ECOLOGY OF THE GREATER SANDHILL CRANE IN CENTRAL WISCONSIN

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By
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ABSTRACT

This study was designed to obtain information pertinent to greater sandhill crane (*Grus canadensis tabida*) productivity, habitat requirements, distribution, and seasonal abundance to facilitate management of the species. The field study was conducted in the central Wisconsin sand counties and was designed to investigate characteristics associated with greater sandhill crane reproduction and breeding habitat in central Wisconsin. Other objectives of the study included determinations of greater sandhill crane distribution and abundance in Wisconsin and identification of migration routes, staging areas, and wintering areas of Wisconsin's greater sandhill cranes.

Fifty sandhill crane nests were located by helicopter early in the nesting seasons of 1974 and 1975. The mean size of marshes occupied by nesting cranes was 31.5 ha (1.6-151.8 ha). Dominant vegetation in these marshes included *Sphagnum* spp., *Carex rostrata*, *Scirpus cyperinus*, *Carex lasiocarpa*, *Salix* spp., *Typha latifolia*, *Spirea tomentosa*, *Carex oligosperma*, and *Calamagrostis canadense*. These species comprised over 80 percent of the vegetation present within 10 m of nests. Nests averaged 91 cm in diameter (65-125 cm), 16.9 cm in height (7-31 cm), and were located in sites which averaged 12.55 cm in water depth (0.13-31.88 cm). Nests averaged 1714 m from sources

of human activity (305-5630 m), 280 m from open water (11-1280 m), and 785 m from the nearest road (100-1905 m). Hatching occurred from 17 May to 17 June and shell thickness of eggshells averaged 0.26 mm (0.20-0.36 mm). Seventy percent of the eggs hatched between 19 and 30 May. Average clutch size was 1.84 and hatching success was 80.44 percent.

Seventy-seven cranes were captured and color-marked with patagial tags in central Wisconsin during pre-migration staging. All captured cranes belonged to the tabida subspecies. Sightings of color-marked cranes indicated that the major flyway staging area of marked cranes during fall migration is the Jasper-Pulaski Refuge in northwestern Indiana and that their major wintering area is in the north-central prairies and marshes of Florida and southern Georgia.

A mail survey was conducted through the Wisconsin Department of Natural Resources during June and July of 1975. A Wisconsin resident population of 780 adults (including 223 pairs) and 118 young of the year was reported. No cranes were reported from 26 counties, and 12 counties in central Wisconsin (Wood, Adams, Marquette, Green Lake, Portage, Marathon, Juneau, Clark, Columbia, Shawano, Jackson, and Monroe) accounted for over 75 percent of the cranes reported.

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INTRODUCTION

Greater sandhill cranes (Grus canadensis tabida) originally nested in suitable habitat throughout the northern United States from the Great Lakes west to the Pacific states and southern Canada (A.O.U. 1957). They disappeared or were greatly reduced in numbers throughout much of their original range during this century largely because of loss of habitat through man's use of their nesting range for agricultural purposes.

The greater sandhill crane was removed from the U.S. Fish and Wildlife Service's List of Threatened Wildlife in 1973 (Office of Endangered Species and International Activities 1973). Population estimates had increased from 6,000-8,000 in 1968 (Office of Endangered Species and International Activities 1968) to 21,500-26,500 in 1975 (Braun et al. 1975).

Four populations of greater sandhill cranes are presently recognized (Lewis et al. 1973): (1) Eastern-nesting in Michigan, Minnesota, Wisconsin, southeastern Manitoba, and southwestern Ontario and wintering in southern Georgia and Florida; (2) Rocky Mountain-nesting in eastern Idaho, western Wyoming, northeastern Utah, southwestern Montana, and northwestern Colorado

and wintering in western New Mexico, northern Mexico, and southeastern Arizona; (3) Colorado River Valley-nesting in northeastern Nevada and southcentral Idaho and wintering in Arizona and California; and (4) Central Valley-nesting in southcentral and southeastern Oregon and northwestern California and wintering in the California central valley.

Despite recent increases in numbers as a result of protection from hunting and preservation of wetlands, greater sandhill cranes no longer nest in Ohio, Indiana, Illinois, Iowa, Nebraska, the Dakotas, Washington, Louisiana, Arizona, and much of southern Canada (Lewis et al. 1973).

It is necessary to gather information regarding productivity, habitat requirements, and other biological characteristics associated with greater sandhill cranes before effective management programs can be initiated. Studies of the greater sandhill crane during the breeding season have been made in Michigan (Walkinshaw 1949, 1950, 1965b, and 1973b); Oregon (Littlefield and Ryder 1968), and Idaho (Drewien 1973). Little research has been done in Wisconsin other than periodic surveys of distribution and abundance (Leopold 1929, Henika 1936, Hamerstrom 1938, Gluesing 1973, and Hunt et al. 1976).

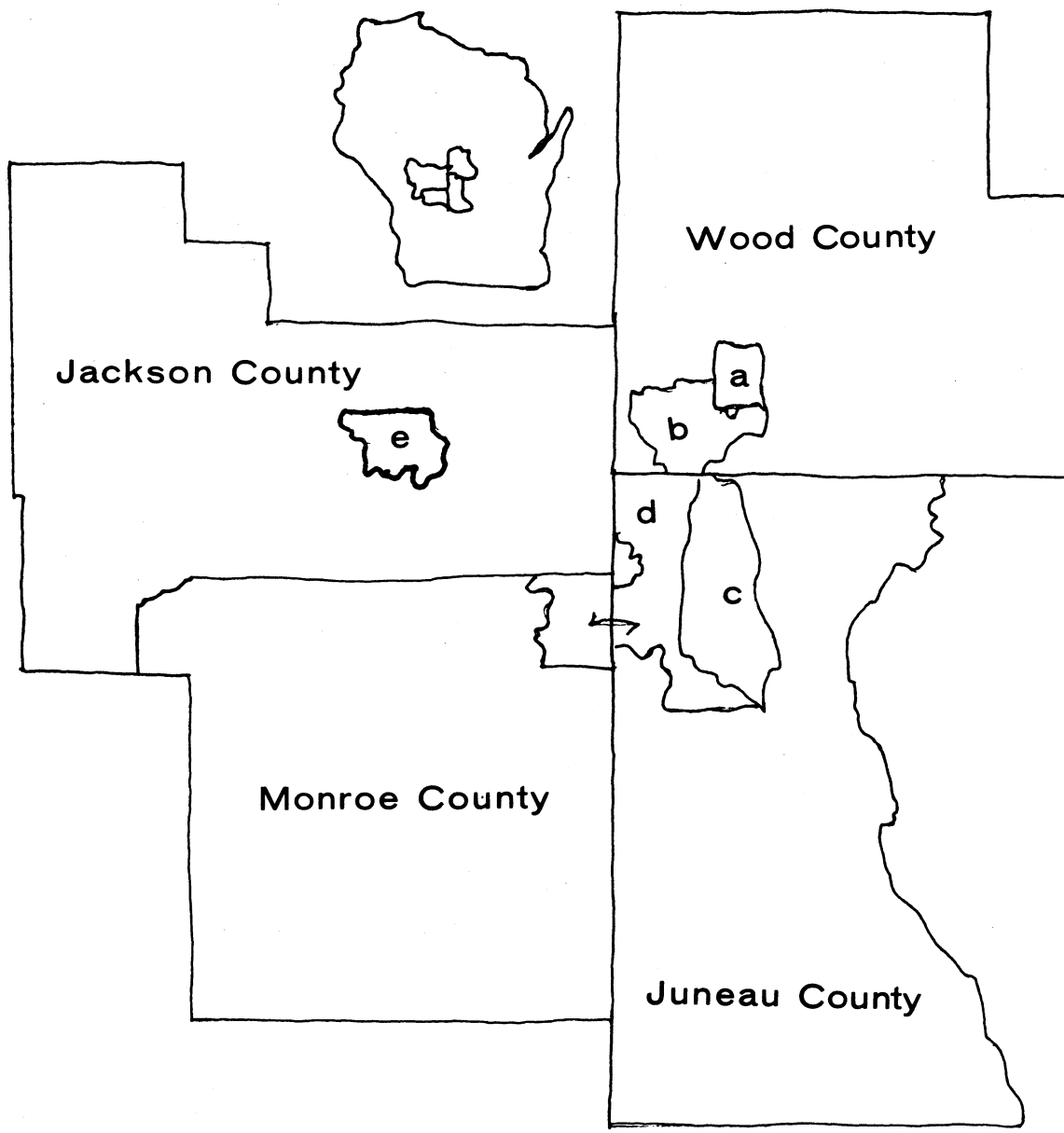
The objectives of this study were to: (1) determine

greater sandhill crane nesting habitat characteristics and nesting phenology in central Wisconsin; (2) identify migration routes, staging areas, and wintering areas of central Wisconsin's greater sandhill cranes; and (3) determine the present distribution and abundance of greater sandhill cranes in Wisconsin during the breeding season.

Study Area

The study area was the central Wisconsin sand counties of Jackson, Juneau, Monroe, and Wood (Figure 1). Sandhill cranes have nested within this area for the past 50 years (Henika 1936, Hamerstrom 1938, and Gluesing 1973). Included within this area are the Necedah National Wildlife Refuge, Sandhill Wildlife Demonstration Area, Wood County Public Hunting Grounds, Meadow Valley Wildlife Area and the Dike Seventeen Flowages. The area consists of peat and sandy soils with low marsh basins and mixed forests of wetland associated species. A thriving cranberry (Vaccinium spp) culture and economically marginal dairy farming are the major agricultural industries in the area.

Early attempts to farm the area failed because of poor soils and a short growing season. As a result, many marshes that had been formerly drained reverted to a semblance of their former condition and the sandhill crane responded to this change by increasing in number.



a=Sandhill Wildlife Demonstration Area
b=Wood County Public Hunting Grounds
c=Necedah National Wildlife Refuge
d=Meadow Valley Wildlife Area
e=Dike 17 Flowages

Fig. 1. Sandhill crane study area in central Wisconsin, 1974—75.

This area was selected as the study site because of the relatively concentrated number of pairs sighted during Gluesing's (1973) study of sandhill crane distribution and status in Wisconsin. Dikes and unimproved roads provided access to many of the larger marshes which facilitated study of cranes in this area.

METHODS

Locating Nests

The wetlands within the study area were surveyed during late March and early April of 1974 and 1975 to determine use by sandhill cranes. The survey was conducted by driving the back roads and improved dikes with a vehicle and noting the locations of pairs of cranes calling between 0600 and 0900 hours (CST). Locations were noted on 7.5 and 15 minute topographic maps.

A light three-passenger fixed-wing aircraft was flown for about 3 hours over the study area both years to better ascertain flight paths for an intensive nest search by helicopter. About 20 hours of helicopter time were used during late April to early May of each year to locate nests. The nest search was conducted over wetlands where intensive crane use had been noted. Flights across the wetlands were made at an altitude of about 30 m at a speed of 50-60 kph. Nesting cranes

would flush at the approach of the helicopter, leaving their nests with eggs clearly visible. The locations of nests were noted on topographic maps and a sketch of surrounding land features was made to facilitate relocation from the ground.

Nest Size

The nests were relocated and marked as soon as possible following the helicopter search. Small pieces of fluorescent orange flagging were tied 2 m above ground on stakes 100 m north and south of each nest. Nest diameter and the height of the nest above water or ground level was measured with a meter stick on this initial visit.

Physical Characteristics of Nesting Marshes

Marsh area was determined from standard 1:7920 aerial photographs. Distances from nests to marsh boundaries in cardinal directions, and to open water, roads, and sources of human activity (cranberry bogs, farms, homes, etc.) were determined by pacing or by measuring them from aerial photographs. Water depths at 1- and 2-m intervals in each cardinal direction from each nest were measured with a meter stick.

Hatching Phenology and Success

All nests were visited every 6 to 8 days to record hatching and incubation activity. More frequent visits would have increased the possibility of desertion

(Littlefield and Ryder 1968). A number of nests had one egg when first observed from the air but had two eggs at the initial ground visit. Greater sandhill cranes typically lay eggs on consecutive days and their incubation period is 30 days (Walkinshaw 1949). Hatching dates for those clutches with known egg-laying dates were obtained by adding 30 days to the date the nest was first located and the dates were later verified by checking the nest on the suspected date of hatching.

Pipping of eggs in some nests was noted, indicating imminent hatching. Approximate hatching dates for other nests were determined by observing young crane chicks a few days old near the nest site.

Eggshell fragments were collected from nests during the second year of the study. The thickness of these fragments was measured with a micrometer. Several measurements of shell fragments collected from each nest were made and their mean recorded.

Incubation Activities

A Minolta Super-8 movie camera equipped with telephoto lens and intervalometer was used to record incubation activity at four nest sites during 1975. The camera was mounted in a weatherproof box on a 3 m pole and was set to expose the film at 1 minute intervals. The camera was directed so that the entire frame was filled with the incubating crane and nest. A total of

12,373 daylight minutes of incubation activity were recorded. Information obtained included nest attendance time and incubation behavior.

Vegetation Analysis

A vegetation analysis was completed at each nest site as soon as the eggs hatched or the nest had been destroyed. The Daubenmire canopy-coverage method of vegetation analysis was used (Daubenmire 1959).

The plant species encountered in the vegetation analysis were coded and the information was collated with a computer program which printed the species and their density for each nesting site. The program also assigned a density value to each species encountered in all areas. This provided a reference for species density and abundance for all nesting marshes.

Capturing and Marking

Sandhill cranes were captured and color-marked with patagial tags during both years of the study. Cranes were captured at the Dike Seventeen Wildlife Area during 1974 and at the Necedah National Wildlife Refuge in 1974 and 1975 during pre-migration staging from August through October. The trapping technique used followed that of Wheeler and Lewis (1973) as modified by Gluesing (1973). Fewer than 10 cranes were captured at each attempt to avoid excessive stress caused by the process time involved in banding, color-marking and measuring.

Captured cranes were banded with size 9 aluminum U.S. Fish and Wildlife Service numbered bands and were fitted with patagial tags. Lovett E. Williams, Jr. first used patagial tags as a color-marking technique on greater sandhill cranes in Florida during 1968-69 (Walkinshaw 1973a). His procedure was modified to provide greater visibility and durability of patagial tags as follows: patagial tags were 23X5 cm and were attached to both dorsal and ventral surfaces of each wing. The tags were constructed of double-thickness fluorescent lime-green Saflag material (The Safety Flag Company of America, Pawtucket, Rhode Island) which was double-stitched around the border. White numbers from A001 to A060 were sewed onto the upper surface of each dorsal tag in 1974. Black numbers from A061 to A077 were used in 1975. The tags were attached to the wing by piercing the patagial membrane and inserting modified nylon cow ear tags (Bock's Cattle Ident. Co., Mattoon, Ill.).

Personnel of the Indiana Department of Natural Resources, the Wisconsin Department of Natural Resources, and the Florida Freshwater Fish and Game Commission were informed of the marking project and requested to forward observations of marked cranes.

Four measurements were made of each captured crane to determine taxonomic subspecificity. Measurements of

captured cranes were similar to those described by Stephen et al. (1966).

Captured cranes were confined in large burlap sacks until they could be processed and were released immediately upon completion of banding, tagging, and measuring.

Mail Survey

A mail survey of Wisconsin Department of Natural Resources wildlife managers, wildlife biologists, and game wardens; of cranberry marsh operators in areas where cranes were known or suspected to be summer residents; and of ornithologists affiliated with the University of Wisconsin was conducted in June-July, 1975, to determine distribution and abundance of sandhill cranes in Wisconsin during the breeding season. The survey procedure generally followed that of Gluesing (1973). Information obtained from the survey included numbers and locations of adult summer resident cranes and of chick observations.

RESULTS AND DISCUSSION

Nests and nesting habitat

Fifteen and 35 sandhill crane nests were located during the 1974 and 1975 nesting seasons, respectively (Table 1). Fourteen hours of actual nest searching time by helicopter was used between 4 and 22 April 1974, resulting in a nest locating rate of 1.06 nests/hour. Actual flight time in nest searching between 14 and 20 May 1975 was 11.5 hours and resulted in a nest locating rate of 3.04 nests/hour. Greater success in locating nests during 1975 was attributed to more familiarity with nesting marshes within the study area, increased skill of observers, and a better understanding of the incubation dates obtained during 1974.

It was found that the helicopter airspeed best suited for locating nests of sandhill cranes is from 50 to 60 kph. This rate of speed was found to be slow enough to allow the cranes to flush at the approach of the helicopter, leaving the nest with eggs visible from the air. Increasing the helicopter speed resulted in overshooting the nests before the cranes had flushed. A slower rate of speed sometimes resulted in a crane leaving the nest too far ahead of the helicopter to permit observers to locate the exact nest site.

Table 1. Sandhill crane nest locations in central Wisconsin during 1975 (1-35) and 1974 (36-50).

Nest Number	Section	Township	Range	County
1	07	25N	8E	Portage
2	17	25N	8E	Portage
3	17	25N	8E	Portage
4	02	21N	7E	Portage
5	14	21N	4E	Wood
6	29	21N	2E	Wood
7	30	21N	2E	Wood
8	03	21N	4E	Wood
9	09	20N	2E	Juneau
10	07	19N	1E	Monroe
11	06	19N	1E	Monroe
12	27	20N	1E	Jackson
13	32	20N	3E	Juneau
14	32	20N	3E	Juneau
15	29	19N	3E	Juneau
16	23	21N	2W	Jackson
17	34	21N	2W	Jackson
18	09	21N	2E	Wood
19	09	21N	2E	Wood
20	26	22N	4E	Wood
21	21	22N	4E	Wood
22	16	22N	4E	Wood

Table 1. Continued.

Nest Number	Section	Township	Range	County
23	10	22N	4E	Wood
24	15	22N	4E	Wood
25	13	22N	4E	Wood
26	08	22N	5E	Wood
27	12	22N	4E	Wood
28	11	22N	4E	Wood
29	14	22N	4E	Wood
30	04	21N	3E	Wood
31	31	21N	3E	Wood
32	30	22N	3E	Wood
33	32	22N	3E	Wood
34	33	21N	3E	Wood
35	06	21N	2E	Wood
36	07	25N	8E	Portage
37	21	25N	8E	Portage
38	29	21N	12E	Waupaca
39	17	25N	7E	Portage
40	08	21N	2E	Wood
41	05	20N	2E	Juneau
42	36	20N	2E	Juneau
43	02	18N	1W	Monroe
44	15	21N	2E	Wood
45	16	21N	2E	Wood

Table 1. Continued.

Nest Number	Section	Township	Range	County
46	24	21N	1W	Jackson
47	33	21N	3E	Wood
48	31	22N	2E	Wood
49	05	21N	3E	Wood
50	34	21N	1E	Jackson

Although most cranes readily flushed at the approach of the helicopter, four or five ran a few meters from the nest and displayed behavior apparently intended to draw the aircraft from the nest site. These cranes performed "broken-wing" acts or ran in small circles with their wings outstretched and held close to the ground when the helicopter approached the nest site. One crane flew towards the helicopter on two occasions when the helicopter approached the nest site. This nest was never observed from the air but was found by searching the area on foot. Cranes were never aggressive or threatening when flushed from nests by an on-ground observer, but often performed the "broken-wing" act.

Ten nests were located during 1975 within the same territories that had contained nests in 1974. Walkinshaw (1973b) stated that pairs of greater sandhill cranes at the Haehnle Sanctuary in Lower Michigan return each year to their past season's nesting territories and may use the previous years' nest in some cases. The same nest was used on consecutive years by only one pair of cranes in this study.

The presence of water is the most important single item in crane nesting habitat. Cranes in central Wisconsin nested in a variety of wetland types including cranberry bog reservoirs, sedge (Carex or Scirpus spp)

meadows, cattail (Typha latifolia) marshes, or in the transitional areas between wet upland meadows and the deeper freshwater marshes. Henika (1936) and Hamerstrom (1938) studied sandhill crane nesting biology in Wisconsin and described sandhill crane range similarly as marshy areas usually of sandy or peat soils. Nests of greater sandhill cranes in North Dakota (Johnson and Stewart 1973), Idaho (Drewien 1973), Oregon (Littlefield and Ryder 1968), the Rocky Mountain states (Drewien and Bizeau 1973), and Michigan (Walkinshaw 1949, 1965b, and 1973a) have also been described as in predominantly wetland areas.

Sandhill cranes in central Wisconsin nested an average of 281 m from open water during 1974-75 (s.d. = 249; range 11-1280 m) (Table 2). Water depths at nest sites averaged 12.6 cm (s.d. = 8.4; range 0.13 - 35.75 cm) (Table 3). Free water at the nest site may be important in nest site selection. All nest sites had some water present during the nest construction and early incubation periods, but in some cases free water was several meters away during the latter stages of incubation. Water depths averaged 21.6 cm (range 0 - 91.5 cm) at 110 nest sites in Michigan (Walkinshaw 1965b) and 16.8 cm (range 0 - 60.4 cm) at 93 nest sites in Oregon (Littlefield and Ryder 1968). Drewien (1973) found that 75 percent of the 337 nests he studied in Idaho were located in water 25 cm or less in depth.

Table 2. Distance (m) and direction from central Wisconsin sandhill crane nests to open water, roads, and sources of human activity, 1974-75.

Nest	Distance to human activity	Distance to nearest road	Distance to open water
1	762 NW	768 W	503 NE
2	1859 NE	1661 N	1280 SE
3	701 SW	1006 W	686 NE
4	1006 NW	907 W	351 N
5	1106 SW	1905 N	482 W
6	1615 SE	805 SW	366 E
7	762 W	305 NE	732 SE
8	457 N	1615 N	23 W
9	3168 NE	754 S	210 S
10	604 SE	402 E	62 S
11	553 SW	1660 E	453 S
12	322 W	704 W	262 N
13	2333 SE	1730 S	101 W
14	2576 SE	960 E	181 W
15	1257 SW	463 S	23 E
16	4345 E	1458 E	201 N
17	1157 SE	905 E	50 S
18	2819 NW	262 S	162 N
19	2615 NW	421 E	91 W

Table 2. Continued.

Nest	Distance to human activity	Distance to nearest road	Distance to open water
20	762 W	198 N	152 S
21	305 SE	411 S	213 S
22	442 S	1006 E	183 S
23	1113 N	549 E	30 E
24	686 S	1052 S	107 W
25	625 S	320 S	122 S
26	991 NE	966 N	701 S
27	844 N	640 E	305 E
28	1402 SE	914 W	914 E
29	701 SE	610 E	241 E
30	1890 W	290 NE	11 E
31	457 N	457 E	297 NW
32	4023 N	594 E	107 S
33	4663 N	604 W	122 E
34	1981 W	594 SE	320 NW
35	1097 E	885 W	351 NW
36	762 NW	768 W	503 NE
37	953 NE	442 E	84 S
38	704 E	151 S	126 NE
39	602 E	1463 W	549 E
40	1157 N	101 N	152 W

Table 2. Continued.

Nest	Distance to human activity	Distance to nearest road	Distance to open water
41	2615 NE	1660 S	177 E
42	5633 SE	181 N	162 NE
43	654 E	1157 S	262 E
44	5029 SW	579 N	366 W
45	2012 SW	704 N	101 S
46	2313 NE	754 E	162 N
47	1981 W	594 SE	320 NW
48	3322 N	549 E	91 W
49	4968 E	549 S	411 E
50	1006 SE	805 E	181 E

Table 3. Water depths (cm) at 1- and 2-meter intervals in cardinal directions from central Wisconsin sandhill crane nests, 1974-75.

Nest	North	South	East	West	Mean
1	10,25	16,20	15,20	30,12	17.25
2	5,4	0,2	4,5	4,2	3.25
3	19,9	11,4	11,16	13,6	10.00
4	0,3	2,4	0,5	6,10	3.75
5	5,12	12,19	8,21	15,15	13.38
6	4,22	5,32	11,21	13,21	16.13
7	9,14	4,15	5,11	14,17	11.13
8	3,12	13,6	5,7	8,11	8.13
9	19,27	20,22	25,32	18,20	22.28
10	9,10	21,13	11,20	10,14	13.50
11	6,8	8,8	7,8	6,10	7.63
12	20,29	27,25	41,36	18,28	28.00
13	6,9	4,13	6,11	9,9	8.13
14	19,26	22,24	17,22	20,21	21.38
15	24,22	24,20	18,26	27,32	24.13
16	26,32	25,30	20,26	26,35	27.50
17	10,10	10,12	6,15	8,11	10.25
18	15,21	18,22	13,10	16,18	16.63
19	2,3	4,2	0,2	0,9	2.75
20	17,15	15,19	16,18	11,15	14.50

Table 3. Continued.

Nest	North	South	East	West	Mean
21	12,12	8,12	9,16	10,19	12.25
22	30,42	30,46	34,53	16,4	31.88
23	15,29	10,15	9,5	8,8	12.38
24	31,34	27,19	23,30	26,20	26.13
25	12,21	6,23	17,18	14,20	16.38
26	4,10	7,9	11,18	8,14	9.88
27	19,11	15,14	7,3	15,10	11.75
28	2,6	5,0	9,12	2,0	4.50
29	16,17	12,11	14,23	17,12	15.25
30	35,42	26,37	32,47	29,38	35.75
31	11,9	11,11	7,13	8,11	10.13
32	17,18	18,20	18,20	16,16	17.88
33	17,17	19,17	24,20	15,22	18.88
34	15,15	10,8	12,15	21,11	13.38
35	10,10	18,10	9,14	6,11	11.00
36	0,0	0,5	2,0	3,5	1.88
37	0,0	0,0	0,0	0,0	0.13
38	2,4	3,5	3,4	5,3	3.63
39	7,11	8,8	10,21	10,12	10.88
40	1,3	6,4	0,4	0,2	2.50
41	19,14	15,15	17,12	13,10	14.38
42	16,16	16,20	10,15	18,20	16.38

Table 3. Continued.

Nest	North	South	East	West	Mean
43	19,11	14,24	15,19	5,14	15.13
44	0,0	0,1	0,0	0,0	0.13
45	0,0	0,1	0,2	1,2	0,75
46	18,20	17,12	22,17	8,9	15.38
47	8,16	5,9	2,8	7,8	7.86
48	8,13	4,1	14,9	5,8	7.75
49	0,2	1,8	1,0	0,3	1,86
50	4,4	0,6	0,2	0,2	2.39

The size of nesting marshes in central Wisconsin averaged 31.5 ha (s.d. = 32.7; range 1.6 - 151.8 ha) (Table 4). Walkinshaw (1973a) stated that territories of greater sandhill cranes in Michigan varied with the density of breeding cranes. Crane territories there ranged from 2.8 to 193.8 ha in size; 76 averaged 53 ha and 13 others averaged 85 ha. The former were located in areas of greater crane density. Eight territories measured by Littlefield and Ryder (1968) averaged 25.1 ha. No indication of relative density of this population was given. The density of nesting pairs of greater sandhill cranes at Gray's Lake, Idaho (Drewien 1973) is the highest reported for the species. Optimum breeding habitat there resulted in a minimum of between 5 and 8 ha necessary to accommodate a breeding pair for successful reproduction.

Crane nests in central Wisconsin were located an average of 785 m (s.d. = 456; range 101 - 1660 m) from the nearest road and an average 1714 m (s.d. = 1390; range 305 - 5633 m) from the nearest source of human activity (Table 2). Nests averaged 83 m (s.d. = 61; range 2 - 251 m) from the nearest edge of the marsh in which they were located (Table 4). Walkinshaw (1965b) measured the distance from 39 Michigan sandhill crane nests and surrounding dry ridges and found that the distance averaged 185.2 m. Thirty-three of these nests

Table 4. Marsh size and distance from sandhill crane nests to marsh edges in cardinal directions in central Wisconsin, 1974-75.

Nest	Marsh size (ha)	Distance from nest to marsh edge (m) North	South	East	West
1	15.4	382	251	140	79
2	19.0	206	335	351	49
3	13.0	262	61	98	23
4	1.6	26	2	2	2
5	22.3	290	274	98	482
6	9.7	91	15	366	335
7	18.2	396	152	457	122
8	28.3	457	30	686	23
9	17.8	341	201	352	120
10	16.6	113	62	322	302
11	38.9	352	453	101	584
12	100.0	363	785	744	81
13	5.7	140	262	120	101
14	4.5	322	162	101	201
15	2.8	162	140	23	76
16	23.5	453	151	101	101
17	14.6	150	81	422	302
18	38.9	503	262	15	671
19	27.9	441	251	55	442
20	22.3	15	152	655	290

Table 4. Continued.

Nest	Marsh size (ha)	Distance from nest to marsh edge (m) North	South	East	West
21	6.5	23	213	91	219
22	8.9	152	316	168	9
23	18.6	396	594	30	152
24	34.8	213	259	899	107
25	10.9	46	137	107	579
26	89.0	183	701	107	213
27	25.5	198	274	305	107
28	9.3	107	91	221	503
29	33.2	341	251	241	160
30	7.3	107	122	67	201
31	51.4	732	76	457	107
32	15.0	198	183	160	189
33	35.2	38	503	213	457
34	151.8	251	564	1106	1311
35	30.4	241	101	61	213
36	15.4	379	251	140	79
37	63.1	853	84	442	503
38	6.5	139	754	101	12
39	71.6	91	91	805	427
40	13.4	162	282	251	152
41	19.8	422	241	177	76
42	31.2	181	201	427	227

Table 4. Continued.

Nest	Marsh size (ha)	Distance from nest to marsh edge (m) North	South	East	West
43	33.2	352	241	262	81
44	17.8	335	198	8	130
45	59.5	704	91	434	152
46	10.5	162	40	90	20
47	151.8	251	564	1106	1311
48	51.4	503	297	549	183
49	46.1	213	396	411	442
50	14.6	61	241	322	50

were over 100 m from the marsh edge. Cranes nesting within the central Wisconsin study area nested in areas as remote from human activity as possible. Sandhill crane nesting areas throughout America are usually in an isolated place, remote from human activity (Walkinshaw 1949). A pair of cranes will occassionally nest and successfully rear young in close proximity to human disturbance, but it is the exception rather than the rule. Walkinshaw (1949) stated that most nests he observed were "long" distances from areas of regular human use, although some nests were "quite close" to residences in Oregon, Michigan, and Idaho. Drewien (1973) stated that potential nesting areas located close to roads or cultivated fields were used little by cranes, suggesting that cranes may avoid suitable habitat when it is too close to areas of human activity. He found a few nests less than 400 m from roads but they were often screened from the marsh by brush or trees. Many apparently suitable nesting areas are not used by central Wisconsin sandhill cranes (although they have the typical vegetative types found in nesting areas) because of their proximity to roads or human activity. As crane populations increase, they may nest closer to areas regularly used by humans, but that point apparently has not yet been reached in central Wisconsin. This is an indication that the sandhill crane has not reached its

greatest density in the study area.

The size of sandhill crane nests varies with the vegetative type in which the nest site is located (Walkinshaw 1949). Vegetation density usually increases from the edge towards the center of marshes in which cranes nested (pers. obs.). Because cranes build their nests of the material available at the nest site, the vegetative type present will be reflected by the diameter and height of the nest above water, i.e., a nest in a stand of pure cattail will be of larger dimensions than one built in a grassy meadow or in wiregrass sedges. The average nest diameter of 91.1 cm (s.d. = 17.5; range 55 - 128 cm) and average nest height of 16.9 cm (s.d. = 6.1; range 7 - 31 cm) (Table 5) reflects the vegetation type and density of the marshes in central Wisconsin rather than an average of the typical sandhill crane nest. Drewien (1973) found average diameters of 132 X 120 cm for 58 nests located within the marsh, 96 X 89 cm for 100 nests located in the marsh edge, 67 X 61 cm for 18 nests located on artificial dikes, and 58 X 54 cm for nests located in dry upland meadows. It is apparent from his findings that sandhill crane nests are larger in the interior of the marsh and become progressively smaller towards the marsh edge and meadows. This is further supported by Walkinshaw (1965b). Ninety-seven

Table 5. Diameter and height (cm) of sandhill crane nests in central Wisconsin, 1974-75.

Nest	Diameter	Height
1	100	22
2	90	13
3	122	15
4	85	26
5	118	19
6	128	22
7	98	15
8	95	17
9	100	16
10	87	21
11	78	13
12	85	16
13	79	19
14	106	27
15	105	28
16	80	18
17	113	27
18	113	22
19	100	12
20	100	14
21	87	17

Table 5. Continued.

Nest	Diameter	Height
22	95	15
23	85	31
24	95	28
25	75	12
26	120	23
27	82	22
28	92	15
29	100	12
30	107	14
31	85	11
32	91	27
33	105	24
34	95	22
35	95	18
36	55	15
37	60	15
38	65	13
39	105	18
40	100	13
41	70	7
42	70	13
43	80	10

Table 5. Continued.

Nest	Diameter	Height
44	60	10
45	70	13
46	80	9
47	125	13
48	65	7
49	75	9
50	85	8

nests he measured averaged 113 X 98 cm. The majority were located in cattail or sedge meadow areas of dense vegetative growth. He reported the average height above water for 109 Michigan nests was 12.63 cm (range 1.5 - 31 cm). Vegetation used in nest construction was primarily the available materials, including the larger coarse dead plant material such as cattail leaves, sedges, rushes (Eleocharis spp), loosestrife (Lysimachia spp) and reeds (Phragmites spp). The height of nests above water is also a function of the vegetation present and the water conditions in the area rather than a propensity for sandhill cranes to construct a nest of given dimensions.

The marsh types in which sandhill crane nests were found in central Wisconsin is reflected by the vegetation types and frequency of particular species (Table 6). The first 14 species of plants listed in Table 6 comprised over 92 percent of the total vegetation present at all nest sites. The additional 36 species listed comprised the remaining canopy coverage. All nests were located in areas where dense vegetation partially screened the nest from view. Littlefield and Ryder (1968) considered nesting cover to be an essential component of all crane nesting territories. They considered stands of pure

Table 6. Vegetation analysis at sandhill crane nest sites in central Wisconsin during 1974-75.

Species	Percent of total canopy coverage	Percent occurrence in 1000 plots	Average percent canopy coverage per occurrence in a plot
Sphagnum spp	29.88	44.1	75.5
Carex rostrata	21.25	58.6	40.4
Scirpus cyperinus	7.92	26.2	33.7
Carex lasiocarpa	6.38	20.5	34.7
Salix spp	5.61	16.6	37.7
Spirea tomentosa	4.20	25.3	18.5
Typha latifolia	3.16	15.0	23.5
Carex oligosperma	3.09	18.9	18.2
Calamagrostis canadense	2.61	25.2	11.5
Carex stricta	2.59	7.6	37.9
Chaemaedaphne calyculata	1.96	7.1	30.1
Theylptra palustris	1.47	11.6	14.1

Table 6. Continued.

Species	Percent of total canopy coverage	Percent occurrence in 1000 plots	Average percent canopy coverage per occurrence in a plot
Eleocharis spp	1.38	4.5	31.4
Saggitaria latifolia	1.31	8.6	17.0
Populus tremuloides	0.92	1.4	73.6
Lysimachia terrestris	0.67	13.4	5.6
Carex tenera	0.65	5.3	13.6
Betula pumila	0.56	1.5	41.9
Dulichium arundinaceum	0.51	4.4	12.9
Amelanchior bartramiana	0.40	0.5	89.0
Carex scoparia	0.33	2.5	14.7
Dactylis glomerata	0.31	1.0	34.5
Lycopus uniflorus	0.29	4.9	6.3
Agropyron repens	0.25	0.7	39.6
Eriophorum spp	0.23	3.2	7.9

Table 6. Continued.

Species	Percent of total canopy coverage	Percent occurrence in 1000 plots	Average percent canopy coverage per occurrence in a plot
Carex brunnescens	0.19	0.9	23.6
Larix laricina	0.19	0.3	69.2
Lonicera oblongifolia	0.18	5.9	3.3
Galium tinctorium	0.17	3.2	6.0
Campanula aparinoides	0.17	2.5	7.4
Scutelaria galliculerata	0.15	3.1	5.3
Tracaulon saggitatum	0.14	2.0	8.0
Potentilla palustris	0.12	1.8	7.4
Carex retrorsa	0.09	0.5	19.5
Leersia oryzoides	0.08	1.9	4.5
Carex lacustris	0.10	1.2	9.6
Iris versicolor	0.07	0.8	10.3
Solidago spp	0.05	0.3	15.0

Table 6. Continued.

Species	Percent of total canopy coverage	Percent occurrence in 1000 plots	Average percent canopy coverage per occurrence in a plot
Alnus rugosa	0.05	0.2	26.3
Caltha palustris	0.05	0.2	26.3
Asclepias incarnata	0.05	0.6	8.8
Cornus stolonifera	0.05	0.4	15.0
Scirpus validus	0.04	0.9	10.0
Ranunculus delphinifolius	0.04	1.1	13.6
Viola spp	0.03	0.7	4.3
Kalmia polifolia	0.03	0.3	10.8
Andromeda glaucophylla	0.03	0.3	10.8
Rubus spp	0.02	0.3	6.7
Eupatorium perfoliatum	0.01	0.1	15.0
Drosera rotundifolia	0.01	0.2	2.5
Poa palustris	0.01	0.1	15.0

Table 6. Continued.

Species	Percent of total canopy coverage	Percent occurrence in 1000 plots	Average percent canopy coverage per occurrence in a plot
Oxycoccus macrocarpus	0.01	0.2	2.5
Toxicodendron radicans	0.01	0.3	2.5

cattail to be most important for early nesting, as it provided the most cover during the early part of the nesting season. Carex rostrata, a coarse-leaved sedge of open marsh areas, was the predominant residual vegetation at most central Wisconsin nest sites. Stands of pure cattail were used at five nest sites.

Drewien (1973) suggested that nest site selection was influenced by predation on eggs. Nests he studied in Idaho were poorly concealed except for the few located there in willow and residual cover of burreed (Sparganium spp) and cattail. Nests in Michigan (Walkinshaw 1965b) were located in cattail and three-cornered sedge which provided good concealment. Egg predation at Gray's Lake was reportedly low which may account for the lack of nest concealment when compared to the nest concealment exhibited by cranes in Michigan and Wisconsin.

Reproduction

Eight crane nests had a single egg each and 42 nests had two eggs each for a mean clutch size of 1.84 eggs per nest (Table 7). This clutch size is less than than found by Drewien (1973) in Idaho (1.94, n = 337), Littlefield and Ryder (1968) in Oregon (1.92, n =108), and Walkinshaw (1949) in Oregon, Idaho, Alberta, and Michigan (1.92, n = 45). Lack (1966) stated that clutch

Table 7. Clutch size and hatching success of sandhill cranes in central Wisconsin, 1974-75.

	1974	1975	1974-75
Number of nests	15	35	50
Eggs laid	26	66	92
Average clutch size	1.73	1.89	1.84
Eggs hatched	19	55	74
Hatching success	73.1%	83.3%	80.4%

size of long-lived birds is correlated with the age of the adults and that older established pairs may have larger clutches and be more successful in raising their young up to fledgling stage. Walkinshaw (1973a) has also suggested that cranes that lay but one egg do so when they are young adults. The population of greater sandhill cranes in Wisconsin and in all of their range east of the Mississippi is increasing (Lewis et al. 1973; Hunt et al. 1976). Because of the presently expanding nature of the eastern population of sandhill cranes, many of the breeding pairs are likely to be in their first or second breeding season, which may account for the reduced clutch size observed in this study.

Hatching success was 80.4 percent in this study (Table 7). Eighteen of 92 eggs failed to hatch because of predation, infertility, and/or desertion (Table 8). The hatching success of sandhill cranes in central Wisconsin compares favorably with a 78 percent hatching success of 308 nests studied in Idaho (Drewien 1973), 73.1 percent hatching success of 26 nests studied in Michigan (Walkinshaw 1949), 83 percent success for 6 nests studied in Alberta, Oregon, and Idaho (Walkinshaw 1949) and 78.9 percent success for 120 eggs laid in the Haehnle Sanctuary in Michigan (Walkinshaw 1973b).

One pair of cranes incubated a single egg for over

Table 8. Sandhill crane hatching dates and success in central Wisconsin, 1974-75.

Nest	Eggs laid	Eggs hatched	Hatching date
1	2	0	5/27/75 (a)
2	2	2	5/27/75
3	2	2	5/22/75
4	2	2	6/03/75
5	2	2	6/17/75
6	2	2	5/27/75
7	2	1	5/19/75 (b)
8	2	2	6/05/75
9	2	0	5/19/75 (a)
10	1	1	5/23/75
11	2	2	5/23/75
12	2	2	5/22/75
13	2	0	5/17/75 (a)
14	2	2	5/21/75
15	1	1	5/17/75
16	2	0	6/16/75 (a)
17	2	2	5/19/75
18	2	2	6/13/75
19	1	0	7/26/75 (c)
20	2	2	5/26/75
21	2	2	5/21/75

Table 8. Continued.

Nest	Eggs laid	Eggs hatched	Hatching date
22	2	2	6/03/75
23	2	2	5/21/75
24	2	2	5/22/75
25	2	2	5/21/75
26	2	2	5/23/75
27	2	2	5/27/75
28	1	1	5/27/75
29	2	2	5/25/75
30	2	2	5/29/75 (d)
31	2	2	5/23/75
32	2	2	5/31/75
33	2	1	6/16/75 (b)
34	2	2	6/13/75
35	2	2	5/23/75
36	1	1	5/19/74
37	2	2	5/20/74
38	2	0	5/20/74
39	2	2	5/27/74
40	1	1	5/27/74
41	2	1	6/12/74 (b)
42	2	1	6/12/74 (b)
43	2	2	6/06/74

Table 8. Continued.

Nest	Eggs laid	Eggs hatched	Hatching date
44	2	2	5/27/74
45	2	0	5/30/74 (a)
46	1	1	5/30/74
47	2	2	5/20/74
48	2	2	5/27/74
49	1	0	5/29/74 (a)
50	2	2	5/30/74

(a) The eggs were destroyed or found abandoned on this date.

(b) One egg hatched and one egg failed to develop in these nests.

(c) This single egg was incubated for over 60 days before being abandoned.

(d) Both chicks from this nest died on hatching date.

60 days before finally abandoning it. Walkinshaw (1965b) has observed that cranes often incubate infertile eggs long beyond the normal period.

One nest was destroyed by skunks (Mephitis mephitis), two were destroyed by crows (Corvus brachyrhynchos), and the remainder of the unsuccessful nests were lost due to unknown causes. A crow was photographed by time-lapse photography perched on the edge of nest 22. Examination of subsequent film footage showed that the adult crane apparently drove it away. The crane was photographed incubating the eggs several minutes after the crow had left the camera's view. Hamerstrom (1938), Littlefield and Ryder (1968), Walkinshaw (1949, 1950, 1965b, 1965d, 1973a, and 1973b) and Drewien (1973) list crows, skunks, ravens (Corvus corax), coyotes (Canis latrans) and raccoons (Procyon lotor) among known sandhill crane nest predators.

A rapid drop in the water level at the nest site was the cause of the failure of nest 30. This cause for nest desertion has been previously documented (Littlefield and Ryder 1968). A rapid drop in water level from 39.5 to 12.5 cm was the direct cause of desertion of a crane nest observed in Oregon. Nest 30 was located in the center of a waterfowl impoundment on the Dike Seventeen Flowage. A camera had been recording incubation activity

at this nest for several days. The pipped egg had already partially hatched and audible peeps were heard from the second egg during an inspection of the nest site to change film in the time-lapse camera. Three days later, the nest had been deserted and both chicks were dead at the nest site. The water had been drawn down in the impoundment to facilitate seeding the exposed mudflats with millet on the day after the nest was visited. Desertion because of observer activity was unlikely because the cranes had continued incubation during previous visits and installation of the camera. No other pair was know to desert as a direct cause of observer interference nor had any other photographed pair deserted.

Cranes may also desert due to flooding (Walkinshaw 1949, but no instances of flooding occurred during 1974-75 in the study area. Desertion due to flooding from heavy precipitation may be a common occurrence during some years.

Hatching dates during 1974 ranged from 17 May to 17 June with a 12-day peak from 19 to 30 May (Figure 2). Seventy percent of hatching occurred during this peak period. Crane incubation in Oregon (Littlefield and Ryder 1968) lasted from 11 April to 4 July 1966 and from 12 April to 13 June 1967. The peak of hatching activity

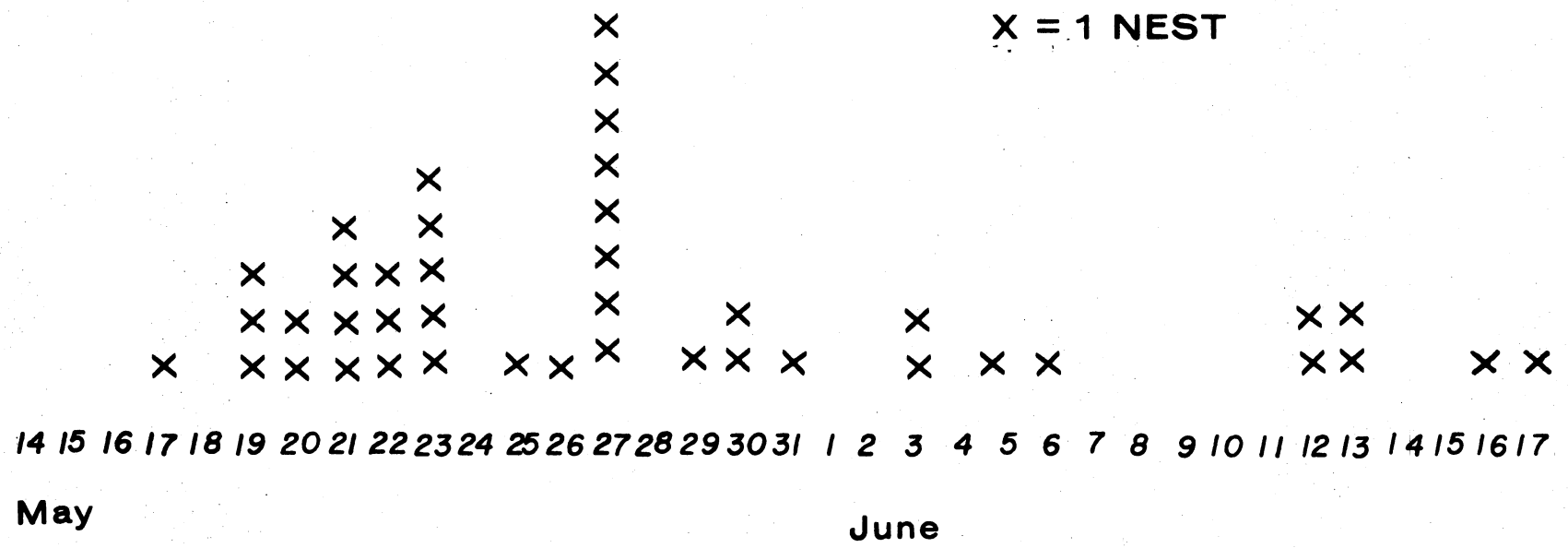


Fig. 2. Sandhill crane hatching dates in central Wisconsin, 1974—1975.

there occurred during the last week of May through the first two weeks of June. Michigan sandhill cranes hatch from early to late May with an average southern Michigan hatching date of 14 May and an average northern Michigan hatching date of 31 May (Walkinshaw 1965b). Nesting occurred from late April through early July in Idaho (Drewien 1973). Drewien (1973) postulated that the lateness of some hatching dates in Idaho resulted from crane activity in defense of territories.

Various demographic parameters peculiar to sandhill cranes result in a low reproductive potential. The maximum longevity of sandhill cranes is estimated to be from 20 to 25 years (Walkinshaw 1949) and they usually reach sexual maturity in their fourth year (Walkinshaw 1965c). More significantly, deferred breeding by long-lived species of birds has frequently been associated with an increased ability of older birds to successfully rear young (Lack 1966). The average clutch size of cranes is less than two and fledging success has been estimated to be as low as 50 percent (Miller et al. 1972). It is usually assumed that birds have a constant rate of annual mortality after they have reached breeding age (Lack 1966) and the mortality rate of adult cranes has been assumed to be from 12 to 15 percent (Miller et al. 1972). Crane numbers are presently

increasing in central Wisconsin as indicated by their slightly depressed clutch size and recent population estimates, but because of the factors mentioned, their increase will proceed at a slow rate.

Eggshell fragments were recovered from 34 nests during 1975. The thickness of these shells averaged 0.264 mm (s.d. = .042, range 0.20 to 0.36 mm) (Table 9). No data exists with which to compare the thickness of eggshells measured in this study, but I recommend that monitoring of eggshell thickness continue in Wisconsin. Walkinshaw (1965a) suggested the possibility of pesticide residues as a cause for reduced breeding success among a population of southern Michigan greater sandhill cranes from 1952 to 1958. No analyses were made of birds or eggs from that population. Miller et al. 1972 reported that sandhill cranes collected in Florida and Nebraska had relatively low amounts of pesticide residues in their tissues, but cranes collected in Oklahoma averaged 1.4 ppm DDT, 0.75 ppm DDE and 19.0 ppm heptachlor epoxide, while individual cranes from Oklahoma had residues as high as 7.8 ppm DDT and 35.3 ppm heptachlor epoxide. While there is presently no evidence of a general decline in breeding success or of eggshell thinning, it is a facet of crane breeding that should be carefully monitored.

Table 9. Thickness (mm) of eggshells recovered from central Wisconsin sandhill crane nests, 1974-75.

Nest	Eggshell thickness
1	0.36
2	0.26
3	0.28
4	0.23
5	0.21
6	0.29
7	0.30
8	0.22
9	0.27
10	0.31
12	0.22
13	0.28
14	0.24
15	0.23
16	0.22
17	0.32
18	0.33
19	0.32
20	0.25
21	0.26
22	0.24

Table 9. Continued.

Nest	Eggshell thickness
23	0.28
24	0.23
26	0.21
28	0.20
29	0.32
30	0.26
31	0.24
33	0.35
34	0.27
36	0.27
41	0.23
43	0.24
44	0.25

Behavior of Incubating Cranes

Incubating cranes usually flushed when an observer entered within the crane's view during inspection visits to nests early in the incubation period, but cranes would wait until an observer was within 10-20 m of the nest before flushing late in the incubation period. The incubating crane flattens its body upon the nest and lowers and extends its head until no part of the bird is more than several inches above the nest. The crane flushed from a nest during the latter stages of incubation would usually fly only a short distance away, watch the observer intently, and sometimes exhibit behavior apparently intended to draw the observer away from the nest site. Such behavior included walking in plain view of the observer, calling loudly, and often stretching out its wings as it slowly walked across the marsh within the observer's view. Both adults were close to the nest when an observer approached on several occasions. Their sex could be distinguished because of the tone of call given (Walkinshaw 1949). The male would walk in plain view of the observer while the female usually called less often and moved through the marsh vegetation in a crouched position, stopping often to screen herself from the observer behind vegetation.

Crane nests were usually occupied by an incubating adult when inspected for hatching activity. Walkinshaw (1965b) reported that the crane at the nest seldom leaves unless relieved by its mate. Incubating cranes left the nest during the day for short periods of a few minutes each, but a nest was rarely vacant for longer than 15 consecutive minutes.

An average of 131 minutes elapsed before the crane would return to the nest after the camera had been positioned. This disturbance apparently did not interfere with hatching success as all nests photographed were successful. Cranes were incubating or were within 1 m of the nest 83 percent of the time (9504 of 11,456 minutes). Incubation was interrupted by the adult to rearrange eggs, stand, or to leave the nest an average of once every 32 minutes. The nest was vacant 17 percent of the time (Table 10). The field of view of the camera was about 2 m in width at the nest site and an adult was within view 83 percent of that time. The adult was probably close to the nest site a greater percentage of the time, but was not within view of the camera. Walkinshaw (1965d) observed greater sandhill cranes at the Haehnle Sanctuary in Michigan incubate an average of 97.6 percent of the time. Cranes appeared to be more attentive late in the incubation period. Walkinshaw

Table 10. Nest behavior of incubating sandhill cranes in central Wisconsin, 1975[a].

Nest number	22	22	22	34	30	1	1
Filming dates	5/28 5/29 5/30	6/1 6/2	6/2 6/3	6/11 6/12 6/13	5/22 5/23 5/24	5/18 5/19 5/20	5/21 5/22
Total minutes filmed	2109	1361	1345	2227	2219	2102	1010
Minutes elapsed before crane returned to nest after camera was installed	222	177	109	313	10	28	58
Minutes incubating	1587	651	852	1167	947	1820	703
Number of times crane interrupted incubation to stand, rearrange eggs, or to leave	34	21	35	15	41	71	26
Minutes nest was vacant	327	428	220	651	870	163	160
Minutes crane spent at nest but not incubating	195	232	273	409	402	119	147

[a]Each vertical column of figures represents the results of a separate roll of film.

(1965d) observed that cranes would flush readily early during the incubation period but would not leave the nest as readily late in the period.

Capturing and Marking

Sixty-four cranes were captured during 1974 at Necedah National Wildlife Refuge and at Dike Seventeen Wildlife Area and 18 cranes were captured during 1975 at the Necedah National Wildlife Refuge (Table 11). Trap mortality included two cranes that suffered broken necks when the leading edge of the net struck them. Another crane suffered a distal wing fracture upon capture and was subsequently taken to the International Crane Foundation at Baraboo, Wisconsin. That crane has since recuperated and has been released. Two cranes were captured that had been marked with aluminum collars the previous year (Gluesing 1973). Two cranes were captured during 1975 that had been previously captured in 1974.

Initial banding and marking of sandhill cranes was done at the Dike Seventeen Wildlife Area in conjunction with a goose banding program being conducted by the Wisconsin Department of Natural Resources. Each attempt to net geese would result in from one to several cranes being captured as they fed on the bait with geese. Several cranes were captured in this manner, but cranes captured

Table 11. Sandhill cranes captured in central Wisconsin during 1974-75.

Date	Location	Band No.	Patagial tag number	Age
7/25/74	Wood Co.	599-23301	A-001	Juv
8/06/74	Jackson Co.	599-23302	A-002	A
8/06/74	Jackson Co.	599-23303	A-003	A
8/13/74	Jackson Co.	599-23304	A-004	A
8/13/74	Jackson Co.	599-23305	A-005	A
8/13/74	Jackson Co.	599-23306	A-006	A
8/19/74	Jackson Co.	599-23307	A-007	A
8/19/74	Jackson Co.	599-23308	A-008	A
8/19/74	Jackson Co.	599-23309(a)	A-009	A
8/19/74	Jackson Co.	599-23310	A-010	A
8/19/74	Jackson Co.	599-23311	A-011	A
8/19/74	Jackson Co.	599-23312	A-012	A
8/19/74	Jackson Co.	599-23313	A-013	A
8/21/74	Juneau Co.	599-23314	A-014	A
8/21/74	Juneau Co.	599-23315	A-015	A
8/21/74	Juneau Co.	599-23316	A-016	A
8/21/74	Juneau Co.	599-23317	A-017	A
8/21/74	Juneau Co.	599-23318	A-018	A
8/21/74	Juneau Co.	599-23319	A-019	A
8/21/74	Juneau Co.	599-23320	A-020	A

Table 11. Continued.

Date	Location	Band No.	Patagial tag number	Age
8/21/74	Juneau Co.	599-23321	A-021	A
8/21/74	Juneau Co.	599-23322	A-022	A
8/21/74	Juneau Co.	599-23323	A-023	A
8/21/74	Juneau Co.	599-23324	A-024	A
8/24/74	Juneau Co.	599-23325	A-025	A
8/24/74	Juneau Co.	599-23326	A-026	A
8/24/74	Juneau Co.	599-23327	A-027	A
8/24/74	Juneau Co.	599-23328	A-028	A
8/24/74	Juneau Co.	599-23329(b)	A-029	A
8/24/74	Juneau Co.	599-23330	A-030	A
8/27/74	Jackson Co.	519-99005(c)	-----	A
8/27/74	Jackson Co.	599-23331	A-031	A
8/27/74	Jackson Co.	599-23332	A-032	A
8/27/74	Jackson Co.	599-23333	A-033	A
8/27/74	Jackson Co.	599-23334	A-034	A
8/27/74	Jackson Co.	599-23335	A-035	A
8/27/74	Jackson Co.	599-23336	A-036	A
8/31/74	Juneau Co.	599-23337	A-037	A
9/04/74	Juneau Co.	599-23338	A-038	A
9/04/74	Juneau Co.	599-23339	A-039	A
9/04/74	Juneau Co.	599-23340	A-040	A

Table 11. Continued.

Date	Location	Band No.	Patagial tag number	Age
9/04/74	Juneau Co.	599-23341	A-041	A
9/04/74	Juneau Co.	599-23342	A-042	A
9/06/74	Juneau Co.	519-99008(d)	A-043	A
9/04/74	Juneau Co.	599-23343	A-044	A
9/04/74	Juneau Co.	599-23344	A-045	A
9/04/74	Juneau Co.	599-23345	A-046	A
9/06/74	Juneau Co.	599-23346	A-047	A
9/06/74	Juneau Co.	599-23347	A-048	A
9/06/74	Juneau Co.	599-23348	A-049	A
9/06/74	Juneau Co.	599-23349	A-050	Juv
9/06/74	Juneau Co.	599-23350	A-051	A
9/06/74	Juneau Co.	599-23351	A-052	A
9/06/74	Juneau Co.	599-23352	A-053	A
9/06/74	Juneau Co.	599-23353	A-054	Juv
9/11/74	Juneau Co.	599-23354	A-055	Juv
9/11/74	Juneau Co.	599-23355	A-056	A
9/11/74	Juneau Co.	599-23356	A-057	Juv
9/11/74	Juneau Co.	599-23357	A-058	A
9/15/74	Juneau Co.	599-23358	A-059	A
9/15/74	Juneau Co.	599-23359	A-060	A
9/04/75	Juneau Co.	599-23360	A-061(e)	A

Table 11. Continued.

Date	Location	Band No.	Patagial tag number	Age
9/04/75	Juneau Co.	599-23361	A-062	A
9/04/75	Juneau Co.	599-23362	A-063	Juv
9/04/75	Juneau Co.	599-23363	A-064	A
9/04/75	Juneau Co.	599-23364	A-065	A
9/13/75	Juneau Co.	599-23365	A-066	A
9/13/75	Juneau Co.	599-23366	A-067	A
9/13/75	Juneau Co.	599-23367	A-068	A
9/13/75	Juneau Co.	599-23368	A-069	A
9/13/75	Juneau Co.	599-23369	A-070	A
9/13/75	Juneau Co.	599-23370	A-071	A
9/13/75	Juneau Co.	599-23371	A-072	A
9/13/75	Juneau Co.	599-23372	A-073	A
9/13/75	Juneau Co.	599-23373	A-074	A
9/13/75	Juneau Co.	599-23374	A-075	A
10/04/75	Juneau Co.	599-23375	A-076	A
10/04/75	Juneau Co.	599-23376	A-077	A
10/04/75	Juneau Co.	599-23355	A-056(f)	A

(a) Crane suffered distal wing fracture upon capture, was treated at International Crane Foundation, Baraboo, Wis., and released to wild one year after capture.

(b) Crane was killed during recapture on 9/06/74.

(c) Previously banded 9/21/73 (Gluesing 1973).

Table 11. Continued.

(d) Previously banded 9/21/73 (Gluesing 1973). Collar A-008 was removed and patagial tag A-043 was placed on this crane.

(e) Patagial tags were lime green with white letters in 1974 and lime green with black letters in 1975.

(f) Crane recaptured one year after initial banding and tagging.

with nets projected from ground level (as in the case of the goose capture program) frequently resulted in injury to cranes. The low trajectory of the nets was sufficient to capture geese, but cranes were tumbled along the ground in the net's path. One crane was killed, one suffered a broken wing, and several had abrasions or suffered loss of feathers during these capture attempts. Elevating the rockets to about 1.5 m above the ground alleviated this problem by altering the trajectory of the nets to clear the cranes' heads and necks.

Only six young of the year cranes were captured. Cranes accompanied by chicks are reluctant to mingle with other cranes. Chicks were captured by attempts to capture family groups. Family groups would feed at bait sites, but would leave when small flocks of adult cranes arrived.

Marking did not appear to affect sandhill crane behavior or reproduction. Marked cranes returned to feed at bait sites the day after their capture. They were often seen feeding, flying, or roosting in the company of unmarked cranes. One crane from nest 30 was marked with patagial tags during 1974. Although this nest was included in the time-lapse photography observations, the marked adult was never photographed on the nest. However, I saw it on three occasions within the nesting territory and it was flushed from the nest on one occasion.

Several cranes that had been marked during 1974 returned to their capture sites in 1975. Three marked adults had juvenile cranes with them, indicating that the marking program did not interfere with normal reproduction.

Marked cranes were seen at Mead Wildlife Area and Sandhill Demonstration Area in central Wisconsin the year after their capture (Table 12). These cranes were marked in Necedah Refuge or Dike Seventeen Wildlife Area, which indicates that these staging areas draw cranes from within at least a 120 km radius. Color-marked cranes were seen throughout the fall of both years in the same vicinity of their capture and in counties adjoining those in which capture sites were located, indicating a wide feeding range during the staging period.

Color-marked cranes were sighted at the Jasper-Pulaski Wildlife Refuge in northwestern Indiana in the falls of 1974, 1975, and 1976, and in Georgia and Florida during the winters following their marking (Figure 3). The Jasper-Pulaski Refuge has long been recognized as the major staging area for migrating cranes east of the Mississippi River (Walkinshaw 1973a). The marsh and prairie areas of southern Georgia south to east-central Florida are the major wintering areas for the eastern population of greater sandhill cranes (Walkinshaw 1960).

Table 12. Observations of sandhill cranes color-marked with green patagial tags in central Wisconsin, 1974-75.

Number observed	Date observed	Year marked	Where observed
1 (unk)	9/30/74	1974	Jasper-Pulaski, Ind.
1 (unk)	10/07/74	1974	Jasper-Pulaski, Ind.
1 (A023)	10/10/74 (shot)	1974	Necedah NWR, Wis.
2 (unk)	10/25/74	1974	Jasper-Pulaski, Ind.
1 (unk)	11/27/74	1974	Payne's Prairie, Fla.
1 (unk)	12/14/74	1974	Wabeso, Fla.
1 (unk)	12/15/74	1974	Varo Beach, Fla.
1 (unk)	1/23/75	1974	Gainesville, Fla.
1 (unk)	1/28/75	1974	Gainesville, Fla.
1 (unk)	2/03/75	1974	Payne's Prairie, Fla.
1 (unk)	2/??/75	1974	Fellsman, Fla.
1 (unk)	3/03/75	1974	Lake Kissimee, Fla.
1 (unk)	6/12/75	1974	Adams Co., Wis.
1 (unk)	6/15/75	1974	Grantsburg, Wis.
1 (unk)	6/18/75	1974	Columbia Co., Wis.
1 (A072)	11/09/75	1975	Necedah NWR, Wis.
5 (unk)	11/09/75	----	Necedah NWR, Wis.
5 (unk)	11/19/75	----	Jasper-Pulaski, Ind.
1 (unk)	2/11/76	----	Leesburg, Fla.
2 (unk)	3/18/76	----	Jasper-Pulaski, Ind.

Table 12. Continued.

Number observed	Date observed	Year marked	Where observed
1 (A008)	3/18/76 (dead)	1974	Jasper-Pulaski, Ind.
3 (unk)	3/18/76	----	Buchanan, Ga.
1 (A016)	3/18/76	1974	Buchanan, Ga.
1 (unk)	4/14/76	----	Necedah NWR, Wis.
1 (unk)	4/21/76	----	Necedah NWR, Wis.
2 (unk)	4/22/76	----	Necedah NWR, Wis.
1 (unk)	5/14/76	----	Necedah NWR, Wis.
1 (A066)	6/02/76	1975	Mead WLA, Wis.
1 (unk)	6/16/76	----	Necedah NWR, Wis.
1 (A065)	9/01/76	1975	Mead WLA, Wis.
4 (unk)	10/20/76	----	Necedah NWR, Wis.
1 (A046)	10/07/76	1974	Necedah NWR, Wis.
1 (A064)	10/18/76	1975	Sandhill WLA, Wis.
1 (unk)	10/29/76	----	Jasper-Pulaski, Ind.
1 (A003)	10/29/76	1974	Jasper-Pulaski, Ind.
1 (A007)	11/10/76	1974	Jasper-Pulaski, Ind.
1 (A059)	11/10/76	1974	Jasper-Pulaski, Ind.
1 (A003)	9/24/76	1974	Necedah NWR, Wis.
1 (A066)	9/24/76	1975	Necedah NWR, Wis.
1 (A069)	9/24/76	1975	Necedah NWR, Wis.
1 (A075)	9/24/76	1975	Necedah NWR, Wis.

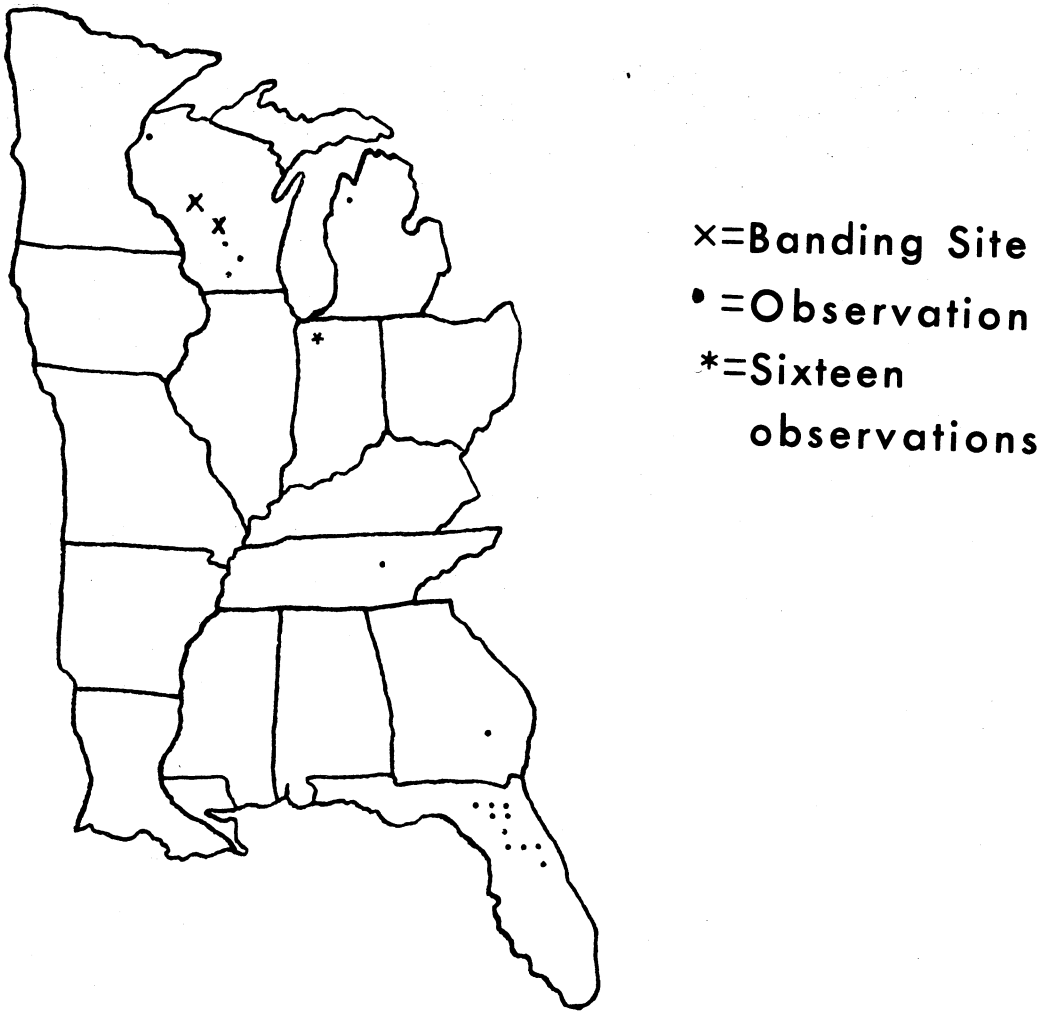


Fig. 3. Observations of Wisconsin color marked sandhill cranes, 1 Sept.1974—14 Dec.1976.

Measurements of the culmen, bill, midtoe, and tarsus of captured cranes are presented in Table 13. The mean culmen length was 101.5 mm (s.d. = 6.5; range 82 - 112 mm) for adult birds. The mean midtoe length was 88 mm (s.d. = 4.3; range 80 - 97) for adults. The mean tarsus length was 248.5 mm (s.d. = 17.9; range 201 - 285 mm) for adults. The mean bill length was 135.7 mm (s.d. = 6.9; range 121 - 151 mm) for adults. Stephen et al. (1966) considered the measurement of bill length to be the most reliable indicator of taxonomic subspecificity. The bill length of the greater sandhill crane is longer than 120 mm, but the bill length of the Canadian sandhill crane (Grus canadensis rowani) is less than 125 mm (Stephen et al. 1966). The bill lengths of 72 adult cranes measured in Wisconsin during 1974-75 were more than 125 mm, whereas four were between 120 and 125 mm. These bill measurements indicate that, although several cranes fell within the range of measurements of the Canadian sandhill crane, none could be definitely classified as that subspecies (Figure 4).

Wisconsin Sandhill Crane Survey

Over 70 percent of the sandhill crane survey questionnaires mailed in 1975 (Appendices A, B, and C) were returned. A total of 780 adults (Figure 5), including an estimated 223 pairs and 118 young of the

Table 13. Measurements (mm) of sandhill cranes captured in central Wisconsin during 1974-75.

Culmen	Bill	Midtoe	Tarsus
100	136	94	260
101	131	87	241
97	127	86	246
102	131	82	256
104	140	89	276
102	127	91	268
97	132	91	263
111	144	95	283
104	130	81	238
100	124	85	252
104	135	91	264
101	126	88	255
111	139	91	274
110	146	90	276
104	133	90	285
82	134	94	280
95	129	87	231
100	128	92	262
105	139	94	272
97	133	84	239
101	130	83	231

Table 13. Continued.

Culmen	Bill	Midtoe	Tarsus
103	132	87	250
95	132	90	276
104	133	93	273
105	133	88	278
84	130	83	253
110	143	84	248
80	105	80	250(a)
85	111	80	232(a)
103	145	85	261
101	133	89	225
102	137	90	246
98	131	91	252
110	140	92	258
102	136	96	255
110	144	92	238
100	130	80	249
101	131	83	242
106	132	88	226
93	126	90	235
103	140	97	256
102	140	89	242
110	141	90	232

Table 13. Continued.

Culmen	Bill	Midtoe	Tarsus
96	130	83	207
107	146	90	242
100	126	81	230
92	132	91	256
108	143	84	242
102	139	90	230
87	121	82	252(a)
105	145	82	249
101	133	89	201
116	151	86	240
112	143	91	245
91	115	89	251(a)
93	123	92	228(a)
95	132	83	216
82	110	85	233(a)
86	121	82	229
105	141	97	235
101	148	88	256
	1975		
105	143	90	265
102	137	84	260
77	105	83	251(a)

Table 13. Continued.

Culmen	Bill	Midtoe	Tarsus
97	130	80	233
101	131	79	233
91	131	92	220
97	132	92	231
112	151	86	248
105	149	89	261
112	142	89	261
92	132	92	254
98	141	89	256
98	140	86	250
92	124	83	250
105	141	86	254
102	141	87	226
96	136	88	229
106	135	86	237

(a) juvenile

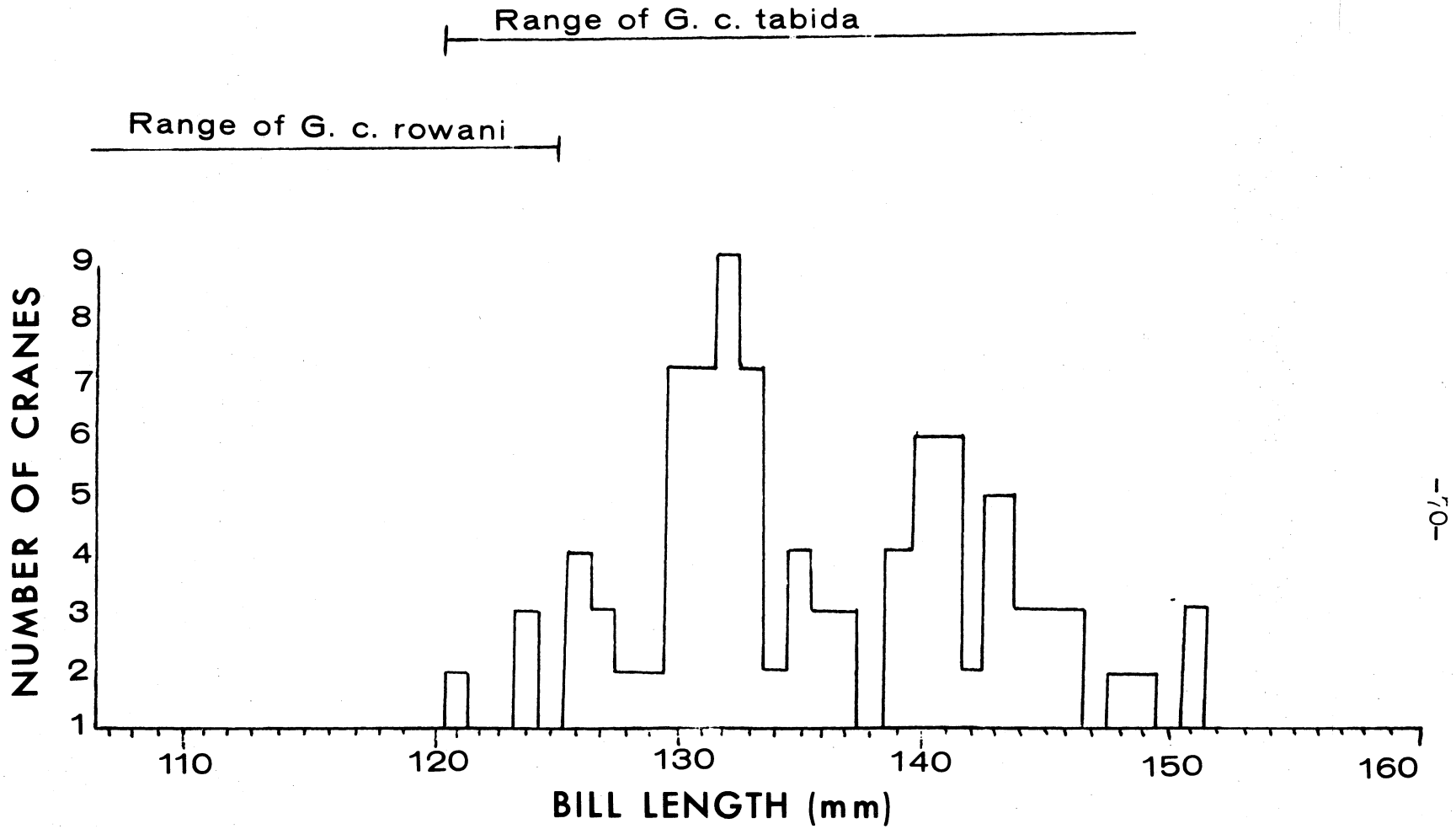


Fig. 4. Bill measurements of adult sandhill cranes captured in central Wisconsin,1974—75.

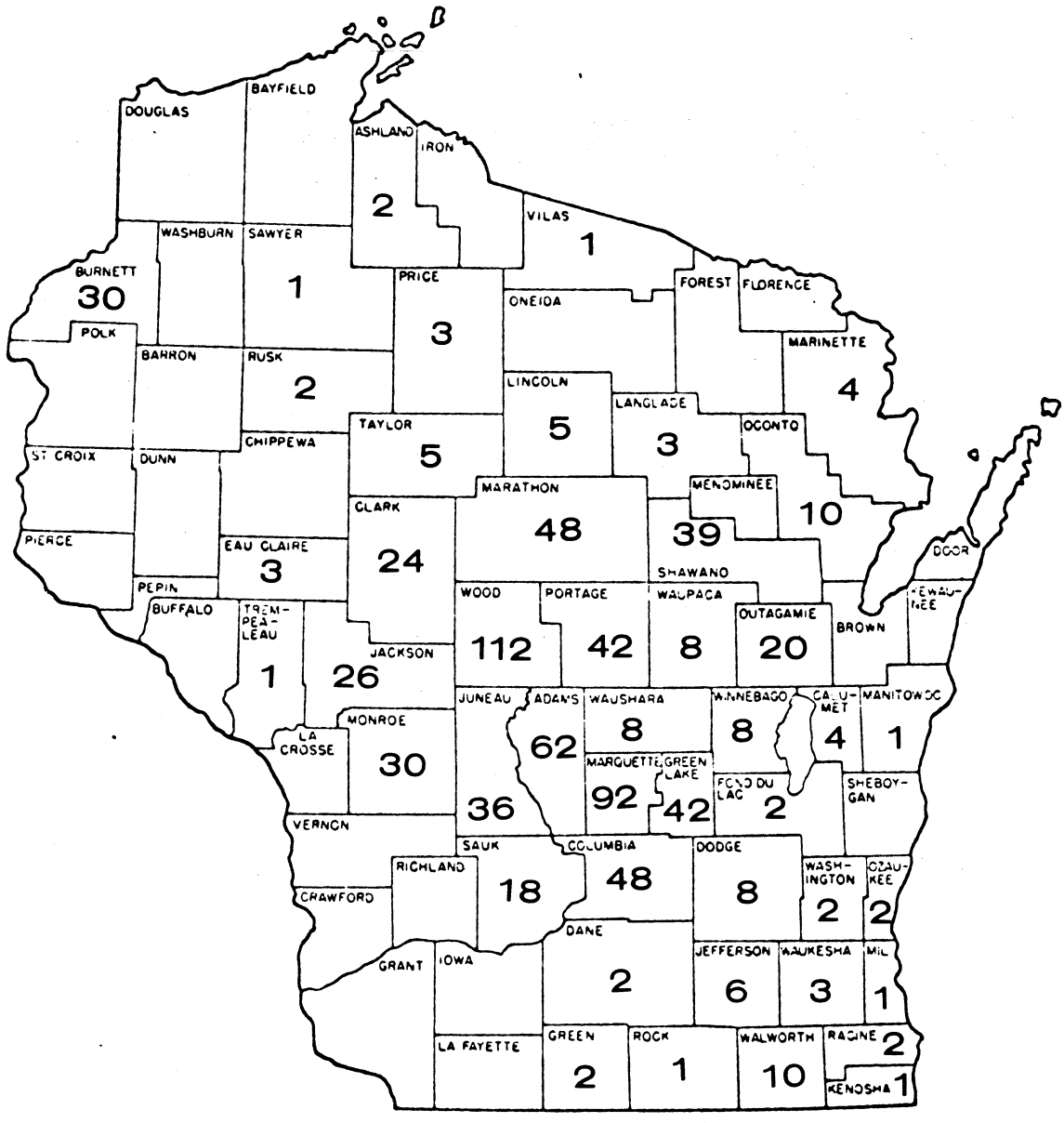


Fig. 5. Numbers of adult sandhill cranes sighted in Wisconsin during the 1975 breeding season as reported from mail questionnaires.

year were reported. Included in these totals are some sightings reported by individuals who learned of the survey through press coverage and reported their sightings of sandhill cranes by mail.

Gluesing (1973) estimated that about 850 sandhill cranes were present in Wisconsin during the summer of 1973, including 250 known pairs. Survey results from 1975 did not differ substantially from these figures.

Since this survey was conducted, I have observed large numbers of cranes in Green Lake, Marquette, and Waushara counties (southeast of the study area) that were not included in the survey results. Less than 50 percent of the sandhill cranes nesting within the study area were reported by survey respondents.

The survey technique used may be reliable in reporting distribution of cranes in Wisconsin, but because of the secretive nature of sandhill cranes during the breeding season, reliable estimates of their abundance cannot be made with the mail questionnaire technique.

The most efficient and reliable census technique is that of counting nests by helicopter. An index to fluctuations in crane numbers should be made on representative nesting areas on a periodic basis utilizing this technique.

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APPENDICES

APPENDIX A. Cover letter used in Wisconsin sandhill crane survey, 1975.

university of wisconsin / stevens point • stevens point, wisconsin 54481

College of Natural Resources

July 1, 1975

To All Crane Survey Participants:

With the aid of the Department of Natural Resources game managers and field personnel, Ernest Gluesing conducted a survey of sandhill cranes in Wisconsin during 1973. The enclosed map is part of the results of that survey. Approximately 850 sandhill cranes, including 250 known pairs, were estimated to be present in Wisconsin during the summer of 1973.

As a follow-up to the survey of 1973, a mail questionnaire is again being conducted this summer. Trends in Wisconsin's sandhill crane population can be monitored in this manner. We again ask your cooperation with this survey and request that you return the enclosed postcard by July 31, 1975.

To DNR Personnel: This survey is being sent to Game Managers, District Directors, and Law Enforcement wardens--Please inquire among your field personnel concerning summer crane sightings during 1975 so that this survey may be as inclusive as possible.

Thank you very much for your cooperation.

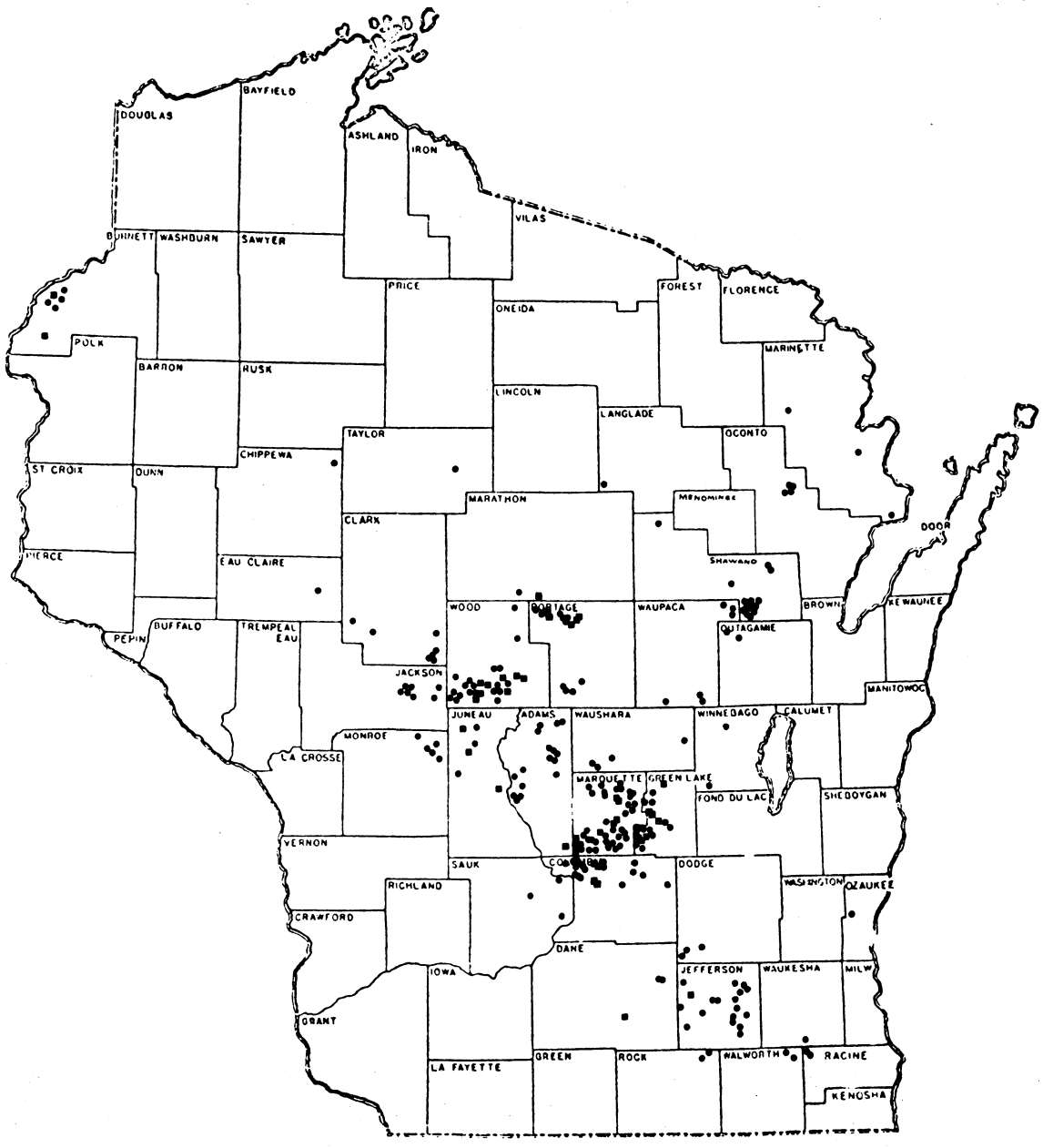
Sincerely,

Thomas J. Howard
Graduate Assistant Office
College of Natural Resources--UW-SP

TH:gg

Enc.

Appendix B. 1973 Sandhill crane distribution map included with 1975 sandhill crane survey.



APPENDIX C. Self-addressed, stamped postcard used in 1975 survey of Wisconsin sandhill cranes.

Were there any summer resident cranes in your area after May 15, 1975?

YES_____NO_____NUMBER_____

Do you suspect or know of any nesting pairs during this period?

YES_____NO_____NUMBER_____

Did you see any pairs with young last year?

YES_____NO_____NUMBER_____

Have you sighted any cranes this summer with lime green tags (2" wide by 9" long) attached to their wings?

YES_____NO_____NUMBER_____

AREA REPORTING FROM: COUNTY_____TOWNSHIP_____

COMMENTS:_____