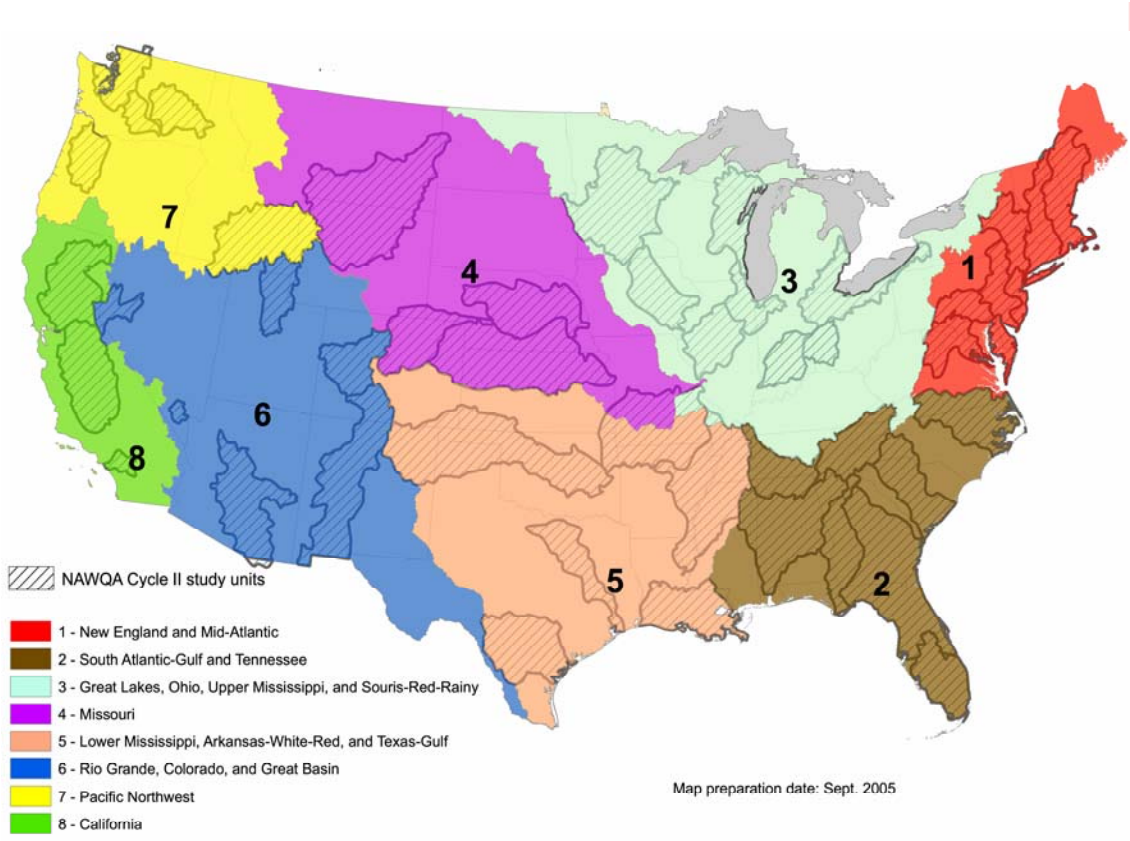
National Water-Quality Assessment Program—Modifications to the Status and Trends Network and Assessments of Streams and Rivers

Prepared by Charlie Crawford, Pixie Hamilton, and Anne Hoos for a NAWQA National Liaison Meeting, Washington D.C., October 5, 2006

Beginning in 2006, the National Water-Quality Assessment (NAWQA) Program is implementing several modifications to its surface-water status and trends network and assessments to meet funding reductions and to maximize the use of its stream-monitoring information. These include (1) a shift in the scale of data analysis and reporting from Study Units to larger "major river basins;" (2) incorporation of modeling with monitoring to help extend water-quality understanding of conditions, sources, and transport to unmonitored, yet comparable areas; and, (3) collaboration and integration of data from other Federal agencies, as well as regional, State, Tribal, and local organizations.

A major focus of the NAWQA Program in its second decade is on regional- and national-scale assessments of water-quality status and trends in streams and rivers. NAWQA has identified eight large geographical regions (referred to as "major river basins") as the basis for its status and trends assessments. The NAWQA assessments build upon previous findings generated from 1992-2001 for streams and rivers in smaller basins (referred to as "Study Units"). Primary goals remain the same: to characterize the status of surface-water quality (stream chemistry and ecology); determine trends at those sites that have been consistently monitored for more than a decade; and build an understanding of how natural features and human activities affect water quality. Analysis and reporting, however, will focus on status, trends, and understanding at the larger "major river basin" scale.



NAWQA's surface-water network continues to support many other activities in the Program (http://water.usgs.gov/nawqa). These include, for example, continuing national assessments on pesticides, nutrients, and stream ecology; and national topical studies on the transport of agricultural chemicals, effects of urbanization on stream ecosystems, nutrient enrichment, mercury in stream ecosystems, and transport of contaminants to public-supply wells (Gilliom and others, 2001).

Status and Trends Network

The number of sites included in NAWQA's status and trends network totals 113 across the 8 major river basins. Twelve of the current sites monitor conditions in large rivers that drain major agricultural areas within 8 of the regions and urban areas in 4 of the regions. The remaining sites represent smaller urban or agricultural watersheds. The NAWQA monitoring network uses a rotational sampling scheme; therefore, sampling intensity varies year to year at the different sites.

Characteristics of the NAWQA Surface-Water Status and Trends Network and Assessments

- Reduced number of sites from 145 monitored in 2001-2004, to 84 monitored from 2005-06, to 113 planned for monitoring from 2007-2012. Twelve of the 113 sites monitor conditions in large rivers that drain major agricultural areas within 8 of the regions and urban areas in 4 of the regions. The remaining sites represent smaller urban or agricultural watersheds.
- Integration of modeling and other scientific tools with monitoring data collected at individual sites to increase understanding of water-quality conditions related to sources and transport and to extend knowledge of water quality to unmonitored, yet comparable areas.
- Ambient resource assessment over decades, with a regional and national perspective.
- Evaluation of specific issues that vary by major river basin, including those related to ecological conditions and the occurrence, trends, and transport of nutrients and pesticides.
- Collaboration and integration of data with other Federal agencies, as well as regional, State, Tribal, and local organizations.

The current status and trends network is considerably reduced from surface-water monitoring supported from 1992-2001, during which a total of nearly 500 sites were sampled at various frequencies to assess the current water-quality conditions (status). On the basis of this reduction, along with acknowledgment that cost-effective management of water resources requires more information than what is available currently at Federal and State levels (Government Accountability Office, 2004; see inset, page 3), NAWQA has implemented several water-quality assessment techniques to maximize the use of its stream-monitoring information.

- *Data from other USGS programs and other Federal, regional, State, Tribal, and local organizations are integrated into NAWQA assessments, where appropriate.* Comparable and consistent data on nutrients, hydrologic conditions, and stream ecology, as well as on landscape features, such as land use and land cover and point-sources of discharge, are used to fill critical gaps in information. For example, data from 32 sites in the USGS NASQAN (National Stream Quality Accounting Network) Program provide information on streamflow and transport of nutrients, sediment, and other compounds in some of the

Nation's largest rivers. Spatially extensive, statistical estimates on stream chemistry and ecology, such as available through State monitoring programs and the U.S. Environmental Protection Agency (EPA), provide enhanced geographic coverage of stream conditions. Integration of spatial and temporal information from multiple programs will help each of the programs go beyond what each could achieve individually.

- *Modeling and other scientific tools are developed on the basis of monitoring data collected at individual sites.* The integration of monitoring and modeling is expected to help extend water-quality understanding of conditions, sources, and transport to unmonitored, yet comparable areas (beyond boundaries of the 42 Study Units to include tributary streams draining to the Nation's largest rivers in the conterminous U.S.). In addition, the models and tools will help to evaluate resource- and land-management scenarios and to predict how protection actions and land-use decisions are likely to affect water conditions within a region.
- *Assessments are conducted and reported at a "major river basin" scale.* The reduced number of sites in the status and trends network results in insufficient data to analyze water-quality conditions at the Study-Unit scale and has, therefore, shifted to major river basins. Fewer reports will result from the analyses at the larger spatial scale. However, it is anticipated that interpretations will be based on more substantive integrated data sets (representing data from other organizations), and thus remaining scientific validity.

Status of Water-Quality Monitoring in the U.S.

Several studies by the Government Accountability Office (2002, 2004), The H. John Heinz III Center for Science, Economics, and the Environment (2002), National Research Council of the National Academies (2004), and other organizations have documented the inadequacy of current water-quality monitoring efforts in the U.S. in recent years. Overall findings point to a lack of consistent and comprehensive, national-level data; the possibility that serious problems may go undetected; data gaps that limit cost-effective management and regulation; and a lack of information on whether water quality is getting better or worse. The most recent GAO study was done in response to the 2002 Heinz Center "State of the Nation's Ecosystems" report stating that high-quality data support only half of 100 key indicators needed for monitoring ecosystem health and measuring the efficacy of environmental protection. The GAO study noted continued slow financial erosion of U.S. water-quality data. It found that 6 of 20 Federal programs—including the USGS NAWQA Program—had produced high-quality environmental indicator data used in the 2002 Heinz report but may not be able to continue producing data of comparable quality, quantity, and scope for the planned 2007 Heinz report (Government Accountability Office, 2004). Specific findings cited in the GAO report and other reports on monitoring can be accessed at http://water.usgs.gov/wicp/acwi/monitoring/network/links.html.

Selected Issues Addressed by NAWQA's Status and Trends Assessments

NAWQA's surface-water assessments will address specific issues, such as trends in nutrients and pesticides; runoff and transport of nutrients and pesticides in urban areas; and the effect of chemical use, soil type, irrigation, and artificial drainage on pollutant transport in agricultural areas. Four issues are highlighted below.

Predictions of nutrient concentrations and loads at unmonitored sites: The USGS SPARROW (SPAtially Referenced Regression On Watershed attributes) model is used, and will continue to be refined, to assess relations between status and trends in nutrient concentrations and loads (amounts of nitrogen transported in streams) as a function of human and natural factors at the national scale and in 6 of the 8 major river basins. Changes in nutrient concentrations and loads are related to, for example, (1) changes in nutrient nonpoint and point sources

(including the use of fertilizers and manure and point discharges); (2) land use; (3) stream characteristics; (4) soil, geology, and other landscape features; and (5) farm and water-quality protection practices. Modeled findings can be used to identify sources and watersheds that contribute most to the transport of nitrogen to coastal and other receiving waters, including, for example, to the South Atlantic and Gulf of Mexico; Inland and Coastal Waters of the Northeastern U.S.; the Upper Mississippi and Great Lakes, and the Puget Sound. These assessments provide key information for managing hypoxia; for addressing water-quality impairments and Total Maximum Daily Loads (TMDLs); and for evaluating benefits of land management practices. Agencies across the Nation, including EPA, USDA, and the States rely on NAWQA assessments to inform such management decisions (Hamilton, 2005, written communication, http://water.usgs.gov/nawqa/xrel.pdf).

***Prediction of pesticide concentrations at unmonitored sites*:** NAWQA's national-scale pesticide models, such as the WARP (Watershed Regressions for Pesticides) model, will continue to be refined on the basis of status and trends information collected at NAWQA's surface-water network, together with information on pesticide use, land use, climate, soil characteristics, and other natural features. The model is used to estimate concentrations of atrazine and other pesticides in streams and at drinking-water intakes, and to predict the likelihood that annual average concentrations exceed certain values, such as EPA drinking-water standards and guidelines (Larson et al., 2004). The information is useful for pesticide management by EPA's Office of Pesticide Program and other Federal and State agencies with pesticide regulatory responsibilities.

Assessments of pesticide use and trends: Assessments of pesticide occurrence and trends are related to pesticide use, which is constantly changing in response to such factors as regulations and market forces. For example, NAWQA is assessing changes in concentrations of diazinon and other pesticides (chlorpyrifos, simazine, prometon, and simazine) in urban streams in the northeastern U.S. (Most urban uses of diazinon and chlorpyrifos, such as on lawns and gardens have been phased out since 2001 because of use restrictions imposed by the EPA.) Similarly, changes in pesticide concentrations are assessed in the Lower Mississippi-Texas Gulf River Basins and in streams draining corn-soybean areas of the U.S. where agricultural-use is changing. This information is particularly helpful to EPA in their assessments of the effectiveness of pesticide management programs, resulting in the introduction of new chemicals, regulation or phasing out of existing chemicals, or expanded registration of chemicals for different uses.

Characterization and prediction of stream ecosystem health in wadeable streams: NAWQA will develop and test ecological modeling and other assessment techniques for understanding and predicting stream ecological health in small (wadeable) streams in a region of the Nation. This effort will integrate NAWQA's long-term data on hydrologic, chemical, and stream ecological conditions with spatially extensive, statistical estimates such as available through State monitoring programs and the EPA Wadeable Streams Assessment program. The integrated assessments will help to (1) predict ecological conditions in unmonitored areas; and (2) relate changes in biological conditions to trends in concentrations of pesticides and nutrients, habitat; and natural hydrologic variation (such as natural fluctuations in streamflow).

How the study results can be used

The analysis of water-quality data in a regional and national context can provide useful information for understanding point and nonpoint sources, natural features, and human activities affecting water resources and ecosystems. Improved understanding can help prioritize streams for protection and restoration, reduce monitoring costs, and evaluate strategies for reducing concentrations of contaminants, such as nutrients in streams. In addition, findings and resource-needs in individual watersheds and basins can be placed within the context of the larger river networks and their receiving bodies of water. This is critical because local decisions related to land-use planning and development or other human actions in individual watersheds can contribute significantly to the cumulative or overall impact on the quality of the downstream resource and receiving water. Because water resources, biological communities, and ecosystems are interconnected across great distances, successful solutions and actions depend on local, State, interstate, and Federal involvement. Other specific applications of NAWQA information may result in improved:

- development of regional criteria and reference values in streams for the protection of aquatic and human health;
- determination of the level of and trends in stream impairment (required in EPA 303(d) reports);
- development of TMDLs, or Total Maximum Daily Loads;
- identification of useful ecological indicators of nutrient enrichment and pesticide contamination;
- prioritization of streams and geographic regions for land-management activities;
- evaluation of the effectiveness of environmental protection and management programs over time; and,
- use of limited monitoring resources to gain maximum information about water-quality conditions and trends.

For additional information about the status and trends network and assessments of streams and rivers, contact:

Charles G. Crawford
cgcrawfo@usgs.gov
(317) 290-3333, ext. 176

For online information, reports, and data from the NAWQA Program:

- Information on the national surface-water status and trends network and sampling design: http://water.usgs.gov/nawqa/
- Monitoring data and maps: http://water.usgs.gov/nawqa/data
- Summary reports of assessments conducted during the first decade in the 51 Study Units: http://water.usgs.gov/nawqa/nawqa_sumr.html
- Information and publications describing the national topical studies and national syntheses of pesticides, volatile organic compounds, nutrients, trace elements, and ecology: http://water.usgs.gov/nawqa/

References

Bricker, S.B., Clement, C.G., Pirhalla, D.E., Orlando, S.P., and Farrow, D.RG., 1999, *National Estuarine Eutrophication Assessment; Effects of Nutrient Enrichment in the Nation's Estuaries*: National Oceanic and Atmospheric Administration, National Ocean Service, Special Projects Office and the National Centers for Coastal Ocean Science, Silver Spring, Maryland, 71 pp.

Gilliom, Robert J., Hamilton, Pixie A., and Timothy L. Miller, 2001, *The National Water-Quality Assessment Program—Entering a New Decade of Investigations*: U.S. Geological Survey Fact Sheet 071-01, July 2001, 6 p. (and companion map)

Government Accountability Office, 2002, *Inconsistent State approaches complicate nation's effort to identify its most polluted waters*: Government Accountability Office, 2002, http://www.gao.gov/new.items/d02186.pdf .

Government Accountability Office, 2004, *Environmental Information: Status of Federal data programs that support ecological indicators*: Government Accountability Office, 2004, http://www.gao.gov/new.items/d05376.pdf.

Larson, S. J., C. G. Crawford and R. J. Gilliom, *Development and application of watershed regressions for pesticides (WARP) for estimating atrazine concentration distributions in streams*: U.S. Geological Survey Water-Resources Investigations Report 2003–4047, USGS, Reston, VA, 2004, p. 68.

National Research Council of the National Academies, *Confronting the nation's water problems: The role of research*: The National Academies Press, Washington, DC, 2004, http://books.nap.edu/books/0309092582/html/index.html.

Schwarz, G.E., A.B. Hoos, R.B. Alexander, and R.A. Smith, 2006, *The SPARROW Surface Water-Quality Model: Theory, Application and User Documentation*: U.S. Geological Survey Techniques and Methods, Book 6, Section B, Chapter 3, Online only at http://pubs.usgs.gov/tm/2006/tm6b3/#PDF

The H. John Heinz III Center for Science, Economics, and the Environment, 2002, *The state of the nation's ecosystems. Measuring the lands, waters, and living resources of the United States*: The H. John Heinz III Center for Science, Economics and the Environment, Washington, DC, 2002, http://www.heinzctr.org/ecosystems/report.html.