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Water Quality in the Central Nebraska Basins

Nebraska, 1992–95

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

Circular 1163

A COORDINATED EFFORT

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Nebraska Natural Resources Commission
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Local Agencies

Central Nebraska Public Power and Irrigation District
Central Platte Natural Resources District
City of Grand Island, Nebraska
City of Lincoln, Nebraska
Lower Elkhorn Natural Resources District
Lower Loup Natural Resources District
Lower Platte North Natural Resources District
Lower Platte South Natural Resources District
Nebraska Public Power District
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Information on the NAWQA Program is also 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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Front cover photograph and back cover photograph of cranes are by Jon Farrar, Nebraskaland Magazine, Nebraska Game and Parks Commission

WATER QUALITY IN THE CENTRAL NEBRASKA BASINS, NEBRASKA, 1992–95

By S.A. Frenzel, R.B. Swanson, T.L. Huntzinger, J.K. Stamer, P.J. Emmons, and R.B. Zelt

U.S. GEOLOGICAL SURVEY CIRCULAR 1163

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Throughout this report, numbers in brackets [1] refer to References.

U.S. DEPARTMENT OF THE INTERIOR

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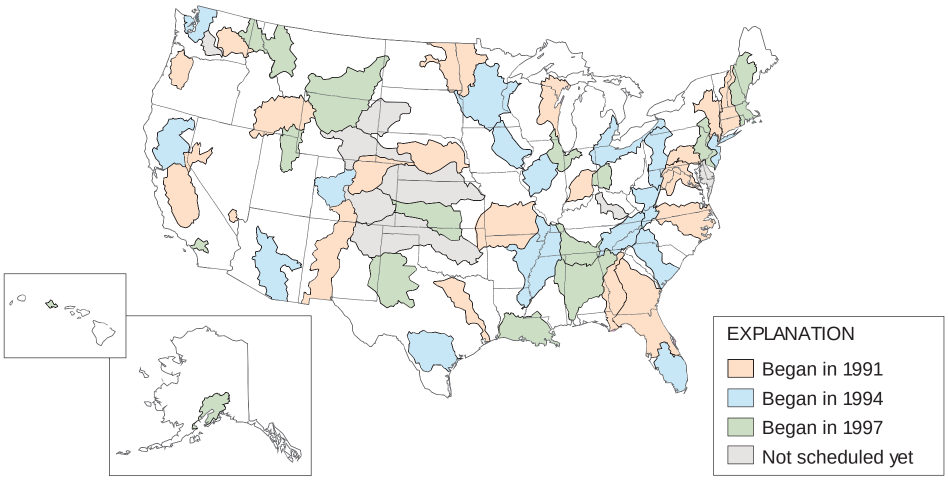
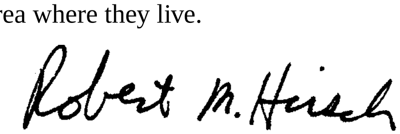


Knowledge of the quality of the Nation's streams and aquifers is important because of the implications to human and aquatic health and because of the significant costs associated with decisions involving land and water management, conservation, and regulation. In 1991, the U.S. Congress appropriated 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 Central Nebraska Basins 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

"In Nebraska, the issues of water quantity and quality are paramount policy concerns. The NAWQA process provides the scientific foundation on which sound public policy can be developed and pursued."

E. Benjamin Nelson, Governor, State of Nebraska

"The Central Nebraska NAWQA Study is an invaluable benchmark of water quality data. The facilitative approach between federal, state and local levels of government in data development lends undeniable credibility to the process, the data, and to programmatic applications."

Dayle E. Williamson Director, Nebraska Natural Resources Commission

"The basic research approach used in the NAWQA study greatly expands our scientific knowledge of aquatic systems in Central Nebraska and provides a comprehensive view of their water quality. This study should serve as an invaluable reference for years to come."

Paul J. Currier, Executive Director, Platte River Whooping Crane Maintenance Trust, Inc.

WHAT FACTORS ARE IMPORTANT IN DETERMINING WATER–QUALITY CONDITIONS IN THE CENTRAL NEBRASKA BASINS?

Land use in central Nebraska appears to affect water quality significantly; streams in rangelands generally had fewer occurrences and smaller concentrations of pesticides than did streams in croplands where corn and soybeans were planted extensively. Subbasins with greater proportions of rangeland, such as the Dismal River, had negligible herbicide concentrations. The largest pesticide concentrations were in storm runoff following pesticide applications. Because some pesticide concentrations may exceed the U.S. Environmental Protection Agency's (USEPA) drinking-water Maximum Contaminant Levels (MCLs) in storm runoff, the timing and intensity of rainfall has implications for drinking-water supplies. Pesticides in streams from storm runoff may enter alluvial aquifers as a consequence of ground-water withdrawals. Sites with degraded water chemistry commonly had degraded physical habitats as well. Streamflow regulation of the Platte River has affected water quality through habitat alterations that are deleterious to native species. The combination of degraded physical and chemical environments commonly resulted in structurally simple fish communities.

Agricultural chemicals are applied to enhance crop production.

Nitrate content in water is related to agricultural land management (p. 6–7)

- Nitrate[1] concentrations in ground water were greatest where more than 60 percent of the area was in corn production, water tables were within 50 feet of the land surface, and soils were most permeable. Nitrate concentrations in ground water often exceeded the MCLs in the Platte Valley, where fertilizer is applied to large areas that produce corn every year.
- Nitrate concentrations varied substantially and tended to be smaller in surface water than in ground water for similar environmental settings. The smallest concentrations were measured in streams during the summer when nitrate uptake by aquatic plants was greatest.
- Land-management practices in the central part of the Platte Valley include constraints on the application of fertilizer. In areas where these constraints are most restrictive, median nitrate concentrations in domestic wells have decreased markedly.

Agricultural activities potentially affect the management of public-water supplies withdrawn from the Platte River and the alluvial aquifer (p. 8–9)

- Alachlor, atrazine, cyanazine, and metolachlor, all organonitrogen herbicides, were the four most commonly applied and detected pesticides for corn, sorghum, and soybean production in the Study Unit.
- Concentrations of these herbicides in surface water varied seasonally and were generally larger in the spring and summer following application than in the fall and winter.
- The Elkhorn River drainage basin contributed the majority of the herbicides flushed from the Study Unit.

[1]Nitrate, as used in this report, was analyzed as nitrite plus nitrate and concentrations were reported as total nitrogen.

- Of 46 pesticides analyzed in water samples from the Platte River at Louisville, it appears that alachlor, atrazine, and cyanazine are the most likely to influence the quality of public-water supplies withdrawn from the Platte River alluvial aquifer downstream from the confluence of the Platte and Elkhorn Rivers. Atrazine is most likely to exceed the MCL in public-water supplies withdrawn from the alluvial aquifer downstream from this part of the aquifer.
- Nutrient concentrations in the Platte River increase downstream as it flows through the Study Unit; however, all measured concentrations were well below the MCLs.

Water quality in the Platte River alluvial aquifer may be affected by surface-water quality in areas of ground-water withdrawals (p. 10–11)

- Ground water is the principal source of drinking water for public- and self-supplied domestic uses in Nebraska.
- The Platte River alluvial aquifer that underlies the Platte Valley subunit is the single most important source of water for public supply and is connected hydraulically to the Platte River.
- The increase in ground-water withdrawals in the Platte Valley has induced additional recharge from the river, and has the potential to change ground-water quality near the river where many of the public supply wells are located.

Aquatic environments potentially are altered by human activities (p. 12–13)

- Streams where row crops dominate the drainage basin had large concentrations of nutrients and pesticides in the water, the largest residues of pesticides in fish tissues, and degraded fish communities. Conversely, streams draining rangelands had small concentrations of pesticides in water and fish tissues and supported diverse fish communities. Chemicals normally associated with urban and industrial sources were detected at small concentrations in water, streambed sediments, and fish tissues throughout the Study Unit.
- Organochlorine concentrations in fish tissues generally were near minimum reporting limits; however, more frequent detection and somewhat larger concentrations of p,p'-DDE, polychlorinated biphenyls (PCBs), *trans*-nonachlor, and dieldrin were detected from areas dominated by row-crop agriculture. One of three fish-tissue samples from the Platte River at Louisville exceeded a water-quality criterion for protection of fish-eating wildlife because of large concentrations of p,p'-DDE.
- Streams that drain basins with large percentages of cropland had fish communities tolerant of physical or chemical water-quality degradation. Fish communities from the Dismal River, which drains primarily rangelands, contained a mix of tolerant species, species with intermediate tolerance, and intolerant species. In contrast, the fish communities at Prairie and Shell Creeks, where nearly all the land is used for corn production, were characterized by a few tolerant species such as green sunfish, common carp, and fathead minnow; no pollution-intolerant species were present. Habitat quality also was degraded at sites draining areas where cropland was the predominant land use.
- Wetlands in drainage basins dominated by row crops had herbicide (atrazine and total organonitrogen herbicides) concentrations that were significantly greater than those from wetlands in either rangelands or mixed land uses. These findings imply that a mixture of land use may reduce the potential for water-quality degradation from agricultural sources.

Aquatic and migratory species are affected directly by changes in the physical characteristics of the Platte River (p. 14-15)

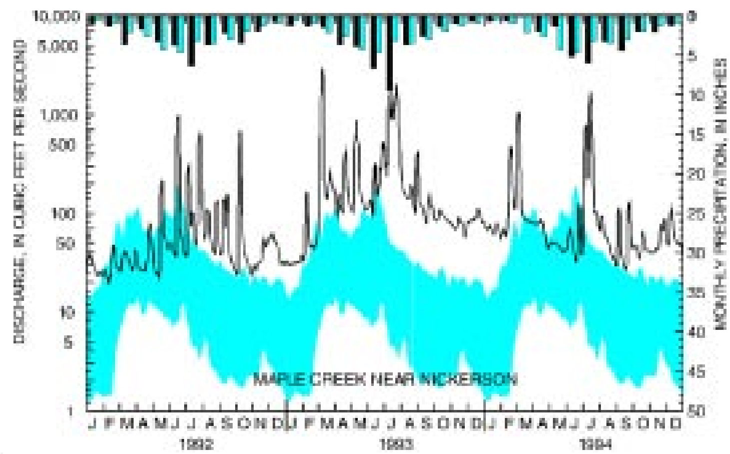
- Channel width has been reduced by as much as 90 percent near North Platte. The narrowing process is continuing at sites downstream. Near Grand Island, the channel has narrowed from 40 to 60 percent of its historical width, and trees have become established on sandbars, which develop into permanent islands. Flow regulation upstream from the Study Unit, water withdrawals, and possibly climate changes have been the primary causes of channel-width reductions.
- Migratory birds, including sandhill cranes and the endangered whooping cranes, rely on critical habitats in the Platte Valley. Habitat loss has created overcrowded conditions, which may lead to outbreaks of diseases such as avian cholera.
- Native fish species also have been adversely affected by habitat loss. Some fish species may be absent or in decline as a result of reductions in habitat. The current fish community contains non-native species that are tolerant of degraded habitats. Some sensitive native species are no longer found or are rarely collected.

Vast grasslands and fertile soils drew Native Americans to hunt and farm in the area that became the State of Nebraska. These same qualities appealed to settlers moving west during the 19th century in search of affordable land. Cattle ranchers found room to sustain their herds in the Sandhills, where grass roots have all but stopped the progression of sand dunes. The development of surface- and ground-water irrigation led to dependable harvests of corn, alfalfa, soybeans, and sorghum. Today the region is still an important agricultural production center for the Nation.

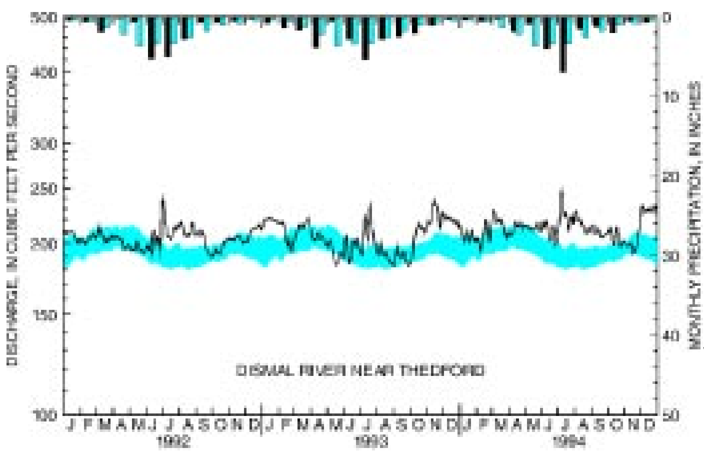
The Central Nebraska Basins Study Unit includes about 30,000 mi^2 (square miles) of the Platte River Basin from the confluence of the North and South Platte Rivers near North Platte, Nebraska, to its mouth near Omaha, Nebraska [1]. The environmental settings of the Central Nebraska Basins are characterized by differences in soils, precipitation, and land use and are divided into the Sandhills, Loess Hills, Glaciated Area, and Platte Valley subunits.

Along the southern part of the Study Unit is the Platte Valley subunit, where sandy soils and a shallow water table provide favorable conditions for crop production.

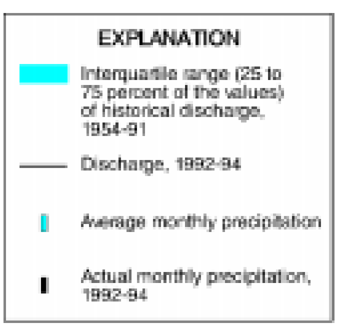
Hydrologic conditions affect water quality because the processes by which many chemicals enter water bodies are functions

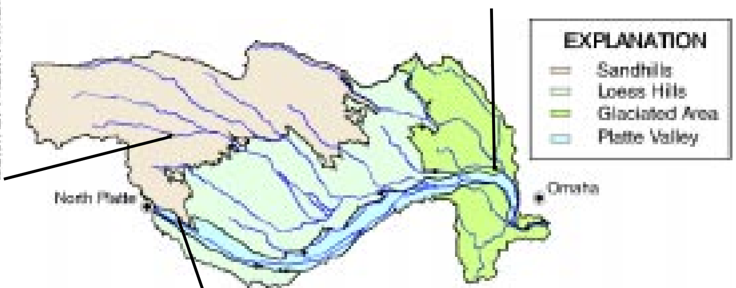


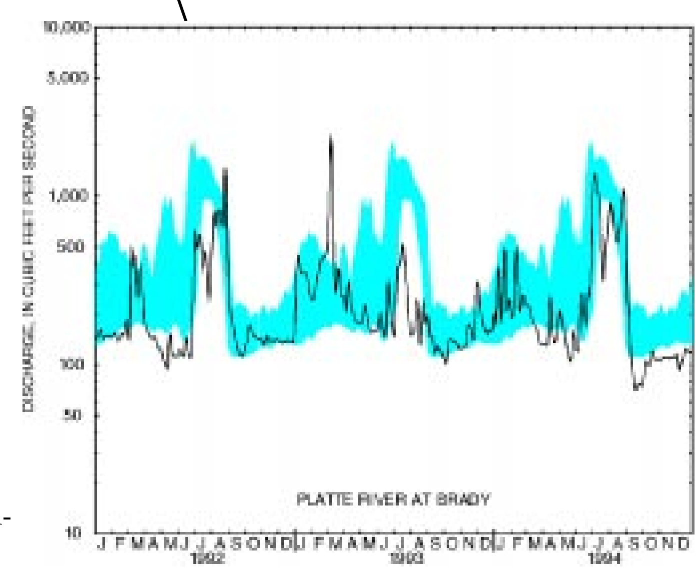
Greater rainfall and relief, less permeable soils, and no regulation result in highly variable streamflow.



Permeable soils of the Sandhills result in stable streamflow sustained by ground-water discharge.





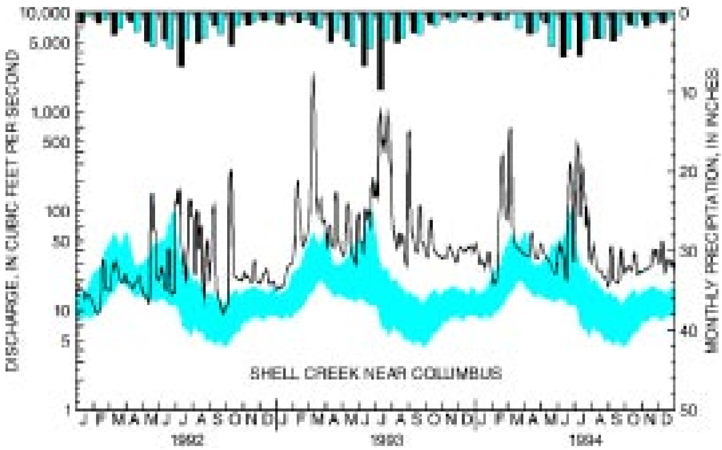


The Platte River is regulated by a series of upstream dams producing similar patterns of streamflow year after year.

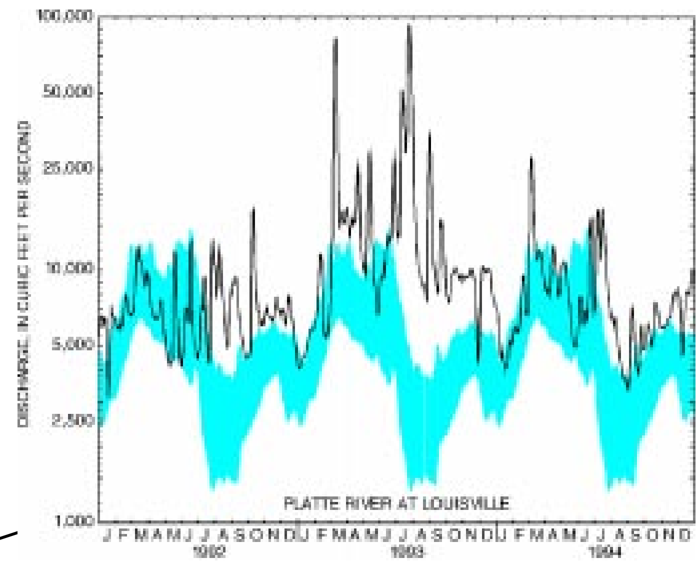
In the northwest part of the Study Unit, the Sandhills subunit has sandy soils, is semiarid, and is used as rangeland. Nearly all the precipitation in the Sandhills subunit infiltrates directly to ground water with very little runoff. Progressing eastward, precipitation increases, soil textures are finer, and runoff increases. The Loess Hills subunit, in central Nebraska, is characterized by a mixture of rangeland and cropland, whereas the Glaciated Area subunit, in the eastern part of the Study Unit, is nearly all cropland.

of precipitation running off the land surface and entering streams or aquifers. For example, herbicides commonly are applied to row-cropped areas in the spring. If this application is followed by intense rainfall, herbicides can be transported overland to streams [2] or downward to ground water. Therefore, any description of current water-quality conditions should consider present and typical hydrologic conditions. In the accompanying figures, the blue-shaded area represents the range of streamflows that occurred 25 to 75 percent of the time from 1954 to 1991 (a period of data available for all sites shown).

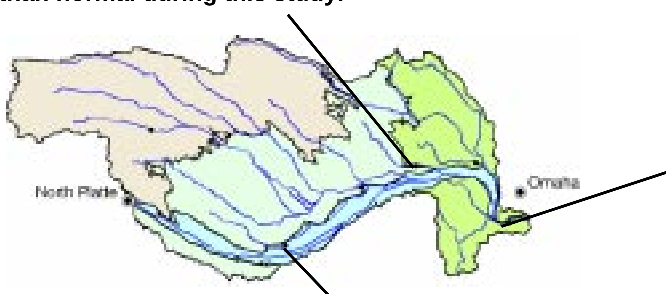
Generally, streamflows throughout the Study Unit were greater than normal during 1992 to 1995. This was particularly noticeable in the eastern part of Nebraska where streamflow has a strong seasonal pattern. In contrast, the Dismal River, in the Nebraska Sandhills, had a fairly uniform streamflow and was slightly above the normal range from 1992 to 1995. Streamflow in the Platte River is regulated by releases from dams outside of the Study Unit and by diversions for irrigation.

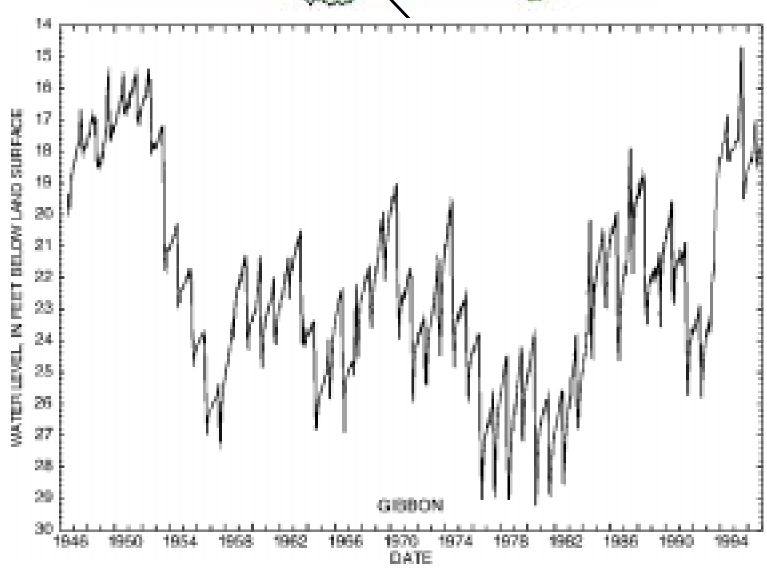


Streamflow in the eastern part of the Study Unit was much greater than normal during this study.



Runoff from the Central Nebraska Basins generally is unregulated by dams and thus shows substantial variability.





The sharp declines each year are the result of irrigation withdrawals. Wet conditions have recently increased water levels.

Comparisons of streamflow between the Platte River at Brady and the Platte River near Louisville show the effect of precipitation and streamflow regulation in the Central Nebraska Basins. Because flow and runoff were greater than normal for streams sampled during the course of this study, constituent loads associated with nonpoint sources, such as nutrients and pesticides, might be expected to be larger than would be found at normal flows.

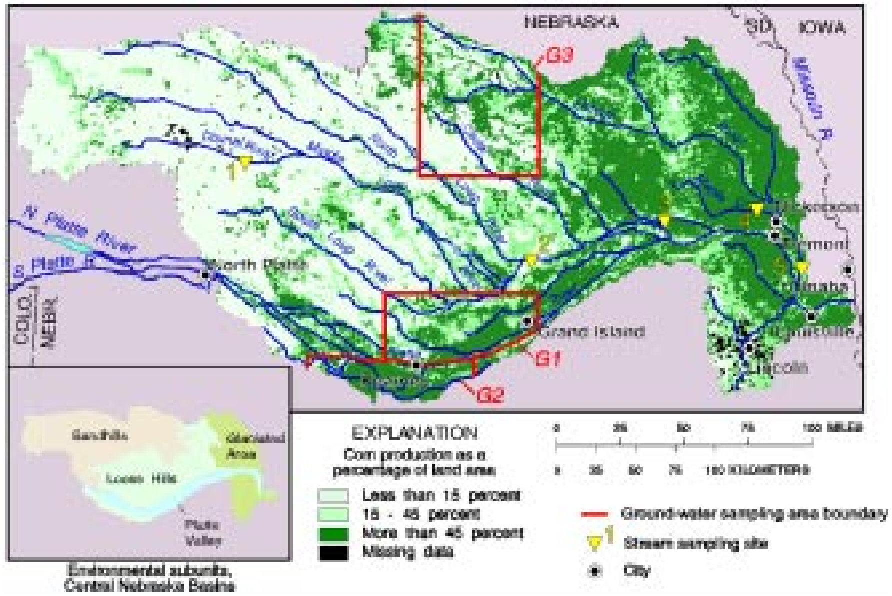
Ground-water withdrawals for irrigation result in substantial declines in ground-water levels during each year. Ground water may be susceptible to contamination from nonpoint sources where unconfined aquifers are shallow and overlying soil texture is coarse, such as in the Platte Valley. Generally, ground-water levels in the Platte Valley declined from the 1950s to the early 1980s. The larger than normal precipitation during 1992 to 1995 increased water levels, and increased nutrient and pesticide concentrations could be expected.

.Nitrate Content in Water is Related to Agricultural Land Management

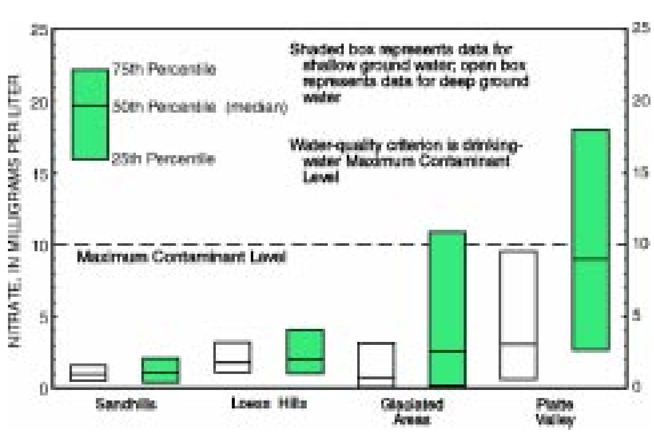
Land use in the Central Nebraska Basins Study Unit is primarily agricultural—typically, large areas are rangeland, mixed rangeland and cropland, or cropland. Rangeland characterizes most of the western part of the basin whereas cropland is more typical in the eastern part [1]. Irrigated corn dominates the land use in the central Platte Valley subunit, where extensive applications of nitrate fertilizers and irrigation water are made each year to sustain crop yields. Nitrate concentrations in water at different locations reflect the differences in agricultural land management within the Study Unit.

Percentage of major land use in drainage basins for selected streams

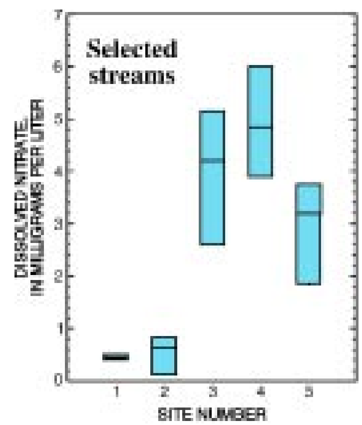
Stream sampling site	Crops, pasture (percent)	Range-land (percent)
1	6.3	92.9
2	26.5	72.6
3	98.4	1.1
4	99.5	No data
5	84.1	14.1



Corn production dominates the land use in the Platte Valley and Glaciated Area subunits.



Nitrate concentrations were largest in the shallow ground water in areas of intense corn production.



Nitrate concentrations were larger in streams in areas of intense crop production.

The Platte Valley subunit includes extensive areas of irrigated corn, permeable soils, and shallow ground water—all characteristics that increase the vulnerability of ground water to agricultural contaminants. The Glaciated Area subunit also has extensive areas of corn and other row crops. Consequently, concentrations of nitrate in shallow ground water are substantially larger in the Platte Valley and the Glaciated Area than in the Sandhills subunit, which is mostly rangeland, and the Loess Hills area, which is predominantly rangeland mixed with cropland. As the graph indicates, 45 percent of the shallow wells sampled in the Platte Valley and more than 25 percent of the shallow wells in the Glaciated Area exceeded the USEPA's MCL [3] of 10 milligrams per liter (mg/L) for nitrate in drinking water. In contrast, 75 percent of the shallow wells sampled in the Sandhills contained less than 2 mg/L of nitrate, and 75 percent of the shallow wells in the Loess Hills contained less than 5 mg/L. Nitrate concentrations in the deeper wells in the Platte Valley and the Glaciated Area were significantly smaller than in the shallow wells. Median nitrate concentrations in samples from the deep wells were similar (2 to 4 mg/L) among subunits. Nitrate concentrations in streams generally were substantially smaller than those from shallow ground water of the same subunits [4].

Annual applications of up to 150–200 pounds of nitrogen per acre are made to achieve large corn yields. Streams draining areas where corn production is extensive and fertilizer is applied every year at rates that sustain high-yielding corn (sampling sites 3, 4, and 5) tended to have larger nitrate concentrations than areas like sites 1 and 2. Nitrate concentrations in streams vary seasonally; larger concentrations of nitrate were detected during winter when aquatic plant growth was minimal, whereas smaller

Nitrate concentrations in selected ground-water areas in central Nebraska reflect the agricultural land use

[%, percent; acre-ft/acre, acre-foot per acre; mg/L, milligrams per liter; <, less than; Source: modified from Druliner and others [6]]

Sampling area (see map)	Cropland (%)	Total land area irrigated (%)	Estimated irrigation water used (acre-ft/acre)	Major crops (% cropland, as of 1989)	Nitrate, 25th percentile (mg/L)	Median nitrate (mg/L)	Nitrate, 75th percentile (mg/L)
G1	59	50	0.82	Corn (64), hay (12), soybeans (10)	9.8	25.0	32.0
G2	67	48	1.0	Corn (68), wheat (9) soybeans (8)	3.8	7.6	10.0
G3	30	13	0.99	Hay (58), corn (35), soybeans (4)	1.6	6.4	18.0

concentrations of nitrate were detected during summer when aquatic plant growth was greatest [5].

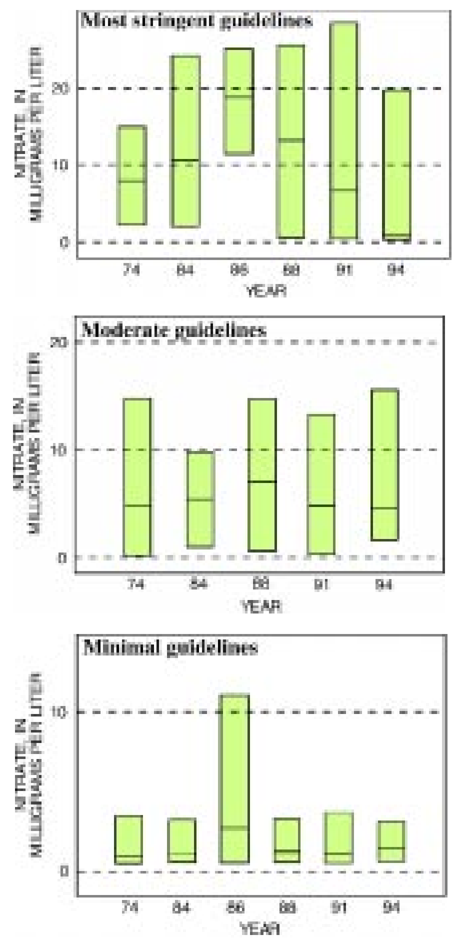
Irrigated cropland can affect nitrate concentrations in ground water. The Central Nebraska Basins Study Unit team examined data from Druliner and others [6] for selected wells in three areas (G1, G2, and G3, which extend beyond the Study Unit) that represent contrasting amounts of irrigated cropland ranging from 13 percent to about 50 percent. Median nitrate concentrations in areas with shallow depths to ground water and underlying intensely irrigated cropland that is dominated by corn production, like area G1 in the table, were more than twice the MCL of 10 mg/L for drinking water. The area G2 is similar to area G1 in the total percentage of land irrigated, but with generally larger depths to ground-water level and a median nitrate concentration that is one-fourth that of area G1. In both the G1 and G2 areas, more than 60 percent of the cropland is planted in corn. In these areas, median nitrate concentrations approached or exceeded the MCL. In comparison, area G3 had 35 percent of the cropland planted to corn, only 13 percent of the total land area irrigated, and relatively shallow depth to ground water, yet had a median nitrate concentration of 6.4 mg/L.

The Central Platte Natural Resources District (CPNRD) has established fertilizer-management areas in part of the central Platte Valley based on corn acreages and nitrate concentrations in ground water, similar to area G1. This area has concentrations of nitrate in ground water up to 40 mg/L. The CPNRD has imposed stringent guidelines on the timing and application rate of fertilizer in this area. In addition, the amount of fertilizer applied must be decreased by the amount of nitrate contained in the irrigation water that is applied. Moderate guidelines on fertilizer application are enforced in areas that are less vulnerable to contamination. A third area with the smallest percentage of cropland has minimal guidelines. This management strategy began during 1986–88.

The Study Unit team analyzed CPNRD data collected from 1974 through 1994 from selected irrigation and domestic wells [7]. Median nitrate concentrations, in areas that were assigned the most stringent guidelines, increased from about 8 mg/L in 1974 to about 18 mg/L in 1986. After implementation of the fertilizer-management strategy, the median nitrate concentrations in domestic wells decreased from 18 mg/L in 1986 to less than 2 mg/L in 1994.

However, despite the most stringent guidelines, nitrate concentrations in nearly 25 percent of the wells in the area continued to exceed 20 mg/L in 1994. Therefore, it is possible that some areas where the most stringent guidelines apply have not been as responsive to the management strategy as others. Nitrate concentrations for different years, under moderate guidelines, did not differ significantly. Median nitrate concentrations in water samples from the domestic wells in the minimal management areas showed little change.

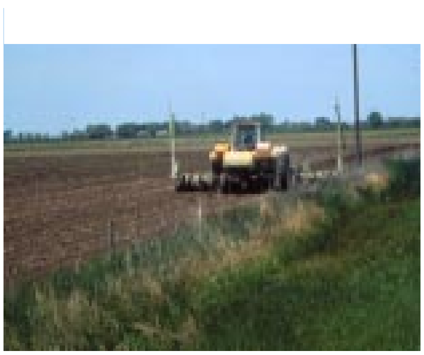
—Thomas L. Huntzinger



Since 1986, median nitrate concentrations from domestic wells have decreased where the most stringent fertilizer-management guidelines have been followed.

Agricultural Activities Potentially Affect the Management of Public Water Supplies

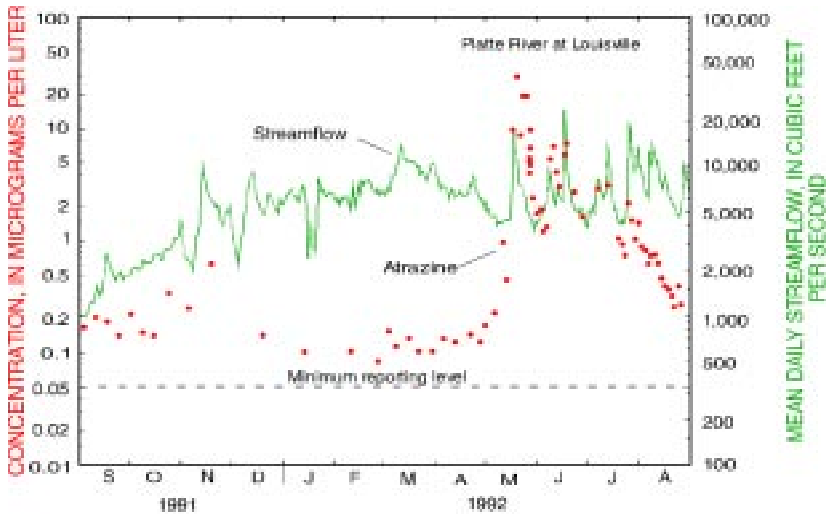
Contamination of surface and ground water from nonpoint sources is a national issue. Examples of nonpoint-source contaminants from agricultural activities are pesticides (fungicides, herbicides, and insecticides), sediment, nutrients (nitrogen and phosphorus), and fecal bacteria [8]. Of the many possible contaminants, pesticides receive the most attention because of the potential toxicity to aquatic life and humans. Pesticides often are used to increase crop yields and values. Herbicides prevent or inhibit the growth of weeds that compete for nutrients and moisture needed by the crops. Herbicides are applied before, during, or following planting. Herbicides also are used for weed control in urban areas, often with large rates of application.



Row-crop agriculture dominates much of the Central Nebraska Basins Study Unit.

Alachlor, atrazine, cyanazine, and metolachlor, which are referred to as organonitrogen herbicides, were the four most commonly applied herbicides for corn, sorghum, and soybean production in the Central Nebraska Basins Study Unit. Of all pesticides used in the Study Unit, atrazine was the most extensively applied.

Insecticides are used to protect the crop seeds in storage prior to planting and also to protect the plants once the seeds germinate. Like herbicides, insecticides are used in urban areas to protect property, including buildings, lawns, trees, and ornamental shrubs.



Atrazine concentrations in the Platte River are a function of the timing and intensity of rainfall with respect to the application of the herbicide.

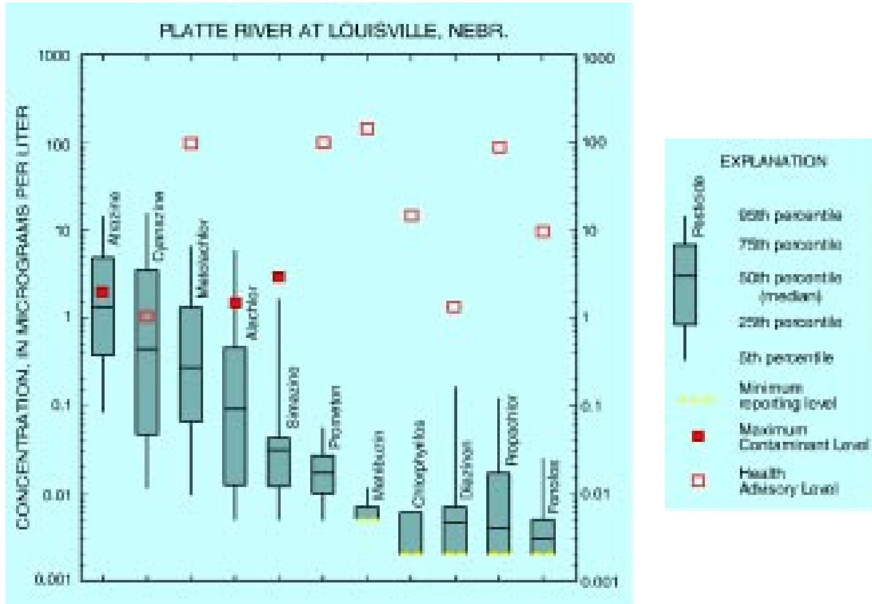
The temporal distributions of alachlor, atrazine, cyanazine, and metolachlor and the concentrations of each were defined on the basis of analyses of water samples collected from the Platte River at Louisville from September 1, 1991, through August 31, 1992 [9, 10]. These data were collected more often when the temporal variability of concentrations was expected to be large and less often when variability was expected to be small. The graph shows the temporal distribution of the concentrations of atrazine in relation to streamflow. Although the graph shows only how atrazine concentrations vary with time, concentrations of alachlor, cyanazine, and metolachlor varied in a similar manner. Concentrations of atrazine were larger in the spring and summer, when nearly all atrazine is applied, and smaller in the fall and winter. During this period of data collection, the largest herbicide concentrations were measured during the growing season following intense rainfall shortly after the herbicide had been applied [11]. Herbicide concentrations peaked in May and then generally declined in the months that followed [9]. For example, atrazine concentrations in May ranged from 0.17 to 30 micrograms per liter (μg/L), and mean daily streamflows ranged from 3,750 to 18,100 cubic feet per second (ft^3/s). In contrast, atrazine concentrations in February ranged from 0.08 to 0.10 μg/L, and mean daily streamflows ranged from 5,110 to 8,150 ft^3/s. The decrease in quantity of atrazine available for entrainment in

Alachlor	Malathion
Atrazine	Methylazinphos
Benfluralin	Methylparathion
Butylate	Metolachlor
Carbaryl	Metribuzin
Carbofuran	Molinate
Chlorpyrifos	Napropamide
cis-Permethrin	*p,p'*-DDE
Cyanazine	Pebulate
DCPA	Pendimethalin
Diazinon	Phorate
Dieldrin	Prometon
Diethylanaline	Pronamide
Dimethoate	Propachlor
Disulfoton	Propanil
EPTC	Propargite
Ethalfluralin	Simazine
Ethoprop	Tebuthiuron
Ethylparathion	Terbacil
Fonofos	Terbufos
HCH, *alpha*-	Thiobencarb
HCH, *gamma*-	Triallate
Linuron	Trifluralin

Water samples from the Platte River at Louisville site were analyzed for 46 pesticides.

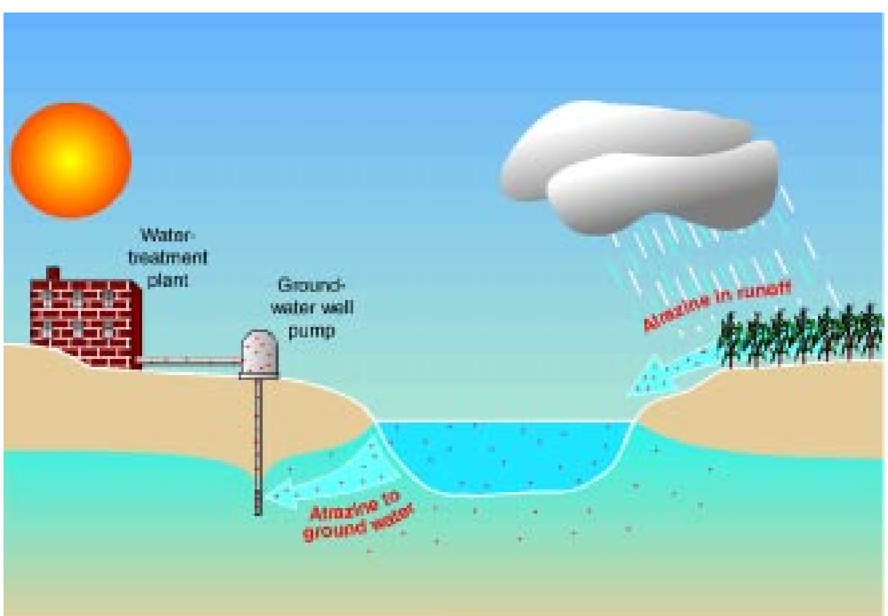
surface runoff is a result of factors such as volatilization into the atmosphere as a result of high land-surface temperatures, photo decomposition and bacterial degradation, adsorption onto soil particles, and uptake by plants.

Of the 46 pesticides, it appears that only atrazine, cyanazine, and alachlor may at times pose potential concern for public water supplies withdrawn downstream from the confluence of the Elkhorn River with the Platte River [12]. Presently, the USEPA has established only a Health Advisory Level (HAL) for cyanazine and not an MCL; a HAL is a guideline whereas an MCL is enforceable. Thus, based on current MCLs, atrazine is the herbicide most likely to exceed the MCL at the Platte River at Louisville. However, the compliance of a public water-supply system relative to an MCL or a HAL for a pesticide is based on an average annual concentration. Therefore, one or more exceedances of the specified value does not necessarily indicate noncompliance. Also the MCL or HAL for a pesticide applies only to the pesticide and not to any of its degradation products.



Alachlor, atrazine, and cyanazine pose potential concerns for drinking-water supplies.

An analysis of these four herbicides at the Platte River at Louisville site indicated that the source of the herbicides was almost entirely in the Study Unit and most was contributed by the Elkhorn River [12]. Most herbicide movement in streams occurred during the growing season (May through August).



Atrazine movement from the Platte River through alluvial aquifers can be induced by ground-water withdrawals for drinking water.

Lincoln, Omaha (outside the Study Unit), and smaller cities along the Platte River withdraw water from the adjacent alluvial aquifer for public supplies. The aquifer adjacent has a direct hydraulic connection to the river and thus is affected appreciably by the quantity and quality of water in the river [13, 8].

Studies have shown that conventional water treatment is ineffective in removing organonitrogen herbicides such as alachlor, atrazine, cyanazine, and metolachlor from finished drinking water. These herbicides remain in solution, in contrast to many other contaminants that are more easily removed by conventional treatment processes, such as coagulation and sand filtration.

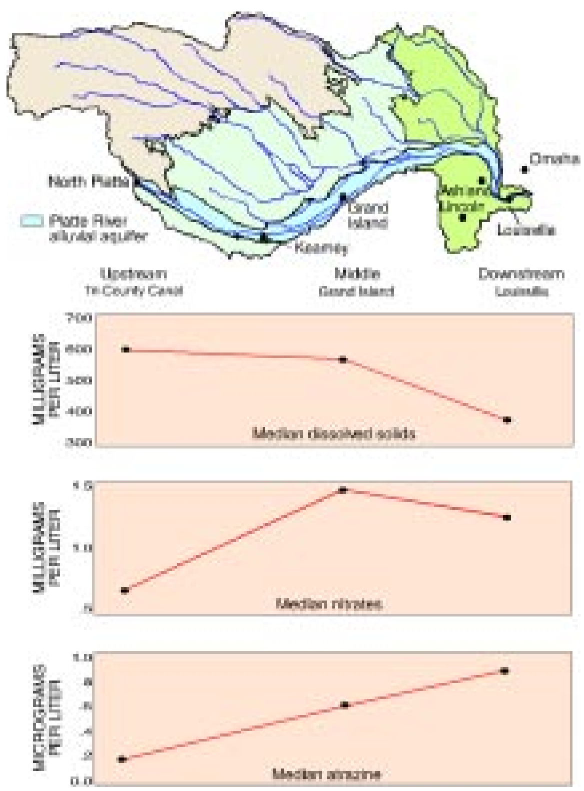
—John K. Stamer

Water Quality in the Platte River Alluvial Aquifer may be Affected by Surface-Water Quality in Areas of Ground-Water Withdrawals

Ground water is the principal source of water for public- and self-supplied domestic uses in Nebraska. Ground water supplied about 235 million gallons per day (Mgal/d) or about 78 percent of the estimated public-supplied water in Nebraska in 1990. The Platte River alluvial aquifer that underlies the Platte Valley is connected hydraulically to the Platte River. The aquifer is the single most important source of water for public supply. It provides about 117 Mgal/d, or about half of the total daily ground-water public-supply production for Nebraska. This aquifer supplies water to Nebraska's largest cities, including Omaha, Lincoln, Grand Island, and Kearney. In addition, ground water supplies about 83 percent, or about 1,017 Mgal/d, of the irrigation water in the valley [14].

Increased ground-water withdrawals from the alluvial aquifer may increase infiltration from the Platte River [15]. This increase in infiltration has the potential to change the ground-water quality near the river where many of the public-supply wells are located. The quality of the Platte River water can differ significantly with respect to location in the valley.

Median concentrations of dissolved solids tend to decrease with distance downstream, whereas nitrate and pesticide concentrations increase with distance downstream. Median dissolved-solids concentrations for samples collected between 1992 and 1995 were 663 mg/L from the Tri-County Canal near North Platte, which represents stream water quality entering the Study Unit from the west, 578 mg/L from the Platte River near Grand Island near the middle of the Study Unit, and 380 mg/L from the Platte River at Louisville at the most downstream point where streamflow leaves the Study Unit. Median nitrate concentrations were 0.68 mg/L in samples from the Tri-County Canal, 1.4 mg/L from the Platte River near Grand Island, and 1.2 mg/L from the Platte River at Louisville. The median concentrations of 12 herbicides in surface water at these locations are listed in the table. Five of the twelve—acetochlor, alachlor, atrazine, cyanazine, and metolachlor— indicate that herbicide loads increase with distance downstream in the Study Unit. Atrazine displayed the highest increase in median concentrations with 0.14 µg/L from Tri-County Canal near North Platte, 0.62 µg/L from the Platte River near Grand Island, and 0.91 µg/L from the Platte River at Louisville.



Stream-water quality in the Platte River with distance downstream.

Median herbicide concentrations at three stream sites in the Platte River, 1992–95

[µg/L, micrograms per liter; <, less than]

Herbicide	Concentration (µg/L) Tri-County (upstream)	Grand Island (middle)	Louisville (downstream)
Acetochlor	<0.05	<0.05	0.31
Alachlor	<0.05	<0.05	0.06
Ametryn	<0.05	<0.05	<0.05
Atrazine	0.14	0.62	0.91
Cyanazine	<0.05	<0.05	0.31
Metolachlor	<0.05	0.07	0.19
Metribuzin	<0.05	<0.05	<0.05
Prometon	<0.05	<0.05	<0.05
Prometryn	<0.05	<0.05	<0.05
Propazine	<0.05	<0.05	<0.05
Simazine	<0.05	<0.05	<0.05
Terbutryn	<0.05	<0.05	<0.05

Dissolved solids and pesticide concentrations in ground water are not greatly different than those in surface water, but nitrate concentrations in intensive agricultural areas are usually much greater in ground water than in surface water. The 1978–90 median dissolved-solids concentration was 533 mg/L and median nitrate was 12 mg/L for the shallow (less than 82 ft) Platte River alluvial aquifer [16]. Of the 12 pesticides listed in the table with median concentrations greater than the method detection limit, alachlor was less than 0.2 µg/L, atrazine was 0.3 µg/L, cyanazine was less than 0.1 µg/L, and metolachlor was less than 0.1 µg/L. These pesticide concentrations are generally greater than the medians of these compounds in surface water at the most upstream surface-water site at Tri-County Canal and less than the median concentrations at the most downstream surface-water site at Louisville.

Three locations in the Platte Valley were studied to assess the effects of water withdrawals on ground-water quality near the river [17]. The areas studied were a wet meadow area located about 15 miles east of Kearney, the city of Grand Island's Indian Island wellfield, and the city of Lincoln's Ashland wellfield.

The wet meadow is an area that has had very little ground-water development and represents essentially unstressed ground-water conditions. A number of observation wells were installed in the wet meadow at selected depths and distances downgradient from a corn field to study the areal and vertical differences in concentrations of selected water-quality constituents. The median dissolved-solids concentration of samples collected in February and June 1994 was 822 mg/L, somewhat above the medians for dissolved solids in surface water at sites upstream and downstream from the wet meadow site. The most pronounced changes in dissolved-solids concentrations occurred with depth. For example, the dissolved-solids concentration for December 1994 was 956 mg/L in the shallowest well in a cluster of wells completed closest to the corn field; the concentrations decreased to 575 mg/L in the deepest well of the cluster, completed at the bottom of the alluvial aquifer. The latter is nearly the same as the median dissolved-solids concentration in the streamflow just downstream at Grand Island. Nitrate concentrations in water samples from the shallow wells in the wet meadow in 1994 ranged from 5.0 to 15 mg/L. These concentrations were generally much larger than those detected in the associated deeper (30 and 45 ft) wells where nitrate concentrations ranged from 1.3 to 6.8 mg/L. Atrazine was detected in small concentrations of 0.1 to 0.6 µg/L in water from all of the wells sampled in February and June 1994, similar to the range of median atrazine concentrations detected in surface water at the upstream and middle sites. Concentrations of the other 11 herbicides were at or below the detection limit of 0.05 µg/L.

Grand Island is typical of cities in the Platte Valley. Concerns about adequate future supplies and the potential for ground-water contamination led to the development of the Indian Island wellfield site in the Platte River. It was anticipated that, with an island location, recharge from the river would act as a barrier to potential ground-water contamination of the wellfield and provide an additional source of good quality water to the aquifer. Control of land use within the wellfield also has the potential to minimize ground-water contamination from land-surface activities in the valley (Gary Mader, Utilities Director, City of Grand Island, written commun., 1994).

Observation wells were installed in four clusters of five wells each in the wellfield. An additional cluster of four observation wells was installed immediately north of the river. The wells in the wellfield clusters were completed at depths ranging from 20 to 123 ft, and wells in the cluster located north of the river were completed at depths of about 13 to 114 ft. Dissolved-solids concentrations varied with location and depth of the observation well. The concentrations ranged from 443 to 746 mg/L in the wellfield, with a median concentration of 578 mg/L. Because of controlled land use and the river barrier, the nitrate concentrations were very low. The median concentration of nitrate for samples collected during late 1994 and early 1995 was 1.37 mg/L. In late August to early September 1995, nitrate concentrations ranged from less than the detection limit of 0.05 mg/L to a maximum of 0.59 mg/L.

Water collected between December 1994 and September 1995 from the observation wells in the Grand Island wellfield also was analyzed for the same 12 pesticides shown in the table. Of the 12, only atrazine, prometon, and propazine were detected at concentrations of 0.05 µg/L or greater. Atrazine was detected at all five observation-well clusters but only in small concentrations. Atrazine was not detected in samples from any of the 123-ft-deep wells. At the cluster most affected by pumping, atrazine was detected in only the shallowest well. The maximum concentration of atrazine from the 47 samples collected at the five cluster sites was 0.38 µg/L. Prometon was detected in three and propazine was detected in two of 47 samples from the five well clusters. Maximum concentrations of prometon and propazine were 0.06 and 0.41 µg/L.

The Ashland wellfield provides almost all of the public supply water for the city of Lincoln, which has a population of about 200,000. Because ground-water withdrawals are large and the supply wells are near the river, major ion and nutrient concentrations in ground water are comparable to the Platte River water at the Louisville site. In studies conducted by others [18, 19], atrazine detected in samples from the observation and supply wells were traced to the river. Atrazine concentrations in water sampled from observation wells in the wellfield were reported as high as 20 µg/L.

Inducing infiltration from the Platte River may have the effect of reducing nitrates to below that of the nearby ground water but also may have the effect of increasing pesticide concentrations. This is particularly true in the lower basin where the surface water may carry higher levels of pesticides and especially during the late spring and early summer when pesticide concentrations in the streams are at their highest. Generally, the closer a well is to a stream and the higher the pumpage rate, the more the quality of the well water will be influenced by the quality of the stream.

—Patrick J. Emmons

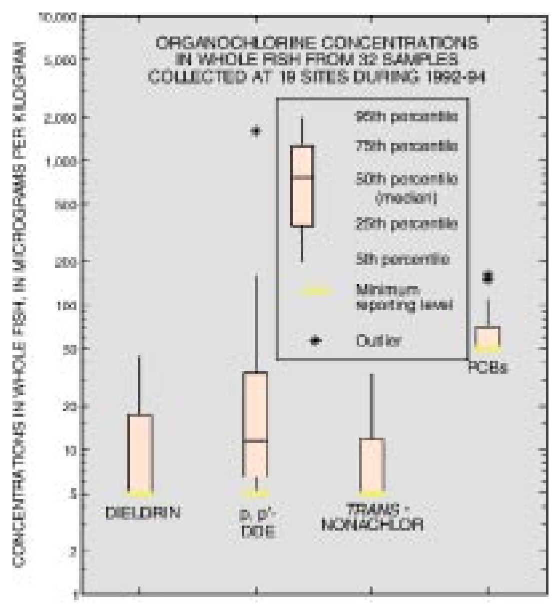
Aquatic Environments Potentially are Altered by Human Activities

Basins in which row crops dominate tended to have larger concentrations of agricultural chemicals in the water, residues of pesticides in fish tissues, and degraded fish communities [20]. Conversely, streams draining rangelands had smaller concentrations of agricultural chemicals in water or fish tissue and supported diverse fish communities. Urban and industrial chemicals generally were detected at small concentrations in water, streambed sediments, and fish-tissue samples throughout the Central Nebraska Basins Study Unit.

In general, chemicals discussed here enter the aquatic environment through nonpoint-source runoff from agricultural lands that dominate the Nebraska landscape. Because some chemicals may be hundreds or thousands of times more concentrated in the tissues of aquatic organisms or in fine sediments these media are well suited for the detection of certain classes of chemicals. Other chemicals are highly soluble and therefore most likely detected in water.

Residues of organochlorine compounds were present in bottom-feeding fish. Generally, concentrations were near method detection limits; however, p,p'-DDE (a degradation product of DDT), PCBs, *trans*-nonachlor, and dieldrin were detected more frequently and in somewhat larger concentrations in areas dominated by row-crop agriculture. Although some of these compounds, or their parent compounds, have not been used in the United States for a quarter of a century, they persist in the environment. Large-magnitude flooding, such as was experienced in the Midwest during 1993, may resuspend compounds long buried in streambed and flood-plain sediments. The largest concentration of organochlorine residues was detected in common carp sampled near the mouth of the Platte River following the flooding in 1993. The p,p'-DDE concentration of 1,600 micrograms per kilogram (µg/kg) was large enough to exceed the National Academy of Sciences and National Academy of Engineering guideline for the protection of fish-eating wildlife [21].

Organochlorine pesticides may also be found associated with organic carbon in streambed sediments. However, the less than 2-mm (millimeter) size fraction analyzed from streams in central Nebraska is mostly sand and has little organic carbon. Consequently only 1 of 28 samples had detectable levels of organochlorine pesticides. There were no detections of these compounds from 8 ground-water samples or 159 stream-water samples.



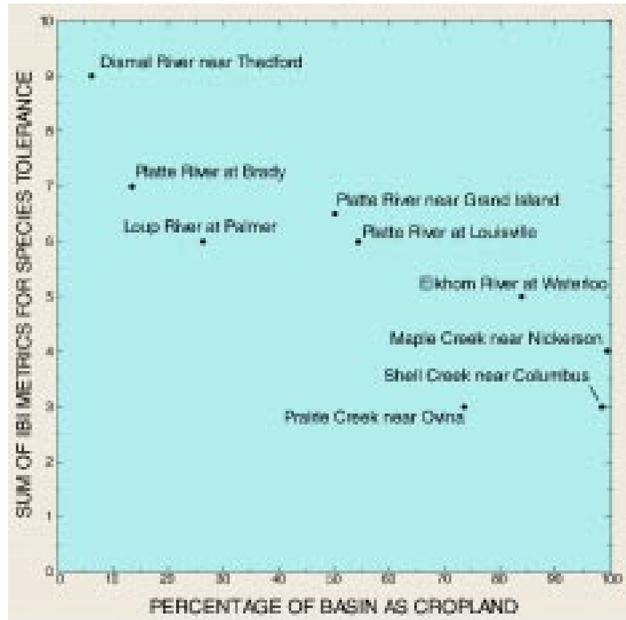
Although some organochlorine compounds have not been used for decades, they remain persistent in the environment.

Volatile organic compounds (VOCs) generally are associated with industrial activities, although some also are used as inert ingredients in pesticide formulations. Because some VOCs are carcinogenic, their presence in water supplies would be of concern. In the Platte Valley, environmental conditions are more likely to allow contamination than in other subunits of the Study Unit, yet no VOCs were detected in any of the 4 surface-water and 11 ground-water samples from streams or the alluvial aquifer.

The same samples were analyzed for alpha and beta radioactivity. Alpha radioactivity has an MCL of 15 picocuries per liter (pCi/L) in drinking water and generally indicates the presence of naturally occurring radium or radon. Alpha radioactivity ranged from 9.9 to 18 pCi/L in streams and from 1.5 to 79 pCi/L in ground water. Beta radioactivity at concentrations greater than 50 pCi/L may indicate the presence of fission products such as potassium-40 or strontium-90. Beta radioactivity ranged from 11 to 35 pCi/L in streams and from 5.2 to 55 pCi/L in ground water. Areas upstream from the Central Nebraska Basins Study Unit contain uranium-rich rock that is a likely source of alpha and beta radioactivity in the Platte Valley.

Generally, trace elements in water, tissue, and streambed sediments of the Central Nebraska Basins Study Unit were not an issue. Water samples from streams and aquifers with trace-element concentrations greater than a detection limit of 1 mg/L were uncommon. No samples exceeded drinking water MCLs for any trace element. However, streambed-sediment samples from the Platte River between North Platte and Grand Island in 1992 had notable selenium concentrations. The North Channel of the Platte River at Brady, with 1.2 micrograms per gram (µg/g), the Platte River at Overton (2.6 µg/g), and the Platte River near Grand Island (2.1 µg/g) all exceeded the median value of 0.7 µg/g from the 20 NAWQA Study Units submitting samples from 1992 to 1995. Samples collected during 1995 at Brady and near Grand Island, following high flows, had selenium

Fish communities were degraded at streams draining mostly cropland.



Measures of fish communities' tolerance to pollution suggest that degraded water quality is associated with a high percentage of cropland in a basin.

concentrations of 2.6 µg/g and 1.8 µg/g.

Because many specific factors should be considered when evaluating water quality, it is often difficult to provide a single result that represents the integration of these factors. However, aquatic biota that are continually subjected to all aspects of physical and chemical factors of their environment provide a means for making an integrated assessment. Species composition reveals information about local environmental conditions. If tolerant species, such as common carp, dominate the community to the exclusion of less-tolerant species, such as smallmouth bass, the implication is that water quality is degraded.

Fish communities were sampled at nine sites in the Central Nebraska Basins and evaluated using an index of biotic integrity (IBI). In this study, the lowest IBI scores (indicating degraded water quality) resulted from the identification of only a few individual fish, all of highly tolerant species. Shell and Prairie Creeks had the lowest IBI scores. Higher scores are associated with samples collected at the Dismal River and Platte River sites. These sites had fish communities represented by species of all tolerance classes. Sites with larger percentages of cropland in a drainage basin had fish communities indicative of degraded water quality [22]. Although cropland does not directly affect a fish community, factors related to the presence of cropland, as well as the effects of cropland on water chemistry and the physical habitat, likely are responsible for this relation.

Wetlands provide a variety of functions including flood and erosion moderation, sediment and nutrient retention, groundwater recharge, and wildlife habitat. Decades of agricultural activities in Nebraska have resulted in substantial decreases in wetland acreage. Remaining wetlands in the predominantly agricultural landscape are subjected to a variety of effects from surrounding land use. Some of the herbicides used in Nebraska are among those reported to have reproductive and endocrine disruptive effects on wildlife. With fewer acres of wetland habitat available to wildlife, the quality of remaining habitat becomes increasingly important.

Thirty-one wetlands representing dominant local land uses were sampled for organonitrogen herbicides in May and August 1994. Analysis of land use within 0.6 mile of each wetland revealed three groups of sites. One group of sites had an average of 74 percent rangeland, a second group of sites averaged no more than 30 percent in a single land-use category, and the third group had an average of 78 percent cropland surrounding the sites. The median concentrations of atrazine and the total of all herbicides analyzed in water samples were significantly smaller in rangeland-dominated sites than in cropland-dominated sites in both sampling periods. Sites without a single dominant land use had significantly smaller atrazine and total herbicide concentrations than sites in cropland-dominated landscapes, but were not significantly different than those in rangelands [23]. These results suggest that herbicide concentrations are elevated in water bodies where most of the surrounding land is used for row-crop production.

—Steven A. Frenzel

Wetlands surrounded mostly by cropland had significantly greater herbicide concentrations than wetlands in other land-use areas.

Aquatic and Migratory Species are Affected Directly by Changes in the Physical Characteristics of the Platte River

Islands and bars of the Platte River east of Grand Island have become densely wooded.

The Platte River Valley has been called "the foremost physical geographic feature of South Central Nebraska" [24]. The river bears little resemblance to the one that led tens of thousands of Native Americans, trappers, and settlers westward.

Though the Platte Valley still serves as a major overland interstate and rail artery, the river and its tributaries also are situated along another "highway." This corridor runs north-south, but instead of settlers, it is one of the major transcontinental routes for migratory birds and waterfowl. The Central Flyway serves as a conduit to bring half a million sandhill cranes, endangered whooping cranes, and vast numbers of other migratory species through the Platte Valley each year. These birds use the Platte Valley for nesting and to replenish their strength for their semiannual journey. The channels of the Platte also provide habitat for more than 50 species of fish [25].

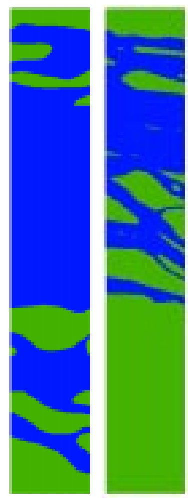
Endangered whooping cranes in the Platte River.

Physical characteristics of a river can be used to assess habitat for biota. These characteristics at a basin scale include basin shape, area, percentage of the basin contributing to runoff, the frequency and timing of floods, and land-use features [26]. Stream segment characteristics include streamflow, the shape of the channel, the stream stage at overflow into the flood plains, and sinuosity (or how curved the river is). Stream reach characteristics include the depth, width, and velocity of the stream, composition of the riverbed, and the available habitat. Different species of plants and animals prefer and are limited to living in the rivers and streams where these physical characteristics are compatible with their preferences and tolerances.

Streamflow regulation on the North Platte River has reduced the magnitude of spring floods in the main stem of the Platte River and, along with possible long-term climate change, has resulted in substantial channel-width reductions [25]. Since the completion of the last major dam on the North Platte River more than 50 years ago, channel width has been reduced by 90 percent immediately downstream from the confluence of the North and South Platte Rivers and from 40 to 60 percent in the middle reaches of the river [27]. Abandoned channels of the stream are now colonized by woodlands [28]. Nearly all researchers agree that birds that use the wide, active channels of the Platte River will lose valuable habitat with further channel narrowing.

The Central Nebraska Basins Study Unit team determined that, though the channel width appears to be stabilized at about 10 percent of its former width near Brady, the nature of its shape has changed markedly. Where the river was once a fairly straight and highly braided stream, it is now in the process of becoming a meandering river.

Although the channel near Grand Island has retained some braided characteristics, it continues to narrow. Since 1962, approximately one-third of the channel width has been lost [25]. Evidence suggests that the forces reshaping the Platte River are progressing at differing rates along the river. W.C. Johnson [29] found that since the 1960s, open channel and woodland areas in most reaches of the Platte River have remained relatively stable. Johnson suggests that channel narrowing downstream from Grand Island has continued because of the accumulation of sediment released by vegetation clearing above the reach. Regardless of the relative effects of water development and vegetation clearing on channel narrowing, it is apparent that the river in the reach below Grand Island is still engaged in the reshaping process and further changes can be expected.



Channel narrowing of the Platte River near Grand Island.

Species must adapt to change in habitat. Native species, such as cranes, use open water and barren sandbars for roosting at night. Other smaller migratory birds, such as the piping plover and interior least tern, use barren sandbars as nesting areas. The width of the Platte River near Grand Island has decreased. Many sandbars have become permanently vegetated in the past 30 years, changing the habitat in this reach of the Platte River.

Traditionally, the Platte Valley has served the sandhill cranes and the endangered whooping cranes as a secure place to rest while they feed [30]. Crane populations are relatively stable, but the habitat that cranes prefer for roosting has been substantially reduced. These habitat areas still exist near Grand Island and are known as the Critical Habitat Reach of the Platte River. The cranes prefer to roost in unobstructed channel areas that are greater than 450 feet (ft) wide,

Sandhill cranes prefer unobstructed river channels as a roosting site.

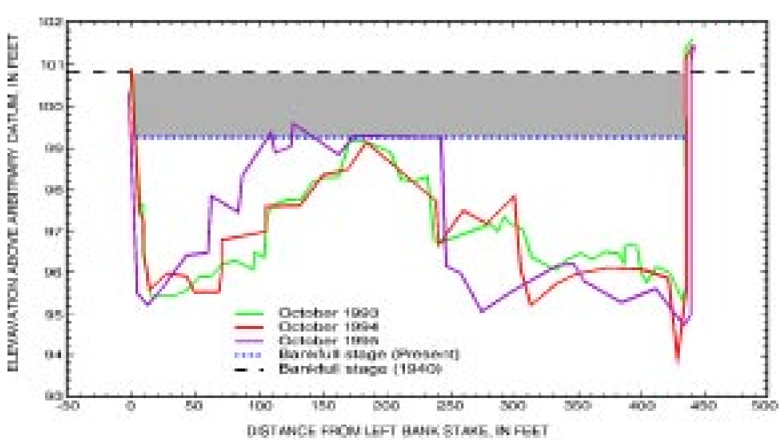
and they are rarely seen where the channel is less than 150 ft wide [31]. The same number of cranes in a smaller area results in crowding. High population densities brings the threat of cholera and other diseases to the bird populations [32]. Tens of thousands of cranes have been killed by tornadoes and storms passing over areas with high crane populations. Other birds, such as the endangered piping plover and threatened least tern, build their nests on the barren sandbars of the river. Channel narrowing also has reduced habitat for these species.

R.E. Johnson [33] described Nebraska fish distribution from 1939 to 1940. Goldowitz [34] demonstrated that the number of fish species had declined through 1995 in the reaches of the Platte River with the greatest channel-width reductions. R.E. Johnson collected fish using seines and 2-person crews, whereas Goldowitz collected fish with a combination of seining and electrofishing with a similar crew size. The Study Unit team used electrofishing with 4–5 personnel, resulting in 200 to 300 percent higher species catches at Brady and up to 40 percent higher species catches at Grand Island than either the R.E. Johnson or the Goldowitz surveys. Even though these sites had highly diverse fish communities, the Central Nebraska Basins Study Unit team, like Goldowitz, noted an absence of some native minnows. The brassy minnow, plains minnow, western silvery minnow, speckled chub, and flathead chub were not found during the Central Nebraska Basins study [22] in 1993 or 1994 at Grand Island, but were recorded by R.E. Johnson in the 1939 or 1940 collections. In addition, the number of moderately tolerant species, such as catfish, bullheads, mosquitofish, and the brook silverside, increased in both the Central Nebraska Basins study and the Goldowitz survey. All species found by the Study Unit team that were exclusive of the Goldowitz and R.E. Johnson surveys were classified as either tolerant species or moderately tolerant species, with the exception of the intolerant longnose dace.

Researchers of similar streams in Kansas had similar results [35]. Where dewatering and habitat destruction have occurred along streams, fish communities have changed in favor of more tolerant native and introduced fish. The native plains minnow, cited as the most abundant and widespread minnow in the central plains region [36], was absent in collections of the Central Nebraska Basins study in 1993 and 1994.

One reason that some fish species are absent or in decline may be a scarcity of critical habitats. Critical habitats are those that are essential for certain species during breeding and early stages of growth. Flood plains may be a critical habitat for many aquatic species. The flood plain is the area adjacent to streams that is inundated on a recurrence interval of about every 2 years. The Platte River has a historical flood plain extending up to hundreds of feet from the bank; however, the current regulated flows infrequently overflow the bank onto the flood plains. A study by Williams [27] of the Platte River has shown that the streambed has been lowered by 1.6 ft near Brady as a result of flow regulation. The Study Unit team confirmed this finding by repeated surveys at the Brady site that showed bankfull flows and the top of a large sandbar that were 1.6 ft below the former flood plain (see figure). A new flood plain has become established in the incised channel that is only a few feet wide, leaving only a small fraction of the flood plain available for habitat on a frequent basis [25].

—Robert B. Swanson and Ronald B. Zelt



Bankfull-flow elevation at the North Channel of the Platte River at Brady is lower today than in 1940.

Comparison of Central Nebraska Basins Study Unit Surface-Water Results with Nationwide NAWQA Findings

Central Nebraska Basins Study Unit

White areas indicate other NAWQA Study Units sampled during 1992–95.

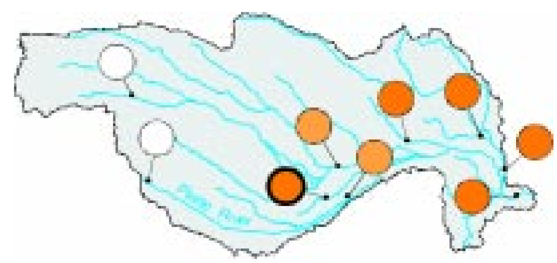
Seven major water-quality characteristics were evaluated for stream sites in each NAWQA Study Unit. Summary scores for each characteristic were computed for all sites with adequate data. Scores for each site in the Central Nebraska Basins were compared to scores for all sites sampled in the 20 NAWQA Study Units during 1992–95. This comparison provides a ranking of each site relative to national conditions for each characteristic. Results are summarized by national percentiles; higher percentile values generally indicate poorer quality compared with other NAWQA sites. Water-quality conditions at each site also are compared to established criteria for protection of aquatic life. Applicable criteria are limited to nutrients and pesticides in water, and to organochlorine pesticides, PCBs, and semivolatile organic compounds in sediment. Methods used to compute rankings and evaluate aquatic-life criteria are described by Gilliom and others [37].

EXPLANATION

Ranking relative to national conditions— Darker colored circles generally indicate poorer quality. **Bold** outline indicates one or more aquatic-life criteria were exceeded.

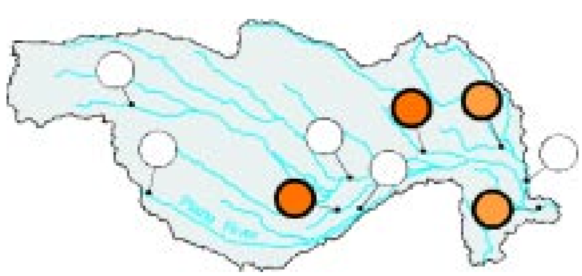
- **Greater than the 75th percentile (Among the highest 25 percent nationally)**
- **Between the median and the 75th percentile**
- **Between the 25th percentile and the median**
- **Less than the 25th percentile (Among the lowest 25 percent nationally)**
- **Insufficient data for analysis**

NUTRIENTS in surface water

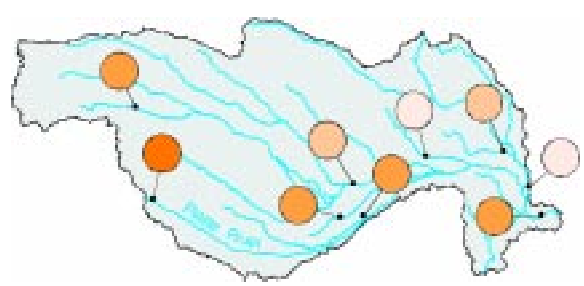


Five of seven sites in the Central Nebraska Basin Study Unit scored higher than the 75th percentile for nutrients, when compared to the other NAWQA sites. Three of the seven—Prairie Creek near Ovina, Shell Creek near Columbus, and Maple Creek near Nickerson—ranked above the 90th percentile when compared nationally. Water samples collected from drainage basins dominated by the production of corn, soybeans, and sorghum had nutrient concentrations among the largest in the Nation. At Prairie Creek, monthly median ammonia concentrations exceeded the USEPA's criterion for protection of aquatic life more than 30 percent of the time. Prairie Creek's basin, like other tributary basins in the Platte Valley, is largely dedicated to the production of corn, but livestock and dairy production near the streams may contribute to elevated nutrient concentrations. Drainage basins with a large percentage of rangeland, such as the Dismal and Loup Rivers drainage basins, had nutrient concentrations in streams more typical of sites in other NAWQA Study Units.

PESTICIDES in surface water



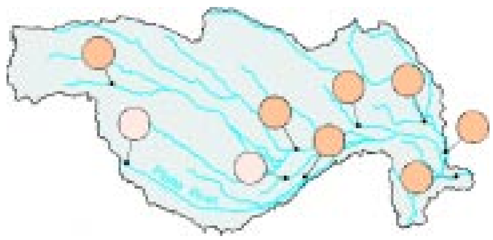
SEMIVOLATILE ORGANIC COMPOUNDS in streambed sediment



Semivolatile organic compounds were present at concentrations comparable to national medians. The most commonly detected compound was *p-cresol*.

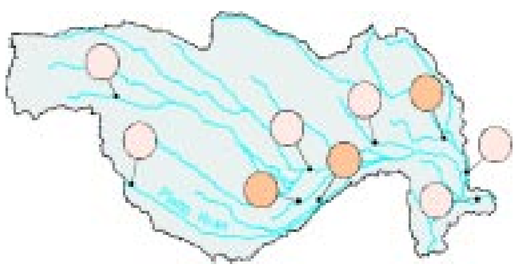
Pesticide concentrations in the Central Nebraska Basins Study Unit were among the highest in the Nation. At all of the four sites—Prairie Creek near Ovina, Shell Creek near Columbus, Maple Creek near Nickerson, and the Platte River at Louisville—included in the national comparison, pesticide scores exceeded the median scores for sites in the 20 NAWQA Study Units and also exceeded the aquatic-life criteria for atrazine. At both Prairie Creek and Shell Creek, monthly median pesticide concentrations exceeded the aquatic-life criteria 25 percent of the time and median pesticide concentrations were about 10 times greater than the median for other NAWQA Study Unit sites. Prairie Creek had the second highest monthly median atrazine concentration of sites nationally. Sites in the eastern part of the Study Unit—Shell Creek, Maple Creek, and the Platte River at Louisville—were more likely to exceed the aquatic-life criteria for cyanazine. Maple Creek had the highest monthly median cyanazine concentration (24.1 µg/L in June 1993) of any site in the NAWQA Program.

PCBs and ORGANOCHLORINES in streambed sediment and fish tissue



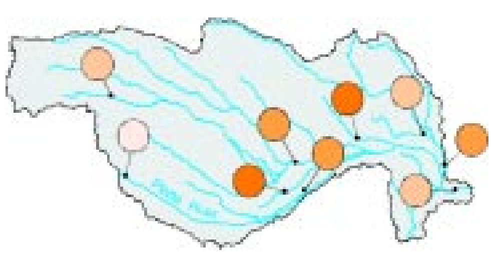
Concentrations of PCBs and organochlorine insecticides such as DDT and chlordane in the Central Nebraska Basins Study Unit were comparable to median concentrations nationally. Because PCBs and organochlorine insecticides have an affinity for fatty tissue, they tend to concentrate in fish rather than in water or sediments. Sampling efforts at Prairie and Shell Creeks did not yield sufficient tissue for analysis; therefore, results from those two sites include only sediment data and may not be comparable to other NAWQA Study Unit sites. One fish sample from the Platte River at Louisville that was collected following widespread flooding in the Midwest had DDT concentrations that exceeded the criterion for the protection of fish-eating wildlife.

TRACE ELEMENTS in streambed sediment



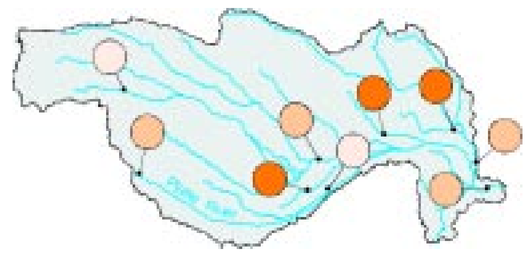
Trace elements in streambed sediments ranked similarly to those from other NAWQA Study Units, although upstream sites on the Platte River had larger-than-average concentrations of selenium. Platte River sediments at Grand Island contained selenium concentrations three times greater than the median for the 20 NAWQA Study Units.

FISH COMMUNITY DEGRADATION



Fish community degradation in central Nebraska as indicated by large percentages of pollution-tolerant species was correlated with the amount of cropland in a basin. Prairie and Shell Creeks, both basins dominated by corn production, had fish communities that were among the top 25 percent of the most degraded of the 20 NAWQA Study Unit stream sites across the nation. In contrast, the Platte River at Brady drainage basin has little cropland and supports a relatively diverse fish community. However, even the Platte River at Brady displayed signs of historical trends towards a degraded fish community. The large-river sites at the Loup River at Palmer, the Elkhorn River at Waterloo, and the Platte River at Grand Island all ranked in the lower half of the NAWQA sites in the nation.

STREAM HABITAT DEGRADATION



Eroding banks with little vegetative cover contribute not only to degraded quality habitats for fish but also yield sediments and associated contaminants to the stream. When evaluated using these criteria, habitat condition was best in rangelands and along the main stem of the Platte River. Both the Dismal River near Thedford and the Platte River near Grand Island were among the 25 percent of the NAWQA sites with the best habitat scores. Prairie, Shell, and Maple Creeks, which drain croplands, had stream-habitat quality among the lowest 25 percent of the NAWQA sites nationally.

CONCLUSIONS

In the Central Nebraska Basins Study Unit, compared to other NAWQA Study Units:

Physical, chemical, and biological measures indicate that streams and rivers in the row-crop-dominated areas of central Nebraska are generally of degraded water quality than the other 19 NAWQA Study Units of the Nation assessed during 1992–95 for the NAWQA Program. Elevated herbicide and nutrient concentrations contribute to the degraded water-quality conditions. These elevated contaminant concentrations could be of concern to communities that withdraw drinking water from shallow wells adjacent to the Platte River.

Streams in basins with greater proportions of rangeland, such as the Dismal River, have negligible herbicide concentrations. Streams with degraded water chemistry commonly have degraded physical habitats as well. The combination of degraded physical and chemical environments often results in fish communities with fewer total species and a higher percentage of tolerant species.

Comparison of Central Nebraska Basins Study Unit Ground-Water Results with Nationwide NAWQA Findings

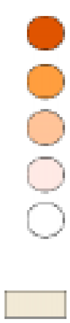
Central Nebraska Basins Study Unit

White areas indicate other NAWQA Study Units sampled during 1992–95.

Five major water-quality characteristics were evaluated for ground water 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. The Central Nebraska Basins Study Unit team conducted one limited survey of 11 wells completed in the Platte River alluvial aquifer, a shallow aquifer underlying an agricultural area. Summary scores were computed for each characteristic for the Platte River alluvial aquifer and compared with scores for all aquifers and shallow ground-water areas sampled in the 20 NAWQA Study Units during 1992–95. This comparison provides a ranking of aquifers and shallow ground-water areas relative to national water-quality conditions. Results are summarized by national percentiles; higher percentile values generally indicate poorer quality compared with other NAWQA ground-water studies. Water-quality conditions in the alluvial aquifer also are compared to established standards and criteria for protection of drinking water. Methods used to compute rankings and evaluate standards and criteria are described by Gilliom and others [37].

EXPLANATION

Ranking relative to national conditions—Darker colored circles generally indicate poorer quality. **Bold** outline indicates one or more drinking-water standards or criteria were exceeded.



Greater than the 75th percentile (Among the highest 25 percent nationally)

Between the median and the 75th percentile

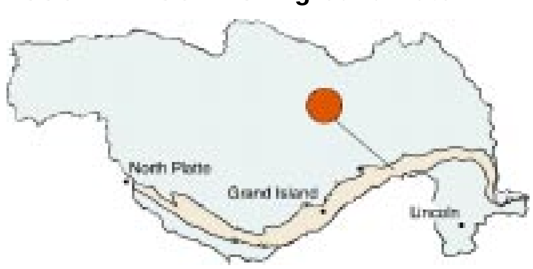
Between the 25th percentile and the median

Less than the 25th percentile (Among the lowest 25 percent nationally)

Insufficient data for analysis

Platte River alluvial aquifer

DISSOLVED SOLIDS in ground water

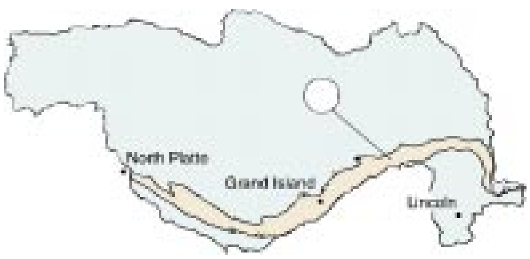


The median dissolve- solids concentration in the Platte River alluvial aquifer was in the highest 25 percent of all sites when compared to the other Study Units.

NUTRIENTS in ground water

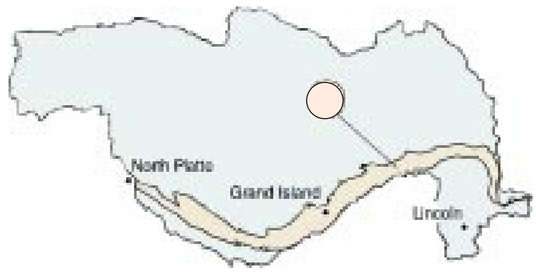
The median nitrate concentration in the Platte River alluvial aquifer was among the highest when compared with the other NAWQA Study Units. Fertilizer is the principal source of the nutrients. Nitrate in ground water is a concern in some parts of the Study Unit, especially in areas having a shallow water table, sandy soils, and intense row-crop production. Nitrate concentrations commonly exceed USEPA's MCL of 10 mg/L for drinking water in these areas.

RADON in ground water



Not enough samples for analysis.

VOLATILE ORGANIC COMPOUNDS in ground water



The median volatile organic compound (VOC) concentration in the ground water of the Platte River alluvial aquifer was among the lowest when compared with the other Study Units; however, the findings are represented by a limited number of samples. The VOC concentrations in water in the alluvial aquifer were all below the detection limit. Urban and industrial land use is minor compared to agricultural land use, limiting both the sources and quantities of potential VOCs that could enter the ground water.

PESTICIDES in ground water

The Platte River alluvial aquifer scored among the highest 25 percent nationally for percent detections of pesticides. Pesticides were detected in 100 percent of the ground-water samples; however, no concentrations exceeded the USEPA's MCLs or HALs for drinking water. Pesticides are used extensively for weed control in row-crop production, and some of the compounds percolate to the ground water. This occurs primarily in areas with permeable sandy soils and shallow ground water.

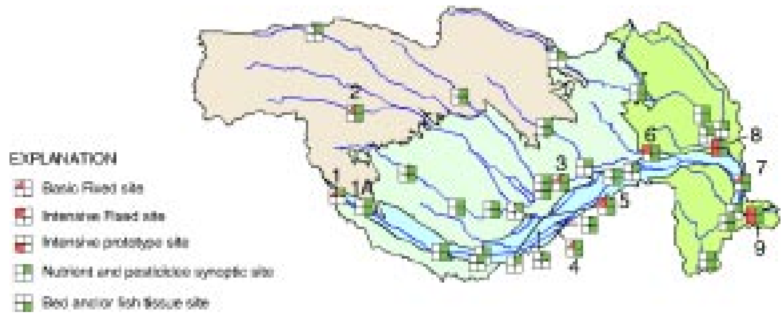
CONCLUSIONS

In the Platte River alluvial aquifer, compared to other NAWQA Study Units:

Nitrate concentrations in ground water exceeded the USEPA's MCL in areas with shallow water tables, sandy soils, and extensive row-crop production. Although pesticides were detected frequently in ground water, the concentrations measured were well below the USEPA's MCLs or HALs.

Stream Chemistry and Ecology

The stream-water quality of the Central Nebraska Basins Study Unit was assessed using chemical, physical, and biological evidence. The network of nine basic, intensive, and intensive prototype fixed sites provided water-chemistry data over a wide range of hydrologic conditions and ecological data for assessing stream-water quality. Synoptic sampling provided additional water chemistry, bed-sediment chemistry, tissue chemistry, and ecological data for increased spatial resolution of specific constituents and ecological investigations



List of Basic Fixed and ecological sites

Site number	Site name	Site number	Site name
1	Tri-County Canal 1.25 mi below diversion	5	Prairie Creek near Ovina
1A	North Channel of Platte River at Brady	6	Shell Creek near Columbus
2	Dismal River near Thedford	7	Elkhorn River at Waterloo
3	Loup River at Palmer	8	Maple Creek near Nickerson
4	Platte River near Grand Island	9	Platte River at Louisville

Ground-Water Chemistry

The ground-water quality of the Platte River alluvial aquifer was assessed on the basis of a small survey of public-supply and monitoring wells. Eleven wells provided water-chemistry data to describe the occurrence and distribution of chemical constituents in the Platte River alluvial aquifer. Samples also were collected along ground-water flow paths at a site near Gibbon, Nebraska, and at a site near Grand Island, Nebraska.

Wetland Chemistry and Ecology

The wetland water quality of the Central Nebraska Study Unit was assessed using chemical, physical, and biological evidence. A network of 31 permanent wetland sites provided water chemistry, bedsediment chemistry, and ecological data for determining the relation between land use and wetland water quality.

Summary of data collection in the Central Nebraska River Basins Study Unit, 1992–95

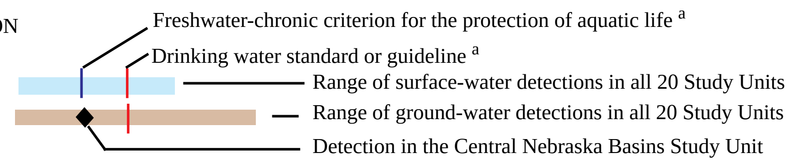
Study component	What data were collected and why	Types of sites sampled	Number of sites	Sampling frequency and period
Stream Chemistry				
Basic Fixed Sites—general water quality	Major ions, organic carbon, suspended sediment, organonitrogen herbicides, nutrients, and physical parameters to describe spatial and temporal variability.	Stream sites representing cropland, rangeland, and a mixture of land uses from across the area.	9	Monthly plus flow-based sampling (1993–94)
Intensive Fixed Sites—pesticides	Same as Basic Fixed Sites plus a suite of 82 pesticides to characterize their seasonal distribution.	Subset of Basic Fixed Sites had intensive agriculture and a site at the basin outflow.	4	Monthly plus flow-based sampling (1993–94)
Intensive Prototype Fixed Sites	Major ions, suspended sediment, nutrients, 46 pesticides, and physical parameters to determine adequate sampling frequency of agriculture-related compounds that enter streams in runoff.	A subset of the Intensive Fixed Sites.	2	Six weeks of alternate-day sampling plus one storm in spring; four weekly samples in early summer; and 6 weeks of alternate-day sampling plus one storm in summer (May to August 1992).
High flow synoptic studies	Organonitrogen herbicides, nutrients, suspended sediment, and streamflow to describe the transport of agriculture-related compounds during runoff.	Streams were sampled to include most Basic Sites from a variety of land uses.	10	Sampled up to seven times during the rise and fall of runoff (1992–93)
Base flow synoptic studies	Organonitrogen herbicides, nutrients, and streamflow to determine their concentrations at base-flow conditions.	Streams sites were selected to provide wide spatial distribution.	28	Two times during the growing season (1994)
Stream Ecology				
Contaminants in bed sediments and fish tissues	Streambed sediments for trace elements, polycyclic aromatic hydrocarbons, and organic compounds; and whole-fish composites for organic compounds and fish liver composites for trace elements to determine the presence and distribution of contaminants.	Basic Fixed Sites were supplemented by stream sites in spatially under-represented areas.	16 (1992) 8 (1993) 5 (1994)	Once per year during late summer
Intensive ecological assessments	Fish, macroinvertebrates, and algae were sampled to assess biological communities and to relate community attributes to water quality. Stream habitat also was described.	Basic Fixed Sites described in the stream chemistry section were sampled.	9	All sites once per year (1993–94), three sites again in 1995
Ground-Water Chemistry				
Aquifer survey	Major ions, nutrients, pesticides, trace elements, volatile organic compounds, organic carbon, and radionuclides to describe water quality of a heavily used alluvial aquifer.	Shallow wells in the Platte River alluvial aquifer were sampled.	11	Once in 1995
Variation along flow paths	Major ions, nutrients, pesticides, and age-dating constituents in water samples to describe land-use effects on surficial aquifers along ground-water flow paths from areas of recharge beneath the land use to discharge to a stream.	Wells were sampled at two flow paths in the Platte Valley: one in a wet meadow, near corn production, and the other in a public-supply wellfield in an agricultural area.	61 wells installed in clusters at two sites	Wet meadow flow path sampled quarterly in 1994 and twice in 1995; public-supply flow path sampled three times (1994–95)
Special Studies				
Ecological synoptic study	Stream macroinvertebrate and algal samples were collected and stream habitat features were measured in conjunction with similar activities in the South Platte River NAWQA Study Unit to describe variability of streams in the plains environment.	Stream sites representing a range of conditions in the Great Plains were sampled.	12 (Central Nebraska Basins)	Once (August 1993)
Wetlands synoptic—water and bed-sediment chemistry	Water-column samples were collected and analyzed for major ions, nutrients, organonitrogen herbicides, and chlorophyll-*a*. Sediment samples were collected and analyzed for nutrients and herbicides to provide baseline information on wetland sediment chemistry. At selected sites, water, sediment, and invertebrate tissues were analyzed for trace elements.	Wetlands characteristic of agricultural landscapes were sampled in late spring following herbicide application and in late summer.	31	May and August 1994
Wetlands synoptic—aquatic communities	Sample and identify macroinvertebrates, aquatic plants, and algae to provide baseline information on aquatic communities in wetlands.	The same wetlands sampled for chemical analysis were sampled for biological attributes.	31	May and August 1994

The following tables summarize data collected for NAWQA studies from 1992–95 by showing results for the Central Nebraska Basins Study Unit compared to 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 waters of the Central Nebraska Basins 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]	Concentration, in µg/L (0.001, 0.01, 0.1, 1, 10, 100, 1,000)
Acetochlor	-- 5%	
Alachlor (Lasso)	78% 5%	
2,6-Diethylaniline (Alachlor metabolite)	3% 0%	
Atrazine (AAtrex, Gesaprim)	100% 81%	
Deethylatrazine[c] (Atrazine metabolite)	78% 76%	
Bentazon (Basagran, bentazone)	2% --	
Bromoxynil (Buctril, Brominal, Torch)	4% --	
Butylate (Sutan, Genate Plus, butilate)	1% 0%	
Cyanazine (Bladex, Fortrol)	91% 5%	
2,4-D (2,4-PA)	8% --	
DCPA (Dacthal, chlorthal-dimethyl)	<1% 0%	
Dinoseb (DNBP, Dinitro, dinosebe)	2% --	
EPTC (Eptam)	6% 0%	
Ethalfluralin (Sonalan,Sonalen)	<1% 0%	
Metolachlor (Dual, Pennant)	93% 5%	
Metribuzin (Lexone, Sencor)	25% 0%	

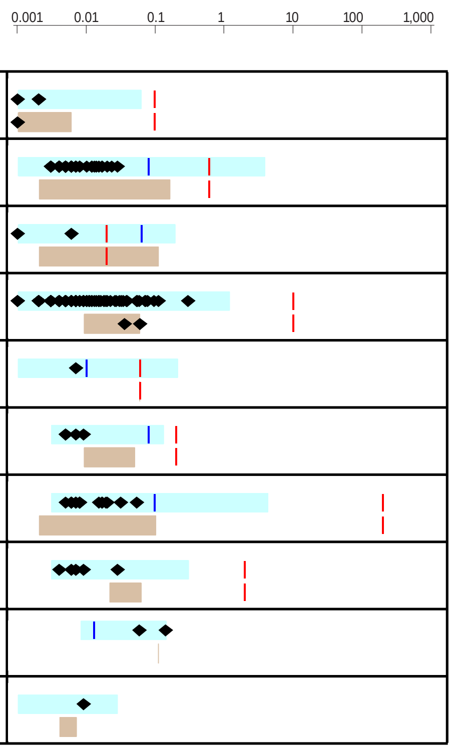
Herbicide (Trade or common name)	Rate of detection [b]	Concentration, in µg/L (0.001, 0.01, 0.1, 1, 10, 100, 1,000)
Napropamide (Devrinol)	1% 0%	
Pebulate (Tillam)	<1% 0%	
Pendimethalin (Prowl, Stomp)	37% 0%	
Prometon (Gesagram, Pramitol)	69% 29%	
Propachlor (Ramrod, propachlore)	32% 0%	
Propanil (Stampede, Surcopur)	<1% 0%	
Simazine (Aquazine, Princep, Weedex)	64% 14%	
Tebuthiuron (Spike, Perflan)	12% 14%	
Terbacil[c] (Sinbar)	3% 0%	
Trifluralin (Treflan, Trinin, Elancolan)	20% 0%	

Insecticide (Trade or common name)	Rate of detection [b]	Concentration, in µg/L (0.001, 0.01, 0.1, 1, 10, 100, 1,000)
Azinphos-methyl[c] (Guthion, Gusathion)	<1% 0%	
Carbaryl[c] (Sevin, Savit)	7% 0%	
Carbofuran[c] (Furadan)	22% 0%	
Chlorpyrifos (Dursban, Lorsban)	24% 0%	

Concentrations of herbicides, insecticides, volatile organic compounds, and nutrients detected in ground and surface waters of the Central Nebraska Basins Study Unit—Continued

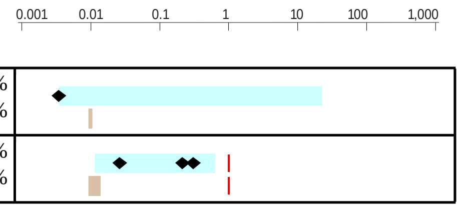
Insecticide (Trade or common name)	Rate of detection [b]
p,p'-DDE (*p,p'*-DDT metabolite)	<1% <1%
Diazinon	7% 0%
Dieldrin (Panoram D-31, Octalox)	<1% 0%
Fonofos (Dyfonate)	22% 10%
alpha-HCH (*alpha*-BHC, *alpha*-lindane)	<1% 0%
gamma-HCH	<1% 0%
Malathion (maldison, malathon, Cythion)	4% 0%
Methyl parathion	1% 0%
Parathion (Thiophos, Bladan, Folidol)	1% 0%
cis-Permethrin[c] (Ambush, Pounce)	<1% 0%

Concentration, in µg/L



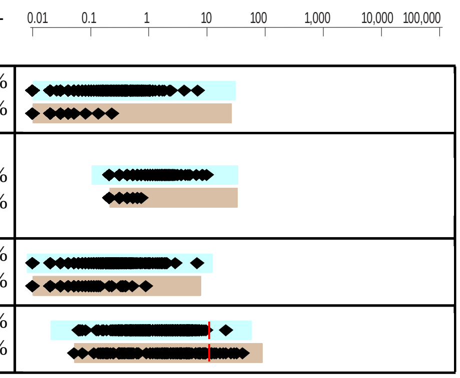
Insecticide (Trade or common name)	Rate of detection [b]
Propargite (Comite, Omite, BPPS)	<1% 0%
Terbufos (Counter)	2% 0%

Concentration, in µg/L



Nutrient	Rate of detection [b]
Dissolved ammonia	96% 49%
Dissolved ammonia plus organic nitrogen as nitrogen	95% 43%
Dissolved phosphorus as phosphorus	98% 95%
Dissolved nitrite plus nitrate	86% 93%

Concentration, in mg/L



Herbicides, insecticides, volatile organic compounds, and nutrients not detected in ground and surface waters of the Central Nebraska Basins Study Unit

Herbicides

2,4,5-T

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

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

Acifluorfen (Blazer, Tackle 2S)

Benfluralin (Balan, Benefin, Bonalan, Benefex)

Bromacil (Hyvar X, Urox B, Bromax)

Chloramben (Amiben, Amilon-WP, Vegiben)

Clopyralid (Stinger, Lontrel, Reclaim, Transline)

Dacthal mono-acid (Dacthal metabolite)

Dicamba (Banvel, Dianat, Scotts Proturf)

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

Diuron (Crisuron, Karmex, Direx, Diurex)

Fenuron (Fenulon, Fenidim)

Fluometuron (Flo-Met, Cotoran, Meturon)

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

MCPA (Rhomene, Rhonox, Chiptox)

MCPB (Thistrol)

Molinate (Ordram)

Neburon (Neburea, Neburyl, Noruben)

Norflurazon (Evital, Predict, Solicam, Zorial)

Oryzalin (Surflan, Dirimal)

Picloram (Grazon, Tordon)

Pronamide (Kerb, Propyzamid)

Propham (Tuberite)

Thiobencarb (Bolero, Saturn, Benthiocarb, Abolish)

Triallate (Far-Go, Avadex BW, Tri-allate)

Triclopyr (Garlon, Grandstand, Redeem, Remedy)

Insecticides

3-Hydroxycarbofuran (Carbofuran metabolite)

Aldicarb sulfone (Standak, aldoxycarb, aldicarb metabolite)

Aldicarb sulfoxide (Aldicarb metabolite)

Aldicarb (Temik, Ambush, Pounce)

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

Ethoprop (Mocap, Ethoprophos)

Methiocarb (Slug-Geta, Grandslam, Mesurol)

Methomyl (Lanox, Lannate, Acinate)

Oxamyl (Vydate L, Pratt)

Phorate (Thimet, Granutox, Geomet, Rampart)

Propoxur (Baygon, Blattanex, Unden, Proprotox)

Volatile organic compounds

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

1,1,1-Trichloroethane (Methylchloroform)

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-Dichloroethane (Ethylidene dichloride)

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-Trimethylbenzene (Pseudocumene)

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

1,2-Dibromoethane (EDB, Ethylene dibromide)

1,2-Dichloroethane (Ethylene dichloride)

1,2-Dichloropropane (Propylene dichloride)

1,3,5-Trimethylbenzene (Mesitylene)

1,3-Dichloropropane (Trimethylene dichloride)

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

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

2,2-Dichloropropane

Benzene

Bromobenzene (Phenyl bromide)

Bromochloromethane (Methylene chlorobromide)

Bromomethane (Methyl bromide)

Chlorobenzene (Monochlorobenzene)

Chloroethane (Ethyl chloride)

Chloroethene (Vinyl chloride)

Chloromethane (Methyl chloride)

Dibromomethane (Methylene dibromide)

Dichlorodifluoromethane (CFC 12, Freon 12)

Dichloromethane (Methylene chloride)

Dimethylbenzenes (Xylenes (total))

Ethenylbenzene (Styrene)

Ethylbenzene (Phenylethane)

Isopropylbenzene (Cumene)

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

Methylbenzene (Toluene)

Tetrachloroethene (Perchloroethene)

Tetrachloromethane (Carbon tetrachloride)

Total Trihalomethanes (Trichloromethane (Chloroform), Dibromochloromethane, Bromodichloromethane, Tribromomethane (Bromoform))

Trichloroethene (TCE)

Trichlorofluoromethane (CFC 11, Freon 11)

cis-1,2-Dichloroethene ((Z)-1,2-Dichloroethene)

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)

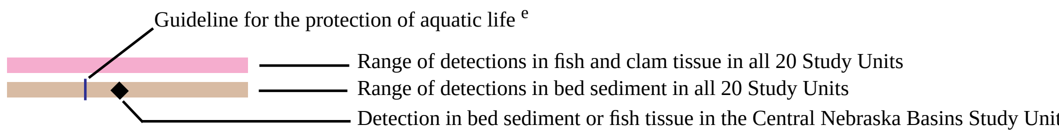
Nutrients

No non-detects

Concentrations of semivolatile organic compounds, organochlorine compounds, and trace elements detected in fish tissue and bed sediment of the Central Nebraska Basins Study Unit

[µg/g, micrograms per gram; µg/kg, micrograms per kilogram; %, percent; <, less than; - -, not measured; trade names may vary]

EXPLANATION

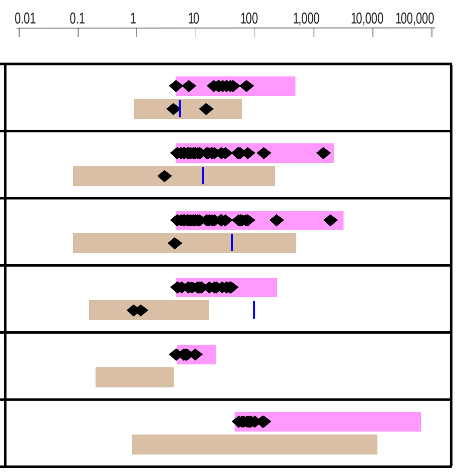


Semivolatile organic compound	Rate of detection [b]	Concentration, in µg/kg (0.1 – 100,000)
1-Methylphenanthrene	-- 7%	
1-Methylpyrene	-- 7%	
2,6-Dimethylnaphthalene	-- 93%	
2-Methylanthracene	-- 10%	
3,5-Dimethylphenol	-- 7%	
4,5-Methylenephenanthrene	-- 10%	
9H-Carbazole	-- 3%	
9H-Fluorene	-- 7%	
Acenaphthene	-- 3%	
Acenaphthylene	-- 13%	
Anthracene	-- 17%	
Anthraquinone	-- 14%	
Benz[*a*]anthracene	-- 27%	
Benzo[*a*]pyrene	-- 20%	
Benzo[*b*]fluoranthene	-- 37%	
Benzo[*ghi*]perylene	-- 7%	
Benzo[*k*]fluoranthene	-- 37%	

Semivolatile organic compound	Rate of detection [b]	Concentration, in µg/kg (0.1 – 100,000)
Butylbenzylphthalate	-- 40%	
Chrysene	-- 33%	
Di- *n* -butylphthalate	-- 93%	
Di- *n* -octylphthalate	-- 13%	
Dibenzothiophene	-- 3%	
Diethylphthalate	-- 30%	
Dimethylphthalate	-- 7%	
Fluoranthene	-- 69%	
Indeno[1,2,3- *cd*]pyrene	-- 10%	
Isoquinoline	-- 13%	
Naphthalene	-- 3%	
Phenanthrene	-- 27%	
Phenol	-- 87%	
Pyrene	-- 55%	
Quinoline	-- 7%	
bis(2-Ethylhexyl)phthalate	-- 93%	
p-Cresol	-- 67%	

Concentrations of semivolatile organic compounds, organochlorine compounds, and trace elements detected in fish tissue and bed sediment of the Central Nebraska Basins Study Unit—Continued

Organochlorine compound (Trade name)	Rate of detection [b]	Concentration, in µg/kg
total-Chlordane	34% 7%	
p,p'-DDE	89% 3%	
total-DDT	89% 3%	
Dieldrin	54% 7%	
Heptachlor epoxide	20% 0%	
PCB, total	29% 0%	



Trace element	Rate of detection [b]	Concentration, in µg/g
Arsenic	90% 100%	
Cadmium	100% 100%	
Chromium	57% 100%	
Copper	100% 100%	
Lead	55% 100%	
Mercury	71% 34%	
Nickel	48% 100%	
Selenium	100% 100%	
Zinc	100% 100%	

Semivolatile organic compounds, organochlorine compounds, and trace elements not detected in fish tissue and bed sediment of the Central Nebraska Basins Study Unit

Semivolatile organic compounds

1,2,4-Trichlorobenzene

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

1,2-Dimethylnaphthalene

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

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

1,6-Dimethylnaphthalene

1-Methyl-9H-fluorene

2,2-Biquinoline

2,3,6-Trimethylnaphthalene

2,4-Dinitrotoluene

2,6-Dinitrotoluene

2-Chloronaphthalene

2-Chlorophenol

2-Ethylnaphthalene

4-Bromophenyl-phenylether

4-Chloro-3-methylphenol

4-Chlorophenyl-phenylether

Acridine

Azobenzene

Benzo [*c*] cinnoline

C8-Alkylphenol

Dibenz [*a*,*h*] anthracene

Isophorone

N-Nitrosodi-*n*-propylamine

N-Nitrosodiphenylamine

Nitrobenzene

Pentachloronitrobenzene

Phenanthridine

bis (2-Chloroethoxy)methane

Organochlorine compounds

Aldrin (HHDN, Octalene)

Chloroneb (chloronebe, Demosan, Soil Fungicide 1823)

DCPA (Dacthal, chlorthal-dimethyl)

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

Endrin (Endrine)

Heptachlor (Heptachlore, Velsicol 104)

Hexachlorobenzene (HCB)

Isodrin (Isodrine, Compound 711)

Mirex (Dechlorane)

Pentachloroanisole (PCA, pentachlorophenol metabolite)

Total Trihalomethanes (Trichloromethane (Chloroform), Dibromochloromethane, Bromodichloromethane, Tribromomethane (Bromoform))

Toxaphene (Camphechlor, Hercules 3956)

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)

delta-HCH (*delta*-BHC, *delta*-hexachlorocyclohexane, *delta*-benzene hexachloride)

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

[a] Selected water-quality standards and guidelines [37].

[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 one 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 [37].

[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 [38].

[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 [37].

[e] Selected sediment-quality guidelines [37].

Summary of Compound Detections and Concentrations tables were designed and built by Sarah Ryker, Jonathon Scott, and Alan Haggland, U.S. Geological Survey.

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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.

Ammonia - A compound of nitrogen and hydrogen (NH_3) that is a common by-product of animal waste. Ammonia readily converts to nitrate in soils and streams.

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

Background concentration - A concentration of a substance in a particular environment that is indicative of minimal influence by human (anthropogenic) sources.

Bank - The sloping ground that borders a stream and confines the water in the natural channel when the water level, or flow is normal.

Basic Fixed Sites - Sites on streams at which streamflow is measured and samples are collected for temperature, salinity, suspended sediment, major ions and metals, nutrients, and organic carbon to assess the broad-scale spatial and temporal character and transport of inorganic constituents of streamwater in relation to hydrologic conditions and environmental settings.

Basin -*See* Drainage basin.

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

Bed sediment and tissue studies - Assessment of concentrations and distributions of trace elements and hydrophobic organic contaminants in streambed sediment and tissues of aquatic organisms to identify potential sources and to assess spatial distribution.

Benthic - Refers to plants or animals that live on the bottom of lakes, streams, or oceans.

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.

Best Management Practice (BMP) - An agricultural practice that has been determined to be an effective, practical means of preventing or reducing nonpoint-source pollution.

Biota - Living organisms.

Community - In ecology, the species that interact in a common area.

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

Confined aquifer (artesian aquifer) - An aquifer that is completely filled with water under pressure and that is overlain by material that restricts the movement of water.

Confluence - The flowing together of two or more streams; the place where a tributary joins the main stream.

Constituent - A chemical or biological substance in water, sediment, or biota that can be measured by an analytical method.

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.

Degradation products - Compounds resulting from transformation of an organic substance through chemical, photochemical, and/or biochemical reactions.

Detection limit - The concentration below which a particular analytical method cannot determine, with a high degree of certainty, a concentration.

DDT - Dichloro-diphenyl-trichloroethane. An organochlorine insecticide no longer registered for use in the United States.

Dieldrin - An organochlorine insecticide no longer registered for use in the United States. Also a degradation product of the insecticide aldrin.

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

Dissolved constituent - Operationally defined as a constituent that passes through a 0.45-micrometer filter.

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

Diversion - A turning aside or alteration of the natural course of a flow of water, normally considered physically to leave the natural channel. In some States, this can be a consumptive use direct from another stream, such as by livestock watering. In other States, a diversion must consist of such actions as taking water through a canal, pipe, or conduit.

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.

Environmental setting - Land area characterized by a unique combination of natural and human-related factors, such as row-crop cultivation or glacial-till soils.

Fecal bacteria - Microscopic single-celled organisms (primarily fecal coliforms and fecal streptococci) found in the wastes of warm-blooded animals. Their presence in water is used to assess the sanitary quality of water for body-contact recreation or for consumption. Their presence indicates contamination by the wastes of warm-blooded animals and the possible presence of pathogenic (disease-producing) organisms.

Fertilizer - Any of a large number of natural or synthetic materials, including manure and nitrogen, phosphorus, and potassium compounds, spread on or worked into soil to increase its fertility.

Fish community - *See* Community.

Fixed Sites - NAWQA's most comprehensive monitoring sites. *See also* Basic Fixed Sites and Intensive Fixed Sites.

Flood - Any relatively high streamflow that overtops the natural or artificial banks of a stream.

Flood plain - The relatively level area of land bordering a stream channel and inundated during moderate to severe floods.

Flow path - An underground route for ground-water movement, extending from a recharge (intake) zone to a discharge (output) zone such as a shallow stream.

Fungicide - A substance or mixture of substances intended for the purpose of killing undesirable fungi.

Ground water - In general, any water that exists beneath the land surface, but more commonly applied to water in fully saturated soils and geologic formations.

Habitat - The part of the physical environment where plants and animals live.

Health advisory levels (HALs) - 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.

Index of Biotic Integrity (IBI) - An aggregated number, or index, based on several attributes or metrics of a fish community that provides an assessment of biological conditions.

Infiltration - Movement of water, typically downward, into soil or porous rock.

Insecticide - A substance or mixture of substances intended to destroy or repel insects.

Intensive Fixed Sites - Basic Fixed Sites with increased sampling frequency during selected seasonal periods and analysis of dissolved pesticides for 1 year. Most NAWQA Study Units have one to two integrator Intensive Fixed Sites and one to four indicator Intensive Fixed Sites.

Intolerant organisms - Organisms that are not adaptable to human alterations to the environment and thus decline in numbers where human alterations occur. *See also* Tolerant species.

Invertebrate - An animal having no backbone or spinal column. See also Benthic invertebrate.

Land-use study - A network of existing shallow wells in an area having a relatively uniform land use. These studies are a subset of the Study-Unit Survey and have the goal of relating the quality of shallow ground water to land use. *See also* Study-Unit Survey.

Loess - Homogeneous, fine-grained sediment made up primarily of silt and clay, and deposited over a wide area (probably by wind).

Macroinvertebrate - An animal that is large enough to be seen without magnification and has no backbone or spinal column. *See* Invertebrate.

Main stem - The principal course of a river or a stream.

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.

Maximum contaminant level (MCL) - Maximum permissible level of a contaminant in water that is delivered to any user of a public water system. MCLs are enforceable standards established by the U.S. Environmental Protection Agency.

Mean - The average of a set of observations, unless otherwise specified.

Median - The middle or central value in a distribution of data ranked in order of magnitude. The median is also known as the 50th percentile.

Method detection limit - The minimum concentration of a substance that can be accurately identified and measured with present laboratory technologies.

Micrograms per liter (µg/L) - A unit expressing the concentration of constituents in solution as weight (micrograms) of solute per unit volume (liter) of water; equivalent to one part per billion in most streamwater and ground water. One thousand micrograms per liter equals 1 mg/L.

Milligrams per liter (mg/L) - A unit expressing the concentration of chemical constituents in solution as weight (milligrams) of solute per unit volume (liter) of water; equivalent to one part per million in most stream water and ground water. One thousand micrograms per liter equals 1 mg/L.

Minimum reporting level (MRL) - The smallest measured concentration of a constituent that may be reliably reported using a given analytical method. In many cases, the MRL is used when documentation for the method detection limit is not available.

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 at the time (1972). The guidelines used in the summary reports are for freshwater.

Natural Resources Districts (NRDs) - Local districts created in 1969 by the Nebraska legislature and charged with properly conserving and developing the State of Nebraska's natural resources. The NRDs' boundaries were established primarily in accordance with Nebraska's natural river basin boundaries. The activities of the 23 NRDs include the management of surface-water and ground-water resources, the construction and operation of flood-control structures, and the administration of land-management plans to prevent soil erosion and sediment problems. The NRDs also have some responsibility for drainage and stream-channel improvement, forestry and range management, management of fish and wildlife habitat, recreational and park facility management, and solid waste disposal and sanitary drainage.

Nitrate - An ion consisting of nitrogen and oxygen (NO_3^-). Nitrate is a plant nutrient and is very mobile in soils.

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.

Nutrient - Element or compound essential for animal and plant growth. Common nutrients in fertilizer include nitrogen, phosphorus, and potassium.

Organonitrogen herbicides - A group of herbicides consisting of a nitrogen ring with associated functional groups and including such classes as triazines and acetanilides. Examples include atrazine, cyanazine, alachlor, and metolachlor.

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.

Organochlorine insecticide - A class of organic insecticides containing a high percentage of chlorine. Includes dichlorodiphenylethanes (such as DDT), chlorinated cyclodienes (such as chlordane), and chlorinated benzenes (such as lindane). Most organochlorine insecticides were banned because of their carcinogenicity, tendency to bioaccumulate, and toxicity to wildlife.

Organochlorine pesticide - *See* Organochlorine insecticide.

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

Picocurie (pCi) - One trillionth (10^{-12}) of the amount of radioactivity represented by a curie (Ci). A curie is the amount of radioactivity that yields 3.7×10^{10} radioactive disintegrations per second (dps). A picocurie yields 2.22 disintegrations per minute (dpm) or 0.037 dps.

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

Point-source contaminant - Any substance that degrades water quality and originates from discrete locations such as discharge pipes, drainage ditches, wells, concentrated livestock operations, 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.

Polycyclic aromatic hydrocarbon (PAH) - A class of organic compounds with a fused-ring aromatic structure. PAHs result from incomplete combustion of organic carbon (including wood), municipal solid waste, and fossil fuels, as well as from natural or anthropogenic introduction of uncombusted coal and oil. PAHs include benzo(a)pyrene, fluoranthene, and pyrene.

Precipitation - Any or all forms of water particles that fall from the atmosphere, such as rain, snow, hail, and sleet.

Public-supply withdrawals - Water withdrawn by public and private water suppliers for use within a general community. Water is used for a variety of purposes such as domestic, commercial, industrial, and public water use.

Recharge - Water that infiltrates the ground and reaches the saturated zone.

Runoff - Excess 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 compound (SVOC) - 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).

Species - Populations of organisms that may interbreed and produce fertile offspring having similar structure, habits, and functions.

Stage - The height of the water surface above an established datum plane, such as in a river above a predetermined point that may (or may not) be near the channel floor.

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.

Stream reach - A continuous part of a stream between two specified points.

Study Unit - A major hydrologic system of the United States in which NAWQA studies are focused. Study Units are geographically defined by a combination of ground- and surface-water features and generally encompass more than 4,000 square miles of land area.

Surface water - An open body of water, such as a lake, river, or stream.

Suspended (as used in tables of chemical analyses) - The amount (concentration) of undissolved material in a water-sediment mixture. It is associated with the material retained on a 0.45-micrometer filter.

Synoptic sites - Sites sampled during a short-term investigation of specific water-quality conditions during selected seasonal or hydrologic conditions to provide improved spatial resolution for critical water-quality conditions.

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

Total concentration - Refers to the concentration of a constituent regardless of its form (dissolved or bound) in a sample.

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.

Tracer - A stable, easily detected substance or a radioisotope added to a material to follow the location of the substance in the environment or to detect any physical or chemical changes it undergoes.

Unconfined aquifer - An aquifer whose upper surface is a water table; an aquifer containing unconfined ground water.

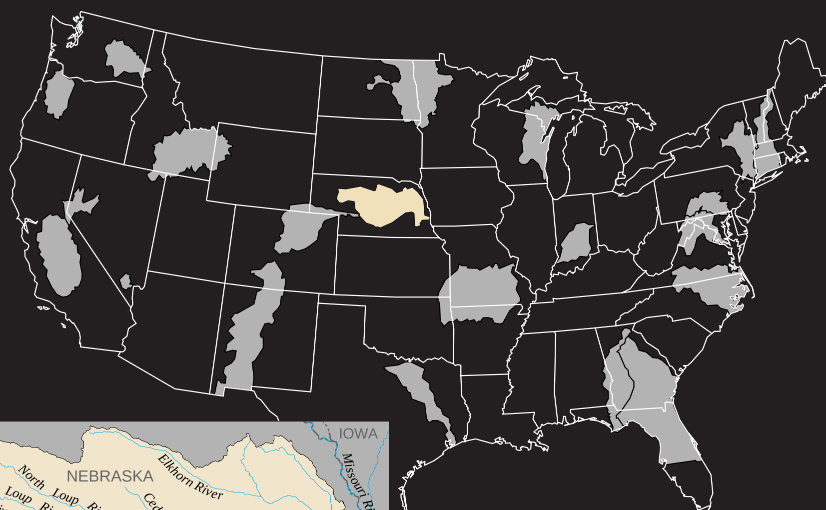
Volatile organic compounds (VOCs) - Organic chemicals that have a high vapor pressure relative to their water solubility. VOCs include components of gasoline, fuel oils, and lubricants, as well as organic solvents, fumigants, some inert ingredients in pesticides, and some by-products of chlorine disinfection.

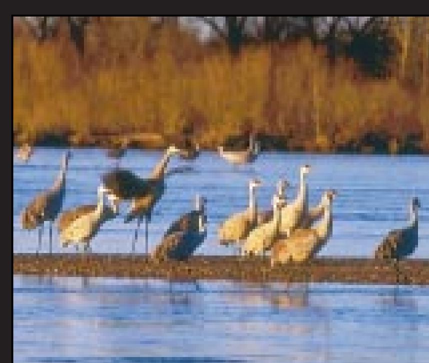
Watershed - *See* Drainage basin.

Wetlands - Ecosystems whose soil is saturated for long periods seasonally or continuously, including marshes, swamps, and ephemeral ponds.

NAWQA

National Water-Quality Assessment (NAWQA) Program
Central Nebraska Basins





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