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GPS Telemetry Reveals Occasional Dispersal of Wood Storks from the Southeastern US to Mexico

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Abstract - *Mycteria americana* (Wood Stork) is an iconic wading bird whose range includes Latin America and the southeastern US, where it is federally listed as threatened. Wetlands in the Gulf Coast states are used as post-breeding grounds by some individuals from both the US and the Mexican/Central American populations, and Wood Storks observed east and west of the Mississippi River Basin are generally thought to originate from the southeastern US and Mexico/Central America, respectively. In the context of a large-scale GPS telemetry study (133 individuals tracked over 14 years), we report the case of 2 Wood Storks that moved from Georgia and eastern Mississippi, respectively, to Mexico. One of the storks dispersed to Mexico as a juvenile and remained there for the subsequent 4 years into adulthood, indicating permanent settlement. Our findings provide evidence of potential mixing between the US and Mexican/Central American populations. These movements suggest that mixing between these Wood Stork populations, although probably sporadic, may be a more complex phenomenon than previously thought. While infrequent mixing may still have relevant consequences for gene flow between populations, such low levels of dispersal would most likely not be sufficient to support population replenishment from Mexico/Central America to the US or vice-versa.

Wood Stork Population Ranges and Movements

Mycteria americana L. (Wood Stork) is a large, iconic wading bird inhabiting tropical and subtropical wetlands of the New World (Coulter et al. 1999). Wood Storks are found in South and Central America, the Caribbean region, and the southeastern US, where they are federally listed as a threatened Distinct Population Segment (USFWS 2014). Historically, most nesting activities in the US occurred primarily in southern Florida (Frederick and Ogden 1997), but the breeding range of Wood Stork in the US has expanded to include all of Florida, as well as Georgia and North and South Carolina (Coulter et al. 1999). Movements of Wood Storks in the southeastern US have been documented and described through several telemetry studies (Borkhataria 2009, Bryan et al. 2008, Hylton 2004, Savage et al. 1999). At the end of the dry season (October through May), most Wood Storks breeding in southern

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Florida disperse northward throughout central and northern Florida, Georgia, South Carolina, and the Gulf Coast plain (Coulter et al. 1999, Kahl 1964). Wood Storks from some colonies in the northern part of the population range also exhibit dispersal to the Gulf Coast plain after breeding (Coulter et al. 1999). Population structure within the southeastern US is homogeneous, with no genetic differentiation recognizable between colonies (Stangel et al. 1990, Van Den Bussche et al. 1999).

Little is known about Wood Stork movements in Latin America. However, post-breeding dispersal of some individuals to the Gulf Coast states—specifically, to the wetlands of the Mississippi River Basin and the adjacent coastal plain—has been documented from both the US and the Mexican/Central American populations (Bryan et al. 2008, Coulter et al. 1999). Generally, storks observed east and west of the Mississippi River Basin are thought to originate from the southeastern US and from Mexico/Central America, respectively (Bryan et al. 2008, Coulter et al. 1999, Hancock et al. 2010). Bryan et al. (2008) provided the first direct evidence of potential mixing between the Mexican/Central American and the southeastern US populations. In their tracking study (2003–2005), Wood Storks were captured in post-breeding sites in eastern Mississippi (Noxubee National Wildlife Refuge [NWR]), southwestern Mississippi (St. Catherine's Creek NWR), and Louisiana (near the Atchafalaya River Basin). All the birds captured at locations east of the Mississippi River Basin (n = 3) then moved to breeding sites in Georgia and South Florida, while all those captured in western Mississippi and Louisiana (n = 7), except for 1 subadult, moved into Mexico or Guatemala (Bryan et al. 2008). A subadult individual captured in Louisiana crossed the Mississippi River and moved across the Gulf coast to eventually reach Everglades National Park, in South Florida (Bryan et al. 2008). These observations supported the general assumption of spatial separation between populations over post-breeding grounds, while at the same time suggesting some extent of overlap and the potential for occasional mixing between the US and Mexican/Central American populations (Bryan et al. 2008).

To our knowledge, no tracking data have been reported for Wood Storks in South America. Banding recoveries provided indications of Wood Stork migrations from the Pantanal to wetlands in south Brazil and northern Argentina (Antas 1994, Del Lama et al. 2015), but no other data are available on movement patterns in this part of the species' range. Movements between South America and other parts of the range have never been documented; the distribution is considered to be interrupted between Central and South America (IUCN 2016). However, use of allozymes (Del Lama et al. 2002, Lopes et al. 2006, Rocha et al. 2004), microsatellites (Rocha et al. 2004), and mitochondrial DNA (Lopes et al. 2011) to compare the genetic structure of the Wood Stork populations in the Brazilian Pantanal and in the US showed little to no divergence.

Observed Dispersal of Wood Storks from the Southeastern US to Mexico

In the context of a large telemetry study of Wood Storks in the southeastern US (133 individuals tracked from 2004 to 2017), we report the case of 2 individuals that moved from Georgia and eastern Mississippi, respectively, to Mexico (Fig. 1).

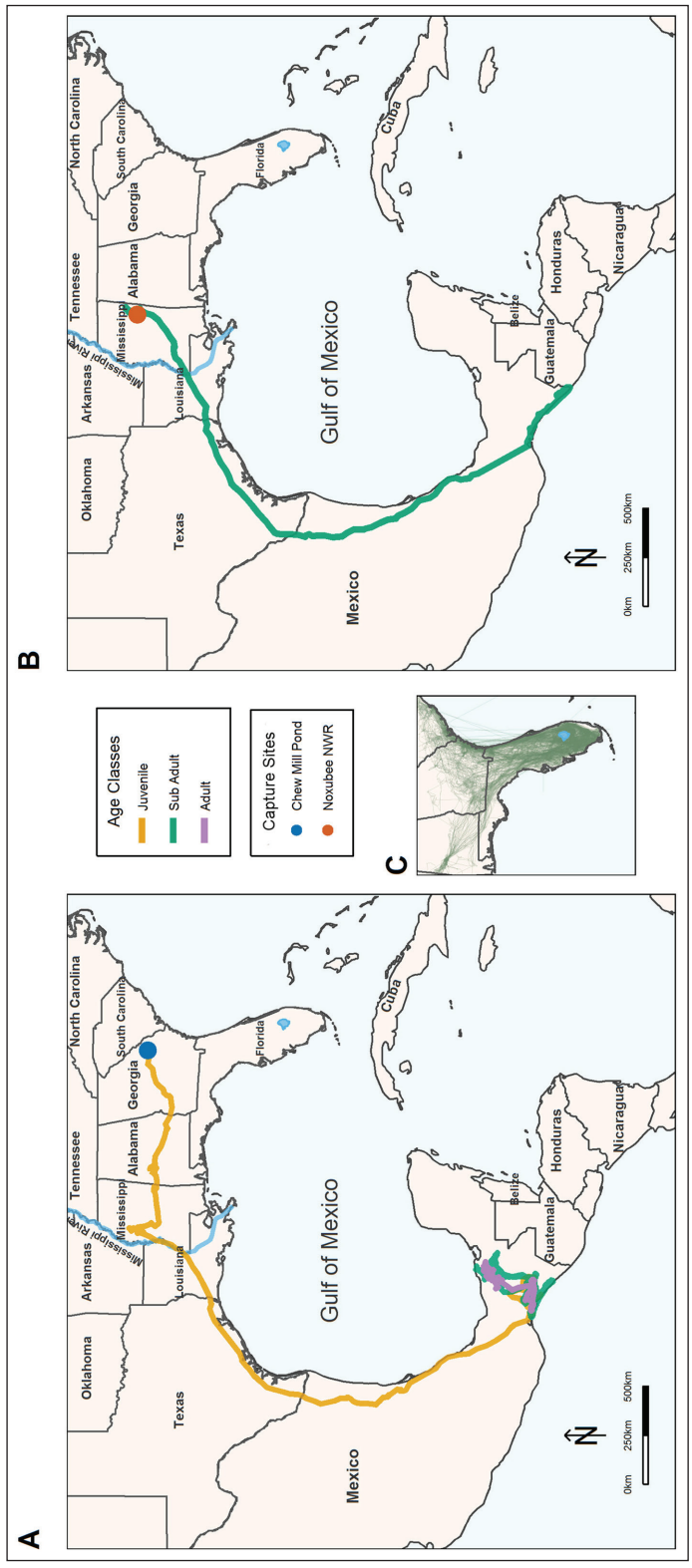

Figure 1. Map of dispersal movements of 2 Wood Storks from the southeastern US to Mexico, obtained through GPS telemetry. (A) Track for stork 572970, from 22 June 2005 to 27 October 2009. (B) Track for stork 475201, from 18 August 2006 to 27 November 2006. (C) Overview of movement tracks for the remaining 131 individuals in the dataset.

Stork 572970 was captured in the Chew Mill Pond colony in east-central Georgia, USA, as a pre-flight juvenile on 22 June 2005, and was tracked as a subadult (<4 y old) and adult until the end of October 2009 (about 4 y and 4 months; Fig. 1A). The bird left the colony on 31 July, flew west for about a week, and initially stopped in Alabama (7 August). It then departed on 31 August and reached northwestern Mississippi during the first week of September. Finally, the stork left Mississippi on 21 October and flew across the Gulf Coast until establishment in the area of Villa Corzo, Chiapas, Mexico (on Pacific coast of Mexico) on 2 November 2005. All subsequent locations until 27 October 2009, when the tag stopped transmitting, were located in Mexico. Stork 475201 was captured in Noxubee NWR, MS, USA, as a subadult on 18 August 2006 and was tracked for about 3 months until November 2006 (Fig. 1B). The bird stayed in the vicinity of the capture site until 29 September 2006, when it started traveling across the coastal plain. It then flew along the Gulf coastline, to settle in mid-October in the proximity of Villa Comaltitlán, Chiapas, Mexico (Pacific coast of Mexico), where it stayed until the tag stopped transmitting on 27 November 2006. In both cases, movement occurred over land across the coastal plain and not over the Gulf of Mexico, in agreement with previous evidence that open water represents a barrier to prolonged flights by Wood Storks due to lack of thermals (Coulter et al. 1999). Ours are the first observations of Wood Storks moving from locations in the southeastern US to Mexico; until the present study, no stork tracked from colonies in the southeastern US had been reported west of the Mississippi river (Hylton 2004).

Significance of Dispersal Movements

Overall, our observations suggest that mixing between Wood Stork populations in the US and Mexico/Central America is a more complex phenomenon than previously thought. First, our data indicate that movements across populations can go both ways, i.e., not only from Mexico/Central America to the US but vice-versa as well, which was previously undocumented. Stork 475201 presumably dispersed from the Southeastern US along with adults headed to Mississippi post-breeding. Then, instead of returning, the subadult resumed its travel west and eventually merged into the Mexican population. Stork 572970 was presumably a natal disperser from the Chew Mill colony. This stork's movement across Mississippi happened in close coincidence with the passage of hurricane Katrina; storm effects on local hydrological conditions may have played a role in influencing the bird's movement patterns. Our observations also indicate that inter-population movements are likely to result in genetic mixing between populations. Stork 572970 reached Mexico as a juvenile and settled there permanently into adulthood, presumably reproducing there once mature. Thus, there is good reason to believe that occasional dispersal between the 2 Wood Stork populations also results in gene flow.

Implications for Genetics and Demography

Our observations provide relevant information to help quantify the mixing between the breeding Wood Stork populations in Mexico/Central America and

the US, of which we already had anecdotal indication. As suggested by Bryan et al. (2008), long-term studies of Wood Stork movements are key contributions for determining the extent of population mixing. We observed inter-population dispersal in only 2 of 133 Wood Storks in our study. Thus, in accordance with previous evidence, the phenomenon seems to be sporadic. However, the importance of such infrequent movements should not be underrated because it could have relevant consequences for genetics. According to the island model of Wright (1943, 1965), a single disperser per generation is sufficient to prevent genetic drift between 2 otherwise distinct populations, under the assumption of random gene flow within sub-populations (Mills and Allendorf 1996), which is supported in the southeastern US by the absence of inter-colony genetic structure (Stangel et al. 1990, Van Den Bussche et al. 1999). There are no studies on the genetic relationships between Wood Stork populations in the US and Mexico or Central America that allow us to directly confirm the potential significance of dispersal events. However, the little genetic divergence observed between Wood Storks in the US and in the Brazilian Pantanal (Del Lama et al. 2002; Lopes et al. 2006, 2011; Rocha et al. 2004) suggests a potential intermediary function of the Mexican/Central American population (Rocha et al. 2004), assuming that direct movements of individuals between the southeastern US and Brazil are unlikely. The results of these studies further support our suggestion that there is functionally relevant gene flow between Wood Stork populations in the US, Mexico, and Central America, despite the low frequency of inter-population dispersal events.

Although sporadic movements between populations may be relevant for gene flow, they would probably not be sufficient to support population replenishment between Mexico/Central America and the US in a meta-population perspective (sensu Hanski 1998). Thus, the rate of inter-population dispersal probably has very different significance in terms of demography than it does from a genetics point of view. The assessment of potential and realized movements between populations across the species range has been indicated as a research priority for the management of Wood Storks in the US (Bryan et al. 2008, Coulter et al. 1999, USFWS 2014). The data presented here contribute to determining the extent of connectivity between Wood Stork populations across the species range and to evaluate its significance from both a genetic and a demographic standpoint.

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