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DISTRIBUTION AND ABUNDANCE OF WADING BIRDS IN THE WATER CONSERVATION AREAS OF THE FLORIDA EVERGLADES, 1996

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EXECUTIVE SUMMARY

Major changes in water management that are currently being proposed or implemented will alter the hydrology of the Water Conservation Areas and, consequently, the use of these areas by wading birds. Because these areas support huge concentrations of foraging wading birds (Hoffman et al. 1994) and the largest percentage of the remaining nesting wading birds in the Everglades (Ogden 1994), monthly systematic reconnaissance flights (SRF) were conducted to investigate and monitor the relationship between modified hydrologic patterns in the Everglades system and the distribution and abundance of these wading birds.

Surveys were flown with a fixed winged aircraft at an altitude of 60 meters along 50 parallel transects with 2 km spacing in the Water Conservation Areas from January to June 1996. The Holey Land and Everglades Nutrient Removal Area which are adjacent to the Water Conservation Areas were also surveyed each month. Wading birds were enumerated, their positions recorded, entered into a database, and summarized into tables. Densities of each species were separated into 4 km² cells and plotted onto maps of the study area.

We observed a pattern of rising water levels throughout the summer to a maximum in the fall then a decline until the end of spring during 1995-96, a pattern also reported in previous years (Bancroft and Sawicki 1995). The range of water levels varied little during each month of the six-month survey season. Mean monthly water levels and the percent of wet cells fell within the wet category for each month of the survey period. The monthly percent of wet cells ranged from 81.2 % (May) to 99.7 % (April) for 1996. Based on water levels and percent wet cells the 1996 survey period was categorized as wet while the previous year (Sawicki et al. 1995) had water conditions that were considered extremely wet (flood). The difference in water conditions was reflected in substantially lower numbers of wading birds during 1995 (Sawicki et al. 1995) than 1996. The highest densities of wading birds in 1996 shifted from area WCA 2A in January

and February to WCA's 1 and 3A in March. This shift in wading bird densities between the areas coincided with an increase in mean and maximum water levels which also began in WCA 2A during March.

Using the mean monthly estimated abundance for January to June each survey year (1985-1995) as an index of long-term trends in abundance, all species/species groups of wading birds (Great Blue Herons, Great Egret, Wood Storks, White Ibis, Glossy Ibis and small herons) had mean monthly abundances during 1996 greater than mean monthly abundances for each of the previous three years. Comparison of a respective species/species group mean monthly estimated abundance in 1996 with the overall mean monthly estimated abundance for the 11 previous years (January to June, 1985-1995) indicated that Great Blue Herons, Great Egrets, and small herons in 1996 were slightly lower than the 11-year mean but slightly lower; Glossy Ibis in 1996 were slightly higher than the 11-year mean; and White Ibises and Wood Storks in 1996 was much lower than the 11-year mean.

The large increases in wading birds during the 1996 "wet year" surveys represents a dramatic contrast to the low abundance, "flood year" survey results in 1995. The contrasting results demonstrate how quickly wading birds can respond in successive years to changing water levels.

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INTRODUCTION

Major changes in water management that are currently being proposed or implemented will alter the hydrology of the Water Conservation Areas and, consequently, the use of these areas by wading birds. The Water Conservation Areas support huge concentrations of foraging wading birds (Hoffman et al. 1994) and the largest percentage of the remaining nesting wading birds in the Everglades (Ogden 1994). Since it is critical that we investigate and monitor the relationship between modified hydrologic patterns in the Everglades system and the distribution and abundance of these wading birds, monthly systematic reconnaissance flights (SRF) were conducted in the Water Conservation Areas from January to June 1996. This document presents the results of these surveys. These data, when combined with survey data from other parts of the Everglades/South Florida Ecosystem, will provide a synoptic view of distribution and abundance of wading birds.

BACKGROUND

The Everglades ecosystem originally extended from the southern shore of Lake Okeechobee south and west to the coastal mangrove forests and estuaries of the Gulf of Mexico and Florida Bay, and consisted of a complex vegetation mosaic (Davis et al. 1994). Water levels within this marsh system rose and fell with the annual rain cycle (Walters et al. 1992). The majority of rain in this ecosystem generally occurs between late May and early November (Bancroft 1989, Duever et al. 1994).

The original Everglades marsh ecosystem provided abundant primary and secondary production during the wet summer and fall months (Holling et al. 1994), and this productivity is concentrated during the dry winter and spring when water levels receded. The concentrations of food provided ideal foraging habitats for numerous wetland species, especially large flocks of wading birds (Bancroft 1989, Ogden 1994). However, the hydrology of the Everglades has been severely altered (Light and Dineen 1994) by extensive draining and the construction of canals and levees. The resulting system is not only spatially smaller, but also drier than historical levels (Walters et al. 1992). Moreover, the timing and distribution of water flow have been highly altered.

Breeding populations of wading birds have responded negatively to altered hydrology (Ogden 1994, Bancroft 1989, Kushlan and Fohring 1986) as numbers of breeding wading birds in the Everglades have decreased by more than 90%. During favorable years in the 1930s, up to 250,000 wading birds, including White Ibises (*Eudocimus albus*), Wood Storks (*Mycteria americana*), Great Egrets (*Casmerodius albus*), Snowy Egrets (*Egretta thula*), and Tricolored Herons (*E. tricolor*) nested in the central and southern Everglades (Ogden 1994). Maximum numbers had decreased to 54,000 by the 1970's and further to 22,000 by the 1980's (Ogden 1994). During the 1930s approximately 90% of the wading birds nested along the interfaces

between the freshwater Everglades and the mangrove-estuaries (Ogden 1994). By the 1980s, the majority of nesting wading birds had shifted to nesting in the interior freshwater Everglades, principally in the Water Conservation Areas (WCA) (Ogden 1994). These changes were presumably the result of extensive hydrological alterations (water flow and volume) in the Everglades system (Ogden 1994, Bancroft 1989).

Significant declines in the numbers of wading birds have contributed to the movement toward restoring the hydrologic conditions of the Everglades to more historic patterns. The South Florida Water Management District (SFWMD) and the U.S. Army Corps of Engineers (USACE) are currently evaluating and implementing water requirements that would restore the Water Conservation Areas (WCA) and Everglades National Park (ENP) in ways that improve and restore the natural conditions of south Florida's Everglades. One goal of this process is to improve conditions for wading birds within the remaining Everglades system.

In 1993, the Florida Legislature passed the Everglades Forever Act which calls for the construction of 34,000 acres of wetland treatment marshes along the northern edge of the Water Conservation Areas. Loxahatchee National Wildlife Refuge has proposed increasing water depths and hydro periods within the refuge. The US Army Corps of Engineers, South Florida Water Management District, and Everglades National Park are initiating modified water deliveries for Northeast Shark Slough and Shark Slough in Everglades National Park, and the South Florida Water Management District is attempting to restore natural hydrologic conditions within the Water Conservation Areas.

METHODS

Systematic Reconnaissance Flights

Similar to Bancroft and Sawicki (1995), we examined the effect that changes in hydrology in the WCA's may have on the distribution and abundance of wading birds. We estimated the number and distribution of foraging wading birds using a systematic aerial transect method (Norton-Griffiths 1978) as modified by the National Audubon Society (Bancroft and Sawicki 1995). Using identical survey parameters (height, ground speed, strip width, transect spacing) as Bancroft and Sawicki (1995), we flew surveys in the areas consisting of east-west transects spaced at 2 km intervals. Transects were flown in a Cessna 182 at 61 m (200 ft) altitude and a ground speed of 145-185 km/h (80-100 nautical mph). Two observers, one on each side of the airplane recorded all wading birds observed within 150 m wide strips paralleling the plane's path. When birds were sighted in the strips, the longitude was recorded from a Global Positioning System receiver. The species, number, behavior, and longitude were recorded for all sightings within the strips.

We identified to species Great Blue Herons (*Ardea herodias*), Great Egrets, Wood Storks, White Ibises, and Glossy Ibises (*Plegadis falcinellus*). Because of the difficulty of identifying Tricolor herons (*Egretta tricolor*) and Little blue herons (*Egretta caerulea*) within a large mix flock, these species were identified as "small dark herons". Snowy Egrets (*Egretta thula*) and first-year Little Blue Herons that could not be correctly identified were classified into a group called "small white herons" (Bancroft and Sawicki 1995). Small white herons and small dark herons were then grouped together into a third category called "small herons". This was done when comparing estimated abundance of each wading bird species from the last 11 years (Appendices D, H, and I). We grouped these species because it is difficult at times to identify them to species from a moving airplane. In addition, small herons usually are seen in low

numbers and would not show a pattern when analyzed and mapped as separate species (Bancroft and Sawicki 1995).

Water Analyses

During the surveys, surface water coverage was recorded. Bancroft and Sawicki (1995) classified water coverage into four categories; (1) *wet* conditions were defined as having water completely covering the ground surface, (2) *wet transitional* conditions had partially exposed ground, but more than 50% of the ground surface flooded, (3) *dry transitional* conditions for areas less than 50% flooded, and (4) *dry conditions* where surface water appeared only in ponds, canals, and alligator holes. These water conditions were recorded on a broad scale, such that each 2-km x 2-km cell was assigned a single value in a given month. The water data recorded during the surveys was coded numerically and transferred to computer files for mapping.

Study Areas

During 1996 systematic transects were flown in three main areas, the Water Conservation Areas, the Holey Land, and the Everglades Nutrient Removal Area (ENR) (Figure 1). The Water Conservation Areas are divided by canals and levees into five water level control impoundments ranging in sized from 124 km² to 2040 km². The five Water Conservation Areas are WCA 1(620 km²), WCA 2A (384 km²), WCA 2B (124 km²), WCA 3A (2040 km²), and WCA 3B (364 km²) (Tables 1 and 2). The Holey Land is 172 km² and the Everglades Nutrient Removal Area is approximately 40 km². The dominant vegetation in the Water Conservation Areas is native species sawgrass (*Cladium jamaicense*), spikerush (*Eleocharis cellulosa*), water lily (*Nymphaea odorata*), cypress tree (*Taxodium ascendens*) and the introduced species melaleuca tree (*Melaleuca quinquenervia*), Australian pine tree (*Casuarina* sp.), Brazilian pepper tree (*Schinus terebinthifolius*), and water hyacinth (*Eichornia crassipes*). The Holey Land dominant vegetation is sawgrass, southern bayberry shrubs (*Myrica cerifera*), and cattail (*Typha domingensis*). For a more detailed description of the vegetation and vegetation associations see

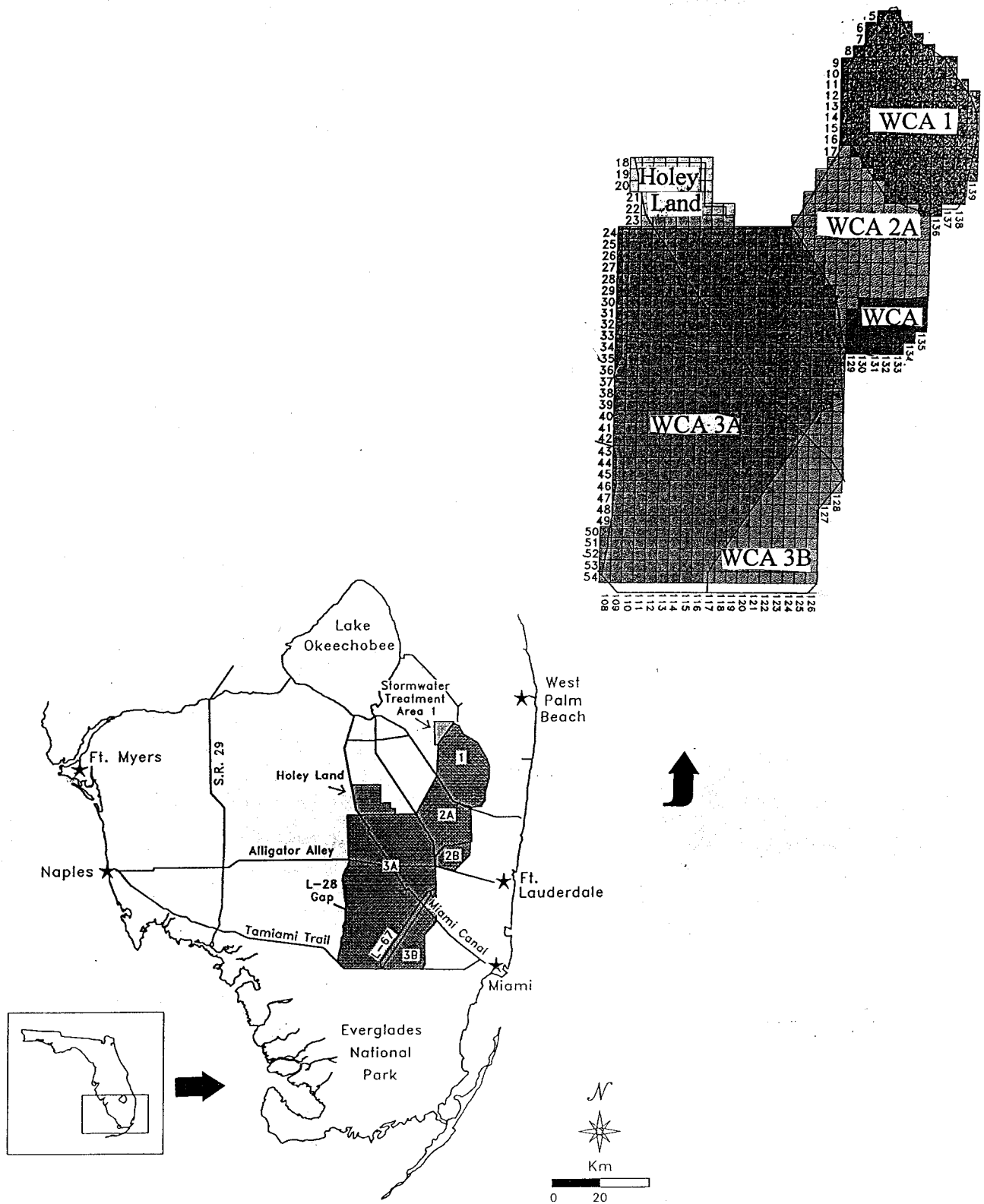


Figure 1. Study areas and transects (adapted from Sawicki et al. 1995).

Table 1. Dates and completed transects for 1996.

Month	Dates	WCAs	Holey Land
Jan	16,17,18	5 through 54	18 through 23
Feb	12,13,14	5 through 54	18 through 23
Mar	12,13,14	5 through 54	18 through 23
Apr	10,11,12	5 through 54	18 through 23
May*	20,22	5 through 41 + 53,54	18 through 23
Jun	24,25,26	5 through 54	18 through 23

* Transects #42 to #52 were not surveyed during May due to no fly zone established around commercial airline crash site.

Table 2. Number of transects and areas for the Water Conservation Areas and the Holey Land.

Areas	Transects in each area	# Cells (4 sq km)	Square Kilometers	Hectares	Acres
1	5-22	155	620	62000	153203
2A	17-31	96	384	38400	94886
2B	30-34	31	124	12400	30640
3A	24-54	510	2040	204000	504084
3B	39-54	91	364	36400	89944
Holey Land	18-23	43	172	17200	42501

Bancroft and Sawicki (1995), Davis and Ogden (1994), and Sawicki et al. (1995).

Survey Personnel

In 1996, Richard J. Sawicki, Wayne Hoffman, and David A. Nelson occupied the right front seat of the airplane, counted birds, and recorded water conditions on the right side of the plane. Craig Theriot and David Nelson occupied the left rear seat and counted birds on the left side of the plane. The pilot for the surveys was John McGehee.

Data Management

Data were entered onto a standard data sheet during the flights. The data was then entered from the data sheets into a dBase III + data management system developed by Dave Buker of ENP and modified by Sawicki et al. (1995). For a more detailed description of the database see Sawicki et al. (1995). The data were then printed from the database and checked against the original data sheets.

A video recording was made of each transect, each month and archived for future reference.

Data Analysis

We used the database analysis program developed by Dave Buker and modified by Sawicki et al. (1995). Each observation was sorted by species and assigned to the correct 4 km² cell. Total population estimates of each species were tabulated for each area and each cell. The density data for each 4 km² cell was stored in a dBase file format and transferred to the ARCINFO Geographic Information System for plotting of density maps.

Map Production

ARCINFO Geographic Information System was used to produce maps of the relative density for each species/species category and for all species combined. The relative density categories were scaled from five categories: 1) 1.67 birds per km² (one bird observed); 2) greater than 1.67 birds per km² but less than 1/10 of the overall (6 month) maximum density; 3) 1/10 to 3/10 maximum density; 4) 3/10 to 7/10 maximum density; and 5) 7/10 to maximum density (Sawicki et al., 1995). These density categories were represented on the maps by dots that increased in size with density. Water maps for each group were calculated by coding the water data from 1 to 4, where 1 was wet and 4 was dry.

RESULTS

Water Conditions for the Water Conservation Areas

The water conditions for the water conservation areas for all months was predominantly wet (81 % to 99% of all cells wet). The percent of wet cells decreased from January (96 % wet) to February (93 % wet), increased for March (97 % wet) and April (98 % wet), decreased to the driest conditions in May (81 % wet), and increased to very wet in June (99 % wet). WCA 2B and WCA 3B remained completely wet during all survey months. WCA 1 was wet from January to April, had some dryer cells in the north during May, and was wet again in June. Except for a few cells on the northwest borders, WCA 2A was wet during most months with May being the driest month. WCA 3A had dry areas in the northwest that expanded and contracted between survey months. In WCA 3A, June was the wettest and May the driest months.

Water Levels for the Water Conservation Areas

Water level data were obtained from the South Florida Water Management District for 3 water level gages. Gage 1-7 is located in central WCA 1, Gage 2A-17 in central WCA 2A, and Gage 3A-4 in south central WCA 3A. Monthly means, minimum and maximum water levels were plotted from June 1995 to June 1996 for the 3 gages (Figure 2, Appendix G).

Mean water levels for Gage 1-7 increased from June (mean 31 cm) to October 1995 (mean 73 cm) then began to decrease in November 1995 (mean 61 cm). Water levels were very variable in October and November 1995. Water levels were somewhat stable in December 1995 (mean 55 cm) and January 1996 (mean 55 cm) then decreased from February (mean 50 cm) to a low in May 1996 (mean 35 cm). Water levels became variable in May 1996 and then increased in June 1996 (mean 47 cm) (Appendix G1).

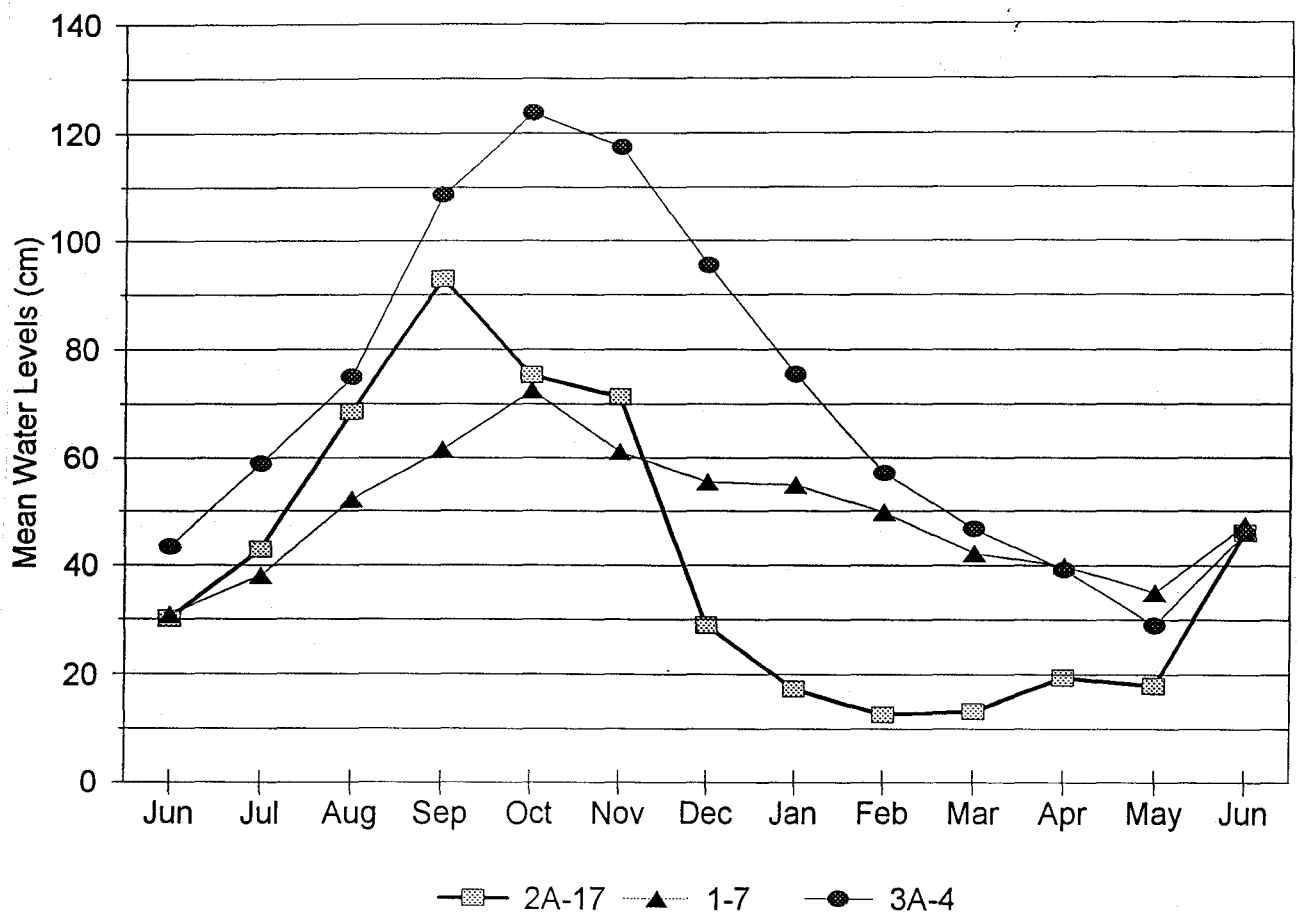


Figure 2. Mean water levels above ground for Gages WCA 1-7, WCA 2A-17, and WCA 3A-4 within the Water Conservation Areas, June 1995 to June 1996 (0 = ground level).

Mean water levels for Gage WCA 2A-7 increased from June (mean 30 cm) to September 1995 (mean 93 cm) then decreased until February 1996 (mean 13 cm). Mean water levels were low but variable in March (13 cm), April (19 cm), and May (18 cm) 1996. Water levels became less stable and higher in June 1996 (mean 46 cm, minimum 25 cm, and maximum 63 cm) (Appendix G2).

Mean water levels for Gage 3A-4 increased from June (mean 43 cm) to October 1995 (mean 124 cm) then decreased to the lowest level in May 1996 (29 cm). Water levels increased and became more variable in June 1996 (mean 46 cm)(Appendix G3).

Wading Bird Abundance and Distribution for the Water Conservation Areas

The population estimates for wading birds in the Water Conservation Areas generally increased from January (29,374) to a high in March (58,674), decreased in April (38,600), increased in May (46,013), and decreased to a low in June (19,573) (Table 3 and Figure 4). The areas with the highest population estimates of wading birds were WCA 2A for January and February; WCA 3A for March, April, and May; and WCA 1 for June (Table 4 and Figure 4). When the population estimates were adjusted for area (relative densities), WCA 2A had the highest average monthly density of wading birds. WCA 3B had the lowest average monthly density. The areas with the highest density each month were WCA 2A for January, February, and March; WCA 1 for April and May; and WCA 2B for June. The areas with the lowest density each month were WCA 3B for January to April, WCA 2B and WCA 3B for May, and WCA 2A for June (Appendix C).

Wading bird distribution maps were scaled to a maximum 1517 birds per square km which provided the highest density category of 1063-1517 birds per km² (Appendices J). The highest density category was observed in west-central WCA 2A during February and in west central WCA 3A during March. The higher densities of wading birds tended to be found in north-central WCA 1, central WCA 2A, and west-central WCA 3A.

Table 3. Estimated abundance of wading birds in the Water Conservation Areas, 1996.

Species	Jan	Feb	Mar	Apr	May*	Jun
Great Blue Heron	1,893	2,727	1,960	1,207	460	760
Great Egret	10,793	13,666	10,574	10,979	17,153	11,307
Small Dark Herons	280	1,227	1,960	700	1,547	420
Small White Herons	2,713	2,207	2,606	2,820	4,093	6,660
White Ibis	10,841	28,053	36,627	21,094	21,340	387
Glossy Ibis	1,314	5,660	4,094	1,260	360	26
Wood Stork	1,533	1,407	833	533	793	0
Other	7	53	20	7	267	13
Total Abundance	29,374	55,000	58,674	38,600	46,013	19,573

* Transects #42 to #52 were not surveyed during May due to no fly zone established around commercial airline crash site.

Table 4. Estimated abundance of wading birds (species combined) in the Water Conservation Areas, 1996.

Month	1	2A	2B	3A	3B	Total
Jan	9,160	14,333	247	5,407	227	29,374
Feb	8,700	32,647	2,933	10,107	613	55,000
Mar	16,440	10,933	527	30,007	767	58,674
Apr	7,873	4,747	607	24,153	1,220	38,600
May*	15,733	6,040	393	22,620	1,227	46,013
Jun	8,207	473	1,873	6,673	2,347	19,573

* Transects #42 to #52 were not surveyed during May due to no fly zone established around commercial airline crash site.

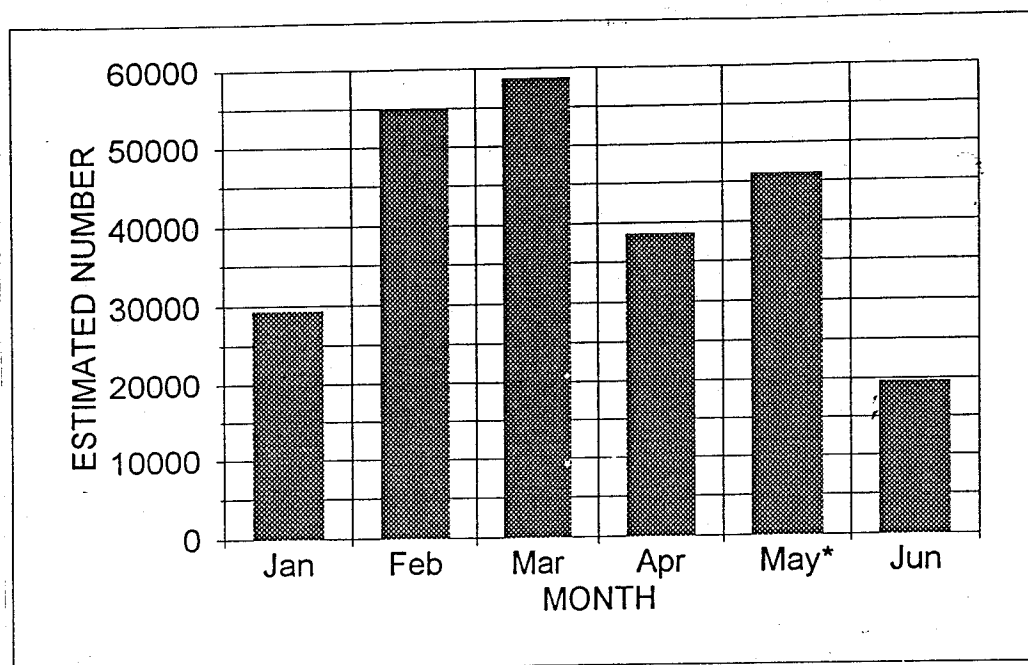


Figure 3. Estimated abundance of wading birds (species combined) in the Water Conservation Area, 1996.

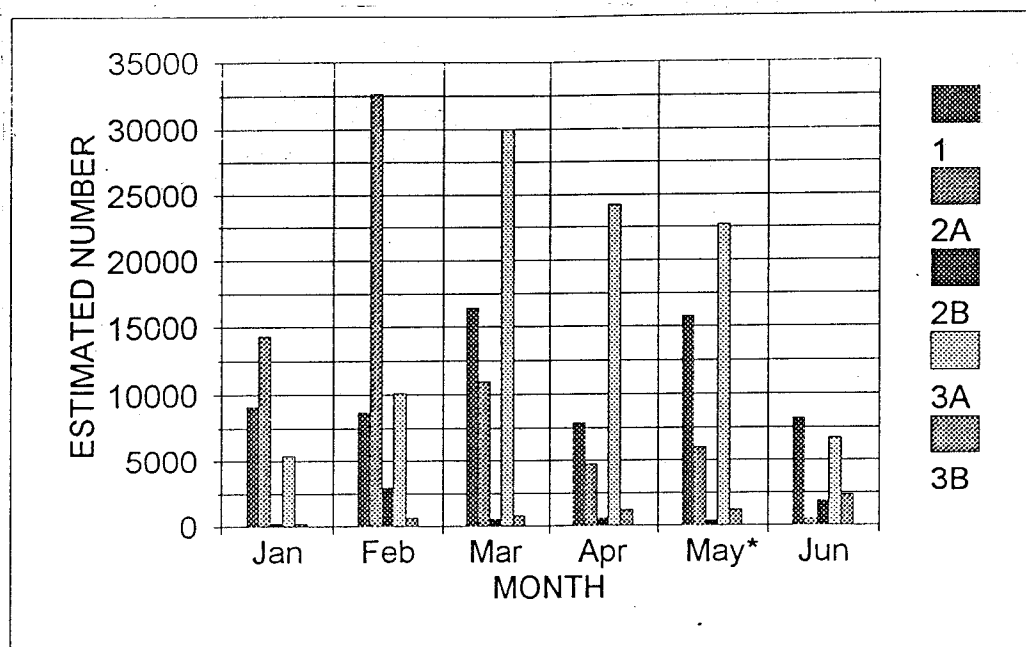


Figure 4. Estimated abundance of wading birds (species combined) in each of the Water Conservation Areas, 1996.

Species Accounts for the Water Conservation Areas

Great Blue Heron (*Ardea herodias herodias*). Great Blue Herons were generally observed singularly when feeding but occasionally in larger numbers when nesting. The population estimates for Great Blue Herons in the Water Conservation Areas generally increased from January (1893) to a high in February (2,727) then decreased each month to lows in May (460) and June (761) (Appendices B1 and E1). The highest population estimates for Great Blue Herons were observed in WCA 3A for all months except May. For May, WCA 1 had the highest population estimate (Appendices B1 and F1). When the population estimates were adjusted for area (relative densities), WCA 1 had the highest average density of Great Blue Herons. WCA 2B and WCA 3B had the lowest relative average densities each month (Appendix C2).

Great Blue Heron distribution maps were scaled to a maximum 37 birds per square km which provided the highest density category of 27-37 birds per km² (Appendix K). The highest density category was observed as nesting aggregations in the southeast corner of WCA 2A during January and in the north central portion of WCA 2B during February. The higher densities of Great Blue Herons tended to be found in the north-central WCA 1, the south-central WCA 2A, and southwest WCA 3A.

Great Egret (*Casmerodius albus*). Great Egrets were the most commonly observed individual bird and the second most abundant bird observed. White ibis were more abundant but were usually observed in large flocks. While Great Egrets were often observed singularly when feeding, groups of 3 or more individuals were also observed feeding, at times, in close proximity to each other. The population estimates for Great Egrets in the Water Conservation Areas generally increased from January (10,793) to February (13,666) then decreased to a low in March (10,574) then increased to a high in May (17,153) (Appendices B2 and E2). The highest population estimates for Great Egrets were observed in WCA 3A for all months except January. For January, WCA 2A had the highest population estimate (Appendices B2 and F2). When the population estimates were adjusted for area (relative densities), WCA 2B had the highest average

density of Great Egrets (Appendix C3). WCA 3A and WCA 3B had the lowest relative average densities each month.

Great Egret distribution maps were scaled to a maximum 505 birds per square km which provided the highest density category of 355-505 birds per km² (Appendix L). The highest density category was observed only once and was a nesting aggregation on the central border between WCA 2A and WCA 2B during February. The higher densities of Great Egrets tended to be found in the central WCA 1, central and southern WCA 2A, southeast 3B, north-central and west-central WCA 3A.

Small Dark Herons. Small dark herons included Tricolored Herons (*Egretta tricolor*) and dark colored Little Blue Herons (*E. caerulea*). These herons sometimes were not distinguishable from each other when observed from an airplane. This was particularly true if the birds were standing. These two species were observed singularly and in mixed flocks with other individuals and species when feeding and flying.

The population estimates for the small dark herons in the Water Conservation Areas generally increased from January (280) to a high in March (1,961) then decreased in April (700), increased in May (1547) then decreased in June (420)(Appendices B3 and E3). The highest population estimates for small dark herons were observed in WCA 2A for January and February, in WCA 3A for March and April, and WCA 1 for May and June (Appendices B3 and F3). When the population estimates were adjusted for area (relative densities), WCA 1 had the highest average density of small dark herons. WCA 2B and WCA 3B had the lowest relative average densities each month (Appendix C4).

Small dark heron distribution maps were scaled to a maximum 77 birds per square km which provided the highest density category of 55-77 birds per km² (Appendix M). The highest density category was observed in central WCA 2A during February, and in west-central 3A during March. The higher densities of small dark herons tended to be found in the north-central

WCA 1, central WCA 2A, and west-central WCA 3A.

Small White Herons. Small white herons included Snowy Egrets (*Egretta thula*) and white (immature) Little Blue Herons (*E. caerulea*). These two smaller, white herons sometimes were not distinguishable from each other when observed from an airplane. This was particularly true if the birds were standing. These birds were observed singularly and in mixed flocks with other individuals and species when flying and feeding.

The population estimates for the small white herons in the Water Conservation Areas decreased from January (2,713) to February (2,207) then increased each of the following months to a high in June (6,661)(Appendices B4 and E4). The highest population estimates for small white herons were observed in WCA 2A for January and February, in WCA 3A for March, April, and May and in WCA 1 for June (Appendices B4 and F4). When the population estimates were adjusted for area (relative densities), WCA 1 had the highest average density of small white herons. WCA 3B had the lowest relative average density each month (Appendix C5).

Small white heron distribution maps were scaled to a maximum 500 birds per square km which provided the highest density category of 351-500 birds per km² (Appendix N). The highest density category was observed in northeast WCA 2A during January, in northeast WCA 1 during May, and in southeast WCA 1 in June. The higher densities of small white herons tended to be found in the north-central WCA 1, central WCA 2A, and west-central WCA 3A.

White Ibis (*Eudocimus albus*). White ibises were most commonly observed in large flocks feeding and flying. These birds were commonly observed in mixed flocks with Glossy Ibises, Little Blue Herons, and/or Tricolored Herons. White ibises were the most abundant bird observed during the surveys. The population estimates for White Ibises in the Water Conservation Areas generally increased from January (10,840) to March (36,627) then decreased to a low in June (387)(Appendices B5 and E5). The highest population estimates for White Ibis were observed in WCA 2A for January and February, in WCA 3A for March and

April, and in WCA 1 for May and June (Appendices B5 and F5). When the population estimates were adjusted for area (relative densities), WCA 2A had the highest average density of White Ibises (Appendix C6). WCA 2B and WCA 3B had the lowest relative average densities each month.

White Ibis distribution maps were scaled to a maximum 1301 birds per square km which provided the highest density category of 911-1301 birds per km² (Appendix O). The highest density category was observed in north-central WCA 1 during January, in west-central WCA 2A during February, and in west-central WCA 3A during March. The higher densities of White Ibis tended to be found in the northeast and central WCA 2A, north-central WCA 1, and north-central and west-central WCA 3A.

Glossy Ibis (*Plegadis facinellus*). Glossy ibises were most commonly observed in small groups of 3 to 10 individuals feeding and flying. These birds were most often observed in mixed flocks with White Ibises, Little Blue Herons, and/or Tricolored Herons. The population estimates for Glossy Ibises in the Water Conservation Areas generally increased from January (1,314) to March (5,660) then decreased to a low in June (27) (Appendices B6 and E6). The highest population estimates for Glossy Ibises were observed in WCA 2A for January and February, in WCA 3A for March, April and May (Appendices B6 and F6). When the population estimates were adjusted for area (relative densities), WCA 2A had the highest average density of Glossy Ibises. WCA 2B and WCA 3B had no Glossy Ibis observed throughout the study (Appendix C7).

Glossy Ibis distribution maps were scaled to a maximum 175 birds per square km which provided the highest density category of 124-175 birds per km² (Appendix P). The highest density category was observed in west-central and central WCA 2A during February and in northeast, north-central, east-central WCA 3A during March. The higher densities of Glossy Ibises tended to be found in central WCA 2A.

Wood Stork (*Mycteria americana*). Wood storks were observed nesting and feeding singularly or in small groups and sometimes flying in mixed flocks with other individuals and species. The population estimates for the Wood Storks in the Water Conservation Areas decreased from January (1,533) in each of the following months to a low in June (0) (Appendices B7 and E7). The highest population estimates for Wood Storks were observed in WCA 2A for January and February, in WCA 3A for March, April, and May, and none was observed in June (Appendices B7 and F7). When the population estimates were adjusted for area (relative densities), WCA 2A had the highest average density of Wood Storks. WCA 2B and WCA 3B generally had the lowest relative average densities each month (Appendix C8).

Wood Stork distribution maps were scaled to a maximum 133 birds per square km which provided the highest density category of 94-133 birds per km² (Appendix Q). The highest density category was observed in east-central WCA 2A during January. The higher densities of Wood Storks tended to be found in the east- central and central WCA 2A.

Other Species of Wading Birds. Four Cattle Egrets (*Bubulcus ibis*) observations were recorded during the surveys (1 in January, 3 in February, and 1 in April) in the Water Conservation Areas. Cattle Egrets were seen in dry areas usually on levees that were adjacent to canals and highways. Eleven Great White Herons (*Ardea herodias occidentalis*) were recorded (5 in February, 3 in March, 1 in May, and 2 in June). Since both birds are large white herons, Great White Herons are difficult to distinguish from Great Egrets when observed from an airplane. If the individuals are seen clearly the two can be separated by the larger size and more massive bill of the Great White Herons and the yellowish legs of the Great White Herons compared to the blackish legs of the Great Egret. A total of 39 Roseate Spoonbills (*Ajaia ajaja*) were observed during the survey. Twenty-one were observed in WCA 2A and 18 in WCA 3A. All of the Roseate Spoonbills were observed in May.

The Holey Land

The Holey Land was flown monthly from January to June 1996 coincident with the Water Conservation Area Surveys. Estimated abundance of all species combined increased from January (220) to April (2,600) and then declined until June (100) (Appendix B8). Most of the species followed the similar estimated abundance monthly patterns. Great Egret and White Ibises were the most abundant species followed by Great Blue Herons, small white herons, and small dark herons. The density category for each species was scaled into the same categories as those for the Water Conservation Area maps, however, the distribution maps for the Holey Land are much larger. Each square represents 4 km² in the Holey Land Maps as in the Water Conservation Area maps. Distribution maps were scaled to a maximum 1517 birds per square km which provided the highest density category of 153-455 birds per km² for the Holey Land (Appendix R). The highest density categories were observed on northern boundary of the Holey Land during February and on north and east boundaries during March and April. Water conditions were mostly wet over most of the Holey Land in January, dry in the western portion in February and March, wet over all in April, mostly dry and dry transitional in May, and mostly wet again in June (Figures 13-18). Birds were often associated with the canal and levee areas on the north and eastern boundaries of the Holey Land. Wading bird use was very light over much of the remaining part of the marsh. Great Blue Herons, Great Egrets, and small dark herons were observed during all months. Small white herons were observed only January to May. White Ibises were observed only February to May; Wood Storks and Glossy Ibises only during March and April. No Great White Herons, Roseate Spoonbills, nor Reddish Egrets were seen in the Holey Land during 1996 surveys.

Everglades Nutrient Removal Area

The Everglades Nutrient Removal Area was flown in adjacent parallel transects such that 100 percent of the area was visually surveyed from the plane. The Everglades Nutrient Removal

Area was wet during all months. The number of wading birds was low in January (32) increased to a high in April (564), were lowest in number in May (20), and increased again in June (115)(Appendix B9). The most numerically abundant wading bird were the small white herons. White Ibises and Great Egrets had the second and third largest number of observations. Great Blue Herons, small white herons, small dark herons and White Ibises were observed each month. Some of the small white herons (were probably) White Ibises but they were concealed by the vegetation and could not be identified to species. Great Egrets were not observed in April but were seen during the other five months. Glossy Ibises were observed only from January to March. Cattle Egrets were observed in January, February, and April. Cattle Egrets were observed on the levees surrounding the area. Wood Storks were seen in the area only in March (30). No Roseate Spoonbills were observed.

DISCUSSION

The typical annual pattern of rising water levels throughout the summer to a maximum in the fall followed a decline until the end of spring (Bancroft and Sawicki 1995) occurred during 1995-96 for selected water gages in the Water Conservation Areas. However, Gage 2A-17 had the lowest level in March and was at a slightly higher level in April, May, and June. The monthly range of water levels (minimum fluctuation) for each of the gages was small during six months of the survey. The exception to this was Gage 2A-17 which had a maximum water level of 31 cm greater than the mean water level for March. Mean monthly water levels for the three gages and the percent of wet cells fell within the wet category each month of the survey period. The monthly percent of wet cells ranged from 81.2 % (May) to 99.7 % (April). Based on water levels and percent wet cells the 1996 survey period was categorized as wet (Bancroft and Sawicki 1995), while the 1995 survey had water conditions that were considered extremely wet (flood). The difference in water conditions was reflected in substantially lower numbers of wading birds than during the 1995 survey (Sawicki et al. 1995) than other earlier years and the 1996 survey. The highest density of wading birds shifted from area WCA 2A to WCA 1 and WCA 3A in March 1996. This shift in wading bird densities between the areas coincided with the increase in mean and maximum water levels which also began in WCA 2A during March.

Using the mean monthly estimated abundance for January to June each survey year (1985-1995) as an index of long term trends in abundance, all species/species groups of wading birds (Great Blue Herons, Great Egrets, Wood Storks, White Ibises, Glossy Ibises and small herons) had mean monthly abundances during 1996 greater than mean monthly abundances for each of the previous three years (Appendices D, H and I). When we compared each respective species/species group mean monthly estimated abundance in 1996 with the overall mean monthly estimated abundance for the 11 previous years (January to June, 1985-1995): Great Blue Herons, Great Egrets, and small herons were close to the 11 year mean but slightly lower in

1996; Glossy Ibises were close to but slightly higher than the 11 year mean in 1996; and White Ibises and Wood Storks were much lower than the 11 year mean in 1996 (Appendices D, H and I). While the values of the estimated numbers for the comparison of long term trends should be viewed with caution (because they are estimates extrapolated from counts), the numbers do serve as an index for examining changes in estimated abundances for the survey area.

The large increase in wading birds during the 1996 "wet year" survey represents a dramatic contrast to the low abundance, "flood year" survey results in 1995. Thus, demonstrating how quickly wading birds can respond from one year to next to changing water levels.

Wading birds in the Holey Land were at their highest estimated abundances during May (1060) and June (1666) and consisted of predominantly small white herons during the 1995 survey (Sawicki et al, 1995). In contrast, wading bird estimated abundances were highest during March (1393) and April (2600) and were composed predominantly of White Ibises during the 1996 survey. During the months of January to April, estimated abundances were higher for 1996 than for 1995 for the Holey Land. During the months of May and June, estimated abundances were higher for 1995 than for 1996. The mean monthly estimated abundance of wading birds was higher for 1996 (938) than for 1995 (538).

Wading birds in the Everglades Nutrient Removal Area (ENR) were at their highest numbers during June (187) and consisted of predominantly small white herons during the 1995 survey (Sawicki et al, 1995). In contrast, wading bird numbers were highest during March (229) and April (564) and were predominantly small white herons, White Ibises, and Great Egrets during the 1996 survey. During the months of March and April, numbers of wading birds were higher in the ENR for 1996 than for 1995. The number of wading birds during the other four survey months were higher in the ENR for 1995 than for 1996. The mean monthly number of wading birds in the ENR was higher for 1996 (174) than for 1995 (82).

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