FINAL PROJECT REPORT

Status and Distribution of Sandhill Cranes in Minnesota

Submitted by:

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INTRODUCTION

The Minnesota Department of Natural Resources (MDNR) needs to develop a sound management plan for Sandhill Cranes (Grus canadensis) in Minnesota. Such a project initially requires the compilation, review and assessment of information currently available on Sandhill Cranes in Minnesota, and other information pertinent to the management of the species in that state. Additional data (if any) needed for management planning under a variety of management options can then be identified, and appropriate research recommended.

In the spring of 1985, the Cooperative Wildlife Research Laboratory at Southern Illinois University - Carbondale contracted with MDNR to develop this report incorporating the above analyses and recommendations. Specific objectives were:

1) To compile and review available information pertinent to the management of Sandhill Cranes in Minnesota.
2) To develop a thorough bibliography of references related to the status and management of Sandhill Cranes in Minnesota.
3) To identify requisite information not currently available for management planning and to recommend feasible, cost-effective research necessary to obtain such information.
4) To identify various management options, based on the synthesis of information.

Data Acquisition and Presentation

A comprehensive literature search during spring and summer 1985 yielded nearly 200 articles and reports pertinent to management of Sandhill Cranes

in Minnesota. Sources searched included professional journals, proceedingsof crane symposia, crane management plans, reference books, popular or regional journals, theses, and project performance reports. A bibliography based on results of the literature search was sent to MDNR-St. Paul in August, 1985.

Unpublished information was collected through correspondence and personal interviews with a wide variety of personnel familiar with Sandhill Crane Management and/or Minnesota Sandhill Cranes. Field data, opinions, and observations were gathered primarily from state and federal wildlife personnel, university professors, and personnel associated with the Minnesota Ornithological Union (MOU). Sources contacted for unpublished information appear in Appendix A.

Citations of published information in the text of this report follow the Council of Biological Editors Style Manual (1978). Internal citation of unpublished information has been abbreviated to the name of the source followed by "pers. comm." to save space and reduce redundancy.

Affiliations and addresses of sources of unpublished data can be found in Appendix A. All unpublished information was gathered in the spring and summer of 1985. Sources of data found within Appendix B are discussed in its preface.

A conservative approach was taken in analysis of data and the following terms are defined to curtail ambiguity. For the purposes of this report, "resident" cranes are those observed in Minnesota between May 1 and August 31. While cranes which summer in Minnesota are probably present outside those dates, difficulty in differentiating residents from migrating "non-residents" (i.e., cranes which summer outside Minnesota) prohibits a less conservative definition. For example, an isolated pair observed unison-calling during

late April does not necessarily indicate a pair on territory (Tacha 1981). Therefore, in Appendix B, cranes observed in Minnesota prior to May 1 and after August 31 are referenced as "unknown". The term "breeder" is applied narrowly to residents associated with a known nest or observed with young. The term "non-breeder" applies to all cranes not meeting those criteria. The term "migrants" is used without regard to resident/non-resident status and simply refers to concentrations observed during migration periods.

Acknowledgments

This report could not have been completed without information provided by numerous wildlife professionals and private citizens, and we gratefully acknowledge their assistance and support (Appendix A). With only two exceptions, response to our requests for information was excellent (Dr. Alfred Grewe and his graduate student, Jeff DiMatteo, declined to cooperate).

We especially thank those personnel who took time to provide a first hand look at areas used by cranes in Minnesota: Jay Johnson and Jim Mattson of the U.S. Fish and Wildlife Service (USFWS); and Walt Rohl, George Davis, Ken Kramer and Gerald Maertens of the MDNR. George Davis also organized a meeting of MDNR Area Wildlife Managers and Non-game personnel in the northwest region, thereby saving many miles and hours of travel. Pam Perry, MDNR, shared her home with a road-weary traveler, and her hospitality is sincerely appreciated. Jay Johnson, USFWS, generously supplied a list of all crane observations published in the Flicker and Loon prior to 1975. Finally, our very special thanks goes to Lee Pfannmuller, MDNR, for efficient, comprehensive assistance when it was most needed, and for her understanding throughout the course of the study.

RESIDENT CRANES

Historic Status

Johnson (1976a) provides a good account of the historical distribution of Sandhill Cranes in Minnesota, a history similar to that of other crane populations in the northern Lake States. While definitive early nesting records are scarce, Sandhill Cranes probably were common residents south and west of Minnesota's heavily wooded areas until about 1875 or 1880 (Roberts 1932). Trippe (1871) reported that in 1870 the species bred commonly in extensive swamps of central Minnesota, and Hatch (1892) reported breeding from several of the southwestern counties in 1873. Roberts (1932) discussed early nesting records from Grant County (1879), Anoka County (1880), Jackson County (1883) and other areas. Additional breeding evidence noted by Johnson (1976a) indicated a widespread early distribution (Figure 1).

Rapid expansion of civilization in the late 1800's resulted in a dramatic decrease in numbers of Sandhill Cranes (Johnson 1976a). Market and subsistence hunting, combined with "greatly altered general conditions" (Roberts 1932:434) brought about by settlement of the prairie, extirpated cranes from much of their former range. By 1900, once common Sandhill Cranes were described as rare in Minnesota (Swanson 1940).

The drought in the 1930's and subsequent drainage and cultivation of large marshes probably led to further extirpation of cranes (Johnson 1976a). By 1936, only one or a few nesting pairs remained in Norman and Pennington counties and in the marshes along the St. Croix River bordering Wisconsin (Henika 1936, Johnson 1976a). Sandhill Cranes were still considered rare in 1942 (Roberts 1942). Walkinshaw (1949:131) noted breeding records "from northern Minnesota," but estimated only 10-25 pairs nested in Minnesota in 1944.

Sandhill Cranes apparently persisted in the remote wetlands of northwestern

Minnesota. In the early 1950's, resident cranes were observed at Roseau River Wildlife Management Area (WMA) in Roseau County (Lee 1953, Lupient 1951); Twin Lakes WMA, Southeastern Kittson County (Lee 1953); in the Grygla area, southeastern Marshall County (Marshall 1950); and on the Red Lake Indian Reservation, Beltrami County (Minnesota Department of Natural Resources, St. Paul, unpubl. data). Jensen (1959:138) stated that the species nested "in the north half of Roseau County." By the early 1960's resident pairs were seen "more than occasionally" in eastern Marshall County (Rundell and Neuschwander, pers. comm.). The northwest population apparently has continued to increase since that time.

It is debatable whether a few pairs persisted undetected in remote areas of eastern Minnesota, or the species reinhabited that part from northwest Wisconsin (Henderson 1979a). Whatever the case, resident cranes were again recorded in east central Minnesota as early as the late 1950's. Grewe (1958) reported 2 small flocks in Morrison County on May 1, 1958. In Aitkin County, resident cranes were observed at Grayling Marsh in 1961 and at Rice Lake National Wildlife Refuge (NWR) in 1965 (Johnson 1976a). In 1963, a wild female paired and nested with a captive-raised male at the Carlos Avery WMA in Anoka County (Longley 1970). The population in east central Minnesota has been gradually increasing since then.

The re-establishment of sandhill cranes in portions of its former range in Minnesota is probably due to several factors. Since 1950, government land acquisition and restoration of marshes for waterfowl production have increased availability of nesting habitat (Johnson 1976a, Hunt et. al. 1976). In the Lake States, cranes have been protected by the Convention for Protection of Migratory Birds since 1916 (Miller 1985). These factors, along with an increased public awareness of wildlife conservation in general,

have contributed significantly to observed increases in the Minnesota Sandhill Crane population.

Since the first half of the 20th Century when Sandhill Cranes were nearly extirpated, the species has been observed in 69 of Minnesota's 87 counties. There has been documentation in at least 54 of these 69 counties since 1975 (Table 1); known observations compiled from approximately 20 sources are listed in Appendix B.

Present Status (since 1975)

Distribution and Abundance - Johnson (1976a), Grewe (1977), and Henderson (1977, 1978a, 1978b, and 1979b) discuss distribution and abundance of resident Minnesota Sandhill Cranes from 1974 through 1979. These studies, which represented the most comprehensive efforts to describe modern status of Minnesota crane populations, indicate a general increase in both distribution and abundance of resident cranes during that period. The upward trend appears to have continued through May, 1985.

According to Henderson (1979b:2), distribution of resident Sandhill Cranes in Minnesota consisted of "two separate populations -- a northwest population and an east central population." While distribution of resident cranes is still generally concentrated around these population centers, observations since 1979 of breeding cranes in Todd, Cass and northern Crow Wing counties has brought the conveniently separable "populations" closer together (Figures 2 and 3). Katie Hirsch (pers. comm.) reports cranes may also breed in the Badoura State Forest in SE Hubbard County. Recent peripheral records of resident cranes in Stevens, Cottonwood and Houston counties may also indicate pioneering into new areas. For purposes of this report, Sandhill Crane distribution and abundance will be described in terms of the northwest and east central regions. Should the population

distribution continue to expand, however, the distinction between the population centers may soon become arbitrary.

Johnson (1976a) reported resident Sandhill Cranes in seven counties in the east central region. Although the number of counties in which residents were observed varied from 1977 to 1979 (Henderson 1979b), only one county was added in this study to the original east central summer range reported by Johnson (1976a)(Table 2). Based on information collected during the course of this study, resident cranes have been observed in 15 east central counties since 1975, with breeding documented in 9 (Table 2).

Henderson (1979b) first discussed distribution of resident cranes at the township level. While the number of townships containing residents varied from year to year, they were reported from 2[illegible] east central townships between 1977 and 1979 (Henderson 1979b). However, resident cranes have been reported from 42 townships, and documented breeding (by our narrow definition) in at least 17 townships in that region during the last decade (Figure 3).

In the northwest region, Johnson (1976a) reported resident cranes from five counties in 1974-75; based on 1977 data, Grewe (1977) noted breeding pairs in seven counties in the same region. From 1977 through 1979, Henderson (1979b) reported resident cranes in 78 townships in 10 northwest counties (Figure 2), and breeding pairs in 8 counties (Table 3). Based on data compiled during this study, resident cranes have been reported from 112 townships in 13 northwest counties (Figure 3), and documented as breeding in 8 (Table 3).

Discussion of crane distribution should include areas where cranes are notably absent. As Johnson (1976a) reported, resident cranes have not been found in the heavily forested areas of northeast Minnesota. In

Beltrami Island State Forest, they are known to use small (3-5 acre) forested openings in uplands surrounding extensive sedge meadows or other open peatlands (Watt, pers. comm.).

The observed increases in distribution of Minnesota cranes during the last decade could be the result of various factors: 1) an actual expansion in the distribution of resident cranes caused by increased population levels, 2) an improvement in the precision of survey methods resulting in detection of cranes in areas previously occupied, and 3) movement of the breeding population from area to area, resulting in an increase in observed distribution without an increase in population levels. The probability of the latter curcumstance is unlikely; such movement might be caused by continual destruction of breeding habitat, but in the east central region where significant increases in distribution occurred, there is little evidence of habitat destruction. The establishment of the Minnesota Non-game Program in 1977 produced an increased interest in the status of Sandhill Cranes. Associated greater awareness and improved precision in survey methods may account for some of the increased crane distribution. However, we believe observed changes in distribution are primarily caused by an expanding Sandhill Crane population, resulting in the pioneering of resident cranes into new areas.

Johnson (1976a) estimated a total resident crane population of 70-85 pairs, with 20-25 pairs occurring in the east central and 50-60 in the northwest region. Based on data compiled from 1977-1979, Henderson (1979b) believed the statewide population might consist of at least 300 nesting pairs, with 75 pairs in the east central population and at least 225 pairs in the northwest. With one exception, all Area Wildlife Managers and other state and federal personnel interviewed during 1985 believed that the breeding population in the northwest and east central portions had increased in

abundance and distribution since 1980. Walt Rohl (pers. comm.) believed the number of breeding pairs on Carlos Avery WMA had decreased, but felt they had simply moved to other nesting areas in east central Minnesota. Based on information resulting from personal interviews, the breeding population in east central Minnesota may consist of 87-109 pairs (Table 4) and the breeding population in the northwest could be 760-1160 pairs (Table 5).

These recent estimates of breeding population levels should be considered with caution. The estimates are at best based on incidental observations of resident cranes, and are not the result of coordinated surveys of described areas (exceptions being Sherburne NWR, Agassiz NWR and southeastern Morrison County where intensive studies have been conducted). Even so, the general accessibility of most known nesting areas in the east central region probably improves the reliability of population estimates for that region over those for the northwest. Managers in the extreme northwest have submitted incidental observations of Sandhill Cranes to the non-game program, but population density and general inaccessibility of most nesting areas prohibits a population estimate based on those sightings. Estimates of breeding pair numbers in the northwest (Table 5) reflect the respective managers' general feel for relative breeding densities (i. e., 1 to 2 pair vs. 0.5 to 1 pair per square mile) and general availability of nesting habitat.

Another caution is that Henderson (1979b) sometimes used subjective judgement in determining breeding status of resident cranes. For example, observation of one or two cranes associated with nesting habitat during May was sometimes interpreted a breeding pair. This interpretation is dangerous in view of the difficulty in distinguishing breeding pair from non-breeding birds on the basis of incidental observations. Year-old cranes, indistinguishable from their parents after April (Tacha and Vohs 1984),

may remain in the general vicinity of the nesting area after driven from the nesting territory by the breeding pair during spring. In addition, young cranes may pair and spend several breeding seasons on territories before they actually breed; they may not reach sexual maturity until 4 years of age (Walkinshaw 1965). However, non-breeders may eventually congregate in small, identifiable flocks, and even single non-breeders can be distinguished from breeding cranes by intensive observation of a given area during the nesting season.

Any overestimate of the breeding population caused by the possible misidentification of breeding pairs is probably overwhelmed by underestimates resulting from the incidental nature of crane observations (vs. coordinated surveys of nesting areas). Nevertheless, population estimates based on incidental observations may provide a general qualitative if not semi-quantitative comparison between time periods. For comparison of abundance estimates (only), no attempt was made to refine the analysis of data compiled since 1980. Comparisons indicate that Minnesota's resident population has increased since 1979; however, the magnitude can only be measured by repeated, coordinated surveys of known nesting areas.

Little is known regarding distribution and abundance of non-breeding resident cranes in Minnesota. Incidental observations of groups of 3 to nearly 60 non-breeding cranes have been made during the nesting season in counties where cranes are known to nest. Whether these non-breeders are near their natal areas is unknown. In Manitoba, Melvin and Temple (1980) observed possible dispersal of 1 year old cranes to locations outside natal areas. Similar juvenile dispersals have been observed by Drewien (1974) and Drewien and Bizeau (1974) among Rocky Mountain populations of Sandhill and Whooping cranes (Grus americana). Bennett (1978) reported

irregular movements of non-breeding groups in Wisconsin. He noted non-breeding adults banded in central Wisconsin returned from wintering grounds to areas 150 km from banding sites (Bennett 1978). Association of non-breeding birds with natal areas is impossible to document without long-term banding programs.

Non-breeding cranes may constitute nearly half of the total Minnesota population. Bennett (1978) found non-breeding cranes made up 48.5 percent of the crane population in southeastern Wisconsin. Walkinshaw (1973:326) found over a 10 year period that non-breeding groups comprised an average of 41 percent of the adult population in Michigan. Thirty-one to 39 percent of the crane population at Gray's Lake, Idaho were non-breeders (Drewien 1974), and 25 percent were non-breeders at Malheur NWR in Oregon (Littlefield and Ryder 1968). The contribution of non-breeders to the Minnesota population can only be determined by coordinated surveys of crane concentration areas.

Reasons for observed increases in crane distribution and abundance since 1979 are not clear. Grewe (1977) and Henderson (1979b) warned against consequences of continued destruction of nesting habitat in the northwest region. However, according to wildlife managers most familiar with cranes in that region, the population has increased substantially since 1980. One manager commented that loss of undeveloped lands to agriculture in the northwest, estimated as much as 10 percent per year, may now be offset by the reversion of farmland to undeveloped lands due to recent increased failures of farming enterprises (George Davis, pers. comm.). Finally, observed increases in crane numbers may also be due to the natural addition of more and more breeding pairs to the population as age structure increases.

Population Characteristics

The resident Minnesota crane population has been assigned to the eastern

population of greater Sandhill Cranes (G. c. tabaida) (Littlefield 1981, Drewien et al. 1975, Nesbitt and Williams 1979). Resident cranes are probably of this subspecies, lacking evidence to the contrary. Sex ratios in a population of any monogamous species are worthy of consideration, but there is little evidence to indicate they differ significantly from 50:50 in Minnesota or in any other area. Information on recruitment (percent juveniles in the population) of the Minnesota residents is also lacking. Crete and Grewe (1981) report annual recruitment at Crex Meadows, Burnett County, Wisconsin (the presumed major staging area for the east-central Minnesota population) to be 12.2% in 1976 and 15.2% in 1977. However, since northwest Wisconsin resident cranes also stage at Crex Meadows, it is unknown whether these figures accurately reflect recruitment in the Minnesota population.

MIGRATION AND MIGRANTS

Migration Chronology

Since 1970, Sandhill Cranes have been seen in Minnesota as early as March 17 (at Sherburne NWR, 1985) and as late as December 17 (Polk County, 1981) (Table 6). However, most spring migration occurs during March and April and in fall early September through mid-November (Green and Janssen 1975).

Migration chronology is similar in the northwest and east central regions. Cranes generally return late March or early April (Pauly, Davis and Mattson, pers. comm.). Johnson (1976b) reported first spring observations of cranes at Rice Lake NWR, Aitkin Co., averaged April 11 over an 8 year period. At Sherburne NWR, cranes were first observed during the last week of March from 1982-1984 (J. Johnson, pers. comm.), and generally are first observed at Carlos Avery WMA in early April (Rohl, pers. comm.). The species usually departs the northwest and east central regions shortly after the

beginning of the general hunting season October 1 (Pauly, pers. comm.). On areas where hunting is prohibited (i.e., Sherburne NWR and Agassiz NWR), the cranes may stay until the second week of October (J. Johnson and Mattson, pers. comm.).

It is currently difficult if not impossible to accurately differentiate between resident cranes and non-resident migrants on the breeding grounds during migration periods. This is especially true in the east-central region, where no noticeable influx of migrating cranes interpretable as non-residents occurs during either spring or fall migration. Yet, based on spring and fall sightings of migrating cranes along the north shore of Lake Superior, and information on migration routes supplied by Nesbitt and Williams (1979), it is reasonable to assume non-residents migrate through the east central region.

In the northwest region, some wildlife managers believe residents and non-residents are separable to a limited degree during migration periods. In spring at Agassiz NWR, Jim Mattson (pers. comm.) reports small numbers of non-resident migrants (usually less than 50) arrive in mid-April, slightly after the arrival of cranes which nest on the refuge. The duration of the migrants stay is uncertain, perhaps 10 days to 2 weeks depending on weather. In fall at Agassiz NWR, cranes nesting on the refuge appear to stay on territories and not mix with flocks of several hundred migrants until near time to depart (Mattson, pers. comm.). At Rosseau River Wildlife Management Area which borders Manitoba in northwestern Roseau County, local residents begin to stage the first week of August; the influx of what are believed to be non-residents does not begin until late August or early September (Kramer, pers. comm.). In eastern Kittson County, however, Davis (pers. comm.) believes that the residents begin to stage (gather

locally in larger flocks) at the end of August or early September; the influx of non-resident cranes generally does not occur until mid-September. Hirsch (pers. comm.) believes Minnesota residents stage in early September in eastern Kittson County, whereas cranes observed in late September and October at a major staging area near Borup in Norman County are primarily non-resident migrants. Whatever the speculations, temporal and/or spatial segregation of residents from non-resident cranes during migration can be determined only by extensive banding studies.

Minnesota Staging Areas

Melvin and Temple (1981) define staging areas as sites where Sandhill Cranes gather during the first segment of their fall migration. These areas are usually within the first 20% of the migration route and generally no more than a day's flight from original breeding territories. We broaden the above definition to include spring concentration areas outside known breeding grounds.

Several staging areas can be described in Minnesota. Although most are located in northwest and west central Minnesota, one has been described in the east central region by Crete and Grewe (1981). From 40-60 cranes stage at the Rice-Skunk WMA in southern Morrison County until waterfowl season opens (Crete and Grewe 1981; G. Johnson, pers. comm.).

In the northwest, Davis (pers. comm.) identified several staging areas in eastern Kittson and northwest Roseau counties based on aerial surveys in the fall of 1982 (Figures 4 and 5). The number of cranes observed during any one flight varied from less than 100 in the minor staging areas to 300-700 in the major staging areas. Total number of cranes observed varied in 1982 from 680 on August 25 to 3105 on September 22; in 1983 totals varied from 1015 on September 2 to 4350 on September 26. Nevertheless, Davis

(pers. comm.) estimates, based on the percent of census area covered, that the total population reached 4200-4800 on September 22, 1982; and 6000 after migrants arrived in 1983. Roseau River WMA also serves as an important fall staging area in the extreme northwest, providing roost habitat for several thousand staging cranes which feed both on and off the unit (Kramer and Davis, pers. comm.). Other high use areas not included in the 1982 and 1983 surveys include the Baudette and Marvin Lake areas in Roseau County, and the Florian WMA and East Park WMA in Marshall County (Davis, pers. comm.).

Additional fall staging areas include Agassiz NWR and Thief Lake WMA eastern Marshall County (Johnson 1976a). At Agassiz NWR, a peak migrant population of at least 2000 cranes is usually observed the last week of September, though staging cranes are known to use the area mid-September through mid-October (Mattson, pers. comm.).

The highest concentrations of fall staging cranes are observed farther south in the Borup-Felton area in southern Norman and northern Clay counties where thousands may be seen in mid-April and October (Eckert 1983). In 1983, at least 12 surveys between October 5 and November 9 were conducted in a portion of the area east and northeast of Borup. Crane numbers ranged from 1200 on October 7 to 2700 on October 26 (Welter and Hirsch, pers. comm.), although 4000 to 4500 were estimated using the area including surrounding roose sites (Welter, pers. comm.). A peak of 8,000-10,000 cranes was observed on October 17, 1982 in Norman County (Loon 55(2):70). Apparently, minor staging areas extend north from the Borup-Felton area between Highway 9 and Highway 32 into Polk County (Figure 6); but, little specific information is available regarding numbers (E. Johnson, pers. comm.). During the spring, from 1000 to 3000 cranes have been observed just northeast of Borup (E.

Johnson, pers. comm.).

Another staging area is located near Rothsay in Wilkin County (Green and Janssen 1975). Incidental observations of several hundred migrating cranes have been made during spring and fall, principally April and late September through October (see Appendix B).

Routes and Destinations

Cranes nesting in the east central region have been observed wintering in north and central Florida (Crete and Toepfer 1978). Crex Meadows in Burnett County, Wisconsin, is the major fall staging area of cranes in east central Minnesota and northwestern Wisconsin (Crete and Grewe 1981). Two cranes captured and marked at Crex Meadows in October 1977 were known to breed the following spring in the Rice-Skunk Lake area, Morrison County, and in southern Pine County, respectively. A third crane (non-breeder) captured at Crex Meadows in July, 1977 was also observed in spring 1978 in Pine County, Minnesota (Crete and Toepfer 1978). Four flocks containing radio-tagged cranes were followed in the fall from Crex Meadows to Jasper-Pulaski Fish and Wildlife Area (FWA) in northwest Indiana. These flocks made overnight stops at Necedah NWR and near Partage in central Wisconsin, but all flocks arrived at Jasper-Pulaski FWA 32-48 hours after leaving Crex Meadows (Crete and Toepfer 1978). Jasper-Pulaski FWA is considered the major traditional spring and fall stopover for much of the eastern greater Sandhill Crane population (Melvin and Temple 1981). Depending on arrival dates and weather conditions, cranes may spend from 1 to 7 weeks at Jasper-Pulaski FWA in the fall, and from 1 day to 2 or 3 weeks in the spring (Melvin and Temple 1981). No traditional staging areas are known to occur between Jasper-Pulaski FWA and the wintering grounds in Florida and Georgia.

Migration routes of resident cranes in northwest Minnesota are unclear

due to contradictory data. Cranes marked on wintering grounds in southern Florida were reported summering in, among other places, western Minnesota (1) and southern Manitoba (2) (Nesbitt and Williams 1979). This evidence supports the contention that resident cranes in northwest Minnesota are part of the eastern greater Sandhill Crane population, and they are included in the Eastern Greater Sandhill Crane Management Plan. However, at least one crane marked as a juvenile at Agassiz NWR in 1984 was observed on the Platte River in Nebraska in March, 1985 (T. Tacha, pers. observation). In addition, on July 11, 1980, a crane marked with a green neck collar with white letters or numbers was observed in northeastern Roseau County (Dittrich, pers. comm.). Collars of this type were used to mark juvenile cranes on staging and wintering grounds in the Central Flyway in 1979 and 1980 (Tacha et al. 1984). These observations indicate that at least some of the northwest resident population use the Central Flyway and therefore belong more appropriately to the mid-continent population. Further discussion of wintering and staging areas is inappropriate until migration route(s) of the northwest Minnesota residents are defined by banding and/or radio-marking studies.

An observable influx of non-resident fall migrants occurs in northwest Minnesota. Without banding studies, the origin and destination of these cranes cannot be defined. However, cranes are known to nest north of Minnesota in southeast Manitoba, and in the Rainy River district and Hudson Bay area of Ontario (Lumsden 1961, Tebbel 1981). It is reasonable to assume that adjacent non-resident populations (at least) move through Minnesota during migration. Tebbel (1981) noted westward fall movements of cranes from central Ontario, and west and/or southward movements of cranes from western Ontario. Considering the magnitude of fall migration in the northwestern

region, and the lack of comparable migration observed in the eastern part of the state, it is also reasonable to assume that most fall migrants observed in the northwest utilize the Central Flyway.

Population Characteristics of Non-Residents

Johnson and Stewart (1973) collected 20 cranes in Kittson County from September 22-24, 1970 to determine subspecific status. Their analysis of body measurements revealed 65 percent (13) to be G. c. tabida and 35 percent (7) to be G. c. rowani. Four cranes collected by MDNR personnel on September 9, 1982 in southeast Kittson County (3) and northwest Roseau County (1) were clearly G. c. tabida (analysis by T. Tacha). However, the proportion of residents vs. non-residents in these samples is unknown. Based on the assumption that only G. c. tabida nests in Minnesota, some non-resident cranes interpretable as G. c. rowani migrate through northwest minnesota in the fall. No age-ratio or recruitment data is available for the non-resident migrant population in Minnesota.

HABITAT USE

Breeding Habitat

Johnson (1978b) described the breeding habitat of a crane population in the Rice-Skunk Lake area of southern Morrison County. The habitat consisted of lowland marshes and meadows dominated by sedges and grasses, with stands of phragmites, cattails and wild rice occurring in deeper water. These lowland areas were interspersed with upland wooded ridges, open prairie knolls, oak savannahs and agricultural fields. All nests studied by Johnson (1976b) were in or near shrubs or dense stands of phragmites which visually isolated pairs from surrounding activities early in the nesting season. Similar concealment of nest sites has been described in several Great Lake

States (Roberts 1918, 1932, Hamerstom 1938, Walkinshaw 1965b, Gluesing 1974) and Canada (Carlisle 1979, Tebbel 1981). Bennett (1978) discussed the importance of structurally diverse marsh vegetation to nesting cranes. In southwest Wisconsin, they prefer marshes with moderately dense stands of emergent plants and low densities of shrubs which provide cover for protection but allow free movement to and from the nest (Bennett 1978).

Crane nesting habitat described by wildlife managers in various parts of Minnesota is structurally similar to that noted by Johnson (1976b). In the east central region, they nest in relatively extensive, open, shallow wetlands containing sedges and varying proportions of phragmites, cattail and shrubby (willow/alder) cover. Water depths at nest sites are generally less than 1 foot (Pauly, pers. comm.). Tuszynski (pers. comm.) noted use of extensive Type 5 and 6 wetlands on Mille Lacs WMA. On Sherburne NWR and Carlos Avery WMA, nests were most commonly in wetlands below water control structures (J. Johnson and Rohl, pers. comm.). In the northwest region, cranes are known to nest in extensive, open peatlands (wet sedge meadows or ericaceous types) associated with forested areas and in large prairie marshes of sedge, cattail and bullrush. A few nests have been found in dry areas such as haylands (Davis, pers. comm.); these are considered exceptions. At Agassiz NWR, cranes nest in shallow, phragmites/cattail/sedge marshes where water depth is generally less than 1 foot; or in peat burnouts rimmed with cattail and phragmites in sedge or drier upland areas (Mattson pers. comm.). At Pembina Trail Preserve in Pembina County, nesting was in a 30-acre marsh of solid bullrush fringed by cattails and surrounded by upland prairie (Svedarsky, pers. comm.). Dittrich (pers. comm.), notes that cranes nest in large Type 2 and 6 wetlands in parts of Lake of the Woods, Roseau and Beltrami Counties. In western Roseau County, Eckert

(1980) found birds in a 5-square mile block of almost continuous sedge marsh containing several stands of aspen or alder. The inaccessibility of such large areas prohibits use of ground surveys to locate cranes in much of the northwest.

Crane chicks typically leave the nest 1 or 2 days after hatching and accompany the adults as they forage in the marsh or surrounding upland areas. Young broods have typically been observed in old fields, haylands, and small agricultural fields adjacent to nesting habitat. When using agricultural fields, very young chicks will sometimes remain concealed in peripheral brush and be fed by the adults foraging in the open (Mattson, pers. comm.).

Breeding habitat use by cranes in Minnesota is similar to that used in adjacent areas. Howard (1977) reported nests in ecotone wetlands in Wisconsin where bogs, shallow marshes and sedge meadows are interspersed. Similar wetlands are used in southern Michigan (Walkinshaw 1973), but in northern Michigan and adjacent Ontario, cranes breed primarily in bogs (Walkinshaw 1973, Tebbel 1981). The size of marshes used in Wisconsin averages several hundred acres and ranges from approximately 20 to 7000 acres (Hung et al. 1976, Howard 1977), though smaller wetlands are utilized in areas of high pair densities (Bennett 1977). While structural diversity of aquatic vegetation is important, the density of shrubby vegetation tolerated has not been quantified. Bennett (1977) noted that in southeast Wisconsin, they generally avoided large areas of thick cattail marsh, monotypic shrub and timber swamps and marshes directly adjacent to highways.

The availability of breeding habitat in Minnesota is difficult to assess (except in general terms) because of variability of wetlands utilized and the general, qualitative nature of available breeding habitat descriptions.

Within the known Sandhill Crane distribution, suitable breeding habitat can include any large, shallow, relatively open, isolated wetland adjacent to open, upland foraging areas. State or federally owned lands are used extensively by resident cranes (Table 7), particularly in the east central region. Wildlife management areas located in largely agricultural areas throughout the state may provide suitable habitat for an expanding crane population. As mentioned previously, the heavily forested northeast region is probably excluded from the present and future distribution of Minnesota Sandhill Cranes.

Habitat Used by Non-Breeders

Non-breeders have been observed in a variety of habitats during the summer. Agricultural fields are used for foraging in many areas. Flocks of non-breeders have also been seen feeding on mudflats at Roseau River WMA; in dozed, dry wetlands at Carlos Avery WMA; and in burned sedge marshes and shallow wetlands at Agassiz NWR. Mattson (pers. comm.) noted that, at Agassiz NWR, non-breeders may be excluded from small agricultural fields by territorial breeding birds, and that non-breeders often roost in reflooded pools with 8 to 12 inches of water. Pasture is most often used for foraging in the Hinckley area and in southern Morrison County. Non-breeders have even been observed feeding in pools located in grazed, mature, riparian forest (Pauly, pers. comm.).

Migration - Staging Habitat and Depredations

Staging fall migrants roost in shallow portions of Type 2, 3 or 4 wetlands, generally within 5 or 6 miles of feeding areas (Davis, pers. comm.). At Agassiz NWR, cranes prefer to roost in less than 1 foot of

water in drawn-down pools (Mattson, pers. comm.). Mudflats and shallow water at the east end of Thief Lake are also used for roosting (Maertens, pers. comm.).

Staging fall migrants feed in agricultural fields, primarily small grains. Henderson (1979b) noted that 77.2 percent of observations during September-October of 1977-1979 occurred in small grain fields. Davis (pers. comm.), reported that staging cranes in Kittson County feed primarily in grain fields and in other extensive, open agricultural areas, including hayland. Spring migrants have been observed feeding in corn stubble at Pembina Trails Preserve (Svedarsky, pers. comm.), and in pasture and cultivated fields on Agassiz NWR (Mattson, pers. comm.).

Concentrations of fall migrants in the northwest can cause severe depredation problems, especially during wet autumns when farmers are unable to harvest crops before September. Depredation problems are apparently concentrated in eastern Kittson and northwest Roseau counties (Davis, pers. comm.), and in the Borup area, Norman County (Pfannmuller, pers. comm.). Few or no depredations are reported in eastern Marshall, western Roseau, Lake of the Woods and northern Beltrami counties, despite presence of migrant flocks (Maertens, Mattson and Dittrich pers. comm.). Davis (pers. comm.), knows of 30 areas (sections) in eastern Kittson County that have received damage and/or have been the subject of depredation complaints; however, the intensity of actual depredations is difficult to quantify due to inconsistency. For example, some may complain when little actual damage exists; others may discontinue legitimate complaints when told that not much can be done to alleviate the problem. Wheat, oats, barley and rye are the principal crops affected. In addition to fall depredations, Davis and Kramer (pers. comm.) report an increase over the last 4 years in complaints regarding

spring damage to emergent small grains. Fortunately, no damage complaints have been reported in the east central region , even though cranes have been observed feeding on sprouting rye in the spring (Tuszynski, pers. comm.). If crane populations continue to grow, increased public demand for depredation control in areas where resident populations occur can be expected.

Johnson (1976c) describes extensive crop damage in North Dakota as a sporadic occurrence, most common during wet autumns when farmers are delayed in harvesting until large numbers of cranes arrive. In Wisconsin, where most depredation by cranes occurs on sprouting corn in the spring, farmers were compensated more than $21,400 for damage 1975 through 1979 (Hunt, pers. comm.); compensatory payments for crane depredations were discontinued in 1980. Damage to crops by fall migrating cranes was described in Saskatchewan as early as 1950 (Monro 1950).

Various measures have been utilized in an attempt to control depredations in Minnesota; none very successfully. Kramer (pers. comm.) indicates that the use of acetylene exploders provided limited relief in the Roseau River WMA area. However, acetylene exploders, scarecrows, flapping plastic streamers, non-lethal shooting and harassment with an airplane, tend to merely relocate feeding cranes to another area in the vicinity (Monro 1950; Wetzel, pers. comm.). The combinations of scare techniques and use of lure crops has met with some success in reducing waterfowl depredations, and may be worth considering if actual crane depredations in the northwest justify the expense.

MANAGEMENT OPTIONS

Management options for Sandhill Cranes in both northwestern and east central Minnesota can be reduced to three basic strategies: 1) maintain current management practices (no active management), 2) active management

to increase populations, and/or 3) to decrease or redistribute populations in local areas where depredations are significant. None of these strategies are viable at present due to lack of necessary information.

Maintain Current Management

Current management of Sandhill Cranes in Minnesota is primarily passive such as wetlands preservation for waterfowl that also benefits cranes. Continuation of this strategy has the single benefit of low cost in dollars or manpower. However, maintain a laizze faire management strategy will eventually lead to problems. Sandhill Cranes in Minnesota are probably increasing in numbers and distribution. This will lead to increased densities as wetlands in semi-agricultural areas (especially in the northwest) are lost; it could result in substantially increased crop loss. As these problems and crane populations increase, internal MDNR and public political pressures for depredation control and/or hunting will increase. On the other hand, dramatic decreases in populations could occur without being detected because no organized surveys are in place to monitor population status. Cranes in Minnesota may ultimately require active management only to preserve required habitats; but, substantial additional information (see integrated research needs below) will be required for defense of any management strategy.

Management For Increased Population Growth Rate

Sandhill Cranes have evolved a K-selected survival strategy that includes low recruitment rates compared to other migratory birds. Despite these reproductive limitations, cranes in Minnesota appear to be slowly increasing in numbers. If population growth continues, depredation problems and demands for control will also increase. However, population increases will also provide increased opportunities for non-consumptive use, and could lead

to justifiable hunting.

Management to increase crane populations in Minnesota will require continued protection of resident birds and their required habitats. The most effective active management technique to aid this strategy would be restoration of degraded wetlands historically used for nesting and brood rearing, or located in high density nesting areas. Wetland restoration projects could be coordinated with private (e.g. Ducks Unlimited), state, or federal wetlands acquisition programs. While Wisconsin has had no active management programs specific to cranes, Hunt et al. (1976) noted populations increased in response to 1) preservation of large wetland areas, 2) selection of wetland sites on peat soils, 3) control of disturbance, and 4) provision of food in upland feeding areas. Johnson (1976b) noted burning and haying the edges of wetlands can reduce encroachment of dense woody vegetation that could eventually inhibit crane reproductive activities. Research needs for population increases are incorporated in the integrated needs described below, with emphasis on identification of specific habitat requirements of resident cranes.

Management to Decrease or Redistribute Crane Populations

We see no need to currently limit population numbers or distribution for depredations control or any other reason. Depredations appear to be relatively localized but occasionally severe. Thus, efforts to redistribute cranes should be limited to specific fields or local areas where severe depredations are in progress. Tabulation of all depredation complaints should continue, but assistance in control efforts should be limited to specific locations where damage is verified by MDNR personnel and assistance is demanded.

Depredation control techniques in order of preference include scare

devises such as acetyline exploders, lure crops, landowner permits to shoot cranes, controlled hunting, and payment for damages. Persistent use of scare devices can be effective in controlling depredations in both emergent small grain fields in spring, and swathed grain in fall. If and only if political pressure for assistance increases, a program of providing acetyline exploders and other scare devices can be instituted through appropriate district or regional MDNR offices. If such devices prove inadequate to control fall problems, then use of scare devices in some fields can be combined with buying or leasing and using selected fields for lure crops where cranes can feed undisturbed. A last resort would be landowner permits to shoot in spring and/or controlled hunting in fall. However, depredation should not be used as an excuse to establish a crane hunting season until research can project allowable harvest. Payment for depredation damages should not be instituted; the precedent in other states is convincingly expensive.

The political necessity for localized population reduction in response to increased depredation problems would provide the only defendable excuse for hunting Sandhill Cranes in Minnesota at this time. Hunting should not be considered until population information is available as delineated below.

INTEGRATED RESEARCH NEEDS

Effective management of Sandhill Cranes in Minnesota is dependent upon acquiring additional information as management options are severely limited in its absence. Integrated research needs are prioritized as in Table 8; these should be viewed as minimum for any management strategy. Information useful to management of Sandhill Cranes in Minnesota is limited. Qualitative information is available for distribution of residents and

distribution of major fall staging areas. Isolated studies of crane nesting habitat have contributed to understanding breeding habitat requirements. However, estimates of population size, population affiliations, and chronology of migration of resident and non-resident cranes are presently little more than educated guesswork.

Research Methods

Residents. (I in Table 8)-Quantitative estimates of the resident breeding population size are the most necessary and most financially demanding research efforts. General criteria for identifying nesting and brood rearing habitat need be established based on information provided in this report. These criteria should then be applied to available wetland inventory information within the breeding range of cranes in Minnesota (Fig. 3). A catalog of wetlands meeting these criteria should be used as a sampling base for surveying breeding pairs. Random samples of the wetlands, or subunits such as quarter sections or sections within wetland complexes, should be systematically inventoried during the first 2 weeks of May. Accessible areas should be ground searched while more remote areas will require low-level surveys by helicopter (after Gluesing 1974). All cranes and nests observed should be recorded. Ground and air survey locations should overlap to 1) provide a correction for aerial visibility bias, and 2) establish selected ground survey sample areas for future annual surveys that will provide an index for population changes. These surveys should yield estimates of 1) numbers of indicated breeding pairs, 2) minimum numbers of resident non-breeders, and 3) a minimum number of nests. In the absence of adequate behavioral observations pairs and singles observed during aerial breeding pair surveys are usually interpreted as indicative of breeding pairs. Proportion of breeders to non-breeders among indicated breeding pairs might be estimated

from ground observations. Groups of three or more cranes can be interpreted as non-breeders from ground or air surveys. Intensive ground and air surveys should be conducted for a minimum of 2 years to avoid influences of random annual weather conditions and to provide an option to refine breeding habitat to be surveyed and/or expand surveys the second year.

Other methods of surveying breeding pairs are available and much less expensive; however, they are generally qualitative in nature or impractical. For example, some investigators use observations of unison calls to identify a breeding pair (J. Johnson, pers. comm.; Christenson, unpubl. memo). Our experience is that not all breeding pairs regularly unison call, introducing a known error. Bennett (1978) used responses of cranes to tape-recorded unison calls to locate breeding pairs but could not determine what proportion of breeding pairs responded. The use of this technique with ground searches may prove useful in surveying small inaccessible areas in east central Minnesota. Harris and Knoop (1986) reported the Wisconsin system of public participation in spring counts, but questioned its research value. All forms of ground counts are impractical if more remote areas of northwestern Minnesota are to be properly sampled.

This report provides a current inventory of known resident and breeding pair distributions. An organized system of reporting sightings (especially in new areas) and annually updating distribution information should be established and maintained.

Major fall staging areas are also tabulated in this report. Additional areas where significant numbers (several hundred) of cranes are sighted during fall should be documented. A permanent information center in conjunction with breeding distribution data should be considered.

The second most critical need is identification of population affiliations

(and associated migration routes and wintering areas) of resident cranes. While cranes in east central Minnesota are almost certainly part of the eastern greater Sandhill Crane population, those from northwestern Minnesota are more likely contribution to the mid-continent population. If northwestern cranes migrate and winter as mid-continent birds, then they are almost certainly part of the Gulf Coast subpopulation which is subject to harvest in eastern North Dakota, western Oklahoma, and most importantly in southern Texas (Tacha et. al. 1984, 1986).

Documentation of subpopulation affiliation should concentrate on resident cranes in northwestern Minnesota and will require an extensive banding effort. Because the mixing of resident and non-resident cranes on fall staging areas is unknown, banding must concentrate on known residents late in the brood rearing period.

As many flightless cranes as possible (mostly juvenile just prior to fledging) need to be captured and color marked with individually identifiable neck collars during June-July (patagial streamers cause abnormal behavior and leg streamers or bands are difficult to observe, Tacha 1979). Methods are detailed in Boise (1977), but require running down juveniles and/or flightless parents. Rapid access to remote nesting areas for capture will require a helicopter in most instances. This marking should be in years when resident breeding pair inventories would greatly facilitate location of cranes to be captured, and reduce aerial search time.

Systematic searches for marked birds should be conducted at fall and spring staging areas in Minnesota, Jasper Palaski FWA in Indiana during fall, wintering areas in Florida, and the Platte River Valley of Nebraska in late March. Observations are commonly being obtained in all locations outside Minnesota except the Platte River Valley. Cooperation of researchers

in Indiana and Florida could be solicited at no cost. An observer in the Platte River Valley would be needed during the studies unless cooperating researchers could be located. Locations of marked cranes in Indiana or Florida would indicate affiliation with the eastern greater Sandhill Crane population (Crete and Toepfer 1978, Anderson et al. 1980), while observations in the Platte River Valley would indicate affiliation with the Gulf Coast subpopulation of mid-continent cranes (Tacha et al. 1984). Additional observations should be solicited from the Minnesota public and MDNR field personnel.

Annual recruitment of resident cranes in Minnesota can be estimated following methods of Tacha and Vohs (1984) if fall staging areas used primarily or exclusively by residents can be documented. The alternative is a difficult and extensive study of nesting, hatching, and fledging success.

If banding programs are successful and adequate numbers of cranes are marked, overall mortality rates can be inferred from resightings of marked birds (e.g. Drewien, pers. comm.) or recoveries of birds shot or found dead. This approach is not precise, but could yield a qualitative or semi-qualitative estimate of average annual survival or mortality rates. Some indication of average annual mortality will be required if hunting is to take place without concern about overharvest.

Migrants (II in Table 8)-Known fall staging areas can be inventoried using weekly roost departure/arrival counts (Iverson et al. 1985a) as part of an integrated study of migration in Minnesota. These counts would quantify the regional distribution, magnitude, and chronology of fall migration.

As many staging cranes as possible should be captured and color marked with neck collars. Rocket netting at pre-baited sites near major roosts or in preferred feeding fields is the most promising technique. Observations

of marked birds should be coordinated with those of resident birds as described above. Observations of both sets of marked birds (migrants or residents) can yield valuable information about population affiliations of both groups, and intermixing of resident and non-resident cranes in Minnesota staging areas.

Annual recruitment rates of migrant populations (non-resident and residents if staging areas differ) can be estimated using age ratio techniques in coordination with weekly counts at staging areas (see Tacha et al. 1985). Knowledge of population affiliations, population sizes of resident and non-resident cranes at staging areas, and annual recruitment rates will provide a biological basis for evaluating the potential for hunting cranes in Minnesota. Criteria for allowable harvest can be inferred from Tacha et al. (in prep., Life equation models for mid-continent Sandhill Cranes) if the above population data are available.

Habitat (III in Table 8)-Habitat requirements of nesting and brooding cranes can be identified for use in habitat preservation and or restoration programs by comparing nest/brood site selection with available habitats (see Tebbel 1981). The key is locating nests and broods; habitat use studies should be coordinated with breeding surveys and subsequent brood trapping efforts. Studies of roost habitat selection can be coordinated with fall staging area counts using methods of Soine (1982). Studies of feeding habitat selection can be obtained using methods of Iverson et al. (1985b) in coordination with age ratio surveys described above (see Tacha et al. 1985).

A Cost-effective Research Plan

The most cost effective approach to obtaining information detailed above is to fund a 2-3 year project that has two major complementary studies.

The first would incorporate all jobs dealing with research on residents discussed above and should be executed by MDNR to a) save dollars and assure access to manpower when needed, and b) insure coordination with the second study of migrants. The migrant studies could be contracted to an independent agency because of lower operating costs and more straightforward technical and support requirements.

The discussions of integrated research needs provide only a framework for cost-effective information gathering. Each study and each job will require specific objectives and methods tailored to available funds and as yet unknown tactical problems. Assistance in funding this research might be obtained from the U. S. Fish and Wildlife Service if the Accelerated Research Program for Migratory Shore and Upland Game Birds is reinstated. Minnesota state non-game funds might provide additional support. Whatever sources of funds, effective management of Sandhill Cranes in Minnesota will require a significant research effort.

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Table 1. Minnesota counties in which Sandhill Cranes have been observed.

Aitkin	Grant	*McLeod	Roseau
Anoka	Hennepin	Mille Lacs	St. Louis
Becker	Houston	Morrison	Scott
Beltrami	Hubbard	Mower	Sherburne
Benton	Isanti	*Murray	Stearns
*Blue Earth	Itasca	**Nicollet	Stevens
Carlton	*Jackson	Norman	*Swift
*Carver	Kanakee	*Olmsted	Todd
Cass	Kittson	Ottertail	Traverse
Chippewa	Koochiching	Pennington	Wabasha
Chisago	Lac Qui Parle	Pine	Wadena
Clay	Lake	**Pipestone	*Washington
Clearwater	Lake of the Woods	Polk	*Watonwan
Cook	Le Sueur	Pope	Wildin
Cottonwood	Lyon	*Ramsey	Yellow Medicine
Crow Wing	Mahnomen	Red Lake	
Dakota	Marshall	**Redwood	
Freeborn	*Martin	**Rice	

* All observations occurred prior to 1975.

** Via Janssen, pers. comm.; observation dates unkown to author.

Table 2. Status of resident[1] Sandhill Cranes reported by county in east central Minnesota by indicated sources (R=residents observed; B=breeding noted).

	Source/Time Period					
	Johnson(1976)	Grewe(1977)	Henderson(1979)			This Study
County	1974-1975	1977	1977	1978	1979	1975-May 1985
Aitkin	R	B	B	B	B	B
Anoka	R	B	B	B	B	B
Benton						R
Carlton						R
Cass						B
Chisago	R	R	R			R
Crow Wing						B
Isanti						R
Kanabec		B	B	B		R
Mille Lacs	R	B	B		B	B
Morrison	B	B	B		B	B
Pine	R	B	B	B	B	B
St. Louis						R
Sherburne	R	B	B	B	B	B
Todd						B

[1]Resident status was assigned unless breeding was specifically indicated. Criteria used to determine breeding status in other studies are not necessarily the same as those used in this study.

Table 3. Status of resident[1] Sandhill Cranes reported by county in northwest Minnesota by indicated sources (R=resident observed; B=breeding noted).

	Source/Time Period					
	Johnson(1976)	Grewe(1977)	Henderson(1979)			This Study
County	1974-1975	1977	1977	1978	1979	1975-May 1985
Becker			R	R		R
Beltrami		B[2]	B	B	B	B
Clearwater	R[1]					R
Kittson	B	B	B	B	B	B
Koochiching					B	R
Lake of the Woods		B	B	B	B	B
Mahnomen			R	R		R
Marshall	B	B	B	B	B	B
Norman						R[2]
Pennington	B	B	B	B	B	B
Polk		B	B	B	B	B
Red Lake						B
Roseau	B	B	B	B	B	B

[1]Resident status was assigned unless breeding was specifically noted during indicated time period. Criteria used to determine breeding status in other studies are not necessarily the same as those used during this study.

[2]Based on May 1, 1985 observation of cranes only-possible late migrants.

Table 4. Possible number of Sandhill Crane pairs breeding in east central Minnesota based on observations and estimates made since 1980.

Area	Estimated No. breeding pair[1]	Source
Cass Co.	4-5	Mike Loss, MDNR and Dennis Amundsen
Crow Wing Co.	3-5	Mike Loss, MDNR
Grayling WMA, Aitkin Co.	1	Dave Dickey, MDNR
Rice Lake NWR, Aitkin Co.	1	Dave Dickey, MDNR
Southeast Todd Co.	1	Dave Pauly, MDNR
Southeast Morrison Co.	25-28	Dave Pauly, MDNR
Mille Lacs WMA, Mille Lacs Co.	6-9	Dave Pauly and Dick Tuszynski, MDNR
Kunkel WMA, Mille Lacs Co.	1	Dick Tuszynski, MDNR
Southern Aitkin, northern Kankakee and central Pine counties	20-30	Dave Pauly, MDNR
Sherburne NWR, Sherburne Co.	15	Jay Johnson, USFWS
Cedar Creek Natural History area, Anoka/Isanti counties	2	Dick Tuszynski, MDNR
Carlos Avery WMA, Anoka Co.	7-10	Walt Rohl and Dick Tuszynski, MDNR
Estimated Total	87-109	

[1]Determination of breeding status was not necessarily based on criteria used in this study.

Table 5. Possible number of Sandhill Crane pairs breeding in northwest Minnesota based on observations and estimates made since 1980.

Area[1]	Estimated No. breeding pair[2]	Source
Roseau River WMA, Rosseau Co.	100	Ken Kramer, MDNR
Eastern Kittson and northwest Roseau counties (excluding RRWMA)	280-560	George Davis, MDNR
Central Kittson Co.	15-25	George Davis, MDNR
Central Marshall and southwest Roseau counties	75-150	George Davis, MDNR
Northeast Marshall, central Roseau, and northwest Beltrami counties	60	Gerald Maertens, MDNR
Western Beltrami Co.	80-125	Gordon Forester, MDNR
Western Marshall Co.	20	Gordon Forester, MDNR
Agassiz NWR, Marshall Co.	32	Jim Mattson, USFWS
Western Pennington Co.	25	Gordon Forester, MDNR
Central Pennington Co.	20	Gordon Forester, MDNR
Eastern Pennington Co.	50	Gordon Forester, MDNR
Mahnomen Co.	10	Doug Bellefeville, BIA
Total Approximately	760-1160	

[1]Areas do not overlap.

[2]With the exception of Agassiz NWR, all figures are gross estimates made by Area Wildlife Managers based on incidental observations of cranes and general knowledge of habitat availability in their respective work areas.

Table 6. Earliest spring date and latest fall date Sandhill Cranes have been observed in Minnesota, by county since 1970 (entries are month-day).

County	Earliest Spring	Latest Fall	County	Earliest Spring	Latest Fall
Aitkin	4-19	10-17	Sherburne	3-17	11-1
Anoka	3-19	10-23	Stearns	3-26	10-1
Becker	4-13	10-27	Swift	4-4	
Beltrami	4-14	10-18	Traverse		11-3
Benton	4-21		Wabasha		10-27
Carver	4-24		Wadena	4-19	
Cass	4-19	10-4	Washington	4-9	11-20
Chippewa	4-5	October	Wilkin	4-1	10-29
Chisago	4-4	9-12	Yellow Medicine	4-8	11-23
Clay	4-5	11-10			
Clearwater	4-4				
Cook		10-15			
Cottonwood		10-22			
Crow Wing	4-20	9-13			
Dakota		9-11			
Freeborn	4-11	9-17			
Grant	4-5				
Hennepin	3-25				
Houston	4-4				
Hubbard	4-19				
Isanti	4-12	11-27			
Itasca	4-10				
Kanakee	4-10				
Kittson	4-24	10-28			
Koochiching	4-28				
Lac Qui Parle	4-5	12-2			
Lake		10-3			
Lake of the Woods	3-19	10-26			
Le Seur	3-22				
Lyon	4-12	10-11			
Mahnomen	4-1				
Marshall	3-27	11-14			
Mille Lacs	4-1	9-19			
Morrison	3-26	9-13			
Mower	3-19				
Norman	4-7	11-6			
Ottertail	3-31	11-25			
Pennington	4-2	11-5			
Pine	4-2				
Polk	4-7	12-17			
Pope	4-11				
Red Lake	3-28	9-8			
Roseau	4-10	9-24			
St. Louis	4-28	10-27			
Scott	4-30				

Table 7. Public lands used by resident Sandhill Cranes in Minnesota

State Areas

Badoura State Forest

Beaches WMA

Beltrami Island State Forest

Caribou WMA

Carlos Avery WMA

Chengwatana State Forest

Crane WMA

Detroit Lakes WMA

Dugdale WMA

Eckvoll WMA

Elm Lake WMA

Ereaux WMA

Florian WMA

Grayling WMA

Kunkel WMA

Mille Lacs WMA

Pembina WMA

Polk WMA

Red Lake WMA

Rice Skunk WMA

Roseau River WMA

Rush WMA

St. Croix State Forest

Theif Lake WMA

Twin Lakes

Federal Areas

Agassiz NWR

Nelson Prairie WPA

Red Lake Indian Reservation

Rice Lake NWR

Sherburne NWR

Table 8. Intergrated research needs for Sandhill Cranes in Minnesota.

I. Research on resident cranes

A. Population size of:

* 1. Breeding pairs

2. Nonbreeders

B. Distribution of:

* 1. Breeding pairs during breeding season

2. Non breeders during breeding season

* 3. Fall staging areas in Minnesota

4. Population affiliations

* a. Migration routes and chronology

* b. Wintering areas

C. Characteristics of the resident populations

1. Subspecies

2. Age structure

3. Sex ratios

D. Annual recruitment of residents

* 1. Overall age ratios

2. Age-related productivity

E. Mortality of residents

* 1. Overall average annual mortality

a. Natural mortality

b. Harvest mortality

2. Age-related mortality

a. Natural mortality by age

b. Harvest mortality by age

Table 8 cont'd.

II Research on cranes during migration

A. Population size in fall

* 1. Chronology of migration

* 2. Distribution of migration staging areas

B. Population Affiliations of migrant cranes

1. Breeding range

2. Migration routes

* 3. Wintering areas

III Habitat requirements

A. Habitat needs of residents

* 1. Nesting

2. Brood rearing

3. Non breeders

B. Habitat needs of migrants

* 1. Roosting

* 2. Feeding

*Priority research needs for management.

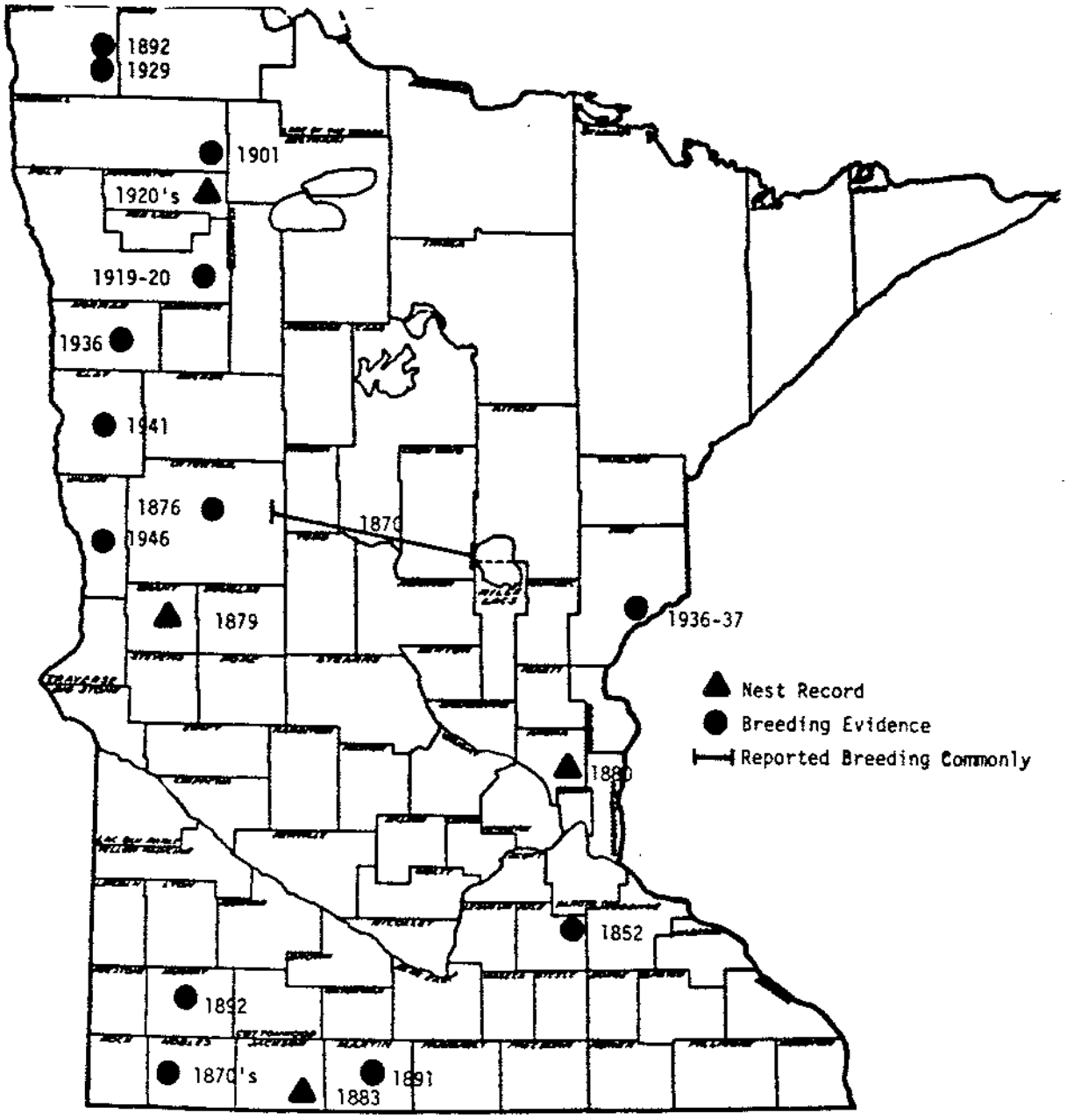


Figure 1. Nest records and breeding evidence of Sandhill Cranes in Minnesota prior to 1950 (from Johnson 1976a).

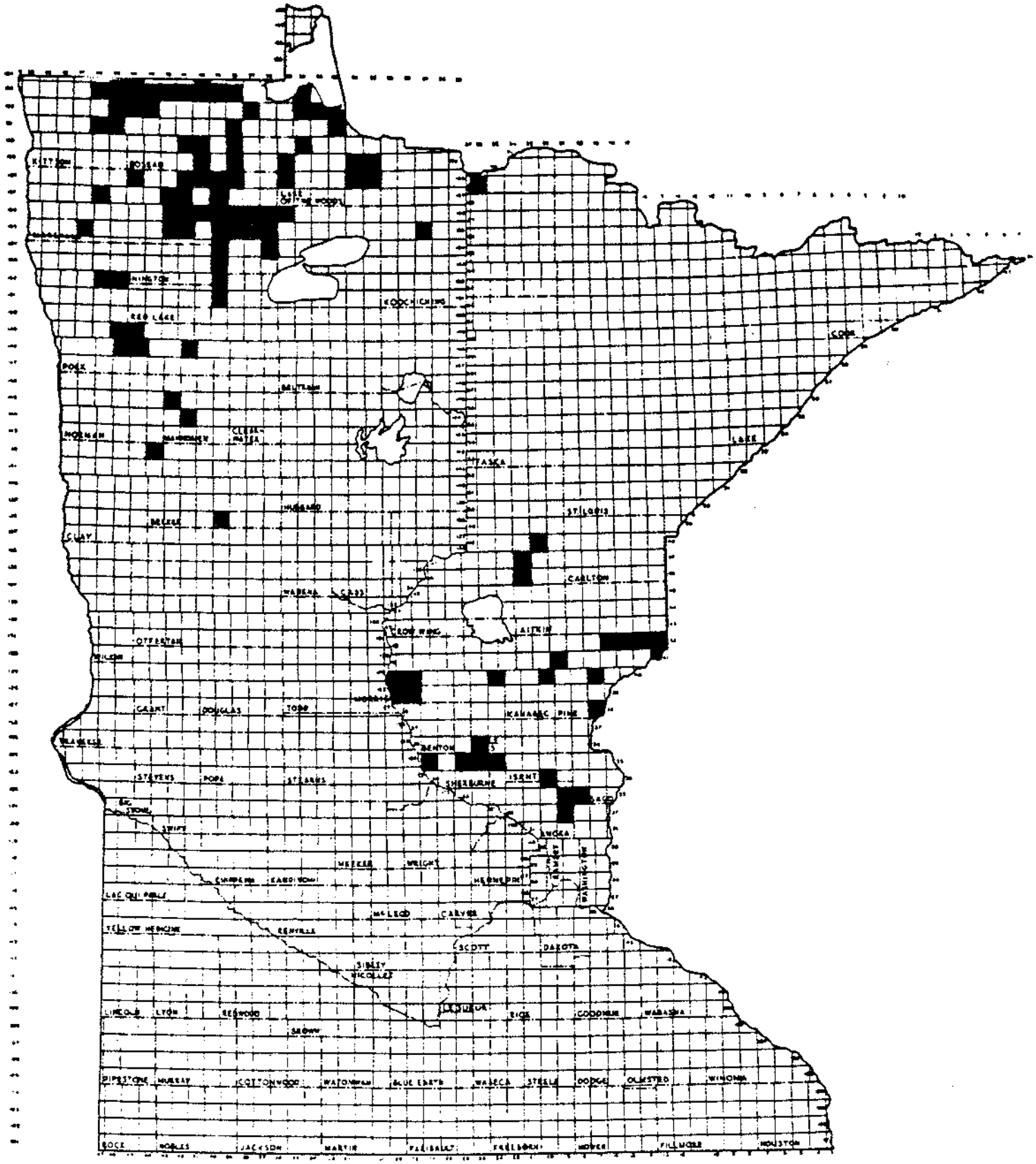


Figure 2. Location of Sandhill Cranes observed in Minnesota from May - August, 1977 - 1979 (from Henderson 1979b).

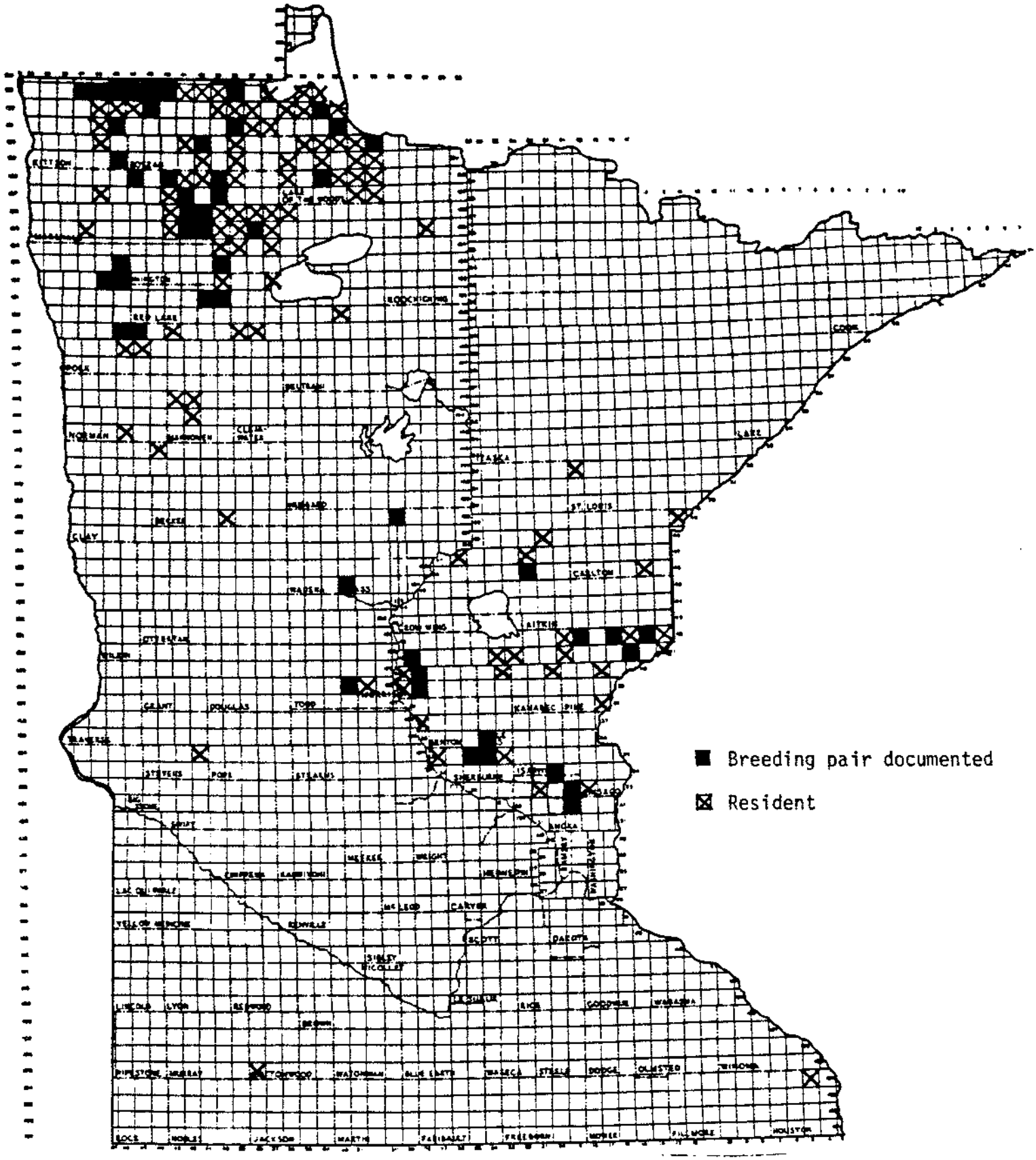


Figure 3. Location of Sandhill Cranes observed in Minnesota from May - August, 1975 - 1984.

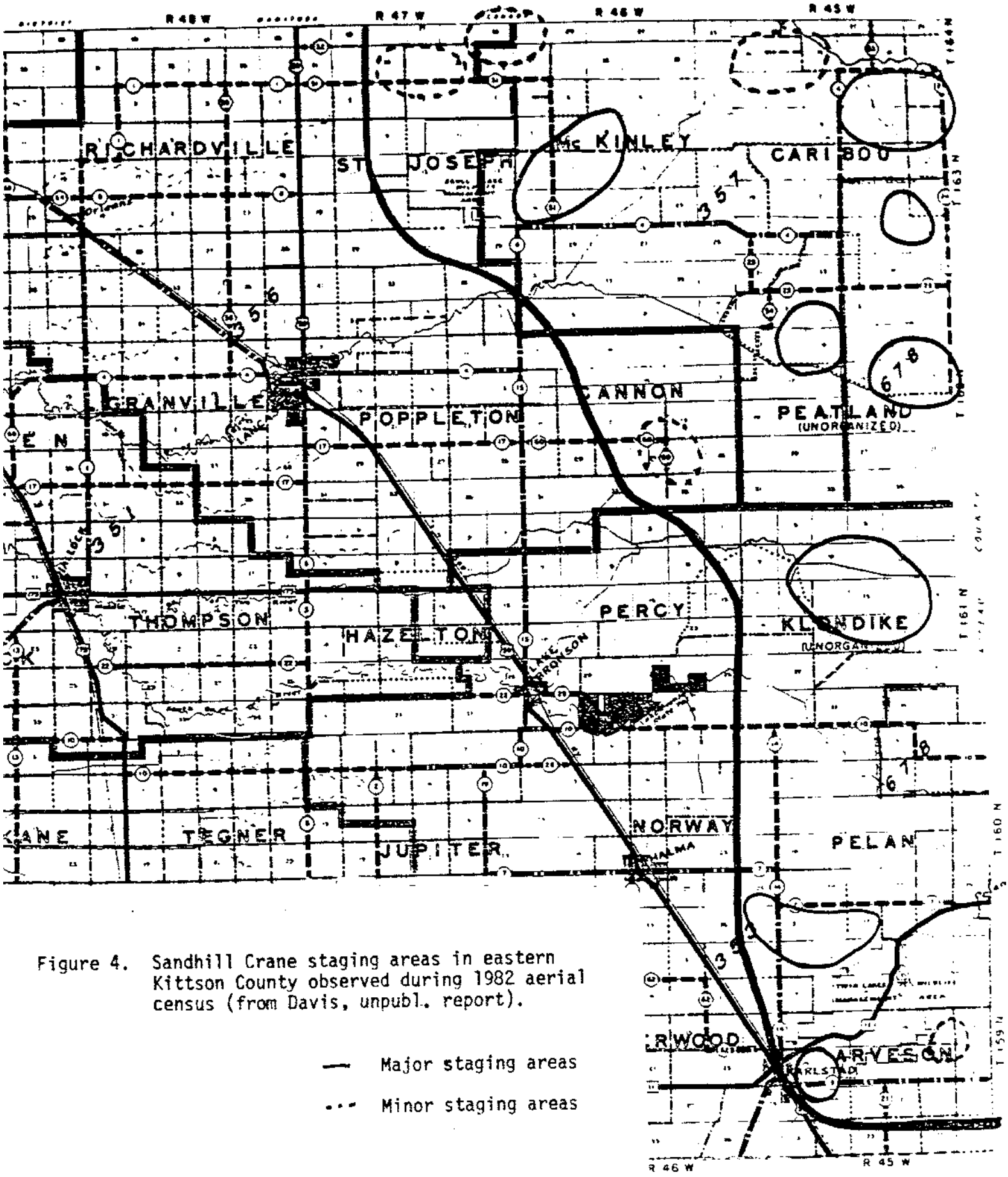
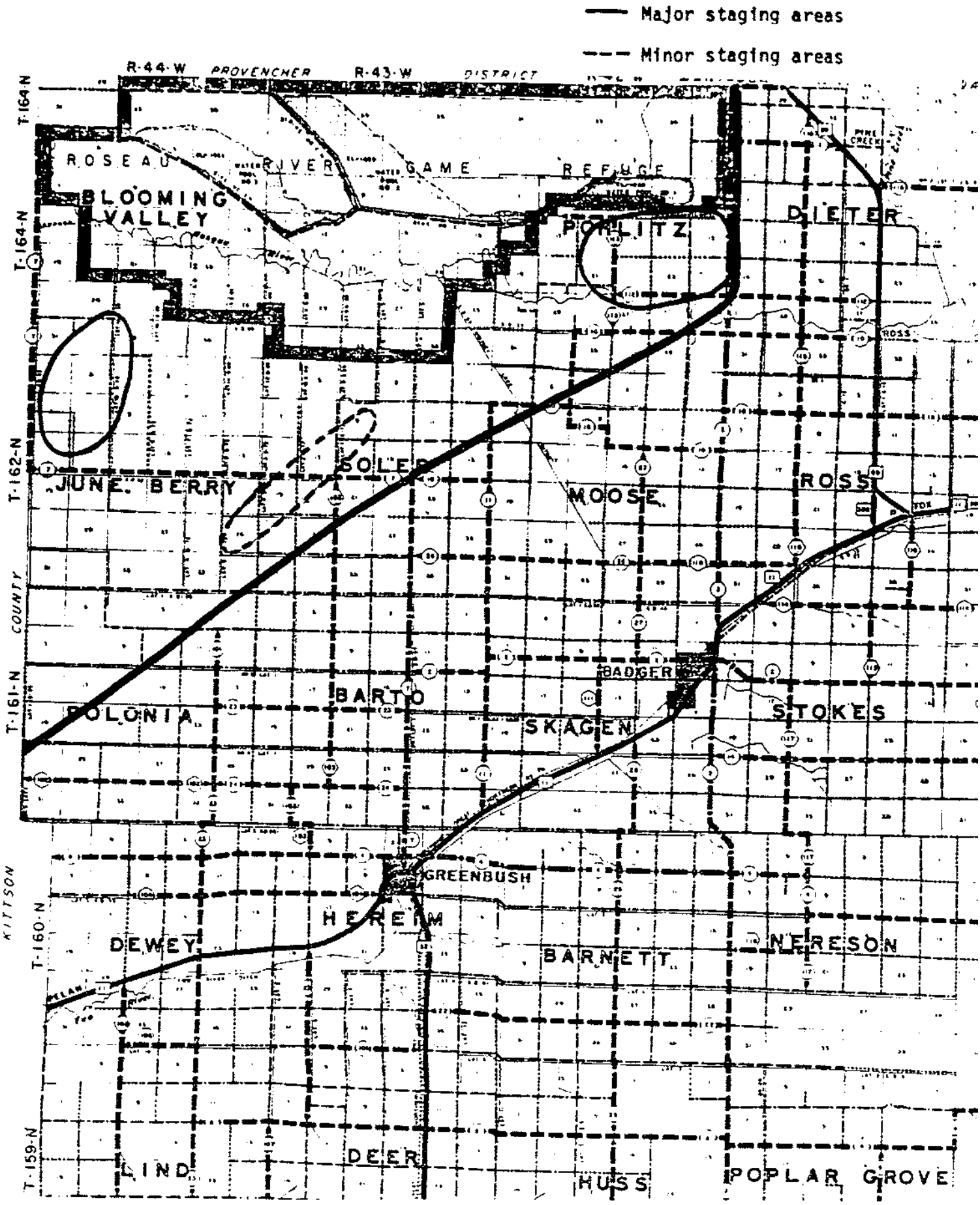


Figure 4. Sandhill Crane staging areas in eastern Kittson County observed during 1982 aerial census (from Davis, unpubl. report).

— Major staging areas

--- Minor staging areas

Figure 5. Sandhill Crane staging areas in western Roseau County observed during 1982 aerial census (from Davis, unpubl. report).



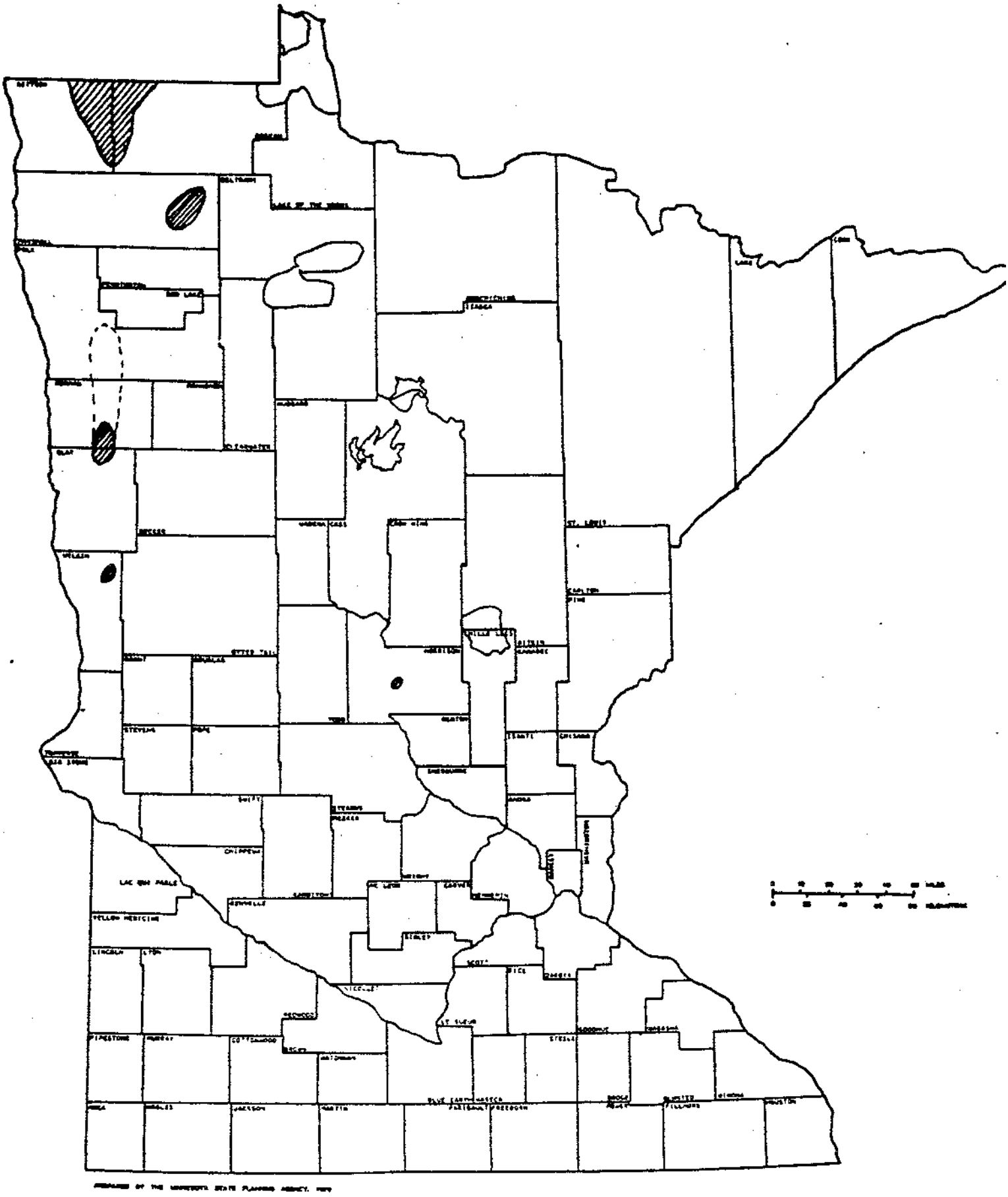


Figure 6. Approximate locations of Sandhill Crane staging areas in Minnesota.

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PREFACE TO APPENDIX B

Appendix B lists observations of Sandhill Cranes in Minnesota compiled from 29 sources. The column headed with numbers of cranes includes ages of cranes observed in groups less than 100 where A = adult, J = juvenile, U = unknown, and T = total. Cranes observed during April and prior to hatch in May were reported as adults due to inability to differentiate age class on the basis of plumage. Most observations of cranes reported in the Flicker or Loon were gathered from the Seasonal Reports section of each issue. To reduce author redundancy and length of the Literature Cited section, readers were referred directly to the issue of Flicker or Loon containing crane observations. Individual papers can be found in Literature Cited section; personal communications are found in Appendix A. In addition, unpublished data was obtained from various sources indicated by the following abbreviations:

NAC = Northwoods Audobon Center, Sandstone, MN

MOU = Minnesota Ornithologist's Union

MDNR = Minnesota Department of Natural Resources

- 001, etc. = individual entry in Minnesota Natural (Heritage) History Database
- Cambridge, etc. = MDNR field office locations
- TLWMA - Thief Lake Wildlife Management Area

FWS = U. S. Fish and Wildlife Service

- Morris = FWS field station

APPENDIX B

County/ Date	Location	No. Cranes A-J-U-T	Status	Comments	Source
Aitkin County					
May, 1961	Grayling Marsh	X-X-1-1	R	3 Mi. NE of McGregor	Flicker 33 (4):125
7-20-61	3 Mi. NE of McGregor	------	R	Two groups calling	Flicker 33 (4):125
4-16-63	Grayling Marsh	2-1-X-3	U	T48N-R23W-Sec 10	MDNR - 001
5-17-64	---	X-X-1-1	R		Loon 36 (2):49
4-14-65	---	------	U		Loon 37 (4):137
4-20-65	---	------	U		Loon 37 (4):137
4-14-66	Rice Lake Refuge	X-X-2-2	U		Loon 38 (3):87
5-29-67	---	X-X-2-2	R		Loon 39 (3):90
10-20-68	Rice Lake Refuge	X-X-2-2	U		Loon 41 (1):17
4-25-70	---	X-X-1-1	U		Loon 42 (3):105
10-17-71	---	------	U		Loon 44 (1):12
Summer,72	Rice Lake Refuge and NE of McGregor	------	B	Nested	Loon 44 (4):108
Summer,73	Rice Lke Refuge and NE of McGregor	------	B	Nested	Loon 46 (1):19

APPENDIX B. Continued.

County/ Date	Location	No. Cranes A-J-U-T	Status	Comments	Source
8-4-73	Grayling Marsh	X-X-5-5	R		Janssen, pers. comm.
Summer,74	---	------	B	Nested	Loon 47 (1):29
7-3-74	Grayling Marsh	X-X-3-3	R		Janssen, pers. comm.
9-10-74	Grayling Marsh	2-1-X-3	U	T48N-R23W-Sec 10	MDNR-001
9-14-74	T47N R27W Sec. 2	X-X-1-1	U		MDNR-002
8-20-76	---	------	R		Loon 49 (3):143
9-17-76	Rice Lake NWR	X-X-3-3	U		Janssen, pers. comm.
5-20-77	Grayling Marsh	2-X-X-2	R	T48N-R23W-Sec 23	MDNR-001
5-27-77	Grayling Marsh	2-2-X-4	B	T48N-R23W-Sec 10	MDNR-001
5-28-77	---	X-X-2-2	R		Loon 49 (4):215
Summer,77	Rice Lake NWR	2-1-X-3	B	T46N-R24W-Sec 5	MDNR-003
5-18-78	Grayling WMA	1-X-X-1	R	T48N-R23W-Sec 10	MDNR-001
10-1-78	---	------	U		Loon 51(2):87
4-19-79	Grayling WMA	2-X-X-2	U	T48N-R23W-Sec 10	MDNR-001
5-7-79	Grayling WMA	1-X-X-1	R	T48N-R23W-Sec 10	MDNR-001