TECHNICAL PUBLICATION 84-9

June 1984

WADING BIRD UTILIZATION OF LAKE OKEECHOBEE MARSHES 1977-1981

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By

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June 1984

South Florida Water Management District
Environmental Sciences Division
Resource Planning Department

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RPD 485 R50

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EXECUTIVE SUMMARY

The regulation schedule for Lake Okeechobee was raised to 15.5-17.5 ft msl in 1978 to provide additional water storage capacity for increasing agricultural and urban needs in south Florida. A five year study to document the effects of these increased water levels on wading bird use of the lake marshes was implemented in 1977. Monthly surveys were conducted from January 1977 through September 1981 spanning a variety of lake stage conditions which ranged from highs exceeding 17.5 ft in 1978 and 1979 to the record low of 9.76 ft msl in 1981.

Lake Okeechobee provides a resource of regional significance for feeding and nesting birds in south Florida. The survey documented a peak number of birds present on the Lake during March through July, with a maximum of 42,000 birds recorded in July of 1977. South Florida wading bird activity is synchronized with historical hydrologic patterns. Significant use of the marshes for feeding coincided with periods of gradually declining lake stages below approximately 15 ft msl. These hydrologic conditions dried marshes, concentrated forage organisms, and provided water depths sufficiently shallow for wading bird use. A major prerequisite for nesting is inundation of the ground within the nesting colony, thereby affording protection from predators. Most nesting on the lake occurred in willows when water levels exceeded 13 ft msl. Nesting may also occur at lower lake stages on island sites such as Kings Bar. Wading birds also nested on the lake during high stages when feeding conditions were unfavorable within the lake marshes. During some of these periods, increased feeding activity was observed in nearby wetlands of Fisheating Creek and Nicodemus Slough.

Were it possible to closely adhere to the present 15.5-17.5 ft msl schedule, the emergent marsh would be constantly inundated. These extended high stages would be detrimental to the long term viability of the major vegetation communities which need periodic drying for marsh regeneration. Stages above 15.5 ft msl would render most of the marsh unusable for wading bird feeding. Extended stages above 13 ft msl may stress the existing willow community, and thus have an adverse impact on the nesting birds which depend primarily on willows for nest building. Givens (1956) suggested that willows have a tolerance of five years when continuously flooded to a depth of two feet. Awareness of lake level-wading bird relationships may prove to be crucial in future water management decisions.

ACKNOWLEDGEMENTS

Aerial surveys of wading birds on Lake Okeechobee were begun in 1977. Gary L. Pesnell was the primary investigator on this program until September 1979. Robert D. Martens provided bird census assistance during flights in 1980 and 1981. Doug Genever and Jim Dunn piloted the helicopters and they became quite adept at spotting and counting birds.

INTRODUCTION

Lake Okeechobee, a 1890 km^2 body of water located in south central Florida, is the second largest fresh water lake entirely within the United States. The 382 km^2 emergent marsh represents a resource of regional significance that is heavily utilized by both feeding and nesting wading birds. These marshes provide prime feeding habitat for large numbers of wading birds during the latter part of the dry season, when most other interior south Florida wetlands have dried. In years of below average rainfall, the lake marshes may provide critical habitat which supports nesting colonies from other locations. This occurred during the spring of 1974 when wood storks from the Corkscrew Sanctuary, 80 km away, depended heavily on Lake Okeechobee marshes to sustain the latter part of the nesting period (Browder, 1974). During 1972, nesting white ibis from Lake Istokpoga were also reported feeding in Lake Okeechobee (Kushlan, 1974).

Continued population growth and expanding agricultural activities in south Florida have led to increased water demands and the need for additional water storage. To meet these needs, plans were initiated in the mid-1970's to increase the storage capacity of Lake Okeechobee by raising the maximum stage level from 15.5 ft msl to 17.5 ft msl. A survey of wading bird utilization of Lake Okeechobee marshes was initiated in 1977 to investigate the impact of an increased regulation schedule on wading bird activity.

DESCRIPTION OF THE STUDY AREA

The extensive Lake Okeechobee littoral zone includes approximately 38,200 ha of emergent marsh (17% of the total lake area), located primarily along the west shore of the lake from Clewiston to the Kissimmee River. These marshes form a band 0.8 to 14.5 km in width and occupy lake bottom

elevations between about 10.0 and 15.5 ft msl. The landward extent of the marsh is limited by the Herbert Hoover dike which encircles the lake at about the 15.5 ft msl elevation contour. The shallow, sandy soils of the littoral zone are underlain by Ft. Thompson limestone. There are muck and peat deposits throughout the area, with the most extensive deposits located within three formerly farmed islands at the south end of the lake. Land elevations on these islands range from 13.0 to over 16.0 ft msl.

The emergent vegetation of Lake Okeechobee was mapped in detail by Pesnell and Brown (1976). The major emergent plant communities within the littoral zone, and their optimum elevation ranges, are:

wire cordgrass and mixed grasses	13.1-15+ ft msl
beakrush	13.1-14.6 ft msl
willow	13.2-14.3 ft msl
cattail	12.4-13.1 ft msl
spikerush	10.6-12.4 ft msl
bulrush	10.1-10.6 ft msl

Wire cordgrass and mixed grass communities occupy the highest elevations within the marsh. Vegetation is dominated by Spartina bakeri and several low stature grasses including torpedo grass (Panicum repens), maidencane (Panicum hemitomon), and Paspalidium paludivagum. Mixed grasses are most extensively developed along the northwest shore. The beakrush community, composed mainly of Rhynchospora tracyi, along with other sedges and grasses, is found at slightly lower elevations than the mixed grasses. This community is most extensive in the southwest section of the lake near Moore Haven. The willow (Salix caroliniana) community forms extensive thickets along elevated ridges in the southwest marsh. The central portion of Kings Bar is

also composed of dense willow surrounded by cattail (Typha domingensis). Cattail stands generally surround the willow community, and are located lakeward of the mixed grasses along the northwest shore. Spikerush (Eleocharis cellulosa) communities are found in a narrow band lakeward of the outer cattail fringe along the northwest shore. The most extensive spikerush flat is located in Moonshine Bay, northeast of Moore Haven. Along most of the lakeward edge of the marsh is a narrow band of bulrush (Scirpus californicus).

A submergent vegetation zone composed of peppergrass (Potamogeton illinoensis), eelgrass (Vallisneria neotropicalis), and Hydrilla verticillata extends from the outer edge of the bulrush up to 0.8 km into the lake at some locations. The three abandoned agricultural islands in the southeast part of the lake are characterized by interior ponds, stressed trees, and adjacent marshes.

Land use surrounding Lake Okeechobee is predominantly improved pasture and intensive agriculture. However, extensive seasonal marshes occur within the Fisheating Creek-Nicodemus Slough floodplain along the west side of the lake. A preserved cypress swamp, Barley Barber, located near the northeast shore provides potential nesting habitat.

HYDROLOGY OF LAKE OKEECHOBEE

Lake Okeechobee water levels have historically been subject to wide fluctuations within a ten foot range since the earliest records were compiled in 1912. Extreme high and low lake stages over the period of record ranged from 20.2 ft msl in 1912 to 9.75 ft msl in 1981. Canal construction and land reclamation in the surrounding area began with Hamilton Disston's attempts in the late 1800's, and after numerous other water control projects the hydrologic regime of the area has been substantially altered. Increased

water control has led to reduced lake stages, with annual fluctuations ranging from over five feet to less than two feet in some years.

Water levels in Lake Okeechobee normally reflect south Florida's rainfall patterns, with lake stages increasing during the summer wet season and receding during the dry spring months. Surface water flows into the lake from the Kissimmee River Basin, Fisheating Creek, Lake Istokpoga Basin, and the Taylor Creek-Nubbin Slough Basin. Excess waters from the agricultural areas to the south may be backpumped into the lake. Regulatory releases are made through the Caloosahatchee River, the St. Lucie Canal, and various other canals flowing into the Everglades Agricultural Area, Water Conservation Areas, and the urbanized east coast.

Prior to 1974, Lake Okeechobee water levels were regulated by a schedule designed to prevent maximum stages from exceeding 15.5 ft msl, while providing a dry season recession to 13.5 ft msl. In order to raise the water storage capacity of Lake Okeechobee to meet increasing demands from nearby urban and agricultural areas, the lake regulation schedule was increased to 14.5-16.0 ft msl in 1974 and to 15.5 - 17.5 ft msl in 1978. Although the regulation schedule specifies maximum allowable levels throughout the year, and regulatory releases can influence lake levels when over schedule, overall climatic conditions remain the predominant factor determining actual lake levels. Figure 1 shows lake stages in relation to the regulation schedule for the period 1972-1981. Note the increasing stages in 1978-80 following implementation of the higher regulation schedule, and also the record low stages during the 1981 drought.

Hydrologic factors which can influence the utilization of Lake Okeechobee wading bird populations include water depths within the marshes, recent rates of water level recession or rise, and conditions throughout the interior wetlands of south Florida during critical times of the year.

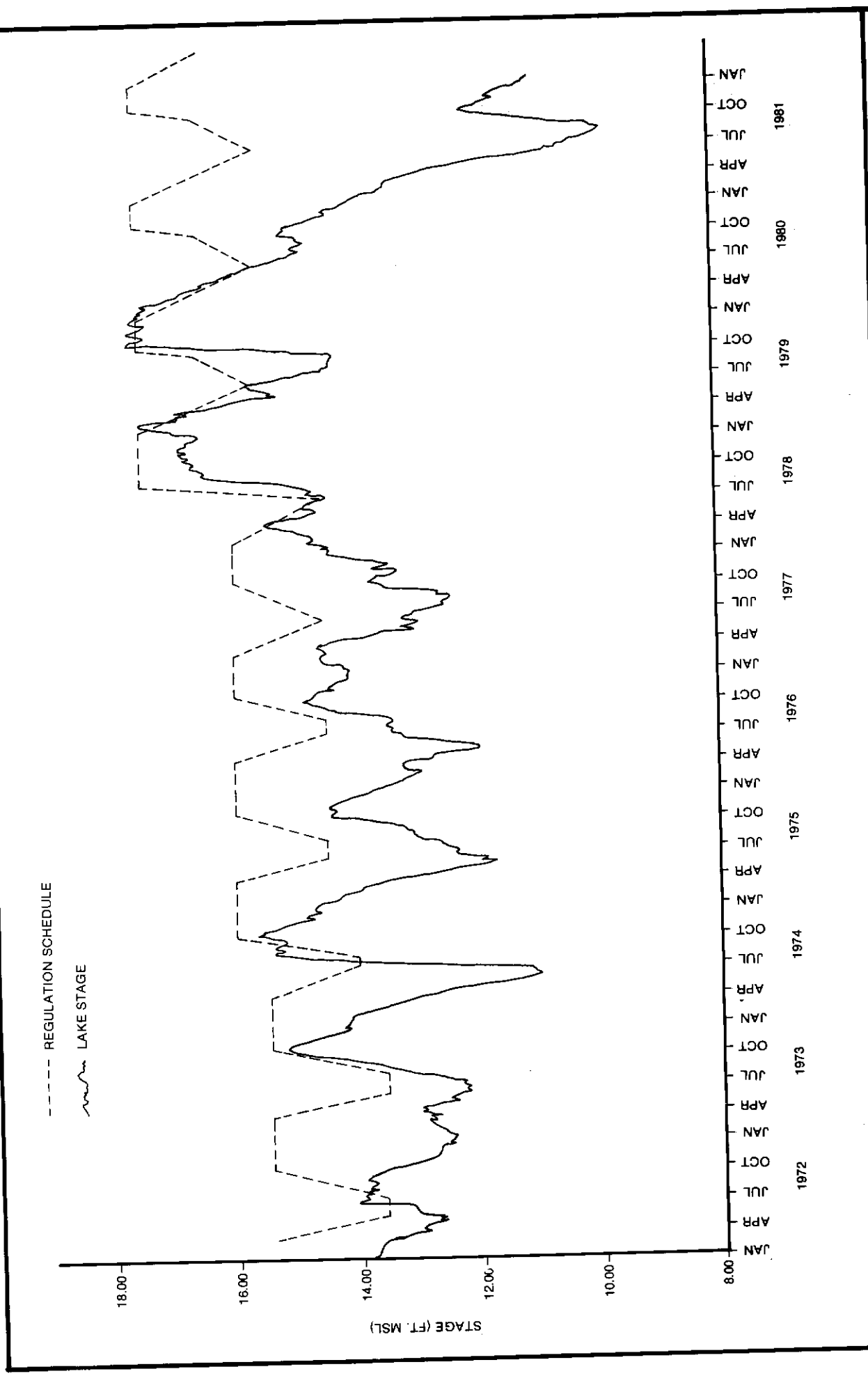


Figure 1 HYDROGRAPH AND REGULATION SCHEDULE FOR LAKE OKEECHOBEE, 1972 - 1981

WADING BIRD HISTORY AND ECOLOGY

The most common and conspicuous wading birds (order Ciconiiformes) which frequently utilize interior freshwater wetlands in south Florida include:

Common Name	Family	Scientific Name
	Ardeidae	
Great Blue Heron		Ardea herodias
Little Blue Heron		Florida caerulea
Louisiana Heron		Hydranassa tricolor
Great Egret		Casmerodius albus
Snowy Egret		Egretta thula
Cattle Egret		Bulbuccus ibis
	Threskiornithidae	
White Ibis		Eudocimus albus
Glossy Ibis		Plegadis falcinellus
Roseate Spoonbill		Ajaia ajaja
	Ciconiidae	
Wood stork		Mycteria americana

South Florida wading bird populations have been reduced drastically since the 1800's, mainly due to plume hunting and habitat alteration. Population estimates in the late 1800's were as high as 2,500,000 birds in south Florida (Robertson and Kushlan, 1974). Following the ban on plume hunting, wading birds began making a rapid recovery from an estimated 500,000 birds in 1910 to 1,200,000 in 1935; however in the 1940's and 1950's another rapid decline followed which was attributed to habitat alteration and wetland drainage. By 1960 the population had been reduced to 300,000 birds, and recent surveys estimate the south Florida population between 130,000 and 150,000 birds (Robertson and Kushlan, 1974; Kushlan and White, 1977).

South Florida also supports a substantial number of wintering birds from the Atlantic Coast, mid-west, and Gulf Coast regions. These birds begin arriving in November, and many remain through June or July. Wading bird activity within the region usually coincides with the pattern of declining water levels and increasing prey density. Feeding activity often begins in the coastal marshes, followed by utilization of the Big Cypress and the Everglades. As the interior marshes dry in the spring and lake stages recede, lake marshes provide increasingly important forage habitat.

Wading bird aggregations are generally found either nesting or feeding, and their presence in an area is largely dependent on specific environmental and hydrologic conditions that provide suitable water depths and sufficiently concentrated food organisms. Nesting activity generally begins during November through February along coastal marshes, and birds feeding in the drying interior wetlands will normally nest between March and June.

The white ibis is a small wading bird, (56 cm high) with a long, slender down-curved bill. The adult plumage is white except for the tips of the primaries which are black, and immature birds have brown wings, tail, neck, and head. The white ibis is an opportunistic feeder that utilizes a wide range of habitats. It is not entirely dependent on receding water levels, and is frequently found foraging in recently flooded areas. White ibis feed on a variety of aquatic invertebrates, with crayfish usually accounting for 70% of their total consumption. White ibis will also feed on fish when these are highly concentrated (Kushlan, 1974). Nesting colonies form in various types of wetland vegetation including trees, shrubs, and herbaceous plant communities, near suitable feeding locations. White ibis are the most abundant wading birds in south Florida, with an estimated population of 56,000 to 60,000 (Robertson and Kushlan, 1974).

The glossy ibis is similar in size and appearance to the white ibis except for its dark plumage. This species is less abundant, with an estimated breeding population of 3500 birds in south Florida (Robertson and Kushlan, 1974). The glossy ibis was considered rare in the 1930's but its population and range has expanded considerably. Recent nesting in south Florida has been primarily confined to Lake Okeechobee and WCA-3 (Kushlan and Schortemeyer, 1974). Nesting generally occurs in colonies with other waders, usually close to the water in low trees, bushes, and grass clumps. Feeding habits are similar to those of white ibis, with crayfish providing the bulk of its diet.

The great egret is a large bird standing about 1 m high, with white plumage and black legs. This species has an extensive breeding range and post-breeding dispersal with most birds from the Atlantic seaboard wintering in Florida. Feeding occurs in a variety of fresh and salt water habitats, with prey consisting of fish, amphibians, invertebrates, and even small mammals and birds (Bent, 1926). Great egrets nest in large, remote colonies with other wading birds. They prefer nesting in mangroves, cypress, and willows surrounded by cattail or sawgrass, and build substantial nests well above other ardeids (Maxwell and Kale, 1977). The great egret population was drastically reduced by plume hunters in the early 1900's, with an estimated 1400 birds remaining in ten colonies in 1911, seven of these in Florida (Allen, 1957). After the ban on plume hunting, the species made a rapid recovery, increasing its population to 73,000 in the 1930's (Allen, 1957). The population has declined once again, probably due to loss of wetland habitat, with an estimated 9000 to 10,000 nesting birds remaining in south Florida (Kushlan and White, 1977).

The snowy egret is a small bird, 60 cm high, with white plumage, black legs, and yellow feet. Snowies have a more coastal range and their post-

breeding dispersal is not as extensive as the great egret. Snowy egret feeding habits are more diverse than other herons. They use a variety of techniques such as foot-stirring and flying low over water to capture prey at the surface. Snowies are found in estuaries, fresh water marshes, and terrestrial habitats feeding on shrimp, small fish, and insects. Nesting usually begins in late March-April in mixed species colonies with nests usually placed in lower limbs scattered among those of other ardeids. Kushlan and White (1977) estimated the nesting population of snowies in south Florida at 10,300 birds.

The cattle egret is slightly larger than the snowy egret, with white plumage and a tan streak usually present along the neck and shoulders; the bill and legs are yellow. The cattle egret is an old world species that first appeared in the United States in the 1940's. The first reported nesting in south Florida was near Lake Okeechobee in 1953 (Sprunt, 1954). This species has since undergone a substantial population increase, making it the most abundant ardeid with over 30,000 nesting birds estimated in south Florida (Kushlan and White, 1977). Cattle egrets are primarily terrestrial feeders that associate with livestock, capturing insects disturbed by these animals (an ecological niche that had not been utilized by native ardeids). Wetland drainage in south Florida, which converted seasonally inundated habitats into pasture, has facilitated expansion of the species. Other factors contributing to the expansion of this egret are increased dispersal tendencies, early reproductive maturity, and higher fledging success than other ardeids (Shanholtzer, 1972). Although interspecific competition remains low at feeding grounds, nesting site competition may increase as the population expands. Cattle egrets utilize well established colonies, but native ardeids are usually well into nesting by the time cattle egrets arrive. Rice (1956) established that the presence of other nesting herons stimulates the cattle egrets' reproductive cycle.

The wood stork is the only true stork in North America. It is a large (about 1 m high with a 1.5 m wingspread) long-legged bird with white plumage, black wing feathers and tail, and an unfeathered head and neck. The wood stork is highly gregarious, nesting primarily in mangrove or cypress swamps, and foraging in freshwater marshes and flooded pastures. Their main food source is small fish 2 to 15 cm long which they capture in shallow water by a special feeding technique when the prey comes in contact with their mandibles (Ogden et al., 1976). For this type of feeding to be effective, ideal conditions with receding water levels and high fish densities are necessary, particularly during the nesting season. The 130 day nesting cycle requires 200 kg of live weight of fish per nest (Kahl, 1964). The rate of water level decline and prey density must be sustained through the nesting season, and even small increases in water levels may cause nest desertion. Of the six species discussed so far, the wood stork has experienced the most rapid rate of decline. Wood stork populations have decreased from an estimated 75,000 birds in 1930 to 8700 breeding birds in 1975 (Kushlan and White, 1977). This species has been averaging a 4% decline annually, with unsuccessful nesting in numerous years, and is currently classified as endangered (Ogden, 1976).

The little blue heron is about 60 cm high. The immature birds are white, the sub-adults have a calico appearance, and the adults' plumage turns blue within a year. The head and neck are dark brown, the bill is bluish with a black tip, and the legs are bluish-gray. This heron occurs in saltwater, brackish or shallow freshwater habitats where they feed on crayfish, insects, frogs, and small fish. Nesting takes place with other herons or in single species colonies (Sprunt, 1954). Flimsy nests are built 1 to 2 m over water in a variety of vegetation. The nesting season usually begins in March, and some little blues breed while still in white plumage during their first year (Bent, 1926).

The Louisiana heron is slightly taller and more slender than the little blue heron. The neck and upper body are dark blue and the under parts are white giving this heron its distinctive appearance. The Louisiana heron is found throughout freshwater wetlands in Florida, but is more commonly associated with estuarine habitats. Louisiana herons feed either singly or in large flocks with other waders, and their diet consists primarily of small fish. Nesting occurs in mixed species colonies, with a distinct preference for coastal estuarine sites. Louisiana herons are usually present in smaller numbers in inland colonies, building their nests in a variety of aquatic shrubs from March through the beginning of June (Sprunt, 1954). Nesting south Florida population was last estimated around 10,000 birds (Kushlan and White, 1977).

The great blue heron is the largest (1 m high) and most widely distributed of the North American herons. This species ranges almost continent-wide, from Florida through Alaska. The head of this heron is white with a black crown, the underparts are mostly a bluish-gray. The principal food for this species is fish, but it will also feed on insects, frogs, reptiles, and rodents (Palmer, 1962). It nests singly or in mixed colonies with other herons, and tall trees are the preferred nesting sites. Nesting may begin as early as November along the coast and in December-January inland. Due to their dark coloration and solitary habits, there are no reliable south Florida population estimates for either this species or the little blue herons.

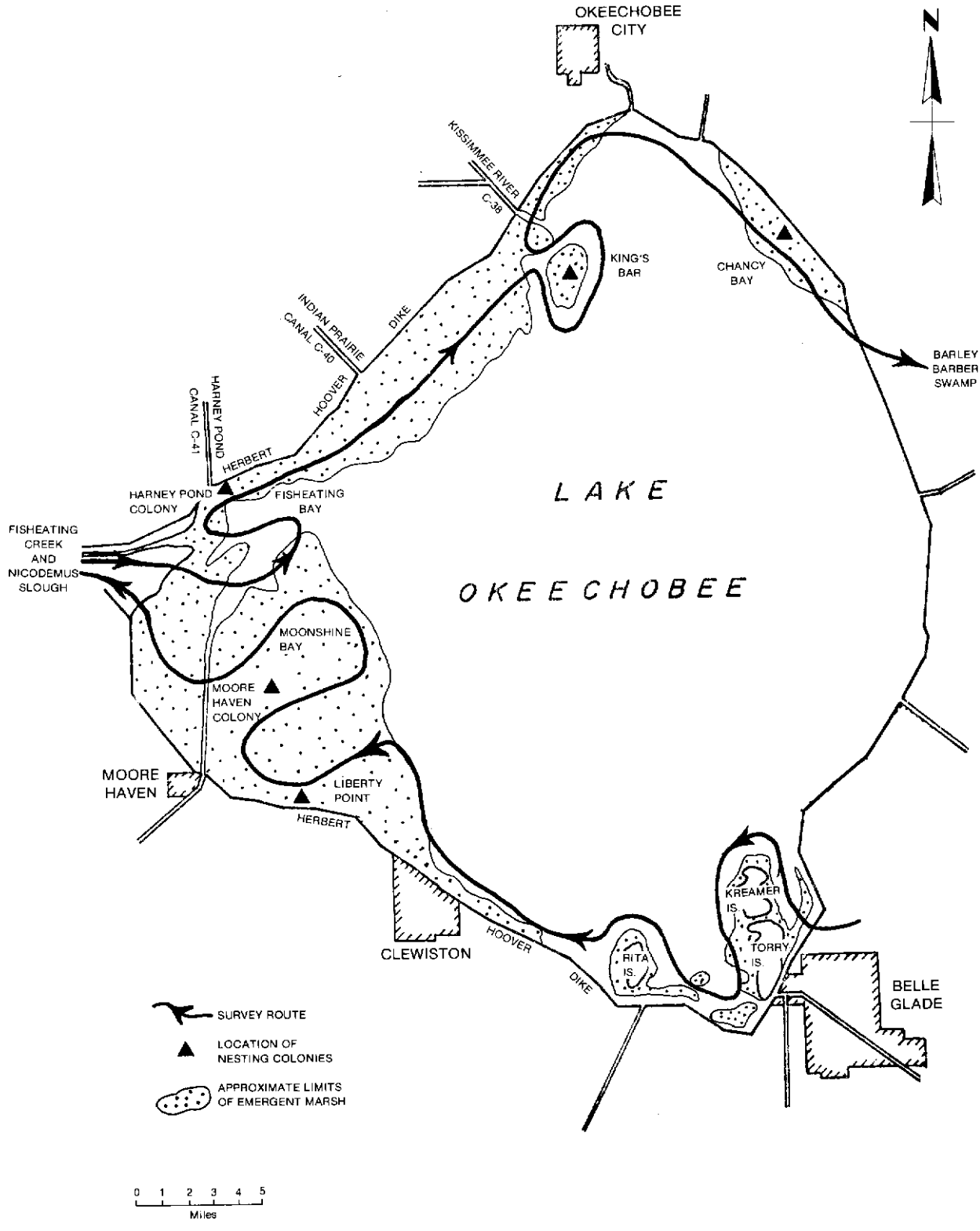
The roseate spoonbill is a tall bird standing about 80 cm high, with bright pink plumage, a flattened bill, and a bare, yellowish-green head. The juveniles are pale pink with feathered heads. Spoonbills feed primarily in coastal bays, mangrove swamps, brackish ponds, and freshwater marshes where concentrations of small fish and prawns occur (Odgen, 1978). Nesting

usually takes place in large mangrove trees in Florida Bay, but they were reported to have nested within Lake Okeechobee marshes in the early 1900's (Bent, 1926). The spoonbill is considered rare in Florida, with a limited distribution and a total stable population of 2000-2500 birds (Odgen, 1978).

METHODS

Wading birds within the Lake Okeechobee littoral zone were inventoried monthly from January 1977 through October 1981, except for June - September 1978. Birds were counted from a Bell jet ranger helicopter, flying the same general route beginning at the southeast corner of the lake (Figure 2). The entire marsh was surveyed up to Chancey Bay east of the Kissimmee River. Flights were also extended into the Nicodemus Slough-Fisheating Creek area to survey birds outside the lake. Barley Barber Swamp adjacent to the Florida Power and Light (FPL) Reservoir near the northeast shore was also checked for nesting activity of wood storks. Slight deviations from this flight path were made to circle observed accumulations of birds. Helicopter flights were generally conducted at an altitude of 75-80 meters. When nesting colonies were located they were circled once or twice. This depended on the colony size, nest distribution within the colony, and amount of disturbance created by the helicopter. Whenever possible, two experienced "bird counters" surveyed the area during each flight and collaborated on survey results. The location and composition of each flock of 12 or more birds was recorded on a vegetation map. Birds encountered were either classified as "feeding" when they were dispersed throughout the marsh foraging for food, or "nesting" when they were congregated into large groups or colonies where visible nests were present.

The six most conspicuous wading birds which were included in the total counts were white ibis, glossy ibis, great egrets, snowy egrets, cattle


OKEECHOBEE CITY
N
KISSIMMEE RIVER
C-38
KING'S BAR
CHANCY BAY
BARLEY BARBER SWAMP
INDIAN PRAIRIE CANAL C-40
DIKE
HOOVER
HARNEY POND CANAL C-41
HERBERT
HARNEY POND COLONY
FISHEATING BAY
FISHEATING CREEK AND NICODEMUS SLOUGH
LAKE OKEECHOBEE
MOONSHINE BAY
MOORE HAVEN COLONY
MOORE HAVEN
LIBERTY POINT
HERBERT
CLEWISTON
HOOVER
DIKE
KREAMER IS.
TORRY IS.
RITA IS.
BELLE GLADE
SURVEY ROUTE
LOCATION OF NESTING COLONIES
APPROXIMATE LIMITS OF EMERGENT MARSH
0 1 2 3 4 5
Miles

[redacted]

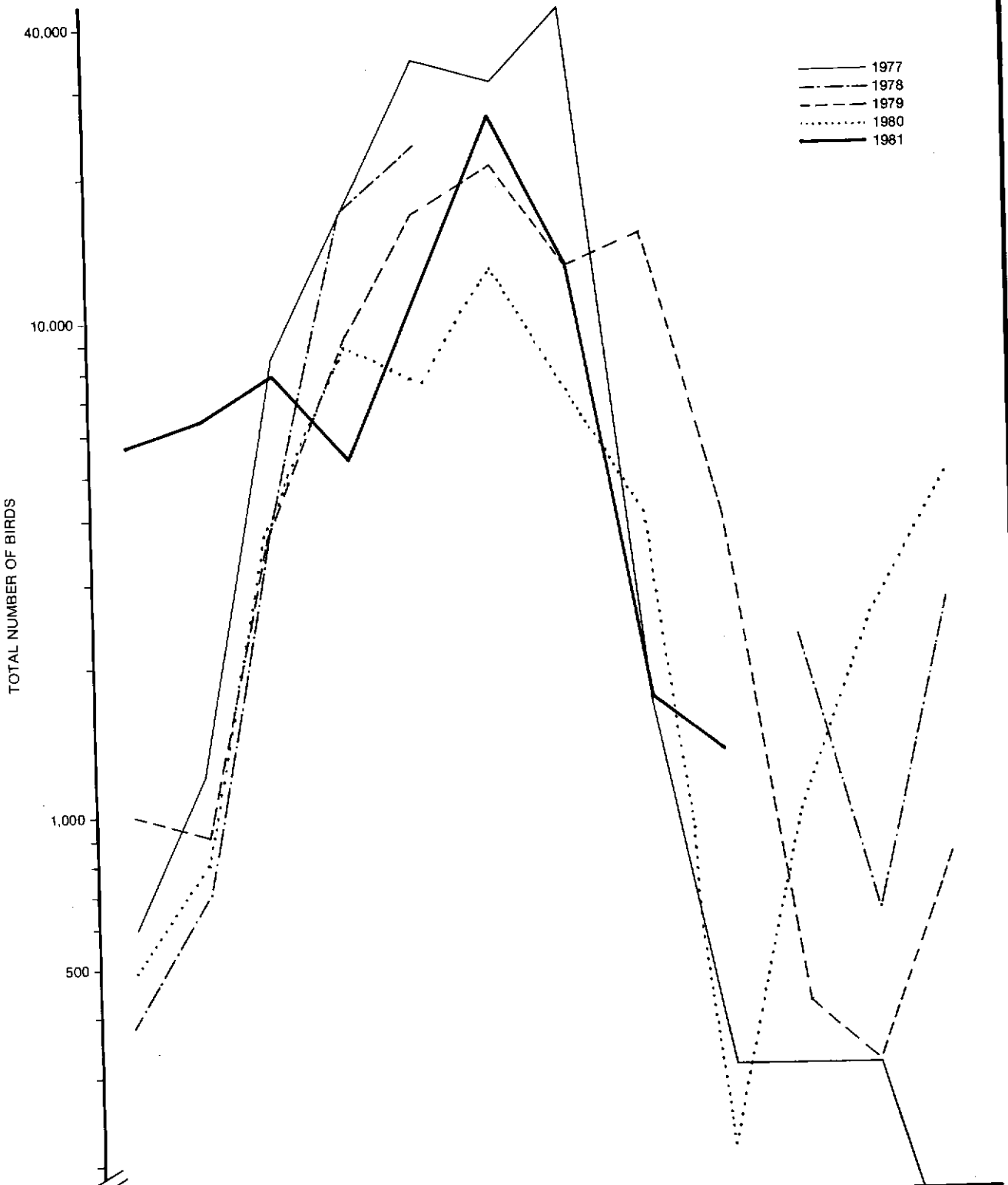
egrets, and wood storks. The three darker herons (little blue herons, great blue herons, and Louisiana herons) were less obvious from the air so counts on these species were less accurate, particularly in nesting colonies. Presence of roseate spoonbills was also noted, but these birds appeared on the lake only occasionally.

RESULTS AND DISCUSSION

GENERAL TRENDS

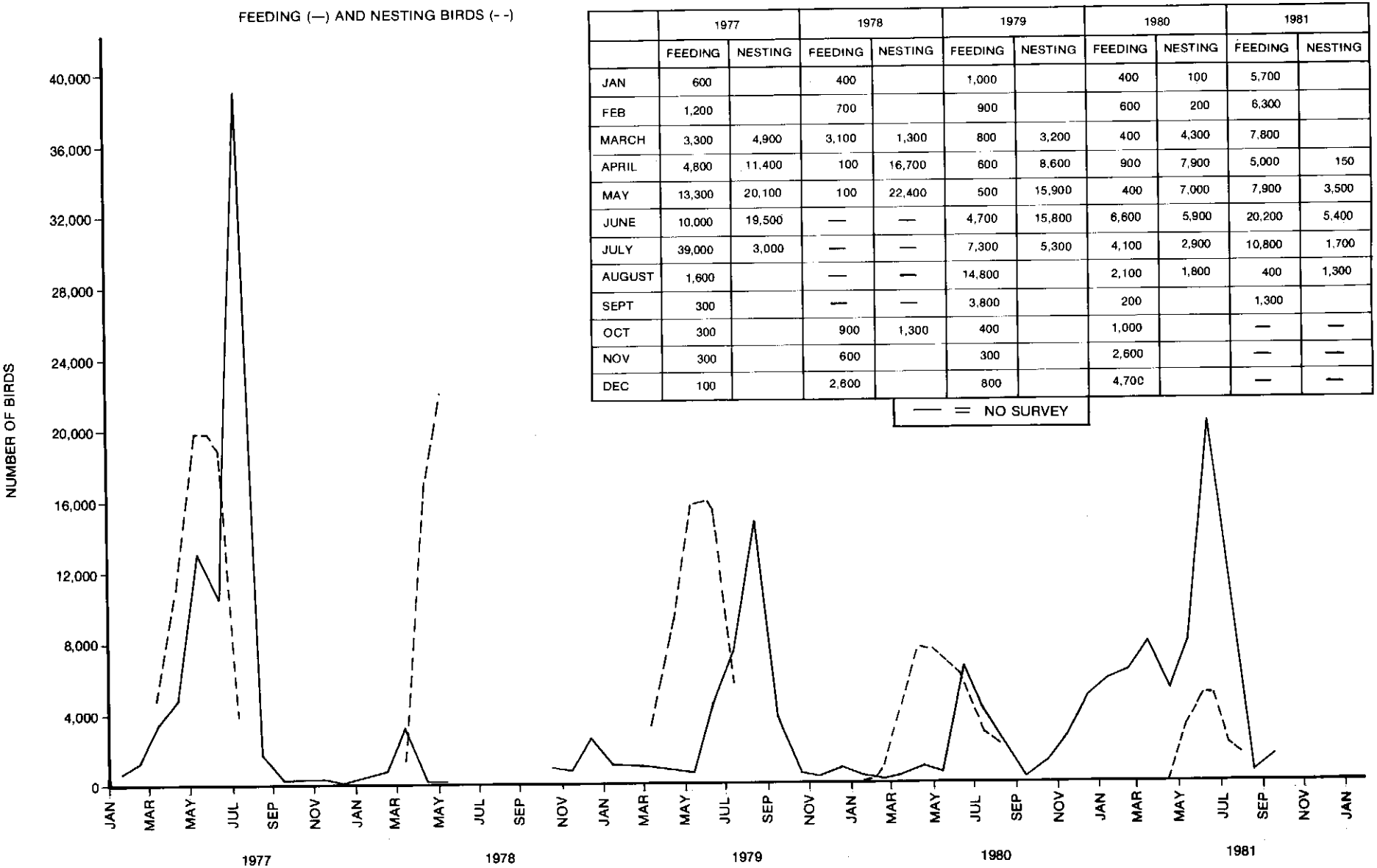
The occurrence of wading birds within the marsh followed a distinct seasonal pattern, with the fewest birds occurring during the fall and winter months (October-February), followed by gradual increases in early spring, with maximum numbers occurring during May-July. Counts declined sharply during the late summer months (August, September). Figure 3 illustrates these seasonal trends in wading bird abundance within the lake littoral zone. Total numbers of wading birds counted within the marsh during any month ranged from 42,000 birds (July 1977) to 100 birds (December 1977). With the exception of 1980, annual maximum counts exceeded 20,000, with the highest numbers being recorded during the months of May, June, and July.

Birds encountered on Lake Okeechobee survey trips were either classified as feeding or nesting. Figure 4 provides the total numbers of birds divided into either activity. Nesting activity generally began in March with peak activity occurring in May and June. Dispersal began in July and nesting activity was generally completed by August. Peak numbers of feeding birds did not always coincide with peak nesting periods. Observed peak feeding periods usually lagged one or two months behind the peak nesting period. An exception occurred in 1981, when both activities peaked within the same months.



	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1977	600	1,200	8,200	16,200	33,400	24,400	42,000	1,600	300	300	300	100
1978	400	700	4,400	16,800	22,500	—	—	—	—	2,200	600	2,600
1979	1000	900	4,000	9,200	16,400	20,500	12,600	14,800	3,800	400	300	800
1980	500	800	4,600	8,700	7,400	12,500	7,000	3,800	200	1,000	2,600	4,700
1981	5,700	6,300	7,800	5,200	11,400	25,500	12,500	1,700	1,300	—	—	—

Figure 3 SEASONAL TRENDS OF TOTAL WADING BIRD UTILIZATION OF LAKE OKEECHOBEE 1977 - 1981



	1977		1978		1979		1980		1981	
	FEEDING	NESTING	FEEDING	NESTING	FEEDING	NESTING	FEEDING	NESTING	FEEDING	NESTING
JAN	600		400		1,000		400	100	5,700	
FEB	1,200		700		900		600	200	6,300	
MARCH	3,300	4,900	3,100	1,300	800	3,200	400	4,300	7,800	
APRIL	4,800	11,400	100	16,700	600	8,600	900	7,900	5,000	150
MAY	13,300	20,100	100	22,400	500	15,900	400	7,000	7,900	3,500
JUNE	10,000	19,500	—	—	4,700	15,800	6,600	5,900	20,200	5,400
JULY	39,000	3,000	—	—	7,300	5,300	4,100	2,900	10,800	1,700
AUGUST	1,600		—	—	14,800		2,100	1,800	400	1,300
SEPT	300		—	—	3,800		200		1,300	
OCT	300		900	1,300	400		1,000		—	—
NOV	300		600		300		2,600		—	—
DEC	100		2,600		800		4,700		—	—

— = NO SURVEY

Figure 4 DIVISION OF WADING BIRDS BY FEEDING AND NESTING ACTIVITIES IN LAKE OKEECHOBEE, 1977 - 1981

The years 1977 and 1978 were the most favorable for wading bird nesting on Lake Okeechobee. A maximum of 20,100 nesting birds were recorded in May 1977 and a maximum of 22,400 birds were recorded in May 1978. Peak nesting months in other years occurred in May 1979 (15,900), April 1980 (7900), and June 1981 (5400). The peak number of nesting birds usually lasted for about two months, spanning April through June, as late nesting species replaced early nesters in the counts.

The years of 1977, 1979, and 1981 were the most productive in terms of wading bird feeding utilization of the littoral zone. During 1977 the peak number of feeding birds reached 39,000 in July, the highest number observed during the study period. Feeding activity was also relatively high in 1979, reaching a maximum of 14,800 in August. Feeding utilization remained high throughout most of the months surveyed in 1981, and 20,200 birds were counted in June. In contrast, relatively low numbers of feeding birds were observed in March 1978 (3100) and June 1980 (6600). Through the typical nesting period of March-July, the percentage of birds feeding, compared to the total birds counted, varied considerably ranging from a low of 8% in 1978 to a high of 83% in 1981.

In summary, Lake Okeechobee marshes were heavily utilized in 1977 for both nesting and feeding; the years of 1978 and early 1979 were successful periods for wading bird nesting; while late summer 1979 provided high feeding utilization. Lake Okeechobee was not utilized substantially as a nesting or feeding resource by wading birds in 1980, whereas 1981 was typified by intensive feeding use but low nesting activity.

Water levels and rates of recession and/or reflooding of Lake Okeechobee marshes have a major effect on wading bird utilization. Successful feeding conditions require receding lake stages below 15.0 ft msl to concentrate forage organisms. These stages provide sufficient marsh habitat with water

shallow enough to enable wading birds to feed. A major prerequisite for successful wading bird nesting is that the ground beneath the colony during the nesting period be flooded (March-July), or that the colony be formed on an island to provide protection from predators (Heard, 1976). Of equal importance is the availability of favorable feeding conditions in Lake Okeechobee or nearby marshes.

Figure 5 shows stage hydrographs for Lake Okeechobee for the five years the surveys were conducted. The years 1977, 1980, and 1981 were typified by gradual and consistent water level reductions during late spring and early summer months. Of these three years, 1977 and 1981 provided the best feeding conditions because water levels were lower and a much larger area of marsh was exposed. Although 1980 stages declined from 16.5 to 14.9 ft msl during April, May, and June, this recession was insufficient to dry all but the highest marshes and did little to concentrate forage.

Gradually declining water levels during the spring of 1979 were interrupted by a rapid rise in lake stage of almost 0.5 ft between April and May due to a tropical depression. As a result, the concentration of forage organisms within the marsh was disrupted and could not support extensive wading bird feeding activities. Subsequent declines in water levels from June-August 1979 to 14.25 ft msl were accompanied by an increase in feeding birds to a maximum of 14,800 birds in August 1979. Although wading bird counts for the summer of 1978 are incomplete, it is doubtful that any substantial feeding activity occurred. Only 100 birds were feeding in April and May, and the hydrograph shows lake stages remained relatively stable until mid-July, at which point levels increased nearly two feet.

The most successful nesting years generally coincided with moderate to high lake stages, (between 13 and 16 ft msl) capable of flooding the ground beneath the colonies (1977, 1978 and 1979). Nesting activity was minimal

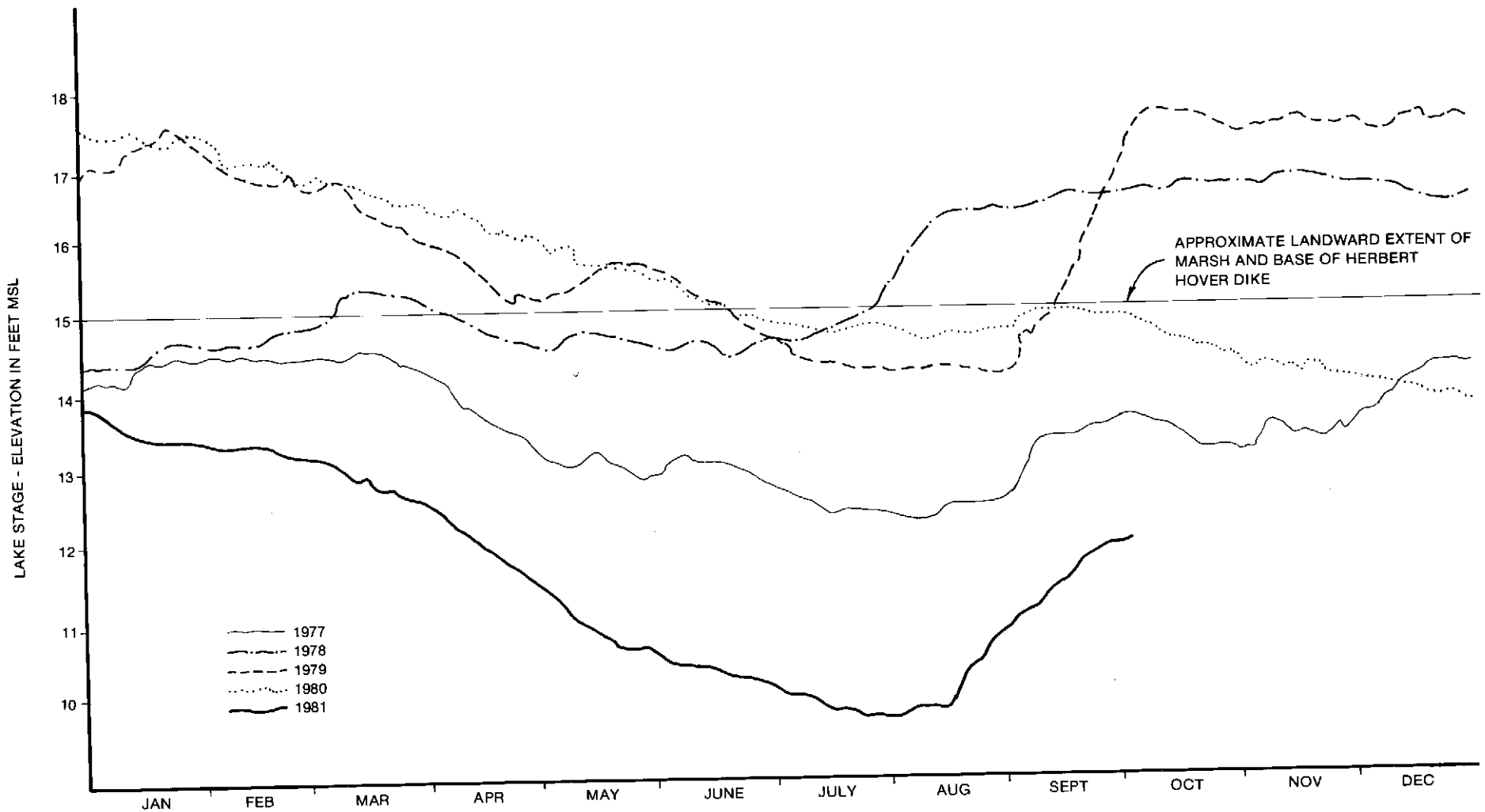


Figure 5 LAKE OKEECHOBEE STAGE HYDROGRAPHS FOR WADING BIRD SURVEY PERIOD, 1977- 1981

during 1981 when stages fell to record lows. Water levels during 1980 were suitable for the establishment of nesting colonies in Lake Okeechobee, but little nesting was recorded. A 3.5 ft increase in lake stages in late 1979 and subsequent high stages in early 1980 were indicative of high water conditions throughout south Florida. This probably impeded the development of appropriate feeding conditions in the vicinity of Lake Okeechobee which is necessary to support nesting. Nesting success was poorest during the extended low lake stages in 1981 which dried most of the nesting colonies.

MAJOR SPECIES COMPOSITION AND TRENDS

To facilitate comparisons of yearly trends in wading bird utilization of Lake Okeechobee marshes, total annual observations were used. This figure is the sum of monthly counts and does not represent the actual number of birds on the lake during any given year. White ibis were the most numerous birds of the major species surveyed over the entire study period, with a maximum total annual count of 62,000 in 1977. White ibis were least abundant during 1978 and 1980. This species was found on the lake every month of the study period except for December 1977, September 1979, and August and September 1981. The white ibis was the second most abundant nesting bird, forming colonies every year except 1981; over 3000 nesting pairs were observed on two occasions.

The second most abundant species utilizing the marshes was the cattle egret, with a maximum total annual count of nearly 43,000 in 1979. Cattle egrets were generally present in greater numbers during the latter part of the peak utilization period (May-July), and were absent or present only in small numbers during fall and winter months. They were the most abundant nesting birds on the lake, with a maximum of 10,000 pairs present during May 1978. Cattle egrets nested every year of the survey, and at times outnumbered

all other species combined, particularly during the latter part of the nesting season.

Great egrets ranked third in overall numbers, with a maximum total annual count of 26,000 birds in 1977. They were present in greater numbers during March through July and were present in the marsh during the entire period except for three months of 1977. Great egrets nested every year of the survey, with a maximum of 3200 pairs observed in April 1978. Only minimal nesting occurred during 1981.

Snowy egrets followed in abundance with a maximum total annual count of 9500 in 1977. Snowies were found in the greatest numbers between April and July, but were frequently absent during high lake stage periods. Snowy egrets nested only in small numbers (less than 100 pairs in 1978 and 1981), and did not exceed 500 nesting pairs in any of the months surveyed.

Wood storks were slightly more numerous than glossy ibis and were present every year of the study period except for the first year of increasing lake stages (1978). They were most numerous during 1981, with a maximum total annual count of 4400 birds. Wood storks did not nest within the Lake Okeechobee littoral zone.

Glossy ibis were the least encountered bird during the five year survey period. They were most abundant in 1981, with a maximum total annual count of 4300 birds in 1981. They were observed on only two occasions in 1978 and were present throughout 1980 and most of 1981. Glossies nested on two occasions during the survey, in May 1977 and May 1979. Total monthly counts for all species are presented in Table 1.

FEEDING ACTIVITY WITHIN VEGETATION COMMUNITIES

Wading bird feeding occurred primarily in three vegetation communities within the littoral zone: beakrush (Rhynchospora tracyi) wet prairie,

TABLE 1. TOTAL MONTHLY AND ANNUAL COUNTS OF WADING BIRDS BY SPECIES 1977-1981.

	GREAT EGRET				
	1977	1978	1979	1980	1981
January		35	316	395	879
February	138	173	502	475	933
March	2599	1875	239	1335	1507
April	4315	6512	1381	1685	1790
May	2844	1100	1741	990	1958
June	2662	-	3240	2090	3787
July	13,210	-	1500	812	2185
August		-	3520	1148	148
September	89	-	142	119	313
October		175	216	219	-
November	28	202	204	801	-
December	45	1298	577	879	-
Total*	25,930	11,370	13,578	10,948	13,500

	CATTLE EGRET				
	1977	1978	1979	1980	1981
January	37	192	75		
February			40		50
March	280	15	1025	100	
April	1315	4100	3445	3520	
May	14,598	20,200	9412	4975	4475
June	13,775	-	14,560	4990	5000
July	1285	-	6095	2203	1755
August	1025	-	4380	1770	1370
September	45	-	3636	42	993
October	220	1592	145		-
November					-
December	50	375	12		-
Total*	32,630	26,494	42,825	17,600	13,643

TABLE 1. TOTAL MONTHLY AND ANNUAL COUNTS OF WADING BIRDS BY SPECIES 1977-1981 (Con't).

	SNOWY EGRET				
	1977	1978	1979	1980	1981
January	14		480	20	20
February	105	49	205		1340
March	606	72	512	152	1008
April	1500		282	942	50
May	90	100	625	500	1364
June	1258	-	745	1210	3145
July	5622	-		666	1055
August	320	-		145	137
September		-	20		32
October		322	20	60	-
November		362	37	175	-
December		827	50	137	-
Total*	9515	1732	2976	4007	8151

	WHITE IBIS				
	1977	1978	1979	1980	1981
January	475	144	45	25	3175
February	738	482	62	229	2057
March	4351	2267	2120	3040	3236
April	8905	6160	4085	2508	2350
May	15,090	1050	4150	860	3119
June	11,521	-	1780	3770	12,860
July	20,525	-	4245	2936	6640
August	276	-	5825	590	
September	137	-		20	
October	10	87	22	561	-
November	283		105	686	-
December		75	120	1749	-
Total*	62,311	10,265	22,559	16,974	33,437

TABLE 1. TOTAL MONTHLY AND ANNUAL COUNTS OF WADING BIRDS BY SPECIES 1977-1981 (Con't).

	GLOSSY IBIS				
	1977	1978	1979	1980	1981
January	45		65	25	817
February	172	30	55	115	915
March	334	156	131	20	1155
April	165		25	67	475
May	772		430	52	262
June	225	-	25	425	390
July		-	175	200	270
August		-	355	50	
September		-		15	
October	20		5	115	-
November				179	-
December			85	550	-
Total*	1733	186	1351	1813	4284

	WOODSTORK				
	1977	1978	1979	1980	1981
January					761
February					1050
March					890
April					530
May	6				200
June	415	-	150		350
July	1390	-	540	185	600
August		-	756	100	
September		-			
October					-
November	20			760	-
December				1407	-
Total*	1831		1446	2452	4381

*Annual total count represents the sum of monthly counts rather than individual birds.

- = Months not surveyed

blank = species not observed

spikerush (Eleocharis cellulosa) sloughs, and the mixed grasses zone (composed mainly of Panicum repens, Spartina bakeri, and Panicum hemitomon). During moderate to low lake stages, spikerush and beakrush communities provided most of the feeding habitat. In 1977, these two communities were utilized by 63% of the feeding birds. During 1978 when stages were high and rising, the mixed grasses provided feeding habitat for 76% of the observed feeding birds. No feeding was observed in spikerush sloughs and only 4% utilization was recorded for beakrush wet prairies. In 1979 and 1980, lake stages remained high and the mixed grass community provided nearly half of the total feeding habitat, while the remaining feeding birds were found within the agricultural islands and beakrush-wet prairies. During 1981, large numbers of feeding birds remained on the lake, following receding water levels in various plant communities. In addition to substantial use of beakrush (14%) and spikerush (26%) communities, submergent vegetation zones accounted for 26% of the feeding use (Table 2).

Wading bird species distribution within vegetation communities showed some trends. Wood stork feeding occurred predominately in beakrush wet prairies and spikerush sloughs. Wood storks were observed in these two communities 73% of the time during the survey period. The spikerush and beakrush communities also supported between 40% and 49% of the total feeding activity of great egrets, snowy egrets, and ibis over the study period. Cattle egrets only fed in these two communities 8% of the time. The third most utilized feeding habitat was the mixed grass community which supported between 17% and 26% of the feeding activity of the great egret, white ibis, and snowy egret. The cattle egret (which is primarily a terrestrial feeder) did not follow the same feeding patterns as the other species and were mainly confined to the mixed grasses (50%) and the agricultural islands (27%) during periods when they were dry. Total distribution of the major species within the feeding communities is provided in Appendix I.

TABLE 2. DISTRIBUTION OF FEEDING BIRDS IN LAKE OKEECHOBEE LITTORAL ZONE PLANT COMMUNITIES. FREQUENCY OF UTILIZATION.

PLANT COMMUNITIES	Optimum Elevation* (ft msl)	% OF TOTAL POPULATION				
		1977	1978	1979	1980	1981
Bulrush	10.1-10.6		0.3			1.4
Spikerush	10.6-12.4	38.1			1.0	26.0
Cattail	12.4-13.1	11.4	4.1	0.2	1.2	0.5
Willow	13.2-14.3	8.7	5.9	5.5	7.7	20.7
Beakrush	13.1-14.6	25.3	4.3	22.3	37.1	14.4
Mixed Grass	13.1-15+	15.0	76.2	47.7	44.4	0.5
Submergents	10.0	0.1				25.9
Buttonbush	Not determined	0.3	0.2	1.3		0.5
Water Lily	Not determined	0.1				2.0
Agricultural Islands	13.0-16+	1.1	9.2	23.0	8.7	8.1

*Optimum Elevation Ranges from Pesnell and Brown (1977)

NESTING ACTIVITIES

The four major nesting sites used during the 1977-81 study period are shown in Figure 2. King's Bar is a large island located southeast of the mouth of the Kissimmee River. The Liberty Point site is situated between Moore Haven and Observation Island. The Moore Haven site is located approximately 8 km northeast of Moore Haven and the Harney Pond colony formed near the Rim Canal in northern Fisheating Bay, just east of the Harney Pond Canal. Each site consisted primarily of willow surrounded by cattail.

King's Bar was the largest and most consistently used nesting colony site on the lake. Nesting birds have used this site consistently since the 1940's (Ogden, 1978). King's Bar was utilized during each of the five study years, and included a maximum of 8000 nesting pairs, including white and glossy ibis, snowy egrets, great egrets, and cattle egrets. Other species which also nested at this site, but not included in the counts were great blue herons, little blue herons, Louisiana herons, and night herons.

The other major sites were not utilized for nesting every year and supported fewer birds than King's Bar. The Moore Haven site was used primarily by cattle egrets and American egrets during 1977-79. Cattle egrets dominated the Harney Pond site during 1978-80, while great egrets and snowy egrets also nested there in 1980. A colony composed primarily of cattle egrets and occasionally great egrets, snowy egrets, and white ibis formed at Liberty Point in 1977, 1979, and 1980. A small colony of 300 to 400 pairs of cattle egrets formed in the northeast part of the lake near Chancey Bay during 1979 and 1980. Appendix II provides detailed counts from each of the colonies.

Several small, scattered nesting sites occasionally appeared throughout the southwest marsh. In 1981, a drought year, nesting activity was very low and King's Bar formed the only active major nesting colony. During this

year, while most of the major colony sites were dry, numerous smaller nesting sites with a total of 450 pairs of cattle and snowy egrets formed in willows on spoil islands in Fisheating Bay.

Great egrets were generally the first species to begin nesting in the marsh, with scattered nesting starts as early as January in some years and peak numbers occurring in March and April. White ibis peak nesting usually occurred in April and May, while cattle egret nesting peaked in May and June, with some nesting extending into August in 1980 and 1981. Snowy egrets did not exhibit a discernible nesting pattern during the study period, while glossy ibis were observed to nest only twice, during May 1977 and May 1979.

Table 3 provides a summary of nesting activity on Lake Okeechobee for each species during the study period. The most abundant nesting birds on Lake Okeechobee were cattle egrets, with a maximum of 10,100 nesting pairs recorded in May 1978. During some months nesting cattle egrets outnumbered all other species combined, particularly during the latter part of the nesting season. Throughout the study period cattle egrets accounted for 60% of the total nesting observations on the lake. White ibis were the second most abundant nesting bird, with a maximum of 3050 pairs nesting in April 1978. White ibis nested on the lake every year except 1981, and accounted for 23% of the total nesting observations. Great egrets nested on the lake throughout the study period, with 1977 and 1978 providing the most successful nesting years. A maximum of 3250 nesting pairs were counted in April 1978, and great egrets accounted for 13% of the total nesting observations. Snowy egrets and glossy ibis were the least abundant of the species surveyed to nest in Lake Okeechobee, collectively accounting for 4.5% of the nesting observations during the study period. Glossy ibis nested in low numbers during 1977 and 1979, and snowy egret nesting was most successful in April 1977 with a total of 750 pairs.

TABLE 3. TOTAL MONTHLY AND ANNUAL COUNTS OF NESTING WADING BIRD PAIRS IN LAKE OKEECHOBEE, 1977-1981.

	GREAT EGRET				
	1977	1978	1979	1980	1981
March	1153	650	50	525	
April	2000	3250	606	608	75
May	520	550	802	425	50
June	10	-	200	305	100
July		-	25	137	
August		-			
Total	3683	4450	1683	2000	225

	SNOWY EGRET				
	1977	1978	1979	1980	1981
March	300		50	70	
April	750		50	400	
May		50	225	250	95
June	20	-	300	300	75
July	500	-		250	50
August		-		25	50
Total	1570	50	625	1295	270

	CATTLE EGRET				
	1977	1978	1979	1980	1981
March			500	50	
April	600	2050	1640	1700	
May	7100	10,100	4700	2480	1400
June	6700	-	7000	2310	2500
July	500	-	2625	1050	800
August		-		850	600
Total	14,900	12,150	16,465	8440	5300

TABLE 3. TOTAL MONTHLY AND ANNUAL COUNTS OF NESTING WADING BIRD PAIRS IN LAKE OKEECHOBEE, 1977-1981 (Con't).

	WHITE IBIS				
	1977	1978	1979	1980	1981
March	1000		1000	1500	
April	2360	3050	2000	1225	
May	2220	500	2000	325	
June	3000	-	400	50	
July	500	-			
August		-			
Total	9080	3550	5400	3100	

	GLOSSY IBIS				
	1977	1978	1979	1980	1981
March					
April					
May	200		200		
June		-			
July		-			
August		-			
Total	200		200		

- = Months not surveyed

blank = species not observed

Peak nesting periods did not generally coincide with increased feeding activity in Lake Okeechobee marshes. During March-June 1977, nesting birds comprised 63% of the total number of birds observed on the Lake, while 99% of the birds counted in April and May 1978 were nesting. In the peak nesting period of April - June 1979, 87% of the total birds observed were nesting in April - July, and in 1980 the nesting-total bird ratio decreased to 72%. Only during the exceptionally dry year of 1981, the least successful nesting year, was the proportion of feeding birds (79%) greater than nesting (21%) during the peak nesting period.

It must be noted that nesting observations do not necessarily reflect nesting success for any particular year. Due to the infrequency of the aerial surveys, the duration of the nesting cycle, and staggering of nesting by individual birds within a species, it was not possible to determine the total number of nesting successes or failures which occurred during any particular season. The data presented provides relative frequency of nesting observations.

OTHER AREAS SURVEYED

Fisheating Creek floodplain and Nicodemus Slough provided seasonal wetland habitat adjacent to Lake Okeechobee which, during some months, supported considerable numbers of wading birds. While no significant nesting activity was observed in the area, feeding activity at times surpassed that of Lake Okeechobee marshes. Wading bird occurrences in the Fisheating Creek-Nicodemus Slough floodplain during the study period are shown in Figure 6. Comparison of this data with the information in Figure 4 indicates that these seasonal marshes provide important feeding habitat during periods of high or increasing lake stages on Lake Okeechobee.

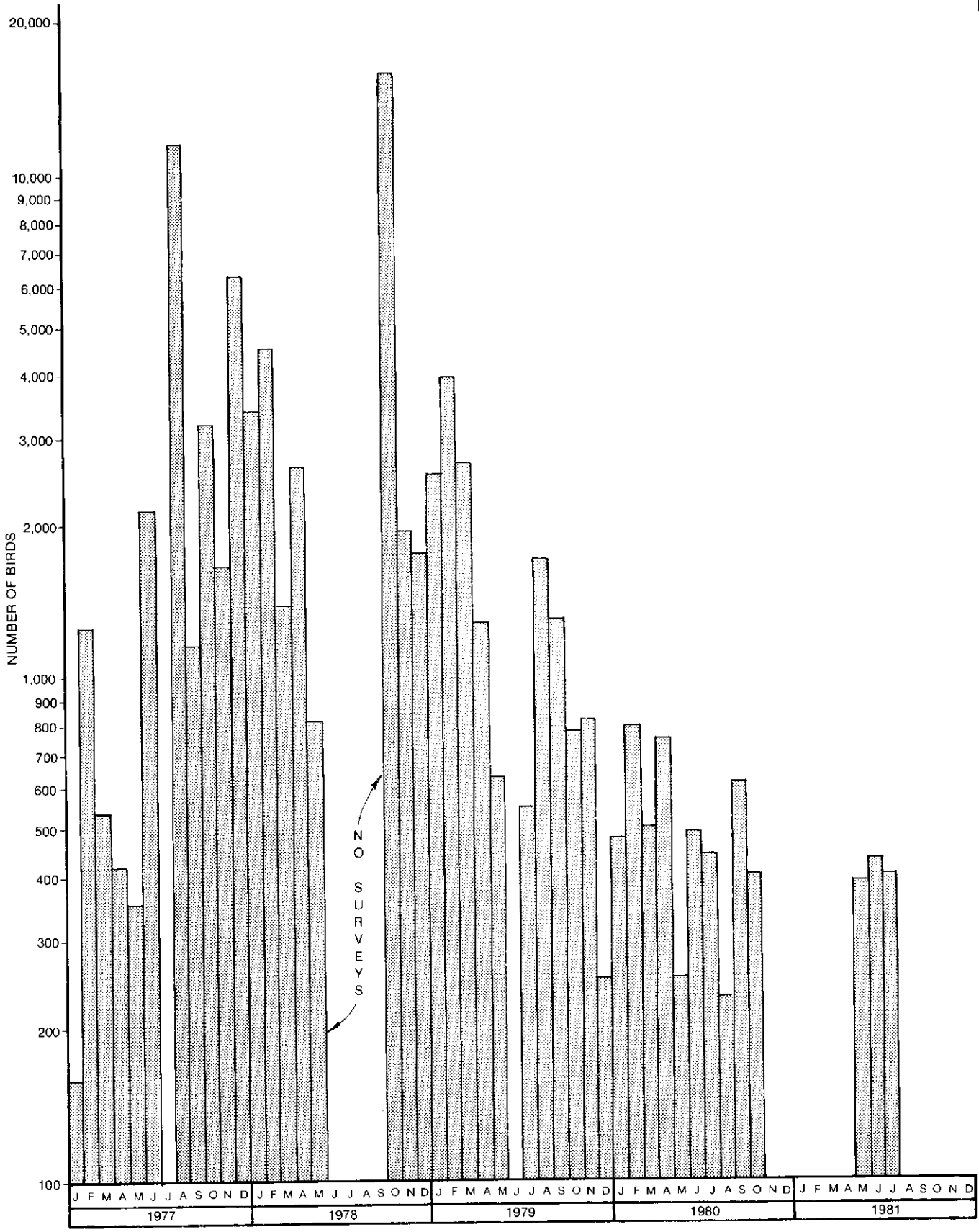


Figure 6 WADING BIRD UTILIZATION OF FISHEATING CREEK-NICODEMUS SLOUGH FOR FEEDING, 1977 - 1981

High wading bird utilization in Fisheating Creek-Nicodemus Slough marshes, from August 1977 (11,500 birds) through May 1978, coincided with increasing stages in the lake and the first year of high stages following the implementation of the 15.5-17.5 regulation schedule. During this ten month period, a total of 36,400 bird observations were made in this area, whereas only 7000 feeding birds were counted on Lake Okeechobee during the same period.

High feeding utilization of the Fisheating Creek-Nicodemus Slough area continued with the resumption of the surveys in October 1978 (11,400 birds). This may indicate that these marshes provided important feeding habitat for birds nesting in Lake Okeechobee in 1978. In 1979 feeding birds remained relatively active in this area during the first part of the year while lake stages were high, but numbers decreased during the rest of the year. During the following two years, 1980 and 1981, feeding activity in the Fisheating Creek-Nicodemus Slough area was minimal, probably due to high water conditions in 1980 followed by a severe drought in 1981, both of which created unfavorable feeding conditions.

In summary, these adjacent wetland areas provided feeding habitat for wading birds when Lake Okeechobee conditions were unfavorable. Fisheating Creek-Nicodemus Slough may serve as an indicator of overall conditions in surrounding south Florida wetlands, and may support extensive wading bird nesting and post-nesting activities from Lake Okeechobee.

Nesting activity by wood storks in Barley Barber Swamp, a few miles east of Chancey Bay and adjacent to the FPL Reservior was also monitored. There was no observed nesting at this site during 1977 and 1978. In April 1979, 200 pairs of wood storks began nesting in the larger cypress trees within the center of the swamp. The following month there were approximately 250 nests that remained active until July. In 1980, 100 to 120 wood stork

pairs began nesting in late March and these nests remained active through July. The Barley Barber Swamp cypress were also utilized by roosting wood storks, particularly following the FPL dike collapse in late 1979. Wood storks remained in the swamp from November through the 1980 nesting season, and were observed feeding in remaining ponds within the reservior.

Feeding conditions within the Lake Okeechobee littoral zone did not appear to be a crucial factor to nesting success in the Barley Barber Colony. The two successful nesting years, 1979 and 1980, were typified by high lake stages, but there was some late summer wood stork feeding during both years. Wood stork nesting in Barley Barber and feeding presence on the lake were only concurrent during the last month of the nesting period (June 1979 and July 1980). During peak feeding periods in Lake Okeechobee, (summer 1977, November and December 1980, and spring through summer 1981), wood storks did not nest in Barley Barber Swamp.

SUMMARY AND CONCLUSIONS

Lake Okeechobee marshes provide a significant resource for feeding and nesting activities of wading birds in south Florida. A five year wading bird inventory documenting utilization of the lake marshes was undertaken from 1977 through 1981 during a wide range of water level regimes. Six species of birds were included in the aerial inventories: great egrets, snowy egrets, cattle egrets, white ibis, glossy ibis, and wood storks.

South Florida wading bird activity is synchronized with historical hydrologic patterns. The occurrence of large numbers of wading birds coincides with the gradual decline of water levels in area marshes, which concentrates aquatic organisms thereby providing ideal feeding conditions. Lake Okeechobee wading bird activity was generally low during fall and winter months, dramatically increasing during early spring, and followed by a peak

in late spring and early summer as other interior wetland areas dried. The maximum utilization period generally occurred from March through July.

A maximum of 42,000 birds were counted on the lake in July 1977, and during each of the other survey years, except 1980, maximum monthly counts exceeded 20,000 birds. Wading birds on the lake were classified as either feeding or nesting. White ibis were the most abundant wading birds observed during the study period and regularly used lake marshes for both feeding and nesting. Nearly 20,000 white ibis were observed feeding in Lake Okeechobee in July 1977, while over 6000 nesting ibis were counted on several occasions. The second most abundant birds during the survey were cattle egrets, which used the lake primarily for nesting purposes. Great egrets were present regularly, with maximum counts exceeding 2000 birds each year. Snowy egrets and wood storks were present with less regularity and occasionally exceeded 1000 birds in a survey. Glossy ibis were the least abundant of the major species counted. Great blue herons, little blue herons, Louisiana herons, night herons and roseate spoonbills were observed but not counted.

Feeding in the lake marshes was greatest during 1977, 1979, and 1981, while nesting observations were highest in 1977 and 1978. High feeding activity coincided with gradually declining lake stages below 15.0 ft msl between March and July. Wading bird nesting required lake stages above 13.0 ft msl sufficient to inundate the ground beneath willows within nesting sites, and provide protection from predators. Nesting occurred on lake islands such as Kings Bar and Fisheating Bay spoil islands, even during lower water years. Wading bird nesting on Lake Okeechobee can also be successful during periods of unfavorable lake feeding conditions if suitable feeding habitat is available in nearby marshes. Fisheating Creek-Nicodemus Slough floodplain apparently provided suitable feeding habitat during late 1977 and 1978 when lake feeding was negligible.

Use of Lake Okeechobee marshes by large accumulations of wading birds for feeding is dependent on the occurrence of declining lake stages which dry marshland and concentrate aquatic organisms. Because the lake marshes generally lie below 15 ft msl, adherence to the present 15.5-17.5 msl regulation schedule will not be conducive to formation of favorable feeding conditions.

In light of the rapid decline of wading bird populations in south Florida resulting from wetland drainage and altered hydroperiods, the Lake Okeechobee marshes provide essential feeding and nesting habitat that may be crucial for long term maintenance of several wading bird species. Extended high lake stages would be detrimental to the viability of major vegetation communities which need periodic drying for marsh regeneration. The long term inundation tolerance of spikerush and beakrush communities is 2-3 years at two feet (Givens, 1956). These extensive communities provide a considerable percentage of the feeding habitat. The willow community, which provided all major nesting during the five year study period, has a long term inundation tolerance of five years at two foot depths (Givens, 1956). A periodic reduction of lake levels to at least 13 ft msl is essential for long term maintenance of the willow community, and continued availability of nesting habitat for wading birds. Periodic stage level reductions will also ensure long term viability of the marsh ecosystem, thereby maintaining its potential for supporting large numbers of feeding birds.

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APPENDIX I. SPECIES DISTRIBUTION WITHIN FEEDING COMMUNITIES.

WHITE IBIS

	1977	1978	1979	1980	1981	Total
Bulrush		22			612	634
Spikerush	14,321			55	6818	21,194
Cattail	6072	161	20	266	155	6674
Willow	3811	109		1271	7642	12,833
Wet Prairie	12,674	225	4450	3963	3460	24,772
Grass	6837	2573	3694	4302	220	17,626
Buttonbush	135		225		330	690
Waterlily					595	595
Wire Cord Grass				100		100
Submergents					11,315	11,315
Other	301	75	3370	817	1890	6453

GLOSSY IBIS

	1977	1978	1979	1980	1981	Total
Bulrush						
Spikerush	30			90	1507	1627
Cattail	120				95	215
Willow	76		125	100	675	976
Wet Prairie	417		200	670	1330	2617
Grass	631	165	245	706	20	1767
Buttonbush	19					19
Waterlily					30	30
Wire Cord Grass				30		30
Submergents					475	475
Other	40	21	381	217	152	811

GREAT EGRET

	1977	1978	1979	1980	1981	Total
Bulrush					82	82
Spikerush	9770			80	4538	14,388
Cattail	1885	142	45		33	2105
Willow	1670	76	434	319	2148	4647
Wet Prairie	3612	134	2362	2357	2192	10,657
Grass	1469	2001	6524	3457	20	13,471
Buttonbush	15	15				30
Waterlily	44				330	374
Wire Cord Grass	12		5	69		86
Submergents	25				2977	3002
Other	62	102	847	454	730	2195

APPENDIX I. SPECIES DISTRIBUTION WITHIN FEEDING COMMUNITIES (Con't).

CATTLE EGRET

	1977	1978	1979	1980	1981	Total
Bulrush		22			105	105
Spikerush					1145	1145
Cattail	375			12		387
Willow	556	184	1431	30	50	2251
Wet Prairie	176			40		216
Grass	1431	770	5787	593		8581
Buttonbush	18					18
Waterlily						
Wire Cord Grass					50	50
Submergents						
Other	274	40	2677	45	1693	4729

SNOWY EGRET

	1977	1978	1979	1980	1981	Total
Bulrush					129	129
Spikerush	3650			12	1987	5649
Cattail	118	37	15		25	195
Willow	310	122		105	2680	3217
Wet Prairie	1308		40	46	555	2049
Grass	860	892	602	972		3326
Buttonbush						
Waterlily			20			20
Wire Cord Grass					1575	1575
Submergents						
Other	129	531	1049	182	660	2551

WOODSTORK

	1977	1978	1979	1980	1981	Total
Bulrush					1040	1900
Spikerush	860					
Cattail					335	435
Willow	100				1891	5484
Wet Prairie	806		1040	1747	45	560
Grass	15		150	350		250
Buttonbush			250		375	375
Waterlily						
Wire Cord Grass					550	550
Submergents						
Other	50		6	355	145	556

APPENDIX II. KINGS BAR COLONY NESTING PAIRS - 1977-1981.

GREAT EGRET

	1977	1978	1979	1980	1981
March	900	600	50	300	
April	1000	3000	500	400	
May	200	500	750	200	50
June		-	200	80	100
July		-		50	

SNOWY EGRET

	1977	1978	1979	1980	1981
March	300		50	50	
April	600			150	
May		50	200	100	
June		-		150	
July	500	-		100	50
August		-		25	50

CATTLE EGRET

	1977	1978	1979	1980	1981
March			500		
April	500	2000	800	800	
May	5000	3500	3000	900	600
June	4000	-	3000	800	1700
July	500	-	1500	450	800
August		-			600

WHITE IBIS

	1977	1978	1979	1980	1981
March	1000		1000	1500	
April	2000	3000	2000	1200	
May	2000	500	2000	300	
June	3000	-	300	50	
July	500	-			

GLOSSY IBIS

	1977	1978	1979	1980	1981
May	200		200		

APPENDIX II. HARNEY POND COLONY NESTING PAIRS - 1977-1981.

GREAT EGRET

	1977	1978	1979	1980	1981
March				150	
April				150	
May				150	
June		-		100	
July		-		75	

SNOWY EGRET

	1977	1978	1979	1980	1981
April				250	
May				150	
June		-		150	
July		-		150	

CATTLE EGRET

	1977	1978	1979	1980	1981
March				50	
April			400	400	
May		3000	1500	500	
June		-	2000	450	
July		-	800	300	
August		-		150	

APPENDIX II. CHANCEY BAY COLONY NESTING PAIRS - 1977-1981.

GREAT EGRET

	1977	1978	1979	1980	1981
June		-		75	

CATTLE EGRET

	1977	1978	1979	1980	1981
April			300	350	
May				450	
June		-		400	
July		-		300	
August		-		300	

APPENDIX II. LIBERTY POINT COLONY NESTING PAIRS - 1977-1981.

GREAT EGRET

	1977	1978	1979	1980	1981
March	250			25	
April	800				
May	200			75	
June	10	-		50	

SNOWY EGRET

	1977	1978	1979	1980	1981
March				20	
April	100				
May					
June		-	200		
July		-			
August		-		25	

CATTLE EGRET

	1977	1978	1979	1980	1981
April	100			150	
May	1000			500	
June	200	-	1550	575	
July		-	200		
August		-		400	

WHITE IBIS

	1977	1978	1979	1980	1981
April	80			25	
May	200			25	

APPENDIX II. MOORE HAVEN COLONY NESTING PAIRS - 1977-1981.

GREAT EGRET

	1977	1978	1979	1980	1981
March		50			
April		250	100	50	
May	100	50	40		
June		-			
July		-	25		

SNOWY EGRET

	1977	1978	1979	1980	1981
April			25		
May			25		
June		-	100		

CATTLE EGRET

	1977	1978	1979	1980	1981
April		50	40		
May	1000	100	150		
June	2500	-	100		
July		-	25		

WHITE IBIS

	1977	1978	1979	1980	1981
April		50			
May					
June		-	100		