Delineating Sandhill Crane Populations in Minnesota[1]

Final Report

31 August 2017

David W. Wolfson
Minnesota Cooperative Fish and Wildlife Research Unit
Department of Fisheries, Wildlife, and Conservation Biology
University of Minnesota
St. Paul, Minnesota 55108

John Fieberg
Department of Fisheries, Wildlife, and Conservation Biology
University of Minnesota
St. Paul, Minnesota 55108

---

[1]Research Work Order No. 101, Minnesota Cooperative Fish and Wildlife Research Unit
[2]Cooperators: U.S. Geological Survey, Minnesota Department of Natural Resources, University of Minnesota, U.S. Fish and Wildlife Service, and the Wildlife Management Institute.

Delineating Sandhill Crane Populations in Minnesota

Final Report

David W. Wolfson, *Minnesota Cooperative Fish and Wildlife Research Unit, Department of Fisheries, Wildlife, and Conservation Biology, University of Minnesota, St. Paul, Minnesota, USA*

John Fieberg*, Department of Fisheries, Wildlife, and Conservation Biology, University of Minnesota, St. Paul, Minnesota 55108*

Abstract: Minnesota supports 2 populations of sandhill cranes (*Antigone canadensis*) – the Mid-continent Population that breeds and migrates through northwestern Minnesota, and the Eastern Population that breeds and migrates throughout much of the remainder of the state. Historically, there was a large area of separation between the breeding ranges of these 2 populations, with MCP and EP cranes restricted to the extreme northwestern and east-central parts of the state, respectively. Over the last 30 years, sandhill cranes have expanded their breeding distribution in Minnesota and elsewhere and are now breeding residents throughout most of the state. The population affiliation of cranes between their historical distributions is not known, however, and this uncertainty has potential implications for harvest management because MCP cranes are hunted in Minnesota, whereas EP cranes are not. We affixed GPS-cell transmitters to 50 sandhill cranes during 2014 and 2015 near the presumed boundary between breeding MCP and EP cranes in Minnesota and monitored their seasonal (i.e., migratory) and local movements to (1) determine the current range boundaries of MCP and EP cranes breeding in Minnesota and identify regions of overlap, (2) quantify habitat-use patterns, especially related use of fall staging areas in Minnesota, and (3) evaluate year-round movement patterns and annual survival of cranes breeding in Minnesota. We identified areas of overlap between breeding populations in northwestern Minnesota, near the historical range boundary of MCP cranes, suggesting that EP cranes have expanded their distribution significantly northwest. Furthermore, cranes from both populations used fall staging areas in northwestern Minnesota in the current zone where recreational harvest of MCP cranes was allowed beginning in 2010, indicating at least some overlap of populations during Minnesota's crane hunting season. In addition, some cranes used migration routes associated with both populations, providing potential for population mixing outside of their breeding ranges. Finally, our estimates of annual survival rate of Minnesota cranes are consistent with other published estimates of crane survival rate, although because we had difficulty distinguishing mortality from transmitter failure, the uncertainty in our estimates is large. Our study provides current information about the population affiliation of Minnesota sandhill cranes, and indicates that the recent dramatic growth in abundance of cranes in

Minnesota is largely a consequence of an increase in the number and distribution of EP sandhill cranes in the state. There is overlap in the distribution of these 2 populations both on the breeding grounds, and to a lesser extent, during staging, migration, and winter, potentially complicating local management options. Generally high annual survival rates likely contribute to a growing Minnesota sandhill crane population, especially EP cranes.

INTRODUCTION

Minnesota is one of few states that supports portions of 2 distinct breeding populations of sandhill cranes (*Antigone canadensis*)—the Mid-continent Population (MCP) that breeds and migrates through northwestern Minnesota, and the Eastern Population (EP) that breeds throughout much of the rest of the state. Although there is a small amount of gene flow between the 2 populations, Jones et al. (2005) concluded that the 2 populations were genetically distinct enough to be managed separately. Sandhill cranes are long-lived birds with relatively low recruitment rates (Tacha 1989), making accurate knowledge of abundance and distribution critical for well-informed harvest management. Whereas the MCP of sandhill cranes has exhibited stable or slightly increasing population estimates over time, the EP is currently experiencing a significant increase in population size, and also appears to be experiencing a concurrent expansion in breeding range.

Sandhill crane numbers in eastern North America sharply declined following widespread European settlement during the late 19th century (Walkinshaw 1955, Johnson 1976). Unregulated harvest and widespread habitat alteration led to an historic low of 25 breeding pairs of EP cranes in the 1930s (Henika 1936, Walkinshaw 1949, Hunt and Gluesing 1976, Meine and Archibald 1996). Since then, sandhill crane numbers increased, in part due to passage of the Migratory Bird Treaty Act of 1918, which banned all hunting of cranes. Cranes have also benefitted from widespread public land acquisitions and wildlife habitat preservation.

Historically, the breeding range of MCP cranes in Minnesota was restricted to the extreme northwestern portion of the state, especially Kittson and Roseau counties (Johnson 1976), whereas the breeding range of EP cranes was limited to the east-central part of the state, with a large area separating the 2 populations (Johnsgard 1983). The breeding ranges of these 2 populations have expanded and come into closer proximity as numbers of cranes have increased, particularly for the EP (Tacha and Tacha 1985, Minnesota Breeding Bird Atlas). However, the current breeding distribution of these 2 populations in Minnesota, and the resulting implications for their management, is unknown.

To better understand the relationship between MCP and EP cranes along the boundaries of their breeding distributions in Minnesota, we captured breeding cranes in the zone between the 2 historical range boundaries and equipped them with GPS-GSM transmitters (Cellular Tracking Technologies, Somerset, PA) to monitor their movement over multiple years. Specifically, our objectives were to:

1. Determine spatial overlap between the EP and MCP ranges in Minnesota, and identify counties that contain both populations.
2. Measure chronology and space use of fall staging areas in Minnesota by EP and MCP cranes.
3. Evaluate year-round movement patterns (e.g., migration) and survival of Minnesota sandhill cranes

STUDY AREA

Our study area consists of 19 counties in northern Minnesota that comprise the area between the historical boundaries of breeding EP and MCP sandhill cranes. We used migration paths of cranes captured during the first field season to inform subsequent capture efforts in the second field season and help focus capture efforts in potential zones of overlap between populations. The majority of the study area is located within the Laurentian Mixed Forest ecological province (Cleland et al. 1997). A small portion along the western edge of the study areas lies within the Eastern Broadleaf Forest ecological province. Norman, Clay, Grant, and Wilkin counties, which are located in the Prairie Parkland ecological province, were included for exploratory purposes, although based on observations of breeding pairs of cranes during the first field season, they do not seem to contain a significant number of breeding sandhill cranes. The Tallgrass Aspen Parkland ecological province in northwestern Minnesota, which contains the historical range of the MCP crane population, was not included in the study area because the population affiliation of cranes breeding there is not in question.

METHODS

Crane capture: We captured cranes using a variety of methods. During the breeding season, the primary capture technique we used was night-lighting, which requires a portable, powerful spotlight in tandem with high levels of white noise from mounted speakers on an external-frame backpack. The bright light helps to locate cranes on their roosts (best night-lighting conditions are extremely dark, moonless nights) while also confusing targeted birds, slowing their escape. The white noise serves to mask the sound of splashing footsteps when approaching cranes. We encountered cranes exclusively in emergent vegetation wetlands with standing water between 15 and 60 cm while night-lighting. Prior knowledge of wetlands and crane roosting locations are essential to night-lighting success (Drewien and Clegg 1992).

In 2014, we targeted areas for night-lighting where we observed pairs of cranes from the ground. In an effort to increase capture success of cranes by night-lighting in 2015, we flew helicopter surveys throughout the study area during April 2015. We identified wetland units to survey by modelling high-quality crane habitat most accessible for night-lighting on foot. We located crane nests, breeding pairs, and groups of cranes, but primarily focused our efforts on areas where there was evidence of nesting (i.e., nests and pairs). Helicopter surveys allowed us to locate sufficient roosting locations early in the season and helped focus our night-lighting efforts.

To aid in the location of night roost locations, we also captured pre-fledged colts in uplands during the day. We temporarily affixed VHF transmitters to captured colts to the tibiotarsus using the same PVC flanges used for GPS-GSM transmitters (2014; see below) or attached transmitters to a patch of lightweight fabric adhered with eyelash glue to a colt's back (2015). We used VHF signals to locate radio-marked colts at night and used their locations to locate adult cranes, which were the preferred target for capture. Later in the season we re-caught colts with VHF transmitters (just prior to fledging) and replaced the VHF transmitter for a GPS-GSM transmitter.

We also used a netlauncher (CODA Enterprises, Mesa, AZ) to capture cranes. We placed small piles of corn in high-use upland areas as an attractant. After a sufficient number of days for cranes to acclimate to the bait, we fired a 30' x 30' net at individual cranes when they were within range of the net. In 2015, we also captured cranes with rocket nets (Wheeler and Lewis 1972). We fired rocket nets in private corn and hay fields just north of Sherburne National Wildlife Refuge during mid-October to early November 2015. We patterned daily movements of cranes in the area and obtained permission from local landowners to access private property. We used crane decoys to attract cranes into the capture zone of the rocket net.

We marked cranes with 60-g GPS-GSM transmitters (Models CTT-1060a-LB and CTT-1060-LM-BT3; Cellular Tracking Technologies, Somerset, PA) above the left tibiotarsus joint using a 2-piece leg band (Krapu et al. 2011). Leg bands consisted of 2 7.6-cm, color-coated, polyvinyl chloride (PVC), flanged halves; one half was bonded to the transmitter and the other was engraved with a unique alpha-numeric code (Haggie Engraving, Crumpton, MD). We lined the leg bands with 1-mm-thick closed-cell neoprene to minimize abrasion (Krapu et al. 2011). We collected a blood sample from the metatarsal vein just below the tibiotarsus joint of the right leg to determine sex of captured cranes by DNA analysis (Avian Biotech, Tallahassee, FL). We weighed and banded all captured cranes above the right tibiotarsus joint with aluminum butt-end bands (size 8 or 9, U.S. Geological Survey Bird Banding Laboratory). We released all processed cranes within 30 min of capture. All capture and handling methods were approved by the University of Minnesota Institutional Animal Care and Use Committee (Protocol #1403-31362A).

Data: Transmitters were programmed to collect GPS locations at 15-min intervals between sunrise and sunset each day. Horizontal precision of GPS locations was <5 m (50% Circular Error Probable). Locations were stored temporarily in the transmitter memory and once a day, the transmitter attempted to upload the entire batch of locations to the Cellular Tracking Technologies database by way of a cell phone tower. To maintain consistency with previous studies of EP cranes, we identified staging areas as places where cranes remained for > 5 consecutive days after leaving their breeding territories in the fall, winter area locations as the terminus of southbound migration and where a crane localized for >10 days (Warnock 2010, Fronczak 2014), and we identified the population affiliation (i.e., MCP or EP) for each crane *post hoc* based on migratory patterns and the location of overwintering areas.

To visually assess the area of overlap between the 2 populations of cranes in our study, we calculated minimum convex polygons from the capture locations of cranes from each population using package adehabitatHR (Calenge 2006) in program R (v.3.2.2, R Development Core Team 2008). It is important to note that these polygons are not intended to represent a comprehensive range distribution for each population, but merely to serve as a visual aid of population classification of marked cranes.

We estimated juvenile and adult survival rates using the Mayfield estimator, assuming a constant hazard rate over time:

$$\hat{s} = \left(1 - \frac{number\ of\ deaths}{number\ of\ exposure\ days}\right)^{365}$$

We assumed that a localized cluster of locations, followed by a lost signal, was indicative of a mortality event. In most cases, however, it was not possible to determine whether lost signals were the result of transmitter failure or a mortality event. Therefore, to bracket the range of likely survival rates, we generated estimates under 2 extreme assumptions: 1) all lost signals occurred because of a mortality event; 2) all lost signals resulted from transmitter failures.

RESULTS

In 2014 (May-September; Fig.1), we captured and affixed GPS-GSM transmitters to 6 cranes (3 male, 3 female). We captured 3 of these cranes by night-lighting, 2 on foot as colts, and 1 using a netlauncher. In 2015 (April-November; Fig. 2), we captured 64 cranes and equipped 44 of them with GPS-GSM transmitters. We captured 16 adult cranes via night-lighting, 32 colts on foot, and 16 cranes with rocket nets.

We monitored the locations of marked cranes via the Cellular Tracking Technologies website following each capture. GPS location data indicated the use of several historical staging areas including Crex Meadows (WI) and Sherburne National Wildlife Refuge (MN). Most of the cranes we captured in 2014 appeared to belong to the EP because they migrated through typical EP migration corridors and settled on traditional EP wintering areas before migrating north in the spring (Fig. 3). Cranes captured in 2015 made migration movements consistent with both the MCP (Fig. 5) and EP (Fig. 6), and movement data from 2014 and 2015 suggest that the current boundary between breeding MCP and EP cranes in Minnesota occurs in Mahnomen and Becker counties.

We removed 14 cranes from our sample due to either transmitter failure or mortality prior to completion of migration. Of the 36 cranes (21 adults, 15 colts) observed over ≥1 winter, we classified 9 cranes as MCP, 23 cranes as EP, and were unable to classify 4 cranes that used migratory pathways of both EP and MCP cranes (Fig. 7). We observed significant overlap in breeding areas of EP and MCP cranes in northwestern Becker County, Minnesota based on visual inspection of minimum convex polygons. In one case, breeding areas of adult cranes from both populations were located < 1 km apart (Fig. 7 inset).

During the breeding season, we identified 3 areas of overlap in northwestern Minnesota that were used by both MCP and EP cranes and cranes that used both flyways (Mississippi and Central; Fig. 7)—2 nearby regions in northwestern Becker and southwestern Mahnomen counties and 1 area in central Clearwater County. We identified 4 fall-staging areas in northwestern Minnesota that were used by both EP and MCP cranes (Fig. 8). Of these, 3 were used in both 2015 and 2016, and 1 was used only in 2016 (Fig. 9). The northwestern Minnesota staging area that had the greatest use by EP cranes in both the fall of 2015 and 2016 was a large, 25-km^2 wetland complex in northern Clearwater County (47.9°N, -95.5°W). Ten GPS-marked EP cranes roosted there during fall staging, whereas only 2 GPS-marked MCP cranes roosted at this this staging area (Fig. 9, labeled Red Lake Reservation).

The 4 cranes that we were unable to assign to a population exhibited unorthodox migration routes (Fig. 10). Two cranes used the Mississippi (EP) Flyway for fall and spring migrations in the fall of 2015 and spring of 2016, but switched to the Central (MCP) Flyway during the fall of 2016. One crane used the Mississippi Flyway in the fall of 2015, continued to Texas to spend the winter in MCP range, then used the Central Flyway to migrate north in the spring of 2016. One crane migrated to Florida, USA, in December 2016 before continuing west to settle for the remainder of the winter on the Texas Gulf Coast. These are the first occurrences to our knowledge of sandhill cranes using both MCP and EP migration routes.

The range of our annual survival rate estimates is quite broad (Table 1), and for adult cranes encompasses estimates from other studies (e.g., 0.95, 95% CI = 0.86, 0.98 for EP cranes; Fronczak et al. 2015).

DISCUSSION

Breeding sandhill cranes in Minnesota are associated with 2 distinct populations with different management objectives and strategies. Historically, breeding distributions of these 2 populations in Minnesota were distinct, but over the past several decades, sandhill cranes have expanded their breeding distribution across most of the state. Based on marking and monitoring movements of cranes breeding near the presumed boundary between the MCP and EP in Minnesota, our results indicate that the EP has expanded its breeding distribution northwest to a much greater extent than the MCP has expanded to the southeast. As a result, MCP and EP breeding distributions currently come into contact in northwestern Minnesota (Fig. 7). Furthermore, a portion of EP cranes we marked near the current range boundary spent some time in fall staging areas within the Northwest Goose and Sandhill Crane Zone where harvest of sandhill cranes is allowed as part of MCP management.

We observed unexpected annual movements of a number of the cranes we marked near the current range boundary between MCP and EP cranes in Minnesota. Of the 36 cranes we marked and subsequently monitored for ≥1 winter, 4 used migratory pathways associated with both the MCP and EP. At least for cranes breeding near the boundary between the MCP and EP, population affiliation might be less certain than previously thought, suggesting that current management strategies based on historical population delineations may need to be reconsidered in the future, especially if the EP continues to expand its breeding distribution.

Our estimates of annual survival rate of Minnesota cranes are consistent with other published estimates of crane survival rate (e.g., Fronczak et al. 2015), although because we had difficulty distinguishing mortality from transmitter failure, the uncertainty in our estimates is large. However, generally high annual survival rates likely contribute to a growing Minnesota sandhill crane population, especially EP cranes

LITERATURE CITED

Calenge, C. 2006. The package `adehabitat` for the R software: a tool for the analysis of space and habitat use by animals. *Ecological Modelling* 197: 516-519.

Cleland, D.T., P.E. Avers, W.H. McNab, M.E. Jensen, R.G. Bailey, T. King, and W.E. Russell. 1997. National hierarchical framework of ecological units. Pages 181-200 *in* Boyce, M.S. and A. Haney, editors. Ecological management application for sustainable forest and wildlife resources. Yale University Press, New Haven, Connecticut, USA.

Drewien, R. and Clegg, K. 1992. Capturing whooping cranes and sandhill cranes by night-lighting. *Proceedings of the North American Crane Workshop* 6:43-49.

Fronczak, D. L. 2014. Distribution, migration chronology, and survival rates of Eastern Population sandhill cranes. Thesis, University of Minnesota, St. Paul, USA.

Fronczak, D. L., D. E. Andersen, E. E. Hanna, and T. Cooper. 2015. Annual survival rate estimate of satellite-transmitter-marked Eastern Population greater sandhill cranes. *Journal of Fish and Wildlife Management* 6:464-471.

Henika, F.S. 1936. Sandhill cranes in Wisconsin and other Lake States. *Proceeding of the North American Wildlife Conference* 1:644-646.

Hunt, R.A. and E.A. Gluesing. 1976. The sandhill crane in Wisconsin. *Proceedings of the North American Crane Workshop*. 1:19-34.

Johnson, J. 1976. Distribution of sandhill cranes in Minnesota. *Proceedings of the North American Crane Workshop* 1:59-68.

Johnsgard, P. A. 1983. Cranes of the world. University of Nebraska Press, Lincoln, Nebraska, USA.

Jones, K. L., G. L. Krapu, D. A. Brandt, and M. V. Ashley. 2005. Population genetic structure in migratory sandhill cranes and the role of Pleistocene glaciations. *Molecular Ecology* 14:2645-2657.

Krapu, G. L, D. A. Brandt, K. L. Jones, and D. H. Johnson. 2011. Geographic distribution of the Mid-Continent Population of sandhill cranes and related management applications. *Wildlife Monographs* 175:1-38.

Meine, C. D., and G. W. Archibald, editors. 1996. The cranes: status survey and conservation action plan. IUCN, Gland, Switzerland, and Cambridge, U.K.

Minnesota Breeding Bird Atlas. 2014. Sandhill crane species map. <http://www.mnbba.org/blockmap/species.php?species=Sandhill%20Crane> Accessed 28 Jan 2015.

R Development Core Team. 2008. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Tacha, M. C. and T.C. Tacha. 1985. Status and distribution of sandhill cranes in Minnesota. Unpublished report, Minnesota Department of Natural Resources, St. Paul, Minnesota, USA.

Tacha, T.C., D.E. Haley, and P.A. Vohs. 1989. Age of sexual maturity of sandhill cranes from mid-continental North America. *Journal of Wildlife Management* 53:43-46.

Walkinshaw, L.H. 1949. The sandhill cranes. Cranbrook Institute of Science. Bulletin 29. Bloomfield Hills, Michigan, USA.

Walkinshaw, L.H. and H.F. Wing. 1955. Censusing southern Michigan sandhill cranes. *Auk* 72:374-384.

Warnock, N. 2010. Stopping vs staging: the difference between a hop and a jump. *Journal of Avian Biology* 41:621-626.

Wheeler, R. H. and J. C. Lewis. 1972. Trapping techniques for sandhill crane studies in the Platte River Valley. U. S. Department of the Interior, U. S. Fish and Wildlife Service Natural Resource Publication 107. 19pp.

Table 1. Mayfield survival rate estimates for juvenile and adult sandhill cranes radio-marked in Minnesota from 2014-2015 under differing assumptions regarding the fate of individuals with lost signals. The true survival rates likely fall somewhere between these 2 sets of estimates.

	Annual survival assuming lost signals were mortality events	95% CI	Annual survival assuming lost signals were due to transmitter failure	95% CI
Colts	0.44	(0.30,0.63)	0.81	(0.68,0.97)
Adults	0.68	(0.55, 0.85)	1	NA

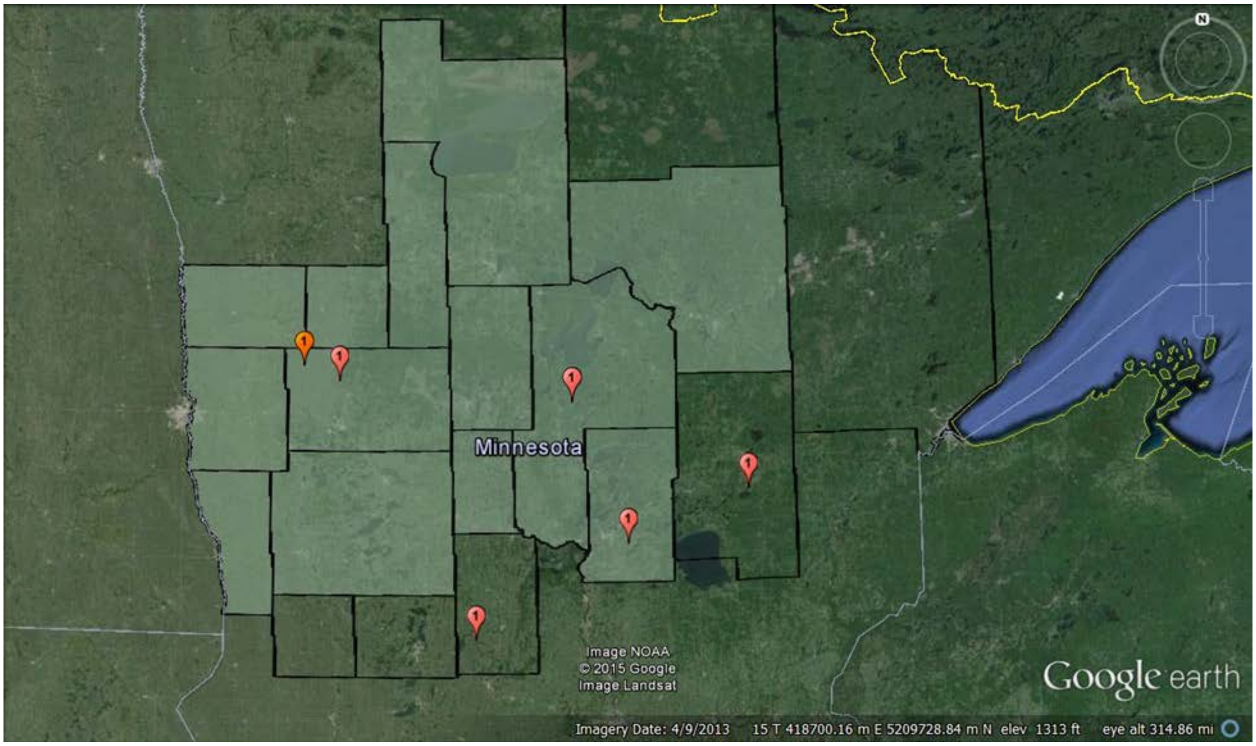

Figure 1. Capture locations of sandhill cranes in Minnesota in 2014. Eastern Population cranes are in pink and Mid-Continent cranes are in orange (the number of cranes captured in the area is represented by the number in the balloon). Counties in the project study area are outlined in black.

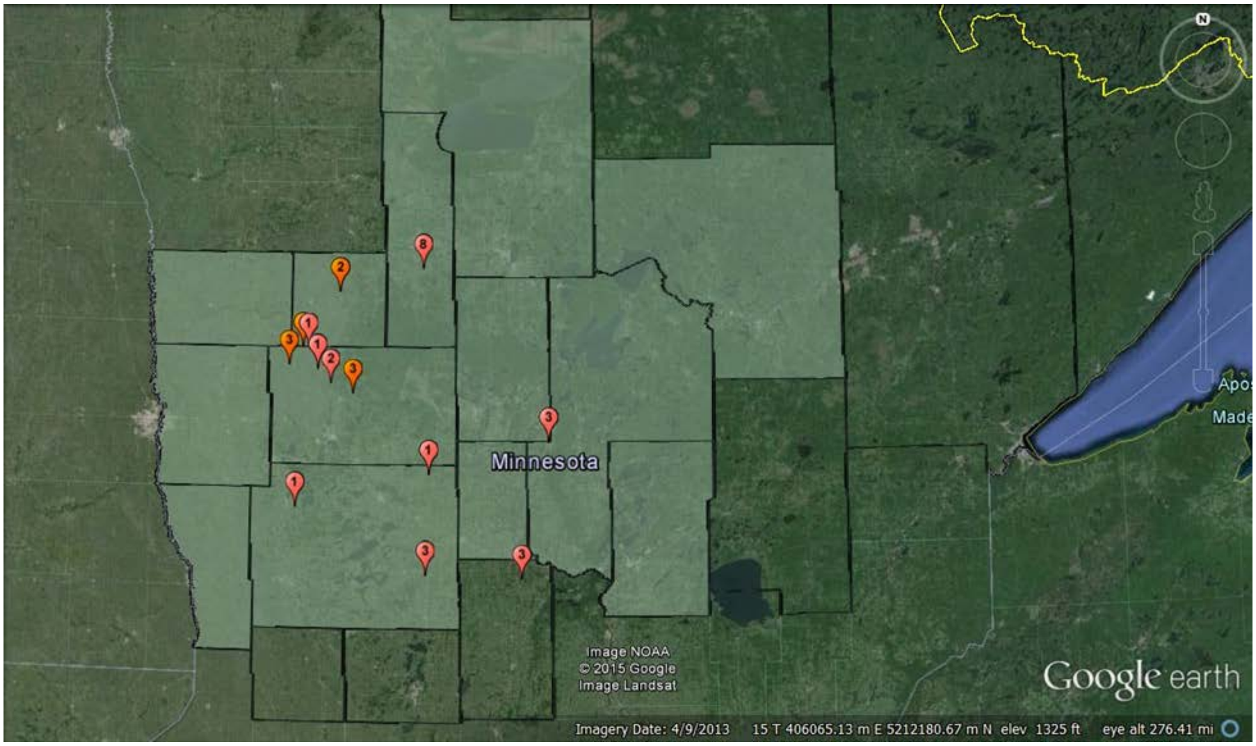

Figure 2. Capture locations of sandhill cranes in Minnesota in 2015. Eastern Population cranes are in pink and Mid-Continent cranes are in orange (the number of cranes captured in the area is represented by the number in the balloon). Counties in the project study area are outlined in black. Shaded counties were prioritized for capture efforts in 2015.

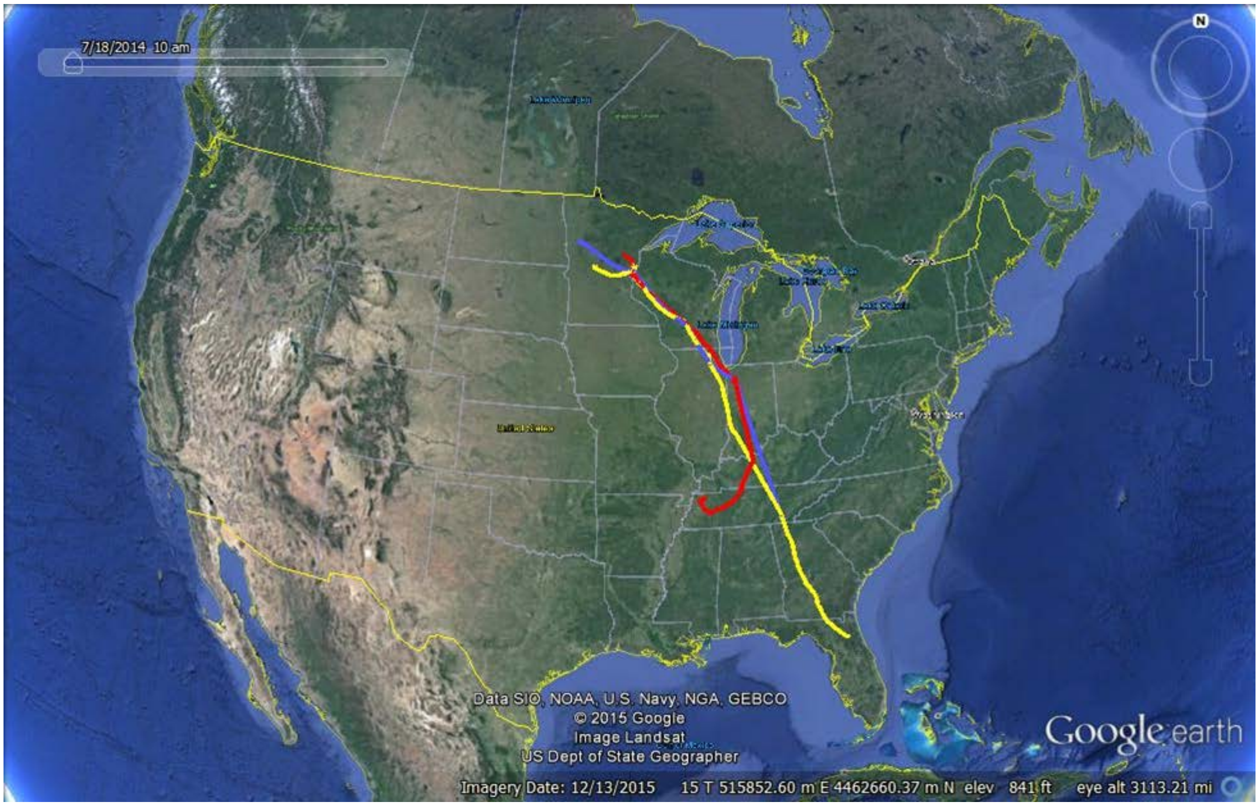

Figure 3. Migration trajectories during fall and early winter of 3 sandhill cranes captured in Minnesota in 2014 with terminal wintering areas in western and eastern Tennessee and northern Florida.

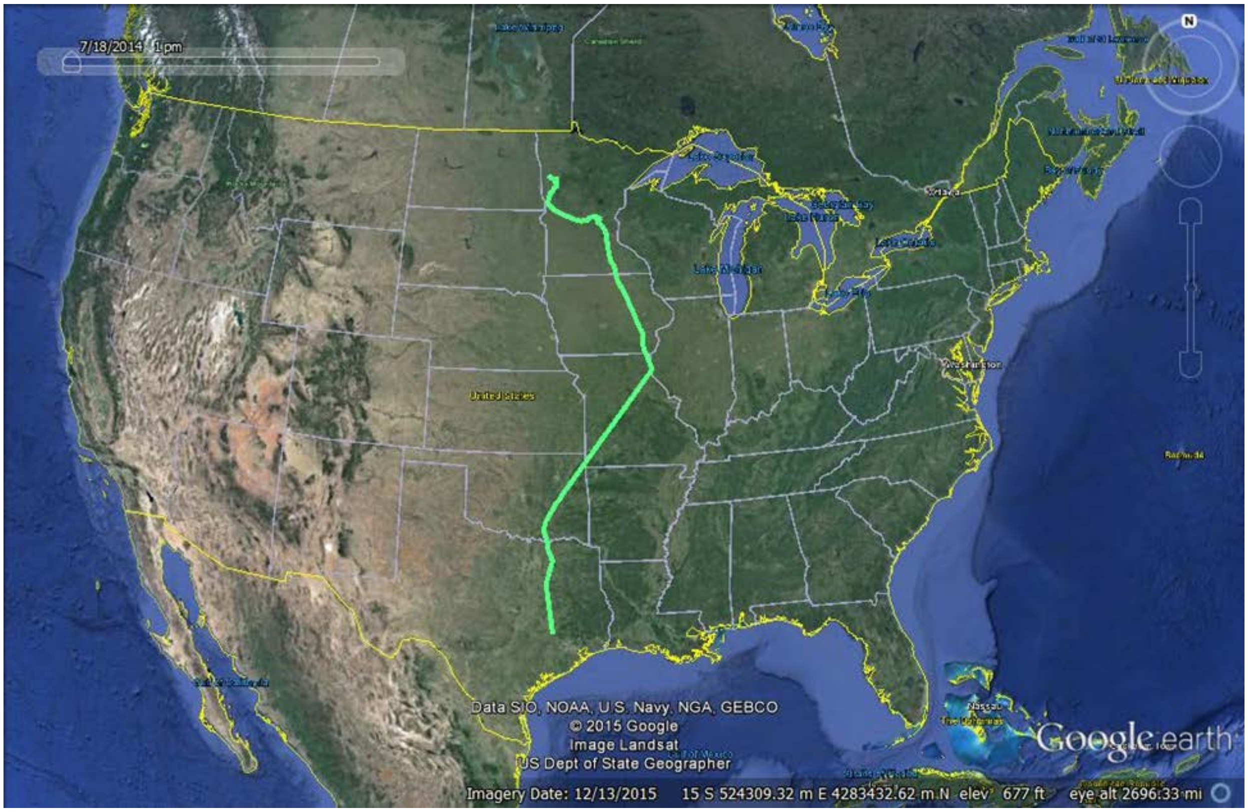

Figure 4. Migration trajectory during fall of a sandhill crane captured in Becker County, Minnesota in 2014 with a terminal wintering area in southeast Texas.

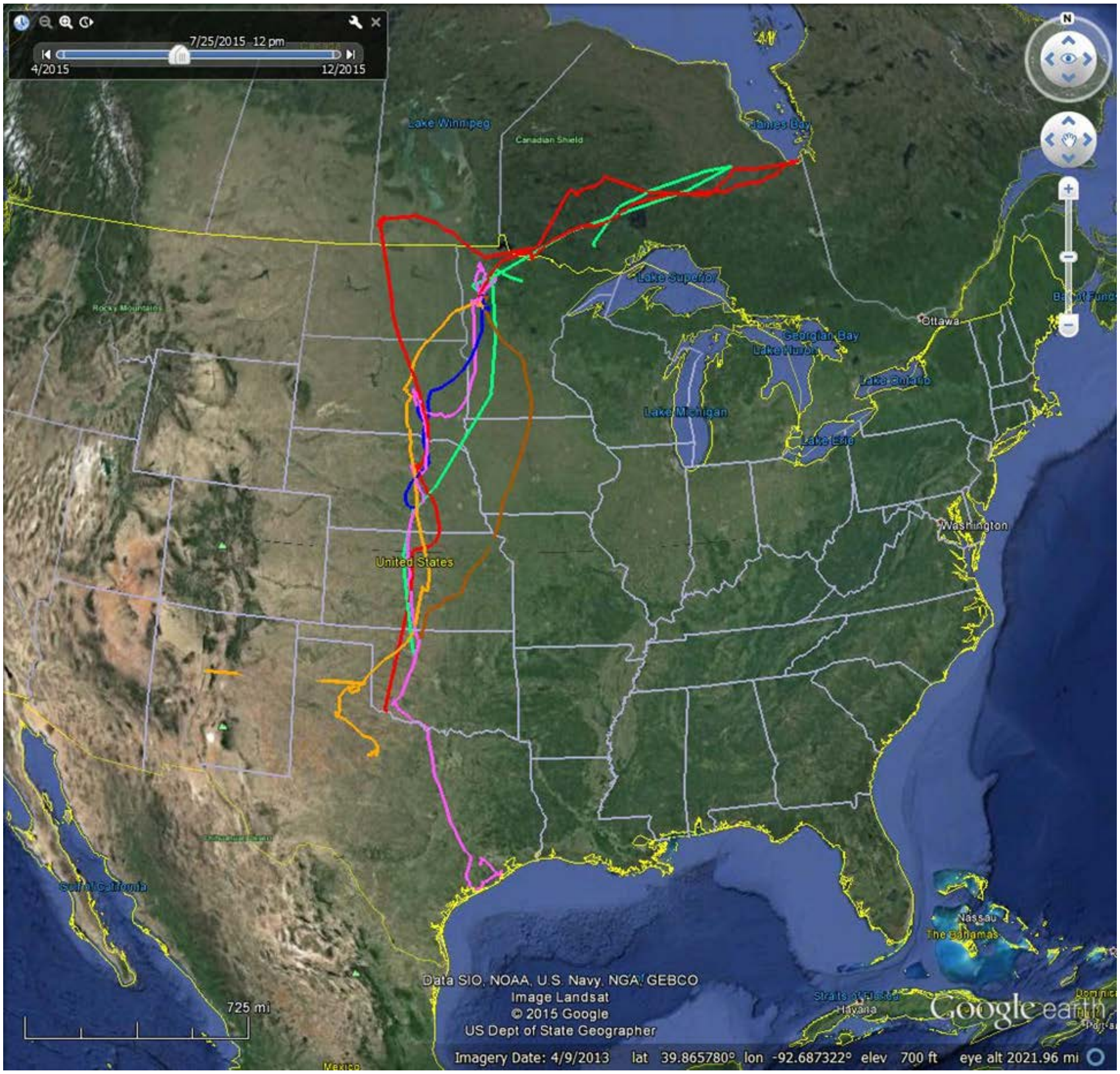

Figure 5. Migration trajectories during the summer and fall of 2015 of Mid-Continent sandhill cranes (n = 6) captured and marked with GPS-GSM transmitters in Minnesota.

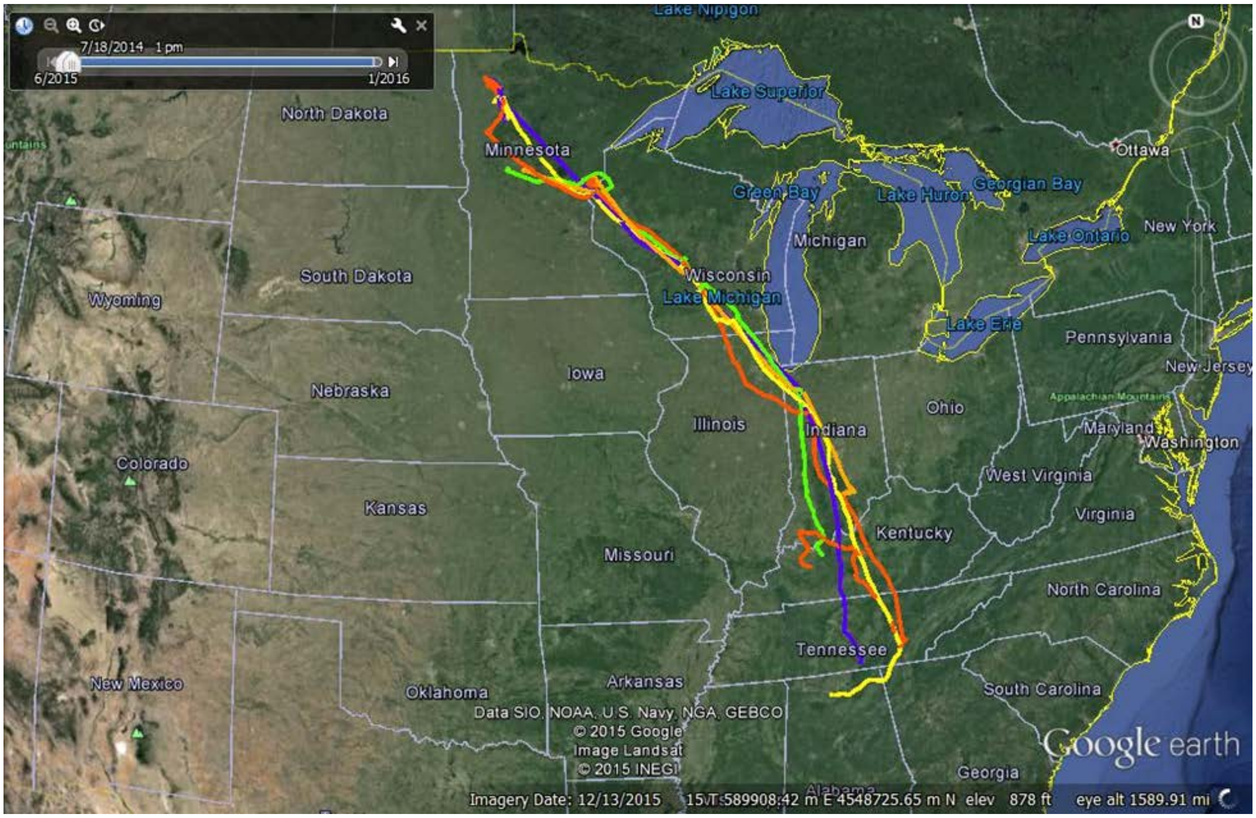

Figure 6. Migration trajectories during the summer and fall of 2015 of Eastern Population sandhill cranes (n = 5) captured in Minnesota.

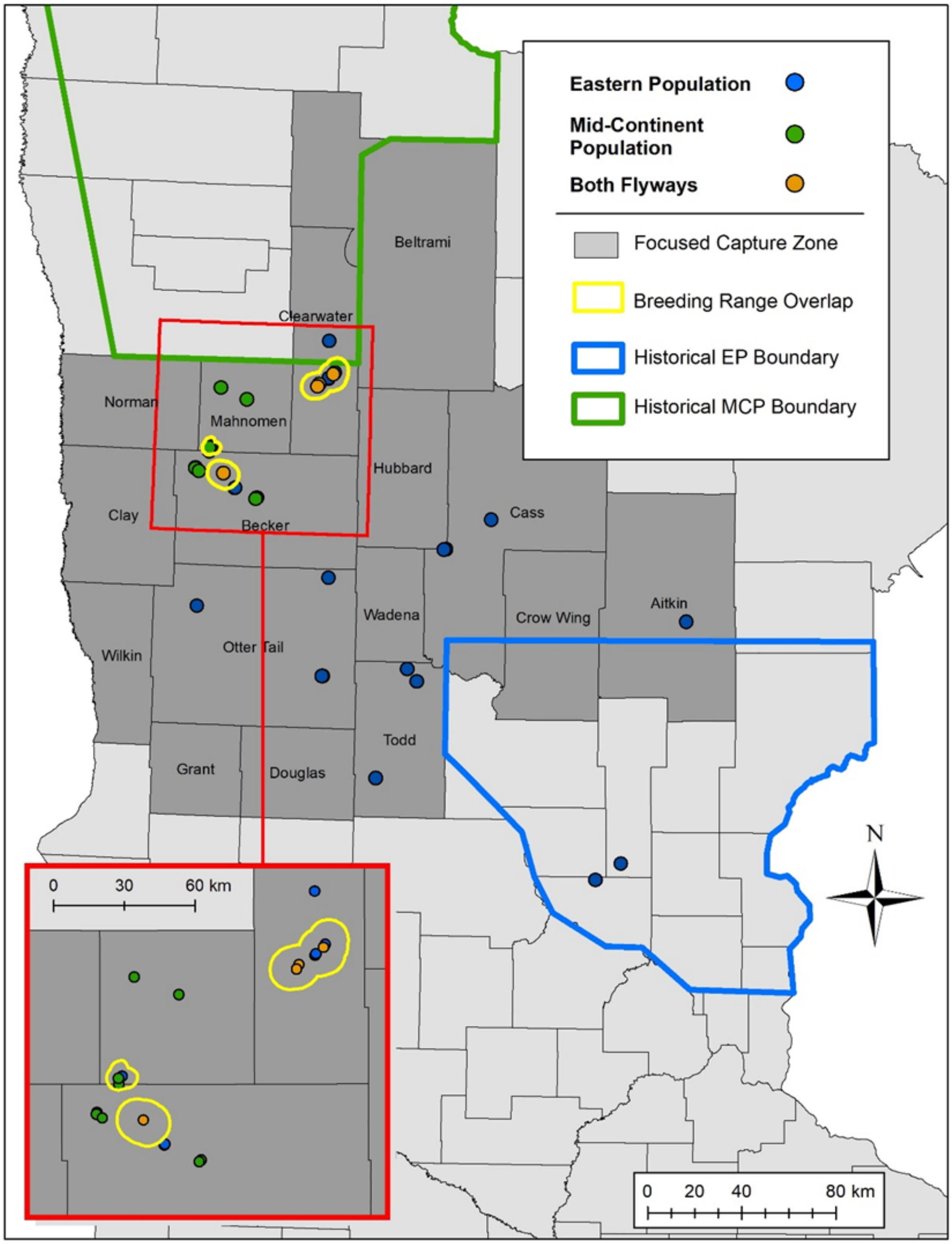

Figure 7. Capture locations of sandhill cranes during May-October 2014 and April-November 2015 in Minnesota, USA. Color of points represent population affiliation assigned based on migratory flyway (Central Flyway = Mid-Continent Population [MCP], Mississippi Flyway = Eastern Population [EP]), with MCP sandhill cranes in green (n = 9), EP sandhill cranes in blue (n = 23), and cranes that used both migration flyways in orange (n = 4). Historical range boundaries are shown with corresponding color affiliation. Areas used by cranes form multiple population segments (EP, MCP, both flyways) during 1 April-1 August of 2015 or 2016 are represented with yellow polygons.

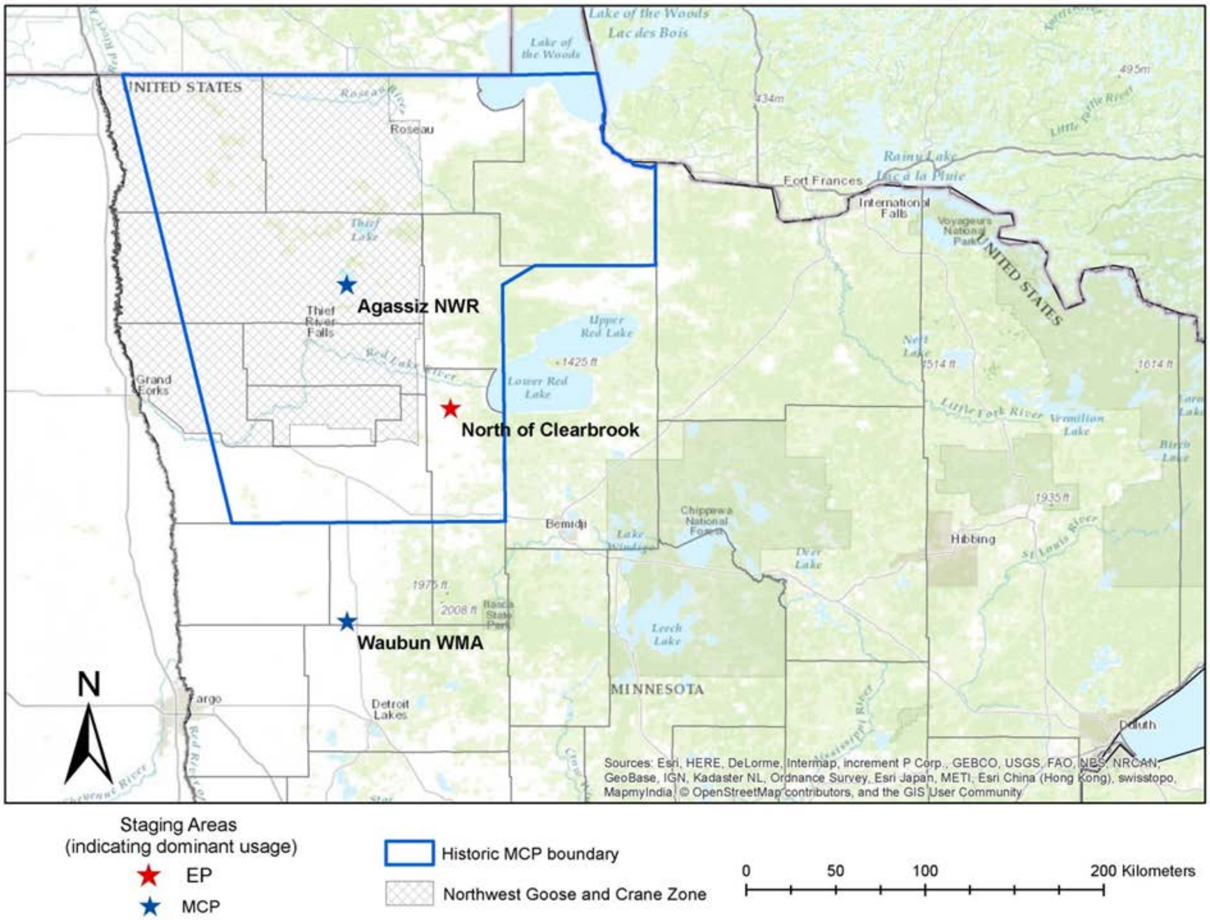

Figure 8. Areas of overlap between Eastern Population and Mid-Continent Population sandhill cranes in Minnesota, USA, during the autumn staging periods of 1 August-1 October 2015 and 2016. Red polygons represent overlap during 2015 and blue polygons represent overlap during 2016. The Northwest Goose and Crane Zone (open to MCP crane hunting) in northwestern Minnesota is indicated by the cross-hatched polygon. The historical Mid-Continent Population range boundary is indicated by the green polygon.

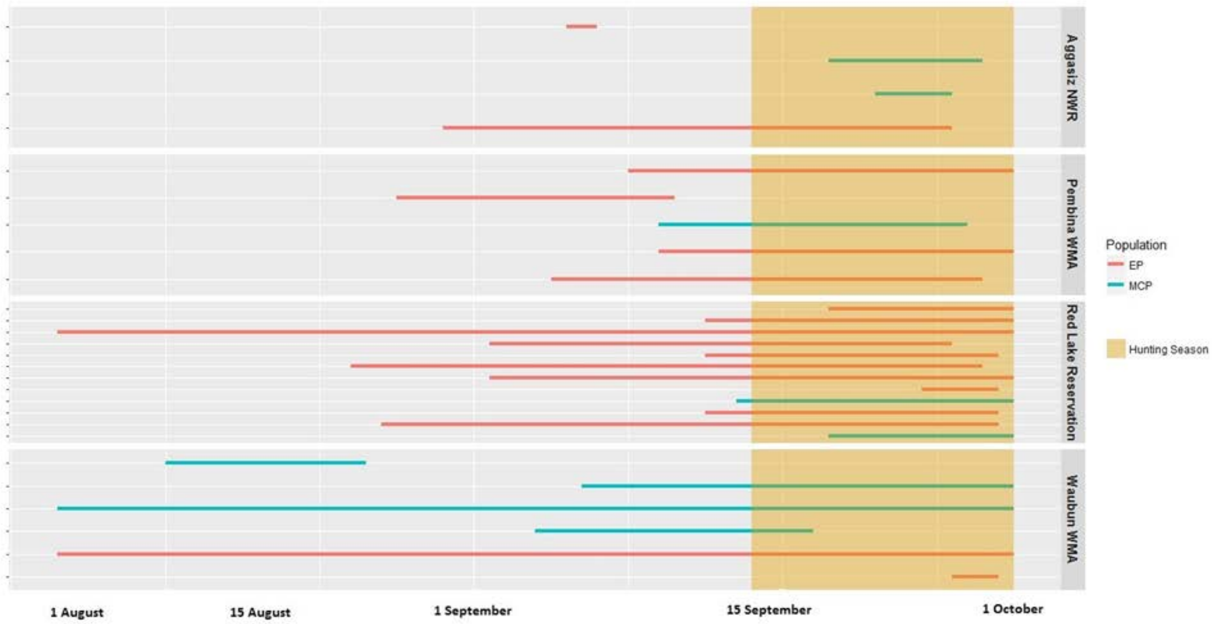

Figure 9. Temporal overlap between Eastern Population (EP) and Mid-Continent (MCP) sandhill cranes in Minnesota, USA, during the fall staging period of 1 August-1 October 2015 and 2016. Red lines represent use by EP cranes and green lines represent use by MCP cranes. The period of the fall hunting season within the Northwest Goose and Crane Zone (NWGCZ) in Minnesota, where MCP cranes are hunted, is highlighted in orange beginning on 15 September. The first and second staging areas (Agassiz National Wildlife Refuge and Pembina Wildlife Management Area) are within the NWGCZ, the third staging area (Red Lake Reservation) is just outside the boundary of the NWGCZ, and the last staging area (Waubun Wildlife Management Area) is further south of the NWGCZ.

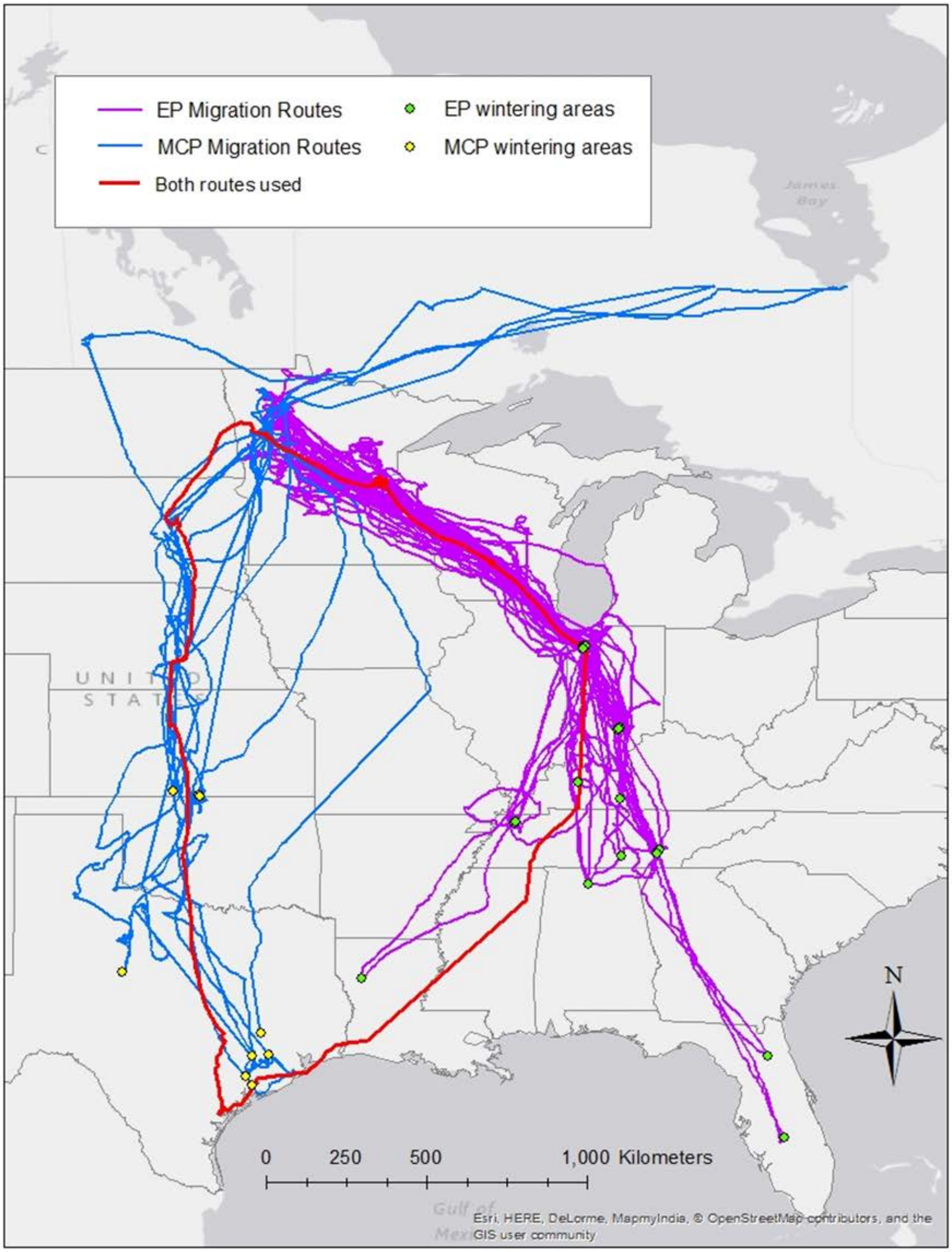

Figure 10. Migration routes of radio-tagged sandhill cranes in 2014 (*n* = 4) and 2015 (*n* = 36). Color of lines represent population affiliation, assigned based on migratory flyway (Central Flyway = Mid-Continent Population [MCP], Mississippi Flyway = Eastern Population [EP], with MCP sandhill cranes in green (*n* = 9), EP sandhill cranes in purple (*n* = 23), and cranes that used both flyways in orange (*n* = 4).