

Opportunities to Improve the USGS National Water Quality Assessment Program

By Mark Gibson

By the 1980s, Congress, federal and state agencies, and industry had recognized a pressing need for a means to systematically assess and track the quality of water throughout the nation. The USGS—regarded as the primary national source of information on surface and groundwater hydrology and related water quantity issues—responded with the establishment of the National Water Quality Assessment (NAWQA) Program in 1985 to assess past, current, and future water-quality conditions and trends in representative river basins and aquifers (called study units) across the United States. Perhaps the most important facet of the program is that the similar design of each investigation and the use of standardized methods makes regional and national assessments of water quality (collectively called “national synthesis”) possible.

More specifically, the three goals of the program are to address the following: (1) status—description of water quality conditions for a large representative part of the nation’s freshwa-

ter resources; (2) trends—assessment of long-term changes in the quality of water resources; and (3) understanding—analysis of how human-related activities, management strategies, and the natural environment interact to control water quality in different parts of the nation. Although the exact wording of these goals has been refined over time, they continue to be the organizing and planning themes for NAWQA’s future and as such are discussed throughout the report.

Nearing completion of its first decade of nationwide monitoring (1991 to 2001; called Cycle I), in 1999 USGS scientists requested the input of the NRC to help shape NAWQA activities during the program’s second decade of monitoring, called Cycle II. This report presents the WSTB’s most recent (of five total) efforts to advise the USGS on the NAWQA program. Although some of the report’s conclusions and recommendations revisit the issues discussed by previous WSTB committees, the majority of the report concerns the increased emphasis in Cycle II on de-

fining long-term water quality trends and understanding the causative factors of water quality conditions.

During Cycle I, NAWQA concentrated primarily on gathering comparable information on water quality (“status assessments”) in a total of 51 study units nationwide. Notably, because of budgetary constraints, a total of eight study units that were slated for monitoring in Cycle I were never initiated. More recent budget constraints have dictated that the number of study units in the second decade of nationwide monitoring (called Cycle II) be further reduced to 42, plus the High Plains Regional Ground Water (HPGW) Study, which was initiated in 1999. Because of this necessary reduction, issues of representativeness and coverage are even more central to Cycle II of the program than to Cycle I. Despite the significant reduction in the number of study units for Cycle II, the committee report concludes that Cycle II will still maintain good coverage of the nation’s stream and groundwater resources.

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The Missouri River Ecosystem: Exploring the Prospects for Recovery

By Jeffrey Jacobs

The Missouri River ecosystem has undergone a variety of human-induced changes since the mid-nineteenth century, many of them as part of efforts to modify the river for society’s needs. To help control floods, enhance navigation, and produce hydropower, seven dams and reservoirs were constructed on the river during the mid-twentieth century. Three of these reservoirs are among the five largest in the United States, and approximately one-third of the length of the river’s channel and floodplain has been submerged. The river’s length from Three Forks, Montana to its mouth at St. Louis has been shortened by roughly 200 miles (from about 2,540 miles to about 2,340 miles) by straightening its many meanders to promote navigation. Between Sioux City, Iowa, and St. Louis—a distance of roughly 735 miles—the river has been channelized.

In the summer of 1999, the WSTB assembled a committee to review the Missouri River ecosystem’s status and trends, science programs and status of scientific knowledge, and organizational choices for supporting ecosystem monitoring programs and for implementing adaptive management. The committee’s report was released in January 2002.

Ecosystem Status and Trends

The report lists several specific, quantified environmental changes in the Missouri River ecosystem. Examples of these changes include a reduction of the annual average pre-dam amount of sediment transported past Sioux City, Iowa roughly 142 millions to roughly 4 million tons today, and the alteration of nearly 3 million acres of natural riverine and floodplain habitat. The report concludes that “[d]egradation of the natu-

ral Missouri River ecosystem is clear and is continuing.” It further states that unless some portion of the hydrologic and geomorphic processes that sustained the pre-regulation Missouri River ecosystem is restored—including flows that emulate the natural hydrograph, and cut-and-fill alluviation processes—that degradation will continue.

State of the Science

There is a rich and extensive body of scientific research on the Missouri River ecosystem. A 1997 USGS report, for example, lists over 2,000 studies of the Missouri ecosystem. This body of work provides a sound scientific understanding of the ecosystem’s structure, functions, and how they have been affected by human actions. This body of research, however, has not been

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Assessment of NAWQA Cycle II Goals

Status. The status component of NAWQA is the baseline for all further trend- and understanding-related activities, including the existing priority issues selected for national synthesis (i.e., pesticides, nutrients, volatile organic compounds, trace elements, and ecological synthesis). The report supports the continuance of all of these national synthesis topics into Cycle II and also strongly recommends that NAWQA make sediment a national synthesis topic (i.e., summarize and synthesize findings on sediment, sediment-related pollutants, and habitat impairment from sediment). Despite reduced resources planned for Cycle II, several changes in water quality status assessments have been proposed for Cycle II and are assessed in the report. For example, NAWQA personnel have proposed to increase the program's focus on the most important previously unsampled stream and groundwater resources—especially those that serve as sources of potable water. The report concurs with this general strategy, as well as focusing on those sources most likely to be impacted by extensive urban and agricultural activities. Additionally, NAWQA proposes to add some new contaminants that have become high national priorities in the last decade (e.g., waterborne pathogens and indicator microorganisms, pharmaceuticals) to its list of constituents to be monitored in Cycle II. Because of the limited funds available, such additions must necessarily be limited. Thus, decisions about which additional contaminants to study in Cycle II of NAWQA should be made with direct input from the EPA and other agencies so that the most important contaminants from a policy-making standpoint can be monitored.

Trends. The reliable and early detection of trends is of fundamental value because it can provide information on changes in water quality (especially related to anthropogenic sources) that might be useful for decision mak-

ing and scientific understanding relating to the management of water quality. The report concludes that the USGS and NAWQA are well positioned to carry out the important work of assessing trends in Cycle II. In this regard, NAWQA has established water quality baselines and monitoring networks in Cycle I and is operating at time and spatial scales sufficient to establish these relationships. Furthermore, NAWQA should continue emphasis on an integrated approach to water quality monitoring network design that attempts to coordinate efforts among various local, state, and federal agencies in an effort to make study unit designs as efficient and cost-effective as possible.

Understanding. Identifying and describing the factors that affect water quality can be gained through the linkage of field studies to the analytical use of models, where observations are compared to a conceptual relationship expressed mathematically. The success of such a model in explaining observations is regarded as a measure of understanding the primary factors or mechanisms involved. As NAWQA progresses into Cycle II, the importance of model application should not be underestimated as understanding and prediction, embodied in water quality models, are the cornerstones of water resources management for the future. Several types of models proposed for application in Cycle II are assessed in the report including those categorized as conceptual, mass balance, statistical regression, process based (mechanistic), and hybrids of these. At this important juncture in the development of NAWQA, the report concludes that the USGS has several major opportunities to advance scientific understanding of factors that affect water quality conditions. However, there is a strong concern as to whether or not sufficient staff, resources, and expertise are allocated to ensure that modeling efforts and targeted studies can be developed and implemented adequately. Regardless, the report strongly recommends that at least a conceptual mass balance be developed for the nonpoint source pollutants studied in each study unit. Furthermore, NAWQA and the USGS should focus on simple, parsimonious process models (i.e., models that

are not overparameterized), where parameter estimation and mechanistic expressions can be related to available data.

Cooperation and Coordination and the Future of NAWQA

The national scope of NAWQA and its potential to provide a nationwide perspective on the status, trends, and understanding of factors that affect water quality have made it a focal point within the USGS. However, the increased use and visibility of NAWQA data and information often occur in conjunction with external attempts to influence the design or to cooperate to broaden NAWQA's coverage. In this regard, NAWQA must stay firm in its design to meet its national goals, and it should not change critical design plans to meet the diverse needs of the many federal, state, and local agencies. In the committee's view, NAWQA program staff has done an excellent job of establishing cooperative relationships within USGS and with external programs. These efforts have strengthened NAWQA and have improved the visibility and viability of the USGS as a whole.

In the last decade-and-a-half, NAWQA has progressed from a sound concept to a mature program that has led the way to allowing the critical, sound scientific assessment of the quality of the nation's waters. Indeed an assessment of NAWQA and its representative accomplishments to date finds it a mature and respected national program with hundreds of publications to its credit and many significant science and policy achievements for the program to build upon in the coming decade. To build on this success, NAWQA must strive to find the appropriate balance of efforts and resources between its three primary goals of status, trends, and understanding as it enters Cycle II. Furthermore, although NAWQA must strive to be responsive to water quality policy and regulatory needs, it cannot be driven or controlled by these needs—thus epitomizing the struggle

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well synthesized, nor are there many studies that consider the ecosystem as a single unit or that explore cross-disciplinary linkages.

The most significant scientific unknowns in the Missouri River ecosystem are how the ecosystem will respond to management actions designed to improve ecological conditions. Carefully planned management actions, combined with monitoring of their impacts, would be important steps toward implementing adaptive management for the Missouri River ecosystem. In addition to management actions and ecosystem monitoring, adaptive management would also entail input from a broad range of Missouri River stakeholders and the establishment of clear goals for the ecosystem.

Missouri River Navigation and Bank Stabilization

No management issue on the Missouri River has polarized the river's stakeholders as much as the debate over how the provision of river flows and channel depths for navigation has affected the Corps of Engineers' abil-

ity to meet ecosystem needs. Current dam and reservoir operations reduce the river's natural hydrologic variability in order to provide a reliable 9-foot deep navigation channel. But these reductions in natural hydrologic variability run counter to established river science, in which a large degree of natural variability is essential for biodiversity and productivity.

The report notes that net national navigation benefits on the Missouri River are relatively small, and that waterway traffic volume decreases as one moves upstream. Congress should therefore grant the Corps of Engineers authority to provide navigation services on an incremental basis along the channelized portion of the Missouri River, based on analysis and stakeholder input.

Policies, Institutions, and Adaptive Management

The Corps of Engineers has always set the water release schedules for the Missouri River mainstem dams, guidelines for which are contained in the Corps "Master Manual" for the mainstem reservoir system. Over time, an accretion of federal laws and congressional committee language, combined with shifting social values and preferences, have made the Corps' management decisions increasingly challenging and often controversial. For example, in the late 1980s the Corps began revisions to its 1979 Master Manual that, because of competing de-

mands for the river's resources and differences of opinion, are still not complete today.

The report thus recommends that a moratorium be enacted on further revisions to the Master Manual until such revisions reflect a collaborative, science-based approach, based upon adaptive management, to improve the state of the Missouri River ecosystem. As part of implementing adaptive management on the Missouri, the report also recommends the establishment of a stakeholder group to help provide input for river management decisions. Membership in the group should consist of a broad range of interest groups, including the Missouri basin states, Indian tribes, relevant federal and state agencies, environmental groups, the navigation industry, and floodplain farmers.

Finally, in order to ensure support of the adaptive management effort and to keep management actions focused on some degree of ecological improvements, the report recommends that Congress enact a Missouri River Protection and Recovery Act

The committee was chaired by Steven Gloss of the Grand Canyon Monitoring Research Center, Flagstaff, AZ. Funding was provided by the Corps of Engineers and EPA. The prepublication of the report is available through the WSTB at 202-334-3422.

Jeffrey Jacobs is a Senior Staff Officer at the WSTB.

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of doing "good science" in the public policy arena. Although NAWQA has done an exemplary job of downsizing for Cycle II, it cannot continue to do so and still be considered a *national* water quality assessment. Though it could certainly be redesigned, this would likely undo the basis for assessment of trends and would waste a decade or more of effort.

The committee was chaired by George Hallberg, principal of the CADMUS Group. Funding was provided by the USGS. To order the report, contact National Academy Press at 800-624-6242 or <http://www.nap.edu>.

Mark Gibson is a Staff Officer with the WSTB.

