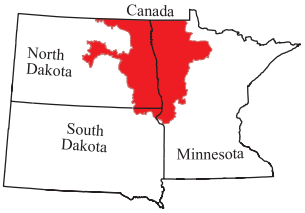
National Water-Quality Assessment Program: Data Collection in the Red River of the North Basin, Minnesota, North Dakota, and South Dakota, 1992-95



A water-quality assessment began in 1991 for the Red River of the North (Red River) Basin as part of a national study. Data collection for the reconnaissance and intensive phases of the study briefly is described for each of the major components (streams, aquatic biology, and ground water) used to assess regional water quality. The data will be analyzed to address national and local water-quality concerns.

WHAT IS THE NAWQA PROGRAM?

During the past two decades, all levels of government and industry have made large financial investments for the protection of water quality across the Nation. Current and future expenditures are anticipated to abate and control water pollution. The U.S. Geological Survey began to implement a full-scale National Water-Quality Assessment (NAWQA) Program in 1991 to address the need for consistent and scientifically sound information for managing the Nation's water resources. This Program builds upon existing water-quality information. The overall goals of the NAWQA Program are to (1) describe current water-quality conditions for a large part of the Nation's freshwater streams and aquifers (water-bearing sediments and rocks), (2) describe how water quality is changing over time, and (3) improve understanding of the primary natural and human factors affecting the water-quality conditions.

Assessing the quality of water in every area of the Nation would not be practical, so major activities of the NAWQA Program are planned within a set of regions called study units. Important rivers and aquifer systems have been selected as 60 study units which represent the diverse geography, water resources, and land and water use of the Nation. The Red River Basin was chosen as a study unit because (1) it represents a major agricultural region for assessing nutrients and pesticides in water, the first two national issues that are being assessed under the NAWQA Program, (2) the quality of the Red River, which flows northward into Canada, is of international concern, and (3) the northern location and possible interaction of surface water and ground water are relevant physical factors necessary for a complete national assessment of water quality.

DATA COLLECTION

Data collection for the study addresses local and national water-quality concerns. Major local concerns were identified and ranked in 1991 through the assistance of a local liaison committee of organizations and people interested in Red River Basin water resources. These are listed below in decreasing order of concern:

1. Toxic contamination from nonpoint sources--primarily from pesticide and fertilizer application for agriculture, but also certain trace metals such as mercury and lead, which may be transported through the air.

2. Salinity and radionuclides from naturally occurring sources--ground water from some deep bedrock aquifers is known to contain large concentrations of dissolved salts and can migrate upward into fresher water in sand and gravel aquifers and in streams; radionuclides, such as radon and radium occurring naturally in rocks, may have elevated concentrations in ground water.

3. Soil erosion and sedimentation--large areas of clayey to silty soil are eroded by wind and water; these soils are moved into streams and reservoirs. Specific effects of sediment on stream biota and the amount of nutrients and toxic substances carried by this sediment are not well understood.

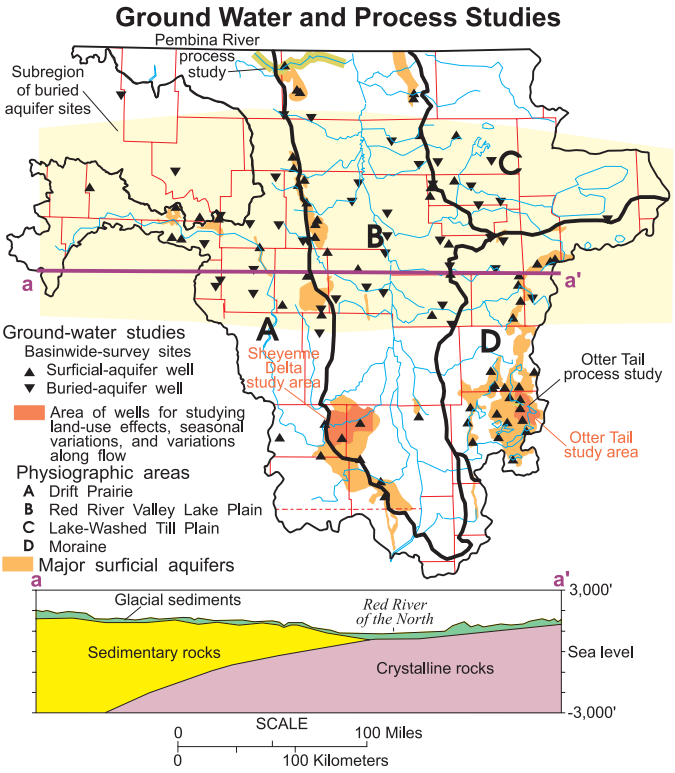
4. Eutrophication--the enrichment of water with nitrogen and phosphorous causes nuisance plant growth, such as algal blooms, and other problems in surface water.

5. Toxic contamination from point sources--although much progress has been made to mitigate these type of discharges over the past 20 years, water managers still are concerned about cumulative effects of point discharges of treated effluent primarily from municipal and industrial (sugar beet, grain, and meat processing) sources which are discharged primarily to the Red River and some of its major tributaries.

The maps and tables on these pages summarize the various NAWQA components of data collection as applied to the Red River Basin study unit.

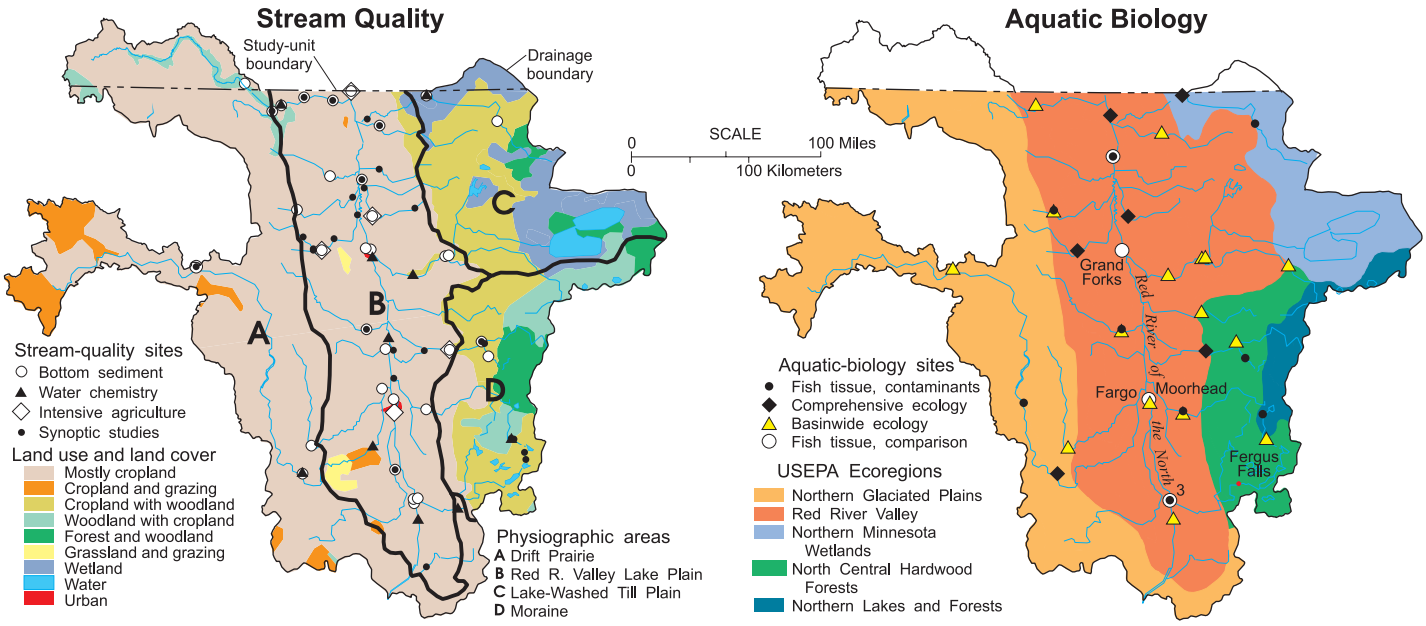
The types and locations of data collected are intended to provide multiple lines of evidence at various scales to assess water quality. Sampling is repeated at selected sites to measure the effects of season and to improve confidence in results.

The review of landscape characteristics (land use, vegetation, land forms, soils) and characteristics of streams and shallow aquifers suggested that the Red River Basin could not be analyzed as a single homogeneous study unit for assessing water quality. Four physiographic areas (Drift Prairie, Red River Valley Lake Plain, Lake-Washed Till Plain, and Moraine), each which exhibit reasonably homogeneous landscape characteristics, are used as primary subareas for water-quality assessment. Additional subdivisions will be based on land use and land cover, ecological regions, geology, and soil groups.



SUMMARY OF DATA COLLECTION FOR GROUND WATER AND PROCESS STUDIES--RED RIVER NAWQA STUDY UNIT, 1993-95

Study component	Objectives	Brief description and water-quality measures	Number of sites or studies	Frequency during 1993-95	Historical data available ?
Ground water					
Basinwide survey - surficial aquifers	Describe overall water quality in surficial sand and gravel aquifers which are susceptible to contamination.	Sample 20-30 wells in three of the major physiographic areas for major ions, nutrients, pesticides, organic carbon, and radionuclides.	69	1	some
Basinwide survey - buried aquifers	Describe the overall water quality and natural chemical patterns in buried aquifers.	Sample wells within a west-east subregion across the central part of the Red River Basin for major ions and trace metals; nutrients and radionuclides collected from 27 wells.	42	1	yes
Land-use effects	Determine the effects of specific land use on the quality of shallow ground water.	For two surficial aquifers lying mostly beneath irrigated cropland, sample wells completed near water table for major ions, nutrients, and pesticides; from one aquifer, sample for volatile-organic compounds and radionuclides.	58	1	limited
Seasonal variation	Determine seasonal variation of concentrations of water-quality indicators in aquifers studied for land-use effects.	Resample selected wells in each aquifer studied for land-use effects for nutrients, major ions, and organic carbon.	16	4-5 per year, 2 years	limited
Variation along flow	Describe land-use effects on surficial aquifers along ground-water flow from areas of recharge beneath the land use to discharge to a stream.	Sample clusters of wells installed along an approximate line of ground-water flow and at various depths within aquifers studied for land-use effects; analyze for major ions, nutrients, pesticides, and age-dating constituents.	19	1	no
Process studies					
Stream-aquifer interaction	Describe processes controlling fate of nitrate-contaminated ground water near areas of discharge to a stream.	Collect detailed chemical, biologic, geologic, and hydrologic data in the interaction zone of the Otter Tail River and the adjacent aquifer.	1	3	no
Stream-sediment nutrients	Describe the role of suspended sediment in transporting nutrients in streams.	Map stream-channel geometry and collect sediment samples during spring runoff and storm flows at selected sites along the Pembina River.	1	12	some



SUMMARY OF DATA COLLECTION FOR STREAM QUALITY AND AQUATIC BIOLOGY--RED RIVER NAWQA STUDY UNIT, 1992-95

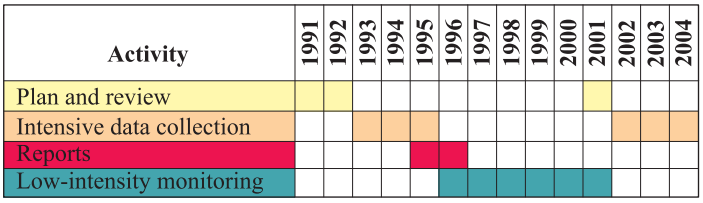
Study component	Objectives	Brief description and water-quality measures	Number of sites	Frequency during 1993-95	Historical data available ?
Stream quality					
Bottom-sediment survey	Determine presence of potentially toxic compounds attached to sediments in major streams.	Sample depositional zones of the Red River and selected tributaries for trace elements and hydrophobic organic compounds.	22	1 (in 1992)	limited
Bottom sediment distribution survey	Determine distribution of toxic compounds attached to sediment in basin streams.	Sample sites in addition to bottom sediment survey sites mostly for trace elements.	8	1	limited
Water chemistry stations	Describe concentrations and loads of chemicals, suspended sediment, and nutrients at selected sites basinwide.	Sample at or near sites where streamflow is measured continuously for major ions, organic carbon, suspended sediment, and nutrients.	15	~14 per year, 3 years	at some sites
Intensive agriculture stations	Determine concentration and timing of agricultural-related compounds that run off to streams.	Subset of basinwide chemistry stations where 80 pesticides are sampled at least monthly and during selected runoff events.	5	~20 per year, 2.5 years	at 2 sites
Synoptic studies	Describe short-term presence and distribution of contamination over broad areas and how well the chemistry stations represent the entire Red River Basin.	Sample streams during high flow for pesticides and (or) nutrients, suspended sediment, organic carbon, and streamflow; one synoptic sampling for volatile organic compounds.	27	1	limited
Aquatic biology					
Fish tissues - contaminants	Determine presence of contaminants that can accumulate in fish tissues.	Collect fish species that can be found in most streams of the Red River Basin; sample composites of whole fishes for organic compounds and fish livers for trace elements.	11	1 (in1992)	at 1 site
Comprehensive ecology	Assess in detail biological communities and habitat in streams representing primary ecological regions.	Sample and quantify fish, macroinvertebrates, and algae in four of the major ecological regions located at or near a stream-chemistry station; quantitatively describe stream habitat for these organisms; replicate sampling for three consecutive years over three stream reaches.	6	1 per year, 3 years	limited
Basinwide ecology	Determine presence and community structure of aquatic species and habitat in representative streams across the Basin.	Sample and identify fish, macroinvertebrates and algae at or near stream-chemistry stations and describe habitat.	16	1	limited
Fish-tissues comparison	Determine differences in concentrations of mercury in different fish tissues in the Red River.	Sample two sizes of carp at four sites and catfish at one site in the Red River for mercury concentration in livers, fillets, and whole bodies.	4	1	limited

ASSESSING WATER QUALITY OVER A LARGE AREA

For each study unit, such as the Red River Basin, large amounts of water-quality and related data are collected in selected areas and at different scales to represent conditions in the entire study unit. Specific water-quality measures include water chemistry in streams and shallow aquifers; suspended sediment and bottom sediments in streams; the variety and number of fish, macroinvertebrates (bugs), and algae in streams; and contaminants in fish tissues. Individual streams and aquifers, particular chemical constituents, and biological species are selected for sampling to represent the primary water resources and water-quality concerns for the study unit.

The Red River Basin study unit encompasses all of the surface drainage to the Red River within the United States and major aquifers in glacial sediments and sedimentary rocks within several hundred feet of land surface. This 35,000 mi^2 area includes closed basins, such as certain wetlands and prairie potholes, which generally do not contribute surface drainage to the Red River. Devils Lake Basin in North Dakota, an area of 3,800 mi^2 that does not contribute surface water or significant ground water to the Red River Basin, is not included as part of the study unit. Areas in Manitoba, Canada that contribute surface drainage to the Pembina and Roseau Rivers in the study unit will be included in the analysis of landscape effects on water quality.

A large amount of data and results of previous studies were reviewed to help understand the primary physical, chemical, and biological factors that affect water quality in the Red River Basin. Examples of how land use and land cover, soils, geology, land slope, climate, and drainage characteristics may influence water quality have been described in technical reports from the NAWQA Program (see suggestions for further reading). These reviews, 1991-92 field checks of existing monitoring stations and candidate sampling sites, and reconnaissance data were used to design of the intensive-phase (1993-95) data collection for the Red River Basin study unit.



The large amount of water-quality data collected for the Red River NAWQA study unit will be tabulated and analyzed with other data, such as land use and sampling-site characteristics. Data will be analyzed to answer local and regional questions about water quality, analyzed with other study-unit data to assess current, national water quality, and used to design a long-term, but lower-intensity monitoring plan for the Red River Basin.

This Fact Sheet is an element of the comprehensive body of information developed as part of the NAWQA Program. This Program depends heavily on the advice, cooperation, and information from many Federal, State, Provincial, interstate, Tribal, and local agencies, and the public. The assistance and suggestions of all are greatly appreciated.

U.S. Department of the Interior

SUGGESTIONS FOR FURTHER READING

Stoner, J.D., Lorenz, D.L., Wiche, G.J., and Goldstein, R.M., 1993, Red River of the North Basin, Minnesota, North Dakota, and South Dakota: American Water Resources Association Monograph Series No. 19 and Water Resources Bulletin, v. 29, no. 4, pp. 575-615.

Tornes, L.H., and Brigham. M.E., 1994, Nutrients, suspended sediment, and pesticides in waters of the Red River of the North Basin, Minnesota, North Dakota, and South Dakota, 1970-1990: U.S. Geological Survey Water-Resources Investigations Report 93-4231, 62 p.

Goldstein, R.M., 1995, Aquatic communities and contaminants in fish from streams of the Red River of the North Basin, Minnesota and North Dakota: U.S. Geological Survey Water-Resources Investigations Report 95-4047, 34 p.

Tornes, L.H., and Brigham. M.E., 1995, Pesticide amounts are small in streams in the Red River of the North Basin, 1993-94: U.S. Geological Survey Open-File Report 95-283, 2 p.

Gilliom, R.J., Alley, W.M., and Gurtz, M.E., 1995, Design of the National Water-Quality Assessment Program: Occurrence and distribution of water-quality conditions: U.S. Geological Survey Circular 1112, 33 p.

The following three papers are in the North Dakota Water Quality Symposium Proceedings, March 30-31, 1994, Fargo, North Dakota, North Dakota State University Extension Service:

Cowdery, T.K., and Goff, K.L., 1994, Nitrogen concentrations near the water table of the Sheyenne Delta aquifer beneath cropland areas, Ransom and Richland Counties, North Dakota, pp. 89-102.

Goldstein, R.M., Simon, T.P, Bailey, P.A., Ell, Michael, Pearson, Eric, Schmidt, Konrad, and Enblom, J.W., 1994, Concepts for an index of biotic integrity for streams of the Red River of the North Basin, pp. 169-180.

Brigham, M.E., 1994, Pesticides detected in surface waters and fish of the Red River of the North drainage basin, pp. 256-269.

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