

## THE HISTORY OF THE SOUTHERN FLORIDA WOOD STORK POPULATION

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**ABSTRACT.**—The largest segment of the North American Wood Stork (*Mycteria americana*) population traditionally nested in southern Florida, where its perceived population decrease over the last 50 years resulted in its addition to the Federal endangered species list. Previously published reports placed the southern Florida population at 30,000 to 100,000 storks. A complete search of published and unpublished records of Wood Storks nesting in southern Florida, however, failed to support such a long-term population decrease. We cannot demonstrate that the historical population was any larger than it was in 1967, when there were 9400 pairs. The Corkscrew-Big Cypress nesting group, not that of the Everglades, was historically the most numerically important population segment. The historic nesting location for southernmost Wood Storks was not inland in the Everglades but on Cape Sable, which has been subject to the effects of drainage canals. The population size of several decades ago is irrelevant to current conservation strategy because the southern Florida marshes have been irrevocably altered reducing their ability to support storks. We can document a population decrease of 75% from 1967 to 1981–82 in southern Florida, a time frame coincident with the operation of water management policies in the Everglades. Wood Storks recently have begun abandoning traditional colony sites in Everglades National Park in favor of sites in shallow reservoirs to the north. Drainage of the Big Cypress Swamp and maintenance of seasonally excessive water levels in the Everglades of Everglades National Park account for the stork's repeated nesting failure and population decrease. Water levels can be manipulated in the Everglades to enhance nesting success and assist in population stabilization. *Received 5 Aug. 1985, accepted 1 Feb. 1986.*

The population stability of the Wood Stork (*Mycteria americana*) in North America long has been a matter of concern and comment. Reproductive failures and apparent population decreases have been well publicized for decades (e.g., Sprunt and Kahl 1960, Allen 1964), and have resulted in the recent addition of this population to the United States Federal list of endangered species (USFWS 1984). Although the North American nesting range of the species includes most of the Gulf and Atlantic coastal plain, the largest population segment traditionally nested in southern Florida. It is the decrease of this population that has created the perception of instability for the North American population as a whole. Thus the history of southern Florida Wood Storks is of overriding importance in evaluating the trend of the U.S. population.

The decreasing status of North American and southern Florida Wood Storks has been described repeatedly (Allen 1958, 1964; Allen et al. 1958; Sprunt and Kahl 1960; Kahl 1964; Robertson and Kushlan 1974; Kushlan

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and White 1977; Ogden 1978a; Ogden and Nesbitt 1979; Ogden and Patty 1981). Unfortunately, these descriptions are not based on explicit evaluations of the primary historic record. Indeed, a variety of estimates for the historic population size exists, and these have been made over various geographical areas. For example Allen estimated that U.S. breeding population was 150,000 in the 1930s (Palmer 1962). He later decreased this estimate to "well over 100,000" (Allen 1964). Ogden (1978b) implicitly questioned Allen's record and concluded that "there may have been 60,000 total storks in the U.S. population at about 1930," including 30,000 breeding adults in southern Florida (Ogden and Patty 1981). Ogden's stated concerns over crucial early records have not precipitated any uniformity of opinion with respect to historic population size, even within the U.S. Fish and Wildlife Service. Its recent estimates include "20,000 pairs [40,000 birds] in the 1930's" (USFWS 1984) and "an estimated southeastern U.S. nesting population of 75,000 to 100,000 pairs in the early 1900's" (Parker 1985).

Clearly divergent conclusions demand a critical assessment of the primary data base. In this paper we document the history of the Wood Stork population segment in southern Florida, based on an objective evaluation of specific historic records and on comprehensive censuses that we conducted during 1974–82. We confirm Ogden's (1978b) concern that early records were exaggerated, argue for the rejection of those records, and provide the documentable history of the Wood Stork's status in southern Florida.

#### METHODS

We assembled and reviewed all available historic and recent information on the southern Florida Wood Stork population. This review included searches of six computerized and one noncomputerized bibliographic sources, complete runs of 35 technical and conservation periodicals, the Colonial Bird Register (Cornell Laboratory of Ornithology), the egg collections at North American museums (J. A. Rodgers, pers. comm.), and, especially, unpublished material at Everglades National Park, the National Audubon Society, and U.S. Fish and Wildlife Service Wildlife Refuges. This material included field notes, reports of censuses and surveys, observation files, and other notes, reports, and memorabilia.

Recent estimates (1974–1982) in the Everglades were derived from our consistent monthly aerial censuses covering all possible nesting habitat in and near the Everglades. Censuses were conducted carefully to provide complete coverage and acceptably unbiased estimates of the number of birds in colony sites. Censuses of colonies in the northern Big Cypress Swamp were sponsored by the National Audubon Society (Kahl 1964; J. Cutlip, pers. comm.; Ogden and Patty 1981).

This search resulted in over 900 unique records of Wood Stork occurrences at colony sites, from 1880 through 1982. Data-base manipulations were performed on a UNIVAC 1100 computer at the Southeast Regional Data Center, Florida International University, Miami, Florida.

Our goal was to elucidate the trend in the nesting population. It is not possible to evaluate

total population size in that the only census data available are the number of birds seen and counted at colony sites. Acceptability of a record of nesting was based upon three criteria: (1) a definite statement that nesting occurred; (2) a definite statement of the number of pairs, nests, or birds; and (3) the credibility of the source. We do not discuss reports in the text that fail to meet these criteria, except for a few frequently cited examples central to previous misunderstandings of the Wood Stork's history.

#### RESULTS

*Colony sites.*—We identified 51 distinct colony sites used by nesting Wood Storks in southern Florida. We do not evaluate the history on the basis of colony sites, however, because such an approach is misleading. Many colony sites are inadequately documented, and all are transitory. Furthermore, colony sites are not a natural division of a population, as there is no indication that storks are attached to a single site. The traditional emphasis on colony sites inhibits an understanding of more important regional patterns. Therefore we have grouped colony sites used in southern Florida into seven regions based upon geography, foraging sites, and habitat (Fig. 1). We do not assume storks are faithful to these regions and in fact demonstrate population shifts among them.

The northern Big Cypress colonies are in Region VII. We divided the more southern colonies, Kahl's (1964) Everglades-mangrove group, into six regions (I–VI). Region I is the area of Cape Sable along the southwestern Florida coast, including the following named colony sites: Bear Lake, Alligator Lake, Flinthead, North Coot Bay, Mud Lake, Durden Key, Cattail Lake, and North Fox Lakes. Region II is the Hells Bay area inland of the southcentral Florida coast, including the following named colony sites: Old Lane River, East River, Ironhead Rookery, Lane River, Noname Rookery, Cuthbert Lake, and North Cuthbert Lake. Region III is the southeastern Florida Coast, including the following named colony sites: Joe Bay, Eagle Key, Glades Canal, and Madeira. Region IV is the southern Everglades including named colony sites at Shark River, Quok Creek, Mudhole, P-36, and North Broad River. Region V is the northern Everglades including 13 sites, most unnamed or inconsistently named, among which storks have moved frequently. Region VI is the southern Big Cypress Swamp including the following named sites: 40-Mile Bend, Loop Road, Monroe Station, and Jetport. Region VII covers Corkscrew Swamp and the northern Big Cypress Swamp area including the following named sites: Deep Lake, Corkscrew Swamp, Okalacoochee, Immokalee Road, Fahkahatchee, Bear Island, Doctor's Hammock, Sadie Cypress, Rocky Lake, and at least one unnamed site.

*Historic population estimates.*—We have documented storks nesting in southern Florida in 72 of 102 years, from 1880 through 1982 (Table 1). Because no information exists for many early years, it may be more useful

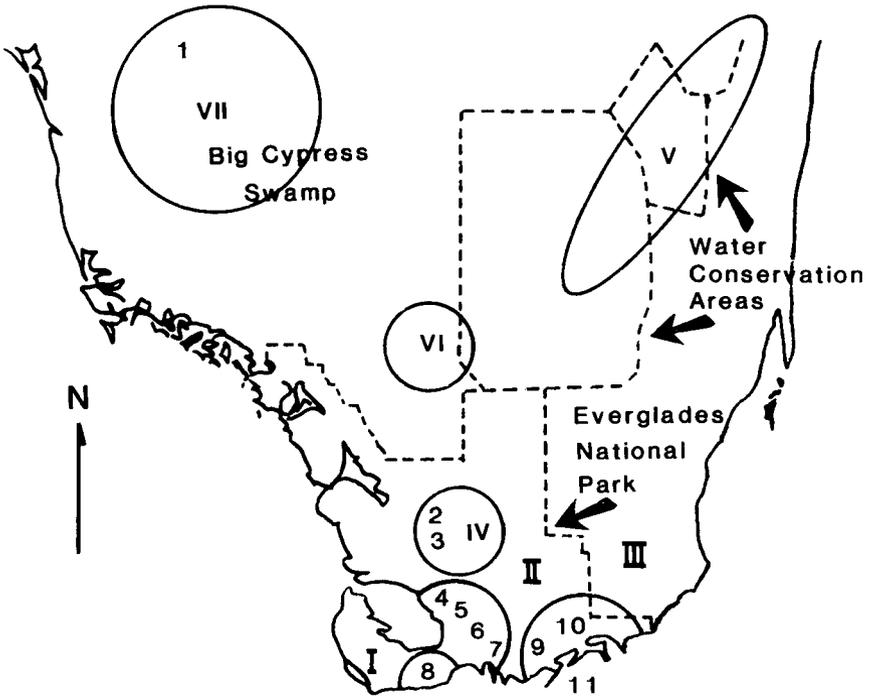


FIG. 1. Map of southern Florida showing seven Wood Stork nesting regions: (I) Cape Sable, (II) Hells Bay, (III) Southeastern Florida coast, (IV) Southern Everglades, (V) Northern Everglades, (VI) Southern Big Cypress Swamp, and (VII) Corkscrew Swamp and northern Big Cypress Swamp. Colony sites discussed in the text are located by number: (1) Corkscrew Swamp, (2) Rookery Branch, (3) Quok Creek, (4) Old Lane River, (5) Lane River, (6) East River, (7) Alligator Lake, (8) Cuthbert, (9) Madeira, (10) Joe Bay, and (11) Eagle Key. Other colony sites in each region are listed in the text.

to note that there is documentation for Wood Storks nesting in southern Florida every year for 60 years, beginning in 1923.

In the vast majority of cases, we know only that nesting occurred. Relatively few records included information on the number of pairs or nests. In some cases, certain numbers of birds were noted as being near a known nest site, but this information was inadequate to infer a number of nesting pairs. It is not possible to know how many storks occurred in southern Florida in the 1800s. Acceptable estimates of nesting numbers for the early 1900s were available only from the Corkscrew-northern Big Cypress Region. Numbers in other regions are unavailable before the early 1950s.

The earliest nesting in southern Florida was documented from the Cape

TABLE 1  
HISTORICAL NUMBERS OF WOOD STORKS NESTING IN SOUTHERN FLORIDA

Year	Maximum number of pairs (nests) by region*							Southern Florida total
	I	II	III	IV	V	VI	VII	
1880	+ <sup>b</sup>							+
1883	+							+
1888	+							+
1891	+							+
1892	+						+	+
1895	+						+	+
1901	+							+
1903	20							20
1910	+							+
1911							500	500
1912							8000	8000
1913							5000	5000
1915	+							+
1923	+							+
1924	230							230
1925	+							+
1926	+						+	+
1927	300							300
1928	+							+
1929	+							+
1930				+		+		+
1932	+	+				+	+	+
1933	+	+		+				+
1934	500	+						500
1935				+			+	+
1936	+							+
1937	+							+
1938	86	+						86
1939							+	+
1940	+	+						+
1941	+							+
1942		+						+
1943		300						300
1944	+	+						+
1945		+						+
1946		+		+				+
1947		+						+
1948		+	+					+
1949		+	+					+
1950		3525	+	+			+	3525
1951		+	+					+
1952		250		+			+	250
1953		+						+

TABLE 1  
CONTINUED

Year	Maximum number of pairs (nests) by region <sup>a</sup>							Southern Florida total
	I	II	III	IV	V	VI	VII	
1954		+						+
1955		+					+	+
1956		+					+	+
1957		+					0	+
1958		580	5	25		25	1615	2250
1959		1450					4655	6105
1960		1900					6635	8535
1961		+	+				6000	6000
1962		150	0	0			0	150
1963		1200	300	100			3000	4600
1964		+					0	+
1965	0	1000	500	150				1650
1966	0	850	750	0			3000	4600
1967	800	825	500	+			7300	9425
1968	0	437	590	0			5000	6027
1969	0	88	190	0			3500	3778
1970	0	19	150	0			1900	2069
1971	0	258	0	200			3000	3458
1972	0	58	275	0			1500	1833
1973	0	388	500	0			0	888
1974	0	700	250	0	0	0	1900	2850
1975	0	810	125	0	0	0	3000	3935
1976	0	1275	35	0	0	0	2300	3610
1977	0	635	80	0	0	0	200	915
1978	0	16	3	0	0	0	+	19
1979	0	1075	275	0	0	15	900	2265
1980	0	80	1	0	0	0	1175	1256
1981	0	381	0	0	297	0	1500	2178
1982	0	670	0	0	549	0	18	1237

<sup>a</sup> I = Cape Sable; II = Hells Bay; III = southeastern coast; IV = southern Everglades; V = northern Everglades; VI = southern Big Cypress Swamp; VII = Corkscrew Swamp-northern Big Cypress Swamp. See Fig. 1 for locations of regions.

<sup>b</sup> + indicates that nesting was reported but that numbers either were not given or are not reliable.

Sable Region (Region I) in the late 1800s (Table 1). This information comes from the activities of naturalists and egg collectors in the latter decades of the nineteenth century. Storks nested on Cape Sable through the 1930s and in much reduced frequency into the 1940s. Unfortunately, the numbers of nests were not specifically documented for most of this period. In 1926, 1500 Wood Storks were reported “with their nests and eggs and young” (Townsend 1926); in 1937, 2500 birds were reported and four colony sites were used. Thus it would seem that the number of

birds using Cape Sable was in the low thousands and that the numbers nesting were no higher and probably were lower. Holt and Sutton (1926) reported 230 nests in 1924 and Christy (1928) reported 300 pairs in 1927 at the Alligator Lake Site. This colony was frequently visited and reported on, as for example by Sutton (1923) in 1923, Holt (1929) in 1924, and Howell (1941) in the 1934 nesting season. Storks abandoned nesting sites on Cape Sable after the 1936 hurricane.

Region II, encompassing Hells Bay, includes several famous colony sites such as Cuthbert and East River. The Cuthbert site holds an important place in North American conservation history. The colony site was discovered by hunters at least as early as 1890 (Moore 1953) and was popularized through the visits of Bent, Job, and Chapman early in the century (Bent 1904, 1926; Dutcher 1904; Job 1905; Chapman 1908), and by the murder of bird warden Guy Bradley in 1904, who was guarding it. (See a later photograph of the colony site in Allen, 1964.) During none of these visits, however, were Wood Storks documented to have nested there.

Wood Storks apparently moved to Cuthbert in the early 1930s. In 1932, 2000 birds were reported there without reference to actual nesting numbers. This colony was active in most years from 1932 to 1960 when a hurricane eliminated most of the island. Nesting Wood Storks returned there in 1963.

It was in this region (II) that a single report of a stork colony precipitated a vastly exaggerated view of historic population sizes. In the 1930s, known colony sites were being tended by wardens who, with few exceptions, were local backwoodsmen employed by the National Association of Audubon Societies (NAAS). This was a highly publicized effort, and most of the bird numbers reported to Association members in its journal originated with the wardens themselves or with NAAS officers on their annual inspections.

In 1933 an extraordinarily high number of birds was reported at a site we now call Old Lane River. This record originated with a report of NAAS Director of Sanctuaries Ernest G. Holt (1933a) on his annual inspection tour of 4–16 May 1933. He received the information in question from his wardens, who told him they had, just prior to his arrival, been guarding 50,000 Wood Storks in the Old Lane River Colony site. Holt (1933b) specifically published the following: "On Lane River, the wardens reported some 50,000 Wood Ibises, 40,000 Louisiana Herons, 40,000 Snowy Egrets, and 15,000 American Egrets breeding. The mortality here was excessively high, caused, by a terrible plague of mosquitoes." Holt himself did not see these large numbers of birds, but rather the wardens told him these numbers of birds had departed just days before his arrival. In an

unpublished report, Holt (1933a) did note carefully what he personally had observed. At Old Lane River he saw only several thousand Wood Stork fledglings and some birds of the other species. He estimated that Old Lane Colony covered 30 acres.

In evaluating this record we should consider several points. By his warden's estimates of 145,000 birds, only 0.8 m<sup>2</sup> of space per bird nest was available, and this necessarily included the water between the scattered islands. Such density of bird nests is not reasonable even in a multi-storied colony site. The wardens with a couple of exceptions, such as E. J. Reimann, had little training or experience with quantified censusing. Few people did in the early 1900s. It should not be surprising that their reports of exceedingly large numbers were not confirmed by outside inspection (e.g., Holt 1933b). Reports from the wardens that they were guarding huge numbers of birds was eminently self-serving at a time of financial crisis in the NAAS. The previous year, all full-time wardens had been released except those in southern Florida, who that year had reported "staggering numbers" to New York (Holt 1932, Anon. 1933). By the next year funds had been found to fix their boats (Holt 1933b). Such factors cast substantial doubt on the wardens' reports of 1933, and it seems inappropriate to accept this record of 50,000 nesting Wood Storks or subsequent restatements and summaries using this record (e.g., Allen 1957, 1958, 1964; Sprunt and Kahl 1960; Robertson and Kushlan 1974).

After the 1930s, the numbers of birds nesting at Cuthbert Colony site decreased slowly. In 1950, the 3375 nests reported there were the highest for the southern colonies. This figure is derived from Cufaude and Brookfield's estimate that Cuthbert contained about 4500 nests, 75% of which were of Wood Storks (Brookfield 1950).

Nesting was first reported at East River, another site in Region II, in 1934, again in 1938, 1940 (Beard 1938, Vinten 1955, Storer 1957), and in nearly every year thereafter. The only numbers available for the 1940s were 300 nests in 1943 and 5500 birds in 1948. The latter estimate offered no information on how many storks were nesting. There are few records for the next decade, despite the creation of Everglades National Park. The East River Colony site was reported to contain 550 nests in 1959 and 650 in 1960. Nesting numbers increased in Region II through 1976 (Table 1).

Storks nested periodically at several sites along the southeastern coast in Region III beginning in 1948 at Joe Bay (Allen 1958). Little is known about these colony sites. In 1961 consistent nesting began at the Madeira Colony site, probably as a result of the hurricane adversely affecting the Cuthbert site island the previous year. A peak of 750 nests was reported at the Madeira site in 1966.

Wood Storks seldom have nested in large numbers in the inland south-

ern Everglades encompassed by Region IV. The earliest information of nesting was at Quok Creek (probably the Squawk Creek tributary to the Shark River) in 1930. Nesting was reported near here in 1933 and 1935 (Allen 1958). Wood Storks nested along the Rookery Branch tributary of Shark River intermittently in 8 of 50 years from 1933 onward. Although well known and visited in most years, this site was never a numerically important nesting site for Wood Storks.

We have no historic records of Wood Storks nesting in the more northern Everglades Region V. Nesting in the southern Big Cypress Swamp Region VI was sporadic.

Our consideration of the historic record of Wood Storks nesting at southern (Everglades-mangrove) sites (Regions I–VI) produced intriguingly few credible censuses, and overall low numbers relative to those commonly reported. Most reliable numerical estimates were in the hundreds with a few in the low thousands. The highest documentable number of *birds* observed near colony sites was in 1937 when 2500 birds were reported from Mud Lake site (Region I) and 1550 birds from the Cuthbert Site (Region II). This was the equivalent of 2025 pairs, but we found no documented evidence that all these birds nested. Ogden (1978b) stated that observers of Old Lane and East River colony sites “between 1934 and 1938 estimated a maximum of about 3000 stork nests,” although giving no source for this figure. The highest historical nesting numbers were 3525 nests in 1950 (Table 1). In that each of these three totals is of similar magnitude, we conclude there is no evidence that the nesting population of Wood Storks in southern (Everglades-mangrove) colony sites exceeded about 3500 nests (7000 birds) historically. This is 30% fewer than the 10,000 estimated by Ogden and Patty (1981).

By far the longest run of quantitative information on nesting numbers is from the more northern Region VIII colonies in Corkscrew Swamp and the northern Big Cypress Swamp (Table 1). Nesting was documented as early as 1892 (Eliot 1892) and acceptable numbers are available for the Corkscrew site in the early 1900s. Baynard (1914) estimated 7000–8000 Wood Stork nests there in 1912; whereas, Phelps (1914) estimated “not less than 5000 pairs in 1913.”

A larger estimate of 10,000 nests at a colony site in the Okaloacoochee Swamp by F. H. Kennard in 1926 (Bent 1926) is not credible. Kennard himself thought that it was “almost impossible to make any estimate of their numbers, even approximately without spending a couple of days counting their nests, but [that] there must have been several thousand flying about or perched.” His accommodating guide, however, after climbing a convenient tree produced the estimate of 10,000 nests, a number that has been often repeated, usually as 20,000 adult storks.

Another repeated estimate of stork numbers in the Big Cypress is 30,000 Wood Storks reported from Corkscrew Swamp in the mid-1930s. We find no primary documentation for this claim. Thus, the largest documented estimate for Wood Storks nesting in the northern Big Cypress was the 8000 nests reported in 1912 by Baynard (1914), 20% less than that provided by Ogden and Patty (1981).

*Recent population estimates.*—The mid-1950s provide a convenient division between historic and recent records, because of the hiatus in numerical estimates available from this period, despite the establishment of Everglades National Park, which encompassed the southern colonies (Regions I–IV). Although data were lacking, it was the strong impression of conservationists that the Wood Stork population decreased drastically in this period because of drought (Buchheister 1960). This perceived decrease led to a heightened concern for the Wood Stork and inspired the initiation of surveys led by R. P. Allen, whose efforts provided fairly comprehensive information for 1959–1960. Aerial surveys and ground checks were initiated in 1958, a season described in detail by Allen (1958). The numbers were higher in 1959 and 1960 owing to his experience, better coverage, and better nesting conditions (Buchheister 1960), suggesting the latter years were more representative of the nesting population of Wood Storks at that time. Ogden and Nesbitt (1979) used these two years as their base of comparison to detect range-wide population decreases.

Allen found about 8500 Wood Stork nests in 1960 (Table 1). This is about the same as the highest population level we can document previously. Thus, it appears that the reported nesting failures of the 1950s did not adversely affect the Wood Stork population, and that conservationists' concerns for a decreasing population (e.g., Allen 1957) were illfounded.

The southern colonies (Regions I–IV) supported 1105 nests in 1959 and 1900 nests in 1960. These numbers are about half the values used by Ogden and Nesbitt (1979), perhaps because of a mix-up of nest numbers (i.e., pairs) and bird numbers. Thus, our maximum estimate for the southern colony sites for the late 1950s is 1900 nests.

There were gaps in census data from 1960 to the late 1960s, several years after substantial changes had occurred in water management in southern Florida. For 1967, we estimate 2100 pairs of Wood Storks in the southern colonies and 9400 pairs in southern Florida (Regions I–VII). This population estimate is higher than that documented in the two previous highest years, 1913 and 1960. Thus, we find no evidence to document a net decrease in the southern Florida Wood Stork population from 1913 through 1967.

In the following several years, the numbers of Wood Storks attempting

to nest in southern colonies (Regions I–IV) were low owing to a period of high water. Surveys during this time checked only major known colonies intermittently. In the early 1970s, monthly surveys were begun, and we undertook these comprehensively from 1975 through 1982. As a result, data from this period are relatively reliable, and comparable. Even with such comparable data it is difficult to trace trends, because in most years many birds apparently did not attempt to nest. As a result, we can evaluate population changes only by contrasting two years, such as 1967 to 1982, or by examining the trend for years of relatively high nesting effort, assuming that in such years most storks attempted to nest.

We can document that the number of Wood Storks attempting to nest decreased from 1967 to 1981–82, overall, and in most regions (Fig. 2). Four contrasts are of particular interest: (1) Corkscrew Swamp and northern Big Cypress (Region I), (2) the southern colonies in Everglades National Park (Regions I–IV), (3) the northern Everglades in the water reservoirs called conservation areas (Region V), and (4) southern Florida as a whole (Regions I–VII). From 1967 through 1981, Wood Storks nesting in the Corkscrew-northern Big Cypress region decreased by about 80%. From 1967 through 1982, the southern Everglades population (Regions I–IV) decreased by about 70%. Overall, then, the southern Florida population decreased by about 75% in 15 years from 1967 to 1981–82. More recently, the number of Wood Storks nesting in the northern Everglades increased from none to over 500, representing a shift of birds from the southern to northern Everglades. This shift increases the importance of maintaining the present, apparently appropriate, foraging and nesting conditions in the Everglades of Conservation Area 3A.

It is difficult to estimate the extant nesting population at the end of our study because nesting effort differed among regions in 1981 and 1982 (Table 1). In these two years Wood Stork nesting effort (nests) was: 1981—Lane River, 50; East River, 55; Cuthbert, 300; three colony sites in Conservation Area Three, 7, 2, 13; colony site in Conservation Area Two, 20, Two colony sites in Conservation Area One, 95, 160; Corkscrew, 1500. 1982—Lane River, 280; East River, 90; Cuthbert, 300; seven colony sites in Conservation Area Three, 75, 40, 380, 15, 9, 6, 24; Corkscrew, 18. Nesting effort was relatively high in the Corkscrew-northern Big Cypress Swamp (Region VII) in 1981 and in the southern and northern Everglades (Regions II and V) in 1982. To arrive at a total for southern Florida, we must assume no interchange between these areas, in order to permit addition of the regional totals for the separate years of high nesting effort. In this way we estimate the nesting Wood Stork population in southern Florida to be about 2700 pairs in 1981–82.

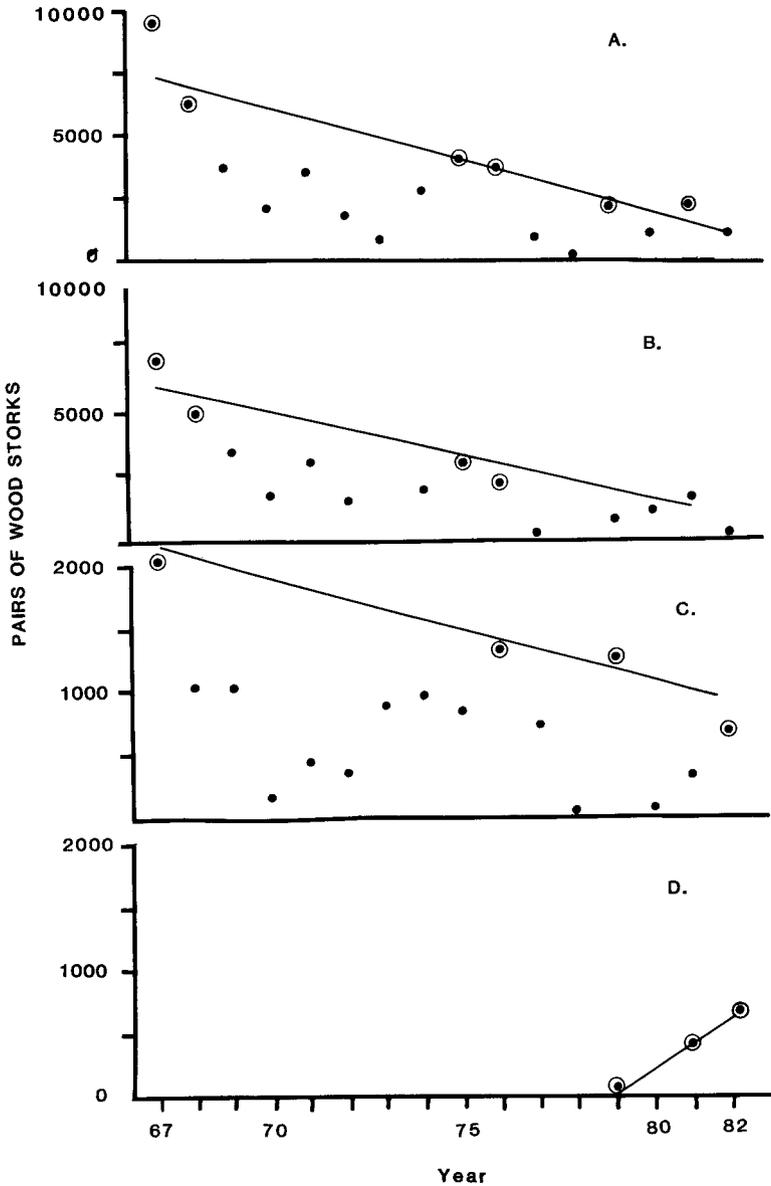


FIG. 2. Recent trends in the numbers of Wood Storks nesting in southern Florida: (A) Southern Florida, (B) Corkscrew-northern Big Cypress Swamp, (C) Southern Everglades, and (D) Northern Everglades. Double symbols indicate years of relatively high nesting effort. Trend lines follow the data for these high-effort years.

## DISCUSSION

*Colony sites.*—Wood Storks are well known for their colony-site tenacity, and indeed the Corkscrew site has been in use for over 70 years. Although storks tend to return to established sites year-after-year, site shifts do occur—usually over a period of several years. We have documented nesting at at least 51 sites in 102 years.

Some of these shifts have substantially redistributed the nesting population; notable is the abandonment of historic sites on Cape Sable (Region I). The principal reasons for the decrease in Wood Storks nesting on Cape Sable were the drainage canals, which were dug beginning in the 1920s (e.g., Holt 1929, Reimann 1940). The hurricane of 1936, the effects of which were exacerbated by the canals, caused massive vegetation changes, which affected several species. The Wood Stork decline was simultaneous with the well-known decrease of the Cape Sable Seaside Sparrow (*Ammodramus maritimus*) population (Kushlan and Bass 1983). Although the Alligator Lake colony site was altered, birds nested there and at other locations on the Cape afterward (Reimann 1940). Thus it was a change in foraging habitat rather than nest site unavailability that led to Wood Storks abandoning Cape Sable for nesting.

The long history and persistence of Wood Stork nesting on Cape Sable, covering 50 years, is notable. Over much of this period, Wood Stork colonies were not documented elsewhere in southern Florida outside the Big Cypress Swamp. This is not an oversight, in that wading bird colony sites elsewhere were well visited. It seems the Cape Sable colony sites were the primary, if not only, Wood Stork nesting colonies near the southern Everglades before the 1930s.

Occupation of the famous sites at East River and Cuthbert, popularized by frequent visits of naturalists and ornithologists of the 1930s and 1940s, resulted from the movement of birds from Cape Sable to Hells Bay (Regions I to II) following the 1936 hurricane. A similar shift from Region II to III also was probably a result of this process, hurricanes in the early 1960s that followed construction of a canal in the 1950s by the National Park Service. Subsequent abandonment of Region III sites coincided with the loss of foraging habitat along the southeastern Florida coast. The most recent shift from southeastern coastal (Region II) to northern Everglades sites (Region V) clearly is in response to lowered food availability due to water management near southern colony sites (Kushlan et al. 1975).

Considering the many sites used for nesting in southern Florida ranging from coastal islands, clumps of mangrove trees, river-edge forest, Everglades tree islands, and cypress swamp; colony-site requirements of Wood Storks appear to be highly flexible. In fact, the number of suitable potential

colony sites in southern Florida seems nearly unlimited. All evidence suggests that patterns of food availability limit area use and colony-site tenacity (Kahl 1964, Kushlan et al. 1975, Ogden et al. 1976). Thus, conservation efforts aimed at protection, establishment, or re-establishment of specific nesting sites alone would be untenable in the long run. Suitable foraging sites rather than nesting sites seem to be the factor limiting the Wood Stork population.

*Nesting areas.*—Examining stork history on a regional basis provides insight into the relative importance of various areas in southern Florida. All evidence suggests that the Corkscrew-Big Cypress Area (Region VII) has always been far more important than the Everglades and coastal areas (Regions I–VI) in supporting the southern Florida population of nesting Wood Storks. Available censuses show more consistent yearly occupancy and higher nesting numbers in the Big Cypress Area than in the more southern colony sites.

Outside the Big Cypress Swamp, Wood Storks have seldom nested inland in large numbers in southern Florida. Similarly, storks have not nested along the west coast of Florida, although they feed there during most winters. Nesting in Florida Bay occurred only in 1949 and 1950 on Eagle Key. Nesting in southern regions for the most part has taken place along the edge of the southern Everglades drainage, on Cape Sable, and on the southeastern coast. The earliest nesting sites in this area were on Cape Sable, not in the Everglades marsh proper, although storks nesting there undoubtedly fed both in coastal mangrove swamps and the Everglades during drying conditions. The recent shift to northern Everglades colony sites is unprecedented, and therefore may well be a response to unnatural but relatively beneficial patterns of water level fluctuation in the northern marshes caused by current water management policy. Conservation of Everglades Wood Storks may require continuation of the unnatural enhancements of foraging conditions in the northern Everglades.

*The historic period.*—In evaluating the historic record we applied several criteria. The first two were objective, requiring a definite statement that nesting occurred and a definite statement of the number of birds, pairs, or nests involved. These do not seem unreasonably stringent to us, but even so their use eliminated some records of birds seen near a known or presumed colony site. We believe, however, that it is inappropriate to impose a second-hand interpretation of nesting on the actual information and to perpetuate such interpretations.

Many records appeared inconsistent or questionable in the light of other acceptable data. We found that most of these inconsistencies could be

resolved by evaluating the observer's credibility. For the most part, careful reading of accounts, usually more than one per record, provided sufficient information to evaluate statements. In nearly all cases of consequence, we found that these records were derived from the untrained and possibly self-serving statements of guides, wardens, and rangers. The primary, and historically tremendously important, responsibility of wardens was to provide the only protection available for these colony sites. Close readings of numerous warden reports convince us that, with very few exceptions (e.g., E. J. Reimann and C. Brookfield), quantification in these accounts is not reliable.

Other important sources of misinformation were the relatively recent censuses, mostly aerial surveys, which account for most modern records except for those from the Corkscrew site. Generally, such censuses were flown on a variable schedule. Most covered only known nesting sites and were done by persons of greatly different skill and experience. Only several recent years of consistent censuses of the southern colonies are available.

For these more recent data, derived from aerial censuses, the number of nests is inferred from the count of birds at the colony site or of birds standing in close proximity to each other and apparently paired. Important identification and counting errors were revealed in available data when we compared counts of different observers of the same colony or the same observer's counts on separate dates. Technique errors are substantial (Kushlan 1979), remain unquantified, and no error estimates have been derived. Such censuses are biased and at most represent the numbers of birds at the colony site at the time of census. Unfortunately, these censuses constitute the only historical data available in recent years and must be used to evaluate trends.

Year-to-year fluctuations of numbers of birds at colony sites suggest that not all birds nest each year and that they do not necessarily return to the same location in subsequent years. Thus, population trends can be evaluated only by comparing years of high colony occupancy over regions larger than a single colony site. The population being monitored, therefore, is the number of birds appearing at the colony site. It does not include the immature birds of several age classes, nor even adult birds that were not at the colony site during a census.

The potential errors involved with such aerial censuses should proscribe their continued use in monitoring Wood Storks. What is required for evaluating the population's status is not the number of birds showing up at a colony site but the per capita productivity of the breeding population, available only from detailed study on the ground.

*Population trends.*—Clearly the large numbers of storks reported from southern Florida as a whole have been based on a few unreliable records.

Allen (1958) used these in his historic population estimates, which were subsequently popularized by others. Sprunt and Kahl (1960), for example, reported that "in the mid-1930's there were lots of storks. According to Robert P. Allen, some 30,000 nested in the Corkscrew Swamp alone and another 50,000 at the heads of Shark and Lane rivers in what is now Everglades National Park. Other smaller colonies probably swelled the total to 100,000 or more birds." We have noted previously that the 50,000 estimate is untenable, and the 30,000 estimate is undocumented. The extra 20,000 was certainly a guess. Nonetheless, this 100,000 has often been taken to be the historic population size for south Florida (Allen 1958, Sprunt and Kahl 1960, Ogden and Nesbitt 1979), sometimes reduced to "over 75,000" (Robertson and Kushlan 1974), "75-100,000" (Parker 1985), or "75,000" (Ogden 1978a).

We have no credible evidence to suggest that the number of storks in southern Florida (Regions I-VII) exceeded the 8000 pairs reported in the northern Big Cypress Swamp and Corkscrew in 1912. The highest historic estimate available for southern colonies is 3500 pairs in 1950, which cannot be added to estimates at the Corkscrew site because of time gaps. In fact, we cannot verify an historic South Florida breeding population larger than that found as late as 1967. A larger population may have existed, without documentation, or it may have fluctuated more than can be verified. Considering the inherent error in the estimates, however, we are compelled to accept the fact that the maximum estimates for 1912, 1960, and 1967 are all about the same. We conclude that we have no historic evidence that southern Florida supported a Wood Stork nesting population larger than that of 1967, when we have documentation of 9400 pairs.

The southern Florida Wood Stork population has been reported to be decreasing for the past 30 years (e.g., Allen 1958). In nearly all cases the decrease is documented through comparison of presumed populations in the 1930s. Ogden and Patty's (1981) evaluation, used by the U.S. Fish and Wildlife Service (1984), concluded that the U.S. population decreased from 20,000 breeding pairs during the 1930s to approximately 4800 in 1980. Their historic number included 5000 pairs in Everglades colonies (our Regions I-IV) and 10,000 in Big Cypress Swamp (Our Region VII). Our highest credible estimate for southern Florida (Regions I-VII) is two-thirds of that estimate.

Ogden and Nesbitt (1979) considered the surveys by Allen in the late 1950s to be a suitable historic baseline. Our review however, indicates that maximum documentable population size was in 1967, rather than in 1959-60. It is during the past 15 years, rather than 22 years, that we can see a clear change in Wood Stork numbers in southern Florida. Over-

all, by 1981–82 the southern Florida population (Regions I–VII) had decreased to about 25% of its level approximately 15 years previously, to a recent nesting population of about 2700 pairs.

The lack of documentably high historic numbers actually should be of little consequence to current Wood Stork conservation, which scarcely needs to appeal to the historic (or really “prehistoric”) occurrence of 100,000, 75,000, or even 30,000 storks. So many changes have occurred in southern Florida since the 1930s that any numbers from that era could have no applicability to current conservation efforts.

Unlike the previously presumed decreases since the 1930s, decreases over the past decade and a half can be linked to potentially reversible management practices, specifically water management in Everglades National Park and drainage in the Big Cypress Swamp (Kushlan et al. 1975, Browder 1976). Birds nesting in the Big Cypress Swamp appear to be suffering from loss of suitable foraging habitat. In recent years southern Everglades Wood Storks have nested successfully only in the few years when the water levels fell substantially during the dry season, (i.e., 1967, 1974, and 1975). In fact, nesting failure in southern Everglades colonies can be attributed directly to maintenance water levels that were too high in spring and to decreased rates of drying in the southern Everglades (Kushlan et al. 1975). To protect the Wood Stork in southern Florida, the southern Everglades must be permitted to dry seasonally, and over-drainage of the Big Cypress Swamp must be abated.

It should be of considerable value to Wood Stork conservation to realize that population decreases in this species in southern Florida are of recent occurrence, on the order of 75% rather than 95%, and have been caused by understandable alteration in feeding habitat. In the Everglades, and to some extent in the Big Cypress Swamp, management to enhance Wood Stork habitat is possible. Meanwhile, southern Everglades storks are responding to environmental changes by shifting colony sites to the northern Everglades where water management actions have apparently provided more suitable foraging habitat than further south.

Allen et al. (1958), after describing the earlier nesting 25 years before of up to 65,000 Wood Storks in southern Florida, stated that “. . . the fact that they once existed—such a relatively short time ago—should not be thrust aside or forgotten. If we are to find a way to insure the permanent survival of the Wood Storks that remain, we must know what destroyed these immense congregations of the recent past.” We suggest that, rather than concentrating on questionable data from the past, attention should be paid to managing present stork foraging habitat in the southern Florida wetlands.

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