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Water-Quality Assessment of the Central Nebraska Basins—Design for Field Operations, 1992 through 1995

By Robert B. Swanson *and* Patrick J. Emmons

Open-File Report 99–454

National Water-Quality Assessment Program

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BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
CHARLES G. GROAT, Director

Lincoln, Nebraska: 2000

For additional information write to:

District Chief
U.S. Geological Survey, WRD
406 Federal Building
100 Centennial Mall North
Lincoln, NE 68508

Copies of this report can be purchased from:

U.S. Geological Survey
Information Services
Box 25286
Denver, CO 80225

FOREWORD

The mission of the U.S. Geological Survey (USGS) is to assess the quantity and quality of the earth resources of the Nation and to provide information that will assist resource managers and policymakers at Federal, State, and local levels in making sound decisions. Assessment of water-quality conditions and trends is an important part of this overall mission.

One of the greatest challenges faced by water-resources scientists is acquiring reliable information that will guide the use and protection of the Nation's water resources. That challenge is being addressed by Federal, State, interstate, and local water-resource agencies and by many academic institutions. These organizations are collecting water-quality data for a host of purposes that include: compliance with permits and water-supply standards; development of remediation plans for a specific contamination problem; operational decisions on industrial, wastewater, or water-supply facilities; and research on factors that affect water quality. An additional need for water-quality information is to provide a basis on which regional and national-level policy decisions can be based. Wise decisions must be based on sound information. As a society we need to know whether certain types of water-quality problems are isolated or ubiquitous, whether there are significant differences in conditions among regions, whether the conditions are changing over time, and why these conditions change from place to place and over time. The information can be used to help determine the efficacy of existing water-quality policies and to help analysts determine the need for and likely consequences of new policies.

To address these needs, the Congress appropriated funds in 1986 for the USGS to begin a pilot program in seven project areas to develop and refine the National Water-Quality Assessment (NAWQA) Program. In 1991, the USGS began full implementation of the program. The NAWQA Program builds upon an existing base of water-quality studies of the USGS, as well as those of other Federal, State, and local agencies. The objectives of the NAWQA Program are to:

- Describe current water-quality conditions for a large part of the Nation's freshwater streams, rivers, and aquifers.
- Describe how water quality is changing over time.
- Improve understanding of the primary natural and human factors that affect water-quality resources.

This information will help support the development and evaluation of management, regulatory, and monitoring decisions by other Federal, State, and local agencies to protect, use, and enhance water resources.

The goals of the NAWQA Program are being achieved through ongoing and proposed investigations of 60 of the Nation's most important river basins and aquifer systems, which are referred to as study units. These study units are distributed throughout the Nation and cover a diversity of hydrogeologic settings. More than two-thirds of the people served by public water-supply systems live within their boundaries.

National synthesis of data analysis, based on aggradation of comparable information obtained from the study units, is a major component of the program. This effort focuses on selected water-quality topics using nationally consistent information. Comparative studies will explain differences and similarities in observed water-quality conditions among study areas and will identify changes and trends and their causes. The first topics addressed by the national synthesis are pesticides, nutrients, volatile organic compounds, and aquatic biology. Discussions on these and other water-quality topics will be published in periodic summaries of the quality of the Nation's ground and surface water as the information becomes available.

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

Robert M. Hirsch

Robert M. Hirsch
Chief Hydrologist

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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
inch (in.)	2.54	centimeter
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
acre	4,047	square meter
acre	0.4047	hectare
acre	0.4047	square hectometer
acre	0.004047	square kilometer
square mile (mi^2)	259.0	hectare
square mile (mi^2)	2.590	square kilometer
pint (pt)	0.4732	liter
quart (qt)	0.9464	liter
gallon (gal)	3.785	liter

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F = (1.8 \times °C) + 32$$

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

$$°C = (°F - 32) / 1.8$$

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Altitude, as used in this report, refers to distance above or below sea level.

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L).

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INTRODUCTION

The protection and enhancement of the quality of the Nation's ground- and surface-water resources are high priority concerns of the public and the government. To address these concerns, nationally consistent information on the status and trends of the Nation's water quality is needed. This will help to determine the degree to which past investments in water-quality management are working and to provide a base of knowledge for evaluating future decisions (Hirsch and others, 1988). The U.S. Geological Survey (USGS) began implementation of a full-scale National Water-Quality Assessment (NAWQA) Program in 1991. NAWQA provides for a hydrologically-based, long-term method for describing the water-quality conditions of a large part of the Nation's water resources, defining long-term trends, and identifying the factors affecting those trends. The intent of the NAWQA Program is to evaluate water-quality conditions on local, regional, and national scales through a nationally consistent multidisciplinary (physical, chemical, and biological) sampling design that results in converging lines of scientific evidence to assess these conditions (Leahy and others, 1990). NAWQA water-quality investigations are designed to incorporate surface-water, ground-water, and ecological components. The inclusion of the ecological component gives NAWQA researchers the capability of evaluating real implications to quality of life by changing water-quality conditions.

NAWQA consists of up to 60 large hydrologic systems called study units, which represent 60 to 70 percent of water use in the Nation. Study units rotate between a 3- to 4-year period of intensive data gathering activity to a 5- to 6-year period of less intensive data collection, data interpretation, and report writing. One-third of the study units are engaged in intense data collection at any given time (Leahy and others, 1993).

One of the first 20 study units in the NAWQA Program was the Central Nebraska River Basins (CNBR) study unit, which began in 1991. The study unit includes about 30,000 square miles of the Platte River Basin in Nebraska, from the confluence of the North and South Platte Rivers near the city of North Platte to the Missouri River near Omaha (fig. 1). The drainage area includes the Platte River, as described, and two major tributaries, the Loup and Elkhorn Rivers (Huntzinger, 1991).

The CNBR study unit is divided into four basic environmental settings—Sandhills, Loess Hills, Glaciated Area, and Platte Valley—which share common hydrologic, geologic, physiographic, land-use, and water-use characteristics that may affect water quality. The Sandhills are in the western part of the study unit and are characterized by highly permeable soil and grasslands. The Loess Hills occupy the central part of the study unit, have less permeable soils than the Sandhills, and consist of a mixture of cropland and grassland. The Glaciated Area is in the eastern quarter of the study unit, has clay-rich soils, and land use is mostly cropland. The Platte Valley is in the southern part of the study unit, has sandy soils, and is a mixture of grassland and cropland (Huntzinger and Ellis, 1993).

Purpose and Scope

The purpose of this report is to describe the design and philosophy of the surface-water, ground-water, and ecological data-collection activities developed to assess the water quality of the CNBR study unit. The scope is limited to CNBR study unit field activities during the intensive period of data collection, May 1992 through September 1995.

Acknowledgments

The authors thank the members of the CNBR study unit liaison committee for their guidance in developing the CNBR NAWQA sampling strategy. The Nebraska Department of Environmental Quality (NDEQ), the Lower Platte North Natural Resources District (NRD), and U.S. Environmental Protection Agency, Region VII, provided sample collection assistance. The U.S. Fish and Wildlife Service (USFWS) provided expertise in the collection of fish community data. The Twin Platte NRD provided office and storage space. The Platte River Whooping Crane Maintenance Trust, Inc. provided field sampling equipment. The authors thank the Central Platte NRD for assistance in locating well drilling sites and contacting public and private landowners. The authors especially acknowledge the Platte River Whooping Crane Maintenance Trust, Inc. and the City of Grand Island for allowing access to their properties for well installation and water-quality or wetlands sampling. The Bureau of Reclamation, Grand Island office, provided assistance in completing the flowpath studies and made storage space available for field equipment and supplies.

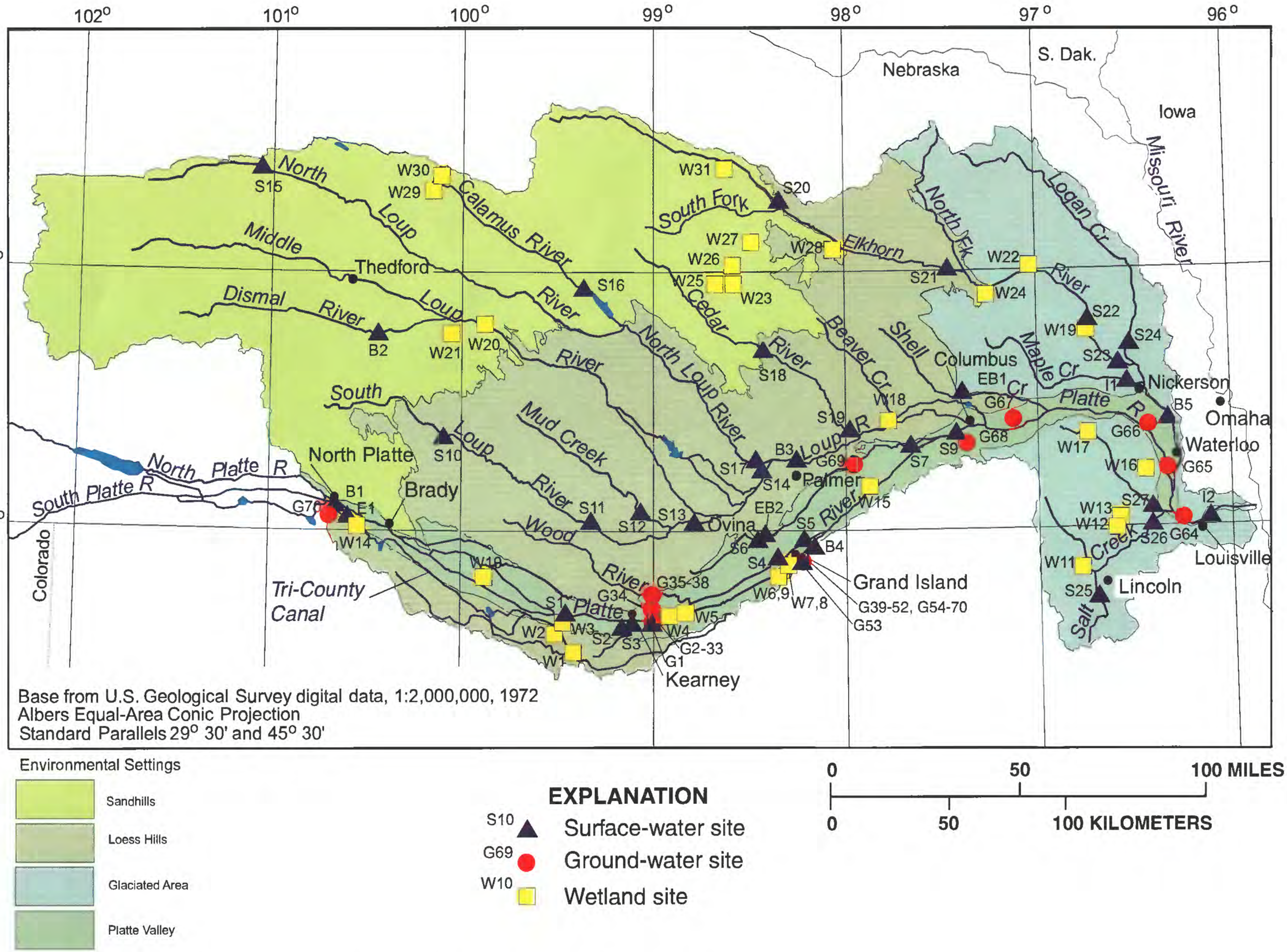


Figure 1. Locations and types of environmental settings and sampling sites, Central Nebraska Basins study unit.

Location of environmental settings and sampling sites, Central Nebraska Basins Study Unit, Nebraska

EXPLANATION

Illustration Site ID	USGS Site ID	Site Name	Site Type
▲ B1	06765698	Tri-County Canal 1.25 mi Below Diversion, NE	Surface-water sampling site
■ W1	403331099192600	Johnson Waterfowl Production Area	Wetland sampling site
● G2	404209098480501	9N 13W 32DDBA1	Ground-water sampling site

B1	06765698	Tri-County Canal 1.25 mi below diversion, NE
B2	06775900	Dismal River near Thedford, NE
B3	06791150	Loup River near Palmer, NE
B4	06770500	Plette River near Grand Island, NE
B5	06800500	Elkhorn River at Waterloo, NE
E1	06766000	North Channel of the Platte River at Brady, NE
EB1	06795500	Shell Creek near Columbus, NE
EB2	06770350	Prairie Creek near Ovina, NE
I1	06800000	Maple Creek near Nickerson, NE
I2	06805500	Platte River at Louisville, NE
S1	06768000	Platte River near Overton, NE
S2	06770190	North Dry Creek near Kearney, NE
S3	06770200	Platte River near Keamey, NE
S4	06772000	Wood River near Alda, NE
S5	06772200	Wood River near Grand Island, NE
S6	06773150	Silver Creek at Ovina, NE
S7	06773500	Prairie Creek near Silver Creek, NE
S9	06774000	Platte River near Duncan, NE
S10	06781800	South Loup River at Calloway, NE
S11	06782000	South Loup River near Cumro, NE
S12	06783500	Mud Creek near Sweetwater, NE
S13	06784000	South Loup River at St. Michaal, NE
S14	06785000	Middle Loup River at St. Paul, NE
S15	06785200	North Loup River North of Mullen, NE
S16	06787000	Calamus River near Harrop, NE
S17	06790500	North Loup River near St. Paul, NE
S18	06791500	Cedar River near Spalding, NE
S19	06792000	Cedar River near Fullerton, NE
S20	06797500	Elkhorn River near Ewing, NE
S21	06799000	Elkhorn River at Norfolk, NE
S22	06799350	Elkhorn River at West Point, NE
S23	06799385	Pebble Creek near Scribner, NE
S24	06799500	Logan Creek near Uehling, NE
S25	06803000	Salt Creek at Roca, NE
S26	06803555	Salt Creek at Greenwood, NE
S27	06804700	Wahoo Creek at Ashland, NE

W1	403331099192600	Johnson Waterfowl Production Area
W2	403939099283500	Whooping Crane Trust (WCT)- Elm Creek Slough
W3	404120099234100	Blue Hole Wildlife Management Area
W4	404123098541800	Bassway Strip Wildlife Management Area
W5	404205098480600	WCT- Dippel Site
W6	404751098263500	WCT - Wild Rose Slough
W7	404802098240300	WCT - Mormon Island Crane Meadow
W8	404628098230100	WCT - Mormon Island Crane Meadow
W9	404854098254300	Loch Linda Wildlife Management Area
W10	405026099504100	Bittern's Call Wildlife Management Area
W11	405734096431100	Bennett Saline Wetland
W12	410318096350100	Otto Saline Wetland
W13	410348096345100	Sabatka Saline Wetland
W14	410512100374600	Miller Lake Outflow
W15	410529097595000	Department of Roads - Central City
W16	410720096255300	Todd Valley - Proctor Site
W17	412020096255600	Todd Valley - Meduna Site
W18	412516097433200	Prairie Wolf Wildlife Management Area
W19	414252096422600	Powder Horn Wildlife Management Area
W20	414453099463000	Milburn Dam Wildlife Management Area
W21	414455100014300	Department of Roads - Dunning
W22	415533097172000	Wood Duck Wildlife Management Area
W23	415948098423500	Foxley Farms - Lake Fred
W24	420001097000700	Black Island Wildlife Management Area
W25	420009098453200	Foxley Farms - No. 1
W26	420219098421000	Foxley Farms - No. 5
W27	420657098341600	Goose Lake Wildlife Management Area
W28	421059098093400	Hackberry Creek Wildlife Management Area
W29	421735100062600	Long Lake State Recreation Area
W30	421836100034200	Americen Game Marsh Wildlife Management Area
W31	422552098390800	Department of Roads - O'Neill

G1	404147098482001	8N 13W 5AACB1	Platte R at WM
G2	404209096480501	9N 13W32DDBA1	South-660-I
G3	404209098480502	9N 13W32DDBA2	South-660-76
G4	404209098480503	9N 13W32DDBA3	South-660-48
G5	404209098480504	9N 13W32DDBA4	South-660-15
G6	404209098480505	9N 13W32DDBA5	South-660-DP
G7	404209098480901	9N 13W32DCAA5	South-200-I
G8	404209098481001	9N 13W32DCAA4	South-100-I
G9	404209098481101	9N 13W32DCAA3	South-50-I
G10	404209098481201	9N 13W32DCAA1	South-Fence-S
G11	404209098481202	9N 13W32DCAA2	South-Fence-I
G12	404209098481203	9N 13W32DCAA6	South-Fence-DP
G13	404217098475101	9N 13W32DAAC1	North-600-S
G14	404217098475102	9N 13W32DAAC2	North-600-I
G15	404217098475103	9N 13W32DAAC3	North-600-D
G16	404217098475104	9N 13W32DAAC4	North-600-DP
G17	404217098480101	9N 13W32DABD8	North-200-S
G18	404217098480102	9N 13W32DABD9	North-200-I
G19	404217098480103	9N 13W32DABD10	North-200-D
G20	404217098480201	9N 13W32DABD6	North-100-S
G21	404217098480202	9N 13W32DABD7	North-100-I
G22	404217098480203	9N 13W32DABD5	North-100-D
G23	404217098480301	9N 13W32DABD3	North-50-S
G24	404217098480302	9N 13W32DABD4	North-50-I
G25	404217098480401	9N 13W32DABD1	North-Fence-I
G26	404217098480402	9N 13W32DABD2	North-Fence-S
G27	404217098480403	9N 13W32DABD11	North-Fence-103
G28	404217098480404	9N 13W32DABD12	North-Fence-78
G29	404217098480405	9N 13W32DABD13	North-Fence-48
G30	404217098480406	9N 13W32DABDB	North-Fence-DP
G31	404226098471201	9N 13W33ACCA1	East-D
G32	404242098474801	9N 13W33BBBD1	Poison Ivy-77
G33	404242098474802	9N 13W33BBBD2	Poison Ivy-18
G34	404436098475501	9N 13W17DDDD1	Blue House-66
G35	404616098475001	9N 13W 9BBBB1	Wood South-79
G36	404616098475002	9N 13W 9BBBB2	Wood R South-18
G37	404619098473201	9N 13W 4CDCC1	Wood North-55
G38	404619096473202	9N 13W 4CDCC2	Wood R North-18
G39	405106098185301	10N 9W11BDCC1	Trees-123
G40	405106098185302	10N 9W11BDCC2	Trees-88
G41	405106098185303	10N 9W11BDCC3	Trees-58
G42	405106098185304	10N 9W11BDCC4	Trees-33
G43	405106098185305	10N 9W11BDCC5	Trees-18
G44	405118098190501	10N 9W11BBDC1	Ent Road-123
G45	405118098190502	10N 9W11BBDC2	Ent Road-98
G46	405118098190503	10N 9W11BBDC3	Ent Road-63
G47	405118098190504	10N 9W11BBDC4	Ent Road-33
G48	405118098190505	10N 9W11BBDC5	Ent Road-18
G49	405127098190901	10N 9W11BBBB1	Girl Scout-123
G50	405127098190902	10N 9W11BBBB2	Girl Scout-78
G51	405127098190903	10N 9W11BBBB3	Girl Scout-38
G52	405127098190904	10N 9W11BBBB4	Girl Scout-13
G53	405127098185201	10N 9W 2CDCD1	Platte R at Girl Scout Camp
G54	405143098181601	10N 9W 2DABA1	River-123
G55	405151098181601	10N 9W 2DABA2	River-105
G56	405143098181603	10N 9W 2DABA3	River-78
G57	405151098181602	10N 9W 2DABA4	River-50
G58	405143098181605	10N 9W 2DABA5	River-20
G59	405143098181201	10N 9W 2DADC1	Windmill-123
G60	405143098181202	10N 9W 2DADC2	Windmill-98
G61	405143098181203	10N 9W 2DADC3	Windmill-63
G62	405143098181204	10N 9W 2DADC4	Windmill-43
G63	405143098181205	10N 9W 2DADC5	Windmill-18
G64	410113096145701	12N 10E12CACC1	Schramm SRA
G65	411302096205301	14N 10E 6BBCB	Two Rivers SRA
G66	412331096264401	16N 9E 6AAAC1	Fremont TW6
G67	412510097060302	17N 3E29AA2	Schuyler
G68	411738097264301	15N 1W 9BBBB1	Shelby
G69	410943097575001	14N 6W26AAAA	Central City
G70	410524100454301	13N 30W21ABBB1	North Platte WCREC OBS7

Figure 1. Locations and types of environmental settings and sampling sites, Central Nebraska Basins study unit—Continued.

APPROACH

The NAWQA Program uses nationally consistent field methods, techniques, and equipment, use of which builds upon established USGS standard methods (Edwards and Glysson, 1988; and Ward and Harr, 1990) and provides data that are comparable on a national scale. Many of the methods are designed for low-level (parts per billion) analyses of constituents. Data and samples were collected for surface-water, ground-water, and ecological sites.

Surface-Water Data

Surface-water quality was assessed through data collection at fixed sites and supplemented by synoptic surveys. The network of nine fixed sites provided water-quality samples over a wide range of hydrologic conditions through monthly and supplemental flow-based sampling. Synoptic survey site sampling conducted at most of the fixed sites and at additional sites provided increased spatial resolution of targeted constituents under specific hydrologic conditions.

The fixed-site network consists of indicator sites, which are representative of relatively small basins of homogeneous land use and physiographic characteristics, and of integrator sites, which are representative of large areas of the study unit with diverse land use and physiographic characteristics. Fixed sites also are distinguished on the basis of sampling intensity. All of the sites in the fixed-site network are basic fixed sites at which monthly samples are collected and mean daily streamflow data are compiled (Table 1). Additional samples are collected during targeted hydrologic conditions. Intensive fixed sites and enhanced basic fixed sites are subsets of basic fixed sites. Intensive fixed sites have seasonal increases in the frequency of sampling during spring and summer, and at least 12 water-column samples are collected for dissolved pesticides analysis (Shelton, 1994). Enhanced basic fixed sites have at least 12 water-column samples to be analyzed for dissolved pesticides. An intensive fixed-site prototype project was conducted in the CNBR study unit from May through August of 1992 at Maple Creek near Nickerson and the Platte River at Louisville with samples collected at least weekly and, at times, every 2 days (Johnson and Swanson, 1994).

Two high-flow synoptic surveys were completed at 10 sites in the spring of 1992 and 1993, after crops had been planted and the majority of agriculture-related chemicals had been applied. The surveys were designed to analyze nutrient and pesticide loading in streams during each period of stormwater runoff. As many as seven samples were collected at each site during one of the first three runoff events.

Two low-flow synoptic surveys were conducted at 28 sites in the spring and late summer of 1994 to assess background concentrations of nutrients and pesticides in the study unit. The samples for the preplant low-flow synoptic survey were collected in March, when minimal concentrations of those agriculture-related constituents might be expected in the water column. The summer low-flow synoptic survey was conducted in August, late in the growing season, when an abundance of agriculture-related constituents might be expected in the water column.

Surface-water samples were collected by personnel of USGS with the exception of some samples collected at the Platte River near Grand Island, the Elkhorn River at Waterloo, and the Loup River at Palmer. These samples were collected by personnel of the NDEQ. All surface-water samples were collected using discharge-integrating samplers following protocols specifically designed for the NAWQA Program (Shelton, 1994) for the collection and preservation of water-column samples. Under certain conditions, when stream depths were too shallow to use depth-integrating equipment or when the mean stream velocity was less than 1.0 foot per second, dip samples or weighted-bottle samples were collected. Water column and bed-sediment samples were collected from thirty-one wetlands in May and again in August of 1994. Swanson (1995) modified available NAWQA surface-water protocols for the wetland study.

Table 1. Description of the Central Nebraska Basins study unit fixed-site network

Site classification	Years of operation	Base sampling frequency	Supplemental sampling	Basic stream chemistry	Pesticide sampling
Basic fixed site	1993-95	Monthly	Targeted hydrologic conditions	Yes	Organo-nitrogen herbicides
Enhanced basic fixed sites	1993-95	Monthly	Targeted hydrologic conditions	Yes	12 samples analyzed for 48 herbicides and insecticides
Intensive basic fixed sites	1992	Weekly	Every other day May 12-June 22 and July 20-Aug 28; Five samples during a spring runoff event and five samples during a late summer runoff event	Yes	All samples analyzed for 48 herbicides and insecticides

Ground-Water Data

Ground-water quality was assessed through the use of previously collected data as well as a reconnaissance survey and two flowpath studies. Prior to the current study, Exner and Spalding (1990) conducted a study of the occurrence of pesticides and nitrate in ground water in Nebraska. They collected water samples or compiled data of 2,260 pesticide and 5,826 nitrate analyses. For the current study, Zelt and Jordan (1993) compiled a screened data set of 5,499 ground-water samples collected at 4,047 sampling sites in the CNBR study unit. These data were used to characterize the general water-quality conditions in the study unit in a manner consistent with the NAWQA study units nationwide. A study of nitrogen and phosphorus in water as related to the four environmental settings in the study unit was conducted by Helgesen and others (1994) using the data set compiled by Zelt and Jordan (1993).

The reconnaissance survey was designed to determine if the available data statistically could be used to compare ground-water quality in the CNBR study unit to other study units across the country. The survey was restricted to the Platte Valley environmental setting because the Platte River alluvial aquifer is susceptible to contamination due to land use practices and because about 99 percent of the land use in the study unit is agricultural. CNBR researchers conducted this limited reconnaissance survey in 1994. The survey was designed to target agriculture-related constituents in the Platte River alluvial aquifer although the ground-water samples also were analyzed for major ions, dissolved organic carbon, trace elements, volatile and semivolatile organic compounds, and radionuclides. Samples were collected once from 11 available wells areally distributed throughout the aquifer.

Flowpath studies were used to define the areal, vertical, and temporal distribution of chemical constituents in ground water over a relatively small area within an environmental setting. During 1994-95, two flowpath studies were conducted in the Platte Valley environmental setting. Clusters of wells were installed along transects in a wet meadow for a riparian-wetlands flowpath study and in the City of Grand Island municipal well field for a public water-supply flowpath study. A total of 63 observation wells were installed by the USGS for the two flowpath studies.

The observation wells were drilled, installed, and completed, and samples were collected and preserved following procedures established for the NAWQA Program (Hardy and others, 1989; Lapham and others, 1995; and Koterba and others, 1995). A generator was used to provide electrical power to operate a small-diameter, stainless-steel positive-displacement pump equipped with a Teflon discharge line. The pump was used to collect all samples from wells that required a pump. In production wells, the samples were collected as near to the well head as possible using the existing in-well pumps.

Ecological Data

The ecological component of the NAWQA Program involved collection of contaminant, habitat, and community data from fixed and synoptic sites. The occurrence of contaminants was determined by sampling fish tissues and bed sediments as described by Crawford and Luoma (1993) and Shelton and Capel (1994).

Collection of ecological samples included the surface-water fixed-station and synoptic-sampling networks. The nine ecological fixed sites are the same as the surface-water fixed sites with the exception of the Tri-County Canal site, which was replaced by the North Channel of the Platte River at Brady site. Stream habitat features were characterized at the nine fixed sites. All fixed sites were sampled in 1993 and 1994 with the exception of the Platte River near Louisville, which was not sampled in 1994. At Dismal River near Thedford, Platte River near Grand Island, and Maple Creek near Nickerson, a single reach was sampled in 1993, 1994, and 1995, to document changes to the reach over time. In 1994, two additional reaches were sampled at the Thedford, Grand Island, and Nickerson sites to document the variability between stream reaches within a stream segment.

Synoptic sites were sampled to address specific water-quality questions. Streambed-sediment and fish-tissue samples were collected at 22 sites and analyzed for synthetic organic compounds and trace elements. Wetlands in the study unit are heavily used by migratory birds as resting and feeding areas, and provide a highly diverse habitat for other wildlife. Thirty-one sites were sampled for water-column and bed-sediment analysis, and algal, benthic invertebrate, and plant community structure during two synoptic surveys in May and August of 1994.

Specific methods used to measure the various habitat features that characterize the streambed, banks, and flood plains at the fixed and synoptic sites are described in Meador, Hupp, and others (1993). Aquatic communities include algal, invertebrate, and fish assemblages. Algal sampling methods are described by Porter and others (1993). Benthic invertebrates were sampled from the same habitats as algal communities using methods described by Cuffney and others (1993). Fish assemblages were sampled using pulsed-direct-current electrofishing equipment (Meador, Cuffney, and others, 1993). Fish were identified by species onsite by USFWS personnel. The methods for the collection and processing of wetland samples were developed from modified NAWQA ecological protocols (Swanson, 1995).

Sample Analysis

All surface-water, ground-water, bed-sediment, and tissue samples were analyzed at the USGS National Water-Quality Laboratory in Arvada, Colorado, or at the USGS Organic Geochemistry Research Laboratory in Lawrence, Kansas. Water samples collected for the wetlands synoptic surveys were analyzed for chlorophyll by the University of Nebraska in Lincoln, Nebraska. Suspended-sediment samples were analyzed by the USGS Sediment Laboratory in Iowa City, Iowa. Benthic invertebrate samples were identified and enumerated at Kansas University in Lawrence, Kansas. Algal samples were identified and enumerated by the Academy of Natural Sciences of Philadelphia, Pennsylvania. Biological data were compiled and examined for integrity and completeness by the USGS Biological Quality Assurance Unit in Arvada, Colorado. Data collected by this study are stored or planned for storage in the USGS National Water Information System.

Quality Assurance

The NAWQA Program is designed with a commitment to the quality assurance of the data collected. Several methods of quality assurance were used to ensure that the data sets were valid, including adherence to nationally consistent protocols and equipment for sample collection.

Field equipment was cleaned and handled in a manner that minimized the risk of contamination. Field meters were calibrated, maintained, and transported to ensure accurate results (Shelton, 1994). Samples were documented and all field measurements and stream-discharge values were computed and examined for correctness.

A total of 17 percent of all samples were collected for the purpose of quality assurance. These included blank, reference, matrix-spike, and replicate samples. Blanks accounted for 6.5 percent of all samples collected. They consisted of inorganic or organic-free blank water that was exposed to a variety of equipment and conditions to check for contamination. The degradation and recovery of constituents and the accuracy of analyzing instruments were verified with reference and matrix-spike samples, which represented 2.2 percent of all samples collected. Reference samples are defined as a known concentration of the analyte of interest in a solution of blank water. Matrix spikes are known concentrations of an analyte in solution with sample water. Instrument accuracy also was checked by the comparison of sample splits, 5.6 percent of all samples collected. Sampling method accuracy was measured through the collection of sample replicates, which constituted 2.7 percent of all samples collected. Replicates are separate samples collected either sequentially or concurrently, whereas splits are separate analyses run on the same sample. Quality-assurance samples were submitted to laboratories using actual station identification numbers that were entered into the database and differed from regular samples by time and quality-assurance sample type.

The validity of the collected data was examined by passing the data through a series of chemical logic checks and by investigating outlying values. All analytical values were tabulated and inspected for accuracy and missing entries. Data failing the validity checks were excluded from the database.

Splits of some benthic invertebrate samples were submitted to the analyzing entities to check the completeness of the identification and enumeration process. At times, the elutriate, which is the sediments and debris remaining after the sampling process, were examined for organisms that might have escaped sample processing.

DESIGN FOR FIELD OPERATIONS

Field activities of the CNBR study unit were designed to answer specific questions of interest at the national, regional, and study unit level. The following sections present the questions, the field strategy, and the data collected to address these questions.

Surface-Water Fixed-Site Monitoring Network

Questions

How does basic water quality and pesticide contamination change in surface water over time at sites that are representative of the four environmental settings in central Nebraska? What are the relative loads of selected herbicides in basins that represent the four environmental settings in central Nebraska?

Field Strategy

Temporal monitoring of water quality necessitates the establishment of fixed sites for a common reference over time. The CNBR research team established a network of nine fixed sites and operated the sites from April 1993 through September 1995. The sites were selected if they had available water-quality data and available streamflow discharge records.

The fixed sites are classified as indicator and integrator sites. The CNBR study unit indicator sites, which were representative of relatively small basins (20 to 200 mi^2) of homogeneous land use and physiographic characteristics, were: Dismal River near Thedford, Prairie Creek near Ovina, Shell Creek near Columbus, and Maple Creek near Nickerson (fig. 2). Integrator sites, which were representative of large areas of the CNBR study unit with diverse land use and physiographic characteristics, were: Tri-County Canal 1.25 miles below diversion, at the upstream end of the study unit; Platte River at Louisville, at the downstream end of the study unit; Elkhorn River at Waterloo; Platte River near Grand Island; and Loup River at Palmer (fig. 2). The Tri-County Canal site was selected to represent streamflow entering the upstream end of the study unit, because usually more than 90 percent of the Platte River is diverted into this canal immediately below the confluence of the North and South Platte Rivers. All other streamflow is considered to originate within the study unit.

Field parameters were measured and samples were collected for basic chemistry and pesticide analyses on a monthly basis to determine seasonal variability. As many as six additional samples were collected each year during targeted hydrologic conditions. Targeted hydrologic conditions were the deciles of historic mean daily discharges, from 10 to 90 percent, and peak streamflow conditions, of 1 and 3 percent, as determined from the analysis of flow duration curves for each site. Samples were distributed temporally to assess seasonal variability and hydrologically to assess water quality under differing flow conditions. Multi-weekly sampling was conducted at Maple Creek near Nickerson and the Platte River at Louisville from May to August 1992 to investigate short-term variability during the crop growing season. These sites were called intensive prototype fixed sites. Flow at the two upstream fixed sites—Dismal River near Thedford and Tri-County Canal—reflect dramatically different climatic and hydrologic characteristics from the other fixed sites. Both sites, which exhibit little variability in flow—the Dismal River, because of natural hydrologic characteristics, and Tri-County Canal, because of regulation of flow—were sampled only quarterly with two additional samples per year during comparatively rare high-flow conditions. All fixed sites will be activated again during subsequent intensive data-collection periods to evaluate trends in water quality.

Data Collection

Basic fixed-site water-column constituents
- Field parameters
- Major ions
- Nutrients
- Organonitrogen herbicides
- Dissolved organic carbon
- Suspended sediment

Enhanced basic fixed-site water-column constituents
- Field parameters
- Major ions
- Nutrients
- Organonitrogen herbicides
- Organochlorine pesticides
- Synthetic organic compounds
- Dissolved organic carbon
- Suspended sediment

Prototype intensive fixed-site water-column constituents
- Field parameters
- Major ions
- Nutrients
- Organonitrogen herbicides
- Synthetic organic compounds
- Suspended sediment

Sites*

B1	Tri-County Canal 1.25 mi below diversion
B2	Dismal River near Thedford
B3	Loup River near Palmer
B4	Platte River near Grand Island
B5	Elkhorn River at Waterloo
EB1	Shell Creek near Columbus
EB2	Prairie Creek near Ovina
I1	Maple Creek near Nickerson
I2	Platte River at Louisville

*See site explanation for complete site description (page 3).

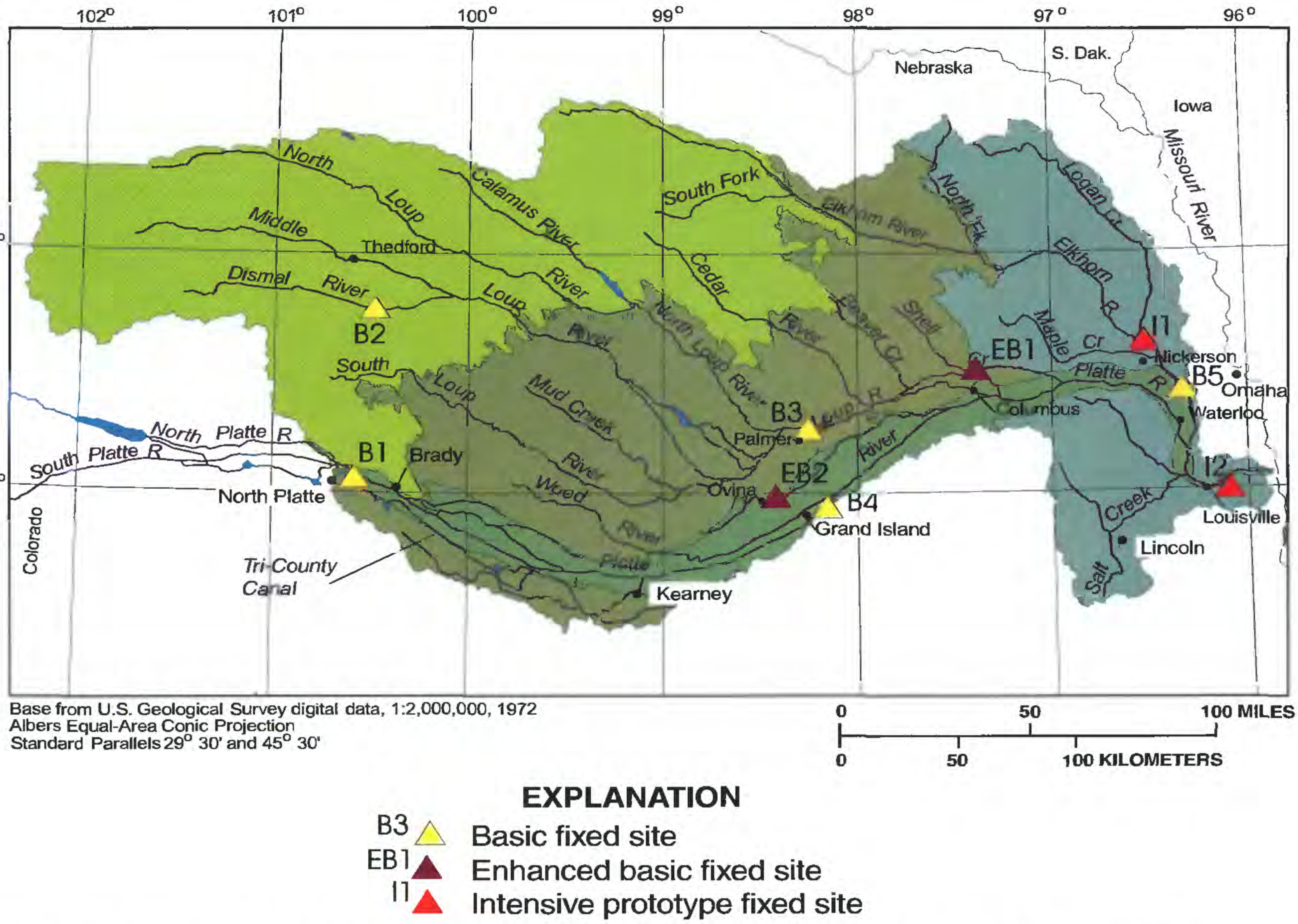


Figure 2. Locations of sites in the surface-water fixed-site monitoring network, Central Nebraska Basins study unit.

Collection of depth-integrated sample at Tri-County Canal, Central Nebraska Basins study unit.

Splitting of composite water sample.

Spring Streamflow Runoff Synoptic Survey

Question

How do concentrations of nutrients, selected herbicides, and sediment vary in streams of the four environmental settings during storm-runoff conditions?

Field Strategy

Goolsby and others (1991) documented that the highest concentrations of herbicides at the Platte River at Louisville occurred after crops had been planted, herbicides applied, and during the first two or three runoff events in the spring.

Ten sites were selected to represent various environmental settings and various rowcrop and rangeland mixtures of land use. The goal of this field activity was to collect as many as seven samples at eight sites from the first runoff event after the application of herbicides and fertilizer in 1992 and 1993. It was not necessary that the resulting streamflow be in the magnitude of a 10-, 50-, or 100-year streamflow event; however, peak flows were of an order of at least 3 to 4 times that of spring baseflow conditions and exhibited evidence that the flows originated from field runoff and not from a reservoir release. A water sample was collected in late April or early May at each of the eight sites to define preplanting conditions.

The Dismal River near Thedford and Tri-County Canal sites were only sampled twice during runoff events because of a lack of climatic and hydrologic variability. These sites are in the semiarid area of the study unit and do not generally experience the runoff conditions described above.

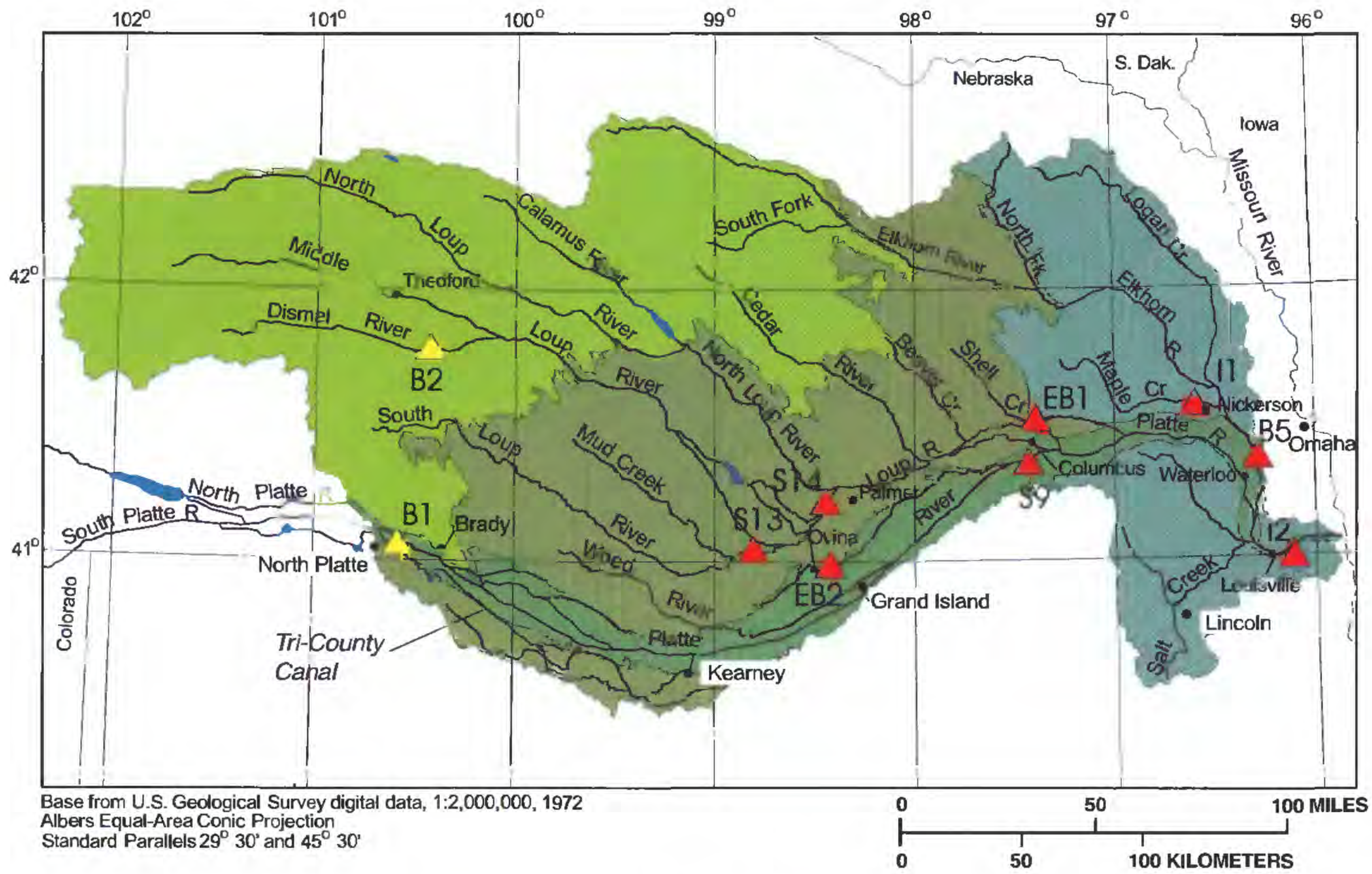
Data Collection

Field parameters
Nutrients
Organonitrogen herbicides
Chlorophenoxy-acid herbicides (1992 only)
Suspended sediment

Sites*

B1	Tri-County Canal 1.25 miles below diversion
EB2	Prairie Creek near Ovina
S9	Platte River near Duncan
B2	Dismal River near Thedford
S13	South Loup River at St. Michael
S14	Middle Loup River at St. Paul
EB1	Shell Creek near Columbus
I1	Maple Creek near Nickerson
B5	Elkhorn River at Waterloo
I2	Platte River at Louisville

*See site explanation for complete site description (page 3).



EXPLANATION

B1 △ Synoptic site (2 samples during runoff event)

S13 ▲ Synoptic site (7 samples during first runoff event)

Figure 3. Locations of spring runoff synoptic sites, Central Nebraska Basins study unit.

View of aftermath of rainfall runoff event on a cornfield.

Collection of storm-runoff water sample, Maple Creek near Nickerson, Nebraska.

Collection of storm-runoff water sample from a bridge, South Loup River near St. Michael, Nebraska.

Preplant and Postplant Synoptic Surveys of Surface-Water Quality

Questions

Do the concentrations and occurrences of nutrients and organonitrogen herbicides in surface water vary during low-flow conditions, before planting, and late in the growing season with respect to land use and environmental settings?

How do concentrations and occurrences of nutrients and organonitrogen herbicides in surface water change between low-flow conditions before planting and those late in the growing season?

Field Strategy

The lowest concentrations of organonitrogen herbicides in Nebraska streams should occur at low flow in late winter or early spring, before the chemicals have been applied and when carryover from the previous year will be minimal because of soil leaching and microbial degradation. For the purpose of this report, low flow is the condition of a stream during hydrologically stable periods with no major storm, runoff, or ice-breakup events. Samples collected late in the growing season are characteristic of concentrations of nutrients and herbicides entering streams after most of the source material has been incorporated into plants or flushed from the system by runoff events.

Twenty-eight surface-water sites were selected to represent wide geographic coverages, diverse land uses, and different environmental settings (fig. 4). Water samples were collected at each site in the months of March and August of 1994.

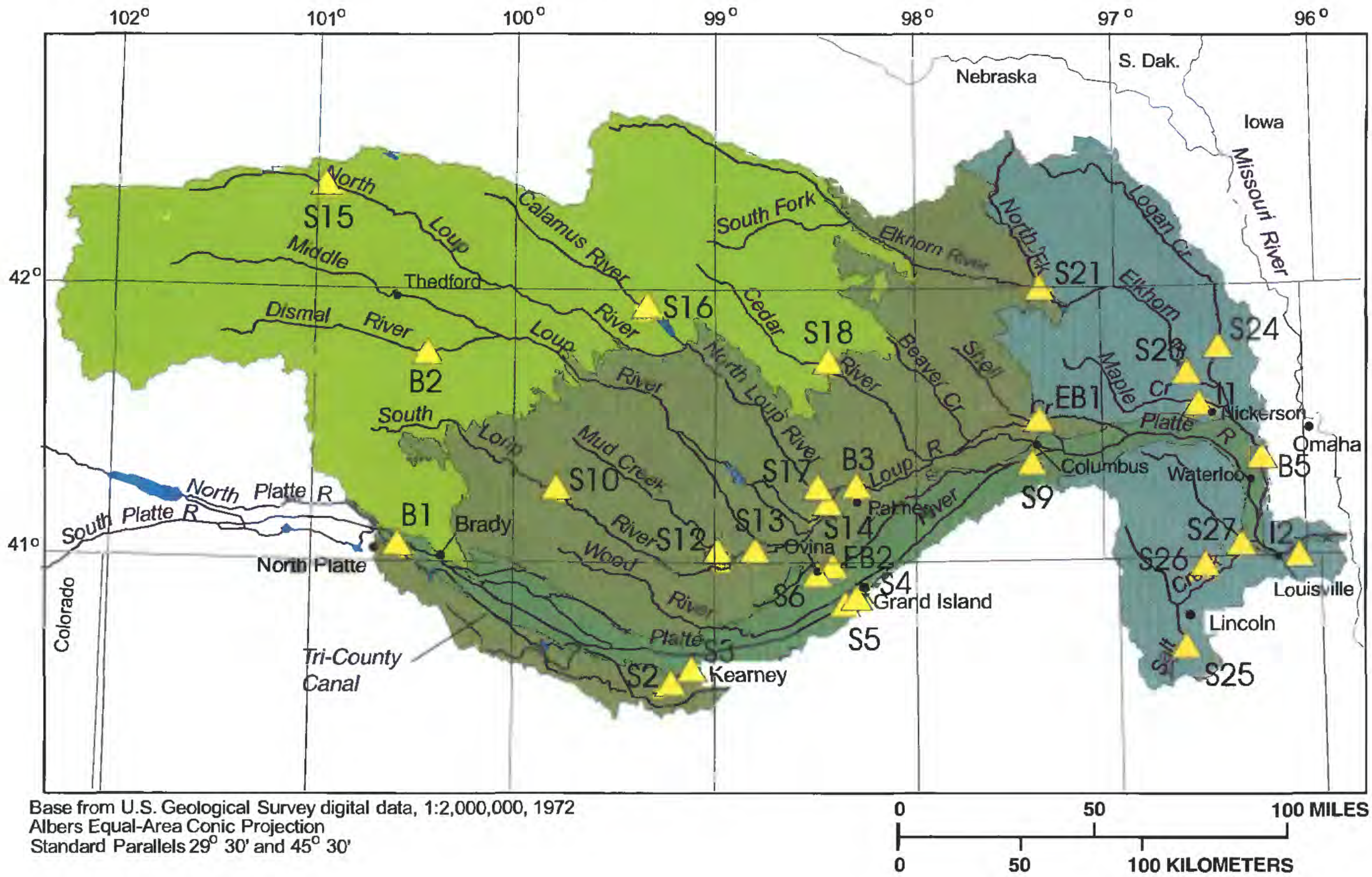
Data Collection

Field parameters
Nutrients
Organonitrogen herbicides

Sites*

B1	Tri-County Canal 1.25 miles below diversion
S2	North Dry Creek near Kearney
S3	Platte River near Kearney
B4	Platte River near Grand Island
S5	Wood River near Grand Island
EB2	Prairie Creek near Ovina
S6	Silver Creek at Ovina
S9	Platte River near Duncan
B2	Dismal River near Thedford
S10	South Loup River at Calloway
S12	Mud Creek near Sweetwater
S13	South Loup River at St. Michael
S14	Middle Loup River at St. Paul
S15	North Loup River North of Mullen
S16	Calamus River near Harrop
S17	North Loup River near St. Paul
B3	Loup River near Palmer
S18	Cedar River near Spalding
EB1	Shell Creek near Columbus
S21	Elkhorn River at Norfolk
S23	Pebble Creek near Scribner
S24	Logan Creek near Uehling
I1	Maple Creek near Nickerson
B5	Elkhorn River at Waterloo
S25	Salt Creek at Roca
S26	Salt Creek at Greenwood
S27	Wahoo Creek at Ashland
I2	Platte River at Louisville

*See site explanation for complete site description (page 3).



EXPLANATION

S5 △ Synoptic site

Figure 4. Locations of postplant and preplant synoptic survey sites, Central Nebraska Basins study unit.

Farmer applying agricultural chemicals to cornfield near Comstock, Nebraska.

Collection of water samples for preplant synoptic survey.

Platte River Alluvial Aquifer Reconnaissance Survey

Question

What is the quality of water in the Platte River alluvial aquifer?

Field Strategy

Exner and Spalding (1990) conducted a study of the occurrence of pesticides and nitrate in ground water in Nebraska. Their data indicated that atrazine concentrations greater than 1.0 μg/L (micrograms per liter) and nitrate as nitrogen, concentrations greater than 10 mg/L (milligrams per liter) were common in the Platte River alluvial aquifer. Zelt and Jordan (1993) compiled a data set for the CNBR study unit. That data indicated that the highest concentrations of atrazine and nitrate as nitrogen were found in the shallow (less than 82 feet deep) wells in the Platte River alluvial aquifer.

About 99 percent of the land in the CNBR study unit is used for agriculture. The Platte River, which drains the study unit, is connected hydraulically to the adjoining alluvial aquifer. The alluvial aquifer in the Platte Valley is shallow, unconfined, and highly susceptible to contamination caused by activities on the land surface or infiltration from the river. Eleven shallow alluvial wells areally distributed from North Platte to Louisville in the Platte River alluvial aquifer (fig. 5) were selected for one-time sampling to confirm the data compiled by Zelt and Jordan (1993). It was assumed that the water-quality samples from these wells were representative of large parts of the Platte River alluvial aquifer.

Because the river is connected hydraulically to the alluvial aquifer, the quality of the Platte River also was sampled once near Kearney, near Grand Island, and at Louisville. Water sampled from the Tri-County Canal 1.25 miles below diversion near North Platte represents the quality of the surface water entering the study unit. Water sampled from the Platte River near Grand Island represents the middle segment. Water sampled from the Platte River near Louisville represents the quality of the surface water leaving the CNBR study unit. A sample also was collected from Salt Creek at Greenwood. This site represented surface-water quality below the City of Lincoln metropolitan area, which is the largest city in the study unit.

Data Collection

Field parameters
Major ions
Nutrients
Trace elements
Organonitrogen herbicides
Synthetic organic compounds
Volatile and semivolatile organic compounds
Dissolved organic carbon
Radionuclides

Sites*

B1	Tri-County Canal 1.25 miles below diversion
B4	Platte River near Grand Island
I2	Platte River at Louisville
S26	Salt Creek at Greenwood
G10	South-Fence-S
G38	Wood R North-18
G48	Ent Road-18
G52	Girl Scout-13
G64	Schram SRA
G65	Two Rivers SRA
G66	Fremont TW6
G67	Schuyler
G68	Shelby
G69	Central City
G70	North Platte WCREC OBS7

*See site explanation for complete site description (page 3).

*

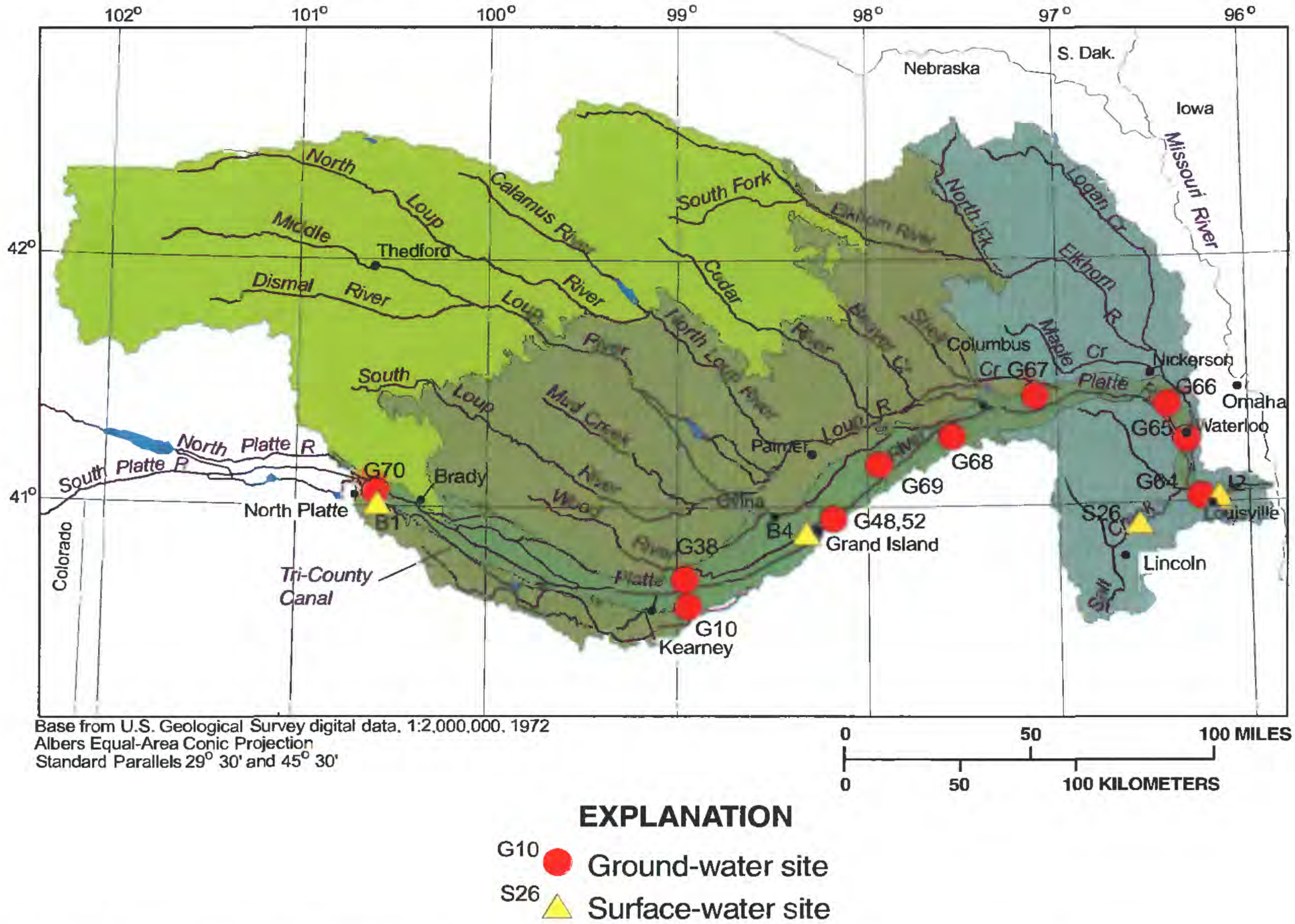


Figure 5. Locations of sites sampled during the Platte River alluvial aquifer reconnaissance survey, Central Nebraska Basins study unit.

Processing of ground-water samples in mobile laboratory.

Processing of ground-water samples for Platte Valley alluvial aquifer reconnaissance survey.

Preparation for collection of water sample from a domestic well.

Ground-Water Flowpath Studies

Question

What is the areal, vertical, and temporal distribution of agriculture related constituents in ground water along selected flowpaths in the Platte River alluvium?

Field strategy

Transport processes in ground water are important in understanding the effects of natural and human factors on water quality. Of the four environmental settings, the shallow aquifer in the Platte River alluvium is believed to be most susceptible to contamination associated with the land-use activities and natural or induced (caused by ground-water pumping) recharge from the Platte River. A series of wells were installed in a relatively small area (measured in acres) at several depths in a grid pattern to determine the water quality along lateral and vertical flowpaths in the Platte River alluvial aquifer. Multiple samples for water-quality analysis were collected. Water samples also were analyzed for tritium, chlorofluorocarbons, and stable isotopes to provide data on the ages and sources of the sampled ground water.

Two sites were selected for flowpath studies. A wet meadow near Kearney was selected for one of the flowpath studies (Emmons, 1996). The wet meadow, defined as grasslands that have waterlogged soils much of the year, is in a rural area in the Platte Valley environmental setting where little development of the ground water has taken place (fig. 6). The second flowpath study is in a public-supply well field owned by and near the City of Grand Island (Emmons, P.J., and Bowman, P.R., 2000), where significant development of the aquifer has taken place (fig. 6).

Observation wells were installed in the wet meadow along two transects at distances of about 20, 70, 120, 220, and 620 or 660 feet downgradient from the edge of a field that has been used to grow corn for several years. The number of wells at each distance ranges from one to five, and they were completed at depths ranging from about 15 to 100 feet. The wet meadow flowpath observation wells were completed with either 2.5- or 5-foot screens.

In the City of Grand Island well field, on an island between channels of the Platte River, observation wells were installed in four clusters along two transects approximately perpendicular to the north channel of the river. An additional cluster of observation wells was installed on the north side of the north channel of the Platte River. The clusters in the well field consist of five wells completed at depths of approximately 20, 40, 60, 90, and 123 feet, whereas the cluster north of the north channel consists of four wells completed at depths of about 13, 38, 70 and 114 feet. All of the public water supply flowpath observation wells were completed with 2.5-foot screens.

Data Collection

Field parameters

Major ions

Nutrients

Organonitrogen herbicides

Synthetic organic compounds[1]

Tritium[2]

Stable isotopes (oxygen-18 and deuterium)[2]

Dissolved gases[1]

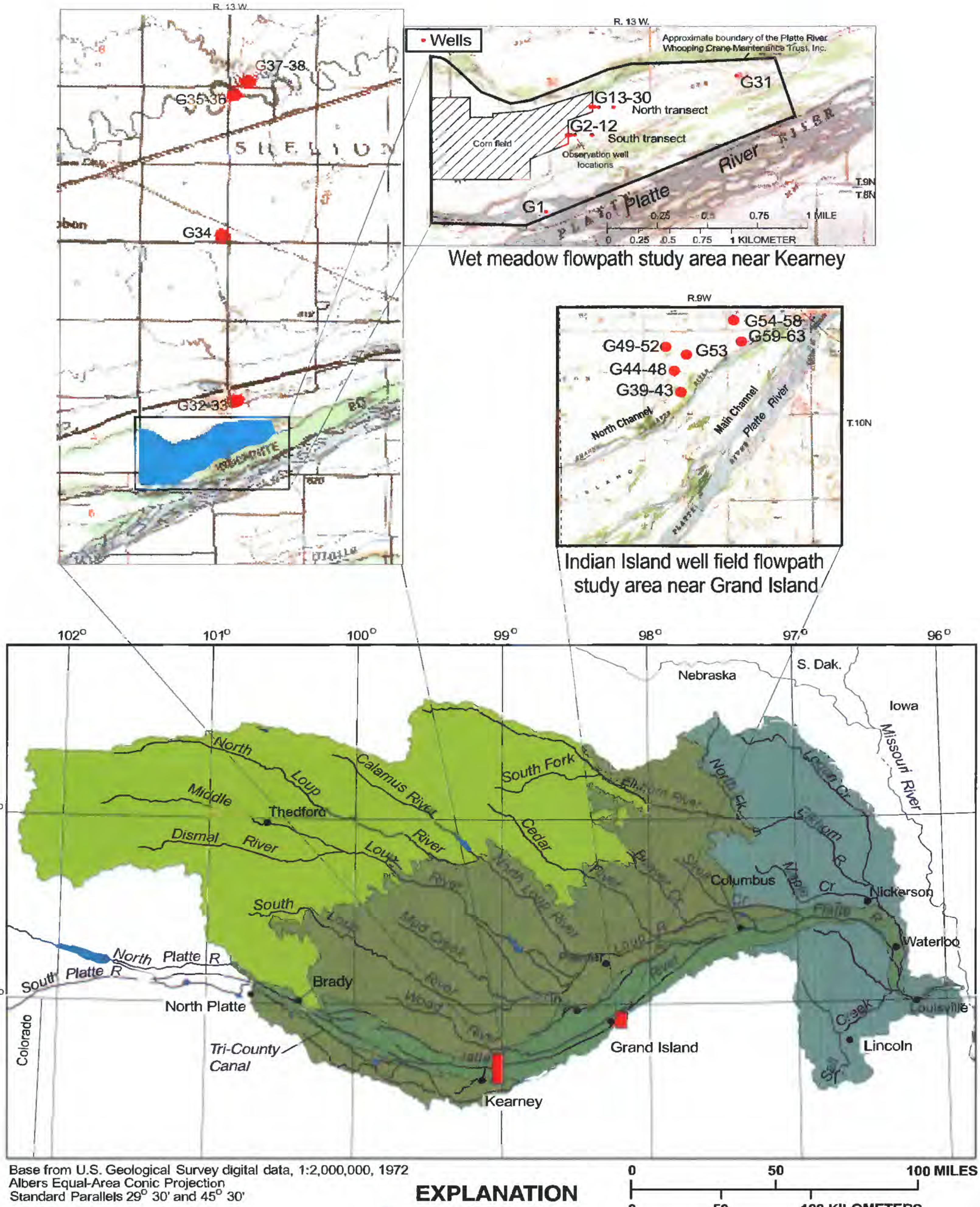
Chlorofluorocarbons[1]

[1]Collected from selected wells only.
[2]Collected from Platte River and selected wells only.

Sites*

G1	Platte River at Wet Meadow	G17	North-200-S	G33	Poison Ivy-18	G49	Girl Scout-123
G2	South-660-I	G18	North-200-I	G34	Blue House-66	G50	Girl Scout-78
G3	South-660-76	G19	North-200-D	G35	Wood South-79	G51	Girl Scout-38
G4	South-660-48	G20	North-100-S	G36	Wood River South-18	G52	Girl Scout-18
G5	South-660-15	G21	North-100-I	G37	Wood North-55	G53	Platte River at Girl Scout Camp
G6	South-660-DP	G22	North-100-D	G38	Wood River North-18	G54	River-123
G7	South-200-I	G23	North-50-S	G39	Trees-123	G55	River-105
G8	South-100-I	G24	North-50-I	G40	Trees-88	G56	River-78
G9	South-50-I	G25	North-Fence-I	G41	Trees-58	G57	River-50
G10	South-Fence-S	G26	North-Fence-S	G42	Trees-33	G58	River-20
G11	South-Fence-I	G27	North-Fence-103	G43	Trees-18	G59	Windmill-123
G12	South-Fence-DP	G28	North-Fence-78	G44	Ent Road-123	G60	Windmill-98
G13	North-600-S	G29	North-Fence-48	G45	Ent Road-98	G61	Windmill-63
G14	North-600-I	G30	North-Fence-DP	G46	Ent Road-63	G62	Windmill-43
G15	North-600-D	G31	East-D	G47	Ent Road-33	G63	Windmill-18
G16	North-600-DP	G32	Poison Ivy-77	G48	Ent Road-18		

*See site explanation for complete site description (page 3).



EXPLANATION

Flowpath study site

Figure 6. Locations of flowpath study areas near Kearney and Grand Island, Nebraska.

Stream Ecology Study

Questions

How are biological communities related to land use, habitat, and water chemistry?

How much do habitat and biological communities change between streams and over time?

Field Strategy

The goal of this activity was to relate stream biology and habitat characteristics to surface-water quality. Nine ecological fixed sites (fig. 7) were established representing various land use and environmental settings and located in close geographic association with the surface-water fixed sites to take advantage of available water and bed-sediment chemistry data. The Tri-County Canal, although representative of the water chemistry, is not typical of the biological and habitat characteristics of the Platte River channel itself at the entrance of the study unit. The North Channel of the Platte River at Brady, approximately 20 miles downstream of the Tri-County Canal diversion, was selected as a site that is representative of the biological and habitat characteristics of the Platte River at the upstream end of the study unit.

All field biologic and habitat data were collected from reaches typical of the local area (Meador and Gurtz, 1994). The reaches were based on repeated geomorphic units, such as meanders, runs, and riffles. The geomorphic unit used most in the CNBR study unit was the meander. However, sites on the braided channels of the Platte and other large river sites are generally one continuous run, and meanders are either not present or are too long to be practical for field activities. Reaches that were sampled were generally less than 300 meters long and equal to about 20 channel widths in length. Large-river sites that were sampled included the North Channel of the Platte River at Brady, the Platte River near Grand Island, the Platte River at Louisville, the Loup River at Palmer, and the Elkhorn River at Waterloo. Reaches at the large-river sites were limited to 300 meters in length or less, because 20 channel widths would have been excessively long. Sampling at the ecological fixed sites was conducted during the late summer, when low-flow conditions prevailed.

In 1994, three reaches at each of three sites (fig. 7)—the Dismal River near Thedford, Platte River near Grand Island, and Maple Creek near Nickerson—were sampled to assess potential variability of biological community structure and habitat at each site. These sites also were sampled during multiple years, 1993 through 1995, at a single reach to measure variability over time.

Semiquantitative macroinvertebrate and algal samples were collected from woody debris, snags, and depositional areas, and processed through a 425-micrometer sieve. Qualitative samples were collected from all available habitats and processed through a 210-micrometer sieve (Cuffney and others, 1993). Algal samples were collected in habitats similar to those where benthic invertebrate samples were collected (Porter and others, 1993).

Fish assemblages were sampled using pulsed-direct-current electrofishing equipment (Meador, Cuffney, and others (1993). Generally, two passes were made through the stream reach, with separate identification and enumeration totals for each pass. Fish were identified onsite by species.

The physical habitat of streams is composed of several layers of information, according to Meador and Gurtz (1994). Much of the information can be obtained from geographic information system databases and topographic maps. However, many stream, bank, and floodplain features were measured in the field as reach-level habitat data (Meador, Hupp, and others, 1993). These features included substrate type, width and depth profiles, stream velocity, stream slope, stream-bank height, and stream-bank stability.

Water temperature is an important parameter that can help investigators assess the amount of stress to which a stream is exposed and the level of biological activity. All ecological fixed sites were equipped with submersible water-temperature recorders and data were collected at 30- to 90-minute intervals from April 1993 through September 1995.

A joint regional synoptic survey was conducted in the late summer of 1993 at 12 additional sites, in conjunction with the South Platte NAWQA study unit, to assess ecological impacts of water quality on a larger scale. Stream habitat features were measured and benthic invertebrate and algal communities were sampled at the sites as part of the synoptic survey.

Data Collection

- Community structure samples
  - Macroinvertebrates
  - Algae
  - Fish
- Habitat characteristics
  - Sun angle
  - Stream slope
  - Stream width
  - Stream depth
  - Stream velocity
  - Stream sinuosity
  - Stream-bank height
  - Stream-floodplain width
  - Stream substrate
  - Water temperature

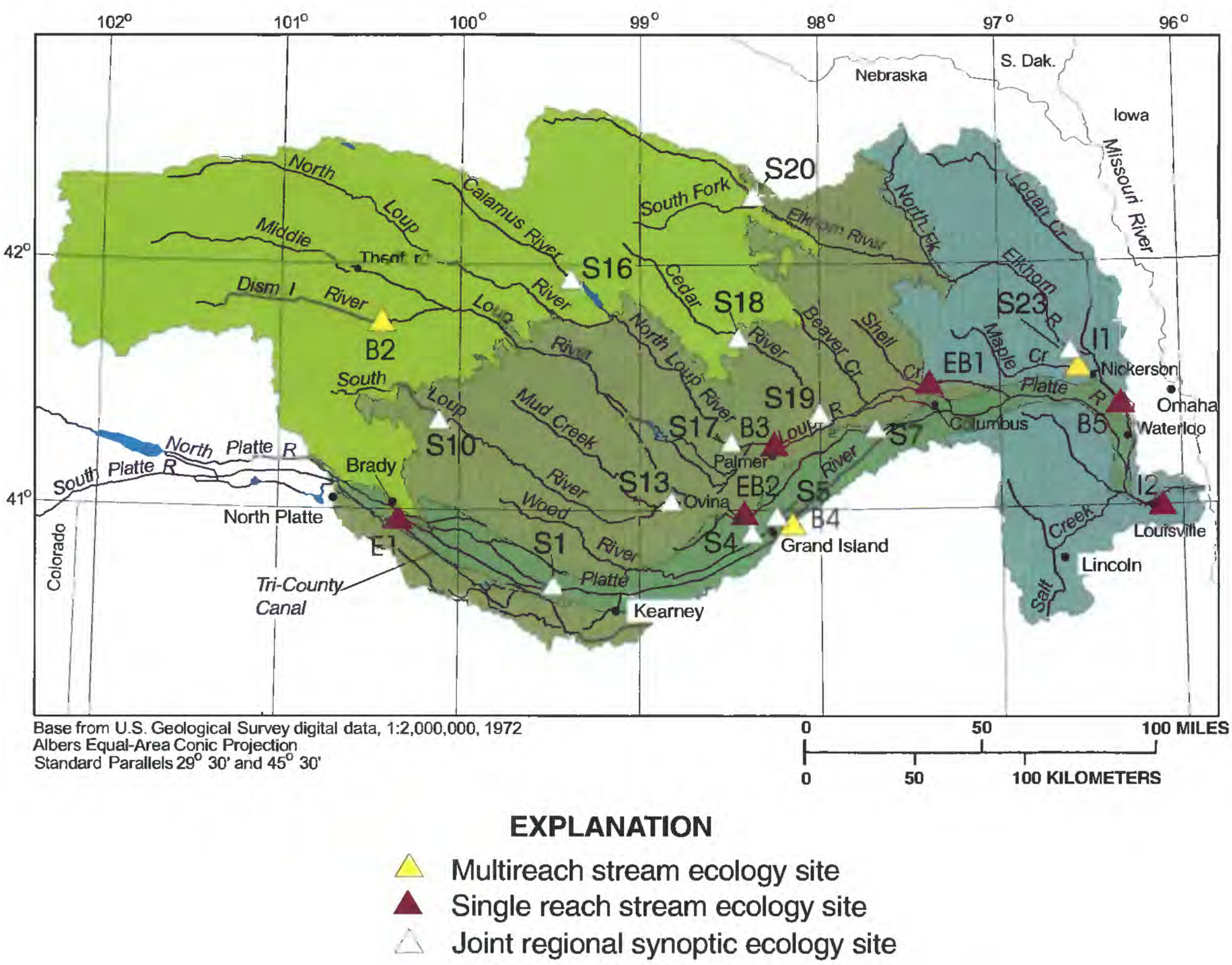


Figure 7. Locations of stream ecology sampling sites.

Sites*

E1	North Channel of the Platte River at Brady
B2	Dismal River near Thedford[1]
B3	Loup River at Palmer
B4	Platte River near Grand Island[1]
EB1	Shell Creek near Columbus
B5	Elkhorn River at Waterloo
EB2	Prairie Creek near Ovina
I1	Maple Creek near Nickerson[1]
I2	Platte River near Louisville
S1	Platte River near Overton[2]
S13	South Loup River at St. Michael[2]
S10	South Loup River at Calloway[2]
S16	Calamus River near Harrup[2]
S17	North Loup River near St. Paul[2]
S18	Cedar River near Spalding[2]
S19	Cedar River near Fullerton[2]
S4	Wood River near Alda[2]
S5	Wood River near Grand Island[2]
S7	Prairie Creek near Silver Creek[2]
S20	Elkhorn River near Ewing[2]
S23	Pebble Creek near Scribner[2]

[1]Multireach site.
[2]Regional synoptic survey site.
*See site explanation for complete site description (page 3).

Collection of sample of benthic macroinvertebrates at Shell Creek, Nebraska.

Collection of reach habitat information at Dismal River near Thedford, Nebraska.

Stream Contaminant Study

Question

What contaminants are found in the streams of central Nebraska?

Field Strategy

Contaminants may be present in the water column on an infrequent basis or at concentrations that are difficult to detect. However, through the processes of sorption to fine-grained sediments, bioaccumulation, and biological magnification, these contaminants may be concentrated in streambed sediments or in animal and plant tissue hundreds to thousands of times above their concentrations in the water column. Therefore, streambed sediment and fish tissue are ideal media for identifying the occurrence and distribution of some contaminants (Frenzel, 1996).

Samples of fine-grained sediment and organic material from the top 2 centimeters of streambed-sediment depositional zones were collected and analyzed for a broad suite of trace elements and synthetic organic compounds as described by Shelton and Capel (1994). Streambed-sediment fines were wet sieved through a 63-micrometer nylon mesh screen and analyzed for trace elements, major ions, and organic carbon. Synthetic organic compounds in streambed sediment were analyzed from streambed-sediment fines wet sieved to 2 millimeters in a stainless steel sieve.

Reconnaisance methods were used to select fish species for contaminant analysis from appropriate resident species. The selected resident species is one that is fairly ubiquitous across the nation, lives in close association with streambed sediments, and is identified in the National Target Taxa List defined by Crawford and Luoma (1993). Species that matched this list were sampled during the study and included common carp (*Cyprinus carpio*), white sucker (*Catostomus commersoni*), river carpsucker (*Carpiodes carpio*), and channel catfish (*Ictalurus punctatus*). Fish tissue samples consisting of composites of livers from five or more individuals were analyzed for trace elements. Composites of five or more whole fish were analyzed for organic synthetic compounds.

In September 1992, 18 sites were selected (fig. 8) that represented various environmental settings and wide geographic dispersal. Streambed sediment and fish tissue were collected during low-flow conditions and were analyzed for trace elements and synthetic organic compounds. Streambed-sediment samples were collected at all nine ecological fixed sites and at the Wood River near Grand Island and Salt Creek at Greenwood sites in 1995. Samples of whole-body fish tissue were collected at all nine ecological fixed sites in 1993 for analysis for synthetic organic compounds, with the exception of Prairie Creek near Ovina, where fish were too scarce to complete the sample. Water-column samples were collected concurrently with streambed-sediment and fish-tissue samples, and were analyzed for nutrients and organonitrogen herbicides.

Data Collection

- Streambed Sediments
  - Major ions
  - Trace elements
  - Pesticides
  - Base/neutral acids
  - Organic carbon
  - Synthetic organic compounds
- Tissue
  - Major ions
  - Trace elements
  - Pesticides
  - Base/neutral acids
  - Synthetic organic compounds
- Water Column
  - Field parameters
  - Nutrients
  - Organonitrogen herbicides

Sites*

E1	North Channel of the Platte River at Brady
S1	Platte River near Overton
B4	Platte River near Grand Island
S5	Wood River near Grand Island
S7	Prairie Creek near Silver Creek
S11	South Loup River near Cumro
S12	Mud Creek near Sweetwater
S14	Middle Loup River at St. Paul
S15	North Loup River North of Mullen
S16	Calamus River near Harrop
S17	North Loup River near St. Paul
S18	Cedar River near Spalding
S21	Elkhorn River at Norfolk
S22	Elkhorn River at West Point
B5	Elkhorn River at Waterloo
S25	Salt Creek at Roca
S26	Salt Creek at Greenwood
I2	Platte River at Louisville
EB2	Prairie Creek near Ovina
EB1	Shell Creek near Columbus
B3	Loup River at Palmer
I1	Maple Creek near Nickerson
B2	Dismal River near Thedford

*See site explanation for complete site description (page 3).

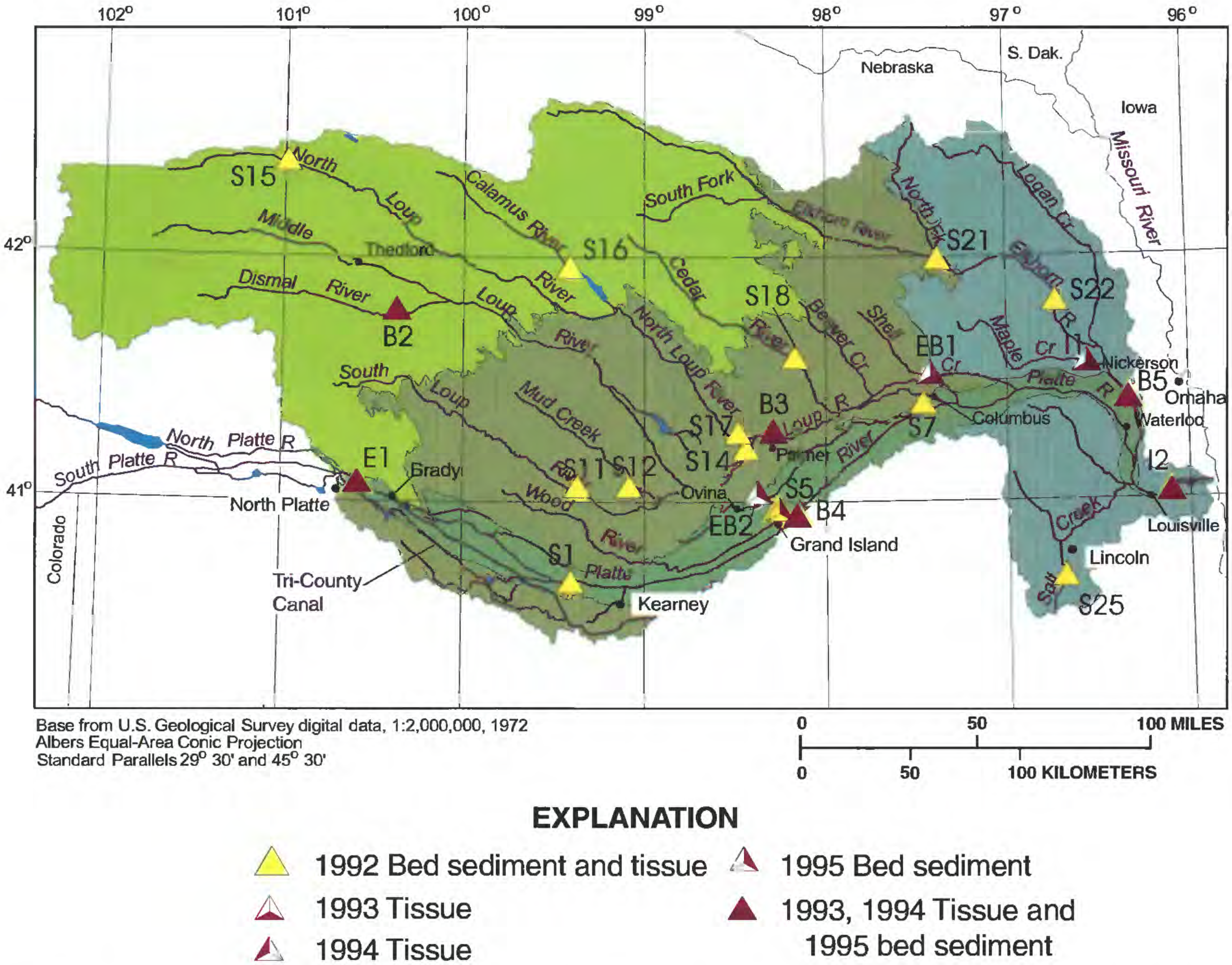


Figure 8. Locations of sites sampled for contaminants in streambed sediment and fish tissue during synoptic survey.

Collection of fish for tissue samples at the North Loup River near St. Paul, Nebraska.

Wetlands Study

Question

What are the physical, biological, and chemical characteristics of wetlands in central Nebraska?

Field Strategy

The CNBR study unit lies entirely within the Central Flyway migratory route and includes numerous wetlands providing migrational and breeding habitat for shorebirds and waterfowl (Gersib, 1991). Wetlands support a number of functions to enhance wildlife in the study unit including flood and erosion control, sediment trapping, and nutrient retention (Frankforter, 1995), and serve as remediation areas for contaminants (Lee and others, 1995).

Thirty-one sites were selected to represent the four environmental settings of central Nebraska (fig. 9) on the basis of water depth, impoundment size, and land management practices (Frankforter, 1995). Areas under the protection of a government or private organization were sampled, so trends in water quality of the wetlands and their vulnerability to changes in climate and hydrology could be assessed in the future. Although many of the sites were riverine, others were not near rivers and streams, allowing for greater spatial distribution across the study unit than would be possible if sampling were restricted to rivers and streams.

Wetlands were sampled early in the crop-growing season in May 1994 and during the late growing season in August 1994. The relation of contaminants to local land use, the response of the wetlands to seasonal loading of agricultural chemicals, and contaminant concentration caused by evaporation of water bodies in late summer were investigated. Chemical analyses of water column, bed sediment, and tissue allowed researchers to study phase changes and compartmentalization of the constituents.

At each of the 31 sites, water-column and bed-sediment samples were collected along a transect (fig. 10) that intersected as many different habitats in the wetland as possible (Swanson, 1995). Analysis for trace elements in tissue, streambed sediment, and the water column were performed during August 1994 at sites where odonate (dragonfly) nymphs could be collected in sufficient quantity for analysis. The biology of the wetlands was characterized by collecting qualitative benthic invertebrate, algal, and plant-community samples in the vicinity of the transect.

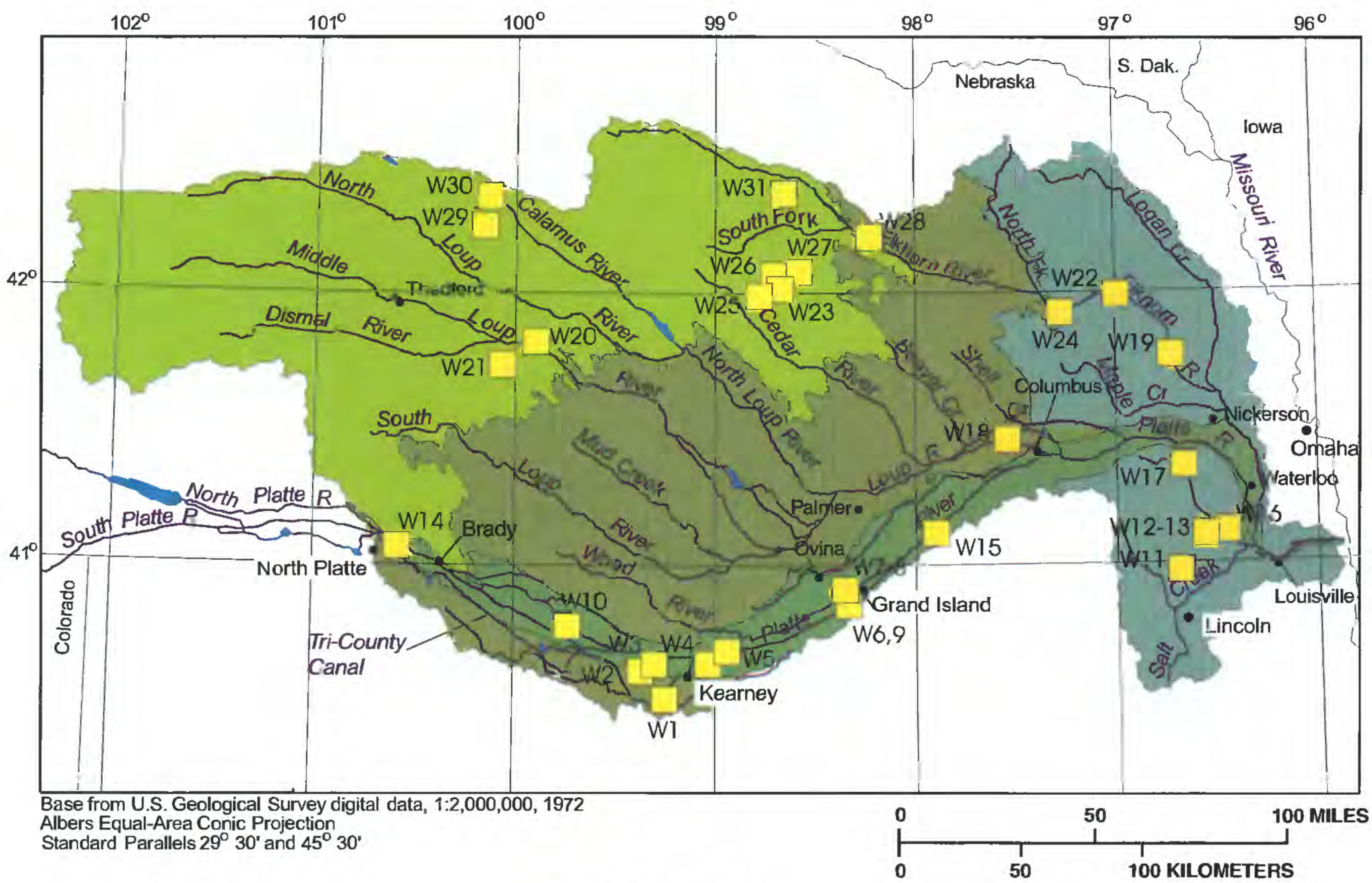
Data Collection

- Taxonomic
  - Macroinvertebrates
  - Algae
  - Macrophytes
- Chemical
  - Water column
    - Field parameters
    - Major ions
    - Nutrients
    - Trace elements
    - Organonitrogen herbicides
    - Chlorophyll-a
  - Bed sediment
    - Major ions
    - Nutrients
    - Trace elements
    - Organic carbon
    - Organonitrogen herbicides
  - Tissue (Odonate nymphs)
    - Major ions
    - Trace elements
- Physical
  - Location
  - Depth
  - Clarity

Sites*

W1	Johnson Waterfowl Production Area
W2	Whooping Crane Trust - Elm Creek Slough
W3	Blue Hole Wildlife Management Area
W4	Bassway Strip Wildlife Management Area
W5	Whooping Crane Trust- Dippel Site
W6	Whooping Crane Trust- Wild Rose Slough
W7	Whooping Crane Trust- Mormon Island Crane Meadow
W8	Whooping Crane Trust- Mormon Island Crane Meadow
W9	Loch Linda Wildlife Management Area
W10	Bittern's Call Wildlife Management Area
W11	Bennett Saline Wetland
W12	Otto Saline Wetland
W13	Sabatka Saline Wetland
W14	Miller Lake Outflow
W15	Department of Roads - Central City
W16	Todd Valley - Proctor Site
W17	Todd Valley - Meduna Site
W18	Prairie Wolf Wildlife Management Area
W19	Powder Horn Wildlife Management Area
W20	Milburn Dam Wildlife Management Area
W21	Department of Roads - Dunning
W22	Wood Duck Wildlife Management Area
W23	Foxley Farms - Lake Fred
W24	Black Island Wildlife Management Area
W25	Foxley Farms - No. 1
W26	Foxley Farms - No. 5
W27	Goose Lake Wildlife Management Area
W28	Hackberry Creek Wildlife Management Area
W29	Long Lake State Recreation Area
W30	American Game Marsh Wildlife Management Area
W31	Department of Roads - O'Neill

*See site explanation for complete site description (page 3).



EXPLANATION

W10 Wetland site

Figure 9. Locations of wetland sites sampled in 1994, Central Nebraska Basins study unit.

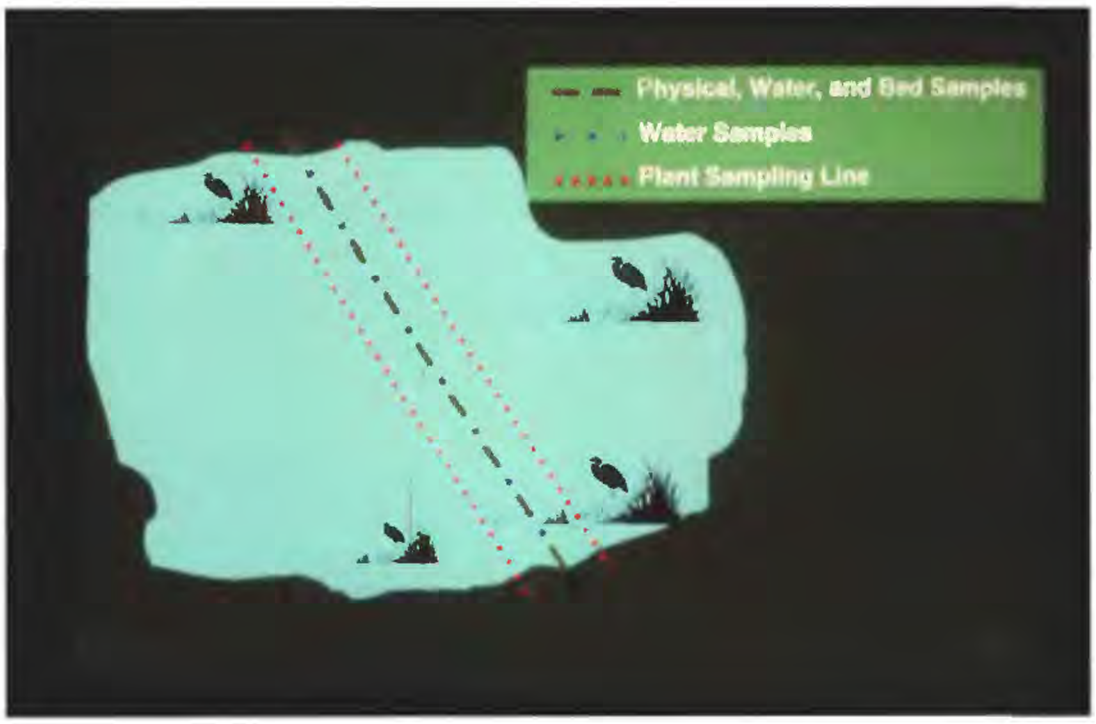


Figure 10. Wetland transect showing water quality, streambed sediment, and plant sampling lines.

Collection of odonate nymphs for tissue analysis, Goose Lake Wildlife Management Area.

Collection of water samples along transect at wetland near O'Neill, Nebraska.

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