MIGRATION OF SANDHILL CRANES FROM THE NORTH SHORE OF THE NORTH CHANNEL OF LAKE HURON, ONTARIO

by

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Abstract: The sandhill cranes along the North Channel of Lake Huron belong to the subspecies Grus canadensis tabida. The autumn population in the area from Thessalon to Massey was minimally 285 individuals in 1987. Autumn recruitment was 15.4 to 17.7 juveniles per 100 adults during 1987, indicative of a growing population. Cranes from this area used migration routes through both Wisconsin and the Lower Peninsula of Michigan en route between Ontario and Jasper-Pulaski State Fish and Wildlife Area, Indiana (J-P). The route taken appeared to be characteristic of the individual. During autumn migration, cranes from the north shore of the North Channel used the Rudyard-Pickford staging area in the eastern Upper Peninsula of Michigan. Two radiotagged cranes, one from Iron Bridge and one from Massey, migrated directly from Pickford through the Lower Peninsula of Michigan to J-P without stopping at known Lower Peninsula staging areas. J-P is the major autumn stopover area for this Ontario population. Its winter distribution in Florida is similar to the widespread but clumped distribution exhibited by other Great Lakes cranes. Three radiotagged cranes, one from as far east as Massey, and family members were located in central Wisconsin during spring migration. Major spring stopover areas consisted of J-P and these traditional areas in Wisconsin. Although some Ontario cranes migrated through the Lower Peninsula of Michigan, the migration routes of Upper Michigan and Ontario cranes were otherwise similar. The same staging, stopover, and wintering areas were used. These similarities indicate that eventual reestablishment of whooping cranes in the Upper

Michigan/Ontario region could be accomplished through introduction at one primary site. The most suitable site in the region for the initial introduction is Seney National Wildlife Refuge. Cranes have received little attention in Ontario; additional work should include study of the sandhill cranes along eastern Lake Superior and northward to the Lowlands south of James Bay.

INTRODUCTION

The Ohio Cooperative Fish and Wildlife Research Unit has been studying the biology of greater sandhill cranes (Grus canadensis tabida) on Seney National Wildlife Refuge in the Upper Peninsula of Michigan since 1984. Seney NWR is under consideration by the U. S. Fish and Wildlife Service as a possible core site for reestablishment of a breeding population of the endangered whooping crane (G. americanus) in the Upper Michigan/Ontario area. The Great Lakes population of sandhill cranes was severely decimated during human settlement of the Midwest/Great Lakes region. However, the remoteness, extensive wetlands, and harsh winters of the Upper Peninsula of Michigan hindered development, and this isolated area has been a relative stronghold for the sandhill crane in recent times. In the mid-1940's about 60% of the breeding pairs in a total Great Lakes population of little more than 500 individuals probably nested there (Walkinshaw 1949:134). The sandhill crane is now a common

breeding species across the eastern Upper Peninsula of Michigan, where the population has been increasing and expanding since the 1930's. The Great Lakes population has made a dramatic recovery, increasing to more than 22,000 individuals by 1987 (Schumann 1988). Over the past two decades, numbers of sandhill cranes have increased substantially in the Algoma District of Ontario, immediately east of the Upper Peninsula, where, in this century, cranes were little known prior to 1960. Early reports of summering birds near Searchmont-Wabos, Lake Superior Provincial Park, and St. Joseph Island were made by Goodwin (1975). Breeding was first verified for this region of Ontario with the sighting of two chicks near Massey in 1977 (Goodwin 1977). Tebbel (1981) conducted the only extensive study of cranes in the area and estimated a minimum population of 225 individuals, mostly in the southern part of the district, in 1978-79.

Taylor (1976) believed that cranes staging near Rudyard in the extreme eastern Upper Peninsula during autumn included birds from Canada. The proximity of the Algoma District to the Upper Peninsula suggests that the cranes in Algoma are an eastward extension of the Upper Michigan population. The objective of this study was to determine the migration route of sandhill cranes from the Algoma District of Ontario. Use of traditional migration routes followed by Upper Peninsula birds would confirm the relationship of these segments of the population and have implications for future reestablishment of whooping cranes.

I am especially grateful to Steve Elliott, Blind River District, Ontario Ministry of Natural Resources (OMNR), for providing me with initial information on crane concentrations in the primary study area and for arranging a location from which to conduct this research. I wish to thank Bill Lanin, District Manager, Blind River District, for allowing me to establish a base of operations at the Kirkwood facility. The hospitality and information provided by the Kirkwood staff, particularly B. Eagleson and K. Hoback, are much appreciated. In the Massey area I thank Diane Corbett (Espanola District, OMNR) for initial information, and I especially thank Dan Smith (OMNR) for locating birds staging in that area. I am grateful to M. Charette for allowing my stay at Chutes Provincial Park while working near Massey. I am most appreciative to Scott Jones and Sam Rosa, Sault Ste. Marie District (OMNR), for providing my initial introduction to possible study sites in Ontario and supplying information on crane sightings in their district. I wish to express my thanks to Steve Curtis, Canadian Wildlife Service (CWS), for his support and cooperation, and to Don Fillman (CWS) for his initial field assistance and for compiling the recent records of Ontario sandhill crane nests cited in this report.

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STUDY AREAS

Field work was limited to those areas in which Tebbel (1981) documented sightings of family units. These areas were located

in the southern Algoma District and the extreme southwestern portion of the southern Sudbury District. The western portion of the study area included St. Joseph Island and the Goulais River valley north to Wabos. The primary study area extended from Thessalon to Iron Bridge. An eastern site near Massey was also examined (Fig. 1). These areas are in the Penokean Hills region on the southern edge of the Canadian shield. Deposition of clay after periods of inundation by post-glacial Lake Huron has resulted in extensive flatlands between the shield and the North Channel. These areas are primarily agricultural. Barley, oats, and hay are principal crops; cattle production and dairy farming are common. The southern portion of the primary study area consists of the Dayton-Eley Swamp, extending 20 km from the Thessalon Indian Reservation eastward to Dean Lake. In addition to these marshes along the North Channel, the area contains many small lakes with marshy or boggy edges. Irregular rocky topography and extensive beaver (Castor canadensis) activity have created substantial suitable nesting and roosting habitat. Tebbel (1981) found that cranes in Algoma nested about equally in bogs and fens. Wetland vegetation was similar to that in the Upper Peninsula of Michigan. Leatherleaf (Chamaedaphne calyculata), sphagnum mosses (Sphagnum spp.), sedges (Carex spp.), and cattail (Typha latifolia) were common species.

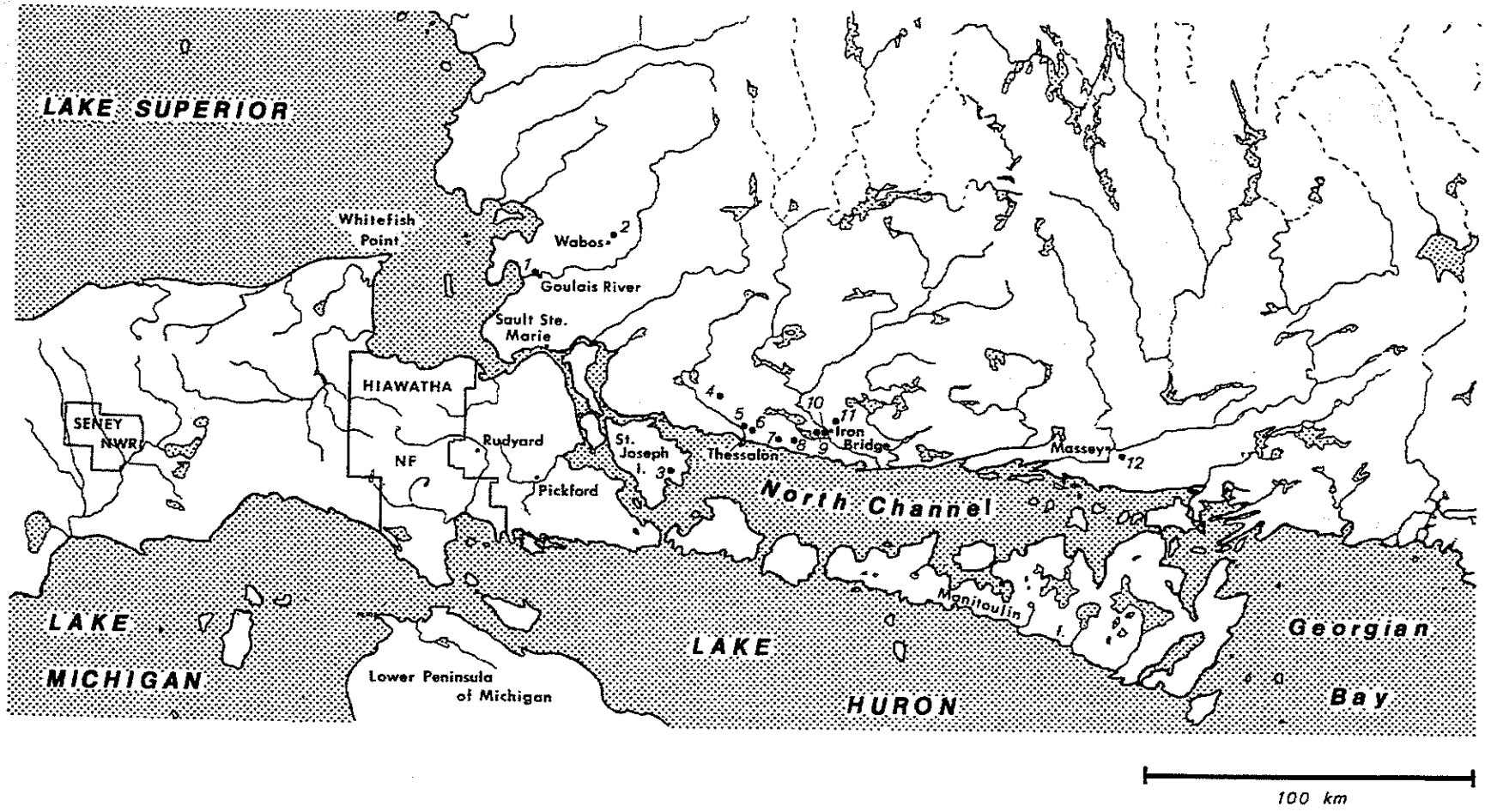

Fig. 1. Location of the Ontario study area and adjacent Upper Peninsula of Michigan. Sites 1 - 12 refer to areas containing baited fields. 1 = Goulais River, 2 = Wabos, 3 = St. Joseph Island, 4 = Rose Lake, 5 - 6 = Little Rapids, 7 - 8 = Dayton, 9 - 11 = Iron Bridge, 12 = Massey.

METHODS AND MATERIALS

Potential sites for crane capture were selected based on information supplied by District offices of the Ontario Ministry of Natural Resources, local residents, and direct observation. Sites consistently used by cranes, especially by adult pairs with fledged young, were each baited with a mixture of ear and shelled corn (Fig. 1, Sites 1 - 12). Except for two old fields near Wabos, local agricultural practices permitted use only of harvested hay or oats fields as bait sites. Monitoring of bait sites for use by cranes was accomplished by driving by baited fields and observing bird feeding activity. Sites without cranes were closely inspected for signs of use, particularly the distinctive white crane down, which typically remains behind at feeding sites. During monitoring from a vehicle, counts of cranes in juvenal and adult plumage were also made. After cranes were accustomed to feeding on the bait, a rocket net was set up and operated to fire in a triangle configuration according to procedures previously used on Seney NWR (Urbanek et al., in press).

Lengths of left tarsus, left middle toe, dorsal surface of exposed culmen, and tip of culmen from distal point to posterior of left nostril were measured for each bird (Stephen et al. 1966). Weight was taken with a spring scale. The anterior width of the ankle (tibio-tarsal joint) and width of the head directly behind the eyes were measured with calipers for each bird. Wing chord was measured for all birds captured during

September. Cranes were aged by feather examination (Nesbitt 1987), and sex of paired birds was estimated by noting relative size (R. P. Urbanek, unpublished data, Seney NWR). Birds of questionable sex were later radiotracked, and their unison call, either unsolicited or in response to a tape recorded unison call, was used to verify sex (Walkinshaw 1949). Birds were banded with No. 8 lock-on Fish and Wildlife Service bands below the right tibio-tarsal joint and with red, green, and white colored bands above both tibio-tarsal joints. Color bands were sealed with PVC pipe cement after placement on each bird. To ensure that cranes captured in Ontario would be readily distinguishable from cranes captured on Seney NWR (where red, green, and white are also the designated colors), I marked all Canada birds without radiotransmitters with 4 bands in the sequence R/W/R/W on one leg and from 1 to 3 colored bands on the other (no more than three color bands per leg have been placed on birds banded on Seney NWR). On legs with four bands, the upper two bands were glued together and the lower two bands were glued together to prevent excessive rattling after release of the bird. Height of these bands was reduced from 19 to 16 mm after the first two net firings (explained in Results). Each captured adult male was equipped with a 3-volt radiotransmitter (164-166 MHz) on the left leg until the supply of transmitters was exhausted. Two transmitters were powered by lithium batteries and had a life expectancy of 6 months. Six were powered by 10 solar and 2 Ni-Cad cells and have an indefinite life expectancy. Each

transmitter-equipped bird was also individually color marked. Transmitters were bicolored (R/W) and were mounted on two 38-mm-tall bands (R/W). Total weight of the transmitter/band package was 57-63 g. One to three 19-mm-tall bands were placed on the right leg.

Birds were radiotracked from roads with a truck-mounted 7-element Yagi antenna and Model TS-1/TR-2 scanner or on foot with a TR-2 receiver and directional H-antenna. Aerial searches for migrating birds were made with the scanner in a Cessna-152 or 172; an H-antenna was mounted on each wing strut. Migrating birds were tracked from the truck by first determining their approximate flight bearing, overtaking the birds, and then repeatedly proceeding ahead along the projected flight path about 16-20 km to stop and wait until the birds had passed overhead. Bearings on the flying birds were taken at each stop. A road route that alternately crossed to either side of the flight path was selected to confine and thus accurately determine the flight path from the ground.

RESULTS

A summary of captures appears in Table 1. Color band combinations used appear in Appendix A. In seven net firings in the Thessalon-Iron Bridge area, 20 individuals were captured. Five families, each consisting of an adult male and female and a juvenile, two pairs without chicks, and one unpaired subadult were captured. All were probably local birds; four of the families had been under observation since mid-August in isolated

Table 1. Summary of sandhill crane captures in Ontario, August-September 1987.

Firing No.	Date	Field No.[a]	Band No.[b]	Frequency (MHz)[c]	Age/Sex	Family Members[b]
1	18 Aug	11	262	164.633	Adult M	347
			347		Subadult F	262
			348		Subadult	
2	19 Aug	10	263	165.020	Adult M	349,350
			349		Juvenile	263,350
			350		Adult F	263,349
3	26 Aug	4	264	165.059	Adult M	351,352
			351		Adult F	264,352
			352		Juvenile	264,351
4	27 Aug	8	265	164.611	Adult M	353,354
			353		Adult F	265,354
			354		Juvenile	265,353
5	16 Sept	12	266	164.285	Adult M	355,356,357
			355		Juvenile	266,356,357
			356		Juvenile	266,355,357
			357		Adult F	266,355,356
			268	164.481	Adult M	
6	22 Sept	11	267	165.041	Adult M	358
			358		Adult F	267
7	26 Sept	7	269	164.257	Adult M	359,360
			359		Adult F	269,360
			360		Juvenile	269,359
8	27 Sept	11	361		Adult M	362,363
			362		Adult F	361,363
			363		Juvenile	361,362

[a]Refer to Fig. 1.

[b]Band No. refers to the final three digits in the eight digit U.S. Fish and Wildlife Service band number. The first five digits are 608-70 for all cranes banded in the Ontario study area during 1987.

[c]Transmitters on frequencies 164.611 and 164.633 MHz are lithium battery powered (Telonics, Inc., Mesa, AZ); all others are solar/Ni-Cad units (Telemetry Systems, Inc., Mequon, WI).

fields thought to be near their respective breeding territories. In the only net firing in the Massey area, five birds were captured, including one family (an adult pair with two chicks) and one unpaired adult male. These birds were part of a staging flock of 120-140 individuals; their exact origin is therefore unknown. An individually color marked crane tagged in Florida by S. Nesbitt (Florida Game and Fresh Water Fish Commission) was also discovered in the Massey flock.

Efforts to capture birds nearer Sault Ste. Marie (Sites 1 - 3, Fig. 1) were abandoned during the first week of September because the travel necessary to adequately work these areas was impractical. Attempts to capture staging birds at Massey from 7 to 21 September precluded attempts to capture birds at Little Rapids (Sites 5 - 6, Fig. 1), the major staging area in the primary study area.

Behavior of Birds and the Capture Technique

The netting and banding procedures used worked well under the conditions encountered. All 25 birds at which firings were directed were captured. One bird (Band No. 267) sustained bleeding in the rear of the oral cavity at capture, but this injury proved to be minor. Two females of breeding pairs were reluctant to fly after banding. Their mates and chicks were seen without them in normal feeding fields shortly after capture, but both females rejoined their families later. The only potentially serious incident resulting from capture occurred on August 18 in a harvested oat field near Iron Bridge. The family was caught

just before dark in standing oat stubble. The male sustained some superficial cuts, but the female developed impeded respiration. Upon release the male flew away normally, but the female flew only to an adjacent field and then landed. The chick, though uninjured, did not fly but ran into some nearby weeds after losing sight of the adults. This adult female and chick were the only individuals of 25 captured birds that have not been subsequently seen (as of 19 February 1988). The adult male was consistently seen associating with two non-banded birds since shortly after capture. After this capture-related family break-up, two modifications in technique were made: first, the size of the bands on the legs containing 4 bands was reduced from 19 to 16 mm, as the former appeared to result in reluctance of the birds to fly, and, second, in an effort to reduce chance of injury caused by the birds thrashing in stubble, standing oat stubble was knocked down by dragging such sites with a section of chain link fence prior to net set-up.

At sites established on summer territories on the primary study area, cranes began feeding on the corn within a few to 12 days after baiting, even though abundant other grain was available in the immediate vicinity. At monitored sites cranes returned to feeding fields 2 - 7 days after capture. On one occasion the adult male and juvenile were observed feeding on the remains of the bait pile on which they were captured just 6 days earlier. The cranes on the Massey staging area were much more difficult to capture than those on summer territory. They did

not feed on most of the bait piles established. Unlike solitary families, their feeding patterns were unpredictable. On one occasion the entire flock, then consisting of 138 birds, appeared at and devoured a bait pile in which they had shown little or no interest during the previous 3 weeks. After a previously removed net was reset at this site, the cranes did not return. During 2 weeks of intensive work, only one shot was made at the Massey area.

Roost Sites and Possible Nesting Areas

Roost sites of local families were 1 - 6 km from feeding locations. Cranes 164.257 and 164.611 roosted in the Dayton Swamp. Crane 165.020 roosted in the wetlands on the northwestern edge of Dean Lake near the eastern portion of the Eley Swamp. These wetlands are both along the North Channel. Crane 165.059 roosted in the bog northwest of Rose Lake. All of these adult males produced young in 1987, and these roosting areas probably were also their nesting territories. Cranes 164.633 and 165.041 roosted in marshes and shallow water in an elongate drainage, extensively affected by beaver, between rocky cliffs 2 km southeast of the capture site. The birds staging at Little Rapids roosted in a bog containing an abandoned pasture flooded by beaver activity, 2 - 5 km east of their feeding areas; the birds at Massey roosted in a boggy lake 2.5 - 5 km east of their feeding areas.

Subadult Flocks and Crop Depredation

Two areas of principal use by subadult flocks during the summer were located near Iron Bridge (Sites 9 and 11, Fig. 1). About 9 and 12 birds, respectively, in adult plumage but without chicks were consistently found at these sites during August. Up to 26 birds per site were found as the onset of migration brought more birds into these areas in September. Of 21 landowners or leasers contacted, 4 (19%) reported crop damage by cranes. All of the complaints were near Iron Bridge and were associated with areas used by subadult flocks. Minor autumn damage associated with trampling apparently occurs in oats and barley fields. Local farmers indicated that most damage occurred in spring when cranes destroyed newly planted grain. In other areas, containing breeding adults dispersed on territory or large numbers of staging birds in harvested fields, the response of the local populace was quite favorable. Most of these people were quite interested in and several were very protective of the cranes on their property.

Subspecific Status

The cranes breeding in the Upper Peninsula of Michigan belong to the greater subspecies (G. c. tabida), which is the subspecies of sandhill crane that attains largest size. The smaller Canadian subspecies (G. c. rowani) occurs in northern Ontario (Lumsden 1971). The following mean values (mm) were reported by Aldrich (1979).

Greater subspecies: tarsus = 243 (males), 227 (females); wing chord = 547 (males), 523 (females).
Canadian subspecies: tarsus = 227 (males), 212 (females); wing chord = 497 (males), 474 (females).
Measurements of birds captured along the North Channel (Table 2) clearly indicate that the cranes of this region of Ontario are the greater subspecies. Some measurements were unusual. One confirmed and another suspected female (paired with an even larger male) had tarsal lengths of 270 and 278 mm, respectively (Appendix B). These values are large, both in comparison to the literature and to data collected on Seney NWR (R. P. Urbanek, unpublished data). Other females were, however, of expected size.

Population Estimation

I observed at least 149 different individuals in the flock staging near Massey. While I was at Massey, the flock on the Little Rapids staging area peaked. Two local residents who lived between the feeding fields and roost counted 125 cranes flying to roost. I sighted 11 more non-staging cranes upon my return; thus a minimum estimate for the Thessalon-Iron Bridge area is 136 birds. I could account for at least 125 different birds even without the roost count. In addition, none of the four birds radiotagged during August was in the Little Rapids flock at peak count, an indication that many local birds probably do not stage there. The segment of the autumn population in the Thessalon-Iron Bridge area was thus underestimated, probably moreso than

Table 2. Morphometry of age/sex classes of sandhill cranes captured in Ontario, August-September 1987.

Measurement	Adult males	Adult females	Juveniles
	(N = 9)	(N = 8)	(N = 7)
Weight (kg)	5.2 ± 0.12	4.5 ± 0.13	4.1 ± 0.19
Tarsus (mm)	267 ± 3.6	257 ± 3.9	262 ± 3.9
Middle Toe (mm)	88 ± 1.1	84 ± 1.7	86 ± 1.9
Culmen (mm)	134 ± 0.74	129 ± 1.9	120 ± 4.4
Culmen Tip (mm)	107 ± 2.2	97 ± 1.2	90 ± 3.2
Ankle Width (mm)	25.4 ± 0.21	23.9 ± 0.26	24.4 ± 0.42
Head Width (mm)	42.6 ± 0.25	41.8 ± 0.23	40.1 ± 0.37
	(N = 5)	(N = 4)	(N = 4)
Wing Chord (mm)	544 ± 2.8	531 ± 10.9	521 ± 11.0

that in the Massey area. I have no estimates for the Goulais River, Sault Ste. Marie, Sylvan Valley, St. Joseph Island, and Desbarats areas west of the primary study area.

Recruitment

Based on counts taken on 7 days when more than 35 cranes were sighted per day (N = 389 observations of individuals), fledged young-of-the-year comprised 13.4% of the fall population or 15.4 juveniles per 100 birds in adult plumage in the Thessalon-Iron Bridge area. At Massey, four surveys (N = 453 observations) revealed that fledged young accounted for 15.0% of all birds or 17.7 juveniles per 100 adults.

Autumn Migration

Staging was underway by mid-August; on 19 August 37 birds were observed in the flock at Little Rapids. The birds at Massey were checked for the first time on 27 August, at which time 123 individuals were observed. Significant movements by some marked birds had been made by the first week of September. On 6 September, Crane No. 348, originally captured at Site 11, Iron Bridge, was observed in a flock of 72 birds at Site 6 in the Little Rapids staging area. On 7 September Crane 165.059 and his family were sighted with at least four other cranes in a hayfield 3 km north of Bruce Mines and about 9.5 km SW of their territory at Rose Lake. On 14 September they were still present in the Bruce Mines area. The three other birds radiotagged during August (Table 1) were still on their respective territories or summering areas when checked on 14 September.

Most of the cranes at Massey, including No. 608-55661 banded in Florida, departed on 18 September, a clear day with a cold NE wind. According to a local observer, the flock staging at Little Rapids departed on the same day. Upon returning to Kirkwood on 21 September, I found that three of the four birds that I had radiotagged in that area to date were gone; two had since been sighted with more than 1,000 other birds at a major staging area near Rudyard and Pickford in the Upper Peninsula of Michigan (Table 3). On 24 September an aerial search of that staging area turned up the third bird (165.059) and another that departed from Massey on 20 September.

Crane 165.041 departed from near Iron Bridge about 1030 h on 30 September. This was an unreliable transmitter, and I soon lost the signal. At about 1210 h Crane 165.020 departed from south of Iron Bridge. I followed him westward until he crossed over northern St. Joseph Island into the Upper Peninsula. I then detoured through the Soo and located the bird on the ground at about 1510 h in a major crane roosting area just SW of the Kinross Airport. The bird had flown 100 km. I also located 165.041 near Pickford. It was then raining. After proceeding back to Ontario and transferring equipment from Kirkwood to Seney, I returned, at 1025 h on the following day, to the location where I had left 165.020. Even though it was still raining, the bird was gone. I began monitoring 164.481 (from Massey) and 164.633 and 165.041 (from Iron Bridge), all at Pickford.

Table 3. Dates that cranes banded in Ontario were detected in Ontario, Michigan, and at Jasper-Pulaski State Fish and Wildlife Area, Indiana during autumn migration, 1987. The dates marked with an asterisk are actual arrival or departure dates. Other dates indicate presence only and are based on non-continuous monitoring by several observers.

Frequency (MHz)	Last observation in Ontario	First observation at Pickford or Rudyard	Last observation at Pickford or Rudyard	First observation at J-P	Last observation at J-P
164.257	2 Oct[a]			23 Oct*	3 Nov*
164.285	21 Sept	5 Oct[b]	5 Oct[b]	9 Oct	5 Nov*
164.481	20 Sept*	22 Sept[b]	3 Oct*	5 Oct*	5 Nov*
164.611	17 Sept[a]	18 Sept[b]	18 Sept[b]	4 Oct	4 Nov*
164.633	14 Sept	16 Sept[b]	3 Oct*	5 Oct*	21 Nov
165.020	30 Sept*	30 Sept*	30 Sept	7 Oct[c]	20 Nov*
165.041	30 Sept*	30 Sept*	5 Oct[b]	11 Oct*	5 Nov*
165.059	14 Sept	24 Sept	24 Sept*	4 Oct	4 Oct

[a]Local Ontario resident.

[b]East Unit, Hiawatha National Forest staff.

[c]J-P staff.

The rain had ended by the morning of 3 October. There were broken clouds and a light N wind. At 1000 h I flushed some birds standing on a road about 5 km W of Pickford; they began spiraling upward on thermals. At 1010 h most of the remaining birds in the flock of about 480 also began spiraling upward. All three of the transmittered birds were up, but 165.041 came back down with about 120 other birds. The remainder were migrating. Crane 164.481 flew westward; Crane 164.633 flew more southerly. I followed 164.633 and saw birds fly over St. Martin Bay (NE of St. Ignace). Crane 164.633 was obviously going to cross the Straits of Mackinac into the Lower Peninsula. I checked 164.481 and found that he had turned southward and was crossing the Straits on the west side of the bridge. The two radioed birds were in separate small groups in a long chain of southbound groups.

The birds and I proceeded southward. Over Kalkaska County 164.481 and 164.633 became members of the same group. They flew until dark and landed at 1950 h in a weedy field 2 km NE of Mendon, St. Joseph County, Michigan. They had flown 492 km in 9.7 h. There were 25 birds in the group--23 in adult plumage and 2 juveniles. The only other banded bird was No. 347, the mate of 164.633. At 0840 - 0842 h on 4 October, the birds flew to a nearby corn stubble field to feed. Despite an 11 - 19 km/h SW wind, it was a clear day and the birds departed toward J-P at 1058 h. By 1500 h the wind had increased to 29 km/h. The birds were making such poor progress that at 1600 h I proceeded ahead to J-P to check birds there. I found 164.611 and 165.059. I

also found the four East Unit Hiawatha National Forest birds with functioning transmitters. All of these birds staged near either Fibre (11 km WSW of Rudyard), Rudyard, or Pickford, and one, 164.043, is known to have migrated through Wisconsin. I proceeded back along the projected flight path of 164.481 and 164.633 and found them already on the ground at 1900 h in a winter wheat field just NE of the intersection of U. S. 30 and S. R. 39, LaPorte County, Indiana. At 1926 h a pair of cranes landed with the flock of 25. The entire flock then became airborne (possibly irritated by my truck) and flew about 10 km SW, where they spent the night. They had covered only 137 km during the day.

On 5 October the wind was still southwesterly and even stronger (40 - 48 km/h). The birds rose four times between sunrise and 1030 h only to land a short distance away. At 1052 h they rose again and this time completed the 29-km flight to J-P. Cranes 164.481 and 164.633 were in separate groups in this final flight. I followed 164.481, which proceeded in a group of 15 birds and landed at 1142 h north of the goose pasture at J-P. Crane 164.633 and his mate landed in a peppermint field in Starke County, just NE of J-P. The migration routes of 165.020 from Iron Bridge to Kinross and of 164.481 and 164.633 from Pickford to J-P are depicted in Fig. 2.

The original bird tracked from Canada (165.020) was still missing. I therefore proceeded to Wisconsin and checked the Oxford-Briggsville, Chaffee Creek, White River Marsh, and

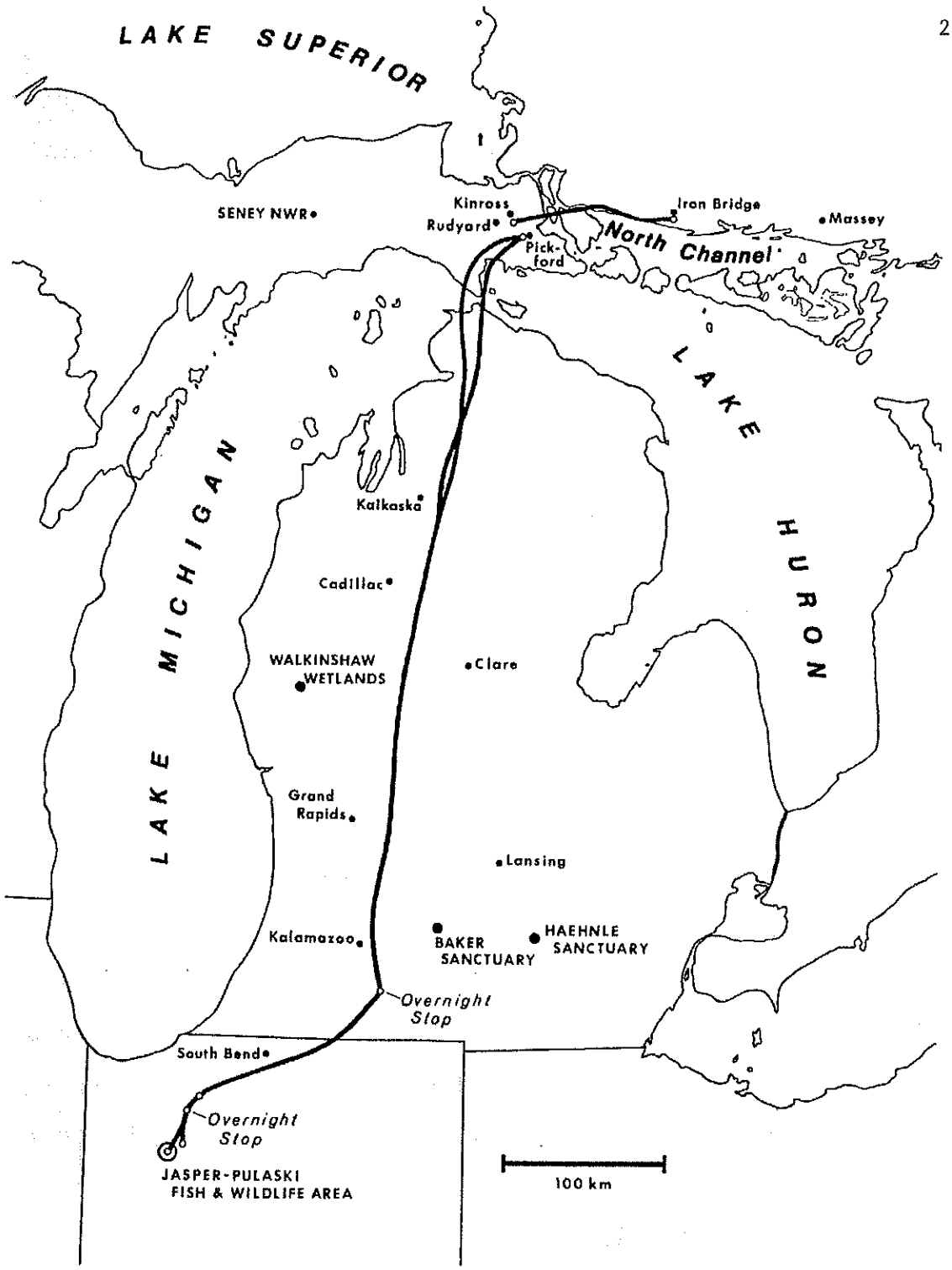

Fig. 2. The autumn migration routes of Crane 165.020 from Iron Bridge to Kinross and of Cranes 164.481 and 164.633 from Pickford to J-P, 1987.

Navarino areas (known stopovers used by birds from Seney NWR) from the ground on 6 October without success. I returned to the Pickford staging area at 1741 h on 7 October, only to find that 164.041 was gone and 164.285 had been there (EUHNF check) and already departed. In addition, missing bird 165.020 had turned up at J-P shortly after my departure there. I checked the area used by Crane 164.257 in the Dayton, Ontario, area that night but detected no signal. Another check of the Pickford area at 1405 h on 8 October again revealed no radioed birds, although Crane 608-55661 color-marked by Nesbitt was still in the remaining flock of about 120 birds. With no radiotagged birds remaining at Pickford, my plans to document the autumn migration of more birds from Ontario were thwarted. I therefore returned to J-P. I checked for 164.257 and 165.041 at Baker and Haehnle Sanctuaries in the Lower Peninsula from the ground on 10 October without success. Both birds later appeared at J-P (Table 3).

Jasper-Pulaski Fish and Wildlife Area

The duration of stay by Ontario birds is indicated in Table 3. Birds roosted in maintained wetlands on the interior of the refuge and fed primarily in corn, soybean, and peppermint fields within 7 km of the wildlife area boundaries. Autumn 1987 was relatively dry, and no flooded fields were available for roosting off J-P during that period, as occurred to a limited extent in previous years. Based on 38 observations of 19 radiotagged or marked birds from Ontario and 171 observations of 83 radiotagged or marked birds from the Upper Peninsula of Michigan, there were

no differences in distribution or use of feeding fields by birds from these different regions (Fig. 3).

Wintering Areas

The migration route followed by cranes between J-P and Florida is well known and consists of a roughly direct route through Indiana, Kentucky, Tennessee, and Georgia (Toepfer and Crete 1979; Anderson et al. 1980; McMillen et al., in press). Seven of the eight cranes radiotagged in Ontario were found on six sites in Florida, ranging from Hixtown Swamp in the north, to Glades County 470 km southward (Fig. 4, Table 4). The winter distribution of cranes from the common Ontario breeding area was within the widespread but clumped distribution noted for birds from the Upper Peninsula of Michigan (Fig. 4, Urbanek et al. 1988). The only radiotagged Ontario crane not found in Florida was later seen on two occasions during spring migration in Wisconsin, at which times the transmitter was non-functional; the failure to find the eighth radiotransmitter on the wintering grounds can thus be attributed to transmitter failure and not to occurrence of the bird outside the typical wintering distribution. Ontario birds wintered with other Great Lakes birds in freshwater marshes, wet prairies, and muck farms and on cattle ranches.

Migration Mortality

Crane 164.481 died during spring migration. Personnel of the Georgia Department of Natural Resources recovered the bird on 25 February 1988 in the north Georgia mountains, Gilmer Co., with

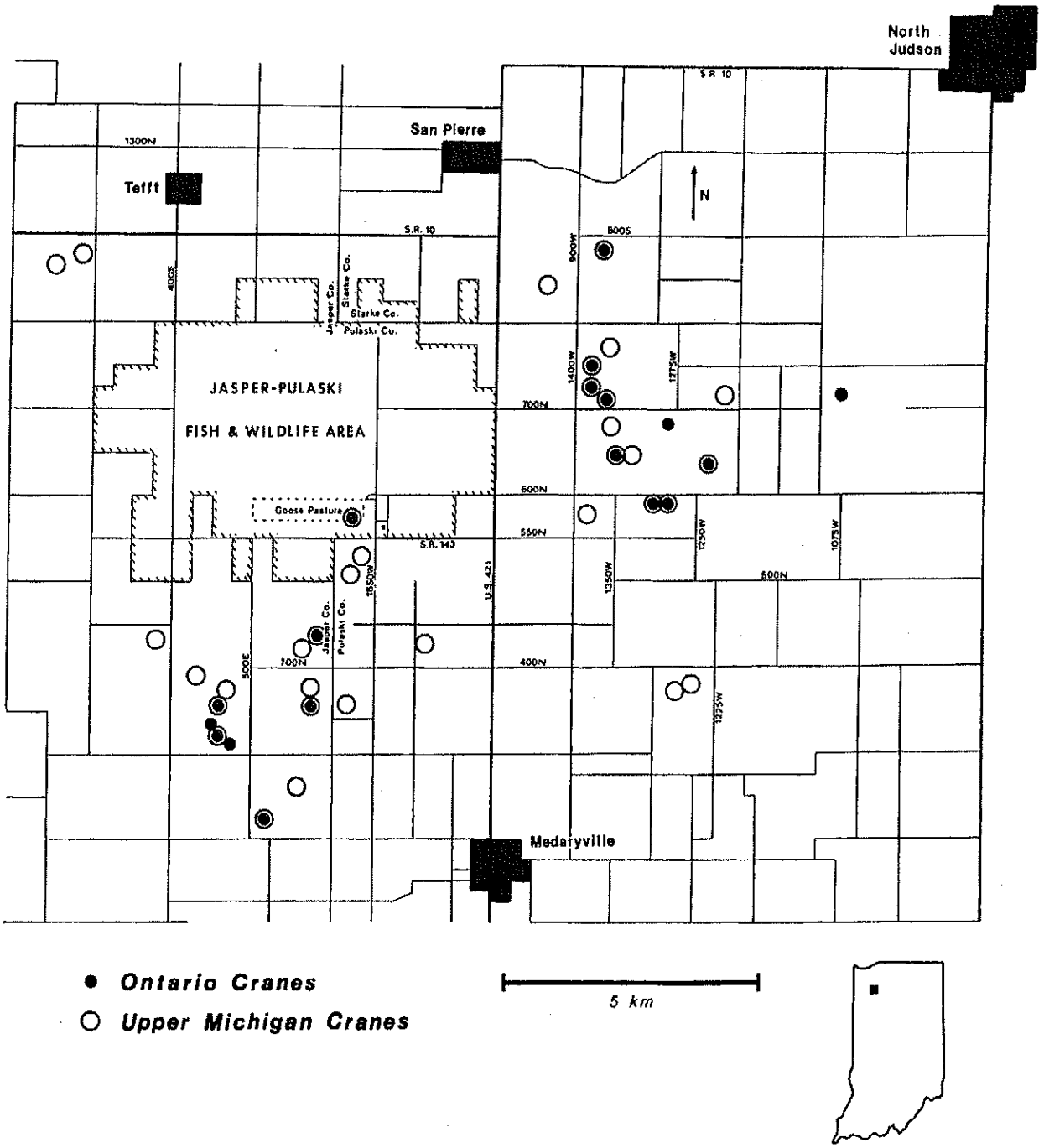

Fig. 3. Feeding locations of greater sandhill cranes from Ontario and the Upper Peninsula of Michigan at their major autumn stop-over, Jasper-Pulaski State Fish and Wildlife Area, Indiana, 1987.

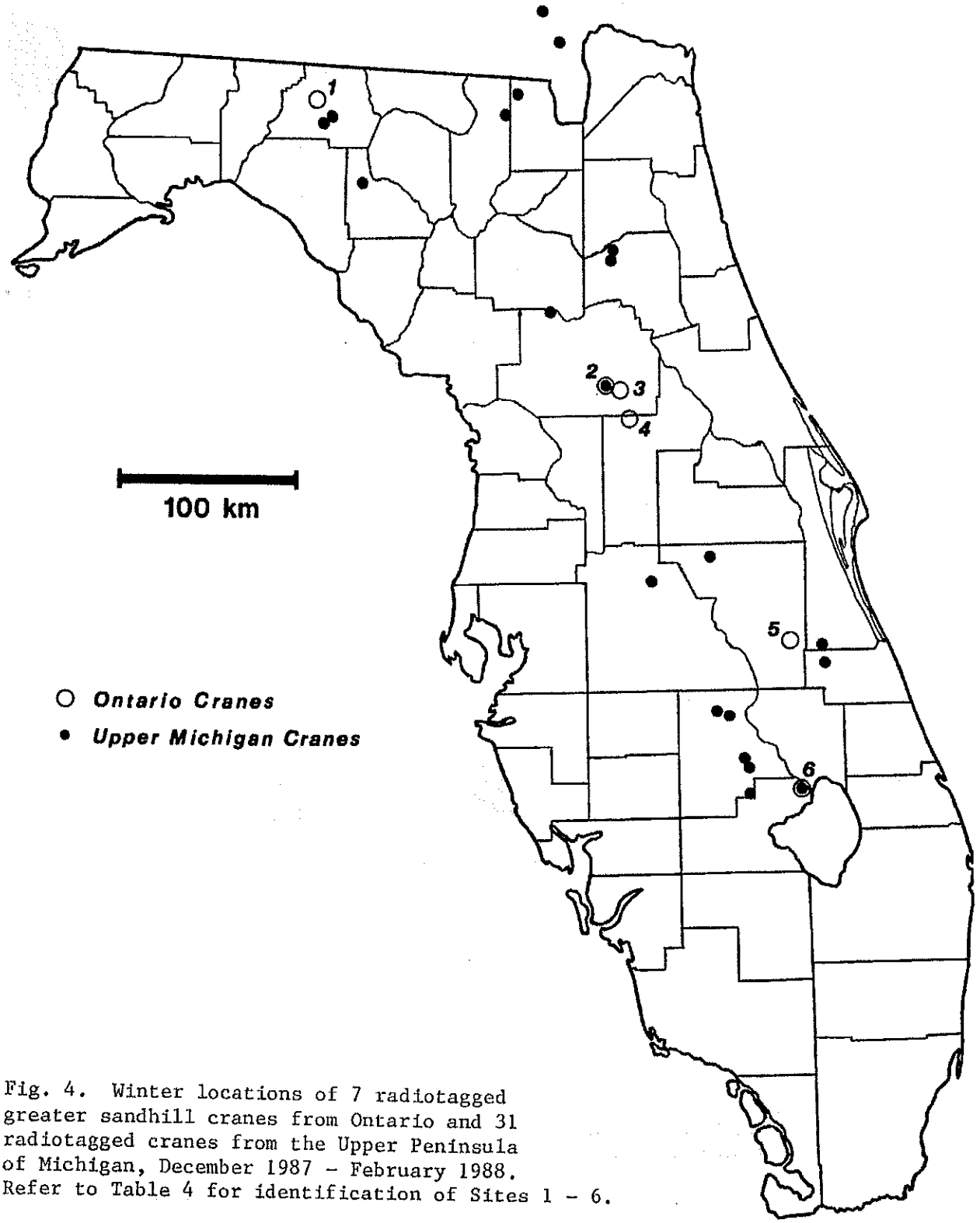

Fig. 4. Winter locations of 7 radiotagged greater sandhill cranes from Ontario and 31 radiotagged cranes from the Upper Peninsula of Michigan, December 1987 - February 1988. Refer to Table 4 for identification of Sites 1 - 6.

Table 4. Winter locations of greater sandhill cranes from the north shore of the North Channel of Lake Huron, Ontario. Sites are plotted on Fig. 4.

Site	Location	County	Crane ID	Check Dates
1	Hixtown Swamp	Madison	165.041	22 Jan 88
2	Oklawaha Muck Farms	Marion	165.020	29 Dec 87 13 Jan 88 19 Jan 88
			164.257	13 Jan 88
3	Mud Prairie Lake	Marion	164.257	19 Jan 88
4	Emeralda Marsh	Lake	164.633	13 Jan 88
	Emeralda Muck Farms	Lake	165.020	3 Dec 87
5	Campbell Escape Ranch	Osceola	165.059	14 Jan 88
6	J. F. Pearce Ranch	Glades	164.481	14 Jan 88
			164.611	14 Jan 88 2 Feb 88 4 Feb 88

a dead, non-banded bird (164.481 apparently paired since capture). Necropsy by the Southern Cooperative Wildlife Disease Study, University of Georgia, Athens, revealed 69 ppm of Famphur, an organophosphate insecticide, well above the acute oral LD_{50} of 9.87 ppm for mallards (Anas platyrhynchos). The crane was in otherwise good physical condition. The cranes might have consumed intentionally poisoned grain illegally placed in the area for crows (Corvus brachyrhynchos) or blackbirds.

The death of 164.481 was an unusual occurrence. Mortality during migration is very low for sandhill cranes in the Great Lakes-Florida flyway. This is the first report of a mortality sustained between the breeding and wintering grounds for cranes from the Upper Michigan/Ontario areas during the course of study on these areas. Annual checks for birds from this region are made each autumn at J-P in Indiana. As of the last such check (autumn 1987), all 46 cranes radiotagged since work began on Seney NWR were accounted for, and no migration mortality had ever occurred. These radiotagged cranes included 33 which had completed 1 or more return migrations since being tagged. The two deaths of radiotagged cranes that have occurred were both on the breeding grounds at Seney NWR. Among non-radiotagged flighted birds, which are color-marked only and can thus not be consistently monitored, two mortalities are known: a juvenile, killed by a predator on Seney NWR, and a wintering adult from the EUHNF. The latter bird died in Florida of mycotoxin poisoning associated with peanuts.

Spring Migration

Checks for Ontario cranes were made during routine monitoring of cranes banded in the Upper Peninsula of Michigan. Jasper-Pulaski Fish and Wildlife Area was checked on 20-21 March; 3 radiotagged cranes were located by telemetry and the only adult male captured in Ontario that was not radiotagged (No. 361) was observed with his mate and chick of the previous year (Table 5). The three major Wisconsin stopover areas used by cranes from Seney NWR (Oxford, Chaffee Creek, and White River Marsh Wildlife Area) were checked 22, 29, and 30 March (Fig. 5). White River Marsh is the major Wisconsin stopover site for Seney cranes during spring, and some birds stopover at the Oxford area. Birds spend daylight hours feeding on waste grain in local cornfields. Chaffee Creek is mainly an autumn stopover area and is little used by migrating cranes during spring. Three radiotagged Ontario birds were found in Wisconsin (Table 5). These adult males did not include the two birds tracked through the Lower Peninsula of Michigan the previous autumn. One of the two radiotagged birds found at White River Marsh was visually observed and found to be accompanied by its mate and chick of the previous year. I found another bird, radiotagged at Massey, at Oxford accompained by its mate and two chicks of the previous year. This latter bird was the only radiotagged bird not found in Florida, and its sightings in Wisconsin verified that its radio was non-functional.

Table 5. Detection of adult male sandhill cranes from Ontario in Indiana, Wisconsin, and Michigan during spring migration, 1988. Presence of family members (see Table 1) is indicated where visual observations were made.

Band No.[a]	Frequency (MHz)	Location	Dates	Comments
262	164.633	J-P,IN	20-21 March	No visual obs.
263	165.020	J-P,IN	20-21 March	No visual obs.
264	165.059	WRM[b],WI	22, 29 March	No visual obs.
			30 March	With mate and chick
		Seney NWR	5 April	Passed while flying[c]
265	164.611	J-P,IN	20-21 March	No visual obs.
266	164.285	Oxford,WI	22, 30 March	With mate and chicks
269	164.257	WRM,WI	22,29 March	No visual obs.
		Seney NWR	1 April	Passed while flying[c]
		Fibre,MI	1 April	With mate only
361		J-P,IN	20-21 March	With mate and chick

[a]Band No. refers to the final three digits in the eight digit U.S. Fish and Wildlife Service band number. The first five digits are 608-70 for all cranes banded in the Ontario study area during 1987.

[b]White River Marsh Wildlife Area and vicinity.

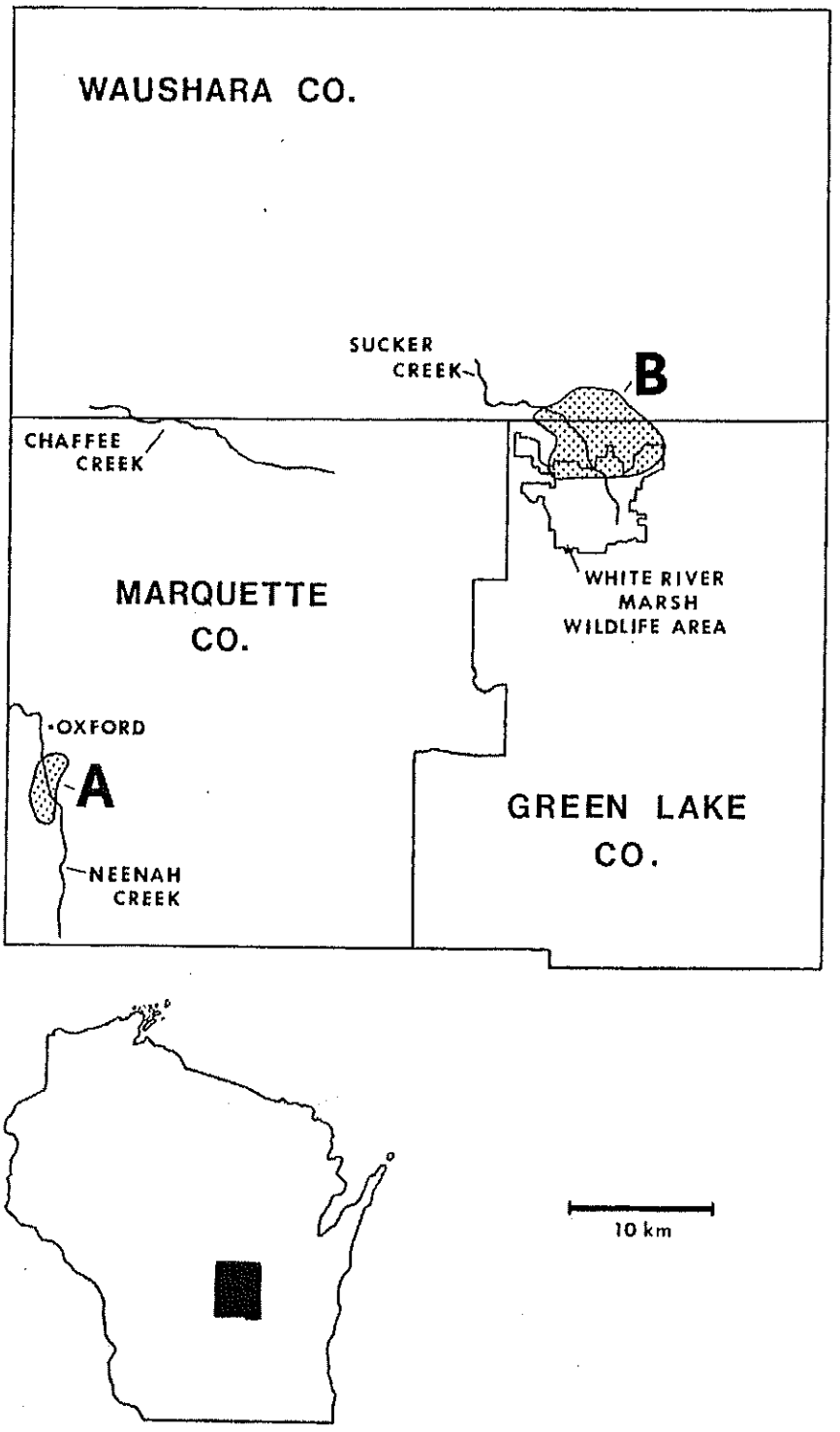

Fig. 5. Location of cranes from the north shore of the North Channel of Lake Huron, Ontario, in central Wisconsin during spring migration, 1988. A = Crane 164.285, B = Cranes 164.257 and 165.059.

Telemetry indicated that Crane 164.257 departed the White River Marsh area on 30 March. Monitoring of incoming or passing cranes began from the fire tower at Seney NWR headquarters on 1 April. The signal of Crane 164.257 was detected SW of the tower at 1425 h on that date. I tracked the bird by truck until it landed at 1700 h in a brushy field 3 km ESE of Fibre, MI, within the major staging area used by flocks of sandhills during autumn. No large flocks were present during spring. The bird was accompanied by its mate, but the chick from the previous year was not present. The bird was not followed further, but the final flight to the breeding territory in Canada was only a few hours away, and the bird probably arrived the following day. I resumed monitoring of radio signals from the Seney tower. At 1500 h on 5 April, the other crane with a functional transmitter found in Wisconsin (165.059) passed the Seney tower en route to Ontario. This bird was not followed.

DISCUSSION

Tebbel (1981) estimated a population size of 225 cranes in the southern Algoma District in 1978-79. His counts in the Thessalon to Massey area accounted for only 36.5% of his observations. The remainder were made west of Thessalon, nearer Sault Ste. Marie, in an area that was not censused during the current study. A minimum autumn population of 285 individuals occurred from Thessalon to Massey in 1987, and although survey results might not be directly comparable, a large increase (248% over Tebbel's data) in the number of cranes in the study area has

obviously occurred during the past 8-9 years. A high recruitment rate of 15-18 juveniles per 100 adults during 1987 indicates that the population is continuing to grow.

At least two different populations of sandhill cranes, the Great Lakes and Hudson Bay populations, have shown a general increase in numbers in eastern North America in recent years. Sandhills, presumably of the Canadian subspecies, are well established in the Hudson-James Bay Lowlands of Ontario (Lumsden 1971, 1987) and are now breeding in adjacent Quebec (Gosselin and David 1981). These birds probably follow a migratory route west of Lake Superior and winter in Texas (Fig. 6). Greater sandhill cranes breeding at Agassiz NWR in northwestern Minnesota (along this same route) have been tracked in the central flyway and winter in Texas (DiMatteo, in press). In addition to major concentrations of sandhills in the Hudson-James Bay Lowlands and greater sandhills in the west and central Great Lakes region, scattered individuals have been sighted as far east as Newfoundland (Tingley 1982). In the Lake Huron area cranes occur on Cockburn and Manitoulin Islands, and breeding has recently been documented on the Bruce Peninsula (Weir 1985). Ten or more individuals have been noted passing by Braddock Bay, New York (on Lake Ontario), during the past two spring migrations (Kibbe and Boise 1986, Kibbe 1987).

This study demonstrated that cranes from the north shore of the North Channel of Lake Huron use two different migration routes between Ontario and the major stopover area at Jasper-

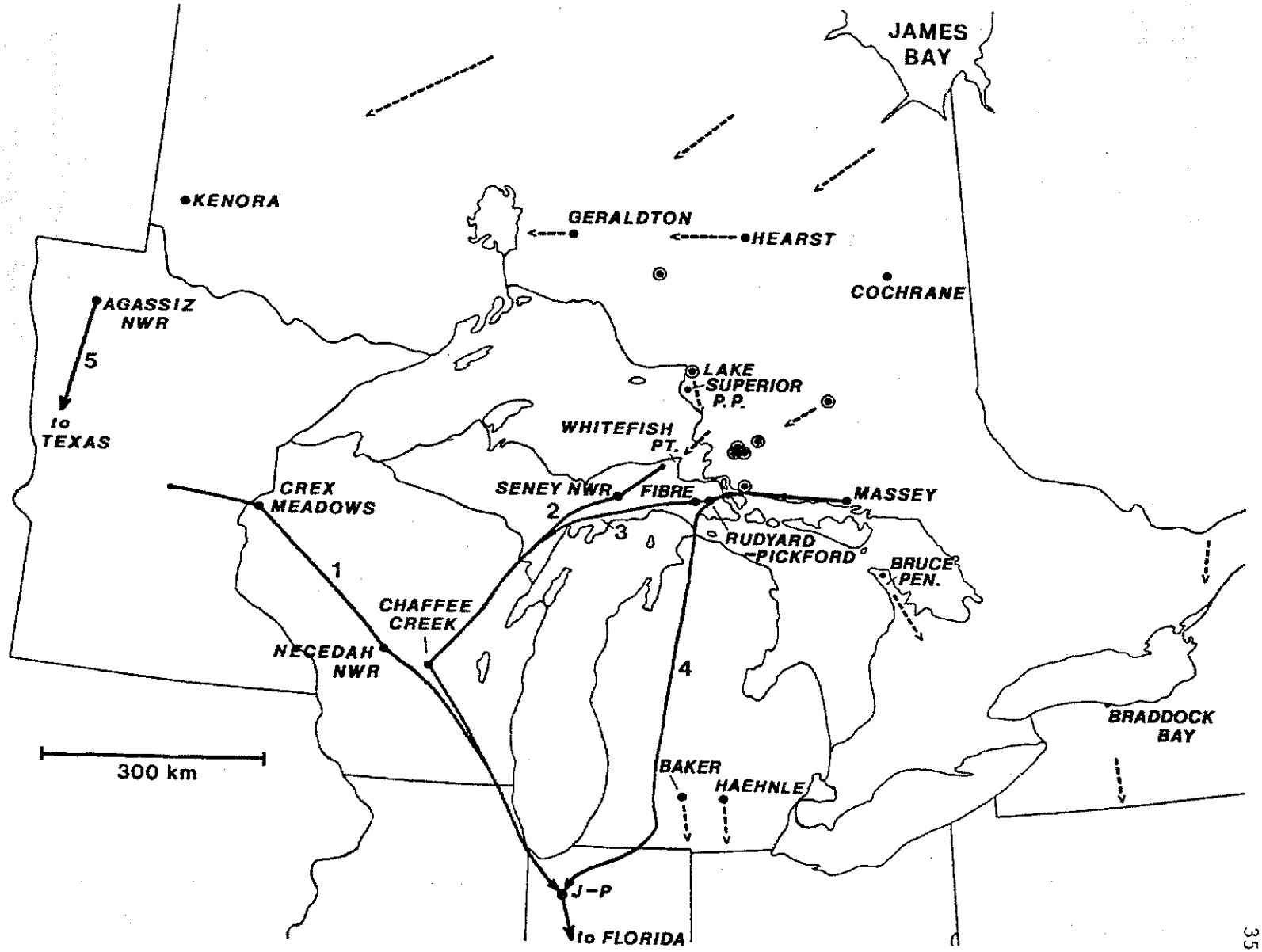

Fig. 6. Known (solid lines) and hypothesized (dashed lines) migration routes of sandhill cranes in the Great Lakes area. 1 = Toepfer and Crete (1979), 2 = McMillen et al. (in press), 3 = T. Kurtz and J. Carrick --EUHNF (pers. comm.) and THIS STUDY, 4 = THIS STUDY, 5 = DiMatteo (in press). Circled points = locations of crane nests found during waterfowl surveys by the Canadian Wildlife Service during 1986-87 (D. Fillman, pers. comm.).

Pulaski Fish and Wildlife Area in Indiana. One route (Fig. 6, Route 3), on which three radiotagged birds were found during spring migration, passes through central Wisconsin and the Upper Peninsula of Michigan. The distance from J-P to Rudyard-Pickford along this route is 830 km. The other route, over which two other radiotagged cranes were tracked during autumn migration 1987, passes through the Lower Peninsula of Michigan (Fig. 6, Route 4) and is 25% shorter. Monitoring of cranes from Upper Michigan has indicated that individual sandhill cranes, specifically adult males, exhibit a high degree of constancy and predictability in migratory movement patterns. Juvenile cranes learn the migration route from their parents. Males continue the tradition, while females may eventually follow a route based on their association with other birds such as a mate. Differences in migration route among Ontario birds is apparently determined at the level of the individual and the same individuals probably use the same routes.

The cranes breeding on Seney NWR use the Wisconsin route, but it is unclear to what extent cranes on the East Unit of the Hiawatha National Forest do so. I have found 3 of 12 cranes color-marked on the EUHNF in Wisconsin during spring migration. One of these cranes has been tracked by EUHNF personnel during autumn migration to Wisconsin as well, confirming that some of the EUHNF cranes use this route. Three radiotagged cranes from EUHNF were found at J-P on 20-21 March 1988, but only one of these was found in Wisconsin on 22 or 29-30 March, despite the

fact that 12 of the 17 radiotagged cranes from Seney that had been present at J-P on 20-21 March were noted during the subsequent checks in Wisconsin. None of the three radiotagged Ontario cranes noted at J-P on 20-21 March was subsequently found in Wisconsin, and one of these was one of the birds followed through Lower Michigan during the previous autumn. It is possible that the probability of cranes using the Lower Peninsula route increases as one moves from west to east across the Upper Peninsula of Michigan into Ontario. However, the documentation of migration through Wisconsin for cranes from as far east as Massey suggests the underlying relationship with major population components in the Upper Peninsula. Without question, two different migration pathways are used by birds staging in the Fibre-Rudyard-Pickford area of the eastern Upper Peninsula during autumn, but both routes have the same destination (J-P, Indiana).

It is possible that the Wisconsin route is older and the Lower Michigan route has developed as a result of an increasing population spreading eastward. The migration route, though primarily determined by tradition, could have been altered as a result of adaptive deviation to find a shorter route by some founder individuals, and this new route could have become a new tradition for their descendants.

The Lower Peninsula route followed by Ontario North Channel birds included no major staging areas between Rudyard-Pickford and J-P. The Phyllis Haehnle and Bernard W. Baker Sanctuaries, known staging areas for birds in the Lower Peninsula of Michigan,

were not used. Observations of Lower Peninsula-marked birds staging near Haehnle and a general lack of sightings of newly-marked birds from near Haehnle at J-P indicate that the cranes summering in that part of Michigan migrate directly to Florida without stopping at J-P (R. Hoffman, pers. comm.). Some of the radiotagged Ontario cranes were missing for several days to 3 weeks before arriving at J-P. Suitable stop-over areas are scattered across the northern Lower Peninsula, including a known staging area at Walkinshaw Wetlands (Fig. 2). Because of logistic constraints, that area was not checked. Other missing cranes probably migrated through Wisconsin, but the conflicts involved with monitoring several birds simultaneously precluded confirmation during the autumn migration.

During the 1983-87 spring migrations, 78 to 425 cranes have been observed migrating past Whitefish Point (Upper Michigan) to Ontario (Walkinshaw 1985, Sawicki 1986, Caron and Wiens 1987). Although some of these birds may be local (apparently some start to cross and then return) most are probably migrants that summer north of Sault Ste. Marie. The breeding distribution of birds captured on Seney NWR in late summer and autumn have indicated that Whitefish Point is in the Seney migration pathway, in which the birds migrate through Wisconsin to J-P. It is therefore probable that Ontario birds that migrate over the Point migrate through Wisconsin as well. Fig. 6 indicates the location of sandhill crane nests found during waterfowl surveys by the Canadian Wildlife Service in 1986-87 (D. Fillman, pers. comm.).

Though the Canadian shield forms somewhat of a barrier between the James Bay and Algoma-North Channel populations, suitable nesting habitat is scattered throughout the shield and these two increasing populations are already probably contiguous within parts of this low-density area.

The number of greater sandhill cranes migrating past Whitefish Point into Canada needs to be documented, and their possible migration route through Wisconsin needs to be verified. Due to more scattered habitat along eastern Lake Superior and in the Canadian shield, the population of greater sandhill cranes in this area is probably less than that from the Goulais River Valley eastward through the north shore areas examined during this study (Tebbel 1981). Of 33 cranes radiotagged on Seney NWR, including some staging birds that had breeding territories off the refuge, all but one have been located on summer territories on or near Seney or to the northeast toward Whitefish Point. The only radiotagged bird for which the summer territory is not known carries a weak transmitter and is thus not readily detectable. The number of birds crossing into Ontario across Whitefish Point is likely small compared to those summering in the Upper Peninsula, which has much more suitable habitat in extensive marshes, bogs, and shrub swamps in comparison to the patchy wetlands scattered through the rocky, wooded shield. Abundant suitable habitat north of the eastern shore of Lake Superior does not occur until north of the shield, into the range of the James Bay Lowland population. The size of the James Bay Lowland

population, the migration route, and the relationship of this population to the greater sandhills along the eastern shore of Lake Superior, if any, needs to be determined.

Ontario cranes from the north shore of the North Channel of Lake Huron were found on the same central Wisconsin stopover areas used by the cranes breeding on Seney. Ontario is contiguous with the Upper Peninsula and supports the same crane population found on the Hiawatha National Forest, Lake Superior State Forest, and Seney NWR. All of the Ontario cranes use J-P as a major stopover area, as do cranes from the Upper Peninsula of Michigan; likewise, the same wintering areas are used. The migration chronology--autumn, winter, and spring--is also the same for the Ontario and Upper Michigan cranes. These similarities indicate that the initial attempt to reestablish whooping cranes at a suitable location within the region could result in the presence of whooping cranes in other parts of the region as well. Because Seney NWR is a large (38,631 ha), well-protected, manageable area with abundant suitable crane habitat, a well-studied crane population, and excellent logistic facilities, it appears to be the best choice for the initial introduction of whooping cranes into the area. Such an introduction could result in the presence of whooping cranes in other areas of the Upper Peninsula and Ontario and ultimately in breeding pairs across this contiguous region as well. One of the objectives of the Canadian Whooping Crane Recovery Plan (Cooch 1988:14) is to establish one independent breeding population of 5

pairs of whooping cranes in Canada, separate from the Wood Buffalo National Park population, by 2010. An initial introduction on Seney NWR could be an integral or a complementary means by which to approach this goal.

The establishment of any new population of whooping cranes in Canada will be dependent on development of an introduction technique applicable to a migratory situation. When crane research was initiated at Seney NWR in 1984, cross fostering, i.e., placing whooping crane eggs in sandhill nests and allowing the sandhills to rear the young, was regarded as a likely technique. However, experimental cross-fostering in the Rocky Mountains has resulted in low whooping crane survival and a failure of the adults produced to breed. Current research at Seney NWR is aimed at developing a soft release technique to be used in establishing a migratory whooping crane population. The first phase of this research tests techniques to produce captive/isolation-reared sandhills (surrogate research subjects) that will survive and migrate in the wild. The next phase will evaluate the use of sandhill cranes, either individuals or flocks, as guides to promote proper survival and migratory behavior in released, captive/isolation-reared whoopers that have been imprinted on whooping cranes since hatching. This approach will avoid the maladaptive imprinting problems and high pre-fledging mortality associated with the alternative technique, cross-fostering from hatching. There is much more suitable habitat for breeding whooping cranes at northern than at southern

latitudes. The importance of the current research, aimed at the development of a migratory population, to the future of the whooping crane in North America should not therefore be underestimated.

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Appendix A. Color band combinations used on sandhill cranes in Ontario, August-September 1987.

Left Leg	Right Leg	Band No.[a]
LR		
LW	G	262
LR	G	
LW	W	263
LR	G	
LW	R	264
LR	W	
LW	G	265
LR	R	
LW	G	266
	G	
LR	R	
LW	W	267
	W	
LR	G	
LW	W	268
	R	
LR	G	
LW	W	269
R		
W		
R		
W	G	347
R		
W		
R	G	
W	W	348
R		
W		
R	G	
W	R	349
R		
W		
R	W	
W	G	350
R		
W		
R	R	
W	G	351
R		
W	G	
R	R	
W	W	352
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W	R	
R	G	
W	R	357
R		
W	R	
R	W	
W	G	358
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W	G	
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W	G	359
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W	W	
R	R	
W	G	360
R		
W	G	
R	R	
W	G	361
	R	
	W	
G	R	
	W	362
	R	
	W	
G	R	
W	W	363
		b
W	Y	
FWS		
R	Y	

R = Red
W = White
G = Green
____ = Ankle joint

LR/LW = Long Red/Long White with attached transmitter

[a]Band No. refers to the final three digits in the eight digit U.S. Fish and Wildlife Service band number. The first five digits are 608-70 for the 25 cranes banded in the Ontario study area during 1987.

[b]Previously marked crane observed near Massey. Originally banded as a juvenile (hatched 1984) on 1 March 1985 by Steve Nesbitt in Florida. His marking scheme involves color bands both above and below the ankles, and the Fish and Wildlife Service band (FWS = 608-55661) is part of the coding sequence. Y = Yellow.

Appendix B. Morphometry of sandhill cranes captured in Ontario, August-September 1987.

Band No.[a]	Age/sex	Weight (kg)	Tarsus (mm)	Middle toe (mm)	Culmen (mm)	Culmen tip (mm)	Ankle width (mm)	Head width (mm)	Wing chord (mm)
262	Adult M	4.9	253	85	135	104	24.4	42.6	
263	Adult M	5.0	264	90	133	102	25.2	41.9	
264	Adult M	4.6	262	82	131	102	26.1	42.6	
265	Adult M	5.1	254	86	134	104	25.6	42.0	
266	Adult M	5.35	269	88	136	116	24.9	42.1	554
267	Adult M	5.5	265	89	132	100	25.7	43.4	545
268	Adult M	5.0	275	90	138	115	25.1	41.9	540
269	Adult M	5.8	289	91	136	116	25.5	44.0	538
347	Subadult F	4.2	251	84	128	97	24.3	41.5	
348	Subadult	4.2	265	91	128	100	25.1	42.2	
349	Juvenile	4.1	266	86	114	82	24.4	40.1	
350	Adult F	4.5	246	82	129	95	22.8	42.7	
351	Adult F	3.95	250	75	128	94	23.0	41.5	
352	Juvenile	3.1	241	75	100	76	22.5	38.6	
353	Adult F	4.65	252	90	118	91	24.1	42.2	
354	Juvenile	4.1	263	88	122	92	25.4	41.3	
355	Juvenile	4.5	270	89	125	94	25.1	40.5	524
356	Juvenile	4.3	259	90	122	91	24.4	39.8	523
357	Adult F	4.35	254	84	126	96	23.5	40.8	511
358	Adult F	5.0	270	89	130	98	24.6	42.2	551
359	Adult F	4.9	278	87	132	101	24.9	42.2	549
360	Juvenile	4.1	264	87	119	92	23.4	41.2	491
361	Adult M	5.4	268	93	133	106	26.5	43.1	545
362	Adult F	4.7	257	84	137	100	23.7	41.1	514
363	Juvenile	4.7	272	86	138	102	25.6	39.4	544

[a]Band No. refers to the final three digits in the eight digit U.S. Fish and Wildlife Service band number. The first five digits are 608-70 for all cranes banded in the Ontario study area during 1987.