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National Water-Quality Assessment Program

Northern Rockies Intermontane Basins

U.S. Department of the Interior
U.S. Geological Survey

MAJOR WATER-QUALITY ISSUES IN THE NORTHERN ROCKIES INTERMONTANE BASINS

The Northern Rockies NAWQA will increase the scientific understanding of surface- and ground-water quality and the factors that influence water quality. This information will benefit the water-resource managers that need, but often lack, the data required to implement effective water-quality management actions and evaluate long-term changes in water quality.

Water-quality improvements in the study area have been identified and these may be related to improvements in mining, forestry, agricultural-related activities, and the treatment of municipal and industrial wastes. However, the effects of land-use and water-use practices on many rivers and ground-water resources remain a priority concern to water-resource managers, planners, State and local governments, and citizen groups.

The following water-quality issues have been identified by water-resource managers as high priority, regional-scale issues of concern:

- Toxic trace elements in surface water and ground water,
- Nutrients in surface water and ground water from point and non-point sources,
- Degradation of surface water and ground water from urban areas and suburban development,
- Sedimentation from timber harvesting and agriculture, and
- Effects of these inputs on aquatic biological communities.

Slickens on mine tailings deposits along the Clark Fork north of Butte, Montana.

WHAT IS THE NAWQA PROGRAM?

During the past 25 years, industry and government have made large financial investments intended to improve water quality across the Nation; however, many water-quality issues remain. To address the need for consistent and scientifically sound information for managing the Nation's water resources, the U.S. Geological Survey began a full-scale National Water-Quality Assessment (NAWQA) Program in 1991. The 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 our understanding of the primary natural and human factors affecting water quality.

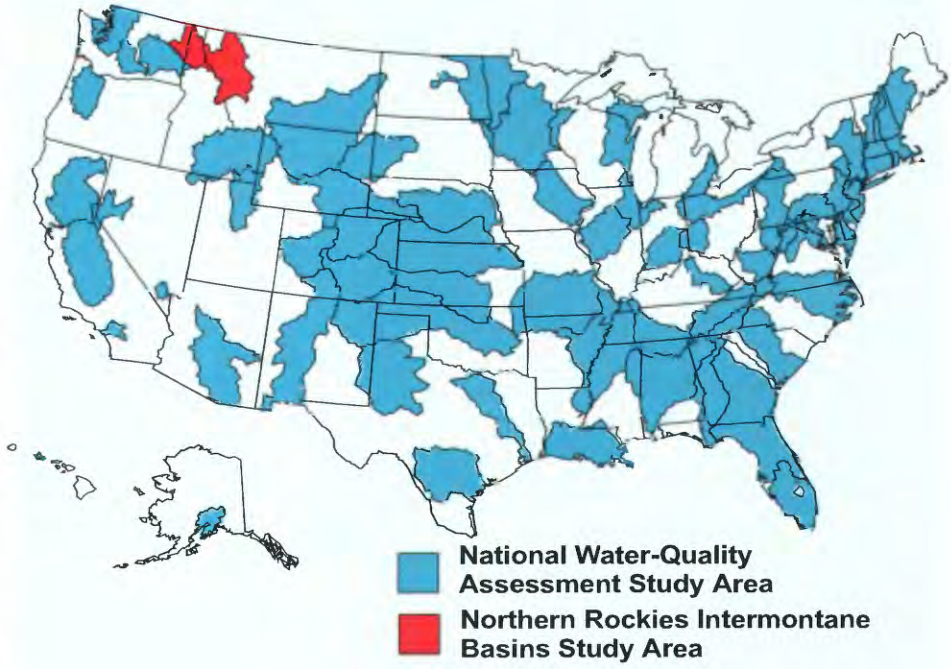


Figure 1. Location of NAWQA studies.

Assessing the quality of water in every area of the Nation would not be practical; therefore, NAWQA Program studies are planned within a set of regions called study areas. These study areas encompass 59 important river and aquifer systems that represent the diverse geography, water resources, and land and water uses of the Nation. The Northern Rockies study area has been selected to (1) include several important river systems, (2) represent a mixture of forested, agricultural, urban, and developing areas, (3) contain major sole-source aquifers such as the Spokane Valley/Rathdrum Prairie and Missoula Valley aquifers, and (4) assess the effects of mining practices on the quality of streams and aquifers. Study activities by the U.S. Geological Survey in the Northern Rockies began in late 1996.

The quality of surface water and ground water in the watersheds of both the Clark Fork-Pend Oreille and Spokane Rivers (figure 2) is affected by mining wastes or tailings. In the Clark Fork drainage, tailings have been transported and deposited along more than 150 miles of river channel and flood plain from Butte to near Missoula. Similarly, tailings discharged directly to the South Fork Coeur d'Alene River have been transported and deposited along the river channel and flood plain into Lake Coeur d'Alene, and potentially out of the lake and along the Spokane River. Mine tailings in the study area typically contain elevated concentrations of the trace metals arsenic, cadmium, copper, lead, and zinc. Six major fish kills in the upper Clark Fork since 1984 and the scarcity of bottom-dwelling organisms in Lake Coeur d'Alene have been attributed to the toxic effects of these trace metals. Public water supplies from the alluvial aquifer near Milltown Reservoir have been abandoned because of arsenic contamination which may come from tailings

accumulated in bottom sediments of the reservoir.

The quality of surface water also is affected by nutrients and sediment. Nitrogen and phosphorus concentrations sometimes exceed criteria for biological enrichment in the Clark Fork headwaters. Nutrient enrichment and potential eutrophication are of concern for Flathead Lake, Lake Pend Oreille, and Lake Coeur d'Alene, where residential and commercial shoreline development and recreational use are rapidly increasing. Sources of nutrients include municipal wastes, septic-system effluent, and soil erosion from timber-harvest activities and agriculture. Increased sediment loads from timber harvesting and attendant road building, and from agriculture may be responsible for declines in populations of native trout species.

The Missoula and Spokane Valley/Rathdrum Prairie aquifers have been designated as sole-source aquifers by the U.S. Environmental Protection Agency. In many areas these coarse-grained aquifers are susceptible to contamination. Whereas the quality of water in these alluvial aquifers generally is good, some parts of these aquifers have been adversely affected by human activities.

STUDY AREA DESCRIPTION

The Northern Rockies Intermontane Basins study area encompasses 31,500 square miles (mi^2) in western Montana, northern Idaho, and northeastern Washington and lies entirely within the Northern Rocky Mountains physiographic province. The study area is comprised of two major river basins: the Clark Fork-Pend Oreille River Basin, which contains about 24,900 mi^2, and the Spokane River Basin, which contains about 6,600 mi^2. The population of the study area was about 725,000 in 1990 with about 350,000 in Washington, 255,000 in Montana, and 120,000 in Idaho.

The Clark Fork originates near Butte in southwestern Montana and flows 350 miles to Lake Pend Oreille in northern Idaho. Outflow from the lake is the Pend Oreille River, with an average annual flow of about 28,000 cubic feet per second, which flows northward to join the Columbia River in Canada. Major tributaries to the Clark Fork are the Blackfoot, Bitterroot, Flathead, and Priest Rivers. The Spokane River originates in northern Idaho as the outflow from Lake Coeur d'Alene which has two principal tributaries, the Coeur d'Alene and St. Joe Rivers. The Spokane River has an average annual streamflow of about 7,000 cubic feet per second at Spokane, Washington.

Annual precipitation ranges from less than 15 inches in many of the intermontane basins of western Montana to more than 100 inches near the Continental Divide in northwestern Montana. Average annual runoff, primarily a result of snowmelt, ranges from more than 50 inches at higher elevations to less than 5 inches at lower elevations. The average annual temperature in the valleys ranges from about 40 to 55 degrees Fahrenheit, depending primarily on elevation. The topography varies from high, mountainous areas to large, flat-lying valleys. The study area has numerous large natural lakes and reservoirs, including Flathead Lake (the largest natural fresh-water lake in the western United States), Lake Pend Oreille (one of the deepest lakes in the United States), Lake Coeur d'Alene, Hungry Horse Reservoir, and Priest Lake.

Land use in the study area includes agriculture, mining-related activities, timber production, livestock grazing, urban and low-density residential development, and recreation, and varies with elevation. The Flathead, Kalispel, Coeur d'Alene, and

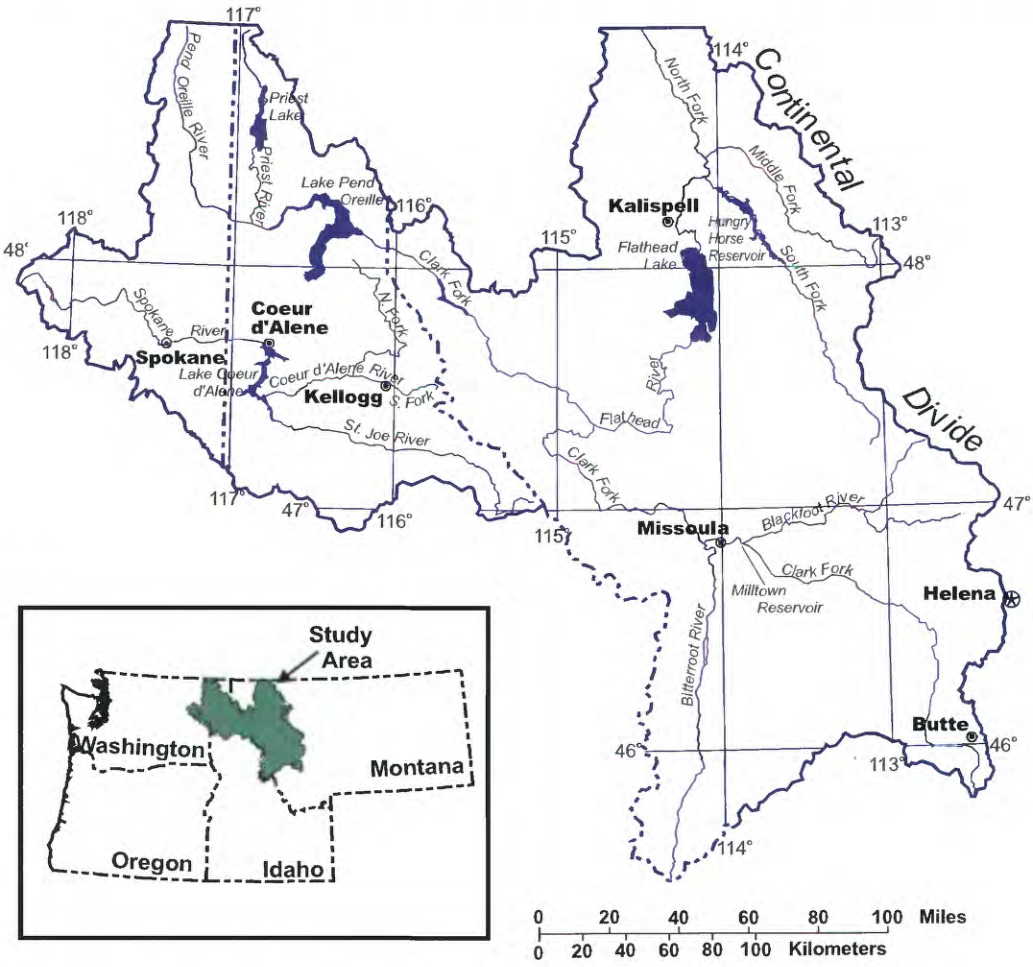


Figure 2. Location and map of the Northern Rockies NAWQA study area.

Spokane Indian Reservations are either wholly or partly within the study area and constitute about 10 percent of the area. The average water use in the study area in 1990 was about 1,600 million gallons per day (Mgal/d). About 80 percent or 1,280 Mgal/d is from surface-water sources. Ground-water use in the study area is about 320 Mgal/d with about 60 percent used for municipal, domestic, and commercial supplies. Ground-water use is increasing as new development extends to rural areas and as communities replace or augment existing surface-water supplies with water from underground sources.

Quaternary and Tertiary basin-fill deposits contain the major aquifers in the study area. The aquifers, which are present along most reaches of the large rivers and main tributaries, are the principal sources of ground water in the study area. The Quaternary deposits, which generally are alluvial or glacial in origin, occur in valleys throughout the area, commonly are less than 200 feet thick, and consist of gravel, sand, silt, and clay. Thick, primarily fine-grained Tertiary deposits, which are fluvial or lacustrine in origin, generally occur in the southern part of the study area and may contain some permeable gravels in the upper sections. Igneous, sedimentary, and metamorphic rocks of Precambrian to Quaternary age generally are not a source of large amounts of ground water. However, because of their large extent, they probably contribute substantial amounts of recharge to the basin-fill aquifers.

SCHEDULE OF STUDY ACTIVITIES

The Northern Rockies study is one of a set of NAWQA studies that started in late 1996 (fig. 3). Planning and design will be conducted during the first 2 years of study. After the planning period, ground-water, surface-water, and biological data will be collected intensively for 3 years. A low-intensity phase will follow, with a reduced level of water-quality monitoring for 6 years, before the next intensive phase resumes. This combination of high- and low-intensity monitoring phases allows the NAWQA Program to examine trends in water quality over time.

As part of the planning process, existing data and results from previous studies will be reviewed to help understand the primary physical, chemical, and biological factors that affect water quality in the study area and to identify gaps in the current data. These reviews, along with field checks of existing monitoring stations and possible sampling sites, and reconnaissance data are to be used to design a sampling program for the study. Descriptions of how land use, land cover, soils, geology, topography, climate, and other characteristics may influence water quality are to be included in technical and non-technical reports.

Activity	FISCAL YEAR											
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Planning and Study Design	X	X									X	
High-intensity Monitoring			X	X	X							X
Report Writing					X	X	X					
Low-intensity Monitoring						X	X	X	X	X	X	

Figure 3. Schedule of study activities.

During the high-intensity phase, water-quality and biological data will be collected from selected areas at both local and regional scales to describe water-quality conditions across the study area. Water chemistry will be measured in streams and aquifers; the quality of stream-bottom sediments will be determined; stream biota will be identified and enumerated; and contaminants in fish tissues will be measured. Individual streams and aquifers, particular chemical constituents, and biological species will be selected for sampling to represent the primary water resources and water-quality concerns for both the study area and the Nation. Monitoring will continue at a limited number of sites during the low-intensity phase so long-term trends can be identified. A series of technical and non-technical reports describing results of the high- and low-intensity phase data collection are planned.

Timber harvesting in northern Idaho.

ASSESSING WATER QUALITY IN THE NORTHERN ROCKIES

All NAWQA studies have several common characteristics designed to address the Nation's water-quality issues. Nationally consistent data collection and assessment methods make this possible and are critical for providing uniform and comparable information on water quality for the Nation. Ground-water, surface-water, and ecological studies will be performed at various scales to understand the water-quality problems and to meet the needs of interested parties at the local, regional, and national levels. Partnerships and cooperative studies between local, State, and Federal agencies can help to meet specific needs. The following sections describe surface-water, ground-water, and ecological monitoring components of the Northern Rockies NAWQA. The design described in the following sections is similar to other NAWQA study areas nationwide.

Surface Water

Surface water will be monitored at basic-fixed sites and intensive-fixed sites. Most NAWQA studies have about eight basic-fixed and four intensive-fixed sites. Basic-fixed sites will be sampled for nutrients and major ions on a regular basis, approximately monthly, for the duration of the 3-year high-intensity phase of the study. The intensive-fixed sites will be sampled frequently, often weekly, for at least 1 year, to characterize short-term variations in water quality. Intensive-fixed site samples will be analyzed for nutrients and major ions and may be analyzed for trace elements, pesticides, and volatile organic compounds (VOC's). Basic-fixed or intensive-fixed sites can be either indicator or integrator sites. Indicator sites will be selected to represent relatively homogeneous, typically smaller basins associated with specific environmental settings. These sites could include a combination of specific land uses and hydrogeology that are considered to have potentially important effects on water-quality

in the study area. Integrator sites may be established at downstream points in larger, heterogeneous drainage basins to incorporate complex combinations of land-use settings and natural influences. These sites could reflect impacts from all land uses in the basin. Synoptic sampling may be performed to investigate specific water-quality conditions during selected hydrologic periods (for example, low streamflow) to provide greater spatial data coverage and to allow investigators to assess whether the basic-fixed or intensive-fixed sites are representative of streams in the study area or to help understand a particular water-quality issue.

Ground Water

Ground-water investigations for a NAWQA study typically include three components: (1) a study-area survey, (2) a land-use survey, and (3) an optional flow-path study. All three components emphasize the study of aquifer systems that may be affected by land-use practices and natural influences. Synoptic samples also may be collected to address particular questions about ground-water quality over large areas. Water samples will be analyzed for major ions and nutrients. Selected water samples also will be analyzed for trace elements, pesticides, and VOC's.

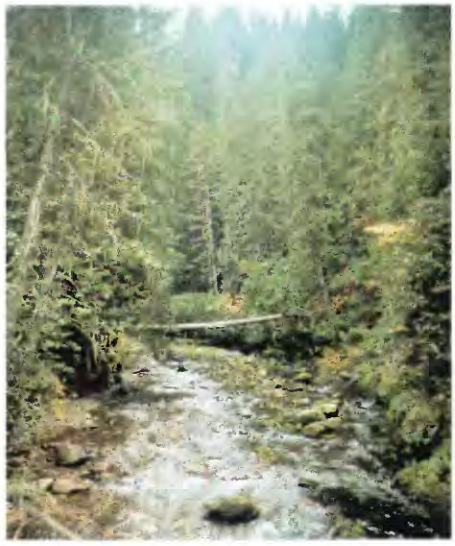
The study-area survey is intended to characterize general baseline water quality in specific types of aquifers and does not target specific land uses. Wells will be randomly selected to be sampled in each of 3-5 aquifer subunits throughout the study area.

The land-use survey will attempt to characterize water quality associated with particular land uses. Wells will be randomly selected within each important land use for each aquifer type. The results of the land-use survey will be compared with the results of the general study-area survey to determine the effects of land use on ground-water quality.

The flow-path study is intended to answer important questions about processes controlling ground-water contamination. Each flow-path study is designed to trace the chemical changes that occur to water as it enters the ground-water-flow system, travels along a flow path, and eventually discharges to a stream. Typically, several wells are installed at selected depths along a flow path and sampled for selected chemical and physical characteristics.

Ecology

Ecological studies will be conducted along with the surface-water and ground-water-sampling activities. At the beginning of the 3-year high-intensity phase, selected sites will be sampled for trace elements and organic compounds in fish tissues and bottom sediments. After this initial work, the ecological study components focus on determining the composition of fish, macroinvertebrate, and algal communities at basic-fixed and intensive-fixed sites to gain insight into ecological variability over time. Synoptic sampling will be conducted to evaluate the spatial variability of the biological community, stream morphology, bank vegetation, and possible differences in fish-tissue chemistry with respect to various land uses.



Sullivan Creek in northeastern Washington.

COMMUNICATION AND COORDINATION

Communication and coordination between the U.S. Geological Survey and other scientific and water-management organizations are critical components of the NAWQA Program. Each NAWQA study maintains a local liaison committee consisting of representatives from Federal, State, and local agencies, universities, and the private sector who have water-resources responsibilities. Activities include the exchange of information about regional and local water-quality issues, identification of sources of data and information, assistance in the design and scope of study products, and the review of study planning documents and reports.

The Northern Rockies NAWQA Program depends on the advice, cooperation, and information from many Federal, State, regional, and local agencies, and the public. All assistance and suggestions are welcomed.

SUGGESTIONS FOR FURTHER READING

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The U.S. Geological Survey water-resources home page at http://water.usgs.gov

FOR MORE INFORMATION

Information on technical reports and hydrologic data related to the NAWQA Program can be obtained from:

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