Wetland Regulation Guidebook

The purpose of the guidebook is to provide planners, developers, and the public with an introduction to the scope and application of existing laws and regulations that directly or indirectly affect wetlands in New York.

Source: Trust for Public Land. 1999. *Economic Benefits of Open Space Bibliography: Infrastructure Savings*. Trust for Public land, San Francisco, CA.



North Carolina

Atlantic White Cedar Wetland Restoration

The purpose of the restoration project was to restore wetland hydrology on 392 acres and plant Atlantic White Cedars on 25 acres of cleared, ditched, and drained wetlands to revitalize wildlife and water quality attributes. The time frame for completing restoration work was limited due to planting requirements. The project was completed in 3 months.

Source: Gantt, L.K. 1994. *Atlantic White Cedar Wetlands Restoration Cookbook of Innovations in Coastal Protection.* U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watershed, Washington, DC.

Coastal Plain vs. Piedmont

The effectiveness of VFS and riparian buffers for trapping sediment and nutrients was compared for two sites in North Carolina, one in the Piedmont Physiographic Province and the other in the Coastal Plain. Runoff, sediment, and chemical analyses were completed on a number of storm events at each site. At both test sites, the grass strips filtered in excess of 50% of the sediment from the agricultural source areas. The riparian strips were less consistent at reducing sediment yields. Chemical filtration of agricultural runoff by the grass and riparian buffers also occurred. Sediment-bound constituents were shown to be reduced to a greater degree than soluble nutrients, such as orthophosphorus.

Source: Parsons, J.E., J.W. Gilliam, R. Munoz-Carpena, R.B. Daniels, and T.A. Dillaha. 1994. Nutrient and Sediment Removal by Grass and Riparian Buffers. In *Proceedings of the Second Environmentally Sound Agriculture Conference*, Orlando, FL, April 20-22, 1994.

Pamlico River

The chemistry of porewaters and soils was compared using a low-organic-matter created intertidal marsh and an adjacent high-organic-matter natural intertidal marsh. Five years after emergent vegetation had established in the created wetland, the conversion from upland porewater and soil properties to natural wetland characteristics was incomplete. Results of the study indicate that wetlands created on upland sites initially may not duplicate the hydrologic and nutrient cycling functions characteristic of natural wetland systems. It is likely to take many more years before the created wetland soils become reduced and soil and porewater nutrient reservoirs develop to produce hydrologic and nutrient cycling attributes comparable to natural wetlands.

Source: Craft, C.B., E.D. Seneca, and S.W. Broome. 1991. Porewater chemistry of natural and created marsh soils. Journal of Experimental Marine Biology and Ecology 152(2):187(14).

Riparian Buffer Width Study

Riparian forests are effective as sediment, nitrogen, and phosphorus filters. Four watersheds in two research projects on the Coastal Plain were studied. The optimal width of a riparian forest for effective filtering is based on the contributing area, slope, and cultural practices on adjacent lands. Riparian strips as narrow as 16 meters were effective in removing nitrate.

Source: Cooper, J.R., J.W. Gilliam, and T.C. Jacobs. 1986. Riparian Areas as a Control of Nonpoint Pollutants. In *Watershed Research Perspectives*, ed. D. Correll, pp. 166-192. Smithsonian Institution Press, Washington, DC.

Streamside Rules for Nuese River

Modified rules protecting existing 50-foot riparian buffers along the Nuese River became effective January 22,1998. The riparian rule makes it illegal to remove existing forest vegetation within 30 feet of the bank, and it requires maintenance of dense vegetative cover for an additional 20 feet. Landowners are

required to keep trees and plants healthy and to promptly repair any eroded channels.

Source: North Carolina Department of Environment and Natural Resources. 1998. News release, January 27, 1998. North Carolina Department of Environment and Natural Resources, Raleigh, NC.

Beaver Dam Creek Watershed

Nitrate concentrations in shallow ground waters beneath cultivated fields and in the drainage waters from those fields were examined to determine the fate of nitrogen lost to drainage waters. Studies indicated that a substantial part of the nitrogen in the drainage water was denitrified in the buffer strip. Buffer strips of less than 16 meters were effective for nitrogen reduction before drainage waters reached the stream. Subsurface nitrate leaving agricultural fields was reduced by 93% on average after passing through a forested buffer.

Source: Jacobs, T.C., and J.W. Gilliam. 1985. Riparian losses of nitrate from agricultural drainage waters. *Journal of Environmental Quality* 14(4):472-478.

Cypress Creek 1

A riparian forest was shown to be a sink for phosphate from cultivated fields. Over a 20-year period the riparian forest provided a sink for about 50% of the phosphate in runoff from adjacent croplands.

Source: Cooper, J.R., and J.W. Gilliam. 1987. Phosphorus redistribution from cultivated fields into riparian areas. *Soil Science Society of America Journal* 51(6):1600-1604.

Cypress Creek 2

Riparian areas adjacent to agricultural fields were examined to determine sediment accumulation over a 20-year period. The areal extent and thickness of sediment were described using ^{137}Cesium data and soil sediment morphology. Sediment delivery estimates for the Coastal Plain watershed indicated that 84% to 90% of the sediment removed from the cultivated fields remained in the watershed.

Source: Cooper, J.R., J.W. Gilliam, R.B. Daniels, and W.P. Robarge. 1987. Riparian areas as filters for agriculture sediment. *Soil Science Society of America Journal* 51(6):417-420.

North Dakota

Red River Riparian Area

The objectives of this research project were to identify and demonstrate BMPs by restoring riparian areas and subsequently reducing NPS pollution and to transfer this technology to producers and natural resource professionals throughout North Dakota.

Source: University of North Dakota. 1997. *Red River Riparian Demonstration Project*. Energy and Environmental Research Center. University of North Dakota, Fargo, ND.

Spring Creek Wetland

Two wetlands constructed on USACE reservoirs were monitored for their ability to remove NPS pollutants from stormwater runoff and possibly improve reservoir water quality. The two sites were the Spring Creek wetland, a 23-acre emergent marsh constructed in 1991 on Bowman Reservoir near Bowman, North Dakota, and a 5-acre wetland constructed in 1992 as part of a larger wetland complex on Range Creek, a major tributary of Ray Roberts Reservoir near Dallas, Texas. Sampling focused on storm events with less emphasis on base low flows. Samples were analyzed for suspended sediments, nutrients, and selected herbicides. Results from the two sites varied, but overall, the wetlands removed suspended sediments from inflows while being less effective at removing dissolved NPS pollutants. The Spring Creek wetland was capable of removing approximately 40% of total phosphorus. Neither wetland was effective at removing nitrogen or herbicide.

Source: Downer, C.W., and T.E. Myers. 1995. Constructed Wetlands for Sediment Control and Non-Point Source Pollution Abatement at US Army Corps of Engineers Project: Ray Roberts Lake, Dallas, Texas, and Bowman Haley Reservoir, Bowman, North Dakota. In *National Interagency Workshop on Wetlands*, USACE Waterways Experiment Station, New Orleans, LA, April 5-7, 1997.

Ohio

Conservation Easement Purchase

The Ohio EPA recently awarded a low-interest SRF loan to The Nature Conservancy to foster creek bank conservation. The Nature Conservancy received the $110,000 loan to purchase a 154-acre permanent conservation easement along Brush Creek in Adams County, Ohio. Ohio EPA's water quality standards classify this section of Brush Creek as almost achieving the exceptional warm water aquatic habitat classification. The creek is a significant statewide water resource and is known to contain four endangered aquatic species, including the club shell mussel. Conservation easements allow owners to voluntarily place permanent restrictions on how their property will be used and are an effective way to protect the quality of streams and their adjacent areas.

Source: U.S. Environmental Protection Agency (USEPA). 1998b. *Wetlands Projects Funded by the Clean Water State Revolving Fund (CW-SRF)*. U.S. Environmental Protection Agency, Office of Wastewater, Washington, DC.

Metzger Marsh Coastal Wetland Restoration Project

The Metzger Marsh Coastal Wetland Restoration Project, undertaken through the North American Waterfowl Management Plan, seeks to restore emergent wetland vegetation while permitting open access between the wetland and Lake Erie. This approach has not been successful in the past along Lake Erie, but innovative methods are being implemented to try to maximize coastal wetland values and functions.

Source: Tori, G. No date. Project 21. Metzger Marsh Coastal Wetland Restoration Project. *In Methods of Modifying Habitat to Benefit the Great Lakes Ecosystem.* Canada Institute for Scientific and Technical Information, Ottowa, ON. Occasional paper no. 1.

Ohio State University Extension Service

The Ohio State University Extension Service calculated the costs associated with creating VSFs on agricultural land. One of the costs they found was for tree planting and maintenance. The planting of seedlings in a VSF adds about $0.45/seedling to the total installation cost. Mowing once per month during May through September of the first 2 years only of the VSF adds $7/acre for each mowing operation. VSFs provide both economic and noneconomic benefits to the farmer, landowner, and surrounding areas. VSFs can cause a reduction in ditch maintenance costs that are assessed to landowners. In 1985 Ohio had 4,615 miles of open ditch under county maintenance programs. The costs of ditch maintenance in those counties with 50 miles or more of maintained ditch averaged $328/mile/year. The total estimated costs would exceed $1.5 million per year.

Since the VSF is an edge-of-the-field best management practice, which reduces the potential for sediment movement into water resources, most of the economic pollution control benefits occur off the farm. Based on a 1987 estimate, sediment added an extra $0.32/ton to water treatment costs. When considering all the communities in Ohio, a 25 percent reduction in the amount of sediment entering surface water supplies would save $2.7 million per year in water treatment costs.

Source: Leeds, R.D., L. Forster, and L.C. Brown. 1993. *Vegetative Filter Strip Economics*. Ohio State University Extension, Columbus, OH.

Ohio Wetlands

The Ohio Wetlands guide provides useful information on wetland status, type, and function. The effects of land use on wetlands and their protection and conservation are also presented.

Source: National Audubon Society. 1995. *Ohio Wetlands*. National Audubon Society, New York, NY.

Protecting Darby Creek

Recently, the Ohio SRF provided a low-interest loan to a homebuilder to construct a variety of preventive nonpoint source measures to protect the Darby Creek, which is one of the highest quality watersheds in the state. The project includes a wide variety of structural and nonstructural best management practices intended to protect approximately 1.5 miles of this high-quality watershed from potential runoff from a new housing development. The project includes construction of sediment and stormwater retention lakes, grassed waterways for stormwater treatment, restoration of the wooded stream corridor, and the establishment of emergent wetland habitat. Additionally, the project

includes a 200-acre conservation easement to protect the most environmentally sensitive areas. The conservation easement contains conditions, covenants, deed restrictions, and regulations that protect the entire area. The project also contains an environmental education component for homeowners and housing contractors. This $575,000 project is part of the Nonpoint Source Program (Clean Water Act §319).

Source: U.S. Environmental Protection Agency (USEPA). 1998b. *Wetlands Projects Funded by the Clean Water State Revolving Fund (CW-SRF)*. U.S. Environmental Protection Agency, Office of Wastewater, Washington, DC.

Oklahoma

Hackberry Flat

More than 4,000 acres of wetlands and associated uplands in Tillman County will be acquired as migration, wintering, and breeding habitat for waterfowl and other migratory birds. A grant of $900,000 through the National Wildlife Refuge System and partner contributions of $2.4 million will fund the project, which also contributes to the habitat goals of the North American Waterfowl Management Plan's Playa Lakes Joint Venture. The project area is in the direct migration route of whooping cranes and provides habitat for bald eagles, thousands of ducks and geese, and sandhill cranes.

Source: U.S. Fish and Wildlife Service (USFWS). 1998e. Wetlands Projects Approved for 19 States. Fish and Wildlife Service News List Server. Listed April 30, 1998. U.S. Department of Interior, Fish and Wildlife Service, Washington, DC.

Wetlands Conservation Award

James Pielsticker, a civic leader in Tulsa who owns land along the Deep Fork River in Chandler, was awarded the Fish and Wildlife Service's Regional Wetlands Conservation Award for his work to restore and enhance wetlands on 310 acres of his property and his efforts to promote wetland conservation across Oklahoma. The restored wetlands are now managed to benefit waterfowl and other wetland-dependent wildlife, such as wintering bald eagles and migratory songbirds. Water quality has also improved with the reduced sedimentation and decreased erosion. Pielsticker participated in the Fish and Wildlife's Partners for Wildlife and has contributed over $150,000 to restoring wetland habitat on his property along the Deep Fork River floodplain.

Source: Langer E., and H. Stuart. 1997. James Pielsticker Wins Regional Wetlands Conservation Award From U.S. Fish and Wildlife Service. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC.

Oregon

Bear Creek

Bear Creek, located in central Oregon, has been undergoing a constant transformation for more than 20 years. During 1977, it was reported that streambanks were eroding and sedimentation levels in Bear Creek were elevated during high water flows. To reverse this condition, grazing was reduced in the area, and during the early 1980s, grazing was stopped. In an attempt to promote willow growth along Bear Creek, existing juniper trees were also felled. By the mid 1980s, a new grazing regime was instituted to preserve newly emerging stream-bank vegetation. The surrounding pasture was divided into three units, and livestock were grazed in late winter and early spring. By this point, the stream channel had narrowed and approximately 1.5 feet of sediment was trapped in the floodplain by vegetation. A flood during the summer of 1987 threatened the stability of the stream, but within one month streamside vegetation reestablished and stabilized the floodplain.

Forage amounts for grazing livestock increased to 5 times the original amount grazed in the area by 1989. This led to local cost savings of $10,000 annually for hay production by local livestock operators. By the mid 1990s, Bear Creek was experiencing minimal damage from occasional flooding because of well-established riparian vegetation. The overall health of the creek was also improving as rainbow trout and beaver returned to the creek. In addition, forage levels increased from 200 pounds/acre to 2,000 pounds/acre, and the area now stores 4 million gallons of water per mile compared to 1977's 500,000 gallons per mile.

Sources: Bureau of Land Management (BLM). No date. *Problems and Solutions: A Riparian Improvement Example*. Bureau of Land Management, Washington, DC.

Salmon River Salt Marsh

Progress in the restoration of the Salmon River Salt Marsh was assessed by examining changes in the plant species, plant communities, elevation of the site, the role of salinity and soil texture, width and depth of creek cross sections, and estimated aboveground net primary production. Restoration goals were determined to be met in the sense that the restored salt marsh now consists of typical Pacific Northwest salt marsh communities; tidal exchanges are complete; creeks now provide habitat for juvenile fish; and the marsh is highly productive. The goal of returning the diked salt marsh to its original high salt marsh condition was not met. Based on study results, guidelines were developed to aid wetland managers in restoration projects.

Source: Frenkel, R.E., and J.C. Morlan. 1991. Can we restore our salt marshes? Lessons from the Salmon River, Oregon. *Northwest Environment Journal* 7:119-135.

Tulatin River, Washington County

A graduate student at Oregon State University studied two tributaries of the Tulatin River. His studies showed that riparian restoration on a widespread scale could result in savings of more than $1 million annually in reduced river dredging and water treatment costs. The costs of restoring 19.7 miles of Gale Creek and 26.1 miles of Dairy Creek, two tributaries of the Tulatin, were estimated at $660,000, or $2 per person in Washington County.

Source: Environmental News Network (ENN). 1996. *Riparian restoration is cost-effective, study shows*. ENN, Sun Valley, ID.

West Eugene Wetlands Project

The West Eugene Wetlands Project is a cooperative partnership between the Bureau of Land Management, the City of Eugene, and Lane County, Oregon, to acquire and manage the last wetlands in the Willamette Valley.

Source: Bureau of Land Management (BLM). 1997. *Environmental Education.* Bureau of Land Management, Eugene, OR.

Wetland Mitigation Bank

The West Eugene Wetland Mitigation Bank was established by the city of Eugene, Public Works Engineering Division, Water Resources Team. Its goal is to provide a mechanisms to fund wetland mitigation projects and to carry out the West Eugene Wetlands Plan. It might also serve other community needs. Funds for mitigation are derived from credit sales. The mitigation bank currently charges $30,000 per mitigation credit, of which 83 percent was spent on the development, design, planning, and construction of the credit. The remaining charge is for the management of the mitigation site and the mandated operation and management period.

Source: Bureau of Land Management (BLM). 1997. *Environmental Education.* Bureau of Land Management, Eugene, OR.

Wetlands Conservation Guide

The Oregon Wetlands Conservation Guide is a comprehensive guide to federal, state, and private/nonprofit programs offering technical and/or financial assistance to private wetland owners in the state of Oregon. It is also an appropriate resource guide for management of public lands (parks, open space, wildlife refuges, recreation areas).

Source: Oregon Wetlands Conservation Alliance. No date. *The Oregon Wetlands Conservation Guide: Voluntary Wetlands Stewardship Options for Oregon's Private Landowners*. Oregon Wetlands Conservation Alliance, Portland, OR.

Wetland Conservation Plan

Local jurisdictions are authorized to develop WCPs. The plans enable decisions on wetland use to be made through the planning process, rather than on a case-by-case basis. The WCPs provide a basis for characterizing wetlands and adjacent uplands over a large area and to evaluate the effects of land use activities on wetlands.

Source: Oregon Administrative Rules. 1994. *Chapter 141, Division of State Lands, Division 86, Wetland Conservation Plan*.

Wetlands Construction

Oregon has taken advantage of its SRF for many wetland projects. In the town of Lakeview, city of Woodburn SRF is funding a project to expand and

upgrade a lagoon wastewater treatment system. Included in this project is the construction of a wetland to improve the natural treatment system. The SRF funded the construction of a wetland in the city of Mount Angel to polish effluent from another lagoon treatment system. The city of Woodburn used the SRF to fund the construction of a wastewater treatment system using a poplar plantation for phytoremediation. Although this is not a constructed wetland, it is a project that expanded and improved a natural treatment system. In addition, the cities of Florence and Ashland plan to use constructed wetlands in future SRF funded projects.

Source: U.S. Environmental Protection Agency (USEPA). 1998b. *Wetlands Projects Funded by the Clean Water State Revolving Fund (CW-SRF)*. U.S. Environmental Protection Agency, Office of Wastewater, Washington, DC.

Pennsylvania

DEP

The Pennsylvania Department of Environmental Protection, through several partnerships, has restored more than 100 miles of tributary habitat. This amounts to 3,728.1 acres of wetlands, representing a net gain of 3,107.4 acres. Funding was provided by section 319 money to initiate *Pennsylvania's Stream ReLeaf—A Plan for Restoring and Conserving Buffers Along Pennsylvania Streams* and the *Forest Buffer Toolkit*, a "how-to" manual.

Source: Pennsylvania Department of Environmental Protection. No date. Coastal Zone Management Program. Pennsylvania Department of Environmental Protection, Harrisburg, PA.

East Goshen

Wetlands destroyed throughout East Goshen, Pennsylvania to make room for rapid development in the town resulted in septic system overflows. Residents' yards were polluted with wastewater, and the town was forced to install a $1.5 million sewer system. The town also expects to expand the system in the future.

Source: National Audubon Society. No date a. *Wetlands Horror Stories*. National Audubon Society, New York, NY.

The Pike Run Restoration Project

The Pike Run restoration project demonstrates the effectiveness of including habitat restoration techniques in a watershed treatment program. Forty wetland acres were restored as a result of cooperative efforts among landowners, government agencies, and conservation groups. The main source of funding for the project came from an EPA section 319 grant administered by the Pennsylvania Department of Environmental Protection, Division of Watershed Conservation. The project is a partnership venture of the USFWS Partners for Wildlife Program, the Pennsylvania Game Commission, the USDA Natural Resources Conservation Service and Pasture Systems and Watershed Management Research Laboratory, Ducks Unlimited, National Fish and Wildlife Foundation, California University of Pennsylvania, Pheasants Forever, the Audubon Society of Western Pennsylvania, and interested landowners.

Source: Environmental Protection Agency. *Polluted Runoff (Nonpoint Source Pollution): Partners in Wildlife- The Pike Run Watershed Restoration Project.* <http://www.epa.gov/owow/NPS/Section319II/PA.html> Accessed January 2003.

Wetland Restoration/Creation Site Registry

Under the Pennsylvania Department of Environmental Protection's Wetland Restoration/Creation Site Registry Program, interested property owners register the number of acres they have available for wetland creation. A developer with requirements to mitigate for wetland impacts then pays the cost of restoration or creation of new wetlands on the property at no cost to the landowner. The developer is also responsible for monitoring the success of the project. So far, 39 landowners have registered 240 acres in the program (as of 1997).

Source: Pennsylvania Department of Environmental Protection. 1997b. *Wetland Restoration: A Lasting Tribute for Earth Day*. Pennsylvania Department of Environmental Protection, Harrisburg, PA.

Wetland Replacement Project

The Pennsylvania Department of Environmental Protection, in cooperation with the USFWS, Ducks Unlimited, and the Lake Naomi Club, will create 7.5 acres of wetlands from an abandoned sand and gravel mine on the club's property in Monroe County. The Wetland Replacement Fund provides permit applicants

with more options for replacing small wetlands that are unavoidably lost. Wetlands can thus be created on a larger scale and in better areas.

Source: Pennsylvania Department of Environmental Protection. 1997a. *Monroe County's Wetlands Protection*. Pennsylvania Department of Environmental Protection, Harrisburg, PA.

Rhode Island

Galilee Bird Sanctuary

In 1992 the Rhode Island Division of Fish, Wildlife and Estuary Resources requested the USACE to act as the federal lead in the restoration of tidal flows into a portion of the salt marsh at the Galilee Bird Sanctuary, Narragansett. Up to one-half of the sanctuary qualifies for salt marsh restoration under the authority of section 1135 of the Water Resources Development Act of 1986. The remaining half will be restored under the authority of the state. Two acres will consist of intertidal habitat within tidal channels, 24 acres will be fully restored to salt marsh, and 8 acres will be partially restored to salt marsh. This will be done by re-excavating natural channels and installing twin box culverts beneath the escape road to improve tidal exchange.

Source: Coastal America Partnership. 1997. *Wetlands Protection and Restoration.* Coastal America, Washington, DC.

Kingston 1

A study was conducted to evaluate the removal of ground water nitrate in and adjacent to wetlands located within three different riparian forests. Removal rates were found to be in excess of 80% within wetlands during both the growing and dormant seasons. Removal rates within transition zones were less than 36% during the growing season and ranged between 50% and 78% in the dormant season. Test results show that both wetlands and transition zones between wetlands and uplands can be important sinks for ground water nitrate.

Source: Simmons, R.C., A.J. Gold, and P.M. Groffman. 1992. Nitrate dynamics in riparian forests: Groundwater studies. *Journal of Environmental Quality* 21:659-665. ISSN: 0047-2425.

Kingston 2

Denitrification was measured in a riparian forest with upland wetland transition zones and red maple wetlands on two sides of a stream. Upland use on one side of the stream was high-density, unsewered residential development, and upland on the other side was undeveloped. The developed and undeveloped sites were compared to determine removal efficiencies. Nitrate removal efficiencies for the developed site were determined to be 59% from ground water.

Source: Hanson, G.C., P.M. Groffman, and A.J. Gold. 1994. Denitrification in riparian wetlands receiving high and low groundwater nitrate inputs. *Journal of Environmental Quality* 23:917-922.

Wetland Protection

The Division of Freshwater Wetlands Rules and Regulations Governing the Administration and Enforcement of the Freshwater Wetlands Act regulates all projects that might alter freshwater wetlands, including activities in close proximity to a freshwater wetland that might impact the natural character or functions of a wetland, including nonpoint source functions. Projects in close proximity to a wetland require a permit if changes result in the flow of surface runoff into or away from a wetland, or if modifications in water quality would change its natural character.

Source: *Rhode Island Coastal Nonpoint Pollution Control Program*. 1995. Rhode Island Department of Environmental Management, Providence, RI.

South Carolina

Congaree Swamp

The Congaree Bottomland Hardwood Swamp has been determined to provide valuable water quality functions, such as removing and stabilizing sediment, nutrients, and toxic contaminants. It was determined that the total cost of constructing, operating, and maintaining a tertiary treatment plant to perform the same functions would be $5 million.

The National Audubon Society estimates that the cost to replace the pollution prevention role of all of the Congaree Bottomland Hardwood Swamp in South

Carolina with a water treatment facility would be $5 million.

Sources: National Audubon Society. No date b. *What's a Wetland Worth?* National Audubon Society, New York, NY.

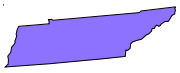
USEPA. 1995b. *National Water Quality Inventory: 1994 Report to Congress*. EPA841-R-95-005. USEPA, Office of Water, Washington, D.C.

South Dakota

Constructed Wetlands for Wastewater Treatment

Five communities in South Dakota have received SRF loans for wetland projects. The communities of Clear Lake, Huron, Lake Cochrane, Pickeral Lake, and Richmond Lake have used SRF loans to construct wetlands as part of improvements to a publicly owned treatment works. Constructed wetlands are a complex of saturated substrates, emergent and subemergent vegetation, animal life, and water that simulates natural wetlands for various benefits. In these cases, the wetlands follow a lagoon treatment system to further reduce pollutant levels in the wastewater prior to discharge. User charges are being used to repay the loans, which total about $7.5 million for all five communities. These projects are all eligible under the Nonpoint Source Program (Clean Water Act §319).

Source: U.S. Environmental Protection Agency (USEPA). 1998b. *Wetlands Projects Funded by the Clean Water State Revolving Fund (CW-SRF)*. U.S. Environmental Protection Agency, Office of Wastewater, Washington, DC.



Tennessee

Riparian Restoration Guide

The *Riparian Restoration and Streamside Erosion Control Handbook* was prepared in response to a need by landowners to prevent erosion of private lands and to rehabilitate damaged streamside or riparian zones. The document presents successful techniques for planting, bank armoring, in-stream structures, and soil bioengineering, which have been used by others to stabilize streambanks and restore riparian and aquatic resources.

Source: Hoffman J.T., Green D.L., and Eager D. 1998. *Riparian Restoration and Streamside Erosion Control Handbook*. Tennessee Department of Agriculture, Nashville, TN.

Rivers and Wetlands Program

The Rivers and Wetlands Program assesses the conditions and trends of rivers and wetlands in Tennessee and uses the information to assist in the restoration and conservation of aquatic resources. The mission of the Rivers Program is to characterize the biological, aesthetic, recreational, and cultural resources of the rivers of Tennessee. The mission of the Wetlands Program is to identify wetlands across Tennessee for conservation and restoration, assist in the development of a strategy for the best use of wetland resources, assist in the implementation of the State Wetlands Conservation Strategy, and educate the public and private sectors about the importance of wetlands. The program was established in 1995 through an EPA Wetlands Planning Grant.

Source: Tennessee Department of Environment and Conservation. 1998. *Tennessee Rivers and Wetlands Program.* Tennessee Department of Environment and Conservation, Nashville, TN.

Wetland Conservation Grant

The Division of Natural Heritage of the Tennessee Department of Environment and Conservation has received a $208,207 grant from EPA's Wetland State Partnership Grant Program to continue funding for the Division's Wetlands Program through June of 1999. The grant will be used to encourage property owners to voluntarily enroll wetlands in state and federal wetland conservation and assistance programs; to work with state, county, and local governments to avoid or minimize impacts to wetlands; and to encourage voluntary wetlands conservation. The grant will also be used to provide information about wetland values and protection to all 95 Tennessee counties.

Source: Tennessee Department of Environment and Conservation. 1997. Environment and Conservation Receives an EPA Grant. Tennessee Department of Environment and Conservation, Nashville, TN.

Texas

Austin

A study was conducted to measure the efficiency of VFS for removing constituents in highway runoff. Efficiency was determined by measuring concentrations of pollutants in samples of the runoff directly off the road and after the runoff passed through the VSF. Two VSF were monitored (U.S. 183 and Walnut Creek) to investigate the potential for variation in performance between VFS.

Source: Walsh, P.M., Barrett, M.E., Malina, J.F., Jr., and Charbeneau, R.J. 1997. *Use of Vegetative Controls for Treatment of Highway Runoff.* Center for Research in Water Resources. CRWR Online Report 97-5. University of Texas, Center for Research in Water Resources, Austin, TX.

Galveston Bay Foundation

A cooperative effort between volunteers and local, state, and federal agencies was organized by the Galveston Bay Foundation to restore coastal marshes primarily through the planting of smooth cordgrass. Approximately 200 volunteers participated in 16 plantings at 6 sites and created over 20,000 square feet of marsh. The large number of volunteers is a reflection of the growing awareness of the need to restore the ecological balance in Galveston Bay.

Source: Shead, L. 1997. *Restoration and Construction of Coastal Wetlands*. U.S. Environmental Protection Agency, Washington, DC.

Ingleside

Underutilized public property is being converted into a multiuse coastal biofilter and wildlife habitat. Best management practices implemented at the site include a VSF, enlargement of a mitigated wetland for filtering runoff, soil enhancement, xeriscaping, and the use of solid waste disposal material and dredge material to improve the effectiveness of the biofilter. The project includes an education component targeting high school and adult populations. The site is being monitored to evaluate the effectiveness of the best management practices.

Source: U.S. Environmental Protection Agency (USEPA). 1997a. Personal communication from Laura J. Talbot to Wetlands Strategies and State Programs Branch, U.S. Environmental Protection Agency.

Refugio

A wetland is being constructed (as of 1997) in Lions/ Shelby Park in the city of Refugio. Stormwater runoff from urban and rangeland sources will be directed to the constructed wetland for treatment. A strong public outreach program is intended to complement the project for maximum effectiveness and demonstration.

Source: U.S. Environmental Protection Agency (USEPA). 1997a. Personal communication from Laura J. Talbot to Wetlands Strategies and State Programs Branch, U.S. Environmental Protection Agency.

Texas Agricultural Experiment Station

A study was conducted to determine the effectiveness of permanent grass and winter wheat strips in trapping herbicides. Study sites were located in nine watersheds. In each watershed, three 30-foot wide buffer strips of grass, winter wheat, and corn were established. Atrazine, cyanazine, and metolachlor were applied as preemergent herbicides. Runoff was measured and sampled during rainfall events to determine the amount and quality of water leaving each field. Results show that 15- and 30-foot-wide filter strips of coastal Bermuda grass were effective at intercepting herbicides and that the filter strips reduced runoff volume by 60%. Herbicide levels in both wheat and grass filter strips were shown to be significantly lower than those in areas that were planted completely in corn.

Source: Hoffman, D., and T. Gerik. 1995. Limiting Herbicide Runoff with Vegetative Filter Strips. In *Proceeding of the 1995 Water for Texas Conference*, TWRI, College Station, TX.

Wetlands Assistance Guide

Texas Parks and Wildlife has developed the *Wetlands Assistance Guide for Landowners* to assist landowners in protecting wetlands and riparian areas according to their different needs within the context of broader conservation goals. The document provides a comprehensive guide to federal, state, and private programs offering technical and/or financial assistance to private wetland owners within the state of Texas.

Source: Texas Parks and Wildlife. 1995. *Wetlands Assistance Guide for Landowners. State Wetlands Conservation Plan*. Texas Parks and Wildlife, Austin, TX.

Wetland Habitat Alliance of Texas

The Wetland Habitat Alliance of Texas (WHAT) is an organization dedicated to preserving Texas wetlands by raising public awareness and appreciation of wetlands and funding projects to manage wetland waters; protect, enhance, and restore natural wetlands; and create wetlands on nonwetland sites. The cooperator and WHAT agree to a proposed project, and the NRCS verifies the operable conditions before the project is approved. Interested landowners can receive up to 100% financial assistance for a 10-year minimum agreement.

Source: Texas Parks and Wildlife. 1995. *Wetlands Assistance Guide for Landowners. State Wetlands Conservation Plan*. Texas Parks and Wildlife, Austin, TX.

Wetlands Conservation Plan

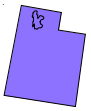
The Conservation Plan focuses on nonregulatory, voluntary approaches to conserving Texas's wetlands. Wetland issues addressed in the plan fall into five general categories: education, economic incentives, statewide and regional conservation, assessment and evaluation, and coordination and funding. Because of the extensive size and physiography of the state, a regional approach is used to best characterize the diverse wetlands needs and resources of Texas.

Source: Texas Parks and Wildlife. 1997a. *Texas Wetlands Conservation Plan*. Texas Parks and Wildlife, Austin, TX.

Wetlands Restoration Site Registry

Texas Parks and Wildlife received a $60,000 grant from EPA to develop a voluntary registry for public and private lands available for mitigation or registration. The program will function to link those who do not own land but who need or want to do wetland restoration with property owners who have similar goals. The purpose of the registry is to identify potential sites for wetland restoration, but there is no guarantee that all registered sites will be restored.

Source: Texas Parks and Wildlife. 1997. *Texas Wetlands Plan Update*. Vol. 2, issue 2. Texas Parks and Wildlife, Austin, TX.



Utah

Decker Lake

The Decker Lake Wetlands Preserve Foundation is a nonprofit group dedicated to preserving its namesake lake as an educational resource and natural preserve. The group is hoping to create a preserve surrounding the 35-acre, West Valley City lake that includes trails, an education center, and wildlife observation areas, thus creating a retreat in the center of the urban valley.

Source: Decker Lake Project. 1998. *Decker Lake Wetlands Preserve Foundation.* Salt Lake City, UT.

Matheson Preserve

The Scott M. Matheson Wetlands Preserve is managed by the Nature Conservancy and the Utah Division of Wildlife Resources (UDWR) to ensure the lasting protection of a spectacular desert wetland system and its associated biological diversity. Studies are being conducted in hydrology and ground salinity to develop an understanding of how the wetland system functions. Surveys are being conducted for sensitive species, such as the northern leopard frog, and to identify invasive plant species that pose a threat to native vegetation communities. Birds are also monitored to assess their resting, breeding, and foraging habits. With this information, the Conservancy and UDWR can better design conservation strategies to maintain the wetland and its plant and animal residents. The Conservancy hopes to demonstrate cooperative private land management efforts and educate children and other visitors about wetlands and broader conservation issues on the Colorado Plateau.

Source: The Nature Conservancy. 1998a. *Matheson Wetland Preserve.* The Nature Conservancy, Arlington, VA.

Wetlands Workbook

Utah's *Guide to Proper Wetland Management and Development* is a workbook that targets decision

makers, land managers, planners, and private citizens and is intended to aid these groups in proper wetland management. The document provides guidelines for wetland identification, discusses wetland functions, and provides guidelines for responsible development. Wetland permitting requirements and a list of available technical and agency resources is provided.

Source: Lock, Patricia A., Division of Wildlife Resources. 1993. Personal communication.

Vermont

Charlotte

A VSF constructed to treat milkhouse wastewater from a dairy farm was evaluated to determine its effectiveness in reducing phosphorus and nitrogen concentrations as well as exports in surface and subsurface flow. The strip significantly reduces solids, phosphorus, and nitrogen on a concentration basis, and it retained 95% solids, 89% phosphorus, and 92% nitrogen on a mass basis. Retention was greatest during the growing season and poorest during periods of snowmelt. Concentrations in subsurface outputs were greater than those in surface runoff.

Source: Schwer, C.B., and J.C. Clausen. 1989. Vegetative filter treatment of dairy milkhouse wastewater. *Journal of Environmental Quality* 18:446-451.

Lake Champlain Basin

The Lake Champlain Basin Watersheds National Monitoring Program is designed to implement and evaluate the effectiveness of livestock exclusion, riparian revegetation, and grazing management in reducing the concentrations and loads of nutrients, bacteria, and sediment from agricultural sources. Monitoring will continue over at least a 6-year period, including a 2-year calibration period prior to best management practice implementation, 1 year during land management implementation, and at least 3 years after best management practice implementation.

Source: U.S. Environmental Protection Agency (USEPA). 1995d. *Section 319 National Monitoring Program: An Overview.* U.S. Environmental Protection Agency, Washington, DC.

Virginia

Blacksburg

VFS were used to remove sediment, nitrate, and phosphate from a confined livestock area. Removal efficiencies were evaluated under varying flow characteristics and filter strip lengths. Results indicated that the VSF were effective for the removal of sediment and other suspended solids if the feedlot runoff was shallow and uniform. Sediment removal decreased with time as sediment accumulated in the filters. Total nitrogen and phosphorus were not removed as effectively as sediment, and the filter strips were not effective in removing soluble nitrogen and phosphorus.

Source: Dillaha, T.A., J.H. Sherrard, D. Lee, S. Mosttaghimi, and V.O. Shanholtz. 1988. Evaluation of vegetative filter strips as a best management practice for feed lots. *Journal of Water Pollution Control Federation* 60(7):1231-1238.

Comprehensive Plan Policy

Fairfax County, Virginia, adopted a comprehensive plan policy in 1982 to protect water quality and sensitive lands along watercourses from encroachment. The *environmental quality corridor (EQC)* policy established a "sensitive lands EQC" that provides for all presently mapped 100-year floodplains (and those mapped during the subsequent development process); all floodplain soils or soils with high water table, poor bearing strength, or other severe development constraints; wetlands adjacent to the streams; and steep slopes (defined as 15 percent or greater) adjacent to the floodplains, soils, or wetlands. Where the floodplains, soils, and wetlands cover only a narrow area, a minimum buffer width of 50 feet plus a factor of 4 times the percent slope is provided. The policy has resulted in protection of substantial portions of Fairfax County stream valleys. However, because it is only a policy rather than an ordinance, it can be implemented in an enforceable manner only on land uses that must be found to be in conformance with the county's comprehensive plan.

Source: Fairfax County, Virginia, Board of Supervisors. 1982. Occoquan Basin Study: Amendments to the Comprehensive Plan Adopted by the Board of

Supervisors June 15, 1982. Fairfax County Office of Comprehensive Planning, Fairfax, VA.

Culpeper County

A study concluded that for every dollar of tax revenue collected from residential land uses in Culpeper County in 1987, $1.25 was spent on county services. For every dollar collected from industrial/commercial or farm/forest/open space lands, only $0.19 was spent on services.

Source: Vance, T., and A.B. Larson. February 1988. Fiscal Impact of Major Land Uses in Culpeper County, Virginia. Piedmont Environmental Council, VA.

Henrico County's Environmental Program

Henrico County, which lies within the Chesapeake Bay Watershed, was dominated by agricultural activity until the 1940s and is now growing at a steady rate. Because of the many wetlands in the county, the Environmental Division of the Department of Public Works is developing a stormwater management program that will offer additional protection to water resources, including wetlands. The goal of this project is to strike a balance between the need to protect stream systems not yet degraded and the desire to restore those that have been impacted by development. This proposed program would help increase the overall effectiveness of the county's future Stormwater Management Program, protect and restore stream systems in the county, and protect and establish forested buffers.

Source: International City/County Management Association and National Association of Counties (ICMA and NACO). 1999. *Protecting Wetlands, Managing Watersheds...Local Government Case Studies.* International City/County Management Association and National Association of Counties, Washington, DC.

Prices Fork Research Farm

Rainfall simulation was used to evaluate the effectiveness of 9.1 and 4.6 meter-long VFS for the removal of sediment, nitrogen, and phosphorus from cropland runoff. The 9.1 and 4.6 meter long VFS under shallow uniform flow conditions removed an average of 84% and 70% of the incoming suspended solids, 79% and 61% of the incoming phosphorus, and 73% and 54% of the incoming nitrogen, respectively. Soluble nutrients in effluent were sometimes greater than the incoming soluble nutrient load.

Source: Dillaha, T.A., R.B. Renear, S. Mostaghimi, and D. Lee. 1989a. Vegetative filter strips for agricultural nonpoint source pollution control. *Transactions of the American Society of Agricultural Engineers* 32(2):513-519.

Riparian Restoration Demonstration

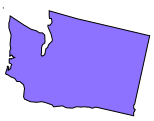
The Riparian Restoration Demonstration and Education Project Committee was established in 1994 to provide technical training and support for riparian restoration. In 1997, as part of the program, the Virginia Department of Conservation and Recreation conducted hands-on riparian restoration seminars at six locations across the Commonwealth. The seminars were designed to present restoration techniques for both rural and urban settings.

Source: Northern Virginia Soil and Water Conservation District. 1997. *Conservation Currents* 25(1, September/October) and 25(2, November/December).

VFS Effectiveness Study

VFS of varying ages were inspected and evaluated throughout rural Virginia through site visits and mail surveys. Results of the study indicate that many VFS performed poorly because of poor design and maintenance. It was determined that in order to make VFS more efficient, one or more of the following should be included in the design or management: a stone trench to spread water effectively; careful shaping of VFS to ensure sheet flow; inspection for, and repair of, damage following major storm events; and removal of any accumulated sediment.

Source: Dillaha, T.A., J.H. Sherrard, and D. Lee. 1989b. Long-term effectiveness of vegetative filter strips. *Water Environment and Technology* (November 1989):419-421.



Washington

City of Bellevue

Estimates of the cost of artificially replacing wetland functions with engineering solutions are enormous and such projects are, in many case, impossible. The city of Bellevue, Washington, conducted a study which

showed that it would be 8 times more expensive to build an artificial stormwater system than to use the natural stormwater control system provided by wetlands. The flood peaks in watersheds with extensively destroyed or degraded wetlands are substantially higher than those in healthy watersheds. Higher flood levels cause greater individual property damage and impose massive costs on taxpayers.

Source: National Audubon Society. No date c. *Why Are Wetlands Important?* National Audubon Society, New York, NY.

Synoptic Assessment Approach

The synoptic assessment approach was applied to provide information on future risk of valued habitat loss and to identify habitat areas for protection as part of the development of a State WCP. The assessment tool was used to evaluate wetland functions, make regional comparisons, and identify significant impacts on wetland resources.

Source: U.S. Environmental Protection Agency (USEPA). 1992a. *A Synoptic Approach to Cumulative Impact Assessment: A Proposed Methodology.* EPE/600/R-92/167. U.S. Environmental Protection Agency, Washington, DC.

Thurston County

A study is being conducted to determine the pollutant removal effectiveness of VFS constructed along roadsides in treating stormwater runoff from highways. Water quality data from the study will be used to assist the Washington State Department of Transportation in developing design criteria for inclusion in its highway runoff manual. Three 20-foot-wide, 10-foot-long VFS located in three different soil types will be evaluated in the study. Removal rates for total suspended solids, zinc, copper, lead, cadmium, total petroleum hydrocarbons, nitrate-nitrite, total phosphorus, soluble reactive phosphorus, and toxics will be measured.

Source: Yonge, D. 1996. *Vegetative Filter Strip Monitoring and Assessment.* Washington State Department of Transportation. Olympia, WA.

Wetland Reconstruction

The City of Des Moines, Washington, is using SRF to purchase and reconstruct a badly degraded wetland area and to construct a sediment trap/pond facility. This project is allowing the city to meet two goals it constantly struggles to achieve: flood protection and wetland preservation and enhancement. Area stormwater will enter one of two sediment traps by way of the surrounding reconstructed wetlands. The wetlands serve the dual purpose of providing flood protection by collecting stormwater runoff and acting as a preliminary filter by removing suspended solids. The majority of sediment and any heavy metal removal will occur while the water is in the sediment traps. The water will then leave the traps through artificial inlets that lead to Barnes Creek, which eventually enters Puget Sound. This $222,500 project is part of the National Estuary Program (Clean Water Act §320).

Source: U.S. Environmental Protection Agency (USEPA). 1998b. *Wetlands Projects Funded by the Clean Water State Revolving Fund (CW-SRF)*. U.S. Environmental Protection Agency, Office of Wastewater, Washington, DC.

Wetlands Regulatory Program

The Washington State Department of Ecology has instituted a regulatory program to counteract encroachment into wetlands due to compliance with infrastructure-related development standards. Local governments in the Puget Sound basin have authority to require more stringent controls to protect water quality where minimum setback requirements do not provide adequate protection of water quality-sensitive areas such as wetlands.

Source: Washington State Department of Ecology. 1992. *Stormwater Program Guidance Manual for the Puget Sound Basin*. Washington State Department of Ecology, Olympia, WA.

Winona Wetlands Purchase

The city of Port Townsend, Washington, was able to meet both stormwater management objectives and a wetlands preservation goal by obtaining funding from Washington's SRF to purchase an area known as the Winona Wetlands. These wetlands act as a critical stormwater basin for the area and provide valuable wildlife habitat. Potential development of the area not only threatened the wetlands but would also result in stormwater management problems. By purchasing the wetlands, the city was able to protect a natural stormwater management system as well as a wildlife refuge. The city purchased 6.5 acres in Phase I and is currently planning to borrow additional SRF for a

Phase II purchase of 9 acres. This $400,000 project is part of the National Estuary Program (Clean Water Act §320) for the Puget Sound estuary. A portion of the city's stormwater utility fee paid by households is being used to repay the Washington SRF.

Source: U.S. Environmental Protection Agency (USEPA). 1998c. *Winona Wetlands Purchase*. U.S. Environmental Protection Agency, Office of Wastewater Management, Washington, DC.

West Virginia

Riparian Task Force

The Hampshire County Riparian Task Force was established in 1992. The task force, which is composed of landowners and 12 local organizations, has dedicated itself to educating the public about the important role that forested riparian buffers play in maintaining water quality. An important part of the task force's message is that individual actions and personal choices can have both good and bad effects on the region's water resources. Committed to reaching as large an audience as possible, the task force developed an educational strategy that targets both children and adults. The task force has developed educational materials and demonstration sites to promote the importance of protecting water quality in the Potomac River Basin.

Source: Chesapeake Bay Program. 1997b. *Riparian Buffer Case Study.* U.S. Environmental Protection Agency, Chesapeake Bay Program, Annapolis, MD.

Wisconsin

State Water Quality Standards

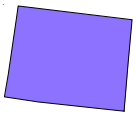
The state of Wisconsin has adopted specific wetlands water quality standards designed to protect the sediment and nutrient filtration or storage function of wetlands. The standards prohibit addition of those substances that would "otherwise adversely impact the quality of other waters of the State" beyond natural conditions of the affected wetland. In addition, the state has adopted criteria protecting the hydrologic conditions in wetlands to prevent significant adverse impacts on water currents, erosion or sedimentation patterns, and the chemical and nutrient regimes of the wetland. Wisconsin has also adopted a sequenced decision-making process for projects potentially affecting wetlands that considers the wetland dependency of a project; practicable alternatives; and the direct, indirect, and cumulative impacts of the project.

Source: Wisconsin Department of Natural Resources. 1991. Water Quality Standards for Wetlands—Natural Resources Chapter 103. *Register*, July 1991, No. 427.

Wisconsin Department of Natural Resources, Oneida Indian Reservation

The Duck, Apple, and Ashwaubenon (DAA) Priority Watershed Project is a 10-year project to reduce runoff and improve water quality and aquatic habitat within the 265-square-mile watershed of Lake Michigan. In 1997 the Wisconsin Land and Water Conservation Board approved the $21.8 million DAA Nonpoint Source Control Plan to improve water quality and quantity and the economy and quality of life in northeastern Wisconsin. The Priority Watershed Project is a watershed-based program that addresses all nonpoint sources of pollution and provides a coordinating framework for environmental management that focuses on public and private efforts to address the highest priority problems within hydrologically defined geographic areas. The goal of the program is to reduce phosphorus and total suspended solids by 50 percent or more.

Source: International City/County Management Association and National Association of Counties (ICMA and NACO). 1999. *Protecting Wetlands, Managing Watersheds...Local Government Case Studies.* International City/County Management Association and National Association of Counties, Washington, DC.



Wyoming

Green River

The Green River drains 12,000 square miles of western Wyoming and northern Utah and incorporates a diverse spectrum of geology, topography, soils, and

climate. Land use is predominantly range and forest. A multiple regression model was used to associate various riparian and nonriparian basin attributes (geologic substrate, land use, channel slopes, etc.) with previous measurements of phosphorus, nitrate, and dissolved solids.

Source: Fannin, T.E., M. Parker, and T.J. Maret. 1985. Multiple Regression Analysis for Evaluating Non-point Source Contributions to Water Quality in the Green River, Wyoming. In *Proceedings of Riparian Ecosystems and Their Management: Reconciling Conflicting Issues*, Tucson, Arizona, April 16-18,1985, pp. 201-205. GTR RM-120. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Washington, DC

Anacostia River Watershed

Intergovernmental agencies that include the District of Columbia, Montgomery County, Prince George's County, and the State of Maryland collaborated and organized efforts to restore the Anacostia River and tributaries. Over 98 percent of the tidal wetlands and nearly 75 percent of the freshwater wetlands within the watershed were destroyed prior to the start of the project. Restoration activities were facilitated by the Metropolitan Council of Governments through administrative and technical support. The project was funded through annual contributions from Anacostia residents.

Source: U.S. Environmental Protection Agency. *Polluted Runoff (Nonpoint Source Pollution): Anacostia River Watershed District of Columbia.* <www.epa.gov/OWOW/NPS/Ecology/chap6ana.html>. Accessed January 2003.

Kenilworth Marsh: A Classic Wetland Restoration Success Story in The Nation's Capitol

The USACE in consultation with several federal and local agencies restored more than 30 acres of emergent wetland in a reconstructed freshwater tidal marsh in Washington, DC's Anacostia River. Restoration of the marsh involved using dredge materials from the Anacostia River and planting about 350,000 plants comprising of 16 local, native species. An EPA section 319 grant administered by the District of Columbia was used to support the monitoring effort of the restored marsh. The lessons learned from using dredged materials were used to build similar wetlands in nearby marshes.

Source: U.S. Environmental Protection Agency (USEPA), Office of Research and Development. 2002. *Kenilworth Marsh: A Classic Wetland Restoration Success Story in The Nation's Capitol.*

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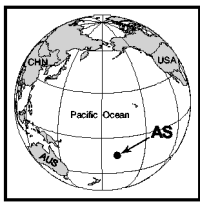
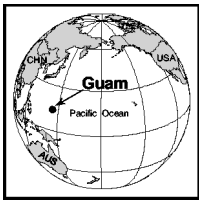


American Samoa

Coastal Management Program

The American Samoa Coastal Management Program Administrative Rules require the establishment of buffer zones of 25 to 50 feet between wetlands and development. Special Management Plans, which provide additional protection to wetlands, have been established for Pago Pago Harbor and the pala, or wetland, areas around the villages of Leone and Nu'uli. In addition, American Samoa, has developed a Comprehensive Wetlands Management Plan for the islands of Tutuila, Aunu'u, American Samoa, and Manu'a that documents the status of wetlands and suggests strategies to protect remaining wetlands.

Source: *American Samoa Coastal Nonpoint Source Pollution Program.* 1995. American Samoa Environmental Protection Agency, American Samoa.



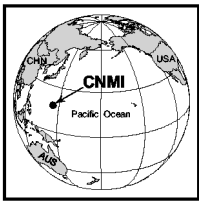
Guam

Wetland Protection

The Guam Environmental Protection Agency includes NPS evaluations of all wetlands in or adjacent to projects under their review. The *Guam Nonpoint*

Source Management Plan states that the Guam Environmental Protection Agency will include in their formal review standards specific evaluations for NPS control potential of existing and constructed wetlands. The agency will also review projects adjacent to wetlands for their impact on wetlands.

Source: *Guam Nonpoint Source Pollution Management Plan*. 1996. Guam Environmental Protection Agency, Tiyan, Guam.



Commonwealth of the Northern Marianas Islands

Tinian Magpo Watershed and Wetland Protection Plan

The Division of Coastal Resources Management and the Division of Environmental Quality applied for and received a grant from EPA to prepare the *Tinian Magpo Watershed and Wetland Protection Plan*. The plan includes rationale for development and descriptions of the environment, previous and ongoing investigations, federal and commonwealth agencies regulating wetlands, and water resources. The final plan includes detailed descriptions of the Magpo watershed and the Magpo wetland. The plan also identifies problems and concerns within the Magpo watershed and wetland and provides recommendations for solutions.

Source: Baldwin G.W. 1995. Tinian Magpo Watershed and Wetland Protection Plan. Prepared for Division of Coastal Resources Management, Department of Lands and Natural Resources, Saipan, MP; Division of Environmental Quality, Department of Public Works, Saipan, MP; U.S. Environmental Protection Agency, Washington, DC.

Puerto Rico

Los Manchos Mangrove Restoration

The $1.6 million Los Manchos Mangrove Restoration Project lies within the Los Manchos Mangrove Forest. It involves the restoration of tidal flushing to approximately 1,000 acres of mangrove forest along the eastern coast of Puerto Rico, at the U.S. Naval Station, Roosevelt Roads. Construction phasing of the project includes the demolition of existing causeways, construction of a new causeway with bridges to allow greater tidal flow and saltwater exchange, and the clearing of damaged or fallen mangroves. New mangroves will be planted in areas that were severely damaged.

Source: Coastal America Partnership. 1997. *Wetlands Protection and Restoration.* Coastal America, Washington, DC.

Mangrove Protection in Puerto Rico

In Puerto Rico protection of mangroves receives priority attention. In 1974 the Environmental Quality Board adopted Resolution 74-21 to protect mangrove wetlands. The resolution states a need to preserve, protect, and when possible restore mangroves; minimize changes in the quantity or quality of water in mangroves; protect mangroves from adverse effects of dredging or the placement of dredge spoils; and promote environmental measures for the protection of mangroves.

Source: *Puerto Rico Coastal Nonpoint Pollution Control Plan*. 1995. Draft. Department of Natural Resources, Puerta de Tierra, PR.

Virgin Islands

GIS Assessment

The U.S. Virgin Islands Department of Planning and Natural Resources is developing a wetland geographic information system (GIS). The system will be used to evaluate wetland management needs and priorities. Data in the GIS wetlands database will be used to ascertain historic losses of salt ponds. This data will also be used to formulate salt pond protection measures, e.g., establishment of specific salt pond boundaries and setbacks, and creation of guidelines for the maintenance and restoration of ponds.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

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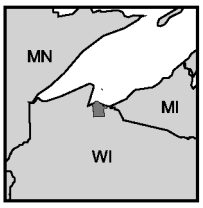
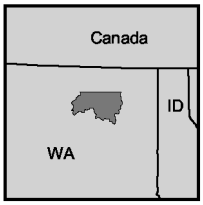


Bad River Band of Chippewa Indians

Wetlands Conservation Plan/Outreach

The Bad River Band of Lake Superior Chippewa Indians is serving as a wetlands information center for Wisconsin tribes. The Bad River Band is focusing on learning various wetland programs and on the development of a tribal Wetlands Conservation Plan (WCP) for their reservation. The WCP addresses the threats to the Kakagon/Bad River Sloughs ecosystem. In conjunction with this plan, the tribe is working with federal agencies to provide outreach services and help other Wisconsin tribes develop WCP.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

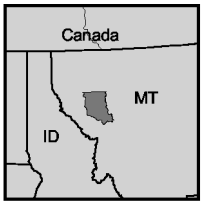


Colville Confederated Tribes

Owhi Lake

Owhi Lake, Washington, has the most important resident fishery within the Colville Confederated Tribes reservation. The tribes have restored riparian areas and limited livestock access to Owhi Creek and Lake in an effort to reduce phosphorus levels. Tribal activities included the fencing of Owhi Lake and creation of livestock enclosures to restrict the use of pastures along the creek. School children worked with tribal technicians; they planted riparian vegetation and helped put medium organic debris in the creek, using only local materials.

Source: U.S. Environmental Protection Agency (USEPA). 1997c. *Section 319 Success Stories: Volume II.* U.S. Environmental Protection Agency, Washington, DC.

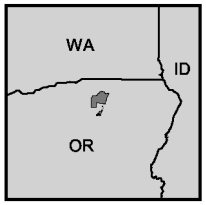


Confederated Salish and Kootenai Tribes of the Flathead Reservation

Watershed Demonstration Project

The tribe is conducting a Watershed Demonstration Project for the Bitterroot watershed. Criteria are being developed by the Flathead Tribes to inventory wetland resources and to identify wetlands that have incurred detrimental impacts. Outreach activities are being undertaken with stakeholders to determine what measures could be taken to restore and enhance the use of wetland resources.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.



Confederated Tribes of the Umatilla Indian Reservation

Wetland Community Park

There are plans to create a community park between two wetland areas near Oregon housing projects and the Umatilla Indian Reservation tribal government campus. The 3.5-acre park, among the cottonwoods of Mission Highway, would provide traditional amenities in addition to a platform that extends into the wetlands to accommodate viewing, with information to educate the public on the value of wetlands and wetland protection.

Source: Plans Developed for Wetland Community Park. *Confederated Umatilla Journal,* Feb. 19, 1998, p. 9.

Umatilla River Watershed

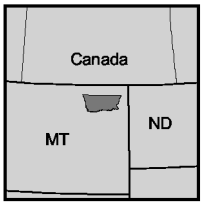
A variety of land uses on the Umatilla Indian Reservation and in the surrounding Umatilla River watershed (in north-central Oregon) result in nonpoint source pollution. Erosion has led to the loss of wetlands and riparian vegetation along the river. The tribes hope to restore these areas by improving livestock and crop management practices. Objectives include increased riparian shade and bank storage to improve productivity and survival of coldwater fisheries habitat; rotational grazing and wider use of upland pastures; improved crop management; increased riparian vegetation and the possible introduction of beaver to provide natural habitat structural improvements; increased in-stream structure and channel diversity; and implementation of a proactive approach to private land grazing and agricultural management.

Source: U.S. Environmental Protection Agency (USEPA). 1997c. *Section 319 Success Stories: Volume II.* U.S. Environmental Protection Agency, Washington, DC.

Watershed Protection

The tribes are conducting a watershed protection approach demonstration project in the Umatilla Basin. Building on last year's grant, they are developing a watershed protection program and multilevel-government integrated watershed management plan.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.



Fort Peck Assiniboine and Sioux Tribes

Managed Grazing

The demonstration of a managed grazing system is under way as part of a riparian restoration and water quality protection plan for the Fort Peck Reservation in northeastern Montana. The system is located in the Little Porcupine Creek watershed. Little Porcupine Creek has lost almost all integrity because of uncontrolled grazing, which has stripped the banks and the riparian corridor of vegetation. The stream also serves as the only livestock watering source for the range. The goal of the project is to restore the riparian zone from a severely impaired to a moderately impaired biological condition.

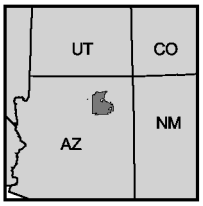
Source: U.S. Environmental Protection Agency (USEPA). 1997c. *Section 319 Success Stories: Volume II.* U.S. Environmental Protection Agency, Washington, DC.

The Grand Portage Reservation

The Grand Portage Reservation received an EPA grant for $50,000 in 1995 to develop a Wetland Protection and Conservation Ordinance for the reservation that includes regulatory and nonregulatory approaches to wetland protection. The draft ordinance was developed, and sections of land on the reservation that were most at risk from development were the focus of the wetland evaluations conducted in conjunction with the development of the ordinance. According to Janice Cheng, EPA Region Wetlands Division, the tribe did not use other outside funding

sources besides EPA for the development of the ordinance, but the tribe did provide a 25 percent match to the grant funds. Ms. Cheng stated that other tribes in EPA Region 5 have received similar grants for developing wetland protection ordinances. The cost of developing the ordinances has varied from approximately $50,000 to $100,000. The length of time involved in their development has also ranged from slightly less than 1 year to more than 2 years. The variation in cost and duration of the projects depends largely on the amount of background wetland information that is available for the reservation.

Source: Cheng, Janice, USEPA, Region 5. January 18, 2000. Personal communication.

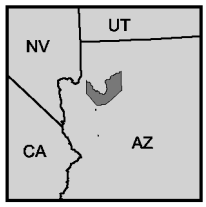


Hopi Tribe

Wetlands Conservation Project

The Hopi Tribe is preparing the *Hopi Wetland Conservation Plan* for protecting and conserving wetlands on the Hopi Reservation. In addition, the tribe is completing a watershed protection demonstration project for the Blue Canyon area of the reservation, a unique riparian area that is currently being considered for a National or Tribal Park. An important objective is to develop a plan that provides adequate protection but still allows for economic development by the tribe. The emphasis is on establishing goals that provide direct protection of the wetland resources.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.



Hualapai Tribe

Spencer Creek

Spencer Creek is the largest perennial stream on the Hualapai Indian Reservation in Arizona. The creek, nearby wetlands, and native vegetation are plagued by fecal contamination resulting from burro overgrazing. A 3-day restoration project involves helicopter crews that will haul fence panels down to Indian Gardens to make a temporary holding pen, net all burros, and transport them by helicopter to the holding pen for relocation to other areas. The Hualapai Department of Natural Resources hopes to prevent the buildup of buro populations to allow woody riparian vegetation, now lost to overgrazing, to reestablish. Removal of the burros will improve wetland plants and water quality throughout the Spencer Creek drainage.

Source: U.S. Environmental Protection Agency (USEPA). 1997c. *Section 319 Success Stories: Volume II.* U.S. Environmental Protection Agency, Washington, DC.

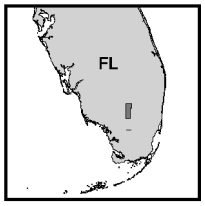
Inter-Tribal Council of Michigan

Wetlands Outreach

The Inter-Tribal Council of Michigan (MITC) is providing wetlands technical assistance to the Bay Mills Indian Community and expanding this assistance to all Michigan tribes. This project is fulfilling the need for outreach and education specific to the 404 program. MITC is determining the specific needs of each tribe and is working with the federal agencies to provide technical information and wetland management assistance. MITC's goal is to eventually develop wetland management strategies for all the Michigan tribes that request their assistance. The strategies

include the identification, preservation, and management of wetlands on reservations.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

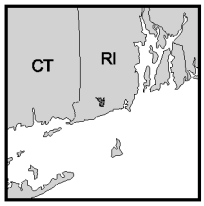


Miccosukee Tribe of Indians of Florida

Wetland Water Quality Standards

The Miccosukee Tribe has vested interests in approximately 2.1 million acres in South Florida, and the vast majority of this acreage is wetlands. The tribe is collecting and analyzing water samples at 20 sites, including eight wetland reference sites on the Miccosukee Tribe's federal reservations. The tribe is using this information to develop wetland water quality standards and to assess and monitor the ecological integrity of the tribe's wetlands with development of potential indicators.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

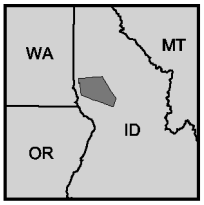


Narragansett Indian Tribe

Wetlands Protection Program

The tribe is developing a program for the protection of tribal wetlands, including development of zoning by-laws, a conservation and recreation plan, and biological criteria/wetland water quality standards. In addition, the tribe is developing educational and training opportunities for tribal members and staff involved in the administration of their newly developed wetland protection program.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

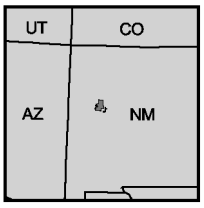


Nez Perce Tribe

Wetland Conservation Program

The tribe is developing and implementing a watershed protection approach demonstration project in the Lapwai Creek Watershed and a comprehensive WCP for the reservation.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

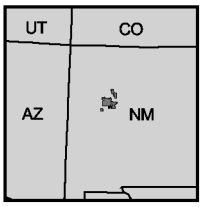


Pueblo of Acoma

Wetlands Protection Program

The tribe is developing a comprehensive plan for wetland areas on the reservation as an ongoing project with other tribal programs such as range management, forestry, fish and wildlife, and various agricultural and recreational programs. By developing a Wetlands Protection Plan, these areas can be incorporated into an overall tribal lands management program.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

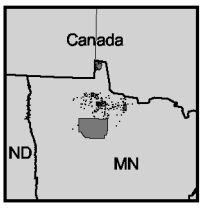


Pueblo of Laguna

Wetlands Program

The tribe is developing a program to manage and conserve its wetlands as they relate to other resources. The elements of the wetland program are being incorporated into the overall Integrated Resources Management Plan. The objectives are to establish a Wetlands Section within the pueblo's Natural Resources Department, to gather data for a WCP, to develop a WCP, to develop water quality standards, to improve wetlands potential through watershed improvement projects, and to gain public input on a WCP.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.



Red Lake Band of Chippewa Indians

Red Lake Farm

The Red Lake Band of Chippewa Indians will manage more than 1,200 acres of wetlands and other habitats, including a portion of the Kiwosay Wildlife Area in Minnesota. A $177,000 grant through the National Wildlife Refuge System, along with $338,000 from partners, will be used to help restore nesting habitat as well as wild rice and small grain food plots, which are a food source for migrating and breeding waterfowl.

Source: U.S. Fish and Wildlife Service (USFWS). 1998e. Wetlands Projects Approved for 19 States. Fish and Wildlife Service News List Server. Listed April 30, 1998. U.S. Department of Interior, Fish and Wildlife Service, Washington, DC.

Wetlands Outreach

The Red Lake Band is developing expertise in both regulatory and advanced planning aspects of the wetland program and providing wetland outreach to the tribes of Minnesota. They are providing technical assistance in wetland delineation, wetlands regulations, and eventually, assistance in the development of individual tribal wetland ordinances or WCP. They are also upgrading their existing computer equipment to accommodate an expanded geographic information system. They are gathering information on current needs of the Minnesota tribes and are working with the federal agencies on training in policy issues.

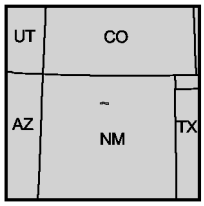
Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Rincon San Luiseno Band of Mission Indians

Wetlands Protection Plan

In 1992 the Rincon San Luiseno Band initiated work to develop a wetland management program for the reservation lands along the San Luis Rey River. The Rincon are defining short- and long-term data requirements to assess water and wetland quality on the reservation. Data include quantitative information on chemical, physical, and biological parameters. Permanent sampling and monitoring stations are being defined on the reservation, along with data collection requirements and protocols.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

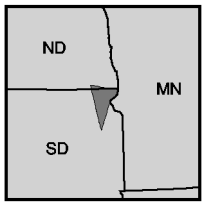


Santa Clara Pueblo

Wetlands Project:

The tribe is developing a comprehensive wetland monitoring and assessment plan for the pueblo, finalizing a draft Wetlands Management Plan, and developing a pollution prevention strategy for remediation of the pueblo's wetlands.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

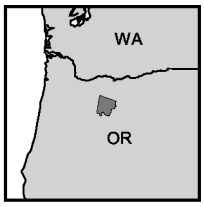


Sisseton-Wahpeton Dakota Nation

Wetlands Conservation Plan

The nation is developing a Tribal WCP. They are undertaking activities to protect, restore, and maintain wetland resources on the reservation. With the assistance of the Natural Resources Conservation Service and USFWS, they are using existing wetland data to inventory wetland resources and identify priority wetlands on the reservation.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.



Warm Springs Tribe

Wetlands Conservation Plan

The tribe is inventorying existing wetlands, identifying functions and values, refining tribal monitoring and enforcement programs, and consolidating existing tribal laws affecting wetlands. These activities will provide the basis for the development of a wetlands conservation programs for the reservation.

Source: U.S. Environmental Protection Agency (USEPA). 1994b. *State/Tribal Wetlands Grant Catalog.* 5th ed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.