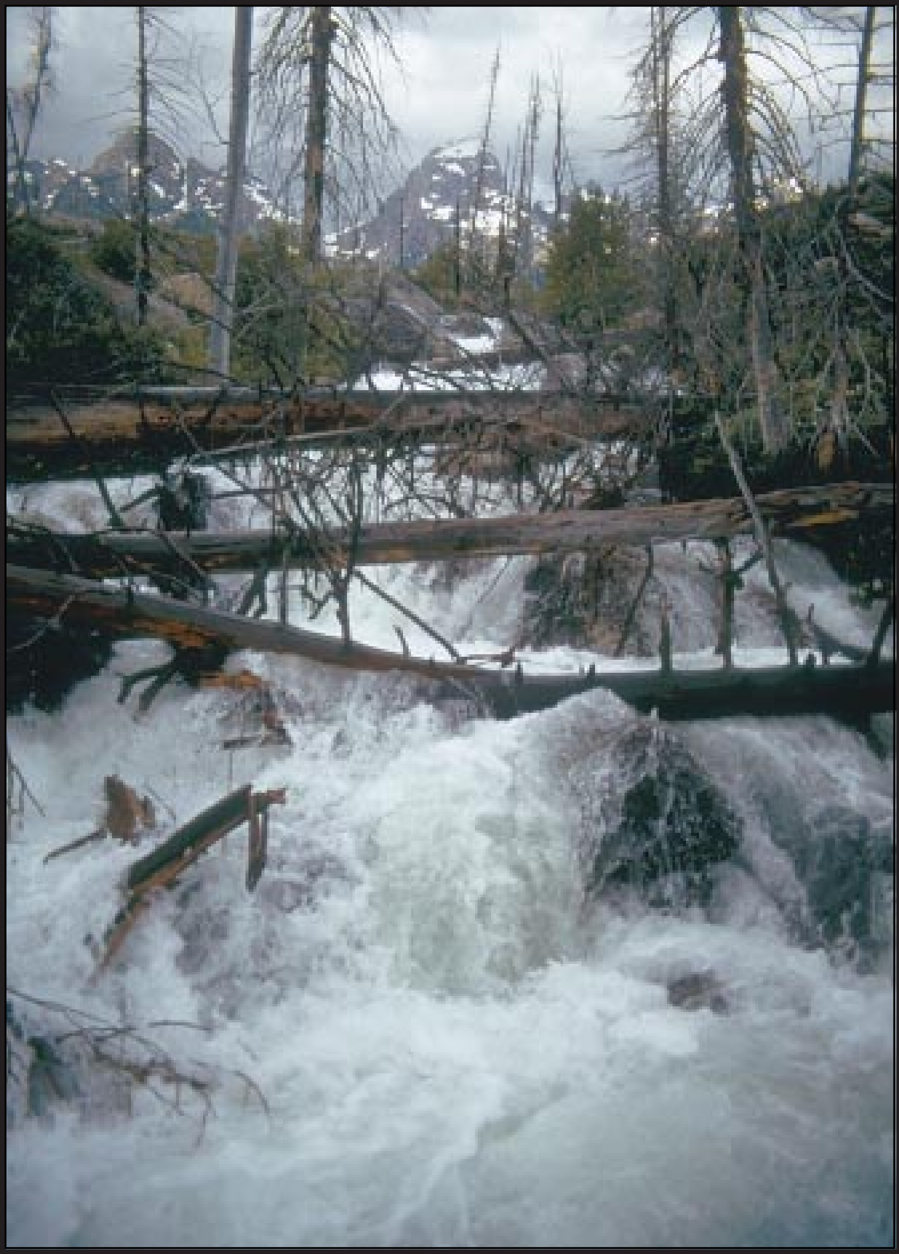
Water Quality in the Upper Snake River Basin

Idaho and Wyoming, 1992–95



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A COORDINATED EFFORT

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Photograph on front cover: Taggart Creek on the east side of the Teton Range, Grand Teton National Park, Wyoming (photograph by M.G. Rupert, U.S. Geological Survey).

Photograph on page 1: Sampling for benthic invertebrates in the Big Lost River, Idaho (photograph by T.R. Maret, U.S. Geological Survey).

Photographs on back cover:
1. Sprinkler irrigation of crops near Pocatello, Idaho (photograph © 1980 by W.H. Mullins and published with permission).
2. Fall harvest of barley in the Teton River Valley, Idaho (photograph © 1995 by W.H. Mullins and published with permission).

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Information on the NAWQA Program also is available on the Internet via the World Wide Web. You may connect to the NAWQA Home Page using the Universal Resources Locator (URL):
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Idaho and Wyoming, 1992–95

By G.M. Clark, T.R. Maret, M.G. Rupert, M.A. Maupin, W.H. Low, and D.S. Ott

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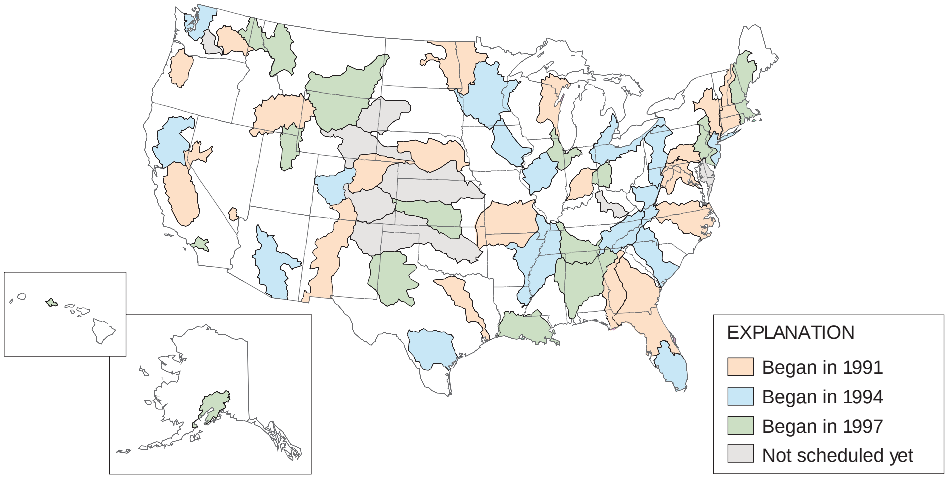


Knowledge of the quality of the Nation's streams and aquifers is important because of the implications to human and aquatic health and because of the significant costs associated with decisions involving land and water management, conservation, and regulation. In 1991, the U.S. Congress appropriated funds for the U.S. Geological Survey (USGS) to begin the National Water-Quality Assessment (NAWQA) Program to help meet the continuing need for sound, scientific information on the areal extent of the water-quality problems, how these problems are changing with time, and an understanding of the effects of human actions and natural factors on water-quality conditions.

The NAWQA Program is assessing the water-quality conditions of more than 50 of the Nation's largest river basins and aquifers, known as Study Units. Collectively, these Study Units cover about one-half of the United States and include sources of drinking water used by about 70 percent of the U.S. population. Comprehensive assessments of about one-third of the Study Units are ongoing at a given time. Each Study Unit is scheduled to be revisited every decade to evaluate changes in water-quality conditions. NAWQA assessments rely heavily on existing information collected by the USGS and many other agencies as well as the use of nationally consistent study designs and methods of sampling and analysis. Such consistency simultaneously provides information about the status and trends in water-quality conditions in a particular stream or aquifer and, more importantly, provides the basis to make comparisons among watersheds and improve our understanding of the factors that affect water-quality conditions regionally and nationally.

This report is intended to summarize major findings that emerged between 1992 and 1995 from the water-quality assessment of the Upper Snake River Basin Study Unit and to relate these findings to water-quality issues of regional and national concern. The information is primarily intended for those who are involved in water-resource management. Indeed, this report addresses many of the concerns raised by regulators, water-utility managers, industry representatives, and other scientists, engineers, public officials, and members of stakeholder groups who provided advice and input to the USGS during this NAWQA Study-Unit investigation. Yet, the information contained here may also interest those who simply wish to know more about the quality of water in the rivers and aquifers in the area where they live.

Robert M. Hirsch, Chief Hydrologist

ISSUE: Do anthropogenic activities adversely affect water quality in the upper Snake River Basin? *PAGE 6*

- Water quality in the upper Snake River Basin is degraded by a variety of nonpoint and point sources of pollutants. Basinwide, nonpoint sources account for about 98 and 99 percent of the total nitrogen and phosphorus, respectively, introduced annually to the upper Snake River Basin. Nonpoint sources account for most of the sediment reaching streams in the basin. Primary nonpoint sources of pollutants in the basin are agricultural activities, confined-animal feeding operations, rangeland grazing, recreational activities, logging, and atmospheric deposition.
- Stream-water and ground-water quality in agricultural areas is affected by pesticide and fertilizer applications and by crop rotation and tillage practices. Agricultural areas, which account for 21 percent of the basin area, are concentrated along the main stem of the Snake River in the downstream parts of the basin. Agricultural areas contribute pesticides, nitrogen, and phosphorus to streams and ground water.
- Primary point sources of pollutants in the basin are industrial discharges, municipal wastewater-treatment facilities, and fish farms. Permitted discharges from these point sources during 1985–90 were about 269 billion gallons per year. Although point sources account for only a small percentage of the total nitrogen and phosphorus introduced annually to the upper Snake River Basin, they discharge directly to streams, where nitrogen and phosphorus become immediately available for uptake.

ISSUE: Does water use in the basin affect the quality of the water resources? *PAGE 8*

- Streamflow regulation and water use for irrigation, hydroelectric power production, and industry affect the water chemistry and biological communities of streams. During the irrigation season, diversions and irrigation returns reduce streamflows and degrade stream-water quality. Storage reservoirs for irrigation, flood control, and hydroelectric power reduce streamflow velocities and stream habitat to the detriment of native biological communities.
- Irrigated agriculture is the primary consumptive use of water in the basin. About 8 million acre-feet, or 53 percent, of the water used for irrigation in the basin in 1990 was diverted from surface-water supplies. About half of these diversions are from five canals at Lake Walcott and Milner Dam. About 7.1 million acre-feet, or 47 percent, of the total irrigation use was withdrawn from ground water. Some water applied to fields for irrigation returns to streams or infiltrates back to the ground water, transporting nutrients, pesticides, and sediment.
- Fish farms and hydroelectric power facilities are the primary nonconsumptive water uses in the basin. Many fish farms, primarily along the Snake River between Milner Dam and King Hill, use ground water discharging from springs as a source of water. Fish farms contribute nitrogen, phosphorus, and organic wastes to streams. Diversions and impoundments for storage and hydroelectric power generation alter streamflows and streamflow velocities and transform some reaches of the Snake River from a high-gradient, coldwater river to a slow-moving river with an abundance of aquatic plants.

ISSUE: Have fish communities in the upper Snake River Basin been affected by water-quality degradation? *PAGE 10*

- There is a large amount of variability in the health of fish communities in the upper Snake River Basin. In some streams of the basin, cutthroat, rainbow, and brown trout fisheries represent some of the best fishing in the Nation. In areas of the basin degraded by land- and water-use activities, the entire fish community is composed of warmwater-tolerant, nongame species of fish.
- High-elevation headwater streams in the basin have excellent water quality; however, of the streams assessed, headwater streams contained the fewest fish and lowest numbers of fish species. In most of the headwater streams assessed, only two to four different fish species were found, primarily trout and sculpin. This lack of species diversity is typical of high-elevation headwater streams in the Western United States, where abundant shading and limited nutrient availability result in cold, nutrient-poor streams.
- Excellent water-quality conditions, in combination with stocking of gamefish, make the upper reaches of the Henrys Fork and the Snake River upstream from its confluence with the Henrys Fork some of the best trout fishing streams in the Nation. These streams support healthy populations of cutthroat, rainbow, and brown trout, but are dependent on stocking.
- From the confluence of the Snake River and the Henrys Fork downstream to Milner Dam, the Snake River and its tributaries are indicative of trout fisheries affected by loss of habitat and introduction of non-native species. Fish communities in this reach also have been affected by nonpoint source inputs of nutrients and sediment and by reductions of streamflows for irrigation and hydroelectric power production.
- The Snake River from Milner Dam to King Hill contains a variety of fish species. However, the reason this reach contains more fish species than do upper reaches of the basin is that the community composition is dominated by introduced warmwater species, which are tolerant of the slow-moving water and degraded water-quality conditions. Few gamefish exist in this reach of the Snake River.

ISSUE: Is nitrate a concern in streams and ground water in the upper Snake River Basin? *PAGE 12*

- Nitrate concentrations in streams in the upper Snake River Basin were generally low, and none exceeded the U.S. Environmental Protection Agency (USEPA) drinking-water standard of 10 milligrams per liter as nitrogen. In contrast, some ground-water samples contained nitrate concentrations in excess of 10 milligrams per liter.

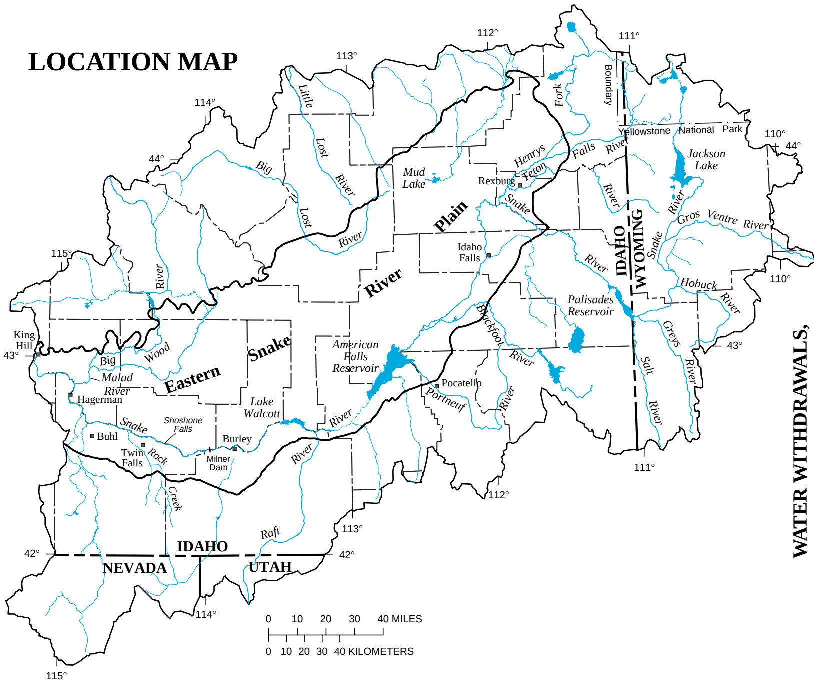
- The major sources of nitrate in the upper Snake River Basin are synthetic fertilizers, cattle manure, and nitrogen-fixing legume crops such as alfalfa and beans. These sources account for 93 percent of the nitrate input to the basin.
- Nitrate concentrations were less than 2.0 milligrams per liter in 95 percent of 527 stream samples collected during the NAWQA study. However, concentrations of nitrate in many streams were sufficient, in combination with sufficient phosphorus, to result in excessive growth of aquatic plants. Nitrate concentrations were highest in streams draining agricultural areas and in streams receiving large amounts of ground-water discharge.
- Nitrate concentrations exceeded a national background level of 3.0 milligrams per liter in water from 25 percent of 726 wells (mostly domestic and water supply) sampled basinwide during 1991–95. Water in 3 percent of the wells contained nitrate concentrations in excess of 10 milligrams per liter.
- In localized areas, nitrate in ground water is becoming a concern. In agricultural areas north of the Snake River between Burley and Hagerman, water from 10 percent of 105 domestic and irrigation wells sampled contained nitrate concentrations in excess of 10 milligrams per liter. Water from 24 percent of 29 domestic wells in a shallow alluvial aquifer in the Minidoka Irrigation District north of Burley contained nitrate concentrations in excess of 10 milligrams per liter.
- Areas where ground water is most vulnerable to nitrate contamination are those where urban or irrigated agricultural land uses are predominant, where the depth to water is shallow, and where soils are well drained.

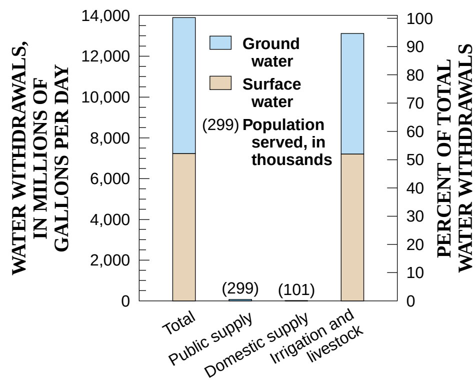
ISSUE: Are pesticides and other organic compounds reaching streams and ground water? Are they persisting in the environment? ***PAGE 14***

- Many different pesticides and other organic compounds are reaching the water resources of the upper Snake River Basin. Some compounds, primarily those which have been banned from use, have accumulated in fish tissue and bed sediment. Although most of the compounds that were detected were at low concentrations, some compounds were detected at concentrations that exceeded either drinking-water standards or national guidelines for the protection of fish-eating wildlife.
- The herbicide EPTC, or Eptam, was detected in 30 of 37 basinwide stream samples collected during May and June 1994. The maximum concentration of EPTC detected was 0.31 microgram per liter. Other pesticides or pesticide breakdown products commonly detected in streams were atrazine, desethylatrazine, metolachlor, and alachlor.
- Pesticides in streams were detected in the greatest numbers and largest concentrations during the spring and early summer following early season crop applications. However, atrazine and desethylatrazine were detected in some streams throughout the year.
- None of the pesticide concentrations detected in stream samples exceeded existing drinking-water standards established by the USEPA. Two samples from irrigation drains, however, contained the insecticides chlorpyrifos and methylazinphos at concentrations exceeding USEPA aquatic-life criteria.
- At least 1 organochlorine compound was detected at 6 of 20 bed-sediment sampling sites and 16 of 20 fish-tissue sampling sites during 1991–94. The most commonly detected organochlorine compounds were DDT, the DDT breakdown products DDD and DDE, and PCBs. Concentrations of organochlorine compounds in tissue of fish from the Portneuf River at Pocatello, Rock Creek near Twin Falls, and Snake River near Twin Falls equaled or exceeded national guidelines for protection of fish-eating wildlife.
- At least 1 semivolatile organic compound (SVOC) was detected in all of the 43 bed-sediment samples collected during the study. The most frequently detected SVOCs in bed sediment were phthalates (98 percent of the samples), phenol (86 percent), and 2,6-dimethylnaphthalene (83 percent). However, none of the SVOC concentrations in the bed-sediment samples exceeded aquatic-life criteria.
- Some pesticides and volatile organic compounds (VOCs) also are reaching ground water. During basinwide sampling in 1994 and 1995, water from 76 of 195 domestic, irrigation, stock, and public supply wells (39 percent) contained at least 1 pesticide, and 11 wells (6 percent) contained at least 1 VOC. Water from 26 of the wells (13 percent) contained 3 or more pesticides. Atrazine and desethylatrazine were detected in 27 percent of the wells.
- Results of a survey of domestic and irrigation wells in agricultural lands in the Twin Falls and Burley areas showed that water from 43 of 105 wells (41 percent) contained 3 or more pesticides. None of the pesticide concentrations and only one VOC (1,2-dichloropropane) concentration detected in ground water exceeded drinking-water standards.

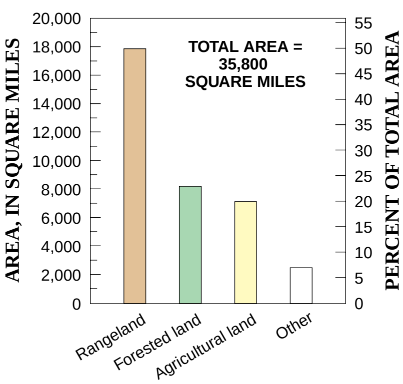
ISSUE: What are the water-quality concerns in the Snake River between Milner Dam and King Hill? What are the primary sources of pollutants? ***PAGE 18***

- The Snake River between Milner Dam and King Hill is degraded because of the cumulative effects of decades of agricultural and industrial activities. The degraded water quality in the river results from a combination of excessive nitrogen, phosphorus, pesticides, and sediment, and reduced streamflows. Excessive aquatic vegetation, low dissolved oxygen, and high water temperatures—all manifestations of a nutrient-rich, eutrophic water body—prevent water in this reach from meeting State water-quality criteria.
- Many aquatic species once native to the Snake River downstream from Milner Dam either have disappeared from the reach or are in danger of doing so because of the degraded water quality and streamflow alteration caused by dams.
- Major sources of nutrients to the Snake River between Milner Dam and King Hill include ground-water discharge, fish farms, and municipal wastewater-treatment facilities. Agriculturally affected tributaries and irrigation return flows are sources of additional nutrients and are the primary sources of pesticides and sediment.

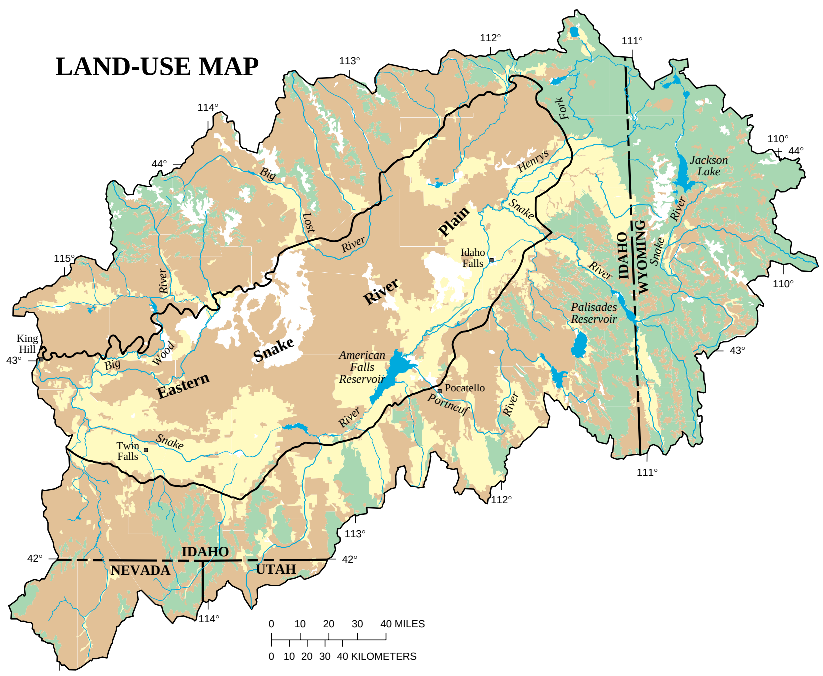




ESTIMATED WATER WITHDRAWALS IN 1990



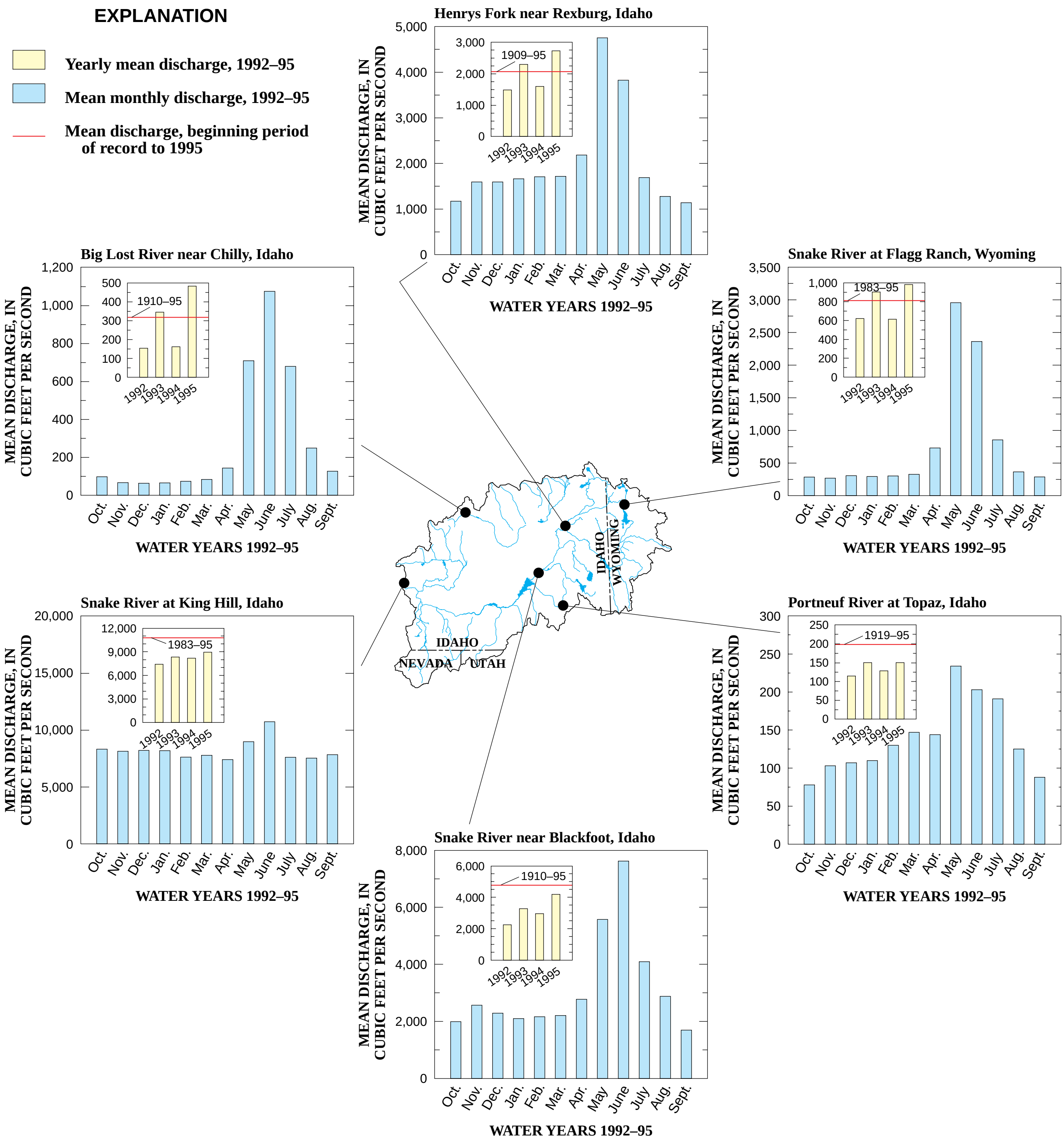
LAND USE IN 1986



Climate in the upper Snake River Basin is influenced predominantly by eastward-moving airmasses from the Pacific Ocean. The semiarid eastern Snake River Plain receives 8 to 10 inches of precipitation annually. The semihumid mountainous parts of the basin receive the greatest amount of precipitation as snow, generally between November and March. Mountains in the northeastern part of the basin may receive more than 60 inches of precipitation annually.

The Snake River is the regional drainage for streams and ground water in the upper Snake River Basin. Five main-stem and numerous tributary reservoirs regulate streamflow in the basin, primarily for agricultural use, flood control, and hydroelectric power production. The major source of ground water in the basin is the fractured basalt aquifer underlying the eastern Snake River Plain. In 1990, about 53 percent of the water used in the upper Snake River Basin was withdrawn from surface-water supplies and 47 percent from ground water, primarily for irrigation and livestock.

About 18,000 square miles, or about 50 percent, of the upper Snake River Basin is rangeland; forested land and agricultural land compose 23 and 21 percent of the basin, respectively. Forested land is located primarily in the mountainous eastern part of the basin where precipitation is the greatest. Agricultural land is concentrated on the Snake River Plain, primarily along the Snake River and near the mouths of tributary drainage basins.



Stream discharges in the upper Snake River Basin during water years 1992–95 were largest during May and June in response to spring snowmelt in mountainous areas of the basin. However, stream discharge at the outlet of the basin was relatively stable throughout the year because of reservoir regulation and the large quantity of ground water discharged to the river as springs between Milner Dam and King Hill. Large stream discharges in response to individual storms were rare during the study.

In the northern and eastern parts of the basin, hydrologic conditions were wetter than normal, and stream discharges larger than long-term averages during water years 1993 and 1995. The opposite was true during water years 1992 and 1994—conditions were drier than normal and stream discharges were below average throughout the basin. In the southern part of the basin and in the main-stem Snake River, stream discharges were smaller than long-term averages during all 4 years of the study.

The Snake River near Idaho Falls, Idaho. The agricultural industry in southern Idaho is dependent on the Snake River and its tributaries for its water supply (photograph © 1978 by W.H. Mullins and published with permission).

DO ANTHROPOGENIC ACTIVITIES ADVERSELY AFFECT WATER QUALITY IN THE UPPER SNAKE RIVER BASIN?

Water quality in the upper Snake River Basin is degraded by numerous anthropogenic activities, including both nonpoint and point sources of pollutants. A 1988 assessment by the Idaho Department of Environmental Quality documented that, of 5,732 river miles assessed for nonpoint source effects in the Idaho part of the basin, 2,913 river miles were degraded by agriculture; 1,766 miles by hydrologic modification; 197 miles by construction activities; 35 miles by forest practices; 134 miles by mining; and 109 miles by other activities, primarily recreation [1]. Other nonpoint sources of pollutants in the basin include beef and dairy cattle feeding operations, atmospheric deposition, and rangeland grazing. These nonpoint sources contribute sediment, bacteria, nutrients, and pesticides to streams and can result in alterations in stream habitat and water temperature. Primary point sources in the upper Snake River Basin include industrial discharges, municipal wastewater-treatment facilities, and fish farms. Permitted discharges from these point sources during 1985–90 were about 269 billion gallons per year [2]. Primary pollutants associated with point sources include nitrogen, phosphorus, and organic wastes.

The types and geographic distribution of land use and land cover, the types and numbers of industries and municipalities using the water resources, and the manner in which the water resources are used are factors that create the water-quality conditions in the upper Snake River Basin as described in this report. Approximately 18,000 square miles of rangeland compose roughly one-half of the basin area. Forested and agricultural lands compose 23 and 21 percent, respectively, of the upper Snake River Basin. Urban areas compose less than 1 percent of the basin area. The geographic distribution of these land-use/land-cover categories has a large effect on the quality of water in the basin. Primary land uses and land cover in the mountainous northern and eastern parts of the basin are forested land and rangeland, and although forest practices and grazing may degrade water quality, water resources and the aquatic biological communities in these areas are generally of high quality. In contrast, agricultural activities, urban communities, and industries concentrated on the Snake River Plain, primarily along the Snake River and near the mouths of major tributary valleys, contribute sediment, fertilizers, organic compounds, and other pollutants to the Snake River and its tributaries [3,4]. As a consequence, stream- and ground-water quality and biological communities in the downstream parts of the upper Snake River Basin have been degraded by anthropogenic activities [4,5,6].

About 71 percent of Idaho's crops are produced in the upper Snake River Basin. Primary crops include potatoes, beans, sugar beets, alfalfa, and grains (photograph © 1976 by W.H. Mullins and published with permission).

A large part of Idaho's economy relies on irrigated agriculture, which subsequently relies on adequate supplies of water. In 1990, 71 percent of all irrigated acreage in Idaho was in the upper Snake River Basin, where potatoes, beans, wheat, sugar beets, alfalfa, and barley are the predominant crops [2]. These agricultural lands are areas where pesticide

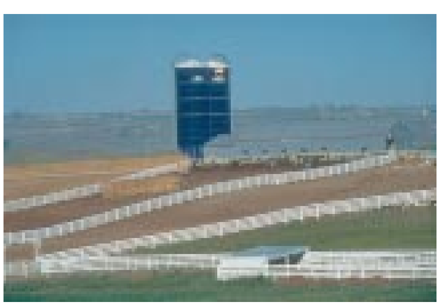
Recreation in the upper Snake River Basin has become increasingly popular, primarily in Wyoming and in the Henrys Fork Basin. Yellowstone and Grand Teton National Parks in Wyoming attract nearly 3 million visitors a year (photograph by M.G. Rupert, U.S. Geological Survey).

and fertilizer applications and crop rotation and tillage practices degrade stream and ground-water quality. Although crop yields are improved by applications of fertilizers and pesticides, the increased production often comes at the expense of water quality.

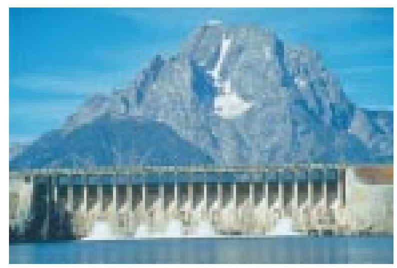
Streamflow regulation in the upper Snake River Basin for irrigation and hydroelectric power production has a detrimental effect on the water chemistry and biology of streams. During the irrigation season (April to October), much of the water in streams is diverted to canals for irrigation needs. These diversions reduce streamflows, to the detriment of the biological communities [6,7]. Fifteen large hydroelectric power facilities, generating about 1.2 million megawatthours of electricity annually, and numerous smaller facilities provide a large percentage of Idaho's electrical output [2]. Although hydroelectric power facilities generally do not produce pollutants, the dams, diversions, and canals associated with the facilities commonly change streamflow characteristics and alter habitat conditions for various species of aquatic organisms [7].

Since 1980, the number of beef and dairy cattle in the basin has grown substantially [8]. Beef and dairy cattle operations (confined-animal feeding operations) discharge some pollutants directly to streams; however, their wastes have a larger effect on ground-water quality [9]. In many areas where the cattle industry is growing, nitrate concentrations in ground water are already high because of fertilizer applications and manure production. Pollutants reaching ground water in the upper Snake River Basin eventually return to the Snake River, providing additional nitrogen and phosphorus to many streams where eutrophication problems are already evident [3,4].

Although urban areas compose less than 1 percent of the basin area, they are a potential source of pollutants to streams and ground water. Major urban areas in the basin are Idaho Falls, Pocatello, Rexburg, and Twin Falls, which together account for about 30 percent of the total basin population. These four cities discharge nearly 7.5 billion gallons of treated wastewater annually to the Snake River and its tributaries [2]. Areas in the Wyoming part of the basin do not have a large resident population but do have a significant influx of people each summer because of tourism and recreational opportunities. In 1990, nearly 3 million people visited the Grand Teton and Yellowstone National Parks. In some parts of the basin, the population is expected to grow substantially in the future. Projections indicate that by 2010, the population in the basin will reach 480,000, a 20-percent increase from the 1980 population [2]. An increasing population will put increasing pressure on the quantity and quality of the water resources in the basin. Urban runoff has the potential to transport fertilizers, organic compounds, and trace elements from streets, parking lots, and lawns to streams and ground water. Fish-tissue and bed-sediment samples collected downstream from urban areas during the National Water-Quality Assessment (NAWQA) study contained some of the largest concentrations of organic compounds in the basin [10].



The growth in the number of confined-animal feeding operations has become a concern in parts of the basin. Animal wastes can pollute streams and ground-water supplies (photograph © 1995 by W.H. Mullins and published with permission).



Numerous dams, like this one on Jackson Lake in Grand Teton National Park, provide storage for downstream water needs. Many of the dams in the upper Snake River Basin also are used to generate hydroelectric power (photograph © 1995 by W.H. Mullins and published with permission).

Although point sources of pollutants account for only about 2 and 1 percent of the total nitrogen and phosphorus, respectively, introduced annually to the upper Snake River Basin [3], they typically discharge directly to streams where pollutants become immediately available for uptake. Primary point sources of pollutants in the basin are industrial discharges, municipal wastewater-treatment facilities, and fish farms. Three industrial facilities, 13 wastewater-treatment facilities, and 12 fish farms are permitted to release 269 billion gallons of effluent in the upper Snake River Basin annually [2]. In addition, numerous other smaller, unpermitted point sources of pollutants exist in the basin. Of the total discharge from point sources, about 95 percent is from fish farms; most of the water passing through the fish farms is supplied by springs downstream from Milner Dam. Wastewater-treatment facilities account for only about 4 percent of the total point source discharge in the basin [2]. However, wastewater-treatment effluent is typically more enriched in nitrogen, phosphorus, and organic wastes than is the effluent from fish farms and, in some areas of the basin, accounts for a disproportionate amount of the pollutants entering streams [4].

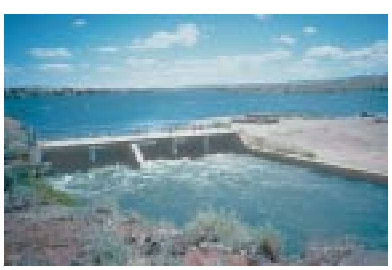
DOES WATER USE IN THE BASIN AFFECT THE QUALITY OF THE WATER RESOURCES?

The Snake River often is referred to as a working river because of its highly regulated streamflow. Five reservoirs on the main stem of the Snake River have a combined storage capacity of more than 4 million acre-feet, and eight reservoirs on Snake River tributaries have storage capacities of more than 50,000 acre-feet each [11]. Numerous dams and diversions, primarily for irrigation and hydroelectric power generation, have resulted in smaller streamflows and streamflow velocities, alterations in biological communities, and growth of nuisance aquatic plants. Other water uses in the upper Snake River Basin are domestic and public supply, fish farms, and confined-animal feeding operations. Inputs of nutrients, organic wastes, and other pollutants from these sources have degraded the water quality in many streams in the upper Snake River Basin.

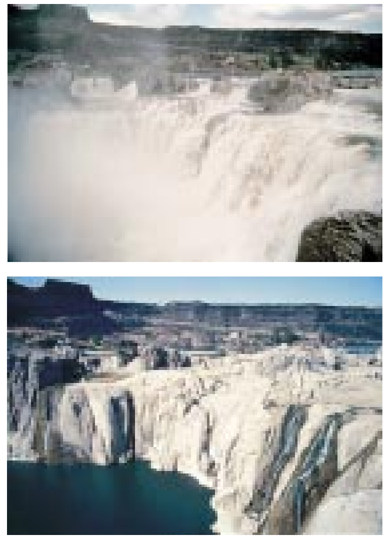
In 1990, water use in Idaho totaled 22 million acre-feet (about 20,000 million gallons per day), ranking third in the Nation behind California and Texas. Of this total, nearly 70 percent was used in the upper Snake River Basin [2]. Use of surface water and ground water in the basin was about equal—about 8 million acre-feet (7,100 million gallons per day) was diverted from surface-water supplies, and about 7.1 million acre-feet (6,300 million gallons per day) was withdrawn from ground-water supplies [2].

Most of the economy in the upper Snake River Basin is dependent on industries that require ample sources of high-quality water. Currently, the largest water uses in the basin are irrigated agriculture, food processing and other industries, public supply, fish farms, and hydroelectric power facilities [2]. Irrigated agricultural, industrial, and public supply water uses are partially consumptive in that water is withdrawn from the source, transported to the point of use, and at least partially consumed. Fish farms and hydroelectric power facilities are nonconsumptive uses because all the water used is returned to streams.

About half of the total surface-water diversions in the upper Snake River Basin are from five canals at Lake Walcott and Milner Dam for irrigation of about 575,000 acres of agricultural land [12]. Some of the water applied to fields for



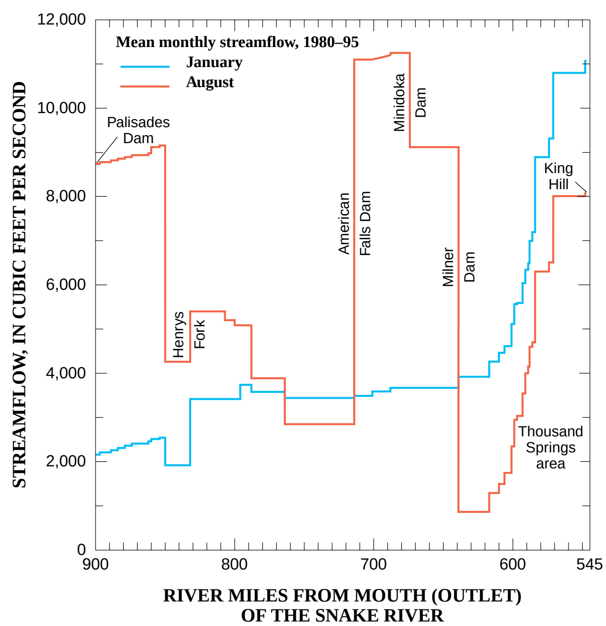
Diversion canals, like this one at American Falls Reservoir, supply irrigation water for large tracts of land adjacent to the Snake River in Idaho. In 1990, about 8 million acre-feet of water was diverted from streams in the basin to irrigate about 4.7 million acres of agricultural land (photograph by G.M. Clark, U.S. Geological Survey).



Diversions of water from the Snake River have a large effect on stream discharge. Shoshone Falls on the Snake River near Twin Falls, Idaho, is an impressive sight during high stream discharge. During the irrigation season, however, discharge over the falls can be reduced to a mere trickle (photographs by G.M. Clark, U.S. Geological Survey).

irrigation infiltrates to the ground water or returns to streams by way of canals, also transporting sediment, fertilizers, and pesticides [4]. Because of diversions, streamflows in the Snake River often are reduced substantially during many months of the year. Low streamflows, combined with instream reservoirs, have transformed some reaches of the Snake River from a high-gradient, coldwater river to a slow-moving, warmwater river supporting primarily nongame species of fish [6].

In 1990, domestic and public supply systems provided less than 150,000 acre-feet (130 million gallons per day) of



Streamflow in the Snake River during the nonirrigation season (January, for example) is typical of an unregulated stream—streamflow increases with downstream distance. During the irrigation season (August, for example), streamflow in the Snake River fluctuates substantially over its length in response to diversions, irrigation return flows, and ground-water discharge.

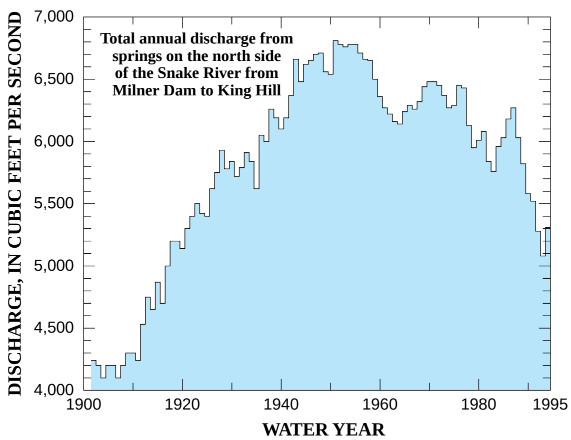
water to about 400,000 people in the upper Snake River Basin. More than 80 percent of this water was derived from ground-water supplies. Domestic and public supplies accounted for less than 1 percent of the total basin water use [2]. However, as the population in the basin continues to grow, the demand for high-quality water for domestic and public supplies will grow accordingly.

Fish farms and hydroelectric power facilities are the primary nonconsumptive water uses in the basin. Fish farms along the Snake River between Milner Dam and King Hill used about 2,500 cubic feet per second of ground-water discharge as source water in 1995 [4]. When water passes through a fish farm, it becomes enriched with nitrogen, phosphorus, and suspended sediments, which eventually are discharged to the Snake River [4].

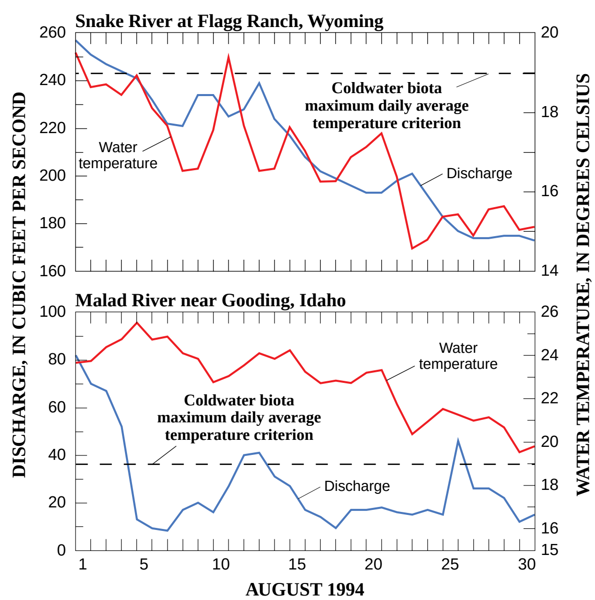
As available surface-water supplies have diminished, use of ground water in the upper Snake River Basin has increased substantially. From 1980 to 1990, annual ground-water use in the basin increased from 2.6 million acre-feet (2,300 million gallons per day) to 7.1 million acre-feet (6,300 million gallons per day) [2]. In 1980, ground water accounted for only 22 percent of the total basin water use. In 1990, ground water accounted for about 47 percent. As a result, ground-water levels in some areas of the basin have declined since 1980 [5,13]. Although most of the increase in ground-water use has been for irrigated agriculture, the number of confined-animal feeding operations in the lower parts of the basin that rely on ground-water supplies has been increasing rapidly [8]. In some areas of the basin where agriculture and confined-animal feeding operations are prominent, small concentrations of pesticides and nitrate concentrations exceeding the U.S. Environmental Protection Agency (USEPA) drinking-water standard of 10 milligrams per liter have been detected in water from domestic wells [5,13].

Historically, furrow irrigation has been the primary method of watering crops. Excess irrigation water either infiltrates to underlying aquifers or returns to streams (photograph by M.A. Maupin, U.S. Geological Survey).

Ground water has become an increasingly important source for agricultural and domestic water needs. In 1990, 47 percent of the water used in the basin was supplied by ground water (photograph by M.G. Rupert, U.S. Geological Survey).



Total discharge from springs along the north side of the Snake River from Milner Dam to King Hill reflects historical changes in water-use patterns. Spring discharge increased substantially from the early 1900's to the late 1950's in response to an increase in ground-water recharge from surface-water irrigation. A general decline in discharge since the mid- to late 1950's is attributable to an increase in ground-water pumpage for irrigation and other purposes.



Streamflow diversions for other uses can result in warmer water temperature, which is detrimental to most native species of fish. At the Snake River at Flagg Ranch, Wyoming, a site with natural hydrologic conditions, even during the warmest period of the year (August), the temperature criterion of 19 degrees Celsius is rarely exceeded. However, at the Malad River near Gooding, Idaho, a site affected by diversions, the temperature criterion is often exceeded during the entire month of August.

HAVE FISH COMMUNITIES IN THE UPPER SNAKE RIVER BASIN BEEN AFFECTED BY WATER-QUALITY DEGRADATION?

A large amount of variability exists in the health of fish communities in the upper Snake River Basin. In some streams of the basin, cutthroat, rainbow, and brown trout fisheries represent some of the highest quality fishing in the Nation. In other areas of the basin, where streams have been degraded by land- and water-use activities, the fish community is composed of warmwater-tolerant, nongame species. Because trout species generally require cold water temperatures and ample dissolved oxygen for survival, trout species have been nearly eliminated in several degraded streams of the basin [6,7].

Fishing enthusiasts from all parts of the Nation enjoy the high-quality fisheries in some headwater areas of the upper Snake River Basin. Large cutthroat, rainbow, and brown trout, like this one caught from the Henrys Fork, are typical of fish communities in the Henrys Fork and the Snake River upstream from its confluence with the Henrys Fork. Although healthy trout populations once existed in all parts of the basin, today they are located primarily in pristine headwater areas of the basin (photograph © 1996 by W.H. Mullins and published with permission).

Characterization of fish communities in streams and reservoirs is a useful tool for assessing effects of land- and water-use activities on water-quality conditions because fish are sensitive to a large array of stresses, many species of fish are widely distributed, and descriptive analyses of fish communities are easy to understand. Fish are also relatively long-lived, and they integrate adverse effects of stresses in the aquatic community. In addition, Idaho water-quality standards designate aquatic biota and salmonid spawning as beneficial uses of many streams in the State and, as a result, water-quality criteria have been established to protect instream fisheries. Specific areas of concern include input of chemical pollutants, loss of instream habitat, sedimentation of spawning beds, decreased streamflows, increased water temperatures, and introduction of non-native species [7].

Overall, 26 native and 13 introduced fish species representing numerous different fish families were collected in the basin during the NAWQA study. About 73 percent of the species collected from all sites were native [6]. An Index of Biotic Integrity derived from NAWQA data indicates that, in general, the quality of fish communities in the Snake River and its tributaries deteriorates from the headwaters of the Snake River near Yellowstone National Park to the basin outlet at King Hill. The notable exception to this trend is in Rock Creek near Twin Falls, where fish stocking and the inflow of sediment-free ground water results in a fish community of better quality than that of many upstream sites.

A common perception about fish communities is that, the greater the number of fish species and the greater the number of total fish, the better the stream-water quality. Usually, a diverse community with many species indicates good water quality. Polluted water, on the other hand, generally contains fewer species, many of which can tolerate pollution and procreate rapidly. Although this perception may be true in some areas of the Nation, it is not necessarily true for fish communities in coldwater streams of Idaho and Wyoming [14].

In the upper Snake River Basin, high-quality streams at high elevations usually contain fewer fish species than do streams at lower elevations [6]. Many headwater streams might have been devoid of fish prior to the introduction of selected species for sportfishing. Coldwater streams generally do not offer the food sources, temperature, and habitat features that many fish species prefer. Fish community sampling during the NAWQA study and historical data from the upper Snake River Basin indicate that relatively small, undisturbed headwater streams in northern, eastern, and southern parts of the basin tend to contain the fewest fish and the lowest number of species. Numerous small reference (least disturbed by human activities) streams in the basin contained an average of only 2 to 4 fish species and less than 100 total fish in the reaches sampled. In most of the reference streams sampled, only native or introduced trout and sculpin were present. In contrast, streams with degraded water quality contained between 5 and 10 different fish species and greater numbers of fish than reference streams contained. Fish communities in degraded streams were predominantly introduced, nongame species tolerant of degraded water-quality conditions.

NAWQA scientists assess fish communities using electrofishing techniques. Most fish collected are catalogued and released. Some fish, however, are collected and sent to laboratories where their tissue is analyzed for the presence of pollutants (photograph by T.R. Maret, U.S. Geological Survey).

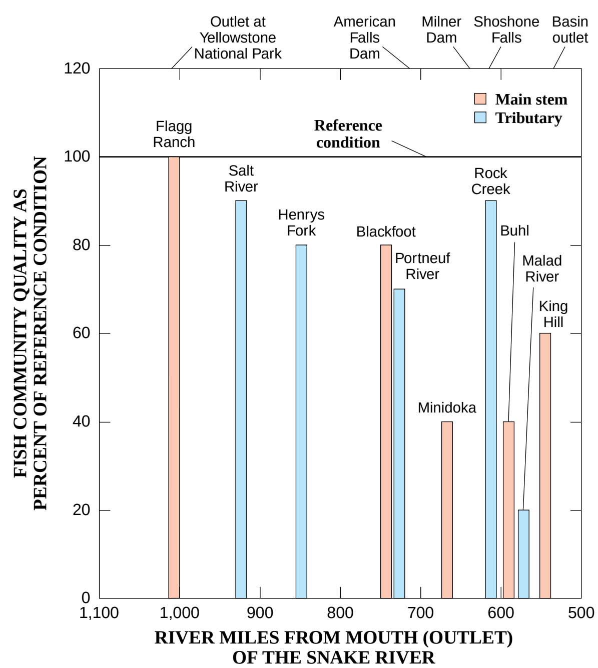
At one time, white sturgeon, like this 630-pounder caught in 1908, were common in the Snake River downstream from Shoshone Falls. Some sturgeon still survive in the reach; however, because of reduction in the available habitat and poor water-quality conditions, their sizes and numbers have dwindled compared with the historical population (photograph courtesy of the Idaho Historical Society).

The upper reaches of the Henrys Fork and the Snake River upstream from its confluence with the Henrys Fork represent two of the best large-river trout fisheries in the Nation. Cutthroat, rainbow, and brown trout make up most of the game species in these stream segments. Nongame species are primarily native sculpin and suckers. Rainbow and brown trout, introduced to enhance the sportfishery, make up most of the non-native species in the upper reaches of the Henrys Fork and the Snake River upstream from the confluence.

Downstream from the confluence of the Snake River and Henrys Fork to Milner Dam, fish communities in the Snake River and its major tributaries are composed primarily of cutthroat trout and other native and non-native species [7]. However, fish communities in this reach have been degraded by the cumulative effects of irrigation return flows, grazing, and diversions. Sediment from bank erosion and irrigation return flows has blanketed stream bottoms and caused loss of suitable spawning habitat. Reservoirs and irrigation diversions in the reach also have resulted in reduced streamflows, degraded water-quality conditions, loss of habitat, and proliferation of non-native, warmwater species of fish [7].

Historical information indicates that, prior to hydroelectric power development, numerous native, ocean-migratory species inhabited the Snake River from Shoshone Falls near the city of Twin Falls downstream to the basin outlet at King Hill. Species included chinook salmon, steelhead, Pacific lamprey, and white sturgeon [7]. Of these species, only the white sturgeon is still present in the reach, but the population is declining and is sparsely distributed. Fish community assessments conducted during the NAWQA study indicate that this reach of the Snake River is composed predominantly of nongame species such as carp and suckers [6]. The presence of a fish community dominated by carp and suckers is attributable to reduced streamflows, large inputs of nutrients and fine-grained sediment, excessive aquatic plant growth, and elevated water temperature. Temperatures in excess of 19 degrees Celsius (the maximum criterion for coldwater biota) and dissolved-oxygen concentrations as small as 1.0 milligram per liter have been measured [7]. Because of the degraded water quality, trout have been nearly eliminated in the reach of the Snake River between Shoshone Falls and King Hill.

In many parts of the upper Snake River Basin, especially in the lower reaches, pollution-tolerant, warmwater species like this common carp dominate the fish community. Trout and other coldwater species of fish cannot tolerate the degraded conditions in some streams of the basin (photograph © 1991 by W.H. Mullins and published with permission).



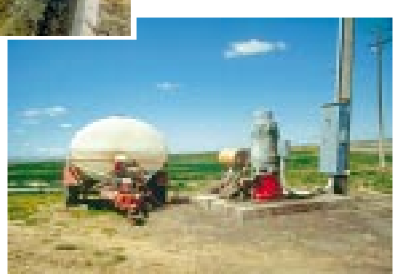
Comparison of fish community indexes for the main-stem Snake River and major tributary sites. The higher the fish community index, the higher the quality of the fish community. Index scores are relative to the best fishery condition (Snake River at Flagg Ranch, Wyoming) and are based on percent introduced species, percent anomalies, percent omnivores, and percent tolerant fish species.

IS NITRATE A CONCERN IN STREAMS AND GROUND WATER IN THE UPPER SNAKE RIVER BASIN?

On the basis of data collected during the NAWQA study, nitrate concentrations in streams in the upper Snake River Basin were generally low, and none exceeded the USEPA drinking-water standard of 10 milligrams per liter. However, in some streams of the basin, nitrate was a contributing factor to the overabundance of aquatic plants. In contrast to stream samples, some ground-water samples contained nitrate concentrations in excess of 10 milligrams per liter. Nitrate contamination in streams and ground water may become a more serious problem in the future as population growth and industrial development in the basin continue.

Nitrate (NO_3) is, in general, the predominant form of nitrogen in streams and ground water. Nitrate is highly soluble in water, stable over a wide range of environmental conditions, and readily transported in streams and in ground water. Nitrate is common in the environment; rainwater contains small concentrations. Although nitrate is an essential plant nutrient, in large concentrations it can be a pollutant in water. Excessive nitrate in streams, in combination with other nutrients, can lead to overabundance of aquatic plants and degraded water-quality conditions. Large concentrations of nitrate in drinking water also have been identified as the cause of blue-baby syndrome in infants, which is characterized by a reduced capacity of the blood to carry oxygen. Nitrate also has been associated with a high incidence of non-Hodgkin's lymphoma and miscarriages [5,15]. Because of the health concerns associated with nitrate, the USEPA established the current drinking-water standard of 10 milligrams per liter for nitrate as nitrogen.

Cattle manure, which contributes about 30 percent of the nitrogen annually introduced to the basin, is used as a fertilizer on crops. Manure may become an even larger source of nitrogen in the future as the dairy and beef cattle industries in the basin expand (photograph by M.G. Rupert, U.S. Geological Survey).

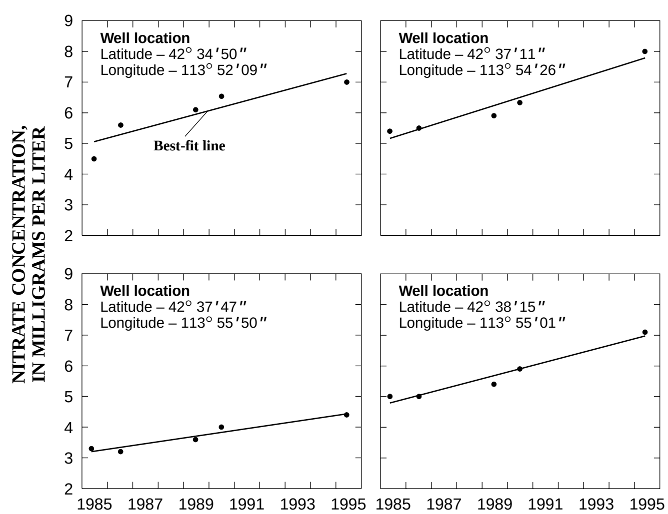


Nitrogen fertilizer is applied to crops to enhance production. It is generally added to irrigation water prior to field application. Excess irrigation water can carry nitrate to underlying ground water or back to streams (photographs by M.G. Rupert, U.S. Geological Survey).

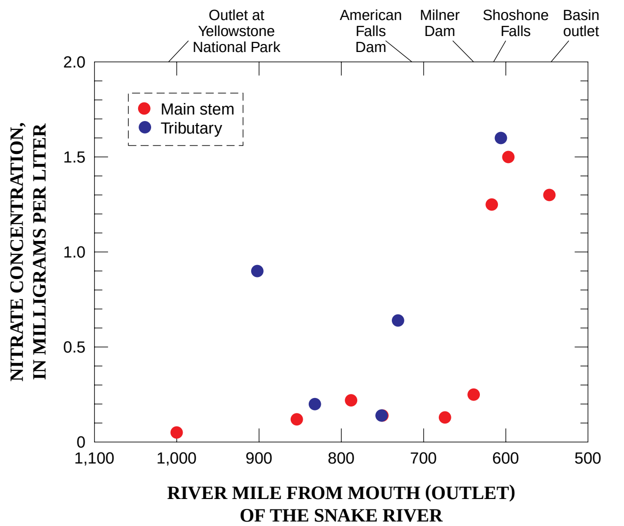
The major sources of nitrate in the upper Snake River Basin are fertilizers, cattle manure, and legume crops. These three sources contribute about 93 percent of the nitrate input to the basin [9]. Precipitation contributes an additional 6 percent of nitrate input to the basin. Domestic septic systems contribute less than 1 percent; however, in densely populated areas, domestic septic systems can contribute substantial amounts of nitrate to ground water [9].

In most areas of the Nation, nitrate concentrations in streams are not as large as in ground water and rarely exceed the drinking-water standard [16]. This is also true in the upper Snake River Basin, where concentrations of nitrate were less than 2.0 milligrams per liter in 95 percent of 527 stream samples collected during the NAWQA study [4]. However, concentrations of nitrate in many streams were sufficient, in combination with sufficient phosphorus and a suitable substrate, to result in the overabundance of aquatic plants, particularly in the downstream reaches of the Snake River.

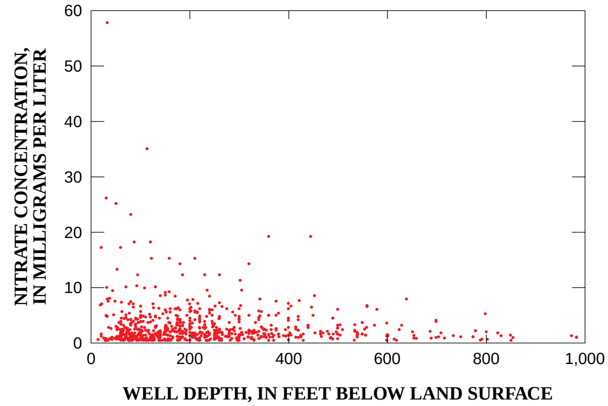
At 19 stream sites sampled during 1992 through 1995 (12 as part of the NAWQA and 7 as part of other U.S. Geological Survey water-quality studies), concentrations of nitrate were largest downstream from agricultural areas. Samples collected at main-stem and tributary sites between Milner Dam and King Hill contained the largest concentrations of nitrate [4]. Nitrate concentrations in samples collected from the Snake River at King Hill during the 16-year period from 1980 through 1995 show no upward or downward trend. Concentrations of nitrate at King Hill were smallest when streamflows were larger than normal and largest when streamflows were smaller than normal. Discharge of ground water to the Snake River from numerous springs between Milner Dam and King Hill is a constant source of nitrate to the river during most years, accounting for about 70 to 80 percent of the nitrate leaving the upper Snake River Basin at King Hill [4,17]. Nitrate in spring water is derived primarily from fertilizers, cattle manure, and legume crops [9].



Concentrations of nitrate in ground water are increasing in areas of the upper Snake River Basin. Water from four wells in the shallow (mean well depth of 40 feet) alluvial aquifer in the Minidoka Irrigation District north of Burley, Idaho, shows an increase in nitrate concentrations since 1985.



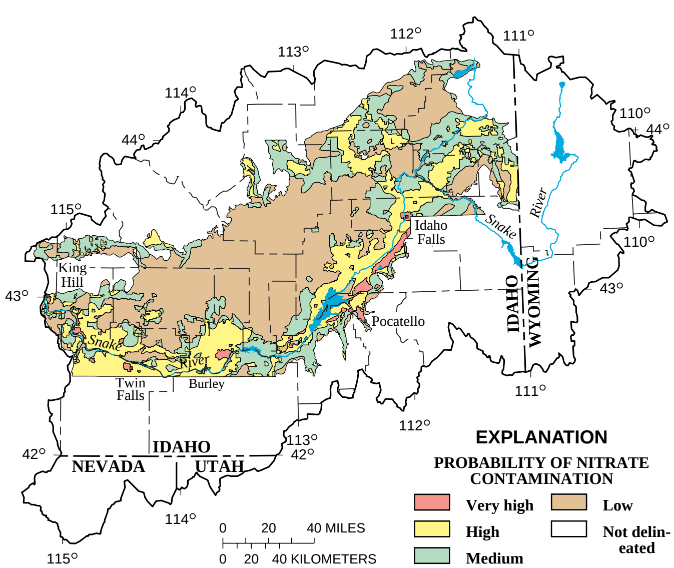
Samples collected during the NAWQA study show that median concentrations of nitrate in the Snake River and at the mouths of major Snake River tributaries upstream from Milner Dam were all less than 1.0 milligram per liter. Downstream from the dam, however, median nitrate concentrations increased substantially in response to large inflows of nitrate-enriched ground water, effluent from industrial and wastewater-treatment facilities, and irrigation return flows.



Ground-water samples collected during 1991–95 indicate that nitrate concentrations were largest in wells less than 200 feet deep. None of the samples collected from wells deeper than 500 feet contained nitrate concentrations in excess of the drinking-water standard of 10 milligrams per liter.

In 1992, the USEPA reported that nitrate was a principal ground-water pollutant in 49 States [16]. In the upper Snake River Basin, elevated nitrate concentrations in ground water were detected in numerous counties, primarily on the Snake River Plain [13]. Nitrate concentrations exceeded the 10 milligrams per liter drinking-water standard in water from wells at the Idaho National Engineering and Environmental Laboratory, in the Fort Hall area north of Pocatello, and in agricultural areas north of the Snake River between Burley and Hagerman [5]. Concentrations in 25 percent of 726 wells (mostly domestic and public supply) sampled basinwide from 1991 through 1995 as part of the NAWQA and other USGS water-quality studies exceeded 3.0 milligrams per liter. Concentrations in only 3 percent of the samples exceeded the drinking-water standard [5]. However, in some areas of the basin, nitrate in ground water is becoming a serious concern. In agricultural areas north of the Snake River between Burley and Hagerman, water from 10 percent of 105 wells sampled during the NAWQA study, ranging in depth from 10 feet to more than 500 feet, contained concentrations of nitrate in excess of 10 milligrams per liter [5]. Water from 24 percent of 29 domestic wells sampled in the shallow (mean well depth of 40 feet) alluvial aquifer in the Minidoka Irrigation District north of Burley contained nitrate concentrations in excess of 10 milligrams per liter. In the A&B Irrigation District north of Burley, nitrate concentrations in water from 10 percent of 31 wells sampled (mean well depth of 230 feet) exceeded 10 milligrams per liter. In some agricultural areas, concentrations of nitrate have increased substantially since the early 1980's [5]. If the current rate of increase continues, nitrate concentrations in a large part of the A&B Irrigation District's ground-water supply may exceed the 10 milligrams per liter drinking-water standard early in the 21st century [5].

On the basis of data collected during the NAWQA study, probability maps were developed to identify areas in the upper Snake River Basin where the potential for ground-water contamination by nitrate is high. Results indicate that the most vulnerable areas are those where urban or irrigated agricultural land uses are predominant, where the depth to water is shallow, and where soils are well drained. Other studies across the Nation also noted that land-use and soil-drainage characteristics markedly influence the concentration of nitrate in ground water [18]. In the upper Snake River Basin, ground water beneath agricultural lands adjacent to the Snake River, especially near Burley and Twin Falls, and between Idaho Falls and Pocatello is particularly vulnerable to nitrate contamination [5].



Probability maps are valuable for determining areas potentially vulnerable to ground-water contamination. This map for nitrate, produced during the NAWQA study and based on depth to ground water, soil characteristics, and land use, shows that ground water near the Snake River between Idaho Falls and the outlet of the basin at King Hill is the most vulnerable to nitrate contamination.

ARE PESTICIDES AND OTHER ORGANIC COMPOUNDS REACHING STREAMS AND GROUND WATER? ARE THEY PERSISTING IN THE ENVIRONMENT?

Use of pesticides and other organic compounds in many parts of the Nation poses a potential for serious nonpoint source contamination of streams and ground water. More than 1.1 billion pounds of pesticides is used each year in the United States [19]. In addition, new pesticides are continually being formulated and introduced to improve safety and minimize adverse environmental effects. As part of the NAWQA study, samples from streams, bed sediment, fish tissue, and ground water were collected and analyzed for pesticides, semivolatile organic compounds (SVOCs), and volatile organic compounds (VOCs). The results indicate that many pesticides and other organic compounds are reaching the water resources of the basin and that some compounds have accumulated in fish tissue and bed sediment. Although most of the compounds detected were at low concentrations, some compounds were detected at concentrations in excess of drinking-water standards or national guidelines for the protection of fish-eating wildlife.

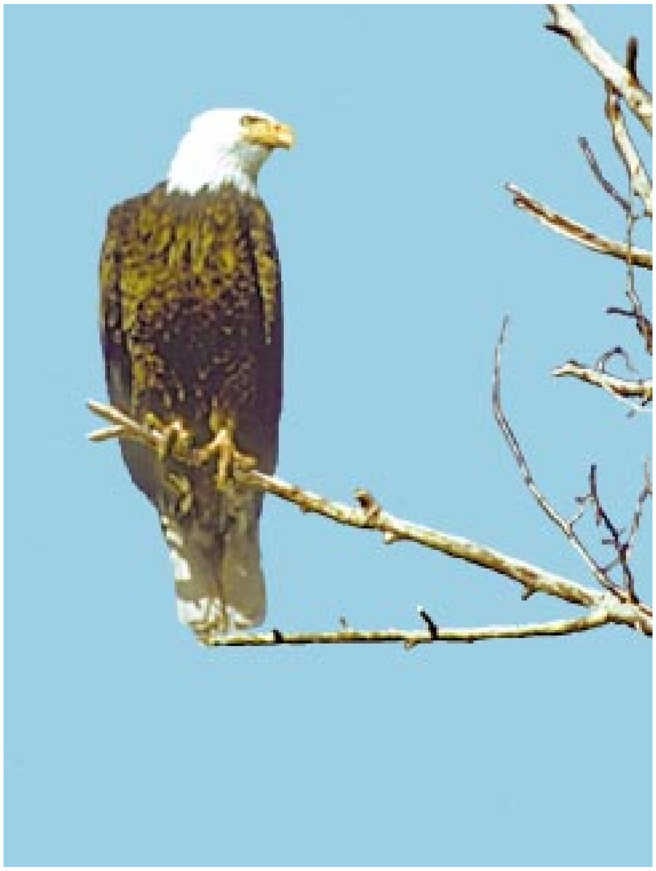
Tributaries, such as Rock Creek near Twin Falls, discharge irrigation wastewater and associated pesticides to the Snake River. The number and concentrations of pesticides in water, bed sediment, and fish tissue are largest in the downstream parts of the upper Snake River Basin (photograph by G.M. Clark, U.S. Geological Survey).

In basinwide stream sampling conducted in May and June 1994, EPTC, or Eptam (used on potatoes, beans, and sugar beets); atrazine (used on corn) and its breakdown product desethylatrazine; metolachlor (used on potatoes and beans); and alachlor (used on beans and corn) were the most commonly detected pesticides, accounting for about 75 percent of all detections [20]. Only four different pesticides were detected in samples collected upstream from American Falls Reservoir. No pesticides were detected in the Snake River or its tributaries upstream from its confluence with the Henrys Fork. Seventeen different pesticides were detected downstream from American Falls Reservoir; the largest number was detected in agriculturally degraded tributaries to the Snake River between Twin Falls and Hagerman [20]. During followup sampling in 1995, two samples from agricultural drains near Twin Falls contained concentrations of the insecticides chlorpyrifos and methylazinphos that exceeded USEPA criteria for the protection of aquatic life (see Summary of Compound Detections and Concentrations, page 26). However, none of the stream samples collected during 1994 and 1995 contained concentrations of pesticides that exceeded USEPA drinking-water standards.

Crop yields have improved in the upper Snake River Basin as a result of widespread pesticide applications. Although many of the pesticides currently in use break down rapidly in the environment following application, some pesticides are reaching the ground- and surface-water supplies of the basin (photograph by M.G. Rupert, U.S. Geological Survey).

Rock Creek near Twin Falls has long been recognized as one of the most severely degraded streams in the State of Idaho [21]. During 2 years of monitoring at Rock Creek, 19 different pesticides were detected in stream samples, and 42 of 43 samples contained at least 1 pesticide, most of which were herbicides [22]. The number of pesticides and the pesticide concentrations were largest in Rock Creek in the spring and early summer following early season crop applications [4]. This pattern is typical in many parts of the United States [19].

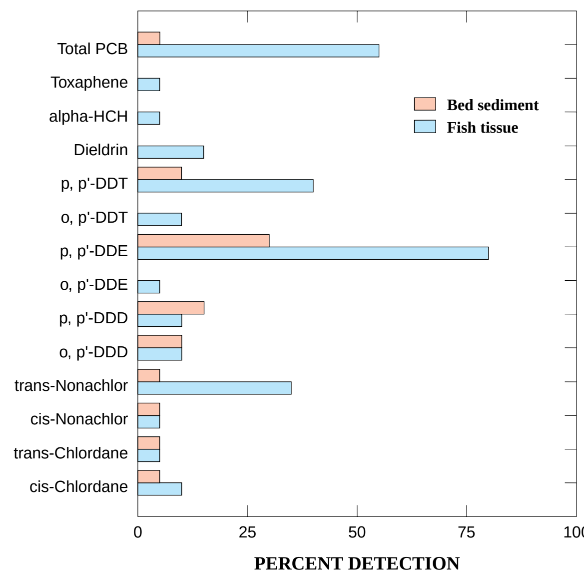
Similar to basinwide sampling results, the most commonly detected compounds in Rock Creek were EPTC, atrazine, desethylatrazine, metolachlor, and alachlor. Concen-



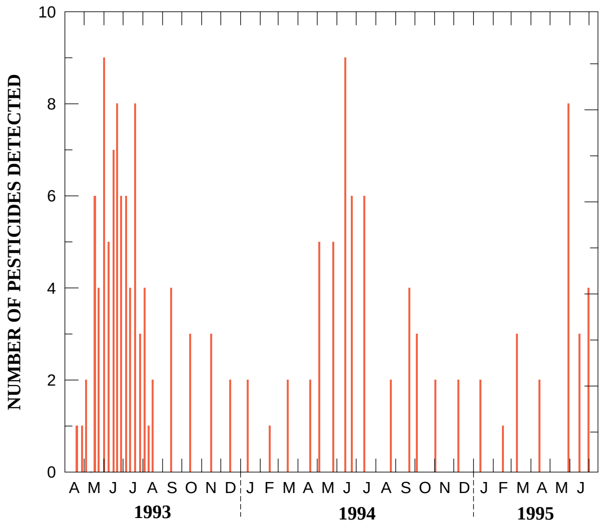
In the 1980's, studies determined that large concentrations of the organochlorine compounds DDT and PCBs in fish tissue were resulting in eggshell thinning and poor reproductive success for fish predators such as the bald eagle. Today, bald eagle populations throughout the United States are nearing recovery levels, which will allow them to be removed from the Endangered Species List (photograph © 1974 by W.H. Mullins and published with permission).

trations of the pesticides in Rock Creek were well below USEPA drinking-water standards and aquatic-life criteria [22]. Even though most of the pesticides in Rock Creek were detected only during the growing season, atrazine and desethylatrazine, because of their mobility and relative resistance to breakdown, were detected year round at concentrations ranging from 0.01 to 0.03 microgram per liter.

Streambed sediment and bottom-feeding fish, primarily suckers and carp, were collected and analyzed for organochlorine compounds such as DDT and PCBs. Because most of these compounds are not water soluble and are not readily broken down, many can remain in relatively large concentrations in bed sediment and in the fat tissue of fish for long periods of time. Although many of the organochlorine compounds have been banned from use in the United States since the early 1970's, studies conducted in the late 1980's documented the presence of DDT in 98 percent of fish-tissue samples collected at 388 stream sites across the Nation [23]. However, comparison of fish-tissue data collected during the NAWQA study with data collected during the early 1970's indicates that the bans on use have been effective in reducing the environmental concentrations of organochlorine compounds in the Snake River Basin. Samples of tissue from fish collected from the Snake River near Twin Falls indicate that concentrations of DDT and other organochlorine compounds, although still present, have decreased substantially, some by as much as 10 times [10].



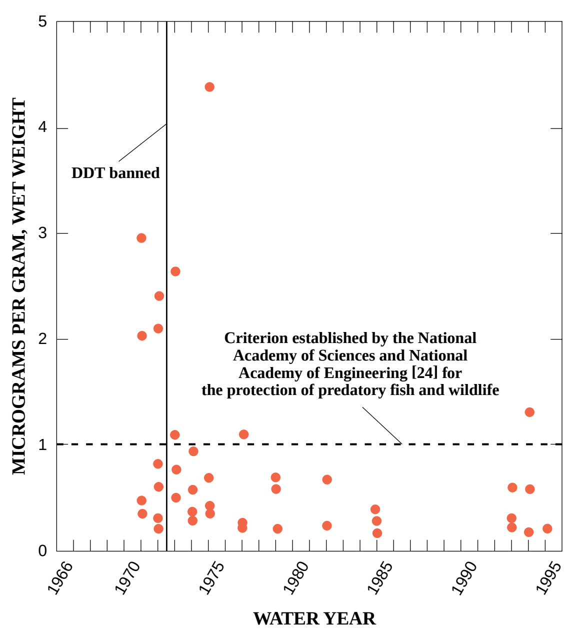
DDE, a breakdown product of DDT, was present in fish tissue at 16 of 20 sites, or 80 percent of sites where samples were collected during the NAWQA study. PCBs were present in samples from 12 of the 20 sites. Overall, fish-tissue samples contained more organochlorine compounds than did bed-sediment samples.



During 2 years of sampling at Rock Creek near Twin Falls, the largest number and largest concentrations of pesticides were detected in the spring and early summer following early season applications. This temporal pattern of pesticide detections in surface water is typical across the Nation. Forty-two of the 43 samples collected during the 2-year period contained at least 1 pesticide.

Of the 41 fish-tissue and 43 bed-sediment samples collected at 22 sites during the upper Snake River Basin NAWQA, 14 different organochlorine compounds were detected in fish tissue, and 9 organochlorine compounds and 47 SVOCs were detected in bed sediment [10]. The most frequently detected organochlorine compounds were DDT and its breakdown products, DDD and DDE, present in fish tissue at 83 percent of the sites and in bed sediment at 29 percent of the sites. At least one SVOC was detected in all of the bed-sediment samples. The most frequently detected SVOCs in bed sediment were phthalates (98 percent of the samples), phenol (86 percent), and 2,6-dimethylnaphthalene (83 percent). Sources of these compounds can be industrial and recreational activities. Currently, however, no human health

Bottom-feeding fish, like this sucker, are sent to the U.S. Geological Survey's National Water Quality Laboratory, where their tissue is analyzed for organochlorine compounds. Many organochlorine compounds, a number of which have been banned from use, accumulate in fish tissue, where they can be passed on to fish-eating predators (photograph by T.R. Maret, U.S. Geological Survey).



The positive results of the 1972 ban on the production and distribution of DDT are evident in tissue concentrations in bottom-feeding fish in the Snake River near Twin Falls. Data were collected for the U.S. Fish and Wildlife Service National Contaminant Biomonitoring Program (1970–84) and the upper Snake River Basin NAWQA study (1992–94). Although concentrations of DDT have declined substantially since the early 1970's, because of their persistence, DDT and its breakdown products are still present in fish tissue and bed sediment.

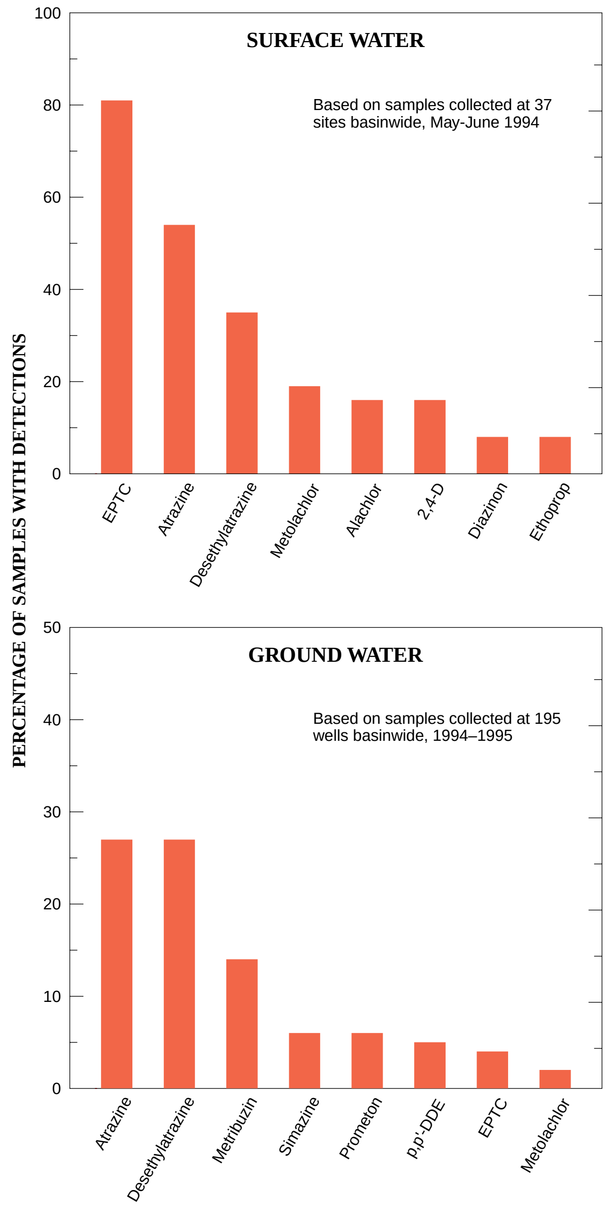
advisories for fish consumption are in force for streams in the upper Snake River Basin.

In headwater streams where degradation of stream-water quality is minimal, tissue of fish, primarily suckers, from four of eight sites contained small concentrations of DDT and its breakdown products. Although no obvious sources exist for DDT in headwater areas of the upper Snake River Basin, other studies in the Nation also have documented the presence of DDT in fish tissue and bed sediments in pristine watersheds [25]. Streams draining areas influenced by agricultural and industrial activities contained the largest number of organochlorine compounds and SVOCs and in the largest concentrations [10]. Concentrations of organochlorine compounds in tissue of fish from the Portneuf River at Pocatello, Rock Creek near Twin Falls, and Snake River near Twin Falls equaled or exceeded national (NAS/NAE) guidelines for the protection of fish-eating wildlife [10].

Water samples from domestic, irrigation, stock, and public supply wells were collected and analyzed for pesticides and VOCs during a basinwide study conducted during the summers of 1994 and 1995 [26]. Results showed that water from 39 percent of 195 wells sampled contained at least 1 detectable pesticide (M.G. Rupert, U.S. Geological Survey, written communication, 1997). Water from 13 percent of the wells contained 3 or more pesticides. Fourteen different pesticides and 11 different VOCs were detected in the 195 well samples. Atrazine (in 27 percent of the samples), desethyl-atrazine (in 27 percent), metribuzin (in 7 percent), simazine (in 7 percent), and prometon (in 7 percent) were the most commonly detected pesticides. None of these pesticides, however, exceeded USEPA drinking-water standards.

Results from the basinwide sampling, in conjunction with intensive sampling in selected areas of the upper Snake River Basin, showed no detectable pesticides in ground water in some areas; however, in other areas, ground water contained numerous pesticides. Samples collected from wells in the Jackson, Wyoming, area; in the mountainous northern part of the basin; and along the southern boundary of the basin contained few, if any, pesticides. The largest number and concentrations of pesticides were in samples from wells that also contained large nitrate concentrations and were located in agricultural areas adjacent to the Snake River. Intensive sampling of 105 domestic and irrigation wells in agricultural areas north of the Snake River between Burley and Hagerman showed that water from 73 percent of the wells contained at least 1 pesticide and that 41 percent contained 3 or more pesticides (M.G. Rupert, U.S. Geological Survey, written communication, 1997). The VOC 1,2-dichloropropane was the only organic compound detected in ground water that exceeded USEPA drinking-water standards. However, it was detected in water from only one shallow domestic well at a concentration of 6.6 micrograms per liter [26].

Because the toxicological effects of drinking water that contains multiple pesticides or other organic compounds are not well understood [19], health risks associated with drinking ground water in some areas of the basin cannot be determined. More research is necessary to establish the health risks associated with drinking water containing small concentrations of more than one pesticide or other organic compound.



Basinwide, EPTC, atrazine, and the atrazine breakdown product desethylatrazine were the most commonly detected pesticides in surface water. In ground water, atrazine, desethylatrazine, and metribuzin were the most commonly detected pesticides. The large percentage of detections of atrazine and desethylatrazine is surprising because atrazine is not widely used on crops in the upper Snake River Basin.

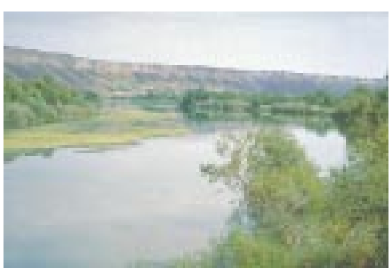
WHAT ARE THE WATER-QUALITY CONCERNS IN THE SNAKE RIVER BETWEEN MILNER DAM AND KING HILL? WHAT ARE THE PRIMARY SOURCES OF POLLUTANTS?

Water quality in the 92-mile reach of the Snake River between Milner Dam and King Hill at the upper Snake River Basin outlet (see location map on page 4) is degraded because of the cumulative effects of decades of agricultural and industrial activities. Sources of pollutants to the Snake River downstream from Milner Dam include irrigation returns, agriculturally degraded tributary streams, fish farms, and wastewater-treatment facilities [4]. Since 1990, the reach from Milner Dam to King Hill has been listed by the Idaho Division of Environmental Quality as “water-quality limited” under the Federal Clean Water Act. The listing indicates degraded water-quality conditions and a violation of at least one State water-quality criterion. Excessive aquatic vegetation, low dissolved oxygen, and high water temperatures in the reach are violations. Because of the degraded conditions, beneficial uses of the reach for aquatic life, fishing, swimming, and boating are impaired [27].

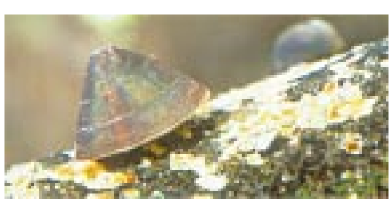
Numerous factors contribute to the poor water-quality conditions in the Snake River from Milner Dam to King Hill. These factors include input of excessive nutrients, pesticides, and sediment from a variety of sources, and alterations in streamflow conditions [4,27]. An abundance of nutrients such as nitrogen and phosphorus, associated with sufficient bed sediment, provides aquatic plants with the ideal environment for rapid growth. Overabundance of aquatic plants, or eutrophication, is the process creating the degraded water-quality conditions in the Snake River from Milner Dam to King Hill. A water body that has become eutrophic has a wide fluctuation in dissolved-oxygen concentrations and does not support a healthy biological community. When aquatic plants die, they settle to the stream bottom and decompose, causing further dissolved-oxygen depletion, odor problems, and a source of nutrients for more aquatic plant growth. Historically, large streamflows during spring snowmelt have scoured bed sediment and transported it downstream. However, drought conditions in recent years, upstream diversions, and impoundments in the reach have substantially reduced streamflow and streamflow velocities in the Snake River downstream from Milner Dam [27]. During most years, the main source of water to the Snake River downstream from Milner Dam is numerous springs that discharge ground water to the river [17]. However, because the amount of water supplied by the springs is not sufficient to scour bed sediment and decaying plants, these materials accumulate on the river bottom, where they supply substrate for aquatic plants and act as a storage reservoir for nutrients [27].

The Snake River between Milner Dam and King Hill receives water and pollutants from a variety of nonpoint and point sources. A dramatic contrast in water quality is visually apparent (see arrow) where sediment-free ground water discharges to the river (photograph © 1978 by W.H. Mullins and published with permission).

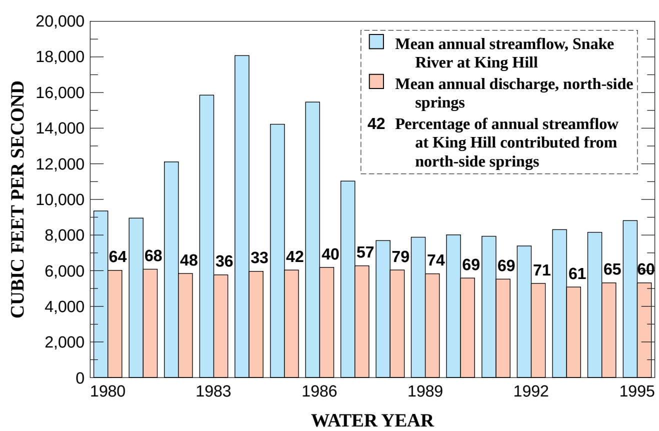
The biological community in the Snake River between Milner Dam and King Hill has become severely stressed as a result of the eutrophic conditions [6]. Large dissolved-oxygen and temperature fluctuations have resulted in water-quality conditions that are intolerable for many aquatic



Accumulations of soft, fine-grained sediment in the river bottom, along with an abundant supply of nutrients, result in algae blooms and dense growths of aquatic plants such as these in the Snake River near Twin Falls (photograph by G.M. Clark, U.S. Geological Survey).



Eight species of endangered snails, such as this Banbury Springs limpet, inhabit areas of the Snake River between Milner Dam and King Hill. A number of studies are underway to determine the extent and abundance of these snail populations in the basin (photograph © 1994 by W.H. Mullins and published with permission).



The percentage of the annual contribution of water to the Snake River from springs along the north bank of the Snake River between Milner Dam and King Hill varies depending on water conditions in the upper Snake River Basin. During the wet years from 1982 to 1986, the springs provided less than 50 percent of the water annually leaving the basin at King Hill. During the dry years from 1988 to 1992, the springs provided more than 68 percent of the water annually leaving the basin.

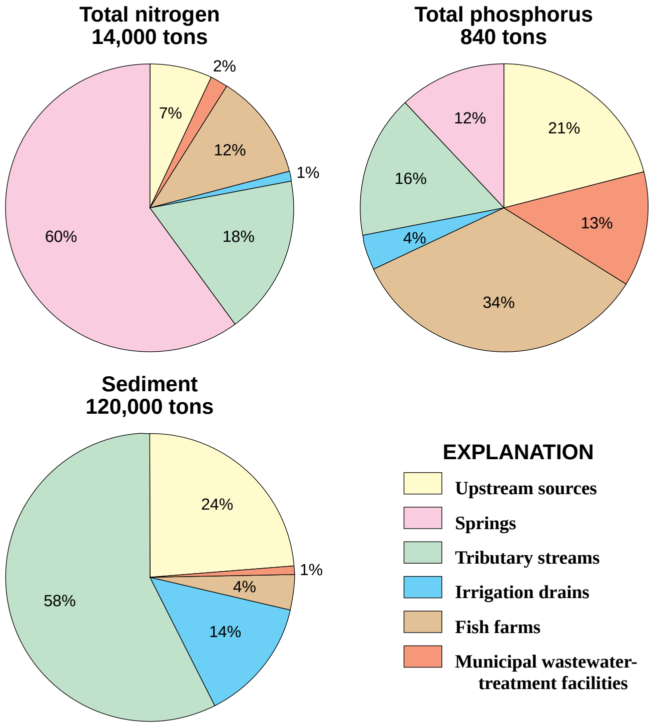
Fish farms along the Snake River use sediment-free spring discharge to raise fish for stocking and commercial use. More than 200 hatcheries in the reach between Milner Dam and King Hill account for more than 70 percent of the live-weight of trout commercially produced in the Nation (photograph © 1995 by W.H. Mullins and published with permission).

organisms. In addition, many of the deep pools and gravel beds once common in the reach have been filled with sediment and decaying plant material and no longer provide suitable habitat for many native species. Few trout or other native fish species currently survive in the reach, which is now dominated by species adapted to polluted, warmwater conditions [6,7]. Downstream dams on the Snake and Columbia Rivers have blocked access to the Snake River between Shoshone Falls and King Hill for other species such as chinook salmon, steelhead, Pacific lamprey, and white sturgeon. Of these species, only the white sturgeon survives in the reach. Seven species of snails and two other species of fish currently inhabiting areas in the reach either have been federally listed or are being considered for listing as endangered or threatened. As a result of the listings, the U.S. Fish and Wildlife Service has issued a recovery plan for the endangered and threatened species in the reach [28].

Sources of pollutants to the Snake River downstream from Milner Dam include irrigation return flows, agriculturally affected tributary streams, fish farms, and wastewater-treatment facilities [4]. Sources such as agriculture, food processing and other industries, and confined-animal feeding operations may not discharge directly to the Snake River; rather, pollutants from these sources are, in many instances, transported to the ground water and ultimately discharged to the Snake River. On the basis of data collected during the NAWQA study and by other agencies, contributions of nitrogen, phosphorus, and sediment to the Snake River between Milner Dam and King Hill were estimated for 1995 [4]. The estimates indicate that ground water discharging as springs supplied about 60 percent of the 14,000 tons of total nitrogen that entered the reach during 1995. Tributary streams and fish farms contributed 18 and 12 percent of the total nitrogen, respectively. Fish farms, tributary streams, and the Twin Falls wastewater-treatment facility contributed 34, 16, and 13 percent, respectively, of the 840 tons of total phosphorus entering the reach in 1995. Sources upstream from Milner Dam contributed 21 percent of the total phosphorus. About 120,000 tons of sediment entered the reach in 1995. The agriculturally affected tributaries—Rock Creek, Cedar Draw, Mud Creek, Deep Creek, Salmon Falls Creek, and the Malad River—contributed about 58 percent of the sediment input to the reach, and upstream sources and irrigation return flows contributed 24 and 14 percent, respectively.

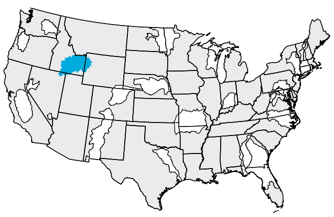
The degraded conditions in the Snake River between Milner Dam and King Hill and increasing water-resource demands by user groups have raised public awareness about this reach of the river. Restoring and maintaining the water quality of the Snake River and protecting existing uses are recognized as important factors influencing the future economic and social well-being of the region. Simply reducing nutrient and sediment inputs to the river might not be sufficient to reverse the eutrophication process occurring in the Snake River downstream from Milner Dam. Future management strategies also might need to ensure that streamflows in the reach are sufficient to move nutrients and sediment downstream and to prevent future accumulations.

Along the north bank of the Snake River between Milner Dam and King Hill are 11 of the 65 springs in the United States that discharge more than 100 cubic feet per second. In addition to the use of spring water in fish hatcheries, the springs also are used for hydroelectric power production, drinking water for local residents, and habitat for native species of fish and endangered snails. In recent years, the amount of water discharging from the springs has declined as a result of increased ground-water withdrawals, more efficient irrigation practices which result in less recharge to the aquifer, and drought conditions (photograph © 1995 by W.H. Mullins and published with permission).



In 1995, springs provided 60 percent of the approximately 14,000 tons of nitrogen that entered the Snake River between Milner Dam and King Hill. Fish farms and Snake River water coming through Milner Dam (upstream sources) were the primary contributors of phosphorus in 1995. Agriculturally affected tributaries to the Snake River provided about 58 percent of the 120,000 tons of sediment entering the Snake River between Milner Dam and King Hill.

Comparison of Stream Quality in the Upper Snake River Basin With NAWQA Findings Nationwide



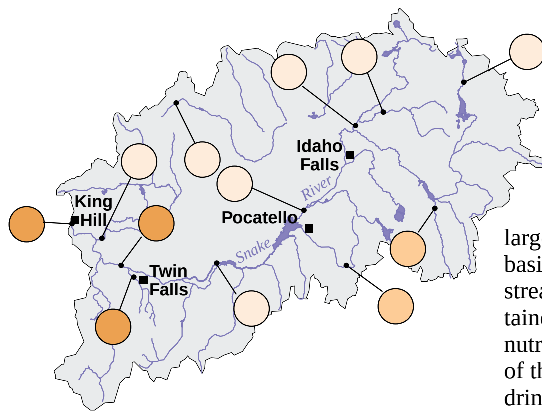
Seven major water-quality characteristics were evaluated for stream sites in each NAWQA Study Unit. Summary scores for each characteristic were computed for all sites that had adequate data. Scores for each site in the upper Snake River Basin were compared with scores for all sites sampled in the 20 NAWQA Study Units during 1992–95. Results are summarized by percentiles; higher percentile values generally indicate poorer quality compared with that at other NAWQA sites. Water-quality conditions at each site also are compared with established criteria for protection of aquatic life. Applicable criteria are limited to nutrients and pesticides in water, and semivolatile organic compounds, organochlorine pesticides, and PCBs in sediment. (Methods used to compute rankings and evaluate aquatic-life criteria are described by Gilliom and others, in press [29].)

EXPLANATION

Ranking of stream quality relative to all NAWQA stream sites—Darker colored circles generally indicate poorer quality. Bold outline of circle indicates that one or more aquatic-life criteria were exceeded.

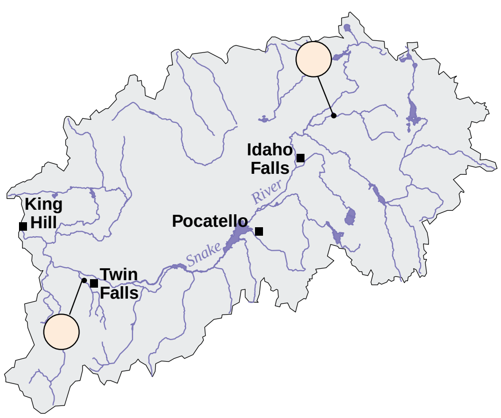
- **Greater than the 75th percentile** (Among the highest 25 percent of NAWQA stream sites)
- **Between the median and the 75th percentile**
- **Between the 25th percentile and the median**
- **Less than the 25th percentile** (Among the lowest 25 percent of NAWQA stream sites)

NUTRIENTS



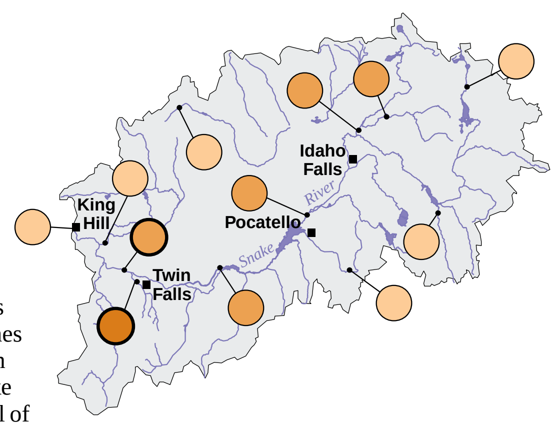
In general, nutrient concentrations in streams of the upper Snake River Basin were among the smallest of those reported in all NAWQA Study Units. Concentrations of nutrients in the Snake River increased in a downstream direction; concentrations were largest between Twin Falls and the basin outlet at King Hill. Sites downstream from agricultural areas contained the largest concentrations of nutrients in the basin. However, none of the concentrations exceeded drinking-water standards for nutrients.

PESTICIDES



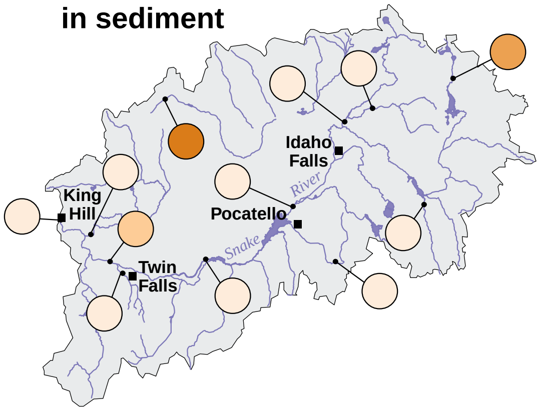
Only two sites in the upper Snake River Basin had sufficient pesticide data to compare with national conditions. Although numerous pesticides were detected at these sites (Teton River near St. Anthony and Rock Creek near Twin Falls), the concentrations were among the smallest of those reported in all NAWQA Study Units. None of the concentrations exceeded drinking-water standards or aquatic-life criteria.

PCBs AND OTHER ORGANOCHLORINES in sediment and fish tissue



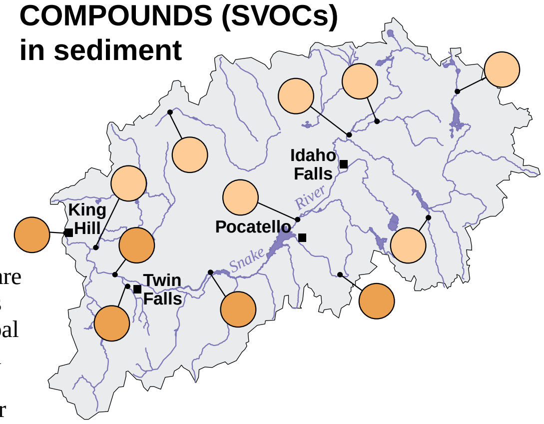
Concentrations of PCBs and other organochlorines in bed sediment and fish tissue in the upper Snake River Basin were typical of concentrations reported in other NAWQA Study Units; concentrations at about half of the sites were larger and about half were smaller, compared with the national median determined by NAWQA. Concentrations in fish tissue at two sites exceeded NAS/NAE aquatic-life criteria. These sites were Rock Creek at Twin Falls and the Snake River near Twin Falls. Compounds that exceeded aquatic-life criteria were PCBs, the insecticide DDT, and the DDT breakdown products DDE and DDD [10]. Concentrations were largest at sites downstream from agricultural and urban areas.

TRACE ELEMENTS in sediment



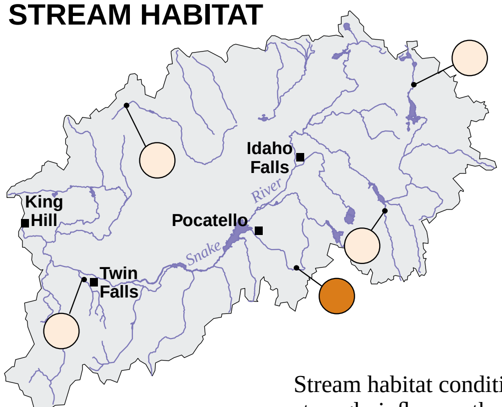
Trace-element contamination does not appear to be a concern in most areas of the upper Snake River Basin. Concentrations in bed sediment were largest in pristine areas where the geology is naturally rich in trace elements.

SEMIVOLATILE ORGANIC COMPOUNDS (SVOCs) in sediment



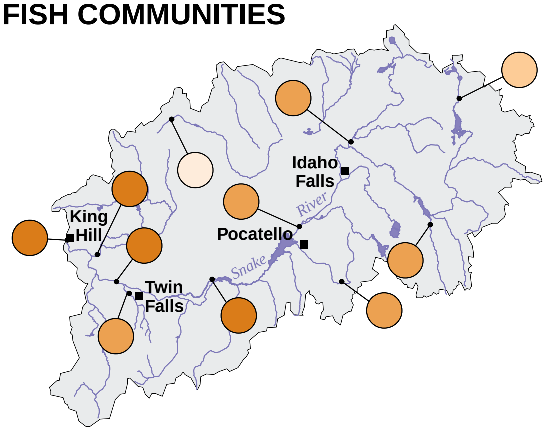
Semivolatile organic compounds typically are present in streams receiving municipal and (or) industrial discharges. In the upper Snake River Basin, 47 different SVOCs were detected in bed-sediment samples. The most commonly detected SVOCs were phthalates (98 percent of the samples), phenol (86 percent of the samples), and 2,6-dimethylnaphthalene (83 percent of the samples). Concentrations of SVOCs in bed sediment were smallest at sites upstream from the influence of municipal and (or) industrial areas. Bed-sediment samples at Snake River sites downstream from Idaho Falls all contained SVOC concentrations that ranked higher than the national median determined by NAWQA. However, no concentrations of SVOCs in bed sediment exceeded NAS/NAE aquatic-life criteria.

STREAM HABITAT



Stream habitat conditions can strongly influence the water quality and associated biological communities of streams. Instream modification, bank erosion, and riparian conditions represent useful measures of stream habitat conditions. In the upper Snake River Basin, the habitat conditions were generally better than those at other NAWQA sites nationwide. Sites where habitat was highly degraded were influenced primarily by hydrologic modification and agricultural activities such as excessive grazing. Because bank and riparian conditions generally are not reflective of habitat conditions in large rivers, the large-river sites in the upper Snake River Basin were not evaluated for stream habitat conditions.

FISH COMMUNITIES



Fish community indices, such as the number of omnivores, pollution-tolerant species, and non-native fish, indicated that most of the sites assessed in the upper Snake River Basin were more degraded than were sites sampled in other NAWQA Study Units. Fish communities were most degraded in the Snake River and its tributaries downstream from Twin Falls, where multiple sources of pollutants degrade water-quality conditions. Even sites where degradation was minimal showed some degradation as a result of introduced fish species.

CONCLUSIONS

In general, nutrient and pesticide concentrations in streams in the upper Snake River Basin were small compared with concentrations in other streams sampled by NAWQA nationwide. Concentrations of nutrients and pesticides did not exceed drinking-water standards in any of the stream samples collected.

PCBs and other organochlorine compounds are more of a concern in fish tissue than in bed sediment. Concentrations of these compounds exceeded aquatic-life criteria for fish tissue at two sites. PCBs and the insecticide DDT and its breakdown products were the most commonly detected organochlorine compounds in bed sediment and fish tissue.

Fish communities in large rivers downstream from anthropogenic effects were degraded compared with communities at sites sampled in other NAWQA Study Units. Degraded sites supported primarily nongame, warmwater species of fish. Headwater streams and large rivers upstream from anthropogenic effects supported healthy communities of predominantly coldwater fish.

Comparison of Ground-Water Quality in the Upper Snake River Basin With NAWQA Findings Nationwide

Five major water-quality characteristics were evaluated for ground-water studies in each NAWQA Study Unit. Ground-water resources were divided into two categories: (1) drinking-water aquifers and (2) shallow ground water underlying agricultural or urban areas. Summary scores were computed for each characteristic for all aquifers and shallow ground-water areas that had adequate data. Scores for each aquifer and shallow ground-water area in the upper Snake River Basin were compared with scores for all aquifers and shallow ground-water areas sampled in the 20 NAWQA Study Units during 1992–95. Results were summarized by percentiles; higher percentile values generally indicate poorer quality compared with other NAWQA ground-water studies. Water-quality conditions for each drinking-water aquifer also were compared with established drinking-water standards and criteria for protection of human health. (Methods used to compute rankings and evaluate standards and criteria are described by Gilliom and others, in press [29].)

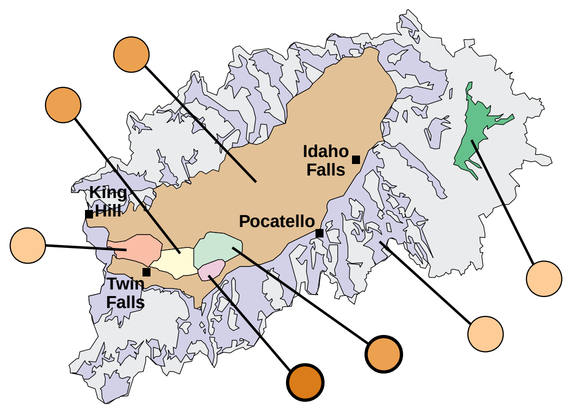
EXPLANATION

- **Eastern Snake River Plain study area**
- **Tributary valley study area**
- **Jackson Valley study area**
- **Minidoka study area**
- **A&B study area**
- **Jerome/Gooding study area**
- **Eden study area**

Ranking of ground-water quality relative to all NAWQA ground-water studies—Darker colored circles generally indicate poorer quality. Bold outline of circle indicates that one or more standards or criteria were exceeded.

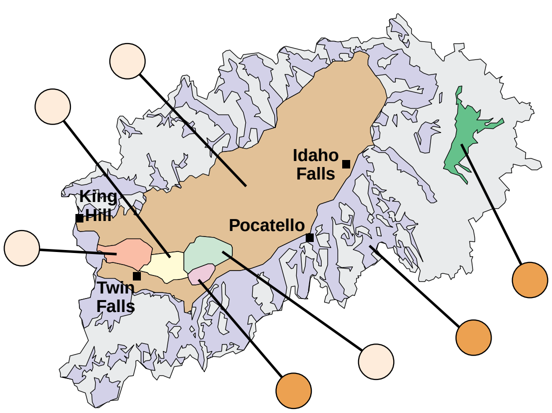
- **Greater than the 75th percentile** (Among the highest 25 percent of NAWQA ground-water studies)
- **Between the median and the 75th percentile**
- **Between the 25th percentile and the median**
- **Less than the 25th percentile** (Among the lowest 25 percent of NAWQA ground-water studies)

NITRATE



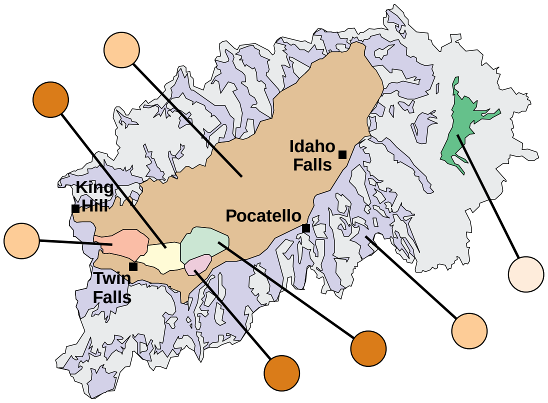
Nitrate is one of the most common anthropogenic-induced contaminants in ground water in the upper Snake River Basin. Nitrate concentrations in ground water from the Minidoka study area were among the largest of those reported in all NAWQA Study Units; concentrations in water from 24 percent of the wells sampled exceeded the drinking-water standard of 10 milligrams per liter. Nitrate concentrations also were larger than the national median in the eastern Snake River Plain, A&B, and Eden study areas.

RADON



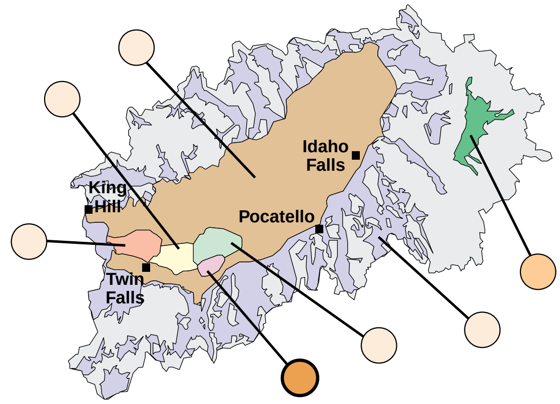
Radon concentrations in water from wells in the tributary valley, Jackson Valley, and Minidoka study areas were larger than the national median determined by NAWQA. Concentrations in water from nearly all wells sampled in these three study areas exceeded the USEPA proposed drinking-water standard of 300 picocuries per liter. Radon concentrations were smaller than the national median in the eastern Snake River Plain, A&B, Jerome/Gooding, and Eden study areas. Radon is naturally occurring and is produced by the radioactive decay of uranium-containing minerals in local geologic materials.

PESTICIDES



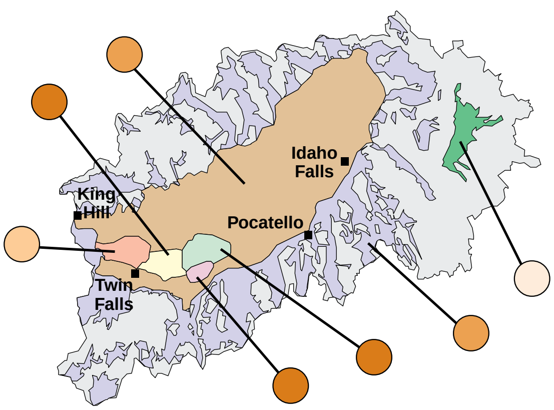
Pesticide detections in water from wells in the Jackson Valley study area were among the smallest of those reported in all NAWQA Study Units. Pesticide detections in water from wells in the Minidoka, A&B, and Eden study areas were larger than the national median determined by NAWQA; water from 86 percent of the wells sampled in the Minidoka study area contained at least one detectable pesticide. None of the concentrations in ground water in the upper Snake River Basin exceeded USEPA drinking-water standards.

VOLATILE ORGANIC COMPOUNDS (VOCs)



Volatile organic compounds include solvents, fuels, and soil fumigants. Eleven different VOCs were detected in ground water in the upper Snake River Basin. Only 1,2-dichloropropane exceeded USEPA drinking-water standards, and in water from only one well in the Minidoka study area. Water from only one well in the Jackson Valley contained VOCs; the source probably was a local landfill.

DISSOLVED SOLIDS (DS)



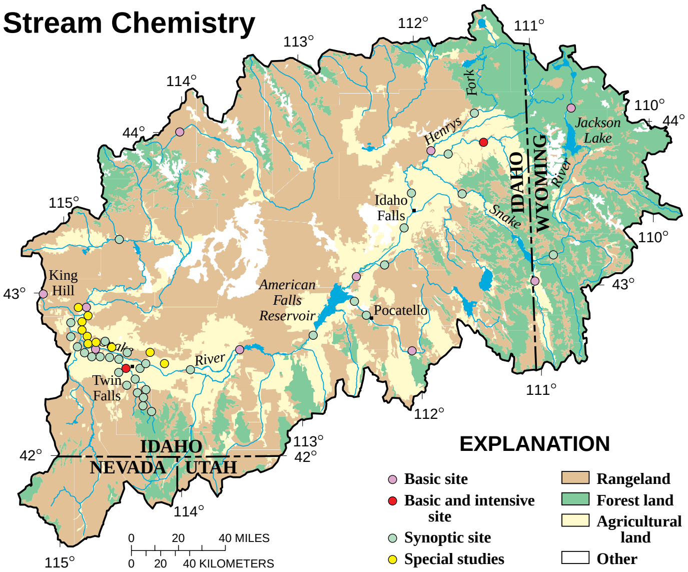
Water from wells in the Minidoka, A&B, and Eden study areas contained some of the largest DS concentrations of those reported in all NAWQA Study Units. Large DS concentrations probably result from leaching of evaporative salts and soil minerals during infiltration of irrigation water.

CONCLUSIONS

In general, ground water in the upper Snake River Basin is safe to drink; the quality of ground water in the Jackson Valley area is some of the highest quality ground water reported in the NAWQA Study Units. However, ground-water quality in some areas of the basin has been degraded as a result of anthropogenic activities. Nitrate poses the greatest concern for public health. Nitrate concentrations in ground water in many areas of the upper Snake River Basin were near or exceeded the USEPA drinking-water standard of 10 milligrams per liter. Nitrate and DS concentrations in ground water in the Minidoka, A&B, and Eden study areas were some of the largest of those reported in all NAWQA Study Units.

Pesticide occurrence in ground water also poses some concern. Even though pesticide concentrations did not exceed USEPA drinking-water standards, the numbers of pesticides detected in some areas were large. More research is needed to establish the toxicological effects of drinking water that contains small concentrations of more than one pesticide or other organic compound.

Stream Chemistry

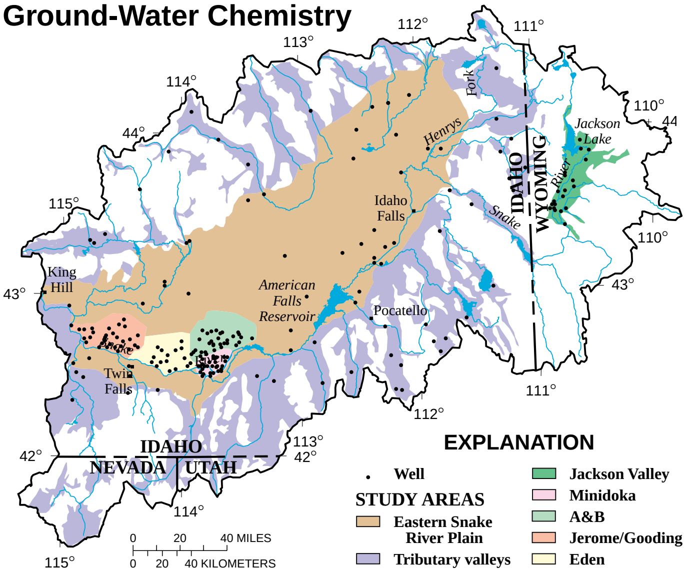


The primary objectives of the stream chemistry component of study were to assess the relation between land use and chemical constituents in surface water and to evaluate fluxes of contaminants in the Snake River. Synoptic studies were designed to assess sources and fluxes of contaminants during selected hydrologic conditions. Intensive sites were monitored for pesticides during a 2-year period from 1993 to 1995.

Stream Ecology

The primary objective of the stream ecology component of study was to assess the surface-water quality by integrating the chemical, physical, and biological factors. Stream ecology sites were distributed among major ecoregions and dominant land uses, which included irrigated agriculture, forested land, and rangeland. The stream types sampled represented wadable streams, large rivers, and least-disturbed springs and streams. Sites were classified as intensive or synoptic on the basis of the level of the sampling effort or the number of years data were collected.

Ground-Water Chemistry



The primary objectives of the ground-water chemistry component of study were to assess the regional water chemistry of the Study Unit and to determine whether the chemical constituents in ground water were related to specific land uses. Samples for regional studies were collected from irrigation, stock, domestic, and public supply wells. Samples for land-use studies were collected mostly from domestic wells completed in a single aquifer.

SUMMARY OF DATA COLLECTION IN THE UPPER SNAKE RIVER BASIN STUDY UNIT, 1992–95

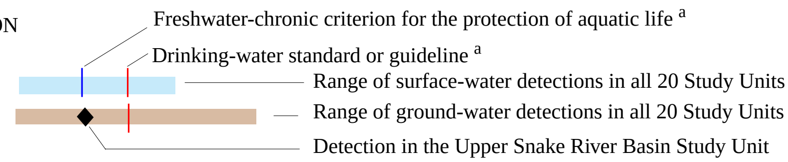
Study component	What data were collected and why	Types of sites sampled	Number of sites	Sampling frequency and period
Stream chemistry				
Basic sites—general water chemistry	Streamflow, nutrients, major ions, organic carbon, suspended sediment, water temperature, specific conductance, pH, and dissolved oxygen to describe concentrations and seasonal variations. Stable isotopes and tritium sampled quarterly.	Streams draining basins representative of common land-use types. Also large-river sites that integrate multiple types of land use.	12	Monthly plus additional high streamflow samples Apr. 1993–Aug. 1995
Intensive sites—pesticides	In addition to the above constituents, dissolved concentrations of 87 pesticides to describe seasonal variations.	Subset of basic sites draining areas of predominantly agricultural land use.	2	Weekly to monthly Apr. 1993–Aug. 1995
Synoptic sites—water chemistry	Streamflow, nutrients, dissolved concentrations of 87 pesticides, suspended sediment, selected isotopes, water temperature, specific conductance, pH, and dissolved oxygen to describe concentrations, assess spatial variability, and determine chemical and sediment fluxes.	Additional main-stem sites, varied land-use sites, and sites in the Rock Creek watershed. Snake River sites between Milner Dam and King Hill.	19 13	May and June 1994 August 1995
Stream ecology				
Intensive assessments	Fish, macroinvertebrates, algae, instream and riparian habitat to assess aquatic biological community structure. Continuous summer water temperature and field parameters collected.	All basic sites.	12	Once in 1993; 6 sites multiple years (1993–95); 2 sites multiple reach
	Contaminants in bed sediments: Total PCBs, 32 organochlorine pesticides, 78 semivolatile organic compounds, and 44 trace elements to determine occurrence and spatial distribution.	All basic sites.	12	6 sites multiple years; 1 site multiple reach
	Contaminants in bottom-feeding aquatic biota: Total PCBs, 30 organochlorine pesticides, and 24 trace elements to determine occurrence and spatial distribution. Organic contaminants in whole fish. Trace elements in fish livers and caddisflies. Organic contaminants and trace elements in fillets of gamefish (one basic site).	All basic sites.	12	6 sites multiple years; 1 site multiple reach
Synoptic studies	Similar to the intensive assessment sites, except only one reach per site sampled to assess spatial distribution and reference conditions of aquatic communities and associated habitats.	Least-disturbed reference sites.	12	Once in 1993
	Contaminants in bottom-feeding aquatic biota and in bed sediments.	Some least-disturbed reference sites, some spring sites, and some basic sites.	10	Once (mostly in 1992–94)
Ground-water chemistry				
Regional Study Unit surveys	Major ions, nutrients, 87 pesticides, volatile organic compounds, and radon to assess occurrence. Data collected in cooperation with the Idaho Statewide Ground-Water Monitoring Program.	Domestic, irrigation, stock, and public supply wells from a wide range of well depths. Snake River Plain, Idaho. Tributary valleys, Idaho. Jackson Valley, Wyoming.	 43 39 20	 Once in 1994 Once in 1995 Once in 1995
Local land-use studies	Major ions, nutrients, 87 pesticides, 60 volatile organic compounds, radon, and selected isotopes to assess the effects of land use and hydrogeology on ground-water quality in locally important aquifers of the basin.	Mostly domestic wells. A&B study area, mean well depth 230 feet. Minidoka study area, mean well depth 40 feet. Jerome/Gooding study area, mean well depth 240 feet. Eden study area, mean well depth 380 feet.	 31 29 30 15	 Once in 1993 Once in 1993 Once in 1994 Once in 1995
Special studies				
Springs between Milner Dam and King Hill: water chemistry and aquatic biota assessment	Nutrients, pesticides, and selected isotopes to determine source water of springs and nutrient loads from ground water to the Snake River. Aquatic habitat and communities of fish, macroinvertebrates, and algae in least-disturbed spring environments.	Springs representing the entire reach from Milner Dam to King Hill. Least-disturbed springs for biological assessment, subset of above springs.	10 6	Springs sampled in Apr. 1994, Oct. 1994, and Aug. 1995 Ecology sampled once in Apr. 1994

SUMMARY OF COMPOUND DETECTIONS AND CONCENTRATIONS

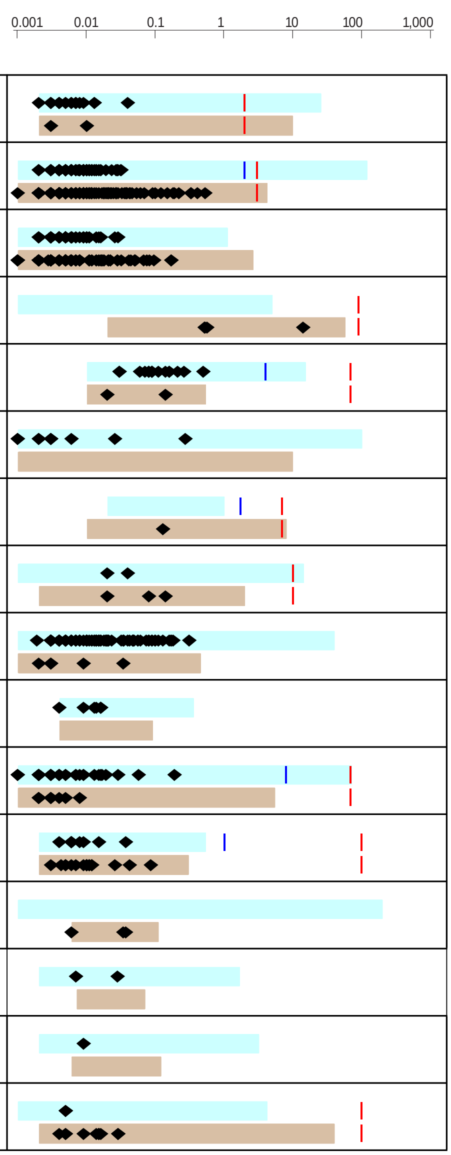
The following tables summarize data collected for NAWQA studies during 1992–95 by showing results for the Upper Snake River Basin Study Unit compared with the NAWQA national range for each compound detected. The data were collected at a wide variety of places and times. In order to represent the wide concentration ranges observed among Study Units, logarithmic scales are used to emphasize the general magnitude of concentrations (such as 10, 100, or 1,000), rather than the precise number. The complete dataset used to construct these tables is available upon request.

Concentrations of herbicides, insecticides, volatile organic compounds, and nutrients detected in ground and surface water of the Upper Snake River Basin Study Unit. [mg/L, milligrams per liter; µg/L, micrograms per liter; pCi/L, picocuries per liter; %, percent; <, less than; - -, not measured; trade names may vary]

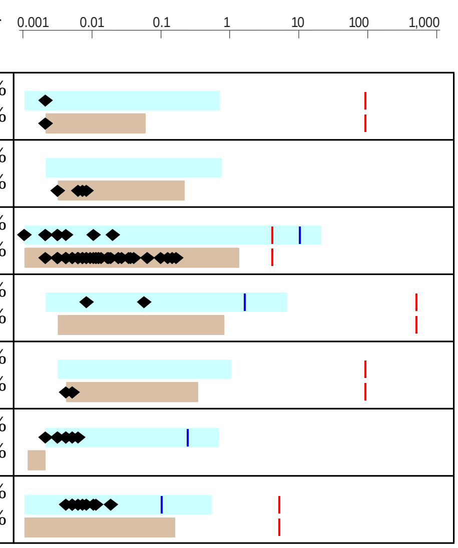
EXPLANATION



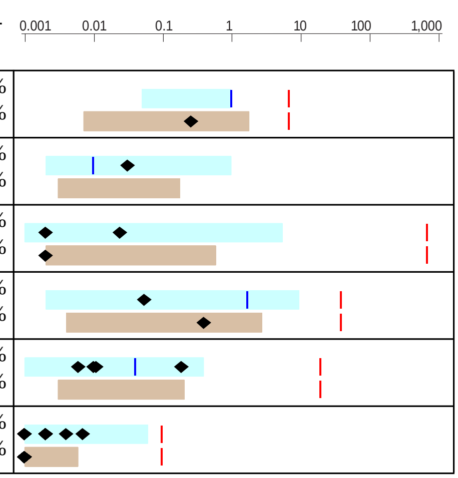
Herbicide (Trade or common name)	Rate of detection [b]
Alachlor (Lasso)	2% <1%
Atrazine (AAtrex, Gesaprim)	19% 21%
Desethylatrazine[c] (Atrazine metabolite)	7% 14%
Bromacil (Hyvar X, Urox B, Bromax)	0% 2%
2,4-D (2,4-PA)	14% 1%
DCPA (Dacthal, chlorthal-dimethyl)	1% 0%
Dinoseb (DNBP, DN 289, Premerge, Aretit)	0% <1%
Diuron (Karmex, Direx, DCMU)	2% 1%
EPTC (Eptam)	33% <1%
Ethalfluralin (Sonalan, Sonalen)	3% 0%
Metolachlor (Dual, Pennant)	5% <1%
Metribuzin (Lexone, Sencor)	1% 4%
Molinate (Ordram)	0% 1%
Napropamide (Devrinol)	1% 0%
Pendimethalin (Prowl, Stomp)	<1% 0%
Prometon (Gesagram, prometone)	<1% 3%



Herbicide (Trade or common name)	Rate of detection [b]
Propachlor (Ramrod, propachlore)	<1% <1%
Propanil (Stampede, Surcopur)	0% <1%
Simazine (Aquazine, Princep, Gesatop)	1% 8%
Tebuthiuron (Spike, Perflan)	1% 0%
Terbacil[c] (Sinbar)	0% <1%
Triallate (Far-Go)	<1% 0%
Trifluralin (Treflan, Trinin, Elancolan)	2% 0%



Insecticide (Trade or common name)	Rate of detection [b]
Aldicarb sulfoxide[c] (Aldicarb metabolite)	0% 1%
Azinphos-methyl[c] (Guthion, Gusathion)	1% 0%
Carbaryl[c] (Sevin, Savit)	1% <1%
Carbofuran[c] (Furadan, Curaterr)	1% <1%
Chlorpyrifos (Dursban, Lorsban)	2% 0%
p,p'-DDE (*p,p'*-DDT metabolite)	<1% <1%



Insecticide (Trade or common name)	Rate of detec- tion [b]	Concentration, in µg/L (0.001, 0.01, 0.1, 1, 10, 100, 1,000)
Diazinon	<1% 0%	
Dieldrin (Panoram D-31, Octalox)	1% <1%	
Ethoprop (Mocap, Prophos)	<1% 0%	
Fonofos (Dyfonate)	<1% 0%	
alpha-HCH (*alpha*-BHC, *alpha*-lindane)	0% <1%	
Malathion (maldison, malathon, Cythion)	1% 0%	
Phorate (Thimet, Rampart)	1% 0%	

Volatile organic compound (Trade or common name)	Rate of detec- tion [b]	Concentration, in µg/L (0.01, 0.1, 1, 10, 100, 1,000)
1,1,1-Trichloroethane (Methylchloroform)	0% <1%	
1,1-Dichloroethane (Ethylidene dichloride)	0% <1%	
1,2-Dichloropropane (Propylene dichloride)	0% <1%	
1,3-Dichloropropane	0% <1%	
Benzene	0% <1%	
Dichlorodifluo-romethane	0% <1%	
total Trihalomethanes	0% <1%	
Trichloroethene (TCE)	0% <1%	
Trichlorofluo-romethane	0% <1%	
cis-1,2-Dichloroeth-ene	0% <1%	

Volatile organic compound (Trade or common name)	Rate of detec- tion [b]	Concentration, in µg/L (0.01, 0.1, 1, 10, 100, 1,000, 10,000, 100,000)
Tetrachloroethene (Perchloroethene)	0% <1%	

Nutrient	Rate of detec- tion [b]	Concentration, in mg/L (0.01, 0.1, 1, 10, 100, 1,000, 10,000, 100,000)
Dissolved ammonia	84% 63%	
Dissolved ammonia plus organic nitrogen as nitrogen	28% 9%	
Dissolved phosphorus as phosphorus	61% 70%	
Dissolved nitrite plus nitrate	87% 97%	

Other	Rate of detec- tion [b]	Concentration, in pCi/L (1, 10, 100, 1,000, 10,000, 100,000)
Radon-222	94%	

SUMMARY OF COMPOUND DETECTIONS AND CONCENTRATIONS

Herbicides, insecticides, volatile organic compounds, and nutrients not detected in ground and surface water of the Upper Snake River Basin Study Unit.

Herbicides

2,4,5-T

2,4,5-TP (Silvex, Fenoprop)

2,4-DB (Butyrac, Butoxone, Embutox Plus, Embutone)

2,6-Diethylaniline (Metabolite of Alachlor)

Acetochlor (Harness Plus, Surpass)

Acifluorfen (Blazer, Tackle 2S)

Benfluralin (Balan, Benefin, Bonalan, Benefex)

Bentazon (Basagran, Bentazone, Bendioxide)

Bromoxynil (Buctril, Brominal)

Butylate (Sutan +, Genate Plus, Butilate)

Chloramben (Amiben, Amilon-WP, Vegiben)

Clopyralid (Stinger, Lontrel, Reclaim, Transline)

Cyanazine (Bladex, Fortrol)

Dacthal mono-acid (Dacthal metabolite)

Dicamba (Banvel, Dianat, Scotts Proturf)

Dichlorprop (2,4-DP, Seritox 50, Kildip, Lentemul)

Fenuron (Fenulon, Fenidim)

Fluometuron (Flo-Met, Cotoran, Cottonex, Meturon)

Linuron (Lorox, Linex, Sarclex, Linurex, Afalon)

MCPA (Rhomene, Rhonox, Chiptox)

MCPB (Thistrol)

Neburon (Neburea, Neburyl, Noruben)

Norflurazon (Evital, Predict, Solicam, Zorial)

Oryzalin (Surflan, Dirimal)

Pebulate (Tillam, PEBC)

Picloram (Grazon, Tordon)

Pronamide (Kerb, Propyzamid)

Propham (Tuberite)

Thiobencarb (Bolero, Saturn, Benthiocarb, Abolish)

Triclopyr (Garlon, Grandstand, Redeem, Remedy)

Insecticides

3-Hydroxycarbofuran (Carbofuran metabolite)

Aldicarb sulfone (Standak, aldoxycarb, aldicarb metabolite)

Aldicarb (Temik, Ambush, Pounce)

Disulfoton (Disyston, Di-Syston, Frumin AL, Solvirex, Ethylthiodemeton)

Methiocarb (Slug-Geta, Grandslam, Mesurol)

Methomyl (Lanox, Lannate, Acinate)

Methyl parathion (Penncap-M, Folidol-M, Metacide, Bladan M)

Oxamyl (Vydate L, Pratt)

Parathion (Roethyl-P, Alkron, Panthion, Phoskil)

Propargite (Comite, Omite, Ornamite)

Propoxur (Baygon, Blattanex, Unden, Proprotox)

Terbufos (Contraven, Counter, Pilarfox)

cis-Permethrin (Ambush, Astro, Pounce, Pramex, Pertox, Ambushfog, Kafil, Perthrine, Picket, Picket G, Dragnet, Talcord, Outflank, Stockade, Eksmin, Coopex, Peregin, Stomoxin, Stomoxin P, Qamlin, Corsair, Tornade)

gamma-HCH (Lindane, *gamma*-BHC, Gammexane, Gexane, Soprocide, *gamma*-hexachlorocyclohexane, *gamma*-benzene hexachloride)

Volatile organic compounds

1,1,1,2-Tetrachloroethane (1,1,1,2-TeCA)

1,1,2,2-Tetrachloroethane

1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113, CFC 113)

1,1,2-Trichloroethane (Vinyl trichloride)

1,1-Dichloroethene (Vinylidene chloride)

1,1-Dichloropropene

1,2,3-Trichlorobenzene (1,2,3-TCB)

1,2,3-Trichloropropane (Allyl trichloride)

1,2,4-Trichlorobenzene

1,2,4-Trimethylbenzene (Pseudocumene)

1,2-Dibromo-3-chloropropane (DBCP, Nemagon)

1,2-Dibromoethane (EDB, Ethylene dibromide)

1,2-Dichlorobenzene (*o*-Dichlorobenzene, 1,2-DCB)

1,2-Dichloroethane (Ethylene dichloride)

1,3,5-Trimethylbenzene (Mesitylene)

1,3-Dichlorobenzene (*m*-Dichlorobenzene)

1,4-Dichlorobenzene (*p*-Dichlorobenzene, 1,4-DCB)

1-Chloro-2-methylbenzene (*o*-Chlorotoluene)

1-Chloro-4-methylbenzene (*p*-Chlorotoluene)

2,2-Dichloropropane

Bromobenzene (Phenyl bromide)

Bromochloromethane (Methylene chlorobromide)

Bromomethane (Methyl bromide)

Chlorobenzene (Monochlorobenzene)

Chloroethane (Ethyl chloride)

Chloroethene (Vinyl chloride)

Chloromethane (Methyl chloride)

Dibromomethane (Methylene dibromide)

Dichloromethane (Methylene chloride)

Dimethylbenzenes (Xylenes (total))

Ethenylbenzene (Styrene)

Ethylbenzene (Phenylethane)

Hexachlorobutadiene

Isopropylbenzene (Cumene)

Methyl *tert*-butyl ether[d] (MTBE)

Methylbenzene (Toluene)

Naphthalene

Tetrachloromethane (Carbon tetrachloride)

cis-1,3-Dichloropropene ((Z)-1,3-Dichloropropene)

n-Butylbenzene (1-Phenylbutane)

n-Propylbenzene (Isocumene)

p-Isopropyltoluene (*p*-Cymene)

sec-Butylbenzene

tert-Butylbenzene

trans-1,2-Dichloroethene ((E)-1,2-Dichlorothene)

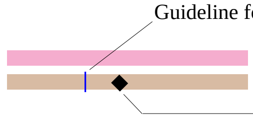
trans-1,3-Dichloropropene ((E)-1,3-Dichloropropene)

Nutrients

No non-detects

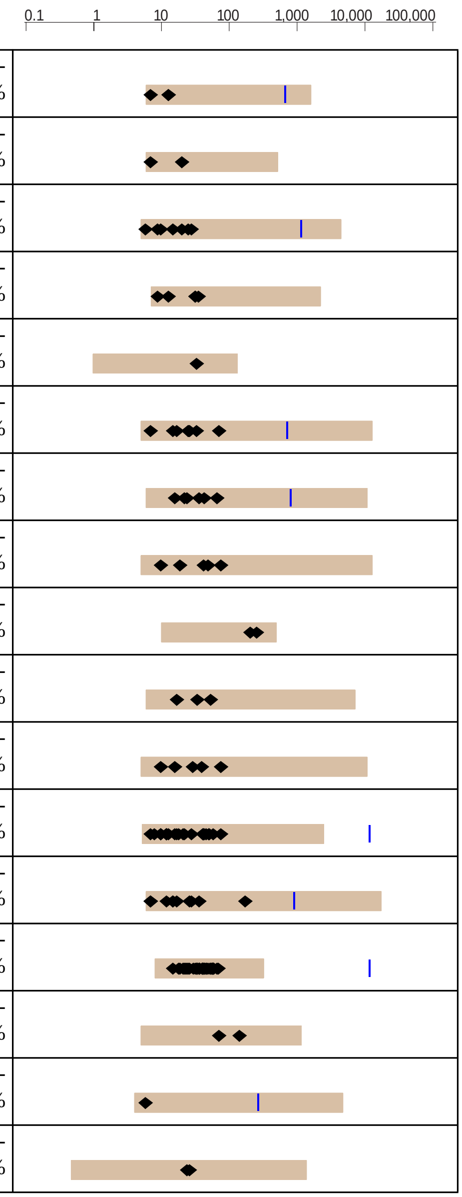
Concentrations of semivolatile organic compounds, organochlorine compounds, and trace elements detected in fish tissue and bed sediment of the Upper Snake River Basin Study Unit. [µg/g, micrograms per gram; µg/kg, micrograms per kilogram; %, percent; <, less than; - -, not measured; trade names may vary]

EXPLANATION

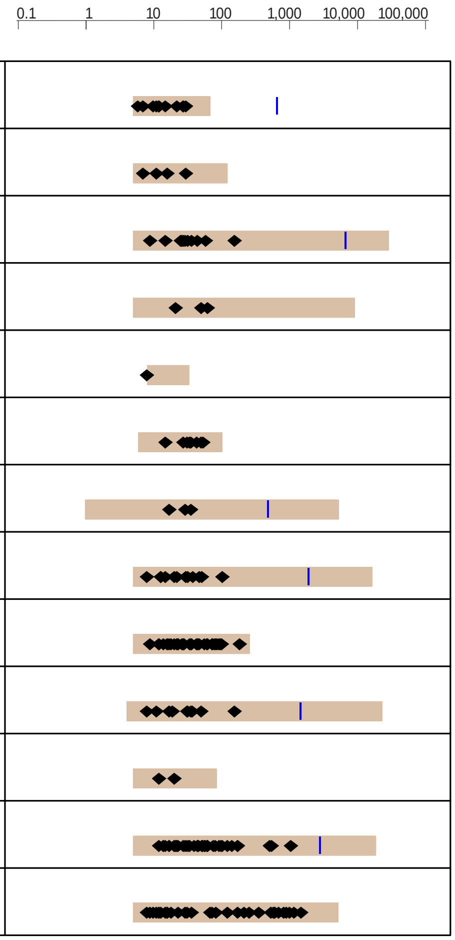


Semivolatile organic compound	Rate of detection [b]	Concentration, in µg/kg (0.1 – 100,000)
1,2-Dimethylnaphthalene	-- 7%	
1,6-Dimethylnaphthalene	-- 26%	
1-Methyl-9H-fluorene	-- 2%	
1-Methylphenanthrene	-- 10%	
1-Methylpyrene	-- 7%	
2,2-Biquinoline	-- 7%	
2,3,6-Trimethylnaphthalene	-- 7%	
2,6-Dimethylnaphthalene	-- 83%	
2,6-Dinitrotoluene	-- 10%	
2-Ethylnaphthalene	-- 5%	
2-Methylanthracene	-- 7%	
3,5-Dimethylphenol	-- 7%	
4,5-Methylenephenanthrene	-- 2%	
4-Chloro-3-methylphenol	-- 5%	
9H-Carbazole	-- 7%	
9H-Fluorene	-- 5%	
Acenaphthene	-- 2%	

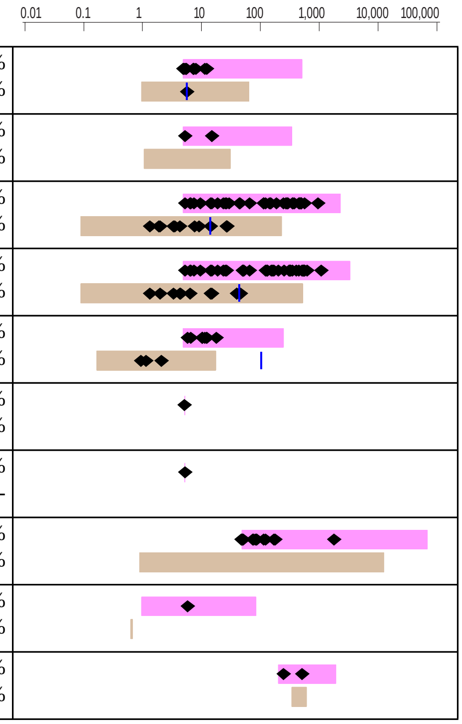
Semivolatile organic compound	Rate of detection [b]	Concentration, in µg/kg (0.1 – 100,000)
Acenaphthylene	-- 7%	
Acridine	-- 5%	
Anthracene	-- 17%	
Anthraquinone	-- 12%	
Azobenzene	-- 2%	
Benz[*a*]anthracene	-- 21%	
Benzo[*a*]pyrene	-- 14%	
Benzo[*b*]fluoranthene	-- 12%	
Benzo[*c*]cinnoline	-- 5%	
Benzo[*ghi*]perylene	-- 7%	
Benzo[*k*]fluoranthene	-- 12%	
Butylbenzylphthalate	-- 60%	
Chrysene	-- 24%	
Di- *n* -butylphthalate	-- 93%	
Di- *n* -octylphthalate	-- 5%	
Dibenz[*a,h*]anthracene	-- 2%	
Dibenzothiophene	-- 5%	



Semivolatile organic compound	Rate of detection [b]
Diethylphthalate	-- 29%
Dimethylphthalate	-- 10%
Fluoranthene	-- 27%
Indeno[1,2,3- *cd*] pyrene	-- 7%
Isophorone	-- 2%
Isoquinoline	-- 19%
Naphthalene	-- 7%
Phenanthrene	-- 29%
Phenol	-- 86%
Pyrene	-- 27%
Quinoline	-- 5%
bis(2-Ethylhexyl)phthalate	-- 98%
p-Cresol	-- 79%



Organochlorine compound[1] (Trade name)	Rate of detection [b]
total-Chlordane	24% 2%
DCPA (dacthal, chlorthal-dimethyl)	4% 0%
p,p'-DDE	83% 29%
total-DDT	83% 29%
Dieldrin (Panoram D-31, Octalox)	20% 7%
alpha-HCH (*alpha*-BHC, *alpha*-lindane)	2% 0%
delta-HCH (*delta*-BHC)	2% --
PCB, total	30% 0%
Pentachloroanisole	2% 0%
Toxaphene (camphechlor)	4% 0%



Trace element	Rate of detection [b]
Arsenic	100% 100%
Cadmium	64% 100%
Chromium	64% 100%
Copper	100% 100%
Lead	36% 100%
Mercury	55% 55%
Nickel	73% 100%
Selenium	73% 100%
Zinc	100% 100%

[1] Some organochlorine compounds and compound breakdown products are not listed.

Semivolatile organic compounds, organochlorine compounds, and trace elements not detected in fish tissue and bed sediment of the Upper Snake River Basin Study Unit.

Semivolatile organic compounds

1,2,4-Trichlorobenzene

1,2-Dichlorobenzene (*o*-Dichlorobenzene, 1,2-DCB)

1,3-Dichlorobenzene (*m*-Dichlorobenzene)

1,4-Dichlorobenzene (*p*-Dichlorobenzene, 1,4-DCB)

2,4-Dinitrotoluene

2-Chloronaphthalene

2-Chlorophenol

4-Bromophenyl-phenylether

4-Chlorophenyl-phenylether

C8-Alkylphenol

N-Nitrosodi-*n*-propylamine

N-Nitrosodiphenylamine

Nitrobenzene

Pentachloronitrobenzene

Phenanthridine

bis (2-Chloroethoxy) methane

bis (2-Chloroisopropyl)ether

Organochlorine compounds

Aldrin (HHDN, Octalene)

Chloroneb (chloronebe, Demosan, Soil Fungicide 1823)

Endosulfan I (*alpha*-Endosulfan, Thiodan, Cyclodan, Beosit, Malix, Thimul, Thifor)

Endrin (Endrine)

Heptachlor epoxide (Heptachlor metabolite)

Heptachlor (Heptachlore, Velsicol 104)

Hexachlorobenzene (HCB)

Isodrin (Isodrine, Compound 711)

Mirex (Dechlorane)

alpha-HCH (*alpha*-BHC, *alpha*-lindane, *alpha*-hexachlorocyclohexane, *alpha*-benzene hexachloride)

beta-HCH (*beta*-BHC, *beta*-hexachlorocyclohexane, *alpha*-benzene hexachloride)

cis-Permethrin (Ambush, Astro, Pounce, Pramex, Pertox, Ambushfog, Kafil, Perthrine, Picket, Picket G, Dragnet, Talcord, Outflank, Stockade, Eksmin, Coopex, Peregin, Stomoxin, Stomoxin P, Qamlin, Corsair, Tornade)

gamma-HCH (Lindane, *gamma*-BHC, Gammexane, Gexane, Soprocide, *gamma*-hexachlorocyclohexane, *gamma*-benzene hexachloride, *gamma*-benzene)

o,p'-Methoxychlor

p,p'-Methoxychlor (Marlate, methoxychlore)

trans-Permethrin (Ambush, Astro, Pounce, Pramex, Pertox, Ambushfog, Kafil, Perthrine, Picket, Picket G, Dragnet, Talcord, Outflank, Stockade, Eksmin, Coopex, Peregin, Stomoxin, Stomoxin P, Qamlin, Corsair, Tornade)

Trace elements

No non-detects

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[a] Selected water-quality standards and guidelines [29].

[b] Rates of detection are based on the number of analyses and detections in the Study Unit, not on national data. Rates of detection for herbicides and insecticides were computed by only counting detections equal to or greater than 0.01 µg/L in order to facilitate equal comparisons among compounds, which had widely varying detection limits. For herbicides and insecticides, a detection rate of "<1%" means that all detections are less than 0.01 µg/L, or the detection rate rounds to less than 1 percent. For other compound groups, all detections were counted and minimum detection limits for most compounds were similar to the lower end of the national ranges shown. Method detection limits for all compounds in these tables are summarized in [29].

[c] Detections of these compounds are reliable, but concentrations are determined with greater uncertainty than for the other compounds and are reported as estimated values [31].

[d] The guideline for methyl *tert*-butyl ether is between 20 and 40 µg/L; if the tentative cancer classification C is accepted, the lifetime health advisory will be 20 µg/L [29].

[e] Selected sediment-quality guidelines [29].

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GLOSSARY

The terms in this glossary were compiled from numerous sources. Some definitions have been modified and may not be the only valid ones for these terms.

Acre-foot - A volume of water equal to 1 foot in depth and covering 1 acre; equivalent to 43,560 cubic feet or 325,851 gallons.

Algae - Chlorophyll-bearing, nonvascular, primarily aquatic species that have no true roots, stems, or leaves; most algae are microscopic, but some species can be as large as vascular plants.

Alluvial aquifer - A water-bearing deposit of unconsolidated material (sand and gravel) left behind by a river or other flowing water.

Anthropogenic - Occurring because of, or influenced by, human activity.

Aquatic-life criteria - Water-quality guidelines for protection of aquatic life. Often refers to U.S. Environmental Protection Agency water-quality criteria for protection of aquatic organisms. *See also* Water-quality guidelines, Water-quality criteria.

Aquifer - A water-bearing layer of soil, sand, gravel, or rock that will yield usable quantities of water to a well.

Bed sediment - The material that temporarily is stationary in the bottom of a stream or other watercourse.

Benthic invertebrates - Insects, mollusks, crustaceans, worms, and other organisms without a backbone that live in, on, or near the bottom of lakes, streams, or oceans.

Breakdown product - A compound derived by chemical, biological, or physical action upon a pesticide. The breakdown is a natural process which may result in a more toxic or a less toxic compound and a more persistent or less persistent compound.

Concentration - The amount or mass of a substance present in a given volume or mass of sample. Usually expressed as micrograms per liter (water sample) or micrograms per kilogram (sediment or tissue sample).

Consumptive use - The quantity of water that is not available for immediate reuse because it has been evaporated, transpired, or incorporated into products, plant tissue, or animal tissue. Also referred to as "water consumption."

Criterion - A standard rule or test on which a judgment or decision can be based.

Cubic foot per second - (ft^3/s, or cfs) rate of water discharge representing a volume of 1 cubic foot passing a given point during 1 second, equivalent to approximately 7.48 gallons per second or 448.8 gallons per minute or 0.02832 cubic meter per second.

Discharge - Rate of fluid flow passing a given point at a given moment in time, expressed as volume per unit of time.

Dissolved solids - Amount of minerals, such as salt, that is dissolved in water; amount of dissolved solids is an indicator of salinity or hardness.

Drainage basin - The portion of the surface of the Earth that contributes water to a stream through overland runoff, including tributaries and impoundments.

Drinking-water standard or guideline - A threshold concentration in a public drinking-water supply, designed to protect human health. As defined here, standards are U.S. Environmental Protection Agency regulations that specify the maximum contamination levels for public water systems required to protect the public welfare; guidelines have no regulatory status and are issued in an advisory capacity.

Ecoregion - An area of similar climate, landform, soil, potential natural vegetation, hydrology, or other ecologically relevant variables.

Eutrophication - The process by which water becomes enriched with plant nutrients, most commonly phosphorus and nitrogen.

Health advisory - Nonregulatory levels of contaminants in drinking water that may be used as guidance in the absence of regulatory limits. Advisories consist of estimates of concentrations that would result in no known or anticipated health effects (for carcinogens, a specified cancer risk) determined for a child or for an adult for various exposure periods.

Herbicide - A chemical or other agent applied for the purpose of killing undesirable plants. *See also* Pesticide.

Insecticide - A substance or mixture of substances intended to destroy or repel insects. *See also* Pesticide.

Load - General term that refers to a material or constituent in solution, in suspension, or in transport; usually expressed in terms of mass or volume.

Major ions - Constituents commonly present in concentrations exceeding 1.0 milligram per liter. Dissolved cations generally are calcium, magnesium, sodium, and potassium; the major anions are sulfate, chloride, fluoride, nitrate, and those contributing to alkalinity, most generally assumed to be bicarbonate and carbonate.

Mouth - The place where a stream discharges to a larger stream, a lake, or the sea.

National Academy of Sciences/National Academy of Engineering (NAS/NAE) recommended maximum concentration in water - Numerical guidelines recommended by two joint NAS/NAE committees for the protection of freshwater and marine aquatic life, respectively. These guidelines were based on available aquatic toxicity studies and were considered preliminary even when formulated (1972). The guidelines used in the summary reports are for freshwater.

Nonpoint source - A pollution source that cannot be defined as originating from discrete points such as pipe discharge. Areas of fertilizer and pesticide applications, atmospheric deposition, manure, and natural inputs from plants and trees are types of nonpoint source pollution.

Organochlorine compound - Synthetic organic compounds containing chlorine. As generally used, term refers to compounds containing mostly or exclusively carbon, hydrogen, and chlorine. Examples include organochlorine insecticides, polychlorinated biphenyls, and some solvents containing chlorine.

Pesticide - A chemical applied to crops, rights of way, lawns, or residences to control weeds, insects, fungi, nematodes, rodents, or other “pests.”

Point source - A source at a discrete location such as a discharge pipe, drainage ditch, tunnel, well, concentrated livestock operation, or floating craft.

Polychlorinated biphenyls (PCBs) - A mixture of chlorinated derivatives of biphenyl, marketed under the trade name Aroclor with a number designating the chlorine content (such as Aroclor 1260). PCBs were used in transformers and capacitors for insulating purposes and in gas pipeline systems as a lubricant. Further sale for new use was banned by law in 1979.

Radon - A naturally occurring, colorless, odorless, radioactive gas formed by the disintegration of the element radium; damaging to human lungs when inhaled.

Riparian - Areas adjacent to rivers and streams with a high density, diversity, and productivity of plant and animal species relative to nearby uplands.

Runoff - Rainwater or snowmelt that is transported to streams by overland flow, tile drains, or ground water.

Sediment - Particles, derived from rocks or biological materials, that have been transported by a fluid or other natural process and are suspended or settled in water.

Semivolatile organic compounds (SVOCs) - Operationally defined as a group of synthetic organic compounds that are solvent-extractable and can be determined by gas chromatography/mass spectrometry. SVOCs include phenols, phthalates, and polycyclic aromatic hydrocarbons (PAHs).

Streamflow - A type of channel flow, applied to that part of surface runoff in a stream whether or not it is affected by diversion or regulation.

Suspended sediment - Particles of rock, sand, soil, and organic detritus carried in suspension in the water column, in contrast to sediment that moves on or near the streambed.

Tolerant species - Those species that are adaptable to (tolerant of) human effects on the environment.

Trace element - An element found in only minor amounts (concentrations less than 1.0 milligram per liter) in water or sediment; includes arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc.

Volatile organic compounds (VOCs) - Organic chemicals that have a high vapor pressure relative to their water solubility. VOCs include components of gasoline, fuel oils, and lubricants, as well as organic solvents, fumigants, some inert ingredients in pesticides, and some byproducts of chlorine disinfection.

Water-quality criteria - Specific levels of water quality which, if reached, are expected to render a body of water unsuitable for its designated use. Commonly refers to water-quality criteria established by the U.S. Environmental Protection Agency. Water-quality criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, fish production, or industrial processes.

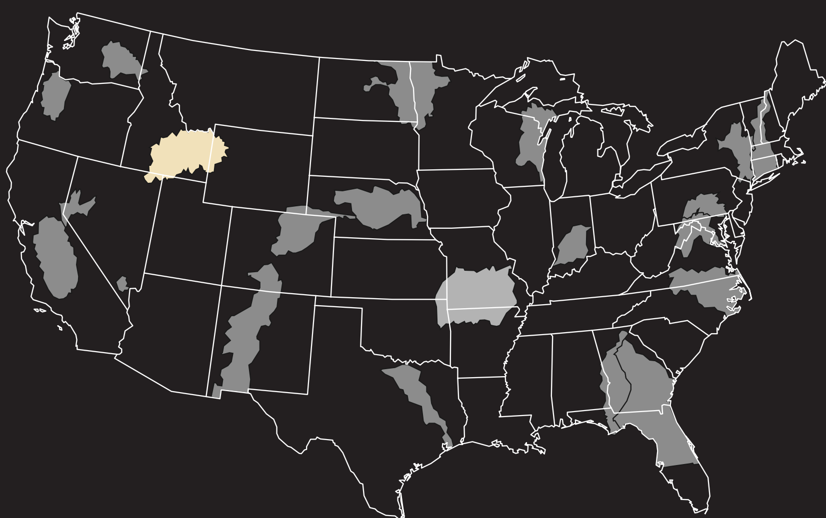
Water-quality guidelines - Specific levels of water quality which, if reached, may adversely affect human health or aquatic life. These are nonenforceable guidelines issued by a governmental agency or other institution.

Water-quality standards - State-adopted and U.S. Environmental Protection Agency-approved ambient standards for water bodies. Standards include the use of the water body and the water-quality criteria that must be met to protect the designated use or uses.

Water year - The continuous 12-month period, October 1 through September 30, in U.S. Geological Survey reports dealing with the surface-water supply. The water year is designated by the calendar year in which it ends and which includes 9 of the 12 months. Thus, the year ending September 30, 1980, is referred to as the “1980” water year.

NAWQA

National Water-Quality Assessment (NAWQA) Program
Upper Snake River Basin



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