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Wood Stork Report

A newsletter dedicated to sharing information about the wood stork.

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Productivity of Wood Storks in North and Central Florida

James A. Rodgers Jr. (FWC)

Abstract: The average fledging rate of wood storks at 19 colonies in north and central Florida during 2004 was 1.53±1.10 fledglings/nest (n=1,574 nests). For only successful nests (fledged at least 1 stork), the average fledging rate was 2.07±0.67 fledglings/nest (n=1,122 nests). About 71.3% of monitored nests fledged at least one bird. Significant differences in the mean fledging rate existed among colonies (range=0.25 to 2.37 fledglings/nest). Differing rates among colonies were due to different frequencies of complete nest failures (no fledglings) and nests with 2-fledglings and/or 3-fledglings. While the mean fledging rate for all stork colonies was similar to 2003 (1.49 fledglings/nest), a comparison of the fledging rates for individual colonies monitored during both years indicates that 8 of 14 colonies exhibited greater fledging rates during the 2003 breeding season. Previously published data on wood stork productivity in Florida is similar to the results of this current study.

INTRODUCTION

The wood stork (*Mycteria americana*) once was a common breeding species throughout the southeast United States. However, precipitous declines in the species= range and population occurred during the mid-1900s (Kushlan and Frohring 1986, Ogden *et al.* 1987). Ultimately, the United States population was listed as endangered in 1984 (USFWS 1984). While the number of stork nests and colonies in Georgia and South Carolina appeared to increase during the 1980s and 1990s, storks were still experiencing nesting related problems in Florida, especially

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Wood Stork Breeding Success in Selected Colonies in Georgia and South Carolina in 2004

Larry Bryan, Warren Stephens and Lehr Brisbin, SREL

Accurate determination of breeding success (average fledged young per nest per colony) is one component required to assess Wood Stork population recovery. In combination with aerial colony counts (to determine the number of nesting storks; not part of this study), breeding success estimates can provide a state's best assessment of stork productivity. Therefore, in 2004, we monitored breeding success in seven Georgia and three South Carolina stork colonies to provide more accurate numbers of stork success in these two states.

Methods: Wood Stork colonies in eastern (coastal), east-central, and south-central Georgia and eastern South Carolina were monitored as part of this study (Table 1, Figure 1). A sample of nests at each colony were identified and enumerated and observed periodically through the breeding season until the nesting attempt failed or the young reached 50+ days of age and thus were too mobile to accurately count (young generally start flying at 50 days). Ages of nestlings were determined by first sighting of nestlings and nestling plumage characteristics. Each colony was visited 6-8 times during the breeding season (Table 1). Permission to enter some colonies took longer to obtain than others and the early nesting phase (early incubation) was missed in some colonies. Therefore, since nest abandonment during the early nesting phase may have been missed, the breeding success averages should be considered estimated maximum success. Breeding success for this study was defined as the average number of nestlings per nest reaching 50 days of age for each colony. The percentage of breeding attempts fledging 0, 1, 2, 3, and 4 nestlings was also determined. For a general regional comparison, we classified the

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Announcement: Wood Stork Ecology and Status Symposium

The Wood Stork Research and Monitoring Working Group is hosting the Waterbird Society Annual Meeting at Jekyll Island, Georgia, October 13-16, 2005. As part of this meeting there will be a Wood Stork Symposium of invited papers and a Wood Stork Workshop for discussions about conservation, management actions, research needs and other topics. The Georgia Conservancy hosted the first Wood Stork Symposium October 19-21, 1993, in Savannah Georgia. For more information visit the Waterbird Society website at: www.waterbirds.org.

The Wood Stork Report

Billy Brooks (USFWS) (*billy_brooks@fws.gov*)

As with most endangered and threatened species, the Wood Stork has a network of people who have mutual goals, mandates, inherent missions, and personal interests to promote and monitor this endangered species' recovery. This web-based newsletter is an effort to recognize the dedication of these people and their organizations' efforts in Wood Stork recovery. This newsletter also serves as a location to exchange information on Wood Stork recovery, research, monitoring, and management. It is our goal to publish this newsletter annually following the Wood Stork Research and Monitoring Working Group annual meeting. Email contact information for our recovery partners is noted in the newsletter. To submit an article or other information regarding Wood Stork recovery, please email *billy_brooks@fws.gov*.

...***Productivity of Wood Storks*** *continued from page 1...*

south Florida (Coulter *et al.* 1999).

Wood stork fledging success often is variable among different years and colonies (Holt 1929, Kahl 1964, Ogden et al. 1978, Clark 1978, Ehrhart 1979, Hopkins and Humphries 1983, Rodgers and Schwikert 1997) suggesting local habitat variables and food resources are the proximate factor in differences in nestling survivorship and fledging rates. Based on statewide surveys conducted by GFC/FWC personnel, stork colonies increased from 32 colonies during 1976-78 (Nesbitt *et al.* 1982) to 52 colonies during 1986-87 (Runde *et al.* 1991), but decreased to 34 colonies in 1999 (Rodgers *et al.* 2002). Storks also continued the trend of exhibiting a shift to an increased number of smaller colonies and fewer large colonies during the last two surveys: 46.9% of the colonies in the 1970s were ≤250 birds compared to 77.0% in the 1980s and 66.7% in 1999, while 37.5% of the colonies in the 1970s were >500 birds compared to 5.7% in the 1980s and 15.2% in 1999. The most recent surveys indicated about 1,585 stork nests at 17 colonies during the drought year of 2001 (Slay and Bryan 2001) but 6,622-7,732 nests at 47 colonies in 2002 (Meyer and Frederick 2002) in Florida.

One of the objectives of the Wood Stork Recovery Plan (i.e., 3.3 Monitor productivity of stork populations) identified productivity levels exceeding a minimum standard to ensure continued viability of the U.S. stork population (USFWS 1997, 2000). Specifically, knowledge of the number of fledged young per nest must be determined for a representative number of colonies for a minimum of 3 years. A reclassification from an endangered to threatened status could be accomplished when there are 6,000 nesting pairs and annual productivity is greater than 1.5 fledglings/nest averaged over three contiguous breeding seasons. Currently, the wood stork has a biological score of 26.3 and an action score of 14, with a monitoring score of 4 and a research score of 5, in the FWC ranking protocol for the year 2003.

Thus, the primary goal of this study is to gather productivity data for storks nesting in Florida in order to examine the variation and trends in fledging success within and among colonies and years. These data for the reproductive success of the north and central Florida stork colonies would then be compared within the metapopulation of storks in the southeast United States by examining the effects of colony size and geographical location on breeding success within and among colonies and years. These data ultimately may be used to determine if the stork population in the U.S. meets recovery criteria for down-listing the species.

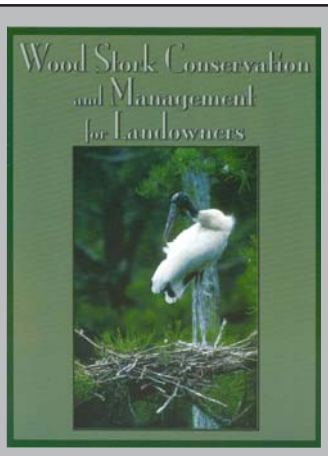
STUDY POPULATION AND METHODS

Study area

Based on information from the previous statewide waterbird atlas conducted by GFC/FWC personnel (Nesbitt *et al.* 1982, Runde *et al.* 1991, Rodgers *et al.* 2002) and concurrent statewide surveys of wood stork colonies funded by the USFWS during 2003-05, stork colonies were randomly selected from the 12-15 active sites in north and central Florida based on number of nests, accessibility and distribution across the state. These sites included colonies located in both coastal and interior counties (Appendix).

Study Approach

Based on previous experience with monitoring stork productivity and requirements for a representative sample size for statistical analyses, either all nests (colonies ≤100 nests) or a sample of the nests (i.e., 25-70% of nests at larger colonies) were monitored on a biweekly schedule



Wood Stork Private Lands Brochure Available

Through a contract with the SREL, Larry Bryan assisted the USFWS by developing a 12-page color brochure that addresses Wood Stork conservation and management for private landowners. The brochure can be printed from the following website: (*http://northflorida.fws.gov/WoodStorks/Documents/WOST-brochure.pdf*); or to receive color/glossy copy of this brochure, email your request to billy_brooks@fws.gov

Appendix. Wood stork colonies monitored in north and central Florida during the 2004 breeding season.

Colony	County	Latitude/Longitude	Estimated total nests	Description
Chaires	Leon County	30° 26.0′/84° 07.8′	280-290	Cypress and black gum-dominated swamp
Ochlockonee North	Leon County	30° 32.6′/84° 22.8′	95-110	Black gum swamp on the edge of a pond
Ochlockonee South	Leon County	30° 30.5′/84° 21.4′	46	Cypress swamp on the edge of a pond
Pumpkin Hill	Duval County	30° 28.7′/81° 30.3′	Not active	Two isolated cypress-dominated domes
Jacksonville Zoo	Duval County	30° 24.4′/81° 38.5′	87	Live oak within a savannas exhibit
Dee Dot	Duval County	30° 13.3′/81° 26.8′	125-130	Remnant cypress swamp in an impounded lake
Matanzas Marsh	St. Johns County	29° 43.8′/81° 17.3′	28	Isolated cypress-dominated dome
Cypress Creek	Hillsborough County	28° 09.8′/82° 23.6′	59	Bottomland hardwood island constructed in a borrow pit
Cross Creek	Hillsborough County	28° 08.5′/82° 21.1′	46	Cypress growing in a man-made pond
New Port Richey	Pasco County	28° 44.0′/82° 43.6′	178	Remnant cypress swamp in a retention pond
Croom	Hernando County	28° 32.2′/82° 12.4′	180-200	Cypress swamp in the Withlacoochee River flood plain
Devils Creek	Pasco County	28° 25.1′/82° 05.0′	8	Isolated oak-cypress swamp
Little Gator Creek	Pasco County	28° 18.0′/82° 04.0′	145-160	Impounded cypress swamp
Lone Palm	Polk County	28° 03.0′/82° 00.5′	82	Remnant bay head island constructed in a borrow pit
Lake Russell	Osceola County	28° 07.5′/81° 25.0′	63	Cypress on the edge of a lake
Deseret Ranch	Brevard County	28° 07.0′/80° 46.0′	254	Brazilian pepper-dominated islands in an old borrow pit
Lake Rosalie	Polk County	27° 54.7′/81° 25.4′	46	Remnant cypress-dominated island created in a lake
Pelican Island	Indian River County	27° 47.8′/80° 26.0′	78	Mangrove-dominated island, Pelican N.W.R.
North Fork	St. Lucie County	27° 15.8′/80° 19.7′	86	Mangrove-dominated island in St. Lucie River
Bird Island	Martin County	27° 11.5′/80° 11.4′	87	Mangrove-dominated island near Sewell's Point

during the breeding season. The study is designed to monitor colonies with differences in nest numbers and densities, at interior and coastal county sites, and with latitudinal and longitudinal dispersal. However, because stork colonies exhibit considerable variation in nest numbers and breeding status among years (Ogden *et al.* 1980, 1987, Rodgers *et al.* 1987, Rodgers and Schwikert 1997), there is a high probability that not all colonies will be active or have similar nest numbers every year of the study. This may result in missing colony-years and ultimately cause an unbalanced study design.

Wood stork colonies were visited every 1-2 weeks throughout the breeding season of MarchBAugust to avoid temporal biases associated within nesting seasons (Rodgers and Schwikert 1997). Care was taken to reduce researcher effects on the breeding storks and other species of colonial waterbirds by minimizing nest monitoring during pair-formation and early egg-laying periods. Colonies were visited during the cooler morning and late afternoon and no visits occurred during inclement weather. The time spent at each nest was minimized by the use of two people to observe and record data and map nest/tree distribution. Binoculars were used to monitor nests from a distance within high-density, mixed-species subcolonies when the nestlings were visible and capable of leaving the nest. After the nestlings were 3 to 4-weeks old, all nests were counted from a distance with binoculars to avoid pre-fledging of nestlings. Most stork nests and trees were individually marked with numbered, colored flagging tape or plastic tags.

Statistical analysis

Data are represented and analyzed as a colony-year unit. Thus, a colony monitored for 3 years or 3 colonies monitored during one year are represented by 3 colony-years. Fledging rates were calculated on a per nest (fledglings/nest) basis for both all nests initiated and successful nests (fledging $\geq$ 1 bird). Sources of nest failure were determined when possible.

Statistical analyses were made with the SAS System (SAS Institute, Inc. 1985). Unless stated otherwise, values represent the mean"s.d. Statistical analyses of reproductive variables were made only for colony-years with $\geq$20 nests. Prior to pairwise comparisons, the data were tested for normal distribution with the Shapiro-Wilk statistic using the UNIVARIATE procedure (SAS Institute, Inc. 1990a) and for homogeneity of variances with Bartlett's likelihood ratio test using the DISCRIM procedure (SAS Institute, Inc. 1990b). The UNIVARIATE procedure also was used to calculate interquartile values. Appropriate nonparametric or parametric statistical analyses were used for fledging success variables. The MEANS procedure was used to calculate standard descriptive statistics including mean, standard deviation, and upper and lower 95th percentile confidence intervals. An inverse variance weighting option was used with the MEANS procedure to account for the uneven sample sizes among colonies. We assumed independence among colonies and a constant correlation within each colony.

Because of the potential unbalanced design of this study due to no nesting activity at colonies in some years, the MIXED procedure (SAS Institute, Inc. 1992) will be use to analyze geographical trends among colonies at the end of the 3 breeding seasons of the study. The MIXED procedure fits mixed linear models (generalizations of standard linear models) using both fixed (e.g. latitude, longitude, colony size, nesting density) and random effects (e.g. colony, year, colony*year). Thus colony and year can be used as class variables, while latitude, longitude, nest numbers and nesting density will be fixed covariates when colony-years are pooled.

All data will be stored at the Wildlife Research Laboratory in Gainesville and with the Division of Wildlife Technical Support Service=s staff in Tallahassee. Annual and final reports will be deposited at \\Wildnet\BWDC\BWDC Projects\Progress Reports\FY02-03 Progress Reports and updates thereafter. Copies of all reports will be provided to cooperators and the USFWS at the end of the field season.

RESULTS

The average fledging rate of wood storks at 19 colonies in north and central Florida during 2004 was 1.53±1.10 fledglings/nest (Table 1). The estimated lower and upper 95th percentile confidence interval for fledging success for all colonies was 1.47 to 1.58

Table 1. Sample size of monitored nests and fledging rates of wood stork colonies in north and central Florida during the 2004 nesting season.[a]

Colony	Number[b]	Mean	Std	Rank[c]
Jacksonville Zoo	87	2.37	1.08	A
Devils Creek	8	2.12	0.35	
Chaires	141	1.93	0.83	BC
Cross Creek	39	1.79	1.00	BCD
Ochlockonee South	37	1.78	1.11	BCDE
New Port Richey	172	1.73	0.98	BCDE
Ochlockonee North	44	1.70	1.13	CDE
Lake Rosalie	47	1.62	1.01	CDE
Cypress Creek	63	1.59	1.16	CDEF
Deseret Ranch	254	1.48	1.05	DEFG
Lone Palm	67	1.48	0.96	DEFG
Dee Dot	69	1.42	1.01	DEFGH
North Fork	86	1.37	1.16	EFGH
Little Gator Creek	78	1.19	1.20	FGHI
Croom	127	1.09	0.99	GHI
Lake Russell	62	1.05	1.11	HI
Bird Island	87	0.95	1.06	I
Pelican Island	78	0.92	0.94	I
Matanzas Marsh	28	0.25	0.65	J
Summary totals	1574	1.53	1.10	

[a]Values given are per nest.
[b]Number represents the number of nests monitored in each colony, not the total colony size.
[c]ANOVA/LSMeans tests for among colony mean comparisons, P=0.05. Colonies with the same letter are not significantly different from one another.

fledglings/nests. For only successful nests (nests that fledged at least 1 stork), the average fledging rate was 2.07±0.67 fledglings/nest (n=1,122 nests). About 71.3% of monitored nests fledged at least one bird.

Significant differences in the mean fledging rate existed among colonies (range=0.25 to 2.37 fledglings/nest) during 2004 (Table 1). Colonies exhibiting higher (> upper 95th percentile confidence interval of 1.58) or lower (< lower 95th percentile confidence interval of 1.47) fledging rates appeared to be evenly distributed across north and central Florida.

An examination of the distribution of the number of fledglings per nest provided additional insight into the fledging success within each colony (Table 2). Jacksonville Zoo and Chaires exhibited high fledging rates due to below average number of complete nest failures (i.e., no fledglings) and above average number of 2-fledgling and/or 3-fledgling nests. In contrast, Bird Island, Lake Russell, Little Gator Creek, Matanzas Marsh, and Pelican Island exhibited low fledging rates due to below average number of 2-fledgling and 3-fledgling nests and above average number of complete nest failures

Several stork colonies exhibited noticeably fewer nests in 2004 compared to 2003. Pumpkin Hill had no nesting activity in 2004 compared to 2003 (n=120 nests). Colonies that possessed fewer nests in 2004 included Dee Dot (2003=225-250 nests, 2004=125-130 nests) Cypress Creek (2003=175 nests, 2004=59 nests), New Port Richey (2003=225 nests, 2004=178 nests), Little Gator Creek (2003=225-250 nests, 2004=145-160 nests), Lone Palm (2003=175 nests, 2004=82 nests), and Lake Rosalie (2003=125 nests, 2004=46 nests).

Table 2. Frequency of fledglings per nest for wood stork colonies in north and central Florida during the 2004 nesting season. Bold print indicates categories that are larger or smaller than the interquartile range (middle 50%) of the statewide summary total below.

		Percent of nests with fledglings				
Colony	Number *	0	1	2	3	4
Bird Island	87	**48.28**	**16.09**	28.74	**5.75**	1.15
Chaires	141	**9.22**	10.64	**58.16**	21.99	0
Cross Creek	39	**17.95**	7.69	**51.28**	23.08	0
Croom	127	40.94	13.39	41.73	**3.94**	0
Cypress Creek	63	28.57	9.52	36.51	**25.40**	0
Devils Creek	8	**0**	**0**	**87.50**	12.50	0
Dee Dot	69	27.54	13.04	**49.28**	10.14	0
Deseret Ranch	254	25.20	**18.90**	38.58	17.32	0
Jacksonville Zoo	87	**14.94**	1.15	**13.78**	**70.11**	0
Lake Rosalie	47	**21.28**	12.77	48.94	17.02	0
Lake Russell	62	**46.77**	12.90	29.03	11.29	0
Little Gator Creek	78	**44.87**	8.97	28.21	17.95	0
Lone Palm	67	22.39	**17.91**	**49.25**	10.45	0
Matanzas Marsh	28	**85.71**	3.57	**10.71**	0	0
North Fork	86	31.40	**20.93**	29.07	16.28	2.33
New Port Richey	172	**18.60**	9.30	**52.91**	19.19	0
Ochlockonee North	44	25.00	**6.82**	40.91	**27.27**	0
Ochlockonee South	37	**21.62**	8.11	40.54	**29.73**	0
Pelican Island	78	**42.31**	**28.21**	**24.36**	**5.13**	0
Summary totals	1574	28.72	13.28	39.45	18.36	0.19

*Number represents the number of nests monitored in each colony, not the total colony size.

DISCUSSION

Although the mean fledging rate for all wood stork colonies was similar for 2003 (1.49 fledglings/nest) and 2004 (1.53 fledglings/nest), a comparison of the fledging rates for individual colonies monitored during both years indicates that 8 of 14 (57.1%) colonies exhibited greater fledging rates during the 2003 breeding season (Table 3). Jacksonville Zoo again possessed the greatest fledging rate in 2004. While several colonies rebounded in 2004 (Chaires, Devils Creek), other colonies (Little Gator Creek, Lake Russell, Matanzas Marsh) exhibited lower productivity in 2004 compared to 2003.

In contrast to severe weather events (wind speeds exceeding 20 mph and rainfall exceeding 1 inch per hour during a short time interval) that contributed to a sizable number of nest failures at several colonies in 2003 (Chaires, Dee Dot, and Croom), the 2004 breeding season was

Recovery Partners

USFWS - US Fish and Wildlife Service
FWC - Florida Fish and Wildlife Conservation Commission
GDNR - Georgia Department of Natural Resources
SCDNR - South Carolina Department of Natural Resources
SREL - Savannah River Ecology Laboratory
UF - University of Florida
ENP - Everglades National Park
BCP - Big Cypress Preserve
SWA - Palm Beach County Solid Waste Authority
FDEP - Florida Department of Environmental Protection State Parks and Preserves
Pumpkin Hill Preserve and Faver Dykes State Park
USGS - US Geological Survey-National Wetlands Research Center
USDA - US Department of Agriculture - National Wildlife Research Center
SFWMD - South Florida Water Management District
SWFWMD - Southwest Florida Water Management District
SJRWMD - St. Johns River Water Management District
FPL - Florida Power and Light
Jacksonville Zoological Gardens
Audubon of Florida Coastal Islands Sanctuaries
Audubon of Florida Corkscrew Swamp Sanctuary
Audubon of Florida Duval/St. Johns/Martin/Pasco County Chapters
ARCI - Avian Research and Conservation Institute
DAK - Disney Animal Kingdom
SCIF - St. Catherines Island Foundation
St. Augustine Alligator Farm

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Table 3. Comparison of the mean fledging rate per nest of wood stork colonies in north and central Florida during the 2003 and 2004 nesting seasons.*

Colony	2003	2004
Jacksonville Zoo	2.21	2.37
Devils Creek	**0.21**	**2.12**
Chaires	**1.06**	**1.93**
New Port Richey	1.85	1.73
Ochlockonee North	1.35	1.70
Lake Rosalie	1.52	1.62
Cypress Creek	1.85	1.59
Lone Palm	1.36	1.48
Dee Dot	1.51	1.42
Little Gator Creek	**1.68**	**1.19**
Croom	1.29	1.09
Lake Russell	**1.71**	**1.05**
Matanzas Marsh	**1.39**	**0.25**
Pumpkin Hill	1.56	Inactive

*T-tests for between year comparison of mean fledging rate by colony. Colony means in bold font are significantly different (P=0.05) between years.

characterized as having below average rainfall. Several colony sites had little (Little Gator Creek, Chaires) or no (Pumpkin Hill) water beneath the nest trees. This probably was the cause of no nesting at the Pumpkin Hill colony in 2004. Lower water levels may have contributed to lower fledging rates at other colonies via the available prey at nearby wetlands used for foraging (Kahl 1964, Clark 1978, Kushlan 1986). Lack of rainfall and the resulting lower water levels at nearby foraging sites also has been suggested as a causal factor for the lower number of nests at individual colonies (Clark 1978, Ogden et al. 1987).

The combined fledging rate for all colonies for both 2003 and 2004 was 1.50±1.10 (n=3,383 nests). The estimated 95th confidence interval for fledging success was 1.47 to 1.54 fledglings/nests. For only successful nests, the average fledging rate was 2.11±0.66 fledglings/nest (n=2,403 nests).

Previously published data on wood stork productivity in Florida dates mostly from the mid-1970s to mid-1980s but appears to be similar to the results of this current study. Ehrhart (1979) reported a rate of 1.7 fledglings/nest for storks nesting at Merritt Island in 1979, while Rodgers *et al.* (1987) reported an average rate of 0.79 (range 0.21-1.54) fledgling/nest for 14 colonies in north and central Florida during 1981-85. The rate during 1981-85 (1.27 fledglings/nest) was higher than 2003 (1.06 fledglings/nest) but lower than 2004 (1.93 fledglings/nest) at Chaires. The rate during 1981-85 (1.54 fledglings/nest) was similar to 2003 (1.51 fledglings/nest) and 2004 (1.42 fledglings/nest) at Dee Dot. Ogden *et al.* (1978) reported an average of about 2.0 fledglings for successful nests in south Florida and Clark (1978) reported a range of 1.4-2.5 fledglings for successful nests at Merritt Island. These published rates are similar to the average of 2.11 fledglings/nest for successful nests in this study.

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U.S. Fish and Wildlife Service Jacksonville Field Office
http://northflorida.fws.gov/WoodStorks/wood-storks.htm
U.S. Fish and Wildlife Service South Florida Field Office (Vero Beach)
http://verobeach.fws.gov/species/birds/wost/wost-guide.htm
Everglades National Park
http://www.nps.gov/ever/eco/wdstork.htm
South Florida Water Management District (South Florida Wading Bird Report)
http://www.sfwmd.gov/org/wrp/wrp_evg/projects/wading01
University of Florida
http://www.wec.ufl.edu/faculty/FrederickP/stork/index.htm
University of Georgia Savannah River Ecology Laboratory
http://www.uga.edu/srel/Fact_Sheets/wood_storks.htm
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Banding at Selected Georgia Colonies Continues

Larry Bryan (SREL)

SREL has continued a leg-banding project that began back in the 1980s at the Big Dukes Pond/Birdsville Colony in GA. In 2004, 28 chicks were banded at Woody Pond at the Harris Neck NWR in coastal Georgia. Larry and other SREL staffers banded 42 chicks at Chew Mill Pond Colony. Larry and Donna Bear-Hull of the Jacksonville Zoological Gardens were able to band 20 chicks at the Zoo. Close to 1000 Wood STork chicks have been banded at these GA and FL colonies since 1995. Re-sightings typically come from coastal GA and SC. There have also been sightings of these birds in MS, AL, and down into FL. This year's banded stork sightings came from Loxahatchee NWR in southern FL, Amelia Island and Jacksonville Zoo in north Florida and at the White Hall colony in SC. The adult observed in the White Hall colony is one of hte few records of a stork observed nesting in a non-natal colony.

The Wood Storks are banded with a USGS band on the left leg and a colored numbered band on the right leg. Yellow bands with black lettering are from the St. Simons Island (GA) Colony; orange bands with black lettering are from the Chew Mill Pond Colony; red bands with white lettering are from the Woody Pond Colony at Harris Neck NWR: and light blue bands with black lettering are from the Jacksonville Zoo.

People on the Move

Debbie Pierce has made a big move with the USFWS from Florida to California where she is continuing to work on endangered species issues. The big change is really just the species and the habitats, but as with all endangered species there are always issues. We welcome **Tylan Dean** (tylan.dean@fws.gov) as the new USFWS South Florida Field Office (Vero Beach) lead for wood stork recovery. Tylan has been working in South Florida and working on avian issues for many years. He has lead responsibility for several listed species in South Florida. We welcome his expertise, experience, and knowledge of endangered species and the South Florida ecosystem.

Wood Stork Research and Monitoring Working Group

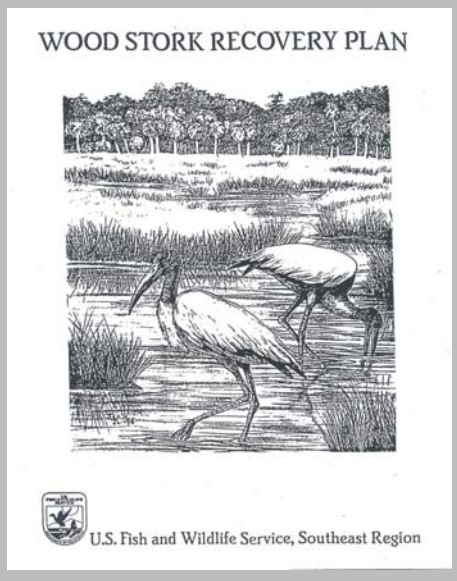
The annual meeting of the Research and Monitoring Working Group was hosted by Disney's Animal Kingdom (DAK) at their Conservation Station at DAK in Orlando, Florida on November 16-17, 2004. We are very grateful to DAK for providing us with a great meeting location. The meeting was well attended, and much of the information presented at the meeting is found within this newsletter. The USFWS is very appreciative of the efforts that were made to attend the meeting and to share inforation regarding Wood Stork recovery. Many thanks to Sue Maher and other staff at DAK for hosting the meeting and providing us with an informative behind the scenes tour of Disney's Animal Kingdom and Conservation Station.

Wood Stork Management Plan for Matanzas State Forest (2004) Available

The St. Johns River Water Management District and Florida Department of Environmnetal Protection acquired the Matanzas Marsh property (St. Johns County) in 2003. This property has a wood stork colony within its boundaries. Matanzas Marsh will be jointly managed by the FDEP's Florida Park Service and by the Florida Department of Agriculture and Consumer Services Division of Forestry. With the assistance of Pandion Systems, Inc. the **Wood Stork Management Plan for Matanzas State Forest** was developed and finalized (2004).

USFWS Wood Stork Recovery Plan Available (1997)

The first recovery plan for wood storks was approved and finalized in 1984. The first revision was finalized in 1997 and is available at:
http://northflorida.fws.gov/WoodStorks/woodstorks.htm.



Web Cams

St. Augustine Alligator Farm Zoological Park has two webcams to view their wading bird nesting colony and roost site.

Gulf Coast Tracking Project Update

Larry Bryan (SREL)

In the summer of 2003, as part of a multi-agency effort to examine origins of Wood Storks observed in Gulf Coast states, 10 satellite transmitters were deployed on storks: 3 in southern Louisiana, 4 in western Mississippi, and 3 in eastern Mississippi. We received signals from 7 of these transmitters in 2004, and four are still active as of December 2004.

The three storks from eastern MS all flew to Florida in 2003. Two of these carrying smaller transmitters were last located in southeastern FL in late May of 2004. The remaining active stork flew north to Valdosta, GA region in late May, but returned to Polk County, FL in October.

One of hte western MS transmitters failed shortly after deployment. Another stork flew to Mexico and was last located near the base of the Yucatan Peninsula (YP) from late December through February 2004. Another stork flew to the base of the YP, where it may have nested (late 2003/early 2004). It returned to the U.S. (mississippi River drainage in LA) in June 2004, and returned to its location near YP in early November 2004. The remaining stork flew to the Mexico/Guatemala border (Pacific coast),where it may have nested. It shifted to the YP region in February and returned to the U.L. (LA) in June 2004. It had returned to its Pacific coast site by early November 2004.

Only two of the 3 LA transmitters functioned after deployment. We received a weak signal from a stork with a small transmitter in September 2003 in eastern Mexico, but it was a poor quality location. The remaining stork flew east in October 2003 to AL and reached Polk County, FL by December 2003. In late December 2003, the stork had shifted to Dade County, FL (west of Miami) and it is still there. This one (LA) stork is the only indication of any mixing of the U.S. and Mexican breeding stork populations.

South Florida Multi-Species Recovery Plan

Finalized and approved in 2001, this document has a section addressing recovery of the wood stork in the South Florida Ecosystem. This document is available at: http://verobeach.fws.gov/Programs/Recovery/vbms5.html

Federal Classification of Wood Storks

On February 28, 1984, the USFWS listed the United States breeding population of the Wood STorks (in Florida, Georgia, South Carolina, and Alabama) as endangered under the Endangered Species Act of 1973, as amended (ESA). a recovery plan for this species was approved in 1986 and waas revised in 1997. The ESA defines an "endangered species" as "any species which is in danger of extinction throughout all or a significant portion of its range." A "threatened species" is defined as "any species which is likely to become an endangered species within the forseeable future throughout all or a significant portion of its range." A species can be listed or delisted if the Secretary of the Interior determines that the species no longer meets the endangered or threatened status based upon these five factors listed in Section 4(a)(1) of the ESA:

(1) the present or threatened destruction, modification, or curtailment of its habitat or range;
(2) overutilization for commercial, recreational, scientific, or educational purposes;
(3) disease or predation;
(4) the inadequacy of existing regulatory mechanisms; and
(5) other natural or manmade factors affecting its continued existence.

Measuring the Biological Recovery of Wood Storks

Measuring the biological aspect of the recovery of the Wood Stork is outlined in the USFWS 1997 Wood Stork Recovery Plan. The plan's recovery criteria state that reclassification from endangered to threatened could be considered when there are 6,000 nesting pairs and annual regional productivity is greater than 1.5 chicks per nest/year (calcualted over a 3-year average). Delisting could be considered when there are 10,000 nesting pairs calculated over a 5-year period beginning at the time of reclassificationand annual regional prductivity is greater than 1.5 chicks per nest/year (calcualted over a 5-year average). As a subset of the 10,000 nesting pairs, a minimum of 2,500 nesting pairs must occur in the Everglades and Big Cypress systems in south Florida. The number of nesting pairs is ascertained throiugh aerial surveys supported and flown by the USFWS, SCDNR, GDNR, and FWC.

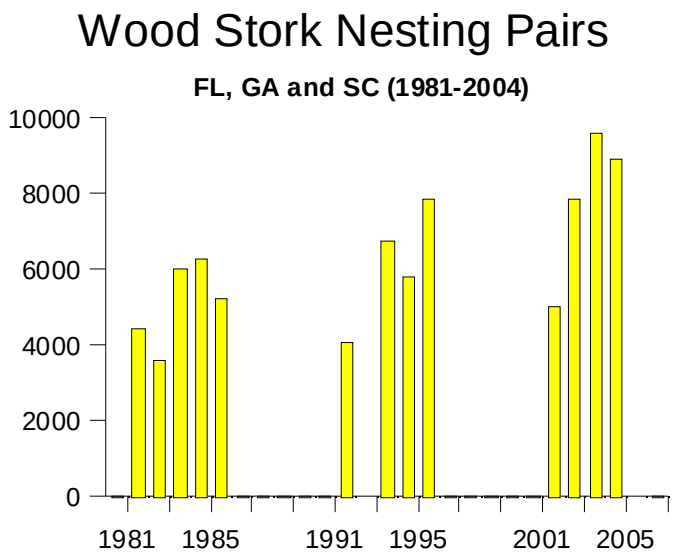
The Productivity Monitoring Initiative began with the drafting of a scientific protocol in 2002 by Jim Rodgers of the FWC. We recently made some minor changes to the protocol. The updated protocols can be found later in this newsletter: **Protocol for monitoring the reproductive success of wood storks in the southeast United States.** The first year of productivity data collection began in 2003 at 15 colonies in Florida. In 2004, 20 colonies were monitored in Florida and an additional 8 colonies were monitored in Georgia (6) and South Carolina (2), thus providing productivity monitoring at 28 colonies throughout the breeding range or approximately one third of the active colonies. The 2004 synoptic aerial surveys to count nests in FL, GA and SC were completed in May 2004 and this effort represents year 4 of a 5-year study.

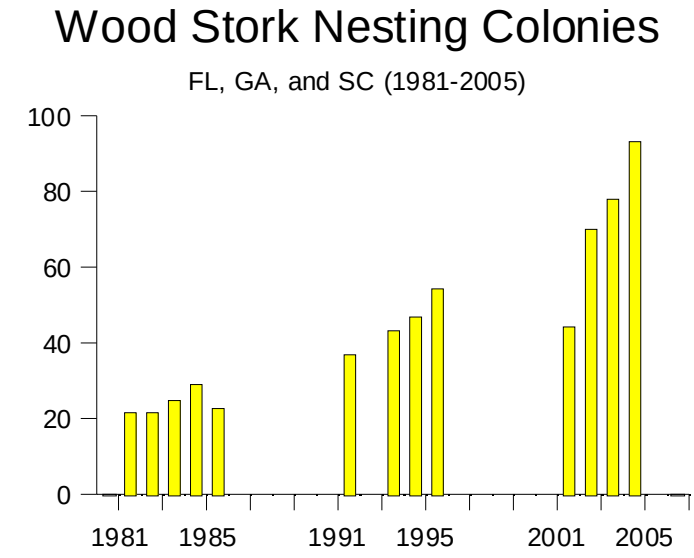
Synoptic Aerial Surveys

The USFWS acknowledges the limitations involved in relying on aerial surveys for developing population estimates. However, storks are a long-lives species that demonstrate considerable variation in population numbers in response to changing hydrolical conditions. Over the long term, aerial surveys are the most cost effective method for estimating population trends. Ground surveys, while providing greater individual colony accuracy, are more time consuming and expensive on a region-wide basis. Replication of surveys and ground counts at selected index colonies will help to minimize variability and will also provide information regarding the second component of the recovery criteria, productivity (chicks per nest). With the capabilities of digital technology, a study is underway to assess the use of aerial digital photography as a new and relatively inexpensive methodology for counting nests and determining productivity within a colony.

A series of aerial surveys to locate all Wood Stork nesting colonies was first flown in 1957. This effort was reinitiated in 1975 and flown for 10 years by the Audubon Society and other partners. These surveys were flown by **John Ogden** (jogden@sfwmd.gov) and others. In 1991, the USFWS reinitiated this synoptic effort again to monitor the nesting pair aspect of the Wood Stork recovery criteria, and partnered with SCDNR, GDNR, The Audubon Society, and FWC to fly surveys from 1991 to 1995 which documented an average of 6,045 wood stork nests per year during this 5-year interval. In 2001, the USFWS reinitiated another 5-year synoptic aerial survey effort. Based upon the surveys and information from monitoring at individual colonies, it is estimated that there were an estimated (8,866) nest starts by Wood Storks at (88) active colonies in FL, GA, and SC in 2004. This compares to (9,291-9,416) nest starts by Wood Storks at (78) active colonies in 2003, (9,016-10,126) at (71) colonies in 2002 and (4,998) at (43) colonies in 2001. Using lower limit values this represents an average of 8,043 nest starts at 70 colonies during this 4-year period.

It shoud be noted that the reported number of nest starts are usually "peak" counts, in which the highest count for the season is used as the estimate of nests. Also, it should be noted that the synoptic numbers presented will be under further review and are likely to change. Finally, there was a synoptic aerial survey flown in 1999 as the GDNR and SCDNR flew their annual Wood Stork surveys and the FWC conducted surveys to update the "Florida Atlas of Breeding Sites for Herons and Their Allies." The FWC survey methodology for this survey (**see Accuracy of Aerial Surveys of Waterbird Colonies in Florida** in Volume 3, Number 1 April 2004 edition of the Wood Stork Report) does not allow for directo comparison of nest numbers, however this survey does suggest a very large nesting effort by Wood Storks in FL in 1999. With 42 active colonies and a minimum range value of 7,000 nesting pairs in FL and with 21 active colonies in GA and SC with 1,658 nesting pairs Wood Stork nests, the 1999 total nesting effort at 63 colonies approached 9,000 nest starts.





Source: South Carolina Department of Natural Resources, Georgia Department of Natural Resources, National Audubon Society, Florida Fish and Wildlife Conservation Commission, and U.S. Fish and Wildlife Service, Ogden 1994

Nesting Success and Productivity of South Florida Wood Storks in 2004

Rena Borkhatari, Peter Frederick, Becky Hylton. (UF)

Introduction We systematically surveyed for Wood Stork colonies from February to June 2004 throughout Water Conservation Areas 1, 2 and 3 using fixed wing aircraft. In addition to the 2 major stork colonies that developed in the WCA's (Crossover and 3B Mud East), we also monitored the Tamiami West and Paurotis Pond colonies located within Everglades National Park from the ground and air and the Palm Beach County Solid Waste Authority (SWA) colony from the ground. Each Wood Stork colony was surveyed to determine layout of the colony, nesting stage, and numbers of nests. Due to the early abandonment of the Tamiami West colony in late February, we chose to follow nesting success intensively at the Palm Beach County Solid Waste Authority (N26º46.41, W80º08.32). The SWA colony was easily accessible, had wildlife viewing towers that aided observations, hosted a large number of nesting Wood Storks, and had stork nests that were easily accessed by climbing or by ladder.

Although storks nesting in Paurotis Pond (N25º16.89, W80º48.18) were also easily reachable by ladder, accessibility to this colony within Everglades National Park was limited due to visibility to the public. Furthermore, reports of widespread nest abandonment early in the nesting season raised concerns about the feasibility of using the colony for our satellite tagging study. Therefore, the Paurotis Pond colony was monitored twice by air and once via a ground visit. Paurotis Pond was also monitored by Park personnel.

Water Conservation Area 3A

Nest initiation at Crossover was substantially higher this year than in 2002 or 2003. This year saw the initiation of 130 nests in the Crossover colony, as compared with 76 nests in 2002 and 40 nests in 2003. Nests were initiated fairly late in the season, with most nest initiation taking place in March; an aerial survey on 23 February showed only 6 nests had been initiated while 130 nests were counted while walking through the colony on 4 April. Of these nests, we estimate that between 72 and 115 were successful based on subsequent aerial surveys. The wide range in estimates is due to the fact that 43 nests were still active on July 17. If these late-fledging nests are assumed to have failed, traditional nest success would be estimated at 55.4% (72 nests), while if they are assumed to have fledged traditional nest success would have been approximately 88.5% (115 nests). We estimate that approximately two-thirds of successful nests fledged 3 chicks and approximately one-third fledged 2 chicks.

Whereas in the previous 2 years the colony at Jetport (N25º52.11, W80º50.61) supported large numbers of storks (375 in 2003, at least 550 in 2002), no Wood Storks were found nesting there in 2004. A small colony of Wood Storks formed to the south of the Jetport site, at (N25º48.45, W80º51.92). Twenty-nine nests were initiated at this location.

Water Conservation Area 3B

A new colony formed this year in Water Conservation Area 3B. This colony, 3B Mud East, was located in a stand of willows bordering a canal (N25º48.08, W80º29.40). Nests were initiated in late March. The colony is within 4 km of the Tamiami West colony which abandoned in early March. The timing and location of the 3b colony is consistent with the idea that it was composed primarily of birds that had previously

failed at Tamiami West. The number of nests in the colony peaked in April at approximately 100 nests. On a subsequent walk through the colony on 14 May, we counted 82 nests. This colony experienced high failure rates, however and by 6 June only 20 nests remained. This area was badly burned by wildfires in mid-June, with fires burning right up to the edge of the colony. Subsequently, only 3 Wood Stork nests remained and young from those nests may not have had time to fledge before the start of the rainy season. Overall the colony appeared to be a failure.

Everglades National Park

The Tamiami West colony in the northern Everglades National Park has supported large colonies over the past 5 years. This year the colony was a total failure. We counted 20 Wood Stork nests during an aerial survey of the colony on 23 February, and labeled 11 nests during a walk through. All 11 nests that we monitored failed within 10 days and Wood Stork nests were not visible in any aerial surveys subsequent to early March.

On a ground visit, we counted a total of 175 Wood Stork nests at the Paurotis Pond colony in late May. Of these nests, approximately 30% had large young (> 6 weeks) and the rest had chicks ranging in age from 2-6 weeks. An aerial survey showed only 24 active nests remaining just prior to the start of the summer rains in mid-July. If these nests are assumed to have failed, we estimate nest success at approximately 86% for the later part of the season (approximately 151 successful nests).

Palm Beach County Solid Waste Authority

The SWA colony occurs on dredge spoil islands in a flooded borrow pit on the property of the Palm Beach County Solid Waste Authority. Approximately 240 Wood Stork nests were initiated in the SWA colony in 2004. Nests were selected for inclusion in this study on 7 islands throughout the borrow pit. Only nests occurring on Brazilian pepper (*Schinus terebinthifolius*) were included in the study. Other nests were located high (> 5 m) in Australian pines (*Casuarina sp*.) and were not accessible for our study. Although nests were not randomly selected, we attempted to mark a good cross-section of the nesting population by including nests from both sides of the borrow pit (east and west of the central open-water area) and both edge and more centrally-located nests. A total of 91 nests were marked with numbered surveyors flagging.

We followed the nesting success of each of the 91 nests every 5-10 days throughout the nesting season. Variations in our schedule were necessary to minimize disturbance during critical nest building and egg-laying stages of Wood Storks and the many other wading bird species that use the rookery. We truncated the nesting information for Mayfield analysis on the last date that nest ID was known if nests became unidentifiable for any reason.

We used three-meter long mirror-poles to view nest contents and determine numbers of eggs and young. For the Mayfield analysis, chicks were considered fledged by day 50. In cases when a full clutch had not yet been completely laid, or a chick in a nest was hatching on the nest check date, we used the Mayfield method to pro-rate nest initiation dates.

At the initial time of marking, only 8 of these 91 nests had hatched young. The average clutch size of marked nests located during incubation was 2.88 (SE=0.083, n=83). Average brood size for nests monitored when at least 1 nestling was 45 days old was 1.94 (SE=0.097, n=52). Overall traditional nesting success (number of nests fledging young /number of nests studied) for this colony was 58.24% (53/91 nests). We also used Mayfield's method of analyzing nesting success, which pro-rates survival on a daily basis (Mayfield 1961). During the incubation stage, Mayfield survival was 51.75%. Survival was higher during the nestling phase, increasing to 89.83%. The overall, combined Mayfield nesting success for these two periods was 46.49%.

Summary

Approximately 279 Wood Stork nests were initiated in the Water Conservation Areas and in Tamiami West. This is dramatically lower than the number of Wood Stork nests initiated in these areas during the previous 3 years (1,800 in 2001; 1,000 in 2002; and 765 in 2003). When nests initiated at Paurotis Pond and the Solid Waste Authority are included in our estimates of nest initiation, the number rises to 695, indicating that this year the 6 colonies that we monitored across south Florida had fewer total nesting attempts than the 3 colonies monitored in previous years. This reduction in nest numbers is probably related to inclement weather in late January and through February. Heavy and frequent rains seem to have caused some early nest failure (Tamiami West, Paurotis Pond) and a delay in nest initiation in most other colonies. It is also possible that birds moved northward in search of more suitable nesting habitat.

Status of Wading Bird Recovery in South Florida – 2004

John C. Ogden (jogden@sfwmd.gov). From the South Florida Wading Bird Report, Volume 10, November 2004, Gaea E. Crozier and Mrk I. Cook, Editors.

Over the years (since 1995) these annual reports have been used to summarize the overall status and trends of wading birds nesting in the mainland, greater Everglades. I have focused my comments on five species which historically have dominated freshwater and estuarine nesting colonies in the Water Conservation Areas and Everglades National Park. These are Great Egret, Snowy Egret, Tricolored Heron, White Ibis and Wood Stork.

A central purpose for these reports has been to present the summaries of status and trends in the context of the goals of Everglades restoration. Restoration planners and scientists, especially those associated with the implementation of the Comprehensive Everglades Restoration Plan (CERP), have established the restoration of healthy wading bird populations in the greater Everglades ecosystem as a primary goal of the Plan. The four key indicators that have been established for this goal are based on our current understanding of the characteristics of the wading bird population in the predrainage Everglades. These wading bird indicators and the desired restoration endpoints are, (1) a substantial increase in the total numbers of nesting pairs for the five species, as shown by three-year running averages of nesting numbers, (2) a recovery of nesting in the region of the traditional "rookeries" in the southern, mainland estuaries downstream from Shark Slough, (3) a return to early dry season nesting by Wood Storks, and (4) an increase in the frequency of supranormal nesting events (i.e., "super colonies").

The importance of documenting and tracking the status and trends in wading bird nesting patterns has recently become elevated in the context of restoration programs because of a new requirement from Congress that Interim Goals be set for the natural system goals of CERP. The logic of this requirement is that the funding sources (the Federal and State governments) do not wish to wait until the implementation of the Plan is completed in approximately 2035 to

determine if it is meeting its goals. Congress now requires "interim" goals, which are "predictions" or expectations of the level of performance by key CERP indicators for 5-year increments of time throughout the implementation of the Plan. Reports on how well the Plan is meeting its Interim Goals will go to Congress at five-year intervals (and annually to the National Academy of Sciences, which also will be reporting to Congress on how well CERP is meeting its natural system goals). Needless to say, the four wading bird indicators will be included in the periodic Interim Goals reports produced by the multiagency RECOVER team.

2004 Results

Numbers and Locations of Nesting Birds: The total of approximately 46,700 nesting pairs for the five species is among the highest recent totals. The break down among species is as follows: Great Egret, 9,040 pairs; Snowy Egret and Tricolored Heron combined, 5,770 pairs; White Ibis, 30,460 pairs; Wood Stork, 865 pairs. The three-year running averages (2002-2004) for two of these are the highest ever recorded since these annual wading bird reports were initiated in 1995 (2002-2004 running averages of 9,656 pairs for Great Egrets; 24,947 pairs for White Ibis). The three-year running average for Snowy Egret and Tricolored Herons combined was 8,079 pairs, which is similar to the previous two reporting periods. The Wood Stork running average for 2002-2004 was 1,191, the lowest since the 1998-2000 reporting period.

Continuing the recent distribution pattern for colonies, only 6.9% of the total number of nesting pairs were in colonies located in the southern Everglades mainland mangrove estuaries in southern Everglades National Park. Less than 10% of birds have nested in the traditional southern estuaries since the mid-1990s. In contrast, over 90% nested in this region (e.g., East River, Lane River, Rookery Branch, Broad River, Cuthbert Lake, etc.) in most years prior to extensive drainage and management of the Everglades.

Discussion

One of the requirements for measuring the progress of CERP and other restoration programs is to determine the conditions in the natural system prior to the implementation of the plans, as a basis for detecting changes brought about by restoration. However, if we use the nesting record for the years 1995-2004 as a basis for characterizing the "pre-CERP" condition for wading birds, we do not find the declining populations that one might expect in a seriously degraded Everglades ecosystem. The three-year running averages for nesting wading birds for the five species have been showing increasing numbers, especially since the mid-to-late 1990s. These increases have been occurring prior to any system-wide benefits from CERP. Great Egrets show a progressive increase that began in the 1991-1993 period, White Ibis show increases beginning in the 1997-1999 period, Snowy Egrets and Tricolored Herons beginning in 1999-2001, and Wood Storks beginning in 1998-2000. The complete picture provided by the running averages calculated for all years since 1986 show that all five species have more than tripled their nesting effort in less than 20 years. So what is my point? It is that if these trends continue (I don't know why they began in the first place; also see Frederick et al. in this 2004 report) we will have a difficult time showing the benefits of the Plan for these five species, especially during the early years of Plan implementation.

It is especially interesting that the numbers of nesting wading birds (for these five species) have been substantially increasing, while at the same time there has been no return by nesting birds to the traditional colony locations in the southern, mainland estuaries of Everglades National Park. One could make the argument that this region is one of the best protected and least altered in the remaining greater Everglades. This may be true, although greatly reduced freshwater flows out of the southern Everglades may have caused a substantial reduction in secondary production in these mainland mangrove forests where many of these wading birds once fed. I have no certain explanation for why the historical "rookeries" in southern Everglades National Park are not being occupied, during a period of years when so many birds are nesting only 50 – 100 km to the north in the interior Everglades. One part of the story may be the fact that the old historical rookeries have become structurally altered due to the expansion of mangroves that is occurring through this region. A comparison of aerial photos of these historical colony sites taken during the late 1960s and again in 2003 shows that the patterns of discreet islands and ponds that once characterized these sites is now largely lost due to the expansion of mangroves. The reasons for the mangrove expansion are not certainly known, but the combined effects of sea level rise and reduced freshwater flows probably are the cause. The obvious question is whether there are alternative sites in the southern estuaries that could be used by large numbers of nesting wading birds.

The three-year running averages of the number of nesting pairs for the five indicator species in the Everglades.

Species	1986 -88	1987 -89	1988 -90	1989 -91	1990 -92	1991 -93	1992 -94	1993 -95	1994 -96	1995 -97	1996 -98	1997 -99	1998 -00	1999 -01	2000 -02	2001 -03	2002 -04
GREG	1,946	1,980	1,640	1,163	2,112	2,924	3,677	3,843	4,043	4,302	4,017	5,084	5,544	5,996	7,276	8,460	9,656
SNEG/ TRHE	2,057	1,680	1,229	903	1,965	2,792	2,939	2,060	1,508	1,488	1,334	1,862	2,788	4,270	8,614	8,088	8,079
WHIB	2,974	2,676	3,433	3,066	8,020	6,162	6,511	2,107	2,172	2,850	2,270	5,100	11,270	16,555	23,983	20,758	24,947
WOST	175	255	276	276	294	250	277	130	343	283	228	279	863	1,538	1,868	1,596	1,191

Wading Bird Prey Concentrations in the Everglades

*Dale E. Gawlik (dgawlik@fau.edu), Garth Herring, Bryan Botson, Rachael Harris, and Brian Garrett (**Florida Atlantic University**)*

This section summarizes the first year of a project that monitors small patches of concentrated prey during the dry season in the Everglades. A key hypothesis underlying the Everglades restoration is that there is a strong linkage among hydrologic patterns, fish populations, and wading birds. The importance and strength of the linkage has been demonstrated in field studies (Kahl 1964, Kushlan 1976, Ogden et al. 1976), experiments (Gawlik 2002) and modeling (Fleming et al. 1994), and it is obvious from the repeated inclusion of these three ecosystem components in the conceptual models of the Monitoring and Assessment Plan for the Comprehensive Everglades Restoration Plan (CERP). This project was needed because the quantitative link between wading bird nesting and food in the landscape has been elusive. Gawlik (2002) proposed a conceptual model with a list of factors that could mask the effect of prey density on wading birds. The model depicts how factors that affect regional prey populations might only partly affect the *availability of prey* for wading birds, which is the variable to which birds respond. Although people commonly use the terms food or prey "availability" and "density" interchangeably, the terms are quite different (Morrison et al. 1992). It is possible that factors affecting the concentration of prey could limit nesting more than factors that produce large prey population sizes, thus producing a disconnect between wading bird nesting and prey populations. It is analogous to looking at a supermarket for a link between olive sales and olive prices by correlating olive sales with the average price off all food items. The latter include olive prices, but it is not likely to be driven up or down by it. This project provides some of the first field data on the spatial and temporal distribution of maximum prey densities across the landscape. It will better define and monitor that fraction of the aquatic fauna biomass on which wading birds depend. In other words, it is looking for olives.

Methods

We sampled prey with 1-m^2 throw traps (Kushlan 1974, Jordan et al. 1997) at random sites just as they were drying up and contained shallow pools (Fig. 1). We were transported by helicopter because there was not enough water for airboat travel. These difficult sampling conditions are an important reason why so few previous studies have examined fish concentrations during the dry season. Water depths typically ranged from 10 cm to 28 cm, including a flocculent layer about 10 cm thick. The sampling area (roughly 8000 km2) included ENP and the WCAs. The landscape was divided into landscape units (LSUs) by CERP personnel based primarily on hydroperiod and vegetation, which approximate a physiographic region (Fig. 2). Our sampling frame consisted of a multi-stage design with the stages being LSUs, primary sampling units (PSUs), sites, and throw trap subsamples. PSUs were 500 m x 500 m in size, each containing two random sites. A site represented a patch of suitable habitat of variable size that contained two throw trap subsamples. Suitable habitat is loosely defined as moderate to sparse emergent vegetation with less than onethird of the area containing surface water. These areas were typically sloughs (Fig. 1). In addition to random sites we also sampled prey at foraging locations of large flocks (>30 birds) of mixed wading bird species. The comparison of random to foraging sites is equivalent to the comparison of habitat availability versus use.

Preliminary Results

From 25 March, 2004 to 7 June, 2004 we collected 117 throw trap samples distributed from central LNWR to southern ENP across 10 LSUs, 13 PSUs, and 40 sites (Fig. 2). The preliminary results reported here reflect the density of all prey items (fish and invertebrates) in a 1-m2 throw trap. We captured 32 species of aquatic fauna. Five species comprised 90% of all large individuals captured. In descending order of frequency these were mosquito fish, flagfish, grass shrimp, sailfin molly and bluefin killifish. When pooling all prey items, prey density ranged from 0 – 1695 prey/m2 and biomass ranged from 0 – 675 g/m2. Foraging sites averaged 125 prey/m2, whereas random sites averaged 31 prey/m2. Although the Everglades is characterized as an ecosystem with unusually low standing stocks of fish (Turner et al. 1999), wading birds were able to find places with high densities, much higher than densities reported in fish population studies (e.g., Loftus and Eklund 1994, Trexler et al. 2002).

Another striking contrast between random and foraging sites was that foraging sites contained a much higher density of large (> 2 cm) prey (Fig. 3). This pattern was fairly consistent across the LSUs. There was a tendency for the density of small fish to be higher at foraging locations, but that may be an artifact of small fish co-occurring in places with large fish. The variability was also higher at foraging sites, but we suspect that was due at least partly to sampling some foraging sites after birds had removed many of the prey items

Future years of data will better define the fraction of the landscape and prey community on which wading birds depend. This information will be used by CERP to assess through the eyes of a wading bird, the progress made by Everglades restoration.

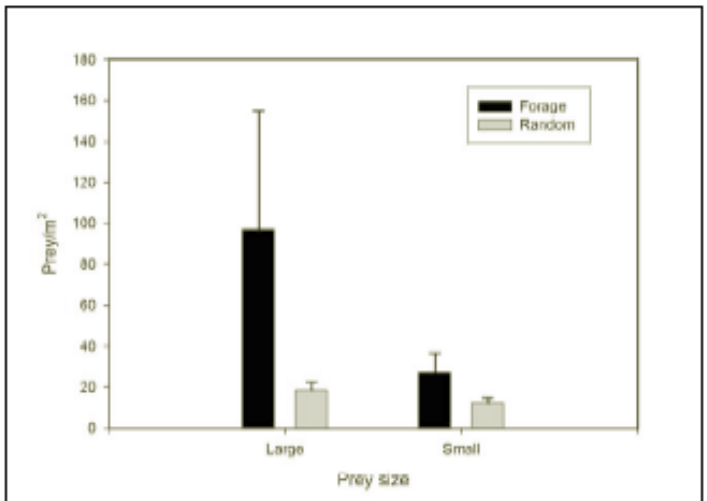


Figure 3. Density of all prey items in 1-m^2 throw traps at random sites and wading bird foraging sites. Error bars are +1 SE.

Acknowledgements

This study was funded by the South Florida Water Management District. We thank Gaea Crozier, Geoff West, April Huffman, and Steve Davis for their help in implementing the study. Joel Trexler, Bill Loftus, and Jerry Lorenz offered many helpful suggestions on fish sampling and fish ecology in the Everglades. Their insight was invaluable.

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Protocol for Monitoring the Reproductive Success of Wood Storks in the Southeast United States

James A. Rodgers, Jr.

Introduction

The ultimate goal of good experimental design in science is the collection of data with minimal error or the sources of error are known and controlled. Inaccurate estimates do not provide conservation agencies with reliable population trend analysis for a species. Even though the Wood Stork is a relatively large, predominately white-plumaged species that tends to nest on top or high in the forested canopy, the variability of aerial estimates from fixed-wing aircraft of the number of nests is large (Rodgers et al. 1995). This problem is especially acute with larger colony sizes and when storks breed with other white-plumaged species. Thus, ground-based monitoring studies are the only reliable technique to accurately determine both colony size and reproductive success. In addition, since nesting success often exhibits a significant negative trend with hatching date (Rodgers and Schwikert 1997), the entire nesting season must be sampled to avoid biasing reproductive success data based on few visits or monitoring nesting only early in the season. The most important component in determining an accurate estimate of colony productivity is to base calculations on the number of fledglings in individually marked nests from the time the nest is started (i.e., egg-laying or early incubation) to the final outcome of the breeding attempt. This will allow the calculation of mean, standard deviation, and confidence intervals for individual colonies and regional populations of storks.

General Guidelines

The following are some general guidelines and recommendations for monitoring Wood Stork productivity. To reduce disturbance and negative impacts on both storks and other waterbirds in the colony, conduct all fieldwork during the cooler morning or late afternoon hours to avoid thermal stress to both the eggs and/or nestlings. Be wary when entering a colony while corvids (either Fish Crows [*Corvus ossifragus*] or American Crows [*C. brachyrhynchos*]) are present as these species can cause depredation of eggs and young nestlings in unattended nests. Allow yourself to be visible as you move through the colony site to allow parent birds to slowly move/flush from the nest and avoid panic flushing that may cause the nest, eggs, and/or nestlings to be lost. Move through the colony in a steady, orderly manner to allow parent birds to return to their nests as soon as possible. Keep track of your current location and course to avoid repeated flushing of individual birds by moving through the colony in a planned path that results in disturbing birds only once. Finally, avoid monitoring regions of a colony that contain a large number/high density of other nesting species (e.g., Cattle Egrets [*Bubulcus ibis*] and White Ibis [*Eudocimus albus*]). Especially later in the nesting season when there are large nestlings (i.e., branchers), there is the potential to cause prefledging of these species. If in doubt, do not monitor these regions of a colony. Another problem species is the Anhinga (*Anhinga anhinga*); while adults will fly away, the older nestlings often jump from their nests and are impossible to capture

as they swim away. These regions of a colony are best monitored from a distance that does not cause the flushing of parent birds.

Frequency of Nest Monitoring

The following are some recommendations regarding the study design for the collection of Wood Stork productivity data. An ideal study would involve marking and monitoring nests on a daily basis. However, this probably would cause excessive disturbance to the nesting birds and would be prohibitively time-consuming for researchers monitoring more than one colony or a large number of nests in a single colony. Based on previous work with storks, I suggest that biweekly visits (once every 14 days) are adequate to mark and monitor the status of stork nests, especially since the nesting season of storks is relatively long in duration and an individual nest is active for 12+ weeks (see below). While there is the possibility that a previously marked nest was abandoned or failed and either the nest was taken over by another pair or a new nest was constructed in the same location as the previous nest, the loss of information on nest starts/failures with a biweekly visitation is only about 3-5% compared to weekly visits. The maintenance of a status chart (see below) for the chronology of individual nests often will allow the detection of nest failure and renesting events.

Duration of Nest Monitoring

As indicated above, stork productivity often varies during the breeding season thus necessitating the monitoring of a sample of nests during the entire breeding season from early egg laying to fledging of the last nestlings of the year. An individual nesting effort by a pair of storks generally lasts about 80-91 days (about 7 days to build the nest, 5-7 days to complete the clutch, 26-28 days of incubation, and 42-49 days to fledge the nestlings). As with other waterbirds, nesting by all storks within a colony is relatively unsynchronized (egg laying or hatching is distributed over time). Based on my previous studies, hatching can occur over a period of 80 to 100 days in north and central Florida. While an individual nest may require 84 days (4 weeks of incubation plus 8 additional weeks for the nestlings to attain fledging age for a total of 12 weeks or 84 days), the monitoring schedule for an individual colony for the entire nesting season will require about 180 days, from the early arrivals and egg laying to fledging of the last nestlings from the last arriving storks.

In general, there is a delay in the onset of stork nesting with both latitude and longitude in Florida. That is, nesting commences (and finishes up) earlier in south Florida compared with north Florida, and colonies along the east coast start earlier compared to west coast and panhandle sites. In south Florida, nesting can begin as early as December but generally initiates in the January–February period. In central Florida, nesting commences during early March-April period, and in north Florida during early April. Preliminary visits to the stork colony will allow for determination of the onset of the nesting cycle. While storks may use a colony site for roosting and leave during the day when not breeding, a slow but steady number of storks will begin pairing and nest building in the spring. Pairs of storks standing side-by-side or carrying nest material into the site are good indications that nesting behavior has begun.

Sample Size of Marked Nests

Aside from the minimal sample size to satisfy normal theory and the requirements of various statistical tests, there is no easy answer for the determination of an adequate number of nests to monitor in a colony of Wood Storks. I would recommend monitoring a minimum of 20-30 nests per colony. Based on my previous experience, it is not too difficult and time consuming to monitor all nests in colonies with less than 100 nests when done over the entire breeding season. On a daily basis, only about 30-40 nests would be checked each visit because of the unsynchronized nesting by storks. I would recommend that a sample of nests be monitored for colonies with $\geq$200 stork nests based on ease of movement through the colony and ability to see the nests and its contents. When monitoring a sample of nests, be sure to mark a random selection of nests throughout the colony to avoid potential biases of edge versus interior differences in nesting success (e.g., nest collapse due to storm events and different nesting vegetation or effects of predators).

General Field Technique

My usual method of monitoring a Wood Stork colony varies slightly from colony to colony and during the nesting season of an individual colony. I use my first visits to a colony early in the nesting cycle to locate access and exit points to the site. This usually involves a preliminary survey of storks and their nests from around the perimeter of the colony/swamp. Once I have begun to mark and monitor nests, I usually establish a standard course through the colony to check on previously marked nests. However, I also occasionally make forays outside the standard course and perimeter of the colony to locate any new nesting regions or subcolonies that initiate later in the season.

I generally traverse a serpentine or zig-zag path through the colony, checking previously marked nests and marking new nests as they appear during the nesting season. New nests can be marked along the main course or in short excursions off to the side of the general course. It also is a good idea to just look around and size up the distribution of nests to plan your course through the colony. Keep an eye out for Anhinga nests and other hazards (e.g., hornet nests). A word of caution: avoid looking up with your mouth open when directly beneath a nest as both adults and especially large nestlings will defecate over the nest edge. Nestlings also will regurgitate partially digested fish and prey items. Both of these behaviors

probably function as anti-predator defense but a hat and sunglasses are all the protection you will need to defend yourself.

I prefer to mark nests using either large cattle ear-tags (available from ranch or feed supply outlets) with numbers that are stapled to the base of the nest tree or 2-inch wide, red-colored plastic flagging tape (available from most office supply stores or survey catalogs). Two-inch wide or large yellow-colored ear-tags are very visible against the trunk of most trees, especially with the aid of binoculars. I use ear-tags when I want to mark a tree in combination with using a diagram of the individual nests to monitor the nesting. I have found that red tape is relatively visible to the researcher and will hold its color throughout the entire field season but is not too visible to attract the attention of the public. I designate each individual nest with a **large-sized** number on the tape using a black **permanent** felt-tipped marker pen (e.g., large-tipped laundry markers). I tie the 2-inch tape flat around a nest tree such that I can easily see the number when approaching. This is especially important later when the nestlings are large and viewing the nest and its contents from a distance with binoculars will prevent pre-fledging the storks. Another technique I use with trees with multiple nests is to tie the number so it is on the side of the tree limb corresponding to the marked nest. With trees with multiple nests, it is sometimes possible to tie the flagging material in a straight-line below individual nests on lower limbs. Practice will make the marking of nests routine.

The above technique generally works well for Wood Storks nesting in smaller cypress and gum trees that are widely spaced apart in the colony. Other colony sites with different nesting habitat may require individual marking/monitoring methods. As the breeding season progresses, storks breeding in dense, closely-spaced subcolonies may be monitored by either drawing diagrams and numbering the nests or taking pictures and numbering the nests for individual identification. Storks nesting in tall, large cypress trees (e.g., Corkscrew Swamp, Croom, River Styx) can be monitored by first mapping the nest arrangement during the initial approach to individual trees, making sure to designate stork nests from similar appearance and sized nests of other waterbirds (e.g., Great Blue Herons [*Ardea herodias*] and Great Egrets [*A. alba*]), then moving off to one or more side locations and viewing the nests with binoculars. One strategy is to mark a tree with a numbered tag (e.g., plastic cattle ear tag that can be identified from a distance with binoculars) and GPS-generated location, with the individual nests designated by letters in a diagram. Often the storks nesting in these tall trees will tolerate visits to the base of their nest trees without flushing and just peer down as you approach. Storks nesting in dense stands of mangrove (both black mangrove [*Avicennia germinans*] and red mangrove [*Rhizophora mangle*]) and Brazilian pepperbush (*Schinus terebinthefolius*) often present special monitoring problems because the closed, dense canopy obstructs viewing storks from below and does not allow observation of distant nests, and nestlings of all waterbirds will attempt to escape by crawling over the vegetation. I have found the best method with these colony-types is to use a selective series of entrances/exits into the colony to mark/check nests, withdraw to the perimeter, and re-enter the colony at another region.

Data Collection

It is important to keep track of individually marked Wood Stork nests on a regular basis. Depending on the colony, I use a combination of aerial photographs, drawn maps, and a tabular list of marked nests from previous visits. I use a series of codes to designate the status of each nest based on the previous visit and update the status of each nest prior to the next visit: A=nest with one or more adults; IA=nest with an incubating adult laying in the prone position (this is a good indicator of the presence of eggs or young nestlings); 0A=nest intact but no adult/nestlings observed in attendance; 0C=original nest structure absent/collapsed; Y=nest with calling/visible young but exact number is uncertain; XN@XW=number of nestlings at number of weeks of age (e.g., 2N@4W is a nest with 2 nestlings approximately 4 weeks of age); and XF=number of large nestlings of fledging age. More about nestling age follows below. Knowledge of the current status will alert you to possibility that large, near-fledged young are in a nest and you should exercise caution when revisiting this site. See the attached data sheet as an example.

Determination of Nestling Age

The ability to visually estimate the age of Wood Stork nestlings can assist with determining when young attain fledging age and a nest does not require further monitoring. I use the 7–8 week age as indicative of fledging because the young are fully feathered and capable of flight albeit they are still present in the colony. Because these large nestlings also are capable of moving away from their nest in response to your approach, it is important to observe the status of a nest in advance in order to count the number of young. I recommend using binoculars and viewing the number of nestlings from as far away as possible.

I have included below photographs of stork nestlings from 2 to 8 weeks of age at 2-week intervals. Because their eggs hatch at 1–2 day intervals, a nest that originally contained 3 eggs (modal clutch size is 3, range is 1–5) can have 3 nestlings whose age span a week. This unsynchronized hatching is responsible for later brood reduction,

especially during a year when the amount of forage is low, as a 1-week old nestling can not compete with the stronger and more aggressive 2-week old sibling that is twice the size of the younger bird. Two-week old nestlings are about the size of a chicken, are covered with down, and generally sit upright in the nest. An adult is always in attendance. Four-week old nestlings have a combination of both down (especially the head and neck regions) and contour body feathers contributing to an "unkept" appearance, the legs appear disproportionately large and the bill looks disproportionately small compared to the body, there is evidence of the black wing feathers, very short tail, and they generally stand in the nest. An adult may or may not be in attendance at this age. Six-week old nestlings have most of the body covered with contour feathers but down is still visible in the crest, the wings are large and the black feathers are visible, the tail is distinctive, and overall they appear similar in size to an adult. At this age, nestlings are often referred to as "yellow-bills" as the bill is nearly the size of adults but is yellow-colored compared to the black of an adult. Eight-week old nestlings appear similar in size and plumage as an adult but have a fully feathered dark-colored head and upper neck. These nestlings are capable of flying from the nest.

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Survival and Movement of Juvenile Wood Storks in 2004

Rena R. Borkhataria and Peter Frederick

This was the third year of a satellite telemetry study of the fledging success, movements, and survival of juvenile Wood Storks (*Mycteria americana*). Although the Wood Stork was declared endangered in 1984, relatively little is known about the demography and population structure of the species. This study was initiated to provide reliable estimates of fledging success and survival rates for use in a demographic model of Wood Stork population dynamics. This information is crucial for understanding the progress that has been made in recovering the Wood Stork and for anticipating future population trends. The study also provides crucial information on movement patterns and habitat use by juvenile storks that will help identify critical habitat. While in previous years juvenile storks were captured and tagged at the Tamiami West colony (N25º45.31, W80º31.90) in northwestern Dade County, abandonment of that colony early in the nesting season caused us to relocate our study to the Palm Beach County Solid Waste Authority (SWA) colony (N26º46.41, W80º08.32). This colony was chosen because it contained a large number of nesting Wood Storks relative to other south Florida colonies, had viewing towers to aid observations, and was easily accessed.

We monitored a total of 91 nests from March through July 2004. We used a mirror pole to view nest contents and visited nests every 5-10 days in order to minimize disturbance to Wood Storks and the many other species of wading birds that occurred within the colony. At the time of initial marking, only 8 nests had hatched young. The average clutch size of marked nests located during incubation was 2.88 (SE=0.083, n=83). Average brood size for nests monitored when at least 1 nestling was 45 days old was 1.94 (SE=0.097, n=52). Overall traditional nesting success (number of nests fledging young /number of nests studied) for this colony was 58.24% (53/91 nests). We also used Mayfield's method of analyzing nesting success, which pro-rates survival on a daily basis (Mayfield 1961). During the incubation stage, Mayfield survival was 51.75%. Survival was higher during the nestling phase, increasing to 89.83%. The overall, combined Mayfield nesting success for these two periods was 46.49%.

Figure 1. Juvenile Wood Stork with satellite transmitter.

To improve the precision of our locations, this year we added 17 45-gram GPS/PTT solar-powered satellite transmitters from Microwave Telemetry to our program. These transmitters are accurate to within 18 m. We also reused 7 35-gram PTT transmitters that had been refurbished from previous years. Each satellite tag had a 10 g VHF transmitter attached to it to aid in relocating birds or tags. First-hatched chicks between 4 and 5 weeks of age were randomly selected for inclusion in the study. After capture, chicks were weighed, measured, examined for ectoparasites and eustrongylides, and had blood drawn for sexing, hematocrit analysis and white blood cell counts. We banded chicks using aluminum Fish and Wildlife Service numbered bands and PVC color bands consisting of white alphanumerics on a green background. We then fitted the combination VHF/satellite transmitter to each bird using a backpack-style harness made of Teflon ribbon and replaced the bird in its nest. In subsequent observations, the birds did not appear to be bothered by the tags (Fig. 1).

Of the 24 birds that were tagged in the SWA colony, 23 fledged successfully (95.8%). Predation was suspected as the cause of the single mortality. All surviving tagged fledglings had left the colony permanently by 22 July. Mortality appeared to be highest in the first 60 days after fledging, with 7 of the 8 tagged storks that had died as of 9 November dying during this period. Two of these deaths appeared to be associated with Hurricane Charley, which passed through south Florida on 13 August.

Prior to leaving the colony permanently, most of the juvenile storks we tagged made use of the West Palm Beach Water Catchment Area just west and south of the rookery. Dispersal patterns differed this year from those observed in the previous two years. While young storks tagged in 2002 and 2003 moved northward and out of the Everglades almost immediately after leaving the colony, many of the birds tagged in 2004 moved southward into the Everglades before heading north (Fig. 2). In June and July, 7 birds were located repeatedly in the Water Conservation Areas, 6 in Everglades National Park, and 3 in the Arthur R. Marshall Loxahatchee National Wildlife Refuge. This difference in movement pattern was likely due to the delayed onset of the summer rains this past year. Upon leaving southeastern Florida, birds ranged widely across the state and into Georgia, South Carolina, and Alabama (Fig. 3). Of birds that left the state, 6 established summer "home ranges" in Georgia, 2 in South Carolina, and 1 bird remained close to the Georgia-Florida border. Eight of the birds remaining in Florida established summer "home ranges" in the central part of the state, while 3 birds remained southwest of Lake Okeechobee throughout the summer. All migrants had returned to Florida by the second week of November. We also had evidence this year of juvenile storks traveling together and foraging together even months after leaving the colony.

Of the 27 birds tagged in 2002, 8 are still alive. Survival rates for this cohort were 44.44% the first year, 66.67% the second year, and 87.5% so far this year. The 2003 cohort fared much worse: only 1 of the 17 birds which fledged successfully survived its first year (5.88% survival). Most of these birds remained in Florida through the summer, but 2 did leave the state (Fig. 4). One bird spent the summer in Georgia, the other in Alabama.

In the future we hope to place GPS PTT transmitters on an additional 50-60 juvenile birds. Our goal is to use information gained from satellite telemetry to understand how Wood Storks respond to their environment and to create models of habitat use in south Florida and beyond. With these models, we can examine the likelihood of population increases or decreases under a variety of scenarios.

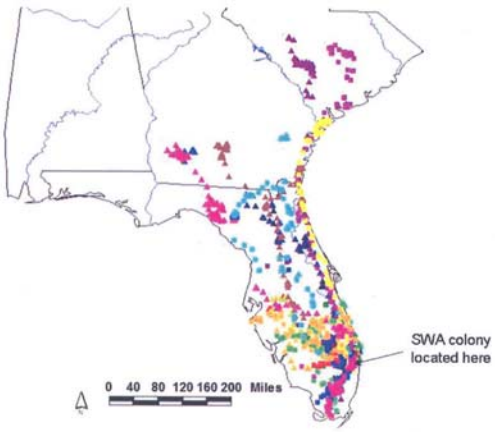


Figure 2. All good quality locations from 1 June through 30 July. Each color/symbol combination represents a different bird.

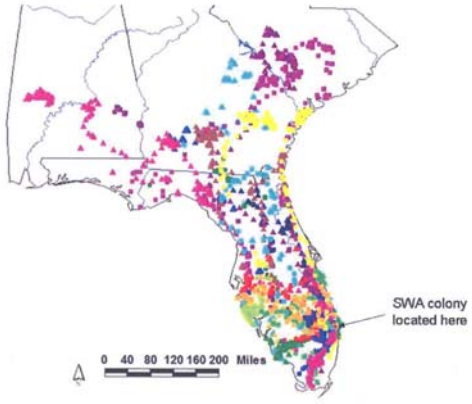


Figure 3. All good quality locations for juvenile Wood Storks tagged in 2004 (1June-9November, 2004).

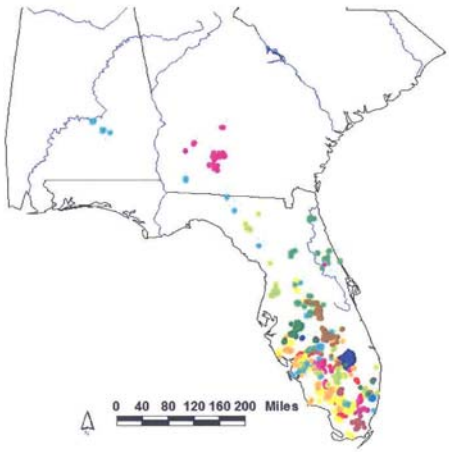


Figure 4. All good quality locations for Wood Storks tagged in 2002 and 2003 (1January-9November, 2004).

Across the Southeast

South Carolina.....*A Record High Nesting Effort!*

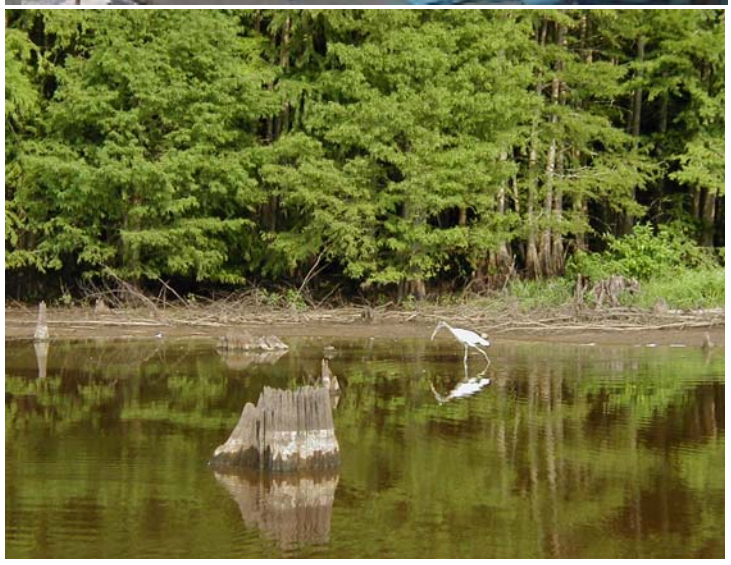
Historically, wood storks used SC as a post-nesting foraging area during the summer and fall. Annual surveys were initiated in 1981 when the first successful stork colony was documented with 11 nests. This survey effort and extensive database is important in quantifying the rate of recruitment to the state and to determining the status of Wood Stork recovery in the southeast U.S. **Tom Murphy** (*murphyt@scdnr.state.sc.us*) with **SCDNR** Division of Wildlife and Freshwater Fisheries reports that their aerial and ground surveys documented a record high (2,034) nest starts at 13 colonies in 2004. This is 700 more nests than have ever been documented in SC, and compares to (1,356) nest starts at 11 colonies in 2003, and (1,136) at 10 sites in 2002. Colonies ranged in size from four nesting pairs to the largest colony in the entire southeast U.S. with 537 pairs at the White Hall colony. As most colony sites in SC are in manmade ponds, land managers have played a critical role in maintaining water levels at Wood Stork colonies. For information regarding specific Wood Stork colonies in SC, you should contact Tom Murphy directly.

Larry Bryan of **SREL**, through a grant from the USFWS and with assistance from the SC DNR monitored the productivity in three South Carolina colonies. Methodologies for this project followed: **Protocol for monitoring the reproductive success of Wood Storks in the southeast United States,** which can be found in this newsletter. Results from this project are also presented in this newsletter: **Wood Stork Breeding Success in Selected Colonies in Georgia and South Carolina (2004)**.

Georgia

The GDNR maintains a Wood Stork database on rookery locations, number of nesting pairs, and when available, productivity of Wood Storks in GA. This database dates back to 1980 and is extremely valuable in monitoring Wood Stork recovery. **Brad Winn** (*brad_winn@dnr.state.ga.us*) of the **GDNR** Non-Game Endangered Wildlife Program reports that helicopter surveys of 62 wading bird rookeries including 36 that have been used historically by Wood Storks, were flown on May 11-17, 2004 and a subset flown again in July. Additionally, Larry Bryan monitored the Big Dukes and Chew Millpond rookeries and John Robinette monitored the Harris Neck NWR colony (details of these efforts are found in the following paragraphs). There were 16 active Wood Stork colonies in GA during the 2004 breeding season. This is down from 18 in 2003 but higher than the 14 in 2002. There were an estimated (1,595) nesting pairs of Wood Storks in 2004, as compared to (1,653) in 2003 and (1,258) in 2002. Eleven of the 16 (69%) active Wood Stork colonies in GA in 2004 were located on private land. Three colonies (19%) were on state properties, and two (12%) were on federal property. Brad notes that most of the landowners are interested in protecting rookeries, however, acquisition of additional sites into public ownership would increase the security of Wood Storks in Georgia.

In 2002, GDNR initiated a pilot study to evaluate estimating productivity with digital aerial photography from two southwest GA



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colonies. There was merit to the study protocol and in 2003 and 2004 this effort was expanded to include several more colonies. In 2004 the study documented 2.25 (±0.47) chicks per nest (n=109) from three colonies (Brunswick Alligator Farm, Durango, and Brailey). In 2003 the study documented 1.91 (±0.65) chicks per nest (n=128). In 2002, the study documented 1.8 (+/-.61) chicks per nest (n=66) at two southwest GA colonies.

John Robinette (*john_robinette@fws.gov*) of the **USFWS** Harris Neck National Wildlife Refuge, reports that nesting effort was down in 2004 with 213 nest starts. This is down there were a record 431 at this colony in 2003. Refuge staff monitored 55ndividual nests (3 days per week) from an observation tower located on the outside edge of the colony. The surveys documented (198) of the (213) nest starts (93%) successfully fledged chicks. John estimates that 2.24 chicks fledged per nest start and 2.41per successful nest. These data suggest that this colony fledged 477 Wood Storks in 2004. The increase in productivity of successful nests at this colony correlates to the Refuge's feeding pond program where a series of ponds are stocked with and drawn down to concentrate the fish at different times during the breeding season. The record nesting effort at the Harris Neck NWR colony during the past several years is attributed to the refuge staff's ability to keep water in the impounded pond, even during times of drought.

Total number of nests was over 50% greater in 2003 than in 2004. Following a five-year drought (the most severe on record) a more normal rainfall pattern was experienced during the 2003-nesting season. However, wood stork nesting colonies were less than optimal and ponds remained below normal. This most likely concentrated stork nesting efforts within managed areas, such as Harris Neck, where water levels could be artificially maintained. When the 2004 nesting season began, a second year of normal rainfall had brought groundwater and surface water to near normal levels. Potential nesting sites were far more numerous than in the past six years. This most likely resulted in storks returning to traditional nesting areas that had been impacted or eliminated by the extreme drought conditions in previous years. Therefore total number of nests at the Harris Neck colony was far less than experienced during the drought years.

Larry Bryan (*bryan@srel.edu*) of the **SREL** reports that the Big Dukes Pond (also known as Birdsville) held water during the 2004 season (dry in 2001 and 2002). A total of 80 nests were initiated at this colony in 2004. An estimated productivity of 2.4 ±1.0 (SD) fledged young per nest attempt for 36 observation nests was made utilizing the methodologies outlined in **Protocol for monitoring the reproductive success of Wood Storks in the southeast United States**. There were 87 nests in 2003. The Chew Mill Pond Colony had an estimated 150 nests in 2004, which averaged 2.4 ±1.1 (SD) fledged young per nest for 51 observation nests. The relatively high reproductive success was attributed to rainfall patterns primarily the heavy rains received in the second half of 2003. Through a grant from the USFWS and with assistance from the GA DNR and Harris Neck NWR, Larry monitored the productivity at seven Georgia colonies. Results from this project are presented in this newsletter: **Wood Stork Breeding Success in Selected Colonies in Georgia and South Carolina (2004)**.

For specific information regarding other Wood Stork colonies in GA, you should contact **Brad Winn** of the **GDNR** (*brad.winn@gadnr.state.ga.us)*.

Florida

Billy Brooks (*billy_brooks@fws.gov*) of the **USFWS** Endangered Species Recovery Program, contracted with **Ken Meyer** (*meyer@arcinst.org*) of **ARCI** to survey a significant number of the Florida Wood Stork colonies known to be active during the past decade. The Everglades National Park, Everglades Water Conservation Areas 2 and 3, Big Cypress Preserve, Corkscrew Sanctuary, Jacksonville Zoo, St. Augustine Alligator Farm are examples of colonies that have ongoing monitoring projects and where not flown by ARCI. Between May 18 and June 14, 2004, ARCI conducted eight survey flights and flew 74 of the 90 FL colony locations. The results of these surveys and monitoring at individual colonies are included in the statewide totals reported below. Descriptions of monitoring at individual colonies are described later in this section of the newsletter.

The 90 locations surveyed for Wood Stork nesting activity in FL in 2004, by ARCI and other recovery partners, contained an estimated (5,179) nesting pairs of woods storks distributed among 57 active colonies in peninsular FL. This compares to (6,153-6,278) nest starts at 48 colonies in 2003, (6,622-7,732) at 47 colonies in 2002 and 2,022 at 22 colonies in 2001 (drought conditions). Additional information regarding many of the FL colonies can be found below.

Nest initiations were late but numbers were high in the large south Florida colonies in 2004. Beginning in March, however, increasing rainfall and surface water apparently caused abandonment of most of the active nest over much of the region (e.g. Tamiami West, Jetport, Crossover, and Corkscrew). The exceptions were the colonies in the southern Everglades (Rodgers River Bay, Paurotis Pond, and Cuthbert Lake), which had good nest success. In contrast, surface water conditions in central and northern Florida apparently were favorable for stork nesting in 2004.

In 2003, a total of about 6,200 nests were distributed over 49 occupied colonies, a per colony average of about 130 nests. The 57 active colonies observed in 2004 contained 5,179 nests, an average of 90 nests per colony. This between year difference in total number and distribution of nests probably reflects the poorer nesting success of the large south Florida colonies in 2004 and the larger component of nesting activity in central and northern Florida, where most colonies are smaller.

Ground observers surveyed 27 (30%) of the 90 the known colonies. ARCI surveyed 74 colonies, but 10 of these also were counted from the ground, leaving 64 ARCI counts (70%) to be used in the total estimate. As Rodgers et al. (1995) warned estimates of Wood Stork nesting effort based on aerial surveys could have very large confidence intervals. Most of this variability results from the cumulative errors associated with counts of large, mixed-species colonies with high proportions of other white-plumaged species; the most common error is to confuse Wood Storks with Great Egrets, usually resulting in an over-estimate of storks. The 2004 counts

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provided a modest opportunity for a tentative evaluation of the accuracy of the aerial counts. Ten of the colonies counted from the air by ARCI also were counted from the ground by other observers, all experienced at estimating numbers of wading bird nests by species. The ground observers counted a total of 1,369 Wood Stork nests in the 10 colonies; ARCI's aerial counts totaled 1,480. The 8.1% higher count by ARCI is most likely attributable to the false identification of Great Egret nests as Wood Stork nests. It also is possible, however, that limited visibility and mobility for the ground observers resulted in a slight underestimation of nests in the colonies they surveyed. Thus, the actual number of nests may lie somewhere between the two types of estimates. The USFWS (1996) has taken the position that, even with the presumed error, aerial surveys are the most cost-effective long-term method for estimating Wood Stork population trends. Based on our limited comparison of ground and aerial counts, this position is justified.

Eleven new colonies were detected in 2004 with a mean of 36 (±23 SD, range 4-65) nests per colony. The 400 nests in these 11 colonies represent 7.7% of the 5,179 nests found in 2004. This is particularly noteworthy considering that most of these colonies were found opportunistically, not as a result of a large-scale systematic search. At least some of these colonies may have consisted of pairs relocating or spilling over from nearby known colonies. In any case, this result is interesting with regard to nesting biology and its implications for monitoring surveys.

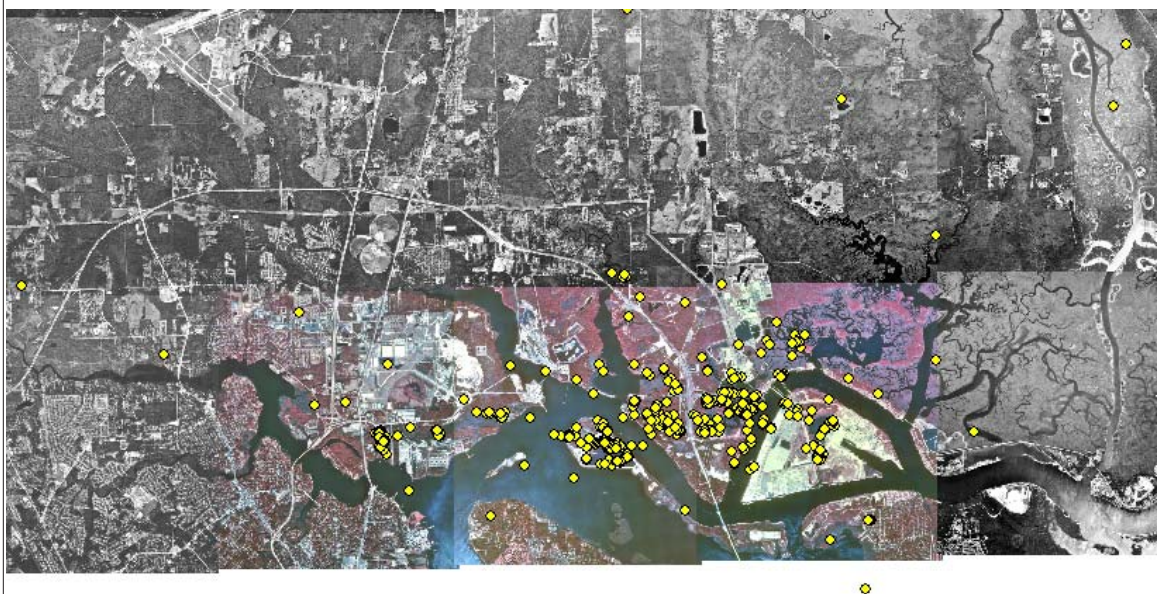
Considerable underestimates can result from shifts in colony locations between years if the birds move far enough to evade detection under the present search protocol, which focuses only, and rather narrowly, on previously used sites. The results of our aerial transect surveys support this contention. We found two previously unidentified colonies on each of the two plots surveyed in 2004, and two colonies newly discovered in plot A in 2003 were not detected in 2004. If funding would permit coverage of more transect plots and more closely spaced transects, and if the surveys could be flown earlier in the season, it is likely that more of these previously undetected small to medium-sized colonies would be found. As we have discussed, we are considering a third survey of one of the transect plots and the addition of several longer, coast-to-coast transects in 2005.

We also believe that there is likely to be considerable underestimation as a result of counting each colony at only a single point in time, because nests that fail earlier or start later than the survey date will not be counted. Modeling suggests that this could result in undercounts of 20–50% in the case of birds with a long nesting season and asynchronous nesting, such as Wood Storks. We suggest that effort should be devoted to finding affordable ways to improve the accuracy of our statewide estimates of Wood Stork nesting effort.

North and Central Florida

Jim Rodgers (*jim.rodgers@fwc.state.fl.us*) of the **FWC** has updated our productivity monitoring protocol, see: **Protocol for monitoring the reproductive success of Wood Storks in the southeast United States**. Funding from the FWC/SJRWMD/USFWS and with assistance from several volunteers, productivity was monitored at 19 North and Central Florida Wood Stork colonies, see: **Productivity of wood storks in north and central Florida**. Abstract: The average fledging rate of wood storks at 19 colonies in north and central Florida during 2004 was 1.53±1.10 fledglings/nest (n=1,574 nests). For only successful nests (fledged at least 1 stork), the average fledging rate was 2.07±0.67 fledglings/nest (n=1,122 nests). About 71.3% of monitored nests fledged at least one bird. Significant differences in the mean fledging rate existed among colonies (range=0.25 to 2.37 fledglings/nest). Differing rates among colonies were due to different frequencies of complete nest failures (no fledglings) and nests with 2-fledglings and/or 3-fledglings. While the mean fledging rate for all stork colonies was similar to 2003 (1.49 fledglings/nest), a comparison of the fledging rates for individual colonies monitored during both years indicates that 8 of 14 colonies exhibited greater fledging rates during the 2003 breeding season. Previously published data on wood stork productivity in Florida is similar to the results of this current study.

Information from individual colonies and conservation efforts at those sites are reported below.



Donna Bear-Hull (*bear-hulld@JaxZoo.org*), from the **Jacksonville Zoological Gardens** reports that the size of the colony has stabilized. In 2004, there were 87 nest starts with thirteen nest failures and the colony successfully fledged over 200 chicks. This compares to 84 nests with 191 chicks fledged in 2003 and 40 nests with 111 chicks fledged in 2002. The productivity success rate again was one of the highest in FL (see **Productivity of Wood Storks in North and Central Florida**). Larry Bryan from SREL and Donna again and were able to band 20 chicks from 7 nests. Six additional chicks

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were brought to the Zoo's rehabilitation center treated, banded and released on grounds. Two adults were also captured and banded. One of the adults had a nest that was not successful. With assistance from **Sue Maher** (*Sue.Maher@Disney.com*), Donna received a grant from **Disney's Animal Kingdom** to put a GPS solar powered satellite tag on adult Wood Stork to be captured at the Zoo. The tag was place on an adult male captured at the Zoo on June 3, 2004.

Kristin Ebersol (*kristin.ebersol@dep.state.fl.us*), **FDEP** park biologist reports that the two cypress domes located within the boundaries of the **Pumpkin Hill Creek Preserve State Park** were not active in 2004. Conservation wise, the Park is planning several control burns at the park to improve habitat conditions. This includes burning areas around the cypress domes where the wood storks nest. The Preserve's Fire Management Plan ensures that the colony sites are considered in the Burn Plan.

The Matanzas Marsh colony is located within the 8,000-acre tract of land that borders the Intracoastal Waterway south of St. Augustine. The St. Johns River Water Management District purchased the Matanzas Marsh property from Rayonier Paper Corporation. This purchase created an area of protected lands of approximately 12,000 acres as it adjoins two other significant pieces of public lands, Favor Dykes State Park to the south and Moses Creek State Preserve to the north. The property was split into two parts and the southern half is managed by the Florida Park Service while the northern half (the section that contains the Wood Stork colony) is managed by Florida's Division of Forestry. The SJRWMD funded the development of a Wood Stork Management Plan, which is available by emailing your request to billy_brooks@fws.gov. J.B. Miller (SJRWMD) along with a Bert Charest, a St. Johns Audubon volunteer monitored this colony again in 2004. This colony has remained significantly smaller with 28 nest starts and a very low fledge rate of 0.25 in 2004. This compares to 18 nest starts in 2003 and 120-150 in 2002.

Amanda Whitaker (*AWhitaker@alligatorfarm.com*), the bird and mammal curator at the **St. Augustine Alligator Farm Zoological Park**, reports that the colony has grown in size again in 2004 with 33 pairs of Wood Storks were successful at fledging an estimated 53 chicks. Amanda documented 17 nests that fledged approximately 45 chicks in 2003. The St. Augustine Alligator Farm is well known for it's multi-species wading bird colony and the staff are very excited about the Wood Stork colony and that it seems to be growing in size. Amanda has installed two webcams to view the wading bird colony/roost. These can be viewed at: http://www.alligatorfarm.com.

Ann Paul (*apaul@audubon.org*) of **Audubon of Florida's Florida Coastal Islands Sanctuaries Program** and volunteer Rich Paul (richpaul13@earthlink.net) report 241 nesting pairs at the Dot Dash Colony in the Braden River in Manatee County in 2004. This is compared to 247 in 2003 and 240 in 2002. They also report that there were 36 pairs at the East Lake colony in Hillsborough County, 62 at Blackburn Bay colony in Sarasota County.

Ken Tracy (*ktracey@gte.net*) of the **Pasco County Audubon Society** continues to provide updates on several colonies in the Pasco County area.

Gabrielle Griffon (*ggriffin@fit.edu*), a graduate student studying under Dr. John Morris at the **Florida Institute of Technology**, received funding from Jim Rodgers (**FWC**) to monitor the **USFWS Pelican Island National Wildlife Refuge** and Deseret Ranch colonies in Brevard County, MC2 spoil island colony in Martin County and the North Fork St. Lucie River colony in St. Lucie County. Gabrielle reports that the Pelican Island colony had 78 nests, which incurred a high nest failure rate of 42%, had a 0.92 fledged young per nest. This compares to 123 and 176 nests in 2003 and 2002 respectively. She also reports that the Deseret Ranch colony had 254 nests and 1.48 fledged young per nest; MC2 spoil island colony had 87 nests and 0.95 fledged young per nest; and the North Fork St. Lucie River had 86 nests with 1.37 fledged young per nest.

For information regarding other Wood Stork colonies in North and Central FL, you should contact **Jim Rodgers** of the **FWC** at *jim.rodgers@fwc.state.fl.us* or **Billy Brooks** of the **USFWS** at *billy_brooks@fws.gov*.

South Florida

The 2004 South Florida Wading Bird Report was edited by **Gaea E. Crozier** (gecrozier@yahoo.com) and Mark Cook (mcook@sfwmd.com). This document is a great resource regarding wading bird ecology in south FL. The 2004 Report is the ninth compilation of this report with the first being published in 1997. The following information on Wood Stork colonies in south FL are excerpts from the November 2004 South Florida Wading Bird Report. The 1997-2004 South Florida Wading Bird Reports can be found at the following website: (http://www.sfwmd.gov/org/wrp/wrp_evg/projects/wading01/).

Jason Lauritson of **Audubon's Corkscrew Swamp Sanctuary** (*jlauritsen@audubon.org*) reports the initial assessment of wood stork nesting activity in Audubon's Corkscrew Swamp Sanctuary colony was made from a helicopter aerial survey on January 6th, 2004. From January 7th to May 13th no aerial surveys were performed. During this time period ten ground surveys were conducted to gather data on a subset of the colony. Seven aerial surveys were conducted from May 14th to July 8th using fixed-wing aircraft. Jason made visual estimates of colony size from the aircraft by counting all individual nests when the colony size was small (three counts were made and averaged to establish the aerial estimate). Once the colony was too large to accurately use this method, counting was done in clusters of 5 (again three estimates were made and averaged). To improve accuracy of nest counts, slide photos were taken with a 70-200mm lens of the entire colony on each survey date from approximately 1000 ft, circling the colony until full slide coverage was attained. Photos of each sub-colony were taken from 400 ft during a single pass to assist in productivity estimates and stage of development. Photos of several aerial surveys were projected on a grid and analyzed. Photos from 1000 ft were used to identify the total number of possible wood stork nests. Slide photos taken from approximately 400 ft were further analyzed to determine what proportion of the colony were wood stork nests, great egret nests, loafing birds, or birds of indeterminate status, in order to reduce the error associated with the image quality of slides taken at 1000 ft. Nest productivity was also determined using the slides taken at 400 ft. On June 2nd there were 2.26 chicks per active nest; this was the last photo date before chicks began to leave the nests to roost on the branches. On June 23rd recently fledged chicks

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were observed in flight around the colony. On June 29th there were 1.83 chicks per active nest, however, there were many chicks on branches at varying distances from the nearest nest. Although these individuals could be counted as successful fledges, there is no sure way of assigning these birds to the appropriate nest, therefore confidence in this number is diminished. Birds were assigned to nests in such cases where chicks were sitting within a meter (estimated from slides) of an intact nest. (15 hours). Approximately 450 chicks fledged from approximately 520 nest attempts. Approximately 210 of these nests were successful. Productivity per nest attempt was calculated to be 0.88 chicks per nest attempt, and 2.26 chicks per successful nest. Heavy local rainfall events occurred in January and February likely contributing to early nest failures. No weather induced abandonment or nest failure was observed from May 14th or later. Late season dry-down was conducive to foraging. All nests observed with chicks on June 2nd were considered successful. This compares to the 2003 season totals that included 780 chicks fledging from approximately 1100 nest attempts, roughly 460 of these nests were successful. Productivity was 0.42 chicks per nest attempt.

Jason also made two site visits to the **Caloosahatchee River colony** in Lee County near the Interstate 75 Bridge in Ft. Myers. Nest counts were conducted on two occasions (April 23 and May 19) from a boat drifting with the current past the strip of mangrove islands where wood storks were nesting. All sides of the island were visible, and the number of nests obscured by vegetation is thought to be very low. The count from May 19th determined probable nesting success. Chicks in many nests were very close to fledging. An estimated 80% of the chicks observed appeared to be at least 6 weeks old. Nests averaged between 2 and 3 chicks. There were 263 successful nests, containing approximately 2.3 chicks per nest. Total colony productivity is estimated to be 600 fledged birds.

Deborah Jansen (*deborah_jansen@nps.org*) of the **Big Cypress National Preserve** reports that searches for wading bird rookeries in Big Cypress National Preserve were conducted during the fixed-wing flights used to locate Florida panthers and during all routine helicopter work at the Preserve. No activity was documented.

Peter Frederick from the **UF's Department of Wildlife Ecology and Conservation** (*pcf@mail.ifas.ufl.edu*) oversees monitoring efforts of wading bird colonies in Water Conservation Areas 2 and 3 (for the past 18 years), and at the Loxahatchee National Wildlife Refuge. This project also monitored nest success of Great Egrets, White Ibises, and Wood Storks, and continued studies of juvenile stork movements and survival; see **Survival and Movements of Juvenile Wood Storks**. Aerial and ground surveys were designed to systematically encounter and document nesting colonies. A Cesna 182, with observers on both sides, is used to fly east west transects that are spaced at 1.6 nautical miles apart at an altitude of 800 feet. This method results in overlapping coverage on successive transects under a variety of weather and visibility conditions and have been utilized to survey this area since 1986.

Wood Storks initiated nesting somewhat late even by the standards of the last 20 years. They were nesting at Tamiami West and Tamiami West and Crossover and in courtship at Jetport by late February but did not achieve peak numbers until early March. Birds at Tamiami West began abandoning nests in response to heavy rainfall in early March, and no nests were found in surveys by the third week in March. Similarly, the birds courting at Jetport disappeared at about the same time. However there was no evidence of abandonment at Crossover colony (130 pairs), and the birds there appeared to have fledged substantial numbers of young. By mid-April what appeared to be many of the birds from Tamiami West apparently re-nested at the 3B Mud East colony (130 pairs), but none of these nests appear to have fledged young. Similarly new nests started up near Jetport (Jetport south, 29 pairs), and their fate was unclear. Some abandonment probably occurred at Paurotis Pond in ENP, but most of these nests produced young, and most (75%) had three chicks in the latter part of the nestling period. Cuthbert Lake also appeared to fledge young from most nests. It is important to remember that most of the late

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initial and re-nesting events would certainly have failed entirely if the onset of summer rains had not been delayed by over a month (early July).

Mary Beth Morrison (*mmorrison@swa.org*) of the **Palm Beach County Solid Waste Authority** reports that from February – July 2004, Breeding Bird Censuses (BBCs) were conducted in the SWA Roost by two observers every 8-10 weeks, representing approximately 12 man-hours. During the BBC, all islands from three abandoned shell pits were systematically surveyed from a small boat, and the identified bird species and nest numbers were recorded. Surveys were conducted during the morning hours so as to minimize any burden caused by the presence of observers.

The SWA roost is located on spoil islands in abandoned shell pits that were mined in the early 1960's in Palm Beach County, Florida (Lat. 26^{o}46'41"N: Long. 80^{o}08'32"W NAD27). The spoil islands consist of overburden material and range from 5 to 367 m in length with an average width of 5 m. Islands are separated by 5-6.5 m with vegetation touching among close islands. The borrow pits are flooded with fresh water to a depth of 3 m. Dominant vegetation is Brazilian pepper (*Schinus terebinthifolius*), Australian pine (*Casurina spp.*), and Melaleuca (*Melaleuca quinquenervia*), all non-native species. Local features influencing the roost include: 1) the North County Resource Recovery Facility and landfill and 2) the City of West Palm Beach's Loxahatchee Watershed Preserve (Water Catchment Area), a 44 km2 remnant of the Loxahatchee Slough.

This report presents preliminary data for the 2004-breeding season. Typically nesting activities have been observed at this colony through September, and these surveys being reported are only through the end of July. Nest surveys were conducted on February 26th, April 14th and July 6th 2004. Only the peak nest numbers are being reported for each of the bird species.

The estimated peak number of wading bird nests for the SWA Colony is 2,712, which represents an 11% decrease from the previous 2003 season. The number of Great Egret, White Ibis, Snowy Egret, and Wood Stork nests was higher during this year than the 2003 season. Anhinga, Cattle Egret, Tricolored Heron, Little Blue Heron, and Great Blue Heron nest numbers appeared to be less than observed in 2003. There is a 71% increase in Wood Stork nests from last year with (240) nests in 2004 compared to (140) in 2003. As part of the Productivity Monitoring Initiative, this colony was also monitored as a South Florida index colony. In 2004, 45 nests were followed through the nesting season, of which there were 12 (26.67%) failures and 33 (73.33%) successful nests. One of the successful nests fledged only one chick, 30 nests fledged two and 2 nests fledged three chicks. The mean number of young fledged from all nests (n=45) was 1.49 and from successful nests (n=33) was 2.03. This compares to 0.63 and 1.76 fledged young from all and successful nests in 2003.

Lori Oberhofer (*lori.oberhofer@nps.gov*) and **Sonny Bass** (*sonny.bass@nps.gov*) from the **Everglades National Park** report that staff flew several wading bird colony surveys during the 2004 wading bird breeding season: 16January, 13February, 12March, 21April, 21May, 18June, and 19July. Wading bird nesting was not initiated until March at most sites. Most colonies had fledged all young by the end of May, however several colonies were still active into late June and July. A significant increase in the numbers of colonies formed and nesting wading birds was observed compared to the 2003-nesting season. NPS staff located approximately 3,415 wading bird nests within 22 colonies. Six colonies had nesting wood storks (540 total). Two of these colonies were new colonies sites. The "New 8" colony formed in the headwaters of the Shark and Harney Rivers. It was a large mixed-species colony (~650 total nests) consisting of mostly Great Egrets, White Ibises, and Snowy Egrets, but also contained approximately 50 Wood Stork nests. The Wood Stork nests contained eggs and new young on 21April, but the nests had been abandoned when checked again on 21May. Wood Storks failed completely at Tamiami West (50) and at the two new colonies, "New 3" (20) and "New 8" (50). Wood Stork colonies at Rodgers River Bay (150), Paurotis Pond (195) and Cuthbert Lake (75) appeared to have successfully fledged young. Also see **Survival and Movements of Juvenile Wood Storks** for a productivity monitoring at the Tamiami West colony and also **Nesting Success and Productivity of South Florida Wood Storks**.

...***Wood Stork Breeding Success*** *continued from page 1...*

colonies as either coastal (< 25 km to tidal habitat) or inland (> 25 km to tidal habitat). We analyzed regional success by ANOVA. All data is presented as the mean $\pm$ one standard deviation.

Results: Mean breeding success for the 10 colonies ranged from 1.93 to 2.68 fledged young per nest (Table 2), with an overall mean success rate of 2.30 $\pm$ 0.95 fledged young/nest (N = 421 nests). Inland storks (N=118, $\bar{x}$ = 2.53 $\pm$ 0.96) averaged more fledged young than coastal storks (N=303, = 2.21 $\pm$ 0.94) (ANOVA, $F_{1,419}$=9.75, P>0.0019). As might be expected from the high colony success averages, few nests failed (8.6% overall) and > 85% of the observation nests fledged 2 or more young (Table 2).

Discussion: Success rates for Wood Storks were very high during the 2004 season, suggesting excellent productivity in the northern half of the stork's breeding range in the U.S. Success for storks

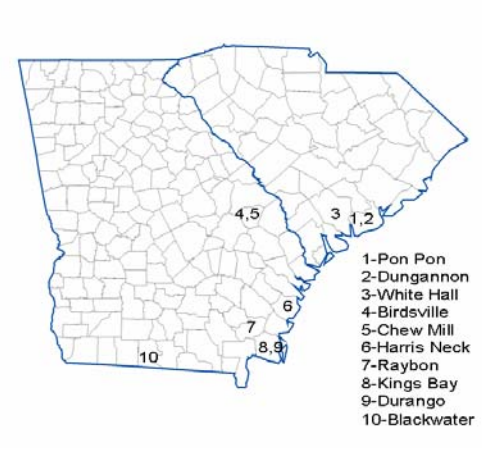

Figure 1. Locations of monitored stork colonies in GA and SC in 2004.

Table 1. Locations of selected Wood Stork colonies in South Carolina and Georgia monitored for breeding success and the dates visited.

State/ Colony	County	Latitude/Longitude	Dates Visited
South Carolina			
Pon Pon	Charleston	32°45.75 80°26.00	4/15, 4/26, 5/4, 5/21, 6/2, 6/22, 7/14
Dungannon	Charleston	32°45.25 80°12.00	4/15, 4/26, 5/4, 5/21, 6/2, 6/22, 7/14
White Hall	Colleton	32°42.25 80°42.00	4/15, 4/26, 5/4, 5/21, 6/2, 6/22, 7/14
Georgia			
Birdsville	Jenkins	32°51.40 82°02.42	4/16, 4/28, 5/7, 5/19, 6/11, 6/28, 7/12
Chew Mill	Jenkins	32°49.76 82°05.92	4/16, 4/28, 5/7, 5/19, 6/11, 6/28, 7/12
Harris			
Raybo			
Kings			
Duran			
Blackv			

Table 2. Breeding success at South Carolina and Georgia Wood Stork colonies in 2004 as determined by ground observations.

Colony	State/Region	Nests Observed	Mean Fledged Young	Std.Dev. Fledged Young	% Failed Nests	% Fledging 1 Young	% Fledging 2 Young	% Fledging 3 Young	% Fledging 4 Young
Dungannon	SC/Coastal	54	2.00	0.80	7	9	60	24	0
Pon Pon	SC/Coastal	36	2.08	1.16	19	3	28	50	0
White Hall	SC/Coastal	82	2.48	0.72	4	0	44	50	2
Harris Neck*	GA/Coastal	55	2.27	0.95	5	11	42	35	7
Raybon	GA/Coastal	11	2.00	1.41	27	0	27	37	9
Kings Bay	GA/Coastal	27	1.93	1.17	19	11	33	33	4
Durango	GA/Coastal	38	2.32	0.74	5	0	53	42	0
Blackwater	GA/Inland	31	2.68	0.70	0	3	35	52	10
Birdsville	GA/Inland	36	2.38	0.97	6	6	25	52	11
Chew Mill	GA/Inland	51	2.41	1.08	12	2	27	51	8
Overall		421	2.30	0.95	8.6%	4.5%	39.4%	43.0%	4.5%

*Data provided by John Robinette/Debra Barnard-Keinath, U.S.F.W.S.- Savannah Coastal Refuges.

typically varies with food availability and predation, with both factors usually linked to rainfall patterns (Coulter and Bryan 1995; Coulter *et al*. 1999). Predation was not observed or thought to be a major factor in 2004. Rainfall patterns influencing food availability and success likely varied between inland and coastal regions, resulting in greater availability of shallow freshwater foraging habitat in the inland region. Availability of freshwater foraging habitat can be a limiting factor for breeding coastal storks as estuarine foraging habitat by itself is not sufficient to allow good breeding success (Gaines *et al*. 1998, 2000).

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