

Science for a Sustainable Future of the Great Plains: Water-Quality Assessment in Central Nebraska



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

The U.S. Geological Survey (USGS) provides the science needed for a sustainable future of the Great Plains through its National Water-Quality Assessment (NAWQA) Program. The objectives of the Program are:

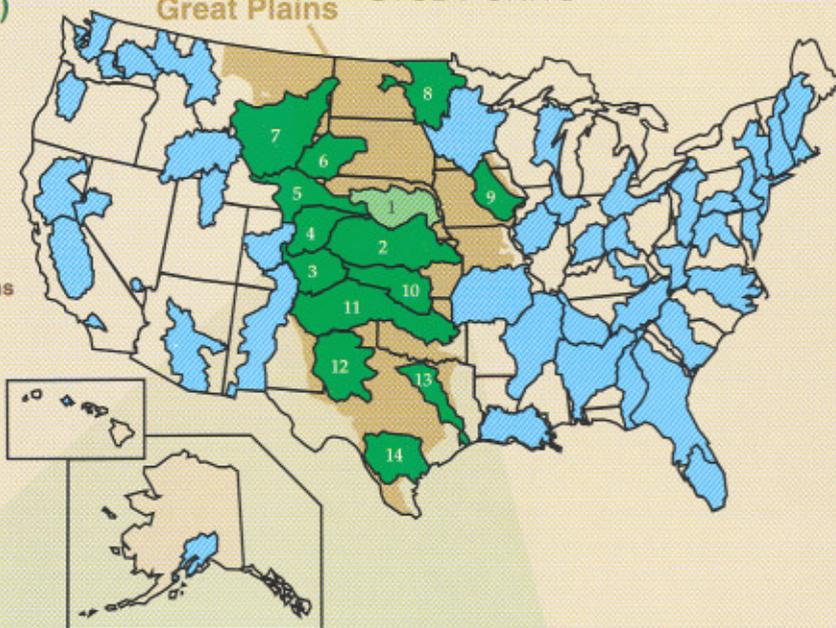
1. Describe current water-quality conditions
2. Define long-term trends in water quality
3. Identify and explain the major natural and human factors that affect water-quality conditions and trends

The water-quality assessment of the Central Nebraska Basins is similar to assessments in other study units in the Great Plains.

NAWQA Study Units in the Great Plains

1. Central Nebraska Basins
2. Kansas River Basin
3. Upper Arkansas River Basin
4. South Platte River Basin
5. North Platte River Basin
6. Cheyenne and Belle Fourche Basins
7. Yellowstone Basin
8. Red River of the North
9. Eastern Iowa Basins
10. Middle Arkansas River
11. Canadian-Cimarron River Basins
12. Southern High Plains
13. Trinity River Basin
14. South Central Texas

LOCATION OF NAWQA STUDY UNITS



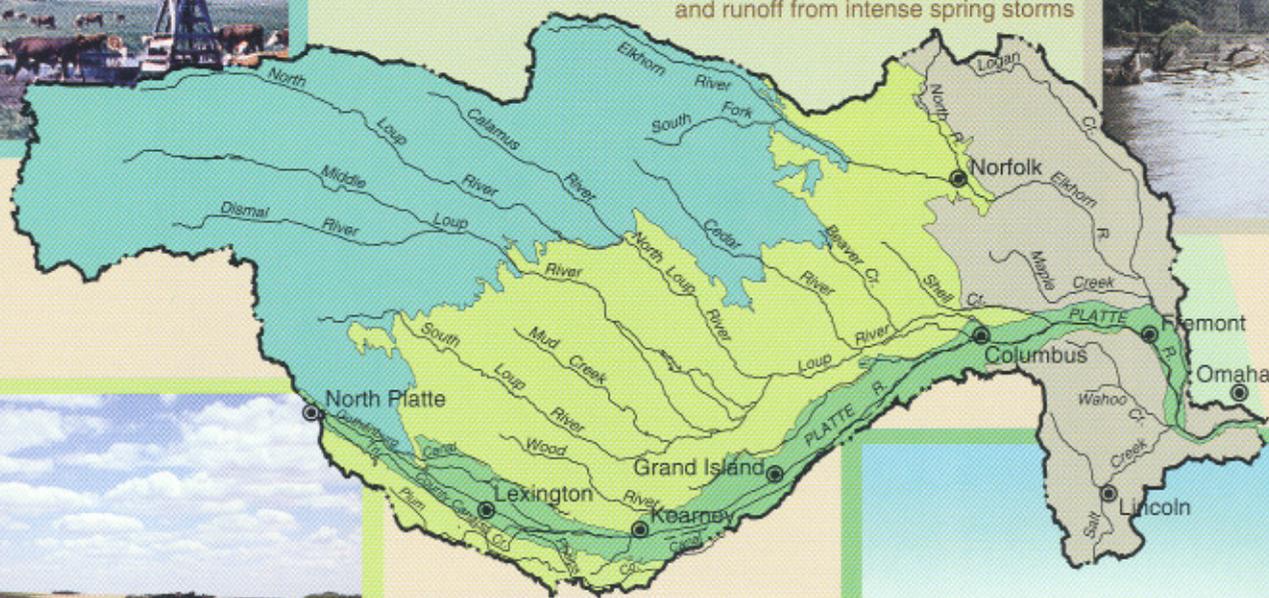
The Central Nebraska Basins Study Unit is...

Sandhills

Steep sloping range land with very permeable soils

Glaciated Area

Rolling landscape of mixed row-crop and pasture with less permeable soils and runoff from intense spring storms

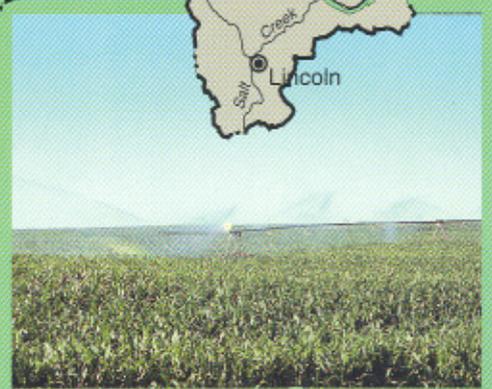
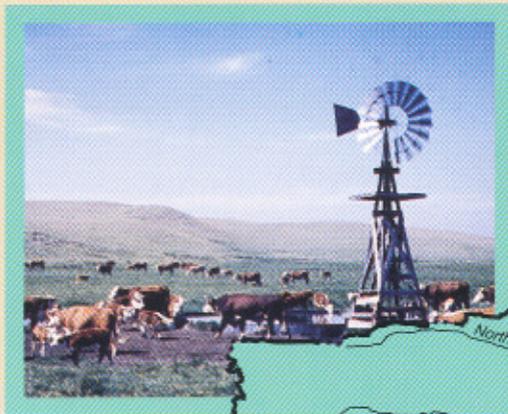


Loess Hills

Rolling landscape of mixed cropland and pasture

Platte Valley

Flat alluvial valley of intense irrigated row-crop agriculture



Data Collection Sites and Activities

Site	Surface-water Location	Activities
1.	Platte River at Louisville	FX, SR, AE, UI
2.	Salt Creek at Greenwood	UI
3.	Elkhorn River at Waterloo	FX, SR, AE
4.	Maple Creek near Nickerson	FX, SR, AE
5.	Shell Creek near Columbus	FX, SR, AE
6.	Loup River near Palmer	FX, SR, AE
7.	Middle Loup River at St. Paul	SR
8.	South Loup River at St. Michael	SR
9.	Dismal River near Thedford	FX, SR, AE
10.	Platte River near Duncan	SR
11.	Prairie Creek at Silver Creek	AE
12.	Prairie Creek near Ovina	FX, SR, AE
13.	Wood River below Grand Island	UI
14.	Platte River near Grand Island	FX, SR
15.	Tri-County Canal near North Platte	FX, SR, UI
Ground-Water Location		
16.	Platte Valley critical habitat area	FP
17.	Grand Island well field	FP
18.	Platte Valley land-use study	LU

Data activities were designed to provide field information on surface- and ground-water quality, biology, and habitat. Data site locations were selected that represented the four environmental settings (Sandhills, Platte Valley, Loess Hills, and Glaciated Area) in central Nebraska. Environmental setting is defined by specific combinations of hydrologic, geologic, physiographic, water use, and land use characteristics.

FX Fixed Stations

Surface-water sampling locations are downstream of a single environmental setting or combination of settings that are representative of the water quality of the basin. Samples were collected monthly, with additional samples collected over a wide range of hydrologic conditions. Tri-County Canal and Dismal River, which have less streamflow variability were sampled three times annually. Sites selected were at or near existing USGS gaging stations to have flow record available.

SR Spring Runoff

Agricultural chemicals occurred in the largest concentrations during the first significant runoff event after application in the spring. Five to seven samples were collected at each site during the first runoff after application of chemicals each year.

AE Aquatic Ecology

Information obtained describes the aquatic ecology at the fixed stations and other sites that are typical of the environmental setting and related to physical and chemical quality. Data collected included chemical analysis of tissue samples of selected fish or mussels, habitat description, and fish and invertebrate community description.

UI Urban Industrial

Samples were collected to determine the occurrence of industrial compounds in surface water downstream of urban or industrial areas.

FP Flowpath Studies

Transport processes in ground water are important in understanding the effects of natural and human factors on water quality. A series of wells were installed at several depths along a transect to determine the water quality along lateral and vertical flowpaths. Samples were collected seasonally, based on application of chemicals to crops.

LU Land-Use Studies

The spatial distribution of ground-water quality may define the effects of land uses such as agricultural and industrial activities on shallow ground water. Shallow wells were sampled one time to define water quality over a relatively broad area, such as the Platte Valley.



1962

1993

Habitat Changes at a Cross Section of the Platte River

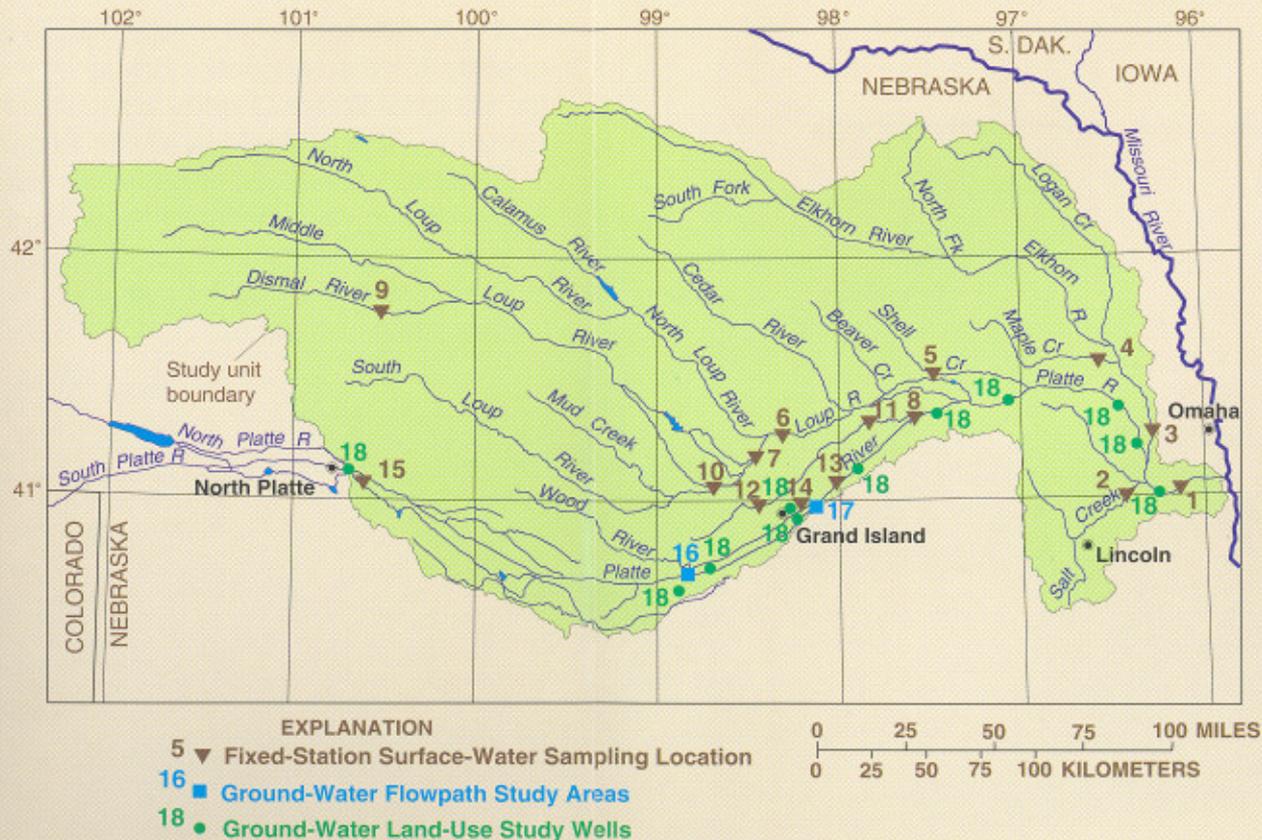
Species must adapt to change in habitat.

Native species, such as cranes, use open water and barren sand bars for roosting at night. Other smaller migratory birds, such as the Piping Plover and Interior Least Tern, use barren sand bars as nesting areas. The width of the Platte River near Grand Island (site 14), typical of many cross sections in the Platte River, has decreased. Many sand bars have become permanently vegetated in the past 30 years, changing the habitat in this reach of the Platte River.

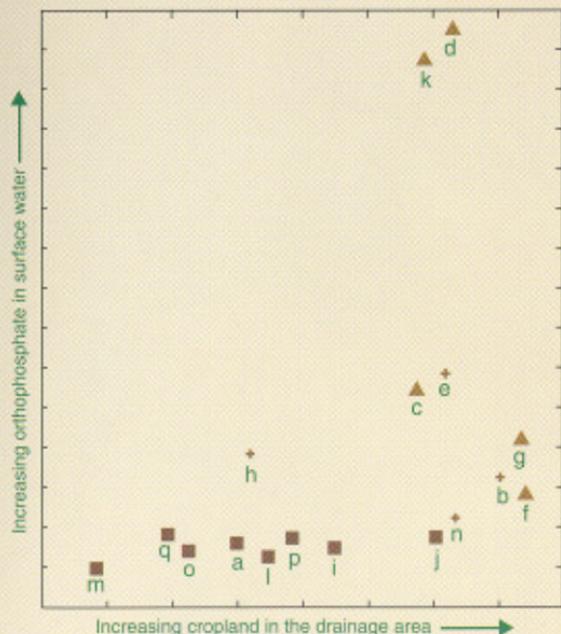
 Vegetated sand bars and shoreline

 Open water and barren sand bars

Water-Quality Assessment in Central Nebraska



Fish Communities as Water-Quality Indicators



EXPLANATION

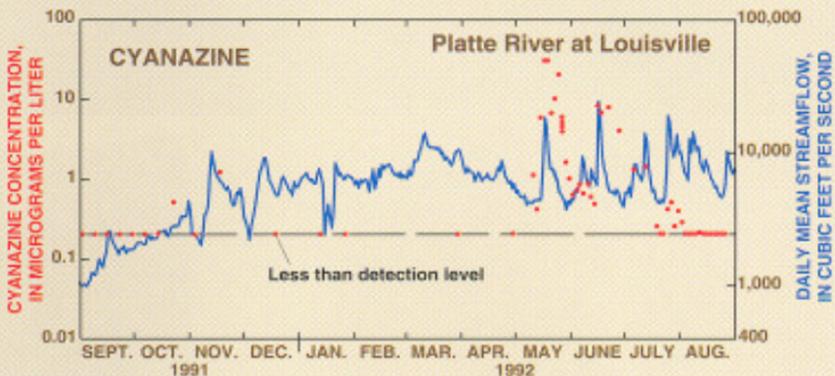
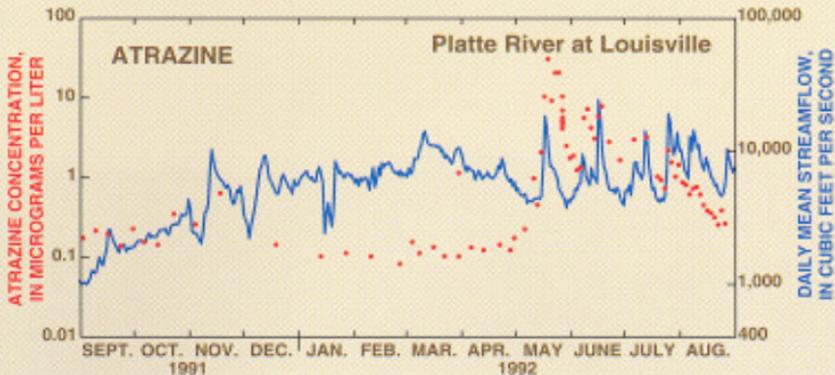
- A species found in the Dismal River which is one of the sampling sites that has small orthophosphate concentrations and little cropland in its drainage area
- ▲ A species found in Prairie Creek which is one of the sampling sites that has large orthophosphate concentrations and much cropland in its drainage area
- + A species found at both sites

Letter represents species commonly found for these amounts of cropland and concentrations of orthophosphate in the stream water.

Fish species	Tolerance level
a. White sucker	Tolerant
b. Red shiner	Tolerant
c. Common carp	Tolerant
d. Yellow bullhead	Tolerant
e. Green sunfish	Tolerant
f. Sand shiner	Tolerant
g. Fathead minnow	Tolerant
h. Creek chub	Tolerant
i. Plains topminnow	Intermediate tolerance
j. Flathead chub	Intermediate tolerance
k. Black bullhead	Intermediate tolerance
l. Shorthead redhorse	Intermediate tolerance
m. River shiner	Intermediate tolerance
n. Bigmouth shiner	Intermediate tolerance
o. Stone cat	Intermediate tolerance
p. Smallmouth bass	Intolerant
q. Longnose dace	Intolerant

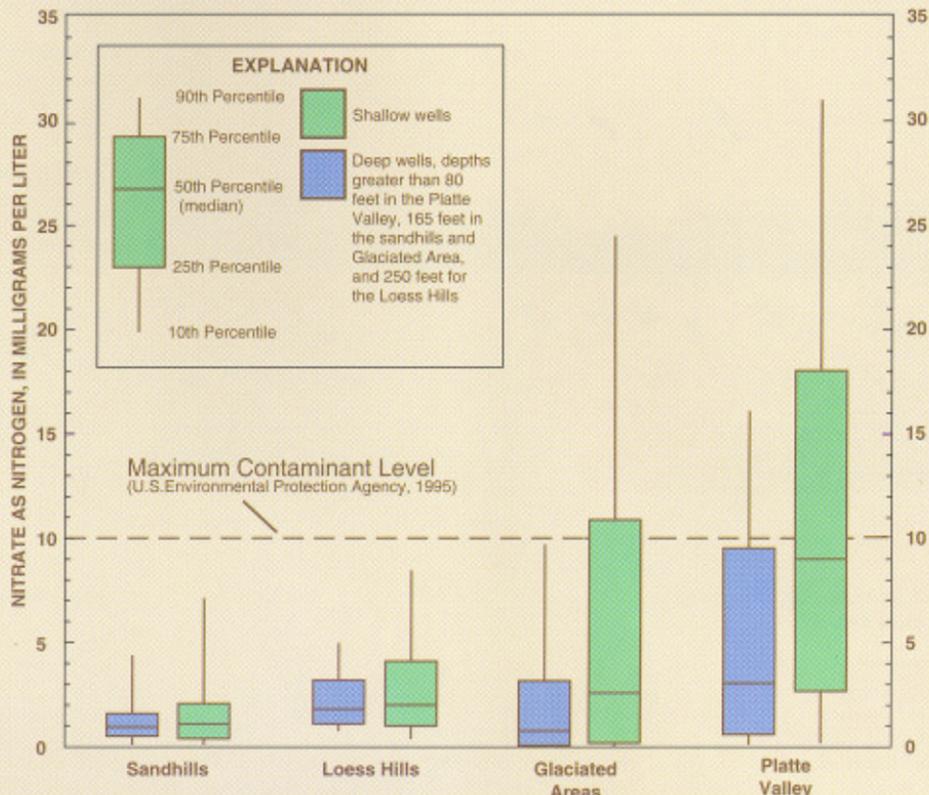
Species listed as tolerant can tolerate degraded water quality, but may also be found where water quality is not degraded. Species listed as intolerant are not commonly found in streams with degraded water quality.

Communities of predominantly tolerant species and minimal numbers of intolerant species indicate degraded stream-water quality. Abundance of fish species relative to the total number of fish sampled at a site is an indicator of species most commonly found or most suited to a habitat characteristic of that site. Fish species most commonly found at sampling sites in central Nebraska were related to amount of cropland within the drainage area and the concentration of orthophosphate, an ingredient in fertilizer, in the water. Tolerant species such as Yellow bullhead (d) and Fathead minnow (g) are commonly found in streams such as Prairie Creek (site 12) in the Platte Valley that drain mostly cropland, and intolerant species such as Smallmouth bass (p) and Longnose dace (q) are commonly found in streams such as the Dismal River (site 9) that drain range land.



The largest concentrations of commonly applied herbicides occur during spring runoff. The annual mean concentration of atrazine in the Platte River at Louisville (site 1) was less than 3 $\mu\text{g}/\text{L}$ (micrograms per liter) which is the Maximum Contaminant Level established by the Environmental Protection Agency (1995). The average annual concentration of cyanazine during the year of sampling in the Platte River at Louisville was greater than 1 $\mu\text{g}/\text{L}$, which is the Health Advisory Level established by the Environmental Protection Agency.

Nitrate in Ground Water



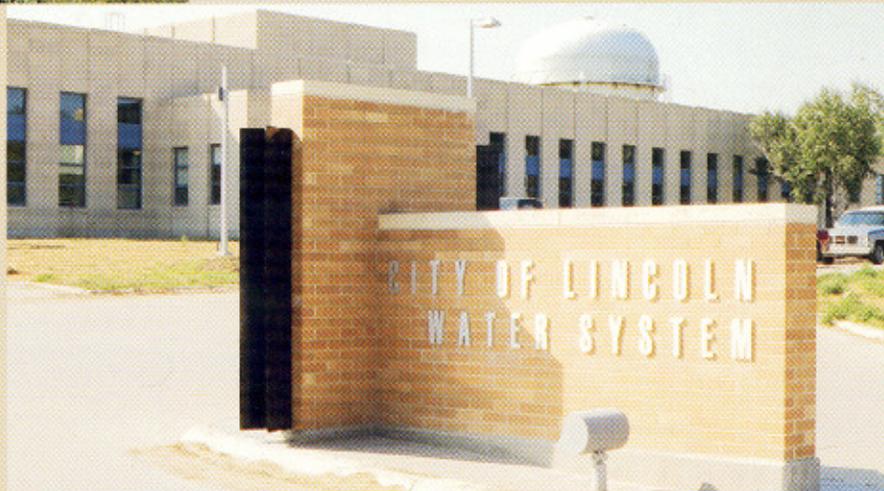
Nitrate concentrations in shallow ground water commonly exceeded the drinking-water standard in the Platte Valley, requiring public utilities to seek deeper sources of ground water or to locate wells close to the Platte River. Median concentrations and concentration variability in the shallow wells were larger than in the deeper wells in all environmental settings.

The U.S. Geological Survey's knowledge and information will help meet challenges for the future...



Advances in agricultural methods

Protection of public water supplies



Plan for a healthy habitat



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This document was prepared in association with the U.S. Geological Survey Great Plains Working Group, which is represented by scientists committed to distributing information and increasing earth-science knowledge of the North American Great Plains.

Additional Reading:

Frenzel, S.A., and Swanson, R.B., in press, Relations of fish community composition to environmental variables in central Nebraska streams: *Environmental Management*

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http://wwwrvares.er.usgs.gov/nawqa/nawqa_home.html