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focus on

Cycle 2:

Understanding the Factors that Govern Water Quality

on the web:

wi.water.usgs.gov/nawqa

What is NAWQA?

In 1991, the U.S. Geological Survey (USGS) began to implement a National Water-Quality Assessment (NAWQA) program. The long-term goals of the NAWQA program are to describe the status and trends in the quality of a large, representative part of the Nation's surface- and ground-water resources and to provide a sound, scientific understanding of the primary natural and anthropogenic factors affecting the quality of these resources.

To achieve these goals, the USGS is employing a multidisciplinary approach that includes the collection of physical, chemical, biological, and ancillary anthropogenic data. These data will provide multiple lines of evidence to assess water quality.

Study-unit investigations comprise the principal building blocks of the national assessment. The study-unit boundaries are based on one or more of the following: surface-water drainage basins, the extent of ground-water aquifers, and political boundaries (fig. 1). The second cycle of NAWQA begins with plans to conduct investigations in 42 of the original 59 study units.

Figure 1. National Water-Quality Assessment Program study units.

NAWQA Cycle II Recommendations
■ Scheduled to begin in fiscal year 2001
▩ Scheduled to begin in fiscal year 2004
□ Scheduled to begin in fiscal year 2007
□ Discontinued
▨ High Plains Ground-Water study area

What is Cycle 2?

In 2001, the U.S. Geological Survey's NAWQA Program began its second cycle of intensive water-quality assessments in the Western Lake Michigan Drainages (fig. 2). Scientists in Wisconsin, Michigan, and Illinois are working together to coordinate the research, field work, and report writing planned for the next 10-year period.

The major difference between Cycles 1 and 2 is an increased emphasis on topical studies, which
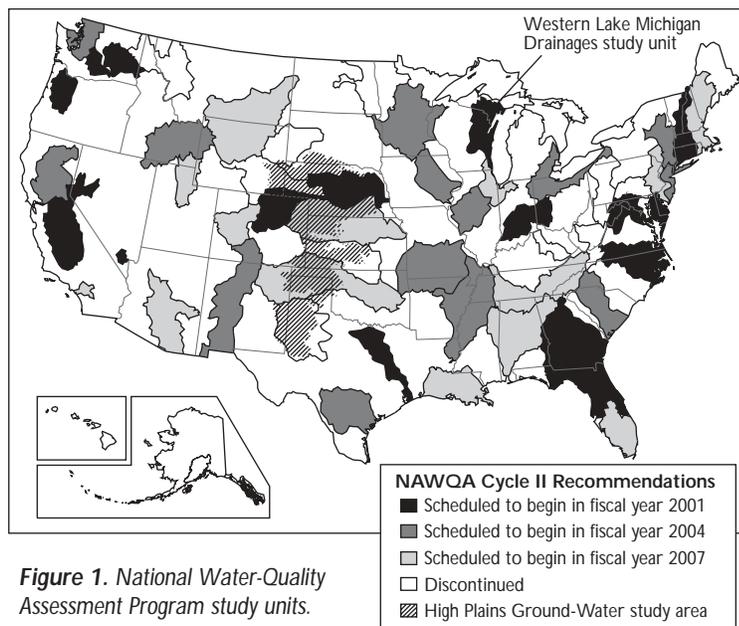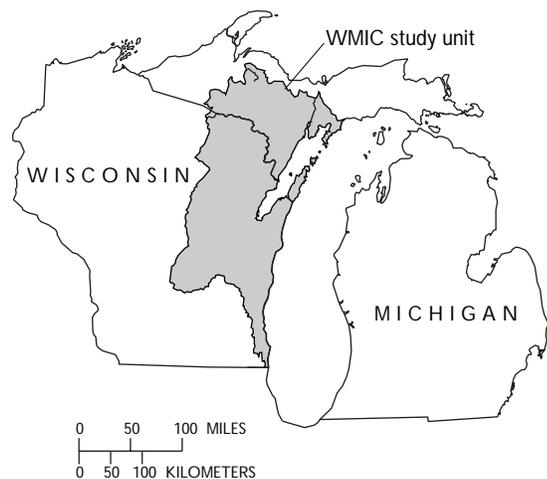

Figure 2. Location of Western Lake Michigan Drainages (WMIC) study area.

focus on developing an understanding of specific issues of concern. Status and trends, the major focus of Cycle 1, will receive a proportionally smaller percentage of funding in Cycle 2 (figure 3).
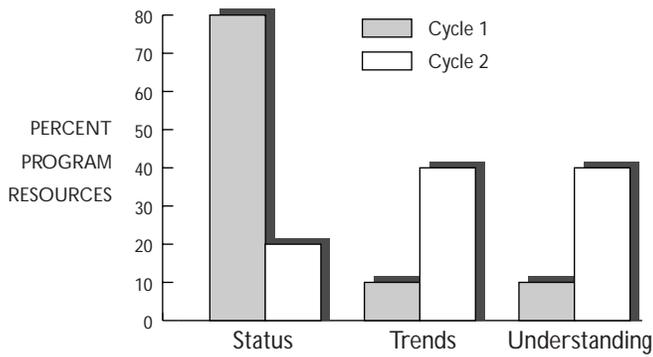
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U.S. GEOLOGICAL SURVEY

Figure 3. Allocation of program resources for Cycles 1 and 2.

Results from Cycle 1

Retrospective data analysis began in 1991, followed by intensive sampling and monitoring during 1993–96, and the preparation of 27 reports during 1997–2000. Selected results are summarized here; to see the reports list, visit our Internet site at http://wi.water.usgs.gov/nawqa/, or contact us to request copies of full reports.

A number of naturally occurring chemicals were found in concentrations that may pose a threat to human and aquatic health, including dissolved solids in the Cambrian-Ordovician (C-O) aquifer, arsenic in streambed sediments and the C-O aquifer, and radon in drinking-water wells.

Agricultural practices were found to affect water quality: as much as 96 percent of phosphorus in streams was attributable to agricultural practices. High nitrate concentrations were found in areas where permeable surficial deposits allowed nitrogen to reach shallow ground water.

Pesticides are widespread in the study area—atrazine was found in every surface water sample collected, including those from northern forested sites where little or no agriculture was present in the watershed. However, concentrations were 100 times greater in streams draining agricultural areas. As found in other studies, the concentrations were highest in spring during runoff events following application to fields.

Urban areas were found to be a source of trace elements and organic compounds in streams. PCB concentrations in sediment and tissues were 10 times higher in urban streams than non-urban streams. Concentrations of eight trace elements exceeded levels determined to have some detrimental effect on stream-dwelling organisms.

Evaluation of biological communities in Cycle 1 revealed that aquatic life was most degraded in urban areas. In these areas, there were few species present in fish and macro-invertebrate communities, and those that were present were generally species tolerant of pollution. In agricultural areas, quality of aquatic communities, as indicated by indexes of biotic integrity (IBIs), varied from very poor to excellent. The IBIs were most influenced by riparian vegetation, geology, and hydrologic condition; however, the relations were aquatic-assemblage-dependent. Indexes did indicate degraded water quality at sites with clayey surficial deposits.

Plans for Cycle 2

As Cycle 2 commences (fig. 4), some details remain to be finalized. As of this writing, the Status and Trends Network for the WMIC study unit is set. Details of topical studies are being finalized through a combination of national coordination and study-unit participation.

Status and Trends Sampling

Surface Water

Sampling for status and trends in surface water is planned for four sites for chemistry and ecology (fig. 5). These sites will be sampled monthly and during hydrologic events for chemical parameters and once annually for biological communities during the high-intensity phase. Specific sampling plans vary by site type: for example, urban sites have samples analyzed for urban-related chemicals such as volatile organic compounds, while agricultural sites have samples analyzed for agricultural pesticides. An additional eight sites will be sampled for occurrence and distribution of mercury in sediment and biotic tissue.

Lake Sediment Coring

During Cycle 2, sediment coring in lakes will take the place of the bed sediment and tissue sampling conducted during Cycle 1. This effort will provide information about the historic occurrences and deposition of organic and trace metal contaminants through the use of age-dating techniques. Two sites, representing a forested and an urban land-use watershed, will be selected for study.

Ground Water

Status and trends in ground water will include revisiting the agricultural land-use study (LUS) as well as the Cambrian-Ordovician (C-O) major aquifer study (MAS). A new MAS study, in the glacial
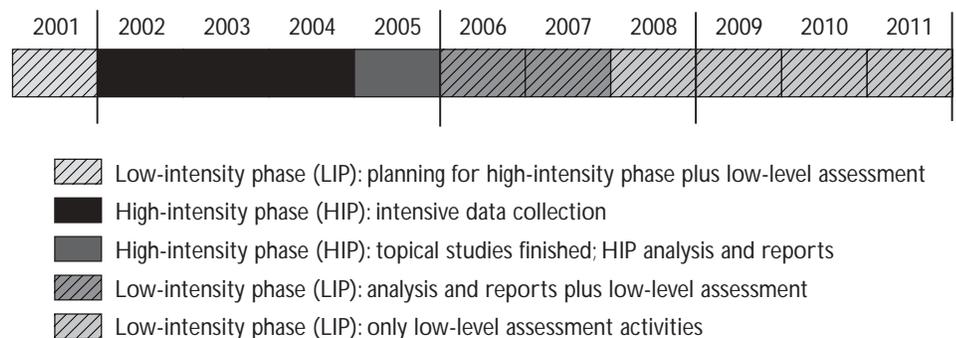
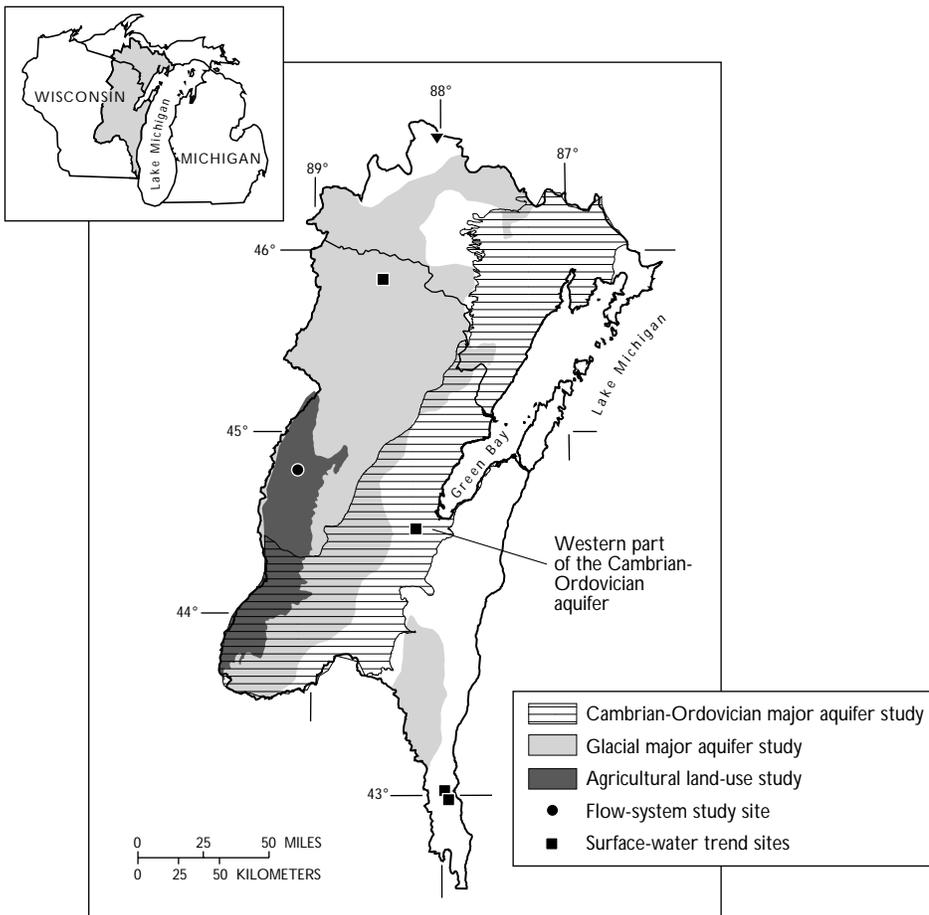PRIMARY ACTIVITIES

Figure 4. Cycle 2 timeline.

Figure 5. General location of Cycle 2 ground-water and surface-water monitoring sites.

aquifer, is planned. Finally, there are plans to conduct a ground-water flow system study in the agricultural land-use study area.

The agricultural LUS area is located in the southwest part of the WMIC study unit (fig. 5). The area was chosen primarily because of the combination of land use and surficial deposit type. The surficial deposits consist primarily of permeable sands and gravels, making the area susceptible to ground-water contamination. The probable influences on water quality are associated with agricultural land-use practices, primarily nutrients and agricultural chemicals. The re-sampling for this study area was done in June 2002.

The C-O MAS study area is located in the central part of the WMIC. The C-O Aquifer is the most used aquifer in the WMIC and the western part was targeted because that is where most of the use occurs. The aquifer is confined in part of this study area. Where it is unconfined, probable influences on water-quality are primarily associated with the dominant land use in the area (agriculture). Where it is confined, probable influences on water-quality are mostly natural (radon, sulfate, total dissolved solids). Naturally occurring arsenic is a water-quality concern along the border between the confined and unconfined part of this aquifer. The re-sampling for this study area will be done in late summer 2002.

The new MAS will cover parts of the entire WMIC study area. Planning will take place in 2002 and sampling in 2003. The Glacial Aquifer was chosen for study because it is one of the most-used aquifers in the study area and is one of the 16 principle aquifers chosen for study by NAWQA. Land-use in the study area ranges from urban to agriculture to forest and probable influences on water quality will include a wide range of natural and anthropogenic sources. Current plans are to sample approximately 30 wells in the study area.

Flow System Study

Cycle 2 Flow-System Studies (FSS) will include a network of approximately 20 wells installed along a ground-water flowpath at varying depths for analysis of historical changes in, and to define the three-dimensional distribution of, ground-water quality constituents. The WMIC FSS will be nested within an existing agricultural land-use study and the Cambrian-Ordovician major aquifer study. The location of the FSS is currently planned for the Waupaca-Tomorrow River Watershed which is representative of the agricultural LUS study area described above.

Topical Studies

During Cycle 2, the NAWQA national leadership team has developed plans for 5 topical studies, or studies aimed at understanding water quality cause-and-effect relationships. Of these 5 topical studies, two will be included in the work being done by the WMIC team: Effect of Urbanization on Stream Ecosystems (Urbanization); and Mercury Accumulation in River Ecosystems (Mercury). The sampling proposed as part of these topical studies is not planned to begin until 2003. In 2002, the major efforts will be to further develop the study approach, choose sites and parameters for sampling in 2003, and contribute to the completion of national papers that describe the approach for each study.

Urbanization Study

The population of the United States is increasingly an urban-based one, and every year more people are living in more and larger cities. Urbanization affects the hydrologic and chemical characteristics of streams, which potentially alters aquatic habitat and the biologic community that depends on it. The Urbanization topical study will focus on areas of clayey surficial deposits underlain by carbonate bedrock. The urban areas of Milwaukee, Racine/Kenosha, Sheboygan, Green Bay and Appleton/Oshkosh are located in this type of geologic setting, with surrounding agricultural land use that is being

converted to urban. Thirty sites will be selected and sampled for: continuous streamflow, water temperature, continuous specific conductance, water chemistry sampling, trace-metal concentrations in bed sediment, aquatic community analysis, habitat measurements, and cross-section surveys.

The 30 urbanization sites selected will span the urbanization gradient. Most of the sites will be located in watersheds that have urbanized land uses between 10 and 30 percent.

Mercury Study

Mercury is the most common contaminant of aquatic ecosystems worldwide; however, its sources, pathways, and toxicity-controlling processes are very complex. The Mercury topical study will focus on understanding the effects of source strength, mercury cycling, and food-web interactions on bioaccumulation of mercury in gamefish. Proposed sampling will include determination of total mercury (HgT) and stable isotopes (C and N) in gamefish, and HgT and methylmercury (MeHg) in food chain organisms (forage fish and invertebrates). Microbial methylation efficiency in sediment will be examined with respect to the environmental factors that control this process. HgT and MeHg in water will be determined seasonally.

Liaison and Outreach

The WMIC study area is officially restricted to the river basins that drain to the western side of Lake Michigan. However, the WMIC study team actively coordinates with other agencies and organizations to ensure that sampling done by NAWQA and other groups will be useful to stakeholders around the entire lake. Ongoing collaborative projects being done by scientists in the USGS Wisconsin District that are directly relevant to NAWQA activities include:

- Water Quality sampling on the Oneida, Ho Chunk and Menominee Nation lands.
- Aquatic GAP Assessment Study to relate environmental features to aquatic communities in the Great Lakes Watershed.
- EMPACT study providing information on microbiological impacts on Milwaukee area beaches.
- A study with the WDNR looking at the relationship between nutrient concentrations and aquatic biota.
- A study with the WDNR to determine the relationship between land use and microbiology in streams.
- Developing a ground-water model with the Southeast Wisconsin Regional Planning Commission
- A retrospective analysis, database development, baseline and long-term water quality monitoring study in the Milwaukee Metropolitan Sewerage District.
- Involvement in the National Methods Board, National Water Quality Monitoring Council, and Lake Michigan Monitoring Coordination Council.

The Lake Michigan Monitoring Coordination Council's biannual meetings will be used to provide study unit updates to the Lake Michigan stakeholder community. Study-unit personnel will attend local and regional conferences and present oral and poster presentations to update attendees on study-unit activities. Topic-based liaison meetings will be held to solicit input and coordination related to the Urbanization and Mercury studies.

Information

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