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## WOOD STORK FEEDING AREAS IN SOUTHWEST FLORIDA

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The largest nesting colony of the Wood Stork (*Mycteria americana*) in the United States occurs in southwest Florida at Corkscrew Swamp, a protected sanctuary of the National Audubon Society. The nesting birds at Corkscrew feed on fish that become concentrated in shallow ponds by the seasonal (November-May) drying of extensive wetlands (Kahl 1962, 1964). Concentrations of fish suitable for Wood Stork feeding are available for only a limited time at any one location; but the Wood Stork, a long-distance flyer that can exploit thermals, has a broad feeding range, and the seasonal dry-down does not concentrate fish in all ponds simultaneously (Kushlan et al. 1975, Ogden et al. 1976). The nesting success of storks at the Corkscrew colony depends upon the availability of concentrations of fish within flight distance of the colony throughout the 4-month nesting season. This report, based on an aerial survey of feeding Wood Storks, identifies the feeding areas of the Corkscrew colony and the sequence in which they were used during the nesting season of 1973-74.

### METHODS

The survey, conducted from 15 December 1973 through 26 May 1974, covered parts of Collier, Hendry, Lee, Charlotte, and Glades counties, Florida. Flights were made daily for the first seven days; subsequent flights were made on one or two days approximately every two weeks. The flights, in a single engine Cessna 150, 172, or 175, originated and terminated at Page Field in Ft. Myers, Lee County.

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TABLE 1. Number of Wood Storks seen per hour and per kilometer of flight from 15 December 1973 through 26 May 1974.

Date	Hours in Flight	Kilometers Covered <sup>1</sup>	Number of Wood Storks <sup>2</sup>	Wood Storks per Hour	Wood Storks per Km
Dec 15-21	28.3	1,210	733	25.9	0.606
Jan 12	6.0	403	246	41.0	0.610
Jan 25-26	7.9	635	407	51.5	0.641
Feb. 9	7.5	655	328	43.7	0.501
Feb 23	8.2	487	275	33.5	0.565
Mar 9	7.5	639	390	52.0	0.610
Mar 26	5.0	416	410 <sup>3</sup>	82.0	0.986
Apr 16-18	12.5	1,015	440 <sup>4</sup>	35.2	0.433
May 2, 3, 5	14.9	1,552	163 <sup>5</sup>	10.9	0.105
May 20	3.8	387	38	10.0	0.098
May 26	3.6	161	230	63.9	1.429

<sup>1</sup>Within study area.

<sup>2</sup>Other than at rookery.

<sup>3</sup>Total of 546, including observations by others as cited in Table 2.

<sup>4</sup>Total of 501, including observations by others as cited in Table 2.

<sup>5</sup>Total of 243, including observations by others as cited in Table 2.

Wood Stork feeding sites were located and recorded on each flight, and feeding sites of large aggregations of other wading birds were also noted. Feeding Wood Storks were routinely spotted from an altitude of 300 to 450 meters (1,000 to 1,500 ft) and their identification was verified with binoculars at 150 to 300 m (500 to 1,000 ft). Wood Storks were easily distinguished from other white wading birds by their large size.

The entire five county area could not be covered on each flight because of its size; nor was it possible, except during intensive periods of reconnaissance such as the first week, to follow individual birds from Corkscrew to their feeding sites because of time limitations. Instead I determined the direction of the flight of birds to and from the Corkscrew rookery and concentrated searches along that vector, or I searched areas where Wood Storks had been seen feeding on the previous flight or where water conditions appeared suitable for Wood Stork feeding. A cue that seemed useful to me (and also may be useful to foraging birds) was the ring of exposed mud between the marsh vegetation and the receding water line of ponds. Flights were directed over areas where previous observations suggested this condition might exist.

Flights were made 15-21 December, 12 January, 25 and 26 January, 9 February, 23 February, 9 March, 15 March, 26 March, 16-18 April, 2, 3, and 5 May, 20 May, and 26 May. Approximately 110 hours were spent in the air and 8,065 km (5,000 miles) (estimated straight flight) were covered. Sightings by other observers on 15 March and 8 April are also included in this report.

## RESULTS AND DISCUSSION

## Background

Records of the approximate number of nesting pairs and the number of fledglings produced at the Corkscrew colony have been maintained by the National Audubon Society since the 1956-57 nesting season. Highest production within this time occurred in 1960-61 when 6,000 nesting pair raised 17,000 fledglings. Both the number of nesting pairs and the frequency of successful nesting seasons has declined since then, probably because the extensive drainage of southwest Florida in the late 1960's and early 1970's reduced the area of seasonally flooded wetlands by approximately one half (Browder 1976).

The nesting season of 1973-74 was the first of three concurrent nesting seasons that each resulted in the production of several thousand fledglings. Approximately 3,800 were raised in 1973-74, 5,900 in 1974-75, and 4,100 in 1975-76. Thereafter, the highest number of fledglings produced at the Corkscrew rookery was 2,140 in 1979-80 (Alexander Sprunt, IV, pers. comm.).

The dry season of 1973-74 was the driest in the record of the National Weather Service at Page Field in Ft. Myers (U. S. Dept. Comm. 1973, 1974). Only 8.1 cm of rain fell from 1 October through 15 May and only 77.5 cm had been recorded during the last four months of the preceding wet season. Despite the low rainfall, the Wood Storks at the Corkscrew rookery had their first successful nesting season in three years (Browder 1978).

Wood Storks began congregating in the Corkscrew area in November but did not begin building nests until late January, possibly because of a hard freeze in December. Eggs began hatching approximately 23 February. According to Kahl's (1962) description of their bioenergetics, the food requirements of the hatchlings must have been greatest in late March and April. By 2 May, fledglings were soaring above the rookery, and by 21 May some of them were foraging outside the rookery. By the end of May the Corkscrew rookery was almost empty and many of the Wood Storks had left south Florida (Fig. 1).

## Observations

At least 300 birds were seen during most one or two-day flights (Table 1). The number of Wood Storks seen per hour of flight reached a maximum of 82 on 26 March and fell to a minimum of 10

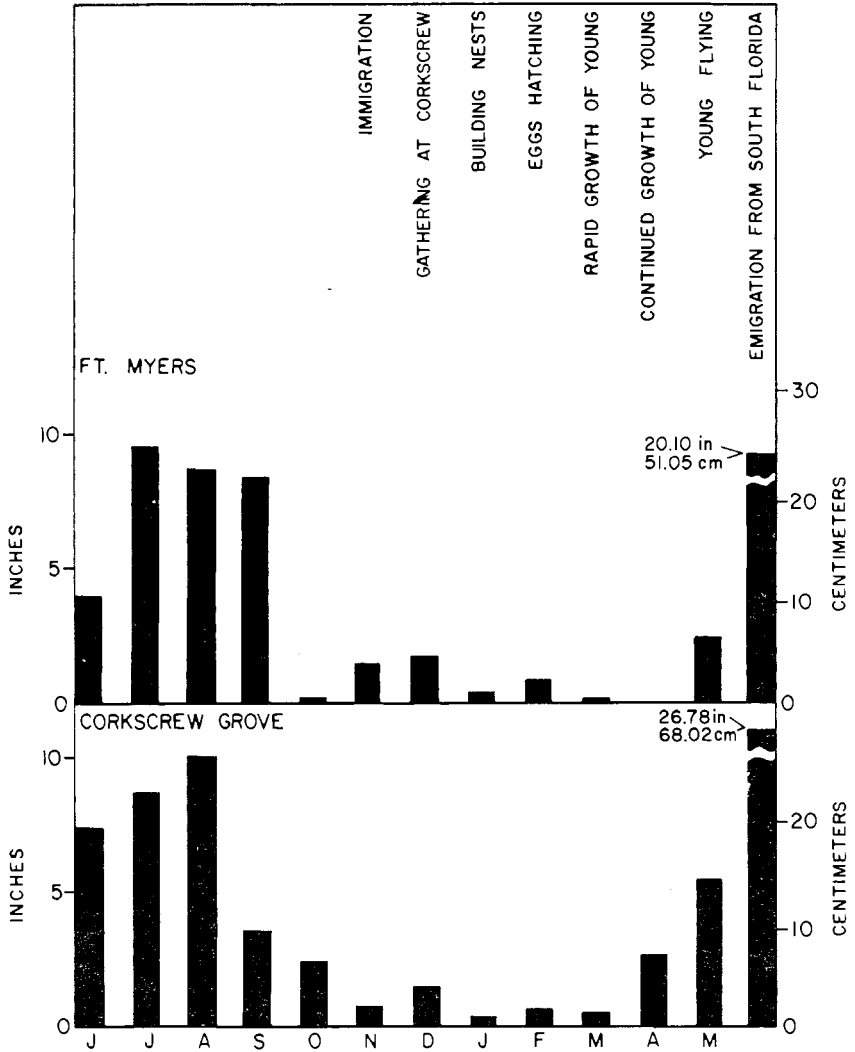


Fig. 1. The timing of breeding activities at the Corkscrew rookery in relation to monthly rainfall measured at Page Field in Ft. Myers (U. S. Dept. Comm. 1974, 1975) and Corkscrew Grove immediately north of north Corkscrew Marsh (ALICO pers. comm.).

on 20 May (Table 1). There may have been some bias in favor of sightings in ponds located in sloughs rather than in ponds located in strands because birds feeding in open ponds were more easily spotted from the air than those in ponds surrounded by cypress. Centers of Wood Stock feeding activity were, however, obvious from the air, even from long distances, because birds were almost continuously approaching or leaving such areas, and feeding birds often rose in mass and circled above the ponds before resettling to continue feeding.

Wood Storks were seen feeding at 38 sites (Fig. 2). The various wetlands in southwest Florida are shown by name in Fig. 3. Thirty-nine sites are indicated in Fig. 3 and listed in Table 2. Area No. 1, Rainey Slough, was included as a feeding site, even though I did not actually see any Wood Storks feeding there, because the flight patterns of birds seen in the air near there suggested that it was an important feeding area. Numbers indicate locations where birds were seen in approximately the order in which birds appeared to be using the areas. The numbers correspond to those in Table 2, which lists the locations by date of sighting and number of Wood Storks seen. Locations and dates of sightings of other species of feeding wading birds are given in Table 3. Some of the Wood Stork feeding sites indicated in Figs. 2 and 3 appear to coincide with general areas of concentrations of feeding White Ibis (*Eudocimus albus*) identified by Kushlan (1979).

#### Pattern of use

Foraging Wood Storks followed the dry-down in Southwest Florida, feeding in upland ponds at the beginning of the dry season and in lowland ponds in the latter part of the season. When the ponds of one area had dried or become depleted, the birds moved to another area where the dry-down was in an earlier stage. In general the birds frequented wet prairie ponds at the beginning of the season and slough ponds later. Feeding centered near Fisheating Creek at the beginning of the season. Then activity was concentrated first near Immokalee, then in the Big Cypress Swamp and the Fahkahatchee Strand, and finally, in the marshes inside the dike at Lake Okeechobee. The Okaloacoochee Slough and Corkscrew Marsh were used extensively by Wood Storks throughout the breeding season. These areas provided suitable feeding habitat for the storks for a long period because their ponds are at several elevations and do not dry at the same time. The feeding birds were seen in the Big Cypress Swamp in March. The Fahkahatchee Strand was

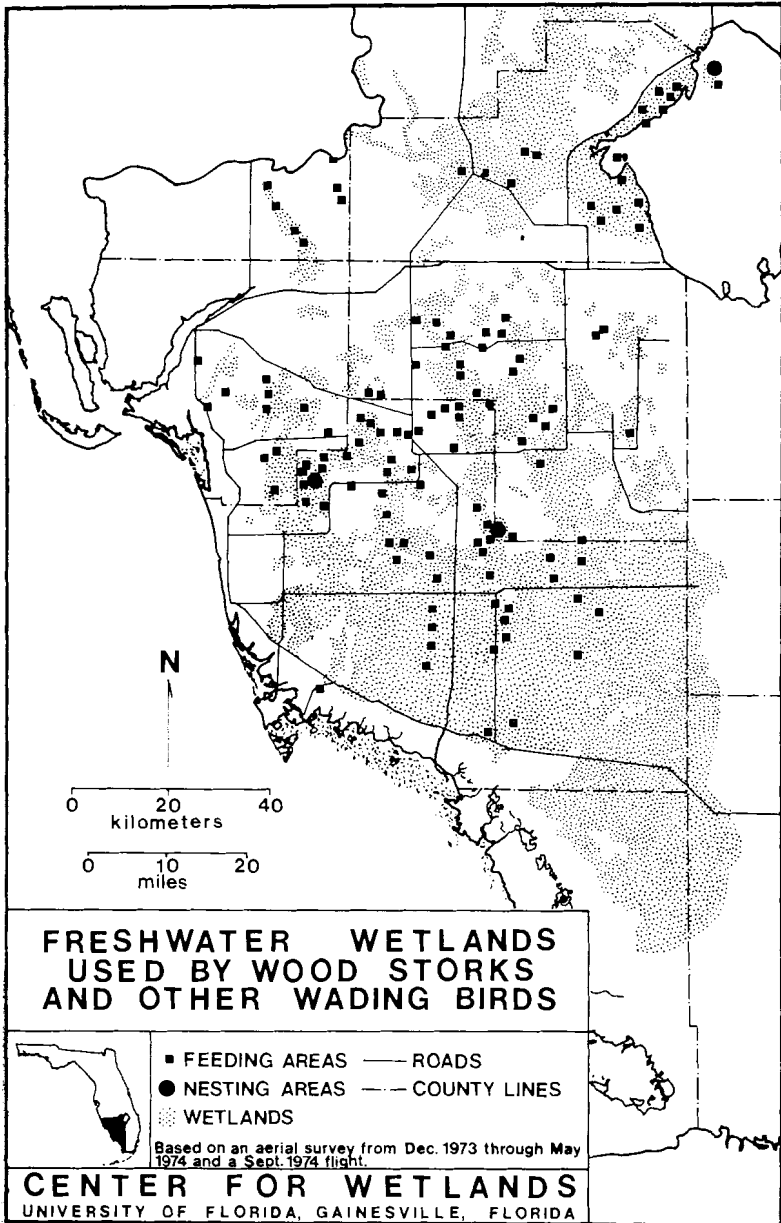


Fig. 2. Location of wetlands (stippling) and of nesting (dots) and feeding sites (squares) used by Wood Storks in southwest Florida during the breeding season of 1973-74.

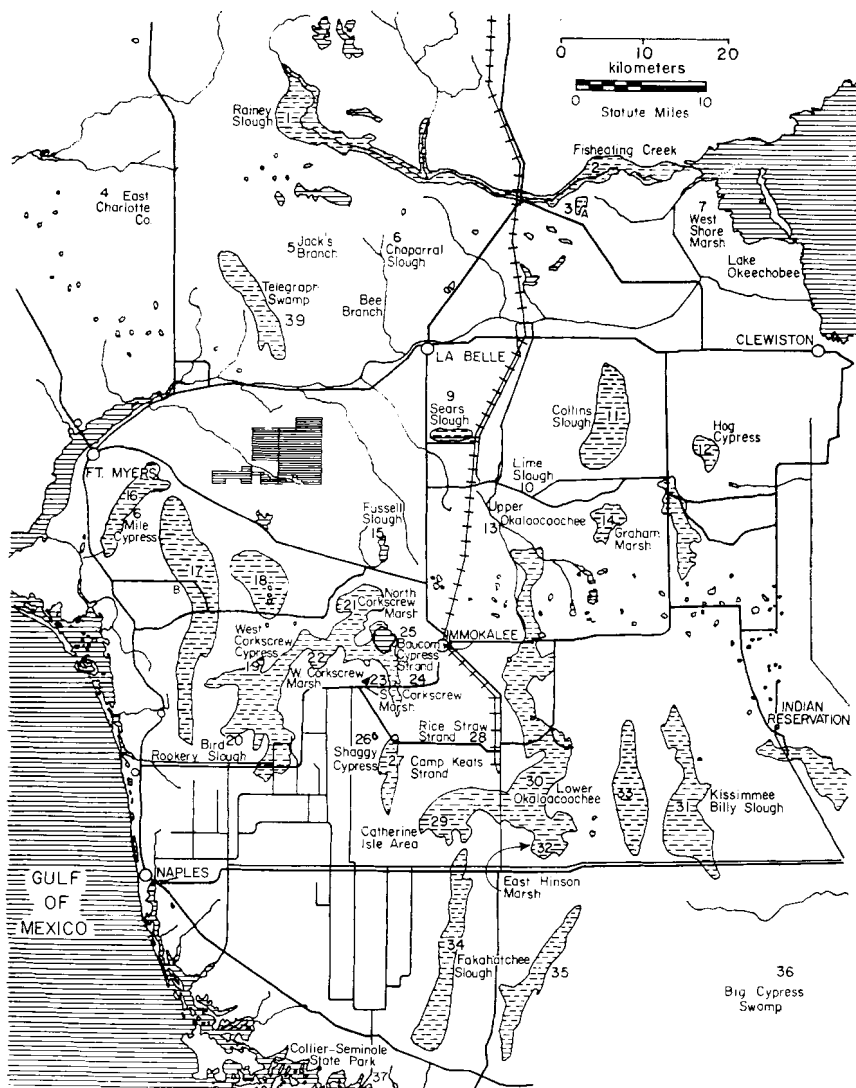


Fig. 3. Map of wetlands of southwest Florida with feeding areas of Wood Storks numbered in order that Wood Storks were seen there. Map based on county maps of the Florida Department of Transportation.

TABLE 2. Number of Wood Storks seen in feeding areas.

	Dec. 15-21	Jan. 12	Jan. 25-26	Feb. 9	Feb. 23	Mar. 9	Mar. 15	Mar. 26	Apr. 8	Apr. 16-18	May 2, 3, 5
1. Rainey Slough	0										
2. Fisheating Creek	96										
3. Marsh A-Glades				100							
4. East Charlotte		18									
5. Jack's Branch		34									
6. Chaparral Slough	29										
7. Lake Okeechobee										15	151
8. Clewiston					6						
9. Sears-Keri Area	212	16	22		6						7
10. Lime Slough				3							
11. Collins Slough		80									
12. Hog Cypress	99										
13. Upper Okaloocoochee	11		25	25	18		8 <sup>1</sup>			4	
14. Graham Marsh	60	52									
15. Fussell Slough											
16. Six Mile Cypress	1										
17. Marsh B-Lee	9	49	82	21							
18. Marsh C-Lee	9	48		6							
19. Western Corkscrew Cypress						7		42		225	
20. Bird Rookery Strand					55	17		29		1	
21. North Corkscrew Marsh 18	18			8			8 <sup>1</sup>	5		15	
22. West Corkscrew Marsh			8			11		106 <sup>2</sup>		51	
23. South Corkscrew Marsh		11	65			3				1	



TABLE 2. (Continued)

	Dec. 15-21	Jan. 12	Jan. 25-26	Feb. 9	Feb. 23	Mar. 9	Mar. 15	Mar. 26	Apr. 8	Apr. 16-18	May 2, 3, 5
24. Baucom Cypress Strand			53			9		30 <sup>3</sup>		50 <sup>3</sup>	
25. Immokalee	80	29	20	4			1 <sup>1</sup>				
26. Shaggy Cypress				102				10			
27. Camp Keais Strand				9		15					
28. Rice Straw Strand											
29. Catherine Isle Area	30			50	19		84 <sup>1</sup>	223	+100 <sup>4</sup>	4	4
30. Lower Okaloacoochee		40			16	93				75	
31. Kissimmee Billy Strand					27						
32. East Hinson Marsh						33					
33. Marsh D							8 <sup>1</sup>				
34. Collier-Hendry											
35. Fahkahatchee Strand					106	16	2 <sup>1</sup>	101	+100 <sup>4</sup>	11 <sup>4</sup>	1
36. Big Cypress											
37. Turner Road										14	
38. Big Cypress-Central					17	66					
39. Collier-Seminole						120					
40. Park 80											
41. Coastal Ridge					5					35	80 <sup>5</sup>
42. Telegraph Swamp										8	

<sup>1</sup>James Hansen, biologist at Corkscrew Swamp Sanctuary.

<sup>2</sup>100 at Flowing Well Pond by Jerry Cutlip, Sanctuary Manager.

<sup>3</sup>Charles Blasquez, Associate Professor of Plant Pathology, University of Florida, Agriculture Experiment Station in Immokalee.

<sup>4</sup>Connie Ryan, Florida Forest Service, LaBelle.

<sup>5</sup>James Hansen, Phyllis Hansen and Patricia Caulfield.

TABLE 3. Observed feeding areas for wading birds other than Wood Storks.

Dec. 15-21	Catherine Island Area, Mangroves, Big Cypress, Rainey Slough, South Lee County Marshes, Bird Rookery Strand, Okaloacoochee Slough, Sears-Keri Area, Hog Cypress
Jan. 12	South Lee Marshes, Okaloacoochee Slough, Graham Slough
Jan. 25, 26	Corkscrew Marsh, Collins Slough
Feb. 9	Lake Okeechobee, Catherine Island Area, Okaloacoochee Slough (Sunniland Area)
Feb. 23	Camp Keais, Mangroves, Kissimmee Billy Slough
March 9	Okaloacoochee Slough
March 26	Not noted
April 16, 17, 18	Not noted
May 2, 3, 5	Lake Okeechobee
May 26	Lake Okeechobee

the site of intensive feeding in April. The Wood Stork population used the *Eleocharis cellulosa* marshes on the western and north-western shores of Lake Okeechobee during late April and throughout May, when the rest of southwest Florida had dried. Irrigation ditches surrounding truck farms and pastures and the drying beds of canals on the coastal ridge were the only other sites where feeding Wood Storks were seen in early May (Fig. 4).

Lake Okeechobee feeding sites were as far as 97 kilometers (60 miles) from the rookery. Feeding at Lake Okeechobee coincided with the occurrence of strong thermals over southwest Florida. The survey plane followed the storks up to approximately 1,525 meters (5000 feet on altimeter) on thermals near the rookery in May. (The birds would soar in circles to ride a thermal to altitude, then glide in a straight line in the direction of the feeding site. Once altitude was lost, the birds might detour from their flight line to find another thermal.)

The general sequence of use of feeding areas by Wood Storks as the dry season progressed followed the primary slope of the land and was from the north to the south. The Wood Storks foraged at the greatest distances from the rookery at the beginning of the season, before eggs were laid, and near the end of the season, when the young were large. They worked nearest to the rookery during incubation and the early stages of raising young.

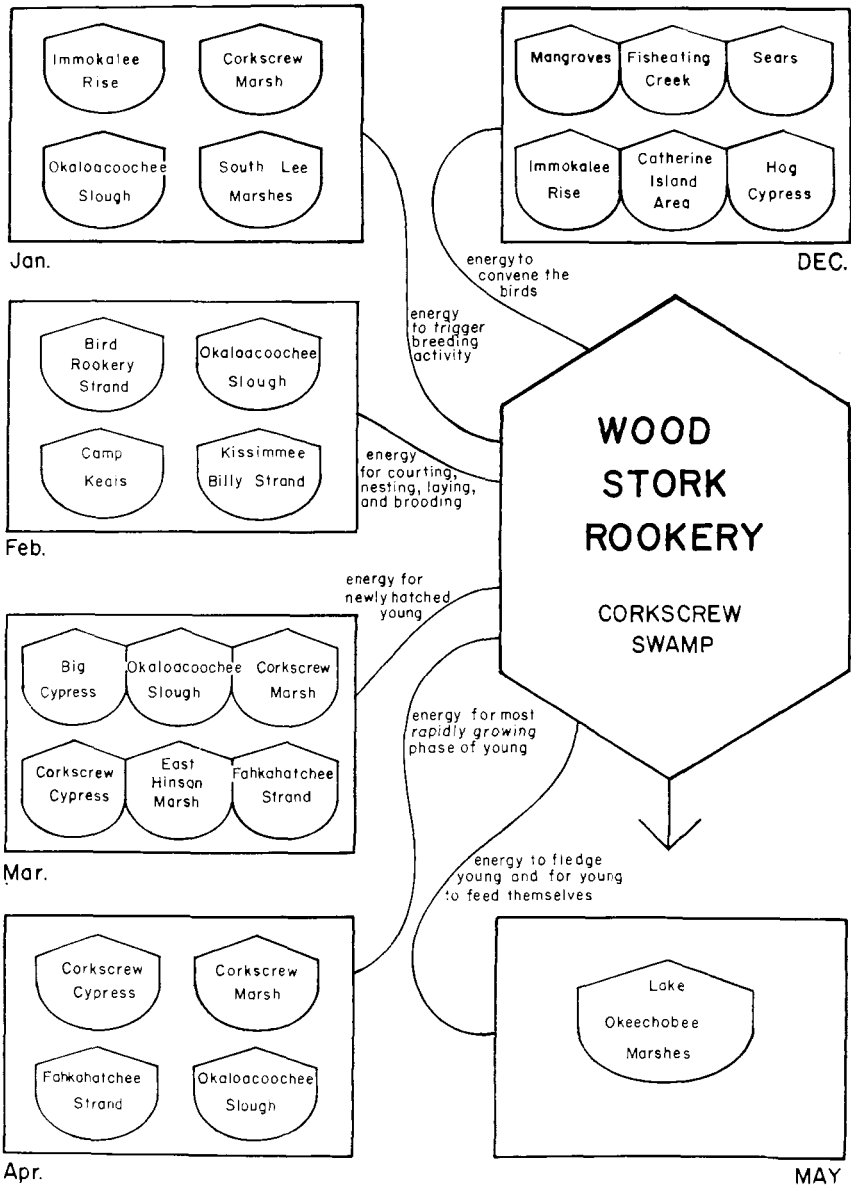


Fig. 4. Major feeding areas used by birds from the Corkscrew Wood Stork colony in relation to nesting activities. Tank-shaped symbols represent storages of food. Lines represent flows of wood to the Wood Stork rookery. The hexagonal shaped symbol represents an organism or group of organisms that obtains food in proportion to its total biomass.

## Other wading birds

Other wading birds were feeding in the same general areas as the Wood Storks and were much more abundant than the Wood Storks (Table 4). The number of other wading birds per Wood Stork seen on survey flights was similar throughout the season except at the beginning and end of the season when the number of other wading birds relative to Wood Storks was very high and on flights in March when the number of other wading birds relative to Wood Storks was very low.

On most of the flights I saw about 15 other wading birds to every Wood Stork. Since there were about 3,800 Wood Storks in the area from the Corkscrew colony, the ratio of 15 other wading birds to one Wood Stork suggests that there were about 57,000 other wading birds feeding in southwest Florida during most of the survey.

TABLE 4. A comparison of number of Wood Storks to number of other wading birds observed.

Date	Number of Wood Storks <sup>1</sup>	Number of other wading birds	Other wading birds/ Wood Storks
Dec 15-21	733	20,875	28.5
Jan 12	246	3,156	12.8
Jan 25-26	407	6,300	15.5
Feb 9	328	5,800	17.7
Feb 23	275	4,130	15.0
Mar 9	390	620	1.6
Mar 26	410	845	2.1
Apr 16-18	440	5,578	12.7
May 2, 3, 5	163 <sup>2</sup>	10,383	6.6

<sup>1</sup>Other than at the rookery.

<sup>2</sup>Including approximately 50 seen flying.

## Feeding in man-made waters

The highest proportions of Wood Storks feeding in man-made waters were seen near the beginning and the end of the nesting season (Table 5). Few natural feeding areas were suitable for feeding at this time. Higher elevations, which, under natural condi-

TABLE 5. Percentage of feeding Wood Storks observed in irrigation ditches or other man-made facilities.

Date	Percentage of Total Birds Seen
Dec. 15-21	34
Jan 12	42
Jan 25, 26	27
Feb 9	20
Feb 23	4
Mar 9	3
Mar 26	10
Apr 16-18	17
May 2, 3, 5	38
May 20, 26	9

tions, had been the first areas to dry and provide concentrated fish for the birds, were also the first areas to be farmed or otherwise developed. After the drainage of much of southwest Florida, irrigation ditches became some of the few sources of concentrations of fish early in the dry season. Drainage caused lower elevations, which, under natural conditions, had provided concentrations of fish near the end of the dry season, to dry more quickly; ponded water in drying coastal sections of canals then became some of the few places where Wood Storks could find food. Thus, irrigation ditches and canals substituted for natural areas no longer available at the beginning and end of the dry season. In the middle of the dry season, when ponds in the center of the sloughs were at the ideal stage for Wood Stork feeding, the proportion of total Wood Storks seen feeding in man-made water bodies was much lower.

The common practice of pumping water off fields into adjacent marshes in the fall may promote high densities of fish, which move back into irrigation ditches when water levels in the marshes fall. Drawing irrigation water out of the ditches for application during rainless periods may further increase the fish concentrations.

Although I kept no records on the topic, I had the general impression that Wood Storks favored wetlands in proximity to truck farms and pastures. Runoff of fertilizers or cow manure from these areas into nearby marshes may enhance fish production. No feeding wading birds were seen in northeast Hendry County or other areas of intensive large-scale agriculture and drainage. Wood Storks were not observed in the perimeter ditches around citrus groves. Citrus areas are usually more completely drained and have deeper ditches than truck farms.

## CONCLUSIONS

Wetlands in five Florida counties contributed to the nesting success of Wood Storks at Corkscrew Swamp Sanctuary during the 1973-74 nesting season. Areas dried at different rates and reached stages useful to Wood Storks at different times, resulting in an uninterrupted supply of food for the rookery through the entire breeding season. A complete loss of feeding habitat during any part of the nesting season could prevent the Wood Stork colony at Corkscrew from producing fledglings.

Upper Corkscrew Swamp, the Okaloacoochee Slough, and the Fahkahatchee Strand may be particularly important feeding areas for the Corkscrew colony because they are near to the rookery and provide concentrated food supplies during the part of the nesting season when the food requirements of the growing young are greatest. These areas have added value to Wood Storks because their ponds are located at different elevations and dry at different times. Its nearness to these major feeding sites may be the attraction of Corkscrew Swamp as a nesting site. A loss of any one of these areas as feeding habitat might reduce the number of birds that the rookery could produce.

My observations suggest that Wood Storks adjusted to an altered habitat and took advantage of new opportunities. The nesting population in 1973-74 was, however, only one third that in the early 1960's (and recent nesting levels have been even lower), possibly reflecting the loss of feeding habitat. It might be possible to increase feeding habitat through a combination of reflooding areas that have been drained but not developed and modifying agricultural structures and practices. Observations from the survey suggest which combinations of natural wetlands and agriculture might be most beneficial to storks.

By locating feeding Wood Storks, I have identified not only which areas contributed to a successful breeding season for the Corkscrew Wood Stork colony but also which areas of southwest Florida still functioned as productive wetlands in 1973-74, despite wide-spread drainage and development. These areas have been located in order that steps might be taken to preserve them—not only because of their importance to the Wood Stork population but also because of the other services that natural wetlands provide.

The significant Wood Stork feeding sites are summarized, by county, in the Appendix. Since the survey was made, one important area, the Fahkahatchee Strand, has become a state preserve. Although the southwestern part of Corkscrew Swamp is owned by the National Audubon Society, the northeastern part is not protected. The Okaloacoochee Slough also is unprotected. The stage regulation schedule implemented at Lake Okeechobee in the late 1970's has reduced the availability of the marshes on the lake's northwestern and western shores as feeding sites for Wood Storks.

#### SUMMARY

The feeding sites of Wood Storks nesting at Corkscrew Swamp Sanctuary during the dry season of 1973-74 were located by means of an aerial survey. From 10 to 82 Wood Storks per hour of flight were seen during each flying period. The Wood Storks fed in shallow, drying ponded waters in six counties: Collier, Hendry, Glades, Lee, Charlotte, and Okeechobee. The most heavily used areas were northern Corkscrew Marsh and the Okaloacoochee Slough. The marshes on the western and northern rim of Lake Okeechobee were important feeding sites of the birds during the latter part of the nesting season, when most ponded water in the rest of the six-county area had dried. The survey revealed that Wood Storks range at least 97 kilometers (60 miles) from their nesting area to feed.

#### ACKNOWLEDGMENTS

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## APPENDIX

Feeding areas of Wood Storks in southwest Florida counties during the 1973-1974 breeding season.

**Collier County:** Corkscrew Swamp, Bird Rookery Strand, Okaloacoochee Slough, East Hensen Marsh, Fahkahatchee Strand, Big Cypress Swamp, Catherine Island Area, Shaggy Cypress, Camp Keais Strand, Baucom Cypress Strand, Rice Straw Strand, Kissimmee Billy Strand, and South Coast Mangroves.

**Hendry County:** Okaloacoochee Slough (Upper and Lower), Sear-Keri Area, Graham Marsh, Collins Slough, Lime Slough, Hog Cypress, Tussell Slough, and Kissimmee Billy Strand.

**Glades County:** Fisheating Creek, Jack's Branch, Chaparral Slough, and Lake Okeechobee Marshes (west of Observation Island, Moonshine Bay, and mouth of Indian Priarie Canal).

**Okeechobee County:** Lake Okeechobee Marshes (King's Bar and Northeast Marsh).

**Charlotte County:** Telegraph Swamp.

**Lee County:** South Central Marshes (2) and Six Mile Cypress.