A COMPREHENSIVE REVIEW OF OBSERVATIONAL AND SITE EVALUATION DATA OF MIGRANT WHOOPING CRANES IN THE UNITED STATES, 1943–99

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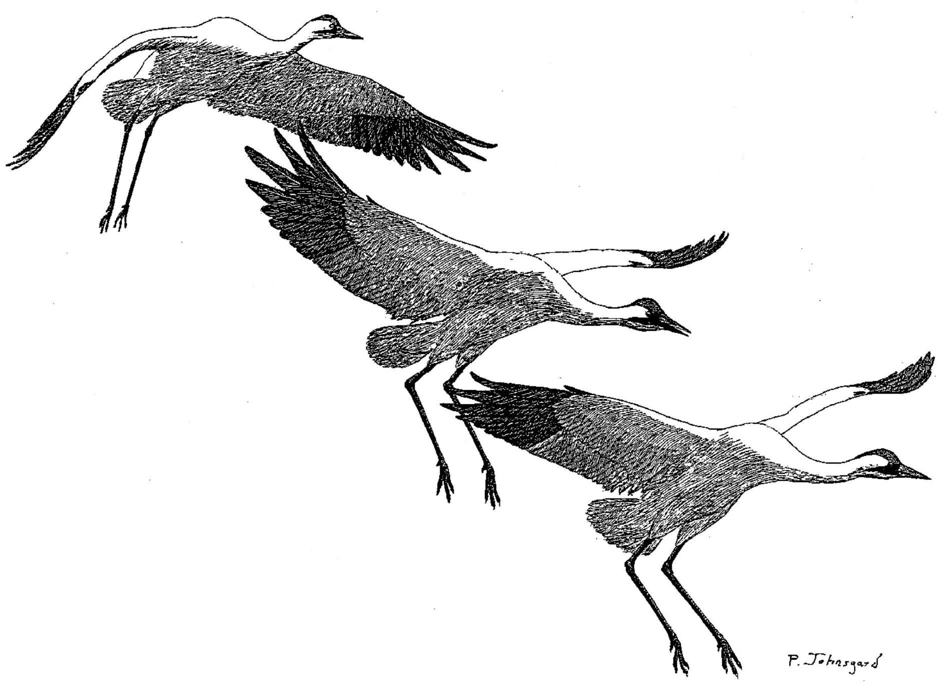

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SUMMARY

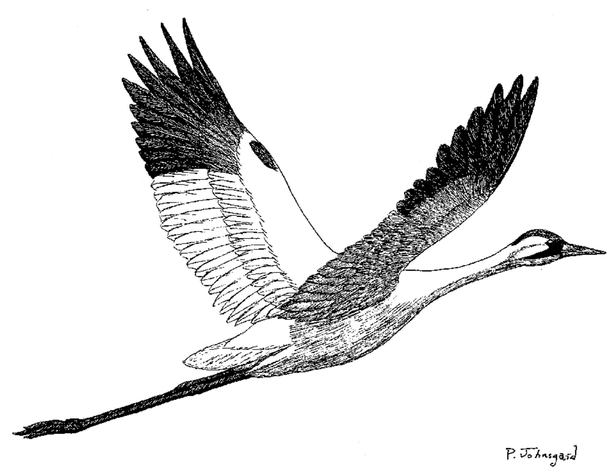
This report is a comprehensive analysis of existing observational data (1943–99) and site evaluation data (1977–99) for locations used by whooping cranes (*Grus americana*) during migration through the United States portion of the Wood Buffalo–Aransas flyway. The apparent migration path, as outlined by the distribution of whooping crane observations, is very similar to that delineated in earlier reports, following a relatively straight line north-northwest from Aransas National Wildlife Refuge (NWR) to central North Dakota then curving northwest along the Missouri Coteau to the North Dakota–Saskatchewan border. The distribution of spring and fall observations were relatively similar, except for the higher frequency of fall observations on Quivira NWR and Cheyenne Bottoms State Wildlife Area in Kansas, Salt Plains NWR in Oklahoma, and in Texas. Timing of spring and fall migrations also appears similar to that described earlier and shows no changes over the 57-year period of data collection. Regardless of season, most sightings included 1–3 whooping cranes, but groups with as many as 14 and 19 cranes have been sighted in spring and fall, respectively.

The complete site evaluation database contained 1060 observations. We examined characteristics of 3 types of stopover habitats: 1) roost sites, 2) feeding sites, and 3) dual-use sites (i.e., where cranes were observed using a site for both roosting and feeding). Characteristics of sites examined included: wetland type or class (system, class, and regime), wetland size, river width, water depth, water quality, wetland substrate, wetland shoreline slope, dominant emergent vegetation, distribution of emergent vegetation, primary adjacent habitat, similar habitat within 16 km (10 mi), site descriptions, distance to feeding sites, primary potential food sources, observed foods consumed, distance to human development or to utility lines, visibility, other bird species present, site ownership, and site security.

Results revealed some new insight into whooping crane habitat use. Palustrine wetlands accounted for >75% of records in all states except Nebraska; in that state, the proportions of observations occurring on palustrine and riverine systems were both high (56.0 and 39.6% of state records, respectively). Roost sites were most common on riverine systems only in Nebraska, primarily the Platte, Niobrara, and North and Middle Loup rivers. Most of the whooping cranes found on riverine roosts were single cranes or nonfamily groups, particularly on the Platte, but we found no strong pattern in social groups on riverine roost sites or on feeding and dual-use sites. Whooping cranes were most commonly observed on wetlands having seasonal and semipermanent water regimes. Cranes were observed on a wide range of wetland sizes in both spring and fall, with no apparent pattern relative to social groups. Cranes used portions of rivers that ranged in width from 27 to 457 m and averaged 267 $\pm$ 87 (SD) m.

Many of the results in this study concur with earlier reports. Maximum depths of wetlands on which cranes were observed averaged 50.8 $\pm$ 41.4 cm (20.0 $\pm$ 16.3 inches), while specific sites within wetlands where cranes were observed feeding or roosting averaged 18.0 $\pm$ 10.7 cm (7.1 $\pm$ 4.2 inches). Most wetland shorelines were classified as having a slight slope (1 to <5% slope). In riverine systems, roosting cranes were more often observed on unvegetated sites than on vegetated sites, but palustrine roost sites had a broad range of emergent vegetation types. Most feeding sites were described as upland crops, whereas dual-use sites were more often wetlands. On upland crop sites, 83% of grain stubble was wheat stubble, 75% of row-crop stubble was corn, and 80% of green crops was winter wheat. Habitats adjacent ($\leq$1.6 km [1 mi]) to roost sites were most frequently described as cropland (73.8%) and upland perennial cover (69.5%). Woodland habitat occurred adjacent to >70% of riverine roost sites but <8% of palustrine roost sites. There was little difference in the frequency distribution of social groups among permanent wetlands, cropland, and upland cover. We detected no patterns in distance between roost and the closest feeding sites. More than two-thirds of sites where cranes were observed were <0.8 km (0.5 mi) of human developments. Nearly half of the roost sites and two-thirds of feeding sites had unobstructed visibility of <0.40 km (0.25 mi). Private ownership accounted for >60% of all sites used by whooping cranes and >80% of feeding sites, which reflected the high use of crop fields.

The 57 years of data in the whooping crane sightings database provide a descriptive summary of whooping crane migration over a large geographic region. As an observational database, however, it is subject to a number of limitations, including 1) seasonal and regional differences in the distribution, density, and activity of individuals reporting crane sightings, 2) area or regional differences in the distribution and strength of interest of biologists to confirm observations and collect additional habitat data, and 3) varying landscape patterns that may hinder observation of cranes in some habitats.   Such spatial and temporal differences affect the chance of detecting whooping cranes and therefore can bias the data set so that particular regions and habitat types may be over- or under-represented relative to actual use by migrants. Therefore, results presented here should be interpreted and used with caution. We provide recommendations on data limitations, needs for further information, and survey protocol for future monitoring of whooping cranes during migration.



INTRODUCTION

Palustrine and riverine habitats in the central Great Plains provide roosting and foraging habitat to whooping cranes (*Grus americana*) during spring and fall migration. Characteristics of roost habitat have been examined in detail for the Platte River in Nebraska (Johnson 1982, Lingle et al. 1984, Faanes 1992, Faanes and Bowman 1992, Faanes et al. 1992), an area long recognized as a critical habitat for whooping cranes during migration. Although the Platte River is the best known spring stopover area for migrating whooping cranes, whooping cranes also use many other areas during spring and fall migration. Whooping cranes have been observed on various roosting and feeding areas throughout the migration path, which extends through North and South Dakota, Nebraska, Kansas, Oklahoma, and Texas. Because these areas play a key role in crane migration, the recovery plan for the whooping crane identified the collection of data on the use of these habitats as an important task in the conservation of the species (U.S. Fish and Wildlife Service 1994).

The Whooping Crane Recovery Team compiled a list of documented whooping crane observations for the period 1943–79. Collection of information on whooping crane use of roost and feeding areas began in 1975. Observations were categorized as confirmed (verified by state or federal biologist or other known, qualified observer), probable (no verification, yet details seem to identify the birds as whooping cranes, based on factors such as location within normal migration corridor and on appropriate site, accurate physical description provided, number of birds is reasonable, and behavior does not eliminate whooping cranes), and unconfirmed (details of sightings met some but not all of the factors listed for a probable sighting). Basic data collected for these records included number of birds, sex, age class, location, and number of days observed. Beginning in 1978, site evaluations were initiated for collection of more extensive information on roost and feeding sites. This greatly expanded the scope and detail of data collected to include wetland type and size, water quality, substrate, water depth at specific roost or feeding sites and at intervals along a transect, visibility, vegetation, land cover, etc. More than 25 parameters were recorded for each site that was evaluated (U.S. Fish and Wildlife Service 1980). The Nebraska Field Office of the United States Fish and Wildlife Service (USFWS) has maintained these data in 2 databases: 1 for observational sightings (containing 1352 confirmed sightings, 1943–99) and 1 for site evaluation data (1060 sightings, 1977–99).

Data from the confirmed sightings and site evaluation databases have been used by a number of researchers for various projects. Johnson (1982) used observational data to investigate the use and significance of habitat in the Platte River valley for whooping cranes. Lingle et al. (1984) used observational and site evaluation data to characterize whooping crane use in the Platte River valley. Carlson et al. (1990) and Ziewietz (1992) used roost and feeding site data to develop a habitat suitability model for the Platte River. Roost site data were used by Stahlecker (1997) to correlate stopover habitat availability with wetlands identified on National Wetland Inventory (NWI) maps. However, there has been no comprehensive summarization of the USFWS databases to characterize roosting and feeding site use throughout the flyway, to explore temporal or spatial patterns, or to examine differences among social groups (families, singles, or groups). Nor has there been a comprehensive review of the data sets to detect and correct errors.

At the 1998 meeting of the Whooping Crane Recovery Team in Calgary, Alberta, team members recommended that, although observational data should continue to be collected, no additional site evaluations should be done until the existing data were analyzed. The analysis of habitat use for the Platte River was identified as a high priority in 2000 by the Technical Committee of the Cooperative Agreement among Colorado, Nebraska, and Wyoming. In a January 1999 letter to Mr. Wallace Jobman, USFWS Nebraska Field Office, Whooping Crane Coordinator Thomas Stehn (USFWS, Region 2) reiterated the need to analyze existing data as expressed by the Recovery Team. As a result, a group of state and federal biologists and other interested parties met to discuss objectives for a better understanding of the USFWS database. The following 12 priority objectives for data analyses were identified: 1) Characterize habitat for palustrine and riverine roost and feeding sites. 2) Determine behavior and use patterns for roost and feeding sites using individually-marked cranes. 3) Determine migration patterns of individually-marked birds. 4) Determine use patterns of family units versus individual and non-family groups. 5) Determine use patterns for fall versus spring. 6) Determine use patterns for palustrine versus riverine habitat throughout the flyway. 7) Determine climatic influence on palustrine versus riverine use. 8) Determine use patterns by state and region throughout the flyway. 9) Determine temporal changes in use patterns – year to year and over time. 10) Determine influence of other species, i.e., sandhill cranes (*Grus canadensis*), waterfowl, and shorebirds, on use patterns. 11) Assess site evaluation data against NWI classification. 12) Assess length of stay regionally for fall versus spring migration.

The goal of this project is to conduct a comprehensive summary of existing observational and site evaluation data for habitat use by whooping cranes through the migration flyway from Texas to North Dakota. This report provides a summary of the sighting locations for 1943–99 and habitat description information for 1977–99. We provide recommendations on data needs, limitations, and survey methods for future monitoring of whooping cranes during migration.

DEVELOPMENT OF OBSERVATION AND SITE EVALUATION DATABASES

Two data sets with information about whooping crane sightings were developed during 1943–99. The type and amount of information collected by observers changed over time. The following history of the databases provides insight on the general characteristics of data collected and idiosyncracies that exist in the computerized databases. Specifically, it describes when changes occurred and how the method of data collection may have influenced summarized results.

Records of whooping crane stopover sightings have been documented since 1943. Prior to 1975, however, there was no flyway-wide organized effort to identify and record whooping crane sightings during migration. In spring 1974, 9 whooping cranes were sighted in the Rainwater Basin region of south-central Nebraska during an avian cholera outbreak. This incident caused biologists to realize the importance of protecting whooping cranes during migration. More information was needed about general migration movements and habitat use at stopover sites. To gain information, the Cooperative Whooping Crane Tracking Project began in the United States and Canada in fall 1975. The United States portion of the program was coordinated by the Endangered Species Supervisor, USFWS Area office, Pierre, South Dakota. In 1975, the Canadian Wildlife Service generated a form for reporting whooping crane sightings in Canada (Report Form 1). No standardized reporting form was developed for the United States sightings until 1977 when the National Audubon Society (NAS) organized a whooping crane reporting network, to boost the effort to monitor sightings of whooping cranes. A goal of the NAS was to help coordinate public sightings with the USFWS program. A whooping crane reporting form (Report Form 2) was developed by USFWS to standardize descriptions of sightings and to classify sightings as confirmed, probable, or unconfirmed (as defined in the Whooping Crane Recovery Plan).

In 1978, Wallace Jobman (Wildlife Biologist, USFWS Area office, Pierre, SD) was designated as Project Coordinator. From that time until the present, a cover letter and form for reporting sightings was sent prior to each migration to federal and state wildlife offices throughout the U.S. portion of the flyway (MT, ND, SD, WY, NE, CO, KS, OK, and TX) to alert biologists of the potential for whooping crane stopovers in their region, to encourage verification of sightings, and to report any unusual hazards along the migration route to the Pierre Area office.

Realizing the need to obtain additional information about habitat requirements of whooping cranes, the Whooping Crane Recovery Team met in February 1978 and developed comprehensive guidelines for reporting observations and evaluating habitats used by whooping cranes. The new guidelines requested information about habitat variables that were suggested as important for evaluating whooping crane habitat, as indicated by published literature and previous sightings reports. The form included 2 components: guidelines for a written report (Report Form 3a), and a sighting report short-form (Report Form 3b).

In 1978, the USFWS designated 9 sites in 6 states as critical habitat (Federal Report Vol. 43, No. 94, May 15): Cheyenne Bottoms State Wildlife Area (SWA), Kansas; Platte River valley between Lexington and Dehman, Nebraska; Salt Plains National Wildlife Refuge (NWR), Oklahoma; Aransas NWR, Texas; Monta Vista NWR, Colorado; Alamosa NWR, Colorado; Grays Lake NWR, Idaho; and Bosque del Apache NWR, New Mexico. The latter 4 areas were associated with the experimental cross-fostering study conducted during 1976-85. All but 1 of these sites are under state or federal protection; the Platte River site remains largely under private ownership. As a result, the Platte River became a priority area for the USFWS. The Pierre Endangered Species Office was subsequently moved to Grand Island, Nebraska, in August 1985. Wallace Jobman moved with the office and continued to coordinate the monitoring effort.

In 1984, a committee of federal and state biologists was formed to further identify hazardous situations within the flyway. The Committee produced a 1985 Contingency Plan for federal-state cooperative protection of whooping cranes. Part of the plan included a protocol for collecting sick or dead cranes and for reporting observations of cranes (Report Form 4). From 1985 to present, the Contingency Plan has been integrated with the Cooperative Whooping Crane Tracking Project. Report Forms 3b and 4 were both used to report whooping crane sightings during 1985-99. These 2 forms were considered as a short form for reporting whooping crane sightings. When a sighting occurred, a biologist could then report the information using 1 of the 2 short forms only, or they also could complete an evaluation guideline (Report Form 3a).

In 1985, data of all confirmed sightings were entered into a computerized (dBase) database. This prompted the USFWS to create a new stopover habitat evaluation form. Some habitat evaluation categories were altered in order to facilitate data entry (Report Form 5). The forms were sent to key state and federal offices for use during reporting, but often only the short form Whooping Crane Sighting Report (Report Form 3b) or Contingency Report (Report Form 4) was returned to the Grand Island office. In many cases, habitat evaluation information (as outlined on Report Form 5) was communicated by telephone to the USFWS office. The computerized format was used for reporting site evaluations until 1999 when the habitat evaluation portion of the monitoring program was halted so that information accumulated to date could be summarized and evaluated.

By the mid-1980s, the Platte River was an important political focus for the state of Nebraska because of pending applications for out-of-stream water use and its influence on threatened and endangered species. In 1987, the Nebraska Game and Parks Commission began to augment the USFWS monitoring with additional evaluation data (Report Form 6). The goal of the Nebraska monitoring program was to gain a more detailed evaluation of habitat used by whooping cranes and to use the information for habitat conservation measures in Nebraska. The Nebraska monitoring program occurred until 1999. Evaluation forms and a computerized database are maintained at the Nebraska Game and Parks Commission office in Lincoln.

During the course of the USFWS sightings monitoring program, information that was recorded changed with each new reporting format. From 1943 to 1977, only observational data were collected. Observations consisted of sightings of cranes on the ground (roosting, foraging, loafing) or in flight. From 1978 to 1999, observation reports were continued, and site evaluations were compiled to describe sites used by cranes sighted on the ground. After sighting evaluations were developed, reporters occasionally would file an observation report only. As a result, 2 separate databases (observation, evaluation) were compiled and continued until 1999. Along with these 2 confirmed sightings databases, the USFWS office in Grand Island houses observation forms with information about probable and unconfirmed sightings.

During the 25 years (1975-99) of the monitoring program, most sightings of whooping cranes were first reported by private citizens. Calls by private citizens most often were made to USFWS or state wildlife offices. All confirmed sightings were verified by a state or federal biologist or other reputable bird expert, such as personnel from The Platte River Whooping Crane Maintenance Trust and Lillian Rowe Audubon Sanctuary. Throughout the flyway at national wildlife refuges, state land areas, and most of Nebraska, birds often were watched after the initial confirmed sighting, and additional sighting locations were recorded. Most other sightings occurred in areas far enough from state and federal offices that an observation was reported in a single location and checks for use of additional locations in that vicinity were not conducted. Since 1978, federal and state offices have provided key contact persons for monitoring stopovers. These offices house many of the biologists that attempted to confirm sighting reports. Offices contacted included USFWS state field offices (Billings, MT; Grand Island, NE; Pierre, SD; Bismarck, ND; and Manhatten, KS); federal refuges or wetland management districts (Medicine Lake NWR, MT; Long Lake NWR, ND; Crosby Wetland Management District, ND; Lake Andes NWR, SD; Quivira NWR, KS; Salt Plains NWR, OK; and Aransas NWR, TX), Cheyenne Bottoms SWA, Kansas; and state wildlife departments (North Dakota Game and Fish Department; South Dakota Department of Game, Fish and Parks; Nebraska Game and Parks Commission; Kansas Department of Wildlife and Parks; Oklahoma Department of Wildlife Conservation; and Texas Parks and Wildlife Department).

METHODS

Data Set Processing

Data were originally stored as dBase IV files, with separate files for each state. We imported files into Excel and appended files from each state to create 1 file of observations and 1 file of site evaluations. We used SAS (SAS Institute, Inc. 1990) to search for and correct errors in identification codes such as non-matching years or seasons, duplicate main and sub-observation codes, and missing records in either observation or site evaluation files. Cranes that had arrived at Aransas NWR in fall traditionally were categorized as "winter" observations, including those arrivals in October and November. We categorized as "winter" observations a few cranes that were sighted in late December and January in areas away from Aransas NWR. Similarly, we categorized a few records occurring after 15 June in North Dakota as "summer" observations. For this report, we ignored those observations determined to be in "winter" or "summer."

Observation Number System

All sightings of whooping cranes reported to the USFWS Grand Island office were uniquely coded using year (e.g., 79) and season (A = spring [January–June] and B = fall [July–December]), in sequence of their reporting within the calendar year; this code is referred to as the "main observation" code. Confirmed, probable, and unconfirmed sightings were assigned such codes. If multiple sightings of a single crane or group of cranes occurred within an area and period (e.g., the same bird[s] were recorded during 1 or more days at several locations), an alphabetic character denoting "sub-observation" was added at the end of the main observation code to identify these additional, associated sighting locations (e.g., 98A-25A, 98A-25B, 98-25C, etc.). Up to 12 such sub-observations occurred for any 1 main observation.

Only confirmed sightings were included in the 2 subsequent data sets developed from incidental sightings of whooping cranes: the observation data set (*OBSERVATIONS*) and site evaluations data set (*EVALUATIONS*). The observation data set includes basic information about whooping crane sightings for the period 1943–99, including dates, locations (description and legal system description), and numbers of adults and juveniles. The site evaluation data set reflects a subset of locations from the observation data, where biologists collected specific habitat information during the period 1977–99. See Appendices for detailed information about the variables within each data set.

We merged *OBSERVATIONS* and *EVALUATIONS* by state, main observation, and sub-observation codes and corrected problems noted during the merging process. Some inconsistencies that occurred in recording were checked and corrected as necessary (e.g., wrong season descriptor, difference in county recorded for observation vs. site evaluation data). We also added some specific records so that all unique locations, based on legal descriptions in each original database (e.g., another section or quarter-section), were represented. This expanded the merged SAS database (*ALL.SD2)* to a total of 1876 records. We used SAS to examine the data set for unusual records, missing data, etc. We found mostly minor errors in the data sets (e.g., variable entered off by 1 field, mistyped, errors in wetland size class). Overall, the data sets were quite clean considering their size and period of development.

We created new codes for numeric observation and site identification based on year, season (spring, fall), main observation number, site (separate area for the same group of birds), and location (based on legal description). For example: 199710101001 includes year (columns 1–4), season (column 5; 1 = spring, 2 = fall), observation number within that year (maintaining original main observation number; columns 6–8), sub-observation number (previously recorded as A,B,C, etc.; columns 9–10), and location number (where there were multiple locations for that main observation and sub-observation code; columns 11–12). This code, referred to as LOCAT_ID, was developed to provide a consistent code format for referencing information at various levels (year, main observation, sub-observation, location).

Locations

Locations had been recorded using the legal description system (county, township, range, section, quarter, quarter-of-quarter) to the detail possible with the information provided. All records had a county noted, but earlier records often lacked township-range-section information because of imprecise descriptions and absence of maps. We used copies of all maps that had been submitted with the observations or site evaluations to proof legal-system locations. We found some errors, but these occurred at a relatively low rate (Table 1). Most errors were due to inconsistencies in recording quarters within quarter-sections (e.g., NW quarter of SE quarter) in the data set. Normally, one reports such third-order locations as "section 1, NW quarter of SE quarter." However, this standard did not readily work in the database format. Most records in the database had data only for first- (SECTION) or second-order (QUARTER) information; for these records, the QUARTER column appropriately represented quarter-section information. However, when third-order locations were recorded, the third-order was recorded in the QUARTER column and the second-order location was recorded in QUARTER-OF-QUARTER column. We corrected these to ensure consistent order level within each column.

Sightings recorded during early years (1943–74) and in some geographic areas had less detailed information or no location information at all. Most reporting forms included driving directions or written descriptions (e.g., distance from a town, bridge, or named lake or feature). We used these descriptions to verify or add location information to the best of our ability, given the information provided. In some cases, we were only able to narrow the location down to a general township/range area (scale of location = 93.2 km^2 [36 mi^2]). By this method, we were able to add quite a few locations to the database. In order to differentiate locations based on our confidence of the original data source, we added a variable (SCALE) to denote the accuracy or scale (2.6 km^2 [1 mi^2] for the most accurate locations, 93.2 km^2 for those located somewhere within a township) of each location.

We used the corrected legal descriptions to convert the locations to x and y coordinates using the Albers equal area map projection; this is the most commonly used projection for U.S. Geological Survey (USGS) mapping data at scales less than 1:100,000. We used electronic data files available from public land survey system data files from USGS to convert legal descriptions to x and y coordinates for North Dakota, South Dakota, Nebraska, Kansas, and Oklahoma. For other states, we determined latitude and longitude from paper maps (to the nearest half degree) and converted these to x and y coordinates using MicroImages "Map Calculator" function (MicroImages, Inc., Lincoln, NE). We used these x and y coordinates for all mapping and graphics.

Table 1. Occurrence of errors in legal descriptions of site locations, by state, as determined by comparison to mapped crane locations. *N* = number of location records having mapped information.

State	N	Occurrence of errors			
		Township	Range	Section	Quarter
Kansas	90	2	3	3	2
Montana	7	0	1	0	0
Nebraska	356	7	0	4	59
North Dakota	51	0	0	0	1
Oklahoma	31	0	2	3	0
South Dakota	53	1	1	2	1
Texas	3	0	0	0	0
All states	591	10 *(1.7%)*	7 *(1.2%)*	12 *(2.0%)*	63 *(10.7%)*

Site Evaluation Data and Codes

For characterizing habitats from site evaluation data, we used only those records from 1977–99. We split the site evaluation data into 3 files, 1 for feeding sites (*FEEDEVAL*), 1 for roosting sites (*ROSTEVAL*), and 1 for sites used for both feeding and roosting or where site use was unknown (*DUALEVAL*), which we refer to hereafter as dual-use sites. Some data were summarized for all site uses combined, but most data summarizations were conducted separately on *ROSTEVAL, FEEDEVAL,* and *DUALEVAL*.

A number of variables included entries with multiple numbers or alphanumeric characters within a single data field (e.g., feeding site description: "21,11X,Z"). We used SAS programs, and in some cases record-by-record hand editing, to divide such information into new habitat variables which could then be separately summarized. Specifically, we extracted the following variables from the description: water depth, wetland size, roost site description, feeding site description, adjacent habitat, primary potential food sources, and foods observed eaten. See sections below for details for each variable.

Howe (1987) reported on the habitat use, survival, and behavior of 27 whooping cranes (9 radio-marked and others associated with them) that were tracked between Wood Buffalo National Park and Aransas National Wildlife Refuges during 1981–84. Sixty-seven observations of these marked cranes were included in *OBSERVATIONS* (OBS_TYPE = ”RADIO”) and 9 site evaluations were recorded in *EVALUATIONS* (SOURCE = 3 [Howe 1987]: 2 in MT, fall 1981; 1 in NE, fall 1981; 3 in KS, fall 1981; 1 in SD, spring 1982; and 2 in KS, spring 1983). Apparently, only the sightings of these marked cranes that were reported by citizens (and other chance observations) were used in the site evaluation data sets. There was no overlap in site evaluation data between Howe’s (1987) data and the data used here (W. Jobman, USFWS, Grand Island, NE, personal communication), therefore results from *EVALUATIONS* are independent of those in Howe (1987).

Multiple sub-observations for given main observation: In a number of cases, multiple observations (2–12 records) existed for the same bird(s) observed in an area. We believed that these multiple observations were similar to repeated measures and thus could bias some measures of habitats used. Therefore, we sought to limit our analyses to only 1 record for each main observation. We assumed a discrete set of observations in an area was denoted by a combination of main observation and sub-observation codes (e.g., 88A-5A, 88A-5B, 88A-5C). In most cases, the multiple records were due to recording a number of different feeding habitats, different locations (e.g., different quarter-sections), or different roost sites. Because we conducted most analyses on each site use separately, we excluded multiple observations within each site-use data set. We selected only the first record where site use = “feeding” to include in the feeding habitat assessments (*FEEDEVAL*), the first record where site-use = “roost” to include in the roosting habitat assessment (*ROSTEVAL*), and the first record where site use = “roost and feed” or “unknown” for dual-use sites (*DUALEVAL*). Selection of the first record may minimize any effects of observer disturbance on habitat use by cranes. We believe roost-only data provide the most conservative assessment of habitats used for roosting, whereas those sites used for both roosting and feeding likely provide a better assessment of sites (nearly all wetlands) used for both purposes. All further summaries were conducted on these 3 data sets unless otherwise noted. We will evaluate habitat-use patterns described by the multiple observations in a separate report at a later time.

We did not conduct any statistical tests on the data because the observational data would violate several key statistical assumptions. First, we cannot verify that data are independent – it is impossible to know whether observations are from the same birds, or whether some cranes are more likely to be included in a series of observations. Second, statistical tests require that the probability of observation is the same among groups. With observational data, there is no way to determine if there is an increased likelihood of an observation in one habitat type over another. Therefore we don’t know if the data are representative of the target population. Our presentation of the data, therefore, is entirely descriptive.

Handling of specific variables and analyses: For each variable in the data set, we describe below specific ways in which the data were examined. For those variables which were categorical, we determined frequency distributions for each category. Unless otherwise noted, data summaries were conducted for each site-use data set. See Appendix I for definitions of original variables.

Wetland classification system: We recognized that wetland description or classification was of particular interest to whooping crane biologists and therefore we were sensitive to checking and clarifying this variable using all available information. We split out the original WETCLASS variable (recorded following Cowardin et al. 1979) into separate classification variables: SYSTEM (lacustrine, palustrine, riverine), SUBSYSTM (e.g., lower or upper perennial, intermittent for riverine systems), CLASS (e.g., rock bottom, unconsolidated bottom, aquatic bed), and REGIME (special modifier for flooding or water regime). For the latter, we merged category 9d (intermittently/temporarily flooded) with 7d (intermittently flooded) because of the rarity of their occurrence and their similarity. A number of earlier records used only wetland classes from Circular 39 (I, II, III, IV, etc; Shaw and Fredine 1956); we converted these, as best possible, into REGIME, but often were unable to add the complete data for wetland classification system following Cowardin et al. (1979) format. We also used comments and information under roost or feeding site descriptions to refine our conversions for CLASS and REGIME. Specifically, we classified I (wet meadow) as emergent-temporary; II (fresh meadow) as emergent-saturated; III as emergent-seasonal (sometimes semipermanent); IV as emergent-semipermanent (sometimes as permanent); and V as aquatic bed-permanent. We pooled classes of wetland regime into 4 categories: permanent (permanent, intermittently exposed, and artificially flooded), semipermanent, seasonal, and temporary (saturated, temporary, and intermittently flooded).

Water depth: Observers recorded the range of depths for the entire wetland (RDEPTH) and range of depths at points within the wetland where cranes were observed (CDEPTH). Because both depth types were recorded in a single column, we separated the 2 depths into 2 variables. Because of the great range of depths given and because the range almost always included 0 or 2.5 cm, we considered only maximum depth for both parameters.

Quality: Observers recorded water quality as clear, turbid, or saline. Because more than 1 category of water quality was sometimes recorded (e.g., clear and saline), the sum of percentages by type was sometimes greater than 100%. For each site use, we determined the frequency distribution by wetland system for each category of water quality.

Substrate: Wetland substrates were categorized as sand, soft mud, hard mud, or other. Although there were some records with more than 1 substrate category recorded (4 in ROSTEVAL, 1 in FEEDEVAL, and 8 in DUALEVAL), we used only the first category, assuming this was the dominant characteristic of that site. For each site use, we determined the frequency distribution for each category of substrate, and also examined their frequency by wetland system.

Slope of wetland: Observers categorized the shoreline slope as <1%, 1 to <5%, 5 – 10%, >10%, not applicable, or other. For each site use, we determined the frequency distribution for each slope category.

Emergent vegetation type: Vegetation types occurring in the wetland were classified as grass, sedge (*Carex*), cattail (*Typha*), rush (*Juncus*), smartweed (*Polygonum*), other, or none. Many records included multiple types of emergent vegetation; only category 7 (no vegetation) occurred without other types (with 1 exception). Because several vegetation types usually were present, the sum of percentages by type was often greater than 100%. We report the frequency distribution, by wetland system and site use, for each vegetation type.

Distribution pattern of vegetation: Observers recorded the distribution of emergent vegetation as none, scattered, clumped, or choked; we found no specific definitions for these categories. This variable was originally referred to as "vegetation density," but it more appropriately describes the distribution of vegetation within a wetland. If >1 code was recorded, we used only the first code for summaries. We report the frequency distribution, by wetland system and site use, for each distribution category.

Roost site description: Observers used 2 category lists to describe roost sites, 1 list of general habitat types and 1 list of crop types. Habitat types included flooded pasture, wooded creek or draw, flooded cropland, stock pond, reservoir, lake, marsh, river, salt marsh, tailwater pit, seasonally-flooded basin, cropland, pasture, wet meadow, hay meadow, woodland, or other; no definitions or descriptions were provided. Crop types included alfalfa, barley, corn, Conservation Reserve Program, rice, sunflower, fallow, milo, disked alfalfa, oat stubble, popcorn, green rye, soybean, bean stubble, sunflower (assumed to be stubble), winter wheat, wheat stubble, milo stubble, and corn stubble; no further definitions or descriptions were given. The recorded variable usually included only 1 numeric code denoting habitat type and infrequently had alphabetic modifiers denoting crop type; thus it was relatively simple to summarize. When >1 code was included (e.g., 11, 17), we used only the first numeric code and assumed that those codes most accurately described the main roost area. We did not examine frequency of alphabetic modifiers because they were rarely recorded.

Feeding site description: Observers used the same list of habitat types and crop types to describe feeding sites. Unlike roost site data, however, the feeding site variable, as originally coded, was quite complex and included 1–5 numeric codes denoting habitat type and, for any 1 numeric code, 1–5 alphabetic codes denoting cropland type. We determined whether each habitat or cropland code occurred in a record and examined the frequency of occurrence of each type code in *FEEDEVAL* and *DUALEVAL*. We did not examine feeding site descriptors of *ROSTEVAL* because no feeding should have occurred during such site use, although a few records did have such information recorded. We pooled some habitat and crop types to facilitate comparison among seasons or site uses and, in particular, to pool appropriate types into a seasonal wetland type, permanent water type, and perennial upland cover (see Table 2). Cropland and woodland types were not pooled with other categories. Habitat classified as "Other" was very uncommon and thus ignored. We pooled crop types to facilitate comparisons among green crops, standing small grain or row crops, small grain or row-crop stubble, and other crop types. One crop type often dominated in the new descriptors: green cover was predominantly winter wheat, small grain stubble was predominantly wheat stubble, and row-crop stubble was predominantly corn stubble.

Adjacent habitat: Observers used the same list of habitat and crop type variables as noted above to describe habitats adjacent to the site. As occurred for feeding sites, this variable usually had multiple numeric and alphabetic codes. Data were extracted and frequencies of occurrence determined for all 3 data sets similar to methods noted above for feeding site description.

Wetland size: For lacustrine and palustrine systems, we used wetland size class, ignoring actual sizes that were sometimes provided. For some data comparison, we pooled the 6 wetland classes into 3 classes: A = <0.4–2 ha, B = 2 to <20 ha, and C = 20 to >40.5 ha. For riverine systems, we extracted river width data (continuous rather than class variable) from the original variable column and created a new variable.

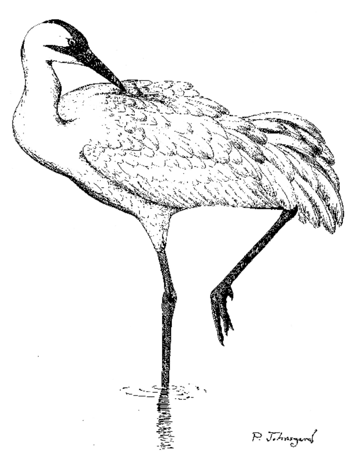


Table 2. Pooled habitat and crop types for descriptions of feeding and adjacent habitats.

New descriptor	Original code no.	Original description
Habitat type		
Seasonally flooded wetlands (WETSEAS)	9	Flooded pasture
	11	Flooded cropland
	19	Seasonally-flooded basin
Permanent water (WETPERM)	12	Stock pond
	13	Reservoir
	14	Lake
	15	Marsh
	16	River
	17	Salt marsh
	18	Tailwater pit
Cropland (UPCROP)	21	Cropland (see below for crop types)
Upland perennial cover (UPCOVER)	22	Pasture
	23	Wet meadow
	24	Hay meadow
Upland woodland (UPWOOD)	25	Woodland

New descriptor	Original code no.	Original description
Crop type		
Green crops (GREENS)	A	Alfalfa
	R	Green rye
	W	Winter wheat
Small grain – standing (GRAIN-STD)	B	Barley
	G	Spring wheat
Small grain – stubble (GRAIN-STUB)	O	Oat stubble
	V	Barley stubble
	X	Wheat stubble
	E	Rice
Row-crop – standing (ROW-STD)	C	Corn
	F	Sunflowers
	M	Milo
	P	Popcorn
	S	Soybeans
Row-crop – stubble (ROW-STUB)	T	Soybean stubble
	U	Sunflower stubble
	Y	Milo stubble
	Z	Corn stubble
Other (OTHER)	L	Fallow
	N	Disked alfalfa
	D	Conservation Reserve Program cover

Distance to feeding site: Distance to feeding sites was categorized as <0.4 km, 0.4 to <0.8 km, 0.8 to <1.2 km, 1.2−1.6 km, >1.6 km, or not applicable. We determined the frequency distribution for each category for roost and dual-use sites.

Distance to human development: Distance to nearest human development was categorized using the same distance categories as used above. No definition of human development was given for USFWS report forms, but the Nebraska reporting form (Report Form 6) listed paved and gravel road, single or urban (>3) dwellings, railroad, commercial development, recreational area, and bridge. We determined the frequency distribution for each distance category. Because this information was the same among site uses for a record, we used only 1 record for each main observation.

Primary potential food sources: Observers categorized potential food sources available to cranes at the site as: grain (seed and plant material), tubers, insects and other invertebrates, molluscs, crustaceans, fish, frogs, other, and salamanders. Data in this variable originally were coded in a similar manner as feeding site and adjacent habitat descriptions. Data similarly were extracted and examined using frequencies of occurrence for *FEEDEVAL* and *DUALEVAL*. Because feeding site descriptions often included both upland and wetland codes, we did not separate the data between upland and wetland habitats.

Foods observed eaten: Foods observed eaten by cranes were recorded using the same categories as above. These data were examined in the same manner as above, but observations were so few that we report only a simple list of foods observed for both *FEEDEVAL* and *DUALEVAL*.

Site security: The security of the site was defined as the stability and security of the habitat and any nearby activities that could threaten the site or cranes there. Categories included stable, threatened, and unknown. We determined the frequency distribution for each category of site security by site use and site ownership.

Extent of similar habitat within 16-km (10-mi) radius: Observers ranked the extent of habitat similar to that of the site within a 16-km radius as none, little, moderate or common, abundant, or unknown. We determined the frequency distribution for each category of similar habitat. Because this information was the same among site uses for a record, we used only 1 record for each main observation.

Site ownership: Ownership of a site was categorized as private, federal, state, and other. Many records included multiple types of site ownership. Because several ownership categories could occur for 1 record, the sum of percentages by type often was greater than 100%. We report the frequency distribution, by site use, for each ownership category.

Visibility: Visibility from the site to the nearest obstruction > 1.4 m high was categorized as <91 m, 91-401 m, 402-805 m, >805 m, and "unlimited;" we pooled the latter 2 categories together. To assess how visibility might differ among main habitat types for *ROSTEVAL*, we summarized data for each wetland system. For *FEEDEVAL* and *DUALEVAL*, we used descriptors from the feeding habitat descriptions to define whether the cranes were in upland, wetland, or riverine habitat.

Distance to utility lines: Distance of the site to power or phone lines were categorized using the same distance categories as visibility. We report the frequency distribution, by site use, for each distance category. Because this information was the same among site uses for a record, we used only 1 record for each main observation.

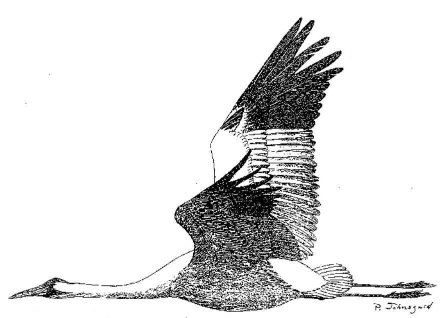
Crane groups: We used 2 variables (number of adults, number of juveniles) from *OBSERVATIONS* to classify social group for each record; *EVALUATIONS* only indicated total number of whooping cranes present. There were only 7 discrepancies between total group size in *EVALUATION* and *OBSERVATION* data sets; these discrepancies likely occurred when observers visited the original observation site 1–2 days later and noted a different number of adults or juveniles present. We classified cranes into 6 groups: 1) single adult, 2) single juvenile, 3) pair, consisting of 2 adults only, 4) single family group, consisting of 1–2 adults and 1–2 juveniles, 5) mixed group, consisting of a group with ≥1 adult and ≥1 juvenile, and 6) adult group, consisting of >2 adults and 0 juveniles. The number of juveniles often was missing (no data recorded), and sometimes the number of adults also was missing; we assumed that these were 0. We pooled records into 3 groups for some summaries: family groups (adults with at least 1 juvenile), nonfamily groups (adults with no juveniles), and single cranes (single adults and single juveniles).

Mapping and Distributional Analyses

The geographic information system (GIS) database consisted of whooping crane sightings, political boundaries, and physical features. We used data layers that were available for the entire flyway. Other suitable data were available in digital format for only portions of the flyway (i.e., NWI, refuge boundaries). State and county boundary data were used for indicating position of whooping crane locations and to identify state-wide trends. Both data layers were obtained from the ESRI ArcView v3.2. sample package (Environmental Systems Research Institute, Inc., Redlands, CA). Ecoregion (aquatic ecoregions of the conterminous United States; Omernik 1987) and stream (1:2,000,000-scale Digital Line Graph files of streams; Lanfear 1991) data were used to show relationships between migration movements and physical features of the landscapes. These data were obtained from the USGS list of spatial data sets for water (http://water.usgs.gov/lookup/getgisfoot?type=gis&value=places).

Distribution patterns were displayed using ESRI ArcView v3.2 software. We projected data layers in Albers equal-area conic. This was consistent with other data files with scales of at least 1:100,000 maintained at USGS offices. Use of Albers also minimized distortion when merging township/range information from the large 10-state area used by whooping cranes during migration. In addition, we used data layers to graphically display spatial trends. When displaying data in Albers projection, equal areas are displayed correctly. Therefore display polygons are depicted with their true representative area.

All maps were made using only main observation data. All data layers were divided into 2 levels (flyway-states and state boundaries). The stream data layer was cut using a clip function and all other data layers were subset using the query tool. Maps were made by overlaying subset whooping crane data with the appropriate region-specific political or physical data.



RESULTS

All Observations

General Description

The apparent migration path in the United States, as outlined by the distribution of whooping crane observations, is very similar to that delineated earlier in Armbruster (1990) and the Whooping Crane Recovery Plan (U.S. Fish and Wildlife Service 1994), following a relatively straight line north-northwest from Aransas NWR to central North Dakota then curving northwest along the Missouri Coteau to the North Dakota–Saskatchewan border (Figure 1). Examination of locations relative to ecoregion on individual state maps (See State Summaries) shows that most observations were in Great Plains or Glaciated Plains ecoregions. During migration, cranes appear to associate with river systems, particularly the Missouri River in the Dakotas, but closer examination of the plots for each state and habitat data indicates only rarely were cranes actually observed on a river, except in Nebraska. Spring and fall observations were relatively similar in their overall pattern (Figures 2 and 3), except for higher frequency observations in fall on Quivira NWR, Cheyenne Bottoms SWA, Salt Plains NWR, and in Texas. See maps in State Summaries for more detailed depiction of spring and fall distributions.

Three confirmed observations were not included in the observation database because they were outside the main flyway, but their locations are noteworthy. On 11 November 1998, 1 whooping crane was observed flying 8 km north of Waukegan at Illinois Beach State Park, Lake County, Illinois. Six whooping cranes were observed during 9–12 April 1999 in Harrison County, Iowa. On these same dates, a family of 3 whooping cranes were sighted in Page County, Iowa.

We plotted the distribution of observations for 4 time periods: 1) 1943–74 (Figure 4), 2) 1975–83 (Figure 5), 3) 1984–91 (Figure 6), and 4) 1992–99 (Figure 7). The first time period corresponds to sightings collected before observational efforts increased. The general pattern of migration appears to have changed little over the 57 years of observations. Very few observations were recorded in Texas during the first time period. Observations around Cheyenne Bottoms SWA and Quivira NWR increased in later periods.

We examined the frequency of observations for 3 of the 4 areas designated as critical habitat for whooping cranes: Cheyenne Bottoms SWA, Salt Plains NWR, and Quivira NWR. We did not summarize the frequency of observations for the reach of the Platte River designated as critical habitat because we did not have clear geographic boundaries for that area, but it is obvious from the Nebraska map that whooping cranes were frequently observed in this area. Whooping cranes have been observed frequently on the other 3 critical habitat areas, primarily during the fall, during the past 43 years and also during the 25 years corresponding to the site evaluation program (Table 3). Only on Quivira NWR have cranes been frequently sighted in spring. A number of other named areas also occurred frequently in the sightings database: Rainwater Basin, Nebraska; Lostwood NWR, North Dakota; and Divide County, North Dakota. Additional observations likely occurred in the Rainwater Basin but were not so named in the site description; we also lacked clear geographic boundaries to examine that area in greater detail. These numbers cannot serve as definitive evidence of frequency of use because of the inconsistencies in how site descriptions were recorded (i.e., whether the formal name of an area was used). Examination of the maps can better indicate those regions where whooping cranes were frequently sighted.

Figure 1.

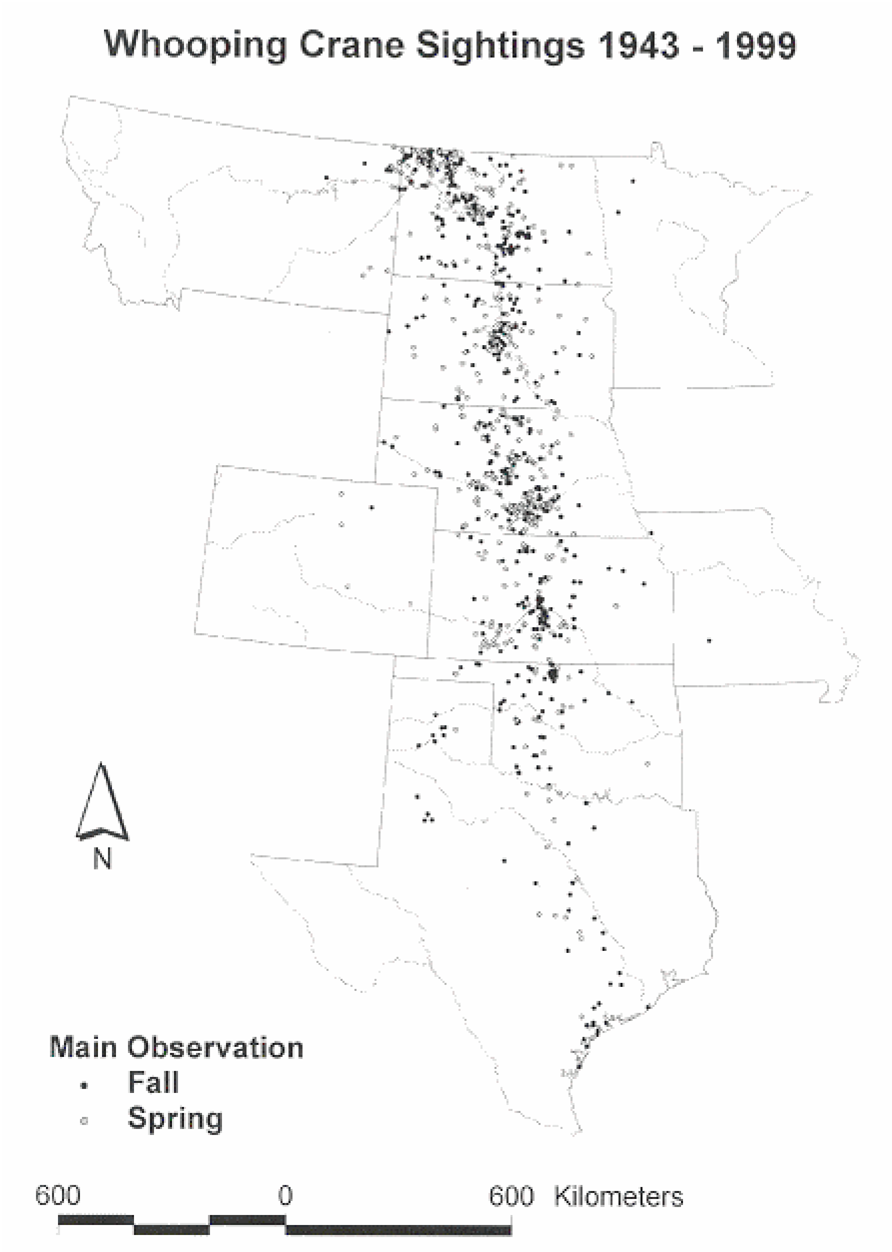

Whooping Crane Sightings 1943 - 1999
N
Main Observation
Fall
Spring
600
0
600 Kilometers

Figure 2.

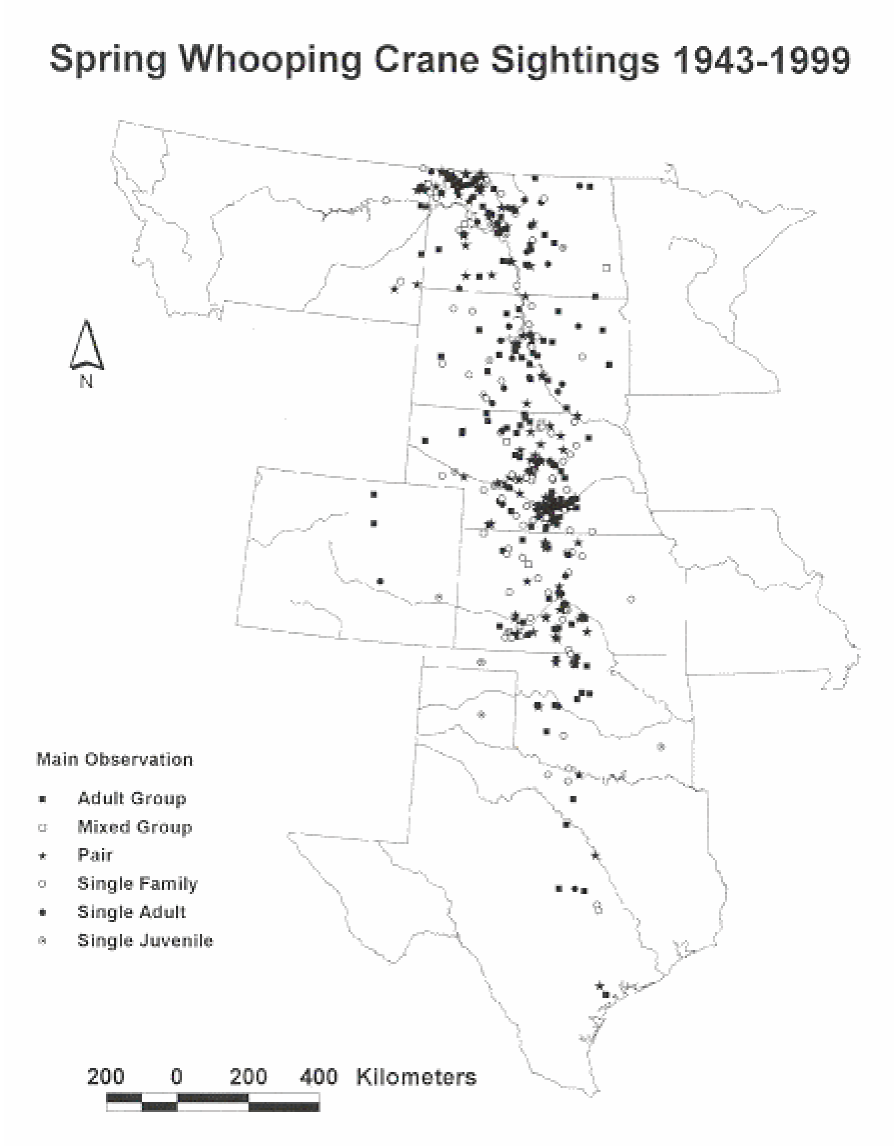

Spring Whooping Crane Sightings 1943-1999
N
Main Observation
Adult Group
Mixed Group
Pair
Single Family
Single Adult
Single Juvenile
200 0 200 400 Kilometers

Figure 3.

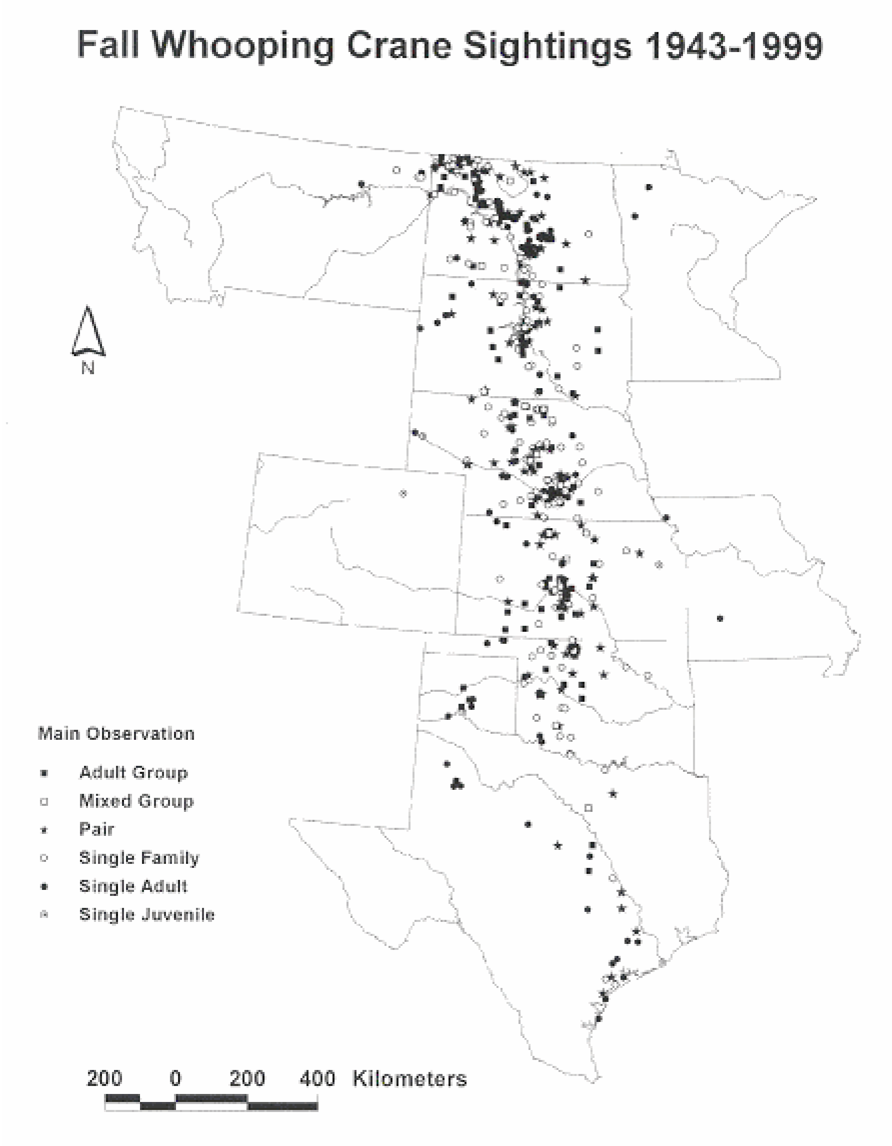
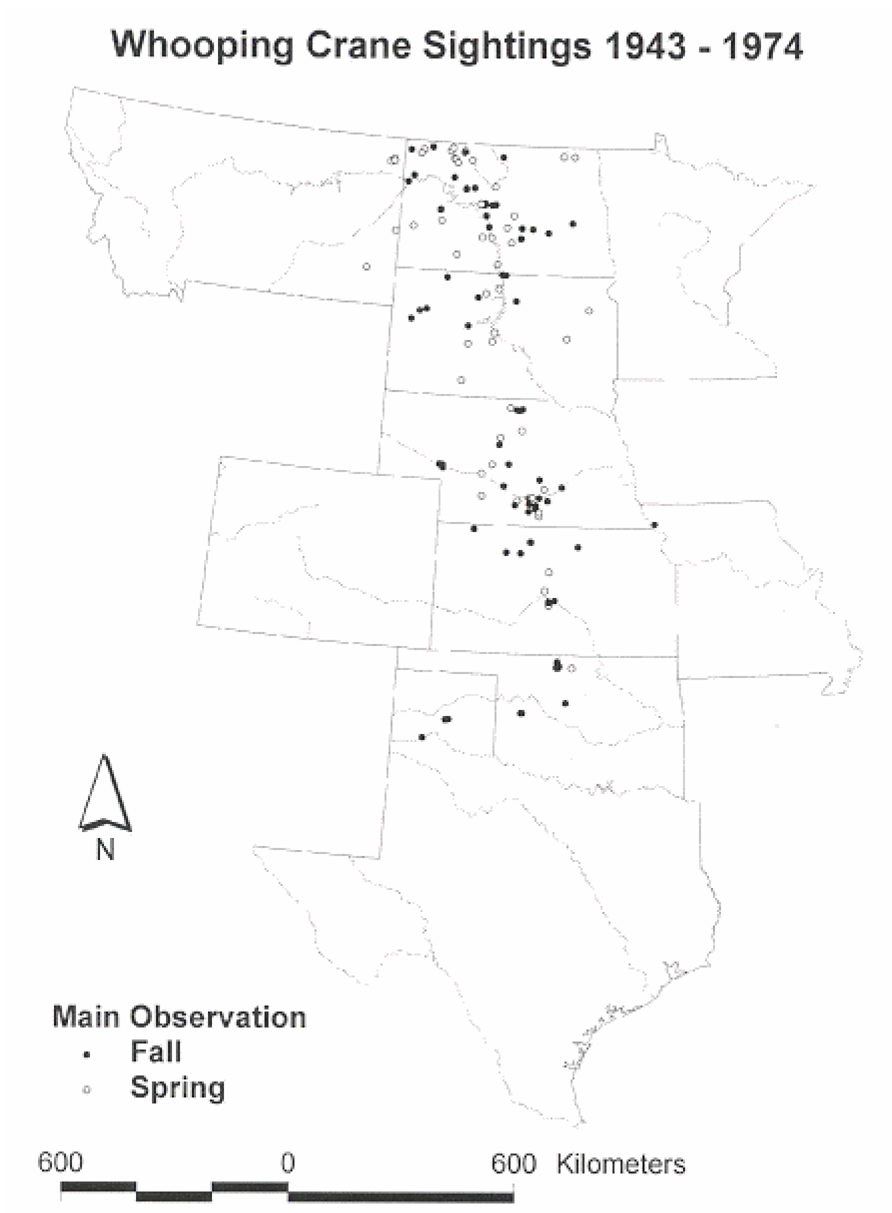
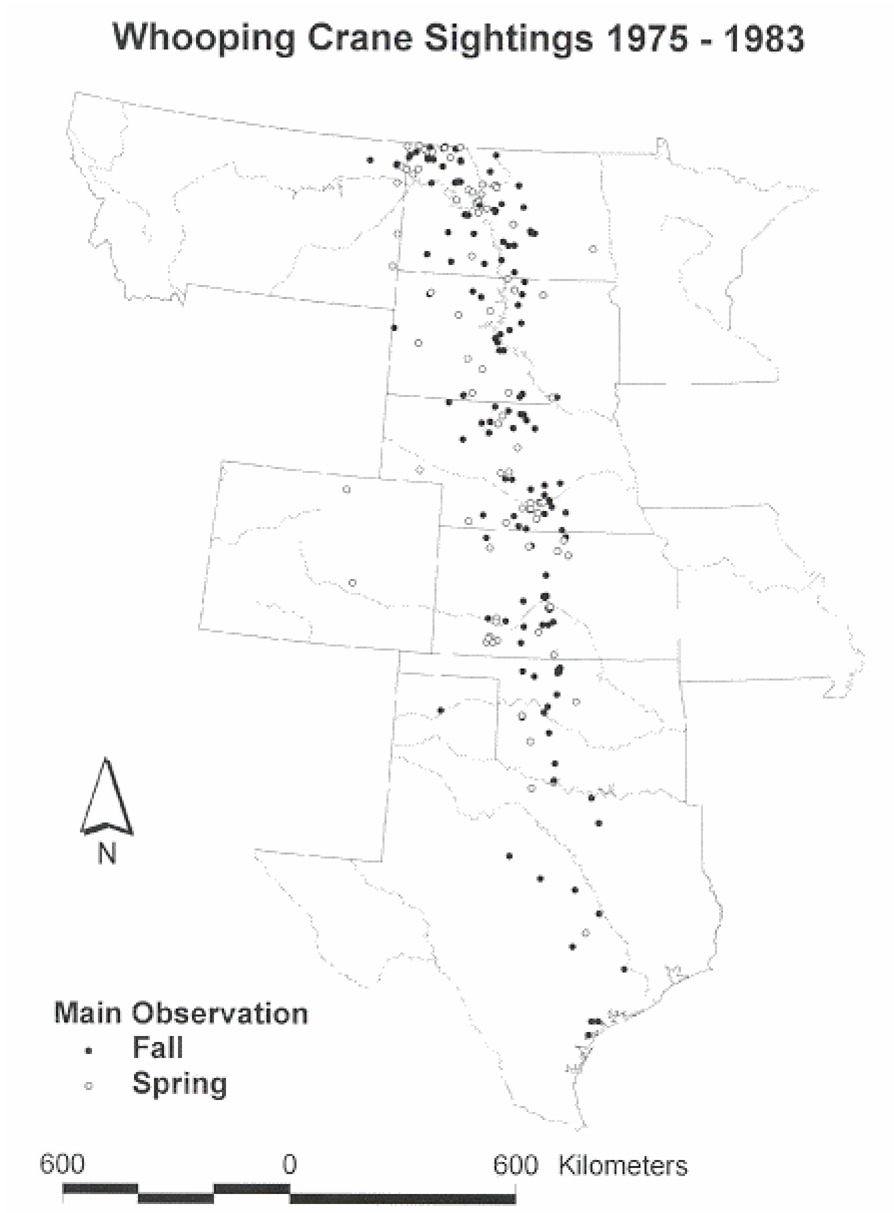

Fall Whooping Crane Sightings 1943-1999
N
Main Observation
Adult Group
Mixed Group
Pair
Single Family
Single Adult
Single Juvenile
200 0 200 400 Kilometers

Figure 4.



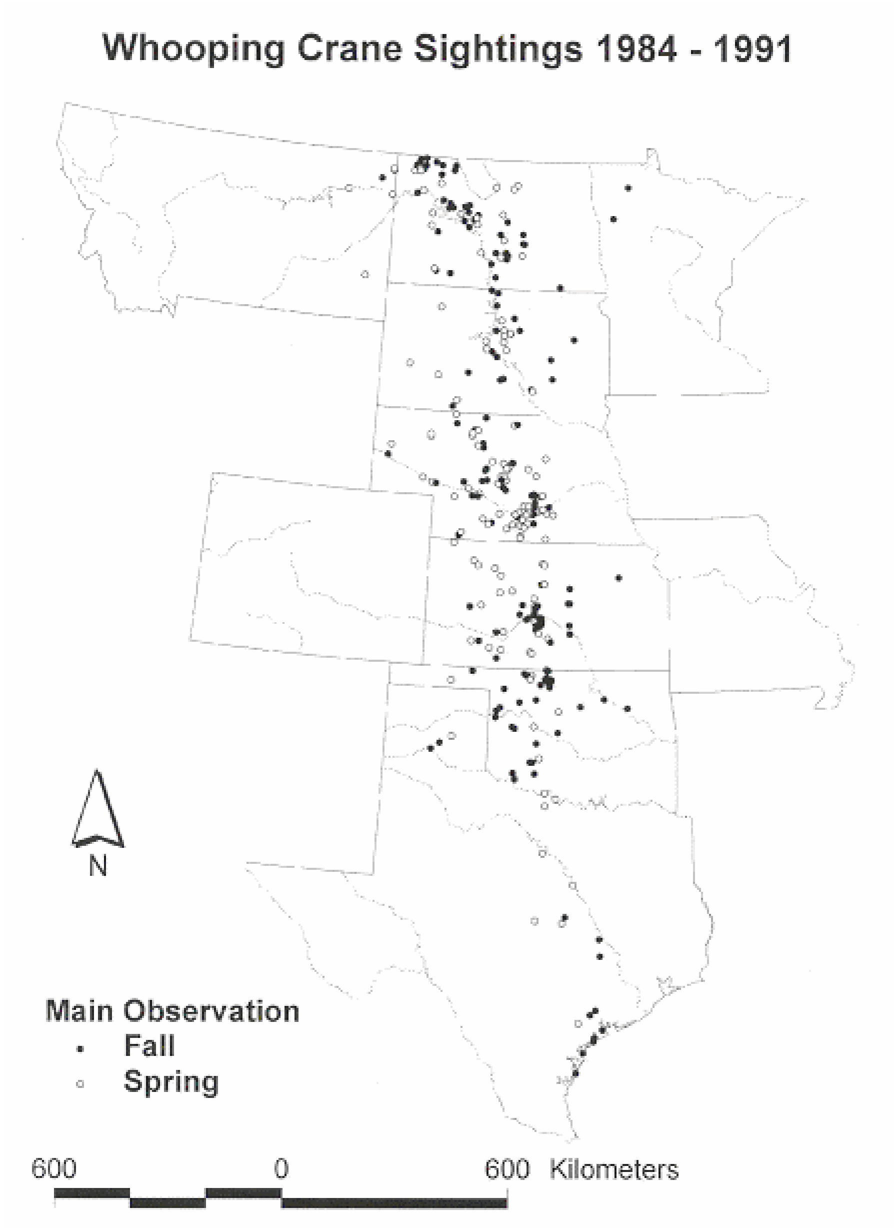
Whooping Crane Sightings 1943 - 1974
N
Main Observation
Fall
Spring
600
0
600 Kilometers

Figure 5.



Whooping Crane Sightings 1975 - 1983
N
Main Observation
Fall
Spring
600
0
600 Kilometers

Figure 6.



Whooping Crane Sightings 1984 - 1991
N
Main Observation
Fall
Spring
600
0
600 Kilometers

Figure 7.

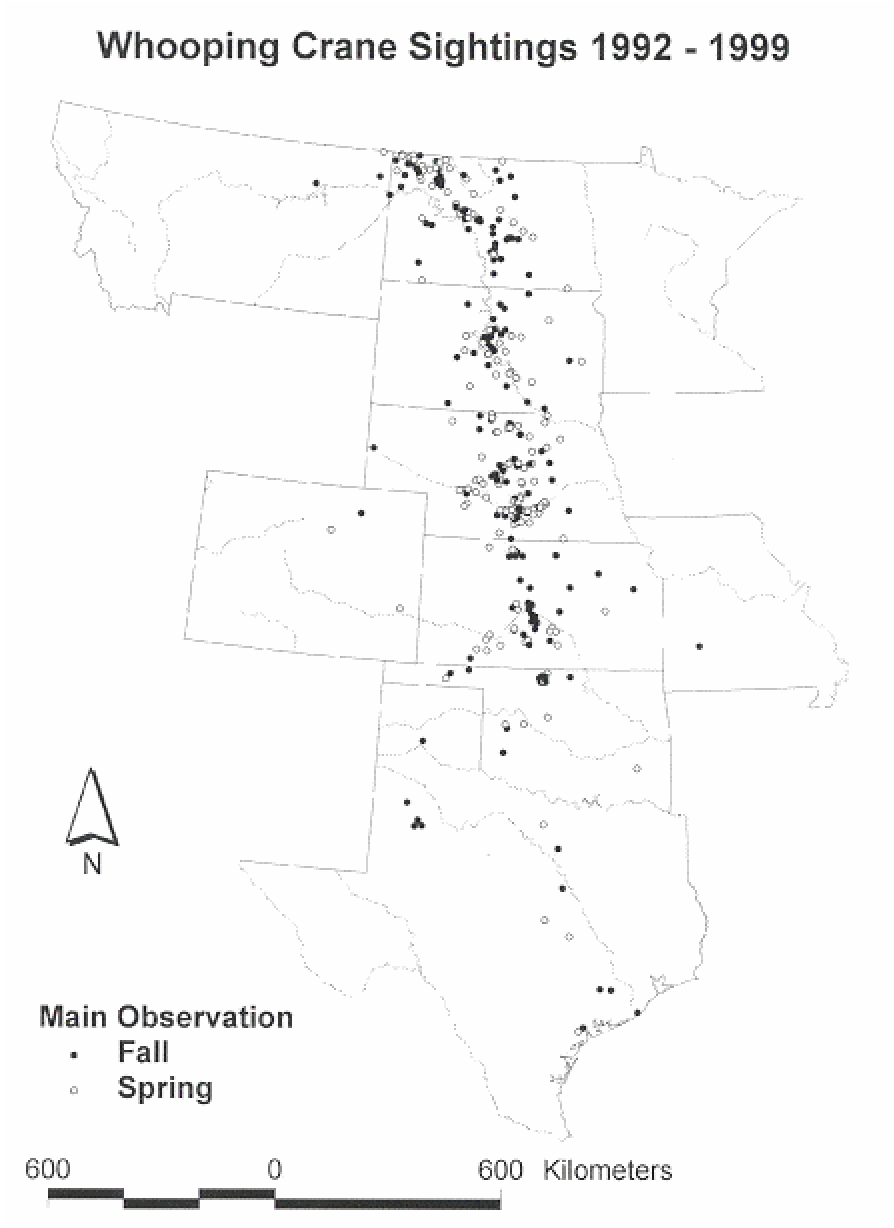

Whooping Crane Sightings 1992 - 1999
N
Main Observation
Fall
Spring
600
0
600 Kilometers

Table 3. Frequency (%) of whooping crane sightings at named locations during 1943–99 (57 years) and 1977–99 (25 years), corresponding to the site evaluation program.

Site	1943–99		1977–99	
	Spring	Fall	Spring	Fall
Cheyenne Bottoms SWA, KS	5	75	8	68
Salt Plains NWR, OK	14	51	2	84
Quivira NWR, KS	28	49	56	88
Rainwater Basin, NE	21	19	32	16
Lostwood NWR, ND	21	21	48	44
Divide Co, ND	17	9	24	2

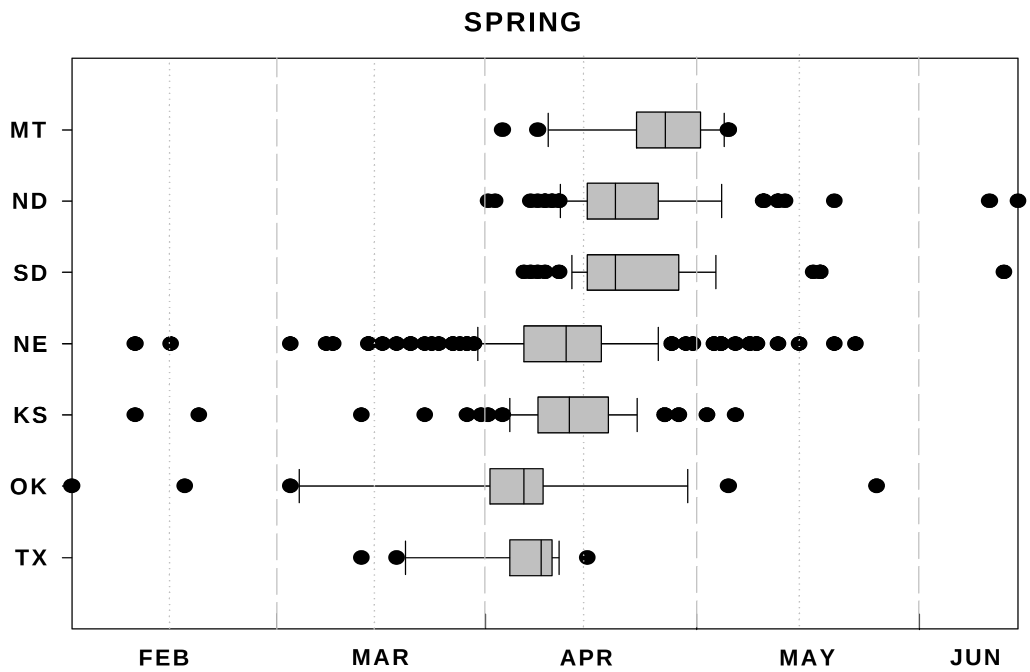
Migration Chronology and Temporal Trends

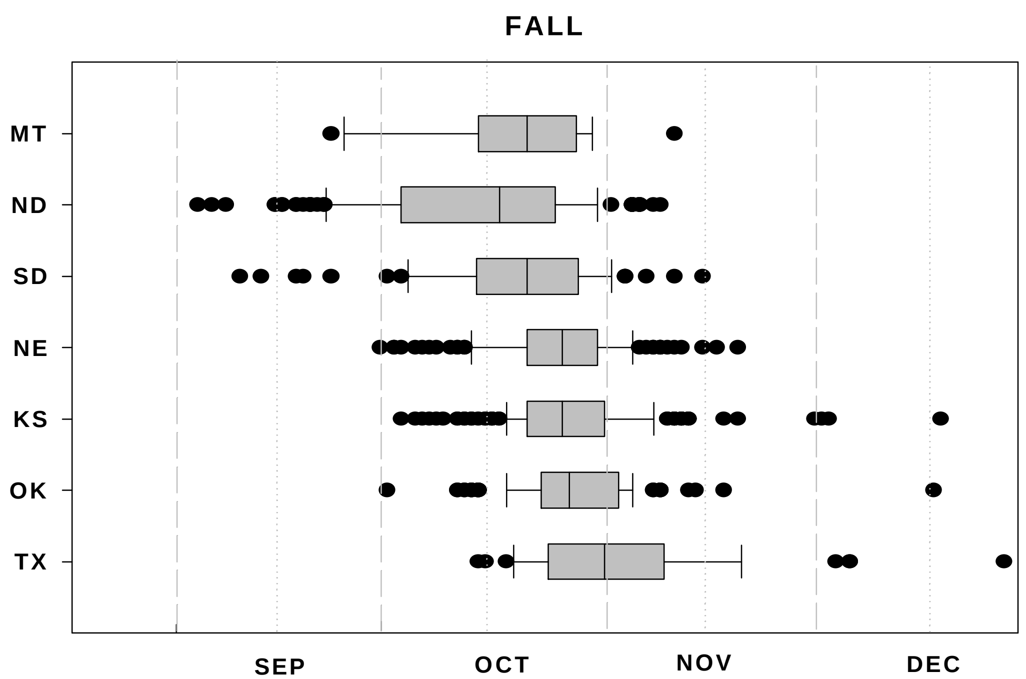
Information on first departure dates of individual cranes from Aransas NWR indicated spring migration commenced as early as 7 March and as late as 4 April and was quite variable among years (W. Jobman, unpublished data for 1975–99). Based on incidental observations, spring migration appeared to commence in mid- to late March and continue through mid-late May (Figure 8). Extreme dates included a few observations in Oklahoma, Nebraska, and Kansas in February and early March, and in South and North Dakota in June. Some of these outliers were cranes that overwintered in Oklahoma or summered in North Dakota; a few dates for additional observations in North Dakota after 15 June were considered "summer" and were not included because these were not considered migrants. Only 4 records were available for Colorado (range 28 Feb to 20 May).

The peak of migration, as indicated by median dates of occurrence, was 8 April in Texas, 6 April in Oklahoma, 12 April in Kansas and Nebraska, 19 April in South and North Dakota, and 26 April in Montana. Few whooping cranes were observed in the United States after early May. The main periods of occurrence in each state over all years seem to be relatively short: the core 50% of the observations, as represented by the shaded box (25^{th} to 75^{th} percentiles), ranged from 6 days in Texas to 13 days in South Dakota.

Fall migrants were first observed in North and South Dakota in early September; in Nebraska, Kansas, and Oklahoma in early October; and in Texas by mid-October. The peak of migration, as indicated by median dates, were 22 October in Montana, 18 October in North Dakota, 22 October in South Dakota, 27 October in Nebraska, 27 October in Kansas, 28 October in Oklahoma, and 1 November in Texas. The main periods of occurrence in each state for all years were somewhat longer in fall than in spring: the core 50% of the observations, as represented by the shaded box (25^{th} to 75^{th} percentiles), ranged from 10 days in Nebraska to 22 days in North Dakota. The latest observations of fall migrants occurred in Kansas, Oklahoma, and Texas in December; a few of these observations included cranes that ultimately overwintered away from Aransas NWR (data for "winter" period not included here). Two records occurred in western Minnesota (11 and 21 Oct), 2 in western Missouri (13 Oct and 1 Nov), and 1 in Colorado (28 Oct). Fall arrival dates to Aransas NWR ranged from 25 September to as late as 29 October but generally occurred in mid-October (W. Jobman, unpublished data for 1975–99).

Figure 8. Dates of occurrence of whooping cranes in spring and fall, by state, all observations, 1943-1999. Box plots show median (vertical line in box), 25th and 75th percentiles (box), 10th and 90th percentiles (bars) and outliers (dots).





Examination of spring and fall migration chronology for each state indicated no apparent change in migration chronology over the 57 years of observations (1943–99) (See graphs for each state in State Summaries). Median dates of spring migration in Nebraska were quite consistent, varying ≤5 days since 1960. Indeed, median dates for both spring and fall for all states usually varied ≤10 days. Sample sizes were generally small (<10) before 1975 for all states. In Oklahoma, some observations of a marked crane that apparently overwintered in 1986–87 were considered "winter" and thus not included. Two very early spring observations in Oklahoma in 1995 probably were associated with 1 crane that apparently overwintered there for several years.

Site Evaluation Data: Characteristics of Habitats

It is important to note that "use" in this report does not connote or imply habitat preference or selection. Whooping crane sightings records were not collected in a systematic fashion but were incidental observations. Because observations were a chance occurrence, patterns evident in the data must be considered with caution. We cannot assume these patterns are representative of actual habitat use or preferences.

General Description

The complete *EVALDAT* database included 1060 observations. We excluded 2 records (2 sub-observations under 1 main observation) of a single bird recorded in North Dakota in late August 1989 because it was a summer record. All other site evaluation records were for fall or spring.

The number of records were equally divided by season but varied by state (Table 4). Spring records of whooping cranes were more common than fall observations for Nebraska and Montana. In other states, fall records were more common. More than two-thirds of spring records were from Nebraska.

Multiple sub-observations: Multiple sub-observations occurred for 175 main observations (16.5% of the total data set; Table 5). Nebraska had the highest number of multiple sub-observations and also had more cases with >3 sub-observations than other states. In all states, multiple sub-observations often included >1 record for a each site use. When multiple sub-observations and records were excluded, sample sizes for habitat assessments by site use were: *FEEDEVAL*, *n* =306; *ROSTEVAL*, *n* =141; and *DUALEVAL*, *n* =248.

Occurrence of Social Groups by Season

Overall: Single family groups included all combinations of 1–2 adults and 1–2 juveniles. Most groups observed had 1–3 cranes, although some had as many as 14 cranes in spring and 19 cranes in fall (Figure 9). Mixed groups in spring included as many as 14 (13 with 1 juvenile), and in fall included as many as 19 (18 adults with 1 juvenile)

Roost Sites: In spring, pairs were most commonly observed at roost sites, followed by single families. Few mixed groups were observed in spring, and only 2 single juveniles were sighted (Figure 10). In fall, single families, pairs, and adult groups were equally common, but few mixed groups or single adults were sighted and no single juveniles were sighted. Single adults were more commonly observed in spring than in fall. In both seasons, adults with juveniles occurred more commonly in single families than in the larger mixed groups.

Feeding: Observations of pairs, adult groups, and single families were most common in spring and fall at feeding sites (Figure 10). Single adults were somewhat more common in fall than in spring. Seven single juveniles were sighted in spring.

Dual-use Sites: Adult groups, single families, and pairs were again the most commonly observed social groups at dual-use sites (Figure 10). Four single juveniles were observed in spring. Maximum group sizes were similar to those noted above for roosting or feeding sites.

Table 4. Distribution of site evaluations among states, overall and by season, and percent of total season observations occurring in each state, 1977–99.

State	Total		Season			
			Spring		Fall	
	N	%	N	%	N	%
Montana	20	2.0	13	2.5	7	1.4
North Dakota*	138	13.6	57	10.8	81	16.7
South Dakota	77	7.6	35	6.6	42	8.7
Nebraska	526	51.9	365	69.1	161	33.1
Kansas	165	16.3	51	9.7	114	23.5
Oklahoma	80	7.9	5	0.9	75	15.4
Texas	8	0.7	2	0.4	6	1.2
*Total**	*1014*	*100*	*528*	*100*	*486*	*100*

*excludes 1 summer record

Table 5. Number of situations in which there were multiple sub-observations for a single main observation, by state, 1977–99.

State	No. sub-observations/main observation					
	2	3	4	5	6	>6
Montana	2					
North Dakota	17	4				
South Dakota	8	5				
Nebraska*	45	30	18	10	4	6*
Kansas	19	1				
Oklahoma	5					
Texas	1					
Total	*97*	*40*	*18*	*10*	*4*	*6*

*Nebraska: 7, 8, 8, 10, 11, 15

Figure 9. Frequency of crane group sizes (total number of cranes per observation) for spring and fall, 1943-99.

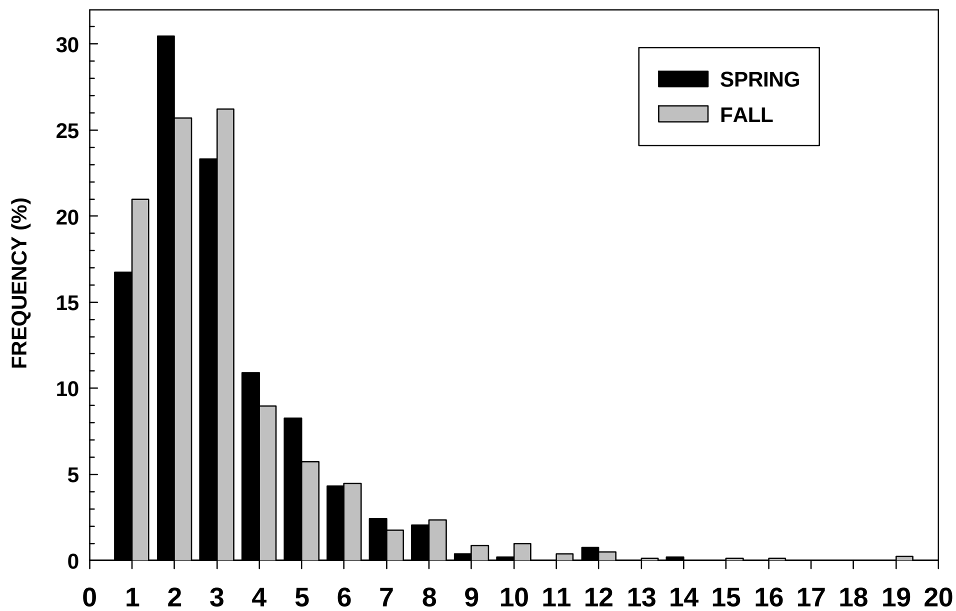
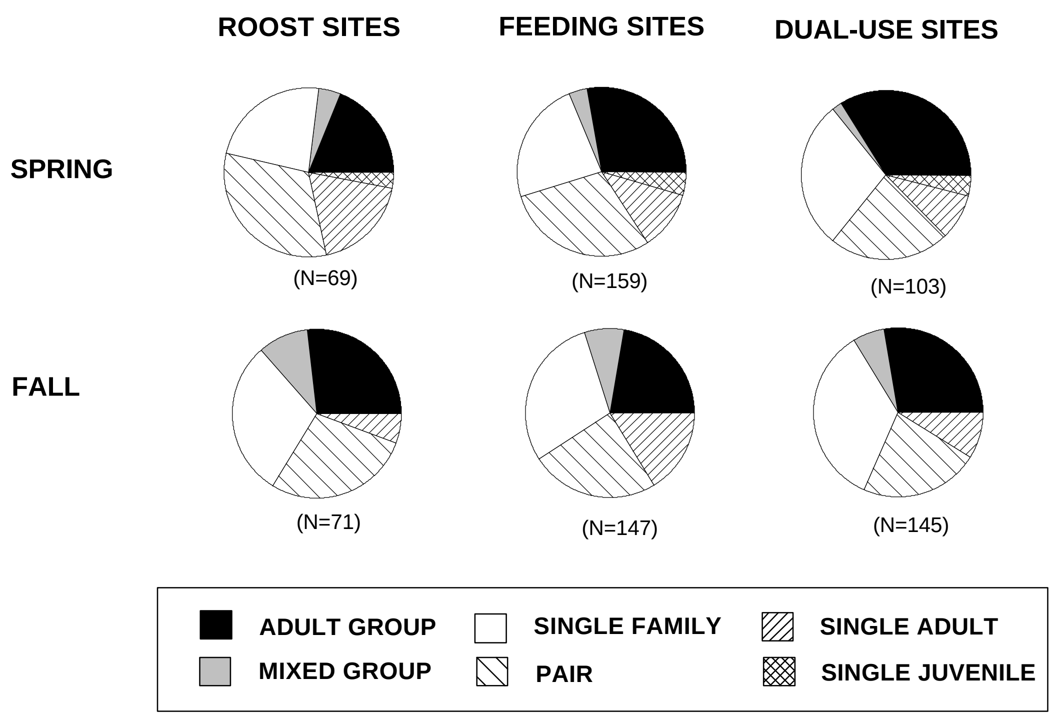


Figure 10. Percent of observations occurring in 6 categories of social groups, by site use and season, 1977-99.



Habitat Characteristics Relative to Site Use

Wetland System

All Records: Palustrine wetlands were the most commonly recorded wetland system used by whooping cranes (68.8%); riverine wetlands accounted for 21.6% and lacustrine wetlands 9.6% of site evaluation records (n = 644). However, these percentages are dominated by records from Nebraska, which comprised 50.2% of all records for which we were able to discern wetland system. Only 11 (7.9%) of the 139 riverine records were from outside of Nebraska: Kansas River, Kansas; Popular River, Montana (2 records under 1 main observation); Missouri River (2 in MT, 3 in ND); Souris River, North Dakota (J. Clark Salyer NWR), and Arkansas River, Oklahoma (2 records under 1 main observation). The distribution of observations among wetland systems clearly differed between Nebraska and other states. In Nebraska, the proportions of observations occurring on palustrine and riverine systems were both high (56.0 and 39.6% of state records, respectively), whereas in other states palustrine records accounted for >75% of records. Only in Montana did the proportion of sightings (4 of 17, or 36%) rivers approach the proportion observed in Nebraska, but note that the total number of observations were low. See State Summaries for details specific to each state.

Roost Sites: Overall, palustrine (58.2%) and riverine (33.3%) wetlands were the predominant wetland systems recorded for roosting cranes; only 11 (7.8%) records were on lacustrine wetlands (n = 141). Four roost sites were recorded as flooded cropland, including 1 site also described as winter wheat stubble and 1 as milo stubble. All of these latter sites were classified as emergent wetlands with seasonal (2) and temporary (2) water regimes. One site in Gray County, Kansas, was described as a tailwater pit. Another site described as flooded cropland had no wetland system recorded.

All but 1 of the 47 records of riverine roosts were from Nebraska; the other record was from the Missouri River in Montana. In Nebraska, 59.0% of roosts were observed on riverine wetlands, 37.2% on palustrine, and 3.8% on lacustrine wetlands. In Montana, the riverine record was 1 of only 2 roost observations; the other record was for a palustrine wetland. In the remaining states, palustrine records account for 71–100% ($\bar{x}$ = 85.5%) of roost sites and lacustrine wetlands for 12.9% of roost sites. No roost sites were described as flooded pasture, wooded creek or draw, or as upland types.

Single families and pairs each comprised >30% of observations on palustrine wetlands; relatively few mixed groups or single cranes were observed (Figure 11). On riverine wetlands, pairs and single adults were most common; family groups (single families [13%] and mixed groups [2%]) were relatively uncommon. Cranes observed on lacustrine wetlands were mostly family groups (54.5% vs. 27.3% nonfamily groups and 18.2% singles). Cranes on palustrine wetlands were somewhat more evenly split between family (42.5%) and nonfamily groups (55.0%), with only 2 singles observed (2.5%). On riverine wetlands, 56.5% were nonfamily groups, 28.3% were single cranes, and 15.2% were families. All single adults were recorded on rivers in spring.

When all states are examined together, use of wetland systems differed by season (Figure 12). Spring-migrant cranes were observed with similar frequency on palustrine and riverine wetlands but only occasionally on lacustrine wetlands, whereas fall-migrant cranes were observed primarily on palustrine wetlands and were infrequently observed on lacustrine and riverine wetlands. These seasonal patterns are largely driven by the large number of observations of cranes in Nebraska on the Platte, Niobrara, Middle Loup, and North Loup rivers in spring. In Nebraska alone, riverine sites accounted for 78% of roost site records in spring, and no roosts were noted on lacustrine wetlands; in fall, half of the records were of riverine wetlands, and 11% were on lacustrine wetlands (Figure 13). For all other states, there was no seasonal difference; palustrine sites accounted for >75% of roost records.

Feeding Sites: Most (239 of 306) feeding site records occurred on non-wetland (upland) sites. Where feeding cranes were observed on wetlands (n =67), palustrine (86.6%) wetlands were the predominant system used; only 7 (10.4%) records were on riverine wetlands and 2 (3.0%) were on lacustrine systems (Calamus Reservoir, NE, and Lake Sakakawea, ND). Palustrine wetlands used for feeding were primarily recorded in Nebraska (49.1%) and North Dakota (23.7%); there were ≤6 palustrine records for each of the other states (*n* = 68). Of the 7 riverine records, 4 occurred in fall and 3 in spring. In fall, cranes were observed feeding on the Souris River in North Dakota (J. Clark Salyer NWR), and on the South Loup River, North Platte River, and Birdwood Creek (Lincoln County) in Nebraska. In spring, cranes were observed feeding on the Middle Loup, Platte, and Niobrara rivers. No sites were described as wooded creek or draw; 4 were described as flooded pasture, and 1 as tailwater pit (6 adults and 1 juvenile, Mead County, KS, in spring). No differences were apparent between seasons (Figure 12).

Figure 11. Percent of observations occurring in 6 categories of social groups for palustrine, riverine, and lacustrine systems and on upland sites, by site and season, 1977-99.

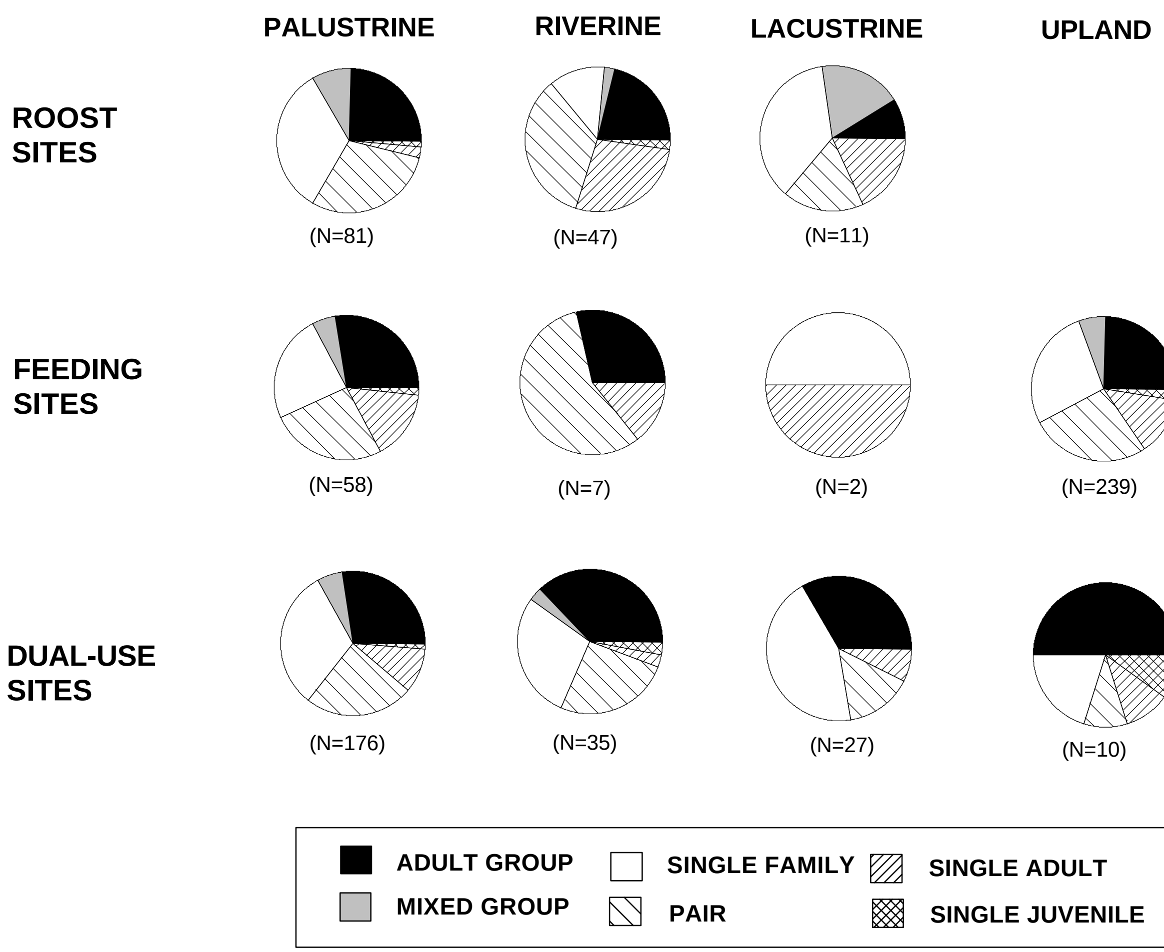


Figure 12. Percent of wetland sites defined as palustrine, riverine, or lacustrine, by season and site use, 1977-99.

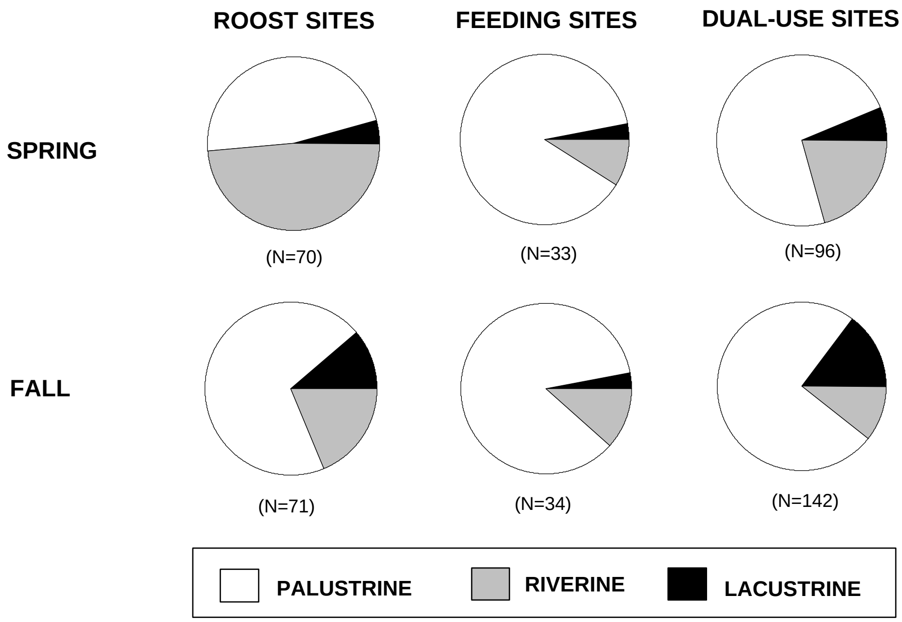
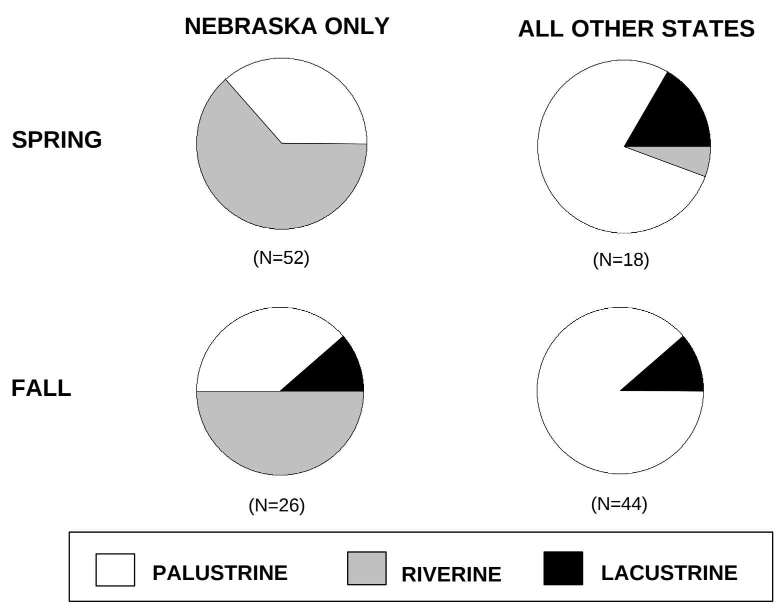


Figure 13. Percent of wetland roost sites defined as palustrine, riverine, or lacustrine, by season and site use, 1977-99, comparing Nebraska with all other states.



Only 2 states had sufficient observations to consider differences among wetland systems within that state. In North Dakota, 87.5% of wetland feeding sites were palustrine, 6.3% were lacustrine, and 6.3% were riverine (*n* = 16). In Nebraska, 80.6% of wetland feeding sites were palustrine, 16.6% were riverine, and 2.8% were lacustrine (*n* = 36).

Adult groups, pairs, and single families each comprised about 25% of cranes observed on palustrine wetlands; relatively few mixed groups and only 1 single juvenile were observed (Figure 11). Only pairs, groups of adults, and 1 single adult were observed feeding on riverine wetlands. Only 2 records of feeding occurred on lacustrine wetlands (1 single family, 1 single adult).

Dual-use Sites: Palustrine systems (71.0%) again were the predominant wetland systems used by cranes for both roosting and feeding; use of lacustrine and riverine wetlands were similar (10.9 and 14.1%, respectively; *n* = 248). Of the 176 palustrine records for dual-use sites, 34.7% were in Nebraska, 30.7% in Kansas, 16.5% in North Dakota, 10.2% in South Dakota, and 5.7% in Oklahoma; there were <5 (<2%) records for each of Montana and Texas. Of the 35 riverine records, 31 (88.6%) were in Nebraska, with 1 record each (all occurring in fall) in Kansas, Montana, North Dakota, and Oklahoma. Use of lacustrine systems varied somewhat among states: 35.7% in North Dakota, 25.0% in South Dakota, 14.3% in Nebraska, 14.3% in Oklahoma, and 10.7% in Kansas (*n* = 28). No sites were described as flooded pasture or wooded draw. Two were described as tailwater pit (Mead County, KS, and Sedgewick County, KS). Fourteen records were described as flooded cropland. One of the 14 had further description codes denoting marsh and oat stubble/green rye, 1 as seasonally flooded basin, and 2 as winter wheat. See State Summaries for details of named rivers and lakes or reservoirs used.

At a state level, palustrine wetlands accounted for >67% of sites used for both roosting and feeding in all states. Lacustrine wetlands accounted for 25–28% of such records in North Dakota, Oklahoma, and South Dakota (see State Summaries for details).

Use of wetland systems differed somewhat by season (Figure 12). Spring migrants were primarily observed on palustrine systems, with proportionately fewer observations on riverine and lacustrine systems In fall, use of palustrine systems remained similar to that in spring but use of lacustrine systems was somewhat lower and use of riverine systems somewhat higher.

Single families, adult groups, and pairs each comprised 24–31% of cranes observed on palustrine wetlands (Figure 11). Cranes observed on lacustrine wetlands were largely single families and adult groups. Half of the 10 observations on upland sites were of adult groups. We noted little difference in the distribution of nonfamilies and singles among wetland systems.

Wetland Class

All records: Wetland class was defined as emergent wetlands (50.7% of all records), unconsolidated bottom (28.4%), aquatic bed (11.2%), and unconsolidated shore (9.3%); 2 (0.4%) were defined as streambed (2 sub-observations for a pair foraging in disked cornfield along unvegetated streambed; Kearney County, NE) (*n* = 493). No cranes were observed in wetland classes defined as rocky bottom, rocky shore, forested wetland, or moss-lichen. Records from Nebraska comprised 61.4% of the data for this variable.

Roost Sites: Cranes most often were observed roosting on unconsolidated bottom (primarily palustrine wetlands) and palustrine emergent wetlands (Table 6). No seasonal differences in wetland classes were apparent.

Feeding Sites: Where cranes were observed feeding on wetlands, they largely occurred on palustrine emergent wetlands (Table 6). Use of wetland classes differed between spring and fall. Use of unconsolidated bottom sites was lower in spring (3.2% [1] than in fall (21.7% [5]), and use of emergent sites was higher in spring than in fall (87.1% [27] to 60.9% [14], respectively).

Table 6. Percent of wetland observations defined as having unconsolidated bottom, aquatic bed, unconsolidated shore, or emergent vegetation relative to wetland system, by site use, 1977–99.

	Roost sites (N = 108)			Feeding sites (N = 52)			Dual-use sites (N = 180)		
Wetland class	Palustrine	Lacustrine	Riverine	Palustrine	Lacustrine	Riverine	Palustrine	Lacustrine	Riverine
Unconsolidated bottom	9.3	4.6	25.9	5.8	0	5.8	6.7	3.9	11.1
Aquatic bed	8.3	1.9	0	7.7	0	0	10.0	3.9	0
Unconsolidated shore	0.9	1.9	15.7	1.9	0	3.8	1.1	0.6	6.7
Emergent	31.5	0	0	73.1	1.9	0	56.0	0	0

Dual-use sites: Wetlands with emergents (palustrine wetlands only) or unconsolidated bottoms were the most common wetland classes used by cranes for both feeding and roosting (Table 6). Differences in use of wetland classes between seasons was slight, with a tendency for greater use of aquatic-bed wetlands in fall and unconsolidated-shore wetlands in spring.

Wetland Regime

Roost Sites: Seasonal and semipermanent water regimes were most commonly used by roosting cranes (Figure 14), although in lacustrine systems, 6 of 11 sites were classified as having permanent water regimes. Use of wetland regimes for roosting differed seasonally among permanent, seasonal, semipermanent, and temporarily flooded regimes. Spring migrants were largely observed roosting on seasonal and semipermanent regimes (43.1 and 39.7%, respectively), with lesser use of permanent (6.9%) and temporary (6.1%) wetlands. Observations of roosting fall migrants were more equally distributed among water regimes (25.0% permanent, 32.5% seasonal, 17.5% semipermanent, and 25.0% temporary).

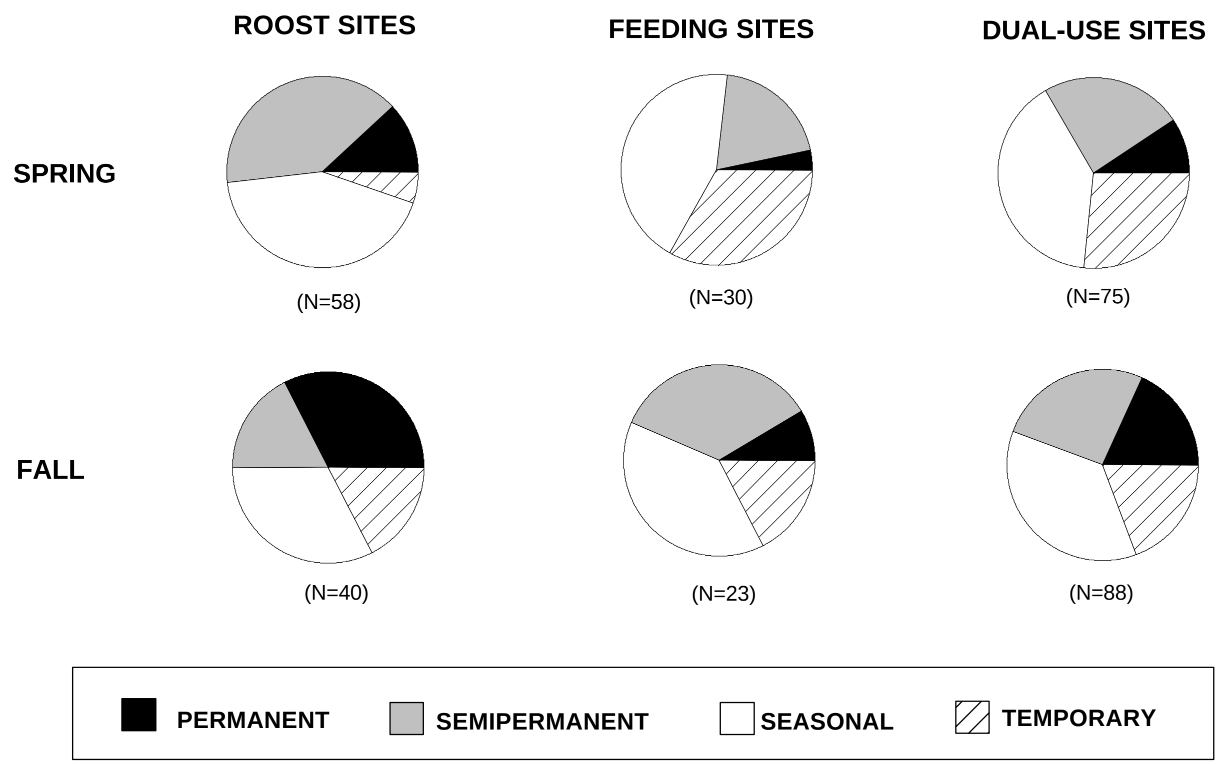
Feeding Sites: Feeding cranes used mostly seasonal, semipermanent, and temporary wetlands (Figure 14). We noted no seasonal differences among permanent, seasonal, semipermanent, and temporary regimes.

Dual-use Sites: Dual-use sites most commonly were seasonal and semipermanent wetlands in both spring and fall (Figure 14). Occurrence at dual-use sites did not vary seasonally among permanent, semipermanent, seasonal, and temporary wetlands, although there was a trend toward higher use of permanent wetlands in fall than in spring.

Wetland Size

Roost Sites: Roosting cranes were commonly observed on large (>40 ha) wetlands; frequency of occurrence on these larger wetlands was higher in fall than in spring (59% vs. 27%; Figure 15). Closer examination of the records indicated that the frequent use of large wetlands is affected by wetland system and, in fall, by frequent observation of cranes on large, managed wetlands within 3 public conservation areas. Nine of the 10 lacustrine sites were >40 ha and the other site was >20 ha; most of these sites were

Figure 14. Percent of wetland sites defined as having permanent, semipermanent, seasonal, or temporary water regimes, by site use and season, 1977-99.



reservoirs or human-altered lakes. Fall lacustrine roost sites included Lovewell Reservoir, Kansas; Harlan County Reservoir, Duck Lake (Cherry County), and Lake Maloney, Nebraska; Pocasse NWR and Stone Lake SWA, South Dakota; and Lake Sakakawea, North Dakota. Spring roost sites included Kirwin NWR and Glen Elder Reservoir, Kansas (2 records). In palustrine systems, wetlands >40 ha accounted for 43% of all records (n = 77). Observations of roosting cranes on the large wetland management units and reservoirs on Salt Plains NWR, Quivira NWR, and Cheyenne Bottoms SWA accounted for 27 (35%) of the 78 records overall, and for 24 (92%) of the 26 records in fall. When we excluded these 3 areas and Funk Waterfowl Production Area (WPA), which also has large managed wetlands and frequently hosted whooping cranes in fall, we found a more even distribution of palustrine wetland sizes used in both spring and fall (Figure 16).

The composition of social groups differed somewhat among the 3 pooled wetland size classes (Figure 17). All observed mixed groups (n = 7) occurred only on wetlands >20 ha, but groups of adults were relatively uncommon on these larger wetlands. Single families and pairs comprised the largest proportion of cranes observed on large wetlands.

Feeding Sites: Wetlands on which cranes fed were smaller than those used for roosting or for dual use (Figure 15). Feeding cranes were more frequently observed on wetlands <2.5 ha in spring than fall, but occurrence of other wetland sizes were similar between seasons.

The composition of social groups on feeding sites showed greater differences among 3 wetland size classes (Figure 17) than on sites used for roosting or dual use. Groups of adults were least commonly

Figure 15. Percent of wetland sites occurring in 6 size classes of wetlands, by site use and season, 1977-99.

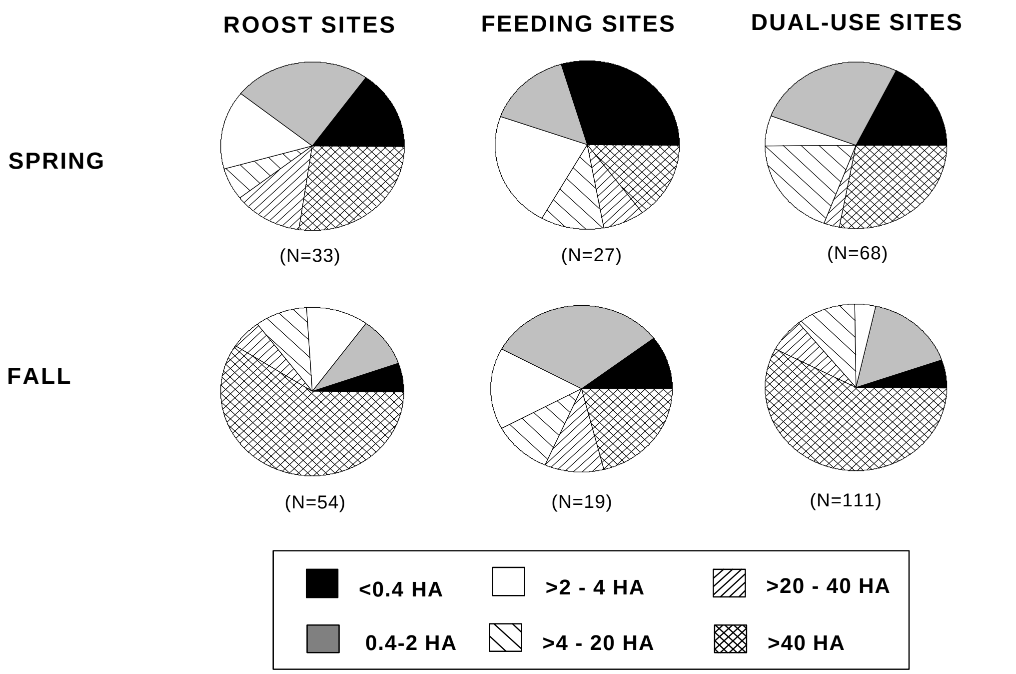


Figure 16. Percent of wetland sites occurring in 6 size classes of wetlands, by site use and season, 1977-99, when records from Quivera NWR, Salt Plains NWR, Cheyenne Bottoms SWA, and Funk Lagoon WMA are excluded. See Figure 15 for legend.

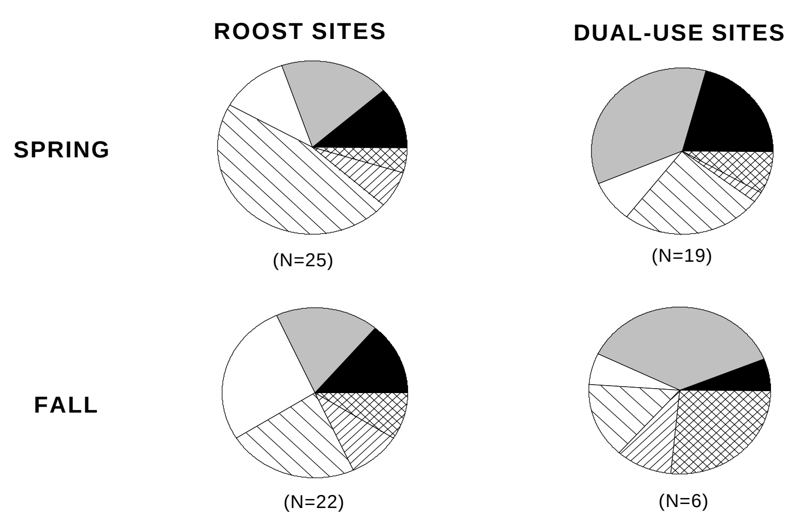
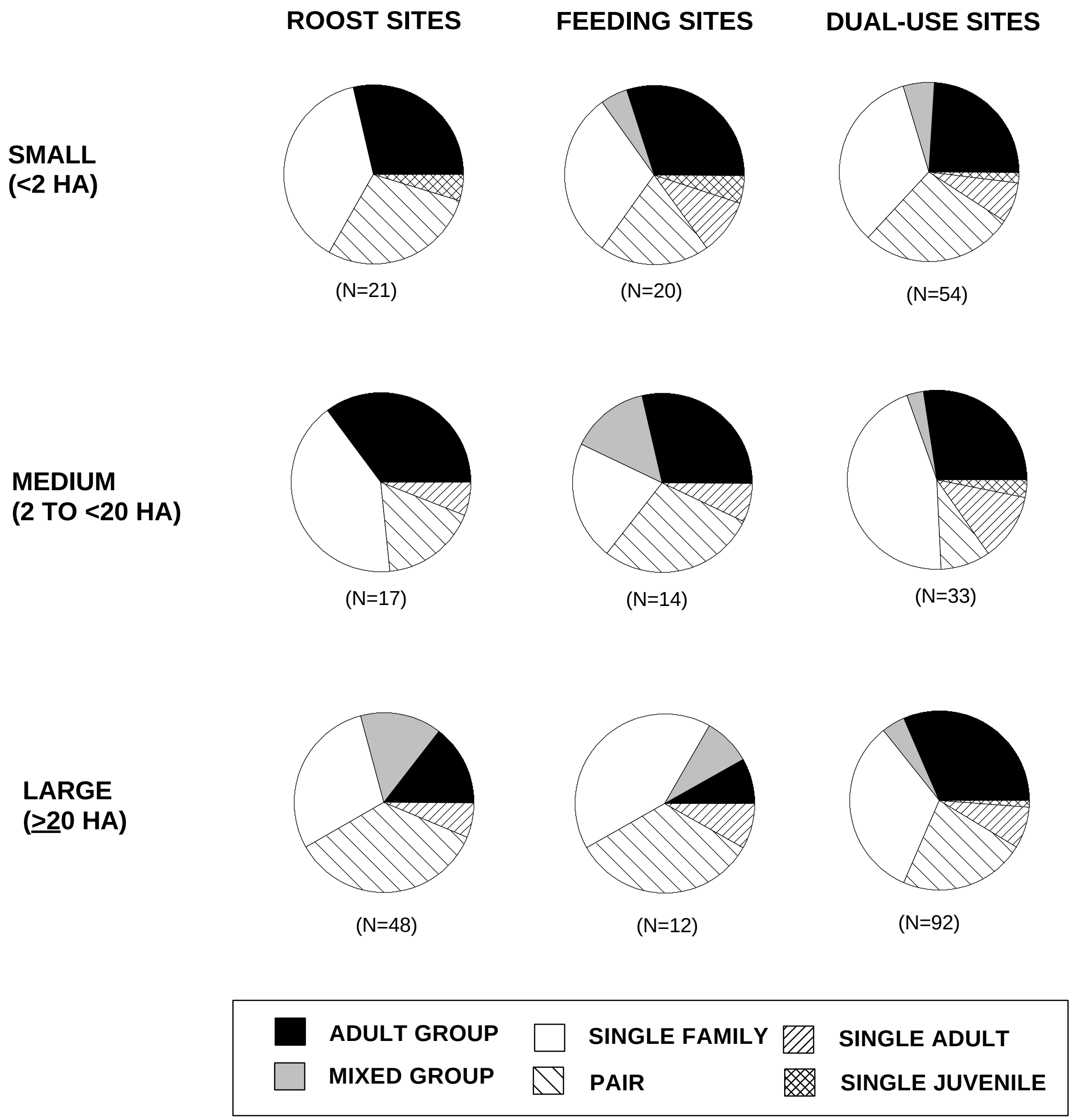


Figure 17. Percent of wetland observations for 6 social group categories occurring in 6 size classes of wetlands, by site use and season, 1977-99.



observed and single families most commonly observed feeding on large (>20 ha) wetlands. As noted for roost sites, single families and pairs comprised the largest proportion of cranes observed on large wetlands.

Dual-use Sites: Similar to roost sites, cranes were commonly observed both roosting and feeding on larger wetlands than were feeding cranes, and cranes were more frequently observed on wetlands >40 ha in fall than in spring (Figure 15). Use of these large wetlands again was primarily due to frequent observations of cranes on the management units and reservoirs of Quivira NWR (9 of 20 records in spring, 26 of 64 records in fall), Cheyenne Bottoms SWA (1 record in spring, 5 in fall), and Salt Plains NWR (9 records in fall). Lakes and reservoirs accounted for many of the other sites >40 ha in fall, but in spring the other sites were large palustrine wetlands on WPAs or private lands. When we examined only palustrine wetlands and excluded the 4 management areas noted above, we found that cranes occurred on a wider variety of wetland sizes, particularly in spring and, in fall, >30% of the sites were wetlands >40 ha (Figure 16).

There were relatively minor differences in occurrence of social groups on the 3 pooled wetland size classes (n = 179) (Figure 17).

River Width

All Data: River width was recorded at 117 (84%) of the 139 riverine sites; 109 (93%) of these 117 records (93%) were for sites in Nebraska. Widths ranged from 36 to 457 m and averaged 227 ± 88 (SD) m.

Roost Sites: Widths of rivers at roost sites ranged from 76 to 457 m and averaged 233 ± 84 m (n =44). Seasonal differences in river width were suggested, with slightly wider river sites used in spring (247 ± 86; n =31) than in fall (200 ± 74; n =13). Occurrence of larger rivers in spring are primarily due to predominance of the Platte River in spring observations (83.3% of spring riverine observations having a width measurement); in fall, smaller rivers such as the Middle Loup, North Loup, and Niobrara rivers accounted for 7 of the 13 records for river width.

Feeding Sites: We had data on river width for only 4 riverine sites used for feeding, all in Nebraska (crane pair on Birdwood Creek, Lincoln County in fall; 3 cranes on Middle Loup River in spring; pair on Platte River in spring; and 4 cranes on Niobrara River in spring). These ranged from 36 (Birdwood Creek) to 274 m wide and averaged 173 ± 100 m.

Dual-use Sites: Widths of rivers used for both roosting and feeding ranged from 91 to 411 m and averaged 229 ± 82 m (n =28). River width did not vary by season.

Water Depths

All Data: Maximum depths of wetlands on which cranes were observed ranged from 3 to 305 cm and averaged 51 ± 41 cm (SD) (n =297). Cranes were observed on shallower wetlands in spring (46 ± 32 cm; n =161) than in fall (56 ± 50 cm; n =136). Specific sites within wetlands where cranes were observed feeding or roosting averaged 18 ± 11 cm (range 3–61 cm; n =196).

Roost Sites: Maximum depths of wetlands used for roosting ranged from 8 to 305 cm and averaged 67 ± 54 cm (n =69). Wetlands used for roosting in spring (65 ± 35 cm; n =40) were similar in depth to those used in fall (69 ± 72 cm; n =29). Depths at specific roost sites within the wetland ranged from 5 to 46 cm and averaged 20 ± 9 cm (n =41).

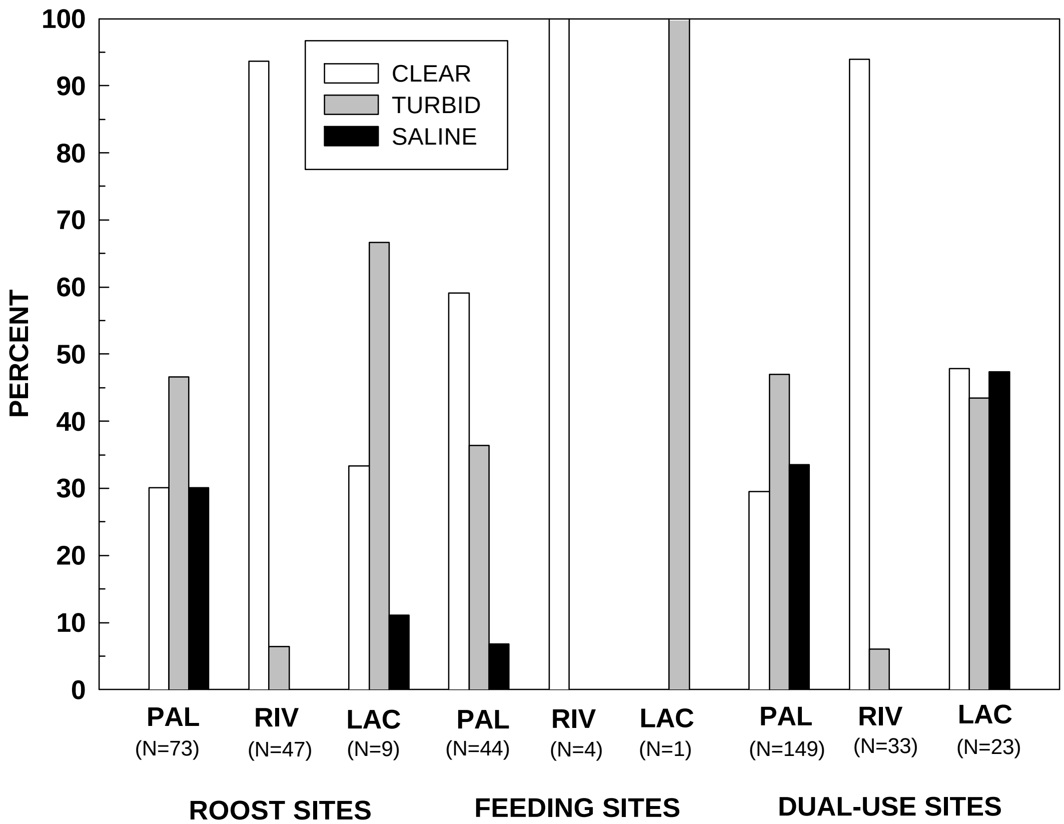
Feeding Sites: Maximum depths of wetlands used for feeding ranged from 3 to 107 cm and averaged 31 ± 25 cm (n =31). Wetlands used for feeding in spring (24 ± 13 cm; n =19) were somewhat shallower than those used in fall (44 ± 10 cm; n =12). Depths at specific sites where cranes had been observed feeding ranged from 3 to 30 cm and averaged 12 ± 7 cm (n =14).

Dual-use Sites: Maximum depths of wetlands used for both roosting and feeding ranged from 3 to 28 cm and averaged 50 ± 39 cm (n =116). Wetlands used by cranes tended to be shallower in spring (44 ± 32 cm; n =56) than in fall (56 ± 43 cm; n =60). Depths at specific sites ranged from 3 to 61 cm and averaged 18 ± 12 cm (n =80).

Water Quality

Roost Sites: Overall, 53.1% of roost sites were described as clear, 33.1% turbid, and 13.8% saline (n =129). Water quality of roost sites clearly varied by wetland system (Figure 18). Most turbid wetlands

Figure 18. Percent of wetland sites defined as clear, turbid, or saline, by site use and wetland system, 1977-99. PAL=palustrine, RIV=riverine, and LAC=lacustrine.



were palustrine, although 3 river sites (Niobrara River, Brown County, NE; 2 sites on Platte River near Doniphan, NE) and 7 lakes also were classified as turbid. All sites described as saline were on Salt Plains NWR or Quivira NWR (often Big Salt Marsh), except for 1 site on Stone Lake SWA, South Dakota.

Feeding Sites: Overall, 59.3% of feeding sites were described as clear, 37.0% turbid, and 3.7% saline (n =58). The majority of the 46 palustrine sites had clear water, however, data for lacustrine and riverine were sparse (Figure 18). Saline sites were located on Loucks WPA, North Dakota, and Quivira NWR, Kansas.

Dual-use Sites: Of the 211 dual-use sites with information, 42.2% were defined as clear, 39.3% turbid, and 18.5% saline. Water quality of dual-use sites clearly varied by wetland system (Figure 18). Most riverine systems had clear waters whereas a high proportion of lacustrine systems were turbid. Most saline sites were on Salt Plains NWR or Quivira NWR, although there were a number of smaller saline wetlands in North and South Dakota, Kansas, and Nebraska.

Substrate

Roost Sites: Most wetlands used for roosting had soft substrates (38.5% sand, 52.6% soft mud), 7.4% had hard mud substrates, and 1.5% had other substrate types (n =135). Substrates were closely associated with wetland systems: 95.7% of riverine wetlands (*n* =46) had sand substrates, 80.3% of palustrine wetlands (*n* =77) had soft mud substrates, and 6 (63.6%) of the 11 lacustrine wetlands had soft mud substrates. Hard mud substrates occurred in lacustrine (*n* =3) and palustrine wetlands (*n* =7).

Feeding Sites: Most (62.1%) wetlands used for feeding had soft mud substrates; 13.8% had sand, 13.8% had hard mud, and 10.3% had other substrates. Substrate again was closely related to wetland system: 65.2% of palustrine wetlands (*n* =46) had soft mud substrates, and 4 of 6 riverine systems had sand substrates. The 1 lacustrine system had soft mud.

Dual-use Sites: Most sites used for both roosting and feeding had soft substrates (23.2% sand, 63.9% soft mud); 8.9% had hard mud, and 4.0% had other substrates. Substrate was closely associated with wetland system: 91.2% of riverine wetlands (*n* =34) had sand substrates, 75.9% of palustrine systems (*n* =158) had soft mud substrates, and 58.3% of lacustrine systems (*n* =25) had soft mud substrates and 29.2% had sand substrates. Hard mud substrates occurred in lacustrine (*n* =2) and palustrine systems (*n* =18).

Shoreline Slope

Roost Sites: Most (78.7%) shorelines of roost sites were classified as having a slight slope (1–<5% slope); 18.5% were classified as having no slope (<1%), and 2.8% had 5–10% slope (*n* = 108). The latter included 1 roost site on the Niobrara River (Rock County, NE) and 2 stock ponds (Furnas County, NE; Jackson County, SD).

Feeding Sites: Most (70.7%) wetland shorelines of feeding sites had a slight slope (1–<5% slope); 17.1% had no slope (<1%), 9.8% had 5–10% slopes (seasonal wetland in McLean County, ND; Stone Lake [seasonal wetland], SD; and 1 marsh in Sully County, ND), and 1 (2.4%) had >10% slope (<6-ha marsh near Gibbon, NE) (*n* = 41). Nearly all of these records were for palustrine systems. Slope was recorded for only 1 lacustrine system (pool at Cheyenne Bottoms SWA) and 2 riverine sites (Platte River and Birdwood Creek, NE).

Dual-use Sites: Most (65.4%) wetland shorelines of dual-use sites had a slight slope (1–<5% slope); 23.5% were classified as having no slope (<1%), 6.2% had 5–10% slope, and 4.9% had >10% slope (*n* = 162). All 23 riverine sites, 68.4% of lacustrine sites, and 58.3% of palustrine systems at dual-use sites were classified as having 1–<5% slope.

Dominant Emergent Vegetation

Roost Sites: In riverine systems, roosting cranes more often were observed on unvegetated sites than on vegetated sites, but in palustrine sites they were observed on sites having a broad range of emergent vegetation types (Table 7). Emergent vegetation characteristics of lacustrine sites were intermediate between those of palustrine and riverine sites. Where vegetation did occur on riverine sites, it usually consisted of grasses or "other" (likely willow [*Salix*]).

Feeding Sites: In riverine systems, feeding cranes primarily were observed on unvegetated wetlands, but they also were observed on sites with some rush, smartweed, or other vegetation (likely willow) (Table 7). Palustrine sites used for feeding had a broader range of emergent vegetation types. One of the "other" categories was described as corn, which is inappropriate as an emergent vegetation for wetlands.

Dual-use Sites: Emergent vegetation on dual-use sites varied among wetland systems used (Table 7). In riverine wetlands, cranes rarely used sites with any vegetation. Palustrine wetlands had a variety of vegetation types. One of the "other" categories was further described as corn. Lacustrine systems used for both roosting and feeding tended to be unvegetated or vegetated with cattail or rush.

Table 7. Frequency (%) of emergent vegetation types, by wetland system and site use. Percentages within a column do not sum to 100% for a wetland system within a site use because more than 1 type often was recorded per site.

	Roost sites			Feeding sites			Dual-use sites		
Vegetation type	Palustrine	Lacustrine	Riverine	Palustrine	Lacustrine	Riverine	Palustrine	Lacustrine	Riverine
Grass	29.0	10.0	13.3	0	29.5	0	4.3	27.3	0
Sedge	17.7	10.0	4.4	0	29.5	0	4.3	22.4	0
Cattail	19.4	20.0	0	0	18.2	0	39.1	19.6	3.1
Rush	24.2	20.0	2.2	0	40.9	28.6	21.7	32.9	0
Smartweed	27.4	20.0	0	100	38.6	14.3	4.3	29.4	0
Other	6.5	0	11.1	100	9.1	14.3	13.0	11.9	6.2
None	30.6	50.0	84.4	0	9.1	57.1	39.1	19.6	93.7
N	*62*	*10*	*45*	*1*	*44*	*7*	*23*	*143*	*32*

Distribution of Emergent Vegetation

Roost Sites: At roost sites, distribution patterns of emergent vegetation varied by wetland system (Figure 19). Although most riverine sites had no vegetation, as noted above, palustrine sites often had scattered vegetation. Palustrine sites having clumped or choked vegetation had a variety of vegetation types, with no single type dominating.

Feeding: Distribution patterns of emergent vegetation at feeding sites varied by wetland system (Figure 19). Although most riverine sites had no vegetation, as noted above, palustrine feeding sites often had scattered or choked vegetation. No vegetation type dominated at palustrine sites relative to the distribution pattern of vegetation.

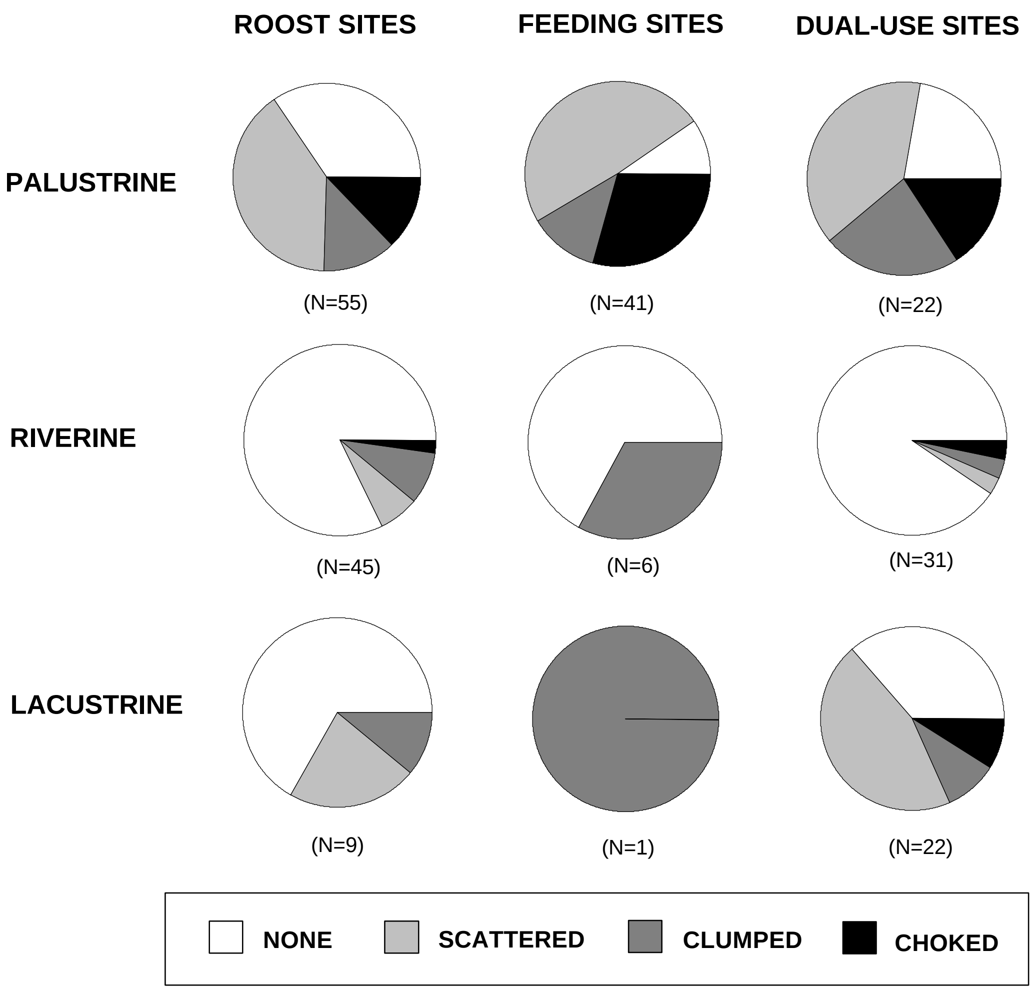
Dual-use Sites: Distribution patterns of emergent vegetation at dual-use sites varied by wetland system (Figure 19). Most riverine sites had no vegetation, as noted above, lacustrine sites were evenly split between no vegetation and scattered vegetation, and palustrine sites had a mix of patterns. No vegetation type dominated at palustrine sites.

Feeding Site Description

All Data: Most sites where cranes were observed feeding were in upland crops whereas cranes observed at dual-use sites were more often in wetlands (see below). Seasonally-flooded habitat was largely comprised of flooded pasture (47% of records) and seasonal wetlands (42% of records). Permanent wetlands were largely marshes (30–40%) and reservoirs (30–40%). Sixty percent of upland cover was described as pasture. For upland crops, wheat comprised 83% of small grain stubble, corn comprised about 75% of row-crop stubble, and winter wheat comprised 80% of green crops.

Feeding Sites: Most sites where cranes were observed feeding were upland crops, with lower occurrence of cranes seen in seasonally flooded habitats, permanent water, or upland perennial cover. No

Figure 19. Percent of wetland sites occurring in 4 categories describing the distribution pattern of emergent vegetation, by site use and wetland system, 1977-99.



cranes were recorded feeding in woodland (Figure 20). Proportions of habitat types varied little between seasons. Although upland crops occurred in similar high proportions in descriptions of both feeding sites and adjacent habitat, it is apparent that cranes were less frequently observed in upland cover or on wetlands than occurred in adjacent habitat (see below) (Figure 21).

There was little difference in the proportions of social groups observed feeding on permanent wetlands, cropland, and upland cover (Figure 22). In seasonal wetlands, groups of adults comprised 40% of cranes observed, with fewer pairs than in other habitat types. Single families tended to comprise a higher proportion of feeding cranes in cropland and upland cover than in wetlands. When we considered pooled social groups, we found no apparent difference in the distribution of family, nonfamily, and single groups among feeding habitat types.

Figure 20. Percent of observations for feeding and dual-used sites described as seasonal wetland, permanent wetland, cropland, or upland cover, by site use and season, 1977-99.

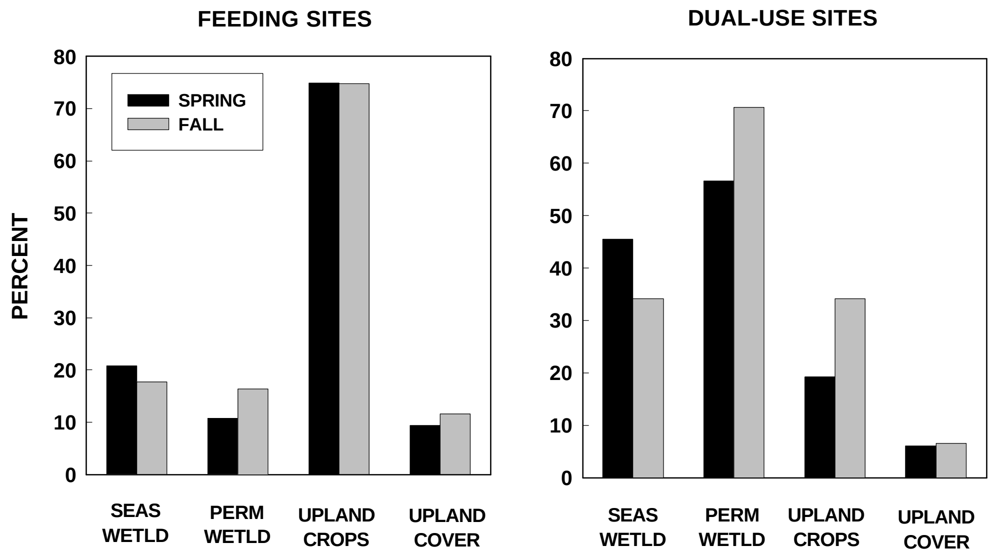


Figure 21. Percent of sites, within 1.6 km of feeding or dual-used sites, described as seasonal wetland, permanent wetland, cropland, or upland cover, by site use, 1977-99.

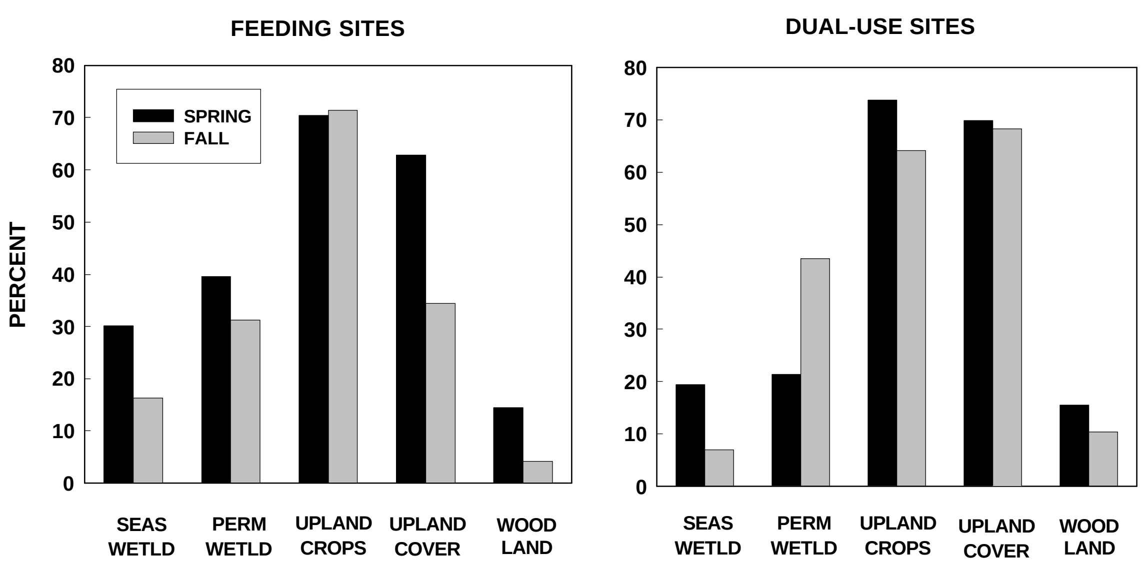
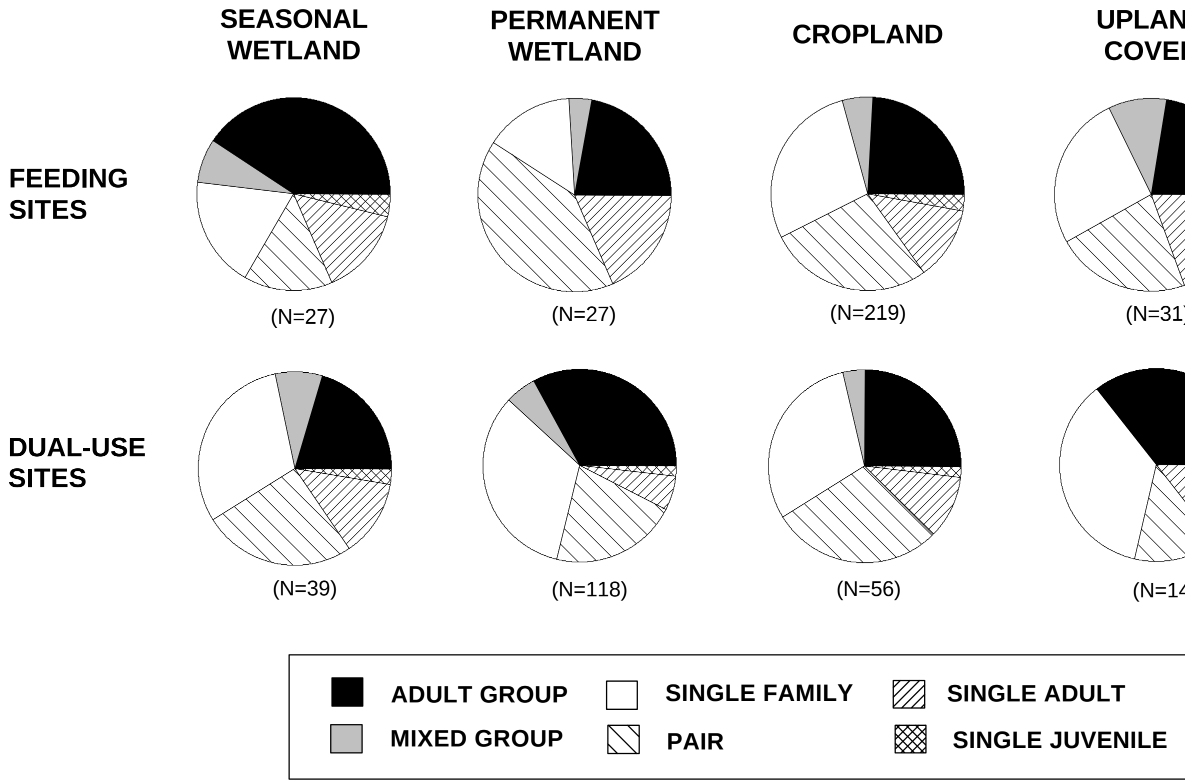


Figure 22. Percent of observations for 6 categories of social groups occurring in each type of feeding habitat, by site use, 1977-99.



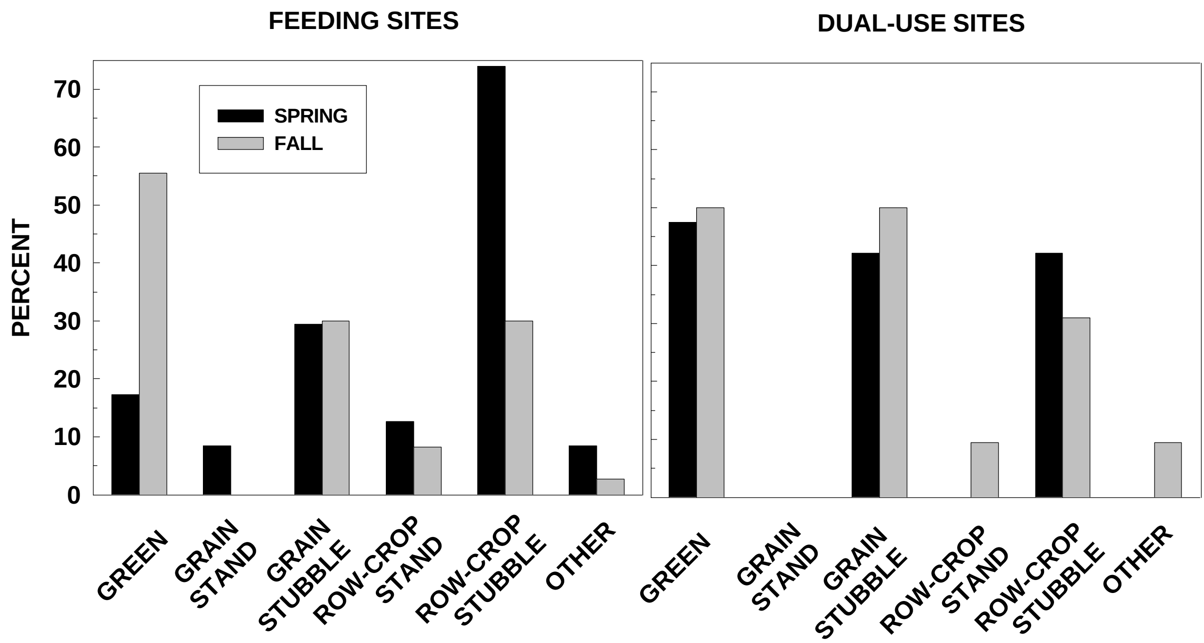
In spring, cranes most frequently were observed feeding on row-crop stubble, with lesser use of small grain stubble and green crops; <10% of records were for standing small grain, standing row-crops and other (Figure 23). In fall, cranes were most frequently observed on green crops, small-grain stubble, and row-crop stubble. Cranes were infrequently observed in standing small grain, small-grain or row-crop stubble, or in other habitats such as CRP.

Dual-use Sites: Most dual-use sites were permanently or seasonally flooded wetlands, with lesser use of upland crops; no cranes were recorded feeding in woodland (Figure 20). Use of seasonal wetlands for both feeding and roosting was somewhat higher in spring whereas use of permanent wetlands and upland crop were higher in fall. Cranes were observed feeding in wetlands more frequently and in upland crops less frequently than occurred in adjacent habitat (see below) (Figure 21).

Similar to feeding sites, groups of adults observed on dual-use sites comprised a larger proportion of cranes observed on seasonal wetlands than on other habitat types. Pairs were the most commonly observed group on cropland and least commonly observed group on seasonal wetlands (Figure 22). When we considered pooled social groups, we found no apparent difference in the distribution of nonfamily, family, and single groups among feeding habitat types.

For spring dual-use sites, cranes were observed with similar frequency on green crops, small-grain stubble, and row-crop stubble but were not observed on other crop types (Figure 23). For fall dual-use sites, proportions of crane observations were similar between small-grain stubble and greens crops, with lower frequency of row-crop stubble, and infrequent occurrence on standing row crops and other cropland habitat.

Figure 23. Percent of cropland types occurring on feeding and dual-use sites, by season, 1977-99.



Primary Adjacent Habitat

Roost Sites: Habitats adjacent to roost sites (≤1.6 km) most frequently were described as cropland (73.8%) and upland perennial cover (69.5%); permanent wetlands (36.2%) and upland cover (30.5%) were also common. We then examined riverine and palustrine systems separately because we suspected the main river roost sites, used primarily in spring (and represented almost entirely by Nebraska records), would differ in occurrence of woodland habitat along the river perimeter. As anticipated, woodland habitat occurred adjacent to >70% of riverine roost sites but adjacent to <8% of palustrine roost sites (Figure 24). All riverine roosts also had adjacent upland cover, whereas only about half of palustrine roost sites had such adjacent cover; however, upland cropland was common. For both wetland systems, seasonal wetlands occurred more frequently in adjacent habitat for spring roost sites, probably reflecting their seasonal occurrence in the landscape, and permanent wetlands occurred more frequently adjacent to roost sites in fall. Upland cropland was more common in spring than in fall, but we caution that the large number of fall records from Cheyenne Bottoms SWA, Quivira NWR, and Salt Plains NWR, where habitat adjacent to roosts is more likely to be non-cropland habitat than on private lands, may be a factor in these seasonal differences.

Feeding Sites: The most common habitats adjacent to feeding sites were cropland and upland perennial cover; permanent and seasonal wetlands and woodland were less common nearby (Figure 21). Occurrences of seasonal wetlands and upland cover in adjacent habitat were higher in spring than in fall. The higher occurrence of woodland in spring likely relates to greater occurrence of feeding observations in spring on river systems, all of which occurred in Nebraska. Adjacent croplands were most likely to be green crops (winter wheat, alfalfa, winter rye, barley) or row-crop stubble (Figure 25).

Figure 24. Percent of adjacent habitat described as seasonal wetland, permanent wetland, cropland, or upland cover for palustrine and riverine roost sites, 1977-99.

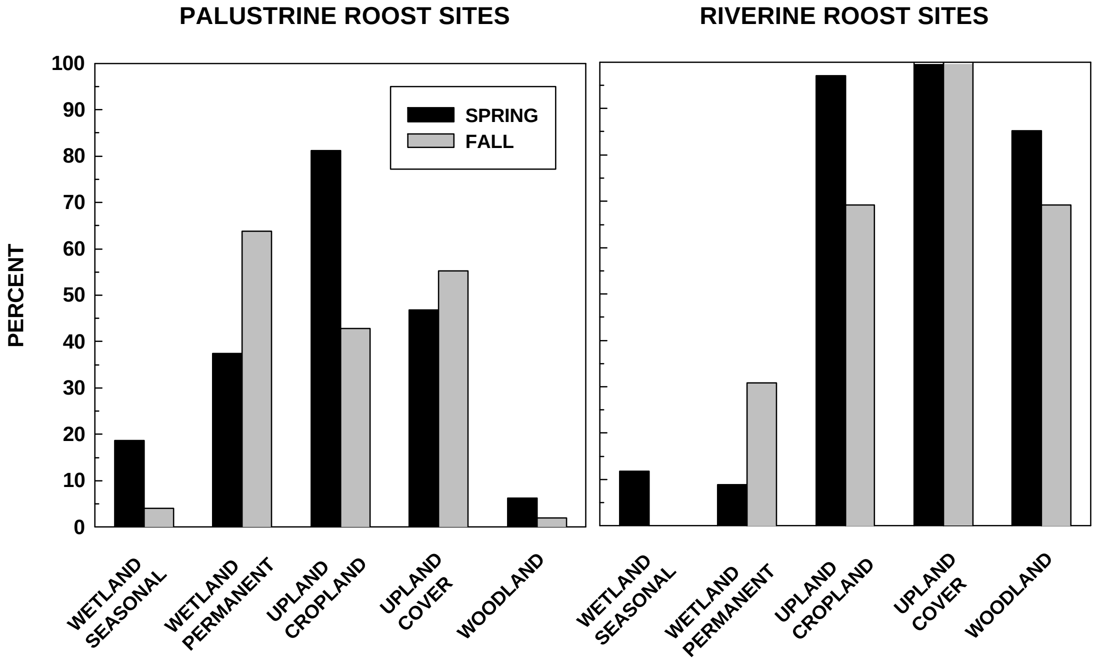
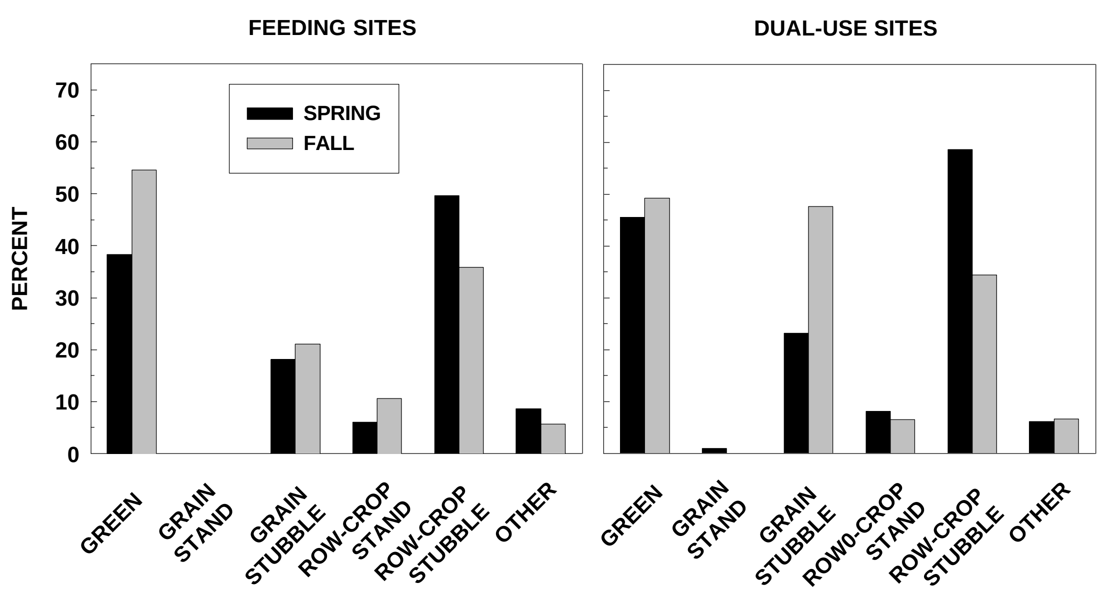


Figure 25. Percent of cropland types occurring within 1.6 km of feeding and dual-use sites, by season, 1977-99.



Dual-use Sites: Habitats adjacent to dual-use sites were largely cropland, upland perennial cover, and permanent water areas, with lesser use of seasonally-flooded wetlands and woodland (Figure 21). Occurrence of seasonal wetlands nearby was higher in spring whereas occurrence of permanent wetlands was higher in fall. Upland cover and row-crop stubble were the most common adjacent crop types (Figure 25).

Similar Habitat Within 16 Km (10 Mi)

We examined similar habitat within 16 km for all records combined, regardless of site use, because distances between feeding and roost sites usually were much less than 16 km. Habitat similar to that of the evaluation site was categorized as moderately abundant (41.2%) to abundant (23.3%) within 16 km of the sites, and extent of similar habitat was low for 33.9% of sites (*n* =561). Two sites (0.4%) had no similar habitat and 7 (1.2%) were recorded as unknown. Those sites recorded as having no similar habitat included 1 record on or near the Platte River southeast of Kearney, Nebraska (apparently considered a wetland but no data on system or regime) and 1 record in Sully County, South Dakota, which from other information appeared to be a flooded corn field (i.e., recorded as palustrine wetland and corn as the emergent vegetation).

Distance to Feeding Sites

Roost Sites: When all roost records were considered, we found no apparent pattern in distances between roost and feeding sites: 28.4% were <0.40 km, 23.0% were 0.40–0.79 km, 8.1% were 0.80–1.19 km, 16.2% were 1.20–1.6 km, and 24.3% were >1.6 km from roost sites (*n* = 74; percentages sum to >100 because of multiple distances given for a single roost site). However, distances obviously varied with wetland system (Figure 27). On palustrine roost sites, about two-thirds of feeding sites were <0.8 km from the roost, likely reflecting wetlands situated in cropland areas, whereas over half of riverine roost sites were >1.2 km from feeding sites. All riverine roosts which were >1.6 km from feeding sites occurred on the Platte River (1 in fall, 9 in spring). Roost sites on the Middle Loup and North Loup rivers were usually <0.8 km from feeding sites. All 5 of the lacustrine records, where distances to feeding sites were recorded, were >1.2 km from the roost.

Feeding Sites: Distances to feeding sites were recorded in 10 records; we assumed these refer to distance to other feeding sites. Five sites were <0.40 km, 1 was 0.40–0.79 km, 1 was 0.80–1.19 km, and 3 were >1.6 km from the first feeding site.

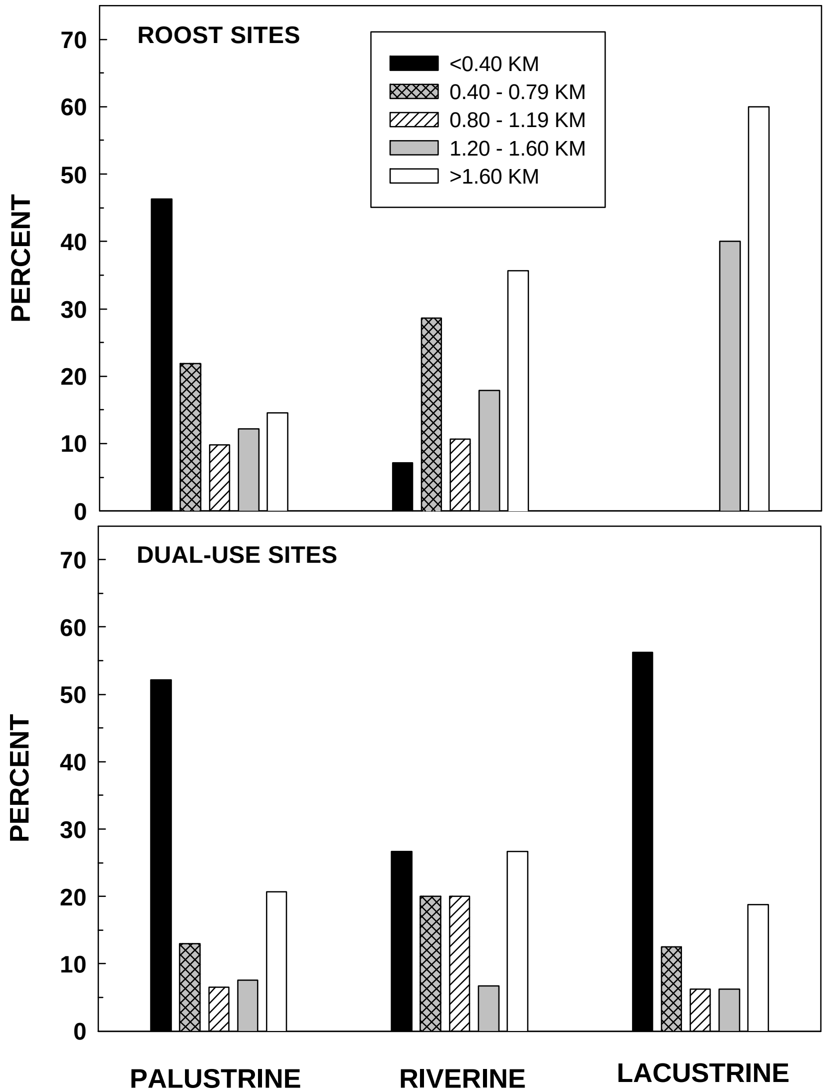
Dual-use Sites: A higher proportion of dual-use sites were within 0.40 km of other feeding sites than for sites used only for roosting: 49.2% of feeding sites were <0.40 km of the site, 13.3% 0.40–0.79 km, 8.6% 0.8–1.19 km, 8.6% 1.20–1.6 km, and 20.3% >1.6 km from the site (*n* = 128). Palustrine and lacustrine dual-use sites often were closer to feeding sites than riverine dual-use sites (Figure 26).

Primary Potential Food Sources

Feeding: Grains and invertebrates were considered most commonly available at feeding sites, reflecting the high use of cropland sites (Table 8).

Dual-use Sites: Invertebrates were considered most commonly available at dual-use sites, with frogs, grains, fish, and tubers also common (Table 8). The diversity of potential foods reflects the mixture of wetland and upland habitat types in these data.

Figure 26. Percent of roost and dual-use sites that were <0.40, 0.40--0.79, 0.80--1.19, 1.19--1.60, and >1.60 km from feeding sites, by wetland system, 1977-99.



Foods Observed Eaten by Cranes

A total of 50 records noted actual foods observed being consumed by cranes; 23 records were for feeding sites (14 in spring, 9 in fall) and 27 records were for dual-use sites (11 in spring, 16 in fall). Thirty (60%) of the observations were from Nebraska. Cranes most often were observed consuming grain on both feeding (n = 20) and dual-use sites (n = 18) even though 76% of dual-use sites were palustrine wetlands. Other items observed consumed by cranes included fish (n =4; in dual-use sites only), invertebrates (n = 3), mollusks (n = 2), snakes or other (n = 4), and salamander, tubers, and frogs (n = 1 each). Cranes were observed eating fish on 4 seasonal wetlands and 1 wetland of unknown regime.

Table 8. Frequency (%) of potential foods available at feeding and dual-use sites, 1977–99. Numbers within a column do not sum to 100% because more than 1 type was often recorded per site.

Potential food	Feeding sites			Dual-use sites		
	Spring	Fall	Overall	Spring	Fall	Overall
Grains	76.1	80.9	78.4	33.0	35.9	34.7
Tubers	8.2	6.8	7.5	20.4	22.1	21.4
Invertebrates	68.6	66.0	67.3	67.0	56.5	60.9
Molluscs	4.4	3.4	3.9	13.6	15.9	14.9
Crustaceans	1.9	2.7	2.3	13.6	20.7	17.7
Fish	3.7	2.0	2.9	24.3	23.4	23.8
Frogs	10.7	7.5	9.1	43.7	31.7	36.7
Salamanders	3.8	1.4	2.6	10.7	6.2	8.1
Other*	0.6	0	0.3	1.0	0.7	0.8
N	*159*	*147*	*306*	*103*	*145*	*248*

*Includes snakes.

Distance to Human Development

More than two-thirds of sites where cranes were observed were <0.8 km of human developments (32.5% <0.4 km, 37.5% 0.4 – <0.8 km), 7.8% were 0.8 – <1.2 km away, 3.8% 1.2–1.6 km away, and 7.9% were >1.6 km away; 10.8% were classified as not applicable (n = 554, using 1 record for each main observation). We noted no apparent differences in distance to human development among roost, feeding, and dual-use sites.

Distance to Utility Lines

Fifty-eight percent of cranes observed were >805 m from utility (power or phone) lines; 2.5% were observed <91 m away, 16.3% were 91-401 m away, and 22.4% were 402–805 m away (n = 362, using 1 record for each main observation). We noted no apparent differences in distance to utility lines among roost, feeding, and dual-use sites.

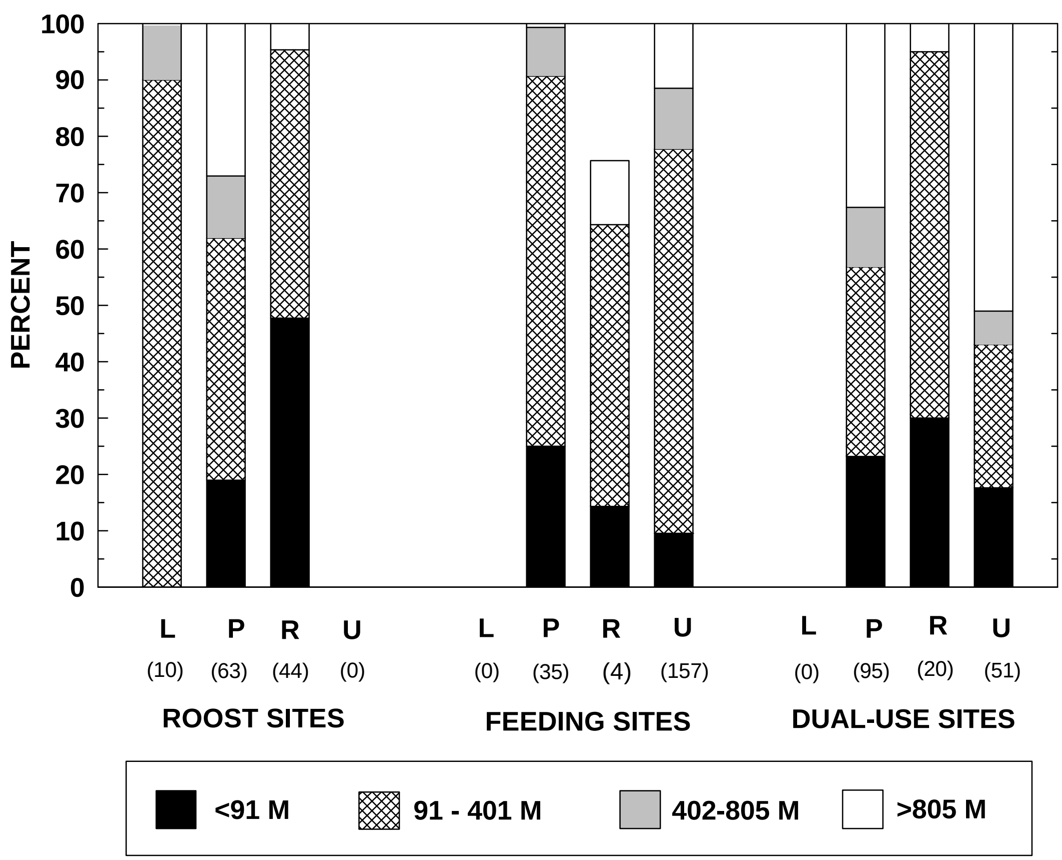
Visibility

Roost Sites: Overall, nearly half (48.7%) of roost sites were classified as having visibility of 91–402 m, 28.2% had visibility <91 m, 6.9% 402–805 m, and 16.2% with >805 m or unlimited visibility (n = 117). Because of the potential influence of trees that are often closely associated with river edges, we separately examined visibility of roost sites by wetland system. Roost sites with greatest visibility distances were on palustrine and lacustrine areas, whereas riverine roost sites had the lowest visibility distances (Figure 27). No riverine roost sites were ranked as having visibility >800 m; visibility on these sites likely was limited by woody growth along the shoreline. We found no difference in the distribution of nonfamily, family, and single groups among visibility classes at roost sites.

Feeding Sites: Two-thirds of feeding sites (67.0%) were classified as having 91–402 m visibility, 10.7% <91 m, 10.1% 402–805 m, and 12.2% with >805 m or unlimited visibility (n = 197). Visibility distances were quite similar among palustrine, riverine, and upland habitats (Figure 27). The distribution of nonfamily, family, and single groups differed little among visibility classes for feeding sites.

Dual-use Sites: Visibility was <91 m for 21.9% of dual-use sites, 91–402 m for 37.7% of sites, 402–805 m for 7.7% of sites, and >805 m or unlimited visibility for 32.7% of sites (n = 183). Dual-use sites with greatest visibility distances were on uplands or palustrine wetlands, whereas riverine dual-use sites tended to have the lowest visibility distances (Figure 27). The distribution of nonfamily, family, and single groups differed little among visibility classes at dual-use sites.

Figure 27. Percent of sites having visibility to <91 m, 91--401 m, 402--805 m, or >805 m, by site use and wetland system or upland site, 1977-99. L=lacustrine, P=palustrine, R=riverine, and U=upland.



Other Species Present

Roost Sites: Roosting whooping cranes were associated with other bird species in 33.3% (47 of 141) records. They were most commonly associated with sandhill cranes (89.4%) but also were observed in association with American white pelicans (*Pelicanus erythrothynchos*; 6.4%) and geese (6.4%; included snow geese [*Chen caerulescens*] and Canada geese [*Branta canadensis*]). Spring associations with sandhill cranes were primarily on Platte River roost areas (24 of 32); 6 palustrine sites in the Rainwater Basin and other areas also were shared with sandhill cranes in spring. In fall, whooping cranes were observed with sandhill cranes on 6 palustrine sites (Quivira NWR and Funk WPA), 1 riverine site, and 4 lacustrine sites. Whooping cranes roosted with geese in 2 palustrine sites in Kansas and 1 in South Dakota.

Feeding Sites: Feeding whooping cranes were associated with other bird species in 31.7% of records (97 of 306). They most commonly were associated with sandhill cranes (94.8% of the 97 records) but also were observed in association with geese (4.1%; identified as snow geese, Canada geese, or simply geese), and with ducks, American white pelicans, swans (*Cygnus* spp.), and great blue herons (*Ardea herodias*) (1 record each). Spring associations with sandhill cranes (n = 49) were primarily on and around the Platte River (n = 26) and Rainwater Basin (n = 6), but in fall whooping cranes were found with sandhill cranes in a wide variety of areas. Whooping cranes were observed with geese in seasonally flooded basins and/or cropland on 2 sites in North Dakota (McLean and Divide counties), 1 in South Dakota (Pennington County), and 1 in Nebraska (Gleason WPA).

We compared habitat types for records where whooping cranes were feeding in association with sandhill cranes and those unassociated with sandhills cranes. Differences were not large, but suggested that whooping cranes associated with sandhill cranes had somewhat lower use of seasonally-flooded wetlands (14.3% vs. 21.5%) and upland cover (8.8% vs. 11.2%), higher use of permanent wetlands (15.0% vs. 9.9%), and higher use of cropland (82.4% vs. 71.5%) than whooping cranes not associated with sandhill cranes.

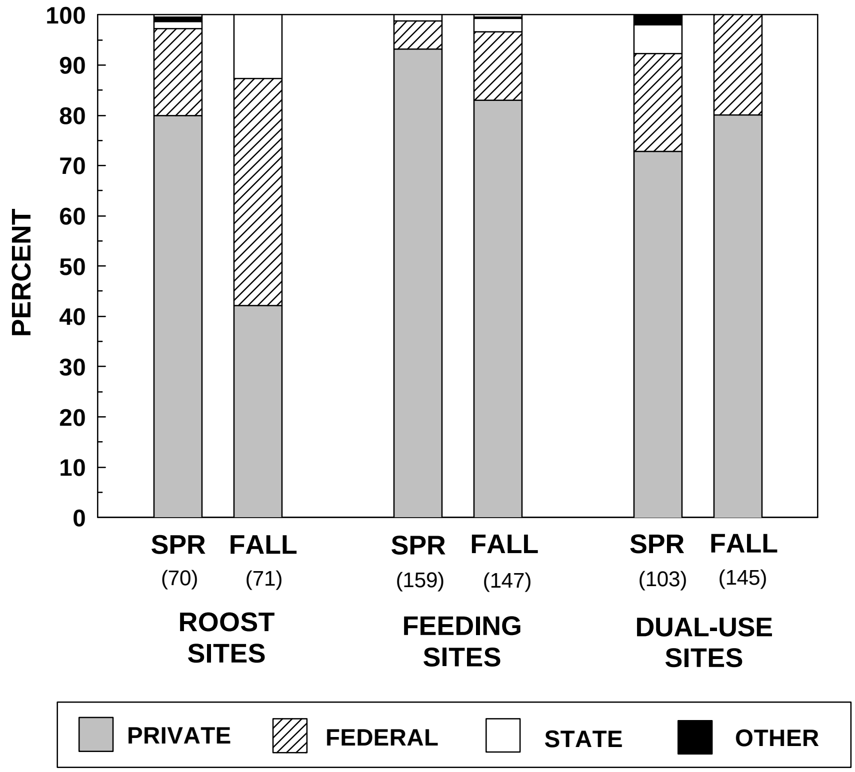
Dual-use Sites: Whooping cranes were associated with other bird species in 24.2% of dual-use site records (60 of 248). They were most commonly associated with sandhill cranes (85.0%) but also were observed in association with geese (8.3%; included snow geese and Canada geese), American white pelicans (6.5%), great blue herons (3.3%), ducks (3.3%), and swans (1.6%). Spring associations with sandhill cranes occurred on palustrine (n = 10), riverine (n = 6), and upland sites (n = 2). In fall, whooping cranes were most often found with sandhill cranes on palustrine sites (23) and occasionally on lacustrine (n = 3), riverine (n = 3), and upland (n = 2) sites. Whooping cranes were observed with white-fronted geese (*Anser albifrons*) at Medicine Lake NWR, Montana; Canada geese and snow geese in North Dakota (Lake Arena WPA and Divide Co.); and unspecified geese species in Nebraska (Gleason WPA).

We compared habitat types for dual-use site records associated with sandhill cranes and those unassociated with sandhill cranes. For dual-use sites, whooping cranes associated with sandhill cranes had lower use of seasonally flooded areas (17.6% vs. 35.6%) and permanent water areas (43.1% vs. 60.1%) but higher use of cropland (45.0% vs. 19.2%) than whooping cranes not associated with sandhill cranes; use of upland cover was similar (7.8% and 5.0%).

Site Ownership

Private ownership accounted for >60% of sites used by whooping cranes, followed by federal ownership (Figure 28). More than 80% of feeding sites were on private land, reflecting the high use of crop fields. Federal ownership accounted for most ownership of roost sites. Seasonal differences were apparent but are probably due to the seasonal dominance of observations for some areas, such as the large number of observations on federal refuges in Kansas and Oklahoma in fall but not in spring.

Figure 28. Percent of sites in private, federal, state, or other ownership, by season and site use, 1977-99.



A number of feeding site records indicated multiple ownership (e.g., federal and The Nature Conservancy, federal and private, federal and state). These were situations where the observed crane(s) moved from a tract of land under 1 ownership to a second under a different ownership (W. Jobman, personal communication). See State Summaries for details within each state.

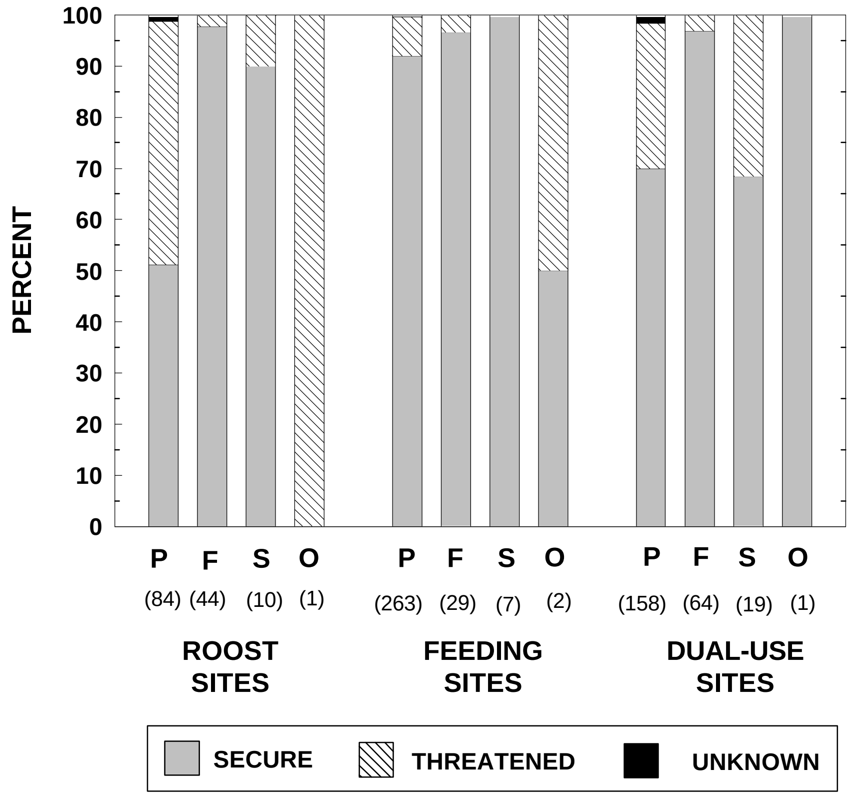
Site Security

Roost Sites: Most roost sites were considered secure, but nearly one-third were considered threatened. More than 90% of roost sites that were under federal or state ownership were considered secure whereas security of roosts on private lands was evenly split between secure and threatened (Figure 29). A higher proportion of roost sites in fall were considered secure than those used in spring (83 vs. 53%; n = 139); this likely is related to the more frequent sightings of cranes on national wildlife refuges in Kansas and Oklahoma in fall.

Feeding Sites: Few feeding sites were considered threatened, although most occurred on private lands (Figure 29). There were no seasonal differences in site security of feeding sites (94% in fall vs. 91% in spring; n = 301).

Dual-use Sites: Overall, >75% of sites used for both roosting and feeding were considered secure. Almost all federally-owned sites were considered secure but 28–32% of privately- and state-owned sites were considered threatened (Figure 29). A higher proportion of sites were considered secure in fall than in spring (82 vs. 69%; n = 242).

Figure 29. Percent of sites considered secure, threatened, or of unknown security that were in private (P), federal (F), state (S) or other (O) owernship, by site use.



Development of Permanent Database and Query System in Access Software

The corrected SAS database, which included all observation and site evaluation records, was exported to Excel, error-checked once again for identification number problems (minor details corrected), then imported to Access software. Data fields were grouped into tables on the basis of subject, and various tables and queries were created to automate data summarization. We developed a number of tables, grouping variables by subjects of likely interest, and created queries so that users could readily seek specific information. Tables developed included:

- Basic sighting information, by year, state, season, site evaluation (yes/no)
- Legal descriptions of evaluation locations; if no site evaluation was conducted, then the location of the observation was given (to allow examination of frequent use or use of specific areas)
- Legal description of observation locations (to allow examination of frequent use or use of specific areas; location may differ from site evaluation location)
- Number of adults, juveniles, and total birds
- Dates of observation for observations and site evaluations

- Number of whooping cranes at each site (based on site identification number, or observation number)
- Descriptive habitat information, by site (based on site identification number)
- Wetland data, with subtable on emergent vegetation types
- Habitat data: separate tables for roost site habitat, feeding habitat, and adjacent habitat descriptions
- Potential foods and foods observed eaten by whooping cranes
- Species observed with whooping cranes and miscellaneous notes on observation
- Legal descriptions of locations: separate tables for observations and site evaluations
- Area names (descriptions) of locations in observations
- Color and USFWS band data [Note: these variables were not error-checked]

Over 50 specific queries were developed to allow users of the Access database to address specific questions of interest. The queries allow variables within each table to be summarized by desired variables, e.g,. by state, year, and/or season. Results are equivalent to those presented in this report but the queries allow users to examine the data for their particular state or for particular years of interest. This database is provided to the U.S. Fish and Wildlife Service and Nebraska Game and Parks Commission as part of this report.

DISCUSSION

To date, most information gained about migrating whooping cranes has been derived from non-standardized, incidental observations, such as those occurring in the 2 databases used here. Observational data can be biased by a number of factors. Because confirmed whooping crane sightings consist of a chance observation made by a variety of constituents (i.e., farmers, ranchers, rural mail carriers, and biologists) and documented by a knowledgeable observer, the sightings database can be biased by the detectability of whooping cranes in different habitats and regions in the flyway and the availability of a knowledgeable observer in the region. For example, whooping cranes that stop in an area with a higher density of farmers and ranchers (e.g., loess region of Nebraska) are more likely to be detected than cranes that stop in less populated ranching areas like the Nebraska Sandhills region. Compared to other places in the flyway, whooping cranes may be more commonly reported on refuges, state management lands, or other conservation areas because biologists are actively looking for birds or are more available for confirmation of citizen-reported sightings. Level of interest and effort also may vary among states. For example, the numerous papers published in *Nebraska Bird Review* and proceedings of crane workshops indicate that biologists in Nebraska have long had a strong interest in recording whooping crane occurrences. Seasonal and yearly biases in observation data also exist. For example, many fall sightings for North Dakota are reported by hunters (S. Kohn, North Dakota Game and Fish Department, Bismarck, ND, personal communication); areas and habitats frequented by hunters likely differ from those frequented by farmers. As areas have become known over the years as whooping crane "use areas," observers have focused increased attention to these regions for further sightings. Landscape patterns also may influence detectability. For example, farmers tend to spend more time monitoring their croplands than wetlands, hence increasing the probability of seeing cranes in crop areas. Furthermore, visibility of areas used by whooping cranes may be obstructed (e.g., heavily forested river edges vs. open reaches, hills that isolate wetland areas from roads). Such spatial and temporal factors will influence the detection of whooping cranes and therefore will bias the data so that particular regions and habitat types may be over- or under represented relative to actual use by migrants. Therefore, these observational data are not appropriate for use in assessing habitat preferences or to address questions such as whether cranes shifted their distribution or habitat use during drought years. Objective evaluation of whooping crane distribution or habitat use patterns, such as determining preferential use of wetland types or feeding habitats, would require targeted studies, preferably using marked or radio-marked cranes.

Although the whooping crane database was collected in a manner that precludes statistical analyses and limits interpretation, it is important to recognize that investigations of any species' habitat use, especially during migration, are subject to many difficulties. Biases associated with detectability and survey effort commonly are discussed in literature relating to monitoring and research. Unlike nesting birds, migrants usually are present in an area for only a short time, and the timing of that occurrence may differ from year to year, depending on abiotic and biotic conditions on their breeding, wintering, or migration areas. For a species with a small population like the whooping crane, it often is very difficult to gather a suitable sample size over a reasonable area of study because migrants often are difficult to locate and occur in small numbers. Solitary or non-gregarious species, such as whooping cranes, are less likely to be detected than large flocks of migrants (i.e., geese, sandhill cranes). Considering the extent of the whooping crane's migration path relative to their non-gregarious nature, the species' sensitivity to human presence, and its small population size, it is easy to understand the difficulty in obtaining a sample size large enough for use in inferential analyses.

It is advantageous that the whooping crane sightings database was collected over a long time period and large geographic region, therefore creating a relatively robust sample size. To date, it is the most inclusive collection of information on general migration patterns of wild, naturally-occurring whooping cranes. The cooperative monitoring program provided a cost-effective method for collecting flyway-wide data, in a manner that was minimally intrusive to whooping cranes. In the discussion below, we consider the research value and limitations of the sightings database that was collected during 1943–99.

Many of the results presented here concur with earlier findings about whooping crane migration. The flyway used by whooping cranes migrating from Aransas NWR through North Dakota is more clearly defined by overlaying 57 years of data, but it remains essentially similar to that outlined by Allen (1952), Johnson and Temple (1980), Armbruster (1990), and in the current recovery plan (U.S. Fish and Wildlife Service 1994). This distribution largely correspond to Allen's (1952:2) grama grass–antelope biome. The apparent association of the migration path with rivers, particularly along the Missouri River in the Dakotas, supports the idea that whooping crane movements during migration are at least partly directed by recognition of landscape features such as stream and wetland mosaics (Gill 1990). The migration path defined from tracking radio-marked cranes (Kuyt 1992: Figure 9) is generally similar to that described here but it did not include locations in North and South Dakota east of the Missouri River or portions of the Platte River or Rainwater Basin east of Kearney, Nebraska as found in the present study. There does not appear to have been any shifts in the spring or fall migration route over the 57 years of data. However, these comparisons were limited by the relatively few observations during the earlier period (1943–74), prior to changes in habitat related to more recent dam building and conversion of grasslands to cropland. Timing of spring and fall migrations also appears similar to that first described by Allen (1952), and no changes in the timing of migration are apparent.

Early studies describing roost sites were generally limited to riverine sites (Aronson and Ellis 1979; Shoemaker et al. 1982; Lingle et al. 1984, 1986), especially along the Platte River and other Nebraska sites. Studies of broader geographical scope have consistently demonstrated the significance of palustrine wetlands for roosting and foraging habitat (Howe 1987, Johns et al. 1997, Richert 1999, this study). The present study showed that riverine roost sites were common only in Nebraska, primarily on the Platte, Niobrara, Middle Loup, and North Loup rivers. The higher use of riverine roosts in Nebraska may be related to the relatively unique geomorphic characteristics of rivers there, which include shallow, relatively slow-moving channel flows and sand bars with little vegetative cover. The other 2 studies examining flyway-wide habitat use also reported high use of palustrine wetlands. Radio-marked cranes roosted primarily on palustrine wetlands in most areas, and only 2 sites used by cranes in the United States were described as riverine (Howe 1987). In Saskatchewan, 84% of observational records were on palustrine wetlands (Johns et al. 1997). In our study, palustrine wetlands were used by all social groups of whooping cranes for both roosting and feeding. However, most of the whooping cranes found on riverine roosts were single cranes or nonfamily groups, particularly on the Platte, although social groups did not differ on feeding or dual-use sites. Richert (1999), using a subset of these data for Nebraska to assess habitat use at various landscape scales, noted that nonfamily groups were primarily the social groups associated with the Rainwater Basin and Platte River areas whereas family groups were more commonly associated with the Table Playa area in Custer County, Nebraska. This area contained a much larger proportion of grassland at both local and landscape scales than did the Rainwater Basin or Platte River areas. Further investigation of other regions of the flyway is needed to determine whether grassland is an important landscape feature for use by family groups.

Most palustrine wetlands used for roosting were defined as seasonal or semipermanent wetlands; feeding sites also included many temporary palustrine wetlands. Howe (1987) reported radio-marked cranes used intermittently-exposed and semipermanent wetlands more than any other regimes for both feeding and roosting; temporarily-flooded wetlands often were used in fall. In Saskatchewan, migrant cranes were most frequently observed on seasonal and temporary wetlands in spring and on semipermanent and permanent wetlands in fall (Johns et al. 1997). Differences among areas, years, or studies likely were affected at least in part by availability of wetland regimes, in response to climate variation on seasonal and yearly basis. Differences found in whooping crane habitat use among states or regions in this study also may reflect differences in how the information on wetland classification was obtained. Based on discussions with W. Jobman, S. Kohn, and other biologists who provided information, it is apparent that the derivation of wetland classification data varied. Most of the Nebraska wetland classification data, particularly for records after the early 1980s when NWI maps became readily available, were derived from the information directly on NWI maps, which were frequently used to map crane locations. In such cases, class and modifiers (water regime) appear to be derived from the map polygon rather than from the deepest water regime mapped for that wetland basin or from field observations. Biologists in other states, however, seemed to have relied primarily on field observations to report wetland class data, and reported water regime where the most permanent water regime applied to the entire basin. Although this would not affect wetland system (lacustrine, palustrine, riverine), it probably did affect whether subclass and class were recorded, and how water regime was characterized. We caution that observers should not rely on NWI maps because 1) some errors do exist in the original NWI maps, 2) NWI maps are now >10 years old, and 3) wetland characteristics – particularly regime – may have changed (e.g., additional drainage efforts, change in water regime due to prolonged drought or flooding). We recommend water regime instead be determined using judgement in the field at the time of observation, based on the deepest regime of the entire wetland.

Whooping cranes were observed on a wide range of wetland sizes in both spring and fall. We found no real pattern of use by social groups among the different sizes of wetlands. Cranes often were observed roosting on large managed wetlands (e.g., moist-soil units, impoundments) on state or federal lands in fall, but large lakes and natural wetlands also were used in both seasons. Radio-tracked cranes (Howe 1987) also were located on a range of wetland sizes, but over 50% were located on wetlands $\leq$1 ha. Unfortunately, wetland sizes were not consistently recorded for all wetland sites in that study (Armbruster 1990:9). Although there was no consistent pattern suggesting cranes usually used smaller wetlands for feeding sites, dual-use sites usually were small (<2 ha) wetlands; the latter might reflect lack of availability of larger wetlands for roosting in those areas. Investigation of wetland densities and size classes available around sites, using archival remote sensing data, could reveal a clearer picture of site-use patterns.

Water depths were recorded for either the entire wetland used during a stopover or for the coordinate location within the wetland where the cranes had been observed roosting or foraging. Unfortunately, there were no records where both were recorded. The significance of shallow water sites for both whooping and sandhill cranes was discussed by Armbruster (1990:8). Average water depths at specific sites within roost wetlands and feeding wetlands were similar to those reported earlier (Lingle et al. 1984, 1986; Howe 1987; Ward and Anderson 1987; Johns et al. 1997) but toward the high end of Johnson and Temple's (1980) optimum water depth of 7.6–20.3 cm (2.2–8.0 inches).

Results of this study also concur with previous findings that cranes usually were associated with sites having scattered or no vegetation (Johnson and Temple 1980, Howe 1987, Johns et al. 1997). Riverine roost sites and dual-use sites were consistent in their lack of vegetation but feeding sites tended to have more vegetation. Most of the commonly occurring vegetative types were of low stature and thus would not likely obstruct visibility for cranes. Unfortunately, willow, which is of interest relative to island management on the Platte River, was not a defined category, so we are unable to evaluate presence or distribution of willow in these data except for a few scattered occurrences when willow was specifically denoted under "other" vegetation.

Whooping cranes appear similar to sandhill cranes in their frequent use of cropland for feeding, particularly corn and wheat stubble (Howe 1987, Johns et al. 1997, this study). However, data from dual-use sites indicated that wetlands may provide important feeding areas for some whooping cranes. Howe (1987) did not distinguish between feeding-only and dual-use sites for radio-marked whooping cranes. He noted that the importance of cropland for feeding-only sites was likely higher than the 42% he reported because many feeding sites were actually categorized as roost sites. That is consistent with the frequent use of permanent or seasonally-flooded wetlands for dual-use sites in this study. The similarity of results between roost and dual-use sites in this study suggest the 2 site uses could be merged for this database. However, we suspect closer examination of sites (i.e., longer observations to verify roost-only or roost-and-feeding activity) may reveal important differences between sites used exclusively for roosting and those used for both feeding and roosting.

We cannot assess the relative value of cropland, wetland, or grassland habitats for foraging cranes with these data because we lack any measure of total time spent feeding in each habitat type. We also do not have adequate data on available habitats around each site. Foraging strategies likely vary depending on season (nutritional needs of cranes, seasonal availability of food), juxtaposition of roost and feeding habitats, availability of habitats, and availability of suitable foods. A more definitive evaluation of the relative use and value of cropland, wetland, and grassland habitats would require a study of color- or radio-marked cranes combined with time-activity budgets, similar to that conducted by Howe (1987) or Lingle et al. (1991). In the latter study, which was conducted in south-central Nebraska, diurnal habitat use was nearly evenly divided between upland and wetland habitats: 37% of bird-hours were on corn stubble, 18% on tilled wetlands, and 17% on natural wetlands. It would be interesting to conduct comparative studies elsewhere in the flyway, particularly in areas with varying proportions of cropland and native habitats. Further examination of the site evaluation data set using GIS also could provide some additional insights into availability of wetland, grassland, or upland habitats relative to site use.

Distance to feeding sites varied with roost type. Palustrine roosts usually were within 0.8 km of feeding sites, as also was reported by Howe (1987). Riverine roost sites, however, tended to be farther from feeding sites. Distances were recorded as categories rather than as a continuous variable, and thus we lack actual maximum distances between roost and feeding sites. Distances between roosts and feeding sites will be influenced by the availability of habitats and foods (e.g., Frederick et al. 1987). On the Platte River, changes in habitat and food availability over time may have increased distances between frequently-used roosts and feeding sites. G. Krapu (Northern Prairie Wildlife Research Center, Jamestown, ND, personal communication) has documented that sandhill cranes roosting on the Platte River in the late 1990s fly longer distances to forage in corn fields than they did 20 years previously; he relates this directly to reduced corn availability in the fields due to improved harvest efficiencies. Palustrine wetlands in the Great Plains often are surrounded by croplands (e.g., Richert 1999, this study). Johns et al. (1997) suggested areas of relatively high wetland density may attract cranes, in particular family groups. We recommend using remote sensing and GIS techniques, similar to the work conducted by Richert (1999) for Nebraska, to examine availability and juxtaposition of habitats relative to roost and feeding sites elsewhere in the flyway.

Horizontal visibility (i.e., having unobstructed view at the level of a crane's head [1.4 m]) has long been considered an important aspect defining optimum and secure habitat for whooping cranes (Shenk and Armbruster 1986, Armbruster 1990). Nearly half of the roost sites and two-thirds of feeding sites, however, were defined as having visibility <0.4 km. These distances are within the range given for sandhill cranes on roosts surrounded by vegetation (140 m) or visible from a road (380 m) (Lovvorn and Kirkpatrick 1981). They suggested that sandhill cranes avoid disturbance by maximizing either distance to human development or visual isolation from human activities. This bears further examination for whooping crane migration habitat, particularly for application to habitat management and interpretive development (e.g., placement and management of crane viewing sites). However, such relationships cannot be adequately examined using the site evaluation database. The scale of measures used here were categorical and relatively coarse (smallest distance to human development was 0.40 km). Over 80% of the sites were within 0.8 km of some human development; this distribution may reflect a relatively high intensity of human development (most likely section roads) and associated human activity, or it may reflect detectability of cranes. For testing an interaction between visibility and distances, however, a better sample size of long distances would be needed. In addition, the type of human development was not defined in the site evaluation database, although it was in the Nebraska forms (Report 6). Cranes' perception and reactions to, or avoidance of, disturbances likely include a combination of factors such as frequency (e.g,. number of vehicles passing per hour), noise level, lighting at night, distance to disturbance source, and visibility of the disturbance and surrounding habitat, and in certain areas also may be influenced by the cranes' habituation to disturbances. More detailed examination of types of disturbances or human developments and their relationship to visibility would be valuable. A study combining surveys and behavioral observations, such as used in Europe to examine effects of disturbances to field-feeding geese (e.g., van der Zande et al. 1980), would be feasible on the Platte River and other areas of concern.

Whooping cranes are commonly associated with sandhill cranes on both palustrine and riverine wetlands (Johns et al. 1997, this study), but the co-occurrence was most frequent for nonfamily groups on riverine sites, primarily on or around the Platte River in spring. These species likely share some preferences for roost habitat, such as shallow water and open visibility for feeding and roost sites (Lovvorn and Kirkpatrick 1981, Armbruster 1990). Single whooping cranes also may be attracted to sandhill crane flocks because their presence would reflect appropriate habitat and they provide additional sentinels for alerting the birds to danger.

Private lands provide the vast majority of cropland and wetland habitats used by whooping cranes during migration (Howe 1987, Johns et al. 1997, this study). However, whooping cranes have been observed on a wide variety of state and federal lands over the years, and some of these areas have received frequent use by cranes. National wildlife refuges, WPAs, and state lands often provide roost locations (often large, shallow natural or managed wetlands), and cranes forage on adjacent private croplands. Three public areas having many observations over the years already have been designated as critical habitat for the whooping crane (Cheyenne Bottoms SWA, Quivira NWR, and Salt Plains NWR). Whooping cranes appear to obtain much of their food on cropland, much like sandhill cranes (Lovvorn and Kirkpatrick 1981, Howe 1987, Johns et al. 1997, this study; but see Lingle et al. 1991). We did not observe a difference among social groups for feeding habitat types as did Johns et al. (1997).

We are reluctant to interpret the results of site security because the meaning of this variable may vary among some observers. For example, S. Kohn (personal communication) had interpreted this term to infer immediate threat to whooping cranes, including the presence of hunters, human disturbances, or threats from utility lines. W. Jobman, however, interpreted this variable to mean that the particular site was threatened with degradation (e.g., drainage, cultivation of wetland or upland habitat). Interestingly, most feeding sites, which largely were composed of private cropland, were considered secure. Although availability of croplands is unlikely to seriously decline in the Great Plains in the foreseeable future, the future quality and security of wetlands used for feeding or roosting are much less clear. Continued loss and degradation of wetlands in intensively-cropped areas of the Great Plains may reduce availability of natural foods and secure roost sites to migrant cranes.

Although these results provide additional insight to distribution and habitat use of whooping cranes during migration, they cannot be used to predict the most suitable habitat for whooping cranes in the proposed Wisconsin−Florida flyway because 1) the data cannot provide an unbiased representation, and 2) most wetland and upland habitats types, and patterns of habitat patches, within the proposed flyway corridor are different from those in the Aransas-Wood Buffalo flyway. As indicated in Richert (1999), conclusions about habitat use are specific to the place of study or to environments with similar habitat composition and landscape pattern. However, trends in habitat use, as found in previous studies and the current investigation, should be considered by those planning the new flyway. For example, studies have consistently found that palustrine wetlands are important for roosting and croplands for feeding. It is likely that these same habitat types will be important to cranes in the new flyway. Although spatial patterns of social groups during migration are difficult to pinpoint, current information suggests there are some differences. Therefore, planners of the new flyway should be attuned to possible differences in habitat needs by different social groups.

Other biologists have stated the need to better understand habitat selection of migratory species (Lingle et al. 1991, Askins 2000), and interests in studies of migration ecology have increased since the application of remote sensing and GIS has become more prevalent within wildlife research (Butler et al. 1995, Farmer and Parent 1997). Further work on whooping crane migration would not only increase the knowledge base about this species but also would contribute to information about migration in general. The works of Lingle et al. (1991), Armbruster (1990), and Richert (1999) suggest that patterns of habitat selection involve recognition of landscape components. Mapped information from observation data also suggests that habitat selection is influenced by landscape structure. For example, North Dakota data suggest a relationship between whooping crane stopovers and the path of the Missouri River and geomorphic features of the Missouri Coteau. We recommend further work using remotely-sensed data and other digital databases, such as the NWI and various data layers created for state GAP analyses, to better understand general migration patterns and to investigate relationships between whooping crane sighting locations and landscape features.

RECOMMENDATIONS

General

Although the data are observational only, and cannot provide unbiased information on habitat use by whooping cranes, there is some merit in continuing to collect data on incidental sightings of whooping cranes during migration, and to collect some specific habitat information at those locations. One example of the data's value is the recent use of whooping crane locations and dates of occurrence by flyway biologists to examine possible conflicts between the snow goose conservation action with migrating whooping cranes. Continuation of data collection, with periodic reviews, will likely provide insights into areas used by migrant whooping cranes and possible shifts in stopover areas. However, we strongly recommend that future data collection efforts be carefully considered and designed to reduce the biases inherent in observational data. The main database probably always will have inherent biases because of unequal observation effort among regions or years, and this needs to be recognized at all times. However, states or regions within states could be targeted for more objective data collection. Areas of particular interest could be targeted to systematically survey for whooping cranes and to document their use-days and habitat use. With appropriate design, such surveys could address questions about effects of habitat condition (e.g., occurrence or use-days of whooping cranes during drought periods) or management (e.g,. moist-soil management or other water management efforts). Caution must be exercised, however, in interpreting data; information collected in 1 area cannot be assumed to apply to other, unsurveyed areas.

The current system of data collection and entry needs to be thoroughly reviewed and revised, mainly to improve efficiency of translating field observations into an electronic records and to simplify field observations. The current system evolved over several decades which included the advent of personal computers and changing ideas about database management and what should be recorded. We believe simplifying the information recorded in the field would enhance the participation of observers by making the task more attractive and requiring less time. But coordinators of such a database also must develop incentives to encourage more participation to contribute both confirmed sightings and habitat data, especially in states or areas within states where there appear to be gaps. For example, local wildlife area managers, active birders, or interested ranchers in more remote regions (e.g., Nebraska Sandhills region, southwestern North Dakota) could be encouraged to participate through educational efforts and improved communication.

Although data sheets for observers in the field can be simplified, especially in terms of the habitat information collected, it also is important to tighten up the protocol for data collection and the definitions so that the data collected are more consistent and more accurate across observers and states. We recommend that the USFWS engage an experienced biologist to simultaneously develop the new database and to more carefully define categories, protocol, and possibly survey designs. The new database should be fully compatible with the existing database but also designed for more efficient data entry and management. If specific states or organizations decide to collect information beyond that in the USFWS efforts, it will be important to coordinate with those groups for consistency in protocol and data sharing.

From our experience working with the current data, we provide below some recommendations on both general data collection and management aspects and on the various variables recorded. The recommended changes made below should be carefully considered and discussed with biologists/observers from different states before implementation. One should consider what whooping cranes encounter in their migration range and what is of real significance (e.g., is it important to differentiate between use of green rye vs. green spring wheat). Also, these measures of "use" must be broad enough to encompass the entire flyway with some consistency and with some biological value. More specific examination of habitat use (e.g., use of CRP vs. alfalfa) should be the focus of targeted studies that will have more intensive measures of use and availability.

Specific Recommendations:

1. Continue to have 1 person or office responsible for data collation, entry, and periodic review or summation. This person would maintain paper records and the central electronic database, as well as inform and coordinate with biologists or other observers in each state. Ideally, this person or office should be with USFWS, which is charged with the management and protection of this endangered species.

2. Combine variables currently used in the Observation and Site Evaluation databases into a single data reporting form and data set. This would allow for more direct linking of variables and minimize errors between data sets. One could still have multiple sub-observations and site locations within 1 main observation, but have a specific category indicating which records have site evaluation variables recorded. Such a data reporting form would have 2 sections, 1 for basic observation information (as currently recorded in Observations) and a separate section for site evaluation data. See recommendations below for specific suggestions on changes to both sections.

3. Use numeric observation and location codes, as we created here, to identify unique records and to allow for easy extraction of information. Continue current system of sequential numbering of main and sub-observations reported.

4. Develop data collection protocol for cooperators and the data manager, including clear, concise definitions of each variable and instructions on how to complete the data form in the field. Biologists or key observers from all states should be consulted during development of the protocol to ensure clarity, consistency, and simplicity, and to circumvent possible differences in interpretation of requested information.

5. Maintain a paper copy of each submitted, confirmed observation, even if the report is submitted by phone or e-mail. The main value of paper copies is for map locations (see below), data proofing, and potential source of miscellaneous comments that might not fit into the data structure.

6. For all confirmed observations, require field observers to plot observations clearly on a county or township-scale map which shows township, range, and section information; locations should be clearly marked and, if multiple observations occur, clearly labeled. This will allow the data manager to readily proof and enter the legal description data with minimal error and effort. Other maps sources, such as NWI maps, soil maps, NRCS crop photographs, or other pertinent types of maps, may be desirable but should be considered as supplemental. These maps should be maintained in the file with any paper copies of all confirmed observations.

7. Maintain the database in Access. We assume this database software will remain a standard of the Department of Interior and many states for some time and that this format will be readily convertible to other software systems. Data entry in Access can be structured to provide pull-down menus, numeric-limited entry, or other constraints or options to ensure high quality of data entered.

8. Summarize data annually and provide a state and national summary to participating states and key observers to reward and encourage their continued participation. As part of this, convert legal descriptions to Albers equal area projection in order to plot locations. Such reports also may provide an opportunity for cooperators to note possible errors or areas of concern.

9. Develop well-defined seasons based on biological factors. The current determination of fall versus winter seasons seems somewhat arbitrary and more driven by location than date. Currently, observations of cranes in or near Aransas NWR and those of marked birds that previously had been sighted that fall/winter in Aransas NWR are classified as winter. Thus, a crane observed in Aransas NWR in mid-November is classified as winter whereas another crane observed in central Texas in mid- to late December would be classified as fall. Further, unmarked cranes may not stay near Aransas NWR, but any December observations elsewhere would be classified as fall since no additional information was available. Although this approach may seem appropriate for defining a migrant crane versus 1 that has arrived at its winter location, it allows no flexibility if cranes do not winter at Aransas NWR, or if they subsequently move away from the Aransas area. Similarly, we found some confusion in the original files in classifying spring versus summer records if cranes still were present in the United States after mid-May.

Observation Data Set Variables:

- *Site and location identifier:* As noted above, maintain a system of sequential, numeric codes to identify each unique observation.

- *Location:* Keep a text field (minimum of 60 characters) to allow field observers to describe site locations, in particular in relation to named rivers, public land areas, or lakes. Encourage observers to include such named features where appropriate, and to keep in a consistent format (e.g., spelled or abbreviated consistently) so that one could search within this field for a specific name or feature. For data entry, it may be helpful to include a pull-down menu that includes some of the most common sites (e.g., Cheyenne Bottoms SWA, Medicine Lake NWR, Funk Lagoon WPA).
- *Legal description of location:* Record township, range, section, quarter-section, and quarter-of-quarter section as separate variables or data fields. This will allow easy conversion of location information into x and y coordinates (Albers equal area projection) for plotting or other GIS-related examinations.
- *Map:* Add new variable to indicate whether location(s) are plotted on a map, and to indicate the map type (county/township, NWI, soil, U.S. Department of Agriculture crop map or photograph, public-land area map, other).
- *Observation dates:* Continue to maintain record of the first and last date that cranes were observed on this site. These variables should be defined specifically as a date variable in Access to allow calculations of time or plotting of chronology. Use only in observation component of data set.
- *Time of initial sighting, and time of departure:* Include times of initial sighting and departure of whooping cranes only in observation component of data set; drop from site evaluation component.
- *Markers:* Provide text field of at least 60–80 characters to record presence of color-marked, radio-tagged, or leg-banded birds. Record only in the observation component of the data set.
- *Source:* This variable allows data to be attributed to specific studies (e.g., specific telemetry studies) and could be modified to allow the data manager to assess data by study or by the type of data collection (e.g., records collected via systematic telemetry or observations vs. incidental observations). The current categories should be more clearly defined and, where possible, a citation given (e.g., Howe 1987). The acronym, "USFWS," which is currently used for incidental observations, should be changed to "incidental observations – general" or similar category. New categories could be added as needed. Use only in observation component of data set.
- *Comments:* Add a text field of 100–120 characters to allow for additional comments.

Site Evaluation Data Set Variables:

- *Site use:* Continue differentiating the 4 site uses (roost, feeding, dual-use, and unknown), but provide clear definitions of the types in the protocol.
- *Wetland system:* Follow NWI format and code (e.g., PEMCx for palustrine emergent seasonal – excavated). The subsystem level (littoral and limnetic for lacustrine; tidal, lower and upper perennial, and intermittent; no subsystems for palustrine) probably does not provide useful information for whooping cranes. We strongly recommend that all levels of the wetland classification, in particular water regime and other special modifiers (e.g., salinity modifier, and if wetland is excavated, partially drained, impounded, etc.) be determined for the entire basin (using deepest water regime of the entire basin as the regime) based on observations in the field, at the time of the crane observation, rather than from the NWI map. NWI maps are now more than 15 years old, and some aspects of the wetland characteristics on many have changed since the original mapping (e.g., drainage, long-term flooding resulting in change in water regime), or errors were made in the original classification. Classifying the wetland based on the deepest water regime will better characterize the type of wetlands used; more detailed mapping of the location on NWI maps or other map sources could be used to provide supplemental information on areas within the wetland. We also suggest adding a salinity modifier (see Cowardin et al. 1979:24–25) to provide information that in the past was recorded under water quality. Clarify in the protocol how flooded croplands should be recorded; if the area is truly a wetland and not just sheet water, one could record "tilled" as a special modifier (Cowardin et al. 1979:26)

- *Wetland size:* Use of size classes is most appropriate because field observers rarely have accurate or current information on wetland size. Keep wetland size classes as currently recorded.
- *River width:* Measurement of river width requires additional time and effort in the field, which likely discourages field observers from completing this information. We recommend recording river width by class, similar to wetland size, to encourage more frequent recording of this variable. Classes could be established by examining existing GIS databases for the distribution of riverine widths throughout the migration area, in concert with current knowledge of the pattern of river widths used by cranes for roosting.
- *Water depth:* Obtaining this information in the field takes extra effort and time and often would require permission to enter private property; these problems likely discourage observers from fully completing the data form. In addition, previous records suggest some measures were estimated from a distance whereas others were carefully measured. We believe additional collection of this data for incidental observations will not provide any significant new insights. Therefore, we recommend dropping this variable. This variable could be recorded in a separate, targeted study if deemed significant to the objectives of such a study. If this variable is retained, only maximum depths should be recorded, perhaps as classes, and separate variables should be used to distinguish betweeen water depth of wetland in general and water depth at the site within the wetland where cranes were observed.
- *Water quality:* We believe little further insight would be gained by continuing to collect water quality data, therefore we recommend dropping this variable. This variable would be of most value for specific studies targeting feeding ecology in which other, more detailed habitat information also was collected. Information on whether a wetland was saline (e.g., on Salt Plains NWR) is important to retain but could be more appropriately recorded under wetland classification.
- *Substrate:* Current information on wetland substrate appears adequate unless a specific study seeks to target this variable. Drop this variable in the new database. If this variable is retained, an “unknown” category should be added.
- *Slope of shoreline:* We suspect it is difficult to get consistent field data for shoreline, and it is apparent from the data presented here that cranes rarely use wetlands with steep (>5%) slopes. We recommend dropping this variable, and recording any unique situations where slope is greater than 5% under a comment section.
- *Dominant emergent vegetation:* Allow only 1 category to represent dominant emergent vegetation at the site; add categories such as “mixed” or “cattail/bulrush/sedge” to cover commonly-occurring mixes of interest or common occurrence. Also, add “willow” as category.
- *Distribution of vegetation:* Keep current system to describe distribution of vegetation, but clearly define each category and allow only 1 category for this variable instead of multiple categories.
- *Roost site description:* We found this alternative descriptor of the roost site provided valuable additional information, particularly for error-checking other variables (e.g., if recorded here as flooded cropland, it should not have wetland classification data). It is important to provide careful descriptions of each category to ensure consistency among observers. Record only 1 category for this variable.
- *Feeding site description:* Feeding site description should be simplified from the current listing of multiple habitat crop types to a shorter list of main types (e.g., lump types least encountered under “other”). Add “various types” or similar category to cover situations where the site includes more than one habitat or crop type. Record a single category of habitat type and add separate variable to delineate a single crop type. Provide general categories of habitat or crop types (e.g., “row crop – stubble” and “small-grain crop – stubble”) for situations where an observer either cannot distinguish (e.g., barley vs. wheat) or there may be multiple types within that category. Provide more specific definitions of each category. Also, pool CRP with all planted perennial cover.
- *Primary adjacent habitat within 1.6 km (1 mi):* We are uncertain of the value of information on adjacent habitats. Some streamlined categories or descriptors could be used, depending on the nature of the information desired here. We suggest that examination of surrounding habitat characteristics also could

rely on GIS techniques, which could be conducted periodically (e.g., every 5–10 years). Sources of data layers could include NWI, state GAP analyses for cover types, and possibly Natural Resources Conservation Service for cropland data.

- *Distance to feeding site:* Record only a single distance (the shortest) between feeding site and roost or dual-use sites.
- *Visibility:* Data on visibility in this data set and in earlier, more detailed studies seem to provide adequate characterization of this variable for incidental observations, therefore we suggest dropping this variable in future observational data. However, specific studies that target habitat use or disturbance in greater detail would be valuable for understading how these factors may affect crane habitat use; in such studies, visibility should be carefully defined and examined relative to a suite of other variables.
- *Distance to nearest utility lines:* We are uncertain of the value, from incidental observations, of data on the distance to utility lines. The USFWS data system does not allow distinguishing between rural phone or power lines and more substantial power lines which might provide more serious concerns for cranes, but the Nebraska data forms did distinguish among types (Report Form 6). Are smaller, local telephone or power lines of concern? If only larger, power-distribution lines are of concern, this feature could be examined using GIS (data layers of major utility lines).
- *Distance to nearest human development:* Distance to nearest human development may not have been consistently defined by observers, and thus any continued use needs to be carefully defined in the protocol. It is undefined in the USFWS forms but is recorded in greater detail in the Nebraska forms (Report Form 6). Some GIS data layers could provide some of this information, e.g., for roads, main power lines, and buildings.
- *Primary potential food source, and foods observed eaten by cranes:* Although some interesting observations of actual foods consumed by cranes were recorded, such observations were rare. We recommend dropping both of these variables and recording any observations of foods actually consumed under a comments section.
- *Site security:* The definition or interpretation of site security appeared to vary among observers, from the apparent standard (whether the habitat characteristics of the site could or will be seriously degraded, e.g., wetland drainage) to whether the cranes were immediately threatened by human disturbance, including hunters. We recommend this variable be dropped because of the difficulties of accurately determining potential or real threats to the landscape.
- *Extent of similar habitat within 16 km (10 mi) radius:* Observers provided a crude ranking of extent of similar habitat within 16 km, and we felt the information provided was not very meaningful. We recommend that examination of surrounding habitat characteristics rely instead on GIS techniques, which could be conducted periodically (e.g., every 5–10 years). Sources of data layers could include NWI, state GAP analyses for cover types, and possibly Natural Resources Conservation Service for cropland data.
- *Site ownership:* Record site ownership only as single code rather than 1 to many codes; add a specific category for those sites where cranes were observed on lands under several types of ownership (e.g., state and federal, federal and non-government organization [NGO]). Also, add new category to denote ownership by non-governmental conservation organizations (NGO; e.g., The Nature Conservancy, National Audubon Society).
- *Number of birds:* The recording of the total number of cranes would be unnecessary if observation and site evaluation data are directly linked in a single data form and data set. Total crane numbers could be directly determined from number of adults and number of juveniles. In the observations component of the data set, however, an additional category of “unknown” is needed to more accurately record number of cranes of known and unknown ages.
- *Observation date:* Use for specific date when the site was visited to collect site evaluation data.
- *Photograph taken:* The Grand Island Office of USFWS has a wealth of photographs, including slides, negatives, and prints, which may at some time be of value, e.g., for future reports or studies of

habitat changes at particular locations. Therefore, it may be worthwhile to keep this variable. Photographs could be kept with the paper copies, as they are currently, for easy access.

- *Comments:* Add a text field of 100–120 characters to allow for additional comments specifically related to site evaluation data.

ACKNOWLEDGMENTS

Wallace Jobman, biologist with the Grand Island, Nebraska Office of the U.S. Fish and Wildlife Service, was the primary individual responsible for the long-term development, coordination, and maintenance of these data sets. We commend Mr. Jobman for his dedication and careful work over the years, and we are very grateful for his assistance during this effort. We thank David Carlson (U.S. Fish and Wildlife Service-Grand Island), Michael Fritz (Nebraska Game and Parks Commission), and Kevin Church (University of Nebraska-Lincoln) for their support and for providing funding to summarize these data. Diane Granfors conducted much of the early data-proofing and developed the Access database, tables, and queries. Tom Sklebar (Northern Prairie Wildlife Research Center), and Scott Taylor (Nebraska Game and Parks Commission) provided computer and software assistance. Mele Koneya (GIS specialist at Nebraska Game and Parks) also provided valuable assistance. John Dinan (Nebraska Game and Parks Commission); Craig Davis (Platte River Whooping Crane Maintenance Trust); Thomas Stehn (U.S. Fish and Wildlife Service), and Larry Igl (Northern Prairie Wildlife Research Center) provided comments on an earlier draft of this report. Paul Johnsgard generously provided line drawings for this report. Finally, and most importantly, we thank the many biologists across the flyway who contributed to these data over the years.

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STATE SUMMARIES

Each state summary consists of 5 tables and 5 figures:

Tables

Table 1. Number of site evaluations and total number of confirmed observations of whooping cranes, by 5-year periods, 1942–99.

Table 2. Number of site evaluations, by wetland system, site use, and season, 1977–99.

Table 3. Site ownership (no. observations), by season and site use, 1977–99.

Table 4. List of named rivers, lakes, and reservoirs where whooping cranes were sighted, 1943–99.

Table 5. List of names of federal and state conservation areas where whooping cranes were sighted, 1943–99.

Figures

Figure 1. Distribution of confirmed whooping crane observation in spring and fall, 1943–99, with county boundaries.

Figure 2. Distribution of confirmed whooping crane observations in spring, by social groups, 1943–99, with ecoregions and rivers.

Figure 3. Distribution of confirmed whooping crane observations in fall, by social groups, 1943–99, with ecoregions and rivers.

Figure 4. Distribution of confirmed whooping crane observations for areas of specific interest (select states).

Figure 5. Dates of occurrence in spring and fall, 5-year periods.

KANSAS

Table KS.1. Number of site evaluations and total number of confirmed observations of whooping cranes, by 5-year periods, 1942–99. Includes only single records for each main observation; site evaluations before 1977 are not included.

	No. observations		
Period	**Spring**	**Fall**	***Total***
1943–59	0	0	*0*
1960–64	2	6	*8*
1965–69	2	8	*10*
1970–74	1	20	*21*
1975–79	6 / 8	10 / 14	*16 / 22*
1980–84	8 / 22	17 / 23	*25 / 45*
1985–89	9 / 14	31 / 32	*40 / 46*
1990–94	17 / 19	32 / 49	*49 / 68*
1995–99	0 / 21	0 / 70	*0 / 91*
Overall	*40 / 89*	*90 / 222*	*130 / 311*

Table KS.2. Number of site evaluations, by wetland system, site use, and season, 1977–99.

Site use	**Wetland system**	**Spring**	**Fall**	***Total***
Roost sites	Palustrine	7	19	*26*
	Riverine	0	0	*0*
	Lacustrine	3	2	*5*
	Unknown	0	1	*1*
	N	*10*	*22*	*32*
Feeding sites	Palustrine	1	5	*6*
	Riverine	0	0	*0*
	Lacustrine	0	0	*0*
	Unknown	19	29	*48*
	N	*20*	*34*	*54*
Dual-use sites	Palustrine	14	43	*57*
	Riverine	0	1	*1*
	Lacustrine	0	5	*5*
	Unknown	3	2	*5*
	N	*17*	*51*	*68*

Table KS.3. Number of sites under private, federal, state, or other ownership, by season and site use, 1977–99.

Site use	Site ownership	Spring	Fall	*Total*
Roost sites	Private	4	3	*7*
	Federal	5	9	*14*
	State	1	6	*7*
	Other	0	0	*0*
Feeding sites	Private	16	29	*45*
	Federal	2	4	*6*
	State	1	1	*2*
	Other	0	0	*0*
Dual-use sites	Private	6	17	*23*
	Federal	10	28	*38*
	State	1	7	*8*
	Other	0	0	*0*

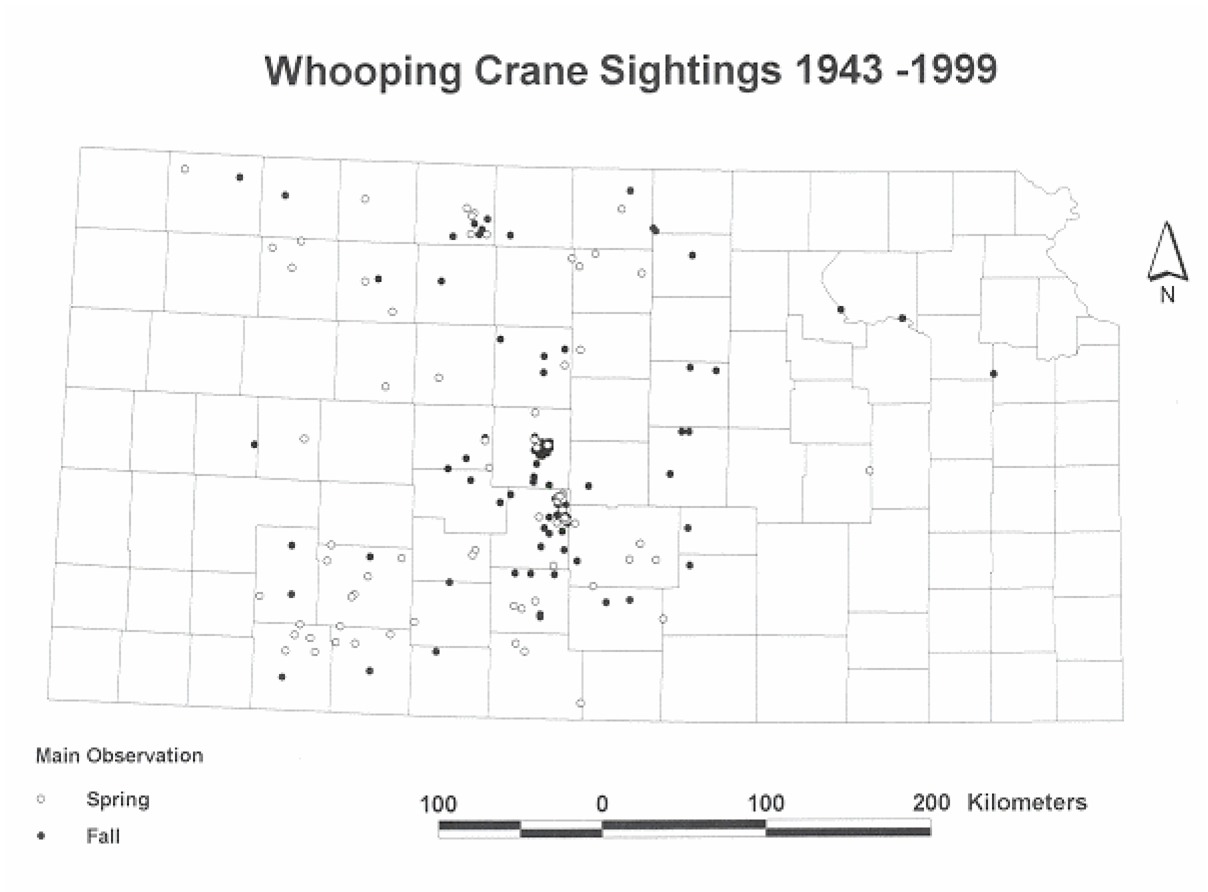
Table KS.4. List of named rivers, lakes, and reservoirs where whooping cranes were sighted, 1943–99.

System	Name	County
River	Kansas River	Wabaunsee
	Hains Lake	Ford
Lake–reservoir	Glen–Elder Reservoir	Mitchell, Osbourne
	Lovewell Reservoir	Jewell
	Hains Lake	Ford
	Webster Reservoir	Rooks
	Wilson Reservoir	Russell

Table KS.5 List of named federal and state conservation areas where whooping cranes were sighted, 1943–99.

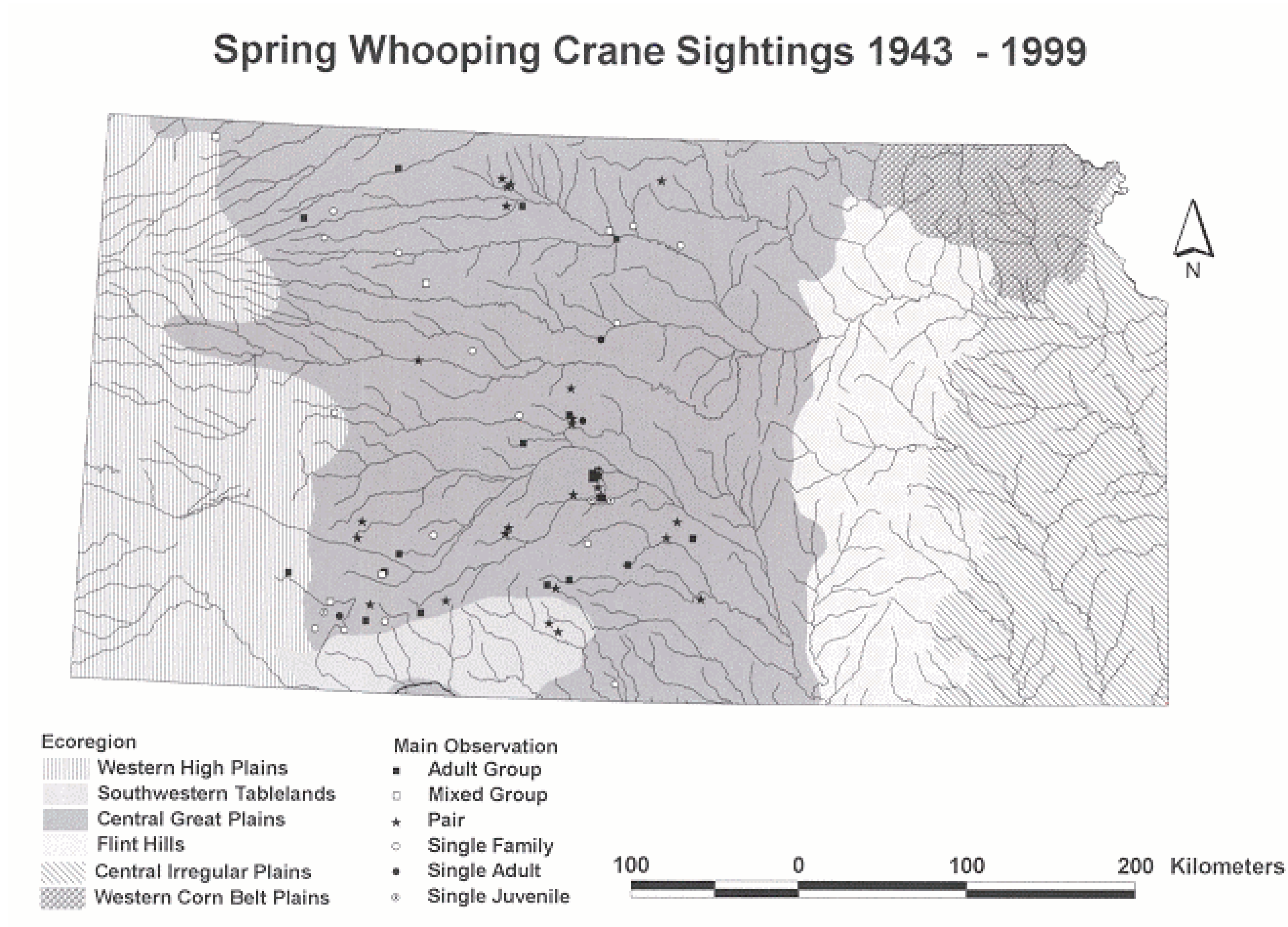
Ownership	Area	County
Federal	Kirwin NWR	Phillips
	Quivira NWR	Stafford
State	Cheyenne Bottoms SWA	Barton
	Clinton Wildlife Area	Douglas
	Jamestown Wildlife Area	Republic
	Norton Reservoir	Norton

KS map 1

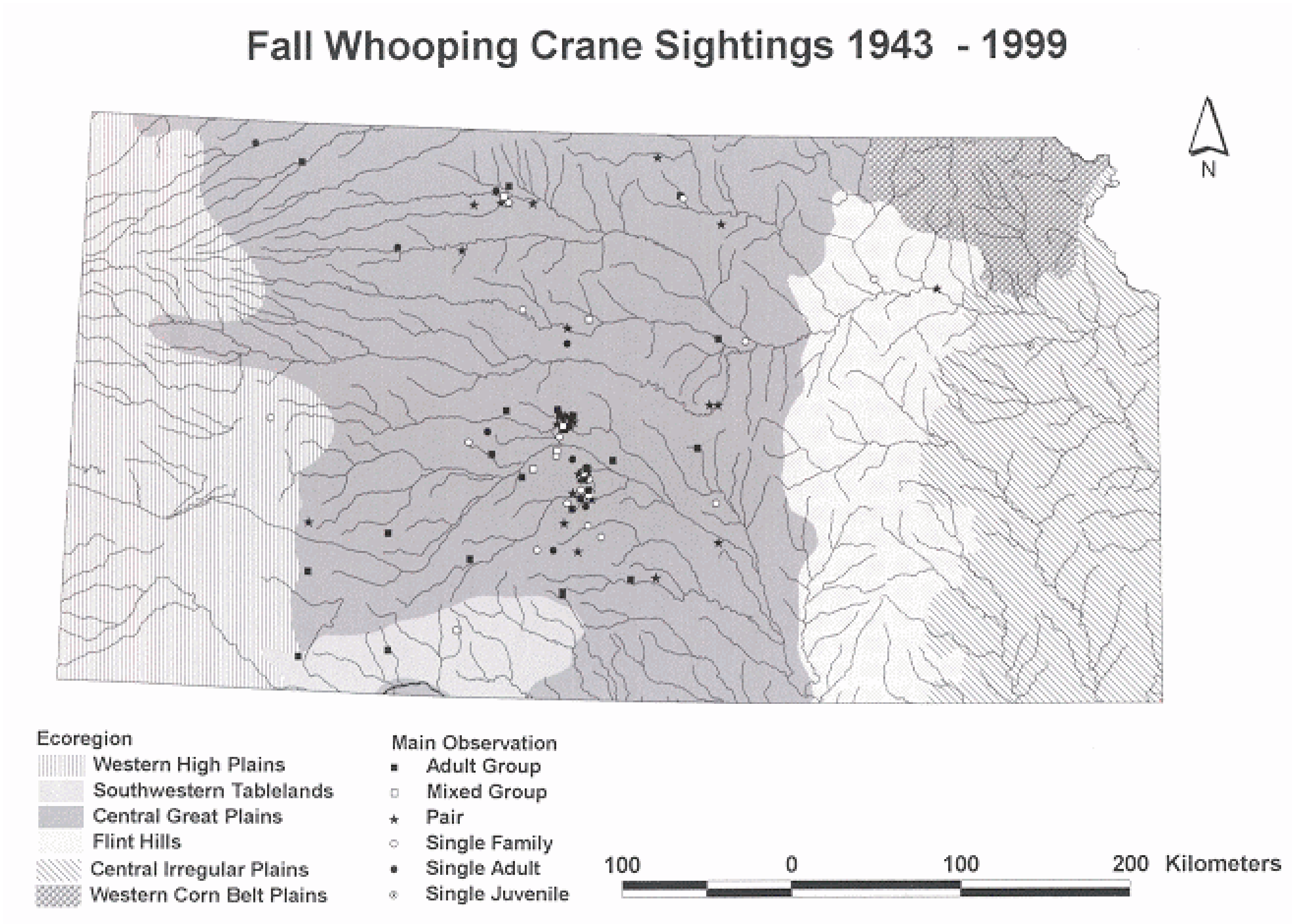


Whooping Crane Sightings 1943 -1999
N
Main Observation
Spring
Fall
100
0
100
200
Kilometers

KS map 2

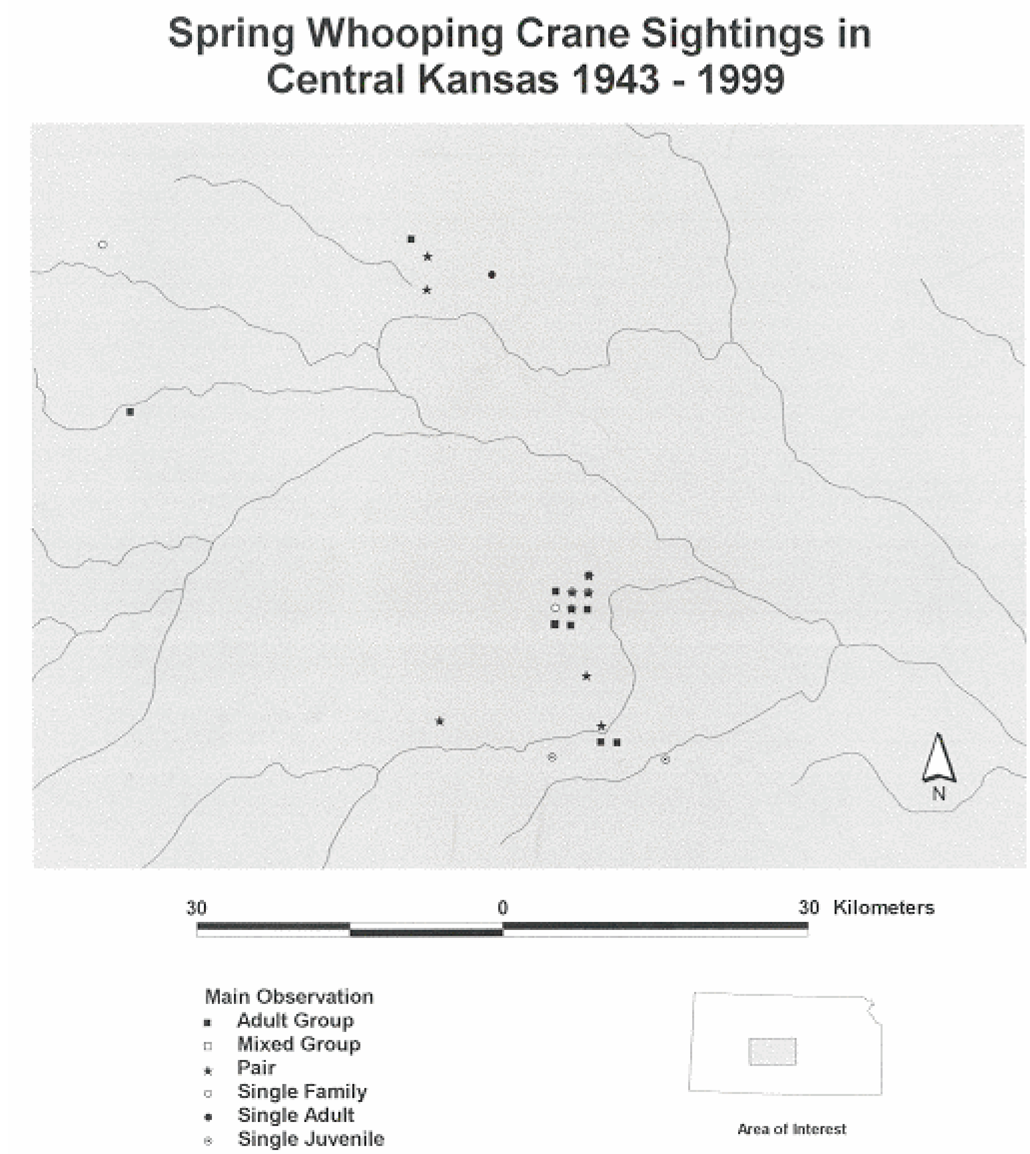

Spring Whooping Crane Sightings 1943 - 1999
N
Ecoregion
Western High Plains
Southwestern Tablelands
Central Great Plains
Flint Hills
Central Irregular Plains
Western Corn Belt Plains
Main Observation
Adult Group
Mixed Group
Pair
Single Family
Single Adult
Single Juvenile
100
0
100
200
Kilometers

KS map 3



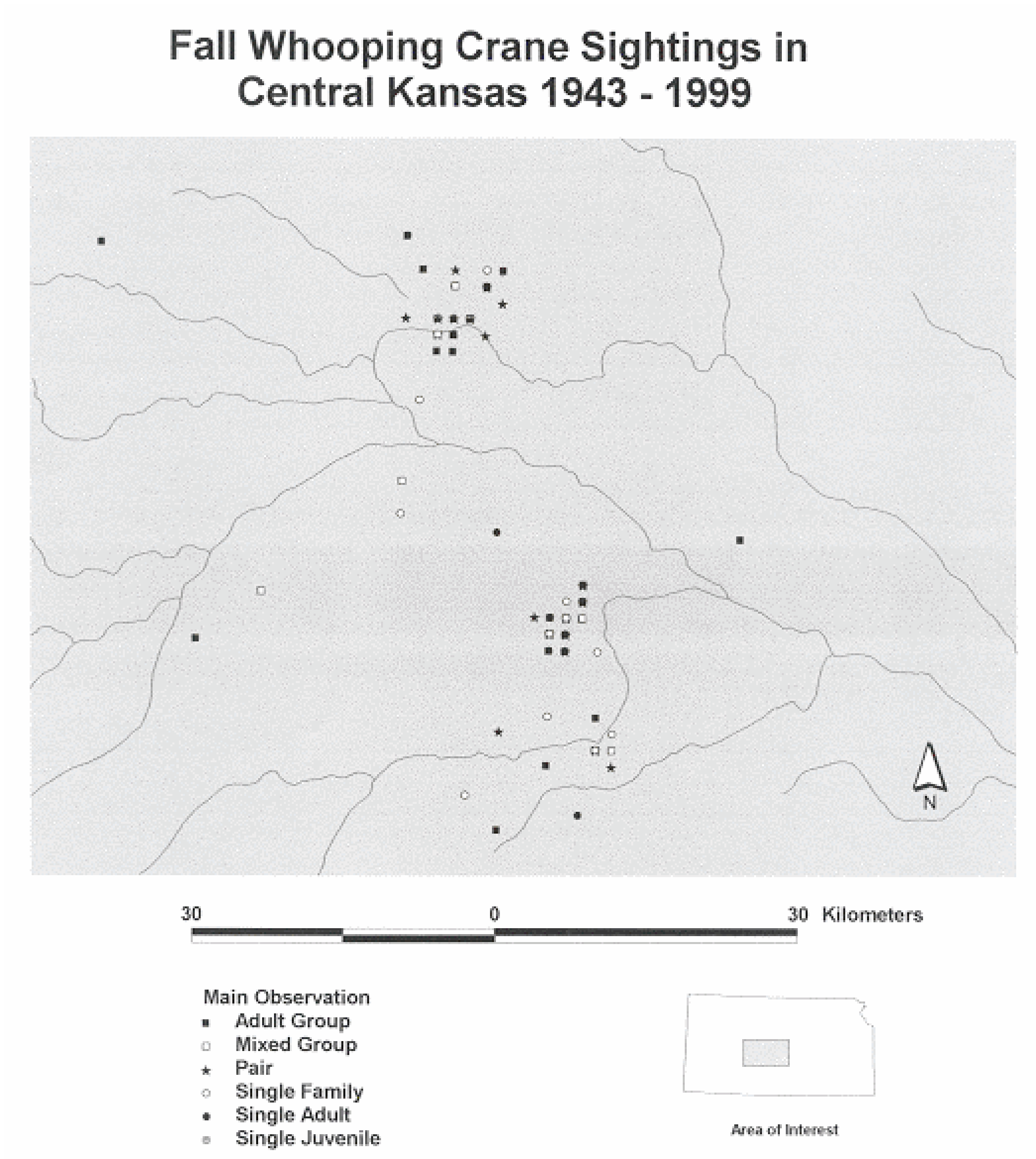
Fall Whooping Crane Sightings 1943 - 1999
N
Ecoregion
Western High Plains
Southwestern Tablelands
Central Great Plains
Flint Hills
Central Irregular Plains
Western Corn Belt Plains
Main Observation
Adult Group
Mixed Group
Pair
Single Family
Single Adult
Single Juvenile
100
0
100
200
Kilometers

KS map 4



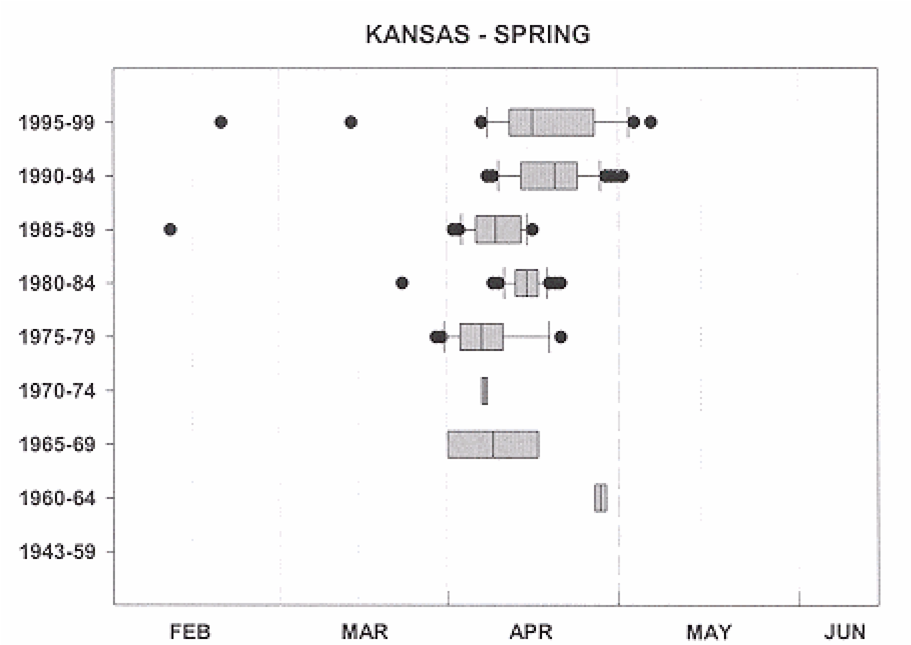
Spring Whooping Crane Sightings in Central Kansas 1943 - 1999
N
30
0
30 Kilometers
Main Observation
Adult Group
Mixed Group
Pair
Single Family
Single Adult
Single Juvenile
Area of Interest

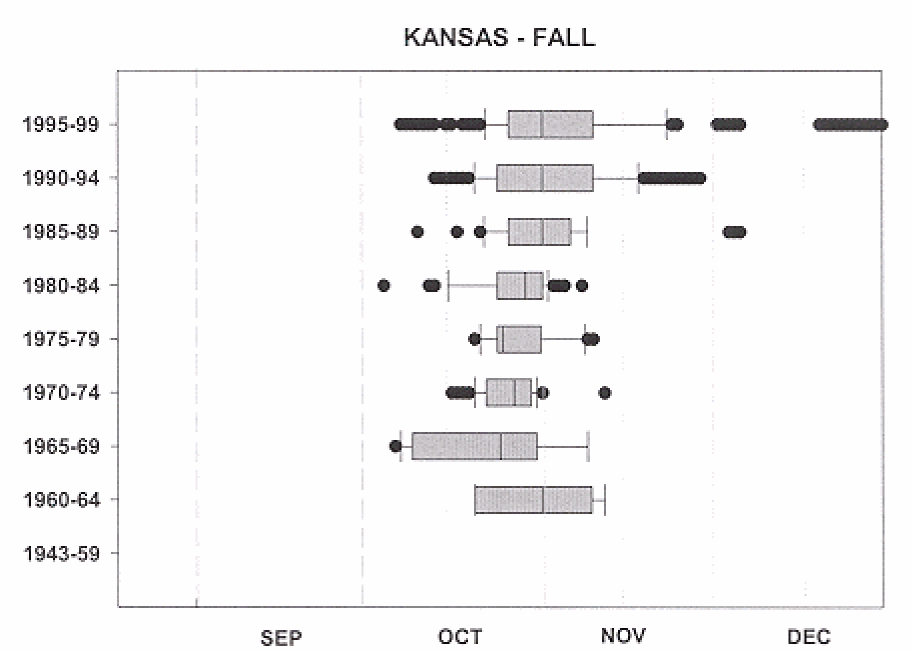
KS map 5



Fall Whooping Crane Sightings in Central Kansas 1943 - 1999
N
30
0
30 Kilometers
Main Observation
Adult Group
Mixed Group
Pair
Single Family
Single Adult
Single Juvenile
Area of Interest

KS DATE GRAPHIC





MONTANA

Table MT.1. Number of site evaluations and total number of confirmed observations of whooping cranes, by 5-year periods, 1942–99. Includes only single records for each main observation; site evaluations before 1977 are not included.

	No. observations		
Period	**Spring**	**Fall**	***Total***
1943–59	0	1	*1*
1960–64	6	1	*7*
1965–69	2	5	*7*
1970–74	3	0	*3*
1975–79	2 / 3	2 / 3	*4 / 6*
1980–84	2 / 2	1 / 1	*3 / 3*
1985–89	3 / 4	1 / 1	*4 / 5*
1990–94	2 / 2	1 / 2	*3 / 4*
1995–99	0	0	*0*
Overall	*9 / 22*	*5 / 14*	*14 / 36*

Table MT.2. Number of site evaluations,, by wetland system, site use, and season, 1977-99.

Site use	Wetland system	Spring	Fall	*Total*
Roost sites	Palustrine	0	3	*3*
	Riverine	1	0	*1*
	Lacustrine	0	0	*0*
	Unknown	0	0	*0*
	N	*1*	*3*	*4*
Feeding sites	Palustrine	3	0	*3*
	Riverine	1	0	*1*
	Lacustrine	0	0	*0*
	Unknown	5	1	*6*
	N	*9*	*1*	*10*
Dual-use sites	Palustrine	1	2	*3*
	Riverine	0	1	*1*
	Lacustrine	0	0	*0*
	Unknown	0	0	*0*
	N	*1*	*3*	*4*

Table MT.3. Number of sites under private, federal, state, or other ownership, by season and site use, 1977–99.

Site use	Site ownership	Spring	Fall	*Total*
Roost sites	Private	1	0	*1*
	Federal	0	0	*0*
	State	0	1	*1*
	Other	0	0	*0*
Feeding sites	Private	8	1	*9*
	Federal	1	0	*1*
	State	0	0	*0*
	Other	0	0	*0*
Dual-use sites	Private	1	1	*2*
	Federal	0	1	*1*
	State	0	0	*0*
	Other	0	0	*0*

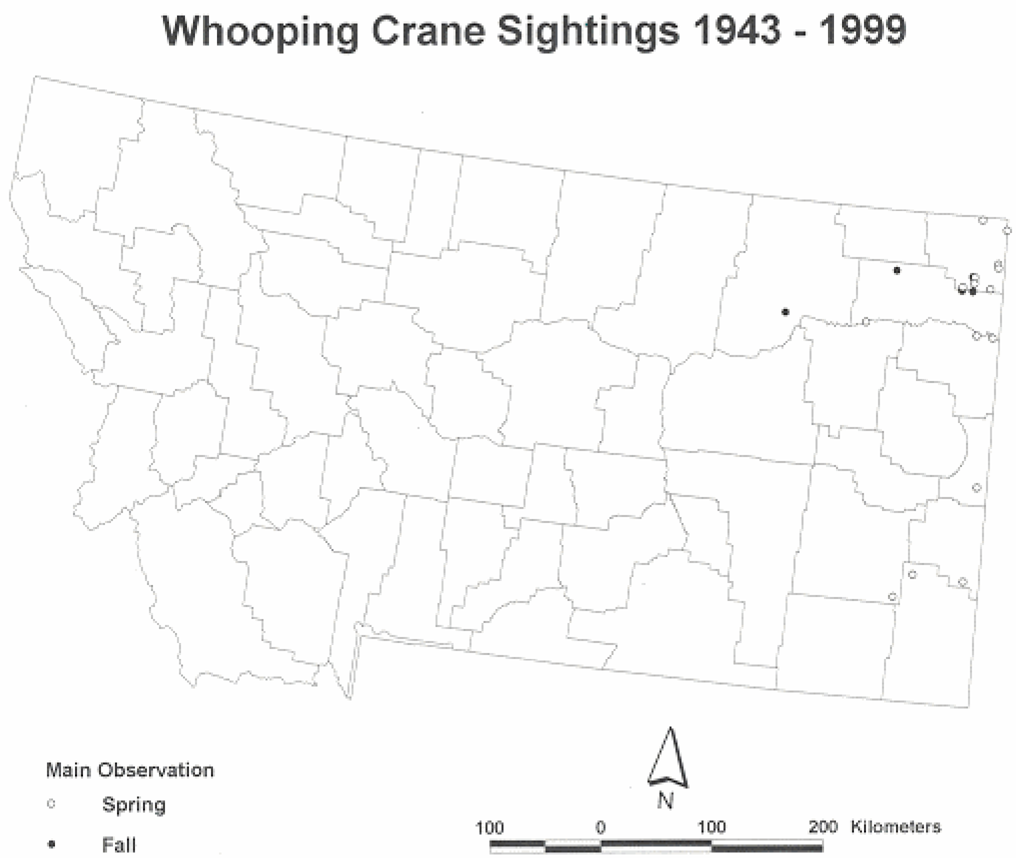
Table MT.4. List of named rivers, lakes, and reservoirs where whooping cranes were sighted, 1943–99.

System	Name	County
River	Missouri River	Roosevelt, Richland
	Poplar River	Roosevelt

Table MT.5. List of named federal and state conservation areas where whooping cranes were sighted, 1943–99.

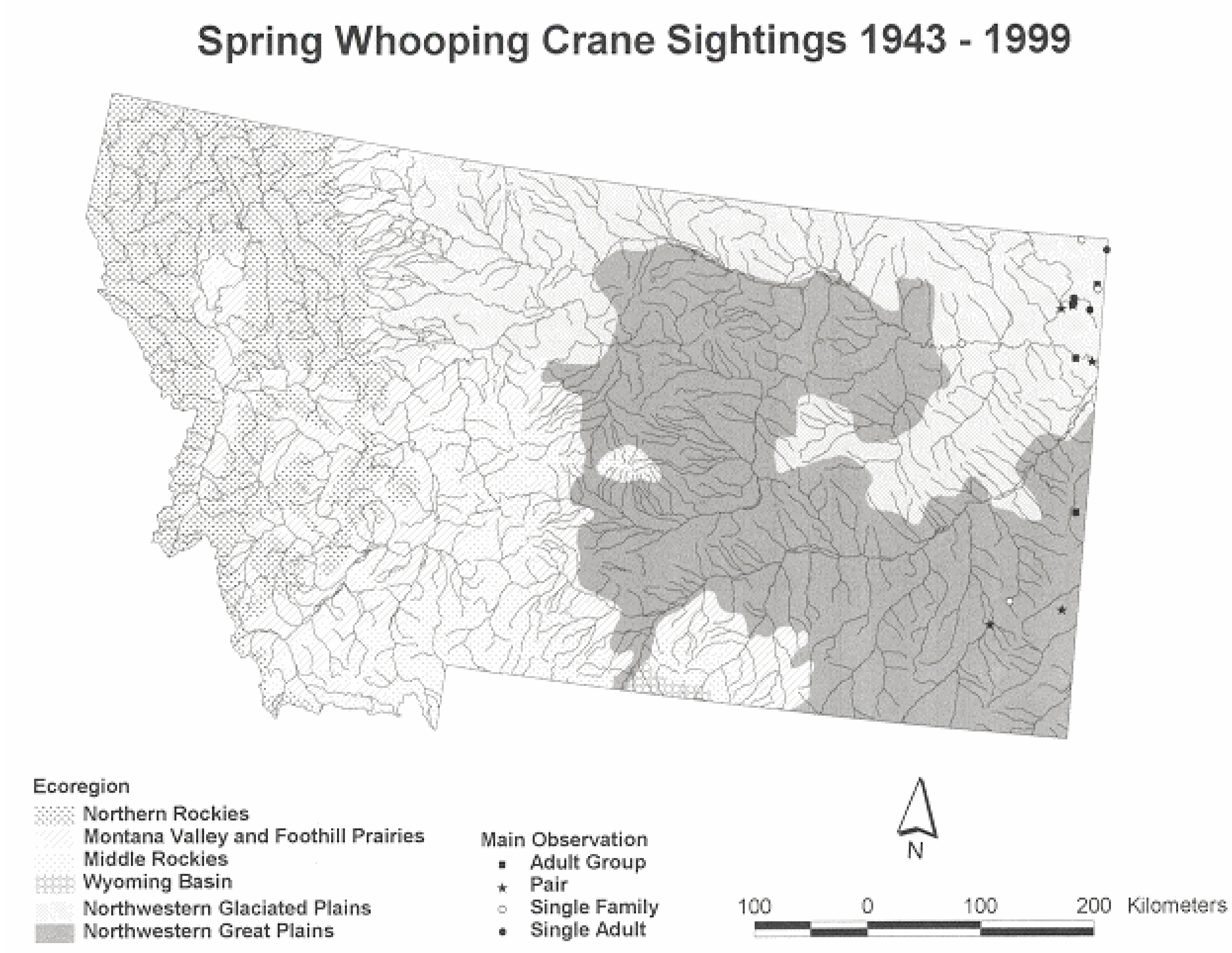
Ownership	Area	County
Federal	Medicine Lake NWR	Sheridan
	Lamesteer NWR	Wibaux

MT map 1

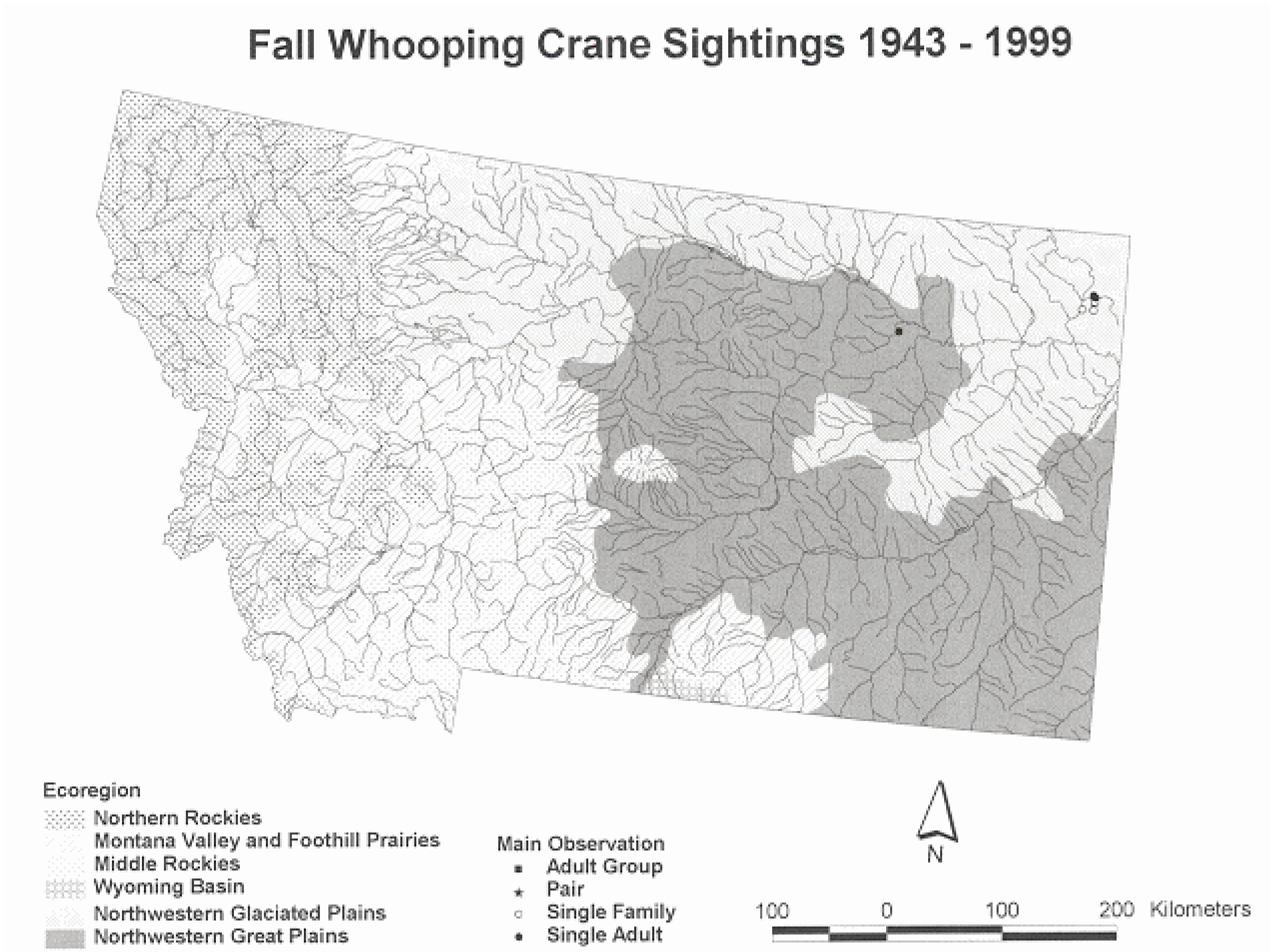


Whooping Crane Sightings 1943 - 1999
Main Observation
Spring
Fall
N
100
0
100
200 Kilometers

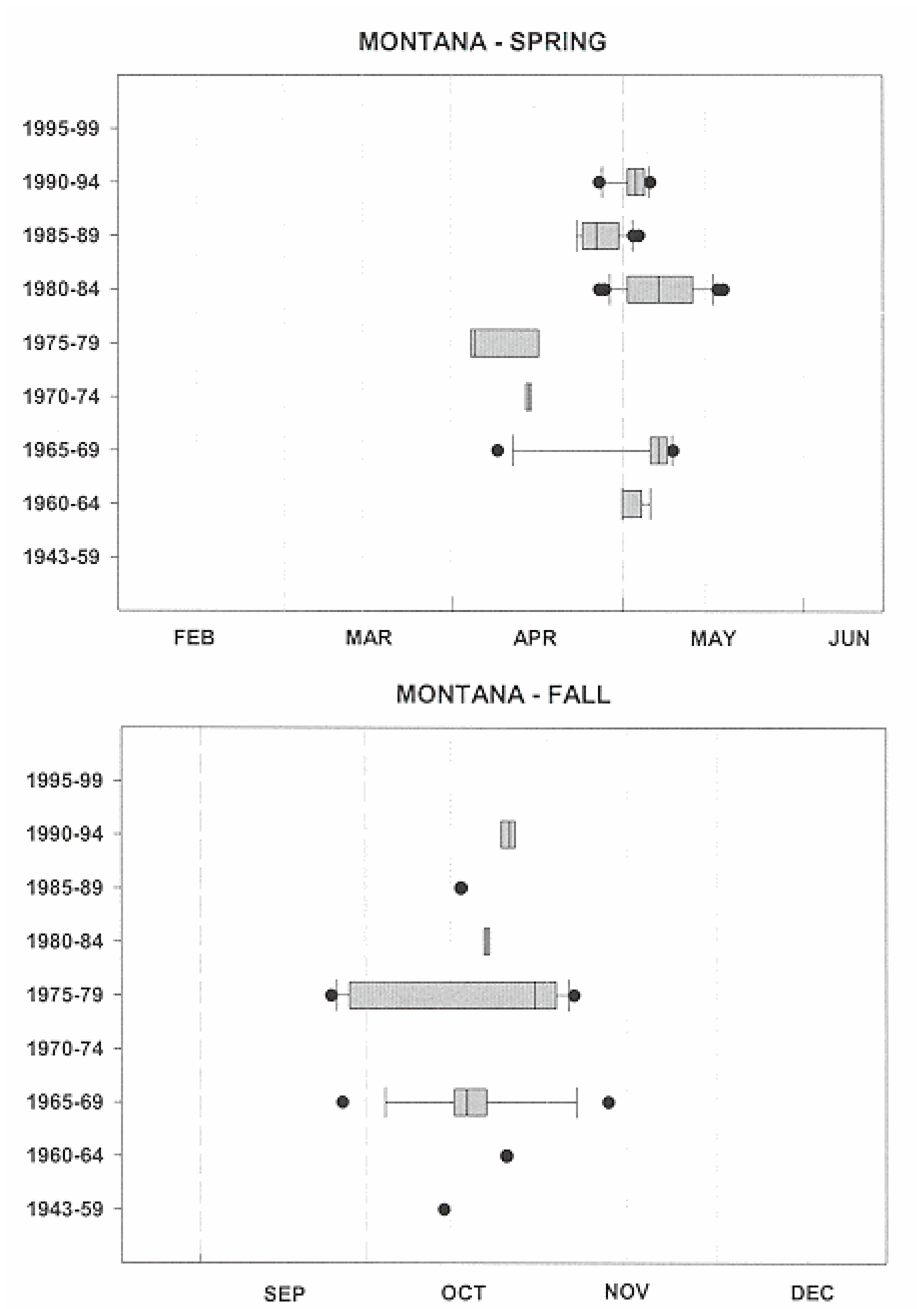
MT map 2


Spring Whooping Crane Sightings 1943 - 1999
Ecoregion
Northern Rockies
Montana Valley and Foothill Prairies
Middle Rockies
Wyoming Basin
Northwestern Glaciated Plains
Northwestern Great Plains
Main Observation
Adult Group
Pair
Single Family
Single Adult
N
100
0
100
200
Kilometers

MT map 3


Fall Whooping Crane Sightings 1943 - 1999
Ecoregion
Northern Rockies
Montana Valley and Foothill Prairies
Middle Rockies
Wyoming Basin
Northwestern Glaciated Plains
Northwestern Great Plains
Main Observation
Adult Group
Pair
Single Family
Single Adult
N
100 0 100 200 Kilometers

MT DATE GRAPHIC



NEBRASKA

Table NE.1. Number of site evaluations and total number of confirmed observations of whooping cranes, by 5-year periods, 1942–99. Includes only single records for each main observation; site evaluations before 1977 are not included.

	No. observations		
Period	**Spring**	**Fall**	***Total***
1943–59	7	3	*10*
1960–64	0	3	*3*
1965–69	2	5	*7*
1970–74	4	8	*12*
1975–79	5 / 7	8 / 8	*13 / 15*
1980–84	12 / 20	16 / 23	*28 / 43*
1985–89	33 / 44	20 / 29	*53 / 73*
1990–94	38 / 49	23 / 29	*61 / 78*
1995–99	47 / 66	7 / 28	*54 / 94*
Overall	*135 / 199*	*74 / 136*	*209 / 335*

Table NE.2. Number of site evaluations, by wetland system, site use, and season, 1977-99.

Site use	**Wetland system**	**Spring**	**Fall**	***Total***
Roost sites	Palustrine	22	12	*34*
	Riverine	42	21	*63*
	Lacustrine	1	3	*4*
	Unknown			
	N	*65*	*36*	*101*
Feeding sites	Palustrine	37	16	*53*
	Riverine	10	5	*15*
	Lacustrine	0	3	*3*
	Unknown	144	45	*189*
	N	*191*	*69*	*260*
Dual-use sites	Palustrine	47	33	*80*
	Riverine	25	17	*42*
	Lacustrine	0	6	*6*
	Unknown	3	0	*3*
	N	*75*	*56*	*131*

Table NE.3. Number of sites under private, federal, state, or other ownership, by season and site use, 1977–99.

Site use	Site ownership	Spring	Fall	*Total*
Roost sites	Private	46	21	*67*
	Federal	5	5	*10*
	State	0	0	*0*
	Other	1	0	*1*
Feeding sites	Private	90	30	*120*
	Federal	3	4	*7*
	State	1	0	*1*
	Other	0	1	*1*
Dual-use sites	Private	49	36	*85*
	Federal	7	3	*10*
	State	3	1	*4*
	Other	1	0	*1*

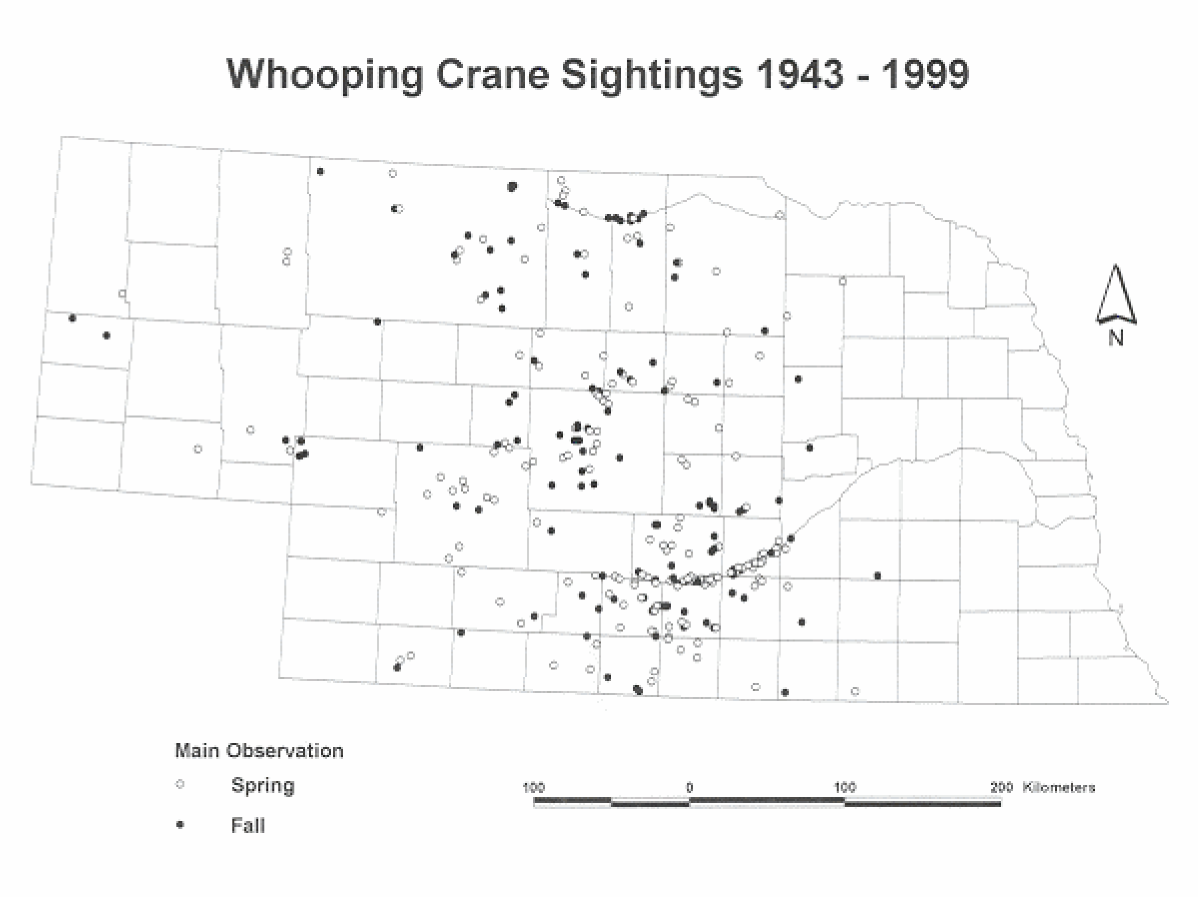
Table NE.4. List of named rivers, lakes, and reservoirs where whooping cranes were sighted, 1943–99.

System	Name	County
River	Cedar River	Wheeler
	Platte River	Buffalo, Dawson, Hall, Hamilton, Kearney, Dawson, Hall, Phelps
	Middle Loup River	Custer, Garfield, Howard, Sherman, Thomas
	Niobrara River	Boyd, Brown, Cherry, Keya–Paha, Rock
	North Loup River	Blaine, Cherry, Garfield, Howard, Loup, Valley
	North Platte River	Garden, Keith, Lincoln
	South Loup River	Howard
Lake & reservoir	Calamus Reservoir	Loup
	Duck Lake	Cherry
	Harlan County Reservoir	Harlan
	Hugh Butler Reservoir	Frontier
	Lone Tree Lake	Cherry
	Lake McConaughy	Keith, Garden
	Lake Maloney	Lincoln
	Medicine Creek Reservoir	Frontier
	Swanson Reservoir	Hitchcock

Table NE.5. List of named federal and state conservation areas where whooping cranes were sighted, 1943–99.

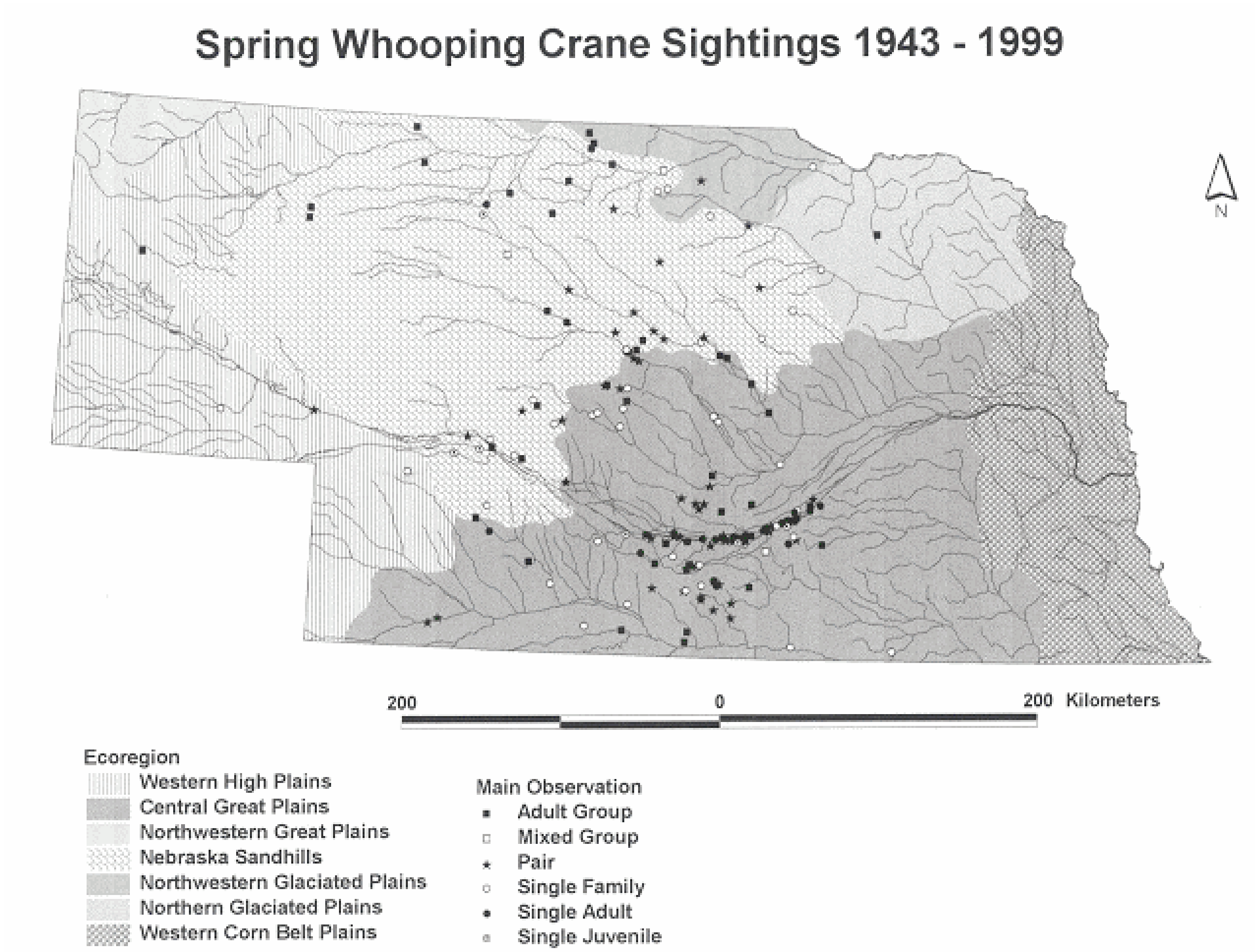
Ownership	Area	County
Federal	Atlanta WPA	Phelps
	Fort Niobrara NWR	Cherry
	Funk Lagoon WPA	Phelps
	Gleason WPA	Kearney
	Johnson WPA	Phelps
	Jensen WPA	Kearney
	Linder WPA	Phelps
	Peterson WPA	Gosper
	Prairie Dog WPA	Kearney
	Valentine NWR	Cherry
State	Sac–Wilcox SWA	Phelps
Other	Mormon Island	Hall
	Rowe Audubond Sanctuary	Kearney

NE map 1



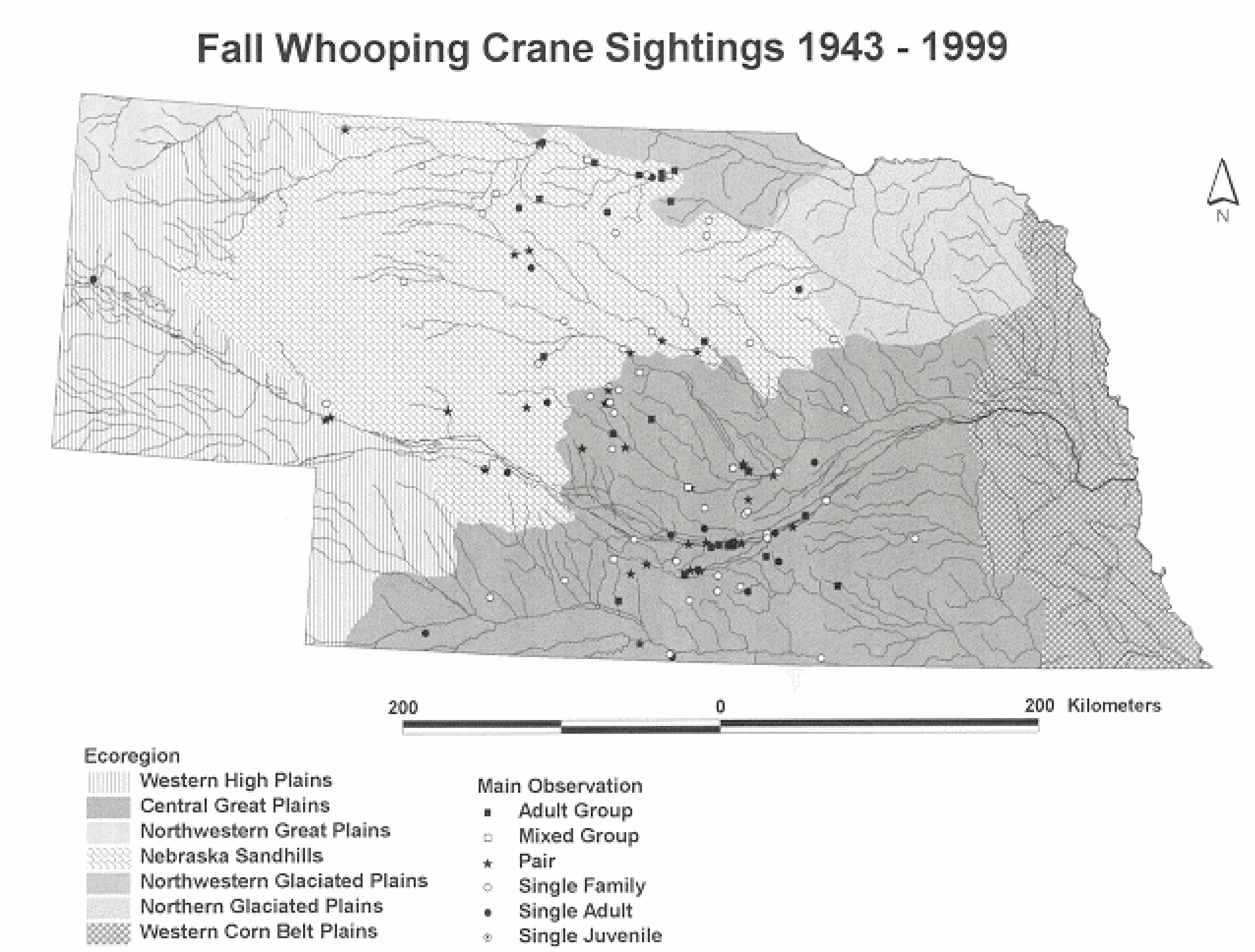
Whooping Crane Sightings 1943 - 1999
N
Main Observation
Spring
Fall
100
0
100
200 Kilometers

NE map 2



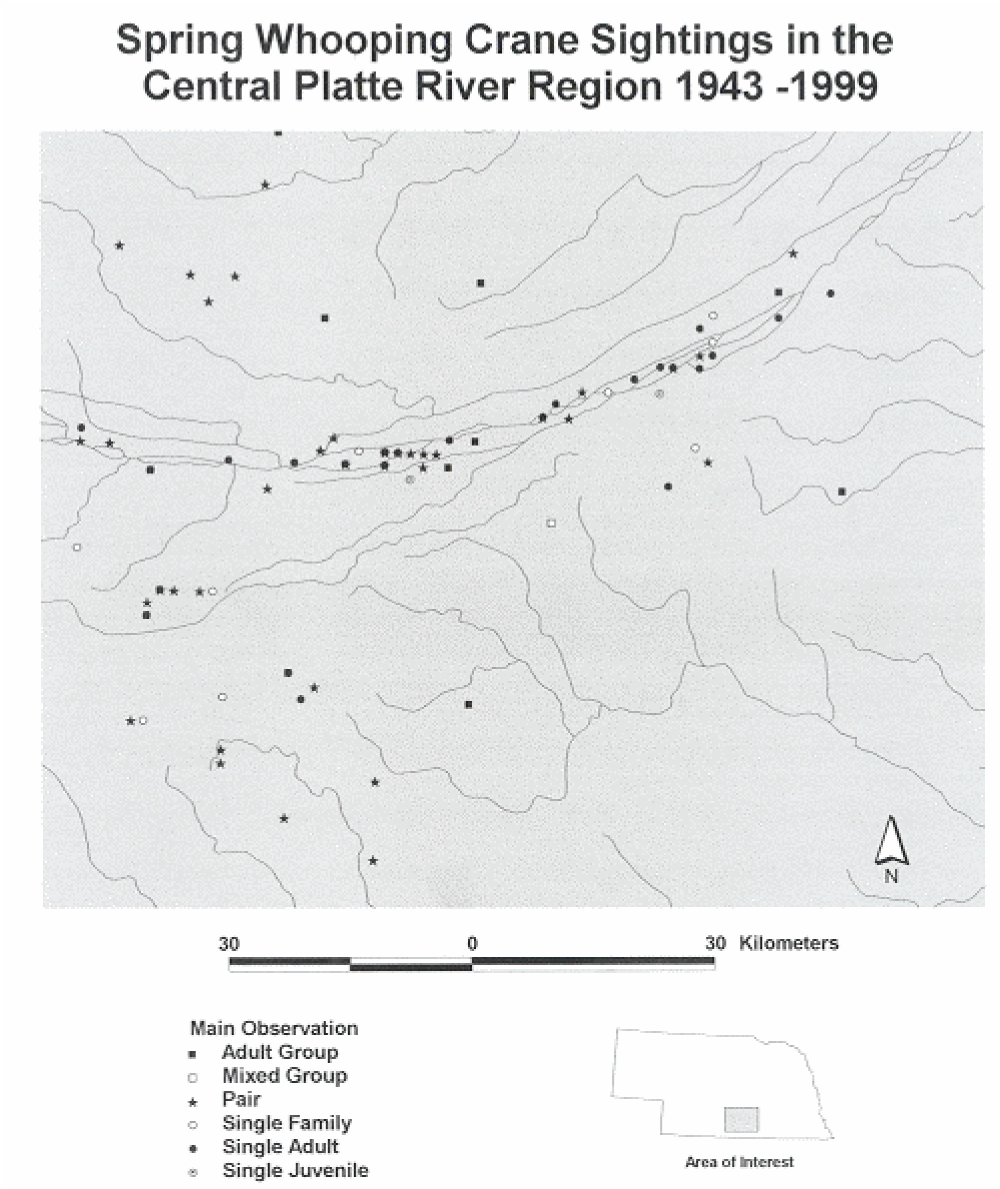
Spring Whooping Crane Sightings 1943 - 1999
N
200
0
200 Kilometers
Ecoregion
Western High Plains
Central Great Plains
Northwestern Great Plains
Nebraska Sandhills
Northwestern Glaciated Plains
Northern Glaciated Plains
Western Corn Belt Plains
Main Observation
Adult Group
Mixed Group
Pair
Single Family
Single Adult
Single Juvenile

NE map 3

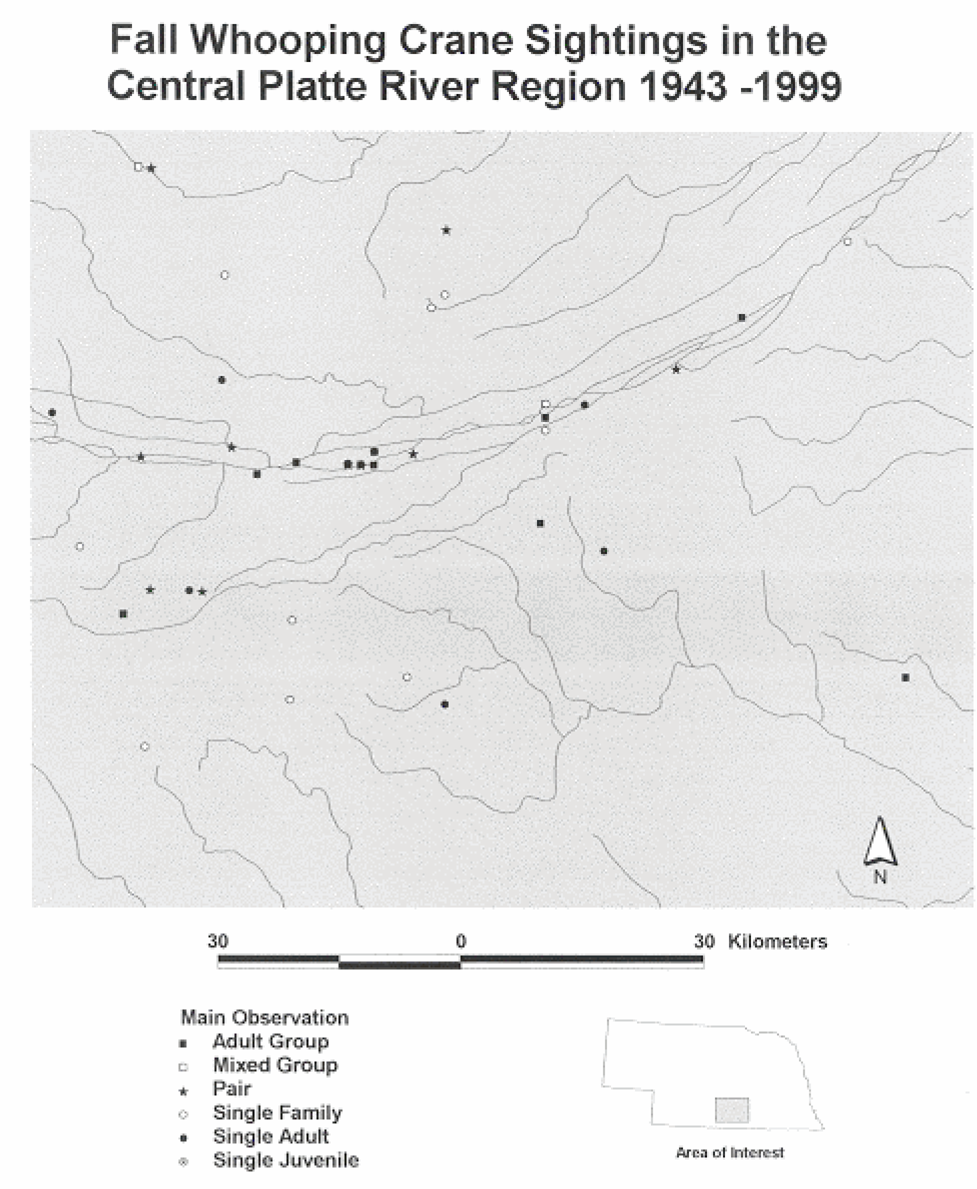


Fall Whooping Crane Sightings 1943 - 1999
N
200
0
200 Kilometers
Ecoregion
Western High Plains
Central Great Plains
Northwestern Great Plains
Nebraska Sandhills
Northwestern Glaciated Plains
Northern Glaciated Plains
Western Corn Belt Plains
Main Observation
Adult Group
Mixed Group
Pair
Single Family
Single Adult
Single Juvenile

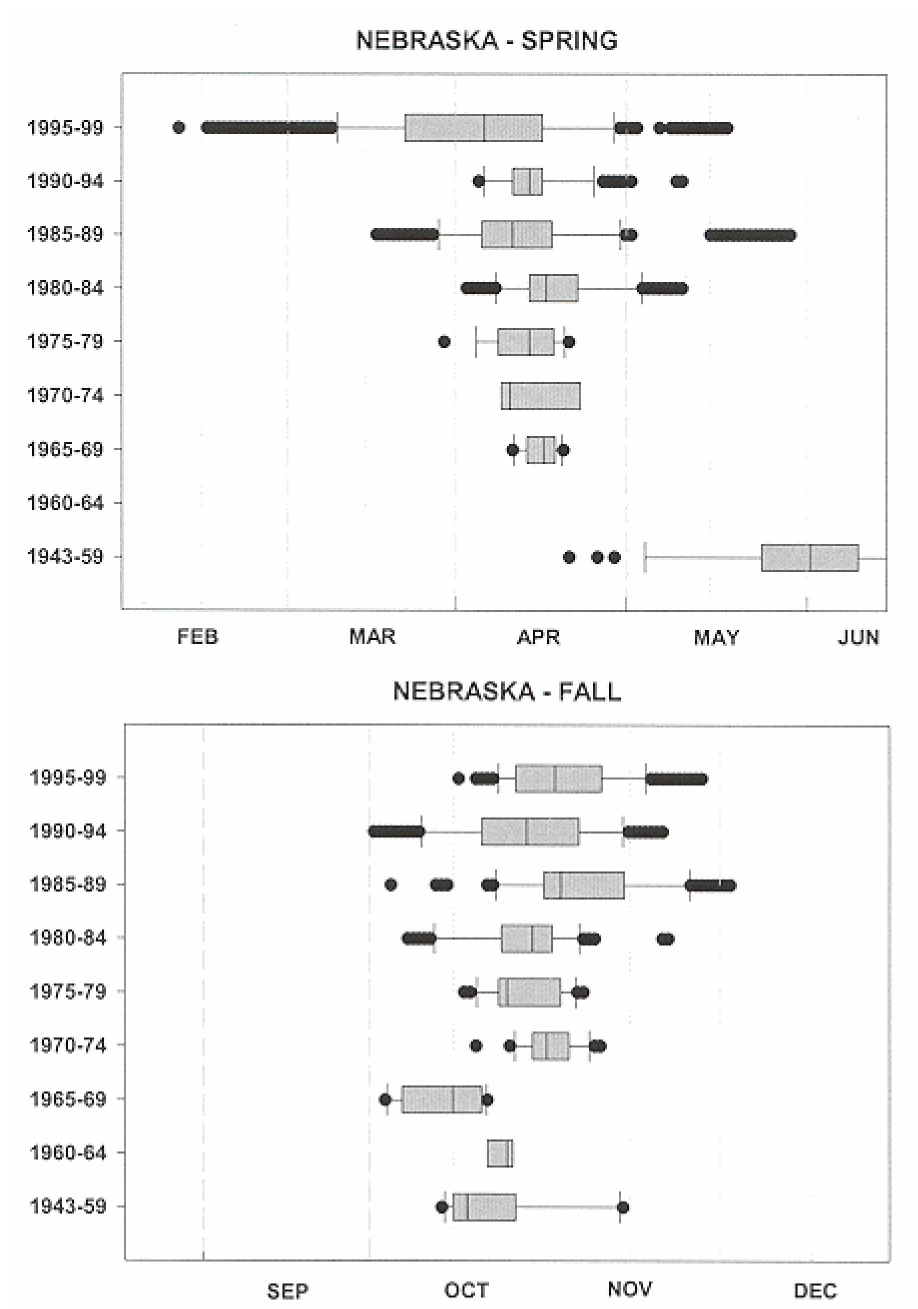
NE map 4


Spring Whooping Crane Sightings in the Central Platte River Region 1943 -1999
N
30
0
30 Kilometers
Main Observation
Adult Group
Mixed Group
Pair
Single Family
Single Adult
Single Juvenile
Area of Interest

NE map 5


Fall Whooping Crane Sightings in the
Central Platte River Region 1943 -1999
N
30
0
30 Kilometers
Main Observation
Adult Group
Mixed Group
Pair
Single Family
Single Adult
Single Juvenile
Area of Interest

NE DATE GRAPHIC



NORTH DAKOTA

Table ND.1. Number of site evaluations and total number of confirmed observations of whooping cranes, by 5-year periods, 1942–99. Includes only single records for each main observation; site evaluations before 1977 are not included.

Period	No. observations		
	Spring	Fall	*Total*
1943–59	2	0	*2*
1960–64	7	12	*19*
1965–69	10	0	*10*
1970–74	9	15	*24*
1975–79	7 / 18	10 / 25	*17 / 43*
1980–84	8 / 15	14 / 25	*22 / 40*
1985–89	8 / 13	15 / 16	*23 / 29*
1990–94	12 / 14	19 / 30	*31 / 44*
1995–99	1 / 31	0 / 37	*1 / 68*
Overall	*36 / 119*	*58 / 160*	*94 / 279*

Table ND.2. Number of site evaluations, by wetland system, site use, and season, 1977-99.

Site use	Wetland system	Spring	Fall	*Total*
Roost sites	Palustrine	5	6	*11*
	Riverine	0	2	*2*
	Lacustrine	1	3	*4*
	Unknown	0	0	*0*
	N	*6*	*11*	*17*
Feeding sites	Palustrine	7	9	*16*
	Riverine	0	1	*1*
	Lacustrine	1	0	*1*
	Unknown	20	25	*45*
	N	*28*	*35*	*63*
Dual-use sites	Palustrine	13	21	*34*
	Riverine	0	1	*1*
	Lacustrine	3	7	*10*
	Unknown	1	1	*2*
	N	*17*	*30*	*47*

Table ND.3. Number of sites under private, federal, state, or other ownership, by season and site use, 1977–99.

Site use	Site ownership	Spring	Fall	*Total*
Roost sites	Private	3	4	*7*
	Federal	1	3	*4*
	State	0	0	*0*
	Other	0	0	*0*
Feeding sites	Private	19	27	*46*
	Federal	2	4	*6*
	State	1	0	*1*
	Other	0	0	*0*
Dual-use sites	Private	11	21	*32*
	Federal	2	11	*13*
	State	0	0	*0*
	Other	0	0	*0*

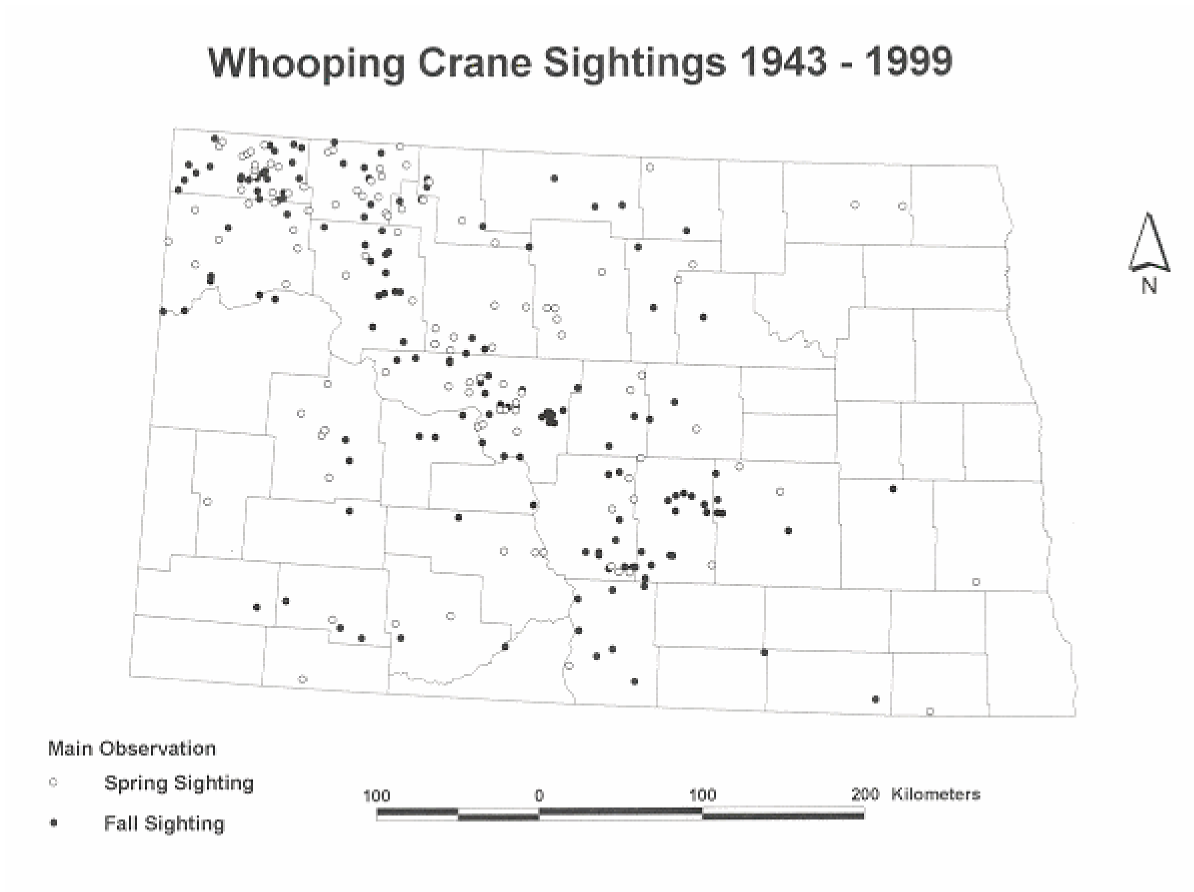
Table ND.4. List of named rivers, lakes, and reservoirs where whooping cranes were sighted, 1943–99.

System	Name	County
River	Missouri River	Emmons, McKenzie, Mercer, McLean
Lake & reservoir	Beaver Lake	Burke
	Cranberry Lake	Benson
	Horsehead Lake	Kidder
	Horseshoe Lake	Pierce
	Lake Audubon	McLean
	Lake Ilo	Dunn
	Lake Sakakawea	McKenzie, Williams
	Lake Williams	McLean
	Long Lake	Burleigh
	Middle Rice Lake	Burleigh
	Round Lake	Pierce
	Shell Lake	Montrail
	Thompson Lake	Burke
	White Lake	Montrail

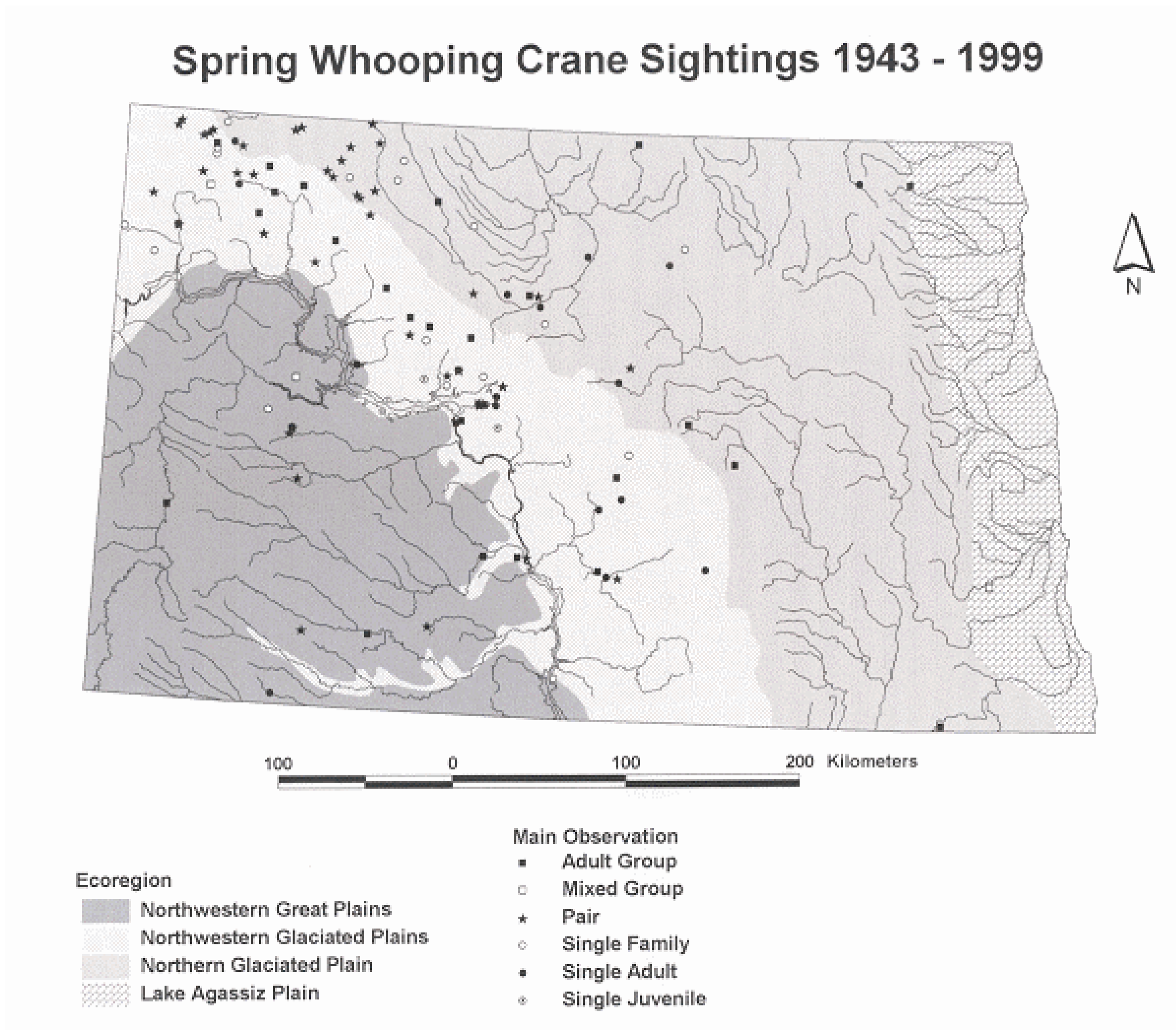
Table ND.5. List of named federal and state conservation areas where whooping cranes were sighted, 1943–99.

Ownership	Area	County
Federal	Audubon NWR	McLean
	Chase Lake NWR	Stutsman
	Dakota Lake NWR	Dickey
	Des Lacs NWR	Ward
	Horshoe Lake WPA	Pierce
	J. Clark Salyer NWR	Bottineau
	Lake Arena WPA	Burleigh
	Lake Ilo NWR	Dunn
	Long Lake NWR	Burleigh
	Lostwood NWR	Burke
	Loucks WPA	Divide
	Pretty Rock NWR	Grant
	Shell Lake NWR	Montrail
	Sheyenne Lake NWR	Sheridan
	Teddy Roosevelt NP	Billings
	Wildrose WPA	Divide
	Writing Rock WPA	Divide
State	Tobacco Garden WMA	McKenzie
Other	Lake Williams	McLean

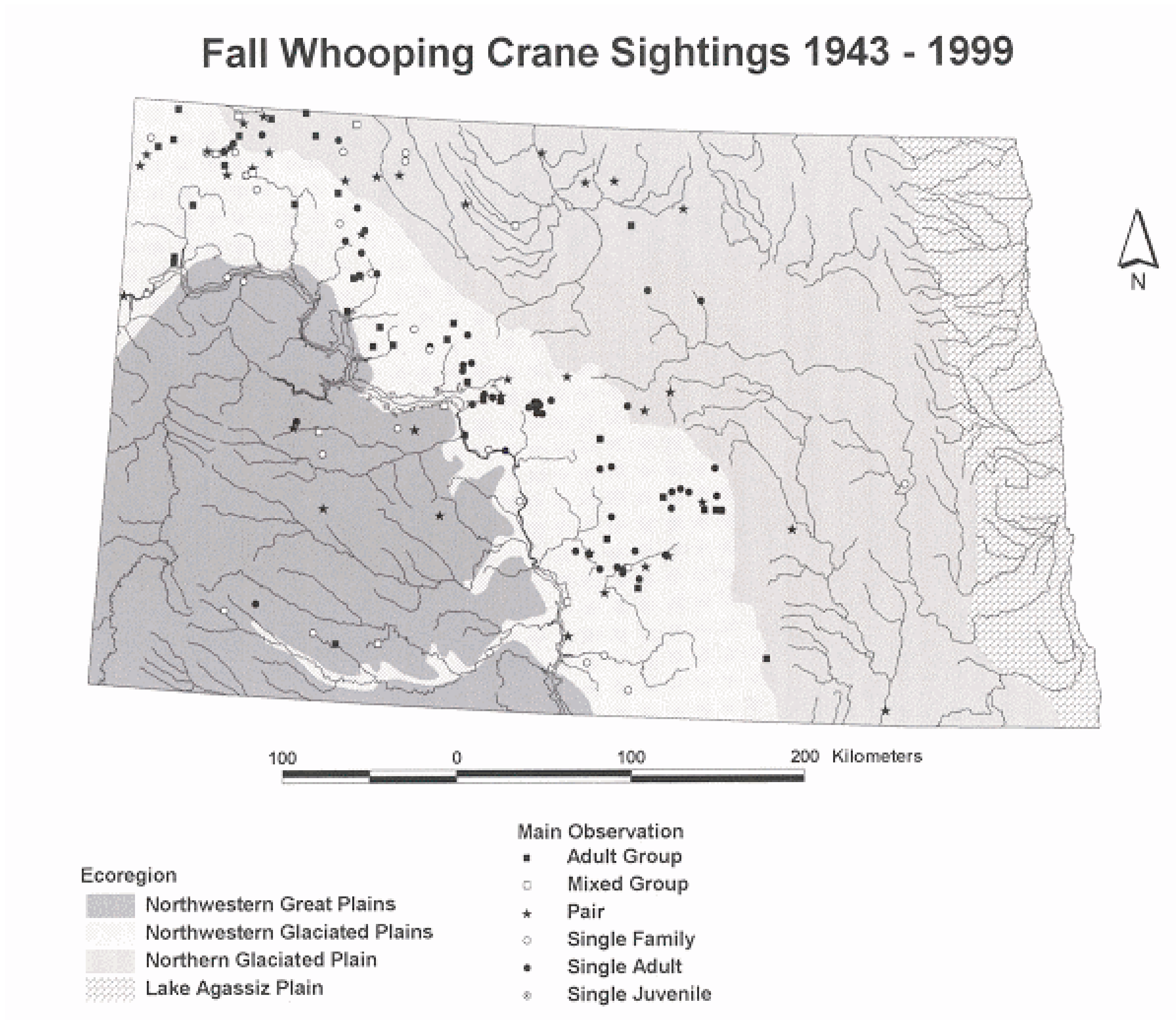
ND map 1


Whooping Crane Sightings 1943 - 1999
N
Main Observation
Spring Sighting
Fall Sighting
100
0
100
200 Kilometers

ND map 2

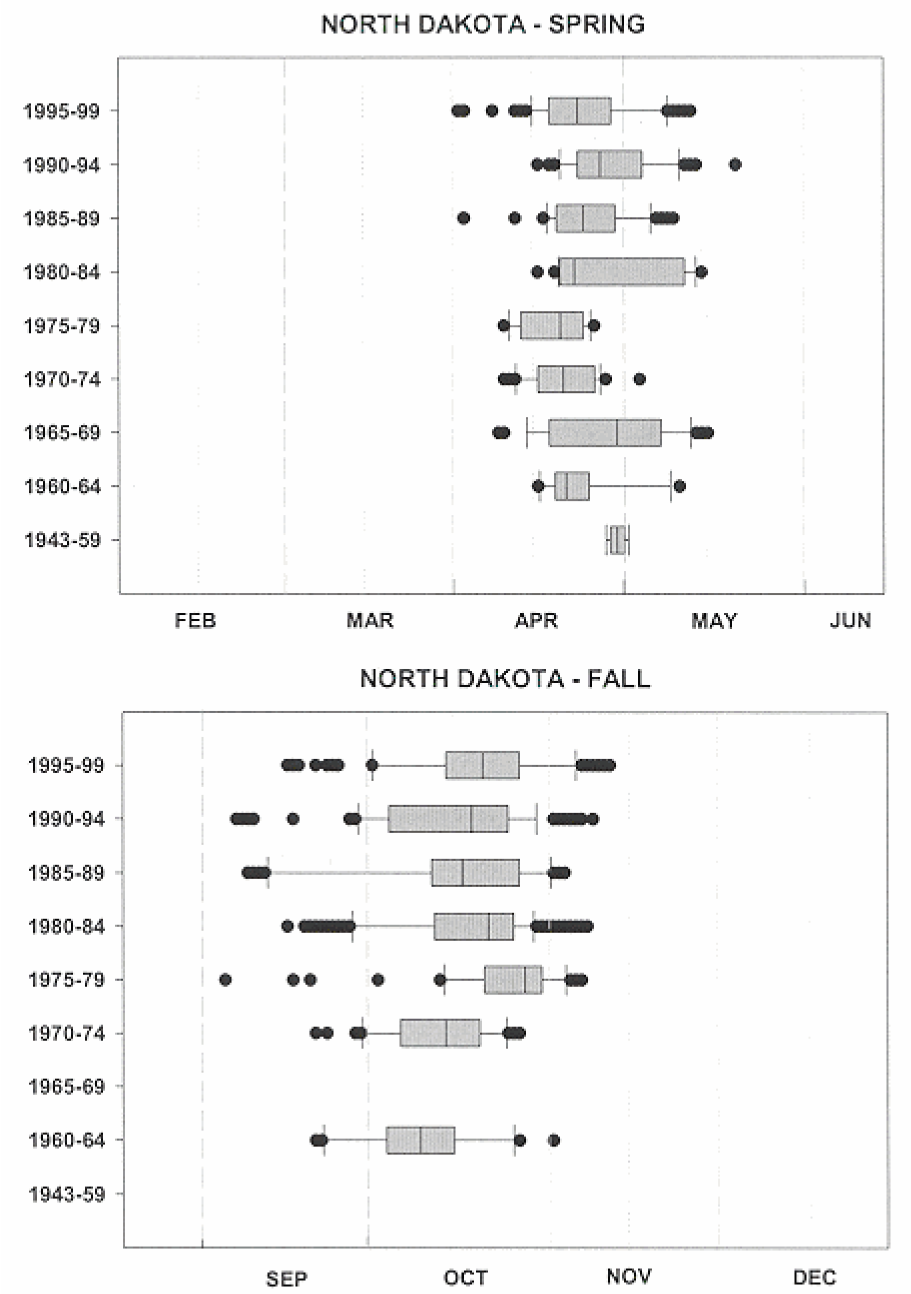

Spring Whooping Crane Sightings 1943 - 1999
N
100
0
100
200 Kilometers
Main Observation
Adult Group
Mixed Group
Pair
Single Family
Single Adult
Single Juvenile
Ecoregion
Northwestern Great Plains
Northwestern Glaciated Plains
Northern Glaciated Plain
Lake Agassiz Plain

ND map 3



Fall Whooping Crane Sightings 1943 - 1999
N
100
0
100
200 Kilometers
Ecoregion
Northwestern Great Plains
Northwestern Glaciated Plains
Northern Glaciated Plain
Lake Agassiz Plain
Main Observation
Adult Group
Mixed Group
Pair
Single Family
Single Adult
Single Juvenile

ND DATE GRAPHIC



OKLAHOMA

Table OK.1. Number of site evaluations and total number of confirmed observations of whooping cranes, by 5-year periods, 1942–99. Includes only single records for each main observation; site evaluations before 1977 are not included.

	No. observations		
Period	**Spring**	**Fall**	***Total***
1943–59	2	2	*4*
1960–64	1	4	*5*
1965–69	0	5	*5*
1970–74	2	5	*7*
1975–79	0	2 / 2	*2 / 2*
1980–84	2 / 4	17 / 26	*19 / 30*
1985–89	3 / 7	26 / 37	*29 / 44*
1990–94	0 / 4	13 / 24	*13 / 28*
1995–99	0 / 7	0 / 23	*0 / 30*
Overall	*5 / 27*	*58 / 128*	*63 / 155*

Table OK.2. Number of site evaluations, by wetland system, site use, and season, 1977–99.

Site use	Wetland system	Spring	Fall	*Total*
Roost sites	Palustrine	2	14	*16*
	Riverine	0	0	*0*
	Lacustrine	0	0	*0*
	Unknown	0	0	*0*
	N	*2*	*14*	*16*
Feeding sites	Palustrine	0	2	*2*
	Riverine	0	0	*0*
	Lacustrine	0	0	*0*
	Unknown	1	34	*35*
	N	*1*	*36*	*37*
Dual-use sites	Palustrine	1	12	*13*
	Riverine	0	1	*1*
	Lacustrine	1	3	*4*
	Unknown	1	0	*1*
	N	*3*	*16*	*19*

Table OK.3. Number of sites under private, federal, state, or other ownership, by season and site use, 1977–99.

Site use	Site ownership	Spring	Fall	*Total*
Roost sites	Private	3	4	*7*
	Federal	1	3	*4*
	State	0	0	*0*
	Other	0	0	*0*
Feeding sites	Private	19	27	*46*
	Federal	2	4	*6*
	State	1	0	*1*
	Other	0	0	*0*
Dual-use sites	Private	11	21	*32*
	Federal	2	11	*13*
	State	0	0	*0*
	Other	0	0	*0*

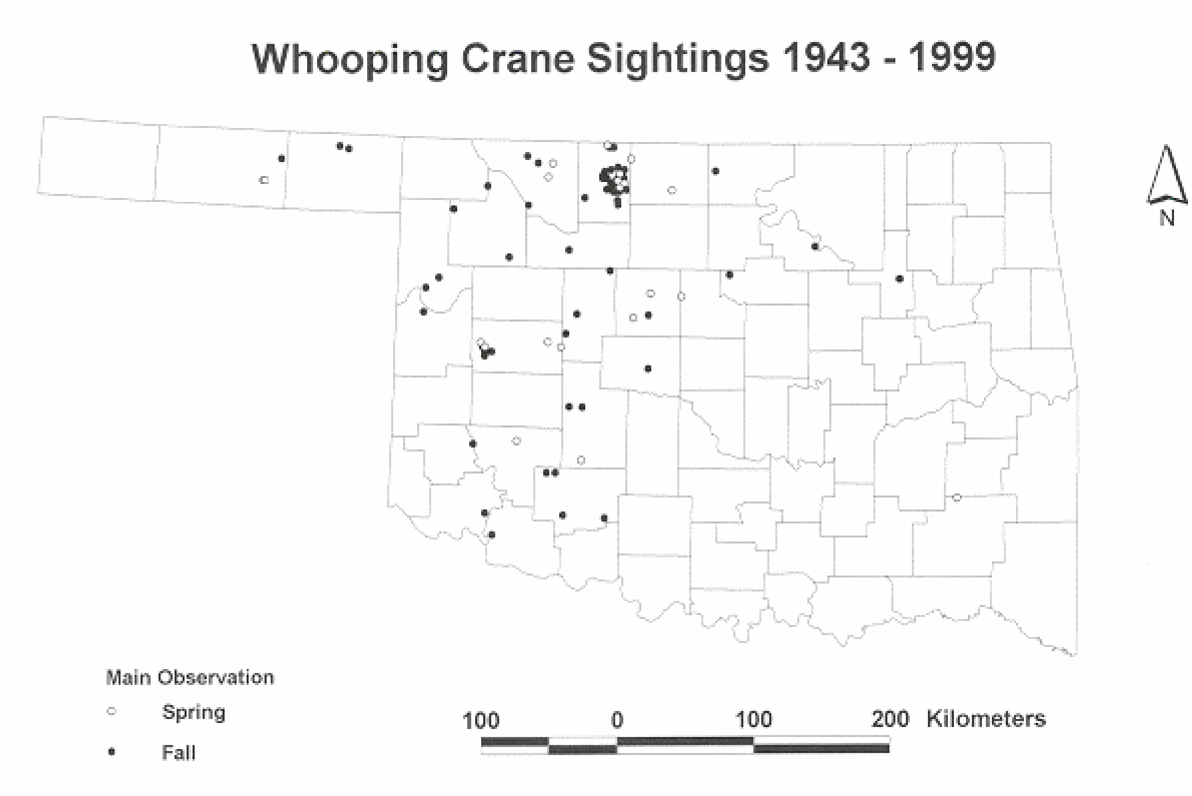
Table OK.4. List of named rivers, lakes, and reservoirs where whooping cranes were sighted, 1943–99.

System	Name	County
River	Arkansas River	Osage/Pawnee
	Canadian River	Ellis
	Cimarron River	Woods
Lake & reservoir	Fort Supply Lake	Woodward
	Fort Cobb Reservoir	Caddo
	Lake Carl Blackwell	Payne

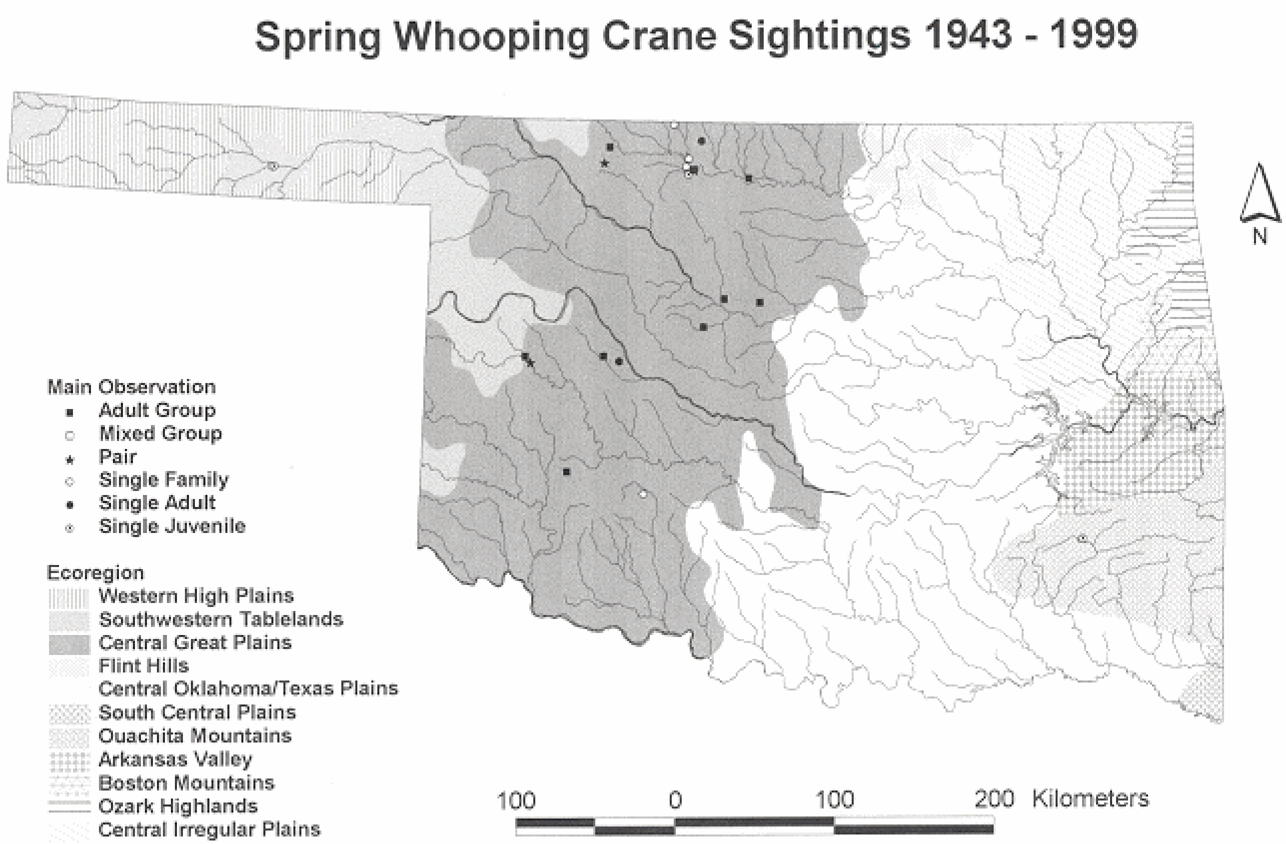
Table OK.5. List of named federal and state conservation areas where whooping cranes were sighted, 1943–99.

Ownership	Area	County
Federal	Optima NWR	Texas
	Salt Plains NWR	Alfalfa
	Washita NWR	Custer
	Witchita Mountains NWR	Comanche
State	Fort Reno Agricultural Station	Canadian
	Beaver Lake WMA	Beaver

OK map 1

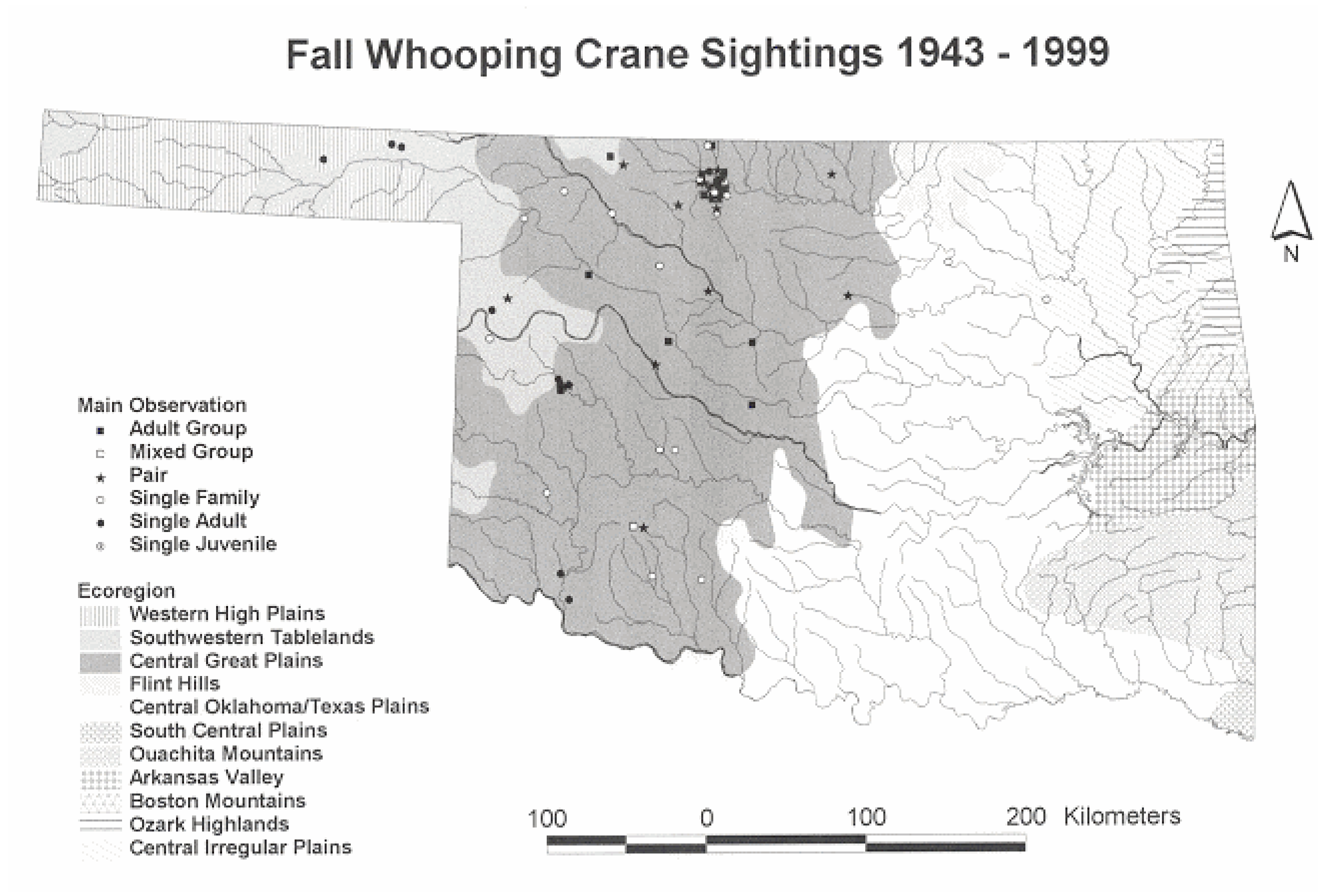

Whooping Crane Sightings 1943 - 1999
N
Main Observation
Spring
Fall
100
0
100
200
Kilometers

OK map 2

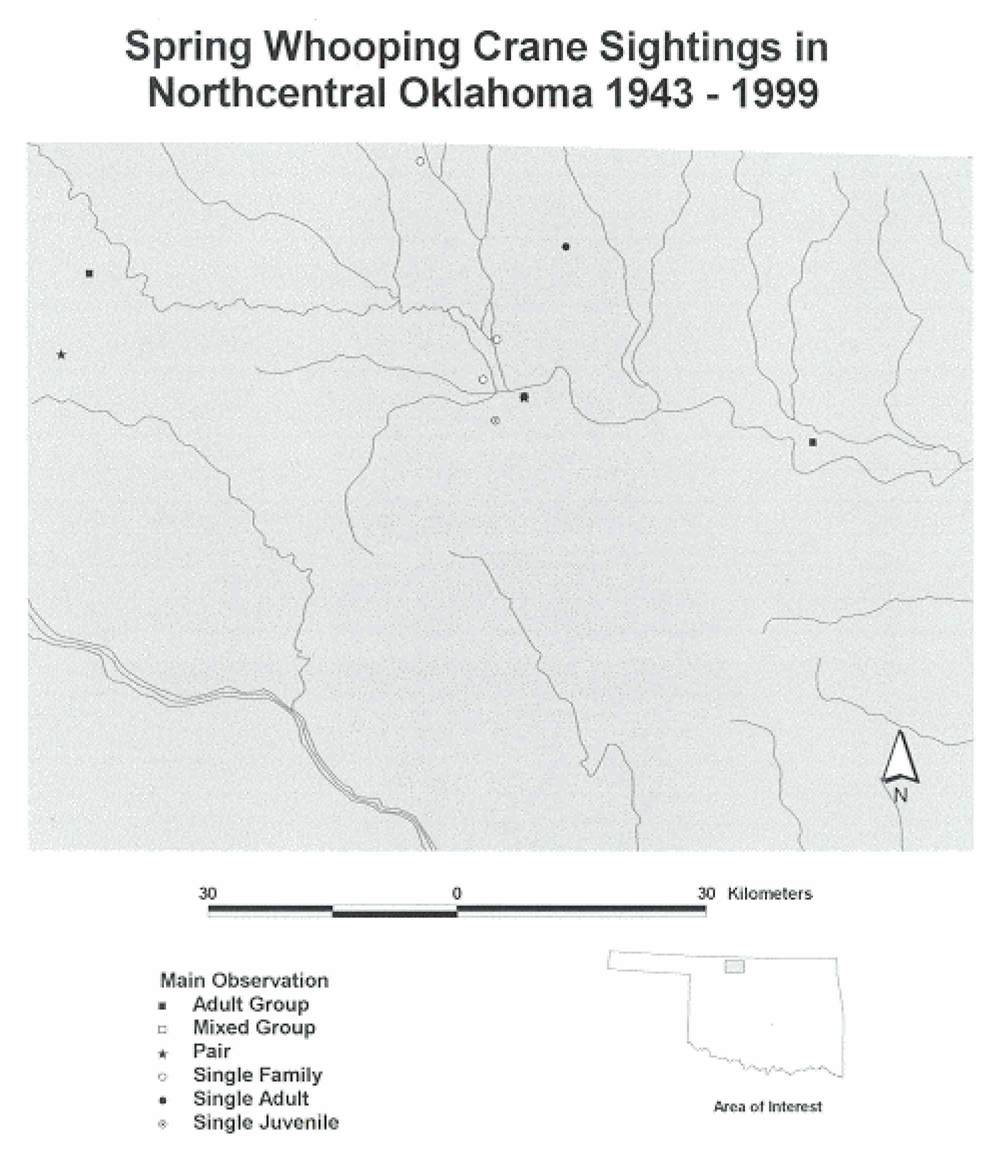


Spring Whooping Crane Sightings 1943 - 1999
Main Observation
Adult Group
Mixed Group
Pair
Single Family
Single Adult
Single Juvenile
Ecoregion
Western High Plains
Southwestern Tablelands
Central Great Plains
Flint Hills
Central Oklahoma/Texas Plains
South Central Plains
Ouachita Mountains
Arkansas Valley
Boston Mountains
Ozark Highlands
Central Irregular Plains
100 0 100 200 Kilometers
N

OK map 3


Fall Whooping Crane Sightings 1943 - 1999
N
Main Observation
Adult Group
Mixed Group
Pair
Single Family
Single Adult
Single Juvenile
Ecoregion
Western High Plains
Southwestern Tablelands
Central Great Plains
Flint Hills
Central Oklahoma/Texas Plains
South Central Plains
Ouachita Mountains
Arkansas Valley
Boston Mountains
Ozark Highlands
Central Irregular Plains
100 0 100 200 Kilometers

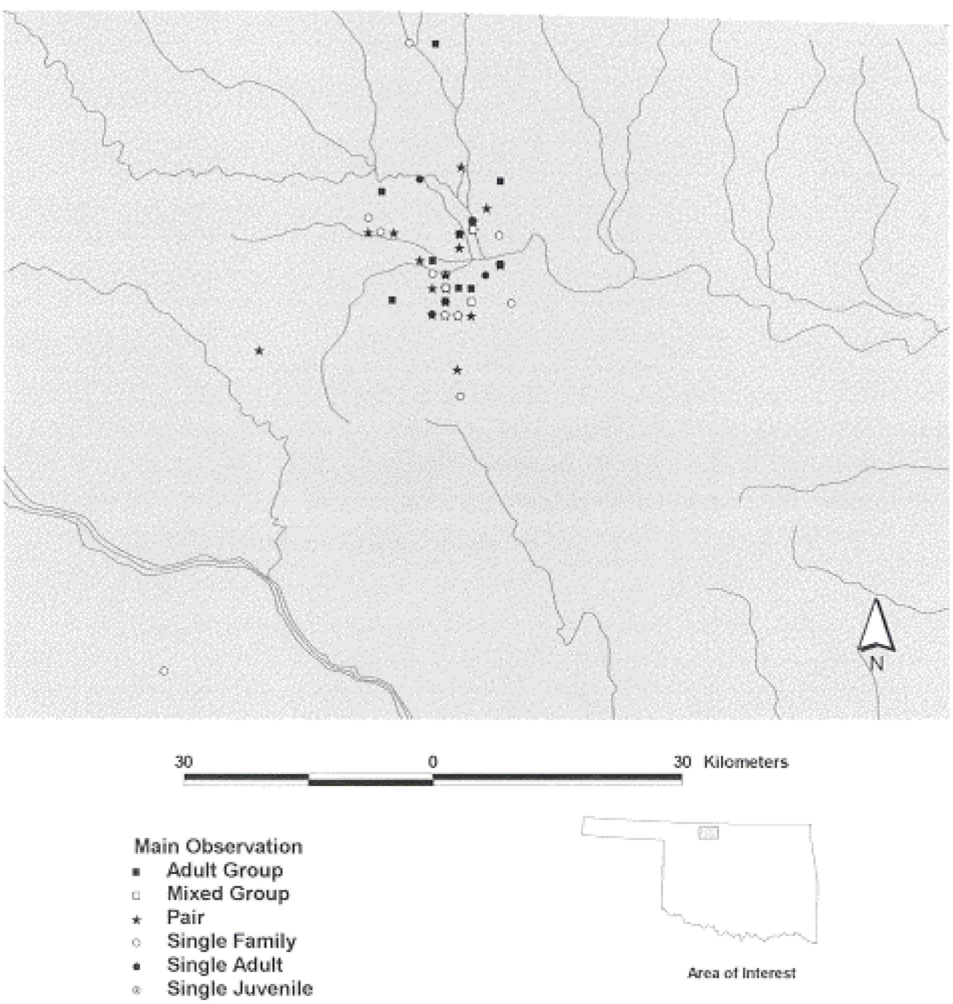
OK map 4



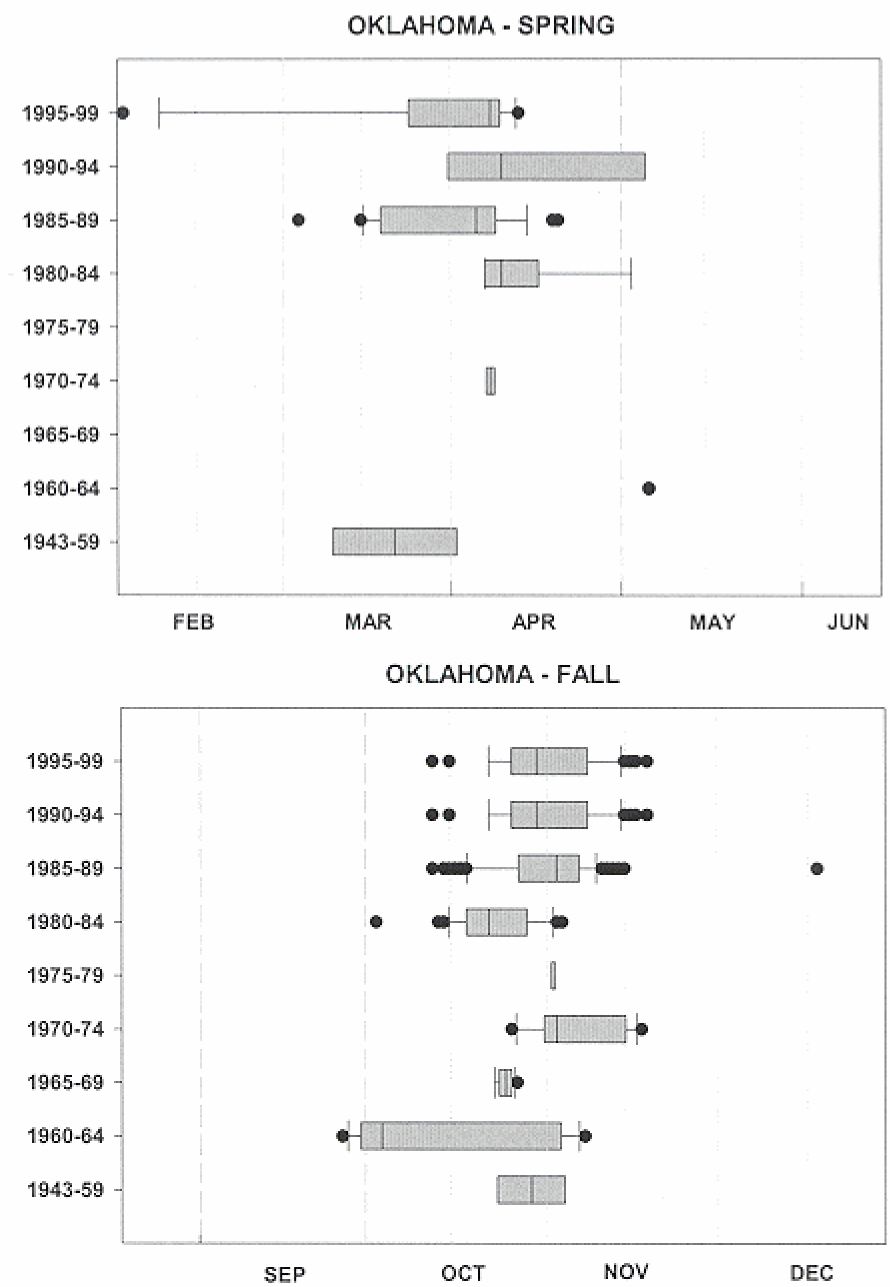
Spring Whooping Crane Sightings in
Northcentral Oklahoma 1943 - 1999
N
30 0 30 Kilometers
Main Observation
Adult Group
Mixed Group
Pair
Single Family
Single Adult
Single Juvenile
Area of Interest

OK map 5

Fall Whooping Crane Sightings in Northcentral Oklahoma 1943 - 1999



OK DATE GRAPHIC



SOUTH DAKOTA

Table SD.1. Number of site evaluations and total number of confirmed observations of whooping cranes, by 5-year periods, 1942–99. Includes only single records for each main observation; site evaluations before 1977 are not included.

	No. observations		
Period	Spring	Fall	*Total*
1943–59	1	2	*3*
1960–64	3	5	*8*
1965–69	1	1	*2*
1970–74	3	9	*12*
1975–79	2 / 7	4 / 6	*6 / 13*
1980–84	4 / 6	8 / 18	*12 / 24*
1985–89	6 / 9	9 / 13	*15 / 22*
1990–94	7 / 10	9 / 9	*16 / 19*
1995–99	0 / 16	5 / 20	*5 / 36*
Overall	*19 / 56*	*35 / 83*	*54 / 139*

Table SD.2. Number of site evaluations, by wetland system, site use, and season, 1977–99.

Site use	Wetland system	Spring	Fall	*Total*
Roost sites	Palustrine	2	5	*7*
	Riverine	0	0	*0*
	Lacustrine	0	1	*1*
	Unknown	0	0	*0*
	N	*2*	*6*	*8*
Feeding sites	Palustrine	5	4	*9*
	Riverine	0	0	*0*
	Lacustrine	1	0	*1*
	Unknown	14	7	*21*
	N	*20*	*11*	*31*
Dual-use sites	Palustrine	6	12	*18*
	Riverine	0	0	*0*
	Lacustrine	3	5	*8*
	Unknown	0	0	*0*
	N	*9*	*17*	*26*

Table SD.3. Number of sites under private, federal, state, or other ownership, by season and site use, 1977–99.

Site use	Site ownership	Spring	Fall	*Total*
Roost sites	Private	2	1	*3*
	Federal	0	2	*2*
	State	0	2	*2*
	Other	0	0	*0*
Feeding sites	Private	13	7	*20*
	Federal	1	0	*1*
	State	0	2	*2*
	Other	0	0	*0*
Dual-use sites	Private	6	8	*14*
	Federal	1	5	*6*
	State	2	4	*6*
	Other	0	0	*0*

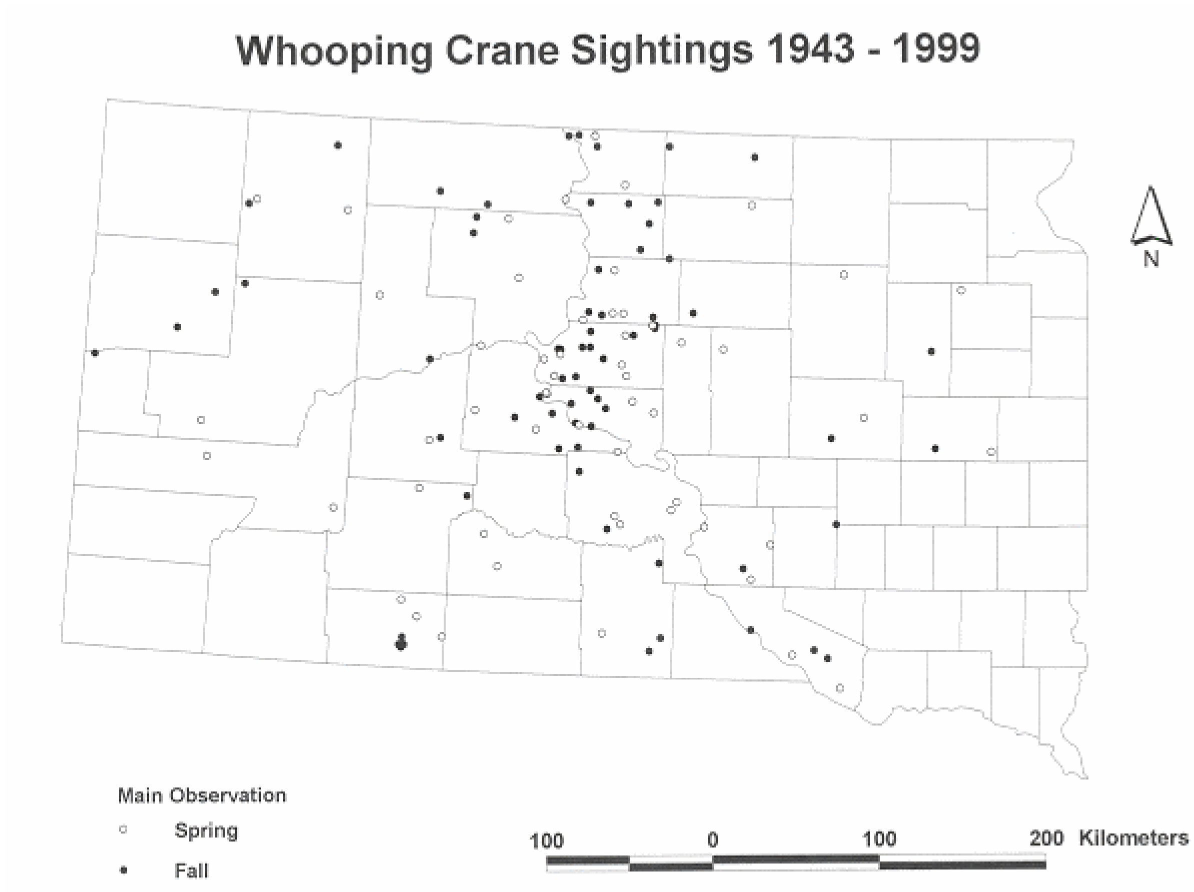
Table SD.4. List of named rivers, lakes, and reservoirs where whooping cranes were sighted, 1943–99.

System	Name	County
River	Cheyenne River	Wiebach
	Missouri River	Campbell
Lake & reservoir	Cottonwood Lake	Sully
	Hausauer Lake	McPhearson
	Lake Francis Case	Charles–Mix
	Lake Hiddenwood	Walworth
	Oahe Reservoir	Campbell, Corson, Hughes
	Roosevelt Lake	Tripp
	Shadehill Reservoir	Perkins
	Stone Lake	Sully
	Swan Lake	Walworth

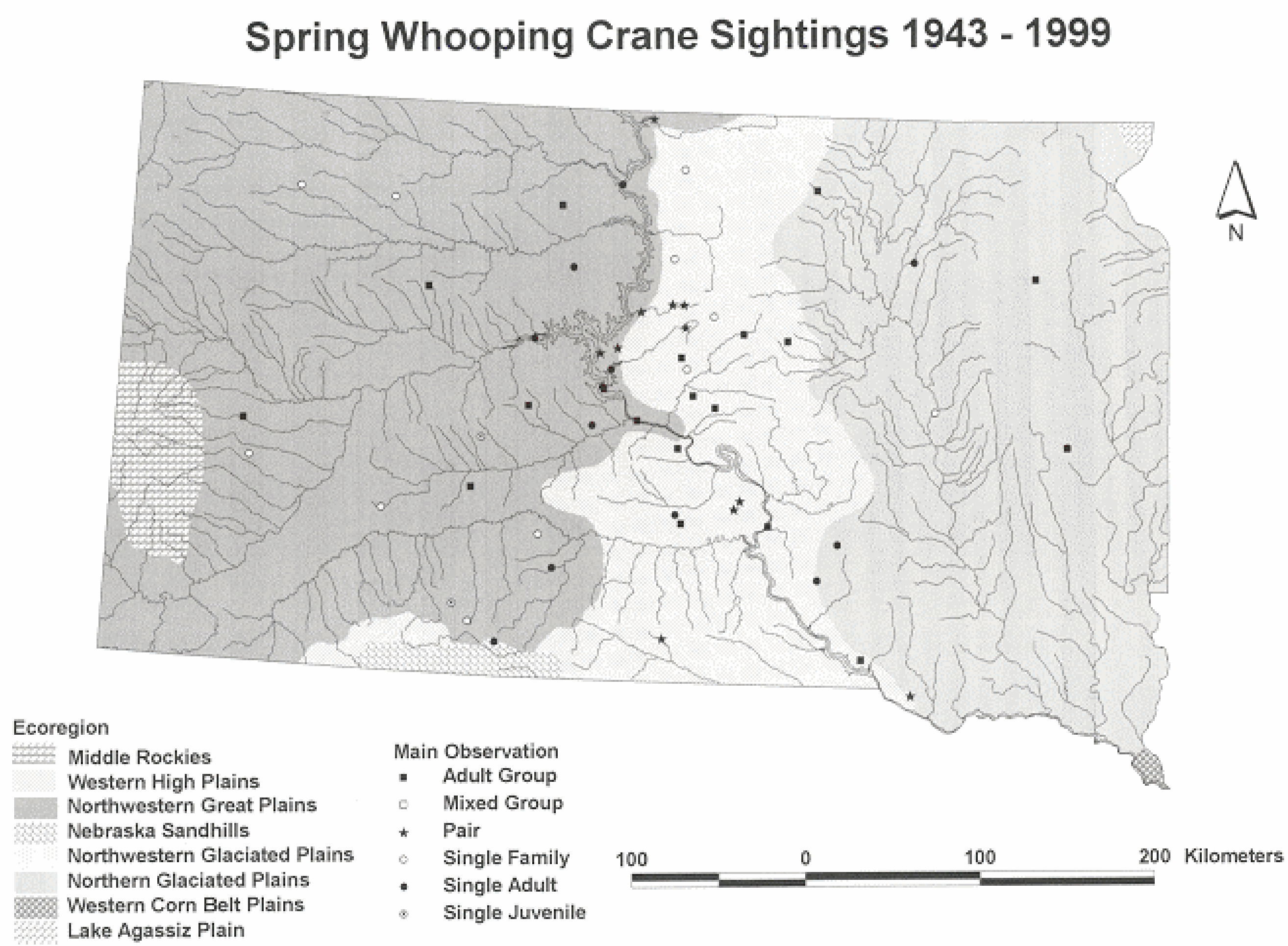
Table SD.5. List of named federal and state conservation areas where whooping cranes were sighted, 1943–99.

Ownership	Area	County
Federal	LaCreek NWR	Bennett
	Lake Andes NWR	Stanley
	McNenny Natl. Fish Hatchery	Lawrence
	Pocasse NWR	Campbell
State	Red Lake SWA	Charles–Mix
	Stone Lake SWA	Sully

SD map 1

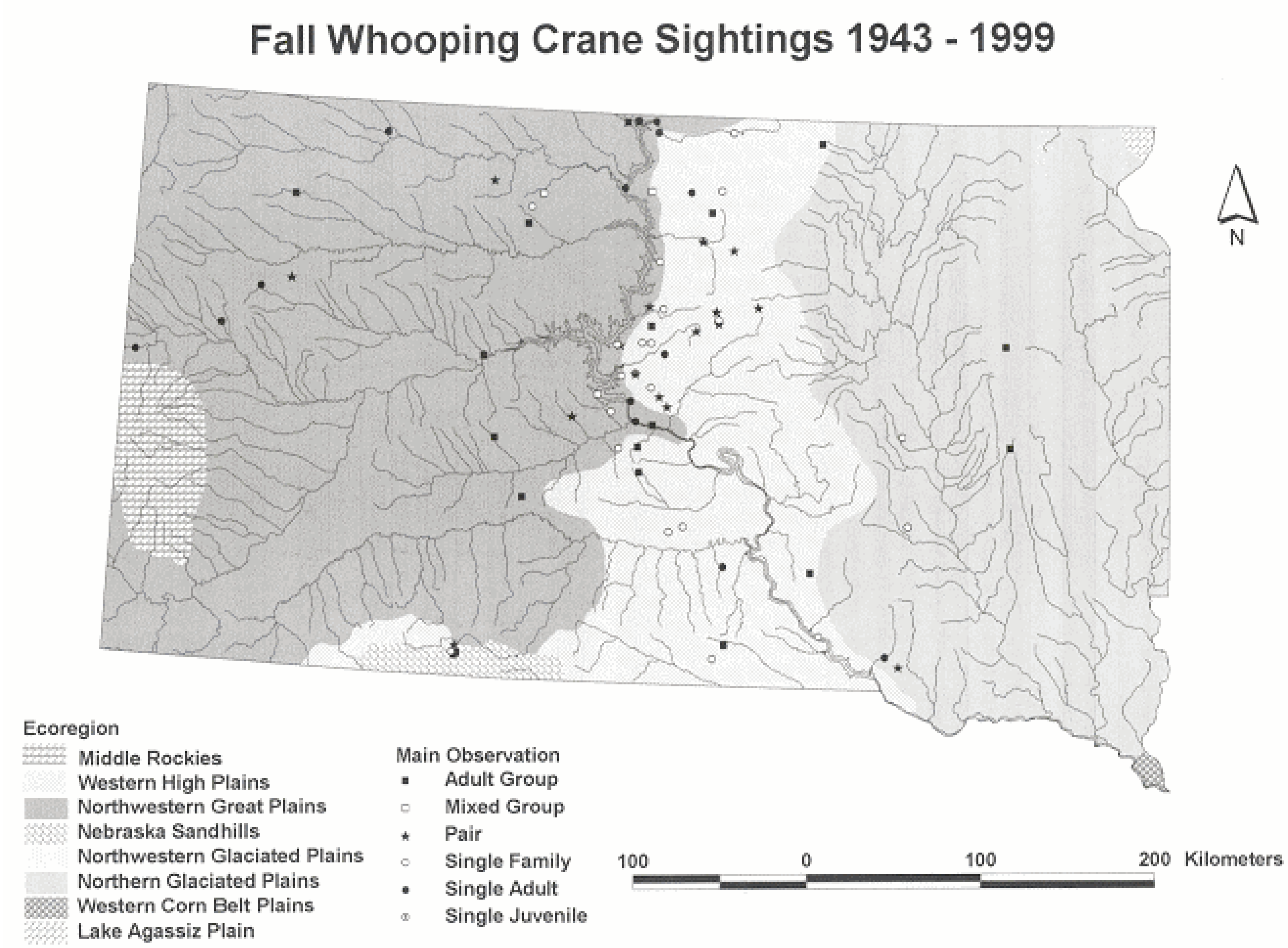

Whooping Crane Sightings 1943 - 1999
N
Main Observation
Spring
Fall
100
0
100
200 Kilometers

SD map 2

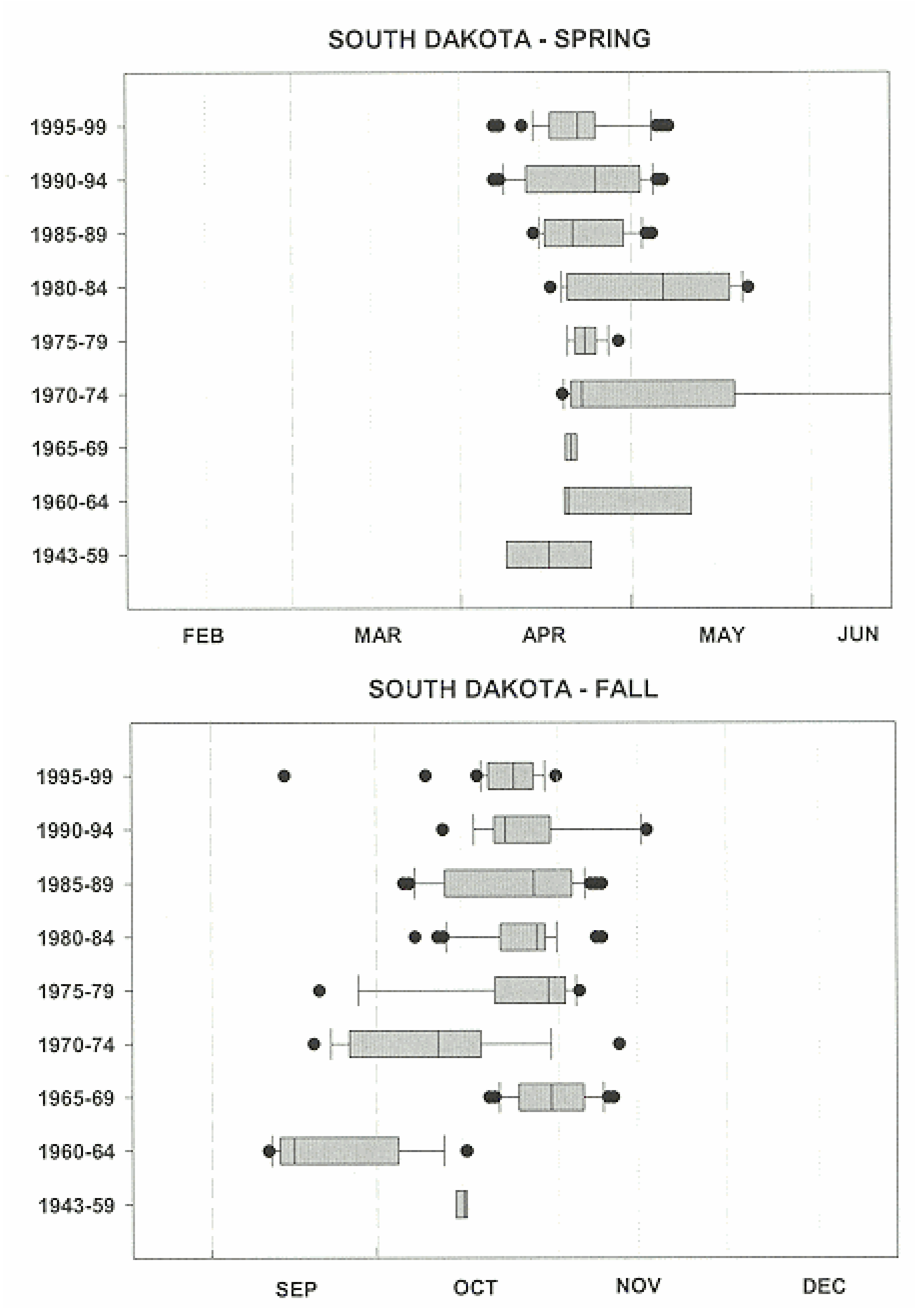


Spring Whooping Crane Sightings 1943 - 1999
N
Ecoregion
Middle Rockies
Western High Plains
Northwestern Great Plains
Nebraska Sandhills
Northwestern Glaciated Plains
Northern Glaciated Plains
Western Corn Belt Plains
Lake Agassiz Plain
Main Observation
Adult Group
Mixed Group
Pair
Single Family
Single Adult
Single Juvenile
100
0
100
200
Kilometers

SD map 3


Fall Whooping Crane Sightings 1943 - 1999
N
Ecoregion
Middle Rockies
Western High Plains
Northwestern Great Plains
Nebraska Sandhills
Northwestern Glaciated Plains
Northern Glaciated Plains
Western Corn Belt Plains
Lake Agassiz Plain
Main Observation
Adult Group
Mixed Group
Pair
Single Family
Single Adult
Single Juvenile
100 0 100 200 Kilometers

SD DATE GRAPHIC



TEXAS

Table TX.1. Number of site evaluations and total number of confirmed observations of whooping cranes, by 5-year periods, 1942–99. Includes only single records for each main observation; site evaluations before 1977 are not included.

	No. observations		
Period	**Spring**	**Fall**	***Total***
1943–59	0	0	*0*
1960–64	0	0	*0*
1965–69	0	1	*1*
1970–74	0	2	*2*
1975–79	0	2 / 4	*2 / 4*
1980–84	0 / 7	0 / 10	*0 / 17*
1985–89	1 / 2	2 / 9	*3 / 11*
1990–94	1 / 7	1 / 6	*2 / 13*
1995–99	0 / 0	0 / 9	*0 / 9*
Overall	*2 / 16*	*5 / 41*	*7 / 57*

Table TX.2. Number of site evaluations, by wetland system, site use, and season, 1977–99.

Site use	**Wetland system**	**Spring**	**Fall**	***Total***
Roost sites	Palustrine	0	0	*0*
	Riverine	0	0	*0*
	Lacustrine	0	0	*0*
	Unknown	0	0	*0*
	N	*0*	*0*	*0*
Feeding sites	Palustrine	0	1	*1*
	Riverine	0	0	*0*
	Lacustrine	0	0	*0*
	Unknown	1	4	*5*
	N	*1*	*5*	*6*
Dual-use sites	Palustrine	1	1	*2*
	Riverine	0	0	*0*
	Lacustrine	0	1	*1*
	Unknown	0	0	*0*
	N	*1*	*2*	*3*

Table TX.3. Number of sites under private, federal, state, or other ownership, by season and site use, 1977–99.

Site use	Site ownership	Spring	Fall	*Total*
Roost sites	Private	0	0	*0*
	Federal	0	0	*0*
	State	0	0	*0*
	Other	0	0	*0*
Feeding sites	Private	1	3	*4*
	Federal	0	1	*1*
	State	0	0	*0*
	Other	0	0	*0*
Dual-use sites	Private	1	1	*2*
	Federal	0	0	*0*
	State	0	0	*0*
	Other	0	0	*0*

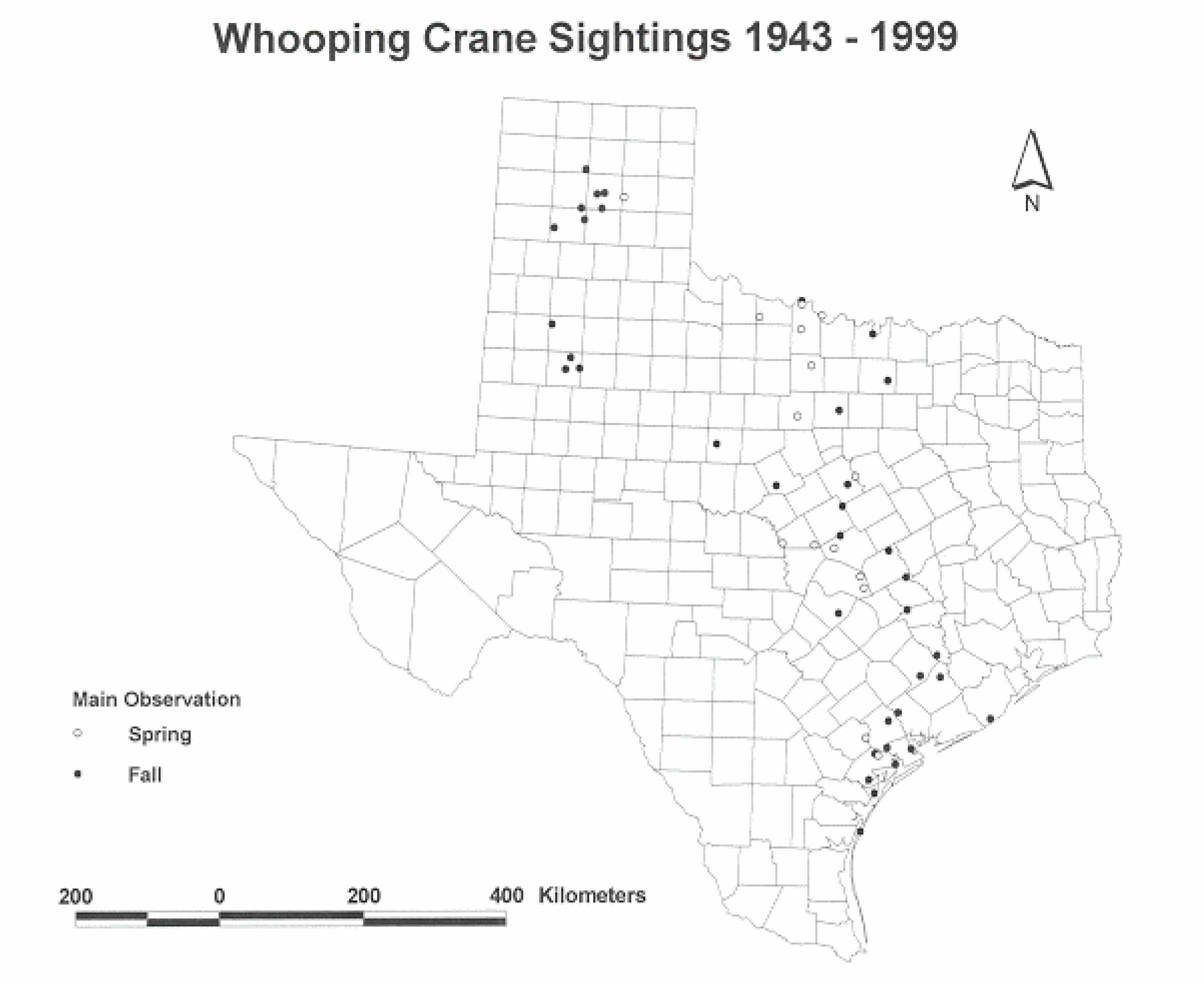
Table TX.4. List of named rivers, lakes, and reservoirs where whooping cranes were sighted, 1943–99.

System	Name	County
River	Colorado River	Lampasas
	Red River	Clay, Cooke
Lake & reservoir	Comanche Lake	Comanche
	Granger Lake	Williamson
	Lake Meredith	Potter
	Lake Somerville	Lee
	Lake Weatherford	Parker
	Lake Whitney	Bosque
	Little Elm Reservoir	Denton
	Playa Lake	Carson
	Old Charlie Lake	Clay

Table TX.5. List of named federal and state conservation areas where whooping cranes were sighted, 1943–99.

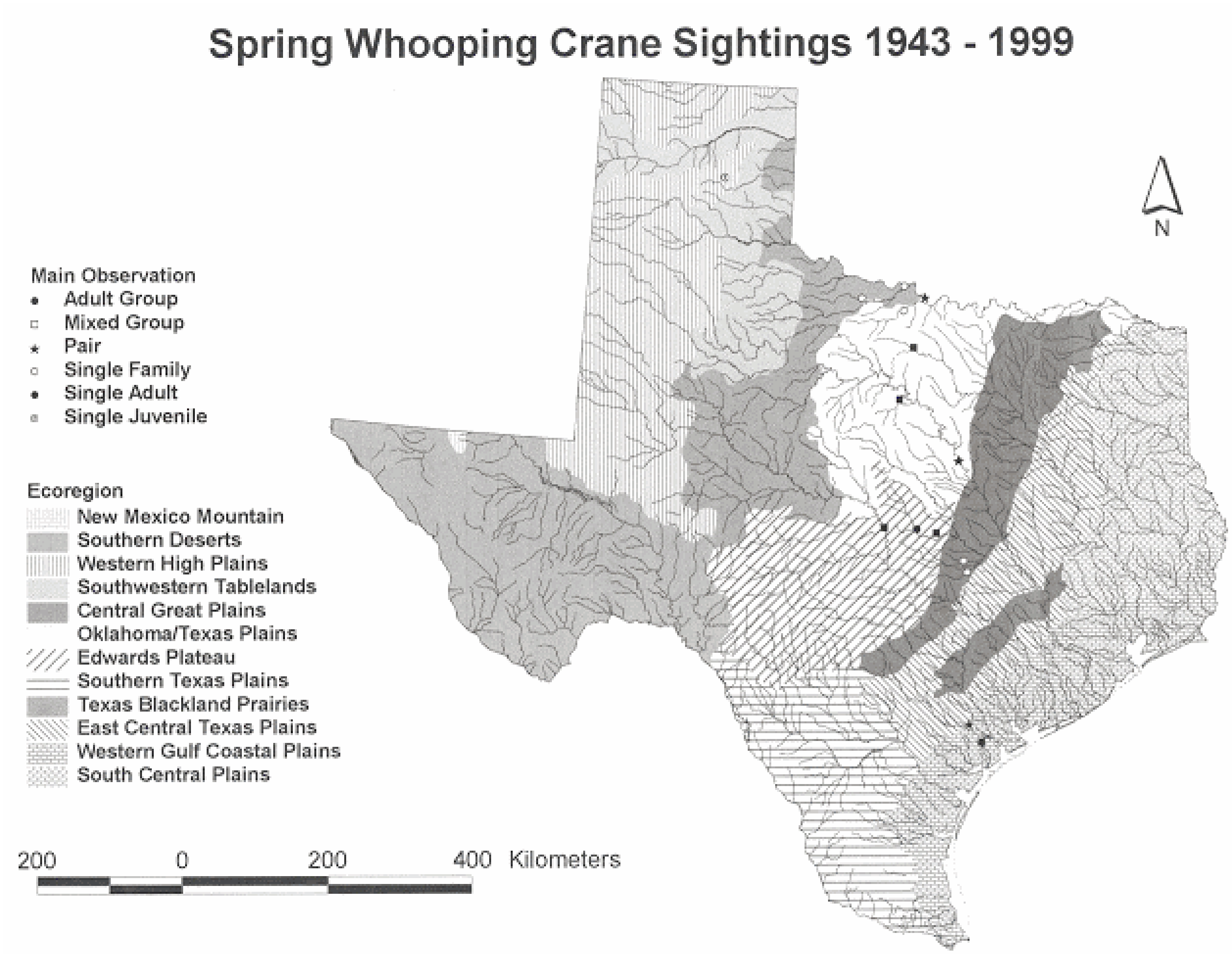
Ownership	Area	County
Federal	Buffalo Lake NWR	Randall
	Fort Hood Military Range	Bell

TX map 1

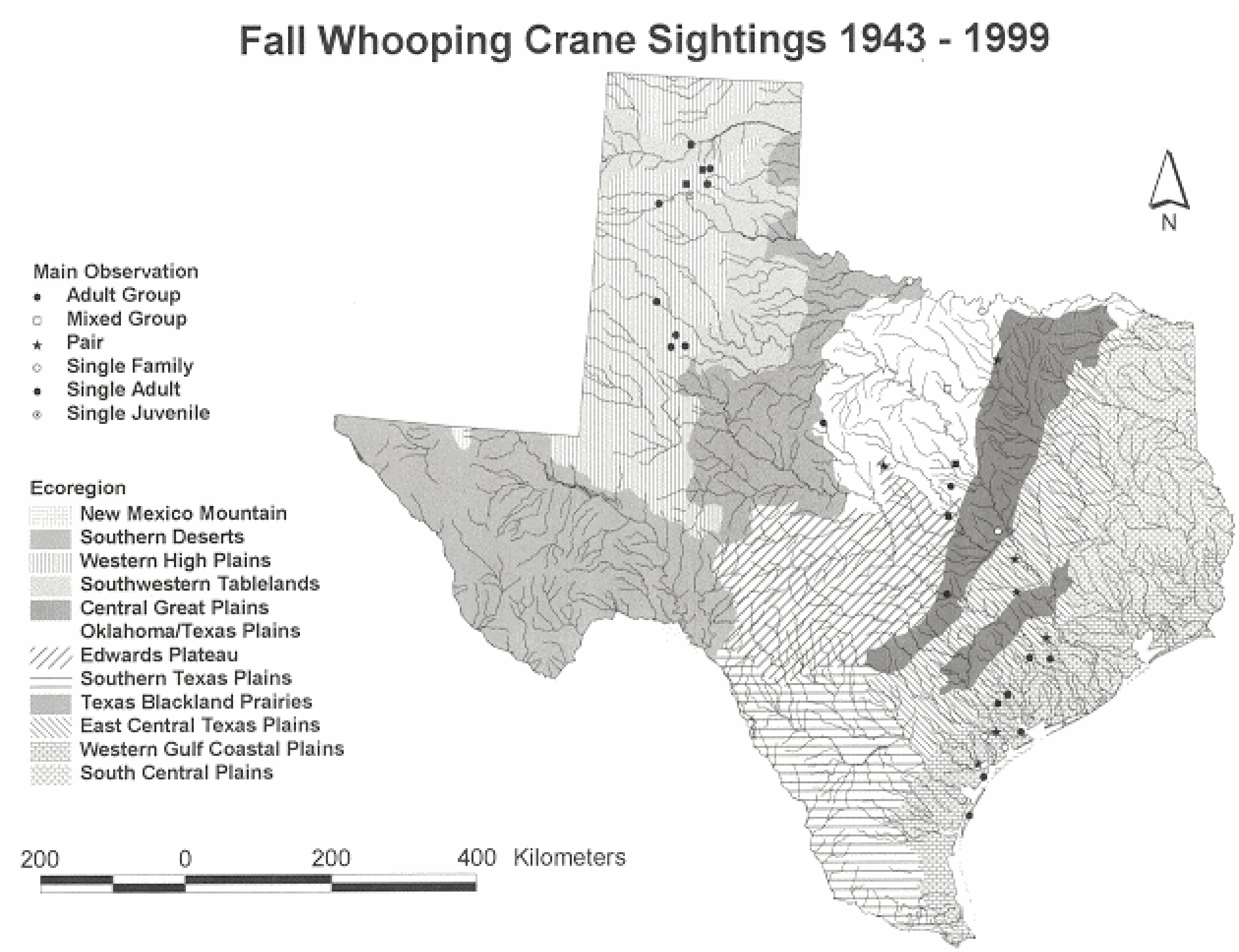


Whooping Crane Sightings 1943 - 1999
N
Main Observation
Spring
Fall
200
0
200
400 Kilometers

TX map 2

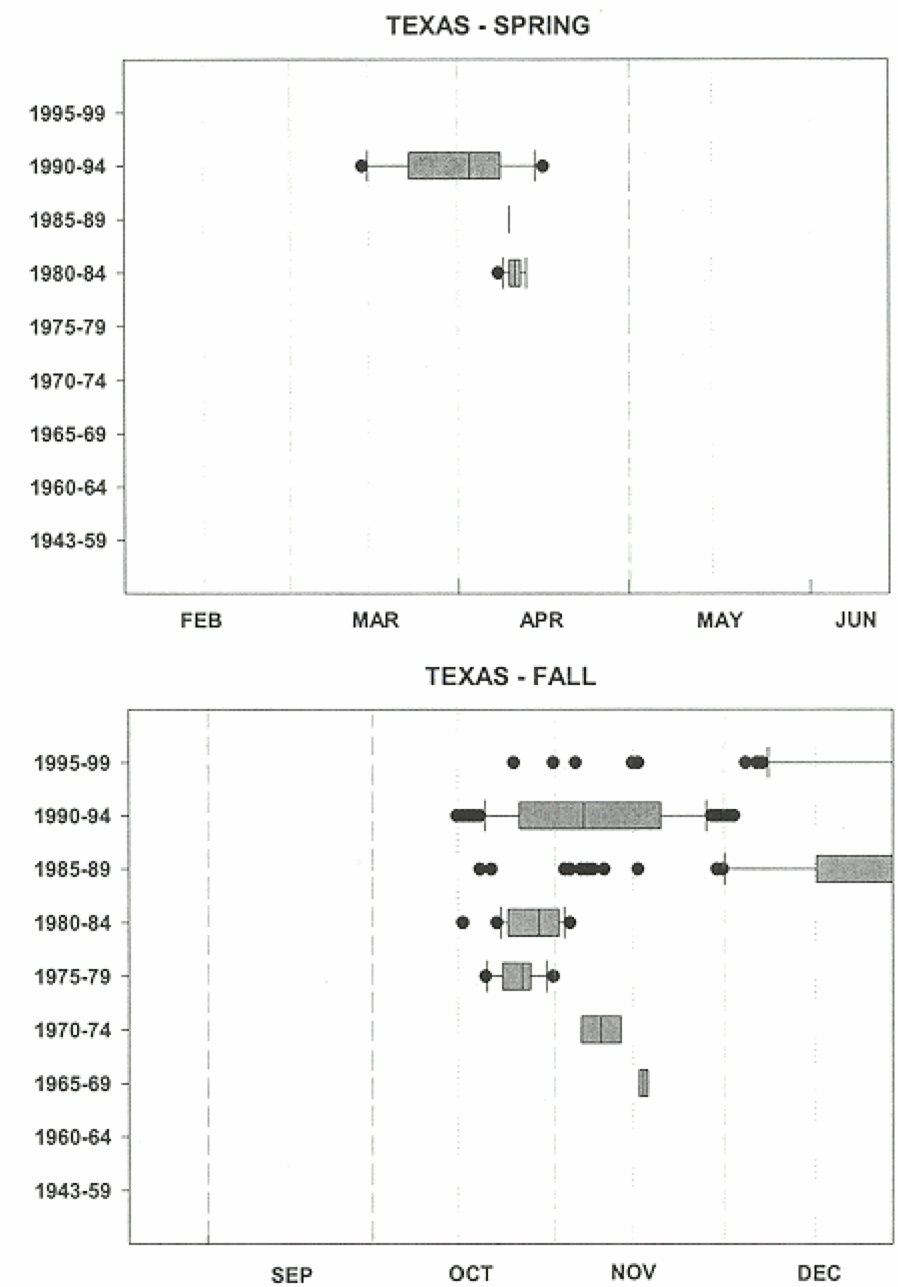

Spring Whooping Crane Sightings 1943 - 1999
Main Observation
Adult Group
Mixed Group
Pair
Single Family
Single Adult
Single Juvenile
Ecoregion
New Mexico Mountain
Southern Deserts
Western High Plains
Southwestern Tablelands
Central Great Plains
Oklahoma/Texas Plains
Edwards Plateau
Southern Texas Plains
Texas Blackland Prairies
East Central Texas Plains
Western Gulf Coastal Plains
South Central Plains
200
0
200
400
Kilometers
N

TX map 3

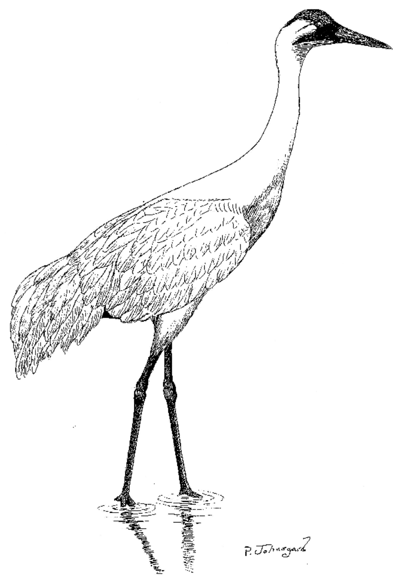


Fall Whooping Crane Sightings 1943 - 1999
N
Main Observation
Adult Group
Mixed Group
Pair
Single Family
Single Adult
Single Juvenile
Ecoregion
New Mexico Mountain
Southern Deserts
Western High Plains
Southwestern Tablelands
Central Great Plains
Oklahoma/Texas Plains
Edwards Plateau
Southern Texas Plains
Texas Blackland Prairies
East Central Texas Plains
Western Gulf Coastal Plains
South Central Plains
200 0 200 400 Kilometers

TX DATE GRAPHIC



REPORTING FORMS



Report 1. Whooping crane report form generated by the Canadian Wildlife Service in 1975.

Report 2. Form for recording reports of whooping crane sightings, used in 1977 and spring 1978.

Report 3a. Guide for evaluation of whooping crane sighting locations, used fall 1978–99.

Report 3b. Whooping crane sighting short form, used fall 1978–99.

Report 4. Whooping crane report field sheet for the contingency plan (also considered a short form), used 1985–99.

Report 5. Whooping crane site evaluation computer coding form, used 1984–99.

Report 6. Whooping crane site evaluation form used by Nebraska Game and Parks Commission, 1977–99. Includes a cover sheet coding form, forms for description of upland and wetland feeding and roosting habitat, and computer coding sheet guides.

WHOOPING CRANE REPORT

Observer(s):__________________________________ Address:____

____ Date Seen: __________________ Number Seen:__________

LAND LOCATION:____

Reported To: ________________________________ Reporter's Telephone:__________________________________

Were the birds you saw:
black and white ( ), all white ( ), rusty ( ), gray ( )

Did you observe the birds:
flying ( ), or landed ( )

If flying, were the:
LEGS – long and trailing ( ), short ( ), black ( ), orange ( )

NECK – curved ( ), or straight out ( )

BILL – long ( ), short ( ), black ( ), orange ( )

FLIGHT – flapping ( ), soaring ( )

If landed:
WALKING ( ) – in pasture ( ), summerfallow ( ), stubble ( )

SWIMMING ( )

WADING ( ) – in a slough ( ), lake ( ), stream ( )

BEHAVIOR – feeding ( ), drinking ( ), dancing ( ), calling ( )

Bird(s):
alone ( ), with geese ( ), with Sandhill cranes ( )

In your own words, describe their behavior, movements, time observed.

____

____

____

Return To:

PRAIRIE MIGRATORY
BIRD RESEARCH CENTRE
CANADIAN WILDLIFE SERVICE
115 PERIMETER ROAD
UNIVERSITY OF SASKATCHEWAN CAMPUS
SASKATOON, SASKATCHEWAN
S7N 0X4

FORM FOR RECORDING REPORTS OF WHOOPING CRANE SIGHTINGS
WHOOPING CRANE OBSERVATION RECORD

DATE OF SIGHTING ____________ TIME OF SIGHTING __________ REPORTING DATE ___________

Location: (exact as possible)

Number observed: ____

How long observed: ____

Distance of observation: ____

Were binoculars used? _____________________ Spotting scope? ____

Check (✓) appropriate spaces.

Were the birds: black and white ( ), all white ( ), rusty ( ), gray ( )?

Were the birds: observed flying ( ), or landed ( )?

If they were flying, were the:

Legs: long and trailing ( ), short ( ), black ( ), orange ( )?

Wings: with black tips ( ), pure white ( )?

Neck: curved ( ), or stretched straight out ( )?

Flight: flapping ( ), soaring ( )?

If they were landed, were the birds:

walking ( ), wading ( ), swimming ( )?

Legs: long ( ), short ( ), black ( ), orange ( )?

Bill: long ( ), short ( ), black ( ), orange ( )?

Behavior:

feeding ( ), drinking ( ), dancing ( ), calling ( )?

Were they alone ( ), with geese ( ), with Sandhill cranes ( ), with other birds (specify) ___________

Description of sighting location and habitat utilized (grain field, marsh, overhead, etc.):

Observer's name ____

Address: ____ Telephone: ___________________________

FOR OFFICIAL USE ONLY

Classification of Observation:

Confirmed ( ), Probable ( ), Unconfirmed ( )

Reasons for classification selection:

GUIDE FOR EVALUATION OF WHOOPING CRANE SIGHTING LOCATIONS

Introduction

The primary objective of this form is to provide guidance related to the kinds of data which are needed from locations where whooping cranes have been sighted. A whooping crane sighting or report of a sighting should first be recorded on the attached form, Whooping Crane Sighting Record. Once that form is completed, the following information should be obtained for each sighting location. Please be as detailed as possible in recording data. Attach the two forms securely together. Daily or other periodic observations should use additional forms.

I. **Describe Location:** Record location of sighting as exact as possible (Mileage on specific roads, names and numbers of townships and sections, etc.).

II. **Photograph Location:** Obtain a good quality photograph showing an overall view of sighting location.

III. **Describe Habitat:** If a wetland, describe, if possible, on basis of Cowardin, et al, 1976, Interim Classification of Wetlands Aquatic Habitats of the United States. *Proceedings National Wetland Classification and Inventory Workshop.*

The following information should also be recorded.

A. Describe water where crane(s) observed.

1. Depth
2. Quality (clear, turbid, salinity, etc.)
3. Bottom Characteristics (soft, mud, sand, etc.)

B. Describe aquatic plant community where cranes observed.

1. Dominant species
2. Sub-dominant species
3. Density of vegetation (scattered, dense, choked, etc.)
4. Density of vegetation immediately surrounding sighting area (pond surrounded by grass fringe 3 feet high, marshy meadow with grass and sedges less than 12 inches high, etc.)

C. Describe surrounding upland habitat types (wheat and corn fields, sandhills, with native grass, etc.)

D. Describe the abundance of potential whooping crane food (scattered waste grain, abundant nutgrass tubers, numerous frogs, crayfish or snails, etc.)

E. Give an idea of numbers and species of other migrating wildlife utilizing the same area (sandhill cranes, waterfowl, etc.)

F. Describe stability and security of habitat type and any nearby activities which could threaten the site or the cranes (perennial cultivated cropland, marsh slated for drainage, wet meadow threatened by dame construction, etc.).

G. What is the extent of similar habitats in surrounding areas (within 10 mile radius)?

H. What is the ownership of the area where the cranes were observed (federal, private, state, etc.)?

IV. **<u>Details of Whooping Crane Use</u>:**

A. How manage, wet meadow threatened by dame construction, etc.).

B. Describe behavior of cranes while under observation (feeding in water, feeding along shoreline, roosting on sandbar, etc.). If cranes were observed feeding, what were they believed to be eating?

C. Describe any other observations which may be of interest (such as any interaction between whooping cranes and other wildlife or humans, flight patterns observed etc.).

WHOOPING CRANE SIGHTING REPORT

Observer: Name ____________________________ Telephone __________________

Address____

Reporter: Name ___________________________ Telephone __________________

Address __________________________ Agency/Org. _________________

Reporting Date _______________________ Sighting Date ______________________

Number Seen: Adults ___________ Young ___________ Total ___________

Location: (Direction and distance from nearest town, and legal description of site)

____

____

____

____

Describe site: (Any details about land use, wetland, etc.)______________________________

____

____

____

Time and duration of sighting: ____

Color-markings observed: ____

Final Tabulation Use, Only
OBS. NO. __________
Classification:
Confirmed _____
Probable _____
Unconfirmed _____
Sighting Date & Duration: __________
____
____
Location:
County __________
Prov/State__________
(Degree Block)
Lat. ___________
Long. ___________
Ground___________
Water ___________
Air ___________
Color-Marking
Lft. ___________
RT. ___________

Observation Details:

Bird(s) observed: (1) flying ________ or, (2) landed ________

Distance of observation ____________________________ Binoc. Used _____________ Scope used ____________

Bird(s) description (ask observer about each)

BODY ____

LEGS ____

WINGS ____

NECK ____

HEAD & BILL ____

Behavior (describe in observers words): ____

____

____

____

____

List other birds present at site: ____

____

List species seen flying with: ____

WHOOPING CRANE REPORT FIELD SHEET

STATE___________________________________

Recorded by_______________________________

Date____

Phone Number_________________________________

FOR RECORDS CENTER ONLY
Obs. Number____________________________
Confirmed______________________________
Probable_______________________________
Unconfirmed____________________________

STATE CONTACT PERSONS:

Name____

Office Phone__________________________________

Home Phone__________________________________

Name____

Office Phone__________________________________

Home Phone__________________________________

FWS CONTACT PERSONS:

Name ____

Office Phone ___________________________________

Home Phone ___________________________________

Name ____

Office Phone ___________________________________

Home Phone ___________________________________

If a whooping crane is sighted or reported, IMMEDIATELY notify your agency contact person. If you are unable to advise your designated agency contact person, please notify a contact person of the cooperative agency. Notify your immediate supervisor, if you are unable to contact any of the people listed above. Complete this form whenever you receive a report of a whooping crane. Inquire about the observer's familiarity with whoopers and look alike species. The question should be worded to gain some insight about the validity of the sighting report. Send completed form to: Wally Jobman, U.S. Fish and Wildlife Service, 2604 St. Patrick, Suite 7, Grand Island, NE 68803.

Observer's Name ____

Address ____

Phone Number (home) _______________________ (work) ________________________

Other Observers (?) Names ____

____

Date of Observation _________________________ Time __________________________

Location of Sighting (distance and direction from nearest town)

____

Description of birds ____

____

Number of adults ___________ young __________ Duration of sighting ____________

Behavior of birds (Circle appropriate descriptor: flying or landed, feeding or roosting).

Evidence of injury, sickness, or hazard? ____

____

Colored leg bands observed: Left ___________ Right ___________

/__ / Reported to Records Center: Date ______________________ Time ______________________

/__ / Phone /__ / Mail By (name) ____

WHOOPING CRANE SITE EVALUATION CODING FORM

1. Obs. No. [e.g. 84A-11(B)]
2. State
3. County
4. Location of Site (e.g. T5N, R2E, S5, NW4)
5. Site Use: 1 = Feeding 2 = Roosting 3 = Both 4= Unknown
6. Wetland Classification: System, Subsystem, Class, Modifiers*, Type**
   (*Cowardin et al. 1979; ** Circular 39)

SYSTEM
- 1a = Riverine
- 2a = Lacustrine
- 3a = Palustrine

SUBSYSTEM
- 1b = Lower perennial
- 2b = Upper perennial
- 3b = Intermittent
- 4b = Limnetic
- 5b = Littoral

CLASS
- 1c = Rock bottom
- 2c = Uncons. Bottom
- 3c = Aquatic bed
- 4c = Uncons. shore
- 5c = Emergent wetland
- 6c = Streambed
- 7c = Rocky shore
- 8c = Forested wetland
- 9c = Moss-lichen wetland

MODIFIERS
- 1d = Permanently flooded
- 2d = Intermit. exposed
- 3d = Semiperm. flooded
- 4d = Seasonally flooded
- 5d = Saturated
- 6d = Temporarily flooded
- 7d = Intermit. Flooded
- 8d = Artificially flooded
- 9d = Interm. Flooded / temp.

TYPE: I – XX

7. Water Depth (where cranes observed, in inches)

   R = Range in wetland (e.g. R1 – 12 or C4)
   C = Range at crane roost

8. Quality

   1 = Clear
   2 = Turbid
   3 = Saline

9. Substrate

   1 = Sand
   2 = Soft mud
   3 = Hard mud
   4 = Other

10. Slope of Shoreline (%)

    1 = < 1
    2 = 1 < 5
    3 = 5 – 10
    4 = > 10
    5 = NA
    6 = Other (term used ________________________________)

11. Dominant emergent vegetation

1 = grass
2 = sedge
3 = cattail
4 = rush
5 = smartweed
6 = other
7 = none

12. Density of vegetation

1 = none
2 = scattered
3 = clumped
4 = choked

13. Roost site description (Place comma between types)

Wetland
9 = flooded pasture
10 = wooded creed or draw
11 = flooded cropland
12 = stockpond
13 = reservoir
14 = lake
15 = marsh
16 = river
17 = salt marsh
18 = tailwater pit
19 = seasonally flooded basin

Upland (Place comma between types but not subtypes, e.g. 14, 21M, 22 or 21ABCD, 22)
21 = cropland (specify type*)
22 = pasture
23 = wet meadow
24 = hay meadow
25 = woodland
26 = other (describe)

* Specified crop type (don’t separate by commas)

A = alfalfa	L = fallow	T = bean stubble
B = barley	M = milo	U = sunflower
C = corn	N = disked alfalfa	V = barley stubble
D = CRP	O = oat stubble	W = winter wheat
E = rice	P = popcorn	X = wheat stubble
F = sunflower	R = green rye	Y = milo stubble
G = spring wheat	S = soybean	Z = corn stubble

14. Feeding site description
(same as # 13)

15. Primary adjacent habitat within 1 mile radius
(same as #13)

16. Size of wetland [if riverine: Rxxx – xxx (yards)]

1 = < 1 acre
2 = 1 < 5
3 = 5 < 10
4 = 10 < 50
5 = 50 < 100
6 = > 100
7 = NA

17. Distance to feeding site (miles)

1 = < ¼
2 = ¼ < ½
3 = ½ < ¾
4 = ¾ - 1
5 = > 1
6 = NA

18. Distance to nearest human development (miles)
(same as #13)

19. Primary potential food source (Separate food types by commas, e.g. 3, 7, 9)

1 = grain (seed & plant material)
2 = tubers
3 = insects and other inverts
4 = mollusks
5 = crustacean
6 = fish
7 = frogs
8 = other
9 = salamanders

20. Foods observed eaten by bird(s)
(same as #13)

21. Site security
1 = stable 2 = threatened 3 = unknown

22. Extent of similar habitat within 10 mile radius

1 = none
2 = little
3 = moderate, common
4 = abundant
5 = unknown

23. Site ownership

    1 = private
    2 = federal
    3 = state
    4 = other

24. Number of birds

25. Observation date

26. Time of initial sighting (____ : ____ AM or PM)

27. Time of departure

28. Color bands (Y, etc.)

29. Visibility (yards)

    1 = unlimited
    2 = < 100
    3 = 100 < 440
    4 = 440 – 880
    5 = > 880
    6 = NA

30. Distance to nearest power or phone line (yards)

    1 = < 100
    2 = 100 <440
    3 = 440 – 880
    4 = NA > 880

31. Source

    1 = Johnson
    2 = USFWS
    3 = radio-tracking

32. Photo taken

    Y / N

OBS. NO. _ _ _ _ _ _ _ _ _ _

SITE _ _ _ _

TYPE OF SITE _ _ _ _ _ _ _ _ _ _ _ _

Roost
Both (feeding and roost)

GENERAL LOCATION (from town, highways, etc.)

____
____

LEGAL DESCRIPTION _

_ _ _ _ _ _ _ _ _ _ (example: T23N, R10W, S28, NE4, SE4)

WETLAND CLASSIFICATION _ _ _ _ _ _ _ _ _ / _ _ _ _
(Use Cowardin, 1979. Special modifiers go after the "/", use commas to separate special modifiers)

____

____

TYPE _ _ _
I
II
III
IV
V

WETLAND SIZE _ _ _ _ _ _ _ _ _ _ _ _ _ _
(Nonriverine – acreage of pond, wetland
Riverine (water width) – use total width of water within the unobstructed channel, in yards)

WATER QUALITY _ _ _ _ _ _ _ _ _ _ _ _ _ _
Clear
Turbid
Saline
Not Available

SUBSTRATE _ _ _ _ _ _ _ _ _ _ _ _ _ _
Sand
Soft mud
Hard mud
Other (describe) ______________________________

____
Not available

PLACE WATER DEPTH MEASUREMENTS BELOW:

Nonriverine sites: Two perpendicular transects intersecting at roost. Limit transect lengths to 100 yards or terminate at an obstruction or when a sustained depth of 36” is reached. Depth at 10’ intervals.

Roost depth (X) = _ _

Transect 1 _ X _

Transect 2 _ X _

Riverine sites: Transect through roost perpendicular to channel. Depth at 10’’ intervals.

Roost depth (Place X in appropriate spaces) = _ _

_ _

_ _

_ _

_ _

_ _

_ _

_ _

_ _

Water Depth Range _ _ _ _ _ _ _ _

(Range of water depths, in inches, in roost area)

CRANE DEPTHS 1 _ _ 2 _ _ 3 _ _ 4 _ _ 5 _ _ 6 _ _

7 _ _ 8 _ _ 9 _ _ 10 _ _ 11 _ _ 12 _ _

(Depth of water in inches where the crane roost was actually located. Each set of blanks is for one particular night, up to 12 nights.)

OBS. _ _ _ _ _ _ _ _ _ _ _ _ SITE _ _ _ _

DOMINANT AQUATIC EMERGENT
VEGETATION OF ENTIRE WETLAND _ _ _ _ _ _ _
(Separate with commas)

VEGETATION _ _ _ _
(Use Golet & Larson, 1974)

____ ____________________________________

____

When determining visibilities, a bank, woody perennial vegetation, or other obstruction greater than 3 feet in height may be an obstruction.

RIVERINE VISIBILITY – WIDTH _ _ _ _
(unobstructed channel width, in yards)

RIVERINE VISIBILITY – LENGTH _ _ _ _
(length of channel from obstruction to obstruction in yards)

VISIBILITY TO NEAREST OBSTRUCTION _ _ _
(both riverine and nonriverine)

DIRECTION AND TYPE OF NEAREST
OBSTRUCTION ______________________
____

ROOST SITE DESCRIPTION _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ ______________________________________

TYPES OF OTHER ROOSTING
HABITAT WITHIN A 2.5 MI. RADIUS _ _ _ _ _ _ _ _ _ _ _ _ _ __________________________________

____

PRIMARY ADJACENT COVER TYPES WITHIN A 1 MILE RADIUS _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

____

DISTANCE TO FEEDING SITES _____________________________

____

DISTANCE TO HUMAN DEVELOPMENTS:

_ Paved Road ______________________________

_ Gravel Road _________________________________

_ Urban Dwelling ___________________________
(3 or more houses)

_ Single Dwelling ______________________________

_ Railroad __________________________________

_ Comm. Development _________________________

_ Recreational Area _________________________

_ Bridge _______________________________________

PRIMARY POTENTIAL FOODS _ _ _ _ _ _ _
(separate food types with commas)

____

FOODS OBSERVED EATEN _ _ _ _ _ _ _ _ _ _ _ _
(separate with commas)

____

SITE SECURITY _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
Stable
Threatened
Unknown

COMMENTS ON SITE SECURITY (i.e. why is site threatened, etc.) ______________________________

____

____

SITE OWNERSHIP _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

Private
State
Federal
Other (power dist. Audubon Soc., etc.)
Not available

NAME AND LOCATION OF OWNER/CONTRACT

____

____

____

DISTANCE TO NEAREST POWER OR PHONE LINE ____

DETAILS OF WHOOPING CRANE USE (how many, behavior, interactions, etc.):

OBS. NO. _ _ _ _ _ _ _ _ _ _

SITE _ _ _ _

TYPE OF SITE _ _ _ _ _ _ _ _ _ _ _ _

Roost
Both (feeding and roost)

GENERAL LOCATION (from town, highways, etc.)

____
____

LEGAL DESCRIPTION _

_ _ _ _ _ _ _ _ _ _ _ (example: T23N, R10W, S28, NE4, SE4)

WETLAND CLASSIFICATION _ _ _ _ _ _ _ _ _ _ / _ _ _ _
(Use Cowardin, 1979. Special modifiers go after the "/", use commas to separate special modifiers)

____
____

TYPE _ _ _
I
II
III
IV
V

WETLAND SIZE _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
(Nonriverine – acreage of pond, wetland
Riverine (water width) – use total width of water within the unobstructed channel, in yards)

WATER QUALITY _ _ _ _ _ _ _ _ _ _ _ _ _
Clear
Turbid
Saline
Not Available

SUBSTRATE _
Sand
Soft mud
Hard mud
Other (describe) ____________________

____
Not available

WATER DEPTH RANGE _ _ _ _
(In inches)

DOMINANT AQUATIC EMERGENT
VEGETATION OF ENTIRE WETLAND _ _ _ _ _ _ _ _ _ _ _ _ _
(Separate with commas)

____

VEGETATION ___
(Use Golet & Larson, 1974 cover types 1 thru 8) ____

____

FEEDING SITE DESCRIPTION ___________________________

TYPES OF OTHER FEEDING
HABITAT WITHIN A 2.5 MI RADIUS _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

____

DISTANCE TO HUMAN DEVELOPMENTS:

_ Paved Road _____________________________ _ Gravel Road ________________________________

_ Urban Dwelling __________________________ _ Single Dwelling _____________________________
(3 or more houses)

_ Railroad ________________________________ _ Comm. Development ________________________

_ Recreational Area ________________________ _ Bridge _____________________________________

PRIMARY POTENTIAL FOODS _ _ _ _ _ _ _ ____
(separate food types with commas)

FOODS OBSERVED EATEN _ _ _ _ _ _ _ _ _ ____

SITE SECURITY _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
Stable
Threatened
Unknown

COMMENTS ON SITE SECURITY (i.e. why is site threatened, etc.) ______________________________

____

____

SITE OWNERSHIP _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
Private
State
Federal
Other (power dist. Audubon Soc., etc.)
Not available

NAME AND LOCATION OF OWNER/CONTRACT

____

____

____

DISTANCE TO NEAREST POWER OR PHONE LINE _______________________________________

DETAILS OF WHOOPING CRANE USE (how many, behavior, interactions, etc.):

OBS. NO. _ _ _ _ _ _ _ _ _ _ SITE _ _ _ _

TYPE OF SITE _ _ _ _ _ _ _ _ _ _ _ _

Feeding
Both (feeding and roost)

GENERAL LOCATION (from town, highways, etc.)

____
____

LEGAL DESCRIPTION _

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ (example: T23N, R10W, S28, NE4, SE4)

FEEDING SITE DESCRIPTION _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

____

TYPES OF OTHER FEEDING HABITAT
WITHIN A 2.5 MI RADIUS _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

____

____

DISTANCE TO HUMAN DEVELOPMENTS:

_ Paved Road _______________________________ _ Gravel Road __________________________________

_ Urban Dwelling ___________________________ _ Single Dwelling _______________________________
(3 or more houses)

_ Railroad ______________________________ _ Comm. Development _________________________

_ Recreational Area _________________________ _ Bridge ____

PRIMARY POTENTIAL FOODS _ _ _ _ _ _ _ _
(separate with commas)

____

FOODS OBSERVED EATEN _ _ _ _ _ _ _ _
(separate with commas)

____

SITE SECURITY _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
Stable
Threatened
Unknown

COMMENTS ON SITE SECURITY (i.e. why is site threatened, etc.) ______________________________

____

____

SITE OWNERSHIP _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
Private
State
Federal
Other (power district, Audubon Society, etc.)
Not Available

NAME AND LOCATION OF OWNER / CONTACT ____

____

____

DISTANCE TO NEAREST POWER OR PHONE LINE____

DETAILS OF WHOOPING CRANE USE (i.e. how many, behavior, interactions, etc.):

CODE KEY – WHOOPING CRANE SITE EVALUATIONS (cont.)

DOMINANT VEGETATION:

Grass	= 1	Smartweed	= 5
Sedge	= 2	Other	= 6
Cattail	= 3	None	= 7
Rush	= 4		

ROOST AND FEEDING SITE DESCRIPTIONS:

Separate types with semicolons. Separate subtypes with commas. To use modifiers with types, place decimal between them. To use modifiers with subtypes, add modifier without a decimal. For example, 11A6; 15; 20.6

TYPE		**CROPLAND SUBTYPE**		**MODIFIERS**	
Flooded pasture	= 09	Alfalfa	= A	Green	= 1
Wooded creek or draw	= 10	Barley	= B	Stubble	= 2
Flooded cropland (specify subtype)	= 11	Corn	= C	Disked	= 3
Stockpond	= 12	Sunflower	= F	Plowed	= 4
Reservoir	= 13	Fallow	= L	Grazed	= 5
Lake	= 14	Milo	= M	Hayed	= 6
Marsh (Type III & IV)	= 15	Oats	= O		
River	= 16	Popcorn	= P		
Seasonally flooded basin	= 17	Rye	= R		
Wet Meadow (Type II)	= 18	Soybean	= S		
Other (describe)	= 19	Wheat	= W		
Flooded hayfield	= 20				
Cropland (specify subtype)	= 21				
Pasture	= 22				
Haymeadow	= 23				
Other	= 24				
Woodland	= 25				

FOODS:

Grain (seed & plant material)	= 1	Fish	= 6
Tubers	= 2	Frogs	= 7
Insects and/or invertebrates	= 3	Other	= 8
Mollusks	= 4	Salamanders	= 9
Crustaceans	= 5	Not available	= 10

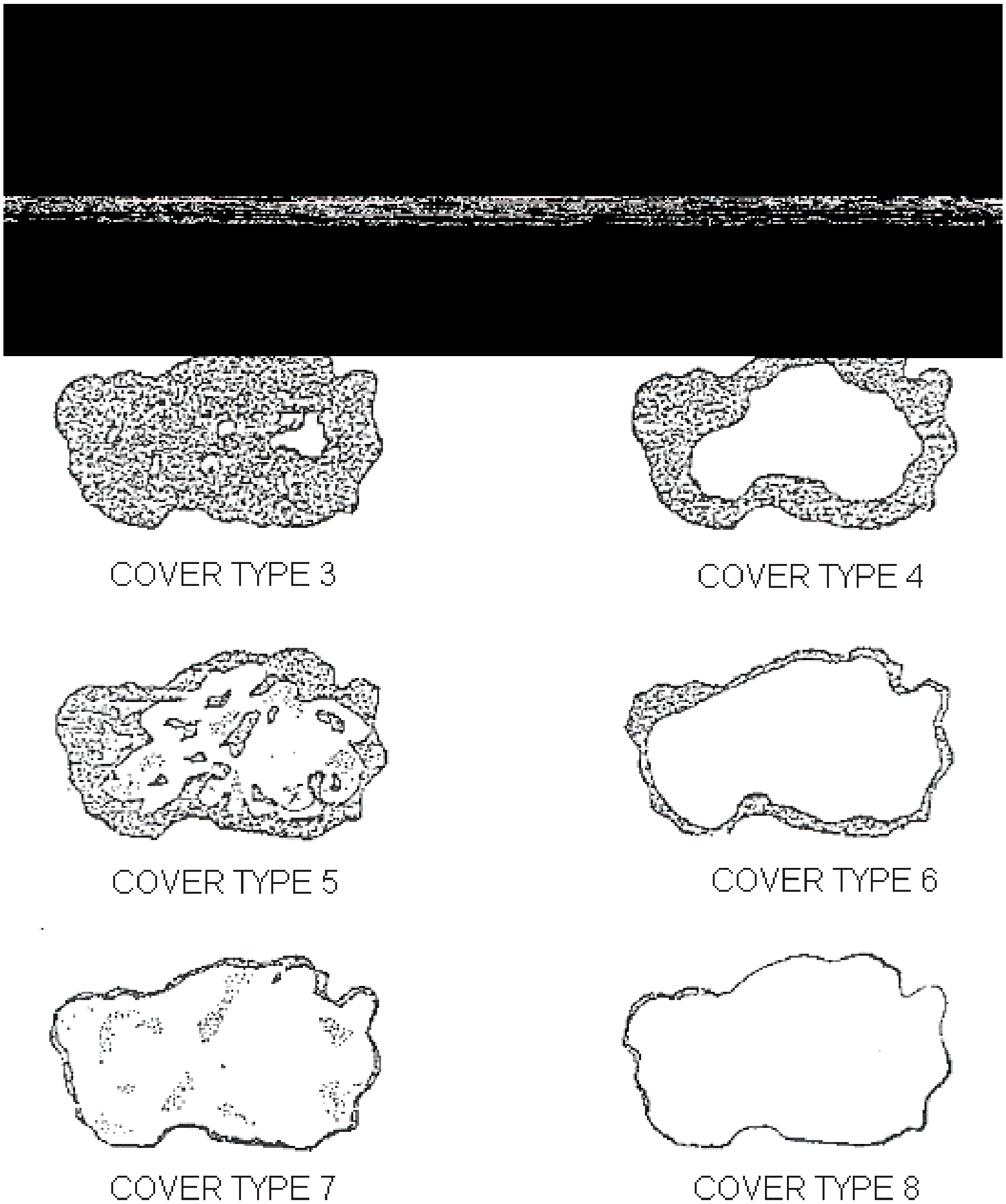
DISTANCE (D):

To Feeding Sites and Human Development:

$D < 1/4$ mile	= 1 mile	$1 \leq D < 2$ miles	= 5
$1/4 \leq D < 1/2$ mile	= 2	$D \geq 2$ miles	= 6
$1/2 \leq D < 3/4$ mile	= 3	Not available	= 7
$3/4 \leq D < 1$ mile	= 4		

To Power or Phone Lines:

$D < 100$ yards	= 1
$100 \leq D < 440$ yards	= 2
$440 \leq D < 880$ yards	= 3
$D \geq 880$ yards	= 4



1. Cover plants occupy more than 95 percent of the wetland area.

2. Cover plants occupy 76-95 percent of the wetland area occurring in peripheral bands.

3. Cover plants occupy 76-95 percent of the wetlands area occurring in dense patches or diffuse open stands.

4. Cover plants occupy 26-75 percent of the wetland area occurring in peripheral bands.

5. Cover plants occupy 26-75 percent of the wetland area occurring in dense patches or diffuse open stands.

6. Cover plants occupy 5-25 percent of the wetland area occurring in a peripheral band.

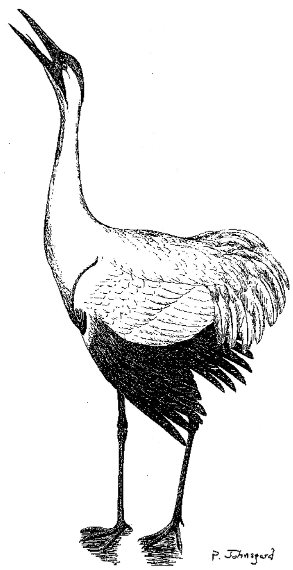
7. Cover plants occupy 5-25 percent of the wetland area occurring in dense patches or diffuse open stands.

8. Cover plants occupy less than 5 percent of the wetland area.

COUNTY CODING FOR COMPUTER

1. Adams
2. Antelope
3. Arthur
4. Banner
5. Blaine
6. Boone
7. Box Butte
8. Boyd
9. Brown
10. Buffalo
11. Burt
12. Butler
13. Cass
14. Cedar
15. Chase
16. Cherry
17. Cheyenne
18. Clay
19. Colfax
20. Cuming
21. Custer
22. Dakota
23. Dawes
24. Dawson
25. Deuel
26. Dixon
27. Dodge
28. Douglas
29. Dundy
30. Fillmore
31. Franklin
32. Frontier
33. Furnas
34. Gage
35. Garden
36. Garfield
37. Gosper
38. Grant
39. Greeley
40. Hall
41. Hamilton
42. Harlan
43. Hayes
44. Hitchcock
45. Holt
46. Hooker
47. Howard
48. Jefferson
49. Johnson
50. Kearney
51. Keith
52. Keya Paha
53. Kimball
54. Knox
55. Lancaster
56. Lincoln
57. Logan
58. Loup
59. McPherson
60. Madison
61. Merrick
62. Morrill
63. Nance
64. Nemaha
65. Nuckolls
66. Otoe
67. Pawnee
68. Perkins
69. Phelps
70. Pierce
71. Platte
72. Polk
73. Red Willow
74. Richardson
75. Rock
76. Saline
77. Sarpy
78. Saunders
79. Scotts Bluff
80. Seward
81. Sheridan
82. Sherman
83. Sioux
84. Stanton
85. Thayer
86. Thomas
87. Thurston
88. Valley
89. Washington
90. Wayne
91. Webster
92. Wheeler
93. York

APPENDICES



I. EXCEL DATABASES

Observation Database (*OBSERVATION.XLS*)

Variable name	Definition
ORIG OBS	Main observation code, original
OBS	Main observation code, corrected
YEAR	Calendar year
DATE FROM	First date crane(s) observed
DADOED	Last date crane(s) observed
GNATS	Total number of days crane(s) observed at that general location
NO_ADULTS	Number of adults
NO_JUV	Number of juveniles
TOTAL	Total number of cranes
SITE_EVAL	*Y* = site evaluation conducted; *n* =no site evaluation
STATE	State
COUNTY	County (specific to Observation record)
LEGAL_DESC	Legal description of location (township, range, section, quarter section, quarter of quarter section)
AREA_NAME	Description of location
LAT	Latitude, original data [not used in this summary]
LONG	Longitude, original data [not used in this summary]
OBS_TYPE	Report (incidental report), Radio (from radio-telemetry studies), Mortality (from crane found dead)
SEASON	Spring, Fall, Winter, Summer
CONFIDENCE	All “Confirmed”
SITE	If crane(s) observed in air, on land, or on water, or some combination.
INIT_TIME	Time at which crane(s) first observed
COLOR_BAND	Listing of color-marked codes observed [note: no proofing or corrections have been made to this variable]
FWS_BANDNO	Numeric code of U.S. Fish and Wildlife Service band [note: no proofing or corrections have been made to this variable]
SPP	Other species occurring with crane(s)

Site Evaluation Database *(EVALUATION.XLS)*

Variable name	Definition & Categories
ORIG_OBS	Main and sub-observation code, original
OBS	Main and sub-observation code, corrected
MAIN_OBS	Main observation code only
SUB_OBS	Sub-observation code
YEAR	Calendar year
STATE	State
COUNTY	County (specific to Site Evaluation location)
LEGAL_DESC	Legal description of site evaluation location (township, range, section, quarter-section, quarter-of-quarter section)
SITE_USE	Primary use of site: *Feed*: Crane(s) primarily feeding on site *Roost*: Crane(s) roosting on site *Both*: Crane(s) observed both feeding and roosting on site *Unknown*: use of site unknown
WET_CLASS	Original wetland classification, mixed systems and formats
SUBSYSTM	Wetland subsystem, following Cowardin et al. (1979)
REGIME	Water regime, following Cowardin et al. (1970)
DEPTH	Original water depth code, including both CDEPTH and RDEPTH, and full range (e.g., C1–15)
CDEPTH	Water depth (inches) at specific site within wetland where crane(s) observed
RDEPTH	Water depth (inches) of wetland
QUALITY	Water quality: *1 = Clear* *2 = Turbid* *3 = Saline*
SUBSTRAT	Wetland substrate characteristic: *1 = Sand* *2 = Soft mud* *3 = Hard mud* *4 = Other*
SLOPE	Slope of wetland shoreline: *1 = < 1°* *2 = 1 – <5°* *3 = 5 – 10°* *4 = >10°* *5 = NA (not applicable)* *6 = Other*
EMERG	Dominant emergent vegetation *1 = Grass* *2 = Sedge* *3 = Cattail* *4 = Rush* *5 = Smartweed* *6 = Other* *7 = None*

DENSITY	Distribution of emergent vegetation
	1 = None
	2 = Scattered
	3 = Clumped
	4 = Choked
ROOST	Roost site descriptors – habitat types:
	9 = Flooded pasture
	10 = Wooded creek or draw
	11 = Flooded cropland
	12 = Stockpond
	13 = Reservoir
	14 = Lake
	15 = Marsh
	16 = River
	17 = Salt (saline) marsh
	18 = Tailwater pit
	19 = Seasonally flooded basin
	21 = Cropland
	22 = Pasture
	23 = Wet meadow
	24 = Hay meadow
	25 = Woodland
	26 = Other
	Roost site description – crop types:
	A = Alfalfa
	B = Barley
	C = Corn (standing?)
	D = Conservation Reserve Program
	E = Rice
	F = Sunflower (standing?)
	G = Spring wheat (standing?)
	L = Fallow
	M = Milo (standing?)
	N =Disked alfalfa
	O =Oat stubble
	P = Popcorn
	R = Green rye
	S = Soybean (standing?)
	T = Bean stubble
	U = Sunflower (stubble?)
	V = Barley stubble
	W =Winter wheat (green?)
	X = Wheat stubble
	Y = Milo stubble
	Z = corn stubble
FEED	Feeding site descriptors – same codes as used in Roost
ADJ_HAB	Primary descriptors of habitats within 1.6 km (1 mi) radius of site

SIZE_WET Original size description for all wetland sites – classes for palustrine and lacustrine wetlands, exact widths for rivers

WSIZE_CL Size class of palustrine and lacustrine wetlands, derived from SIZE_WET, recorded in acres

1 = <0.4 ha [1 ac]
2 = 0.4 – <2 ha [1 – <5 ac]
3 = 2 – <4 ha [5 - <10 ac]
4 = 4 – <20 ha [10 – <50 ac]
5 = 20 – <40 ha [50 – <100 ac]
6 = >40 ha [>100 ac]

RWIDTH Width of riverine wetlands, derived from SIZE_WET, recorded in yards

DIST_FEED Distance to feeding site (miles)

1 = <0.40 km [<0.25 mi]
2 = 0.40-0.79 km [0.25 – <0.50 mi]
3 = 0.8-1.19 km [0.50 – <0.75 mi]
4 = 1.2-1.6 km [0.75 – 1.0 mi]
5 = >1.0 mi [>1.6 km]
6 = NA (not applicable)

DIST_DEV Distance to human development (e.g., structure, road, railroad, bridge), recorded in yards; same distance categories as DIST_FEED

POT_FOOD Primary potential food source on site

1 = Grain (seed and plant material)
2 = Tubers
3 = Insects and other invertebrates
4 = Molluscs
5 = Crustacean
6 = Fish
7 = Frogs
8 = Other
9 = Salamanders

OBS_FOOD Foods observed eaten by crane(s); same categories as POT_FOOD

SITE_SEC Security of site: stability and security of the habitat and any nearby activities that could threaten the site or the cranes

1 = Stable
2 = Threatened
3 = Unknown

SIM_HAB Extent of similar habitat within 16-km (10-mi) radius of site

1 = None
2 = Little
3 = Moderate or common
4 = Abundant
5 = Unknown

SITE_OWNER Site ownership

1 = Private
2 = Federal
3 = State
4 = Other

NO_BIRDS Total number of cranes observed on site evaluation site

OBS_DATE	Date site evaluation was conducted
FIRSTDATE	First date crane(s) were observed at site
LASTDATE	Last date crane(s) were observed at site
INIT	Time of day of initial crane sighting
DEP	Time of day of departure
INIT_TIME	Initial time of sighting for site by observer
DEP_TIME	Time of departure from that site by observer
COLOR_BAND	Description of color markers observed at site during site evaluation
VISIBILITY	Shortest straight-line distance to the nearest obstruction >1.4 m in height *1 = unlimited* *2 = <91 m (<100 yd)* *3 = 91 – 401 m (100 – <440 yd)* *4 = 402 – 805 m (440 – 880 yd)* *5 = >805 m (880 yd)* *6 = NA (not applicable)*
DIST_LINE	Distance to nearest utility (power or phone) lines *1 = <91 m (<100 yd)* *2 = 91 –401 m (100 – <440 yd)* *3 = 402 –805 m (440 – 880 yd)* *4 = >805 m (>880 yd) [or NA for some earlier records]*
SOURCE	Source of record; to distinguish among incidental and study-related observations *1 = Johnson* *2 = USFWS [all incidental observations]* *3 = Radio-tracking (Howe 1987)*
PHOTO	Photograph taken at site (*Yes / No)*

II. SAS DATABASES

Variables listed in alphabetical order; see above variables for listing of categories

ADJ_HAB	Primary descriptors of habitats within 1.6 km (1 mi) radius of site
AREANAME	Description of location
CDEPTH	Water depth (recorded in inches) at specific site within wetland where crane(s) observed
CLASS	Wetland c lass, following Cowardin et al. (1979)
COLOR_BD	Description of color markers observed at site during site evaluation
COUNTYE	County−Site Evaluation record
COUNTYO	County−Observation record
DATA_E	Indicates Site Evaluation record
DATA_O	Indicates Observation record
DENSITY	Plant Distribution/density
DEPUTIZE	Time of day of departure – Site Evaluation record
DESTINE	Distance to nearest utility (power or phone) lines
DIST_DEV	Distance to human development
DIST_FED	Distance to feeding site (recorded in miles)
EMERGE	Emergent vegetation
EVAL	*Y* = Site Evaluation completed
FEED	Feeding site descriptors
FROMO	First date crane(s) observed – Observation record
FRSTDATE	First date – Site Evaluation record
FWSBAND	Numeric code of U.S. Fish and Wildlife Service band [note: no proofing or corrections have been made to this variable]
IN_TIME	Initial time observed – Site Evaluation record
JFROMO	First Julian date crane(s) observed – Observation record
JFRSTDAT	First Julian date crane(s) observed – Site Evaluation record
JLASTDAT	Last Julian last date crane(s) observed – Site Evaluation record
JTO	Last Julian date crane(s) observed – Observation record
LASTDATE	Last Date crane(s) observed – Site Evaluation record
LEGALOBS	Legal description of location – Observation record
LEG_DESC	Legal description of location – Site Evaluation record
LOCAT_ID	Unique numeric identifying code (year–season–mainobs–subobs–location)
MAIN_OBS	Main observation and sub-observation code
MAP	If map of location exists (*M* = map)
NADULT	Number of adults
NJUV	Number of juveniles
NO_BIRDS	Total number of cranes – Site Evaluation record
NO_DAYS	Number of days crane(s) were present at that site – Observation Record
OBS	Main observation code only
OBSDATES	Range of dates for crane observations
OBS_FOOD	Foods observed eaten by crane(s)
OBS_TYPE	Report, Radio or Mortality
ORIG_E	Original Site Evaluation identification number
ORIG_O	Original Observation identification number
PHOTO	Photograph taken at site (*Yes / No)*
POT_FOOD	Primary potential food source on site

QUALITY	Water quality
QUARTER	Location: quarter-section
RANGE	Range location
RDEPTH	Water depth (recorded in inches) of wetland
REGIME	Water Regime, following Cowardin et al. (1979)
ROOST	Roost site descriptors
RWIDTH	Width of riverine wetlands, derived from SIZE_WET, recorded in yards
SEASON	Season
SEC	Location: section
SIM_HAB	Extent of similar habitat within 16 km (10-mi) radius of site
SITE	If crane(s) observed in air, on land, water, or some combination
SITE_OWN	Site ownership
SITE_SEC	Security of site
SITE_USE	Site use
SLOPE	Shoreline slope of wetland
SOURCE	Source of record; to distinguish among incidental and study-related observations
SPPWITH	Other species occurring with whooping cranes
STATE	State
SUBSTRAT	Wetland substrate
SUBSYSTM	Wetland subsystem, following Cowardin et al. (1979)
SUB_OBS	Sub-observation Code
TIME	Time of Site Evaluation
TO	Date Last observed at location
TOTAL	Total Number of cranes – Site Evaluation record
TOWNSHIP	Location: township
VISIBL	Shortest straight-line distance to the nearest obstruction >1.4 m in height
WETCLASS	Wetland classification – original code
WETSYSTM	Wetland system, following Cowardin et al. (1979) (*P* = Palustrine, *R* = Riverine, *L* = Lacustrine)
WSIZE_CL	Size class of palustrine and lacustrine wetlands, derived from SIZE_WET, recorded in acres
YEAR	Year

III. METADATA

Spatial_Reference_Information:

Horizontal_Coordinate_System_Definition:

Planar:

Map_Projection:

Map_Projection_Name: Albers Conical Equal Area

Albers_Conical_Equal_Area:

Standard_Parallel: 29.5

Standard_Parallel: 45.5

Longitude_of_Central_Meridian: -96

Latitude_of_Projection_Origin: 23

False_Easting: 0.0

False_Northing: 0.0

Planar_Coordinate_Information:

Planar_Coordinate_Encoding_Method: coordinate pair

Coordinate_Representation:

Abscissa_Resolution: 1.0

Ordinate_Resolution: 1.0

Planar_Distance_Units: METERS

Geodetic_Model:

Horizontal_Datum_Name: Unknown

Ellipsoid_Name: Clarke 1866

Semi-major_Axis: 6378206.4

Denominator_of_Flattening_Ratio: 294.98