A Selected Bibliography on the Hydrology of the Platte River Basin in Nebraska Through 1991

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CONVERSION FACTORS

Multiply	By	To obtain
inch	2.54	millimeter
foot	0.3048	meter
mile	1.609	kilometer
acre	4,047	square meter
square mile	2.590	square kilometer
cubic foot per second	0.02832	cubic meter per second
acre-foot	1,233	cubic meter
million gallons per day	0.04381	cubic meter per second
pound per acre	1.121	kilogram per hectare

Selected Bibliography on the Hydrology of the Platte River Basin in Nebraska Through 1991

By Melissa L. Hardgree[1] *and* Jennifer McChesney[2]

Abstract

A literature search on the hydrology of the Platte River Basin in Nebraska was conducted to help facilitate current and future water-quality assessments of the Central Nebraska Basins for the U.S. Geological Survey's National Water-Quality Assessment Program and the U.S. Environmental Protection Agency's Platte River Ecosystem Management Initiative. More than 1,000 citations from the scientific literature on water resources and water quality were obtained from six computerized bibliographic data bases—GEOREF, NTIS, COMPENDEX PLUS, WATER RESOURCES ABSTRACTS, WATERNET, and OCLC. Federal, State, and local agencies, universities, and private groups also provided reference materials. Selected studies conducted in the Platte River Ecosystem Management Initiative area are described in the report. Appropriate audio-visual materials from the U.S. Environmental Protection Agency, Region VII Wetlands Protection Section, also are included. The references are available on 5 1/4- and 3 1/2-inch computer diskettes from the U.S. Geological Survey in Lawrence, Kansas.

INTRODUCTION

The U.S. Geological Survey (USGS) initiated a National Water-Quality Assessment (NAWQA) Program to describe the status and trends in the quality of a large, representative part of the Nation's surface- and ground-water resources and to provide a sound, scientific understanding of the primary natural and human factors affecting the quality of these resources (Huntzinger, 1991). In meeting these long-term goals, the program provides water-quality information that will be useful to policy makers and managers at the national, state, and local levels. Sixty study units were identified for water-quality assessment activities. These study units generally correspond to the major river basins throughout the United States (fig. 1). The Central Nebraska Basins study unit was one of the initial 20 started in fiscal year 1991 (Leahy and others, 1990). This study unit includes the Platte River and its tributaries from the confluence of the North and South Platte Rivers at North Platte, Nebraska, downstream to the Missouri River north of Omaha (fig. 2).

The U.S. Environmental Protection Agency (USEPA), Region VII, initiated the Platte River Ecosystem Management Initiative (PREMI) in 1990 (Elfving, 1992). The Nebraska Department of Environmental Quality (NDEQ) has since joined the USEPA in this effort to address ways in which the Platte River and its ecosystem can be protected and enhanced through improved water-quality management. The focus of the USEPA and the NDEQ in the PREMI is on water quality of the river, its associated riparian areas, and its alluvial aquifer. The goals of the PREMI program are to enhance, maintain, and expand, as necessary, efforts to protect water quality, public health, and the environment in the Platte River Basin of Nebraska through comprehensive and integrated Federal, State, and local environmental program management and implementation. The PREMI study area includes all of the Platte River Basin that is in Nebraska.

To help facilitate the current and future water-quality assessment of the USGS's Central Nebraska Basins study unit and the USEPA's Platte River study area, a search of the scientific literature was performed, and more than 1,000 citations of published or unpublished reports, pamphlets,

[1]U.S. Environmental Protection Agency, Region VII, Kansas City, Kansas.
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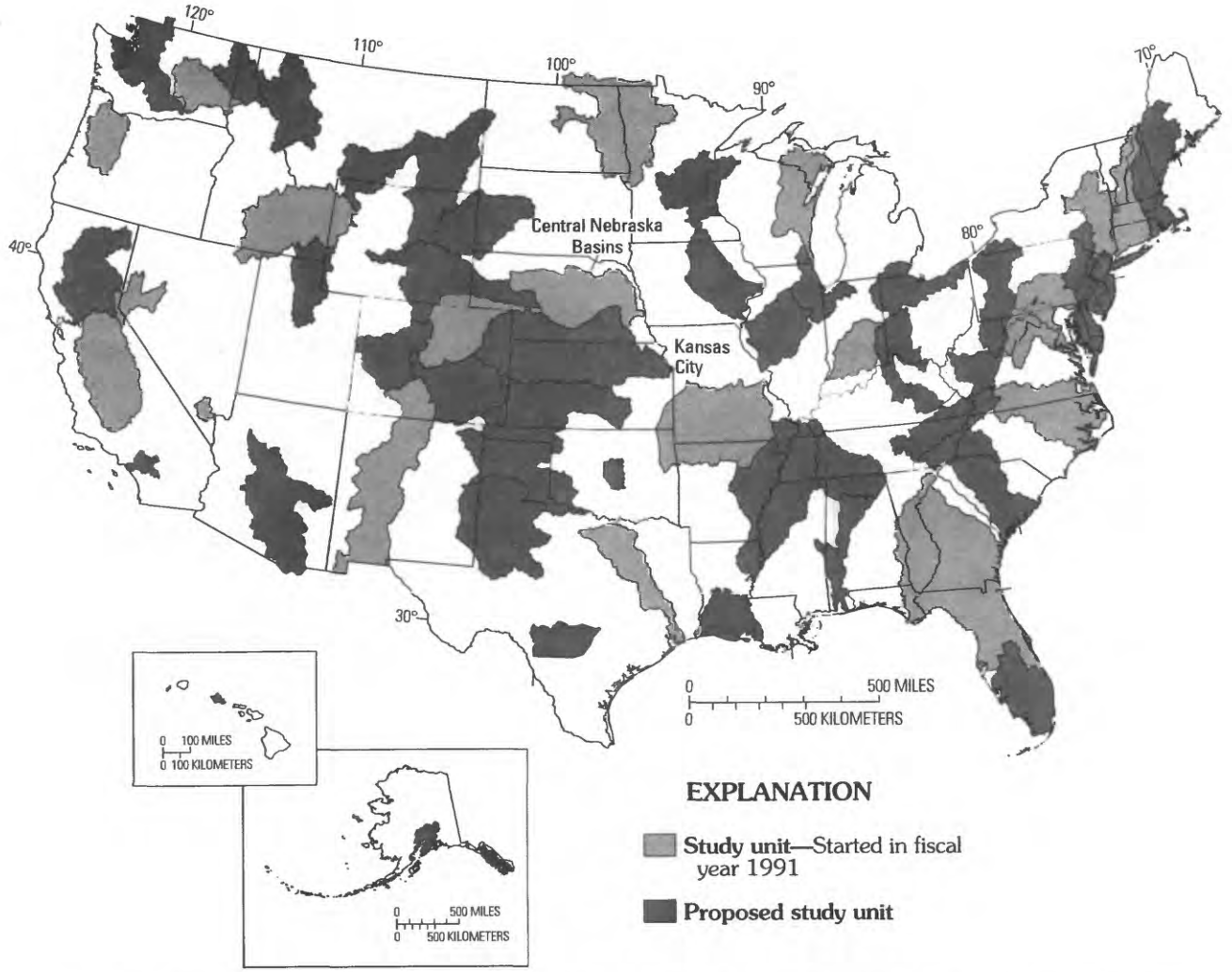

Figure 1. Location of study units for the U.S. Geological Survey's National Water-Quality Assessment Program (modified from Leahy and others, 1990).

research projects, magazine and journal articles, conference proceedings, theses, dissertations, and videos concerning water resources and water quality were compiled. In addition, selected studies conducted in the Platte River Ecosystem Management Initiative study area are described in this report.

ACKNOWLEDGMENTS

Many agencies and local organizations provided publication lists and abstracts that were included in the report. The authors wish to thank Federal and State agencies and the members of the Central Nebraska Basins NAWQA Liaison Committee for their cooperation in providing information for this report. Without their contribution, the report would be less useful.

SOURCES OF LITERATURE CITATIONS

Automated library searches were conducted utilizing six bibliographic data bases. References for this report were selected on the basis of geographic boundaries of the Central Nebraska Basins study unit. The following data bases were used to conduct automated library searches: (1) the GEOREF data base (American Geological Institute, Alexandria, Va.) consists of "Bibliography and Index of North American Geology," "Bibliography of Theses in Geology," "Geophysical Abstracts," "Bibliography and Index of Geology Exclusive of North America," and "Bibliography and Index of Geology;" (2) the NTIS data base (National Technical Information Service, Springfield, Va.) consists of government-sponsored research, development, and engineering,

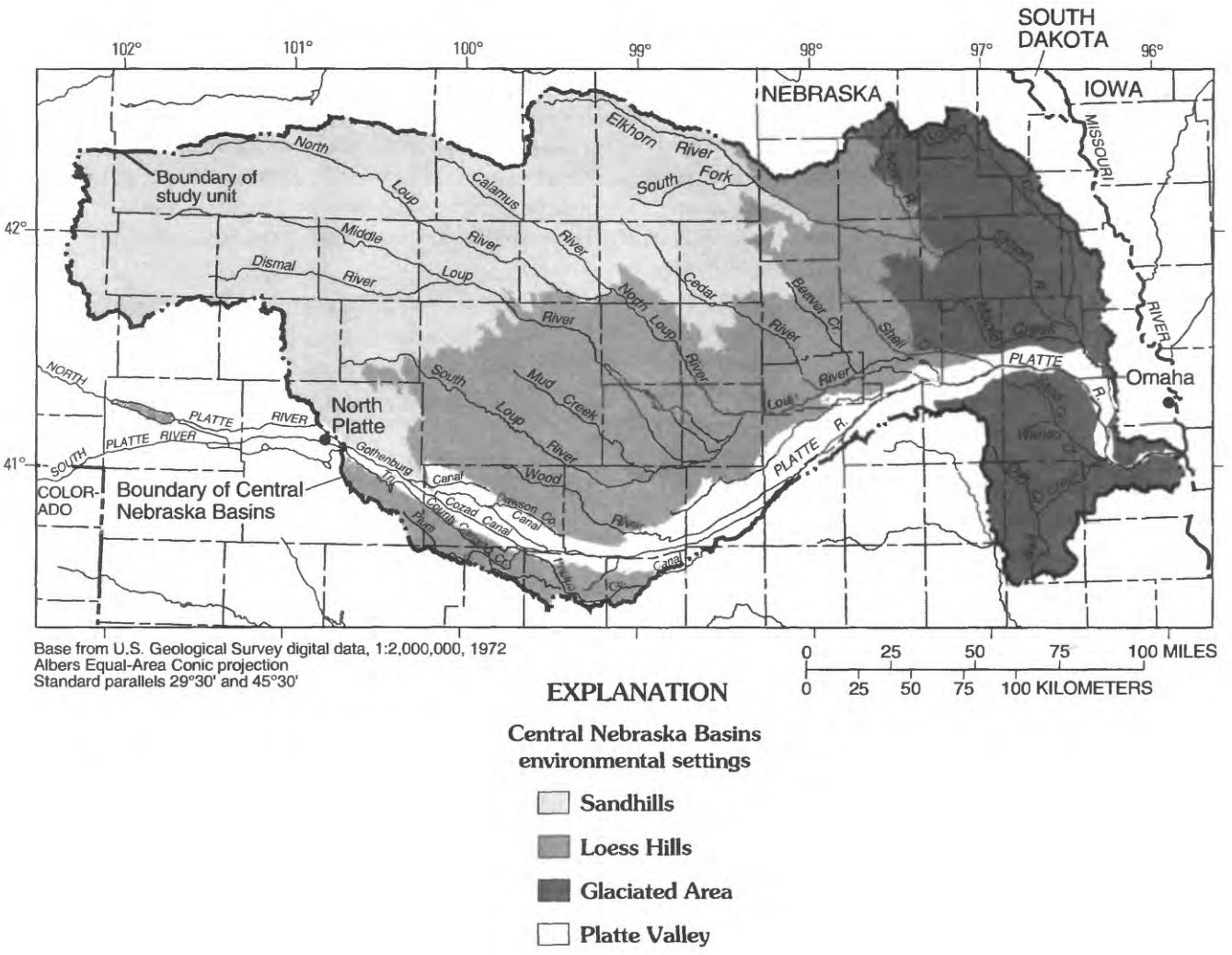

Figure 2. Location of the Central Nebraska Basins study unit (modified from Huntzinger, 1991).

plus analyses prepared by Federal agencies, their contractors, or grantees; (3) the COMPENDEX*PLUS data base (Engineering Information, Inc., New York, N.Y.) is the machine-readable version of the Engineering Index; (4) WATER RESOURCES ABSTRACTS (WRA) is prepared from materials collected by more than 50 water research centers and institutes in the United States (U.S. Department of the Interior, 1991); (5) WATERNET provides a comprehensive index of the publications of the American Water Works Association (Denver, Colo.) and their research foundation; and (6) the OCLC data base contains more than 23 million bibliographic

records, including dissertations and theses, and is used by almost 14,000 libraries for cataloging purposes (OCLC Online Union Catalog, 1991).

Ground-water literature was selected using the key words High Plains, Ogallala, and Sandhills, which are three principal aquifers in the Central Nebraska study unit. Surface-water literature was compiled using the names of rivers found within the study unit as key words and spatially limiting them to Nebraska and states upstream of the study area (Colorado and Wyoming). The river names used were Platte, Elkhorn, Loup, and Cedar Rivers.

References additionally produced by the literature search included publications from: (1) the U.S. Environmental Protection Agency's Region VII Office in Kansas City, Kansas; (2) State and Federal agencies and local organizations who have responsibilities and interests within the Platte River Basin; (3) private groups, such as The Whooping Crane Trust and The National Audubon Society; and (4) the U.S. Geological Survey.

SELECTION OF CITATIONS, STUDY DESCRIPTIONS, AUDIO-VISUAL MATERIALS, AND ABSTRACTS

The list of references in this report include citations related to water resources and water quality. References are listed in alphabetical order by author. In some cases, references are only partially complete but were deemed important enough to retain in this bibliography. The reference list, organized alphabetically by author's last name or organizational name also is available on 5 1/4-inch and 3 1/2-inch computer diskettes under two main directories—"AUTHOR" and "PROJECT and AUDIOS." There are eight files in each directory; the files are named A–C, D–F, G–I, J–L, M–O, P–R, S–U, and V–Z. For example, to find an abstract for author Adams, one must first access the directory AUTHOR, then the file named A-C. The diskettes are in standard ASCII format for relatively universal retrieval by most computer systems and are available from the U.S. Geological Survey office in Lawrence, Kansas. The requestor will be charged the cost of the diskette and the labor involved in transferring the files to the diskette.

Study descriptions in this report relate to hydrologic investigations conducted in the Platte River Basin that had reports on file with the USEPA office in Kansas City, Kansas.

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STUDY DESCRIPTIONS

Ashton, G.D., 1989, Ice effects on hydraulics and fish habitat: U.S. Army Corps of Engineers, Omaha District, 51 p.

Study Description: The formation of ice on a stream may result in different hydraulic conditions of depth of water and velocity even when the stream discharge does not change. This report is a summarization of the effects of river ice on hydraulic behavior with examples meant to provide guidance in evaluating what habitats may be expected in winter in comparison with non-ice conditions of the same stream. Emphasis is on a shallow river such as the Platte River in Nebraska.

Bartels, Carlton, and Bernow, Stephen, 1989, Regulating the Kingsley hydroelectric facility and dam to provide scouring flows on the Platte River: Energy Systems Research Group, Report No. 89-134, 26 p.

Study Description: This report summarizes a preliminary study of the effects of the Kingsley hydroelectric facility on the habitat of the sandhill cranes and other migrating wildlife in the Platte River Basin. This important habitat has been deteriorating owing to use of the river for crop irrigation and hydroelectric production for over half a century. The purpose of this study is to provide an initial evaluation of the potential for improving the habitat through modification of the existing operating practices at the Kingsley hydroelectric facility to provide scouring flows.

Bartz, P.A., Kastner, W.M., and Ellis, M.J., 1990, Nebraska water supply and use, *in* National water summary 1987—Hydrologic events and water supply and use: U.S. Geological Survey Water-Supply Paper 2350, p. 345-352.

Study Description: This report talks about the history of water development, water use, public supply, domestic and commercial, industrial and mining, thermoelectric power, agricultural, and water management.

Bentall, Ray, 1982, Nebraska's Platte River—A graphic analysis of flows: Lincoln, University of Nebraska-Lincoln, Conservation and Survey Division, Nebraska Water Survey Paper 53, 47 p.

Study Description: This report contains many graphic analyses of the Platte River in order to portray data on historic Platte River flows and to explain why flow amounts differ at the several gaging sites along the river. Several water-usage, water-diversion, and water-storage projects within the last few years have been proposed. Their effects on the river's flow is feared by many to be detrimental to the large flocks of migrating waterfowl and to be detrimental to river flows because of ground-water withdrawals. Therefore, the author hopes that this presentation of facts about recorded annual mean discharges, mean and median annual discharges since 1942, annual least daily and least monthly discharges, and annual maximum instantaneous discharges at gaging stations will help to place those fears in proper perspective.

Bentall, Ray, 1991, Special supplement to the 1991 Nebraska Water Conference, "Facts and figures about Nebraska rivers": Lincoln, University of Nebraska-Lincoln, Conservation and Survey Division, 52 p.

Study Description: The special supplement to the 1991 Nebraska Water Conference Report contains facts and figures about rivers throughout Nebraska.

Bueltel, Clarence, 1982, A hydrology study—Technical paper, Ground water depletion: Omaha, Nebr., Missouri River Basin States Association, 238 p.

Study Description: The number of irrigation wells in the Platte River Basin and the Kansas River Basin is increasing at a very rapid rate. From 1968 to 1978, irrigation wells in the Platte Basin increased almost 65 percent and in the Kansas Basin 71 percent. This report shows how the irrigation volumes are very significant when compared to the average annual flow of the Platte River at Louisville, Nebraska, or the average annual flow of the Kansas River at Topeka, Kansas.

The purpose of the ground-water work group's activities is to assess the magnitude of impact and to quantify depletions to streamflow due to ground-water pumpage using the stream-depletion technique (SDT). The two major objectives of this

study are to: (1) assemble a data base describing historic water availability and uses in the 10-state Missouri River Basin that is acceptable to the State and Federal agencies involved in water management in the Missouri River Basin, and (2) develop a computerized water-accounting system incorporating the data base that will aid in estimating the effects of using additional quantities of water in the future.

The water-accounting system will be a tool for use by Federal and State water-resources managers. The report also includes appendix I—A user's manual, stream-depletion factor, and stream-depletion calculation computer programs. It is a manual that presents the methodology, and two computer programs used by the Missouri River Basin Hydrology Study for computation of stream-flow depletion due to the ground-water pumping.

Burt, C.M., 1990, Efficiency in irrigation: San Luis Obispo, California Polytechnic State University, 23 p.

Study Description: Agricultural irrigation plays a major role in water and power consumption in California. Virtually every viable method of irrigation used in the world can be found in California. A study by the GAO (1976) found that the average on-farm irrigation efficiency in the U.S. is 50 percent.

This study discusses the ways a good irrigation efficiency can be obtained:

1. Achieving a good distribution uniformity.
2. Proper scheduling of irrigations (when and how much).
3. Collecting runoff.
4. Minimizing evaporation and spray losses (**except for some moving systems such as linear moves or fast cycling systems such as solid set sprinklers, this is maybe a minor concern relative to the other factors).

Carlson, D., Holz, D., and Ziewitz, J., 1990, Whooping crane roosting habitat simulation model for the Platte River in Nebraska: U.S. Fish and Wildlife Service, 22 p.

Study Description: This report provides documentation for a whooping crane roost habitat simulation model developed for the Platte River in Nebraska. The purpose of the model is to characterize the relation between river discharge and roosting habitat. The relation is based on physical habitat characteristics within the channel that are related to flow. Habitat suitability criteria are used in conjunction with hydraulic simulations of the instream-flow incremental methodology (IFIM). The model is applied to an 89-mile reach of the Platte River between Lexington and Chapman, Nebraska.

This report describes whooping crane use of riverene habitats for roosting, the development and application of habitat criteria in the physical habitat simulation using IFIM, and modeling output. The report is organized into five sections:

I. The study area

II. Hydraulic modeling and simulation procedures

III. Whooping crane roosting habitat suitability criteria

IV. Application of the whooping crane criteria and hydraulic models using IFIM

V. Results of the model application.

Central Nebraska Basins NAWQA Liaison Committee, 1991, Minutes of meeting in Lincoln, Nebraska, May 3, 1991: Lincoln, Nebr., U.S. Geological Survey.

Study Description: Minutes—The NAWQA program as it relates to the Central Nebraska Basins includes the Platte River and its tributaries between the confluence of the North and South Platte Rivers downstream to the Missouri River. At the meeting, Tom Huntzinger, U.S. Geological Survey, outlined the major objectives of the study: (1) to provide a description of current water-quality conditions in the basins; (2) to define time trends in water quality; and (3) to identify and describe the natural and human factors that affect water-quality conditions and trends. Huntzinger stressed that in order to achieve the objectives set forth in the Central Nebraska Basins study, it will be necessary to work closely with member agencies of the Liaison Committee and to receive input regarding data bases and other available hydrologic data.

In the discussion of water-quality issues, it was agreed that the effects of agricultural land use on water quality was a major issue. Specific interests were related to the management of agricultural chemicals such as nutrients and pesticides.

Another aspect included feedlot operations in the area.

Central Nebraska Public Power and Irrigation District, 1991, Central's Irrigation Division Water Conservation and Management Program executive summary: Holdrege, Nebr., 8 p.

Study Description: The Central Nebraska Public Power and Irrigation District offers irrigation services through a system that exemplifies modern irrigation management techniques and water stewardship. This report examines the districts' background, management practices, and irrigation system improvements. This executive summary focuses on the report's five conclusions, examines the rationale behind them, and suggests their importance.

Central Platte Natural Resources District, 1983, An evaluation of historical flow conditions in the Platte River as related to vegetation growth and habitat use by the endangered whooping crane and bald eagle and the threatened interior least tern: Lincoln, Nebr., Ecological Analysts, Inc., 110 p.

Study Description: The Nebraska Game and Parks Commission issued a biological opinion on the Little Blue Natural Resources District's proposed Caterland Project, dated January 31, 1983, hereinafter referred to as the opinion. The opinion, as stated, was prepared in accordance with the rules and regulations promulgated by the Game and Parks Commission governing the interagency consultation process and under the authority of the Nongame and Endangered Species Conservation Act, Sections 37–495 and 37–436 of the State Statutes. The Act requires that..."all state agencies and departments shall, in consultation with and with the assistance of the Commission, utilize their authorities in furtherance of the purposes of Sections 37–430 to 37–438 by carrying out programs for the conservation of endangered or threatened species, and by taking such action necessary to insure that actions authorized, funded, or carried out by them do not jeopardize the continued existence of such endangered or threatened species or result in the destruction or modification of habitat of such species which is determined by the Commission to be critical."

The stated primary purpose of the opinion is "...to provide a written report concluding whether an action will jeopardize the continued existence of an endangered or threatened species in Nebraska or result in the destruction of an endangered or threatened species in Nebraska or result in the destruction or adverse modification of critical habitat." The context of the opinion is that the Platte River downstream of the proposed diversion (between Overton and Grand Island) is critical to the continued existence of the endangered whooping crane and bald eagle and the threatened interior least tern. No definition is provided in the opinion as to what constitutes critical habitat. The opinion does infer that habitat used for one or more activities including feeding, loafing, roosting, and nesting may be considered as "critical" for endangered or threatened species of birds. However, to properly weight and evaluate the conclusions and recommendations offered in the opinion, the full meaning embodied in the concept of "critical habitat" is important.

The opinion asserts that the Catherland Project will jeopardize the continued existence of the whooping crane, bald eagle, and least tern. The presumption underlying this assertion is that the continued existence or recovery of these three species in Nebraska is contingent on the maintenance of habitat along the Overton to Grand Island reach of the Platte River.

The purpose of this report is to provide an evaluation of the rationale, recommendations, and conclusions formed in the opinion in light of existing, available information. Added perspective as well as constructive comments and suggestions are presented as necessary to assist the Nebraska Game and Parks Commission, the Nebraska Department of Water Resources, and other agencies and committees responsible for the formulation and implementation of State water policy, in giving due consideration to the above three matters and other issues relevant to the establishment of an effective water-management strategy for the species of concern. In the interest of facilitating reader perspective, background information on the historical character of the Platte River (chapter 2), including factors which have affected the growth of vegetation, precedes the presentation of specific information relative to the whooping crane, bald eagle, and interior least tern

(chapters 3, 4, and 5, respectively). A summary of the key information contained in the report is presented in chapter 6.

Chu, T.M., and Pederson, D.T., 1988, Investigation of the thermal regime in a river-aquifer system near Ashland, Nebraska: Lincoln, University of Nebraska-Lincoln, master's thesis, 113 p.

Study Description: This is a thesis presented to the faculty of the graduate college at the University of Nebraska in partial fulfillment of requirements for the Degree of Master of Science. Major: Geology. Under the supervision of Professor Darryll T. Pederson. The study area is located in the Platte Valley northeast of Ashland, Nebraska.

Currier, P.J., Lingle, G.R., and VanDerwalker, J.G., 1985, Migratory bird habitat on the Platte and North Platte Rivers in Nebraska: Grand Island, Nebr., Platte River Whooping Crane Critical Habitat Maintenance Trust, Inc., 177 p.

Study Description: This report provides baseline data on the current status of migratory bird habitat on the Platte and North Platte Rivers in Nebraska. The Platte River Whooping Crane Trust initiated this study as part of its management for migratory birds. The establishment of the Trust and its goals and objectives are discussed in chapter 1. The following chapters (2, 3, and 4) provide a description of the natural resources of the Platte and North Platte River Valleys.

Historical features of the natural environment, an analysis of the migratory birds that use the river today, and an inventory of the current habitat are presented. In particular, emphasis is given to the habitat in different river segments. Since the time of settlement (1840's), there have been major changes in the natural environment in the Platte River Valley.

As pioneer settlement, population growth, and agricultural development advanced, the native prairie was converted to cropland, and the unvegetated, sandy riverbed began to fill with trees and shrubs. These losses of grasslands and open river channel are described and quantified in chapters 5 and 6. Habitat changes also have had a substantial effect on populations of sandhill cranes, whooping cranes, and other migratory birds.

An assessment and discussion of these impacts are presented in chapter 7. Recommendations for management and maintenance of Platte River habitat for migratory birds are presented in the final chapter (8). The Platte River Whooping Crane Critical Habitat Maintenance Trust is a nonprofit conservation organization whose purpose is to protect and enhance habitat for migratory birds in Nebraska along the Platte and North Platte Rivers.

David & Associates, 1991, Platte River field notes—Conservation of biodiversity: U.S. Fish and Wildlife Service, 16 p.

Study Description: This report explains the idea of the need for biodiversity in the Platte River. Biodiversity describes the variety of life around us, including microorganisms, insects, plants, animals, and explains the various ways in which these varieties interact with each other, the environment, and humans.

The Platte River is a permanent or temporary home for eight endangered species: whooping crane, piping plover, bald eagle, least tern, eskimo curlew, peregrine falcon, American burying beetle, and western prairie-fringed orchid. All year long, the Platte River area is home to native grasses and plants, reptiles, amphibians, mammals, insects, fishes, and other living things. The Platte River area is teeming with life—an interdependent network of biodiversity.

The U.S. Fish and Wildlife Service is using the Platte River area as a pilot for several biodiversity studies and conservation projects. In the business of biodiversity, the Platte River offers a case study-—a close-up look at one of this Nation's biological "subsidiaries."

Dolan, L.S., Wesche, T.A., and Skinner, Q.D., 1988, Platte River wetlands hydrology study—Progress report: Laramie, Wyoming Water Research Center, 12 p.

Study Description: The purpose of this research is to examine the hydrology of wetland areas along the Platte River between Overton and Grand Island, Nebraska. This is being accomplished by (a) determining the relationship between groundwater elevations under wet meadows and river stage, (b) examining the extent to which wet meadows are maintained by ground water, and (c)

examining the extent to which wet meadows are maintained by precipitation and surface runoff. Seasonal changes in the water balance of wet meadows is examined as well. The research will also help to expand the knowledge base on the hydrology of wetlands.

This progress report contains an update on the present status of the Platte River wetlands hydrology study. It includes a brief description of the study sites and a summary of work that has been completed at each site. The report also includes a summary of future work plans.

Ellison, Daryl, and Hutchinson, Larry, 1990, A review of Bureau of Reclamation Lake McConaughy water quality simulations pertaining to trout habitat in the reservoir, Lake Ogallala, and downstream: Lincoln, Nebraska Game and Parks Commission, 12 p.

Study Description: The Federal Energy Regulatory Commission (FERC) hydropower relicensing process is underway for facilities operated by Central Nebraska Public Power Irrigation District and Nebraska Public Power District (Districts). Resource agencies and various environmental organizations have proposed that the new licenses by FERC be conditioned to provide reregulation of water in the District's system to improve the frequency of fish and wildlife instream flow needs in the Platte River system within and below the projects. The major source of water for this proposed reregulation is Lake McConaughy.

A computer model utilizing several climatological, hydrological and limnological parameters was developed to describe processes affecting water quality of Lake McConaughy. The model may be used as a tool to simulate potential effects of various operating criteria on temperature and dissolved-oxygen profiles in Lake McConaughy as well as the temperature of water released into Lake Ogallala. The purpose of this report is to describe the results of the model output as they relate to habitat supporting the trout fisheries of Lake McConaughy, Lake Ogallala, and the North Platte River and Sutherland Canal downstream of Lake Ogallala.

Engberg, R.A., and Druliner, A.D., 1988, Nebraska ground-water quality, *in* National water summary 1986—Hydrologic events and ground-water quality: U.S. Geological Survey Water-Supply Paper 2325, p. 347–354.

Study Description: This is a summary of the ground-water quality in Nebraska in 1986. The report talks about water quality in principal aquifers, effects of land use on water quality, hazardous waste, water use and irrigation, potential for water-quality changes and ground-water-quality management.

Eschner, T.R., Hadley, R.F., and Crowley, K.D., 1983, Hydrologic and morphologic changes in channels of the Platte River Basin in Colorado, Wyoming, and Nebraska—A historical perspective: U.S. Geological Survey Professional Paper 1277-A, p. A1–A39.

Study Description: In 1979, the U.S. Geological Survey began investigations in the Platte River Basin to determine the effects of water use on the hydrology and morphology of the Platte River and its major tributaries. These investigations also considered the relation of hydrologic regime to factors that control or affect the habitat of migratory waterfowl in the Platte River Valley.

This report brings together the results of several research studies on historical changes in channel morphology, surface-water hydrology, hydraulic geometry, sediment-transport and bedform processes, ground-water and surface-water relations, stochastic models of streamflow and precipitation, and methods for estimating discharge required to maintain channel width. In each of the studies, data on some segment of the Platte River hydrologic system were collected and interpreted. All the studies are interrelated; together they provide some degree of understanding of regime changes that are occurring. The hydrologic research described will be useful in decisionmaking pertaining to the management of water resources and migratory waterfowl habitat.

Exner, M.E., Brown, B., Myer, S., and Unger, M., 1990, Evaluation of the potential for pollution of the ground water in the Lower Platte Valley: Lincoln, University of Nebraska-Lincoln, Conservation and Survey Division, 34 p.

Study Description: One of the objectives of the first year of this investigation was to delineate the areas where the ground water is most vulnerable to nonpoint contamination. The methodology used DRASTIC, a relatively new method to predict the pollution potential of the ground water in areas larger than 100 acres. A waste-disposal site could not be selected with DRASTIC, but areas that are hydrogeologically unsuitable could be eliminated from further consideration and more promising areas identified.

Faanes, C.A., and Bowman, D.B., 1988, Relationship of channel maintenance flows to whooping crane use of the Platte River: U.S. Fish and Wildlife Service, 19 p.

Study Description: Periodic high flows in the Platte River are necessary to scour vegetation and to redistribute sediment in the stream channel. Although peak and mean annual flows have been reduced by as much as 70 percent from predevelopment times, channel-maintenance flows still occur, although at a much reduced frequency and magnitude of occurrence. Use of the Platte River by migrant whooping cranes in recent years appears to be related to the recent occurrence of flows in excess of 8,000 cubic feet per second for 5 or more days.

The Platte River is an important and strategically located migrational area for whooping cranes. While on the Platte River, whooping cranes roost nightly in shallow river channels.

An important factor limiting contemporary use of the Platte River by migrant whooping cranes is degradation of the river channel and the subsequent encroachment of wooded vegetation. This report is a presentation on the magnitude of flows prior to observations of whooping cranes on the Platte River. It is also an argument of the biological validity of providing adequate flows to maintain river channels in a condition suitable for supporting whooping cranes.

Folk, M.J., and Tacha, T.C., 1989, Sandhill crane roost site characteristics in the North Platte River Valley: Journal of Wildlife Management, v. 54, no. 3, p. 480–486.

Study Description: The authors documented sandhill crane roost site characteristics in the North Platte River Valley of Nebraska in riverine and semipermanent palustrine wetlands from late February through mid-April in 1988 and 1989. Crane roost sites in the river were located closer to visual obstructions, in narrower channels, and in a wider range of water depths than determined previously in the Platte River.

Gersib, D., Cornely, J., Trout, A., Hyland, J., and Gabig, J., 1990, Concept plan for waterfowl habitat protection, Rainwater Basin area of Nebraska: Lincoln, Nebraska Game and Parks Commission, U.S. Fish and Wildlife Service, and Ducks Unlimited, Inc., Category 25 of the North American Waterfowl Management Plan, 71 p.

Study Description: The continental loss of wetland habitat has resulted in alarming declines in the population size of many waterfowl species. These declines prompted the United States and Canadian governments to adopt the North American Management Plan (NAWMP) in 1986. This plan identifies specific waterfowl habitat needs to ensure an adequate habitat base for the perpetuation of North American waterfowl populations.

Nebraska's Rainwater Basin wetland area is identified by the NAWMP as a waterfowl habitat area of major concern in North America. The overall goal of this plan is to restore and maintain sufficient wetland habitat in the Rainwater Basin area of Nebraska that will assist in meeting population objectives identified in the North American Waterfowl Management Plan.

The Rainwater Basin area is recognized as the focal point of the Central Flyway spring migration corridor used by millions of ducks and geese annually. Although spring staging habitat is of paramount importance, it must be recognized that Rainwater Basin wetlands also provide fall migration and breeding habitat for waterfowl.

This wetland area also serves as important migration habitat for endangered species and other migratory water birds. Rainwater Basin wetlands provide or have the potential to provide important flood-control and water-quality benefits to Nebraskans. Also, hunting, trapping, and bird-watching provide important economic benefits to the State while providing recreational opportunities for all Americans.

Loss of more than 90 percent of all major wetlands within this area has forced birds to crowd

onto the few remaining basins. This overcrowding has resulted in the avian cholera outbreaks that have killed more than 200,000 waterfowl since 1975. A broad-based wetland protection and restoration initiative is both justified and necessary to meet continental waterfowl goals.

Gessaman, P.H., 1984a, NebGuide—An overview of appropriative water rights: Lincoln, University of Nebraska-Lincoln Cooperative Extension Service, G79–437, 4 p.

Study Description: One of Nebraska's primary legal mechanisms for managing surface-water resources is described in this NebGuide. An overview of the State's appropriative water rights system is presented through a series of questions and answers. In recognition that all water-resource management systems are to some extent inter-related, brief mention is made of riparian water rights to use ground water.

Gessamen, P.H., 1984b, NebGuide—An overview of riparian water rights: Lincoln, University of Nebraska-Lincoln Cooperative Extension Service, G79–438, 3 p.

Study Description: An overview of the State's riparian water rights system is presented through a series of questions and answers. In recognition that all water-resource management systems are to some extent interrelated, brief mention is made of appropriative water rights and rights to use ground water.

Gessaman, P.H., 1984c, NebGuide—Instream flows—Issues and concerns: Lincoln, University of Nebraska-Lincoln Cooperative Extension Service, G79–439, 3 p.

Study Description: This is the first of two NebGuides that provide information about instream flows. It starts with definitions of three terms used in discussions related to the recognition and maintenance of instream flows in Nebraska's rivers and streams. Several aspects of instream flow-related issues are identified and principal concerns are briefly described.

Gessaman, P.H., 1984d, NebGuide—Physical and legal aspects of instream flows: Lincoln, University of Nebraska-Lincoln Cooperative Extension Service, G79–440, 4 p.

Study Description: This is the second of two NebGuides that provide information about instream flows in Nebraska. Physical and legal aspects of instream flows are examined through a series of questions and answers. Authorizations for legal recognition of instream flows enacted in LB1106 of 1984, Nebraska's first legislation giving legal recognition to instream flows, are briefly discussed.

Gessaman, P.H., 1984e, NebGuide—Groundwater rights, Part I—Property rights, preferences, and conflict resolution: Lincoln, University of Nebraska-Lincoln Cooperative Extension Service, G79–441, 4 p.

Study Description: This is the first of two NebGuides that summarize ground-water rights and management in Nebraska. Property rights and ground-water preferences, the principal bases for resolving conflicts over the use of ground water, are discussed in a series of questions and answers. This discussion is preceded by an introductory statement and definitions of several terms commonly used when discussing ground-water use and management.

Gessaman, P.H., 1984f, NebGuide—Groundwater rights, Part II—Public management of ground water: Lincoln, University of Nebraska-Lincoln Cooperative Extension Service, G79–442, 4 p.

Study Description: This is the second of two NebGuides that summarize ground-water rights and management in Nebraska. Several legal mechanisms for public management of Nebraska's ground-water resources are briefly described and discussed.

Hadley, R.F., Karlinger, M.R., Burns, A.W., and Eschner, T.R., 1987, Water development and associated hydrologic changes in the Platte River, Nebraska, U.S.A., *in* Regulated rivers—Research and management: New York, John Wiley & Sons, v. 1, p. 331–341.

Study Description: Major changes in hydrologic regime and morphology of channels of the Platte River and its major tributaries, the South Platte

River and North Platte River in Colorado, Wyoming, and Nebraska, have occurred since about 1860 when the water resources of the basin began to be developed for agriculture, municipal, and industrial uses.

The extent of this water development, which continues to increase with growth in population and land use, has affected the timing of streamflow and transport of fluvial sediment in the Platte River through diversions, reservoir storage, and increased use of ground water. Changes in flow regime, such as increase in low-flow magnitudes and abatement of peak-flow magnitudes, have made the riverine environment conducive to vegetative growth while reducing channel scour.

These factors, in turn, contribute to morphologic chances of decreased channel width and channel area and increased island formation. Development of surface water and ground water for irrigation also has affected the hydrologic characteristics of the Platte River. This report focuses on these trends over the last several decades in the study area of the Platte River in Nebraska.

Hirsch, R.M., Alley, W.M., and Wilber, W.G., 1988, Concepts for a National Water-Quality Assessment Program: U.S. Geological Survey Circular 1021, 42 p.

Study Description: The National Water-Quality Assessment (NAWQA) Program will be conducted at a combination of spatial and temporal scales that are unique for water-quality assessment. By conducting the national program as an aggregation of individual studies of key river basins and aquifer systems, the assessment will provide results that are useful in understanding and managing these important water resources, as well as answering national questions about water quality. Information to be provided by the NAWQA program will help to answer some of the major questions concerning the Nation's water quality.

Huntzinger, T.L., 1991, National Water-Quality Assessment Program—The Central Nebraska Basins: U.S. Geological Survey Open-File Report 91-97, 2 p.

Study Description: Water Fact Sheet for the National Water-Quality Assessment Program—The Central Nebraska Basins describes the long-term goals of the NAWQA program, which are to assess the status and trends in the quality of a large, representative part of the Nation's surface- and ground-water resources and to provide a sound, scientific understanding of the primary natural and human factors affecting the quality of these resources.

Iverson, G.C., Tacha, T.C., and Vohs, P.A., 1981, Food contents of sandhill cranes during winter and spring: Tavernier, Fla., National Audubon Society, Proceedings 1981 Crane Workshop, p. 95-98.

Study Description: Three hundred sandhill cranes from mid-continental North America were analyzed for food content. Cranes were obtained from western Texas during winter; from Nebraska, Saskatchewan, and Alaska during spring migration; and on the Yukon-Kuskokwim Delta, Alaska, during prenesting. Cereal grains made up more than 96 percent of the aggregate volume of food items from winter through spring migration. The proportion of animal matter in the diet did not increase during any period.

Iverson, G.C., Vohs, P.A., and Tacha, T.C., 1987, Habitat use by Mid-continent sandhill cranes during spring migration: Journal of Wildlife Management, v. 51, no. 2, p. 448-458.

Study Description: Harvested grain fields were the principal habitat types used by sandhill cranes during spring migration in Nebraska, Saskatchewan, and Alaska, respectively. Wetlands, temporary and semipermanent, were used at each study location as roosting and loafing sites. Grain stubble fields and wetlands use exceeded relative availability at each study location. Availability of waste grain in corn, wheat, and barley stubble, under current land-use practices, appears adequate for energy needs of spring migrant cranes. Habitat juxtaposition involving roosting, feeding, and other activities is important on spring staging areas. Optimum habitat in the North Platte River Valley included a river roost site, an interspersion of 35-70 percent corn stubble, 5-40 percent pasture, less than 13 percent alfalfa, and less than 1 percent shallow wetland located within 2.5 miles of the roost site. Habitats currently threatened are river

roost sites and wetlands adjacent to the North Platte River in Nebraska.

Krapu, G.L., Facey, D.E., Fritzell, E.K., and Johnson, D.H., 1984, Habitat use by migrant sandhill cranes in Nebraska: Journal of Wildlife Management, v. 48, no. 2, p. 407–417.

Study Description: The principal spring staging areas of the mid-continent population of sandhill cranes are along the Platte and North Platte Rivers in south-central Nebraska. Most of these lands are privately owned and managed for corn and cattle production. Diurnal habitat use by radio-tagged cranes was primarily in cropland (55 percent), native grassland (28 percent), and tame hayland (15 percent).

Ninety-nine percent of the cropland use was in cornfields; 55 percent as grazed stubble, 36 percent as diced, cultivated, and plowed stubble, 7 percent as ungrazed stubble, and 1 percent unclassified. Grazed pastures accounted for 95 percent of the grassland locations and mowed alfalfa fields 77 percent of the tame hayland locations. Other habitats were seldom used.

Time budget analyses indicated that cranes, while in croplands, grasslands, and haylands, spent 35, 36, and 50 percent of the time foraging, respectively. Cranes roosted in the shallows and on nearby sandbars of about 70 miles of river channel. Cranes usually roosted where the channel was at least 150 miles wide and avoided stretches narrower than 50 miles. Height of woody vegetation along shorelines and on islands influenced where cranes roosted when unobstructed channel width was less than 150 miles; bridges or roads adjacent to the channel also reduced use by about one-half. Management recommendations are made for maintaining suitable habitat for sandhill cranes on their staging areas in Nebraska.

Kroeker, Bruce, supported by City of Fremont, City of Lincoln, and Omaha Metropolitan Utilities District, 1988, Assessment of the cumulative effects of major water diversions from the Platte River watershed: Denver, Colo., Ted Zorich & Associates, Inc., and Groundwater Management, 174 p.

Study Description: Groundwater Management and Ted Zorich & Associates have been retained by the City of Fremont, the City of Lincoln, and the Omaha Metropolitan Utilities District to evaluate the effects of the proposed Landmark Project, and other existing and proposed water-supply development projects, upon the water resources of the lower Platte River.

Streamflow data for the Platte River at North Bend and Louisville indicate that the July to September flows appear to be decreasing due to stream depletions caused by increased ground-water pumpage from the alluvial aquifer upstream.

A streamflow model was developed, and an analysis performed on the monthly streamflows in the Platte River Basin from Brady to Louisville, Nebraska. The model was based on the historic streamflows that occurred during water years 1950 to 1985.

The effects of new diversions by the Landmark, Prairie Bend/Twin Valley, and Little Blue (Catherland) Projects, as well as the accumulative effect of all of these projects upon streamflows in the lower Platte River, were then analyzed.

The streamflow model indicated that stream depletions due to increased ground-water pumpage had the largest single effect on downstream flows. These effects, when combined with effects of additional surface-water diversions, will result in significant reductions in streamflow and in periods of zero or very low flow at and below North Bend.

A ground-water model was used to simulate pumping from the City of Lincoln's Ashland well field. Over 80 percent of the well-field yield is obtained by induced recharge from the Platte River. Well-field yields decrease significantly within 10 to 50 days of consecutive zero or very low flows. Such an occurrence would result in significant operational problems for a municipal water-supply system.

Zero flow has never occurred historically at or below North Bend, and extensive periods of very low-flow conditions have been rare. These conditions will occur more frequently in the future if additional upstream diversions and a continued increase in ground-water pumpage for irrigation occur.

Lamb, B.L., and Doerksen, Harvey, 1987, Instream water use in the United States—Water laws and methods for determining flow requirements, *in* National water summary 1987—Water supply and use: U.S. Geological Survey Water-Supply Paper 2350, p. 109–116.

Study Description: Water laws that have favored the more traditional water uses, the inherent nature of conflict between instream and offstream water uses, and the special kinds of technological and philosophical problems posed by the "newer" types of instream uses are described. Water laws that have been passed to accommodate the more recently recognized instream uses are summarized.

Leahy, P.P., Rosenshein, J.S., and Knopman, D.S., 1990, Implementation plan for the National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 90–174, 10 p.

Study Description: The National Water-Quality Assessment (NAWQA) Program is designed to describe the status and trends in the quality of the Nation's ground- and surface-water resources and to provide a sound understanding of the natural and human factors that affect the quality of these resources.

As part of the program, study-unit investigations will be conducted in 60 areas throughout the Nation to provide a framework for national and regional water-quality assessments. National and regional assessments of ground- and surface-water quality will be provided from issue-oriented findings of nationally consistent information from the study units.

Leonard, P.M., and Orth, D.J., 1988, Use of habitat guilds of fishes to determine instream flow requirements: North American Journal of Fisheries Management, v. 8, p. 399–409.

Study Description: The authors grouped eight warmwater fishes, each represented by one to four life stages, into habitat-use guilds (that is, groups of species) to select target species for instream flow studies. Cluster analysis of depth, velocity, substrate, and cover use identified four primary habitat-use guilds, which were distinguished largely on the basis of water velocity. Habitat-suitability criteria were developed for each species and life-stage combination, and these criteria were used in physical habitat simulations to determine relations between weighted usable area (WUA) and discharge for three streams in the upper James River Basin, Virginia.

Weighted usable areas for species within each habitat-use guild generally exhibited similar responses to discharge except those for some stream-margin inhabitants and for strongly cover-oriented species. Four types of habitat-discharge relations, which were consistent among streams, were identified. Curves of WUA versus discharge for habitat generalists and some specialists indicated relatively stable WUA over a wide range of flows. Target species and life stages should be selected from appropriate habitat-use guilds to ensure that flow recommendations represent the best compromise between the needs of fast-water and slack-water inhabitants.

Lewis, Gary, 1989, Inventory of Platte River surface water simulation models: Platte River Management Joint Study Hydrology Work Group, 48 p.

Study Description: This inventory presents an overview of existing surface-water flow-simulation models of the Platte, North Platte and South Platte Rivers. The models are introduced in a summary matrix. Two-page descriptions for each model follow, listed in alphabetical order by model acronym. The descriptions include the region modeled, date of development, principal contact, availability, type of model, inputs, outputs, previous uses, reason for development, period of record used, strengths, weaknesses, and assumptions.

Lincoln Water System, 1989, Ashland well field comprehensive development plan—Updated ground water modeling study: Denver, Colo., Ted Zorich & Associates, 54 p., 5 appendices.

Study Description: The purpose of this study was to supervise a set of pump tests, perform data analysis, and conduct ground-water modeling studies. The purposes of the pump tests were to determine the effects of river stage on the shape and magnitude of the ground-water levels around a pumping well, to observe any effects of river recharge on the ground-water levels, and to collect data for use in

evaluating the hydraulic conductivity of the Platte River streambed material.

The purpose of the 1987 study was to evaluate the yields of the existing Ashland well field and proposed island and east-bank well fields. The Ashland well field is located on the west bank of the Platte River approximately 25 miles northeast of Lincoln. The yields were evaluated for the individual well fields and also for combinations of well fields. This study was conducted in order to collect additional information about the hydraulic conductivity of the Platte River streambed material and to incorporate newly acquired hydrogeologic data into the ground-water model developed during the 1987 study.

Two pump tests were conducted on well 54-10 in the Ashland well field. The first test was conducted in August 1988, during a period of low river flow. The second test was performed in October 1988, during a period of greater flow in the Platte River. The results of these pump tests were used to refine the estimated value for riverbed hydraulic conductivity, which is a critical input parameter for the ground-water model. Bedrock elevation data from a geophysical survey conducted by Dr. Jerry Ayers also were incorporated into the ground-water model.

The updated ground-water model was used to estimate the sustainable and seasonal yields of Ashland, island, and east-bank well fields under river conditions of 1,000 cubic feet per second flow and zero flow. Sustainable yield refers to the maximum amount of water that can be extracted from an aquifer year after year without causing water-level declines that exceed a predetermined criteria after 120 days of continuous pumping.

The 1,000 cubic feet per second river-flow simulations conducted with the updated model considered the entire river flow as occurring in the channel on the east side of the island. This corresponds to the river-channel conditions observed during low flows in the summer of 1988.

The sustainable yield under 1,000 cubic feet per second river-flow conditions is estimated to be 94 million gallons per day for a combined Ashland/Island well field, and 143 million gallons per day for a combined Ashland/Island/East Bank well field.

The 120-day seasonal yield under 1,000 cubic feet per second river-flow conditions is estimated to be 96 million gallons per day for a combined Ashland/Island well field, and 145 million gallons per day for a combined Ashland/Island/East Bank well field. Comparable values determined during the 1987 study were 158 and 229 million gallons per day, respectively. The reductions in the estimated seasonal yield values result from using a lower riverbed hydraulic conductivity and from locating the river flows to the far side of the channel away from the Ashland well field.

The 120-day seasonal yield under zero river-flow conditions is estimated to be 40 million gallons per day for a combined Ashland/Island well field, and also for a combined Ashland/Island/East Bank well field. Wells on the east bank, when combined with wells on the island, provide no additional water supply under prolonged zero flow conditions.

The results of the updated ground-water model simulations demonstrate the importance of adequate river flows in the vicinity of the Ashland well field. The water supply that can be yielded from the existing and proposed well fields is reduced substantially by prolonged periods of very low flow or zero flow in the Platte River.

Some conclusions are: reduced river flows and changes in channel geometry significantly affect the sustainable and seasonal yields of the City's Platte River well fields. The 1987 study indicated that the 120-day seasonal yield of a combined Ashland/Island well field is 158 million gallons per day under bank-to-bank river-flow conditions. This value is reduced to 96 million gallons per day when the river flow is 1,000 cubic feet per second and the flow is confined to the channel east of the island. The 120-day seasonal yield is reduced further to 40 million gallons per day when the river is completely dry.

Other studies by Ted Zorich & Associates, Inc., and Groundwater Management, Inc., indicate that in the future, very low river-flow conditions near the Ashland well field will be more frequent and of longer duration if upstream surface- and ground-water supply development continues.

Lingle, G.R., 1990, Least tern and piping plover nesting ecology along the Central Platte River Valley, Nebraska progress report 1990: Grand Island, Nebr., Platte River Whooping Crane Habitat Trust, Inc., 4 p.

Study Description: This progress report complements the 4-year summary of work Lingle completed in 1988 and his 1989 progress report. It is submitted in accordance with the conditions of his Regional Blanket Permit PRT-704930. The primary objectives of this study were: (1) to monitor nesting populations and habitat use, (2) to determine causes of nest failure, (3) to identify mortality factors, (4) to color-band least terns and search for marked terns and plovers, (5) to determine hatching rates, (6) to determine fledging success, and (7) to remove leg bands from piping plovers in order to protect them from leg injury.

Lowe, T.P., 1982, Hydrology study—Technical paper—Agriculture water use including identification of irrigated lands: Omaha, Nebr., Missouri River Basin States Association, 320 p.

Study Description: The main task of the Agricultural Water Use Work Group was to identify irrigated lands throughout the Missouri Basin and estimate streamflow depletions resulting from irrigation of those lands. Other tasks included collection of information and estimation of streamflow depletions caused by conservation practices, farm ponds, and livestock water consumption. Accretions to streamflow resulting from forest-management practices also were considered. Estimates of forest accretions that are a result of increased runoff due to forest cutting and road construction also were made.

The water-accounting system describes, at 93 locations (Platte-Niobrara being one of the sites), the water supply that would have been available during the 35-year period from 1944 through 1978 had the 1978 level of water use existed. Given the established depletion relationships, future potential depletions can be analyzed to show their effects on streamflow. These results can be used by water-resources planners or managers to help decide future water-management actions.

The two objectives of this study are to: (1) assemble a data base describing historic water availability and uses in the 10-state Missouri River Basin that is acceptable to the State and Federal agencies involved in water management in the basin and (2) develop a computerized water-accounting system incorporating the data base that will aid in estimating the effects of using additional quantities of water in the future. The water-accounting system will be a tool for use by Federal and State water-resources managers.

Mayio, Alice, 1990, National water quality inventory—1988 report to Congress: U.S. Environmental Protection Agency, Office of Water, Washington, D.C., EPA 440-4-90-003, 226 p.

Study Description: This report was prepared pursuant to Section 305(b) of the Clean Water Act or Federal Water Pollution Control Act. It is based primarily on reports submitted by the States in 1988; in some cases, State-reported information has been supplemented by data developed by the U.S. Environmental Protection Agency (USEPA). Although USEPA has analyzed and summarized the water-quality information in the State reports, the views and recommendations presented are those of individual States, not those of USEPA or the Administration. The leading causes of pollution cited by the States in impaired rivers and lakes are siltation and nutrients; in impaired estuarine waters, nutrients and fecal coliform bacteria are most commonly cited. Agricultural activities are the most extensively reported source of pollution in rivers and lakes, and municipal discharges are cited as the leading source of pollution in estuaries. Wetland loss is also a significant problem reported by the States. Land development for residential or commercial uses is cited as the leading cause of loss of wetland acreage.

Major threats to ground-water quality, as reported by the States, include underground storage tanks, septic systems, agricultural activities, municipal landfills, surface impoundments, and abandoned hazardous-waste sites. Nitrates, pesticides, volatile organic compounds, petroleum products, metals, and brine are cited as the leading contaminants of concern in ground water.

Nevertheless, as this report shows, the Nation's water-pollution control programs have achieved significant results. Expenditures to construct and upgrade sewage-treatment facilities have substantially increased the population served by higher levels of treatment. Municipal and industrial facilities are at a high rate of compliance with the conditions of their permit limits. A variety of State

and Federal programs have led to progress in reducing the effects of diffuse sources of pollution, such as agricultural runoff. The States are engaged in a number of ground-water protection activities, such as development of wellhead-protection programs and ground-water mapping.

In addition, under the impetus provided by the Water Quality Act of 1987, the States have identified specific waters with impairments due to toxic contaminants and diffuse sources of pollution. The USEPA and the States are beginning to develop and implement control programs for these waters. In future editions of this report, the USEPA will be reporting on the progress achieved by these programs.

Missouri River Basin Commission, 1976, Report on the Platte River Basin, Nebraska—Level B study: Omaha, Nebr., 252 p.

Study Description: The recommended plan included over 100 structural and development plan elements whose total costs exceed $500 million on the basis of cost capitalized to 1974 values. These elements range from small recreation facility development at sandpit lakes to large multipurpose reservoirs. Recommended institutional legal elements would remove inequities in cost sharing in one program and establish an integrated water administration system in another. Additional elements would provide for protection or enhancement of wildlife habitat. In total, they cover a wide range of recommended actions.

The analysis of some proposed elements proved inconclusive, and in such cases, additional study was recommended. Those structural elements included in the plan, in most instances, will be subjected to further study. More detailed analysis and design will be required for those projects that have not passed beyond the reconnaissance level of investigation as required in this Level B study.

Several areas of the basin would have remaining needs even if the recommended plan were implemented.

National Water Resources Association, 1991, Water quality 2000—Work group, executive summaries: Worthington, Ohio, 18 p.

Study Description: This report contains only the executive summaries; the entire report can be obtained for $20 from the Water Pollution Control Federation, 601 Wythe Street, Alexandria, VA 22314 or telephone (703) 684-2492. Water Quality 2000 is a group of national, state and local organizations who have formalized a cooperative effort to address the water-quality problems facing the United States today.

The report covers work group executive summaries from: Agriculture Work Group, Aquatic Ecosystem and Habitat, Community Work Group, Legislation Work Group, Recreation Work Group, Water Supply Work Group, and Watershed Work Group.

Nebraska Department of Environmental Control, 1990, The 1990 Nebraska water quality report: Lincoln, Nebr., Water Quality Division, 288 p.

Study Description: The report has been prepared with three main objectives. The first is to provide information on the status of Nebraska's water quality and the progress of activities that address water-quality issues to the general public of Nebraska, organizations, and governmental agencies with an interest in water quality. The second objective is to determine responsiveness to water-pollution problems and to provide future direction for the Department's water-quality programs. The third objective is to satisfy the requirements of Section 305(b) of the Clean Water Act.

Adequate data and information were available to assess 7,329 miles or 56 percent of Nebraska's 13,013 miles of designated stream segments for beneficial-use support during 1988 and 1989. Water-quality indices, which indicate general water quality, were calculated for 3,502 stream miles. Water quality was rated excellent in 21 percent, good in 74 percent, and fair in 5 percent of the rated streams. No streams were rated as having water quality unsuitable for most uses.

Very few significant water-quality trends have occurred in Nebraska's streams during the past 10 years. Much of the variation in water quality ob- served during this period appears to be due to random fluctuation or related to streamflows.

Although several toxic substances have been detected in water samples and fish-tissue samples, only mercury, silver, lead, copper and chlordane

were detected at levels that would indicate water-quality impairment. Data from the past 10 years were available to determine water-quality trends for 13 lakes. Water quality showed no significant changes in 4 lakes. Improvements were noted in 8 lakes, while 1 lake showed a deteriorating trend.

Although natural ground-water quality in Nebraska is suitable for most uses, many areas have experienced degradation from human activities. Major sources of contamination have included agricultural activities, industrial facilities, leaking underground-storage tanks, oil or hazardous-substance spills, solid-waste landfills, wastewater lagoons, brine disposal pits, septic systems, and other sources.

Nebraska Department of Water Resources, 1991, Before the Nebraska Department of Water Resources—In the matter of applications A-16027, A-16028, A-16031, A-16039, A-16600, A-16603, A-16606 for permits to appropriate and store water: Water Divisions 1-A and 1-D, v. 32, 180 p. and v. 33, 272 p.

Study Description: This hearing consists of two volumes—volumes 32 and 33. Jerry Kenny, a hydrologist, water resources engineer, from Boyle Engineering Corporation in Colorado is called as a witness on behalf of the applicant, Upper Big Blue Natural Resources District. Having been first duly sworn by the hearing officer, Kenny was examined and testified for permits to appropriate and store water in the Platte River area and the impacts on the Platte River environment due to the Landmark Project.

Nebraska Natural Resources Commission, 1982, Policy issue study on instream flows: Lincoln, Nebr., State Water Planning and Review Process, 107 p.

Study Description: The purpose of this report is to provide information needed by Nebraska policy makers to assist them in deciding whether the present State policies on instream water uses should be changed and, if so, what State policies should be adopted.

Chapters 1, 2, and 3, examine each instream water use and problems associated with that use. Ratings for some instream uses, streamflow characteristics, and methods of determining flow requirements for various instream uses also will be discussed.

The second section of the report, chapters 4, 5, 6, and 7, will introduce alternative State policies on instream water use and examine the hydrologic, environmental, social-economic, administrative, and legal impacts of each alternative. That examination will include an analysis of existing State policy as well as a description of policies of other states.

Nebraska Natural Resources Commission, 1985, Platte River forum for the future: Lincoln, Nebr., State Water Planning and Review Process, 32 p.

Study Description: Increasing concern about the competition and conflict over Platte River water plus probably the need for greater State financial commitment in water-resource development prompted both public officials and private citizens to seek some means to resolve these issues. This led the Natural Resources Commission to initiate and conduct this conflict-resolution process.

The two basic objectives were: (1) to provide a vehicle to develop and improve the general understanding of the Platte River, and (2) to provide a means for developing a consensus among those responsible for decisions concerning use of the Platte River water. This consensus then could have provided the basis for establishing State priorities for cost-sharing on Federal feasibility studies and water-development projects.

Nebraska Natural Resources Commission, 1990a, Nebraska soil and water conservation strategy 1990 update: Lincoln, Nebr., 70 p.

Study Description: The Soil and Water Conservation Strategy is a course of action for efficiently conserving the State's soil and water resources, both in quantity and quality. It identifies problems and remedies; presents potential actions and alternatives; and makes recommendations for action by the Governor, Legislature, Federal and State agencies, local districts, and landowners.

The aim of the strategy, developed in 1986, is to sustain the ability of the oil and water resources to support a high quality of life for present and succeeding generations.

Nebraska Natural Resources Commission, 1990b, Report on the south-central area ground water planning study: Lincoln, Nebr., 68 p.

Study Description: The South-Central Area Ground Water Planning Study was a cooperative study of the water and related land resources of parts of the Platte, Little Blue, and Republican River Basins. The study is an extension of the hydrogeology study NRC decided to conduct with the USGS to gain improved knowledge of the south-central area from the Platte River to the Republican River.

This NRC report presents the results of many ground-water model simulations of future conditions or hypothetical conditions without existing projects. For some situations, it also presents information on potential economic impacts projected by the economic model. It contains enough background information on the area modeled, and the study participants, conditions, methods, and procedures to provide an understanding of those results.

The purpose of this study was to utilize the computer models and knowledge gained from previous studies to simulate future conditions.

Nelson, M.E., 1983, Platte River water supply downstream from Columbus: Lincoln, Nebraska Department of Water Resources, 11 p.

Study Description: This report examines the water supply of the lower reach of the Platte River, which stretches more than 100 miles from the point where the Loup River flows into the Platte near Columbus to its confluence with the Missouri River near Plattsmouth. This examination includes an analysis of tributary rivers and streams, and the demands placed upon the Platte River by various water users.

There should be little concern that the Platte River will be unable to supply the demands placed on it within its downstream reaches in the foreseeable future. There are several reasons for this optimistic assessment. River flows have and will likely continue to exceed demand. Despite periodic ups and downs, the total supply of the lower Platte River gives no indication of long-term, progressive depletion.

Nelson, M.E., and France, S.A., 1983, Surface water resources of the Cedar River, Beaver Creek, and nearby streams: Lincoln, Nebraska Department of Water Resources, 23 p.

Study Description: In light of considerable ground-water irrigation development, concern has been expressed regarding the continuation of dependable flows. The flow of the Cedar River is nearly double that of Beaver Creek. Both waterways began as poorly defined channels in the wet meadows of the Sandhills. They gain large amounts of ground-water seepage as they flow through the eastern Sandhills, downstream from the surrounding water table, and converge with the Loup River.

A comparison of the water supply and demand in the two basins indicates that water shortages have been infrequent and short-lived. The Cedar River is particularly capable of handling the demands placed upon it.

In general, the Beaver and Cedar Basins have provided more than ample supply of water for present irrigation demand. During periods of extreme drought, the flow in the lower portions of Beaver and Plum Creeks may not be sufficient to satisfy all possible demands that could occur. Periods of summer low flow have always been followed by a return to historic flows the following fall, due to the dependable supply of ground water.

Despite large increases in demand for surface water for irrigation during the past three decades, annual streamflow records indicate that no lasting depletion of flow has occurred. Short-term trends toward lower annual flows during droughts have been erased by a return to wetter conditions. While human activities have a noticeable impact upon streamflow during dry summers, they are minor in comparison to the effects caused by fluctuations in climatic conditions.

O'Brien, J.S., and Currier, P.J., 1987a, Platte River channel morphology and riparian vegetation—Changes in the Big Bend reach and minimum streamflow criteria for channel maintenance: Grand Island, Nebr., Platte River Whooping Crane Habitat Maintenance Trust Report, 49 p.

Study Description: The objectives of this paper are: (1) to familiarize the reader with the general characteristics of alluvial and braided streams, (2)

to provide a historical and physiological background of the Platte's hydrology and channel morphology, and (3) to present a methodology to determine the flow regime required to maintain the existing remnants of braided channel.

In addition to adjusting to natural fluctuations in discharge and sediment load, the Platte has had to adjust to short-term regulation imposed by humans. These changes in discharge and sediment supply have been compensated for by changes in river pattern, shape, bed-material size, and slope. As the river degrades, it is trending towards a series of stable, more sinuous channels, threading through permanently vegetated islands and banks.

The key to sustaining the remaining braided characteristics of the Platte is to maintain a balance between the sediment load and the sediment-transport capacity. Assuming that sediment supplies remain adequate, flushing or scouring flows in the 8,000 cubic foot per second range should maintain the channel morphology and inhibit future woody vegetation encroachment in the remaining braided stretches of the Platte.

Peckenpaugh, J.M., Dugan, J.T., Kern, R.A., and Schroeder, W.J., 1987, Hydrogeology of the Tri-Basin and parts of the Lower Republican and Central Platte Natural Resources Districts, Nebraska: U.S. Geological Survey Water-Resources Investigations Report 87–4176, 117 p.

Study Description: Water-level declines of at least 15 feet have occurred in this intensively irrigated area of central Nebraska since the early 1930's, and potential for additional declines is great. The continuation of additional water-level declines is predictable; however, the location and magnitude of future declines are less predictable. Realizing this, the Central Platte and Lower Loup Natural Resources Districts, in 1977, entered into an agreement with the U.S. Geological Survey to do a quantitative hydrogeologic study of the area. The results of this study are to serve as a basis for testing the effects of various management alternatives for additional irrigation development on water levels and streamflow in the study area and are the subject of this report. Results indicate that substantial additional water-level declines will occur even if there is no additional ground-water development.

The potential for additional water-level declines is great for several reasons. First, current ground-water pumpage for irrigation, which caused the present declines, will continue. Second, within the area, additional development that will accelerate current declines is likely. Finally, additional ground-water irrigation west of the study area and additional surface-water diversions from the Platte River may result in additional water-level declines, but only if these developments reduce the annual flows of the Platte River within the study area below a critical level.

Peters, E.J., Holland, R.S., Callam, M.A., and Bunnell, D.L., 1989, Platte River suitability criteria—Habitat utilization, preference and suitability index criteria for fish and aquatic invertebrates in the Lower Platte River: Lincoln, Nebraska Game and Parks Commission, Nebraska Technical Series 17, 135 p.

Study Description: A 2-year study from 1986–88 developed microhabitat suitability index criteria for the dominant fish and macroinvertebrate taxa of the lower Platte River. Habitat use of adult channel and flathead catfish was determined by implantation of radio transmitters and subsequent tracking. Fish were located using a yagi antenna by a combination of aerial surveys and surface tracking. Forage fish were sampled weekly, using prepositioned electrofishing grids placed along a series of 328-foot transects. Macroinvertebrates were sampled weekly from available substrates including silt, sand, gravel, wood, rock, and plant debris. At each sample site, depth, current velocity, and substrate type were recorded.

Microhabitat suitability criteria were developed for 10 species of fish and 18 invertebrate taxa. In addition, habitat-utilization data are presented for 19 more fish species.

The study area lies within the channels of the Platte River in eastern Nebraska between its confluence with the Loup River in Platte County and its confluence with Salt Creek in Cass County. The objectives of the study were to: (1) document the applicability of existing channel-catfish suitability index criteria, and if warranted, propose changes to adapt the criteria to braided streams, such as the Platte River; (2) develop and test suitability index criteria for several species of

obligate riverene fishes that serve as forage for channel catfish; (3) develop suitability index criteria for several taxa of aquatic invertebrates that are common to the Platte River and serve as forage for channel catfish.

Platte River Whooping Crane Habitat Maintenance Trust, Inc., 1989, The first ten years, 1979–1989: Grand Island, Nebr., 6 p.

Study Description: The trust is a private, nonprofit organization dedicated to the preservation of migratory-bird habitat in the Big Bend reach of the Platte River in Nebraska. The Big Bend reach is the area of the Platte River between Overton and Chapman. The mission of the trust is to protect and maintain "the physical, hydrological, and biological integrity of the Big Bend area so that it may continue to function as a life-support system for the Whooping Crane and other migratory species which utilize it."

Platte River Whooping Crane Habitat Maintenance Trust, Inc., 1991, Research publications and reports, 1980–January 1991: Grand Island, Nebr., 6 p.

Study Description: A copy of the Platte River Trust's publications list of specific and general documents that integrate hydrology, history, and ecology.

Randle, T.J., and Lyons, Joe, 1988, Platte River channel characteristics in the Big Bend reach, Prairie Bend Project: U.S. Bureau of Reclamation, 28 p.

Study Description: The importance of the Platte River is evident from several standpoints. Historically, settlers used the river valley as a migration corridor and developed numerous towns and industries that are located along the river today. Ecologically, numerous species of wildlife use the habitats associated with the river, and agricultural and power-generation uses of the river have been continually expanding during the last century.

During the same time span, the wide and shallow Platte channel has tended to narrow and deepen. In some locations, smaller multiple channels have replaced the former single wide channel. Impoundments of water and sediment in storage reservoirs, transbasin diversions, irrigation withdrawals, return flows, vegetation establishment, bank stabilization, and bridges are factors that affect the Platte channel. The purpose of this report is to document the historical trends of channel geometry, water discharge, and sediment transport of the Platte River.

The study area encompasses the Platte River from Brady, Nebraska, downstream to Grand Island, Nebraska; this reach is commonly referred to as the "Big Bend Reach of the Platte."

Randle, T.J., and Woodward, Duane, 1984, Predicting channel shape of the Platte River: U.S. Bureau of Reclamation, 8 p.

Study Description: This paper demonstrates that channel narrowing of the Platte River can be described primarily by changes in water discharge and sediment load even when the effects of vegetation, streambank protection, or bridges are ignored.

Comparison of the width-discharge curves for the 1938 and 1983 conditions shows that the channel has remained primarily narrow due to a reduction in the bed-material load supplied to the Platte River. The reduction in bed-material load also has resulted in coarsening of the bed with concurrent narrowing.

Changes in the hydrology in 1938 would cause changes in channel width. Because of the reduction in supply of sediment from 1938 to 1983, an increase in the effective discharge will not result in a substantial change in channel width. However, a decrease in the effective discharge would cause further narrowing of the channel under 1983 conditions.

This approach can be used to qualitatively predict the effects of future changes in hydrology or sediment for specific reaches of the Platte River.

Reinecke, K.J., and Krapu, G.L., 1986, Feeding ecology of sandhill cranes during spring migration in Nebraska: Journal of Wildlife Management, v. 50, no. 1, p. 71–79.

Study Description: The authors studied the food habitats of Midcontinent sandhill cranes during spring 1978 and 1979 at their primary staging area along the Platte River and compared population food and foraging habitat requirements with availability.

Crane diets varied among the three principal foraging habitats but not between sexes, ages, or years. Cranes feeding in cornfields ate more than 90 percent corn; those feeding in native grasslands and alfalfa fields consumed 70–99 percent invertebrates. The composite diet of cranes was 97 percent corn and 3 percent invertebrates, including 2 percent earthworms, 0.5 percent snails, and 0.5 percent insects. Presumably, corn provided energy, whereas invertebrates from grasslands and alfalfa fields provided supplemental nutrients to compensate for protein and calcium deficiencies in corn.

The mean density of waste corn decreased from 356 pounds per acre in November, to 183 pounds per acre in early March, to 114 pounds per acre after departure of the cranes. Simulations of population energetics indicated that 450,000–550,000 cranes would consume 20–25 percent of the waste corn available in the Platte River Valley during spring.

Corn availability is unlikely to affect crane use of staging areas unless cropping practices or fall tillage reduce the acreage of harvested cornfields by more than 50 percent. Management by burning, haying, and grazing is compatible with crane use of grasslands, and reduced-till farming could benefit cranes by increasing invertebrate populations.

Rosier, W.S., Faanes, C.A., and Bradander, J.J., 1989, Wet meadows in the Platte River system—A community at risk: U.S. Fish and Wildlife Service, 12 p.

Study Description: Wet meadows in the Platte River system are native grasslands that appear to be hydrologically related to river stage. Topography is characterized by a complex of swales, sloughs, and terraces subject to seasonal flooding and soil saturation. Floral and faunal diversity is closely related to variations in topography and hydrology.

Wet meadows provide invertebrate nutrient resources essential for maintenance of reproductive health of sandhill cranes and whooping cranes, as well as waterfowl and other migratory bird species. Once widely distributed throughout central Platte Valley, the extent of wet meadows has been reduced by as much as 73 percent in some river reaches.

Despite recognized wildlife values and rapidly diminishing availability, wet meadow ecology remains poorly understood; this lack of knowledge has impeded preservation efforts and development of management strategies. The U.S. Fish and Wildlife Service is currently conducting research to: (1) delineate the current distribution of wet meadow habitats and (2) determine the relations among various physical and biological parameters.

Safina, Carl, Rosenbluth, Lewis, Pustmueller, Carse, Strom, Kenneth, Klataske, Ronald, Lee, Mercedes, and Beyea, Jan, 1989, Threats to wildlife and the Platte River: National Audubon Society, 128 p.

Study Description: This report provides a synthesis of the complex problems and controversies associated with protecting the Platte River system. The authors focus on the Big Bend reach of the Platte River in Nebraska, where most of the region's irrigation demands and water development projects now proposed will have significant repercussions. Audubon's Platte River Management Plan, now in the initial stages of preparation, will offer specific recommendations on how to manage the Platte for both wildlife and human needs.

The ecosystems of the Platte are stretched to their limit and if habitat-loss trends continue, wildlife will undoubtedly suffer. Development along the river has reached a critical threshold. Audubon is not content to wait until wildlife become a rare occurrence in the valley; Audubon believes the time to protect a species and its habitat is when they are still common. The challenge is now upon Audubon to wisely plan a course of management wherein the resources of the Platte can all maintain their vitality.

Sidle, J.G., 1990, To list or not to list: The Living Bird Quarterly, v. 9, no. 3, p. 16–23.

Study Description: Does the piping plover belong on the endangered species list? A biologist examines the rules and procedures. He knows that water departments will dam, that land developers will argue. Public hearings will heat up, and plover numbers will continue to decrease. Can Federal protection come in time to save the small shorebird?

Sidle, J.G., Faanes, C.A., and Jobman, W.G., 1990, Occurrence of American white pelicans along the Platte River, Nebraska: Prairie Naturalist, v. 22, no. 3, p. 165–170.

Study Description: The authors censured American white pelicans along the central Platte River in Nebraska during spring and fall 1988–89. The pelicans occurred in a river channel averaging 824 feet in width. They sighted few pelicans in river reaches where riparian forest and narrow channels predominated. The birds' occurrence in wide channels suggests a preference for a type of habitat that is disappearing along the Platte River.

Sidle, J.G., and Harrison, W.F., 1990, Interior population of the least tern (*Sterna Antillarum*)—Recovery plan: U.S. Fish and Wildlife Service, 90 p.

Study Description: The interior population of the least tern has been of concern for many years because of its perceived small numbers and the vast transformation of its riverene habitat. The interior least tern was listed as an endangered species on June 27, 1985, in several states.

Section 4 of the Endangered Species Act directs the Secretary of the Interior to develop and implement recovery plans for the conservation and survival of endangered and threatened species listed pursuant to Section 4 unless he finds that such a plan will not promote the conservation of the species.

The goal of this recovery plan is to describe actions for the conservation and survival of the interior least tern and to return the species to nonendangered status throughout its range. This plan summarizes available biological data, details various actions to stabilize and/or restore the interior least tern, and establishes criteria to remove it from the Federal list of endangered species.

Sidle, J.G., Miller, E.D., and Currier, P.J., 1989, Changing habitats in the Platte River valley of Nebraska: Prairie Naturalist, v. 21, no. 2, p. 91–104.

Study Description: The authors summarized data on habitat changes in segments of the North Platte and Platte Rivers, Nebraska, by examination of aerial photographs taken in 1938, 1965, 1969 and 1982. Their data are presented alongside data from other sources to view habitat changes since early settlement by Europeans. An 85–91 percent reduction in the area of the active channel along some segments has occurred. The channel has been transformed from nearly treeless to a mostly wooded environment. There has been a 23–45 percent loss of wetland meadows between 1938–82, and a 12–73 percent increase in cropland during the same period.

Snow, D.D., 1987, Occurrence and use of dissolved uranium isotopes in the Platte River drainage basin: Lincoln, University of Nebraska-Lincoln, Conservation and Survey Division, 17 p.

Study Description: The author investigated the occurrence of dissolved pesticides in the Platte River drainage basin and concluded that there was potential for pesticides in spring runoff to contaminate the alluvial aquifer in the Lower Platte Region.

Dissolved uranium occurs naturally in the Platte River in concentrations far in excess of the worldwide averages for rivers. Uranium concentrations were measured to determine if the large concentrations of dissolved uranium in the Platte River are maintained across the State and if these levels in drinking water are a health concern.

The elevated concentrations of uranium in the North and South Platte Rivers most likely result from leaching of sandstone-type ore deposits in the Front Range of the Rocky Mountains of Colorado and Wyoming and from paleoalkali deposits within these drainage systems. The elevated concentrations of dissolved uranium are reduced by dilution in the Platte River from the confluence of the North and South Platte eastward into the Lower Platte Valley.

Mixing calculations using uranium concentrations and activity ratios as natural tracers indicate a lack of lateral mixing in the Platte River, especially during greater discharge. Others have indicated that drinking water can be a significant source of uranium intake. Uranium concentrations in the surface water of the Platte River drainage basin exceed the U.S. Environmental Protection Agency Maximum Containment Level of between 20 and 40 picourries per liter in the western and central parts of the State. Uranium concentrations

in the lower Platte are substantially reduced by dilution from input from the small uranium-source areas of the Loup River, Elkhorn River, and other eastern tributaries.

Snow, D.D., and Spalding, R.F., 1988, Soluble pesticide levels in the Platte River Basin of Nebraska, *in* Proceedings of the Agricultural Impacts on Ground Water Conference: Dublin, Ohio, National Water Well Association, p. 211–233.

Study Description: A potential pathway for contamination of ground water by pesticides is via exchange with a river or stream contaminated by runoff from treated fields. The Platte River serves as a conduit for overland runoff containing pesticides. Three sets of river-water samples were collected from 23 sites during the 1987 agricultural season. These samples were analyzed for 23 pesticide residues.

The pesticides found in the Platte River included the herbicides alachlor, atrazine, butylate, cyanazine, EPTC, metolachlor, metribuzin, propachlor, and trifluralin. The insecticide terbufos also was detected in the Elkhorn River. Pesticide concentrations were largest in the eastern tributaries and in the Platte River downstream from where these tributaries discharge into the Platte. Pesticide concentrations were largest in the late spring during major storms and runoff. Lateral mixing is slight even during periods of high river flow; therefore, the mixing did not immediately dilute the pesticides.

Ground-water contamination was most likely during periods of high flow, which would coincide with periods of substantial pesticide application in the spring. Greatest ground-water contamination concerns were along the Platte River in the eastern part of the State, downstream from its eastern tributaries.

Spalding, R.F., and Exner, M.E., 1989, Groundwater quality in the Lower Platte Valley: Lincoln, University of Nebraska-Lincoln, Conservation and Survey Division, 35 p.

Study Description: The ground-water quality investigation in this 3-year study of the Lower Platte Valley has two objectives. They are (1) to determine the rates of increase in nitrate concentrations throughout the study area and (2) to increase the data base for nitrate and atrazine by obtaining more closely spaced samples in areas especially vulnerable to contamination and in areas adjacent to the Platte River well fields of Fremont, the Lincoln Water System, and the Omaha Metropolitan Utilities District well fields.

Spalding, R.F., and Snow, D.D., 1989, Surface water investigations—Stream levels of agrichemicals during a spring discharge event: Lincoln, University of Nebraska-Lincoln, Conservation and Survey Division, 12 p.

Study Description: Levels of agrichemicals were monitored during spring runoff in Shell Creek, an eastern tributary of the Platte River. Maximum concentrations of alachlor, atrazine, and cyanazine occurred prior to the peak in stream discharge. Other residues detected at small concentrations during the peak in stream discharge include the herbicides butylate, EPTC, metolachlor, metribuzin, propachlor, and trifluralin, and one insecticide, disulfoton. Suspended-sediment concentrations correlated with pesticide levels, whereas nitrate-as-nitrogen concentrations did not.

State of Colorado, 1923, South Platte River Compact: The Groundwater Appropriators of the South Platte River Basin, Inc., 31 p.

Study Description: The South Platte Compact between Colorado and Nebraska marks the successful conclusion of the first effort to adjust by treaty an interstate river controversy between two or more states of an arid region. The contract was signed by Commissioners for the States of Colorado and Nebraska at Lincoln, Nebraska, April 27, 1923, providing for the permanent equitable distribution of the waters of the South Platte River.

The compact divided the South Platte River in Colorado into two sections. The upper section includes the part of the South Platte River in Colorado above the intersection of the river with the west boundary of Washington County, Colorado. The lower section is that part of the South Platte in Colorado between the west boundary of Washington County and the intersection of the river with the west boundary of Washington County. Besides designating the upper and lower

sections, the compact contains many other statutes concerning water use of the Platte River in both states.

Tacha, T.C., 1985, Foraging and maintenance behaviors of sandhill cranes: Grand Island, Nebr., Proceedings 1985 Crane Workshop, National Audobon Society, p. 93–105.

Study Description: The purpose of this paper is to provide a quantitative description of the maintenance behaviors of sandhill cranes. Many maintenance behaviors of sandhill cranes are stereotyped in performance.

Acquisition of essential nutrients, comfort movements, and locomotor activities accounted for more than 85 percent of diurnal time expenditures of sandhill cranes. Juvenile sandhill cranes apparently benefited directly from parental investment through reduced time spent searching for food and increased time spent gleaning small grains.

Mated adults spent a smaller percentage of time gleaning and a greater percentage of time exhibiting social signals than adults without mates. Adult males spent a greater percentage of time exhibiting social signals; searched, gleaned, and probed for shorter periods; slept less frequently and for shorter periods; and were more mobile than adult females.

Tacha, T.C., 1988, Wildlife monographs—A publication of the Wildlife Society—Social organization of sandhill cranes from mid-continental North America: The Wildlife Society, no. 99, 37 p.

Study Description: Social behavior and relationships of mid-continent sandhill cranes were studied during winter and spring 1978–80 in western Texas, Nebraska, Saskatchewan, and Alaska. Social behaviors were described, and frequency of occur- rence, duration, and percentages of time allocated to each behavior were compared among age, sex, and social classes.

Unpaired subadults and adults, mated pairs, and families were the primary social units. Evidence suggests pairs were formed primarily during spring migration staging in Nebraska. Sandhill cranes exhibited perennial monogamy, allocating substantial time but minimal energy to maintaining pair bonds.

Associations between social behavior and environmental variables suggested several management implications. Pair formation was highly associated with wet pasture areas of the North Platte River, a habitat type threatened by conversion to row crops.

Tacha, T.C., Vohs, P.A., and Iverson, G.C., 1984, Migration routes of sandhill cranes from mid-continental North America: Journal of Wildlife Management, v. 48, no. 3, p. 1028–1033.

Study Description: The purpose of this paper is to describe the migration routes and relationships between wintering, migration-staging, and nesting areas of sandhill cranes from mid-continental North America. This paper integrates current information on the winter distribution, fall and spring migration routes, and breeding distribution of mid-continent sandhill cranes.

Tacha, T.C., Vohs, P.A., and Iverson, G.C., 1987, Time and energy budgets of sandhill cranes from mid-continental North America: Journal of Wildlife Management, v. 51, no. 2, p. 440–448.

Study Description: Time and energy budgets were quantified for sandhill cranes wintering in western Texas at three spring migration staging areas and during the prenesting period in western Alaska. Integration of habitat use, food habits, and physiology and condition data with concurrent time and energy budgets indicated that lipid dynamics covaried with reproductive status, habitat conditions, and time and energy allocations.

Cereal grains provided less than 95 percent of the energy during winter and spring migration. Lipid reserves obtained during migration were used on nesting areas because of large energy demands and little food availability. Lipids were accumulated primarily in Nebraska where cranes exploited concentrated maximum energy food with minimum energy expenditures. Amounts of small grains necessary to meet daily food requirements were quantified for each study location to assist managers in determining availability of adequate food supplies based on crane-use days.

U.S. Army Corps of Engineers, 1987, Platte River cumulative impact study, present and historic hydraulic characteristics and annotated bibliography: Omaha, Nebr., 43 p.

Study Description: The purpose of this report is to present information relative to the physical characteristics of the Platte River in Nebraska. There have been numerous reports written about the morphology of the Platte River, and it would be redundant to restate all the information available. Therefore, this report summarizes some of the basic data available with respect to channel geometry, water development, hydrology, and sediment.

U.S. Army Corps of Engineers, 1988a, Platte River cumulative impact study, erosion, bank stabilization, and bankline assessment: Omaha, Nebr., 22 p.

Study Description: An evaluation of the existing bankline conditions of the Platte River system was performed to determine baseline conditions and to better understand the potential for future bank-stabilization needs. Erosion rates for each reach were determined by analyzing aerial photography over a period of years. Erosion assessments of the four study reaches indicate that erosion is active in every reach. Erosion is more severe on both the North and South Platte than on either reach of the river.

Surveyors documented all existing fill activities and pertinent information at each site. A survey of fill activities on the rivers indicates that bank-stabilization practices are very similar for each reach. Bankline measurements for each reach, including outer bank, total bankline, and eroding bankline, provided additional insight.

All information was placed in a data base and upon aerial-photography mosaics for evaluation. These data assisted in the development of scenarios for future bank-stabilization efforts. Relation between bankline length, erosion rates, channel configuration, bank stabilization, and structure type were determined.

U.S. Army Corps of Engineers, 1988b, Platte River cumulative impact study, qualitative assessment and glossary: Omaha, Nebr., 33 p.

Study Description: In any alluvial channel there is a set of complex relations that include a number of important physical characteristics. Water discharge is perhaps the most important variable, but sediment transport, energy slope, geology, soils, vegetation, and channel geometry are also major physical processes. Changes to any one variable causes changes in all other variables.

The Platte River has undergone considerable change in the past. Water development within the basin, floods, and land-use transition are some of the major causes of change. These factors have led to an alteration of the morphology of the river, which manifests itself in changes in appearance of the channels. Width and flow reduction, vegetation islands, and a reduction in channel capacity are the major changes.

Bank-protection structures affect the hydraulics, sediment transport, and geometry of the adjacent channel. Streambank-protection projects can result in a wide range of positive and adverse environmental impacts. Through proper planning and design, negative impacts can be minimized, and positive impacts maximized. This requires a thorough understanding of the river system and adherence to several design characteristics.

U.S. Army Corps of Engineers, 1989a, Platte River streambank erosion control, Lincoln County, Nebraska, decision document: Omaha, Nebr., 198 p.

Study Description: Local interests, represented by the Twin Platte Natural Resources District, are seeking Federal assistance to develop a plan for erosion control that would use locally available materials and self-help methods to resolve erosion problems on the Platte River in Lincoln County, Nebraska.

Currently there are many erosion-control practices on the Platte River system that are ineffective and environmentally unacceptable. The Water Resources Development Act of 1986 authorizes the Corps of Engineers to plan, design, and construct streambank erosion-control projects when such work is economically justified and environmentally acceptable. This report presents a rationale for development of a plan that meets the objectives of the authorizing legislation, is responsive to the needs of the local community, and provides viable, effective alternatives to current, noneffective practices.

U.S. Army Corps of Engineers, 1989b, Platte River cumulative impacts analysis—Quantitative analysis of hydrogeologic impacts from bank stabilization: Omaha, Nebr., River and Reservoir Engineering Special Studies Unit Report 4, 89 p.

Study Description: This report is the fourth in a series prepared in response to concerns over the impact of bank-stabilization activities on the Platte River upon the threatened and endangered species that inhabit the region. Three specific topics are discussed in this report. They include a sediment study, an assessment of bank-stabilization practices and structures, and model studies of bank-stabilization alternatives. Approximately 11 percent of the outer banks within the study reach currently (1989) are protected with structures that prevent erosion. It is estimated that an additional 9 percent of the bank will erode to the point that it may become desirable to protect it within the next 30 years. Two major findings from the investigation of the erosion and yield of sediment from the Platte River were found: (1) bank erosion contributes less than 5 percent of the total bed-material sediment load, and (2) the river within the study reach is in a state of quasi-equilibrium. The assessment of sediment transport for the study reach showed that the median particle sizes for bed, bank, and suspended sediment are 0.03, 0.02, and 0.001 inch, respectively.

A one-dimensional, sediment transport model, HEC-6, was used to evaluate the cumulative impacts of structures on the Platte River. Fifteen different conditions for partial and complete bank-erosion control were simulated, with the results compared to a future baseline condition. Analysis of the one-dimensional model results indicated that the revetments, even in a worst-case scenario with both banks reveted the entire reach, have essentially no impacts on the physical characteristics of the channel.

An analysis of structures that prevent erosion by deflecting the current, such as hardpoints and jetties, indicated that the impacts from these structures are largely a factor of the degree in which they constrict the channel. On the basis of observed stabilization practices, it was projected that a mixture of revetments and hardpoints at a ratio of about 2:1 was the most likely future scenario.

An attempt was made to simulate the clearing of vegetation from islands and bars in an effort to create habitat because it has been proposed as a mitigative measure for many planned activities on the river. That analysis indicated that an increase in width and area of about 5 and 3 percent, respectively, could be expected, whereas average depth and velocity would decrease by about 3 percent. A general decline in water-surface elevation could be expected at most discharges, but the average bed elevation would remain relatively unchanged.

TABS-2, a two-dimensional, sediment transport model, was used to analyze the local impacts of different structure types and configurations for a 1.8-mile reach of the river immediately downstream of Kearney, Nebraska. Analysis of armoring techniques, such as revetments, that do not encroach on the channel showed the two-dimensional model results to be similar to the one-dimensional results. Changes in bed configuration and hydraulics generally were restricted to the zone immediately adjacent to the structures and did not extend riverward more than 5 percent of the channel width. Some bed scour adjacent to the structure was indicated, with an associated change in velocity distribution and a slight increase in magnitude.

Effects of flow-deflection structures varied with location, length, and design. Individual structures or groups of structures that extended riverward less than 5 percent of the channel width had relatively little impact on the overall channel characteristics.

On the basis of model studies and the other analyses performed, the following conclusions can be drawn regarding bank-stabilization activities on the Platte River: (1) Relative to the other variables affecting the physical properties of the Platte River, erosion-control structures have had little historical impact; (2) revetments, fences, vegetation, and other armoring techniques that do not constrict the channel have essentially no impact upon the physical river properties; (3) jetties, hardpoints, and other deflective structures may impact the system if placed at every section, but only if their length exceeds 5 percent of the channel width. These impacts may be reduced by proper design and positioning of the structures; and (4) additional information is required to properly evaluate the practice of vegetation clearing. Preliminary analysis indi-

cates that clearing may have some impact on the river characteristics, depending upon the particular bars and islands selected and upon flows subsequent to the vegetation removal.

U.S. Army Corps of Engineers, 1990, Platte River cumulative impacts analysis: Omaha, Nebr., River and Reservoir Engineering Special Studies Unit, Report 5, 113 p.

Study Description: This report is fifth in a series prepared in response to concerns over the impact of bank-stabilization activities on the Platte River upon threatened and endangered species that inhabit the region. Information generated from this study regarding the physical impacts of bank stabilization upon the Platte River system will be evaluated for its environmental significance. On the basis of the evaluation, bank-stabilization criteria will be proposed for the Corps of Engineers' regulatory activities. Impacts to the physical character of the river, and thus the impact upon threatened and endangered species, will be reduced by adherence to these criterion.

Cumulative effects of bank-stabilization structures were found from this analysis to be affected primarily by the degree of constriction they exerted on the river. When structures encroached riverward less than 5 percent of the active channel width, the impacts were negligible.

Based on this evaluation, a general permit for Section 404 activities on the Platte River has been formulated and submitted to the public. This general permit would allow an expedited review and approval of applications for those categories of activities determined to have negligible local and cumulative impacts.

U.S. Army Corps of Engineers, 1991, Platte River cumulative impacts—Final report of physical analysis: Omaha, Nebr., 300 p.

Study Description: The purpose of this study and the environmental assessment is to determine the cumulative impacts of all existing and expected bank-stabilization activities on the Platte River. This will assist the Corps in deciding whether a general permit is appropriate for these types of actions.

U.S. Bureau of Reclamation, 1990a, Prairie Bend Unit—Nebraska planning report—Draft environmental statement: Great Plains Region, 366 p.

Study Description: The objectives of the study are: (1) to assess environmental impacts of a construction project to recharge and stabilize ground-water levels in Buffalo and Hall Counties of Nebraska and (2) to aid in the conservation and recovery of migratory birds and Federally listed threatened and endangered species habitat in the Big Bend reach of the Platte River in Nebraska.

The study's related effects on species and habitat attributable to construction of recharge reservoirs, offstream reservoir storage, canals, recharge ponds, and the diversion of Platte River flows are evaluated, and appropriate recommendations are provided in the report.

On the basis of the revised biological assessment, the Bureau does not think that the construction project would adversely affect whooping-crane designated critical habitat, whooping-crane roosting habitat morphology, least-tern and piping-plover nesting habitat morphology, or least-tern nonsummer forage fish habitat, assuming flows of 400 cubic feet per second are adequate to maintain viable forage fish population during the winter and spring periods.

U.S. Bureau of Reclamation, 1990b, Plan of study for evaluation of operation of existing reclamation projects on the Platte River for the potential to affect threatened or endangered species: Mills, Wyo., North Platte River Projects, 20 p.

Study Description: The study area includes the North and South Platte Rivers from the project facilities downstream to the confluence of the Platte River with the Missouri River. The Reclamation is embarking upon a 5-year program, scheduled for fiscal years 1990 through 1995, to determine if the operations of Reclamation facilities in the Platte River Basin are in compliance with Section 7(a)(1) and (2) of the Endangered Species Act (ESA).

If the study shows that operations are adversely affecting listed species or other habitats, formal consultation with the U.S. Fish and Wildlife Service would be initiated, in accordance with the requirements of Section 7. If the evaluation leads

to a plan for changing operations and if that plan constitutes a significant Federal action, full compliance with the Endangered Species Act, including an environmental document, will be required.

U.S. Bureau of Reclamation, 1990–1991, Annual operating plans for Niobrara, lower Platte, and Kansas River Basins: Billings, Montana, 114 p.

Study Description: This is the 38th Annual Operating Plan for the irrigation units (dams and reservoirs) in the Kansas River Basin and the 24th Annual Operating Plan for the irrigation units in the Niobrara and lower Platte River Basins.

U.S. Department of Energy, 1990, U.S. Department of Energy before the Federal Energy Regulatory Commission: Washington, D.C.—Joint response of the Central Nebraska Public Power District to the Federal Energy Regulatory Commission's December 7, 1984, deficiency notice: 227 p.

Study Description: This document is exhibit E of the new license and application for two hydropower projects in the Platte River Basin. On June 28, 1984, Nebraska Public Power District and The Central Nebraska Public Power and Irrigation District (jointly referred to as "the districts") filed new license applications with the Federal Energy Regulatory Commission (FERC) for Projects 1835 and 1417, respectively.

On December 7, 1984, FERC notified the Districts that their new license applications were deficient in three areas. The first deficiency was corrected. The second deficiency was that a description must be provided of the minimum-flow recommendations made by the agencies consulted, including an explanation of why the applicant has rejected any such flow recommendations.

The third deficiency is an analysis must be provided of the following issues: (1) the long-term impact on the vegetation and wildlife of the North Platte and Platte River systems resulting from past project operations; (2) feasible operating alternatives and mitigative measures that would minimize continuing project impacts and enhance existing botanical and wildlife resources; and (3) project impacts on the whooping crane's designated habitat and alternatives for protecting and enhancing the critical habitat.

This document referred to as the "Deficiency Response" responds to the two remaining deficiencies, and it addresses issues raised during several years of consultation between the Districts and the U.S. Fish and Wildlife Service and the Nebraska Game and Parks Commission. There are 16 appendices to the document: appendix I contains a study plan and key correspondence relevant to the Joint Study; appendix II contains correspondence between the Districts and the resource agencies; appendix III reports on woodland expansion and channel change on the Platte River system and the prospects for future changes; it also contains Dr. Johnson's statistical analysis of the causes of woodland expansion, and his 4-year vegetation demography field study of the Big Bend reach of the Platte River, and results of a probabilistic simulation model of vegetation dynamics; appendix IV describes past and continuing impacts of projects 1417 and 1835 on Platte River system hydrology; appendix V describes geomorphology and channel morphology; appendix VI describes woodland expansion and wetlands; appendix VII describes past and continuing impacts of projects on bald eagles along the Platte; appendix VIII describes impacts on least terns and piping plovers along the Platte; appendix IX describes impacts on whooping cranes along the Platte; appendix X describes impacts on sandhill cranes along the Platte; appendix XI describes impacts on waterfowl along the Platte; appendix XII describes impacts on fish in the Platte (volumes 1 and 2); appendix XIII contains the resource agencies' instream flow recommendations and supporting rationale as described in previous biological opinions; appendix XIV contains the agencies' comments on the draft Deficiency Response; appendix XV contains documentation of public hearings on FERC Projects 1417 and 1835, with supporting correspondence; and appendix XVI contains the results of the 10 study scenarios evaluated by the Districts in the course of assessing feasible operating alternatives.

U.S. Environmental Protection Agency, 1990a, Recommended determination to prohibit construction of Two Forks Dam Reservoir Pursuant to Section 404(c) of the Clean Water Act: Washington D.C., Office of Water, 129 p.

Study Description: Two Forks dam and reservoir is a water-supply project proposed by the Denver Board of Water Commissioners (DWB) and the Metropolitan Water Providers (MWP) to help meet the water-supply needs of the Denver metropolitan area. Construction and operation of the Two Forks dam and reservoir would inundate a diverse riverene, wetland, upland complex with important aquatic, wildlife, and recreational values.

The fishery is one of the most productive in Colorado and is designated as "Gold Medal Trout Water" by the Colorado Wildlife Commission. Both projects would eliminate approximately 90 percent of the Gold Medal reach of the South Platte River; result in the loss of mule deer, elk, wild turkey, bighorn sheep, small animals, avian, and threatened pawnee bald eagle and peregrine falcon. The reservoir also would inundate the South Platte River areas currently receiving the most intense recreational use.

The U.S. Environmental Protection Agency's (USEPA) Final Determination concludes that the discharge of dredged or fill material associated with the proposed 1.1-million acre-foot Two Forks dam and water-supply reservoir on the South Platte River in Jefferson and Douglas Counties, Colorado, as well as the 400,000-acre-foot project and 450,000-acre-foot corrective-action proposal, would result in unacceptable adverse effects on fishery areas and recreational areas. The Section 404(c) regulations define an unacceptable adverse effect as an impact on an aquatic ecosystem that is likely to result in significant degradation of municipal water supplies or significant loss of or damage to fisheries, shellfishing, or wildlife habitat or recreation areas.

This conclusion that the subject projects would have unacceptable adverse effects on fishery and recreational areas based upon two independent grounds. First, USEPA finds that the effects are unacceptable in light of the significant loss of or damage to these resources that would occur as a result of the subject projects; the loss and damage are avoidable because practicable, less-damaging alternatives are available.

Second, USEPA has concluded that even if no less-damaging practicable alternatives were available, the significance of the damage to fishery and recreational areas caused by the projects would be so great that they would constitute an unacceptable adverse effect under section 404(c), the effects of which are not adequately compensated for by the mitigation proposed by the applicant.

On the basis of these findings, this Final Determination prohibits, pursuant to Section 404(c) of the Clean Water Act, the specification of the subject waters of the United States within the South Platte River as a discharge site for dredged or fill material for the purpose of creating any reservoir or impoundment as described in the Two Forks 1.1 million acre-foot proposal, 400,000 acre-foot project, and the proposed 450,000 acre-foot corrective action.

U.S. Fish and Wildlife Service, 1981, The Platte River ecology study special research report: Jamestown, N. Dak., 187 p.

Study Description: This report summarizes findings of the Platte River Ecology Study. The 3-year investigation was conducted by the U.S. Fish and Wildlife Service to: (1) determine the role of the Platte River Valley in contributing to the requirements of mid-continent migratory bird populations and (2) develop guidelines for management of riverine habitats and adjacent lands supporting populations of selected species of migratory birds.

Birds and subjects discussed are: sandhill cranes, whooping cranes, waterfowl, bald eagles and other raptors, breeding birds, effects of habitat alteration on migratory birds, disease concerns, development of woody vegetation, and maintenance of crane habitat.

U.S. Fish and Wildlife Service, 1987a, Recovery implementation program for endangered fish species in the upper Colorado River Basin: 81 p.

Study Description: This document provides the framework upon which recovery of three species of endangered fish and the management of a fourth fish species in the upper Colorado River Basin is to be based and the concrete steps that are to be implemented as part of a comprehensive program for all four species, herein referred to as the recovery program. Three species, the Colorado squawfish, humpback chub, and bonytail chub, have been listed as endangered by the Secretary of the Interior under the Endangered Species Act of 1973. The

fourth species, the razorback sucker, is a candidate for Federal listing under this act. The ultimate goal of this recovery program is recover and delist the three endangered species and to manage the razorback so it would not need the protection of the Endangered Species Act.

U.S. Fish and Wildlife Service, 1989, Platte River management joint study—Evaluating management alternatives—Sediment, flow, and channel geometry considerations, summary of findings: U.S. Fish and Wildlife Service Hydrology Work Group, 84 p.

Study Description: During the last century, the wide and shallow Platte River has tended to narrow and deepen. Impoundments of water and sediment in storage reservoirs, transbasin diversions, irrigation withdrawals, return flows, vegetation establishment, bank stabilization, sand and gravel mining, bridges, precipitation, geology, and soil-conservation practices are factors that affect the Platte channel.

There are many species of fish and wildlife that utilize the braided Platte River channel with its characteristic wide, shallow water and sand-gravel bottom bed. The threatened and endangered species that are the focus of the Platte River Management Joint Study are the whooping crane, interior least tern, piping plover, and bald eagle.

The habitat requirements of these species are being defined by the Biology Work Group. The habitat requirements associated with each species are based on the physical channel characteristics and hydraulics that are utilized in the Platte River. The focus of this report is on reviewing and evaluating techniques for assessing changes in channel characteristics.

U.S. Fish and Wildlife Service, 1990a, Endangered resources in the Platte River ecosystem—Description, human influences and management options: 52 p.

Study Description: The Platte River system provides important habitat for fish and wildlife resources of national and international significance. Among endangered species, however, the Platte River is probably best known as a migration stopover area for whooping cranes. About 70 percent of the historic annual flow in the Platte River system has been diverted upstream for consumptive uses in Colorado, western Nebraska, and Wyoming.

Since development began, channel widths have been reduced, peak flows have been reduced, and subsequent agricultural development caused by water impoundments and diversions have resulted in significant losses of flood-plain, wet meadow habitat.

In March, 1990, the U.S. Fish and Wildlife Service and the U.S. Bureau of Reclamation agreed that a conceptual habitat management plan for the Platte River system should be developed. Growing concerns for environmental impacts resulting from proposed and existing water development projects on the Platte River system impelled the Fish and Wildlife Service to develop a document to outline the needs of the Platte River ecosystem and strive to meet the recommendations within the report.

This report describes historical and current river geomorphology, resource concerns, human influences, and suggested management options.

U.S. Fish and Wildlife Service, 1990b, Platte River management joint study: Biology Workgroup final report, 131 p.

Study Description: Working groups of the joint study are charged with developing a wildlife management plan for the Platte River ecosystem in central Nebraska.

The purpose of the parties involved in Phase 1 of the Platte River Management Joint Study is to cooperate in discussions seeking ways to develop and implement recovery plans and programs that will enable Federal-agency actions associated with water-project development and depletions in the Platte River Basin to proceed in compliance with the Endangered Species Act while avoiding conflicts between the Endangered Species Act and State water-rights systems and the uses of water apportioned to a State pursuant to the compact and decrees concerning the water of the Platte River and its tributaries.

The data contained in this report are a synthesis of the best information available on the endangered species resource in the Big Bend reach of the Platte River. Included is information on past and current area of habitat, changes in endangered species use of the river, a description of criteria

used in developing species models, and a list of potential alternatives for the management of Platte River resources in the future.

University of Nebraska-Lincoln, Conservation and Survey Division, 1991 Proceedings of Nebraska water conference, 1991, The rivers of Nebraska—Character, conflicts and cooperation: Lincoln, Nebr., 13 p.

Study Description: This report contains the conference schedule, conference sponsors and special credits and presenter's biographies.

University of Nebraska-Lincoln, Institute of Agriculture and Natural Resources, 1990, Center for Advanced Land Management Information Technologies (CALMIT) projects: Lincoln, Nebr., 16 p.

Study Description: James Merchant, Associate Professor and Associate Director at the University of Nebraska-Lincoln, sent information on CLAMIT projects and activities that he thought would be of interest in planning the Platte River Initiative. CALMIT was founded to significantly enhance and expand research and instructional activities in remote sensing, geographic information systems, automated cartography and image processing that had, since 1972, been conducted through the University of Nebraska-Lincoln Remote Sensing Center.

Williams, G.P., 1978, The case of the shrinking channels—The North Platte and Platte Rivers in Nebraska: U.S. Geological Survey Circular 781, 48 p.

Study Description: The purpose of this study was to determine whether the channels of the North Platte and Platte Rivers in western and central Nebraska have been changing in character since the latter part of the 19th century. The 298-mile study reach extended from Minatare, Wyoming, on the North Platte River to Grand Island, Nebraska, on the Platte River.

The channels have changed considerably. Changes in the 227-mile reach from Minatare to Overton, Wyoming, differ in magnitude and sometimes in character from the downstream stretch from Overton to Grand Island (71 miles). Within the former reach, the channel by 1969 was only about 0.10 to 0.20 as wide as in 1865. The 1969 channel for this reach was less braided and slightly more sinuous than the 1938 channel. From Overton to Grand Island, the 1969 channel was about 0.60 to 0.70 as wide as in 1865, and various changes in braiding and sinuosity took place between 1938 and 1969.

The decreases in channel width are related to decreases in water discharge. Such flow reductions have resulted primarily from the regulating effect of major upstream dams and the greater use of river water by humans. Much of the former river channel is now overgrown with vegetation.

AUDIO-VISUAL MATERIALS AVAILABLE THROUGH U.S. ENVIRONMENTAL PROTECTION AGENCY

The following audio-visual materials are available from the U.S. Environmental Protection Agency, Region VII, Wetlands Protection Section, Kansas City, Kansas.

Agriculture & Wildlife Series, #6 Stockponds and Waterfowl; #8 Streamside Woodlands; #10 Wetlands and Restoration: video-VHS, Kansas State University Cooperative Extension Service.

Description: #6 "Stockponds and Waterfowl" contrasts the Prairie Pothole Region, historically a significant contributor to waterfowl production, which has had its habitat reduced nearly 40 percent by expanding agriculture, with semiarid areas of Montana, the Dakotas, and Wyoming, where the establishment of farm ponds has resulted in increased habitat and nesting. Discusses types of farm ponds and their effectiveness in creating waterfowl habitat. Length 11.00 minutes.

#8 "Streamside Woodlands" discusses the Conservation Reserve Program (CRP) requirements for streamside woodlands. The video reviews values of streamside woodlands adjacent to croplands and discusses effectiveness of a 50-foot buffer strip in removing the majority of fertilizer components such as nitrogen and phosphorus, eroded soil, pesticides, and animal wastes. Length 7.30 minutes.

#10 "Wetlands and Restoration" discusses values of wetland restoration under the Conservation Reserve Program, such as reduced soil erosion, improved water quality, curbed production of surplus commodities, increased commodity prices, reduced sedimentation, enhanced timber supply, and improved wildlife habitat. Financial incentives are available under the CRP. Length 13.00 minutes.

Aquatic Plant Control, January 1991: video-VHS, Kansas State University Cooperative Extension Service, Manhattan.

Description: "Aquatic Plant Control" describes types of aquatic plants in the interesting format of a farmer and an extension agent fishing in a farm pond. The farmer encounters various types of plants, and the extension agent discusses them and their control. The video describes how to collect samples for plant identification. Length 34.45 minutes.

Champions of Wildlife Conserving America Series, December 1988: video-VHS, National Wildlife Federation.

Description: The video is the story of people who are making a difference by championing wildlife. The script is devoted mostly to Dayton and Gerda Hyde and how they manage their 5,000-acre Oregon ranch, with 1,200 cattle, for wild creatures as well as business. "Champions of Wildlife Conserving America" tells of their conservation and wetland-management practices and the resulting improvements to the land. Length 15.00 minutes.

Crane River, April 1989: video-VHS, National Audubon Society.

Description: Documentary on the importance of the Platte River as a migration habitat for cranes, primarily the sandhill and whooping cranes. It reviews impacts of flow reductions due to upstream impoundments and water consumption. Expresses concerns about additional projects under consideration. Length 57:49 minutes.

Ducks Under Siege, 1987: video-VHS, National Audubon Society Special.

Description: It has been two decades since ducks literally blackened the sky. The duck count for 1985 was the worst on record. Mallard numbers were down almost 50 percent from 1955; blue-winged teal, 41 percent; and pintails, an alarming 69 percent. The Canadian drought was partially to blame, but it may have masked a more serious threat. All along their instinctual path from Canada through the American flyway, their habitat was threatened. The draining, filling, polluting of wetlands is the source of this threat. This docu-

mentary describes problem areas, such as California and Louisiana, and work being done for conservation. Length 55.00 minutes.

Fabulous Wetlands, January 1, 1989: video-VHS, Iowa Department of Natural Resources.

Description: The information presented by Mr. Science is an elementary-level, entertaining explanation of what a wetland is. The video is useful for all ages. Length 7.00 minutes.

Farming With Wetlands—How to Turn These Nuisance Areas Into Profit for Farmers While Improving the Environment, June 1, 1991: video-VHS, Sierra Club National Wetlands Committee.

Description: "Farming With Wetlands" features Ray McCormick who farms 1,500 acres of river bottom near Vincennes, Indiana; 150 acres remain in year-round wetland. Ray blocks drainage on his fields after harvest each year and then floods them, creating additional wetland habitat for migrating waterfowl. He describes results of farming during the 1987 drought and producing large yields of corn because of the wetlands. He explains income he gets from the Conservation Reserve Program and discusses the North American Waterfowl Management Plan. Length 8.58 minutes.

Headwaters: video-VHS, Missouri Department of Conservation.

Description: "Headwaters" describes fishes of the headwaters of streams. The video details preparation for spawning, spawning, and hatching of small mouth bass. "Headwaters" is a somewhat dated production, but the information is still valid. Length 32.00 minutes.

Last of the Rainwater Basins, February 1, 1990: video-VHS, Nebraska Public Television KUDN-TV.

Description: Five to seven million ducks and geese chase spring northward on their way to nesting grounds in northern prairies and arctic tundra. In the marshes of the Rainwater Basin their success or failure on the nesting ground will be determined. Here they rest and feed, preparing for the difficult journey that lies ahead. Soil surveys from the early 1900's suggest the Rainwater Basin once contained nearly 4,000 marshes covering nearly 150 square miles. During the last century, 90 percent of these wetlands have been filled or drained principally to make way for increased crop production. Length 30.00 minutes.

Planning for the Future—Wetlands on Federal Lands, January 1, 1990: video-VHS, Interagency Wetlands Coordinating Body.

Description: The video is the story of one of our Nation's most valuable natural resources, wetlands, and how major Federal land-management agencies are working to sustain them for present and future generations. The United States encompasses a wide variety of wetlands from the tundra of Alaska to the mangrove forests of Florida. Wetland losses are a growing concern, and Federal land-management agencies are responding by ensuring that healthy, productive wetlands remain a visible part of our national heritage. Length 27.00 minutes.

Platte River Road, April 1, 1991: video-VHS, Nebraska Public Television KUDN-TV.

Description: The video tells the history of the Platte River and how its banks became the route of pioneers traveling west. Many stopped along the way, and towns were established. "Platte River Road" describes how water utilization and demands on the river have impacted its function as a habitat. Length 88.00 minutes.

Rainwater Basin Wildlife, March 1, 1991: video-VHS, Robert Horton Video Photography.

Description: The video provides scenes of wildlife, mostly waterfowl in the Rainwater Basin. The

video is a serene presentation with excellent musical background. Length 17.42 minutes.

Restoring Wetlands On Your Property, June 1, 1991: video-VHS, Purdue University's Cooperative Extension Service.

Description: The video discusses the details of a U.S. Fish and Wildlife Service program that restores previously drained wetlands at no cost to the landowner. All procedures and equipment used in the restoration program are illustrated, and all details of the program are fully explained. The video helps the landowner anticipating such a project to visualize the process and the resulting wetland that could be restored on the property. Quality footage of the different types of wetlands found in Indiana is accompanied by a brief narrative that discusses the importance of each. One Hoosier landowner, who had previously drained his wetland, discusses the reasons for wetland restoration and the benefits derived from them. Information is presented on additional State and Federal programs that provide monetary return on wetland acreage. The video is intended for general agricultural audiences and landowners interested in wetland restoration. Length 11.00 minutes.

Status of Ducks, January 1, 1988: video-VHS, U.S. Fish and Wildlife Service.

Description: The video describes the impacts of the drought of 1985–87 on drying up of wetlands and agricultural encroachment in the Prairie Pothole Region. "Status of Ducks" reviews statistical information on duck-breeding population and indicates reduction of 16 percent overall compared to the 1955–87 average. Length 15.00 minutes.

Stream Sense, January 4, 1990: video-VHS, Missouri Department of Conservation.

Description: The video discusses Missouri's streams, one of the State's greatest natural resources—a place to swim on a hot day, a road to adventure, a fisherman's haven, and environment with a beauty all its own, but there are times when all these benefits seem overshadowed by serious problems. These problems make adviseries of streams and people and, over time, can destroy both the quality of the stream and the value of nearby property. These problems are bank erosion, fill erosion, and siltation. "Stream Sense" discusses problems with streams and the causes of the problems and compares channelization with stream-corridor management as a means of solving stream problems. Length 19.00 minutes.

Wetlands, Farming and You: video-VHS, U.S. Department of Agriculture, Soil Conservation Service (SCS).

Description: The video is a segment from an SCS presentation on Swampbuster provisions of the farm bill. "Wetlands, Farming and You" broadly defines wetlands and describes how the U.S. Fish and Wildlife Service and other agencies are inventorying wetlands and preparing National Wetland Inventory maps. The video describes how SCS will review wetland information with farmers to determine if wetlands are present and also cautions farmers about program benefits that may be affected if wetlands are altered. Length 4.44 minutes.

Wetlands Nightmare, January 1, 1989: video-VHS, Washington State Environmental Protection Agency, Ecology Department.

Description: "Wetlands Nightmare" is a compilation of interviews with concerned individuals in several communities about wetlands and the desirability of developing a wetland area management plan for the community. The information is presented in a satirical, old-style movie format. Length 20.00 minutes.

ABSTRACTS

Bard, C.S., 1982, Delineation of uranium exploration targets in western Nebraska by statistical analysis of groundwater geochemistry: Oak Ridge, Tenn., Union Carbide Corp., Oakridge Gaseous Diffusion Plant, 126 p.

Recent exploration in northwestern Nebraska resulted in the discovery of a major uranium deposit in the Alliance 1 degrees X 2 degrees NTMS quadrangle of western Nebraska. R-mode cluster analysis and multivariate correlation analysis is used in this report to characterize the groundwater geochemistry of the Alliance and Scottsbluff quadrangles. The presence of relatively high concentrations of dissolved solids has the effect of masking important geochemical associations between uranium and typical pathfinder elements. Weighted sums analysis and resultant derivative maps are used to delineate two major trends of potential uranium mineralization. Trend I is located in the Alliance Quadrangle near the Pierre Shale-White River Group contact. The town of Crawford is on this trend. Trend II is located in the Scottsbluff Quadrangle south of the Platte River in the White River Group. Areas of sharp concentration decreases of calcium and magnesium along these trends are considered to represent good uranium exploration targets.

Barnes, Ivan, and Bentall, Ray, 1968, Water-mineral relations of Quaternary deposits in the lower Platte River drainage area in eastern Nebraska: U.S. Geological Survey Water-Supply Paper 1859-D, 39 p.

In the Platte River area sand is dominant in sediment beneath the loess of the terrace plain, with gravel at greater depths. Under the river valley, gravel is common at all depths, and sand is coarser. Light minerals, mostly quartz, constitute 95 percent of the sediment. Soils are permeable and readily absorb precipitation, and recharge takes place from the rivers. Water from wells on the terrace plain was undersaturated with respect to calcite, as it is so uncommon in the deposits, but the partial pressure of CO_2 was 30 to 90 times greater than in the atmosphere, probably due to solution from loess. River water differs from that of the Lincoln City well field in that it is about 10 times supersaturated with respect to calcite, contains less dissolved CO_2, and has a higher pH. There may be a smaller fraction of river water in these wells than thought. Nine test hole logs are included.

Crowley, K.D., 1983, Large-scale bed configurations (macroforms), Platte River Basin, Colorado and Nebraska—Primary structures and formative processes: Geological Society of America Bulletin, v. 94, no. 1, p. 117-133.

Large-scale bed forms are not hydrodynamically equivalent to the regime bed forms but constitute a unique hierarchical class of bed configurations produced by turbulent vortices that involve the entire boundary layer. Three members of a continuum of geometries are recognized in the channels of the Platte River Basin. The internal stratification for each of the three types is similar and in its simplest form consists of the coarsening-upward sequence apron laminae-foreset laminae-topset laminae, offering a potentially powerful tool for identifying these environments.—Modified journal abstract.

Eschner, T.R., and Kircher, J.E., 1984, Interpretation of grain-size distributions from measured sediment data, Platte River, Nebraska: Sedimentology, v. 31, no. 4, p. 569-573.

Breaks in the slope of log-probability plots of cumulative grain-size distributions of bed material are compared with frequency distributions of bedload and suspended sediment over a range of discharges at two stations on the Platte River in south-central Nebraska. Although grain-size distributions of bedload change little with discharge, the size of the coarsest grains in suspension increases with increasing discharge. Thus, the length of overlap of bedload and suspended-sediment distributions increases with increasing discharge. The limits of grain-size overlap of bedload and suspended-sediment distribution curves associated with near-flood discharges most closely approximate the breaks in the bed-material grain-size distribution.

Galvin, C.J., Jr., and DeVries, M., 1965, Sand transport studies with radioactive tracers: American Society of Civil Engineers, Proceedings, Journal of Hydraulics Division, v. 91, no. HY 1, pt. 1, p. 173–185.

Galvin cites additional bibliographic references of papers issued from 1955 to 1964 on the subject of the use of radioactive tracers in sediment transport studies and comments on the effects of nonuniform vertical distribution of tracers in the transported sediments. DeVries comments on the description of sand movement and the determination of transported quantities of sediment. He used fluorescent tracers for study of total grain-size distribution and applied a number of instantaneous sources, whereas Hubbell and Sayre used radioactive tracers for part of the grain-size distribution and applied one instantaneous source.

Grigg, R.D., and Williams, M.C., 1965, Distribution of *Amoebidium* and *Smittium* species (*Trichomycetes*) in mosquito larvae on the Platte River floodplain of central Nebraska (USA): Transactions of the Nebraska Academy of Sciences, v. 17, p. 23–28.

Trichomycetes (fungi) inhabit the digestive tract of insects and other arthropods. Two genera, *Smittium* and *Amoebidium*, were collected from mosquito larvae (*Culicidae*) from 36 sites in a six-county area of central Nebraska, in the Platte River flood plain during the summers of 1986 and 1987. When present, 30 mosquito larvae per site per month were identified at the fourth instar, checked for the epizooite A. parasiticum, and then dissected and the gut examined by phase-contrast microscopy for *S. culisetae* and *S. culicis*. In 1986, 17 species of mosquito larvae from six genera (n = 665) were dissected, and 22.7 percent were infested with *Smittium spp.* and 14.7 percent with *Amoebidium sp.* In 1987, eight species from four genera (n = 380) were dissected, and 26.6 percent were infested with *Smittium spp.* and 11.8 percent with *Amoebidium sp.* (n+n = 1045). The percentage of trichomycete infestation remained similar from year to year, although the yearly total of dissected potential hosts varied. Two sites had *Smittium* species only once each in 2 years, which suggests that host continuity is not necessary for trichomycete infestation.

Holland, R.S., and Peters, E.J., 1989, Persistence of a chemical gradient in the lower Platte River, Nebraska (USA): Transactions of The Nebraska Academy of Sciences and Affiliated Societies, no. 17, p. 111–116.

During a 1986–87 study of microhabitat utilization by Platte River fauna we noted a persistent difference in conductance between north and south banks. A series of transects across the river, measured on August 11, 1987, between river miles 78–59, demonstrated that the conductivity gradient persisted throughout the 20-mile study segment. Typical readings were 315 micromhos per centimeter^{-1} for the north side and 550 micromhos per centimeter^{-1} for the south side. Additional upstream measurements showed that the gradient originates at the confluence of the Platte River and the Loup River Power Canal (river mile 101). Upstream, the Platte River mean monthly conductivity was 922 micromhos per centimeter^{-1}, whereas the conductivity of the Canal was 283 micromhos per centimeter^{-1}. Correlation analysis of the relative contribution of the Canal to total downstream discharge showed a significant negative correlation ($r = -0.60$; $P = 0.001$) to the conductivity levels of the Platte River downstream of the confluence. Occurrence of this conductivity gradient may indicate a lack of mixing of other chemical constituents in the water, including pollutants.

Hubbell, D.W., and Sayre, W.W., 1965, Application of radioactive tracers in the study of sediment movement: U.S. Department of Agriculture Miscellaneous Publication 970, p. 569–578.

Radioactive tracer techniques were used to investigate the dispersion and transport of bed material in a test reach of the North Loup River near Purdum, Nebr. Sand particles, labeled with iridium-192, were used as tracers. A description of the experimental procedure is given. The results of the field study and subsequent laboratory flume studies indicate a potential for the wide application of radioactive tracer in sediment studies.

Keech, C.F., 1968, Water levels in observation wells in Nebraska, 1967: Nebraska Water-Survey Paper 23, 60 p.

Water levels in many observation wells in Nebraska have been measured for more than 20

years, and some since 1934; however, new wells are continually being added and some are inadvertently destroyed. Currently the program includes 1,198 wells, and for 531 of these, the water-level measurements made in 1967 are given in this report. Except for a few, measurements were made in the fall after the close of the irrigation season. Average water levels in wells were lower than the 1966 fall readings in 49 of the 93 counties. Declines occurred in all counties in the Blue River Basin except in Butler County, and generally in the Panhandle area as a result of dry weather conditions. Levels rose in the lower Platte River Valley and in Gosper, Phelps, and Kearney Counties.

Krothe, N.C., Oliver, J.W., and Weeks, J.B., 1982, Dissolved solids and sodium in water from the High Plains aquifer in parts of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming: U.S. Geological Survey Hydrologic Investigations Atlas HA-658, 2 sheets, scale 1:2,500,000.

Brief description of the variation in the concentration of dissolved solids and sodium in water from the High Plains aquifer, which includes an area of about 174,000 square miles. The effects of geology and mixing water from bedrock units on water chemistry in the aquifer are described and the salinity and sodium hazards associated with use of the water for irrigation are discussed.

Lugn, A.L., 1968, The origin of loesses and their relation to the Great Plains in North America, *in* Loess and related eolian deposits of the world: International Association of Quaternary Research, Nebraska Press, p. 139-182.

There is little doubt that eastern Colorado and other areas of the western High Plains were important sources of loessic materials and ancient and modern dust storms, particularly since mid-Pleistocene times during the stripping of the Tertiary cover. In these areas, as in the more easterly area of the Nebraska Sand Hills, where stripping of Ogallala beds may still be less than 50 percent complete, normal fluvial erosion and slope wash also have been important and necessary for facilitating wind erosion and transportation of eolian silt and loessic materials out of the area by wind.

Norling, B.S., Anderson, S.H., and Hubert, W.A., 1965, Nocturnal behavior of sandhill cranes roosting in the Platte River, Nebraska (USA): Prairie Naturalist, v. 23, no. 1, p. 17-20.

We studied nocturnal roosting behavior of sandhill cranes (*Grus canadensis*) roosting in the Platte River in Nebraska during March and April 1990. Individual cranes were most active from arrival in the roosting area to 2100 hours and from 0505 hours to departure. Resting was the predominant behavior, followed by standing. Preening, flying, walking, alert, courtship, and agonistic activities constituted the remainder of observed behaviors. Roosting activities of sandhill cranes (*Grus canadensis*) have been described, but little is known regarding the nocturnal behavior of sandhill cranes while roosting. We studied temporal variation in behavior patterns of roosting sandhill cranes throughout the night during a portion of the spring staging period on the Platte River, Nebraska, and examined the influence of weather on behavior patterns.

O'Shea, D.T., Hubert, W.A., and Anderson, S.H., 1965, Assemblages of small fish in three habitat types along the Platte River, Nebraska (USA): Prairie Naturalist, v. 22, no. 3, p. 145-154.

We examined small-fish assemblages in three aquatic habitat types along the Platte River, Nebraska, in June and July 1988. Fish were sampled from the main channel of the Platte River, excavated sand pits connected to the river by side channels (open pits), and excavated pits not connected to the river (closed pits). Four distinct fish assemblages were identified: (1) *piscivorous centrarchids* and *nonpiscivorous centrarchids* in sand pits lacking aquatic vegetation; (2) *nonpiscivorous centrarchids* and small forage fish in sand pits with aquatic vegetation; (3) red shiners, *Cyprinella lutensis*, in narrow river channels with large proportions of river-edge habitat; and (4) sand shiners, *Notropis ludibundus*, and big mouth shiners, *hybopsis dorsalis*, in wide river channels with abundant sandbars and little river-edge habitat.

Reed, E.C., Dreeszen, V.H., Bayne, C.K., and Schultz, C.B., 1965, The Pleistocene in Nebraska and northern Kansas: Princeton, N.J., Princeton University Press, p. 187–202.

The eastern sixth of the area was glaciated during Nebraskan, Kansan, Illinoian, and Wisconsin time. Classification of the Pleistocene for both States is given. Two glacial drifts of Nebraskan age, and three of Kansan age are correlated with depositional sequences in the periglacial area. Only one till is found in both the Illinoian and Wisconsin, but three formations are in the periglacial section of each. The Pearlette Ash is the best key horizon. Formations are described. Geomorphology and drainage pattern development are discussed and illustrated on a map. An area of stabilized sand hills in north-central Nebraska is reviewed; their origin from the Ogallala and relations to the Peoria loess are suggested. The Pleistocene mammals found in terraces in western Nebraska are listed, including some Asiatic forms.

Roedel, M.D., 1965, Unionid mollusks in the Big Bend reach of the Platte River, Nebraska (USA): Prairie Naturalist, v. 22, no. 1, p. 27–32.

Historically, the Platte River in Nebraska was, for the most part, a braided stream with a constantly shifting bottom. Bivalve molluscs typically are not found in this type of habitat and thus are not common in the Platte River. During the summer of 1988, six species of unionid mussels were collected by the author from a channel of the Platte River in Hall County, Nebraska. Two additional species were collected by others from the Platte River in Dawson County. All of the specimens were collected within the Big Bend reach of the Platte River, which extends from Lexington to Grand Island, Nebr. *Quadrula quadrula* was the most abundant species sampled, and *Potamilis obiensis* was the least abundant.

Sautter, E.H., 1964, Potassium-bearing feldspars in some soils of the Sandhills of Nebraska: Soil Science Society of America Proceedings, v. 28, no. 5, p. 709–710.

Orthoclase and microcline were studied in 59 soil horizons made up of sand or sandy loam in the Tripp soil of the North Platte River Valley. Organic matter and coatings were removed from the mineral grains, and the sand and coarse silt fraction separated by sedimentation. Potassium-bearing feldspars make up from 12 to 26 percent of this fraction, but there are marked differences in the amounts of minerals between horizons of individual soil profiles and between those in soil profiles of the same series. These differences probably are related to stratification within the profiles and reflect the wind-laid and water-laid nature of the sediment in which the soils formed. Weathering was not severe enough to cause uniform increases of K-bearing feldspar with depth, and distribution seems to be unrelated to differences in soil drainage.

Sayre, W.W., and Hubbell, D.W.,1965, Transport and dispersion of labeled bed material, North Loup River, Nebraska: U.S. Geological Survey Professional Paper 433–C, 48 p.

Radioactive tracer techniques were used to investigate experimentally the transport and longitudinal dispersion of bed-material sand particles. The design and conduct of experiments in which radioactive particles are used as sediment tracers are discussed. A concentration-distribution function for tracer particles is derived with the aid of probability theory and evaluated with experimental data. A method for determining bed-material discharge from observed distributions of tracer particles is presented also.

Sidle, J.G., Faanes, C.A., and Jobman, W. G., 1990, Occurrence of American white pelicans along the Platte River, Nebraska (USA): Prairie Naturalist, v. 22, no. 3, p. 165–170.

We censused American white pelicans (*Pelecanus erythrorhynchos*) along the central Platte River in Nebraska during spring and fall 1988–89. The pelicans occurred in a river channel averaging 824 feet in width. We sighted few pelicans in river reaches where riparian forest and narrow channels predominated. The birds' occurrence in wide channels suggests a preference for a type of habitat that is disappearing along the Platte River.

Spalding, R.F., and Snow, D.D., 1965, Stream levels of agrichemicals during a spring discharge event: Chemosphere, v. 19, nos. 8–9, p. 1129–1140.

Levels of agrichemicals were monitored during spring runoff in Shell Creek, an eastern tributary of the Platte River, which drains a 270-square-mile watershed of predominantly row-cropped corn. Discharge during the runoff event ranged from 19 to 781 cubic feet per second. Maximum levels of atrazine, cyanazine, and alachlor of 89, 76, and 46 micrograms per liter, respectively, occurred prior to the peak in stream discharge. Other residues detected at small concentrations during the peak in stream discharge include the herbicides—butylate, EPTC, metolachlor, metribuzin, propachlor, and trifluralin, and one insecticide—disulfoton. Suspended-sediment levels (maximum = 19.7 grams per liter) correlated with pesticide levels, whereas nitrate-N concentrations (maximum = 6.3 milligrams per liter) did not.

Stewart, B.A., Viets, F.G, Jr., and Hutchinson, G.L., 1968, Agriculture's effect on nitrate pollution of groundwater: Journal of Soil and Water Conservation, v. 23, no. 1, p. 13–15.

Among agricultural sources of ground-water pollution, nitrogen has received particular attention because of increased use of fertilizers and the health hazard to livestock and humans, especially infants. Victims of nitrate poisoning show symptoms of oxygen deficiency. Natural sources cannot be neglected in appraising the nitrate problem created in a watershed or basin by adding large amounts in foods, feeds, fertilizers, and legumes. Little is known about the relative contributions of domestic sewage effluents, fertilizers, and wastes from corrals to pollution of ground water. Comparison of chemical data for water samples beneath feedlots and irrigated fields in Colorado suggests that leaching losses have been greatly underestimated. Profile differences are discussed and illustrated graphically; need for management is emphasized.