2022

MISSISSIPPI SANDHILL CRANE CONSERVATION UPDATE 2017-2019

SCOTT G. HEREFORD

ANGELA J. DEDRICKSON

MISSISSIPPI SANDHILL CRANE CONSERVATION UPDATE 2017-2019

SCOTT G. HEREFORD,[1] U.S. Fish and Wildlife Service, Mississippi Sandhill Crane National Wildlife Refuge, 7200 Crane Lane, Gautier, MS 39553, USA

ANGELA J. DEDRICKSON,[2] U.S. Fish and Wildlife Service, Mississippi Sandhill Crane National Wildlife Refuge, 7200 Crane Lane, Gautier, MS 39553, USA

Abstract: To manage crane habitat on the Mississippi Sandhill Crane National Wildlife Refuge during 2017-2019, 5,822 ha were treated with prescribed burns, 648 ha of woody vegetation were removed, 97 ha of invasive plants were chemically treated, and 1.2 ha of crops were planted. Mississippi sandhill crane (*Grus canadensis pulla*) use responded to habitat treatment; 348 of 349 VHF radio locations were in treated areas. There were 316 target predators removed. Eighteen captive-reared juveniles were acclimated and released. We detected an average of 38 nests per year, including a record 40 nests in 2019. Fifteen chicks fledged in 2019, a 25% increase over numbers fledging during 2014-2016. The December 2019 population was 138 cranes, up 7% from the previous 3 years, including 98 banded. The total home area used by the crane population during the period was 25,552 ha.

PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 15:134-140

Key words: endangered species, *Grus canadensis pulla*, habitat management, Mississippi, Mississippi sandhill crane, population, reintroduction techniques.

The Mississippi sandhill crane (*Grus canadensis pulla*) is an endangered non-migratory subspecies found in the wild only on and near the Mississippi Sandhill Crane National Wildlife Refuge (Refuge) in southeastern Mississippi (Fig. 1, USFWS 1991, Gee and Hereford 1995). The Refuge was established in 1975 to provide protection and recovery for the cranes, restore and maintain their wet pine savanna habitat, and provide compatible wildlife-oriented recreation (Hereford and Grazia 2008, Hereford and Billodeaux 2014, Hereford and Dedrickson 2016, Hereford and Dedrickson 2018). Recovery goals include ending the need for captive-reared cranes; attaining a free-living, stable, and self-sustaining population for 10 continuous years; and providing necessary habitat (USFWS 1991). A 1992 population viability assessment determined that the best chance of recovery included 60% fledgling production, 20% juvenile mortality, and 8% adult mortality (Seal and Hereford 1994). Refuge objectives include providing a self-sustaining population of 130-170 individuals, including 30-35 nesting pairs, fledging 10-15 young annually for at least 10 years; conducting effective predator control to provide maximum protection; providing 6,070 ha (15,000 acres) of savanna habitat; conducting prescribed burns of a 2-3 year rotation, or about 2,428 ha (6,000 acres) annually; creating shallow ponds for roosting; and conducting mechanical and chemical treatments to reduce woody vegetation (USFWS 2007). This update summarizes habitat management and predator control actions, crane monitoring, and crane population.

STUDY AREA

The 8,000-ha Mississippi Sandhill Crane National Wildlife Refuge is located in the Gulf Coastal Plain, less than 15 km from the Gulf of Mexico, in Jackson County, Mississippi. The area is characterized by a temperate climate, flat and low (mostly less than 10 m above sea level) topography, and poorly drained soils (Norquist 1984). Primary habitat types include coastal pine savannas, pine flatwoods/scrub, wooded swamps, and tidal marsh. Pine savannas comprise approximately half of the refuge and are dominated by a diverse, species-rich groundcover, low-growing shrubs, and scattered trees (Norquist 1984, Frost et al 1986). Characteristic savanna graminoids include *Aristida stricta*, *Andropogon* spp., *Ctenium aromaticum*, *Dicanthelium* spp., *Muhlenburgia capillaris*, *Rhynchospora* spp., *Schizachyrium scoparium*, and *Scleria* spp. Savanna forbs include *Aletris* spp.; *Balduina uniflora*; *Bigelowia nudata*; *Chaptalia tomentosa*; *Drosera brevifolia, capillaris, intermedia,* and *tracyii*; *Carphephorus* spp.; *Eriocaulon* spp.; *Eryngium* spp.; *Lachnanthes caroliniana*; *Lophiola americana*; *Polygala* spp.; *Rhexia alifanus, lutea, mariana,* and *petiolata*; *Sarracenia* spp.; *Tiedemannia filiformis*; *Triantha racemosa*; *Utricularia*

[1] E-mail: scott_hereford@fws.gov

[2] Present address: Upper Mississippi River NWFR–Savanna District, 7071 Riverview Road, Thomson, IL 61285, USA

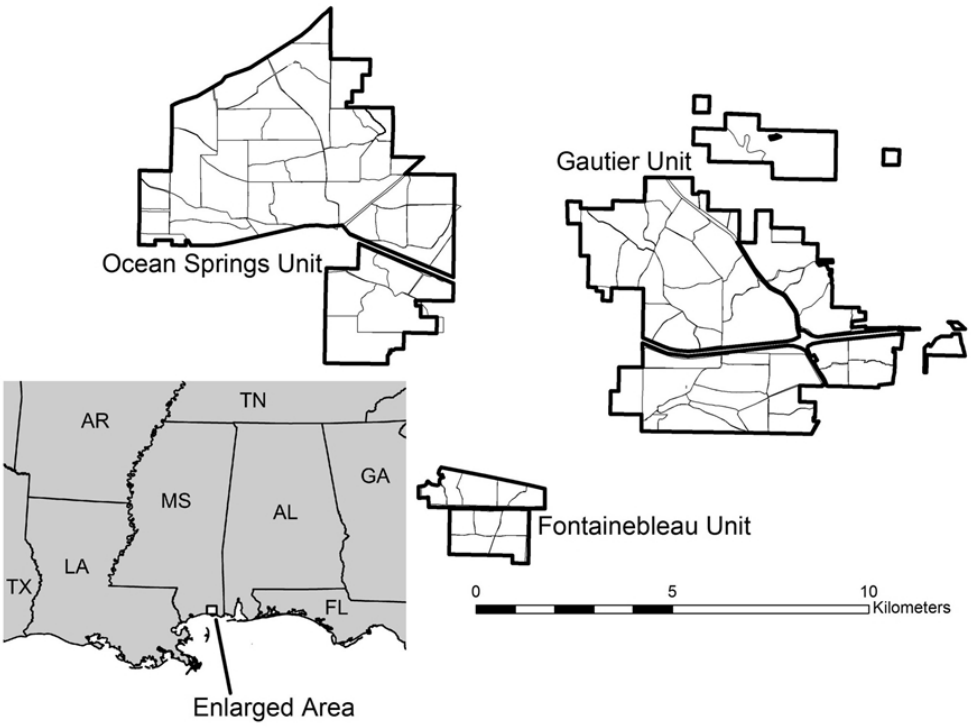

Figure 1. Location of Mississippi Sandhill Crane National Wildlife Refuge in southeast U.S. and the boundaries of its 3 main units and 102 management compartments.

spp.; and *Xyris* spp. Shrubs include *Cyrilla racemiflora, Cliftonia monophylla, Gaylussacia* spp., *Hypericum* spp., and *Ilex* spp., and trees include *Pinus elliotii, Pinus palustris,* and *Taxodium ascendens* (Norquist 1984, Clewell and Raymond 1995).

HABITAT MANAGEMENT

From 2017 to 2019, conservation efforts for the recovery of this population included protection and law enforcement, restocking, predator management, farming, prescribed burning, mechanical vegetation removal, hydrological restoration, pest plant management, and education. The 7,810-ha Refuge is comprised of 3 major units, 49 major management compartments, and 102 sub-compartments, the latter used primarily as boundaries for prescribed burning. To maintain open savanna and mimic the natural fire return interval of 2-3 years, Refuge staff conducted 72 prescribed burns on 67 days, totaling 5,822 ha, with 41.7% of the area burned during the growing season. There were 20 burns totaling 1,563 ha in 2017, 27 burns totaling 2,317 ha in 2018, and 25 burns completed for 1,942 ha in 2019. Several compartments were burned more than once during the period.

To restore open savanna, Refuge wildlife biologist and interns, Fire Management staff, contractors, college students, and Climb Community Development Corporation's Conservation Corps removed more than 648 ha (1,602 acres) of woody vegetation in 41 areas using mechanical methods. There were 377 ha (838 acres) of pine saplings treated with chain saws, including 2 ha in 2017, 120 ha in 2018, and 255 ha in 2019. There were 209 hectares (491 acres) of pine seedlings treated with lopping, including 45 ha in 2017, 120 ha in 2018, and 44 ha in 2019. Mulching machines were used to treat 96 ha (237 acres), including 58 ha in 2017, 18 ha in 2018, and 20 ha in 2019. There were 18 pasture or crop units totaling 182 ha which were mowed either 2 or 3 times annually. In 2017, there were 1.2 ha planted of an annual winter "wildlife mix" that included ryegrass (*Lolium* spp.) into 2 different units, which the cranes utilized for supplemental food. Cogongrass (*Imperata cylindrica***)** remained the most invasive plant and Refuge staff chemically treated 97 ha (242 acres) of cogongrass, including 17 ha in 2017, 6 ha in 2018, and 74 ha in 2019, the last being a record high. Biology staff hand pulled 4 ha of bag pod (*Sesbania vesicaria*) and

chemically treated 0.1 ha of Chinese tallow (*Triadica sebifera*).

POPULATION MANAGEMENT

Predator Removal

To protect cranes during nesting and release, a local contracted predator trapper conducted trapping 4-6 months per year, from November into April or May. There was a total effort of 11,952 trap nights, including 4,397 in 2018, 3,487 in 2018, and 4,068 in 2019. The trapper removed a total of 53 coyotes (*Canis latrans*), 14 bobcats (*Lynx rufus*), 12 foxes (*Vulpes vulpes*), and 237 raccoons (*Procyon lotor*) over the 3 years. That included 21 coyotes, 5 bobcats, 1 fox, and 101 raccoons in 2017, 21 coyotes, 8 bobcats, 6 foxes, and 40 raccoons in 2018, and 11 coyotes, 1 bobcat, 5 foxes, and 96 raccoons in 2019.

Release of Captive-Reared Cranes

As part of the ongoing supplementation program conducted to bolster the population, 545 captive-reared cranes in 84 cohorts have been released since 1981. All but 8 were released using the acclimated technique developed for this population with parent-reared juveniles (Zwank and Derrickson 1982) and later enhanced by adding costume-reared juveniles and other productivity-increasing procedures (Ellis et al. 1992, Ellis et al. 2000). Top-netted pens were added in 2015 (Hereford and Dedrickson 2018). During 2017-2019, 20 captive-reared juveniles were received as part of 5 cohorts. Ten juvenile cranes were from the Audubon Species Survival Center (ASSC), New Orleans, Louisiana, and 10 were from the White Oak Conservation Center (WOCC), Yulee, Florida. Two juveniles from the ASSC 2018 cohort died during acclimation. We released 18 juvenile cranes, including 3 in 2017, 6 in 2018, and 9 in 2019. The 3 juveniles in 2017 were released from the East Flat Crop Unit in Refuge unit O10N. In late 2019 and early 2020, 2 cohorts of 3 were released from the Headquarters Savanna in Refuge unit G07. In late 2019, 1 cohort of 6 was released from Gautier Crop Unit in Refuge unit G05N and a cohort of 3 from the Headquarters Savanna.

We acclimated all 5 cohorts for 4-5 weeks in top-netted pens. Four pens were used for pre-release acclimation during this period: 2017 East Flat, 2018 Headquarters, 2019 Headquarters, and 2019 Gautier. The first 3 pens were stand-alone pens and 30.5 m wide × 46 m long with the top-netting height varying between 2.1 m and 3.0 m. The first 2 pens were the same size and material with a single 35-m × 50-m piece of polyethylene mesh netting (6.3 cm × 6.3 cm) forming the sides and top of the pen. The 2019 Headquarters pen was the same size and footprint, but was built with metal ground tube supports, metal perimeter posts, metal perimeter fencing, and metal door. The Gautier netted pen was built inside the permanent chain link 1-ha Gautier open-top pen and incorporated the chain link of the open-topped pen for 3 of its 4 sides. Because that larger pen was a hexagon, the new 0.11-ha (0.28-acre) top-netted pen was a trapezoid with dimensions of 18.6 m (61 feet) × 61 m (200 feet) × 18.6 m (61 feet) × 80m (261 feet). The longer internal side was built by extending the top netting down to the ground and staking it so cranes could not get under it. At release in the side-netted pens, 1 end was opened for the cranes to leave. In the 2 pens with metal perimeter, the cranes were herded through the narrow door.

Each release crane was fitted with a unique color combination of 3 plastic leg bands (Fraunhofer Institute, Berghausen, Germany) above the right hock joint and an aluminum U.S. Geological Survey (USGS) band above the left hock joint. One individual in each of the 2018 and 2019 Headquarters and the 2019 Gautier cohorts was fitted with a backpack-mounted Global Positioning System/Global System for Mobile Communication or GPS-GSM transmitter (Cellular Tracking Technologies, Rio Grande, New Jersey). The rest of the cranes were fitted with a leather leg-mount VHF radio transmitter (Lotek, Newmarket, Ontario, Canada) below the USGS band and just above the hock joint on the left leg.

To assess vigilance during acclimation, interval time budget data were collected. During each 50-minute sampling session, behavior of all cranes in the pen was scored every 30 seconds. The percentage of time each crane was alert and the percentage of time where at least 1 crane in the release cohort was alert was used to measure vigilance. The average percent alert behavior varied from 4.5 to 34.3. Percent alert behavior increased during acclimation in all but 1 crane; the trendline slope of alert behavior in individual cranes varied from $y = -1.1407x + 18.626$ to $y = 2.455x + 21.073$. The percent of time where at least 1 crane in a cohort was alert averaged between 30.2 and 34.2% for 4 of the cohorts with the fifth cohort averaging 60.2%. It increased

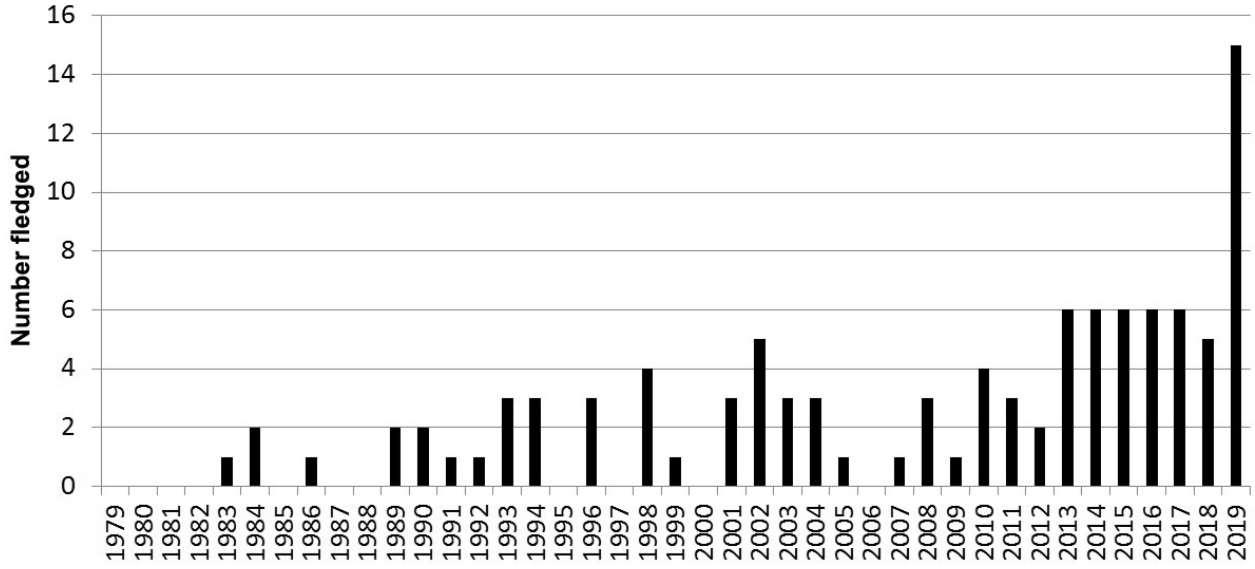

Figure 2. Number of Mississippi sandhill crane chicks fledged per year on and near the Mississippi Sandhill Crane National Wildlife Refuge, Jackson County, Mississippi, 1979-2019.

during acclimation for all 5 cohorts with the slope trendline varying between $y = 0.2273x + 58.818$ and $y = 1.6549x + 18.802$.

To assess response to a predator and effects of prior antipredator training (Howard et al. 2018), each cohort was presented with 1 predator challenge during acclimation. A human wearing a ghillie suit led a leashed German shepherd dog in view of the cranes and past 1 side of the pen. Distance from the predator to the cranes and their behavioral response was measured as well as the time it took them to return to foraging or maintenance behavior after the predator was out of view. The detection distance was 200 m to 100 m, responses varied from walk away, flush up into the top netting, and fly away, and recovery time was from 3 to 9 minutes.

MONITORING

To monitor crane response and assess progress towards recovery, 3,624 observations were collected for an average of 1,208 per year, including 518 VHF radio fix locations (172.6/yr), 2,898 visual-only (966/yr), and 171 aural observations (57/yr). There were 2,625 observations (875/yr) on the Refuge and 969 (323/yr) off the Refuge. Camera traps were used at 42 locations, all but 1 on the Refuge. From the hundreds of thousands of camera trap images, 4,160 (1,386.7/yr) key observations were recorded as observations. Twelve cranes, 4 AHY and 8 HY, were captured for banding or replacing radio transmitters during the period of this report. Six were caught by running down and 6 were caught using a soft coffin or trough blind (Folk et al. 1999). Forty-one cranes were equipped with VHF radios during 2017-2019.

Crane use responded to habitat management. All but 1 of the 349 radio-fix locations on the Refuge were in areas that received habitat treatments during the same period. Of the 2,046 visual observations on the refuge, 1847 (90%) were in areas that received habitat treatments. Since most treatments removed woody vegetation and or reduced height of herbaceous vegetation, cranes were more visible in those areas. Eight new nesting territories were in areas receiving habitat treatment.

Using the ArcMap 10.6 (Esri, Redlands, California, USA) convex hull function, the total range of all locations was 25,552 ha (63,142 acres). Using the USGS National Landover 2016 database (Jin et al. 2019), 38.5% of the locations were in shrub/scrub, 19.9% in woody wetlands, 12.4% in grassland/herbaceous, 9.9% in evergreen forest, 7.5% in emergent herbaceous wetland, 5.2% in developed open space, 3.6% in pasture/hay, 1.8% in cultivated crops, and 1.2 % in other habitats. For the radio fix locations, 41.9% were in shrub/scrub, 20.7% in evergreen forest, 12.8% in woody wetlands, 5.5% in

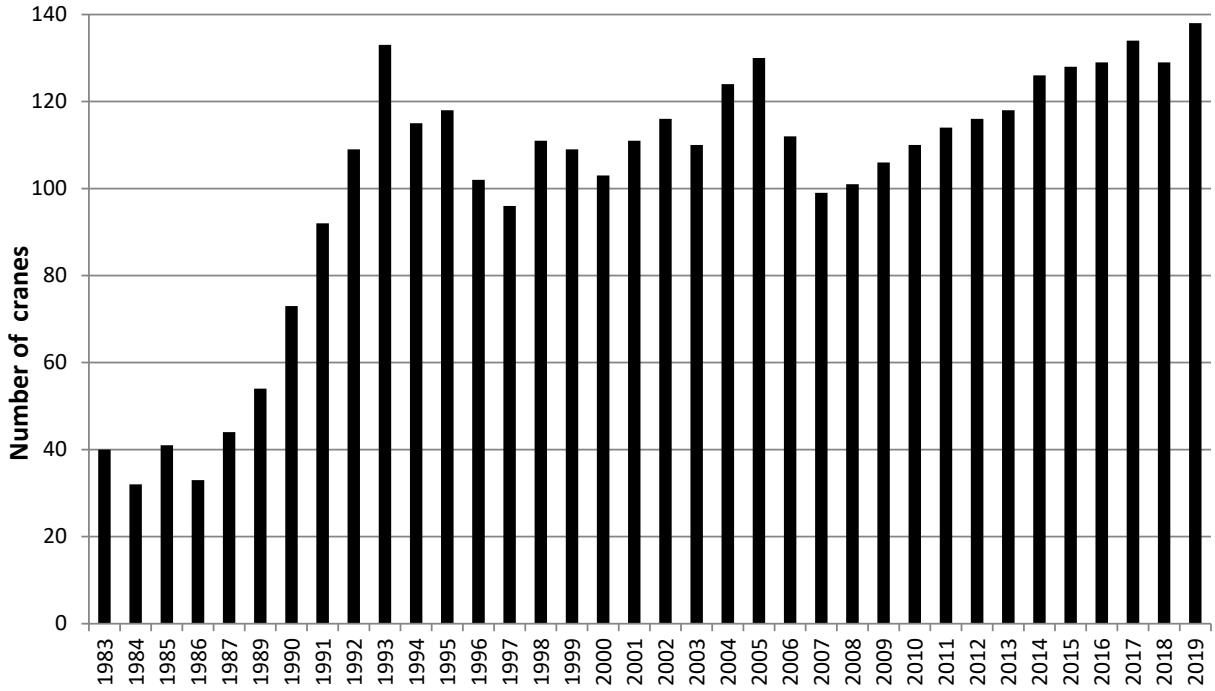

Figure 3. Year-end population of Mississippi sandhill cranes on and near the Mississippi Sandhill Crane National Wildlife Refuge, Jackson County, Mississippi, 1983-2019.

grassland/herbaceous, 4.5% in cultivated crops, 4.1% in emergent herbaceous wetlands, 3.4% in developed open space, 3.1% in pasture/hay, and less than 4.1% in other landcover types.

From November 2018 through 2019, we obtained 5,995 locations from GPS-GSM units (490 for crane 1803, 5,172 for crane 1807, 239 for crane 1901, and 94 locations for crane 1904). There were 43.9% locations for evergreen forest, 30.4% for shrub/scrub, 12.4% for developed open space, 6.6% for emergent herbaceous wetlands, 2.4% for woody wetlands, and the remaining 4.3% across other habitats (less than 1% in each). Habitat use was greater than availability for evergreen forest and shrub/scrub and less than availability for open water and woody wetlands.

Nesting

Nest surveys (Hereford and Dedrickson 2018) were conducted over 86 days in 2017 (171-day span), 78 days in 2018 (155-day span), and 61 days in 2019 (182-day span). Camera traps were used at 42 areas, all but 1 on the Refuge. There were 117 road surveys (43 in 2017, 40 in 2018, and 34 in 2019), 44 call surveys (12 in 2017, 21 in 2018, and 11 in 2019), 76 early morning blind surveys (18 in 2017, 43 in 2018, and 15 in 2019), 241 ground searches/visits (82 in 2017, 92 in 2018, and 67 in 2019), 3 surveys using all-terrain vehicles (2 in 2018 and 1 in 2019), 78 aerial surveys using small unmanned aerial systems (Hereford et al. 2022), 2 boat surveys (1 each in 2018 and 2019), and 279 total area visits (90 in 2017, 115 in 2018, and 74 in 2019) to 42 different areas in 2017, 39 in 2018, and 38 in 2019.

During the 3-year period, 155 nests were detected. There were 36 pairs and 48 nests in 2017, 37 pairs and 55 nests in 2018, and 40 pairs and 52 nests in 2019. Sixty-four nests were located (19 in 2017, 27 in 2018, and 18 in 2019) and the rest were indicated by behavioral evidence away from the nest. Forty nesting pairs was a record high, going back to the first nest surveys in 1965. Over the 3 years, 40 nests were located in ponds, 17 in savanna, 4 in hydric drains, and 3 in estuarine marsh. A total of 114 live-chick nests visits were made (39 in 2017, 37 in 2018, and 38 in 2019). Chick handling events (to weigh or measure small chicks or band larger chicks) were limited to 7 events (3 in 2017, 1 in 2018, and 3 in 2019). There were 14 new nesting pairs (8 in 2017, 3 in 2018, and 3 in 2019), as determined from bands or observing new unbanded birds in an area. We removed 11 eggs from 9 nests (5 in 2017, 2 in 2018, and 4 in 2019); all eggs went to ASSC for captive rearing for later releases. There were 6 chicks fledged in 2017,

5 in 2018, and a record 15 chicks fledged in 2019 (Fig. 2), a 250% increase over the previous high and close to replacing annual mortality. There was no known reason for the record recruitment in 2019. Weather, predator management, habitat, availability of supplemental food, and other factors did not seem different from other recent years.

POPULATION

There were confirmed mortalities of 13 cranes: 1 in 2017, 5 in 2018, and 7 in 2019. Of 11 with known or suspected causes of death, 6 were due to predation, 4 to disease, and 1 to trauma (vehicle strike). Another 31 birds were missing and presumed dead, including 8 in 2017, 11 in 2018, and 12 in 2019. The monitoring effort and number of transmitter-equipped cranes was lower than 20 years earlier, so the cause of death for most was unknown. Diseases, like adenocarcinoma (Ellis et al. 2000), may still be important but undetected.

The December 2019 population was 138 cranes, up 7% from 3 years earlier, 98 of which were banded (Fig. 3). The proportion of banded cranes has decreased from 80% to 67% due to the sharp recent increase in wild recruitment, most of which are not banded. There were 53 males, 60 females, and 25 of unknown sex. Seventy-three were in the Gautier Unit (east) area, 51 in the Ocean Springs (west) area, and 13 in the Fontainebleau (south) area. The population included 55 cranes that had been reared at ASSC, 20 at WOCC, and 2 at the Patuxent Wildlife Research Center, Laurel, Maryland, and 61 cranes that were wild-hatched. There were 39 breeding pairs, 4 pairs with 1 experienced breeder, an additional 4 behavioral pairs, and 45 unpaired cranes. At least 32 cranes were 3 years of age or younger. The oldest marked crane was 30 years old.

ACKNOWLEDGMENTS

We thank Refuge staff, including management, fire management, law enforcement, and visitor services. Interns R. K. Caplan, M. S. Conrad, S. M. Finnerty, R. K. Hogarth, K. C. Russo, V. D. Schneider, K. M. Stemmler, J. W. Stockdale, V. E. Thorpe, V. M. van Vianen, and S. G. Welch provided invaluable field support. The U.S. Fish and Wildlife Service's Mississippi Field Office, Audubon Species Survival Center, White Oak Conservation Center, and University of New Orleans were key conservation partners. The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

LITERATURE CITED

Clewell, A. F., and C.A. Raymond. 1995. Preliminary characterization of vegetation at Mississippi Sandhill Crane National Wildlife Refuge. Unpublished report, U.S. Fish and Wildlife Service, Jackson, Mississippi, USA.

Ellis, D. H, G. F. Gee, S. G. Hereford, G. H. Olsen, T. D. Chisolm, J. M. Nicolich, K. A. Sullivan, N. J. Thomas, M. Nagendran, and J. S. Hatfield. 2000. Post-release survival of hand-reared and parent-reared Mississippi sandhill cranes. Condor 102:104-112.

Ellis, D. H, G. H. Olsen, G. F. Gee, J. M. Nicolich, K. E. O'Malley, M. Nagendran, S. G. Hereford, P. Range, W. T. Harper, R. P. Ingram, and D. G. Smith. 1992. Techniques for rearing and releasing nonmigratory cranes: lessons from the Mississippi sandhill crane program. Proceedings of the North American Crane Workshop 6:135-141.

Folk, M. J., J. A. Schmidt, and S. A. Nesbitt. 1999. A trough blind for capturing cranes. Journal of Field Ornithology 70:251-256.

Frost, C. C., J. Walker, and R. K. Peet. 1986. Fire-dependent savannas and prairies of the Southeast: original extent, preservation status and management problems. Pages 348–357 *in* D. L. Kulhavy, and R. N. Connor, editors. Wilderness and natural areas in the eastern United States: a management challenge. Center for Allied Studies, School of Forestry, Stephen F. Austin University, Nacogdoches, Texas, USA.

Gee, G. F., and S. G. Hereford. 1995. Mississippi sandhill cranes. Pages 75-77 *in* E. T. Larue, G. S. Farris, C. E. Puckett, P. D. Doran, and M. J. Mac, editors. Our living resources: a report to the nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems. U.S. Department of the Interior, National Biological Service, Washington, D.C., USA.

Hereford, S. G., R. Brown, and S. Bishaw. 2022. Testing use of small UAS to detect nesting sandhill cranes. Proceedings of the North American Crane Workshop 15:164 [abstract].

Hereford, S. G., and A. J. Dedrickson. 2016. Mississippi sandhill crane conservation update 2011-13. Proceedings of the North American Crane Workshop 13:128.

Hereford, S. G., and A. J. Dedrickson. 2018. Mississippi sandhill crane conservation update 2014-2016. Proceedings of the North American Crane Workshop 14:131-136.

Hereford, S. G., and L. E. Billodeaux. 2014. Mississippi sandhill crane update. Proceedings of the North American Crane Workshop 12:91 [abstract].

Hereford, S. G., and T. E. Grazia. 2008. Mississippi sandhill crane conservation update, 2003-2005. Proceedings of the North American Crane Workshop 10:156 [abstract].

Howard, J. J., R. A. Dunn, and S. G. Hereford. 2018. Antipredator training for captive-reared Mississippi sandhill crane chicks. Proceedings of the North American Crane Workshop 14:137-141.

Jin, S., C. G. Homer, L. Yang, P. Danielson, J. Dewitz, C. Li, Z. Zhu, G. Xian, and D. Howard. 2019. Overall methodology design for the United States National Land Cover Database 2016 products. Remote Sensing 11(24):2971.

Norquist, C. 1984. A comparative study of the soils and vegetation of savannas in Mississippi. Thesis, Mississippi State University, Starkville, USA.

Seal, U. S., and S. Hereford, editors. 1994. Mississippi sandhill crane *Grus canadensis pulla* population and habitat viability assessment workshop report. IUCN/SSC Captive Breeding Specialist Group. Apple Valley, Minnesota, USA.

U.S. Fish and Wildlife Service [USFWS]. 1991. Mississippi sandhill crane *Grus canadensis pulla* recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia, USA.

U.S. Fish and Wildlife Service [USFWS]. 2007. Mississippi Sandhill Crane National Wildlife Refuge comprehensive conservation plan. U.S. Fish and Wildlife Service. Atlanta, Georgia, USA.

White, G. C., and R. A. Garrott. 1990. Analysis of radio-tracking data. Academic Press, San Diego, California, USA.

Zwank, P. J., and S. R. Derrickson. 1982. Gentle release of captive parent-reared sandhill cranes for release in the wild. Pages 112-116 *in* J. C. Lewis, editor. Proceedings 1981 crane workshop. National Audubon Society, Tavernier, Florida, USA.