

First description of a Bald Eagle (*Haliaeetus leucocephalus*) attempting depredation on an adult Whooping Crane (*Grus americana*) of the Aransas-Wood Buffalo population

MATTHEW R. RABBE^{1,*}, ANDREW J. CAVEN², AND JOSHUA D. WIESE²

¹United States Fish and Wildlife Service, Nebraska Ecological Services Office, Wood River, NE 68883

²Platte River Whooping Crane Maintenance Trust, Wood River, NE 68883

ABSTRACT.—Twice annually, the last remaining wild and self-sustaining migratory population of Whooping Cranes (*Grus americana*) migrates through central Nebraska on its approximately 3900-km journey between Aransas National Wildlife Refuge on the Gulf Coast of Texas and Wood Buffalo National Park in Alberta, Canada. On 27 March 2018, a juvenile Bald Eagle (*Haliaeetus leucocephalus*) was observed attacking a Whooping Crane on the Loup River near Rockville, Nebraska. The encounter, documented by a private landowner, was forwarded to the U.S. Fish and Wildlife Service as part of the decades-long citizen-science effort undertaken to track and record public sightings of Whooping Cranes during migration. Crane species have few avian predators, and observations of depredations upon these crane species are rare. The Whooping Crane fended off the Bald Eagle, utilizing a “jump-rake” defense; neither species appeared harmed by the clearly aggressive interaction. The episode was reflective of recent observations of Bald Eagles depredating Sandhill Cranes on the Platte River during the spring migration. To our knowledge, this is the first description in scientific literature of a Bald Eagle attacking a Whooping Crane from the Aransas-Wood Buffalo population.

RESUMEN.—Dos veces al año, la población migratoria remanente de grullas trompeteras (*Grus americana*) salvajes y autosuficientes migra por el centro de Nebraska, en un viaje de aproximadamente 3900 km entre el Refugio Nacional de Vida Silvestre Aransas (en la costa del golfo de Texas) y el Parque Nacional Wood Buffalo (Alberta, Canadá). El 27 de marzo de 2018, se observó a un águila calva joven (*Haliaeetus leucocephalus*) atacando a una grulla trompetera en el río Loup cerca de Rockville, Nebraska. El encuentro, documentado por un vecino de la zona, fue enviado al Servicio de Pesca y Vida Silvestre de los EE.UU. como parte de una labor científica realizada durante décadas por ciudadanos comunes cuyo objetivo es el de rastrear y registrar avistamientos públicos de grullas trompeteras durante sus períodos migratorios. Estas especies de grullas tienen pocos depredadores aviares, por lo que es raro observar actos de depredación sobre ellas. La grulla trompetera se defendió del águila calva mediante una defensa de tipo “rastrillo”; sin embargo, ninguna de las especies pareció dañarse ante esta interacción claramente agresiva. El episodio fue el reflejo de recientes observaciones de águilas calvas depredando a grullas canadienses en el río Platte durante su migración en primavera. Hasta donde sabemos, esta es la primera descripción en la literatura científica de un águila calva atacando a una grulla trompetera de la población de Aransas-Wood Buffalo.

The Whooping Crane (*Grus americana*; WHCR), federally listed as endangered under the U.S. Endangered Species Act (ESA; 93rd U.S. Congress 1973, as amended), is one of North America’s rarest and most iconic avian species (Gray and Harrell 2017). The Aransas-Wood Buffalo population, the only wild and self-sustaining migratory population, numbered as few as 16 birds in 1941. Recent estimates suggest the species has sustained considerable long-term growth with numbers now reaching about 500 individuals (Butler and Harrell 2018).

The species’ biannual migration through the Great Plains includes large portions of central Nebraska, where a remaining network of intact wetlands and rivers is used for principal stopover habitat on the approximately 3900-km journey the species makes every spring and fall (Lingle et al. 1991, Stahlecker 1997, Farmer et al. 2005, Pearse et al. 2017). Stopover sites provide necessary caloric resources and secure roosting places for WHCRs throughout their migration corridor (Alerstam and Högstedt 1982, Newton 2006).

*Corresponding author: matt_rabbe@fws.gov

Nebraska is known for having more miles of river than any other state, and is the only state within the migration corridor where WHCR use of riverine stopover sites may outnumber palustrine or lacustrine wetland stopover sites (Austin and Richert 2005). Some of the earliest and most frequent migratory records of WHCRs were in Nebraska (Allen 1952). As conservation efforts and awareness increased and the ESA was enacted into law, the United States Fish and Wildlife Service (USFWS) cataloged historic records of WHCR sightings. Opportunistic sightings of WHCRs were collected and recorded using a citizen-science approach, wherein a network of state and federal contacts gathered, investigated, and recorded Whooping Crane sightings during migration (Niemuth et al. 2018). Over time, these efforts increased and the scope of collected information expanded to include descriptions of the behaviors observed, site characteristics, circumstances of observation (e.g., binoculars at 600 m), and photographic or video documentation (if available). The effort collectively became referred to as the Cooperative Whooping Crane Tracking Project (WCTP), and the records are updated with each spring and fall migration. Confirmed sightings include those documented by photographic or video records, by a professional biologist or qualified individual, or from observer interviews and circumstances surrounding the sighting.

The Loup River system in Nebraska (North, South, Middle, and main-stem Loup River collectively) is a tributary of the Platte River and part of a vast network of rivers within the state that provide habitat for WHCRs (Sharpe et al. 2001). The Loup River is primarily a spring-fed, sandy-bottom braided river, with wide channels containing shallow sandbars that are used as night-roosting and diurnal-foraging habitat by migrating WHCRs (Stahlecker 1997, Austin and Richert 2005). The neighboring landscape consists of agricultural fields, lowland grasslands and wet meadows, and riparian forest (Kaul et al. 2006, Bishop et al. 2011). The Loup River is also used by Bald Eagles (*Haliaeetus leucocephalus*; BAEA) throughout the year as breeding, migratory, and wintering habitat. In Nebraska, BAEAs are most abundant during their spring migration from late February to early March (Sharpe et al. 2001). Mature

eastern cottonwoods (*Populus deltoides*) adjacent to the Loup River offer perching trees and nesting habitat in close proximity to prey sources preferred by BAEAs whose use of the area has expanded over time (Steenhof et al. 1980, Anthony and Isaacs 1989, Buehler et al. 1992, Sharpe et al. 2001, Bishop et al. 2011, Jorgensen and Dinan 2018). BAEAs were formerly on the ESA, but range expansion and an increasing population led the U.S. Fish and Wildlife Service (USFWS) to remove them in 2009, though they remain protected under the Bald and Golden Eagle Protection Act (USFWS 2018a).

On 27 March 2018, a juvenile BAEA was observed and photographed attacking a WHCR on the Loup River near Rockville, Nebraska, midway through the WHCR's 29-d stopover (John Conkin, Canadian Wildlife Service, personal communication). The attack provides novel information regarding the behavioral strategies of both species. The report was forwarded by a local landowner on the Loup River who had observed the group many times previously. At approximately 17:30, the landowner concealed himself near a previously known roost location on the bank of the Loup River. At this point, the WHCRs were about 400 m away. A short time later, they flew up and over the riparian forest to an adjacent cornfield. At 19:00, after feeding for an hour, the WHCRs got up and landed on the river directly in front of the landowner at a distance of 75 m (approximate coordinates: 41.141598°, -98.876501°). There, he began closely observing them. The WHCRs were engaged in both social displays and bathing in the water, and did not appear alert, vigilant, or disturbed in any way. At 19:15, a single juvenile BAEA flew over them, causing a sudden change in behavior. The family group instantly became alert and alarmed, adopting the characteristic alert posture described by Ellis et al. (1998), with their heads extended upward and somewhat forward, watching and following as the BAEA flew overhead (Fig. 1). Moments later, a second juvenile BAEA was observed in the vicinity. At approximately 19:30, another fly-over by one of the 2 BAEAs prompted the landowner to try to take a picture of the BAEA. As the landowner clicked the shutter, the BAEA dove straight down and attacked one of the adult WHCRs. The encounter was



Fig. 1. A family group of Whooping Cranes (*Grus americana*) displaying alert behavior as a 2-year-old Bald Eagle (*Haliaeetus leucocephalus*) hovers overhead on 27 March 2018 within the main channel of the Middle Loup River, Sherman County, Nebraska, USA. Photo by L. Burman.

brief and the attempted depredation was unsuccessful as the attacked adult WHCR engaged with the BAEA, utilizing an agonistic “attack and mob” behavior termed a “jump-rake” by Ellis et al. (1998) and Heatley (2002). The WHCR leaped into the air with its wings spread wide and met the BAEA, slashing at its opponent with its talons (Fig. 2). The BAEA is believed to have made brief physical contact with the crane’s wing, though neither bird exhibited signs of injury.

The events were photographed by using a Canon Eos 60D camera equipped with a 150–600-mm lens (images captured using a 600-mm lens). Following the report, we visited the site of the observation to visually assess habitat conditions. The river channel at this location was approximately 215 m wide (measure tool, Google Earth Pro 2018). Water depth varied from 0 cm deep (exposed sandbar) to approximately 10 cm at the location of the attack. Data from the WCTP and radio-tracking telemetry data indicate repeated high use of the Loup River by WHCRs (Austin and Richert 2005, Pearse et

al. 2015, USFWS 2018b). The Loupe River is likely used annually, though efforts to document its use in WCTP are less intensive than in other areas of Nebraska such as the Platte River (Hefley et al. 2015).

We observed 2 BAEAs during the attack and aged them using the plumage molt progression portrayed by McCollough (1989). The BAEA involved in the attack was a 2-year-old juvenile and the second BAEA was a 1-year-old juvenile. The WHCRs did not immediately attempt to fly away and remained in the vicinity following the attack. Upon review of the photographs, the juvenile WHCR was noted as having GPS tracking equipment on its left leg with the identification 5A (ID: 2017-5A). Given that the individual was <1 year old, we determined that it had been recently affixed with radio-tracking equipment and was likely transmitting at the time of its stay in Nebraska. Whooping Crane 2017-5A was banded in 2017 as a chick on its breeding grounds and likely traveled with its family throughout the spring migration north (John Conkin, Canadian Wildlife Service,



Fig. 2. A second-year Bald Eagle (*Haliaeetus leucocephalus*) engaged in attack on a Whooping Crane (*Grus americana*) as it defends itself using the “jump rake” agonistic behavior on 27 March 2018 in the main channel of the Middle Loup River, Sherman County, Nebraska, USA. Photo by L. Burman.

personal communication). Radio-tracking data indicated that the crane group departed their previous known stopover location near Coats, Kansas, at approximately 09:30 on 14 March 2018, and arrived on the Middle Loup River at approximately 17:50 that same day. On 27 March, shortly after the attack occurred, radio-tracking data indicated that the family group permanently moved roost locations approximately 2.4 km upstream from their former roosting area and stayed an additional 16 evenings before departing on 12 April 2018. The 29-d stopover represents one of the longer stopovers documented during migration in the United States (USFWS 2018b). Records from the WCTP (2018) indicate that the average length of stay at stopovers for WHCRs in the Aransas-Wood Buffalo population during migration throughout the United States is <3 d ($\bar{x} = 2.87$, $SD = 5.85$, $n = 3245$, 1942–2018). However, in Nebraska, an average length of stay for the population was 4.04 d ($SD = 6.85$, $n = 801$, 1942–2018). The individuals’ encounter with the BAEA described here occurred near the midpoint of

the stopover, 13 d after they first arrived in the area. During the remaining portion of their stay, they were observed numerous times by the public with no discernable injuries noted (WCTP 2018). It remains unknown whether the attack had any lasting impact on the cranes’ length of stay or the remainder of their migration.

BAEA populations have continued to increase in size throughout Nebraska, including on the Loup River system (Sharpe et al. 2001, Jorgensen and Dinan 2018). BAEAs are also common year-round in the general vicinity of the encounter, and they were observed on a follow-up site visit to the area with the landowner on 28 September 2018 (Lawrence Burman personal communication). An eagle nest was also observed approximately 900 m downstream (41.1352° , -98.86801°) of the attack location. The landowner provided records of nesting on the property since 2014 from memory and photo documentation, suggesting that the area contains suitable BAEA habitat (Granger 1992, Bowerman et al. 2002).

Juvenile BAEAs are more likely than adults to exhibit migratory or nomadic behavior, and they follow temporospatial prey availability until nesting territories are established in adulthood (Hodges et al. 1987). With GPS equipment, Wheat et al. (2017) tracked 28 BAEAs of different age classes and social statuses and found that movement strategies varied among adults (nesting, localized, migratory, or nomadic), while immature BAEAs in the study were all nomadic or migratory. The juveniles involved in this attack may have migrated to the area, following prey availability. Juvenile BAEAs of multiple age classes were recently associated with the depredation and consumption of Sandhill Cranes (SACRs) on the Central Platte River (Caven et al. 2018). BAEAs' diets are often variable; in times when resources are scarce, they modify their diets to exploit readily available prey (Stalmaster and Plettner 1992). Juvenile BAEAs learn foraging techniques from older individuals (Knight and Knight 1983, Stalmaster and Plettner 1992). Research suggests that juvenile and subadult BAEAs are less efficient predators and less discerning in prey selection than adults. They may seek prey items associated with a higher risk of injury and experience caloric deficiencies at higher rates than adults do, and therefore experience higher rates of mortality (Fischer 1982, Harper 1983, Stalmaster and Gessaman 1984, Stalmaster and Plettner 1992). Additionally, foraging locations occupied by other BAEAs are often selected over unattended sites (Knight and Knight 1983, Stalmaster and Gessaman 1984). In this way, multiple individuals may congregate where abundant resources are being exploited.

Large prey such as WHCRs have high edible and caloric contents, and similar large prey contribute to most of the energetic needs of wintering BAEAs (Stalmaster and Plettner 1992). Given the large concentrations of SACRs and other waterfowl that are potential prey resources for BAEA during spring migration along wooded riparian areas in Nebraska, it is possible that BAEAs could exploit WHCRs if they were available or vulnerable (e.g., sick, injured, etc.) (Knight and Knight 1983, Stalmaster and Plettner 1992, Lefebvre and Bouchard 2003, Caven et al. 2018). However, WHCRs have a diverse defensive and agonistic repertoire. They have

been recorded effectively fending off depredation attempts from a variety of predators using “bill-stab,” “jump-rake,” and “wing-spread” displays (Neshitt and Archibald 1981, Ellis et al. 1996, 1998, Heatley 2002). It is notable that cranes are behaviorally oriented to defend themselves and exhibit no known antipredator escape behaviors (Lima 1993). BAEAs have been filmed “prey testing” WHCRs in Wisconsin (part of the Experimental Eastern Migratory Population; Fuad Azmat/YARNutopia by Nadia 2014). The 2 WHCRs in the film displayed agonistic defensive and territorial behaviors described by Ellis et al. (1998) and Heatley (2002) in the presence of 5 BAEAs (adult and juvenile) as the WHCRs competed for access to an appropriate roosting location in shallow water near a submerged tree, suggesting that the adult cranes viewed the BAEAs as a potential depredation threat (Fuad Azmat/YARNutopia by Nadia 2014).

Golden Eagle (*Aquila chrysaetos*) depredation of cranes may be more common; depredation has been documented on multiple SACRs and one WHCR (Windingstad et al. 1981, Ellis et al. 1999, Heatley 2002, Stehn and Haralson-Strobel 2014). Ellis et al. (1999) described numerous successful attempts on SACRs and one unsuccessful attempt on a WHCR during aircraft-led migration flights associated with the Eastern Migratory Population of WHCRs (experimental reintroduced population); the WHCR was struck by a Golden Eagle but survived and recovered. Windingstad (1981) documented a successful attack on a single juvenile WHCR within the Grays Lake National Wildlife Refuge Population (formerly reintroduced experimental population now extirpated) wherein the individual, migrating with its foster SACR parents, was killed by a Golden Eagle on the individual's first southward migration. Stehn and Haralson-Strobel (2014) detected talon marks suggestive of Great Horned Owl (*Bubo virginianus*) depredation during the necropsy of one WHCR found on the wintering grounds in Texas, which is the only probable mortality resulting from avian predation recorded for the Aransas Wood-Buffalo Population of WHCRs.

During late winter and spring, BAEA numbers peak in Nebraska as migrating BAEAs concentrate on the river, where abundant food supplies include fish and migratory waterbirds

(Lingle and Krapu 1986, Jorde and Lingle 1988, Stalmaster and Plettner 1992, Caven et al. 2018, Jorgensen and Dinan 2018). Interactions between WHCRs and BAEAs are likely promoted by the increase of cottonwood gallery forests along the banks of rivers in the Platte River Basin since the late 1800s (Loup, Platte etc.; Williams 1978, Johnson 1994, Currier 1997), as well as the robust recovery of BAEA populations within riverine ecosystems in Nebraska since the 1970s (Sharpe et al. 2001, Jorgensen and Dinan 2018).

As suggested by Caven et al. (2018) regarding SACRs, it is possible that BAEAs prey on or attempt to prey on WHCRs more commonly than previously understood. Until recently, it was widely believed that even most SACRs preyed upon by BAEAs were likely sick, injured, or already dead, and that healthy adult cranes were likely too large and aggressive to be considered prey by BAEAs (Wood et al. 1993). Given the orders-of-magnitude difference in population sizes of North America's 2 Gruidae species (660,000+ SACRs—Dubovsky 2018; ~500 WHCRs—Butler and Harrell 2018), the implications of recent observations (Caven et al. 2018) are of highest concern regarding WHCRs in central Nebraska. WHCRs and SACRs often spatially and temporally overlap during migration (Lingle et al. 1991); predators of SACRs can threaten WHCRs as well. Radio-tracking data indicate that the WHCRs observed in this work abandoned their roost following the attack and relocated 2.4 km upstream, suggesting that they no longer deemed the habitat suitable or safe after the attack. Though it is possible that WHCRs migrating through wooded rivers in the Great Plains are preyed upon infrequently by BAEAs, it may be more likely that BAEA recovery, range expansion, and increased presence on the landscape could result in a reduction of the availability of suitable WHCR habitat secure from predators.

Frequent harassment by BAEAs may increase WHCR movement during stopovers or could alter stay length in wooded riverine habitats. Cole et al. (2009) linked inappropriate roosting habitat to several predations of WHCRs in the reintroduced eastern flock, particularly due to bobcats (*Lynx rufus*). WHCRs prefer wide unobstructed views, shallow water, and gentle bank slopes for roosting (Austin and Richert 2005, Farmer

et al. 2005, Pearse et al. 2017, Farnsworth et al. 2018). Models suggest that distance to nearest forest is positively related to WHCR roosting-habitat use on the Platte River (Farnsworth et al. 2018, Baasch et al. 2019). While the location where the attack occurred had suitably wide channels, the distance to the nearest trees and other tall vegetation along the banks, where the presence of predators is increased, was approximately 100 m less than the distance to the nearest forest (181 m) prescribed in Baasch et al. (2019). Trees and other tall vegetation can provide cover and habitat for both terrestrial and aerial predators of waterbirds (Anthony and Isaacs 1989, Buehler et al. 1992, Ruiz-Olmo et al. 2003, Whittingham and Evans 2004, Cole et al. 2009), which may pose a risk to WHCRs. Forest cover has increased in the Platte River Basin and in other lowland ecosystems in Nebraska (Currier 1997, Briggs et al. 2002, Kaul et al. 2006, Bishop et al. 2011). WHCRs face numerous threats during migration (Lewis et al. 1992, Stehn and Haralson-Strobel 2014), and recent research suggests that predation may be a leading cause of mortality among Whooping Cranes (Pearse et al. 2018). Ongoing efforts to remove woody cover to improve contiguous areas of quality riverine roosting habitat (Farnsworth et al. 2018) and wet-meadow and slough foraging habitat (Chávez-Ramírez and Weir 2010) for the benefit of WHCRs may also reduce predation and the occurrence of WHCR–BAEA interactions, while benefiting other wet-meadow and braided-river species of concern (Kirsch 1996, Rosenberg et al. 2016, Caven et al. 2017). A management approach may be preferred, one that considers the regional habitat needs of both species while also minimizing their interaction. For instance, a plan could include clearing trees and reducing the presence of predator perches in some sections of the river with wide channels, while allowing other sections of the river not targeted for WHCR habitat to maintain aging cottonwood galleries to encourage continued BAEA use at those locations.

ACKNOWLEDGMENTS

We extend a special thank you to Lawrence Burman who kindly provided information and photographs surrounding this record and

access to his property to conduct follow up investigations. We also thank the USFWS and the Crane Trust for funding the writing of this natural history note. A special thanks to John Conkin, Aaron Pearse, and Dave Brandt for providing WHCR satellite tracking data. 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

- ALERSTAM, T., AND G. HÖGSTEDT. 1982. Bird migration and reproduction in relation to habitats for survival and breeding. *Ornis Scandinavica* 13:25–37.
- ALLEN, R.P. 1952. The Whooping Crane: research report No. 3 of the National Audubon Society. National Audubon Society, New York, NY. 246 pp.
- ANTHONY, R.G., AND F.B. ISAACS. 1989. Characteristics of Bald Eagle nest sites in Oregon. *Journal of Wildlife Management* 53:148–159.
- AUSTIN, J.E., AND A.L. RICHERT. 2005. Patterns of habitat use by Whooping Cranes during migration: summary from 1977–1999 site evaluation data. Pages 79–104 in F. Chavez-Ramirez, editor, *Proceedings of the Ninth North American Crane Workshop*, January 17–20, 2003. North American Crane Working Group, Sacramento, CA.
- BAASCH, D.M., P.D. FARRELL, S. HOWLIN, A.T. PEARSE, J.M. FARNSWORTH, AND C.B. SMITH. 2019. Whooping Crane use of riverine stopover sites. *PLOS ONE* 14(1):e0209612.
- BISHOP, A., A. BARENBERG, N. VOLPE, AND R. GROSSE. 2011. Nebraska land cover development. Rainwater Basin Joint Venture Report, Grand Island, NE.
- BOWERMAN, W.W., A.S. ROE, M.J. GILBERTSON, D.A. BEST, J.G. SIKARSKIE, B.S. MITCHELL, AND C.L. SUMMER. 2002. Using Bald Eagles to indicate the health of the Great Lakes' environment. *Lakes & Reservoirs: Research and Management* 7(3):183–187.
- BIGGS, J.M., G.A. HOCH, AND L.C. JOHNSON. 2002. Assessing the rate, mechanisms, and consequences of the conversion of tallgrass prairie to *Juniperus virginiana* forest. *Ecosystems* 5(6):578–586.
- BUEHLER, D.A., S.K. CHANDLER, T.J. MERSMANN, J.D. FRASER, AND J.K. SEEGAR. 1992. Nonbreeding Bald Eagle perch habitat on the northern Chesapeake Bay. *Wilson Bulletin* 104:540–545.
- BUTLER, M.J., AND W. HARRELL. 2018. Whooping Crane survey results: winter 2017–2018. U.S. Fish and Wildlife Service, Division of Biological Services, Albuquerque, NM.
- CAVEN, A.J., K.C. KING, J.D. WIESE, AND E.M. BRINLEY BUCKLEY. 2017. A descriptive analysis of Regal Fritillary (*Speyeria idalia*) habitat utilizing biological monitoring data along the Big Bend of the Platte River, NE. *Journal of Insect Conservation* 21:183–205.
- CAVEN, A.J., J.D. WIESE, W.R. WALLAUER, AND K.J. MOSHER. 2018. First description of a Bald Eagle (*Haliaeetus leucocephalus*) actively depredating an adult Sandhill Crane (*Antigone canadensis*). *Western North American Naturalist* 78:216–220.
- CHÁVEZ-RAMÍREZ, F., AND E. WEIR. 2010. Wet meadow literature and information review. Technical Report, Platte River Recovery Implementation Program, Kearney, NE. 42 pp.
- COLE, G.A., N.J. THOMAS, M. SPALDING, R. STROUD, R.P. URBANEK, AND B.K. HARTUP. 2009. Postmortem evaluation of reintroduced migratory Whooping Cranes in eastern North America. *Journal of Wildlife Diseases* 45:29–40.
- CURRIER, P.J. 1997. Woody vegetation expansion and continuing declines in open channel habitat on the Platte River in Nebraska. *Proceedings of the North American Crane Workshop* 7:141–152.
- DUBOVSKY, J.A. 2018. Status and harvests of Sandhill Cranes: mid-continent, Rocky Mountain, Lower Colorado River Valley and eastern populations. Administrative Report, U.S. Fish and Wildlife Service, Lakewood, CO.
- ELLIS, D.H., K.R. CLEGG, L.C. LEWIS, AND E. SPAULDING. 1999. Golden Eagle predation on experimental Sandhill and Whooping Cranes. *Condor* 101:664–666.
- ELLIS, D.H., G.F. GEE, AND C.M. MIRANDE. 1996. Cranes: their biology, husbandry and conservation. U.S. Department of the Interior, National Biological Service, Washington, DC, and International Crane Foundation, Baraboo, WI.
- ELLIS, D.H., S.R. SWENGEL, G.W. ARCHIBALD, AND C.B. KEPLER. 1998. A sociogram for the cranes of the world. *Behavioural Processes* 43:125–151.
- FARMER, A.H., B.S. CADE, J.W. TERRELL, J.H. HENRIKSEN, AND J.T. RUNGE. 2005. Evaluation of models and data for assessing Whooping Crane habitat in the Central Platte River, Nebraska. U.S. Geological Survey Scientific Investigations Report 2005-5123, Reston, VA. 78 pp.
- FARNSWORTH, J.M., D.M. BAASCH, P.D. FARRELL, C.B. SMITH, AND K.L. WERBYLO. 2018. Investigating Whooping Crane habitat in relation to hydrology, channel morphology and a water-centric management strategy on the central Platte River, Nebraska. *Heliyon* 4(10):e00851.
- FISCHER, D.L. 1982. The seasonal abundance, habitat use and foraging behavior of wintering Bald Eagles, *Haliaeetus leucocephalus*, in west-central Illinois. Master's thesis, Western Illinois University, Macomb, IL. 178 pp.
- FUAD AZMAT/YARNUTOPIA BY NADIA. 2014. Two Whooping Cranes vs five Bald Eagles territory conflict. YouTube, 3 November 2014. https://www.youtube.com/watch?v=jnFnBsX_LY
- GRANGER, W. 1992. Foraging ecology of Bald Eagles on a regulated river. *Journal of Raptor Research* 26:243–256.
- GRAY, L., AND W. HARRELL. 2017. Journeying toward recovery: dramatic conservation efforts bring Whooping Crane back from the brink. U.S. Fish and Wildlife Service Endangered Species Bulletin. <https://www.fws.gov/Endangered/news/episodes/bu-Spring2017/story3/index.html>
- HARPER, R.G. 1983. An ecological investigation of wintering Bald Eagles at Lock and Dam 24, Mississippi River. Master's thesis, Western Illinois University, Macomb, IL. 117 pp.
- HEATLEY, J.J. 2002. Antipredator conditioning in Mississippi Sandhill Cranes (*Grus canadensis pulla*).

- Master's thesis, Louisiana State University, Baton Rouge, LA. https://digitalcommons.lsu.edu/gradschool_theses/4127
- HEFLEY, T.J., D.M. BAASCH, A.J. TYRE, AND E.E. BLANKENSHIP. 2015. Use of opportunistic sightings and expert knowledge to predict and compare Whooping Crane stopover habitat: Species distribution model for Whooping Cranes. *Conservation Biology* 29:1337–1346.
- HODGES, J.I., E.L. BOEKER, AND A.J. HANSEN. 1987. Movements of radio-tagged Bald Eagles, *Haliaeetus leucocephalus*, in and from southeastern Alaska. *Canadian Field-Naturalist* 101:136–140.
- JOHNSON, W.C. 1994. Woodland expansions in the Platte River, Nebraska: patterns and causes. *Ecological Monographs* 64:45–84.
- JORDE, D.G., AND G.R. LINGLE. 1988. Kleptoparasitism by Bald Eagles wintering in south-central Nebraska. *Journal of Field Ornithology* 59:183–188.
- JORGENSEN, J.G., AND L.R. DINAN. 2018. 2017 Nebraska Bald Eagle nesting report. Nongame Bird Program of the Nebraska Game and Parks Commission, Lincoln, NE.
- KAUL, R.B., D. SUTHERLAND, AND S. ROLFSMEIER. 2006. The flora of Nebraska. School of Natural Resources, University of Nebraska–Lincoln, Lincoln, NE. 966 pp.
- KIRSCH, E.M. 1996. Habitat selection and productivity of Least Terns on the lower Platte River, Nebraska. *Wildlife Monographs* 132:3–48.
- KNIGHT, S.K., AND R.L. KNIGHT. 1983. Aspects of food finding by wintering Bald Eagles. *Auk* 100:447–484.
- LEFEBVRE, L., AND J. BOUCHARD. 2003. Social learning about food in birds. Pages 94–126 in D. Frigaszy and S. Perry, editors, *The biology of traditions: models and evidence*. Cambridge University Press, Cambridge, United Kingdom.
- LEWIS, C.J., E. KUYT, K.E. SCHWINDT, AND T.V. STEHN. 1992. Mortality in fledged Whooping Cranes of the Aransas/Wood Buffalo population. *North American Crane Workshop Proceedings*. Paper 313.
- LIMA, S. 1993. Ecological and evolutionary perspectives on escape from predatory attack: a survey of North American birds. *Wilson Bulletin* 105:1–47.
- LINGLE, G.R., AND G.L. KRAPU. 1986. Winter ecology of Bald Eagles in south-central Nebraska. *Prairie Naturalist* 18:65–78.
- LINGLE, G.R., G.A. WINGFIELD, AND J.W. ZIEWITZ. 1991. The migration ecology of Whooping Cranes in Nebraska, USA. Pages 395–401 in J. Harris, editor, *Proceedings of the 1987 International Crane Workshop*. International Crane Foundation, Baraboo, WI.
- MCCOLLOUGH, M.A. 1989. Molting sequence and aging of Bald Eagles. *Wilson Bulletin* 101:1–10.
- NESBITT, S.A., AND G.W. ARCHIBALD. 1981. The agonistic repertoire of Sandhill Cranes. *Wilson Bulletin* 93: 99–103.
- NEWTON, I. 2006. Can conditions experienced during migration limit population levels of birds. *Journal of Ornithology* 147:146–166.
- NIEMUTH, N.D., A.J. RYBA, A.T. PEARSE, S.M. KVAS, D.A. BRANDT, B. WANGLER, J.E. AUSTIN, AND M.J. CARLISLE. 2018. Opportunistically collected data reveal habitat selection by migrating Whooping Cranes in the US Northern Plains. *Condor* 120:343–356.
- [93RD U.S. CONGRESS] NINETY-THIRD UNITED STATES CONGRESS. U.S. Endangered Species Act of 1973. Pub. L. No. 93-205, 87 Stat. 884 (28 December 1973). <https://www.govinfo.gov/content/pkg/STATUTE-87-Pg884.pdf>. As amended through the 108th Congress. <http://www.fws.gov/endangered/esa-library/pdf/ESAall.pdf>
- PEARSE, A.T., D.A. BRANDT, W.C. HARRELL, K.L. METZGER, D.M. BAASCH, AND T.J. HEFLEY. 2015. Whooping Crane stopover site use intensity within the Great Plains. U.S. Geological Survey Open-file Report 2015-1166.
- PEARSE, A.T., D.A. BRANDT, B.K. HARTUP, AND M.T. BIDWELL. 2018. Mortality in Aransas-Wood Buffalo Whooping Cranes: timing, location, and causes. Pages 125–138 in P.J. Nyhus, editor, *Whooping Cranes: biology and conservation*. Academic Press, Cambridge, MA. 538 pp.
- PEARSE, A.T., M.J. HARNER, D.M. BAASCH, G.D. WRIGHT, A.J. CAVEN, AND K.L. METZGER. 2017. Evaluation of nocturnal roost and diurnal sites used by Whooping Cranes in the Great Plains, USA. U.S. Geological Survey Open-File Report 2016-1209. 29 pp.
- ROSENBERG, K.V., J.A. KENNEDY, R. DETTMERS, R.P. FORD, D. REYNOLDS, J.D. ALEXANDER, C.J. BEARDMORE, P.J. BLANCHER, R.E. BOGART, G.S. BUTCHER, ET AL. 2016. Partners in Flight landbird conservation plan: 2016 revision for Canada and continental United States. *Partners in Flight Science Committee*. 119 pp.
- RUIZ-OLMO, J., F. BLANCH, AND F. VIDAL. 2003. Relationships between the red fox and waterbirds in the Ebro Delta Natural Park, NE Spain. *Waterbirds* 26:217–225.
- SHARPE, R.S., W.R. SILCOCK, AND J.G. JORGENSEN. 2001. *Birds of Nebraska: their distribution and temporal occurrence*. University of Nebraska Press, Lincoln, NE.
- STAHLECKER, D.W. 1997. Availability of stopover habitat for migrant Whooping Cranes in Nebraska. *Proceedings of the North American Crane Workshop* 7: 132–140.
- STALMASTER, M.V., AND J.A. GESSAMAN. 1984. Ecological energetics and foraging behavior of overwintering Bald Eagles. *Ecological Monographs* 54:407–428.
- STALMASTER, M.V., AND R.G. PLETTNER. 1992. Diets and foraging effectiveness of Bald Eagles during extreme winter weather in Nebraska. *Journal of Wildlife Management* 56:355–367.
- STEENHOF, K., S.S. BERLINGER, AND L.H. FREDERICKSON. 1980. Habitat use by wintering Bald Eagles in South Dakota. *Journal of Wildlife Management* 44: 798–805.
- STEHN, T.V., AND C.L. HARALSON-STROBEL. 2014. An update on mortality of fledged Whooping Cranes in the Aransas/Wood Buffalo population. *Proceedings of the North American Crane Workshop* 12: 43–50.
- [USFWS] UNITED STATES FISH AND WILDLIFE SERVICE. 2018a. Bald and Golden Eagle Protection Act. USFWS, Midwest Region, Bloomington, MN. <https://www.fws.gov/midwest/eagle/protect/laws.html>
- [USFWS] UNITED STATES FISH AND WILDLIFE SERVICE. 2018b. Whooping Crane Tracking Project: public sightings database [ongoing]. Nebraska Ecological Services Field Office, Wood River, NE.
- WHEAT, R.E., S.B. LEWIS, Y. WANG, T. LEVI, AND C.C. WILMERS. 2017. To migrate, stay put, or wander? Varied movement strategies in Bald Eagles (*Haliaeetus leucocephalus*). *Movement Ecology* 5(9):1–10.

- WHITTINGHAM, M.J., AND K.L. EVANS. 2004. The effects of habitat structure on predation risk of birds in agricultural landscapes. *Ibis* 146:210–220.
- WILLIAMS, G.P. 1978. The case of the shrinking channels: the North Platte and Platte Rivers in Nebraska. *Circulars of the United States Geological Survey* 781: 1–48.
- WINDINGSTAD, R.M., H.E. STILES, AND R.C. DREWEN. 1981. Whooping Crane preyed upon by Golden Eagle. *Auk* 98:393–394.
- WOOD, P.B., S.A. NESBITT, AND A. STEFFER. 1993. Bald Eagles prey on Sandhill Cranes in Florida. *Journal of Raptor Research* 27:164–165.

Received 25 February 2019

Revised 29 May 2019

Accepted 18 June 2019

Published online 24 September 2019