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CHANGES IN WOOD STORK (MYCTERIA AMERICANA) NESTLING SUCCESS OBSERVED IN FOUR FLORIDA BIRD COLONIES DURING THE 2004, 2005, AND 2006 BREEDING SEASONS

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Concern for the declining population size of the wood stork in the southeastern U.S. compelled federal authorities to list this species as endangered in February 1984. Since this time, efforts have been made to gather productivity data for wood storks nesting in all parts of Florida in hopes of gaining further insight into the trends that drive their fluctuating population size. Weekly surveys were conducted at four east-central Florida bird colonies during the 2004, 2005, and 2006 breeding seasons. Median nestling success decreased significantly at Deseret Ranch (2 to 0 fledglings/nest), Bird Island (1 to 0 fledglings/nest), North Fork (1 to fledglings/nest), and Pelican Island (1 to 0 fledglings/nest) between 2004 and 2005. Median nestling success increased significantly at Deseret Ranch (3 fledglings/nest), North Fork (3 fledglings/nest), and Bird Island (2 fledglings/nest) during the 2006 breeding season. When nest failures were excluded from the analysis, there was no significant difference in median nestling success during 2004 and 2005. Median nestling success observed at Deseret Ranch, North Fork, and Bird Island did, however, differ significantly in 2006 when nest failures were excluded from the analysis. Changes in productivity between years appear to mirror shifts in the hydrology of local foraging habitat.

Key words: *Mycteria americana,* wood stork, Florida, productivity, survivorship

INTRODUCTION

The number of wood storks observed in the United States has decreased dramatically in the last century. Between 1960 and the mid–1970s the number of breeding pairs in the southeastern United States decreased by approximately forty-one percent (OGDEN & NESBITT 1979). Since its listing as an endangered species in 1984, populations have stabilized but have failed to rebound to the numbers observed during the mid-nineteen hundreds (USFWS 2003).

Many authors have speculated as to the cause of the wood storks' declining U.S. population. Early declines in total stork numbers were attributed to loss of feeding and nesting sites caused by an increase in land development coupled with the associated drainage of freshwater wetland habitats (OGDEN & NESBITT 1979). Wood storks are tactile feeders and therefore require access to shallow areas with

high densities of prey (KAHL 1964). High densities of fish and other prey items are normally provided by seasonal fluctuations in water levels (KAHL 1964). COULTER and BRYAN (1993) observed that storks usually foraged in water depths between 10 and 25 cm and in areas lacking dense patches of vegetation which could hinder the storks foraging efficiency and ability to detect predators. Many of the remaining tracts of freshwater wetlands and swamps in Florida have since been impounded or partially drained, which may preclude adequate maintenance of the wood storks' food base (OGDEN & NESBITT 1979) and reduce the number of nesting sites that provide safe refuge from predators (RODGERS 1987).

The climatic conditions that contribute to fluctuations in a region's hydrological regime can vary in their severity from year to year. Changes in the timing, distribution, and quality of water flow could potentially lead to declines in nestling survival and, ultimately, population numbers. For this study, we looked at nestling success in four Florida colonies to determine if there was a significant difference in wood stork productivity during three different nesting seasons, each with varying hydrologic conditions.

MATERIALS AND METHODS

Study sites

Bird surveys were conducted at four breeding colonies in east-central Florida, U.S.A. (Fig. 1). The first colony is located on the Deseret Ranch in Brevard County, Florida. The colony is surrounded by grazing lands with small wetland areas scattered throughout. The birds build their nests in Brazilian Pepper and Cabbage Palms on a string of islands located inside an old borrow pit. The borrow pit

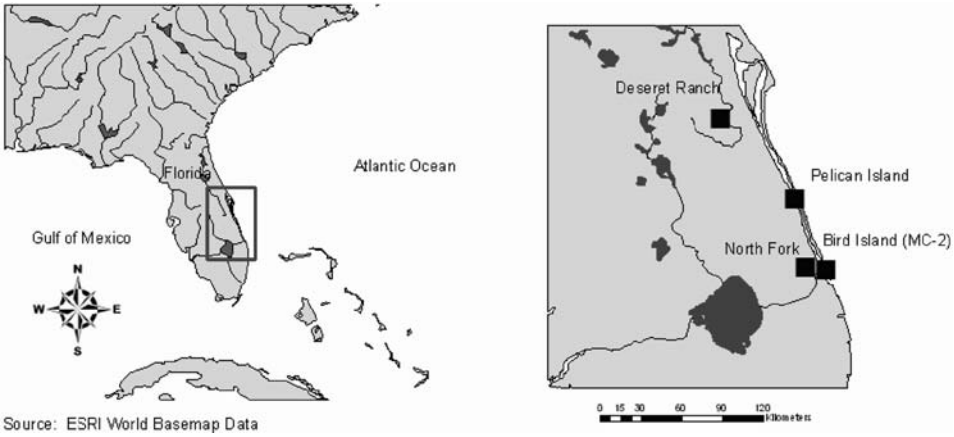

Fig. 1. Location of Four Breeding Colonies in Florida, U.S.A

itself is approximately 8.10 hectares with a maximum recorded depth of approximately 5 m. Visibility in the borrow pit is less than 1.5 m year round. The second colony surveyed is located within the Pelican Island National Wildlife Refuge, in Indian River County, FL. Pelican Island is located within the Indian River Lagoon which is an approximately 155 mile long estuary that extends up the east coast of Florida. The area immediately surrounding the island is relatively shallow (< 1 m) and brackish with visibility of ≤ 1.5 m during breeding season. The third breeding colony surveyed is also located within the confines of the Indian River Lagoon. Bird Island (MC-2) is located just off the western shore, north of the St. Lucie River inlet in Martin County, FL. The southern and western sides of the island are lined by mangroves and invasives such as Brazilian Pepper. The eastern side of the island, the side facing the intercoastal waterway, is lined with grasses and other low lying vegetation which help to maintain the sandy shore. Visibility ranges from 1–2 m during the breeding bird season (MRC 2006). The fourth colony surveyed is located in the North Fork of the St. Lucie River in St. Lucie County, FL. The main breeding colony is located on a mangrove island within the North Fork Aquatic Preserve. The water surrounding the island is brackish, though with a slightly lower salinity than in the Indian River Lagoon. Visibility in the area usually does not extend beyond 1.5m during the height of the breeding season (MRC 2006). The area immediately surrounding the main island is relatively shallow (< 1 m).

Survey methodology

Colonies were surveyed for the duration of the breeding season (February–August), either by boat or land, once a week beginning in March of 2004 and ending in August of 2006. Nest locations were recorded by drawing each section of the colony and noting how nests were situated relative to natural markers in the environment and/or photographed each week using a Nikon D70 digital camera with a telephoto lens. Nest locations were noted on photographs and compared weekly to determine nest status. The date of first observed incubation was used to determine the start date of each nest. The number of attending adults and the number of young were also recorded during each survey period. Once chicks reached the stage in their development when they had all their primary flight feathers (approximately 8 weeks from hatch date), they were recorded as fledged. Nests were monitored post-fledging in order to ascertain how long fledglings remained at the nest past their fledging date. The number of fledglings was recorded per nest then used for statistical analysis.

Statistical analysis

Data collected during these surveys were used to calculate the mean and median nestling success for each colony during each respective year. Because of the discrete nature of count data and the fact that data sets failed the test for normality, nonparametric tests were used to analyze nestling success data. Between-year comparisons were conducted for all four sites using Kruskal-Wallace and Mann-Whitney U Tests.

RESULTS

Data recorded during the 2005 breeding season were analyzed and compared to data collected during the 2004 and 2006 breeding seasons. There were fewer nests initiated at each site in 2005. The number of nests initiated at Deseret Ranch

Table 1. Summary of data collected at four Florida breeding bird colonies for the 2004, 2005, and 2006 breeding seasons

	Deseret Ranch			North Fork			Bird Island			Pelican Island		
	2004	2005	2006	2004	2005	2006	2004	2005	2006	2004	2005	2006
Number of nests	254	176	249	86	68	132	87	74	147	78	29	0
Nest density (# nests/m^2)	0.15	0.10	0.19	0.08	0.06	0.08	0.01	0.01	0.02	0.01	<0.01	N/A
% failures	25	77	9	31	60	5	48	89	2	42	100	N/A
Number of fledglings	376	77	645	118	44	335	83	14	340	72	0	N/A
Mean nestling success	1.48	0.44	2.59	1.37	0.65	2.54	0.95	0.19	2.31	0.92	0.00	N/A
Median nestling success	2	0	3	1	0	3	1	0	2	1	0	N/A
Mean nestling success (excluding failures)	1.98	1.88	2.73	2.00	1.63	2.68	1.84	1.75	2.36	1.60	N/A	N/A
Median nestling success (excluding failures)	2	2	3	2	2	3	2	2	2	2	N/A	N/A

was 31% lower in 2005 than in 2004 and 30% lower in 2005 than in 2006 (Table 1). The number of nests initiated at North Fork and Bird Island were 21% and 15% lower in 2005 than in 2004 and 52% and 50% lower in 2005 than in 2006 (Table 1). The number of nests initiated at Pelican Island was 63% lower in 2005 than in 2004 (Table 1).

All sites experienced an increase in the percent nest failures between 2004 and 2005. Deseret Ranch, North Fork, and Bird Island experienced a 52%, 29%, and 41% increase in nest failures, respectively (Table 1). Pelican Island experienced a 58% increase in nest failures, the largest percent increase in nest failures out of all four colonies (Table 1). Percent nest failures at Deseret Ranch, North Fork, and, Bird Island decreased by 68%, 55%, and 87%, respectively between 2005 and 2006 (Table 1). Pelican Island failed to start at all during the 2006 season and it is thought that birds may have settled on other islands in the Indian River Lagoon or dispersed to other active colonies.

The number of chicks fledged at each site decreased between 2004 and 2005 as well. There were 80% fewer chicks fledged at Deseret Ranch during the 2005 season than during 2004 (Table 1). There were approximately 68% fewer chicks fledged at North Fork and 83% fewer chicks fledged at Bird Island during the 2005 breeding season (Table 1). Pelican Island had the sharpest decrease in the number of fledglings produced due to all out failure of the colony during the

2005 breeding season and failure to start during the 2006 breeding season (Table 1). Chick numbers were highest during the 2006 breeding season for all colonies except Pelican Island.

Median yearly nestling success was compared for each of the four colonies and found to be significantly different between years (Deseret Ranch $H = 302.26$/ $p < 0.05$/ $df = 2$; North Fork $H = 118.23$/ $p < 0.05$/ $df = 2$; Bird Island $H = 169.67$/ $p < 0.05$/ $df = 2$; Pelican Island $U = 478.50$/ $p < 0.05$). The median nestling success at Deseret Ranch was 2 fledglings/nest during 2004 but fell to 0 fledglings/nest in 2005 (Table 1). The median nestling success at North Fork was 1 fledgling/nest in 2004 and 0 fledglings/nest in 2005 (Table 1). The median nestling success at Bird Island was 1 fledgling/nest in 2004 and 0 fledglings/nest in 2005 (Table 1). Median nestling success at Pelican Island dropped from 1 fledgling/nest in 2004 to 0 fledglings/nest in 2005 (Table 1). Median nestling success increased in 2006 at Deseret Ranch, North Fork, and Bird Island to 3, 3, and 2 fledglings/nest, respectively, but failed to rebound at Pelican Island (Table 1).

There was no significant difference between the 2004 and 2005 median nestling success when nest failures were excluded from the analysis at Deseret Ranch ($U = 3602.00$ / $p > 0.05$), North Fork ($U = 606.50$ / $p > 0.05$), or Bird Island ($U = 173.00$ / $p > 0.05$). Median nestling success did differ significantly between the 2004–2005 breeding seasons and that of 2006 breeding season for Deseret Ranch (2004 vs. 2006 $U = 10851.00$/ $p < 0.05$; 2005 vs. 2006 $U = 1891.00$ / $p < 0.05$), North Fork (2004 vs. 2006 $U = 1970.50$ / $p < 0.05$; 2005 vs. 2006 $U = 440.00$ / $p < 0.05$), and Bird Island (2004 vs. 2006 $U = 1974.00$ / $p < 0.05$; 2005 vs. 2006 $U = 297.00$ / $p < 0.05$). No statistical comparison could be conducted at Pelican Island because of colony failure in 2005 and the failure to start in 2006.

DISCUSSION

The between year differences in median nestling success observed for 2004 and 2005 at all four colonies may be attributed to the differences in the number of failures recorded in any given year. Deseret Ranch experienced a 52% increase in nest failures between 2004 and 2005. North Fork and Bird Island experienced 29% and 41% increase in nest failures, respectively, while Pelican Island experienced a 58% increase in nest failure, the largest percent increase in nest failure out of all four colonies. When data for 2004 and 2005 were compared statistically, the data only differed significantly when nest failures were included in the analysis. When failures were excluded from the analysis for 2004 and 2005, there appeared to be

no significant difference in nestling success, meaning that productivity for successful nests remained relatively constant for both years.

The fact that so many birds abandoned their nests instead of remaining in attendance and producing a smaller brood also implies that there may be a certain threshold, after which it is less costly for the parent to abandon this year's brood and live to breed another year. According to KAHL (1964) an adult wood stork has a metabolism that requires approximately 450 kcal/bird/day, which translates into 520 g of food (for a 2.5 kg individual) per day. During the breeding season at least one parent remains in attendance of the nest after the eggs are lain. The responsibility for guarding the nest is thought to be shared equally amongst the two parents. If this assumption is true then the amount of foraging time available for each parent is halved. In years where prey is scarce or hard to capture, the parents may not be able to procure enough food to support their own metabolic needs.

Parents who are able to procure the resources needed to support their own metabolism face a second hurdle once the chicks hatch. KAHL (1962) studied the bioenergetics of nestling wood storks and found that between day 0 and day 22 there was a linear increase (from approximately 25 g to just under 350 g per day) in the amount of food each chick must consume to support their metabolism. This is above and beyond what each adult stork must procure to support itself and will vary even more depending on how many chicks have hatched per nest. From day 23 to day 45 they observed that the amount of food taken by nestling wood storks plateaued (350 g/nestling/day) (KAHL 1962). This plateau was followed by a sharp decline in the amount of food consumed between 46 days to age of fledging (KAHL 1962). Any given nestling will need to consume as much as 40 lbs of prey during the 60–65 day nestling period (KAHL 1962). Fifty percent of this amount is consumed between 23 and 45 days of age (KAHL 1962). Even if parents make it through the initial 22 days, they may find it impossible to keep up with the food needs of their chicks as well as there own needs. This would most likely lead to nest abandonment during the incubation phase or early nestling phase. The majority of nests that failed at each of the four colonies did so relatively early in the season, which would appear to support this assertion.

Interestingly enough, median nestling success (excluding nest failures) was significantly different in 2006 than in 2004 and 2005 for all of the active breeding colonies surveyed for this study. In other words, productivity of successful nests actually increased in 2006. Parents were able to support more chicks per nest than in previous years. Nests were even observed with as many as five chicks per nest, though in each of these instances the fifth chick was lost during the nestling phase.

Differences in median nestling success may reflect variation in Florida's hydrologic regime during the 2004, 2005, and 2006 seasons. Inter-year variation in

the number of nesting wood storks has been attributed in the past to differences in yearly weather conditions (OGDEN & NESBITT 1979), which may have a direct or indirect impact on nestling success. OGDEN and NESBIT (1979) speculated that average/above-average rainfall during the previous summer and the absence of unusually cold and rainy weather during the beginning of the nesting season may work in unison to stimulate the most intense nesting efforts by wood storks. This pattern of rainfall is believed to maximize production of freshwater fishes by flooding summer marshes and concentrate freshwater fishes during the dryer season when wood storks nest (KAHL 1964). The second study year was uncharacteristically wet, leaving many of the wood storks' foraging areas flooded and making prey less accessible (Fig. 2). Florida experienced a drought during the 2006 season, which may have helped to concentrate prey species and thereby increase wood stork foraging efficiency. Extensive post-season flooding in 2005 may also have helped to increase fish populations in 2006 which would explain why median nestling success was so high in 2006 even when failed nests were excluded from the analysis. In years where foraging resources are abundant, parents may not be as "food limited" and differences in productivity may be more dependent on site specific differences.

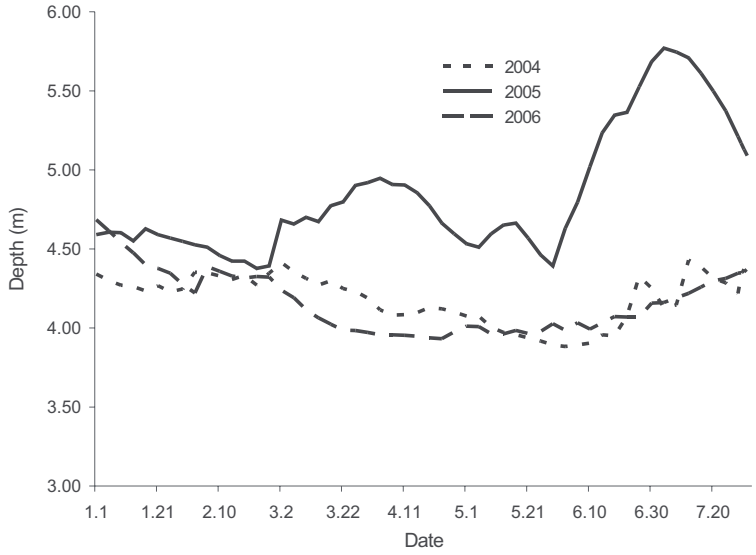

Fig. 2. Example of hydrologic trends observed during 2004, 2005, and 2006 breeding seasons. Graph shows changes in water depth at the St. Johns River at Palm Bay (01560735) measuring station. Water depths remained low during crucial segments of breeding season in 2004 and 2006. Water levels remained high during 2005, flooding wood stork foraging areas and possibly lowering adult foraging efficiency. Source: St. Johns River Water Management District (2006)

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REFERENCES

COULTER, M. C. & BRYAN, A. L. (1993) Foraging ecology of Wood Storks (Mycteria americana) in East-Central Georgia: Characteristics of foraging sites. *Colonial Waterbirds* **16**: 59–70.

KAHL, M. P. (1962) Bioenergetics of growth in nestling Wood Storks. *The Condor* **64**: 169–183.

KAHL, M. P., JR. (1964) Food ecology of the Wood Stork (Mycteria americana) in Florida. *Ecological Monographs* **34**: 97–117.

MARINE RESOURCES COUNCIL (MRC) (2006) Marine Resources Council: Water quality data. http://www.mrcirl.org/water/wqmonthlydata.html

OGDEN, J. C. & NESBITT, S. A. (1979) Recent Wood Stork population trends in the United States. *Wilson Bulletin* **91**: 512–523.

RODGERS, J. (1987) On the antipredator advantages of coloniality: a word of caution. *Wilson Bulletin* **99**: 269–271.

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT (2006) Hydrological Data. http://arcimspub.sjrwmd.com//website/dahds/design/index.html

U.S. FISH AND WILDLIFE SERVICE (USFWS) (2003) Multi-species Recovery Plan for South Florida: Wood Stork. Pp. 393–427. Available at: www.fws.gov/southeast/vbpdfs/species/birds/wost.pdf

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