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Adult Whooping Crane (*Grus americana*) consumption of juvenile channel catfish (*Ictalurus punctatus*) during the avian spring migration in the Central Platte River Valley, Nebraska, USA

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Abstract.—Stopover sites provide important forage resources and protection from predators to the Aransas-Wood Buffalo population of Whooping Cranes (*Grus americana*) as they migrate 4000 km across the Great Plains each spring and fall. Given the Whooping Crane's expansive migration corridor, sensitivity to human disturbance, small population size, and protected status under the Endangered Species Act, it is challenging to gather detailed information regarding the particular forage resources that the cranes exploit at various stopover locations. On 22 March 2018 we observed and photo-documented an adult Whooping Crane consuming at least 5 individual juvenile channel catfish (*Ictalurus punctatus*) after it landed 100 m in front of our Sandhill Crane viewing blind on the south channel of the Platte River. Using the average exposed culmen length of an adult Whooping Crane for reference, we estimated that the length of the channel catfish ranged from 97 mm to 117 mm. Growth estimates developed from the Lower Platte River suggest that the depredated channel catfish were just over one year old. To the best of our knowledge, our observations represent the first definitive record of a Whooping Crane consuming fish in the Platte River, as well as the first record of a Whooping Crane depredating a channel catfish in the Great Plains. Given the relatively long distances at which Whooping Cranes are generally viewed (≥650 m), small-bodied fish may be a more common prey item during migration than indicated by current scientific literature. Our note demonstrates how wildlife photography and ecotourism can contribute to our understanding of species' natural histories.

Resumen.—Las zonas de descanso ofrecen importantes recursos para forrajeo y protección contra depredadores a la población de Grullas Trompeteras (*Grus americana*), ya que estas migran 4000 km a través de las Grandes Llanuras cada primavera y otoño. Debido a la extensión de su ruta migratoria, la sensibilidad a la perturbación humana, la población reducida y el estado de protección bajo la Ley de Especies en Peligro de Extinción en la que se encuentra esta especie, resulta complejo la recopilación de información detallada acerca de los recursos que las grullas trompeteras explotan para forrajear, en las diferentes zonas de descanso. El 22 de marzo del 2018 detectamos y documentamos fotográficamente una grulla trompetera adulta consumiendo por lo menos 5 ejemplares juveniles de peces gato (*Ictalurus punctatus*), después de aterrizó a 100 m de nuestra ventana con vistas a las Grullas Canadienses del canal Sur del río Platte. Tomando como referencia la longitud promedio del culmen de una grulla canadiense, estimamos que la longitud del pez gato varió de 97 mm a 117 mm. Las estimaciones de crecimiento obtenidas del río Lower Platte sugieren que el pez gato depredado tenía más de un año de edad. Hasta donde conocemos, nuestras observaciones representan el primer registro definitivo de una grulla canadiense en el río Platte, así como el primer registro de una grulla canadiense depredando a un pez gato en las Grandes Llanuras. Debido a que generalmente las Grullas Canadienses son detectadas a distancias relativamente largas (≥650 m), los peces de cuerpo pequeño pueden ser un objeto de presa más común durante los períodos migratorios de lo que indica la literatura científica actual. Nuestro artículo demuestra cómo la fotografía de vida silvestre y el ecoturismo pueden contribuir a comprensión de la historia natural de las especies.

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Whooping Cranes (*Grus americana*) undertake a biennial north–south migration of approximately 4000 km through the Great Plains of North America (Kuyt 1992, Pearse et al. 2018). Their migration corridor averages about 300 km in width and traverses the Central Platte River Valley (CPRV), Nebraska (Pearse et al. 2018). The U.S. Fish and Wildlife Service designated the Platte River Bottoms between Lexington and Denman, Nebraska, as one of the 5 critical habitats in the Central Flyway for the Aransas-Wood Buffalo Population of Whooping Cranes (USFWS 1978). The Platte River is a braided prairie river characterized by shifting exposed and submerged sandbars that provide night roosting and foraging habitat for both Sandhill Cranes (*Antigone canadensis*) and Whooping Cranes (Smith 1971, Currier and Ziewitz 1987, Farmer et al. 2005, Kinzel et al. 2009). Historically, the main channel of the Platte River was bordered by prairie habitats and exceeded 1.6 km in width in many locations, but it has become narrower and more wooded with the appropriation of river flows for human use (Williams 1978, Currier 1982, Johnson 1994).

Today the CPRV landscape is a mosaic of irrigated agricultural fields, riparian woodlands, lowland tallgrass prairies, wet meadows, and linear wetlands called "sloughs" (Currier 1982, 1989, Kaul et al. 2006, Brei and Bishop 2008, Whiles et al. 2010, Krapu et al. 2014, Caven et al. 2017). The diversity of wetlands and agricultural fields in the CPRV provides quality stopover habitat for Whooping Cranes (Lingle et al. 1991, Chávez-Ramírez and Weir 2010, Jorgensen and Dinan 2016, Pearse et al. 2017). Stopover sites are necessary for migrating birds as they provide forage resources and protection from predators (Alerstam and Högstedt 1982, Newton 2006). Whooping Cranes prefer wide, unobstructed view widths away from forests, channel widths over 150 m, vegetation under 1.5 m in height, and a lack of human disturbances (Lingle et al. 1991, Faanes 1992, Faanes et al. 1992, Farmer et al. 2005, Howlin and Nasman 2017, Pearse et al. 2017). One of the major risks facing Whooping Cranes is the loss of wetland habitats to development (Meine and Archibald 1996). Stahlecker (1992) found that there were 4 or fewer suitable wetland roosting locations per 100 km^2 of the migration corridor through Oklahoma. By contrast, Nebraska contains suitable stopover habitat throughout the migration corridor (Stahlecker 1997).

Forage patterns have been more thoroughly researched on wintering and breeding grounds than they have been during migration. Whooping Crane diet on the wintering grounds in coastal Texas is well studied, revealing that the species primarily subsists on blue crabs (*Callinectes sapidus*), common fiddler crabs (*Uca pugilator*), razor clams (*Tagelus plebeius*), snails (*Littorina* spp., *Melampus coffeus,* and *Cerithidea pliculosa*), crayfish (*Cambarus* spp.), acorns (*Quercus* spp.), and wolfberry (*Lycium carolinianum*) fruits, while occasionally consuming vertebrates such as snakes (*Nerodia clarkii clarkii*) (Allen 1952, 1954, Uhler and Locke 1970, Blankinship 1976, Hunt and Slack 1989, Chávez-Ramírez 1996, Westwood and Chávez-Ramírez 2005, Greer 2010, Geluso and Harner 2013). Data from the breeding grounds at Wood Buffalo National Park in Canada suggests that they forage on fish (*Culaea inconstans, Pimephales promelas,* and Cyprinidae), snails (*Lymnaea stagnalis* and *Helisoma* spp.), dragonflies (*Libellula* spp. and *Aeshna* spp.), and diving beetles (*Rhantus binotatus, Acilius semisulcatus, Graphoderus occidentalis,* and *Dytiscus alaskanus*) (Novakowski 1966, Bergeson et al. 2001, Sotiropoulos 2002, Classen 2008). Incidental accounts from reintroduced populations have discovered Whooping Cranes consuming amphibians (*Ranidae*) and reptiles, including turtles (*Chelydra serpentina, Kinosternon subrubrum*) (Zimorski et al. 2013, Dinets 2016). However, much less is known regarding the prey items selected by Whooping Cranes during migration (Allen 1952, Austin and Richert 2001). During migration, Whooping Cranes have been recorded eating agricultural waste grains such as sorghum (*Sorghum vulgare*), wheat (*Triticum aestivum*), and corn (*Zea mays*); nutsedge tubers (*Cyperus* spp.); invertebrates including beetles, mollusks, and crayfish; as well as vertebrates including frogs (*Lithobates blairi*), fish, snakes, salamanders, and small mammals (Allen 1952, USFWS 1978, 1981, Kauffeld 1981, Howe 1987, Kuyt 1987, Austin and Richert 2001, 2005, Geluso et al. 2013). However, most of these data comes from incidental observations made from long physical distances; therefore, very little species-specific information exists regarding the variety of prey items consumed by Whooping Cranes during migration. In this report, we

Fig. 1. Photo of an adult Whooping Crane (*Grus americana*), with a channel catfish (*Ictalurus punctatus;* estimated at just over one year old) in its bill, moving among Sandhill Cranes (*Antigone canadensis*) on 22 March 2018 at about 10:30 on the main channel of the Platte River, Hall County, Nebraska, USA. Photo by C. Steenson.

add to the sparse information concerning Whooping Crane diet during migration by describing an observation novel to the scientific literature regarding an adult feeding on multiple juvenile channel catfish (*Ictalurus punctatus*) in the CPRV.

On 22 March 2018, we observed an adult Whooping Crane consuming juvenile channel catfish within the south channel of the Platte River (40°45′45″N, 98°30′45″W; 600 m elevation; Figs. 1, 2). The viewing blind was located on the south bank of the channel on the edge of a 37.4-ha restored prairie. Ten photographers entered the viewing blind about 1 h before sunrise (06:35) to photograph roosting Sandhill Cranes (*Antigone canadensis*). At approximately 10:15 a Whooping Crane with adult plumage landed near a group of Sandhill Cranes about 100 m in front of the viewing blind. Weekly aerial Sandhill Crane surveys estimated that there were about 58,000 Sandhill Cranes within 1600 m of the viewing blind, one of the highest densities on the river (Crane Trust unpublished data). Using the "measure tool" in ArcGIS 10.5.1 and digitized aerial imagery from 2016 (ESRI 2017, RWBJV 2017), we estimated that the river channel was about 450 m wide in this location. The Whooping Crane walked along the edge of an exposed sandbar slowly bobbing its head, a physical behavior associated with foraging thought to aid in gaze stabilization and prey detection (Cronin et al. 2005, 2007). At about 10:30 we first detected the Whooping Crane catching a small fish (Fig. 1). The Whooping Crane was detected catching and consuming at least 4 more individual fish over the next 1.75 h before it took flight and left our field of view (Fig. 2). The Whooping Crane's behaviors were photodocumented using a 600 mm Nikon lens and a 100–400 mm Canon lens with a 1.4× extender.

The Whooping Crane appeared to be foraging in between 5 cm and 25 cm of water based on the level to which the tarsus was submerged in photos (tarsus length: female mean = 27.7 cm [n = 7], male mean = 28.1 cm [n = 15]; Johnsgard 1983; Fig. 2). We estimated that the Whooping Crane spent between 70% and 75% of its time foraging, with the remainder of its time dedicated to preening and interspecific

Fig. 2. Whooping Crane (*Grus americana*), capturing a channel catfish (*Ictalurus punctatus;* estimated at just over one year old) in its bill, surrounded by onlooking Sandhill Cranes (*Antigone canadensis*) on 22 March 2018 at about 10:45 on the main channel of the Platte River, Hall County, Nebraska, USA. Photo by C. Steenson.

agonistic behavior with Sandhill Cranes (see Ellis et al. 1998 for a description of agonistic behaviors). We identified all 5 fish consumed as juvenile channel catfish from a series of 19 photos taken by 2 photographers noting the following features: the presence of a forked caudal fin, the presence of an adipose fin, a lack of scales, the body-depth-to-length ratio, and the placement of pectoral fins (Page and Burr 2011; Fig. 2). We approximated the length of the channel catfish by using the average exposed culmen length (upper bill, 13.8 cm) of adult Whooping Cranes (culmen length: female mean = 13.7 cm [n = 7], male mean = 13.9 cm [n = 15]; Johnsgard 1983). We estimated that the channel catfish ranged from 70% to 85% of the crane's exposed culmen length, resulting in estimated total body lengths ranging from 97 mm to 117 mm. Holland et al. (1992) found that 1-year-old channel catfish (at annulus formation) had an average total length of 84 mm (range 69–101 mm) and that 2-year-old channel catfish ranged from 137 to 168 mm within the Lower Platte River from 1988 to 1991. These results suggest that the channel catfish the Whooping Crane was consuming were just over 1 year old.

North American Ictaluridae, including channel catfish, are territorial and communicate through chemical signals in low-light habitats (Bryant and Atema 1987, Jamzadeh 1992). However, Brown et al. (1970) found that channel catfish ≤10 months old gathered in the bottom of pools during the day when structural cover was absent; they also gathered during all hours of the day when temperatures were below 4 °C. Ambient temperatures were as low as 8 °C and water temperatures were as low as 5.7 °C during our observations (USGS 2018, Weather Underground 2018), suggesting

that any aggregation behavior was more likely to have resulted from habitat structure or predation pressure. In the absence of shelter, it is possible that these juvenile channel catfish were aggregated in the bottom of a shallow pool within the wide and open braided river channel. Power (1984) found that the spatial distribution of armored catfish (Loricariidae) appears to be determined more by avian predator avoidance than by available food resources. Though fish are not common forage resources for Sandhill Cranes, cranes have occasionally been detected depredating fish in the Platte River (Lewis 1979, Mergler Niemeier and Niemeier 1982). Given that Sandhill Crane abundance can exceed 600,000 individuals during the spring migration staging period in mid to late March (Dubovsky 2018), it is possible that channel catfish exhibit predator avoidance aggregation behavior as a response to perceived Sandhill Crane predation risk. It is also feasible that there was simply an abundance of juvenile channel catfish in this microhabitat. As Phelps et al. (2011) notes, juvenile channel catfish in the Mississippi River preferred shallow islands and off-channel habitats with sandy substrate and slow-flowing water. Finally, it is conceivable that Whooping Cranes selected for juvenile channel catfish among the available small-bodied fishes because the catfish represented preferred forage. Research regarding Double-crested Cormorants (*Phalacrocorax auritus*) suggests that channel catfish are easily digestible and provide greater energy content than gizzard shad (*Dorosoma cepedianum*) or bluegill (*Lepomis macrochirus*) (Brugger 1993).

To the best of our knowledge, our observations represent the first scientific record of a Whooping Crane depredating a channel catfish in the Platte River and in the Central Flyway. Despite the Platte River supporting 56 species of fish (Goldowitz 1996, Chadwick et al. 1997), there have been no detailed reports of Whooping Cranes depredating fish there. However, Whooping Cranes have been reported consuming fish (unidentified) in the Rainwater Basin, just south of the CPRV (USFWS 1981). Research suggests that fish are a potentially important food source for Whooping Cranes during migration (Armbruster 1990), but only Allen (1952) discusses potential prey species including the white sucker (*Catostomus commersonii sucklii*), the creek chub (*Semotilus atromaculatus*), shiner species (*Notropis* spp.), the brassy minnow (*Hybognathus hankinsoni*), and topminnow/killifish species (*Fundulus* spp.). Stable isotope analysis of Whooping Crane feathers suggests that fish are an important prey item for the Aransas-Wood Buffalo population (Duxbury and Holroyd 1996). Bergeson et al. (2001) directly observed Whooping Cranes consuming brook sticklebacks (*Culaea inconstans*) on their breeding grounds in Wood Buffalo National Park. Brook sticklebacks are also present in the Platte River Basin (Goldowitz 1996). Research from the breeding grounds also suggests that pond habitats containing small-bodied fishes such as brook stickleback, fathead minnow (*Pimephales promelas*), and dace species (*Phoxinus* spp.) received higher Whooping Crane use than ponds dominated by invertebrate species (Bergeson 1998, Classen 2008). On their wintering grounds, Whooping Cranes have also been observed consuming fish, including topminnow/killifish, sheepshead minnow (*Cyprinodon variegatus*), flathead grey mullet (*Mugil cephalus*), and speckled worm-eel (*Myrophis punctatus*) (Allen 1952, Greer 2010).

Channel catfish are important prey items for a number of wading bird species, such as Great Blue Herons (*Ardea herodias*) and Great Egrets (*Ardea alba*) (Stickley 1995, Glahn et al. 1999, 2000, Werner et al. 2001, Dorr and Taylor 2003). According to Stickley (1995) and Glahn et al. (1999), Great Blue Herons showed a preference for smaller-sized channel catfish ranging from 110 to 160 mm. Glahn et al. (1999) and Werner et al. (2001) similarly found that Great Egrets preferred catfish ranging from 75 to 103 mm. Our observations suggest that Whooping Cranes select channel catfish sizes similar to those selected by Great Blue Herons and Great Egrets (97–117 mm). Willard (1977) found that wading bird species demonstrate similar depth preferences for hunting fish; Great Blue Herons and Great Egrets preferred hunting depths of 15 to 25 cm, while Snowy Egrets and Little Blue Herons generally foraged in shallower water of 5 to 15 cm. Our observations again demonstrated significant overlap in fish foraging depths between Whooping Cranes (5 to 25 cm) and wading birds in the family Ardeidae. Water depth data collected from Whooping Crane stopover sites suggest that on average Whooping Cranes roost and forage in 14 to 20 cm of water (Howe 1987, 1989, Pearse et al. 2017). Both Great

Blue Herons and Great Egrets were predominantly observed depredating channel catfish in the spring and fall when catfish diseases, such as enteric septicemia, were more prevalent (Stickley 1995, Glahn et al. 1999, 2000). Disease could reduce the ability of channel catfish to escape and defend themselves from depredation attempts (Glahn et al. 2000). Whooping Crane migration may overlap with periods of channel catfish disease prevalence in the CPRV, making the catfish a more easily attainable food source.

Stopover sites throughout the Central Flyway provide Whooping Cranes with necessary energy reserves and safe refuge during migration (Alerstam and Högstedt 1982, Stahlecker 1992, 1997, Meine and Archibald 1996, Austin and Richert 2001, Newton 2006, Pearse et al. 2017). This observation underscores the importance of managing the CPRV holistically to benefit a broad swath of native species, such as channel catfish, brook sticklebacks, plains leopard frogs (*Lithobates blairi*) and others that fill niches in the ecosystem's food web and provide important forage resources to endangered species such as the Least Tern (*Sternula antillarum*) and the Whooping Crane (Wilson et al. 1993, Bergeson et al. 2001, Sherfy et al. 2012, Geluso et al. 2013).

Despite the importance of gathering information on Whooping Crane forage resources during migration, systematically studying crane behavior at stopover locations presents several challenges. First, Whooping Cranes can be challenging to detect even in relatively limited ranges such as their wintering grounds (Strobel and Butler 2014). Whooping Cranes, numbering about 500 individuals (Butler and Harrel 2018), migrate through a corridor spanning over 100 million ha of the Great Plains (Pearse et al. 2018), and they avoid human disturbances (Pearse et al. 2017); they are therefore challenging to locate while in migration. Moreover, Whooping Cranes are sensitive to human disturbances, including people on foot or approaching vehicles (Lewis and Slack 2008); therefore, government wildlife management authorities require a distance of approximately 650 m for public observation and most research investigations (USFWS and NGPC 2015). Consequently, most behavioral studies have been conducted at distances that only allow for a broad interpretation of foraging behavior in particular habitats but not the visual classification of forage (Lingle et al. 1991, Jorgensen and Dinan 2016). Therefore, it is possible that small-bodied fish species and the young of larger fish species may be relatively common prey items for Whooping Cranes during migration but may also be underrepresented in scientific records due to low detection probability.

Given the challenges of studying the behavior of this cryptic endangered species during migration, incidental observations play an important role in furthering our understanding of Whooping Crane natural history, and such observations provide an opportunity for citizen scientists to make significant contributions (Geluso and Harner 2013, Geluso et al. 2013). During the early spring, thousands of people flock to the CPRV to observe the Sandhill Crane migration (Dority et al. 2017); the number of tourists watching the river is vastly greater than the sum of researchers on the ground. Publically reported Whooping Crane sightings and associated photographs provide a rich information repository, which can be used to better understand habitat-use patterns and track changes in the migration corridor over time (Austin and Richert 2001, Niemuth et al. 2018, Pearse et al. 2018). Photographs also provide information regarding Whooping Crane behavior and ecology, such as the documentation of prey items and potential predators (Geluso et al. 2013, Geluso and Harner 2013, Caven et al. 2018). Publicly sourced photographs provide a form of visual evidence that can be validated and further investigated, and photographs often provide additional details depending on factors such as resolution, quality, and distance (Pimm et al. 2015). Publicly sourced images have been a useful conservation research tool for studying various wildlife species including sea turtles (Long and Azmi 2017), whale sharks (Davies et al. 2012), and cheetahs (Weise et al. 2017), as well as for monitoring protected habitat areas (Walden-Schreiner et al. 2018). In this case, images of an adult Whooping Crane eating juvenile channel catfish provided documentation of a novel forage event and allowed us to visually examine characteristics and approximate measurements of the prey. Our research further demonstrates the value of publically sourced imagery for natural history research and provides valuable insight into the variety of diet items exploited regionally by Whooping Cranes during migration.

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