ECOLOGY OF NON-BREEDING WISCONSIN SANDHILL CRANES, WITH EMPHASIS ON CROP DAMAGE AND MIGRATION

by

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ABSTRACT

Studies of non-breeding greater sandhill cranes (*Grus canadensis tabida*), their movements, habitat use, migration, wintering grounds, and involvement in crop damage, were conducted in Wisconsin, Indiana, and Florida from April 1976 through November 1977. Fifty-eight cranes were captured and color-marked in central Wisconsin and another 10 non-breeders were fitted with radio transmitters. Radio-tagged cranes inhabited minimum home ranges of 774 to 3,691 ha during 6-18 week periods from April through September. At least 1 non-breeder spent consecutive summers at locations more than 56 km apart.

Non-breeding birds are responsible for nearly all the sandhill crane crop damage occurring in Wisconsin. In a majority of cases the damage is caused by 10 or fewer cranes, and in many areas damages are recurrent from year to year. Tests using the chemical methiocarb as a repellent to cranes in sprouting corn (*Zea mays*) were inconclusive. Acetylene exploders are the most effective method of control presently in use. Visits by landowners to fields to scare cranes are effective and should be encouraged when practical. Lure crops may be of value in areas that experience recurrent damage and are located near wetlands with large numbers of cranes. Wisconsin Department of Natural Resources personnel should continue to evaluate crane damage complaints critically and as soon as possible after damage occurs.

Eleven major sandhill crane staging areas in Wisconsin supported a peak fall population of over 3,500 cranes in 1977. Five of these areas were in private ownership. Sandhill cranes from the Mead Wildlife Area in central Wisconsin moved southwestward to the Sandhill Wildlife Area before leaving Wisconsin in the fall, and cranes from Shawano County in northeast Wisconsin moved to staging areas in southeast-central Wisconsin. The fall migration of cranes from Wisconsin is related to the opening of the waterfowl hunting season. Cranes in southeast-central Wisconsin, where roosting marshes are subjected to heavy hunting pressure, leave the state up to 6 weeks earlier than cranes with undisturbed roosts at the Necedah National Wildlife Refuge and the Sandhill Wildlife Area.

More than 80 percent of the sandhill cranes color-marked or radio-tagged in central and northeastern Wisconsin in 1977 were observed at the Jasper-Pulaski Wildlife Area, Indiana, during the fall migration. Some stayed less than 1 week, others for 7 weeks or longer. Cranes from southeast-central Wisconsin staging areas arrived at Jasper-Pulaski earlier and stayed for longer periods than cranes from west-central Wisconsin. Variations in the "typical" activity patterns of cranes at Jasper-Pulaski are due to the changing influences of weather, season, disturbances to the birds, farming practices, and land-use patterns.

Over 4,500 wintering greater sandhill cranes were accounted for in central Florida and southern Georgia during

the winter of 1976-77. Eight cranes color-marked or radio-tagged in central Wisconsin since 1973 were reported from 5 locations in central, eastern, and western Florida during the winters of 1976-77 and 1977-78.

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INTRODUCTION

A number of studies have dealt with aspects of the breeding biology of sandhill cranes. However, relatively little research has been done on the non-breeding segment of the population, from the age of 10 months when the young birds are driven off by their parents until the 3rd or 4th year, when these birds themselves become breeders. Little is known about non-breeding eastern greater sandhill cranes, their daily and seasonal movements, habitat requirements, wintering grounds, interactions with breeding pairs and other non-breeders, and involvement in crop damage.

Six subspecies of sandhill crane occur in North America (Drewien et al. 1975): the greater sandhill crane, lesser sandhill crane (G. c. canadensis), Canadian sandhill crane (G. c. rowani), Florida sandhill crane (G. c. pratensis), Mississippi sandhill crane (G. c. pulla), and Cuban sandhill crane (G. c. nesiotes). Four populations of the greater sandhill crane subspecies are recognized. These are: (1) Eastern, (2) Rocky Mountain, (3) Colorado River Valley, and (4) Central Valley.

The breeding range of the Eastern population of greater sandhill cranes includes parts of Wisconsin, Michigan, Minnesota, and the provinces of Ontario and Manitoba. These birds migrate southward in the fall to a stopover at the Jasper-Pulaski Fish and Wildlife Area in Indiana before continuing on to their wintering grounds in Florida and

southern Georgia.

This thesis is a report of a study conducted in Wisconsin, Indiana, and Florida from April 1976 through November 1977. The objectives were:

(1) To determine the movements and habitat use of non-breeding greater sandhill cranes in Wisconsin.

(2) To characterize the sandhill crane crop damage problem in Wisconsin and recommend methods for its control.

(3) To characterize the staging areas, migration patterns, and wintering grounds of Wisconsin sandhill cranes.

The classic work of Walkinshaw (1949) on the sandhill cranes of North America reported much of the life history of these birds, including information on behavior, territories, nesting, plumages, and food habits. Walkinshaw (1973) presented more recent material on distribution and life history. The work of Littlefield and Ryder (1968) in Oregon and Drewien (1973) in Idaho contributed to our knowledge of the breeding biology of greater sandhill cranes. Henika (1936) and Hamerstrom (1938) presented early information on the distribution and habitat requirements of Wisconsin's sandhill cranes. Gluesing (1974), Hunt et al. (1976), and Howard (1977) presented more recent data on the history, distribution, status, and nesting requirements of cranes in Wisconsin.

Walkinshaw (1961) reported crop damage by sandhill cranes from several parts of the United States and Canada. The most

serious damages occur in the prairie provinces of Canada, where in autumn thousands of migrating cranes feed in unharvested wheat fields (Harper 1959, Ledingham 1960, Munro 1961). Stephen (1967) presents results of an intensive study of sandhill crane crop damage and its control in Saskatchewan. Crane damage to grain crops has also occured in North Dakota (Buller 1967) and Idaho (Drewien 1973).

Most Wisconsin crane damage occurs in the spring to sprouting corn (Hunt et al. 1976). Cranes destroy young corn plants by uprooting the sprouts to feed on the seed corn underneath the soil. Sandhill crane damage to sprouting corn has also been reported from Michigan (Hoffman 1976), Georgia, and Florida (Stone and Mott 1973). The Wisconsin Legislature passed Assembly Bill 62 in 1975, requiring the Wisconsin Department of Natural Resources to pay for crop damage caused by sandhill cranes. Over $10,000 was paid for 20 damage claims in the first year after passage of this legislation. The sandhill crane population has been increasing steadily in Wisconsin in recent years (Gluesing 1974, Howard 1977, Bennett 1978). Increases in the amount of actual crop damage and the number of damage complaints filed by farmers are likely if this growth continues. Research was needed at the time of this study to examine the nature and extent of this problem and recommend methods for its control.

Walkinshaw (1960, 1973) discussed the fall migration of Wisconsin cranes through Indiana southward to Georgia and Florida. Shroufe (1976) described the primary staging area of eastern greater sandhill cranes at the Jasper-Pulaski

Fish and Wildlife Area in northwestern Indiana. Migration studies of greater sandhill cranes in Wisconsin were initiated in 1973 by Gluesing (1974), and were continued in 1974 and 1975 by Howard (1977).

Walkinshaw (1973) stated that greater sandhill cranes wintered in Florida on the Kissimmee Prairie and at Paynes Prairie near Gainesville, and possibly in the Okefenokee Swamp of southern Georgia. At Paynes Prairie, a peak winter population (January 1970) of 1,800 greater sandhill cranes (Williams and Phillips 1972) has declined over the past 6 years to less than 400 (Nesbitt 1977). In Sanderson (1977:16) J.R. Eadie reported 1,200 greater sandhill cranes wintering in the Okefenokee Swamp, Georgia, and L.E. Williams, Jr. reported 5,100 greater sandhill cranes wintering in Florida. No dates or specific locations for the Florida-wintering cranes were given.

STUDY AREAS

Studies of the ecology of non-breeding sandhill cranes and crane crop damage were conducted in central Wisconsin, primarily on the Buena Vista Marsh and at the Mead Wildlife Area. Migration research outside Wisconsin took place at the Jasper-Pulaski Fish and Wildlife Area in northwestern Indiana. Research on the wintering grounds of eastern greater sandhill cranes was conducted in Florida and southern Georgia.

Buena Vista Marsh

The Buena Vista Marsh contains about 300 km^2 of land in southwestern Portage County, Wisconsin, at elevations of 319.1-332.2 m above sea level. The topography is flat, sloping from east to west at 0.5 to 1.1 m per km (Weeks and Strangland 1971). The marsh was originally a tamarack (Larix laricina) swamp, but the trees were logged off shortly before 1900 (Finley 1951). During the early 1900's ditches were dug in an east - west direction to drain the marsh and create agricultural lands.

The Buena Vista Marsh at present contains extensive areas of grasslands overlaying drained peat and Newton sand soils containing scattered islands of higher Plainfield sand (U.S. Soil Conservation Service 1971). Many of the grasslands are used as pastures for beef cattle and horses, while others are managed by the Wisconsin Department of Natural Resources for the greater prairie chicken (Tympanuchus cupido pinnatus). Corn, oats (Avena sativa), potatoes (Solanum tuberosum), and

other truck crops are grown on the marsh, and small tracts of shrubs and other woody vegetation are scattered throughout. Areas of sheetwater and numerous shallow depressions that are flooded by snow melt and spring rains are the only nesting areas available to sandhill cranes. These areas are usually dry by mid-May. Surface water which persists throughout the summer occurs only in the drainage ditches and in numerous small stock ponds.

Mead Wildlife Area

The George W. Mead Wildlife Area, located in Marathon, Wood, and Portage counties, is owned by the State of Wisconsin and managed by the Wisconsin Department of Natural Resources. It comprises about 10,680 ha of aspen (Populus spp.) and mixed hardwood uplands, shrub swamps, open marshes, and farmland within the basin of the Little Eau Pleine River. The topography is rolling with elevations of 341.4-387.1 m above sea level.

The construction of numerous dikes and ditches along the meandering course of the Little Eau Pleine River has created over 2,520 ha of impounded wetlands. These impoundments and numerous smaller wetlands nearby provide nesting habitat for sandhill cranes. Oats, corn, wheat (Triticum aestivum), buckwheat (Fagopyrum esculentum), and alfalfa (Medicago sativa) are grown on over 720 ha of sharecropped farmland. These crops and pastures also occur on adjacent private farmlands.

Jasper-Pulaski Fish and Wildlife Area

The Jasper-Pulaski Fish and Wildlife Area is located in Jasper and Pulaski counties in northwestern Indiana. It has been a traditional migration staging area for the eastern population of greater sandhill cranes since its acquisition by the Indiana Department of Conservation in the early 1930's. The Area consists of about 810 ha of wetlands and 2,429 ha devoted to the management of resident upland game species (Shroufe 1976). The wetlands are small ponds, impoundments, and shallow marshes occurring near the center of the property and surrounded by oak (Quercus spp.) uplands. A complex of upland crop fields known as the "goose pasture", 0.8 km south of these wetlands, is planted to corn, winter wheat, buckwheat, and clover (Trifolium spp.). The goose pasture and most of the wetland areas are closed to waterfowl hunting.

Migrating greater sandhill cranes stop at Jasper-Pulaski each year during March and April and again in September, October, and November. The cranes roost in the complex of wetlands and feed during the day either in the goose pasture or on waste grain in outlying privately-owned corn and soybean (Glycine max) fields.

METHODS

Daily activities, behavior, and habitat preferences of non-breeding cranes at Buena Vista and Mead were determined by direct observation from April through September in both years of the study. "Non-breeders" included birds too young to be paired and pairs that either did not attempt to nest or did not nest successfully. Population estimates were obtained by comparing and combining information from censuses of calling pairs in spring and counts of cranes at roosts and in feeding fields throughout the summer.

Capture and Color-marking

Sandhill cranes were captured in Wisconsin and Indiana during the periods May-November 1976 and March-October 1977. Captures were made using recoilless rocket nets (Gluesing 1974, Howard 1977). During most of 1976 the rockets were fired from metal fenceposts at a height of about 1.5 m. However, such a set-up was unnatural looking and difficult to camouflage, and cranes often were reluctant to approach the bait.

Rockets were fired from ground level in 1977. This set-up varied from that of Wheeler and Lewis (1973) in that the rockets were projected at an angle of about 30 degrees, with the tails inserted into metal pipes, about 80 cm long and 2 cm wide, driven obliquely into the ground. Nets, rockets, pipes, and detonation wire were completely camouflaged with grass clippings and/or natural vegetation, resulting in more natural appearing trap sites which cranes were more willing

to approach. Care was taken to fire the nets at an instant when all or most of the cranes had their heads down feeding, to preclude injury from the rockets or the leading edge of the net.

All captured cranes were banded with size 9 interlocking aluminum U.S. Fish and Wildlife Service leg bands. Weights and standard measurements as described by Stephen (1967) were taken for subspecies verification. Most cranes captured in Wisconsin were color-marked with a pair of 23 cm X 5 cm lime-green patagial tags, each bearing a set of four black letters and numerals (Howard 1977) (Fig. 1).

Radiotelemetry

Ten non-breeding cranes not patagial-tagged were fitted with portable radio transmitters, permitting intensive study of their movements and activities (Fig. 2). Five cranes were radio-tagged at the Buena Vista Marsh, 4 at the Mead Wildlife Area, and 1 at the White River Marsh in Green Lake County. Only migration data is presented for the White River bird.

Telemetry equipment was purchased from the AVM Instrument Company, Champaign, Illinois. Each radio package consisted of a SB2 transmitter, 660-3 lithium battery, and 30 cm whip antenna, spring reinforced at the antenna-transmitter attachment point (Fig. 3). These components were mounted on a thin strip of brass shimstock, to which were soldered three, 1.3 cm-wide cylinders, one anterior and two posterior, through which the harness wire would pass. The whole package was sealed in dental repair and rebase acrylic. Insulated eight

Fig. 1. Greater sandhill crane with patagial tag.

Fig. 2. Greater sandhill crane being fitted with radio transmitter.

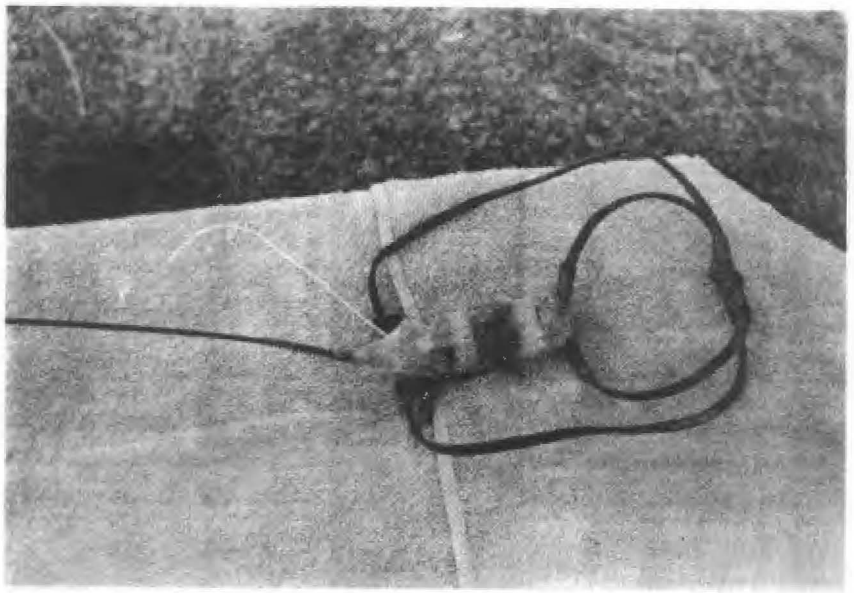

Fig. 3. Transmitter used on greater sandhill cranes in central Wisconsin, 1976-77.

gauge stranded copper wire was selected for the harness because of its flexibility and durability. A single wire, 80-90 cm in length, was passed through the small attachment cylinder at the front of the radio package and then tied in a square knot. This created a loop as big as the base of a crane's neck and 2 free ends about 35 cm long. In the field the loop of the harness was slipped down over the crane's head to the base of the neck, allowing the radio package to ride in the middle of the bird's back. Each of the free ends was pulled back underneath a wing and pulled in opposite directions through one of the attachment cylinders at the back of the package, tightly enough to insure a snug but unbinding fit. Each free end was then secured with 2 half hitches at the back of the radio package, and the remaining 5-7 cm of free wire were secured to the sides of the package with all-weather electrician's tape. All knots in the harness were also taped, to prevent slippage and deter the crane from undoing them with its bill. The weight of the entire package averaged 135 g, less than 3 percent of the body weight of an adult greater sandhill crane.

Frequencies of the transmitters ranged between 150.925 MHz and 151.125 MHz. A portable 24-channel LA12 receiver and either a Hy-Gain 8-element directional antenna (Hy-Gain Electronics Corp., Lincoln, Nebraska) mounted on an automobile rooftop, or a 4-element Yagi hand-held antenna were used for radiotracking. Two hand-held antennas mounted on the wing struts of an airplane were used when large areas were searched for radio-tagged birds. The signals could be received at

distances of 2.4 - 6.4 km ground to ground and 14.5 - 24.1 km ground to air. The expected life of each radio-package was 12-15 months. Radio-tagged cranes were tracked intermittently from April through September in Wisconsin and during spring and fall migration at the Jasper-Pulaski Wildlife Area, Indiana. Minimum summer home ranges were calculated by plotting radiolocations on U.S.G.S. topographic maps and connecting the outer points (Hayne 1949, Odum and Kuenzler 1955).

Crop Damage

The chemical methiocarb (trade name Mesurol, generic name 4-(methylthio)-3,5-xylyl N-methylcarbamate) was tested as a repellent to sandhill cranes in sprouting corn during May and June, 1977. Methiocarb is applied directly to the seed corn before planting and has shown excellent potential as a non-lethal broad-spectrum avian repellent. It has proven effective in repelling red-winged blackbirds (Agelaius phoeniceus), common grackles (Quisculus quiscula), brown-headed cowbirds (Molothrus ater), and crows (Corvus brachyrhynchus) (Stickley and Guarino 1972, Guarino and Forbes 1970), boat-tailed grackles (Cassidix mexicanus) (West and Dunks 1969), and pheasants (Phasianus colchicus) (West et al. 1969) from sprouting corn. The reason why methiocarb repels birds is not well understood, but an aversion to the chemical is probably caused by: (1) a post-ingestinal disturbance such as nausea or lack of appetite or (2) unpleasant taste

(Guarino 1972).

Eleven cornfields with histories of crane damage, 8 at Mead and 3 at Buena Vista, were treated with methiocarb. Eight fields received a complete treatment, while in 3 others (one at Mead, two at Buena Vista) all the rows in one half of the field were treated while those in the other half were left untreated. Six other cornfields, 5 at Mead and one at Buena Vista, were left untreated and were used as controls. Each control field was within 150 m of a treated field, and all fields ranged between 0.8 and 2.0 ha in size. The methiocarb - 50 H.B. Mesurol, a gray powder mixture of the chemical and graphite - was applied directly to the seed corn before planting at a rate of 454 g methiocarb per 45.4 kg seed. About 32 ha could be planted with 45.4 kg of seed.

Each field was observed 2-5 times weekly, from the time corn began to sprout until it was about 0.3 m tall and beyond the damage stage. The number of cranes, time spent in each field, and behavior while in the field were recorded. Portions of each field were searched at least twice weekly for signs of crane use.

Fields in which cranes or signs of cranes had been observed were sampled for damage. Twenty-five 0.0064-ha plots (2 rows wide and 30.5 m long) were established in most fields, while in one narrow 1.04-ha field, which was half treated and half control, 4 complete rows (0.09 ha total) were sampled in each half. The number of plants destroyed on each was recorded 3 times over a 2-week period. Uprooted

plants were collected to prevent duplicate counts. The total number of plants in each plot was recorded during the initial sample.

Data on the characteristics of sandhill crane crop damage were gathered from interviews with farmers and local game managers, and through personal observations of damage situations. These data included information on the state-wide distribution of crane damage, history of prior damage, amount of damage, size of crane flocks involved in damage, and the effectiveness of control methods.

Migration

Wisconsin

Intensive efforts to observe color-marked cranes in Wisconsin were made during the fall of 1976 and the spring and fall of 1977. Marked cranes included birds fitted in 1973 with white aluminum neck collars with black letters and numerals (Gluesing 1974) and cranes patagial-tagged during 1975-76 (Howard 1977) and 1976-77. Observations were made with the aid of 7x50 binoculars and a 15-60x variable power spotting scope. The activities of color-marked and radio-tagged cranes were monitored at staging areas in Wisconsin during fall migration, and data on arrival and departure dates, movements, habitat use, and ownership of the properties involved were collected. The characteristics of 4 central Wisconsin staging areas, the Mead Wildlife Area, Sandhill Wildlife Area, Necedah National Wildlife Refuge, and Dike 17 Wildlife Area, were studied intensively during the fall of 1977. The numbers

of cranes using 11 major Wisconsin staging areas were censused during the fall of 1977.

Jasper-Pulaski

Graduate students from the University of Wisconsin-Stevens Point spent a total of 72 days at the Jasper-Pulaski Fish and Wildlife Area, Indiana, during the periods 23 October - 19 November 1976, 4-25 March 1977, and 7 October - 10 November 1977. Observations and locations of color-marked and radio-tagged cranes were reported for the period 12-26 November 1977 by Ron Crete, St. Cloud State University, Minnesota, and John Toepfer, University of Wisconsin-Stevens Point. Data on arrival and departure dates, lengths of stay, daily movements, habitat use, and roosting behavior were collected from color-marked and radio-tagged central Wisconsin cranes and from daily observations of the thousands of unmarked cranes using the Wildlife Area.

Wintering Grounds

The period 23 December 1976 - 11 January 1977 was spent in Florida and southern Georgia seeking (1) concentrations of wintering greater sandhill cranes, and (2) cranes color-marked or radio-tagged in Wisconsin. I travelled over 3,000 miles while in those two states, contacted 25 persons believed to have information on wintering cranes, and spent 3 hours in the air searching the Gainesville vicinity and much of the Kissimmee Prairie for radio-tagged birds.

Care was taken to attempt to distinguish between the migratory greater sandhill crane and the Florida sandhill

crane, a year-round resident of Florida and southern Georgia. Since the 2 subspecies are nearly identical in appearance, they can be separated in the field only by behavioral differences. Florida sandhill cranes usually are observed in family groups of 2, 3, or 4 birds, while wintering greater sandhill cranes occur in larger flocks in which distinct pairs and family groups usually are not apparent.

RESULTS AND DISCUSSION

Ecology Of Non-breeding Cranes

Buena Vista Marsh

Non-breeding sandhill cranes were observed on the Buena Vista Marsh singly and in groups of 2 to 38 during the day in the spring, summer, and early fall of 1976 and 1977. An estimated 50-60 cranes inhabited the Marsh in both years, 40-50 (75-80 percent) of which were considered non-breeders. Drewien (1973) estimated that non-breeders comprised only 31-39 percent of the total sandhill crane population at the Grays Lake National Wildlife Refuge in Idaho. The higher percentage of non-breeders at Buena Vista may be due to differences in the quality of nesting habitat at the two locations. The marshes at Grays Lake are considered optimum nesting habitat and support the highest reported density of nesting sandhill cranes in North America. Water is one of the most important requirements of sandhill crane nesting habitat (Howard 1977, Sanderson 1977). Sheetwater areas for nesting cranes were limited in size at Buena Vista during 1976-77, and persisted only through mid-May. Many of the cranes found there in non-breeding flocks may have been pairs without territories or birds that nested unsuccessfully.

Cranes at Buena Vista fed in pastures and in fields of corn, oats, and hay, and on grasslands managed for prairie chickens. Groups of 2,4, and 12 cranes fed during May 1977 in 3 different fields of sprouting corn, but destroyed

less than 0.4 ha total. Cranes also were observed feeding in fields of young oats. Damage to the oats was not evident, and the cranes may have been foraging for invertebrates or waste corn. Harvested fields of oats and corn attracted flocks of 6 to 42 cranes in late summer and early fall. Cranes in pastures, hayfields, and other grasslands preferred those in which the vegetation was 15-20 cm or less in height. Guthery (1976) noted that sandhill cranes wintering in Texas preferred feeding at sites where vegetation was less than 25 cm tall.

Stock ponds were the only water roosting sites on the marsh. There were no observed instances of cranes roosting in drainage ditches. A shallow 0.4-ha pond served as a roost for groups of 2 to 71 cranes throughout the summer. Most of the cranes on the marsh roosted there in September prior to migration. On one occasion a pair of cranes roosted in another smaller pond. Cranes which did not roost in stock ponds roosted on dry land - in pastures and grasslands managed for prairie chickens. Dry land roosting by single cranes and groups of 2-12 was a common occurrence during the summer through July. Even in August and September flocks of 45 and 71 cranes that were flushed from the stock pond roost spent at least one night in pastures and grasslands.

Between 80 and 90 percent of the cranes on the marsh were roosting at the stock pond by the end of August. Breeding pairs with chicks had left their territories and were roosting at the pond as early as 19 August. A maximum of 10 chicks roosted there on 3 and 5 September 1976, and 11

chicks were observed there on 10 September 1977. Maximum evening roost counts at the pond were 70 cranes on 3 and 5 September 1976, and 76 cranes on 13 September 1977.

Mead Wildlife Area

An estimated 80 to 100 sandhill cranes were at the Mead Wildlife Area during the summers of 1976 and 1977, and at least 60 were non-breeding birds. Non-breeding cranes were observed singly and in groups of 2 to 60 at the Mead in spring and summer. Flocks of 20 or more non-breeders were first observed in early May, feeding in upland fields of alfalfa and young wheat, corn, and oats. The normal activity pattern was to leave the roosting marshes shortly after sunrise and fly 1.1 - 4.0 km to these feeding fields. The cranes would feed until midmorning and then return to the marshes until mid-afternoon. As many as 44 cranes would feed in upland fields again in late afternoon and early evening, while the remaining cranes fed in upland fields only in the morning and spent the rest of the day in the marshes.

Roosting occurred in shallow impounded water areas and no dry land roosting was observed. Cranes also used these marshes for feeding and loafing, particularly in June and July when vegetation in upland agricultural fields had grown tall and dense.

In both years of the study the water was removed from one or more of the impoundments during spring and summer. These drained flowages were preferred by the cranes, probably because they provided feeding areas of short, sparse

vegetation and exposed mudflats and also contained water areas for roosting. The water levels in a number of flowages were raised in late summer and fall to attract waterfowl, and in at least 3 instances cranes were forced to use different roosting and loafing areas when water depths at the former areas rose to intolerable levels.

In August and September flocks of 20–60 cranes resumed use of upland fields of wheat, oats, corn, alfalfa, and hay soon after they were cut. As at Buena Vista, cranes showed a preference for vegetation 15–20 cm or less in height.

Some crane damage occurs each year to sprouting corn in sharecropped and private fields on or adjacent to the Mead Wildlife Area. The pattern of crane use is sometimes unpredictable, with certain cornfields sustaining damage one year and none the next. In 1977 crane damage occurred in four different fields, but totaled less than 0.4 ha.

Capture and Tagging

Fifty-eight sandhill cranes were captured, banded, and patagial-tagged at 7 locations in Wisconsin during the periods 6 June - 13 October 1976 and 3 June - 26 August 1977 (Fig. 4). An additional 10 cranes captured in central Wisconsin were fitted with radio transmitters for home range and migration studies. Fifty-three cranes were captured and banded at the Jasper-Pulaski Wildlife Area, Indiana, in the fall of 1976 and the spring and fall of 1977. Five cranes died during capture in Wisconsin and Indiana, a trapping mortality of 4.5 percent. Banding data for all captured cranes are listed in Appendix A.

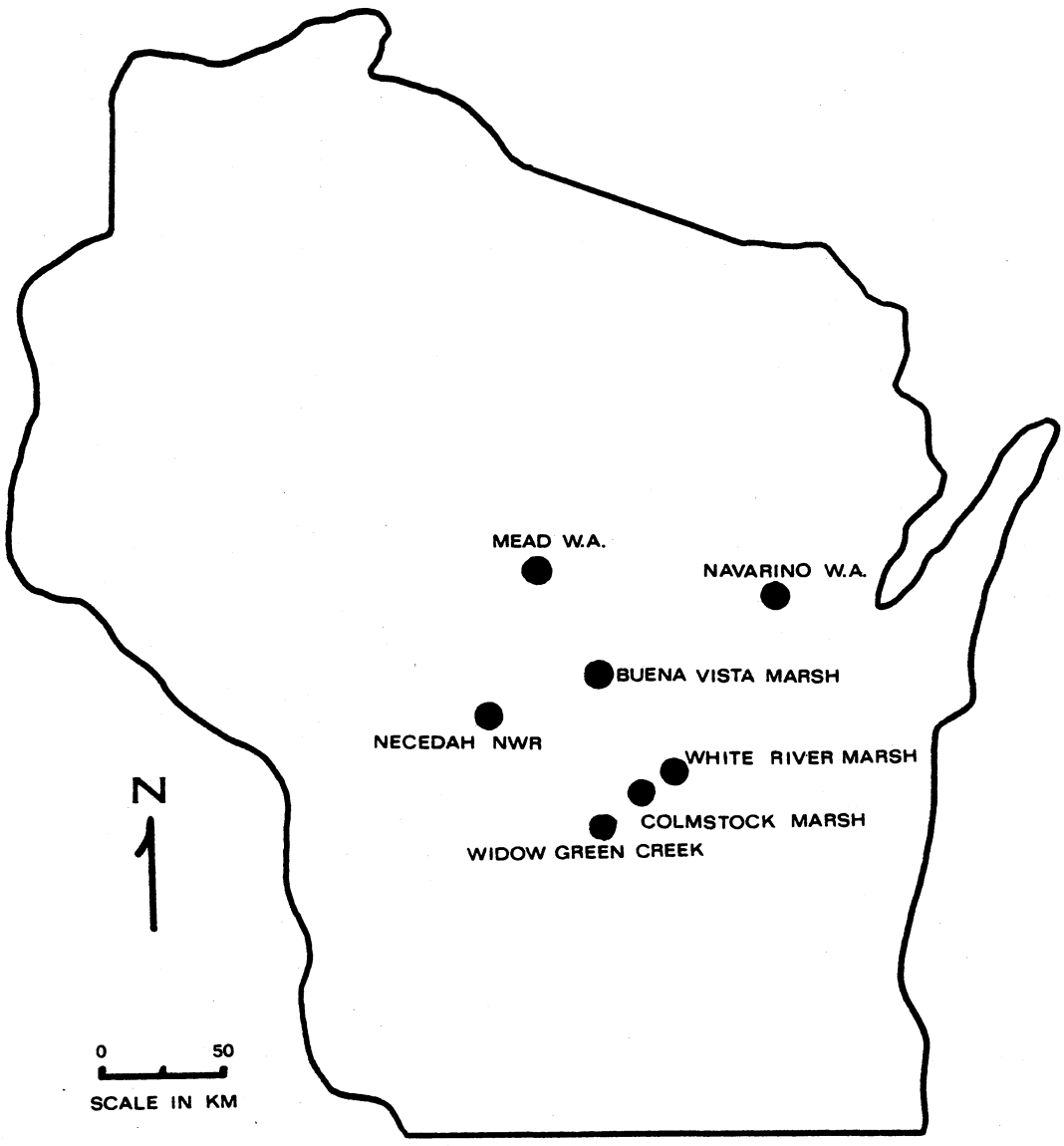

Fig. 4. Sandhill crane banding sites in Wisconsin, 1976-77.

Radio-tagged Cranes

All radio-tagged cranes were non-breeding adults, with the exception of BV-3, a bird of the year (Table 1). Radio-tagged cranes went through a 1-4 day period of readjustment after being released, similar to that described by Nesbitt (1976). One crane flew immediately after being radio-tagged, while the others walked away from the release site. After the readjustment period there were no indications that the transmitters affected the birds physically or behaviorally.

Five cranes were radio-tagged at Buena Vista (BV1 - BV5). Crane BV-1 was tracked intermittently during the summer of 1976. It recovered quickly after capture and flew 3.9 km to an evening roost on the day after release. Daytime periods were spent in grasslands and pastures and roosting took place either in these same pastures or at the stock pond. Radio contact with BV-1 was lost for over a month beginning on 21 July. An aerial search failed to locate a signal from the bird over a 3,185 km^2 area including the entire Buena Vista Marsh and the area west to the Sandhill Wildlife Area and the Necedah National Wildlife Refuge. BV-1 was relocated at Buena Vista on 29 August when it roosted at the stock pond with a flock of 32 cranes. Although a temporary transmitter malfunction could have been responsible for the loss of signal, it seems more likely that the bird made a long range movement out of the study area to an area not covered by the aerial search.

When BV-1 arrived at the stock pond roost on the evening

Table 1. Age, location, and home range information for 9 sandhill cranes radio-tagged at the Buena Vista Marsh and Mead Wildlife Area, Wisconsin, 1976-77.

Crane No.	Age	Date Caught (First Location)	Final Location	Total Locations	Home Range (ha)
BV-1	Ad.	3 Jul 76	20 Sep 76	34	-[a]
BV-2	Ad.	27 Jul 76	13 Aug 76	9	-
BV-3	Imm.	4 Aug 76	9 Aug 76	16	-
BV-4	Ad.	3 Jun 77	3 Oct 77	118	2,633
BV-5	Ad.	26 Jul 77	26 Sep 77	38	2,575
M-1	Ad.	28 Jun 76	24 Sep 76	23	2,605
		2 Apr 77	30 May 77	39	3,691
M-2	Ad.	8 Aug 77	26 Sep 77	26	881
M-3	Ad.	8 Aug 77	26 Sep 77	28	774
M-4	Ad.	8 Aug 77	19 Sep 77	27	1,608

[a]Ten of these locations were at the stock pond roost. Insufficient daytime locations for accurate calculation of actual home range.

of 3 September it had sustained a head injury as evidenced by an area of raw flesh about 4 cm in diameter on the top of its head. Otherwise it appeared healthy, behaved normally, and was treated normally by the other cranes. BV-1 roosted at the stock pond through 8 September, still exhibiting the head wound. During that period it made at least one flight of 4.4 km. The bird was not observed at the stock pond roost after 8 September, and over the next 12 days a constant radio signal was received from a point 1.2 km south of the pond. On 20 September the remains of BV-1 were located in an old drainage ditch. The cause of death could not be determined.

Crane BV-2 was radioed on 27 July 1976 and tracked for 17 days before radio contact was permanently lost. This crane's last location was 6.3 km south of the site where it was captured, in the company of 5 other cranes. An aerial search of Buena Vista and the area west to Sandhill and Necedah was unsuccessful in locating BV-2, and again it is not known if the transmitter failed or if the bird moved a substantial distance out of the study area.

Crane BV-3 was run down and radio-tagged on 4 August 1976. The same sized transmitter and harness as used on adults were put on this chick, with the harness fitted loosely to allow for growth. Within 2 weeks BV-3 was flying strongly. This bird and its parents restricted their movements to a 380-ha area of shrubby grassland and pastures until the last week in August. On 27 August they moved 3.5 km eastward to roost on the stock pond with other family

groups and non-breeders, and during the next 2 weeks they varied their roosting sites between the stock pond and various dry land roosts. BV-3 left Buena Vista on 9 or 10 September and arrived at the Jasper-Pulaski Wildlife Area in Indiana on 16 October.

Crane BV-4 was radio-tagged at Buena Vista on 4 June 1977 and monitored until it left the marsh in early October. BV-4 occupied a home range of about 2,633 ha through the summer, making flights from roosts to feeding areas of up to 3.9 km and total daily movements of at least 7.9 km. During late July this bird made at least one exploratory movement 5.8 km southwest of the outer edge of its normal home range. It spent most of its time in grasslands, hayfields, and pastures from June through mid-August, and in harvested oats and cornfields from mid-August through September. It roosted primarily on dry land during June and July, and more often in the stock pond during August and September. It was usually seen in the company of 2 other cranes from June through mid-August, but during late August and September it spent the day in flocks of 9 to 40 and roosted with groups of 31 to 75. BV-4 left Buena Vista on 4 or 5 October, and arrived at the Jasper-Pulaski Wildlife Area on 9 October.

Crane BV-5 was radio-tagged on 27 July 1977 and its activities were monitored through September. During this 2-month period it occupied a home range of 2,575 ha, similar in size to that of BV-4. Like most non-breeding cranes on the marsh during late summer it fed primarily in pastures and harvested

fields of oats and corn and roosted in the stock pond. It associated during the day with flocks of cranes varying in size from 2 to 41. Crane BV-5's transmitter had failed by 26 September, but the bird was observed at Jasper-Pulaski during the 2nd week in October.

Four sandhill cranes were radio-tagged at the Mead Wildlife Area (M1-M4). Crane M-1 was radio-tagged on 28 June 1976 and was tracked intermittently until migration in late September. The calculated minimum home range of M-1 in 1976 was 2,600 ha. This crane remained in some of the more remote marshes and bogs at the Mead during July, but in early August began to use recently mowed fields of hay and alfalfa. M-1 was observed in one of the flooded impoundments feeding with 45 other cranes on 24 September. It had left the Mead by 27 September, probably migrating southwestward to the Sandhill Wildlife Area for the month of October. M-1 was at the Jasper-Pulaski Wildlife Area in Indiana during the first 2 weeks in November, and was located in central Florida in January 1977.

Crane M-1 returned to Jasper-Pulaski for 6 days in late March 1977, leaving on the morning of 25 March. It returned to the Mead during the period 28 March - 1 April, indicating that a stopover of several days was made somewhere between Jasper-Pulaski and Mead. Crane M-1 was radio-tracked intensively during the next 2 months, during which time it was always observed in the company of another crane. Unison calling indicated that a pair bond existed between the two,

and size and behavioral differences indicated that M-1 was a male.

M-1 and his mate exhibited great mobility during April and May, occupying a home range of at least 3,691 ha. Movements were greatest in April, when at least five different roosts, all at least 2 km apart, were used. Flights of up to 8 km between feeding fields and roosts were not uncommon, and once the pair moved 2.7 km outside their calculated home range to roost in a commercial cranberry bog. The pair became less nomadic during May, roosting and loafing in a 250-ha area of marshes and backwaters near the mouth of the Little Eau Pleine River, and feeding in early morning in upland hayfields, corn stubble, and fallow fields, 0.8-2.7 km away. Nesting did not occur.

No signals were received from M-1 after 30 May, nor was the bird observed throughout the rest of the summer. It is not known if the transmitter failed or if the pair moved out of the study area. An aerial search of a 6,240 km area, which included all of the Mead Wildlife Area and much of central Wisconsin, failed to locate the bird.

Walkinshaw (1973) stated that mated sandhill cranes may occupy a territory for several years before successful nesting occurs. The movements of M-1 and its female during April and May may have represented the exploratory behavior of a newly-mated pair seeking out a suitable unoccupied territory.

Three adult non-breeding cranes were radio-tagged at

the Mead on 8 August 1977 and tracked intensively until migration in late September. The 3 cranes, M-2, M-3, and M-4, occupied minimum home ranges of 881, 774, and 1,608 ha, respectively. The calculated home ranges for all 3 of these cranes probably would have been larger if the birds had been radio-tagged earlier in the summer. Crane M-4 roosted and fed on several occasions in a flowage 3.2 km from the roosting and feeding areas frequented by M-2 and M-3, and hence M-4's calculated minimum home range was twice the size of that of the other 2 cranes.

Cranes M-2, M-3, and M-4 were associated with increasingly larger flocks of 30-75 cranes as pre-migration staging continued through late August and September. The cranes roosted in shallow water in several impoundments on the property and fed during the day either in these impoundments or in mowed or harvested upland fields of alfalfa, corn, and wheat, at distances 1.5-3.7 km away.

Crane M-4 moved 45 km southwestward to the Sandhill Wildlife Area during the period 20-24 September, and M-2 and M-3 followed on 26 or 27 September. All 3 remained at Sandhill through October and migrated to the Jasper-Pulaski Wildlife Area, Indiana, in mid-November. Again, M-4 did not associate with M-2 and M-3 during migration, and its arrival and departure dates at Jasper-Pulaski were about 1 week ahead of those of the other 2 radio-tagged cranes from Mead.

Variations In Movements Of Non-breeders

Limited sightings of patagial-tagged cranes suggest that some non-breeding adults spend consecutive summers at different locations in Wisconsin. Of 16 cranes that were radio-tagged or color-marked at Buena Vista Marsh in 1976 and which survived the first fall, only 2 were known to have returned to the Marsh in 1977. Two others were observed at the Dike 17 Wildlife Area, Jackson County, 72 km west of Buena Vista, on 20 September 1977, and a third was at Colmstock Marsh, Marquette County, 56 km southeast of Buena Vista, from 16 August through September 1977. Two additional color-marked 1976 Buena Vista cranes were observed at the Jasper-Pulaski Wildlife Area in Indiana in November 1977, suggesting that they too had spent the summer of 1977 somewhere other than at Buena Vista.

Crop Damage

Characteristics Of Crop Damage By Sandhill Cranes

Personal observations in the field, interviews with landowners and Wisconsin Department of Natural Resources personnel, and official reports of sandhill crane crop damage claims filed in 1975-77 provided information on crane crop damage at 67 locations in Wisconsin. Eight instances of crane damage to sprouting corn were investigated in the field during May and June 1977.

Twenty claims for reimbursements for crop damage caused by cranes were filed with the Wisconsin DNR in 1975, 21 claims

in 1976, and 11 claims in 1977 (Fig. 5). All but two of these claims were for damages to sprouting corn. Single claims were filed in 1975 for fall damage to mature hay and mature corn. The total amount paid for crane damage, total acres damaged, average amount paid per claim, and average acreage damaged per claim all decreased substantially during the 3-year period (Table 2). These declines came in spite of 1976 legislation which increased the allowable maximum payment from $1,500 to $10,000. The decrease in the number of claims filed in 1977 was probably due in part to (1) the use of acetylene exploders to repel cranes from cornfields and (2) above average May temperatures which allowed young corn to grow faster than normal and shortened the period during which it was susceptible to crane damage. Crane damage ceased after corn plants reached a height of about 30 cm.

The average acreage per damage claim decreased from 2.38 ha in 1975 to 0.66 ha in 1977 (Table 2). In 1975 50 percent of the claims were for damages in excess of $500 (Table 3), while in 1976 and 1977 more than 80 percent of the claims were for less than $300. These decreases in acreages and payments for claims filed in 1976 and 1977 do not reflect a decrease in the amount of actual crane damage. Rather, they are the result of prior experience gained by Wisconsin DNR personnel in handling complaints and of the development of a standardized system for estimating damages. Inexperience in handling crane damage complaints and damage

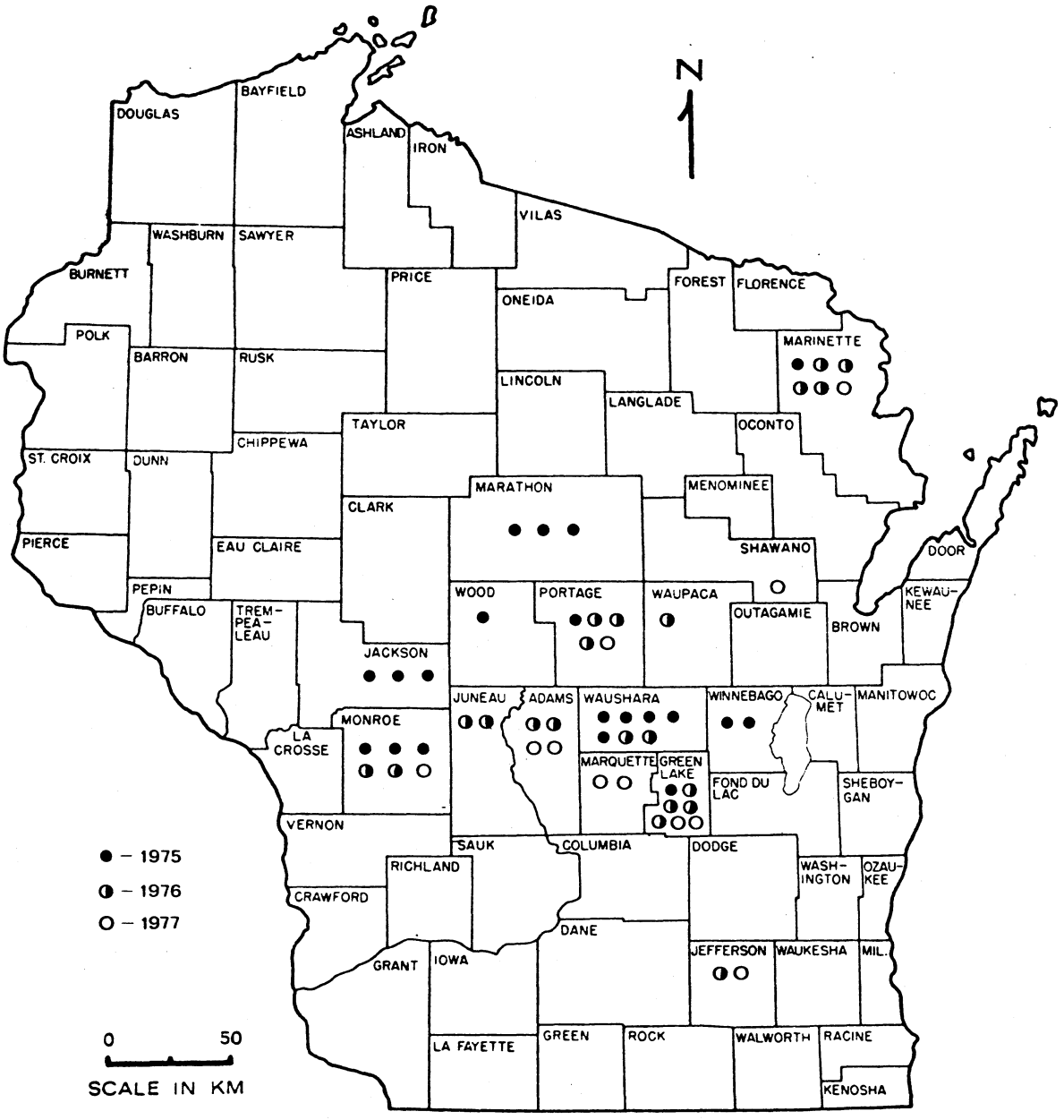

Fig. 5. Locations of sandhill crane crop damage complaints in Wisconsin, 1975-77.

Table 2. Sandhill crane crop damage claims in Wisconsin, 1975-77.

	1975	1976	1977[a]
Total claims filed	20	21	11
Total amount paid in damages	$10,110	$4,017	$1,875
Average amount paid per claim	$505.50	$191.29	$192.18
Total hectares damaged	47.60	21.61	7.25
Average hectares damaged per claim	2.38	1.03	0.66

[a]Figures are for 1977 claims that were filed but had not been paid as of 1 May 1978, pending proration of payments.

Table 3. Values of sandhill crane crop damage payments in Wisconsin, 1975-77.

Range of payments	Number and percentage[a] of claims paid 1975	1976	1977[b]
$0-100	2(10)	7(33)	2(18)
$100-200	3(15)	8(38)	4(36)
$200-300	4(20)	2(10)	3(27)
$300-400	1(5)	2(10)	2(18)
$400-500	0(0)	1(5)	0(0)
$500-1,000	7(35)	1(5)	0(0)
$1,000-1,500	3(15)	0(0)	0(0)

[a]Percentages of total claims are given in parentheses.

[b]1977 amounts were filed but had not been paid as of 1 May 1978 pending proration of payments.

estimates that were sometimes made long after the damage had occurred resulted in overestimates of damage and overpayments for some claims filed in 1975.

Groups of 10 or fewer cranes were responsible for 18 of 24 instances of crop damage where information was available (Table 4). There were no reports of cranes with chicks and only one report of a single crane feeding on sprouting corn, indicating that non-breeding cranes are responsible for most of the crop damage occurring in Wisconsin. Breeding cranes spend much of their time in the marshes during May, incubating eggs and defending territories. During late May and June they are busy rearing the chicks and are more likely to frequent pastures and other locales where insects are abundant.

Patterns of damage over the past 3 years indicate that in many areas crop damage by sandhill cranes is recurrent from year to year. This is particularly true of cornfields located close to wetlands that continue to support stable or increasing populations of sandhill cranes. Recurrent damage was reported by 12 landowners. Damage complaints were filed from the same 7 townships twice during the past 3 years, and 2 of these townships had damage claims all 3 years.

Methiocarb Repellency Tests

One control and 2 treated cornfields at the Mead Wildlife Area suffered light crane damage over the period 12 May - 8 June 1977. Cranes pulled 81 sprouts from sample plots in the control field, compared with 49 and 30 sprouts pulled

Table 4. Numbers of sandhill cranes involved in 24 instances of damage to sprouting corn in Wisconsin, 1975-77.

Number of cranes causing damage	Number of instances of crane damage
1-5	12
6-10	6
11-15	2
16-20	2
21-30	1
30+	1

from the fields treated with methiocarb (Table 5). An analysis of variance indicated that the mean percentage of sprouts damaged in treated fields was significantly lower than in the control field ($p < 0.05$). Groups of 1-18 cranes spent short periods of time feeding, preening, and loafing in both the treated and control fields, and no abnormal behavior was observed. The cranes spent more time, however, in adjacent fields of wheat and hay. It is not known if this apparent preference for wheat and hayfields over corn was the result of methiocarb repellency.

Five cranes spent 75 minutes on 14 May feeding and preening in another treated cornfield at the Mead Wildlife Area. Although no abnormal behavior was observed, the damage ceased after that day and cranes were never again observed in that cornfield. Again it is not known if effects of the methiocarb were responsible.

A 1.04-ha cornfield at the Buena Vista Marsh, one half of which had been treated with methiocarb, received continuous crane damage during the period 4-21 June 1977. Cranes pulled 583 sprouts in the treated rows, compared to only 466 sprouts in the untreated rows (Table 6). A Student's T-test indicated that this difference was not significant ($p < 0.05$). A pair of cranes were seen 3 times and 4 cranes were seen once feeding in both halves of the field with no observed ill effects. Examination of the field several days after damage began revealed that 45 sprouts had been pulled from a single 30.5-m section of a methiocarb treated row.

Table 5. Sandhill crane damage to sprouting corn in one control and two methiocarb-treated fields based on 25 0.006-ha plots in each field, Mead Wildlife Area, 1977.

	Control[a]	Treated No. 1	Treated No. 2
Field size (hectares)	1.20	1.96	1.20
Total stems in plots before damage	2,294	3,266	3,119
Total stems damaged in plots	81	49	30
Percentage of stems damaged in plots	3.53	1.50	0.96
Hectares damaged in sample	0.0056	0.0024	0.0016
Total hectares damaged	0.0424	0.0296	0.0160
Percentage of total field damaged	3.53	1.50	0.96

[a]The control was significantly different from the two treatments ($p < 0.05$).

Table 6. Sandhill crane damage to sprouting corn in a 1.04-ha field, half methiocarb-treated and half control, based on four 0.058-ha plots in each half, Buena Vista Marsh, 1977.

	Control[a]	Treated
Field size (ha)	0.52	0.52
Total stems in plots before damage	11,072	11,486
Total stems damaged in plots	466	583
Percentage of stems damaged in plots	4.2	5.1
Hectares damaged in sample	0.0036	0.0116
Total hectares damaged	0.0212	0.0260
Percentage of total field damaged	4.1	5.1

[a]No significant difference between control and treatment ($p < 0.05$).

It could not be concluded that methiocarb was effective in repelling sandhill cranes from sprouting corn in these tests. Damages occurring in the treated and untreated sections of a cornfield at Buena Vista were not significantly different. Damage occurring in a control field at Mead, although significantly different from damage in 2 nearby treated fields, was not of sufficient magnitude to be conclusive. Results would have been more conclusive if a larger number of treated and control fields in both study areas had suffered crane damage and could have been compared. In discussing past tests of methiocarb as an avian repellent, Schafer and Guarino (1970:9) noted that "even with an extensive knowledge of damage areas, less than a third of the efficacy tests yielded reportable data because of a lack of bird pressure."

U.S. Fish and Wildlife Service laboratory tests of methiocarb as a crane repellent have not been encouraging (Jerome Besser, pers. comm.). More successful repellency may be attainable in the field if in future tests the methiocarb is applied to the seed with an adhesive and in a wettable powder formulation instead of the dry, hopper box formulation used in the Mead and Buena Vista tests. Tests with pheasants and blackbirds (Jerome Besser, pers. comm.) have shown that methiocarb exhibits superior repellency when applied with such adhesives as Dow Latex (West et al. 1969) or Kelzan (Stickley and Guarino 1972).

Other Control Methods

Acetylene exploders were partially or completely successful in repelling sandhill cranes from sprouting corn in 9 instances in which they were used in 1977. They were most effective if deployed before cranes became accustomed to feeding in a particular field. Small fields of less than 2 ha, particularly those partly surrounded by woods, are most easily protected by exploders. Cranes using large, open fields sometimes become accustomed to the exploders by feeding at a distance for a time and then moving gradually closer.

Stephen (1967) found that acetylene exploders prevented sandhill cranes from landing in grain crops in Saskatchewan, and that exploders produced significant differences in the mean number and mean frequency of occurrence of cranes in treated and untreated fields. He noted that it was usually more difficult to prevent cranes from landing in a field once they had started to use it regularly. He also concluded that the use of exploders exposed a greater number of fields to damage, since cranes driven out of treated fields fed in other fields in the vicinity but did not leave the general area. The situation in Wisconsin differs from that of the large monotypic grain fields of Saskatchewan. Many of the Wisconsin cornfields subject to crane damage are small and close to wetlands, pastures, and fields of corn stubble, hay, and young wheat and oats, all of which are frequented by cranes in May and June. Cranes driven from sprouting corn often move to one of these alternate habitats or crop types, where

damages are usually not a problem.

Other control methods which appear to have some value with respect to cranes include the planting of lure crops and baiting. Stephen (1967) concluded that lure crops combined with the use of exploders reduced the amount of crane damage to private grainfields in Saskatchewan. Drewien (1973) recommended lure crops planted close to wetlands used by fall concentrations of sandhill cranes as a means of curbing damage in privately-owned grainfields near Grays Lake National Wildlife Refuge, Idaho. The use of lure crops in Wisconsin, in this case corn, would seem to be of most value on large state-owned properties with wetlands harboring large numbers of cranes. Most crane damage in the vicinity of the Mead Wildlife Area and the Buena Vista Marsh occurs on state-owned sharecropped fields that are located closer to wetlands frequented by cranes than are privately-owned fields.

Bennett (1978) reduced both the time cranes spent in a cornfield and the damage to sprouting corn by establishing bait sites of shelled corn in fields where damage was occurring. Dambach and Leedy (1948) and Dambach (1949) reduced pheasant damage by scattering shell corn around the margins of sprouting cornfields.

Visits by landowners to cornfields to scare cranes, though often inconvenient and time-consuming, are very effective and should be encouraged when practical. Sandhill cranes usually exhibit a very low tolerance for direct human disturbance. Many times during this study cranes would flush when an

observer in plain view approached to within 150 m.

One central Wisconsin farmer parked a pick-up truck in the middle of a cornfield being damaged by a flock of 12-14 cranes. Early on several consecutive mornings he would ride to the field on a motorscooter, scare out any cranes already present, and then leave the truck radio running for an hour or more to scare off any cranes that returned. The cranes ceased feeding in this field after less than a week of this harassment. In another instance a farmer's son was assigned the task of keeping cranes out of a cornfield and did so by firing shell crackers into the field with a shotgun.

Observations and interviews with farmers and game managers indicated that various types of scarecrow devices, including human-like figures, reflectors, and brightly colored fabrics suspended from poles, are usually ineffective in repelling cranes from sprouting corn. The cranes often become accustomed to such devices and feed undisturbed nearby.

A fall hunting season on sandhill cranes does not offer a satisfactory solution to the crop damage problem in Wisconsin. Sandhill cranes have a low recruitment rate (Miller et al. 1972, Bennett 1978) and the greater subspecies was considered threatened as recently as 1973 (Office of Endangered Species and International Activities 1973). An intensive statewide census of greater sandhill cranes in Wisconsin is to date incomplete. Most crane damage in Wisconsin occurs to sprouting corn in late spring and early summer and is usually caused by groups of 10 or fewer non-breeding birds. Non-

breeding cranes occupy large home ranges in the summer and may move more than 100 km to migration staging areas in late summer and early fall. A drastic reduction in crane numbers over a large area of the state in the fall would be necessary to affect the amount of damage occurring in the spring. Stephen (1967) predicted that limited hunting of sandhill cranes in western Canada would have little effect on the reduction of crop damage in that region.

Migration

Migration In Wisconsin

The autumn migration of sandhill cranes in Wisconsin begins in mid-August and continues through mid-November, as the birds congregate in progressively larger flocks and move from summer haunts to various staging areas prior to southward movements out of the state. This gradual 3-month process contrasts with the more hurried spring migration, when flocks of cranes return to Wisconsin in March and early April and almost immediately split up into pairs, family units of 3 or 4 birds, and small groups of non-breeders.

Eleven major sandhill crane staging areas (peak numbers of 100 or more cranes) were identified in Wisconsin during the 1977 fall migration (Fig. 6, Table 7). Peak numbers of cranes occurred at some areas as early as the second week in September, while others did not peak until the third week in October. The statewide 1977 fall peak came during the 10-day

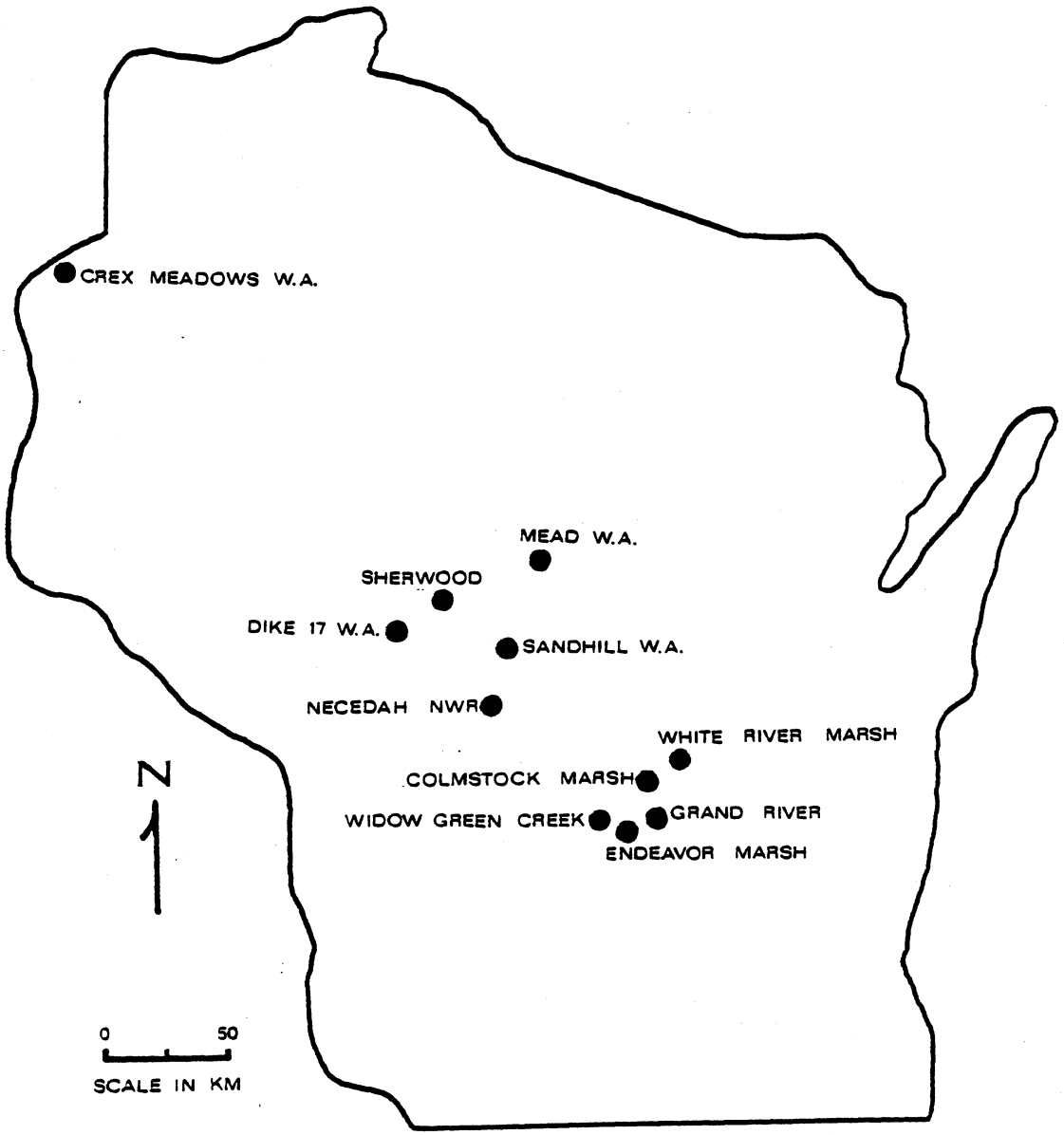

Fig. 6. Major fall sandhill crane staging areas in Wisconsin, 1977.

Table 7. Ownership, location, and peak counts of major sandhill crane fall staging areas, Wisconsin, 1977.

	Peak count	Date of count
Private		
White River Marsh, Green Lake Co.[a] T17N-R11,12,13E Sec. 8,13,21	1,030	20 Sep
Widow Green Creek, Marquette Co. T14N-R8E, Sec. 17,18	450	20 Sep
Colmstock Marsh, Marquette Co. T16N-R10E, Sec. 10,11,15	400	20 Sep
Endeavor Marsh, Marquette Co. T14N-R9E, Sec. 15	200	30 Sep
Sherwood T23N-R1E, Sec. 34,35 Clark Co. T22N-R1E, Sec. 2 Jackson Co.	160	1 Oct
State		
Sandhill Wildl. Area, Wood Co. T22N-R3E, Sec. 29,30,31,32	834	16 Oct
Grand River, Green Lake Co. T14N-R11,12E, Sec. 8	252	20 Sep
Dike 17 Wildl. Area, Jackson Co. T12N-R2W	225	20 Sep
Crex Meadows Wildl. Area, Burnett Co. T39N-R18,19W	166	21 Oct
Mead Wildl. Area, Marathon Co. T26N-R5E, Sec. 25-29,33,34,35 T26N-R6E, Sec. 29,30,32	130	12 Sep
Federal		
Necedah NWR, Juneau Co. T18,19N-R3E, Sec. 5,6,31,32	396	2 Oct

[a]Cranes in 1976 and 1977 roosted on private property outside the state-owned White River Marsh Wildlife Area.

period 23 September - 3 October, when at least 3,500 cranes were known to be in Wisconsin.

James Anderson (pers. comm.) reported another fall concentration of sandhill cranes near Hortonville, Outagamie County, where about 180 cranes were observed feeding in corn stubble during the first 2 weeks of September in 1975 and 1976. No large concentrations were observed there in 1977, possibly due to a late corn harvest which resulted in a lack of attractive fields of corn stubble. Giles Putnam (Dayton 1940) reported that cranes in groups of 11-30 had congregated in this area prior to migration since as early as 1900.

Five of the 11 major sandhill crane staging areas in Wisconsin, including the first, third, and fourth largest, are in private ownership (Table 7). The future status of these wetlands may be threatened if the rapid rate of wetland drainage occurring in parts of southeastern Wisconsin (Bennett 1978) continues.

Staging areas generally had two components: a wetland area for roosting and loafing, and upland agricultural fields used for feeding and loafing. Cranes travelled distances of 0.8-10.0 km from roosts to feeding fields of corn stubble, alfalfa, or hay.

Sandhill cranes staging at the Mead Wildlife Area in Marathon County roosted in shallow areas of waterfowl impoundments and fed during the day either in those impoundments or in fields of alfalfa and corn stubble 1.5-3.7 km from the roosts. One hundred or more cranes were present during most

of September, with a peak count of 130 observed on 12 September. At least 100 of these cranes are believed to have been local birds. Eighty percent of the cranes color-marked or radio-tagged in 1977 left the Mead during the 4th week in September and moved 45 km southwestward to the Sandhill Wildlife Area.

The Sandhill Wildlife Area in Wood County is probably the fastest growing staging area in Wisconsin in terms of fall crane use. In 1974 and 1975 400-500 cranes used the property, approximately 700 were present in 1976 (Joseph Haug, pers. comm.), and 834 were observed on 16 October 1977. Over 300 cranes were still present on 6 November 1977. The cranes at Sandhill roost and loaf in the shallow areas of waterfowl flowages inside the northern boundary of the refuge, and feed in corn stubble, pastures, and hayfields 0.8 - 13.0 km to the north.

The Necedah National Wildlife Refuge, Juneau County, has supported a fall population of about 400 cranes since at least 1973 (Gluesing 1974). From 300 to 400 cranes were observed on the property during the last week of September through the third week of October in 1976, and a count of 396 was made on 2 October 1977. The cranes at Necedah roost in the extensive flowages on the property, and in 1977 they remained all day in these shallow wetlands, feeding on arrowhead tubers within 1 mile of the roosting sites. During the fall of 1976 - a dry year with extremely low water levels - the cranes flew from the roosting areas shortly after sunrise to feed in corn and hayfields 3.3 to 6.0 km to the south and

east.

Sandhill cranes staging at the Dike 17 Wildlife Area, Jackson County, have numbered from 200 to 250 birds since 1973 (Eugene Kohlmeier, pers. comm.), with the peaks occurring during the 3rd and 4th weeks of September. It is not known if cranes move from Dike 17 to either Necedah or Sandhill before leaving the state.

Marked and radio-tagged cranes provided information on the movements of individual cranes during fall migration in Wisconsin. During the 2nd week in September 1977, 5 cranes patagial-tagged in June and July 1977 at the Navarino Wildlife Area, Shawano County, migrated 87 and 101 km southwestward to the staging areas at the White River Marsh (2 cranes) and Colmstock Marsh (3 cranes) in southeast-central Wisconsin (Fig. 7). Two weeks later the 3 marked cranes at Colmstock moved 16 km northeastward to White River. All 5 marked cranes from Navarino migrated to the Jasper-Pulaski Wildlife Area in Indiana during the 1st week in October. This is the first verification that sandhill cranes from northeastern Wisconsin move to staging areas in southeast-central Wisconsin before leaving the state in the fall.

A crane radio-tagged on 10 August 1977 at White River Marsh, Green Lake County, moved 27 km southward to the staging area at Grand River Marsh, Marquette County, in mid-September (Fig. 7). The bird exhibited great mobility while at Grand River, flying 8-16 km from the roost to feed in harvested cornfields. During the 1st week in October this crane returned to the White River Marsh staging area, a reverse

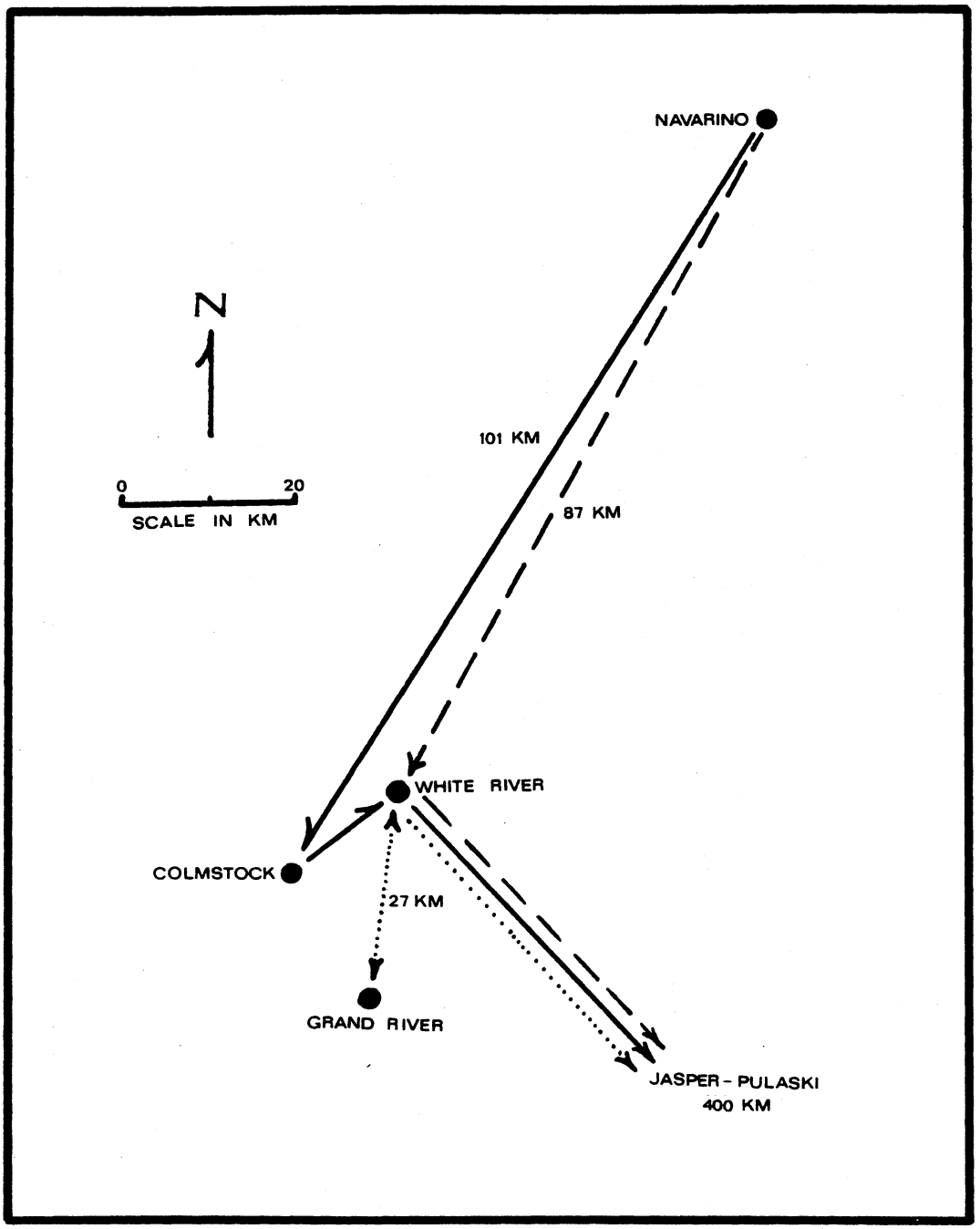

Fig. 7. Fall movements of color-marked and radio-tagged sandhill cranes, northeast and southeast-central Wisconsin, September-October 1977.

migration of 27 km. This bird was part of a small flock of cranes that remained at the White River Marsh throughout October. It did not arrive at Jasper-Pulaski until 2 November.

Two patagial-tagged cranes from Buena Vista Marsh moved 48 km west to the Sandhill Wildlife Area in September 1976, before migrating southeastward to the Jasper-Pulaski Wildlife Area (Fig. 8). In late September 1977, 6 patagial-tagged and 3 radio-tagged cranes moved from the Mead Wildlife Area 45 km southwestward to Sandhill (Fig. 8). These cranes remained at Sandhill for about 6 weeks, arriving at Jasper-Pulaski in mid-November.

Data collected during the fall of 1977 from patagial-tagged and radio-tagged cranes and from censuses of the major staging areas indicate that, in general, sandhill cranes that stage in southeast-central Wisconsin (Marquette and Green Lake counties) leave the state earlier than do cranes that stage in west-central Wisconsin (Juneau and Wood counties). The total number of cranes at 5 staging areas in southeast-central Wisconsin peaked during the 3rd week in September and declined rapidly after 1 October, while the numbers of cranes at the Necedah and Sandhill staging areas in west-central Wisconsin were still increasing when the last censuses were made during the 1st and 3rd weeks of October, respectively (Fig. 9). Sixteen of 28 (52 percent) color-marked and radio-tagged cranes from southeast-central Wisconsin staging areas had been observed at the Jasper-Pulaski Wildlife Area, Indiana, by the end of the 2nd week of October 1977, while marked and radio-tagged cranes from west-central Wisconsin did not arrive

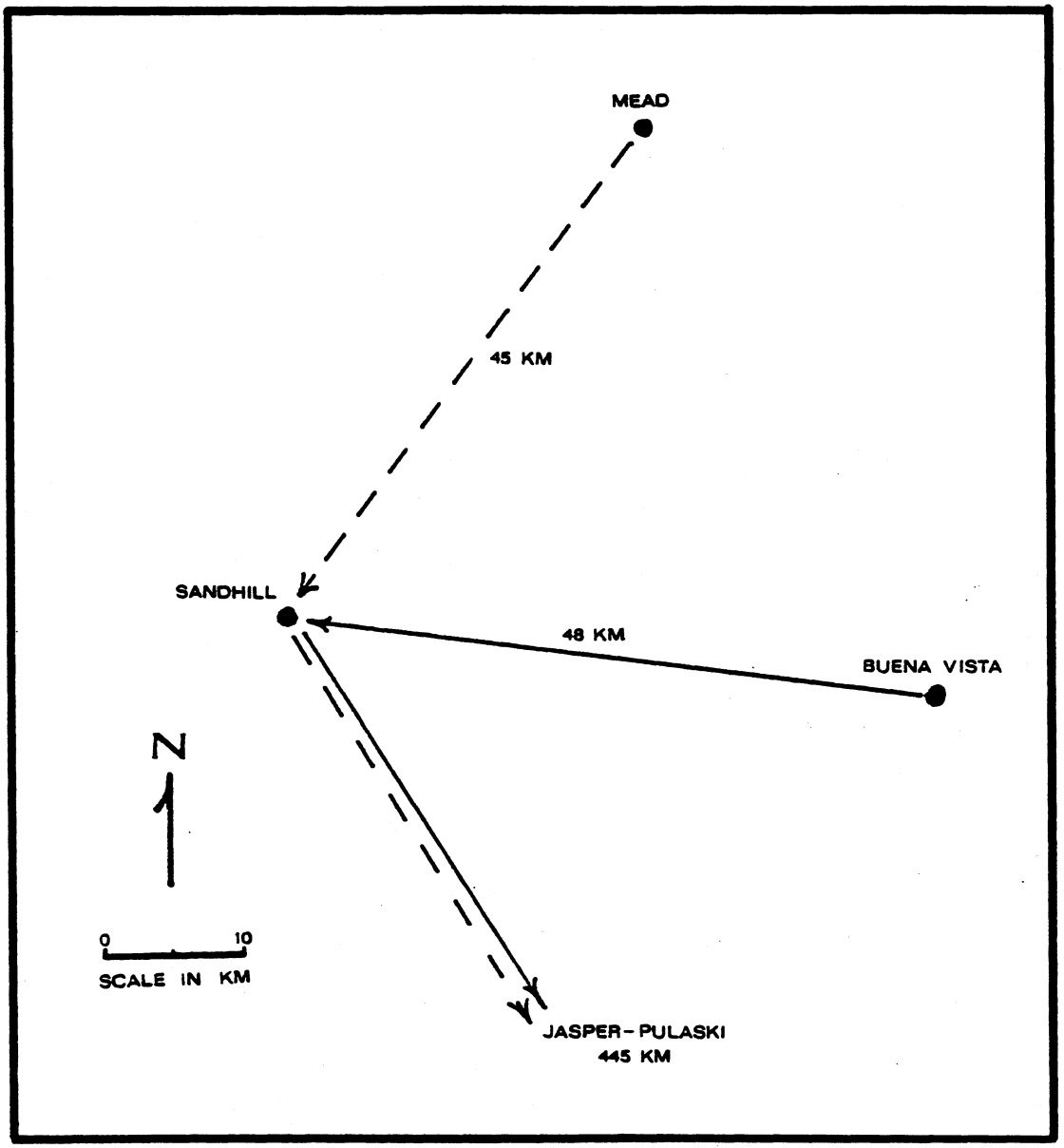

Fig. 8. Fall movements of color-marked and radio-tagged sandhill cranes, west-central Wisconsin, September 1976, September 1977.

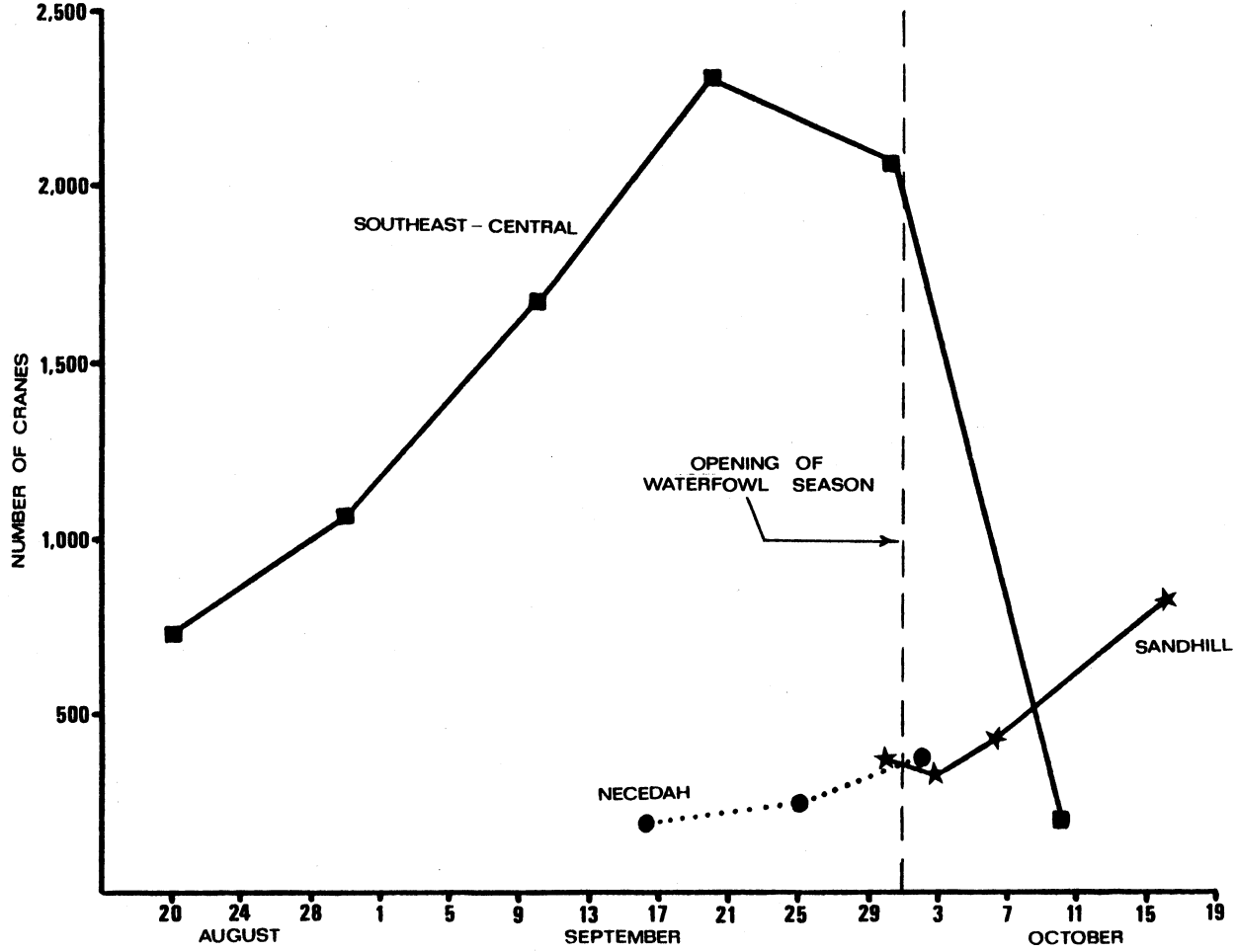

Fig. 9. Comparison of fall crane censuses at Necedah National Wildlife Refuge, Sandhill Wildlife Area, and five southeast-central Wisconsin staging areas, 1977.

at Jasper-Pulaski until the 2nd and 3rd weeks of November.

The earlier fall migration of sandhill cranes from southeast-central Wisconsin is probably related to the opening of the waterfowl hunting season in early October (Alan Bennett pers. comm.). The 1977 season in Wisconsin opened at noon on Saturday, 1 October, and crane roosts at most of the staging areas in southeast-central Wisconsin were subject to heavy hunting pressure. Observers at Grand River Marsh, a staging area for over 150 sandhill cranes, reported that cranes disturbed by hunters circled the marsh calling for several hours before disappearing southward. Other large movements of cranes were reported from Marquette and Green Lake counties during the weekend of 1-2 October, and substantial decreases in crane numbers at staging areas in these counties were noted thereafter. Stephen (1967) reported that sandhill cranes would not tolerate continued disturbances at the roost. In west-central Wisconsin, however, sandhill crane roosts at the Necedah and Sandhill staging areas were located on federal and state land closed to hunting, and the cranes were able to remain relatively undisturbed during October and November. Similar effects of waterfowl hunting on crane migration have been reported from southern Michigan (Walkinshaw and Hoffman 1974).

Jasper-Pulaski Wildlife Area

During the 1977 fall migration, 579 observations (including 83 locations of radio-tagged birds) were made of 55 different central Wisconsin sandhill cranes at the Jasper-

Pulaski Wildlife Area, Indiana. These included cranes tagged at each of the seven 1976-77 trapping sites and at the Dike 17 Wildlife Area. During the fall migration 82 percent of the cranes patagial-tagged or radio-tagged in central Wisconsin in 1977 were observed at Jasper-Pulaski. Fifty-one observations of eight Wisconsin cranes were made at Jasper-Pulaski in the spring of 1977, and 116 observations of 17 Wisconsin cranes were made during the fall of 1976.

The peak fall census of cranes at Jasper-Pulaski decreased from a high of 12,113 in 1976 to 8,746 in 1977 (John Goold pers. comm.) (Fig. 10). It is not known if the decrease was due to (1) an actual decrease in the population of eastern greater sandhill cranes, (2) inaccuracies in censusing, or (3) differences in arrival and departure dates and turnover rates, probably caused by variations in weather patterns favorable to migration. A combination of the latter two seems most likely. The 1977 peak of 8,746 cranes on 21 October was the earliest peak count in 7 years.

Two radio-tagged cranes stopped at Jasper-Pulaski for periods of 20 and 7-14 days during the fall of 1976 (Table 8). One of these cranes returned to Jasper-Pulaski for 6 days the following spring. Four radio-tagged cranes passed through Jasper-Pulaski in the fall of 1977, staying for periods of 7, 8, and 25 days. A fifth radio-tagged crane arrived at Jasper-Pulaski on 9 October and remained through at least the evening of 13 October, a period of only 4.5 days. No signal was received from this bird after 1900 hours CST that evening, and it is assumed that either the transmitter failed or the

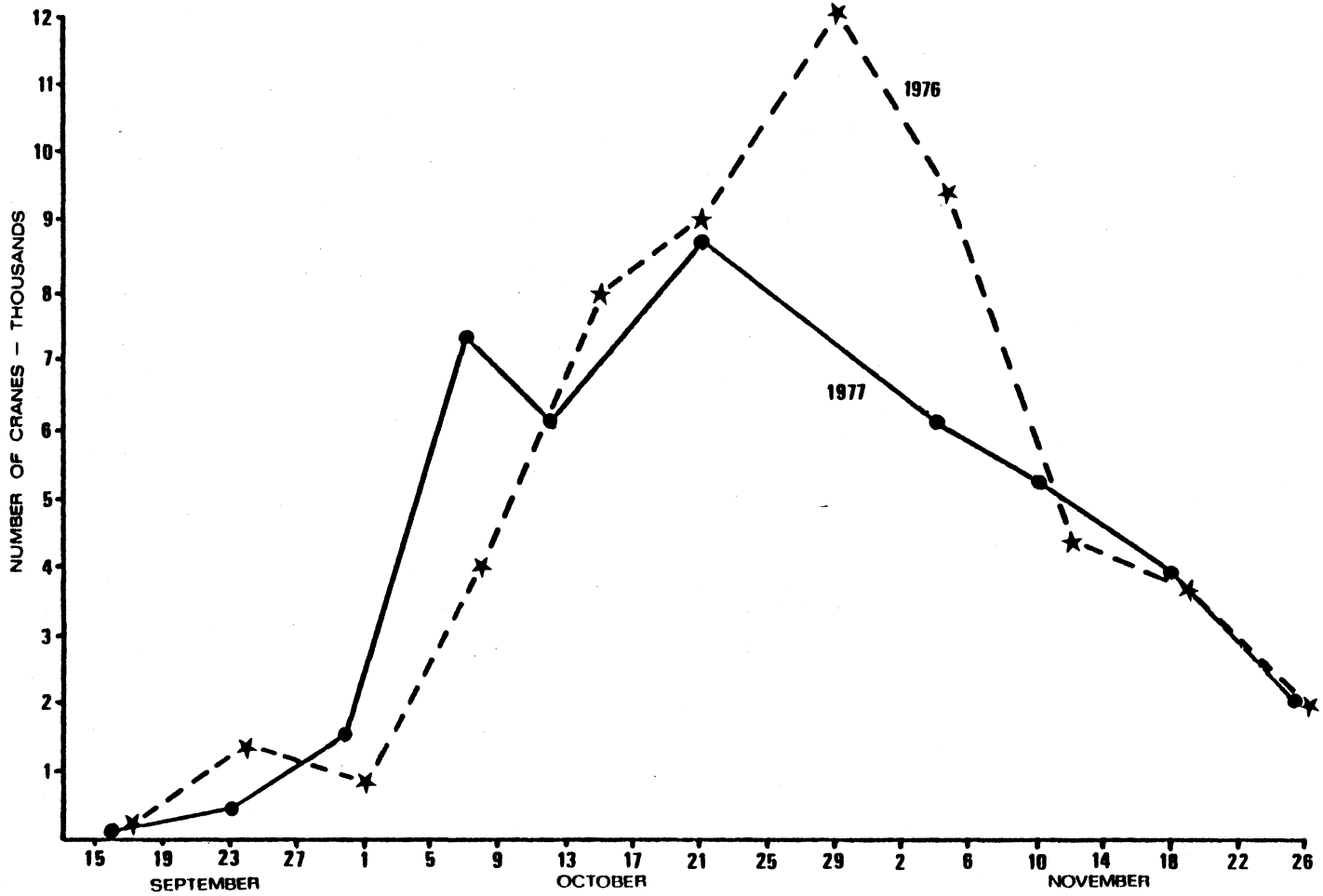

Fig. 10. Fall sandhill crane censuses, Jasper–Pulaski Wildlife Area, Indiana, 1976–77.

Table 8. Central Wisconsin radio-tagged cranes at Jasper-Pulaski Wildlife Area, Indiana, 1976-77.

	Arrival	Departure	Length of stay (days)
Fall 1976			
BV-3	10/18	11/7	20
M-1	11/4	11/11-11/18	7-14[a]
Spring 1977			
M-1	3/19	3/25	6
Fall 1977			
BV-4	10/9	10/13	4.5[b]
M-2	11/18	11/26	8
M-3	11/18	11/26	8
M-4	11/12	11/18	6
White River	11/2	11/26	24

[a]7-day gap between radio checks

[b]Possible transmitter failure

bird resumed its migration before dawn on 14 October. A sixth radio-tagged crane whose transmitter had failed in September was observed at Jasper-Pulaski in mid-October. Cranes from the same staging areas in Wisconsin did not always arrive at or depart from Jasper-Pulaski on the same dates.

Out of 46 different patagial-tagged cranes observed at Jasper-Pulaski during the fall of 1977, 20 (43 percent) remained at Jasper-Pulaski for at least 4 weeks, 10 (22 percent) remained for at least 6 weeks, and 2 (4 percent) were present for 7 weeks or more (Table 9). Temperatures in the 60's and a lack of northwest winds favorable to migration were noted in northwestern Indiana during much of October and early November and may have caused some cranes to remain at Jasper-Pulaski longer than usual.

Most cranes followed a "typical" activity pattern at Jasper-Pulaski, leaving the roosting marshes in early morning and flying to privately-owned agricultural fields outside the Wildlife Area to feed. Most cranes left the roosts from 0.5 to 2.5 hours after sunrise. Overcast skies, rain, and fog usually delayed peak flights to varying degrees. On some mornings as many as 4,500 cranes would fly from the roosts to the agricultural fields inside the Wildlife Area known as the "goose pasture", remaining there until midmorning before flying out to private fields to feed. This use of the goose pasture as a secondary roost usually was caused by early morning disturbances by hunters, birders, or refuge personnel at the primary roosting areas, or by rain, fog, or low cloud cover which restricted flight.

Table 9. Dates of observation and minimum lengths of stay of 24 color-marked Wisconsin sandhill cranes at Jasper-Pulaski Wildlife Area, Indiana, October-November 1977.

Patagial Tag No.	First Date Observed	Last Date Observed	Minimum Days At J.P.
A118	11/2	11/20	19
A119	10/18	11/6	20
A120	10/18	11/6	20
A091	10/18	11/9	23
A125	10/12	11/8	28
A100	10/7	11/7	32
A129	10/7	11/8	33
A137	10/7	11/8	33
A128	10/7	11/9	34
A133	10/7	11/9	34
A088	10/7	11/9	34
A102	10/16	11/19	35
A103	10/7	11/16	41
A121	10/9	11/19	41
A101	10/11	11/21	42
A105	10/15	11/25	42
A127	10/15	11/25	42
A132	10/15	11/25	42
A134	10/7	11/18	43
A124	10/9	11/22	44
A130	10/7	11/19	44
A131	10/7	11/20	45
A135	10/7	11/24	49
A104	10/7	11/25	50

Most cranes fed during the day on waste corn and soybeans found in harvested, privately-owned fields 1.5 to 9.0 km from the roosting marshes. On several occasions in fall, however, 1,000 or more cranes spent the whole day on the goose pasture, feeding in corn stubble, buckwheat, and winter wheat. Cranes in fall, both 1976 and 1977, fed in fields to the northwest, north, east, south, and west of the Wildlife Area, with the northwestern, northern, and eastern fields receiving the heaviest use. Fields to the south were harvested later than other fields during the fall of 1976. As a result, these southern fields received little crane use that fall, but were used almost exclusively the following spring.

Although many cranes remained in one field all day while feeding outside the Wildlife Area, short daily movements of 0.2-1.2 km between feeding fields by individuals and small flocks were not uncommon. Cranes disturbed in feeding fields during the morning usually moved to nearby fields and resumed feeding. Cranes disturbed in the afternoon, particularly late afternoon, usually returned directly to the roosting marshes or the goose pasture. Three particularly long movements of 8.0, 11.0, and 12.0 km were recorded for 4 patagial-tagged cranes between fields north and east of the Wildlife Area in October 1977. These feeding movements resulted in total daily movements from roost to feeding areas and back to roost of at least 19.0, 21.5, and 25.5 km respectively.

Groups of cranes which had been captured and tagged at the same location in Wisconsin several months earlier often did not remain together while in the feeding fields at Jasper-Pulaski.

However, 19 observations of an adult and its chick, both of which were patagial-tagged, indicated that they were always within 20 m of one another.

Most cranes returned from outlying fields to the Wildlife Area from 2.5 hours before sunset to 0.5 hours after sunset, although on one occasion 2,000 birds returned as early as 1230 hours. On some days nearly all the cranes would spend 0.5-2.5 hours feeding and loafing in the goose pasture before going to roost, while on other days up to half the returning cranes would fly directly to the roosts.

Considerable intermixing of cranes occurs at the roosts, with returning birds dispersing throughout the shallow marshes and small impoundments which occupy the center of the Area. Individual cranes do not necessarily occupy the same roosting sites night after night. A radio-tagged crane roosted at four different locations within the 810 ha of roosting wetlands during the period 2 November - 9 November 1977. Hundreds of cranes may flush from their roost sites at the slightest disturbance and fly about excitedly for several minutes before landing among other cranes at different roost sites.

Cranes in spring may roost at locations other than the wetlands in the center of the Wildlife Area. In March 1977 200-400 cranes roosted in a marsh 2.3 km northeast of the roosting areas and 3.0 km north of the Jasper-Pulaski headquarters building. Another 200-400 cranes roosted several evenings in an area of sheetwater on the goose pasture. On the evening of 25 March 1977 a radio-tagged crane roosted in

agricultural fields in which it had been feeding during the day, 2.4 km south of the Wildlife Area.

Crop damage by cranes is not a problem in the vicinity of Jasper-Pulaski. Cranes feed in spring and fall almost entirely on waste grain in harvested corn and soybean fields, and leave northwestern Indiana before new corn has sprouted in the spring. Minor damage by cranes to young winter wheat has been reported, where cranes have uprooted young plants while scratching and probing in the soil for waste corn.

Wintering Grounds

Over 4,500 wintering greater sandhill cranes were accounted for by direct observation and through the reports of others (Fig. 11). The largest concentrations were in north-central Florida and southeastern Georgia. The two locations with the largest concentrations of cranes, at Oklawaha and Weirsdale, had been used by wintering sandhill cranes for at least 14 years.

Eight Wisconsin-marked cranes were observed or reported from 5 locations. A crane patagial-tagged on 27 July 1976, at Buena Vista Marsh, Wisconsin, was observed with about 100 other cranes on 7 January 1977 at Paynes Prairie, Alachua County, Florida. Two cranes patagial-tagged in central Wisconsin between 1974 and 1976 were among the 800 cranes near Weirsdale, Marion County in January 1977, as was Crane M-1, radio-tagged on 28 June 1976 at the Mead Wildlife Area, Wisconsin. Another crane, marked with a white neck collar in the fall of 1973 at the Necedah National Wildlife Refuge,

Number		Locality	Date	Observer
1	1, 300	Oklawaha, 5 mi. E Oklawaha Farm	9 Jan.	SM
2	800	Weirsdale, 5 mi. E Sunnyhill South Farm	8 Jan.	SM
3	600	Ware Co., Georgia Okefenokee NWR	Jan.	WM
4	400	Paynes Prairie	Jan.	SN
5	500	Umatilla, 5 mi. SE Rhoades Dairy	8 Jan.	SM
6	250	Interlachen, 5 mi. W	7 Jan.	SN
7	250	KD Ranch	Jan.	SN
8	125	Keenansville, Hayman Ranch	28 Dec.	SM, LW
9	85-100	Orange Lake	7 Jan.	SN
10	83	Leesburg, 4 mi. NW Jeffcoate Farm	5 Jan.	SM
11	65	Eastern Madison Co.	Jan.	SN
12	31, 35	Lake Placid, 8 mi. SE Buck Island Ranch	2 Jan.	SM
13	35	Paynes Prairie, 4 mi. W	Jan.	SN
14	25-30	Avon Park Bombing Range	Jan.	DA

SM - Scott Melvin, WM - Wendell Metzen,
SN - Stephen Nesbitt, LW - Lawrence Walkinshaw,
DA - David Austin

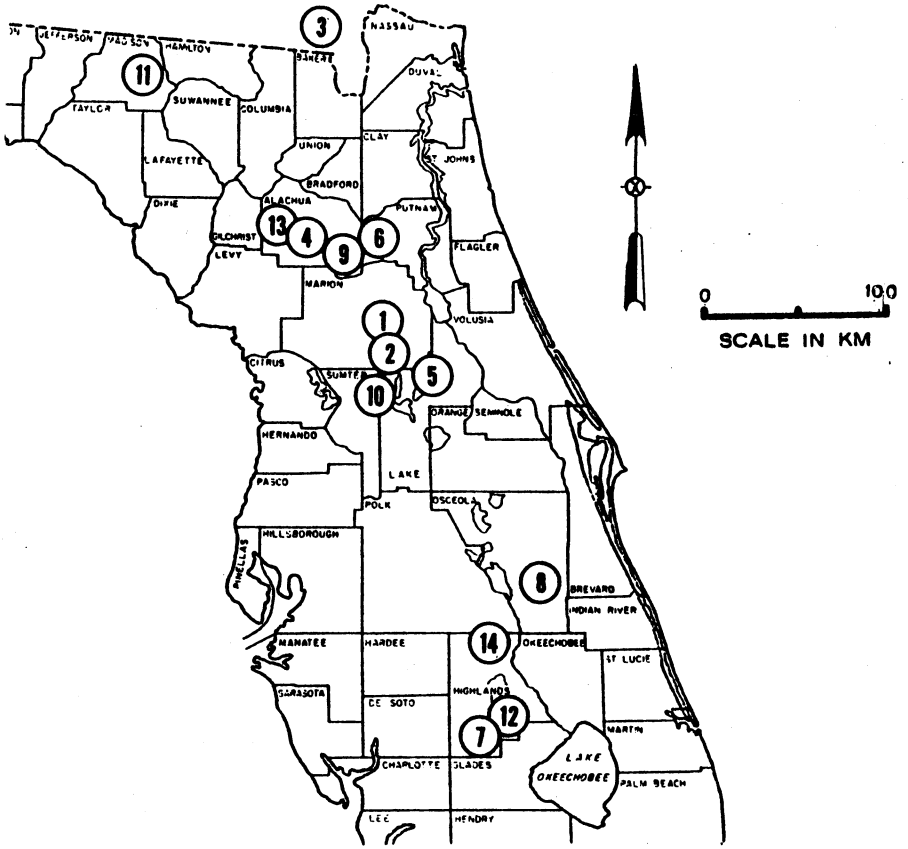

Fig. 11. Concentrations of greater sandhill cranes in Florida and Georgia, winter 1976-77.

Wisconsin, was among the 125 cranes at the Hayman Ranch, Osceola County, Florida, in December 1976. Another crane patagial-tagged in central Wisconsin during the period 1974-1976 was observed with 20 cranes on the Platt Ranch, near Fellsmere, Indian River County, Florida, in January 1977 (Alfred Bartleson pers. comm.).

A crane patagial-tagged on 25 August 1977 at Widow Green Creek, Marquette County, was observed with a flock of about 40 cranes at Paynes Prairie, Florida, during December 1977 and January 1978 (Stephen Nesbitt pers. comm.). Another crane, tagged on 18 August 1977 near Colmstock Marsh, Marquette County, was shot 6 km west of Chipley, Washington County, Florida (130 km west-northwest of Tallahassee) on 26 November 1977 (Roy Chance pers. comm.). To my knowledge this is the western-most location in Florida from which wintering greater sandhill cranes have been reported. These two cranes were tagged in Wisconsin 1 week and 30 km apart, yet migrated to wintering areas more than 330 km apart.

Concentrations of wintering greater sandhill cranes were observed in three habitats. In Highlands and Osceola counties cranes were found on the extensive improved pastures characteristic of the Kissimmee Prairie. In north-central Florida (Alachua, Putnam, Marion, and Lake counties) concentrations of cranes were associated with agricultural land, green fields of oats and rye, fallow fields where the earth had been recently disturbed, and cornfields harvested the previous summer. In the Okefenokee Swamp, Georgia, cranes inhabited a diverse wetland of wooded and shrub swamps inter-

spersed with areas of emergent and floating vegetation and open water.

Complaints of crane damage to sprouting corn in late February and early March came from 2 locations - Rhoades Dairy near Umatilla, Lake County, and another dairy farm near Myakka City, Manatee County. At most locations, however, wintering greater sandhill cranes usually departed northward for the summer before corn was planted.

These 4,500+ wintering greater sandhill cranes probably represent 30-35 percent of the eastern population, so clearly there are other concentrations to be located. In south-central Florida it is possible that flocks of several hundred cranes could be overlooked on the extensive prairies and pastures of the Kissimmee Prairie and from the DeSoto Prairie west to the Sarasota-Fruitville area. Flocks of 200-300 cranes have been observed in recent years at several locations in south-central Florida: on the DD Ranch northwest of Myakka River State Park, Sarasota County, at Indian River Marsh, Glades County, and south of Lake Istokpoga, Highlands County.

Most (76 percent) of the cranes reported here were from north-central Florida (Alachua, Putnam, Marion, and Lake counties), and evidence exists of other wintering flocks in these counties. Cranes have been reported from the vicinity of the Ocala National Forest, both near the southeast corner (John Hartsfield pers. comm.) and from the Alexander Springs area (Brian Knowles pers. comm.).

The greater sandhill crane population in the Okefenokee

Swamp also needs further study. The region's inaccessibility makes accurate population estimates difficult, and the 600 reported here could be an underestimate. The possibility also exists that cranes are wintering in other parts of southern Georgia.

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APPENDICES

Appendix A. Banding and tagging data for sandhill cranes captured in Wisconsin and Indiana, 1976 - 1977.

USFW Band Number	Patagial Tag Number	Location	Date	Mid-Toe Length mm	Tarsus Length mm	Short Bill mm	Long Bill mm	Weight gm
599-25801	Transmitter	Mead	6-28-76	79	250	105	141	
803	A079	Mead	6-29-76	78	248	108	133	
804	A081	Mead	6-29-76	84	249	102	138	
805	Transmitter	Buena Vista	7-03-76	89	251	109	146	
806	A082	Buena Vista	7-03-76	85	255	100	130	
802	A083	Buena Vista	7-27-76	85	244	104	137	
807	Transmitter	Buena Vista	7-27-76	79	238	100	131	4550
808	A084	Buena Vista	7-27-76	90	278	104	137	
809	A085	Buena Vista	7-27-76	92	253	109	142	4700
810	A086	Buena Vista	7-27-76	81	255	107	141	4950
811	A087	Buena Vista	7-27-76	86	255	100	130	4550
812	A088	Buena Vista	7-27-76	89	277	102	133	5650
813	A089	Buena Vista	7-27-76	90	276	106	130	5250
814	A090	Buena Vista	7-27-76	86	262	101	135	4550
815	A091	Buena Vista	7-27-76	82	255	91	116	4200
816	A092	Buena Vista	7-27-76	86	270	92	118	4600
817	A093	Buena Vista	7-27-76	84	270	112	121	5050
818	A094	Buena Vista	7-27-76	90	276	106	137	5550
819	A095	Buena Vista	7-27-76	81	237	92	127	4450
599-23345	A046	Necedah	10-07-76	95	268	111	146	5700
599-25820	A096	Necedah	10-08-76	86	251	102	139	5150
509-84820	-	Necedah	10-08-76	88	249	106	126	4750
599-25821	A097	Necedah	10-13-76	91	240	96	121	4550
822	A098	Necedah	10-13-76	91	250	111	149	5300
823	-	Jasper-Pulaski	10-23-76	90	261	98	126	5400
824	-	Jasper-Pulaski	10-23-76	89	275	101	126	5150
825	-	Jasper-Pulaski	10-26-76	82	253	85	114	5000
599-26201	-	Jasper-Pulaski	10-27-76	79	267	99	127	5450
202	-	Jasper-Pulaski	11-02-76	87	231	94	121	4800

Appendix A. (continued)

USFW Band Number	Patagial Tag Number	Location	Date	Mid-Toe Length mm	Tarsus Length mm	Short Bill mm	Long Bill mm	Weight gm
599-26203	-	Jasper-Pulaski	11-02-76	84	258	111	140	6000
204	-	Jasper-Pulaski	11-06-76	83	241	99	128	5700
205	-	Jasper-Pulaski	11-07-76	81	275	96	126	4950
206	-	Jasper-Pulaski	11-07-76	82	252	104	139	5350
207	-	Jasper-Pulaski	11-07-76	86	236	98	124	4550
208	-	Jasper-Pulaski	11-07-76	83	239	93	121	4700
209	-	Jasper-Pulaski	11-07-76	90	270	102	131	6050
210	-	Jasper-Pulaski	11-07-76	96	282	119	146	6700
211	-	Jasper-Pulaski	11-07-76	84	267	115	139	5200
212	-	Jasper-Pulaski	11-07-76	79	239	100	138	5300
213	-	Jasper-Pulaski	11-07-76	86	276	116	142	6800
214	-	Jasper-Pulaski	11-07-76	84	242	92	116	4700
215	-	Jasper-Pulaski	11-07-76	98	272	111	148	6400
216	-	Jasper-Pulaski	11-08-76	88	244	94	126	5100
217	-	Jasper-Pulaski	11-08-76	86	260	103	138	5550
218	-	Jasper-Pulaski	11-08-76	84	258	105	136	5650
219	-	Jasper-Pulaski	11-08-76	80	242	92	126	5300
220	-	Jasper-Pulaski	11-08-76	87	253	92	126	4900
221	-	Jasper-Pulaski	11-08-76	80	268	111	148	6300
222	-	Jasper-Pulaski	3-17-77	87	275	102	146	5550
223	-	Jasper-Pulaski	3-17-77	91	262	106	145	5850
224	-	Jasper-Pulaski	3-17-77	91	256	99	132	5500
225	-	Jasper-Pulaski	3-17-77	82	258	105	141	5100
226	-	Jasper-Pulaski	3-17-77	83	246	100	134	5500
227	Transmitter	Buena Vista	6-03-77	82	264	102	130	4950
228	A099	Buena Vista	6-08-77	87	276	104	141	5750
229	-	Buena Vista	6-08-77	85	241	97	131	5250
235	A100	Marquette Co.	6-17-77	88	275	104	130	4700

Appendix A. (continued)

USFW Band Number	Patagial Tag Number	Location	Date	Mid-Toe Length mm	Tarsus Length mm	Short Bill mm	Long Bill mm	Weight gm
599-26245	A101	Navarino	6-29-77	80	262	107	141	4950
246	A102	Navarino	6-29-77	84	262	96	128	4500
247	-	Navarino	6-29-77	78	256	91	121	3850
248	A103	Navarino	6-30-77	84	255	96	132	4600
249	A104	Navarino	7-08-77	88	265	94	132	5100
250	A105	Navarino	7-08-77	98	276	114	150	5000
251	Transmitter	Buena Vista	7-26-77	88	262	98	136	4800
252	Transmitter	Mead	8-08-77	89	257	107	137	4750
253	Transmitter	Mead	8-08-77	83	255	106	137	4700
254	Transmitter	Mead	8-08-77	89	251	92	130	4500
255	Transmitter	White River	8-10-77	97	250	98	126	5000
256	A106	White River	8-10-77	86	261	100	132	4100
257	A107	Mead	8-17-77	87	265	115	145	5500
258	A108	Mead	8-17-77	84	272	96	130	5200
259	A109	Mead	8-17-77	95	272	94	130	5800
260	A111	Mead	8-17-77	83	248	96	132	4700
261	A112	Mead	8-17-77	80	251	106	141	4800
262	A113	Mead	8-17-77	86	258	105	133	5050
263	A114	Mead	8-17-77	79	249	99	130	5050
264	-	Mead	8-17-77	92	252	99	132	4400
265	A115	Colmstock	8-18-77	85	283	101	132	5000
266	A116	Colmstock	8-18-77	80	260	90	121	4450
267	A117	Colmstock	8-18-77	90	285	106	140	5250
268	A118	Colmstock	8-18-77	84	242	114	139	4200
269	A119	Colmstock	8-18-77	81	251	91	117	3950
270	A120	Colmstock	8-18-77	87	268	109	142	4800
271	A121	Colmstock	8-18-77	76	231	95	121	4200
272	A122	Colmstock	8-18-77	87	284	106	142	5150

Appendix A. (continued)

USFW Band Number	Patagial Tag Number	Location	Date	Mid-Toe Length mm	Tarsus Length mm	Short Bill mm	Long Bill mm	Weight gm
599-26273	A123	Colmstock	8-18-77	92	273	106	145	5750
274	A124	Colmstock	8-21-77	86	260	94	123	4700
275	A125	Colmstock	8-21-77	83	282	112	149	5250
276	A126	Colmstock	8-21-77	81	244	94	126	4450
277	A127	Colmstock	8-21-77	88	261	95	130	4700
278	A128	Widow Creek	8-25-77	79	257	102	123	4750
279	A129	Widow Creek	8-25-77	83	272	95	129	4800
280	A130	Widow Creek	8-25-77	79	269	94	131	4850
281	A131	Widow Creek	8-25-77	84	274	103	138	5600
282	A132	Widow Creek	8-25-77	80	271	103	136	4550
283	A133	Widow Creek	8-26-77	81	259	96	132	4950
284	A134	Widow Creek	8-26-77	78	255	95	129	4400
285	A135	Widow Creek	8-26-77	92	276	101	141	5400
286	A136	Widow Creek	8-26-77	80	251	101	137	5100
287	A137	Widow Creek	8-26-77	90	251	102	136	4850
288	A138	Widow Creek	8-26-77	90	277	106	142	5550
-	-	Widow Creek	8-26-77	86	271	106	141	5200
289	-	Jasper-Pulaski	10-12-77	87	270	103	136	5600
290	-	Jasper-Pulaski	10-12-77	83	252	101	134	4650
291	-	Jasper-Pulaski	10-12-77	84	251	93	125	5100
292	-	Jasper-Pulaski	10-12-77	86	252	101	132	5650
293	-	Jasper-Pulaski	10-12-77	81	229	98	137	4400
294	-	Jasper-Pulaski	10-12-77	86	255	102	140	5300
295	-	Jasper-Pulaski	10-12-77	83	252	97	128	4900
296	-	Jasper-Pulaski	10-12-77	86	246	114	141	5100
297	-	Jasper-Pulaski	10-15-77	86	267	108	142	5150
298	-	Jasper-Pulaski	10-15-77	85	281	109	150	5900
299	-	Jasper-Pulaski	10-15-77	88	269	101	134	5500
300	-	Jasper-Pulaski	10-15-77	86	251	96	134	5700

Appendix A. (continued)

USFW Band Number	Patagial Tag Number	Location	Date	Mid-Toe Length mm	Tarsus Length mm	Short Bill mm	Long Bill mm	Weight gm
599-26601	-	Jasper-Pulaski	10-15-77	93	272	110	147	6000
602	-	Jasper-Pulaski	10-15-77	81	247	94	131	5150
603	-	Jasper-Pulaski	10-15-77	86	266	97	138	5700
604	-	Jasper-Pulaski	10-15-77	83	238	99	129	4650
605	-	Jasper-Pulaski	10-15-77	85	250	94	126	4900
606	-	Jasper-Pulaski	10-15-77	89	258	95	132	5050
607	-	Jasper-Pulaski	10-15-77	86	250	101	134	4600
608	-	Jasper-Pulaski	10-19-77	87	256	105	139	5950
609	-	Jasper-Pulaski	10-19-77	79	241	97	131	4550
610	-	Jasper-Pulaski	10-27-77	85	263	105	132	5500
611	-	Jasper-Pulaski	10-27-77	85	270	112	131	5450
612	-	Jasper-Pulaski	10-27-77	83	265	103	139	5700
613	-	Jasper-Pulaski	10-27-77	83	251	108	137	4850
614	-	Jasper-Pulaski	10-27-77	81	239	100	130	5300
615	-	Jasper-Pulaski	10-27-77	86	259	100	128	5200
616	-	Jasper-Pulaski	10-27-77	86	256	102	133	5800

APPENDIX B. Capture and color-marking.

The wariness of greater sandhill cranes made them very difficult birds to capture and many hundreds of man-hours were devoted to trapping efforts. Attracting cranes within range of the nets was nearly always difficult and, in many situations, impossible. Nets, rockets, and detonation wire were carefully camouflaged, and it was often necessary to prebait potential trapping sites for several days. The angle at which the net was projected was critical, and rockets fired at an angle much greater than 30 degrees often gave cranes near the outer edges of the bait site the extra second they needed to escape. Even with skirted nets some birds failed to become entangled and were able to escape from beneath the nets before they could be secured. Another problem which occurred on several occasions and reduced trapping success involved aggressive pairs of cranes, particularly those with chicks, which would establish themselves at the bait site and drive away all other cranes which attempted to feed.

Trapping proved to be most successful during August in recently cut fields of hay, oats, and wheat. Cranes in late summer were attracted to such fields by the close-cropped vegetation and ready food supply. The long swaths of hay and straw provided excellent opportunities for camouflaging the nets and rockets.

Some cranes flew immediately after being patagial-tagged although the majority walked or ran from the trap sites upon release. There was no evidence of unusual aggressive or

avoidance behavior of untagged cranes toward tagged cranes. Four cranes patagial-tagged since 1974 were observed with mates during 1976 or 1977, and one of these pairs was accompanied by a chick. One neck collared crane also was observed with a mate and one chick.

Numerous field observations were made of neck collars which had been on cranes since 1973 (Gluesing 1974) and patagial tags which ranged in age from new to 3 years (Howard 1977). The patagial tags were very visible during their first 5-6 months on the birds and could be read at distances up to 0.7 km using a 15-60X spotting scope. Sometimes new tags could not be read if they were flipped upside down or partially obscured by a wing, or if the bird failed to turn sideways. However, older tags often had numerals which were partially torn off or completely missing, presumably due to pecking and preening of the tag by the crane. Feather staining (Taverner 1929) also reduced the readability of older patagial tags. After the first winter in the field many tags took on a brownish coloration, which reduced the contrast between black numerals and lime-green tag and often blended in with the plumage of the bird. The white lettering used by Howard (1977) on 1974 patagial tags was particularly difficult to read when stained.

Neck collars are also affected to varying degrees by feather staining. Some collars were read with a 15-60X spotting scope at distances in excess of 180 m, while in one instance, under poor light conditions 2 badly stained collars could not be read 60 m away. Another disadvantage of neck

collars was desbribed by Gluesing (1974), when in two instances cranes were observed with their bill caught between their neck and collar.

Neck collars have advantages over patagial tags in that they are more durable and remain readable over a longer period of time, cannot flip upside down or be obscured by plumage, and are probably less of a hindrance during flight. Since cranes are continually turning their head and neck from side to side, all parts of the collar usually can be viewed in a short period of time. During 1976-77 34.5 percent (10 of 29) of the neck collars used in 1973 were observed in the field and could be positively identified. This compares to only 22.4 percent (17 of 77) of the 1974-75 patagial tags.