REVIEW OF THE NATIONAL WATER QUALITY ASSESSMENT (NAWQA) PROGRAM IN NATIONAL PARKS, FISCAL YEAR 1996

Barry A. Long, William L. Jackson, Gary W. Rosenlieb, and William H. Walker

Technical Report NPS/NRWRD/NRTR-97/110

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BACKGROUND

In January of 1994, the National Park Service (NPS) and the U.S. Geological Survey (USGS) signed a formal Memorandum of Understanding to coordinate the integration of National Parks into the National Water Quality Assessment (NAWQA) Program. In 1995, the NPS and USGS initiated a small "demonstration" partnership to increase NAWQA work in national parks. The purpose of this formal collaboration was to demonstrate the workability of a possible full-scale NPS-USGS water quality monitoring partnership, and to learn how to effectively implement cooperative programs at both the national and field levels. The focus of the demonstration partnership has been on monitoring that is of high interest to NPS but which would otherwise not have been included in the study design of the NAWQA program. During 1995 and 1996, each agency spent about $200,000 per year to monitor park water resources. Some park issues being addressed include: endocrine system disruption in fish at Lake Mead National Recreation Area, urban development at Chattahoochee National Recreation Area, growth conditions of zebra mussels at St. Croix National Scenic Riverway, and river restoration at Yosemite National Park.

This document reviews the progress of cooperative work completed in fiscal year 1996 in nine NAWQA study units affecting eleven park units (Figure 1). An evaluation of the success of the second year of this partnership program is included below, followed by a rationale for expanding the program, and a statement of progress for the NPS-NAWQA projects in fiscal year 1996. Expenditures for the program by agency in fiscal year 1996 are included in Table 1. A list of the primary participants from the NPS and USGS is included in the Acknowledgements section at the end of the report.

EVALUATION OF NAWQA DEMONSTRATION PROGRAM IN NATIONAL PARKS

The demonstration partnership between NPS and USGS-NAWQA has been extremely valuable and has laid the groundwork for the expanded national monitoring partnership. Three critical factors were demonstrated as part of the collaborations initiated in 1995 (Long and others 1996). First, the program showed that the two agencies could effectively define and coordinate overall program direction at the national level, and that park managers were able to utilize technical professionals from USGS to address park-specific water quality issues. Effective communication and coordination between park staffs and USGS staffs occurred both in the design of specific studies and through participation in NAWQA Liaison Committee meetings. USGS staff consistently demonstrated the willingness and ability to orient their activities to meet the needs of its NPS "customer."

Second, the demonstration program showed that NPS and USGS could effectively interact at the technical staff level to design the specific elements of park-based studies, negotiate efficient budgets, and reasonably allocate budget responsibilities based upon the relative contributions of the studies to each agency's mission. In 1996, the NPS spent $190,000 for approximately $420,000 worth of professional water quality monitoring.

Third, the demonstration program met high standards of accountability. Project tasks were implemented on schedule and within budget. Studies were oriented to meet park management

needs and study results were documented in reports oriented to assist managers in making resource management decisions. Deliverables to NPS included: read-only access to USGS district and national databases; hydrologic and chemical data upload to USGS WATSTORE and EPA STORET national databases; hydrologic and chemical data published in USGS Annual Reports; rating curves for newly-installed gaging stations; and professional reports with analyses and interpretations of data. Examples of published reports with NPS data and information are: Bevans and others (1996), Hippe and others (1996), and Spahr and others (1996).

In summary, demonstration collaborations confirmed that the NPS-USGS partnership is a credible, efficient and cost-effective method of meeting NPS water quality information needs. The program showed that the mechanics of study design, coordination, and implementation could be effectively implemented at the field level. The program also demonstrated an ability to effectively coordinate program direction at the national level, and also suggested that an increased level of national direction will be needed to implement a fully-funded national NPS-USGS water quality monitoring partnership. This direction will be needed to insure that site-specific studies are prioritized and designed not only to meet site-specific information needs, but also to contribute optimally to the broader analysis of issues at the multi-park, regional (e.g., NAWQA study basin), and national levels.

The Water Resources Division of the NPS intends to maintain support for the NAWQA Program in National Parks at existing funding levels in fiscal year 1997. In the future, additional funds may be utilized to develop an expanded cooperative program. In fiscal year 1997, it is expected that monitoring will continue in seven of the nine "pilot" projects, and three new cooperative projects will be implemented. The new projects will be conducted in New River Gorge National River, Gauley River National Recreation Area, and Bluestone River National Scenic Riverway by the Kanawha-New River Basin NAWQA study unit; Obed Wild and Scenic River by the Upper Tennessee River Basin NAWQA study unit; and Olympic National Park by the Puget Sound Basin NAWQA study unit.

RATIONALE FOR EXPANDING THE PARTNERSHIP BETWEEN NPS AND NAWQA

While a small number of individual assessments of park water quality have occurred on a project-by-project basis, NPS has no systematic or sustainable water quality assessment activity. In addition, most parks are inadequately staffed and trained to conduct and sustain water quality monitoring technical programs. Furthermore, NPS lacks the basic equipment and organizational infrastructure to support a servicewide water quality monitoring activity. Things such as technical protocols, databases and data management protocols, quality assurance/quality control (QA/QC) procedures, training, laboratory capability, and reporting protocols would have to be developed within NPS to implement a credible servicewide water quality monitoring activity in-house. An expanded NPS-NAWQA partnership fills this void by providing a sustainable, standardized program of water quality data acquisition in parks which will permit objective, periodic assessments of the status of water quality in parks, and enable NPS to address its most pressing water quality protection problems. The partnership would match the water quality technical capabilities of USGS with the water quality management responsibilities of NPS.

Water quality monitoring is part of the mission of USGS. The USGS is staffed at the District and sub-District levels to conduct field-based monitoring activities. These activities are supported at the national level by all necessary infrastructure including training, laboratories, database systems, and QA/QC and reporting protocols. Rather than reinventing the capabilities of the USGS in-house, it is logical and efficient to partner with USGS and bring the water quality monitoring capabilities of USGS to bear on critical NPS water quality monitoring needs. Also, by emphasizing implementation of park-based water quality monitoring through the USGS-NAWQA program, NPS strengthens its ability to factor in a regional or ecosystem-scale perspective into the design of park-based water quality monitoring projects and in the interpretation of monitoring results. Because the USGS-NAWQA program is implemented on a river-basin scale and is designed around broad regional or water-use themes, there is opportunity to enhance the value of park water quality data by evaluating it in a broader ecosystem context. Finally, because USGS is a scientific organization rather than an advocacy organization, data developed by the agency carries strong scientific and legal credibility.

In past years, NPS has submitted a budget initiative for funding an expanded partnership with the NAWQA program. Although well received by management in NPS, USGS, the Department of the Interior, and the Office of Management and Budget (OMB), the initiative was not funded due to other budget priorities. The NPS Water Resources Division will again submit a revised NPS Water Quality Monitoring initiative for fiscal year 1999 funding. The revised initiative will contain a strategic water quality monitoring plan for implementing a long-term partnership program. The water quality monitoring plan will be developed in coordination with USGS.

National Water-Quality Assessment (NAWQA) Program

in National Parks, Fiscal Year 1996 Projects

Figure 1

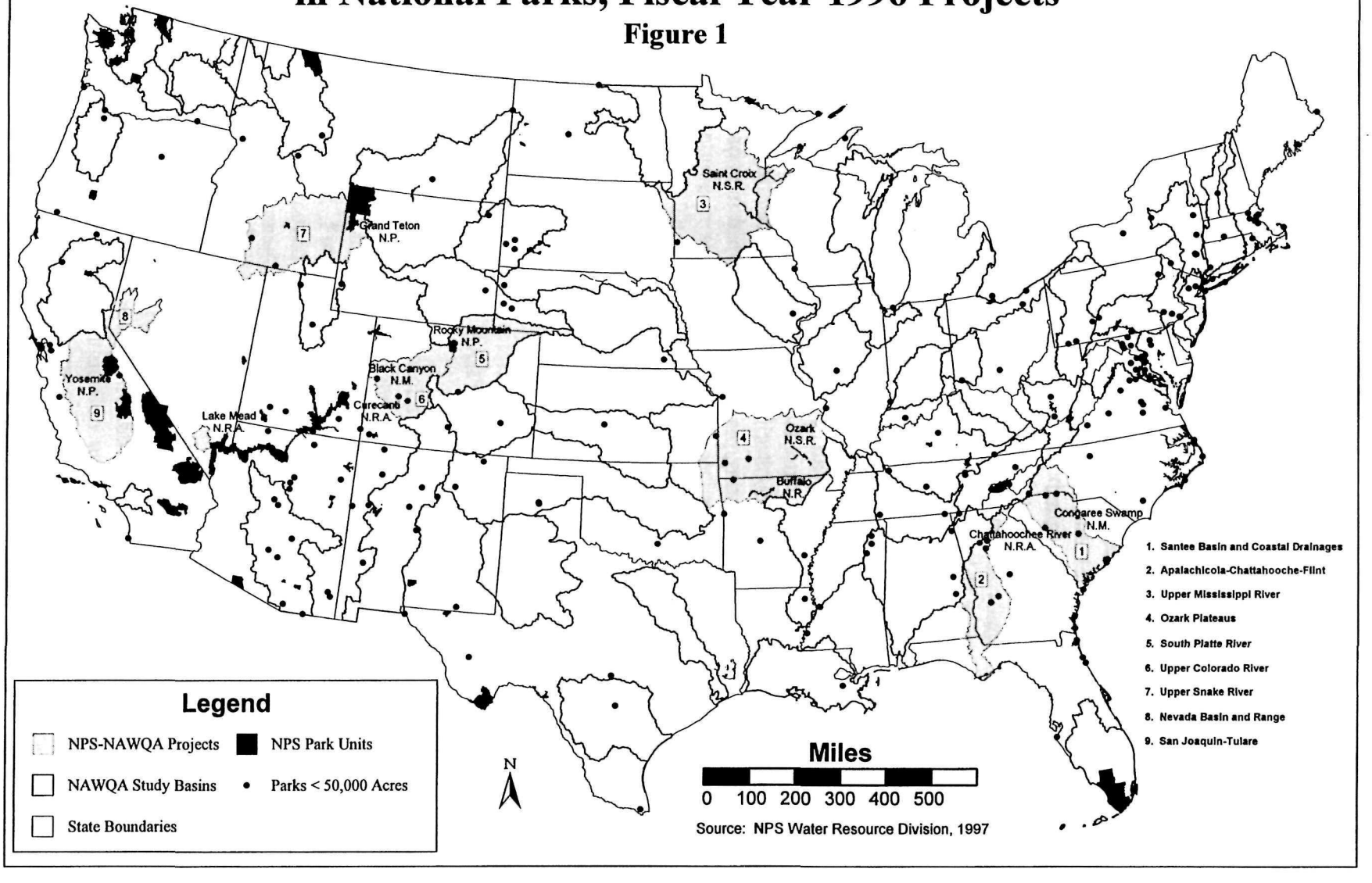

Table 1.

NAWQA PROGRAM IN NATIONAL PARKS, FISCAL YEAR 1996 BUDGET

NPS Unit(s)	NAWQA Study Unit	NPS Funds	USGS Funds	Study Focus
St. Croix National Scenic Riverway	Upper Mississippi River Basin	$12,300	$16,700	Basic fixed-station water quality and ecological sampling, and reconnaissance sampling for trace elements/organics in bed sediments and fish tissue, in the St. Croix River and Namekagon River
Grand Teton National Park	Upper Snake River Basin	$15,400	$15,400	Basic fixed-station monitoring at park downstream boundary; Snake River at Moose Junction
Curecanti National Recreation Area, Black Canyon of the Gunnison National Monument, Rocky Mountain National Park	Upper Colorado River Basin	$41,300	$50,400	Basic fixed-station monitoring; Colorado River below Baker Gulch, Gunnison River below Gunnison Tunnel, and Gunnison River at County Road 32 (Riverway)
Yosemite National Park	San Joaquin-Tulare Basin	$13,100	$13,500	Basic fixed-station and synoptic biological monitoring in Yosemite Valley; Merced River at Pohono and five other park sites
Lake Mead National Recreation Area	Nevada Basin and Range	$42,200	$42,300	Intensive study in Las Vegas Wash and Las Vegas Bay in Lake Mead to assess synthetic organic compounds in urban runoff
Chattahoochee River National Recreation Area	Apalachicola-Chattahoochee-Flint River Basin	$20,000	$32,700	Upper Chattahoochee River poster containing facts and information related to water-resource issues in the basin
Rocky Mountain National Park	South Platte River Basin	$10,000	$29,000	Basic fixed-station monitoring as a basin reference; Big Thompson River at Moraine Park
Ozark National Scenic Riverways, Buffalo National River	Ozark Plateaus	$15,500	$14,300	Basic fixed-station monitoring in the Current River, Jacks Fork, and Buffalo River
Congaree Swamp National Monument	Santee Basin and Coastal Drainages	$20,200	$20,200	Synoptic water, sediment, and biological monitoring to provide baseline for tributaries to the Congaree River
	TOTAL FUNDS	$190,000	$234,500	

STATEMENT OF PROGRESS FOR MONITORING PROJECTS IN FISCAL YEAR 1996

St. Croix National Scenic Riverway - Upper Mississippi River Basin NAWQA Study Unit

St. Croix National Scenic Riverway is a river corridor that receives flow and constituent inputs from the surrounding forested watershed. Therefore, adjacent land uses have great potential for impacting pristine habitats within the park. The potential for organic and trace element contamination from urban development and agriculture (e.g., cranberry bog plantations) have prompted the park to partner with various entities in the basin for consultation and support.

The NPS-NAWQA project at St. Croix National Scenic Riverway is being conducted by a team of hydrologists, biologists, chemists, and hydrologic technicians stationed in Mounds View, Minnesota with support from USGS staff in Wisconsin. This team consists of personnel that specialize in water quality, environmental chemistry, data and GIS processing, aquatic biology, and geochemistry.

Water quality and ecological field work in 1996 consisted of water-quality sampling at three fixed sites in Wisconsin (Namekagon River near Leonards, St. Croix River near Danbury, and St. Croix River at St. Croix Falls), and bed sediment and tissue sampling at the Namekagon River near Hayward, Wisconsin.

Monthly and high-flow water-quality sampling continued at the jointly-funded fixed site on the St. Croix River near Danbury, Wisconsin. However, no samples were collected in December and January due to government furloughs. Monthly water-quality sampling began in April at fixed sites on the Namekagon River at Leonards, Wisconsin and St. Croix River at St. Croix Falls, Wisconsin. Water-quality samples were collected for the determination of major ions, nutrients, suspended sediment, suspended and dissolved organic carbon, chlorophyll *a*, and phytoplankton. Streamflow has been monitored at the Danbury and St. Croix sites since 1912 and 1902, respectively, and continuous streamflow monitoring on the Namekagon River at Leonards began in March. Near Danbury, samples were collected over 80 percent of the streamflow range that occurred in water year 1996. In the Namekagon River near Leonards, samples were collected over 77 percent of the streamflow range that occurred from March through October. In the St. Croix River at St. Croix Falls, samples were collected over 93 percent of the streamflow range that occurred in water year 1996.

Preliminary results indicated the water at the three fixed sites was predominantly a calcium-magnesium-bicarbonate type. Calcium concentrations ranged from a minimum of 7 to a maximum of 20 milligrams per liter (mg/L). Alkalinities were low relative to concentrations measured at the other stream sites outside of the St. Croix River Basin. Mean concentrations ranged from approximately 35 to 46 mg/L as calcium carbonate. Suspended sediment concentrations ranged from a minimum of 3 to a maximum of 62 mg/L. The largest suspended concentration occurred in the St. Croix River at St. Croix Falls (62 mg/L) during a streamflow recession in April. Concentrations of nutrients were low relative to concentrations measured in other stream sites outside of the St. Croix River Basin. Concentrations of nitrite, dissolved orthophosphate, dissolved phosphorus, and total phosphorus were near or below reporting limits (0.01 mg/L). Dissolved nitrite plus nitrate nitrogen concentrations ranged from below the method

reporting limit (0.05 mg/L) to 0.18 mg/L. Total organic plus ammonia nitrogen concentrations ranged from below the reporting limit (0.2 mg/L) to 0.7 mg/L. Concentrations of suspended organic carbon ranged from 5.4 to 7.7 mg/L, and concentrations of dissolved organic carbon ranged from below the reporting limit (0.1 mg/L) to 0.8 mg/L.

Ecological work during 1996 included collection of fish, algae, invertebrates, and instream habitat measures. To date, fish data have been analyzed the most and are focused on here. Two measures or metrics of fish used for biological assessment include species composition and trophic composition. Preliminary analysis of fish community data includes summaries of species diversity (number of species) and composition based on trophic level. Species diversity is expected to be lower at disturbed sites; however, barriers to migration and water temperatures also have a significant impact upon fish distribution. Species diversity found among all sites ranged from 16 species at the Namekagon River at Leonards to 30 species at both the St. Croix River at Danbury and Osceola. Disturbance in a stream often results in trophic-level shifts due to changes in food resources. Degraded streams generally support a higher percentage of omnivores (those fish that can feed on a variety of food sources). The Namekagon River had 16 percent piscivores (comprising 60 percent of the biomass) and 84 percent invertivores (comprising 40 percent of the biomass). The Namekagon River is a cold water, high velocity habitat that supports a trout fishery. The St. Croix River at Danbury was comprised of over 80 percent invertivores comprising over 90 percent of the biomass and the remainder were piscivores. The Danbury site has complex and variable habitat features which could support a complex fish community. Downstream on the St. Croix River at Osceola there were approximately 15 percent omnivores (carp, comprising 50 percent of the biomass). The habitat at the Osceola site is much less variable that at Danbury and can be characterized by extensive sand flats with occasional woody snags and limited boulder or cobble areas. The invertebrate community at Osceola did not appear as dense as it was at Danbury.

Sediments and aquatic animal tissue often contain higher concentrations of potentially toxic trace elements and hydrophobic organic compounds than the surrounding water column. Thus, bed sediment and tissue are often sampled for these constituents because these media are efficient indicators of trace level contaminants and because these constituents can be hazardous to human and ecosystem health. In September 1996, USGS and NPS staff sampled bed sediment and tissue from the Namekagon River near Hayward. The stream reach sampled is located down-gradient of a ground-water contaminant plume that originated at a nearby gasoline spill. Analytical results are unavailable at the time of writing. In July 1995, bed sediment and tissue samples were collected from five sites on the St. Croix River mainstem and tributaries. Three sites were within the boundaries of the St. Croix National Scenic Riverway; Namekagon River near Leonards, St. Croix River near Danbury, and St. Croix River near Sunrise, Minnesota. Concentrations of trace elements, including arsenic, cadmium, chromium, lead, mercury, nickel, selenium, and zinc, were similar for each constituent within and draining to the St. Croix National Scenic Riverway park boundary. Only below the NPS boundary, at Hudson, Wisconsin, were trace element concentrations higher. Trace element concentrations within the park were similar to national median concentrations of 1991 NAWQA study units. Concentrations of most hydrophobic organic compounds including, phthalates, phenols, and polycyclic aromatic hydrocarbons and organochlorine insecticides were generally below or near detection levels in samples collected within or upstream of park boundaries. Organochlorine insecticide concentrations were

summarized last year; only the insecticide endosulfan-I was detected at concentrations from 1.6-3.2 micrograms per kilogram (µg/kg). No DDTs or PCBs were detected in bed sediment.

Trace elements and organic compounds are often concentrated in fish tissue which makes this matrix ideal for detection of these contaminants. Fish tissue were analyzed for trace elements (liver) and organic compounds (whole fish). Mercury was detected at three of the five St. Croix River sites above Taylor's Falls. Mercury concentrations ranged from 0.18 micrograms per gram (µg/g) at the Namekagon River at Leonards to 0.37 µg/g at the St. Croix River at Sunrise. The use of synthetic compounds such as organochlorine pesticides and PCBs were restricted in the mid 1970s; however, they still persist in fish tissue. Fish were collected at each site and the whole fish tissue analyzed for DDT (dichlorodiphenyltrichloroethane) and its metabolites DDD, and DDE (all as p,p'isomers) and polychlorinated biphenyls (PCBs). p,p'-DDE was detected at the St. Croix River at Danbury (17 and 5.6 µg/kg) and the St. Croix River at Hudson (26 µg/kg). Total PCBs were detected at one of the five St. Croix River sites. Total PCB concentration was 210 µg/kg at the St. Croix River at Hudson.

Grand Teton National Park - Upper Snake River Basin NAWQA Study Unit

Grand Teton National Park is dominated by the Teton Range and the Snake River Valley. In 1986, the park contracted with the USGS to monitor water quality on the Snake River at Flagg Ranch to determine background water quality entering the park. Since 1992, the Flagg Ranch site has been a NAWQA fixed-station reference site. The addition of a downstream site is important because it could provide water resource and biological information to assess potential impacts from various activities within the park (e.g., recreation, wastewater treatment, aggregate extraction).

Last year, the NPS-NAWQA project at Grand Teton National Park included the installation of a new streamflow gage (No. 13013650) on the Snake River at Moose, Wyoming. In 1996, the USGS Wyoming District collected the water-quality and ecological data, and maintained the streamflow gage. A joint funding agreement with the Teton County Natural Resource District was utilized to implement this collaborative project. Water quality and ecological data were analyzed; however, no contaminant data or invertebrate data have been received from the USGS laboratory to date.

Fourteen discharge measurements were obtained during water year 1996 (ranging from 1,050 to 18,230 cubic feet per second, cfs). The stage-discharge rating for the gage was adjusted on May 20 to account for channel scouring. Using the new rating, the maximum instantaneous discharge was 22,000 cfs (14.76 feet) on June 16. The minimum daily discharge, 967 cfs, occurred on December 21.

Water samples were collected near the gage located on the right downstream side of the Teton Park Road bridge, 1/4 mile west of Moose Junction, in Grand Teton National Park. The samples were collected by wading 500 feet upstream of the bridge at low flows and from immediately upstream of the bridge at higher flows. Water samples were collected on October 26, November 28, January 9, February 9, March 15, April 15, May 20, June 10, June 26, July 26, August 9, and September 10. One major high flow event was sampled on June 10. Water samples were

analyzed at the USGS National Water Laboratory (NWQL) in Colorado.

The ecological assessment was conducted approximately three river miles downstream of the Teton Park Road bridge. This is the same location used last year and represents a braided channel, which is the dominant channel characteristic in the mid-Snake River corridor. Access to the site was obtained from R-lazy-S guest ranch located in the northwest corner of Section 20, Township 42 North, Range 116 West. Due to high velocities and extreme depths in the main channel, all sampling was conducted along the right channel margin. The upper end of the sampling reach was located just below the outlet to Granite Creek Supplemental irrigation canal, and continued to a point 705 meters downstream. The reach consisted mainly of deep runs with very little riffle or pool habitat.

Macroinvertebrates: Semi-quantitative richest targeted-habitat (RTH) samples were collected at five locations in small riffles along the right channel margin, using a 0.425 mesh frame-net. Qualitative multi-habitat (QMH) samples were collected at all habitats along the right channel margin within the reach with a 0.212 mesh net. The RTH and QMH samples were preserved with a 10 percent Formalin solution immediately after collection and will be analyzed at the NWQL.

Algae: Quantitative RTH periphyton samples were collected at the same five locations in riffle areas where the RTH macroinvertebrate samples were collected. A sub-sample was taken from the RTH sample and was filtered for chlorophyll *a* & *b*, plus biomass. QMH samples were collected at various habitats along the right channel margin. RTH and QMH samples were preserved with a 10 percent Formalin solution immediately after collection and were submitted to the NWQL for analysis.

In addition, the following field parameters were collected: discharge (from the rating curve); specific conductance at 25 degrees Celsius; pH; dissolved oxygen (mg/l and percent saturation); and water temperature (reported to the nearest 0.5 degrees Celsius). No photo documentation was done this year at transects 1, 2, and 4, but are on file at the USGS district office in Boise, Idaho. To insure consistency in future data collection activities, transect locations were documented in 1995 using a Global Positioning System.

Curecanti National Recreation Area, Black Canyon of the Gunnison National Monument, and Rocky Mountain National Park - Upper Colorado River Basin NAWQA Study Unit

Curecanti National Recreation Area encompasses Blue Mesa, Morrow Point, and Crystal Reservoirs of the Colorado River Storage Project's Aspinall Unit. Black Canyon of the Gunnison National Monument is located at the outfall of the lower reservoir. Land use activities upstream and within these two parks (such as: grazing, logging, mining, development, recreation, and dam operations) may ultimately impact these high quality waters. This situation has prompted both parks to conduct baseline monitoring and actively participate in studies by other federal and state agencies. Rocky Mountain National Park has supported various water-related research in the past, but has conducted little baseline monitoring. The Colorado River site was selected to provide long-term water quality data for an important river in the park.

The NPS-NAWQA project in the Upper Colorado basin involved collaborative monitoring at three water quality stations located at Curecanti National Recreation Area, Black Canyon of the Gunnison National Monument, and Rocky Mountain National Park. The Gunnison River below the Gunnison Tunnel (or East Portal site) is on the boundary between two park units. This site was selected because it characterizes water quality discharged from three reservoirs and establishes baseline water quality for the Wild and Scenic River segment of the Gunnison River. The Gunnison River at Riverway site represents an important site to NPS because it is located between the town of Gunnison and the park. The Colorado River below Baker Gulch site represents an excellent pristine reference site on the main stem of the river.

In fiscal year 1996, seven water quality samples were collected at the Gunnison River at County Road 32 (Riverway), which is located at the inflow to the Curecanti National Recreation Area. Data collection started in October, 1995, and samples were collected bimonthly with one additional extreme flow sample. Water samples were analyzed for nutrients, major cations, anions, and metals, organic carbons, suspended sediment, and field parameters. Stage measurements for discharge were also collected on an hourly basis at two stations upstream of this station. Discharge was measured at the Gunnison River at County Road 32 station to compare with the discharges of the two upstream stations.

Fifteen water quality samples were collected at the Gunnison River below the Gunnison Tunnel, which is located at the downstream end of the Curecanti National Recreation Area and the upstream end of the Black Canyon of the Gunnison National Monument. Data collection started in October, 1995, and samples were collected monthly with three additional extreme flow samples. Water samples were analyzed for nutrients, major cations, anions, and metals, organic carbon, suspended sediment, and field parameters. Stage measurements for discharge were collected on an hourly basis at the station.

Water quality data were analyzed to compare the two stations on the Gunnison River and to determine any significant findings. Detailed preliminary summaries with box plots and Piper diagrams were produced. The general conclusions of the analysis are very similar to last year. The nutrient concentrations are low or at reporting levels for both stations, and there is less variability in nutrient concentrations at the Gunnison Tunnel station. Many of the major ions are similar for the two stations, but the largest differences are found in potassium, chloride, and sulfate. The Gunnison Tunnel station has higher values of potassium and sulfate, whereas the County Road 32 station has slightly higher values of chloride. Iron and manganese are definitely higher at County Road 32. In general, there is greater variability in the data from the County Road 32 station. Constituents associated with the suspended phase (e.g. sediment, suspended organic carbon) definitely have a lower concentration and a very low variance at the Gunnison Tunnel station. The "reset" mechanism of the Aspinall Unit is observable as would be expected.

Fifteen water quality samples were collected at the Colorado River below Baker Gulch, which is located at the downstream end of Rocky Mountain National Park on the Colorado River. Data collection started in October, 1995, and samples were collected monthly with three additional extreme flow samples. Water samples were analyzed for nutrients, major cations, anions, and metals, organic carbon, suspended sediment, and field parameters. Stage measurements for discharge were collected on an hourly basis at this station.

Water quality data were analyzed to determine any significant findings at this station. Detailed preliminary summaries with box plots and Piper diagrams were produced. The general conclusions of the analysis follow. This station is a reference-background station, and the water quality reflects the station type. There were a few detections of ammonia and nitrite plus nitrate. All other nutrient concentrations were below the reporting levels. Some dissolved organic carbon (DOC) is present in the water, but the concentrations are low. Suspended organic carbon (SOC) concentrations are very low. Sum of cations and anions are in the 600 microequivalents per liter range reflecting the dilute water. There is some fluoride, iron, and manganese as a result of local geology, and all other concentrations are low. Conductivity is around 60 microsiemens per centimeter and pH is circumneutral.

Yosemite National Park - San Joaquin-Tulare Basins NAWQA Study Unit

Yosemite National Park receives heavy visitor use in the Merced River drainage. Synoptic and long-term water resource and biological information is needed to determine if there are changes in the water quality of the Merced River as it moves through the Yosemite Valley. The park is interested in evaluating benthic community responses to water quality changes, and analyzing long-term trends in riparian, wetland and stream habitats related to the Merced River Restoration Project.

The NPS-NAWQA project in Yosemite National Park is being conducted by USGS personnel working out of the California District Office in Sacramento, California. The project involved physical, chemical, and biological sampling at several sites on the Merced River in Yosemite Valley. In 1996, the project focused on synoptic biological monitoring. Six reaches were sampled on the Merced River within Yosemite National Park. These reaches, proceeding from upstream to downstream, were:

1. Merced River near Happy Isles gaging station. This station has been sampled each summer since 1993.

2. Merced River above Clark's Bridge. This station was sampled for RTH algae in 1995. This station is at the upper end of Upper Pines campground.

3. Merced River below Ahwahnee Bridge. This was a new station chosen to correspond with an area of ongoing river restoration work. The intent is to gather background data for assessment of any changes in response to the work. The station is located in the area of Lower Pines and Upper River campgrounds.

4. Merced River below Stoneman Bridge. This was also a new station chosen to monitor river restoration work. The station is located at Housekeeping Camp and included an area of intensive bank improvement efforts.

5. Merced River near Yosemite Lodge. This station was sampled for RTH algae in 1995. It is located just upstream of the footbridge.

6. Merced River at Pohono Bridge. This site was sampled in 1994 and 1995.

Work at these sites included the NAWQA habitat protocol and collection of RTH and QMH invertebrates, and RTH and QMH algae. All work was completed on September 17-19, 1996. All samples have been submitted for analysis.

An administrative report will be prepared which summarizes data collected at Yosemite National Park between 1993 and 1996. All water quality, bed sediment and tissue, stream habitat, and some algae and invertebrate data will be presented in this report. NPS may fund a professional USGS Open-File Report, which would analyze all NAWQA data from the park, at some time in the future after the remaining biological data is received from the USGS laboratory.

Lake Mead National Recreation Area - Nevada Basin and Range NAWQA Study Unit

Lake Mead National Recreation Area, formed by Hoover Dam on the Colorado River, is the largest reservoir in the western United States. The water of Lake Mead is used for public supplies, aquatic habitat, and recreation. Las Vegas Wash transports urban runoff, industrial discharge, and treated sewage effluent from the Las Vegas urban area to Las Vegas Bay of Lake Mead. This flow may contain synthetic-organic compounds that could pose potential threats to humans and wildlife.

A cooperative investigation by the NPS and USGS NAWQA Program is being conducted to answer questions about the occurrence, distribution, and bioavailability of hydrophobic synthetic-organic compounds in surface water and bottom sediment of the Lake Mead National Recreation Area. Concurrent collaborative studies by the NAWQA Program, the USGS Biological Resources Division (formerly the National Biological Service), and the U.S. Fish and Wildlife Service are being conducted to evaluate endocrine disruption and histopathologic effects in carp (Cyprinus carpio). The Bureau of Reclamation and the U.S. Environmental Protection Agency are providing services in support of this investigation.

The first phase of this investigation, an occurrence survey to identify potential endocrine-disrupting chemicals present in Las Vegas Wash and Bay of Lake Mead, was carried out in the spring and summer of 1995. Semipermeable-membrane devices (SPMD's) were used to sample the water column in Las Vegas Wash, Las Vegas Bay, and Callville Bay (a reference site for comparisons to Las Vegas Bay). SPMD's are passive sampling devices that contain fish lipid or triolein in a low-density polyethylene tube; they are effective in sequestering organochlorines and semivolatile industrial compounds from water and in assessing their bioavailability. Carp were collected from these three sites using electrofishing techniques. Bottom-sediment samples were collected from Las Vegas and Callville Bays. SPMD, bottom-sediment, and carp-tissue samples were analyzed for organochlorines (pesticides and industrial compounds) and semivolatile industrial compounds. Blood-plasma samples from the carp were analyzed for male and female sex-steroid hormones and for vitellogenin, an estrogen-controlled egg protein that normally occurs only in females. Samples of carp hepatopancreas, liver, and gonads were analyzed for histologic abnormalities that could be caused by the presence of synthetic organic compounds.

The results of the first phase of the investigation were presented at the 17th Annual Meeting of the Society of Environmental Toxicology and Chemistry, which was held in Washington, DC on

November 17-21, 1996. The results also have been published in USGS Water-Resources Investigations Report 96-4266 (Bevans and others 1996). The principal results are:

1. Concentrations of organochlorines were higher in SPMD, carp-tissue, and bottom-sediment samples from Las Vegas Wash and Bay than in samples from Callville Bay, the reference site.

2. Concentrations of polycyclic aromatic hydrocarbons (PAH's), phthalates, and phenols were higher in bottom-sediment samples from Las Vegas Bay than in samples from Callville Bay.

3. Median concentrations of DDT residues in cross-section samples of carp from Las Vegas Wash and Bay exceeded some risk-based consumption limits for cancer. DDT residues and Aroclor 1254 exceeded some risk-based consumption limits for chronic-systemic health effects.

4. Endocrine disruption of carp from Las Vegas Wash and Bay, compared to Callville Bay, was shown by high levels of male sex-steriod hormone in female carp from Las Vegas Wash and low levels in male carp from Las Vegas Bay. The most compelling evidence of endocrine disruption was the occurrence of vitellogenin in male carp from Las Vegas Wash and Bay.

5. Bioassays of carp tissue indicated the presence of dioxins or furans with low toxic-equivalent factors, relative to 2,3,7,8-tetrachloro-dibenzo-p-dioxin, in Las Vegas Wash and Bay; this is consistent with the types of dioxins and furans detected in SPMD and bottom-sediment samples.

6. Patterns of necrosis observed in hepatopancreas and kidney samples of carp were consistent with long-term subchronic exposure to toxicants.

The second phase of the investigation, a distribution survey to identify general source areas of synthetic-organic compounds to Lake Mead, was carried out in the spring and summer of 1996. Tributaries to Las Vegas Wash (Las Vegas Wash above its confluence with Flamingo Wash, Flamingo Wash, Sloan Channel, and Duck Creek) were sampled for compounds in bottom sediments. SPMD's were used to sample the Las Vegas Wasteway, which transports treated sewage effluent from city and county facilities to Las Vegas Wash. Las Vegas Wash bottom sediments also were sampled near Henderson, downstream from tributary and wasteway inputs. SPMD, bottom-sediment, and carp samples were collected from the inlets of the Muddy, Virgin, and Colorado Rivers to Lake Mead. Carp-tissue samples were collected at the inlet sites but have not been analyzed. Carp blood-plasma analyses have not been completed. Organochlorine analyses for SPMD samples have not been completed. Preliminary analyses of SPMD and bottom-sediment data indicate:

1. Las Vegas Wash above Flamingo Wash had the highest numbers and concentrations of organochlorine pesticides, polycyclic aromatic hydrocarbons (PAH's), phenols, and phthalates in bottom-sediment samples.

2. Dioxin and/or furans were detected in all Las Vegas Wash and tributary bottom-sediment samples. Las Vegas Wash near Henderson had about twice as many compounds and twice the concentrations of any tributary.

3. SPMD samples from the Las Vegas Wasteway had higher concentrations of organochlorine pesticides and dioxins and furans than any other site sampled during the occurrence and distribution phases of this study.

4. Bottom-sediment samples from the Muddy, Virgin, and Colorado River inlets had no organochlorine pesticides and concentrations of phthalates were less than half of those measured in Las Vegas Bay.

5. SPMD samples from the Muddy, Virgin, and Colorado River inlets had much lower concentrations of PAH's than those measured in Las Vegas Bay Wash and Bay.

Chattahoochee River National Recreation Area - Apalachicola-Chattahoochee-Flint River Basin NAWQA Study Unit

Chattahoochee River National Recreation Area is located north of the Atlanta Metropolitan Area and receives heavy recreational use on the weekends. In addition, suburban development along the river corridor contributes significant sediment and contaminant loads to the river. Many agencies, organizations, and user groups (such as the Chattahoochee Riverkeeper) are involved in studying and interpreting the river resources. Better coordination and cooperation amongst organizations and users is needed to protect this resource. In addition, better information and education on water quality issues and threats is needed by the general public.

In May 1996, the NAWQA study team and the NPS began a project to publish a lay reader publication that describes water-quality issues in the Atlanta Metropolitan Area and the upper Chattahoochee River watershed. The publication, a 36 by 46 inch poster, will: 1) summarize selected findings of the NAWQA study, 2) provide the NPS with an educational tool to aid in protecting the water resources of the Chattahoochee National Recreational Area, and 3) provide educators and the interested public with a brief and colorful summary of water-quality concepts and issues related to urban development in the Atlanta Metropolitan Area and the Upper Chattahoochee River.

In December 1996, the poster was approved for publication as a USGS Water-Resources Investigation Report (Hippe and others 1997). In February 1997, final corrections were made to the poster, and its publication date was in March 1997. Color separates of the publication were prepared by the USGS Cartographic and Publications Program office located in Madison, Wisconsin. It was printed by the USGS National Mapping Division located in Reston, Virginia. The poster contains 15 illustrations, 21 photographs, and text that describes 9 major topics: population growth, erosion and sedimentation, urban runoff, phosphorus, sewage overflows, waterborne pathogens, toxic metals, pesticides, and pcbs and chlordane in fish. The poster was produced using Adobe Illustrator software on a Macintosh computer.

A team approach was used to design and review the poster. Team members included the authors, USGS reviewers, and outside reviewers. The outside reviewers were chosen to represent the primary customers of the poster. Copies of the poster have been distributed to organizations which participated in or expressed an interest in the project, and the poster will be available at the Chattahoochee National Recreation Area visitor center.

Rocky Mountain National Park - South Platte River Basin NAWQA Study Unit

Rocky Mountain National Park has supported water-related research in the past (e.g., Loch Vale water quality studies), but has conducted little baseline monitoring. Streams and rivers draining east toward the South Platte River receive the heaviest recreational use in the park. Meadows in these drainages are also sanctuaries for elk. The Big Thompson River is the largest river drainage on the eastern slope of the Continental Divide in the park, and no long-term water quality data are available for this river.

In 1995, the USGS, in cooperation with NPS, established a long-term stream water quality monitoring station in Rocky Mountain National Park, Colorado. The station, Big Thompson River below Moraine Park near Estes Park, is part of the USGS NAWQA program-- South Platte River Basin Study. The approach taken by NAWQA to assess the water quality of streams is based on three interrelated components: Physical, Chemical, and Biological Studies. This document summarizes work completed by the USGS during fiscal year (water year) 1996 which involved data collection and analysis in all three components.

The surface water quantity and quality results which are discussed below will be published in the annual data report for Colorado streams (Crowfoot and others, in review). The data report will be published by late May.

Surface Water Quantity - In 1996, a stage-discharge relation (rating table, rating curve) for the Big Thompson River monitoring site was derived from monthly discharge measurements. Ten measurements were used in the development of the rating. Five measurements, made during the winter months under ice affected conditions, were not used for rating purposes. Stream stage data recorded at the site were used in conjunction with the stage-discharge relation to produce a record of daily mean streamflow for the entire year. Daily mean streamflow varied from a minimum of 3.4 cfs in late February and early March to a maximum of 410 cfs on June 10. The maximum instantaneous streamflow equal to 510 cfs occurred on June 11 at 0115 hours.

Surface Water Quality - Thirteen water samples were collected for chemical analysis during the 1996 water year. Streamflows sampled ranged from 3.4 cfs on March 8 to 292 cfs on June 17. Water samples were analyzed at the USGS National Water Quality Laboratory in Arvada, Colorado for total and dissolved nutrient (nitrogen and phosphorus) species, and measurements of discharge, water temperature, dissolved oxygen, pH, alkalinity, and specific conductance were obtained in the field.

Results of water quality analyses indicate that stream water at the monitoring site is primarily unaffected by anthropogenic sources. Among the field parameters, specific conductance is generally below 30 microsiemens per centimeter, pH ranges from slightly acidic to neutral, water temperatures are primarily less than 10 degrees Celsius, dissolved oxygen is high and typically ranges from 90 to 100 percent of saturation, and the buffering capacity of the water is low with values of alkalinity generally less than 8 mg/L as calcium carbonate. The concentrations of most nitrogen and phosphorus species were less than detection levels. Nitrate was detected in every sample; however, nitrate values were much less than the maximum contaminant level (MCL) of 10 mg/L nitrate as nitrogen, which has been set by the Environmental Protection Agency for drinking water. Suspended sediment concentrations in samples were low throughout the year,

even during high flow in May and June when suspended sediment concentrations were equal to or less than 10 mg/L. Suspended sediment was primarily transported in the clay and silt size fractions, or in sizes finer the 0.062 millimeters. In addition to the environmental samples, three replicate samples and two equipment blanks were processed for this site in 1996.

Biological Studies - The biological components of NAWQA consist of ecological surveys and fish tissue and bed sediment contaminant studies. Ecological surveys are designed to characterize fish, benthic invertebrate, and algal communities and associated instream and riparian habitats. The fish community survey was completed on August 20, 1996. With the help of personnel from the Colorado Division of Wildlife, forty-nine fish (45 brown trout, 1 rainbow trout, and 3 longnose suckers) were temporarily captured in a 200 meter reach in the vicinity of the stream gage. Each fish was identified, measured, weighed, and checked for anomalies such as deformities, lesions, tumors, and blindness. All fish were immediately returned to the stream unharmed. Benthic invertebrate and algal samples were also collected in August for taxonomic identification; however, results are not available at this time.

A survey of instream and riparian habitat was completed for the 200 meter reach in 1996. Several hundred survey points were acquired by measuring width and depth of channel transects, bank features, and delineation of the flood plain. Initial review of the 1995 and 1996 surveys indicate that geomorphic conditions are good (for example, satisfactory pool, riffle, and run sequences exist in the stream), however, bank stability is poor, and probably results from intensive elk grazing during winter months and from angler traffic during summer.

Concurrent with the fish community survey, fish tissue and bed sediment samples were collected for analysis of organochlorine compounds and trace elements. None of the organochlorine compounds analyzed were detected in fish tissues or bed sediment. Results of the trace element analysis are not available at this time but will be forwarded to the NPS upon receipt and review by the USGS.

Data Availability/Access - Physical, chemical, and biological data are now readily accessible via the South Platte NAWQA Web Page on the World Wide Web (Qi and Dennehy 1997). An on-line data report is accessible to retrieve and download data of interest specific to the Big Thompson River monitoring site. All the available data that have been collected and analyzed to date are accessible via the web.

Ozark National Scenic Riverways and Buffalo National River - Ozark Plateaus NAWQA Study Unit

Ozark National Scenic Riverways is located in a region influenced by karst topography. The park contains two major rivers (Current River and Jacks Fork) and several large springs. Big Springs is thought to be the largest single-outlet freshwater spring in the world. The springs are the primary sources of surface flow to the two rivers. Canoeing and fishing are traditional recreational uses that depend on a consistent supply of high quality water. Land use activities in the watershed posing water quality concerns include: past and proposed lead mining, timber harvesting and milling, cattle and hog grazing, horse trailing, and dump sites. Buffalo National River is also influenced by karst geology, with numerous caves, cliffs, sinkholes, waterfalls, springs, and rock formations. Agricultural land uses predominate along this river corridor.

The NPS-NAWQA project was expanded to two parks during fiscal year 1996. This change was made because of the shift to low intensity monitoring by the Ozark Plateaus NAWQA study unit. Three NPS fixed-station sites previously supported by NAWQA were not scheduled for monitoring during this period. As a result, NPS-NAWQA funds for the Current River station were apportioned to support four NPS stations at a reduced monitoring frequency.

Two stream sites within the Buffalo National River in Arkansas, and two stream sites within the Ozark National Scenic Riverways in Missouri, were sampled quarterly in fiscal year 1996 as a collaborative effort between NPS and USGS NAWQA. These sites are: (1) Buffalo River near Boxley, Ark.; (2) Buffalo River near St. Joe, Ark.; (3) Jacks Fork River at Alley Spring, Mo.; and (4) Current River at Van Buren, Mo. The primary objective of this monitoring was to provide both NPS and USGS with continuing water-quality and quantity data at four stream sites of importance to our agencies.

Activities at the four stream sites listed above included USGS collection and analysis of water-quality samples and continuous streamflow. NPS collaborative funds were used specifically for:

1. Quarterly (November 1995; February, May, and August 1996) sampling for nutrients, common constituents, dissolved and suspended organic carbon, suspended sediment, bacteria, and field parameters at the Buffalo, Jacks Fork, and Current Rivers. An additional high-flow sample was also collected at the Buffalo River stations.

2. Upgrading of operation and maintenance of continuous streamflow at the Buffalo River near St. Joe gage from partial record to full record.

USGS Ozark Plateaus NAWQA funds were used for partial record gaging station operation and maintenance at Buffalo River near Boxley and Jacks Fork River, and all sampling travel and supplies. Other agencies participating in water-quality and streamflow monitoring at these four stations include the Arkansas Geological Commission and the U.S. Army Corps of Engineers. Water-quality data for all four sites were provided to NPS in tabular format.

Congaree Swamp National Monument - Santee River Basin and Coastal Drainages NAWQA Study Unit

Congaree Swamp National Monument contains the last significant stand of old-growth riverbottom hardwood forest in the nation. The park has approximately 90 tree species, with many holding state and national records for size. The Congaree-Santee River is a major river system on the southeast coast, and tributaries in the park are typical of blackwater streams. Industrial and municipal discharges, water withdrawals, agriculture, and silviculture are examples of land uses that may affect water resources in the park.

The NPS-USGS cooperative water-quality study and ecological assessment of Congaree Swamp National Monument began in February 1996. Planned work consists of monitoring water quality in three tributaries that flow into the monument and a stream within the monument. In addition, water-quality is being monitored at a NAWQA site upstream of the monument in the Congaree River. Habitat and aquatic communities will be characterized at all of these sites.

The ecological well being of Congaree Swamp is largely dependent upon the quality of the water that enters it via the Congaree River and several small tributaries that drain into the swamp. The Congaree River is the main source of floodwaters to the swamp and the tributaries are the main sources of water during low- to moderate-flow conditions. Current land uses in the tributaries include agriculture, forestry, residential/commercial, and industrial development. These land uses could potentially lead to water-quality degradation in Congaree Swamp and expected further development in the watersheds could exacerbate the problem by accelerating runoff and increasing nonpoint-source discharges.

During fiscal year 1996, bed-sediment samples were collected at five locations. The sites included Myers Creek, Cedar Creek at SC 48, Cedar Creek near Wise Lake, Toms Creek, and Congaree River at the US 601 bridge. Samples were also collected upstream of the monument in the Congaree River near Columbia as part of the work associated with the NAWQA fixed surface-water site located there. Tissue samples were collected at the US 601 and Columbia Congaree River sites. Tissue sample collection for Myers Creek, Cedar Creek at SC 48, Cedar Creek near Wise Lake, and Toms Creek was delayed until fiscal year 1997 because of the absence of the target organism, the asiatic clam (Corbicula), at these locations.

The bed sediment and tissue samples will be analyzed for trace elements and hydrophobic organic chemicals including pesticides. The sediment samples give an indication of the availability of these chemicals in the ecosystem and the tissue samples will indicate which of the available chemicals are being taken up by the organisms. Corbicula were collected at the Congaree River sites for tissue analysis and in the tributaries, where Corbicula was absent, the target organisms will be the redbreast sunfish (Lepomis auritus). Both sediment and tissue tend to accumulate contaminants over long periods of time and can indicate the presence of chemicals that might be missed by synoptic water-quality samples. Detailed physical descriptions of the habitats at Myers Creek and Cedar Creek at SC 48 were completed in fiscal year 1996. Habitat work at Toms and Cedar Creek at Wise Lake will be completed in fiscal year 1997.

Water samples were collected and stream discharge was measured quarterly at Cedar Creek at SC 48, Cedar Creek at Wise Lake, Myers Creek, and Toms Creek in fiscal year 1996. Water samples were collected monthly and discharge was measured continuously at the Congaree River in Columbia. Water samples were analyzed for major ions, nutrients, organic carbon, bacteria, and pesticides. Samples were collected for analysis of pesticides only during the growing season (March-October or 3 times each year). Constituent loads were calculated using the discharge measurements coupled with the measured concentrations. All water-quality samples were collected using NAWQA protocols and analyzed at the USGS National Water Quality Laboratory in Arvada, Colorado.

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