

Wading Bird Populations and Distributions
in the Water Conservation Areas
of the Everglades:

The 1988-1989 Season

by

Wayne Hoffman

Richard J. Sawicki

and

G. Thomas Bancroft

Ornithological Research Unit

National Audubon Society

115 Indian Mound Trail

Tavernier, Florida 33070

Prepared for

Environmental Sciences Division

South Florida Water Management District

Contract #396-M87-0345-A2

TABLE OF CONTENTS

LIST OF TABLES	iv
LIST OF FIGURES	v
EXECUTIVE SUMMARY	xi
ACKNOWLEDGEMENTS	xiv
INTRODUCTION	1
METHODS	2
Survey Area	2
Survey Personnel	3
Survey Procedures	4
Data Management	6
Data Analysis	6
Map Production	7
Vegetation Analyses	8
Water Analyses	10
Correlates of Abundance and Distribution	10
RESULTS.....	15
Abundance and Distribution	15
Water Analysis	20
Species Accounts	30
Great Egret	31
Great Blue Heron	40
Small Dark Heron	47
Small White Heron	54
Wood Stork	62
White Ibis	69
Glossy Ibis	77
Cattle Egret	85
Roseate Spoonbill	92
Great White Heron	95
Correlates of Abundance and Distribution	97
DISCUSSION	100

LIST OF TABLES

Table 1.	Surveys completed and dates flown during the 1988-1989 season.	15
Table 2.	Estimated abundance of all species in 1988-1989 surveys	16
Table 3.	Estimated abundance of Great Egrets in 1988-1989 surveys	31
Table 4.	Estimated abundance of Great Blue Herons in 1988-1989 surveys	40
Table 5.	Estimated abundance of small dark herons in 1988-1989 surveys	47
Table 6.	Estimated abundance of small white herons in 1988-1989 surveys	54
Table 7.	Estimated abundance of Wood Storks in 1988-1989 surveys	62
Table 8.	Estimated abundance of White Ibises in 1988-1989 surveys	69
Table 9.	Estimated abundance of Glossy Ibises in 1988-1989 surveys	77
Table 10.	Estimated abundance of Cattle Egrets in 1988-1989 surveys	85
Table 11.	Estimated abundance of Roseate Spoonbills in 1988-1989 surveys	92
Table 12.	Estimated abundance of Great White Herons in 1988-1989 surveys	95
Table 13.	Patterns of interaction between Great Egret distribution, vegetation, and water conditions	97
Table 14.	Patterns of interaction between Great Blue Heron distribution, vegetation, and water conditions	98
Table 15.	Patterns of interaction between Wood Stork distribution, vegetation, and water conditions	99
Table 16.	Patterns of interaction between White Ibis distribution, vegetation, and water conditions	99

LIST OF FIGURES

Figure 1.	Study area in south Florida showing Everglades Agricultural Area and Water Conservation Area landmarks	3
Figure 2.	The survey grid of 4 km ² cells superimposed on outline maps of the Everglades Agricultural Area (EAA) and Water Conservation Areas (WCAs)	5
Figure 3.	Vegetational categories found within the Water Conservation Areas based on our aerial surveys in 1987 and 1988	11
Figure 4.	Estimated population of all species using the Water Conservation Areas during each month. The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	17
Figure 5.	Estimated population of all species using the total survey area during each month. The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	17
Figure 6a.	The distribution of all species in the Water Conservation Areas in December 1988, and January, February, March 1989	21
Figure 6b.	The distribution of all species in the Water Conservation Areas in April, May, June and August 1989	22
Figure 6c.	The distribution of all species in the Everglades Agricultural Area in December 1988, and January, February, March 1989	23
Figure 6d.	The distribution of all species in the Everglades Agricultural Area in April, May, June and August 1989	24
Figure 7.	Percentage of the study area in the five water condition categories each month. December combines the two transitional and dry categories into one each. Percentages are based on counts of 4 km ² cells	25
Figure 8a.	The distribution of water condition categories in December 1988 and January, February, March 1989. The December map is based on three water condition categories	28

Figure 8b.	The distribution of water condition categories in April, May, June and August 1989	29
Figure 9.	Outline map of Water Conservation Areas used in species accounts	30
Figure 10.	Outline map of Everglades Agricultural Area used in species accounts	30
Figure 11.	Estimated population of Great Egrets using the Water Conservation Areas during each month. The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	32
Figure 12.	Estimated population of Great Egrets using the total survey area during each month. The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	32
Figure 13a.	The distribution of Great Egrets in the Water Conservation Areas in December 1988, and January, February, March 1989	36
Figure 13b.	The distribution of Great Egrets in the Water Conservation Areas in April, May, June and August 1989	37
Figure 13c.	The distribution of Great Egrets in the Everglades Agricultural Area in December 1988, and January, February, March 1989	38
Figure 13d.	The distribution of Great Egrets in the Everglades Agricultural Area in April, May, June and August 1989	39
Figure 14.	Estimated population of Great Blue Herons using the Water Conservation Areas during each month. The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	41
Figure 15.	Estimated population of Great Blue Herons using the total survey area during each month. The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	41
Figure 16a.	The distribution of Great Blue Herons in the Water Conservation Areas in December 1988, and January, February, March 1989	43

Figure 16b.	The distribution of Great Blue Herons in the Water Conservation Areas in April, May, June and August 1989	44
Figure 16c.	The distribution of Great Blue Herons in the Everglades Agricultural Area in December 1988, and January, February, March 1989	45
Figure 16d.	The distribution of Great Blue Herons in the Everglades Agricultural Area in April, May, June and August 1989	46
Figure 17.	Estimated population of small dark herons using the Water Conservation Areas during each month. The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	48
Figure 18.	Estimated population of small dark herons using the total survey area during each month. The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	48
Figure 19a.	The distribution of small dark herons in the Water Conservation Areas in December 1988, and January, February, March 1989	50
Figure 19b.	The distribution of small dark herons in the Water Conservation Areas in April, May, June and August 1989	51
Figure 19c.	The distribution of small dark herons in the Everglades Agricultural Area in December 1988, and January, February, March 1989	52
Figure 19d.	The distribution of small dark herons in the Everglades Agricultural Area in April, May, June and August 1989	53
Figure 20.	Estimated population of small white herons using the Water Conservation Areas during each month. The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	55
Figure 21.	Estimated population of small white herons using the total survey area during each month. The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	55

Figure 22a.	The distribution of small white herons in the Water Conservation Areas in December 1988, and January, February, March 1989	58
Figure 22b.	The distribution of small white herons in the Water Conservation Areas in April, May, June and August 1989	59
Figure 22c.	The distribution of small white herons in the Everglades Agricultural Area in December 1988, and January, February, March 1989	60
Figure 22d.	The distribution of small white herons in the Everglades Agricultural Area in April, May, June and August 1989	61
Figure 23.	Estimated population of Wood Storks using the Water Conservation Areas during each month. The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	63
Figure 24.	Estimated population of Wood Storks using the total survey area during each month. The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	63
Figure 25a.	The distribution of Wood Storks in the Water Conservation Areas in December 1988, and January, February, March 1989	65
Figure 25b.	The distribution of Wood Storks in the Water Conservation Areas in April, May, June and August 1989	66
Figure 25c.	The distribution of Wood Storks in the Everglades Agricultural Area in December 1988, and January, February, March 1989	67
Figure 25d.	The distribution of Wood Storks in the Everglades Agricultural Area in April, May, June and August 1989	68
Figure 26.	Estimated population of White Ibises using the Water Conservation Areas during each month. The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	70
Figure 27.	Estimated population of White Ibises using the total survey area during each month. The box represents the 95% confidence interval around the estimate	

	using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	70
Figure 28a.	The distribution of White Ibises in the Water Conservation Areas in December 1988, and January, February, March 1989	73
Figure 28b.	The distribution of White Ibises in the Water Conservation Areas in April, May, June and August 1989	74
Figure 28c.	The distribution of White Ibises in the Everglades Agricultural Area in December 1988, and January, February, March 1989	75
Figure 28d.	The distribution of White Ibises in the Everglades Agricultural Area in April, May, June and August 1989	76
Figure 29.	Estimated population of Glossy Ibises using the Water Conservation Areas during each month. The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	78
Figure 30.	Estimated population of Glossy Ibises using the total survey area during each month. The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	78
Figure 31a.	The distribution of Glossy Ibises in the Water Conservation Areas in December 1988, and January, February, March 1989	81
Figure 31b.	The distribution of Glossy Ibises in the Water Conservation Areas in April, May, June and August 1989	82
Figure 31c.	The distribution of Glossy Ibises in the Everglades Agricultural Area in December 1988, and January, February, March 1989	83
Figure 31d.	The distribution of Glossy Ibises in the Everglades Agricultural Area in April, May, June and August 1989	84
Figure 32.	Estimated population of Cattle Egrets using the Water Conservation Areas during each month. The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	86

Figure 33.	Estimated population of Cattle Egrets using the total survey area during each month. The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	86
Figure 34a.	The distribution of Cattle Egrets in the Water Conservation Areas in December 1988, and January, February, March 1989	88
Figure 34b.	The distribution of Cattle Egrets in the Water Conservation Areas in April, May, June and August 1989	89
Figure 34c.	The distribution of Cattle Egrets in the Everglades Agricultural Area in December 1988, and January, February, March 1989	90
Figure 34d.	The distribution of Cattle Egrets in the Everglades Agricultural Area in April, May, June and August 1989	91
Figure 35.	Estimated population of Roseate Spoonbills using the Water Conservation Areas during each month. The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	93
Figure 36.	Estimated population of Roseate Spoonbills using the total survey area during each month. The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	93
Figure 37.	The distribution of Roseate Spoonbills in the Water Conservation Areas in April and May 1989	94
Figure 38.	Estimated population of Great White Herons using the Water Conservation Areas during each month. The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	96
Figure 39.	Estimated population of Great White Herons using the total survey area during each month. The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances	96

EXECUTIVE SUMMARY

This report covers the 1988-1989 dry season surveys of the Systematic Reconnaissance Flight (SRF) program of aerial surveys in the Water Conservation Areas (WCAs) and the Everglades Agricultural Area (EAA). This is the third season of surveys conducted by National Audubon Society (NAS) personnel and the fifth dry season overall for the Water Conservation Areas. This season is the first time the Everglades Agricultural Area has been surveyed.

The SRF program was conceived to determine foraging habitat requirements and to map movements of the colonial wading birds (herons, egrets, storks, and ibises) using the system. It is a cooperative program involving Everglades National Park, the South Florida Water Management District, Florida Game and Fresh Water Fish Commission, and the National Audubon Society. This year (1988-1989) coverage was expanded around Everglades National Park and Big Cypress Preserve, and NAS added over 2800 km² of the Everglades Agricultural Area. Researchers from the University of Florida began conducting similar surveys in Lake Okeechobee this season, as well.

Surveys were conducted along 64 east-west transects spaced at 2 km intervals in WCAs 1, 2A, 2B, 3A, 3B, and in the EAA. They were flown in Cessna 182 aircraft at an altitude of 200 feet and at 80 knots. Two observers counted the numbers and species of wading birds in 150-m-wide strips on the ground on both sides of the airplane. The transects were divided into 4 km² blocks or cells. The transect number and longitude for each bird was recorded, allowing it to be assigned to a particular cell. These surveys cover 15% of the survey area. Surveys were flown monthly from December, 1988 through June 1989, and in August 1989.

The most prominent feature of the 1988-1989 season was drought. The 1988 wet season ended early, and fall 1988 was warm and dry. The 1988-1989 winter was also exceptionally dry, and relatively warm. By the December survey, the Water Conservation Areas were drier than in March 1988. By February, the area was drier than it has been since spring 1985 and by June it was virtually all dry. Bird populations responded by moving into the WCAs in larger than usual numbers, probably because peripheral wetland areas were dry.

During the dry season, wading bird populations in the Water Conservation Areas ranged from 14,000 in June to 137,000 in March. In the wet season (August) survey fewer than 13,000 birds were present. In December 1988, birds were spread throughout the WCAs, except for the dry

areas in the north and west sides. As the season progressed, the birds shifted south and east. By April, most of the birds were in a 15-km band along the L-67 levee in WCA 3.

Great Egrets (*Casmerodias albus*) were the second-most common birds in the WCAs in most months after White Ibises. Dry season population estimates ranged from 3500 in August to 29,600 in March. These are the lowest and highest population estimates, respectively, for Great Egrets in the five years of dry season surveys. The March total included most of the Great Egrets in the whole Everglades system. In the EAA, Great Egrets numbered fewer than 300 birds in each month from December through April, then climbed to 1300 in May, 2000 in June and 6600 in August.

The population estimates for Great Blue Herons (*Ardea herodias*) in the WCAs ranged from 400 in August to 5800 in March. In every month except June, most were in WCA 3A. In the EAA, population estimates ranged from 33 in June to 327 in February.

Small dark herons include Tricolored Herons (*Egretta tricolor*) and adult and pied Little Blue Herons (*E. caerulea*). From the airplane, these species could not always be distinguished and therefore we combine them here. Population estimates in the WCAs ranged from 1270 in August to 8960 in January. The small dark heron populations peaked earlier than those of the other species, and then declined each month through the spring. In the EAA, numbers ranged from 20 in April to 2100 in August. Most of the small dark herons seen in the EAA have been Little Blue Herons.

Small white herons include Snowy Egrets (*E. thula*) and white immature Little Blue Herons. In the past, we have also included Cattle Egrets (*Bulbulcus ibis*), but we believe we can distinguish them consistently enough that we are now treating them separately. In the WCAs, population estimates ranged from 1200 in August to 8200 in February. In the EAA, numbers ranged between 26 in April and 500 in June, then jumped to 7900 in August.

Cattle Egrets were never very common in the WCAs. Numbers ranged from 0 in February to 1100 in May and 2260 in June. Most of the birds in May and June were feeding in a 38,000 acre area in WCA 1 that had burned during May. In the EAA, however, numbers ranged from 7000 in March to 88,000 in August. Numbers were bimodal, with a peak of 33,000 in December, a decline through March, then a rapid rise to the August throngs. In the EAA, Cattle Egrets used virtually all habitats available, although they seemed to prefer most other habitats to sugar cane.

Wood Stork (*Mycteria americana*) numbers in the WCAs ranged from 7 in August to 7800 in March. The latter figure may be nearly half of the entire U.S. population. It is also by far the largest stork count in the history of the SRF program. Evidently, the WCAs are extremely important stork habitat during drought years. In the EAA, stork numbers were insignificant except in August, when 3400 were found. The latter figure is important as it confirms the impression of ground-based observers that the EAA is important wet season habitat for storks.

White Ibis (*Eudocimus albus*) numbers in the WCAs varied from 3800 in June to 78,000 in March. The March peak was very similar to the peak populations in the previous years, and probably represents a major fraction of the ibis population of southeastern Atlantic states. Ibis numbers in December, January, February, April and May were higher than in previous years. In the EAA, numbers were small until 1000 showed up in June, and 9900 in August.

Glossy Ibises (*Plegadis falcinellus*) were not recorded in the WCAs in June. Otherwise, numbers ranged from 600 in August to 5500 in February. The numbers for the months January, February and April were all higher than had been recorded on previous SRF surveys, and attest to the attractiveness of the season's rapid dry down. In the EAA, numbers varied from zero in February, March, and April to a remarkable 11,000 in August. This is the largest concentration of Glossy Ibises we know of in Florida.

Analyses of habitat selection indicate that wading birds in the WCAs tend to avoid dense sawgrass and cattail habitats and shrub strand habitats, and prefer tree-island dominated habitats. Great Blue Herons and Great Egrets tend to prefer wet areas to transitional areas, while ibises and storks prefer transitional areas. All avoided dry areas.

ACKNOWLEDGEMENTS

This work was conducted under contract #396-M87-0345-A2 from the South Florida Water Management District. We thank Peter David, J. Walter Dineen, James F. Milleson, and Vyke Osmondson of the South Florida Water Management District for their advice and generous support of this project. Discussions with Reed Bowman, Paul Cavanagh, Martin Fleming, Peter Frederick, Theo Glenn, Susan Jewell, John Ogden, William B. Robertson, Jr., James Schortemeier, Devi Sharp, and Allan Strong have contributed much to the continued success of this project. Reed Bowman, Mary Carrington, Theo Glenn, Susan Jewell, Allan Strong, Dan Taylor, and Cindy Thompson flew as front seat observers on various surveys. The pilots of James Wyatt Enterprises, Inc., successfully and safely flew the surveys for us. Alexander Sprunt IV read and commented on an earlier version of the manuscript. Ann M. Bancroft generously provided original artwork for the cover and text. Theo Glenn's help in creating and revising figures, as well as data entry, was indispensable. Cindy Thompson's digitizing talents provided us with several maps for our figures. James McCann efficiently helped with data entry whenever called upon. We are, as always, especially indebted to Nancy Paul, who remained cheerful through countless revisions, provided us with sage advice and comments, and somehow magically assembled and produced the final draft for us. We thank all these people and institutions for their help.

INTRODUCTION

This report covers the fifth dry season of Systematic Reconnaissance Flight (SRF) surveys of wading birds in the Water Conservation Areas (WCAs). This is the third season of surveys by National Audubon Society (NAS) personnel and the third annual report.

The SRF program began in 1984 with a pilot study in Shark Slough and adjacent areas of Everglades National Park (ENP). The pilot study, organized by Martin Fleming, was used to measure the efficacy of the SRF method and to determine optimum flight parameters (altitude, ground-speed, strip widths, percent coverage). In 1985, the program was expanded with participation of the South Florida Water Management District (SFWMD) and the Florida Game and Fresh Water Fish Commission (FGFWFC), to include the Water Conservation Areas and the Big Cypress National Preserve. Following the 1985-1986 dry season, the SFWMD contracted with the National Audubon Society for the surveys of the Water Conservation Areas. For the 1988-1989 dry season, the survey area was expanded to include the Rotenberger Tract, Holey Land, and the Everglades Agricultural Area (EAA).

The methods section of this report includes a description of our survey grid and our data collection and analysis systems. In the results section, we describe seasonal patterns of wading bird abundance and distribution, and habitat use. The birds' habitat use is analyzed with respect to major vegetation associations and to our water categories.

METHODS

In our 1986-1987 and 1987-1988 annual reports, and in our comprehensive report covering the years 1985-1988, we described the theory behind our transect sampling method and analyses. The same methodology was used in the 1988-1989 surveys. This section describes our survey area, survey procedures, data management and analyses, and map production. Finally, we describe our analysis of the relationship of bird distribution in the Water Conservation Areas to vegetational associations and water distribution.

Survey Area. This report covers surveys conducted in the Water Conservation Areas, and in the Holey Land and Rotenberger Tracts, and the Everglades Agricultural Area (Fig. 1). The survey tract in the Water Conservation Areas covers approximately 3600 square kilometers. The added areas include slightly more than 2800 square kilometers, for a total of over 6400 square kilometers. The study area is bounded on the south by U.S. Highway 41 (Tamiami Trail). On the east it is bounded by the L-8, L-40, L-36, L-35A, L-35, L-37 and L-30 levees. These extend from the eastern shore of Lake Okeechobee south of Port Myakka southeast to the eastern boundary of Arthur C. Marshall Loxahatchee National Wildlife Refuge, south along the Sawgrass Expressway to Interstate 73, west to U.S. Highway 27, south to State Road 944 and to Tamiami Trail. On the north, the area is bounded by the shore of Lake Okeechobee and by a line from South Bay west to the L-2 canal. The western boundaries are the L-2 canal in eastern Hendry County, the L-3 canal, and the L-28 canal, separating the WCAs from the Big Cypress National Preserve.

The Water Conservation Areas are vegetated with a variety of Everglades vegetation, ranging from sawgrass marshes, to cypress strands, to tree islands interspersed with *Eleocharis* sloughs. The Rotenberger Tract and the Holey Land are sawgrass marshes, but both are extensively invaded by Wax Myrtle and other brushy vegetation. The Everglades Agricultural Area is intensively cultivated. The predominant crop is sugar cane. Sod farms are common, particularly in the southern and eastern parts. Smaller acreages are devoted to rice culture and vegetable crops. A strip along the western edge is used as grazing land for cattle.

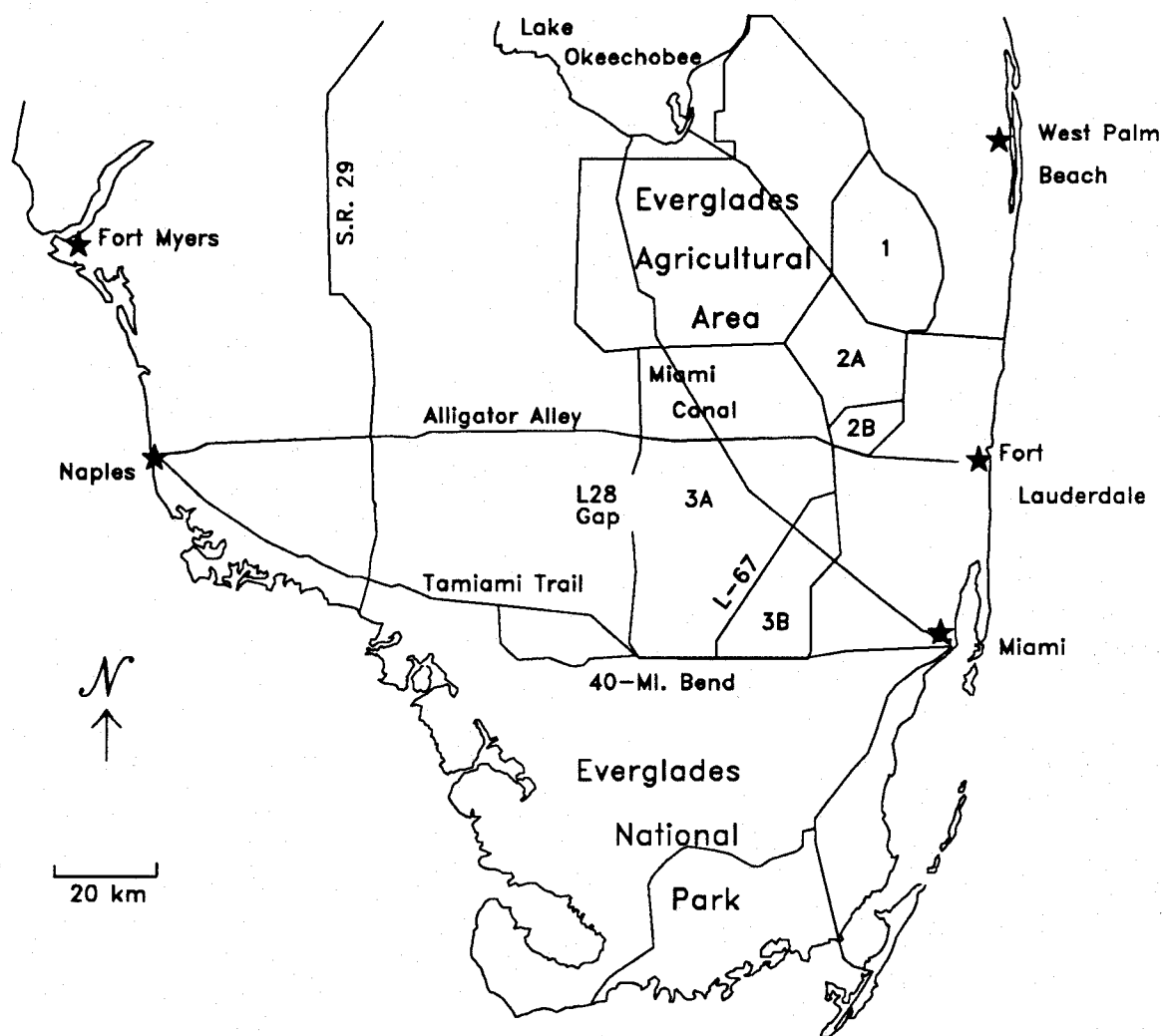


Figure 1. Study area in south Florida showing Everglades Agricultural Area and Water Conservation Area landmarks.

Survey Personnel. This project is being conducted by the Ornithological Research Unit of the National Audubon Society under the direction of G. Thomas Bancroft, Ph.D., Principal Investigator. Wayne Hoffman, Ph.D., Research Biologist and Richard J. Sawicki, Research Assistant, were hired to perform the field data collection and the data analyses. Reed Bowman, Susan D. Jewell and Allan M. Strong, Research Biologists and Mary Carrington, Theo Glenn, Dan Taylor, and Cindy Thompson, Research Assistants, assisted as front seat observers.

Survey Procedure. The surveys are conducted in a Cessna 182 fixed-wing aircraft chartered from James Wyatt Enterprises, Inc., based at Homestead General Airfield, Dade County. The plane is equipped with an Apollo LORAN C navigational receiver, and a Radar altimeter as well as normal safety and navigation equipment. The survey consists of a series of east-west transects spaced 2 km apart. The transects are flown at an altitude of 200 feet (controlled by the radar altimeter) and at a ground speed of 80 nautical miles per hour. All wading birds detected in strips 150 m wide along both sides of the transect lines are recorded and located by recording the longitude from the LORAN C. The LORAN C is also used to keep the plane on the transect lines. We require that the plane be kept within 0.10 minutes latitude ($\pm$ 600 feet) of the transect line.

Three biologists plus the pilot flew on each survey. An intercom system on board allowed communication among the biologists. The two biologists in the back seat recorded all of the wading birds observed within 150 m strips paralleling the plane's path. These strips were defined by wax-pencil marks on the windows and on the plane's struts. When birds were sighted in the strips, the back seat observers would call for a position recording over the intercom, and record species, number, behavior, and the longitude reported by the front seat observer. The front seat observer also recorded water condition, locations of recent large burns, vegetational categories, and monitored the pilot and instruments to assure that the plane maintained the proper altitude, latitude, and speed. Tricolored Herons and Little Blue Herons could not always be identified to species. Unidentified ones were lumped into the category "small dark herons". Snowy Egrets and first-year Little Blue Herons also were not always identified to species, and unidentified ones were called "small white herons".

The transects are laid out at 2 km intervals on a "pseudo-UTM" grid, set up by Dave Buker of Everglades National Park. The transects are divided into 4 km² blocks, or cells (Fig. 2). The Water Conservation Areas occupy transects 5 (north end of WCA 1) through 54 (parallels Tamiami Trail, through the south end of WCAs 3A and 3B); and cells 108 (western edge of WCA 3A) to 139 (eastern edge of WCA 1). A total of 898 cells fall within the boundaries of the Water Conservation Areas. We recorded birds only to the edges of the levees surrounding the WCAs, even when these fell in the middle of grid blocks.

The Everglades Agricultural Area extends the survey area west to cell 103. It also extends north of the original grid, and we have created new transects, numbered 0 through -9 to cover the areas east of Lake Okeechobee. A total of 610 new cells are included, for a grand total of 1508 4 km² cells.

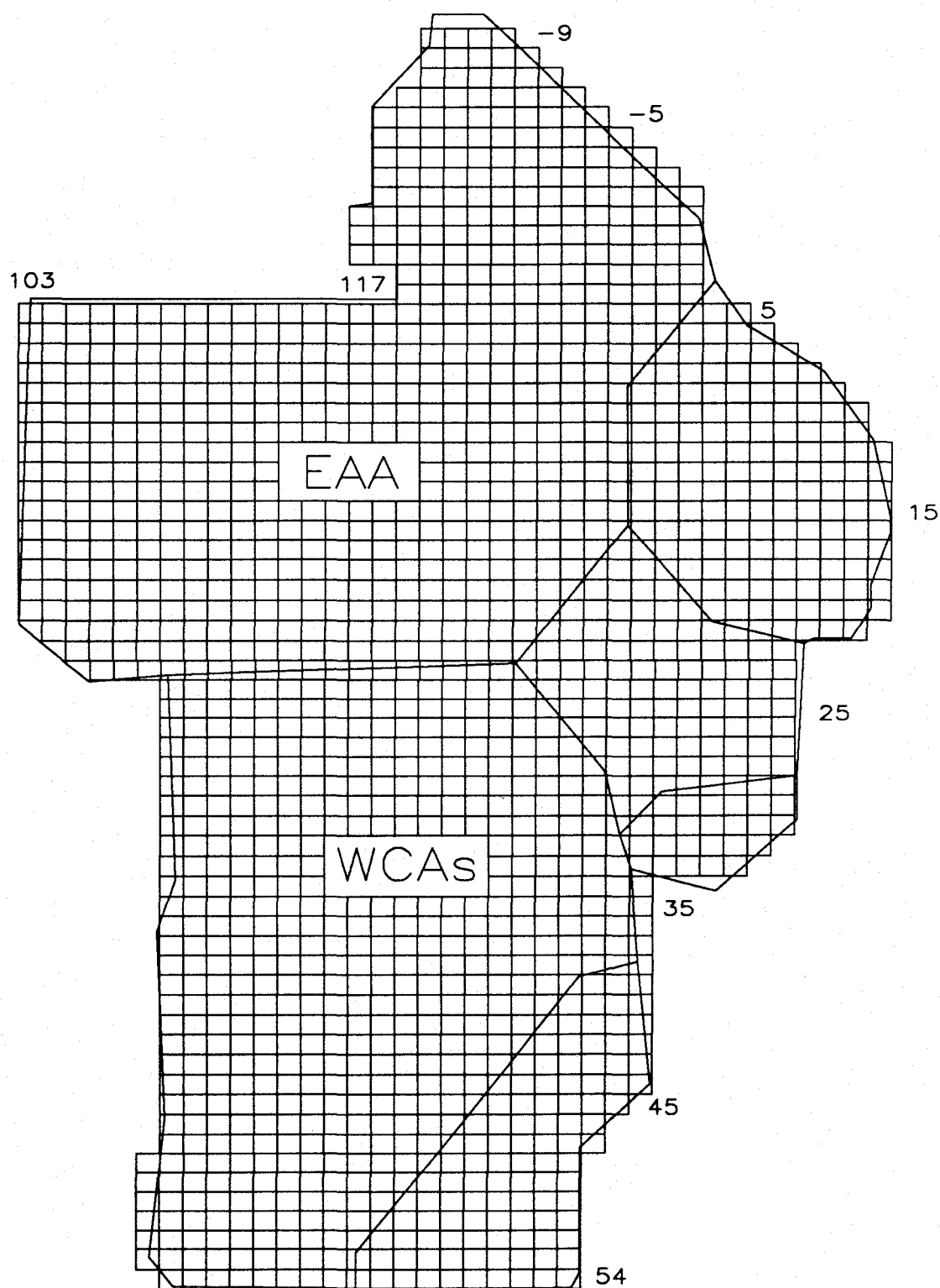


Figure 2. The survey grid of 4 km² cells superimposed on outline maps of the Everglades Agricultural Area (EAA) and Water Conservation Areas (WCAs).

Data Management. The original data management and entry system for the SRF program was developed by Dave Buker of Everglades National Park. A package of Entry and Analysis programs was written to run on ENP's Wang computer. The SFWMD and FGFWFC researchers brought their data to ENP to analyze on the Wang computer. When NAS contracted to perform the WCA surveys, we developed a database management and entry system that runs on our IBM PC-AT and IBM PC-XT microcomputers. We feel that the critical components of a data management program are 1) a data entry system that is labor-efficient and that minimizes the creation of errors during entry, 2) an efficient and effective data-verification system, 3) an efficient file-management system, and 4) an effective data back-up system.

We use the dBASE III+ data management system (Ashton-Tate Corp.). Data are entered directly from the field data sheets, avoiding the labor and errors associated with hand-transcription. Our data-entry programs, written in dBASE, incorporate a variety of error-prevention and labor-saving features. Information that remains constant for a transect (e.g. date, transect number) are entered only once, and automatically added to each record. The remaining data are entered using an input screen that prompts each entry. Data type restrictions prevent many errors. If letter keys are hit while entering data in a numeric field, for example, the data are rejected and a warning bell sounds. Attempts to enter more key strokes than permitted also trigger warning bells. At the end of a record the program loops to accept the next record but displays the previous record's data. The contents of the individual data fields can be repeated with a single keystroke, rather than requiring reentry. Thus, in effect, entry of a record involves editing a copy of the previous record. The display of the previous record also provides an opportunity for discovering errors in that record.

After data is entered, it is hand-proofed against the data sheets, and corrected. Proofing includes both record-by-record examination and scanning of columns. We periodically back up the system by making two copies on diskettes of each file. One set of disks is kept in the office, and the other is kept at a distant location. A copy of the bird portion of the data is transferred to the Everglades National Park, for use in pooled analyses.

Data Analysis. The SRF program package developed by Dave Buker for the Wang computer included modules that calculated density with confidence intervals, and printed maps of distribution. ENP is in the process of retiring their WANG computer, so the SRF functions are being

transferred to micro-computers using MS-DOS operating systems and to a GIS system being installed in the park.

We have written an analysis program that essentially duplicates the analyses done by the SRF analysis program running at ENP. Our program reads in the data from the storage files sorted by species, assigns each observation to its appropriate 4 km² cell, calculates a density estimate for each cell, and assigns it to a relative density category. The program produces a set of summary statistics, including a total population estimate and the two variance and confidence interval estimates. It also produces the relative density categories, a table of occurrence and population estimates by WCA and a multipage map providing the count, density estimates and density categories for each 4 km² cell. The program also stores files of density and density category data for each 4 km² cell to floppy disks. These files are used in plotting density maps. In January 1989, we modified the program to include the additional transects and cells of the Everglades Agricultural Area. We now can run combined analyses or analyses only on the original study area. We have provided a copy of this program to FGFWFC biologists and helped them adapt it for their deer surveys in the WCAs.

Map Production. The SRF program package written by Dave Buker at ENP produces multipage printout maps with bird numbers, density, and density category printed on them. It also produces on the computer printer maps with the different density categories shaded in various hatching patterns. The hatching maps were used as templates for hand-coloring maps on mylar sheets.

We have developed a computer system for producing colored and hatched maps. This uses the Atlas Graphics software package from Strategic Locations Planning. Colored maps can be produced on paper or on mylar sheets on a Hewlett-Packard 7475A Graphics Plotter. Black-and-white maps can also be produced on the plotter, or they can be produced, at higher resolution, on a laser printer.

In our monthly analyses we plot maps of relative density for each species-category and for all species combined. These relative density categories are produced by taking the highest cell-density value found for the species-category in the survey, and scaling density from it. Category 1 includes cells with density greater than 0 but less than one-eighth of the maximum cell density.

Category 2 is from one-eighth to three-eighths, category 3 from three-eighths to seven-eighths, and category 4 includes cells with densities over seven-eighths of the maximum cell density. These maps are prepared in color. They are not included in this report but are on file with the South Florida Water Management District.

In the annual reports (including this report), we have mapped bird distributions in black and white, using a different scaling method. The density categories are scaled from the highest cell density encountered in any of the eight surveys in the season. The scaling system includes five categories rather than the four used in the monthly reports. Category 1 includes cells with a density of 1.67 birds per km² (cells where only one individual was recorded). Category 2 includes cells with densities greater than 1.67 but less than one-tenth of the overall maximum density. Category 3 is from one-tenth to three-tenths maximum, category 4 is from three-tenths to seven-tenths maximum, and category 5 is from seven-tenths to maximum density. The different density categories are distinguished by a series of hatching patterns, such that the density of hatching reflects the bird density. Density category 1 uses wide-spaced horizontal hatching, category 2 uses wide-spaced vertical hatching, category 3 uses densely-spaced diagonal hatching, category 4 uses dense crosshatching, and category 5 uses solid black cells.

This second scaling system has several advantages, although it cannot be used until all surveys have been conducted. First, it facilitates comparisons among months. Because the same scale is used for all surveys in the season, the density categories are the same for all maps in a season for a species category. Second, the first density category is defined by the occurrence of a single individual in the cell, so it can be used as a rough index of sociality. Species having a preponderance of category 1 cells are considered less social than ones with fewer category 1 cells. Third, the addition of a fifth category improves resolution. Fourth, this scaling scheme provides more resolution at the lower end of the scale, where the great majority of sightings occur.

The maps in this report have been produced in Atlas Graphics, exported as HPGL files, loaded into WordPerfect 5.0, and printed on an Apple Laserwriter IINT Laser Printer.

Vegetation Analyses. Beginning in February 1987, we recorded the major habitats (vegetation associations) we could identify from the plane during each survey to look for correlations with patterns of wading bird distribution and abundance. These were recorded on a very broad

scale so that each 4 km² block is assigned to a single category and most habitat patches recorded include many 4 km² blocks. A finer resolution could not have been accomplished without interfering with our primary responsibility of surveying birds. We used 8 general vegetation categories. "Dense Grass" is essentially continuous coverage of sawgrass, cattails, sedges, reeds, or grasses. "Open Grass" has stands of sawgrass and other grasslike plants interspersed with at least 25% (by area) open water (or exposed mud). Typically the water forms long narrow sloughs and pools, generally oriented north-south. Areas with tree islands form 2 separate categories, named "Tree Islands Open" and "Tree Islands with Grass". In the latter the area between islands is filled with dense grass, while the former have sloughs and pools with some open water, equivalent to those in the Open Grass category. The largest individual tree islands were recorded separately, but only two were large enough to be recorded consistently. One is John Buck island in the southern part of WCA 3A, and the other is located in the southern half of WCA 1. "Cypress" is used for areas along the western margin of WCA 3A with cypress trees interspersed with sloughs and sawgrass. "Shrub Strand" is used for areas of dense grass with large numbers of shrubs (often willows) interspersed. They differ from tree islands in having the shrubs spread out and surrounded by grass rather than clumped. "Open Water" is used for relatively large areas of water, generally with water lilies, but with little if any interspersed sawgrass.

The vegetation categories were recorded by the front seat observer. Vegetation maps differed substantially from month to month. Some areas changed from one habitat category to another between months as the dry season progressed. As water levels receded, the slough or pool portions of Open Grass and Tree Islands Open areas became exposed, and often grew a dense cover of shorter grasses, sedges, and rushes. These areas were then recorded as Dense Grass, and Tree Islands with Grass, respectively. The Open Water areas also decreased as the water receded. Other month-to-month changes resulted from recording lapses. Sometimes, when the front seat observer was busy with other tasks the vegetation code was not changed until well after passing into a new habitat.

We created wet and dry vegetation maps based on the 1987 data (included in our 1986-1987 annual report) and separate vegetation maps based on the 1987-1988 dry season data (included in our 1987-1988 annual report). We regard the 1987-1988 season maps the best we can produce with the data through June 1988 so we repeat those maps in this report. December,

January, February, and August were considered wet, and the March, April, May, and June surveys were dry. Monthly vegetation maps were plotted and single consensus "wet" and "dry" maps were produced by comparing the features of the monthly maps and correcting obvious lapses and inconsistencies (Fig. 3).

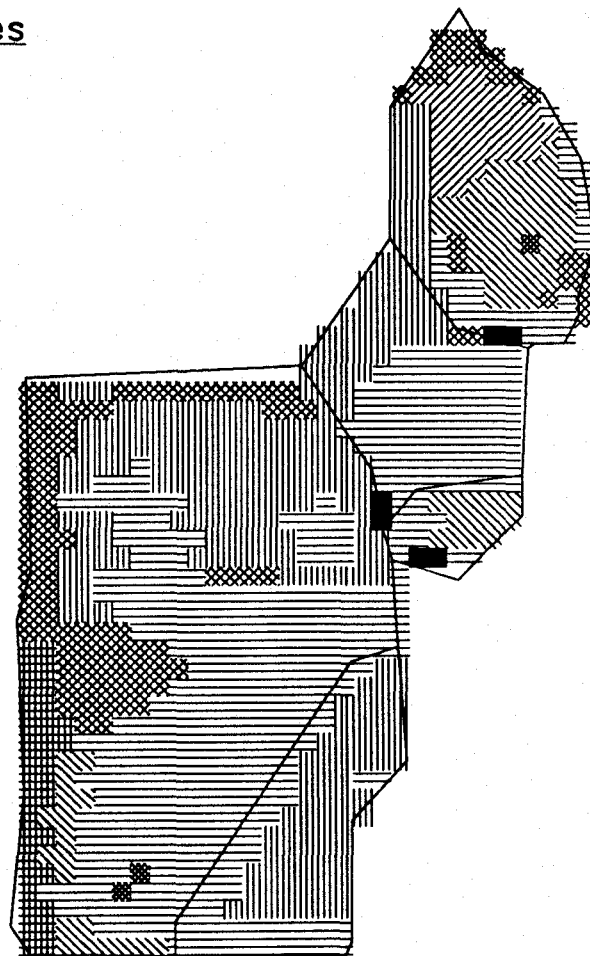
We have not extended the vegetation mapping to the Everglades Agricultural Area. The EAA is a mosaic of 40 acre fields in various stages of cultivation and harvest, so mapping at a 2-km scale would be meaningless. We do record the vegetation type with each bird sighting, but we are unable to use these data in the same analyses because we do not know the relative abundance of the agricultural vegetation categories. The categories are 1) Plowed Field for cultivated land without visible crops; 2) Young Cane for immature sugar cane that is small enough that much soil is still visible between the plants; 3) Cane for mature sugar cane; 4) Harvested Cane for sugar cane fields with cut stalks or cane residue covering the ground; 5) Fallow for fields grown up to weeds; 6) Sod for sod-grass fields; 7) Rice Paddy for fields in rice cultivation; 8) Flooded Field for other fields covered with water; 9) Vegetable Fields for row crops; and 10) Pasture for grazed land. The EAA also includes a single section of orange groves.

Water Analyses. In December 1988, we recorded water conditions in three categories, as in previous years: Dry, Transitional, and Wet. At the request of Martin Fleming, we changed our water condition recording to a 5-category system beginning with the January 1989 survey.

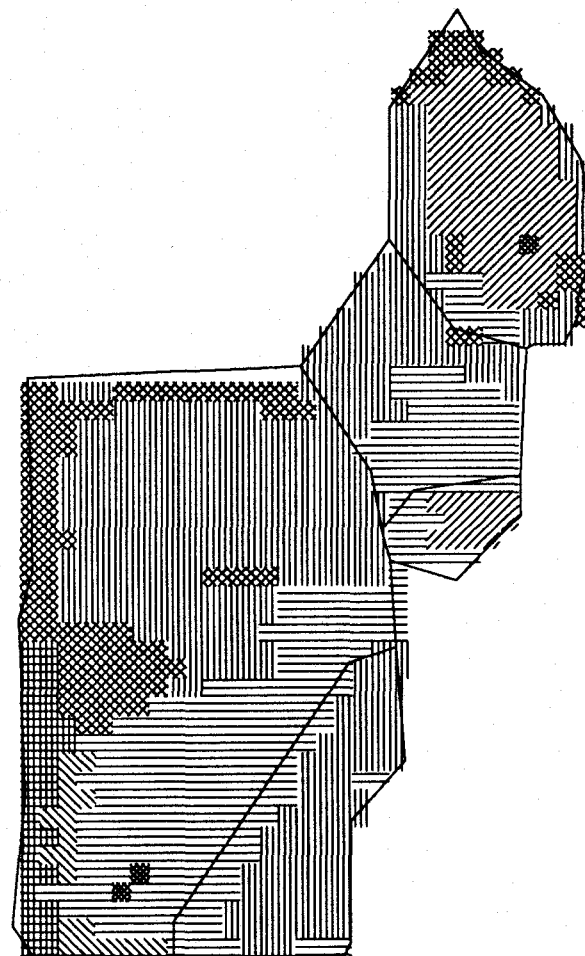
These water data were coded numerically and transferred to computer files for mapping. Each 4 km² cell is assigned a single water category code. Colored maps were produced monthly, and area on file with the SFWMD. For this report, water maps have been produced in black and white.

Correlates of Abundance and Distribution. In our 1986-1987 and 1987-1988 annual reports we examined the associations of wading birds with vegetation categories and with particular water conditions separately using tests of random dispersion (G-tests) in 2-way contingency tables. For the present report we use a more sophisticated approach, Hierarchical Log-Linear Analysis. This approach allows us to ask additional questions about these associations, and to get more detailed answers to the questions we have asked in the past. The field of Hierarchical Log-Linear

Vegetation Categories



WET MONTHS



DRY MONTHS

Figure 3. Vegetational categories found within the Water Conservation Areas based on our aerial surveys in 1987 and 1988.

Analysis is extensive and complex, so we will give here a very brief introduction, and then describe in more detail the particular applications that we are using. Hierarchical Log-Linear Analysis is a powerful approach to analyzing categorical data in multi-way contingency tables. Rather than simply analyzing the relationships between two variables, multiple variables can be analyzed simultaneously. This allows the detection of complex interactions among several variables, as well as the 2-way interactions discoverable in our previous approach. Hierarchical Log-Linear Analysis also can do a better job than simpler analyses in determining which particular cells in a contingency table contribute most strongly to a significant effect. Thus, we may be able to determine whether a strong interaction between bird distribution and vegetation categories results from avoidance of Dense Grass, from a preference for Tree Island Open, and so on.

We used Hierarchical Log-Linear Analyses to study the roles of vegetation patterns and of water conditions in determining the distribution of wading birds in the Water Conservation Areas. This analysis includes an examination of possible complex interactions between water conditions and vegetation in determining bird distribution.

For these analyses, data files were constructed that had one data record for each of the 898 cells in the grid. One file was constructed for each survey month. Each record contained the cell name, the density codes categorizing bird density for the eight species and species groups, and the vegetation category of the cell. Each record also contained the water condition code for the survey month and for up to 7 previous months (August files included data from each month in the survey season, June files included only December through June, etc.). We conducted the analyses using density data for Great Egrets, Great Blue Herons, and White Ibises. We also used Wood Stork data, but only for the months January through April of the two years. We did not use data from the small dark and small white herons because we were concerned that the lumping of species in these categories would obscure single-species patterns, and would possibly create combined-species patterns that were artifacts of the lumping procedure. Great White Herons, Roseate Spoonbills, and Glossy Ibises in all months and Wood Storks in December, May, June, and August were considered too uncommon to be worth analyzing.

We used the HiLoglinear procedure in the SPSS PC+ statistical program (SPSS Inc.) for these analyses. For each month we constructed a saturated log linear model for a 3-way contingency table containing bird density categories, vegetation categories, and water categories. By

definition the saturated model includes all possible interactions, and explains all the variance (heterogeneity) in the table. We then constructed a series of unsaturated models, removing the higher-order interaction terms, one at a time. The Likelihood Ratio χ^2 value reported for each model represents the variance (heterogeneity) not explained by that model and hence attributable to the higher-order terms left out. Thus the χ^2 value reported for the first unsaturated model (excludes the 3-way interaction; includes all 2-way and 1-way terms) is attributable entirely to the 3-way interaction. The next model excludes the 3-way interaction and one 2-way interaction (excludes the vegetation x water interaction). Its χ^2 is attributable to the two excluded interactions, and because the 3-way effect is already known, the χ^2 for the vegetation x water interaction can be determined by subtraction. Similarly, as the remaining effects are removed, their contributions can be determined by further subtractions.

For interactions with significant χ^2 values, the relative contributions of different cells to the interaction can be examined by looking at the parameter values for the contingency table cells. The SPSS printout provides standard errors and z-values for these parameters. A positive parameter value with a z-value greater than 1.96 indicates that that cell contains a significant associative relationship between the variables. A significant negative parameter value (z-value less than -1.96) indicates a significant disassociative (avoidance) relationship. Unfortunately, in many cases, a significant interaction may not be attributable to a single cell or set of cells, but may be the result of individually non-significant deviation in many cells. In some cases the degrees of freedom (D.F.) for the χ^2 values are uncertain. SPSS reports "unadjusted" D.F. and "adjusted" D.F., in which one degree of freedom is subtracted for each cell of the multi-way contingency table with an expected value of zero. The unadjusted D.F. provides an upper bound to the actual D.F., while the adjusted D.F. is generally an underestimate. We chose to use the unadjusted D.F. In our applications, the unadjusted D.F. is probably an overestimate on the 3-way interactions, so we may be making type II errors (failing to recognize some significant interactions). For the two-way interactions, D.F. is determined by subtraction, and therefore adjusted and unadjusted values are usually very similar.

The relationships between bird distribution and environmental conditions are to a degree obscured by the method of data collection. Ideally, only foraging birds should be included in these analyses as birds may choose different habitats for roosting and nesting than for feeding, and may fly over still other habitats. We did not separate out only foraging birds for a couple of reasons. First, many birds we recorded as flying were flushed by the plane and may have been foraging in

the immediate area. Second, birds standing on the ground were usually assumed to be foraging but this may often be incorrect.

We also used Hierarchical Log-Linear Analysis to test the hypothesis that water conditions a month before a survey may be important in determining bird distribution (primarily through effects on prey distribution). For this analysis we used data from January through August 1989. We did not use the December survey because the previous month's (November) water conditions were unknown. We conducted this analysis using distribution data for Great Egrets, Great Blue Herons, and White Ibises. Our saturated model included the 3-way interaction birds x concurrent water condition x water condition on the preceding survey. Interaction terms were removed stepwise as in the previous analysis.



RESULTS

Surveys were usually flown during the first full week of each survey month. In the February and March surveys, our flights began on the last two days of the previous month and continued into the current month in order to achieve a more even spacing of surveys throughout the survey period. Survey dates are listed in Table 1. All transects were successfully flown in all but three survey months. These omissions usually involved a single transect and were most often attributable to localized storms and/or time constraints. Most of these transects were deemed expendable due to lack of water and hence, foraging birds. Several times this year we flew part of a transect (or group of transects) to avoid a local storm and then flew the remaining portion later that day or the next day.

The results section begins with a presentation of abundance estimates and distributional patterns for all species combined. We then present an analysis of the water categories recorded during the surveys. Species accounts form the remainder of the results. These accounts include presentations of the seasonal abundance and distributional changes of each surveyed species. Lastly, we present correlates of abundance and distribution, species-specific patterns of habitat use for a select number of species.

Abundance and Distribution. The overall abundance and distribution of wading birds in the 1988-89 dry-season surveys and August wet-season survey is shown in Table 2. Monthly totals

Table 1. Surveys completed and dates flown during the 1988-1989 season.

Month	Dates	Completed Transects
December	3,5,6,7,9	-9 through 54
January	3,4,5,6	-9 through 54
February	30 & 31 Jan; 1,2	-9 through 54; 0,2 omitted
March	27 & 28 Feb; 1,2	-9 through 54; 8 omitted
April	3,4,5,6	-9 through 54
May	1,2,3,4	-9 through 54
June	5,6,7,8	-9 through 54; 38 omitted
August	7,8,9,10,11	-9 through 54

Table 2. Estimated abundance of all species in 1988-1989 surveys.

Month	Water Conservation Areas						Everglades Agricultural Areas		
	1	2A	2B	3A	3B	Total	North	South	Total
December	34200	23147	5113	13860	1807	78127	15027	19527	112681
January	17807	23413	4633	59207	8280	113340	3113	18787	135240
February	8740	8213	22773	66140	10120	115986	2453	11640	130079
March	3947	6773	3527	80907	41947	137101	2947	4547	144595
April	2573	2027	453	66740	9460	81253	3293	6340	90886
May	4353	1187	2260	40933	2053	50786	5360	16100	72246
June	3313	6133	3707	360	427	13940	5533	24027	43500
August	2167	633	140	9700	227	12867	14887	114667	142421

for the Water Conservation Areas are listed separately, as are overall monthly totals for the entire survey area. Individual species abundances and distribution are presented in the species accounts at the end of this section. The dry-season population estimates varied by a factor of three from 43,500 in June to 144,595 in March. In the Water Conservation Areas alone, estimates ranged from 13,940 birds in June to 137,101 birds in March. The average estimate for all dry-season surveys in the WCAs (mean = 84,362) is substantially larger than both the 1988 average (mean = 63,142) and the 1987 average (mean = 57,460). These totals suggest that more wading birds were using the system in 1989; in all likelihood, a direct result of the 1989 drought. The drought caused an extreme dry down which allowed birds to feed in deep water sloughs usually inaccessible to most wading birds in most years.

In the WCAs, the December estimate is significantly lower than the following three months (Fig. 4). The peak estimates of March is significantly higher than all months except for January and February. From the period March through June, each successive population estimate is significantly lower than the preceding month, graphically demonstrating the exodus from the WCAs as the area totally dried out. In the total survey area (Fig. 5) population trends were similar to the WCAs, but smoothed out somewhat by the large "resident" Cattle Egret population. However, the March estimate is still significantly larger than the April, May, and June estimates. In the wet-season survey, the August estimate for the WCAs is significantly smaller than all dry season months but June. In the total area, however, the estimate is significantly larger than the April, May and June estimates, demonstrating the influx of birds into the EAA.

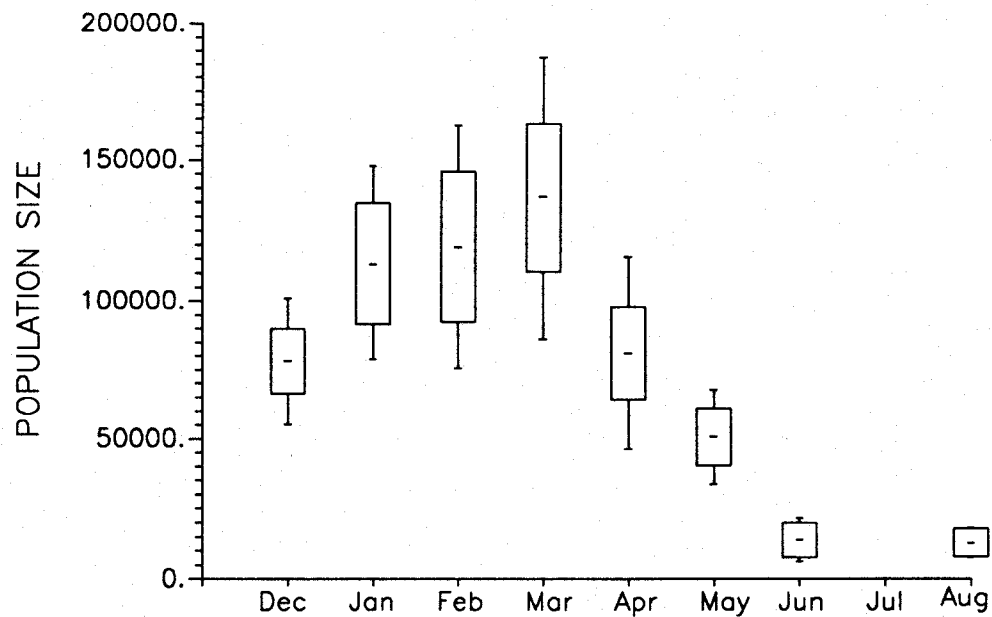


Figure 4. Estimated population of all species using the Water Conservation Areas during each month.

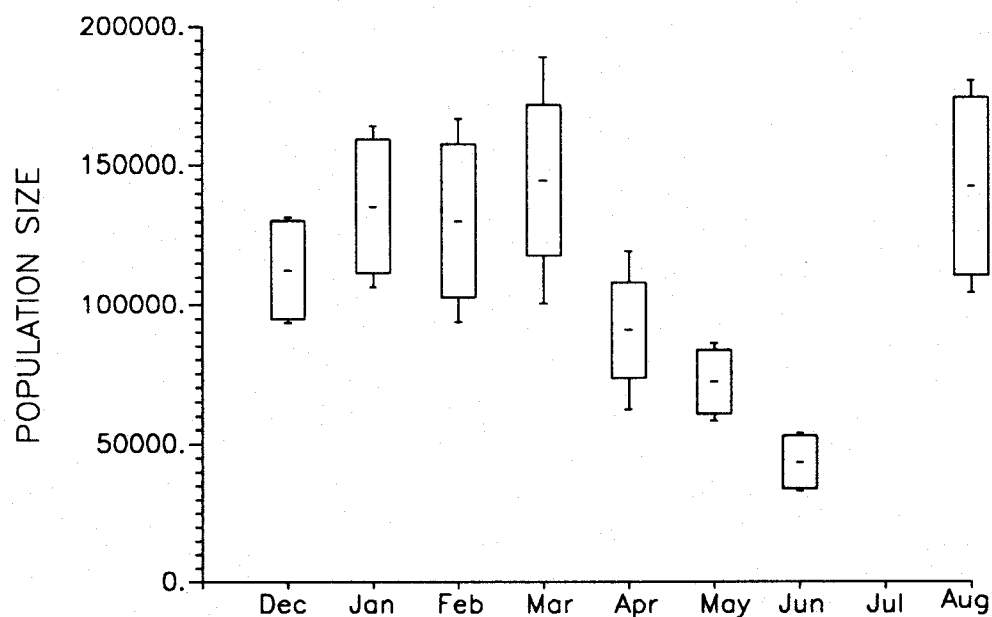


Figure 5. Estimated population of all species using the total survey area during each month.

The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances.

In WCA 1, overall population estimates ranged from 2573 in April to 34,200 in December during the dry season. WCA 1 ranked first only in December. After the December peak, bird numbers declined rapidly until April and then rose only slightly (Table 2).

Estimates for WCA 2A ranged from 1187 in May to 23,413 birds in January. WCA 2A ranked first only in June when all other areas were quite dry and water was being pooled at the south end of the area. Except for the slight increase in numbers in June, WCA 2A estimates were high in December and January and declined steadily thereafter.

Numbers of birds in WCA 2B varied widely from month to month. Population estimates peaked in WCA 2B in February when large flocks of mixed wading bird species were observed in the drying pools at the south end of the area. In that month, it ranked second in abundance.

WCA 3A ranked first in five out of the seven dry-season surveys. Estimates ranged from 360 estimated birds in June to 80,907 birds in March, 225 times more than the June estimates. Although the peak in March probably included many migrants, use of WCA 3A was very heavy from January through May.

Population estimates for WCA 3B ranged from 427 birds in June to 41,947 in March. Use of the area increased steadily from December through March and thereafter declined to the June estimate. WCA 3B ranked second in both March and April.

Use of the Everglades Agricultural Area was extensive during the dry season due to the abundance of Cattle Egrets. However, with the exception of the June survey, overall numbers of birds in the EAA was always less than were present in the WCAs (Table 2). In December 30.7% of all birds estimated were using the EAA. This percentage dropped steadily each month until March, when only 5.2% of all estimated birds were in the EAA. Interestingly, this is the month when wading bird use of the WCAs peaked. Although Cattle Egrets were at their lowest numbers in the EAA in March, they were not observed to be present in the WCAs. After March the percentage of birds in the Everglades Agricultural Area increased to a peak of 68% in June.

In the wet-season survey in August, WCA 3A again ranked first in species abundance (N = 9700), while WCA 1 ranked second (N = 2167). Use of the EAA was extensive, however. Nearly 130,000 birds were estimated for this area. Although Cattle Egret numbers were up considerably (N = 87,887), substantially more wading birds were in the area than had been present in any earlier survey. An estimated population of 41,667 wading birds were observed in rice paddies, flooded fields, and the refloded marshes of the Holey Land. This number is more than three times the number of wading birds using the Water Conservation Areas.

The maps of all species distribution (Fig. 6) are scaled from a maximum estimated cell density of 1763 birds/km² (= 1058 birds counted in one 4 km² cell). In the December survey, areas of concentration were located in the south central portions of WCA 1 and 2A. Overall, the northwest portion of the three largest areas were already drying out and lacked foraging birds. Bird use along the Miami Canal is clearly apparent, however, in the north end of WCA 3A. By January, the areas of concentration in WCAs 1 and 2A were shifted slightly south and east and a large area of concentration had formed in the central sloughs of WCA 3A, east of the L-28 gap. Very large flocks of mixed wading birds were observed along the airboat trails leading from the southeast corner of WCA 3B. In the February survey foraging distributions had shifted noticeably south in WCAs 1, 2A, 2B and 3A. Concentrations in 3A were still centered in the sloughs east of the L-28 gap. Very large flocks were also feeding at the south end of WCA 2B. Use of the deeper sloughs along the L-67A levee in WCA 3A was becoming more evident. The March map shows a dramatic shift in distribution in all areas. Use of WCAs 1 and 2A was largely restricted to the southern third. Birds were no longer foraging at the south end of WCA 2B. WCA 3A had birds closer to the south end of the area and much closer to the L-67A levee as the deeper sloughs dried out. Use of WCA 3B was also heavy, but more diffuse.

The April survey shows the tightest concentration of birds in WCA 3A. By April the area had become quite dry, except for a relatively narrow band along the L-67A levee and the extreme south end of the area. This time period also includes peak activity in the very large L-67 colony and a segment of the foraging population was associated with this colony. Use of WCA 1 and 2A was limited and largely restricted to the south ends. The distribution in WCA 3B was heaviest near the L-67C levee. The map of the May survey shows an interesting distributional trend. Although the overall distribution is still packed along the L-67A levee in WCA 2A, there is distinct shift of a segment of the foraging population to the west edge of the area, particularly near the L-28 gap. Some of the largest concentrations of birds occur here as well as the southwest corner of the area. This time period overlaps the beginnings of large scale nesting failures in the L-67 colony. Presumably, breeding birds from that colony were having to travel greater and greater distances to find suitable foraging habitat. Use of the other areas was similar to the April survey with the exception of WCA 1. A small number of birds were observed foraging in recently reflooded marsh along the east-central edge of the area. Cattle Egrets were also observed foraging in small numbers in the recently burned marsh along the west edge.

The June map is remarkable in its contrast to earlier survey maps. WCA 3A is mostly devoid of birds. By this time the L-67 colony had completely failed. Use of WCA 3B was scattered. The distribution in WCAs 1 and 2A was largely restricted to the south ends. In WCA 1, Cattle Egrets were again observed foraging in the burned marsh in the northwest corner of the area.

The wet season map in August shows scattered bird use. Most observations in WCA 3A were along the L-67A levee and east and south of the L-28 gap. A moderate number of birds were foraging in the reflooded dense sawgrass marsh at the north end of WCA 3A, east of the Miami Canal. This area had burned extensively during the drought. Although it was "greening up" in August, the fires had burned deep into the peat and created numerous openings in the dense sawgrass.

During all months of the dry season, the EAA contained moderate to large numbers of Cattle Egrets and small numbers of other wading birds. Use of the area was scattered. In January, the entire southwest corner of the area was avoided. In the wet-season survey, use of the area was heavy and the distribution map showed occurrence in nearly all parts of the area. Only the Rotenberger tract, Brown's Farm and the extreme northeast corner were largely avoided.

Water Analysis. Beginning with the January survey, we began recording water conditions using five water categories instead of the standard three. Discussions with M. Fleming of Everglades National Park convinced us that a finer degree of category discrimination could be achieved with five categories. The "wet" water condition category remained the same. Transitional conditions were separated into two categories. Wet transitional represented habitat where greater than 50% of the surface area was covered with water, but some dry land was observed. Dry transitional represented habitat where less than 50% of the surface area was covered with water. Since the transitional category had encompassed a very wide array of water levels (from barely any surface water to a nearly continuous sheet), the separation would allow us to look at water conditions in this important category much more critically. In addition, the dry category was also divided up into dry and sere. The dry category remained, by definition, the same. However, when conditions had dried out to such an extent that water levels were below ground level we called such areas sere. To determine sere, we used alligator holes and other natural and man-made features (such as tire ruts) which allowed us to visibly determine that water levels were below ground level.

Density Categories

Birds per Square Kilometer

No Birds

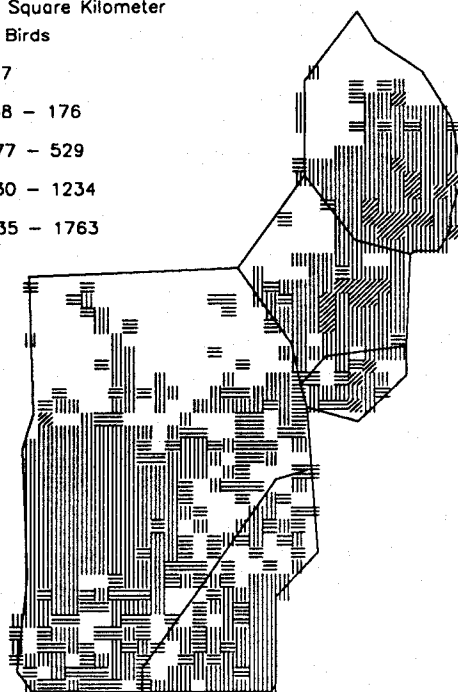
1.67

1.68 - 176

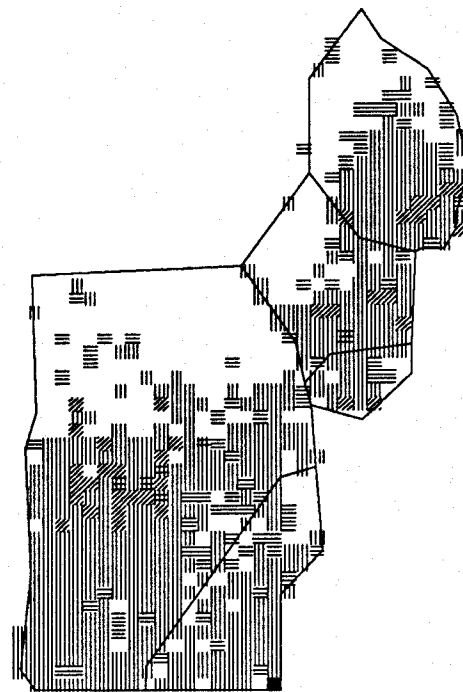
177 - 529

530 - 1234

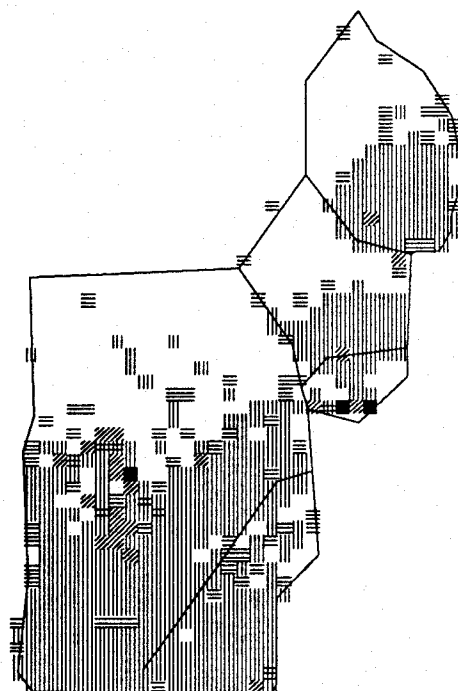
1235 - 1763



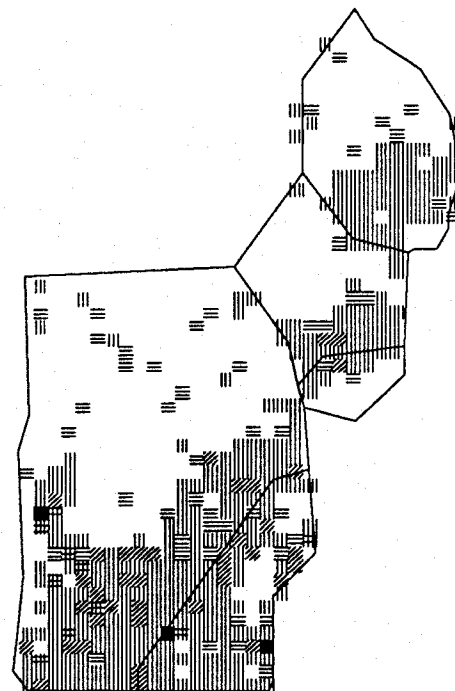
December 1988



January 1989



February 1989



March 1989

Figure 6a. The distribution of all species in the Water Conservation Areas in December 1988, and January, February, March 1989.

Density Categories

Birds per Square Kilometer

No Birds

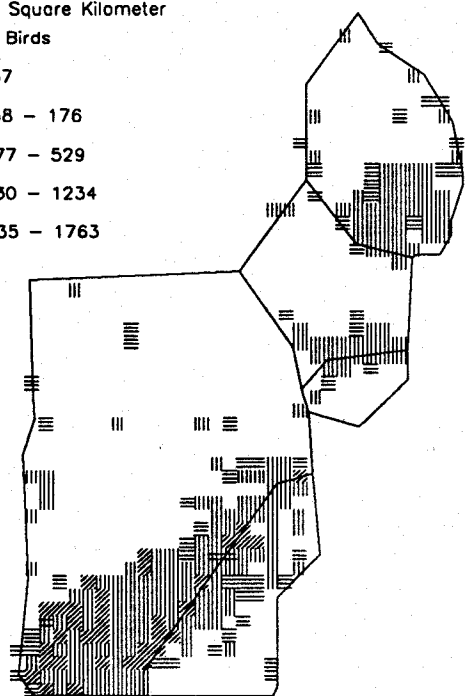
1.67

1.68 - 176

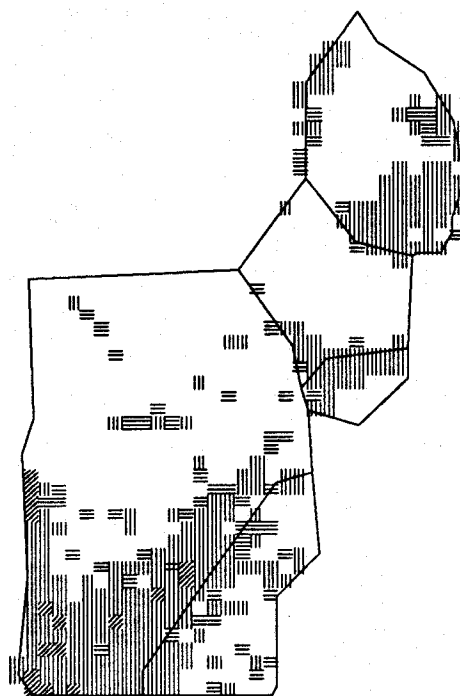
177 - 529

530 - 1234

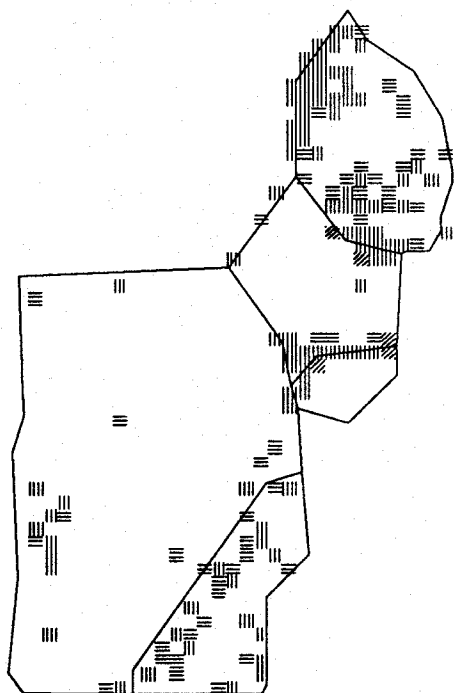
1235 - 1763



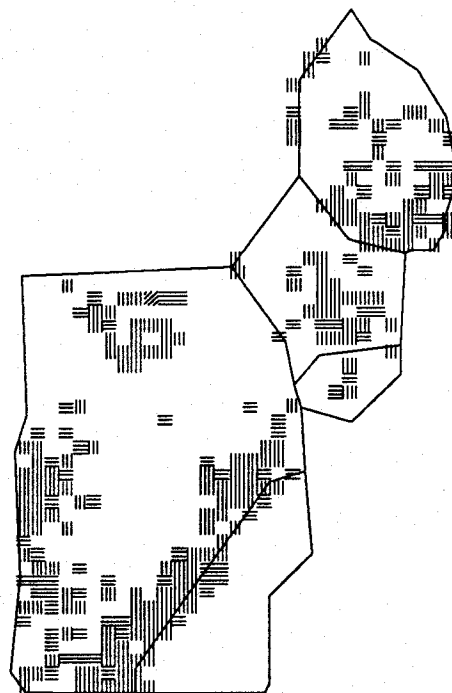
April 1989



May 1989



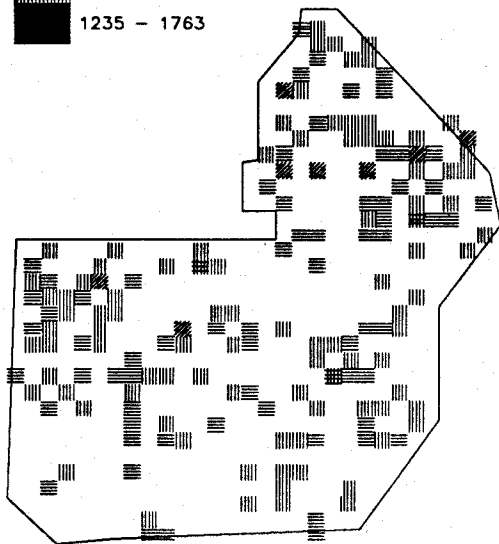
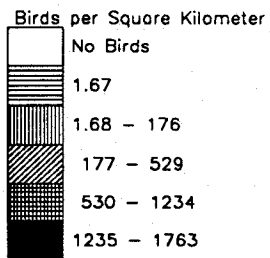
June 1989



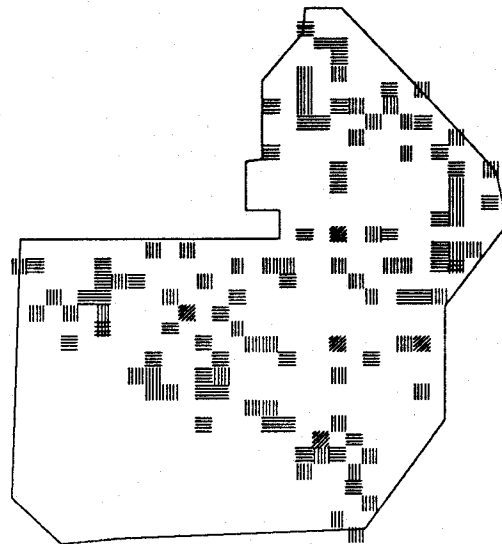
August 1989

Figure 6b. The distribution of all species in the Water Conservation Areas in April, May, June and August 1989.

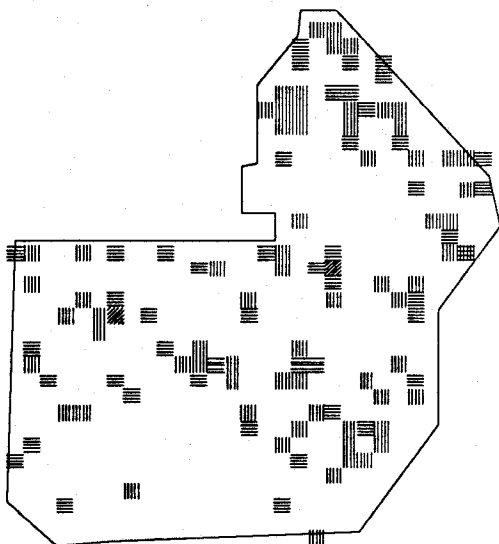
Density Categories



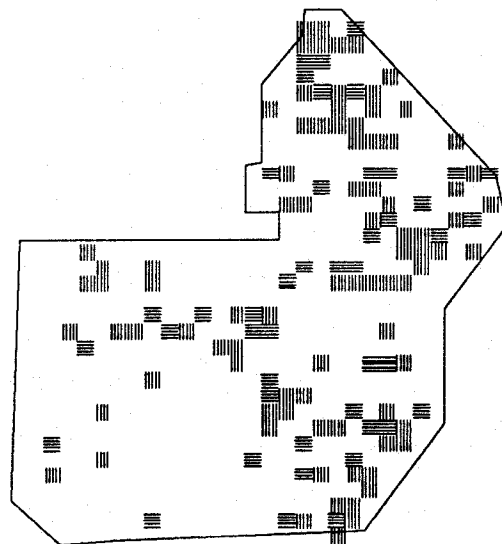
December 1988



January 1989

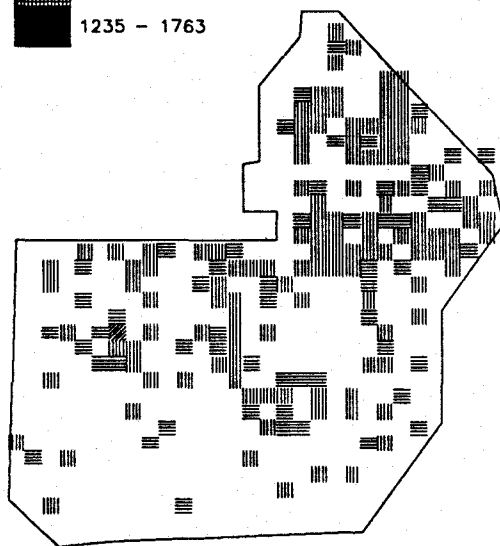
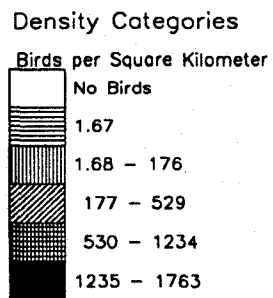


February 1989

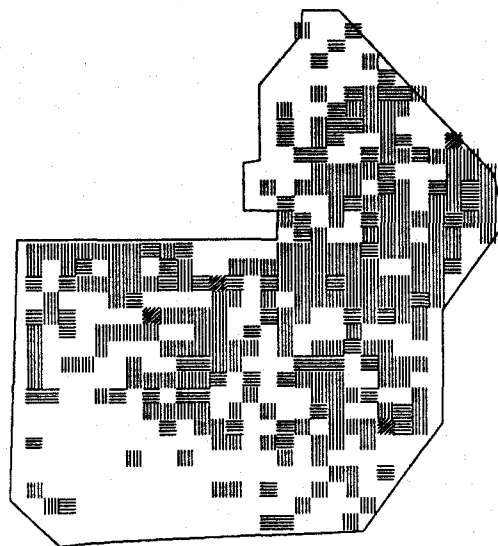


March 1989

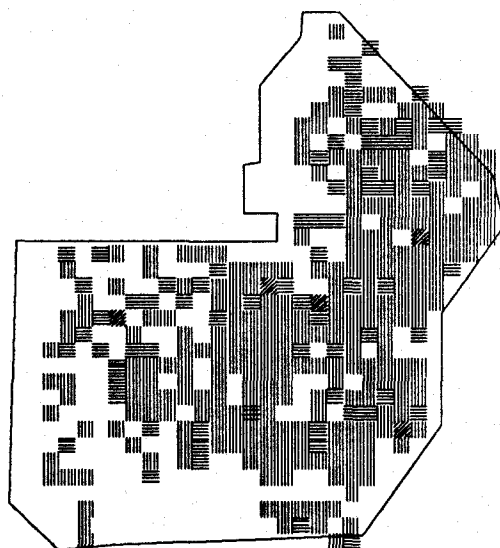
Figure 6c. The distribution of all species in the Everglades Agricultural Area in December 1988, and January, February, March 1989.



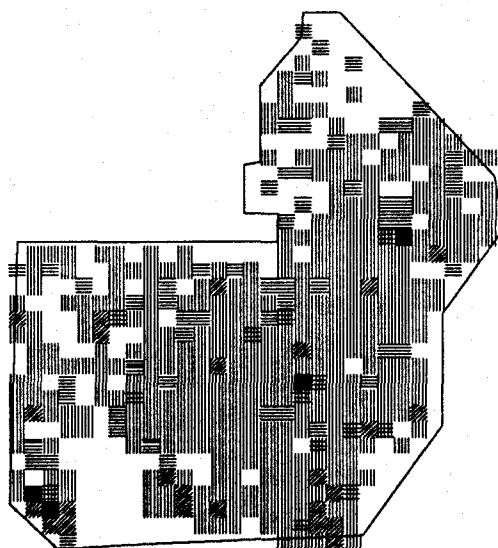
April 1989



May 1989



June 1989



August 1989

Figure 6d. The distribution of all species in the Everglades Agricultural Area in April, May, June and August 1989.

For this report we only present water conditions in the Water Conservation Areas. The Everglades Agricultural Area is broken into 40-acre fields with individually managed water levels. The units are far too small to be of practical value in describing a 4 km² cell in the survey grid. In addition, water levels can change drastically within a very short time. A dry field can be flooded for rice production within a day, while a field flooded by a heavy rain can be drained in a matter of hours. To incorporate water conditions into a bird observation, we have devised a list of vegetation codes which include a water condition when appropriate. These codes are then assigned to each species observation along a transect.

The 1988-89 dry season will long be remembered as the year of the drought. The Water Conservation Areas were already drier than normal at the start of the dry season in December (Fig. 7). Lack of additional rain and a warmer than average winter and spring led to an extremely fast and extensive dry-down. During the March through June surveys, there was as much or more dry habitat than any other water category.

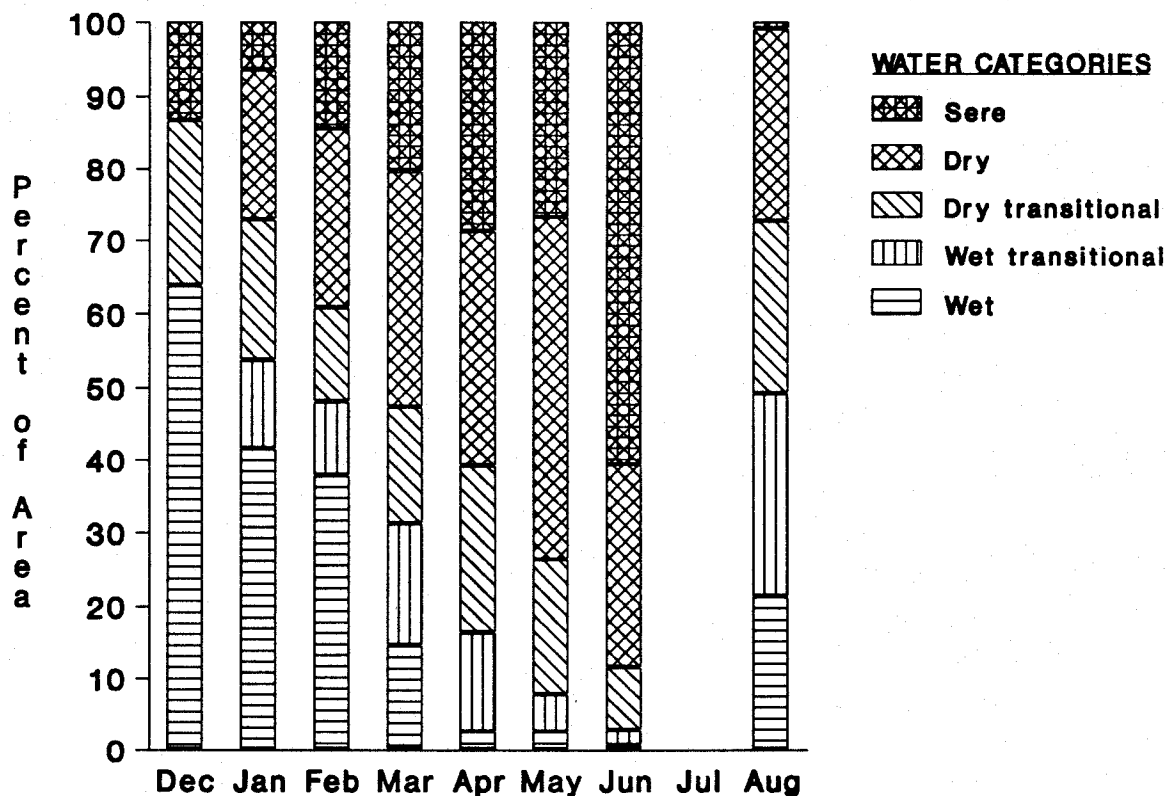


Figure 7. Percentage of the study area in the five water condition categories each month. December combines the two transitional and dry categories into one each. Percentages are based on counts of 4 km² cells.

The 1988-89 water maps are shown in Figure 8. The December map is the only map which only uses three water categories. The remaining monthly maps all use the five categories as described above. In the December map, horizontal lines represent wet, diagonal lines represent both transitional categories and diagonal cross-hatching represents both dry categories. WCA 1 was already drying rapidly in December. Over two-thirds of the area was already transitional while nearly all the remaining cells were dry. Except for the southern third, WCA 2A was also transitional or dry. WCA 2B was still wet, as was WCA 3B. WCA 3A was mostly wet, but a drying zone was very prominent at the north end. The January map shows continued drying with sere water conditions beginning to appear at the north ends of WCAs 1, 2A and 3A. Only the southern half of WCA 1 still had dry transitional habitat. WCA 2A had dried considerably and only remained wet at the extreme southern tip. A small portion of marsh was wet transitional, but three-quarters of the area was already dry transitional or dry. Most of WCA 2B was wet transitional. WCA 3A had dried considerably. A large lobe of both transitional types was present in the west central portion of the area. The February map shows continued drying of all areas. Sere water conditions were more pronounced in the northern portions of WCAs 1 and 3A. WCA 2A was transitional only in the southern third. WCA 2B continued drying from the south. Wet water conditions in WCA 3A and 3B were very similar to the January map. A small area of transitional water was beginning to appear at the extreme southeast corner of WCA 3B.

The March map shows continued drying. Dry or sere conditions were found in more than half of WCA 2A and 3A. In WCA 3A wet water conditions were only found at the south end of the area, in patches along the L-67 levees, and near the L-28 gap. Small areas also remained wet in WCA 3B and the southern end of WCA 2A. Large areas of transitional marsh were found in the southern third of WCA 3A and the south end of WCA 3B. The day before WCA 1 was flown a localized rainfall of 4-5 inches reflooded the southern third of the area. Therefore, there is more wet transitional habitat than was present in February. This "reversal" was, however, quite transient, probably lasting only a day or two.

The April map shows sere water conditions covering the entire area of WCA 3A north of Alligator Alley. Sere also covers large portions of WCA 2A. Wet water conditions only occur in very small patches in WCA 3A and 3B and at the southern tip of WCA 2A. In WCA 3A the remaining transitional habitat was restricted to a band along the L-67A levee and the south edge.

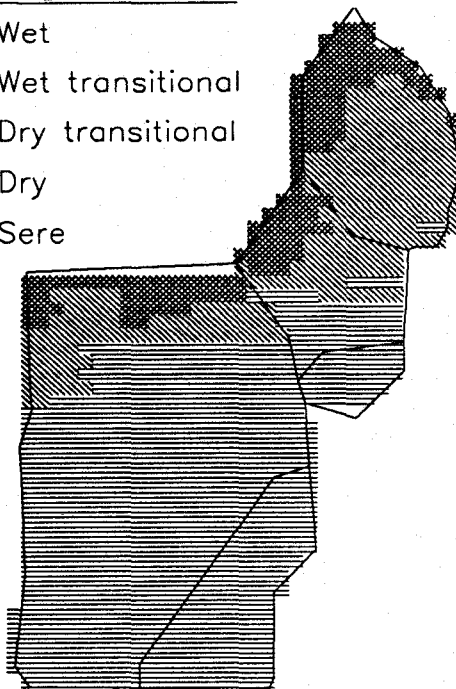
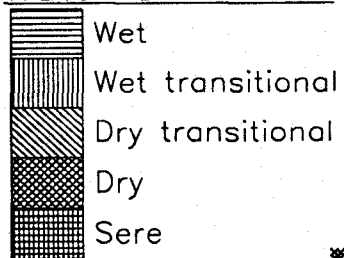
An area of localized heavy rains rehydrated a patch of dry habitat in the central portion of the area just south of Alligator Alley. In WCA 1, it appeared that water had been permitted to enter the northeast corner of the area to put out fires.

The May map shows continued drying. The most noticeable change is in WCA 3A south of Alligator Alley and WCA 3B. WCA 3A is nearly all dry except for a band of dry transitional water conditions along the L-67 levee and the base of the area. WCA 3B is entirely dry. Small areas of wet habitat were observed at the south end of WCA 2A and north end of WCA 2B. Some localized areas of short-term reversals should be mentioned. In WCA 1, an area of dry-transitional marsh is present along the eastern edge which is not visible in the April map. This event is probably the result of localized heavy rain or a temporary outflow from the L-40 canal into the area. In the northwest corner of WCA 3A water appeared and put out fires burning west of the Miami Canal. In addition, wet transitional habitat had developed at the west end of WCA 3A from water flowing south from the L-28 gap.

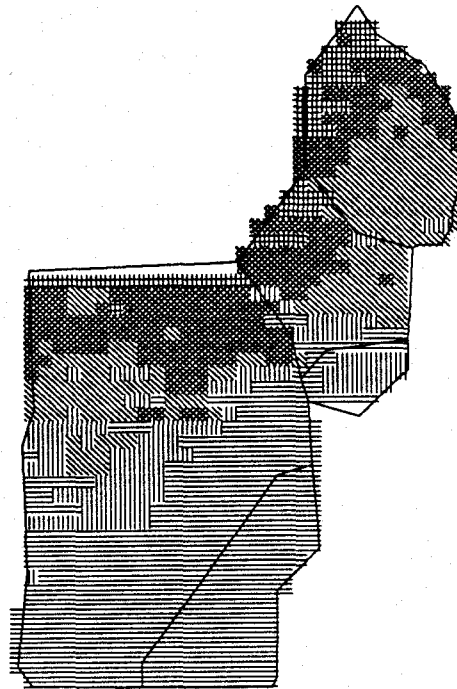
The June map shows the WCAs at or very near their driest point. Severe water conditions cover nearly all of WCAs 3A and 3B. A small amount of both transitional habitats is present again from water flowing in through the L-28 gap. WCA 2A is nearly all dry except for water pooled at the southern tip of the area. Both WCAs 1 and 2B have small amounts of transitional habitat, but are largely dry.

The wet-season survey of August shows an interesting pattern of re-hydration. While most August surveys show an entirely wet system, this year's survey shows large areas of dry habitat still present. WCA 1 is still predominantly dry transitional, whereas WCA 2A is largely wet transitional. WCA 2B is a mosaic of both transitional water conditions. WCA 3A north of Alligator Alley is largely dry except for a lobe of transitional habitat in the center. This area occurred in the middle of a large burn and attracted medium-sized flocks of mixed wading birds. South of Alligator Alley the area was slowly rehydrating. Wet water conditions were found along the L-67A levee and at the south end. Water was also flowing into the area from the L-28 gap. The large central portion of the area is a combination of both transitional water types. WCA 3B was slowly rehydrating from the L-67C levee southeast.

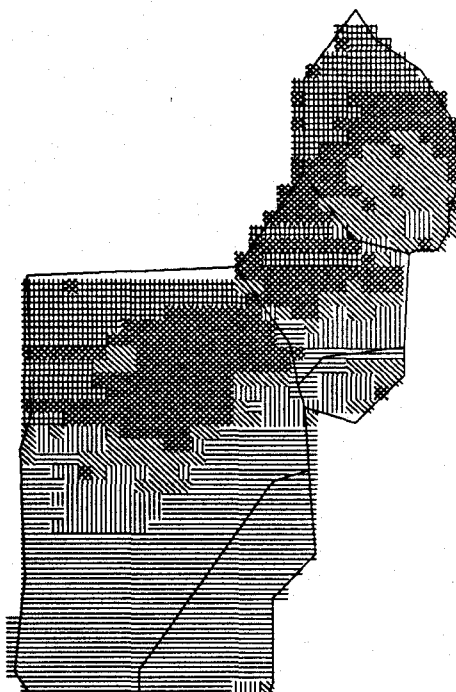
Water Conditions



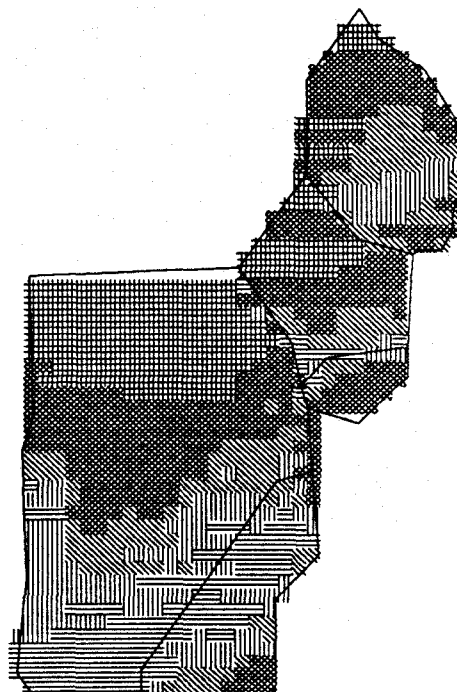
December 1988



January 1989



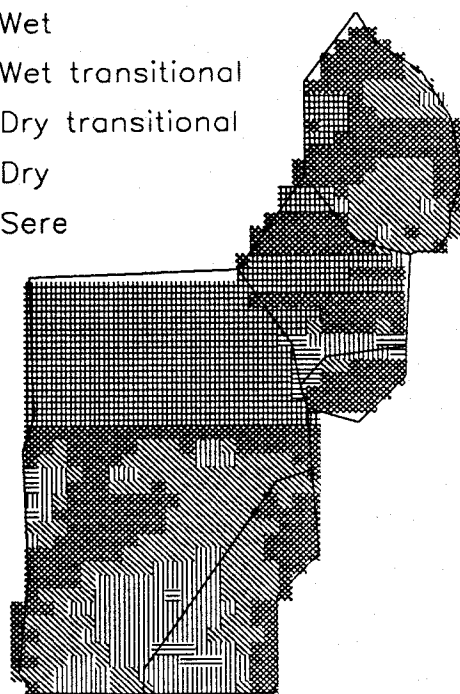
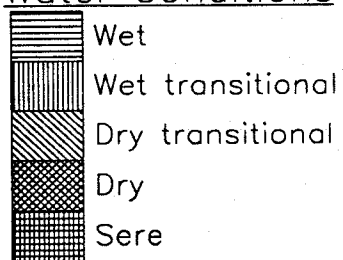
February 1989



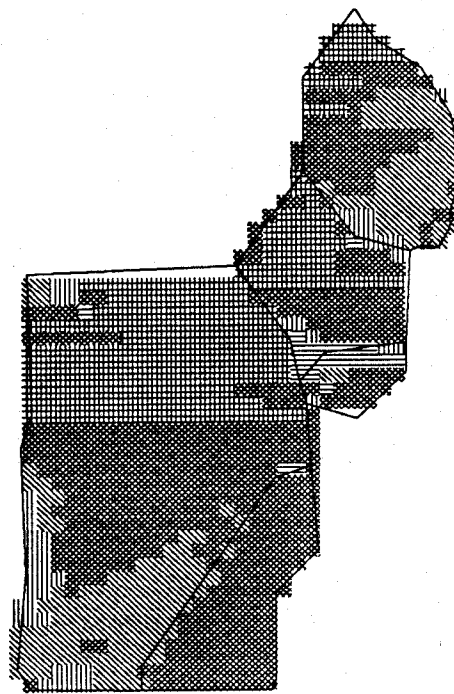
March 1989

Figure 8a. The distribution of water condition categories in December 1988, and January, February, March 1989. The December map is based on three water condition categories.

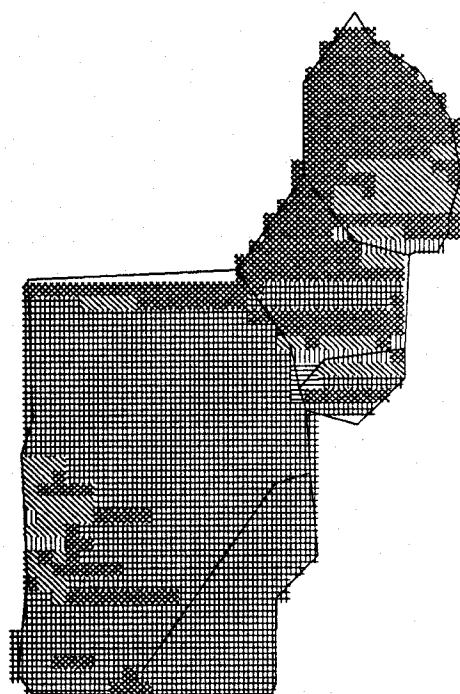
Water Conditions



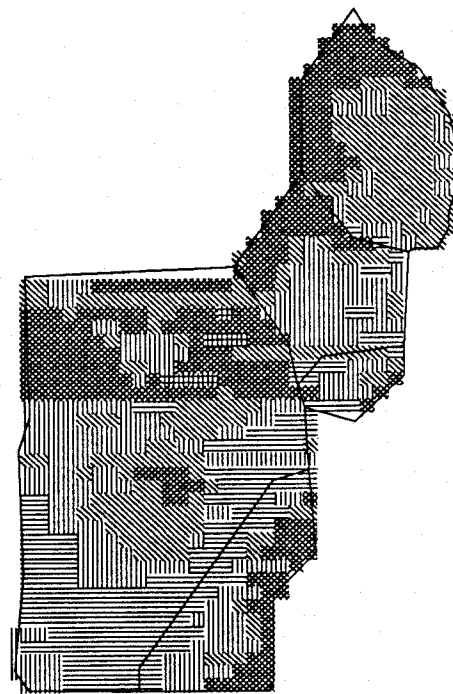
April 1989



May 1989



June 1989



August 1989

Figure 8b. The distribution of water condition categories in April, May, June, August 1989.

Species Accounts. The species accounts describe the abundance and distribution of each species within the survey area. Abundances are summarized in tables by Water Conservation Area or Everglades Agricultural Area and month. The overall and Water Conservation Area abundances and their confidence intervals are displayed graphically. All references to significant differences between population estimates are figured at the 95% confidence level. Monthly maps present the relative density and the distribution of birds within the WCAs and the EAA. We have presented these two areas separately and an outline map of each area is presented in Figures 9 and 10. The map figures for each species are presented at the end of its account. Following the species accounts we present the analyses of the association of birds with the vegetation categories and with the water categories.

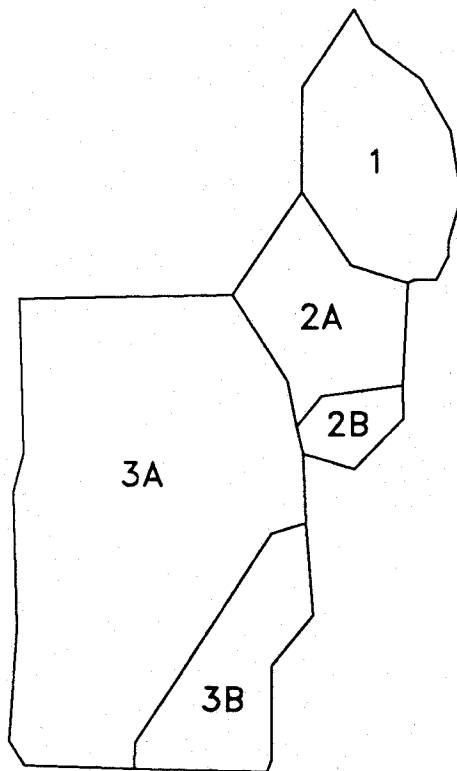


Figure 9. Outline map of Water Conservation Areas used in species accounts.

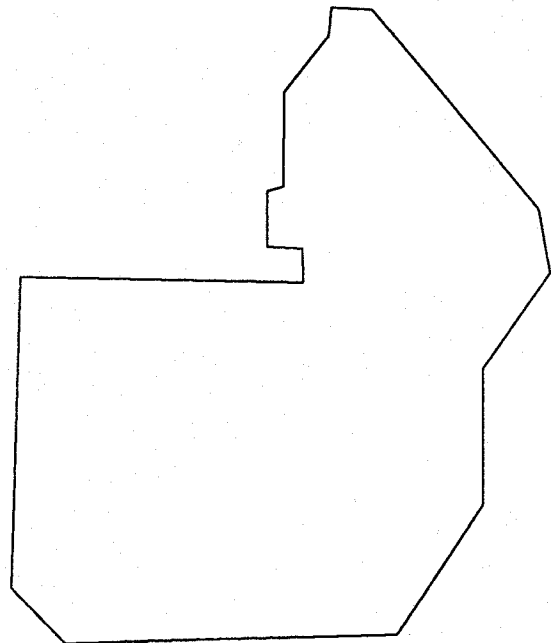


Figure 10. Outline map of Everglades Agricultural Area used in species accounts.

Great Egret (*Casmerodias albus*). - In all the dry-season surveys, Great Egrets were again the second-most abundant birds, after White Ibises (in the Water Conservation Areas). However, when the Everglades Agricultural Area are included, Cattle Egret numbers surpass Great Egrets in four out of the eight survey months. Population estimates range from 5547 in June to 29,813 in March (Table 3). In the WCAs the estimate for March was significantly higher than all months except for February (Fig. 11). The May and June estimates were significantly lower than those for December through April. In the total survey area, the March estimate was again significantly higher than all months except for February (Fig. 12). However, the May and June estimates were significantly lower than those for December through March only. In the WCAs, the August estimate was significantly lower than all dry season estimates except for June, while in the total survey area it was only significantly lower than December through April estimates.

The March peak coincides with peak migration of wading birds and probably includes individuals that subsequently left for colonies further north. The slight decline of birds in May and the sharp reduction of Great Egrets in June reflects the exodus of birds from the Water Conservation Areas in response to the ensuing drought.

Great Egret numbers during the dry season averaged slightly higher in this year's surveys than both 1986-87 and 1987-88 (Hoffman, W., R. Sawicki and G.T. Bancroft. 1988. Wading Bird Populations and Distributions in the Water Conservation Areas of the Everglades: The 1987-1988 Season. Second Annual Report to the South Florida Water Management District, West Palm Beach, Florida. 88 pp; Bancroft, G.T., W. Hoffman and R. Sawicki. 1987. Wading Bird Populations and

Table 3. Estimated abundance of Great Egrets in 1988-1989 surveys.

Month	Water Conservation Areas						Everglades Agricultural Areas		
	1	2A	2B	3A	3B	Total	North	South	Total
December	4213	4120	1447	6913	1433	18126	47	100	18273
January	2013	3107	793	11527	2287	19727	47	180	19954
February	1607	1253	2813	13107	2527	21307	193	80	21580
March	913	1247	827	16253	10413	29653	80	80	29813
April	200	300	127	14767	2747	18141	53	60	18254
May	1027	640	1593	7467	653	11380	53	1240	12673
June	127	2087	1213	13	107	3547	653	1347	5547
August	167	207	80	2733	227	3414	1767	4907	10088

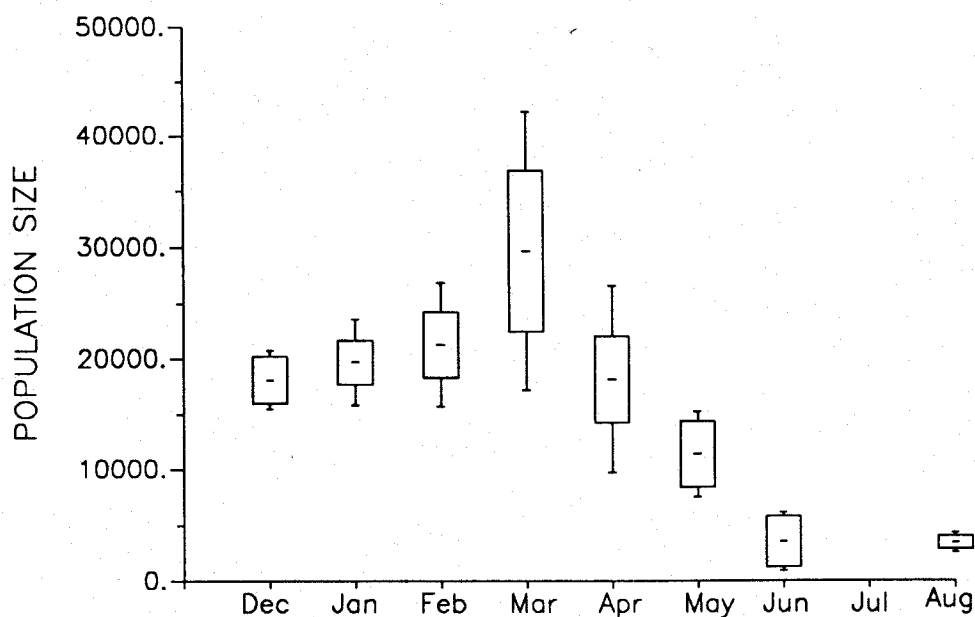


Figure 11. Estimated population of Great Egrets using the Water Conservation Areas during each month.

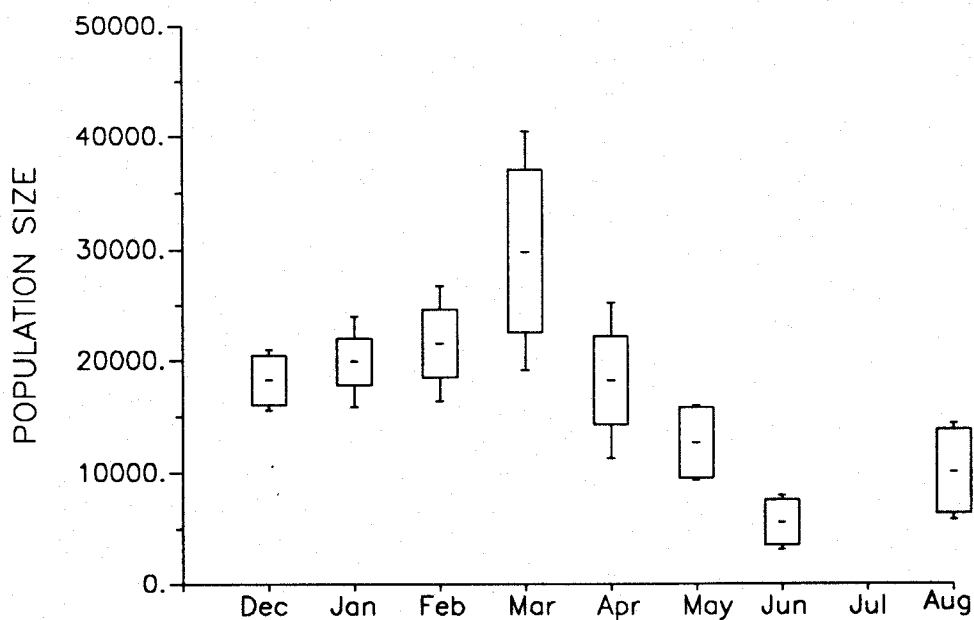


Figure 12. Estimated population of Great Egrets using the total survey area during each month.

The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances.

Distribution in the Water Conservation Areas of the Everglades. First Annual Report to the South Florida Water Management District, West Palm Beach, Florida. 166 pp). In addition, in contrast to the last two years, Great Egret numbers fluctuated to a much larger degree. Both of these effects are responses to the 1988-1989 drought. As areas such as the south end of WCA 3A dried out, presumably high fish concentrations attracted large numbers of Great Egrets from other areas, such as Everglades National Park. As the drought continued, these areas eventually were "fished-out" and the birds responded by leaving the system. This is evident by the low population estimate of 3500 birds in June. As the population estimates for the Water Conservation Areas begin to decrease in May, there is a subsequent increase in Great Egret numbers in the Everglades Agricultural Areas. However, the numbers of Great Egrets in the Everglades Agricultural Area do not account for all the birds which had left the WCAs.

Great Egret use of the individual Water Conservation Areas also differed from that seen in previous years. WCA 3A nearly always had the highest numbers (in the June survey only 13 Great Egrets were estimated for WCA 3A, significantly fewer birds than any other area). Estimates for WCA 3A varied from the 13 birds in June to 16,300 birds in the March survey. With the exception of WCA 3A, there is no clear-cut pattern of Great Egret use of the other four areas in 1989. While WCA 1 often ranked second in previous years, this year it ranked second only in December (N = 4213). Water Conservation Area 2A ranked second only in January (N = 3107); however it was the most heavily used area in June (N = 2087) by a large margin. Area 2B, which usually ranks fourth of fifth, had the second highest number of birds in February, May and June. WCA 3B contained an unusually high estimated population of 10,400 birds in March ranking it second. Overall, estimated numbers of Great Egrets using the WCAs varied from 3547 birds in June to 29,653 birds in March (Table 3).

While Great Egret use of the Everglades Agricultural Area was minimal during the period December through April (0.5% - 1.2% of total estimated populations), in May, 10% of the Great Egrets were found in the EAA. By June, the percentage had climbed to 36% (Table 3).

The wet-season survey in August still showed low populations of Great Egrets in the Water Conservation Areas. An estimated 3400 birds were present. Although similar to the 3500 estimated birds in June, the distribution was quite different. Water Conservation Area 3A contained 80% of all Great Egrets in the WCAs. In addition, the EAA contained 66% of the total estimated population of Great Egrets (Table 3).

The maps of Great Egret distribution (Fig. 13) are scaled from a maximum estimated cell density of 643 birds/km² (= 386 birds recorded in one 4 km² cell). The maps of the Water Conservation Areas demonstrate rather remarkable distributional shifts. In WCA 1 there was a distinct shift toward the southeast as the area dried out. In 1989, birds never used the northwest corner of the area. Major concentrations of Great Egrets were located in the southern two-thirds of the area in both December and January. By February, the birds were confined to the southern half of the areas, while in March the foraging area had diminished to a "narrow" band in the southeastern third of the area. From April through August, only individuals and small groups of Great Egrets were observed foraging in primarily the southeastern third of the area.

The Great Egret distribution in WCA 2A shows a similar trend. There was a distinct shift in foraging locations toward the southeast as the area dried out. By April and May, only small foraging populations remained in the southern tip of the area. In June, however, nearly 60% of the Great Egret population in the WCAs was located in the extreme, southern tip of the area (where water was apparently being pooled). WCA 2B was used most heavily during the dry-season surveys. Bird concentrations tended to move toward the northern edge of the area as the dry season progressed. In the February survey, however, we observed large concentrations of Great Egrets in the drying pools at the extreme southern edge of the area.

Use of WCA 3A by Great Egrets was extensive in the December through April surveys. A large area of heavy use in the west-central part of the area had spread to the south and east by the January survey. By February, only the southern half of the area was being used heavily and birds were already observed foraging in the deeper sloughs along the L-67A levee. Concentrations of foraging birds continued to shift south and east during the March surveys, foraging extensively in the deeper sloughs along the L-67A levee. Scattered Great Egrets also foraged in a small area just south of the L-28 gap. By April, foraging habitat was largely confined to the sloughs immediately adjacent to the L-67A levee and the south end of WCA 3A. In the May survey, many Great Egrets had left WCA 3A. Bird distribution was more scattered and a small number of birds were again using the sloughs near the L-28 gap. The June survey was notable for its nearly complete absence of Great Egrets from WCA 3A, indeed, only 13 birds were estimated to be present in the entire area. In the August wet-season survey, birds began to return to WCA 3A. The area was just beginning to rehydrate and bird distribution was confined largely to the sloughs immediately west of

the L-67A levee and the L-28 gap. There was also some use of the reflooded areas north of Alligator Alley. Earlier fires in this area had burned deep into the peat and created openings in the dense stands of sawgrass. Birds were observed using these openings.

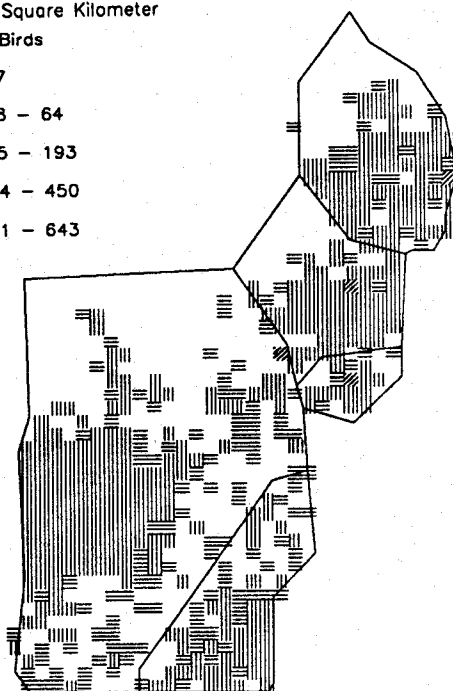
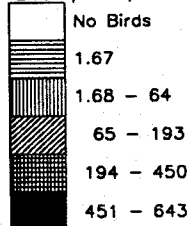
WCA 3B was used primarily in December through April. As the area dried out, birds tended to move north and closer to the L-67C levee. From May through June and the August survey, Great Egrets used the area in small numbers and primarily near the L-67C levee.

Great Egret use of the Everglades Agricultural Area remained low for most months of the 1989 surveys. Most observations were of single birds standing at ditches or flying. By May, however, Great Egrets began moving into the area, and, in particular, into fields that had recently been flooded for the growing of rice. This trend continued and by August, large numbers of Great Egrets were foraging in rice paddies, as well as flooded fallow fields. Moderate numbers of Great Egrets had also moved into the recently flooded marshes of the Holey Land and Brown's Farm.

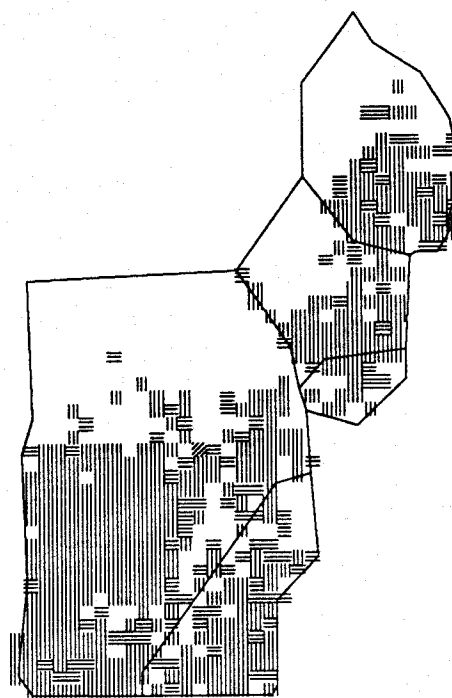


Density Categories

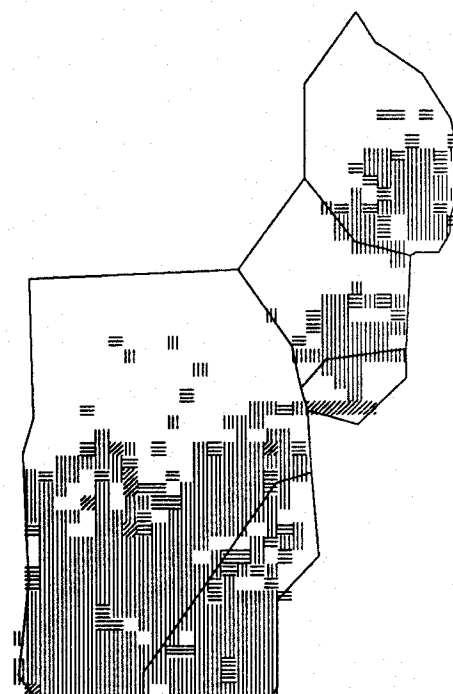
Birds per Square Kilometer



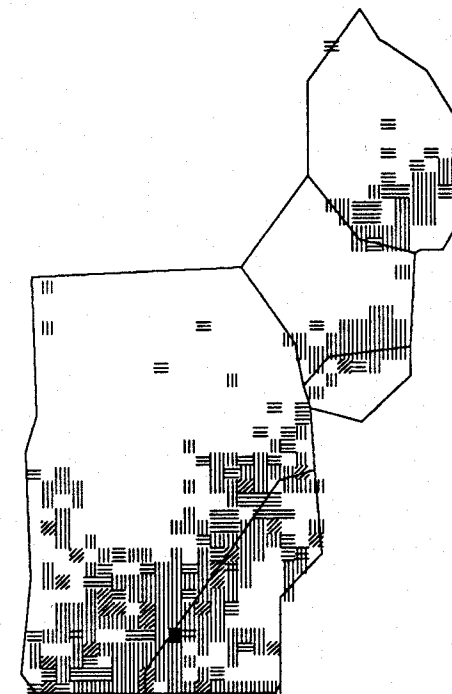
December 1988



January 1989

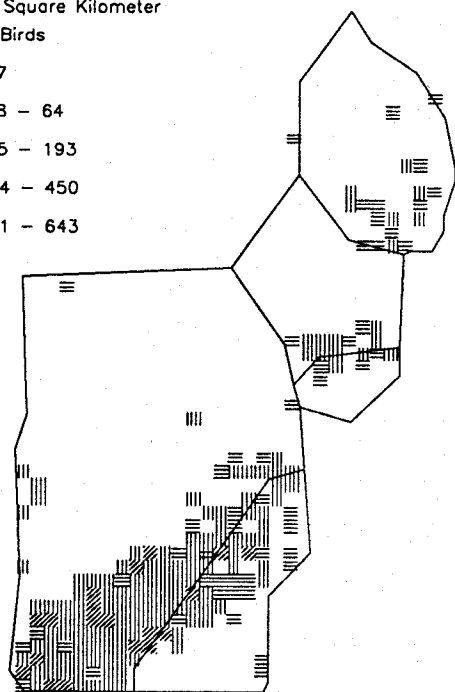
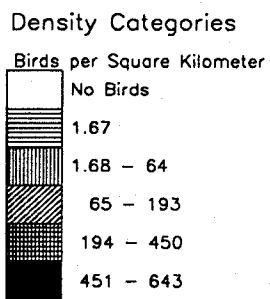


February 1989

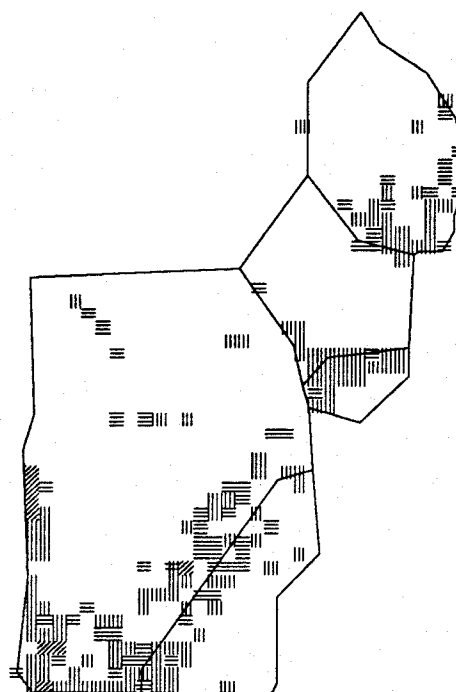


March 1989

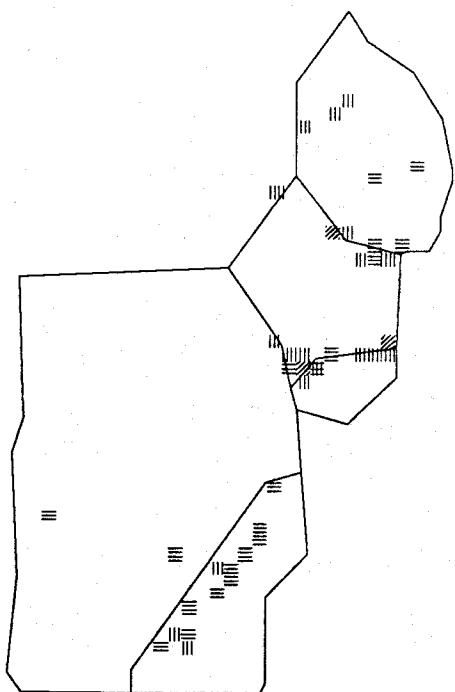
Figure 13a. The distribution of Great Egrets in the Water Conservation Areas in December 1988, and January, February, March 1989.



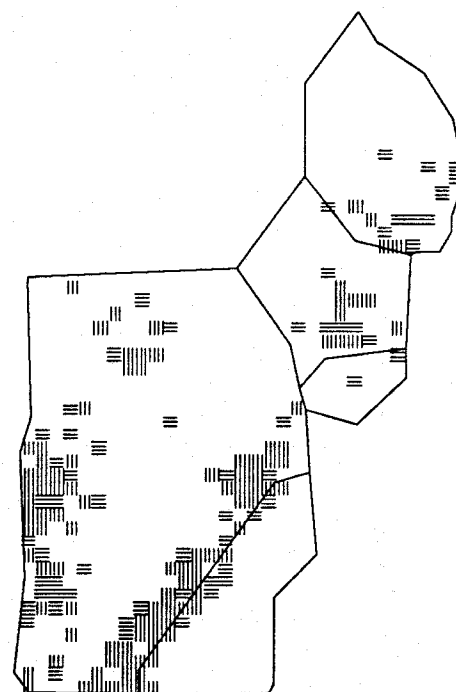
April 1989



May 1989



June 1989

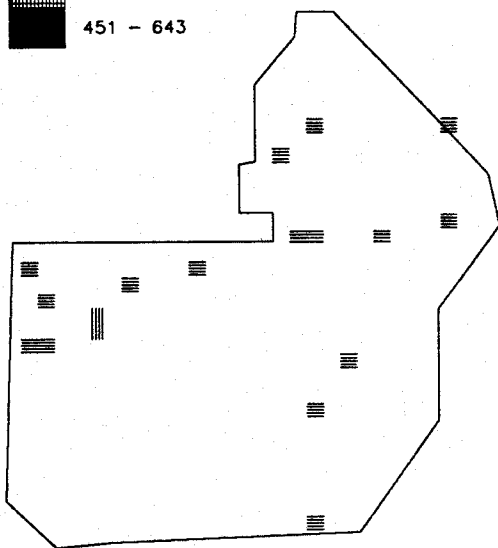
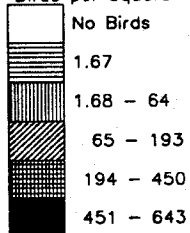


August 1989

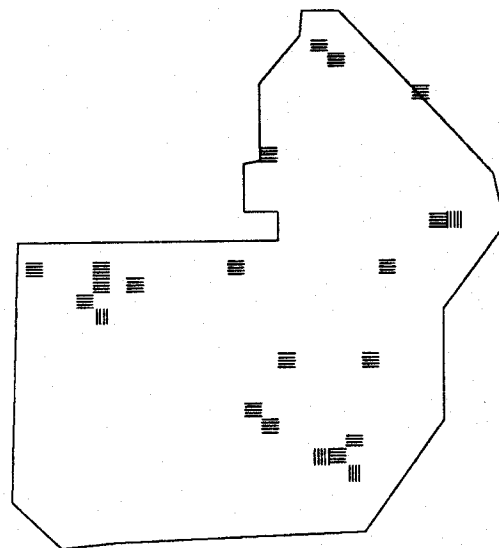
Figure 13b. The distribution of Great Egrets in the Water Conservation Areas in April, May, June and August 1989.

Density Categories

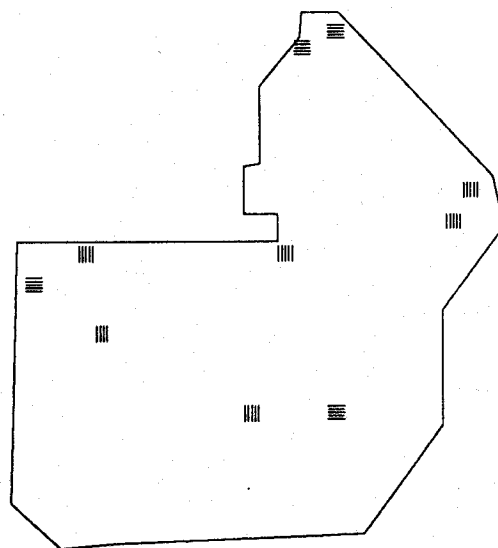
Birds per Square Kilometer



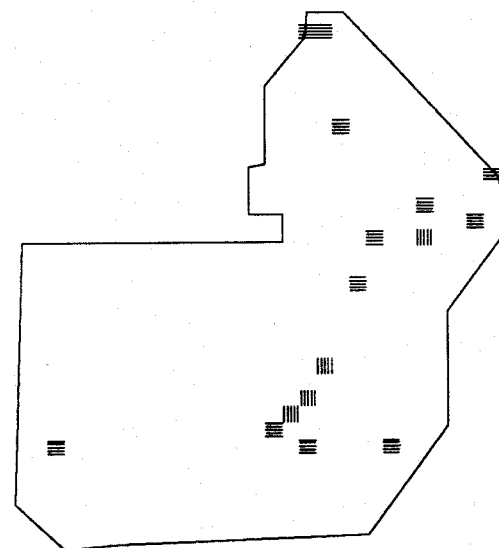
December 1988



January 1989

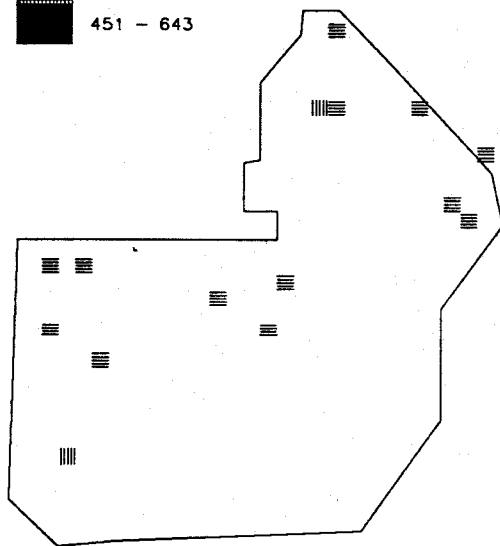
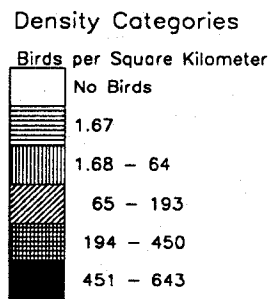


February 1989

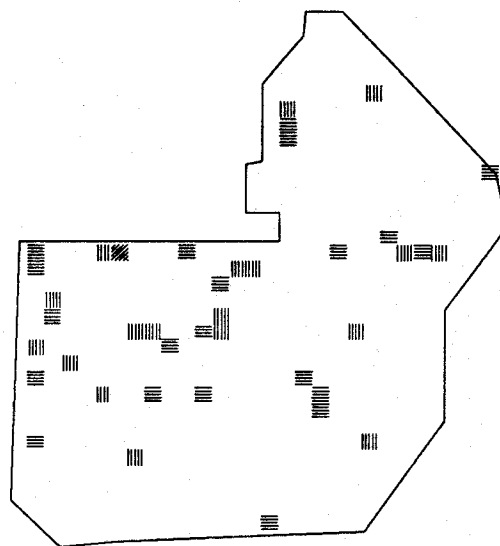


March 1989

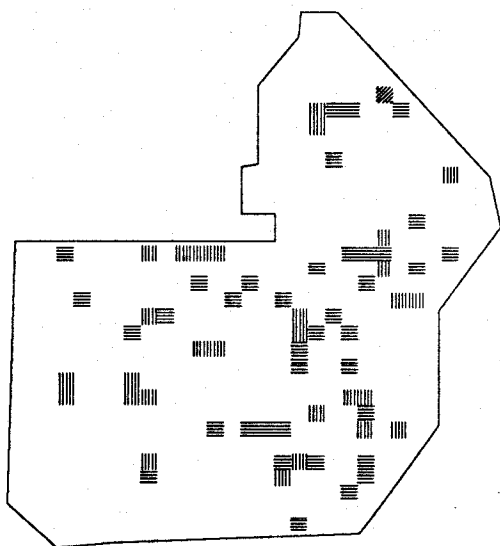
Figure 13c. The distribution of Great Egrets in the Everglades Agricultural Area in December 1988, and January, February, March 1989.



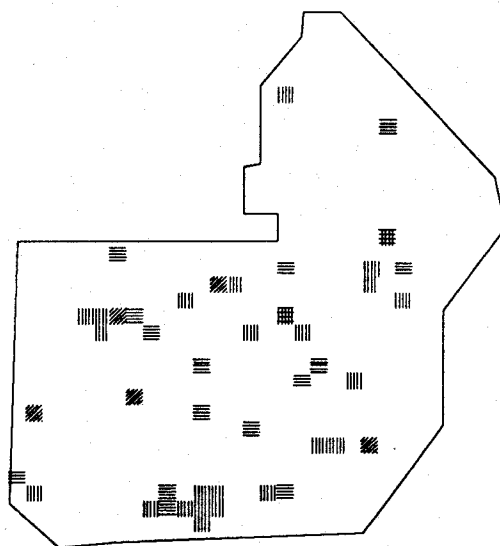
April 1989



May 1989



June 1989



August 1989

Figure 13d. The distribution of Great Egrets in the Everglades Agricultural Area in April, May, June and August 1989.

Great Blue Heron (*Ardea herodias*). - Population estimates for Great Blue Herons range from 606 in June to 6066 in March (Table 4). In the WCAs, the estimates for the December, January and February surveys did not vary significantly from each other (Fig. 14). The January and February estimates were significantly higher than the April, May and June estimates during the dry season surveys. In March, however, an influx of birds peaked at 6066, significantly higher than any other SRF survey. Although previous surveys have demonstrated a fairly stable resident population (Bancroft, Hoffman and Sawicki, 1987; Hoffman, Sawicki and Bancroft, 1988; ob. cit.), this year's dry season survey showed a sharp rise and fall in numbers of birds and indicates a strong response to the effects of the drought. Since there was only a small percentage of additional birds present in the EAA each month, the estimates for the total survey area show similar trends (Fig. 15).

Use of the Water Conservation Areas was similar to that seen in earlier surveys. WCA 3A again had the highest estimated populations in six of the seven dry season surveys, but only ranked fourth in the June survey (Table 4). WCA 1 ranked second in four out of the seven months and third the other three months. WCA 3B fluctuated more than in previous years. Although it most often ranked fourth, it ranked second in both March and May. WCAs 2A and 2B usually ranked fourth or fifth, however, WCA 2A ranked third in December, January and February. In June when most of the WCAs were dried out, WCA 2B ranked first and WCA 2A ranked second.

Use of the Everglades Agricultural Area was small but relatively stable in the dry season surveys. The estimated population peaked at 327 birds during the February survey and only 33 birds were estimated for the June survey. The percentage of birds using the EAA usually fell between five and ten percent of the total estimated population.

Table 4. Estimated abundance of Great Blue Herons in 1988-1989 surveys.

Month	Water Conservation Areas						Everglades Agricultural Areas		
	1	2A	2B	3A	3B	Total	North	South	Total
December	673	427	253	1540	233	3126	113	200	3439
January	1000	327	160	1720	300	3507	80	100	3687
February	893	373	47	1947	333	3593	147	180	3920
March	533	253	73	3420	1507	5786	100	180	6066
April	367	93	53	1720	213	2446	40	73	2559
May	233	53	113	427	333	1159	53	100	1312
June	80	113	280	27	73	573	0	33	606
August	87	47	20	247	0	401	167	47	615

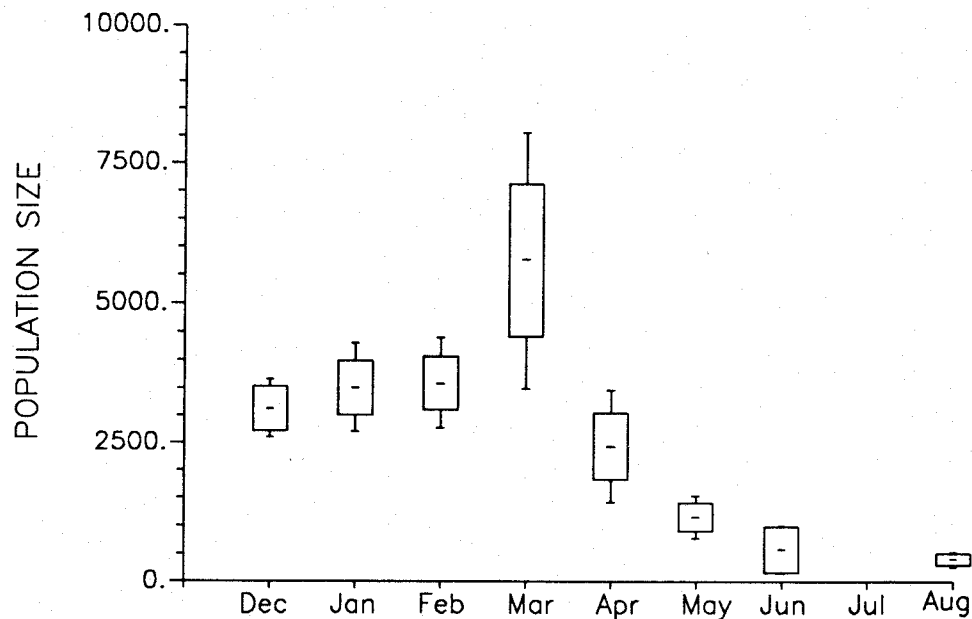


Figure 14. Estimated population of Great Blue Herons using the Water Conservation Areas during each month.

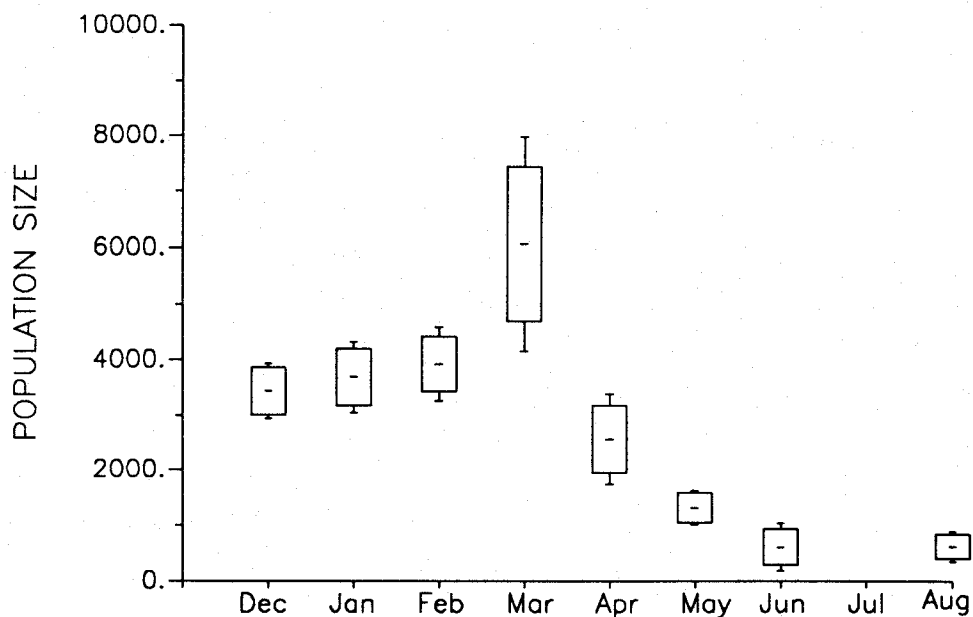


Figure 15. Estimated population of Great Blue Herons using the total survey area during each month.

The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances.

The monthly distribution of Great Blue Herons is shown in Figure 16. The maps are scaled from a maximum estimated cell density of 100 birds/km² (= 60 individuals counted in one 4 km² cell). During the dry-season surveys, Great Blue Herons were widely distributed in the Water Conservation Areas only in December and January. There was a gradual shift of birds toward the south and east in WCAs 1, 2A, and 3A from the period February through May, similar to the shift in distribution of Great Egrets. Although Great Blue Herons can often feed in the deeper sloughs along L-67A (even with higher water conditions), as the WCAs dried out, they were largely confined to this area. By the June survey, Great Blue Herons had mostly left the Water Conservation Areas and the only area of concentration was the southern tip of WCA 2A; smaller numbers of birds were found at the base of WCA 1.

Use of the Everglades Agricultural Area by Great Blue Herons shows no apparent shifts in distribution. Great Blue Herons were observed most often along the small ditches which drain the fields. Overall use of the Everglades Agricultural Area drops after the March survey and there was no apparent shift to forage in recently flooded fields during May as was seen in Great Egrets. Indeed, even in June, when Great Blue Herons had largely left the WCAs, there was no shift into the EAA. The estimated EAA population for June was only 33 birds.

In the wet-season survey in August, Great Blue Heron numbers were still low with an estimated population of only 615 birds for the entire area. Of these birds, 34.8% (N = 214) were found in the EAA. WCA 3A again contained the largest number of birds (N = 247). They were primarily confined to the southern third of the area, particularly along the L-67 levee and in the L-28 gap area. WCA 1 was ranked second (N = 87). Most of these birds were confined to the extreme southern edge. WCAs 2A and 2B contained few birds and none were observed in WCA 3B. In the EAA, Great Blue Herons were found primarily in the northern portion and were now found with greater frequency in rice paddies and flooded fields.

Density Categories

Birds per Square Kilometer

No Birds

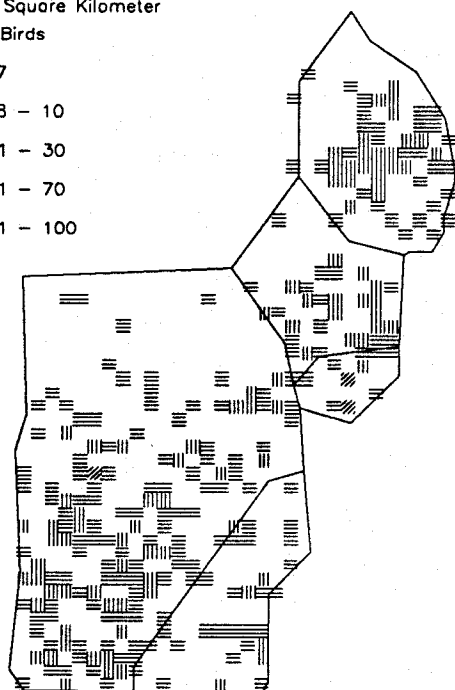
1.67

1.68 - 10

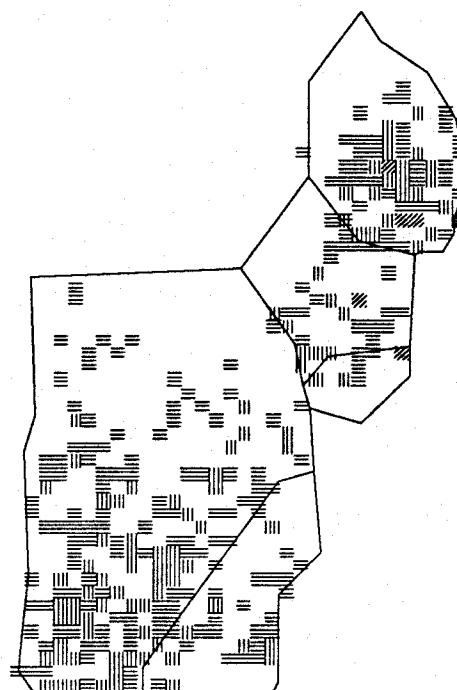
11 - 30

31 - 70

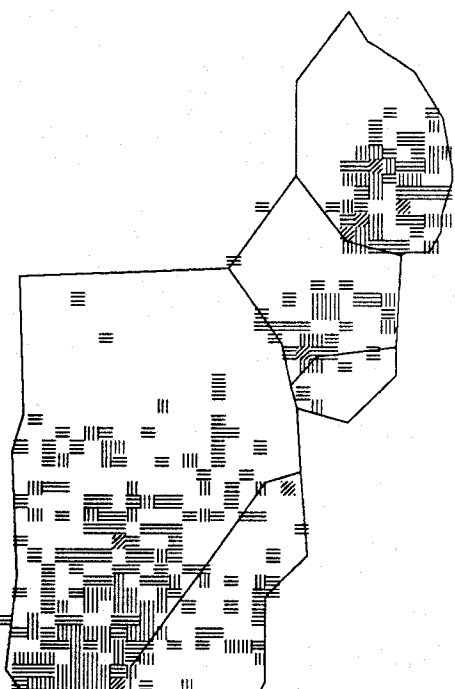
71 - 100



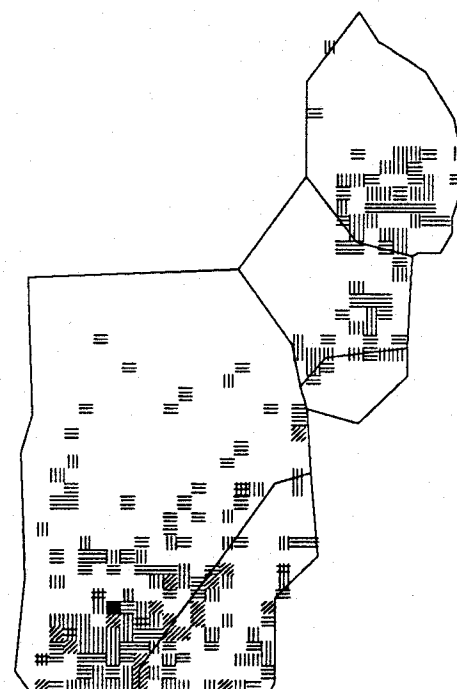
December 1988



January 1989



February 1989



March 1989

Figure 16a. The distribution of Great Blue Herons in the Water Conservation Areas in December 1988, and January, February, March 1989.

Density Categories

Birds per Square Kilometer

No Birds

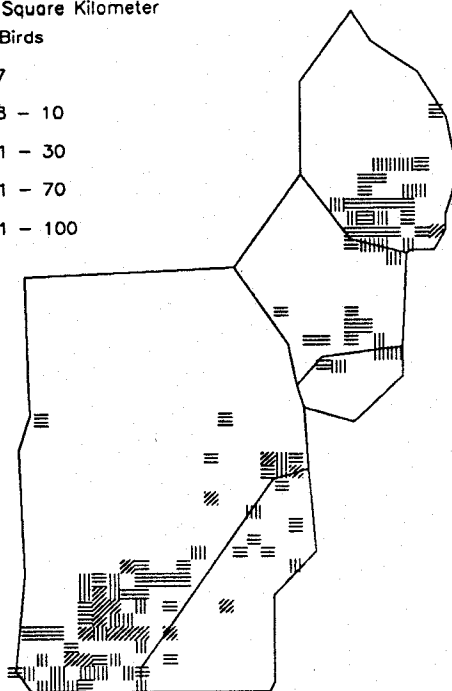
1.67

1.68 - 10

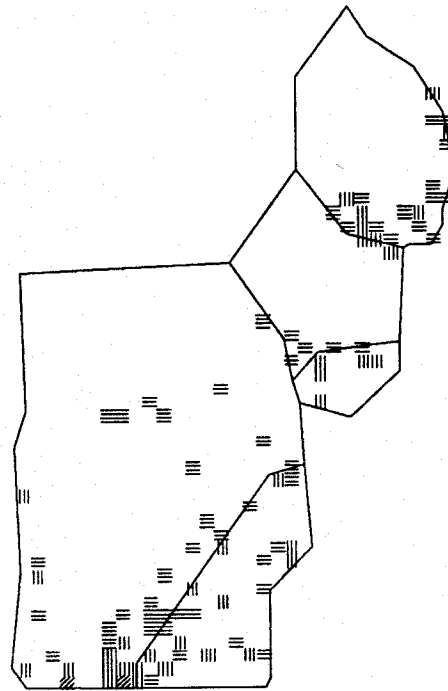
11 - 30

31 - 70

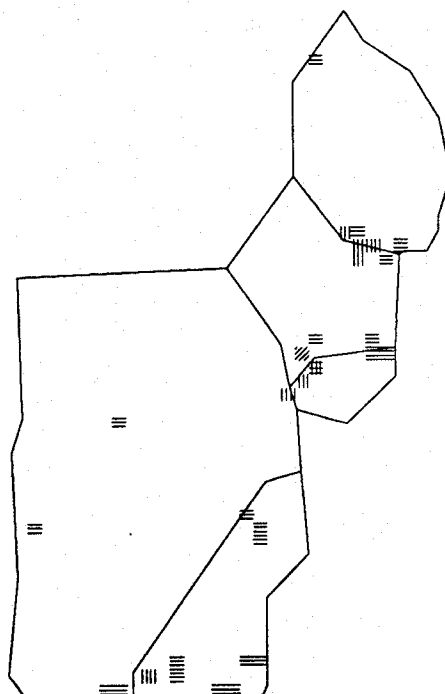
71 - 100



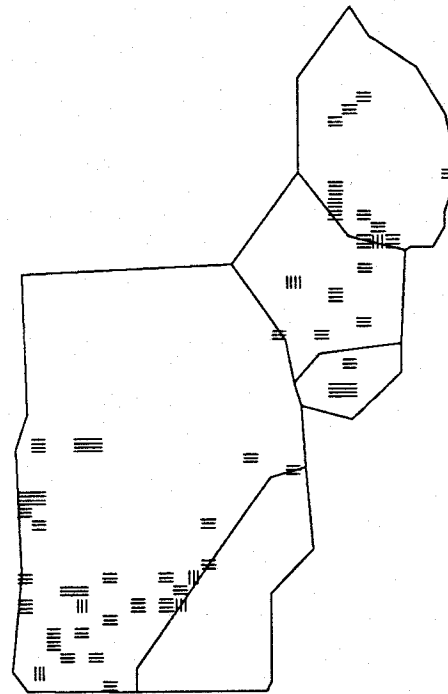
April 1989



May 1989



June 1989



August 1989

Figure 16b. The distribution of Great Blue Herons in the Water Conservation Areas in April, May, June and August 1989.

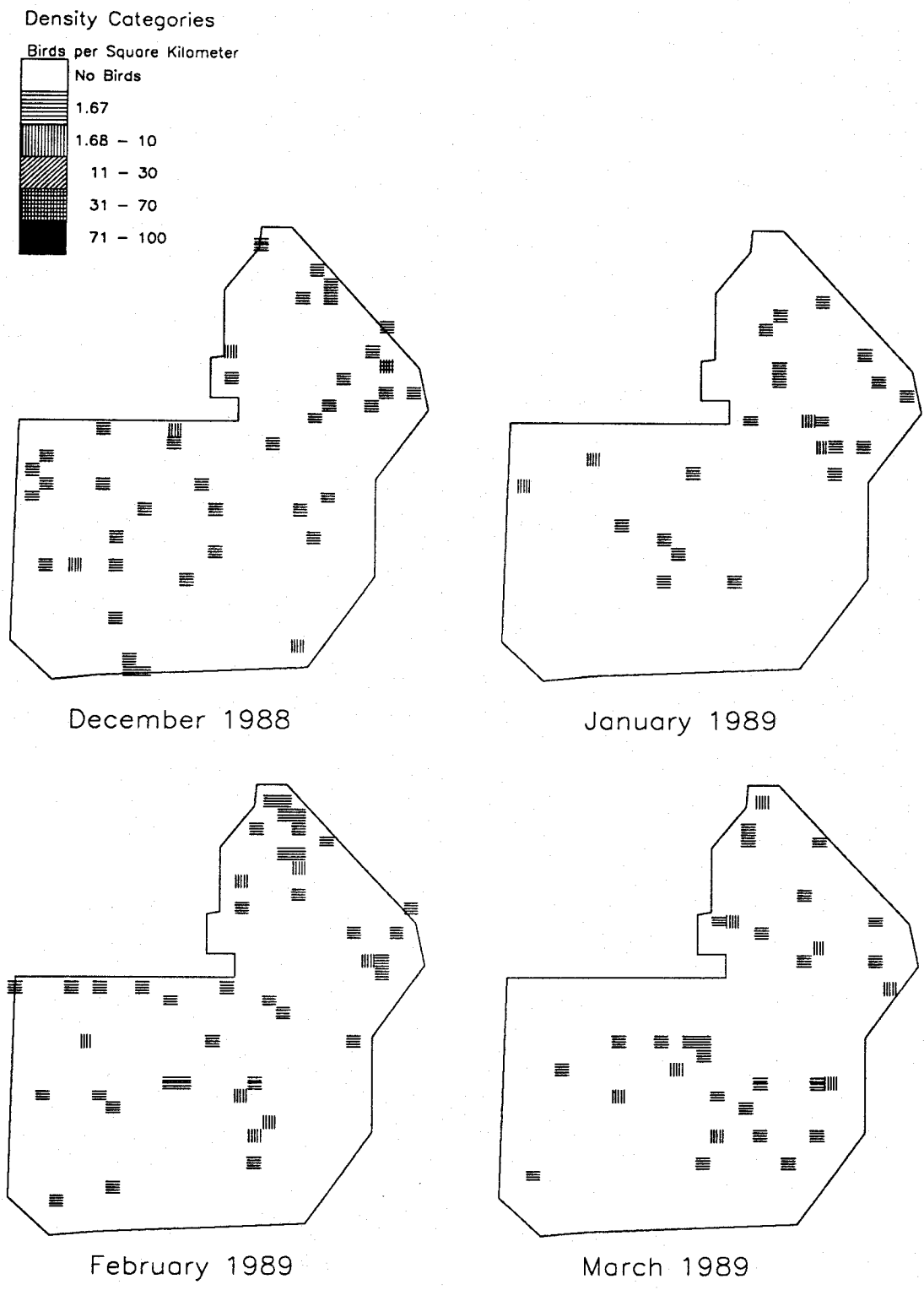
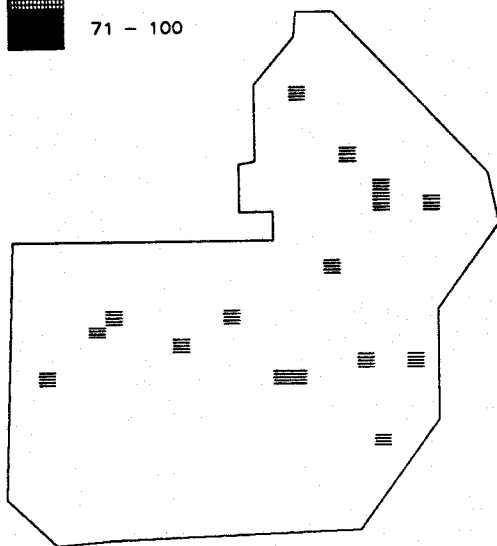
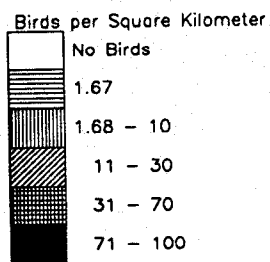
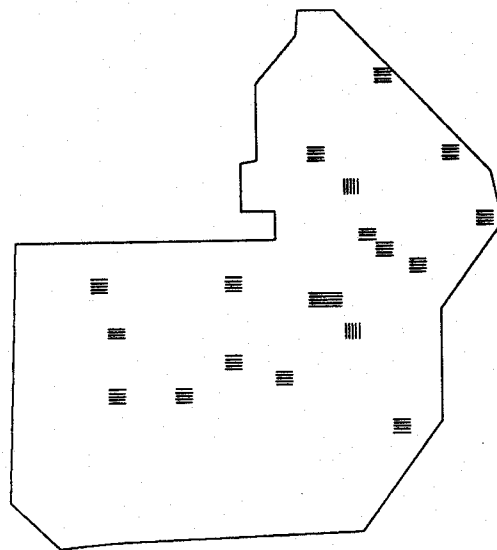


Figure 16c. The distribution of Great Blue Herons in the Everglades Agricultural Area in December 1988, and January, February, March 1989.

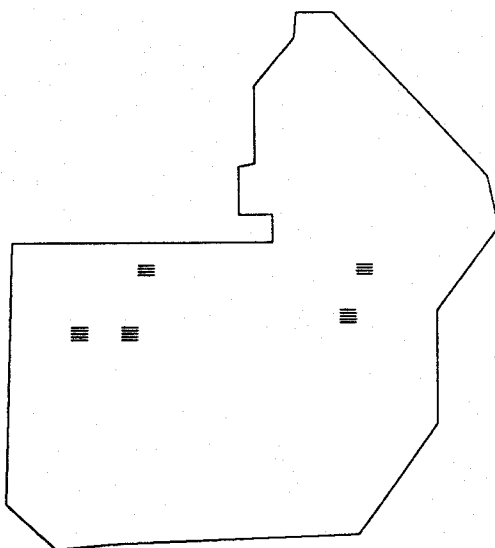
Density Categories



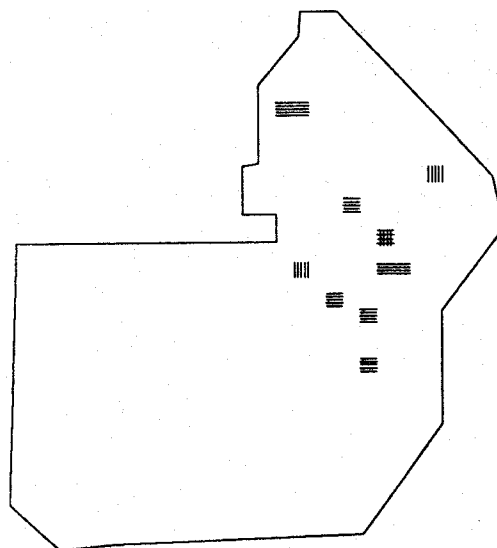
April 1989



May 1989



June 1989



August 1989

Figure 16d. The distribution of Great Blue Herons in the Everglades Agricultural Area in April, May, June and August 1989.

Small Dark Herons.- The small dark heron category contains Tricolored Herons (*Egretta tricolor*) and adult and pied Little Blue Herons (*E. caerulea*). It was not always possible to consistently separate these species from the air and we combine them here for analyses.

Population estimates for small dark herons during the dry season in the entire survey area ranged from 2640 birds in June to 9006 birds in January (Table 5). The January estimate is significantly higher than the March, April, May and June estimates for both the Water Conservation Areas (Fig. 17) and the total survey area (Fig. 18). Presumably, this peak represents an influx of migrants into the area. Water Conservation Area 3A ranked first in five out of the seven dry-season surveys, while WCAs 1 and 2A ranked first in December and June, respectively (Table 5). Although WCA 1 ranked second in four of seven dry-season surveys, and WCA 2B most often ranked fifth, there is no further clear-cut ranking of use for the other Water Conservation Areas. While WCA 2A was ranked fifth in May (only 7 estimated small dark herons), one month later during the June survey, it ranked first and contained nearly 50% of all small dark herons in the WCAs. Overall, the average estimated population (mean = 4894) of small dark herons in the WCAs in 1989 was up by 58% over the 1986-1988 average of 3094 birds (Hoffman, Sawicki and Bancroft 1988; Bancroft Hoffman and Sawicki, 1987; ob. cit.). This large increase is due, at least in part, to the drought and the attraction of birds to the drying sloughs of WCA 3A.

Use of the Everglades Agricultural Area was low in December through April (0.5% to 1.5% of total estimated population). However, the percentages jumped to 26.5% and 38.6%, respectively, in the May and June surveys, when the Water Conservation Areas were becoming quite dry.

Table 5. Estimated abundance of small dark herons in 1988-1989 surveys.

Month	Water Conservation Areas						Everglades Agricultural Areas		
	1	2A	2B	3A	3B	Total	North	South	Total
December	2933	2133	527	407	20	6020	40	53	6113
January	2647	2513	400	3380	20	8960	13	33	9006
February	873	727	340	3640	60	5640	7	67	5714
March	260	307	173	2473	1893	5106	20	27	5153
April	200	233	120	3353	173	4079	13	7	4099
May	340	7	100	2340	47	2834	67	953	3854
June	440	787	260	100	33	1620	47	973	2640
August	647	133	20	467	0	1267	627	1487	3381

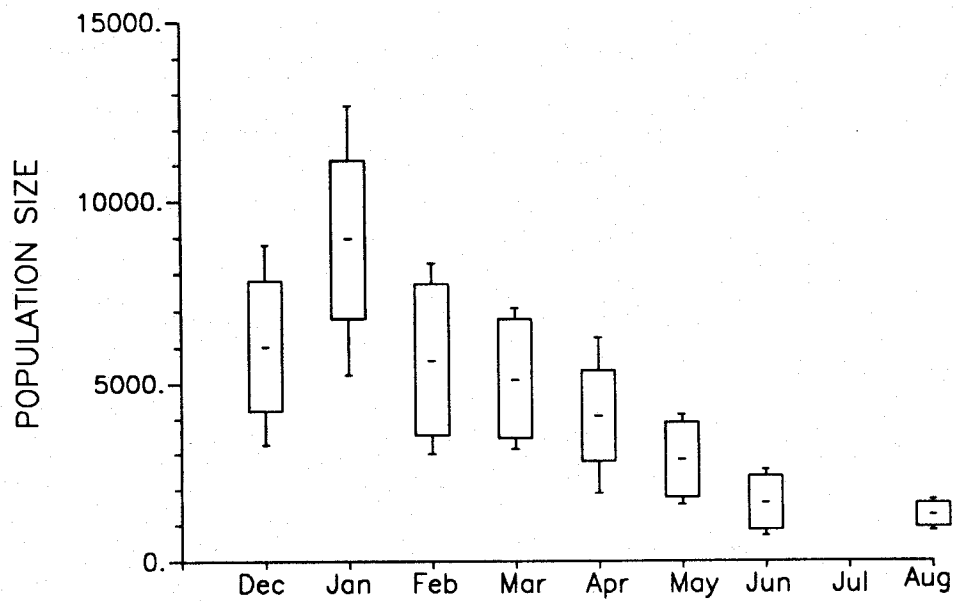


Figure 17. Estimated population of small dark herons using the Water Conservation Areas during each month.

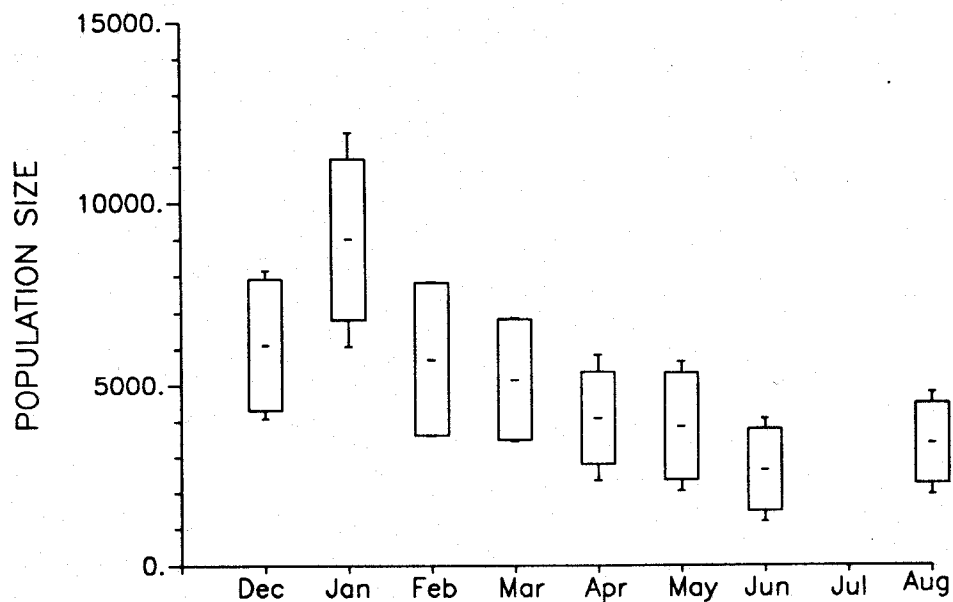


Figure 18. Estimated population of small dark herons using the total survey area during each month.

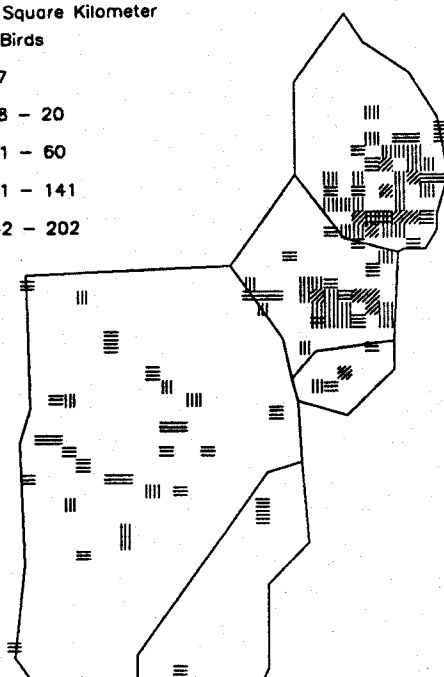
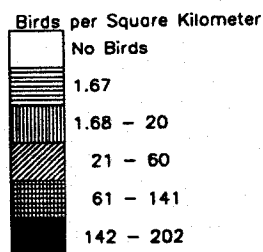
The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances.

In the wet-season survey in August, the estimated population for the WCAs was 1267, while the EAA contained 2114 birds or 62.5% of the total estimated population (Table 5). In the Water Conservation Areas alone, the August total was significantly lower than all dry-season surveys except June (Fig. 17). In the total survey area, however, the August estimated population was significantly lower than only the December and January totals. We suspect many of these birds shifted from the WCAs into the EAA prior to the August survey (Fig. 18).

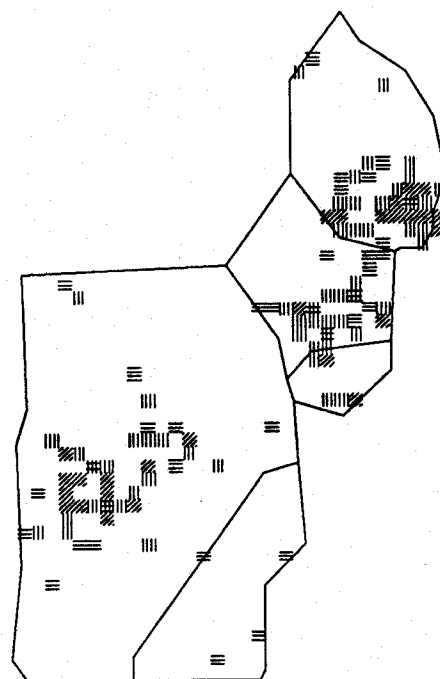
The maps of small dark heron distribution (Fig. 19) are scaled from a maximum estimated cell density of 202 birds/km² (= 121 birds observed in one 4 km² cell). Birds tended to be concentrated primarily in the southeast portion of WCA 1 and 2A in the December survey. By January, a movement of birds into WCA 3A was evident, although use of WCA 1 and 2A was still heavy. By February, large concentrations of small dark herons had moved into the southern half of WCA 3A. In March the concentration of foraging birds had moved closer to the L-67A levee and also were using WCA 3B more than any other month. The April survey estimated large numbers of birds using WCA 3A (82% of all estimated birds in the WCAs). During this survey, they were found primarily along the L-67A levee and the south end of WCA 3A. By May, birds were still using the deep sloughs along the L-67A levee and the south end of WCA 3A. In addition, small dark herons were also using the L-28 gap as well as areas of WCA 1 recently reflooded from isolated heavy rains. During the June survey, most small dark herons had moved out of WCA 3A and back into WCAs 1 and 2A. The wet-season survey showed a similar, but more diffuse distribution with birds also observed in the burned and reflooded dense sawgrass areas north of Alligator Alley.

The Everglades Agricultural Area (Fig. 19) shows only scattered observations of predominantly single birds from December through April. In May and June small flocks were also present as well as one large concentration of birds in each survey. Many of these sightings were in rice paddies and flooded fields. In the August wet-season survey, large numbers of birds were again using rice paddies, as well as flooded fields and the recently reflooded marshes of the Holey Land.

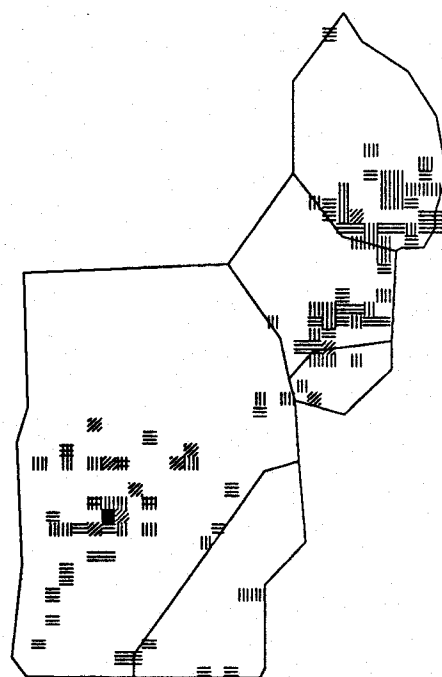
Density Categories



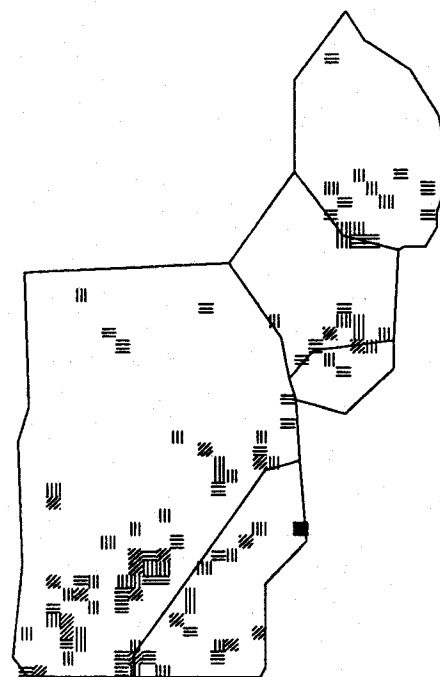
December 1988



January 1989



February 1989

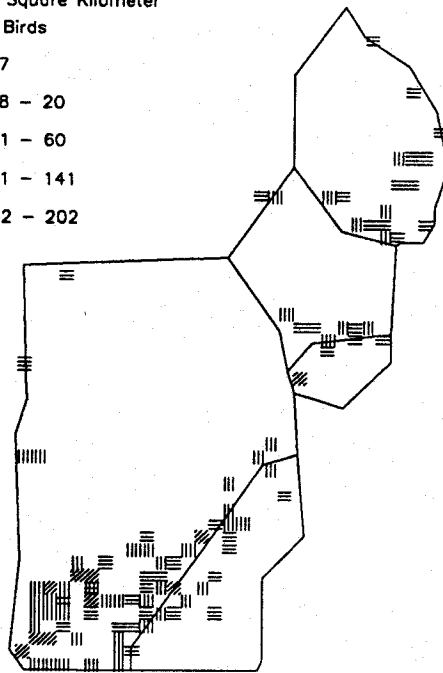
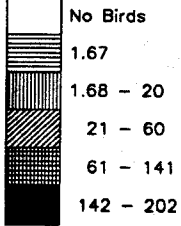


March 1989

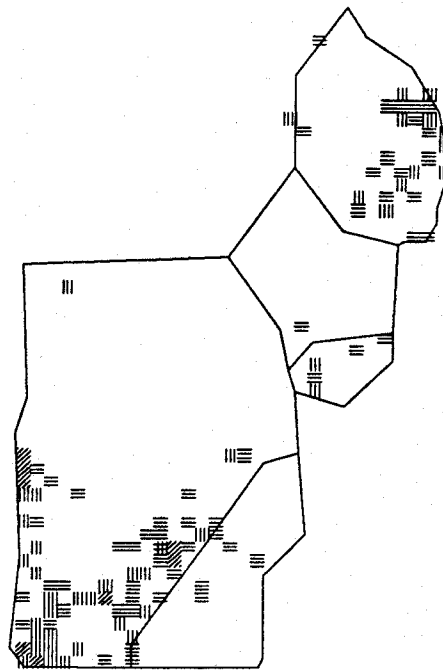
Figure 19a. The distribution of small dark herons in the Water Conservation Areas in December 1988, and January, February, March 1989.

Density Categories

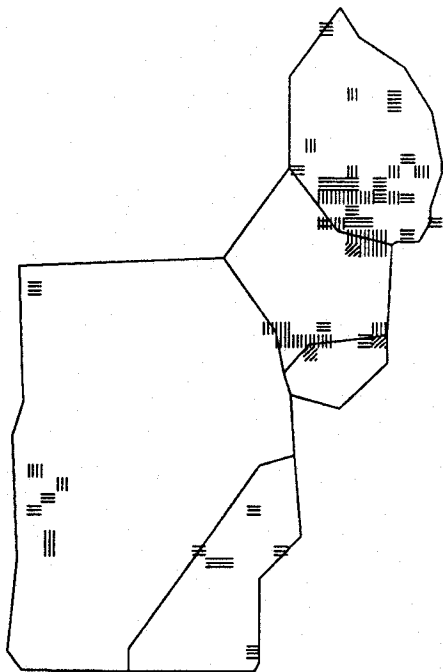
Birds per Square Kilometer



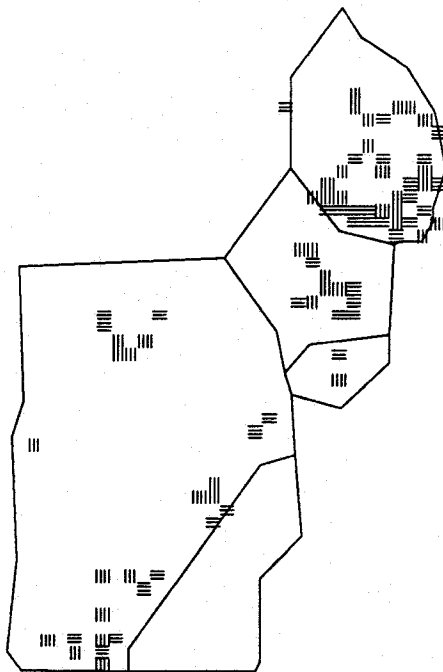
April 1989



May 1989



June 1989

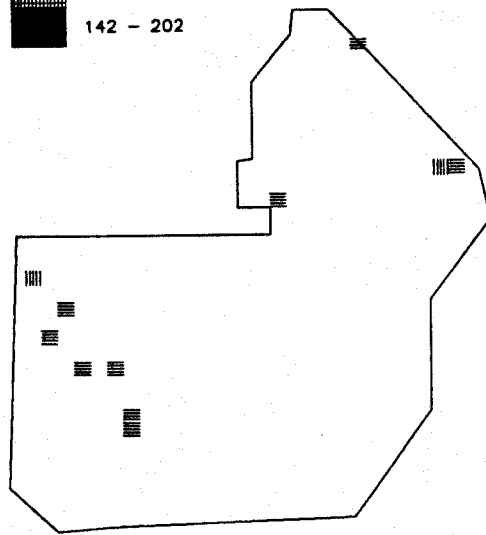
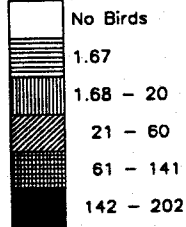


August 1989

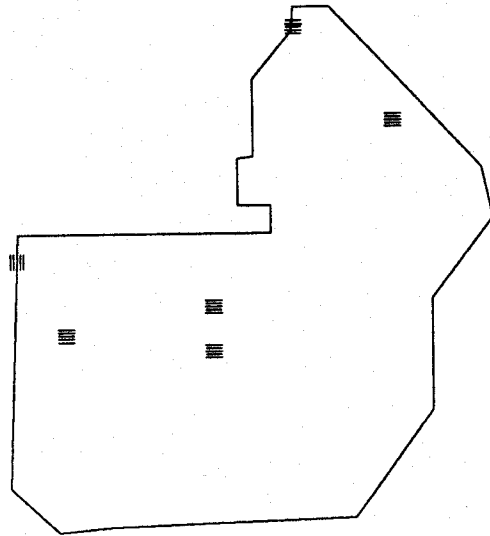
Figure 19b. The distribution of small dark herons in the Water Conservation Areas in April, May, June and August 1989.

Density Categories

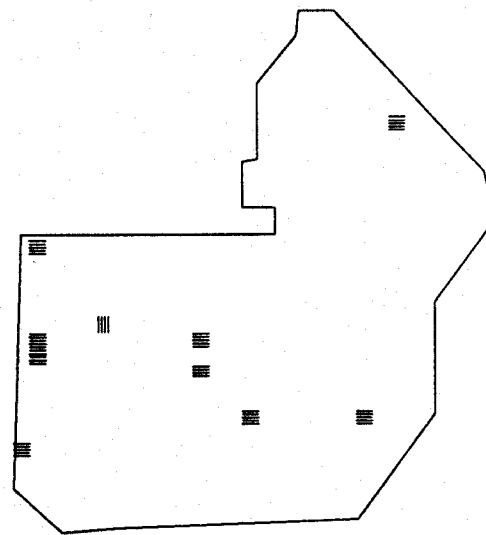
Birds per Square Kilometer



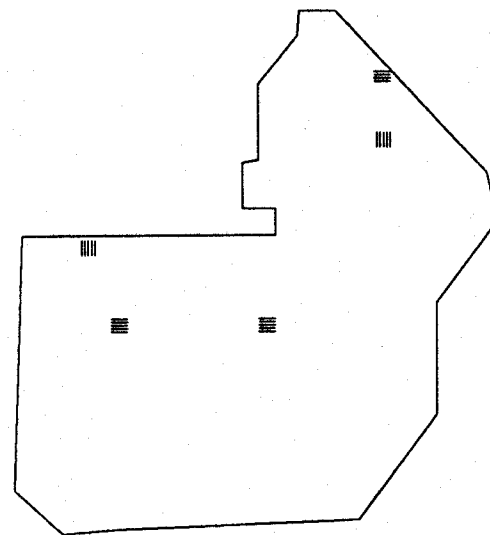
December 1988



January 1989



February 1989



March 1989

Figure 19c. The distribution of small dark herons in the Everglades Agricultural Area in December 1988, and January, February, March 1989.

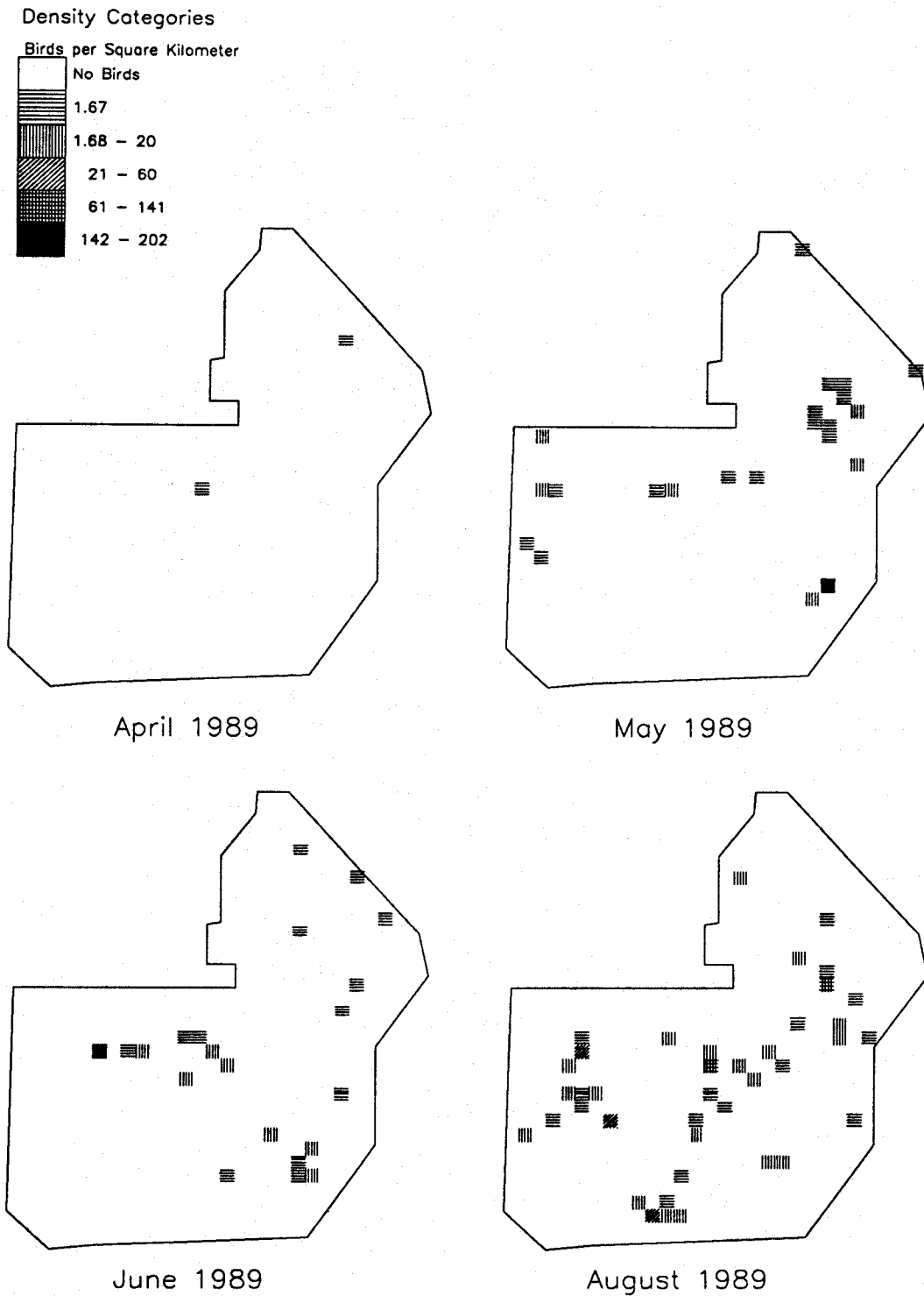


Figure 19d. The distribution of small dark herons in the Everglades Agricultural Area in April, May, June and August 1989.

Small White Herons.- The category small white herons includes Snowy Egrets (*Egretta thula*) and white (immature) Little Blue Herons (*E. caerulea*). These species are sometimes difficult to distinguish from each other from the air. For consistency, they are grouped together for our analyses. During May and June when juvenile Little Blue Herons are molting into adult plumage and have a "pied" look, we can identify them with more certainty and therefore include them in the small dark heron category. For this year's analyses, we have excluded Cattle Egrets (*Bulbulcus ibis*) from the small white heron category and have analyzed them separately. Cattle Egrets occur in very large numbers in the EAA and only small numbers are observed in the Water Conservation Areas. Therefore, density categories would be calculated on the very large flocks of Cattle Egrets seen in the EAA and most observations of Snowy Egrets and immature Little Blue Herons would fall in the lowest density categories within the WCAs. Separating the species paints a truer picture of small white heron distribution and also demonstrates quite well the spatial isolation of Cattle Egrets from the indigenous small white herons.

Population estimates for small white herons during the dry-season surveys ranged from 2486 birds in June to 8461 birds in February (Table 6). In the WCAs, the estimates for February are significantly larger than only May and June estimates in the dry season (Fig. 20.) In the total survey area population trends were similar to those in the WCAs (Fig. 21). The August survey was quite different, however. The August estimate for the WCAs was significantly lower than all dry-season estimates except for that of June. In the total survey area, the August population estimate is significantly larger than both the May and June estimates. Although it is not statistically larger, the actual August estimate is greater than any of the dry-season estimates.

Table 6. Estimated abundance of small white herons in 1988-1989 surveys.

Month	Water Conservation Areas						Everglades Agricultural Areas		
	1	2A	2B	3A	3B	Total	North	South	Total
December	2093	1527	440	800	20	4880	540	340	5320
January	1913	1540	813	1980	53	6299	630	47	6366
February	1700	667	2333	3207	307	8214	0	200	8461
March	860	393	460	1880	2927	6520	713	27	6620
April	660	287	20	4687	520	6174	637	13	6200
May	907	207	93	2213	187	3607	410	467	4101
June	373	1087	220	113	173	1966	53	467	2486
August	340	73	20	767	0	1200	653	7293	9146

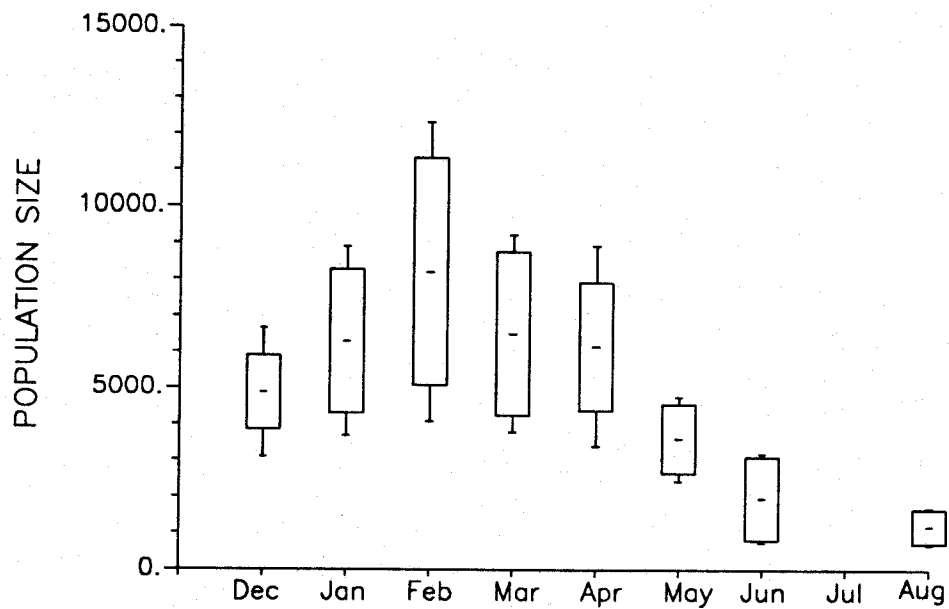


Figure 20. Estimated population of small white herons using the Water Conservation Areas during each month.

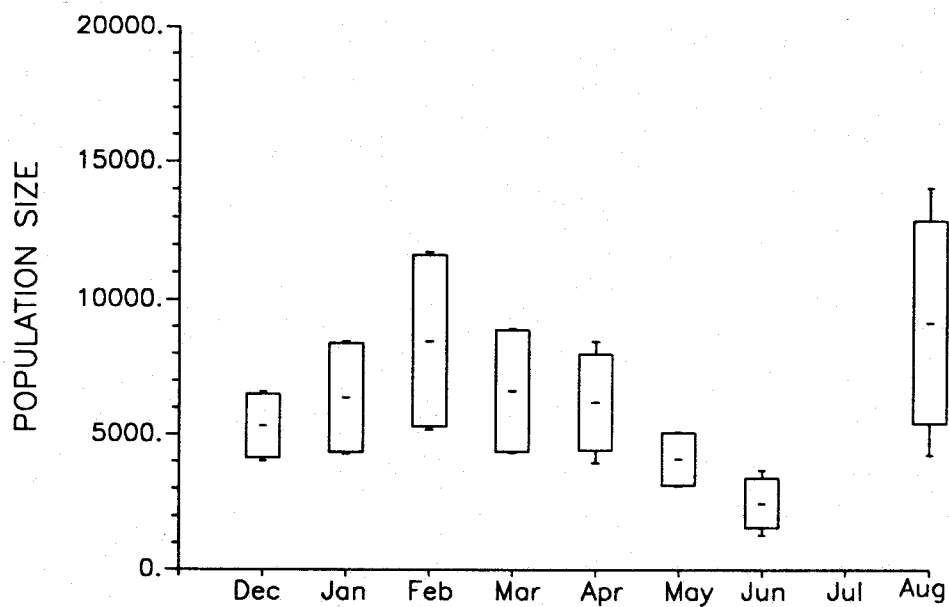


Figure 21. Estimated population of small white herons using the total survey area during each month.

The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances.

The numbers of small white herons using the Water Conservation Areas varied greatly from month to month during the dry season. WCA 3A ranked first in four out of the seven surveys and WCA 1 ranked second in four months also (Table 6). Beyond those generalizations, small white herons tend to be a very mobile group of wading birds and no consistent use of any one area was noted in this year's surveys. Indeed, in March WCA 3B ranked first although it most often ranked fourth or fifth. This pattern of irregular use of the WCAs has also been observed in previous surveys (Hoffman, Sawicki and Bancroft, 1988; Bancroft, Hoffman and Sawicki, 1987; ob. cit.). While the average dry-season WCA total (mean = 5380) in 1989 was only slightly higher than the 1987 average (mean = 4790), it was significantly higher than the 1988 total (mean = 2988). Clearly, in 1988, many small white herons were in areas other than the WCAs, while in 1989, large numbers moved into the WCAs to take advantage of the unusually "productive" dry-down.

Use of the Everglades Agricultural Area varied considerably from month to month (Table 6). Although 8.3% (N = 440) of small white herons used the EAA in December, the percentage dropped to less than three percent for the next four surveys. In May, the percentage had risen to 12% (N = 494) and by June 20.9% (N = 520) of small white herons were using the EAA. Although there were similar numbers of birds using the EAA during the May and June surveys, the number of birds using the WCAs had dropped considerably and many birds had left the survey area entirely.

The wet-season survey in August, however, was quite different. While the WCAs contained an estimated 1200 birds, the EAA contained nearly 8000, 87% of all estimated small white herons. The number of total estimated small white herons (N = 9146) was higher than any of the dry-season surveys. Since it was too early to expect an influx of northern migrants, it appears that a significant number of small white herons in south Florida were using the EAA in August.

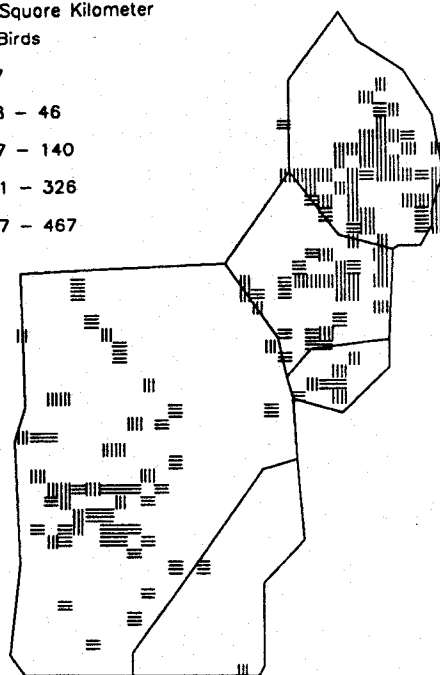
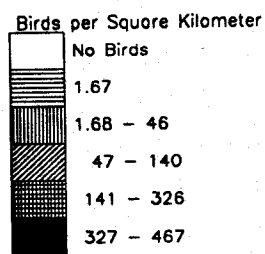
The maps of small white heron distribution (Fig. 22) are scaled from a maximum estimated cell density of 467 birds/km² (= 280 birds observed in one 4 km² cell). In the WCAs birds tended to be located in the southern half of WCAs 1 and 2A in December, as well as the south central portion of WCA 3A. Birds using the Miami Canal are also clearly shown by the diagonal line of birds in the northern end of WCA 3A. The January map was not significantly different, however, birds had begun to move southeast in all areas but WCA 3B. By February, birds were still using the southeast portions of WCAs 1 and 2A and had moved in large numbers into the drying pools at the south end of WCA 2B along with other wading bird species. WCA 3A still contained a somewhat

scattered distribution of birds east of the L-28 gap. By March, birds were still using WCAs 1 and 2A, had largely left WCA 2B, but had moved substantially closer to the L-67 levees in both WCA 3A and 3B as well as the southern edges of these units. During April and May, the deeper sloughs along the L-67A levee in WCA 3A were used more heavily than any other area. The June survey shows a very diffuse pattern of use. WCA 3A was largely devoid of birds and most birds were foraging in the southern tip of WCA 2A where water was being pooled. Birds were also observed at the northeast edge along the Hillsboro Canal, from which, it appeared, water was flowing into WCA 2A. The August wet-season survey showed a diffuse distribution as well. Birds were observed in the reflooded marshes of all areas except for WCA 3B. In WCA 3A birds were primarily found along the L-67A levee as well as the burned dense sawgrass marsh north of Alligator Alley.

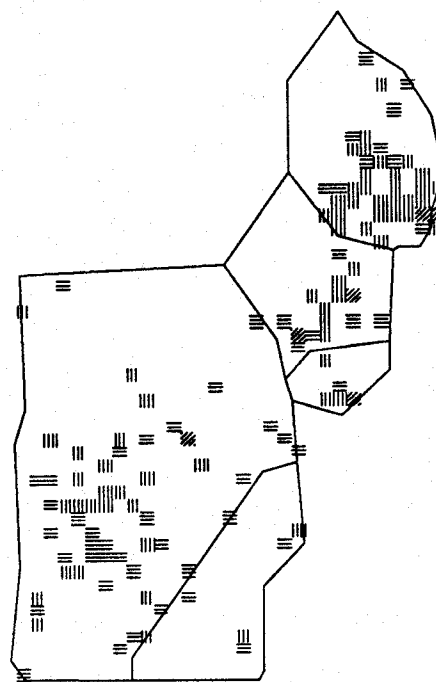
The EAA maps (Fig. 22) show light use of the area by individual birds until May when moderate numbers of birds began to use the reflooded rice paddies. Use of these areas as well as flooded fields and the marshes of the Holey Land, increased substantially by the wet-season survey of August.



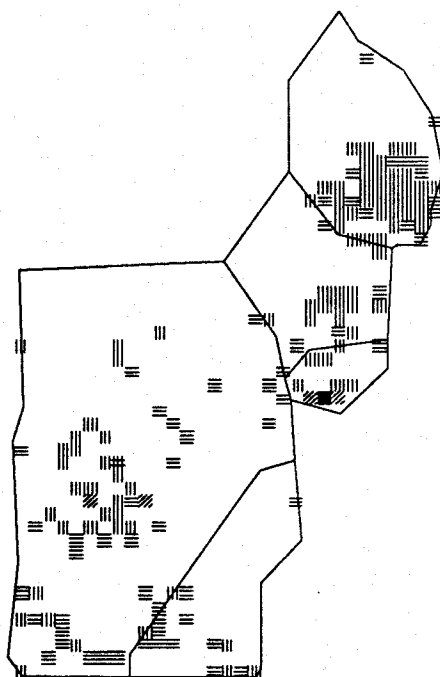
Density Categories



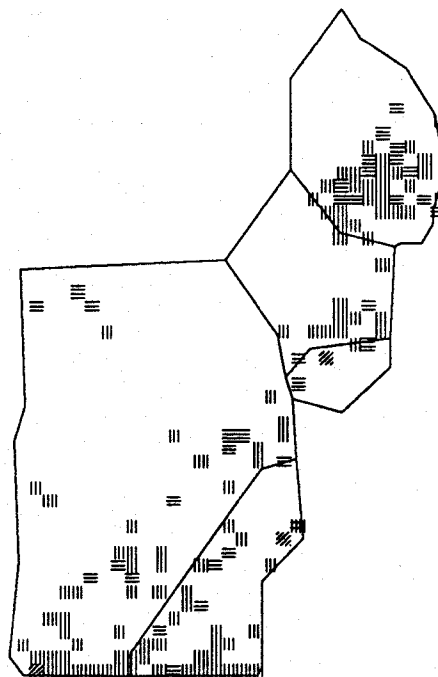
December 1988



January 1989



February 1989

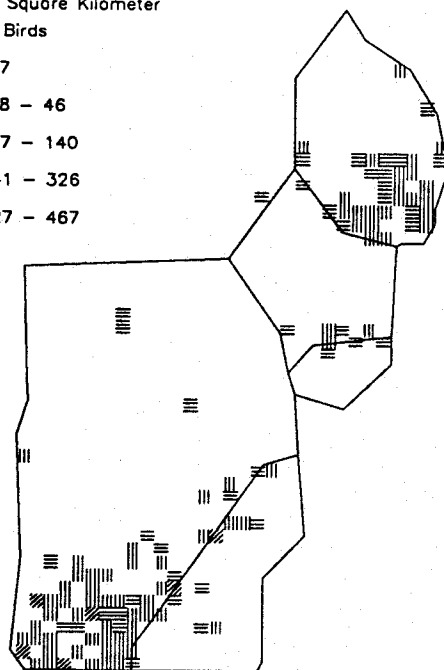
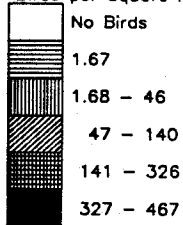


March 1989

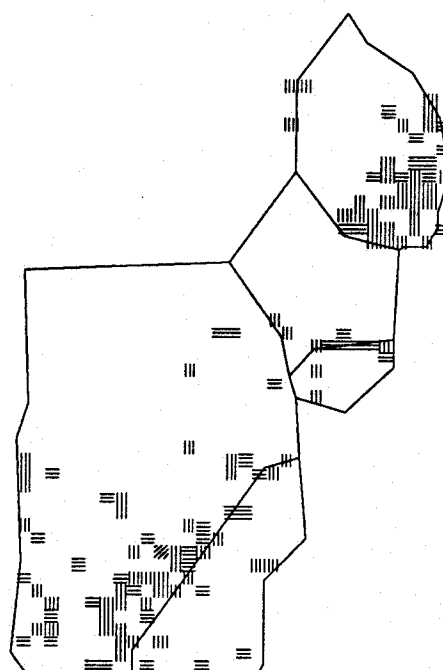
Figure 22a. The distribution of small white herons in the Water Conservation Areas in December 1988, and January, February, March 1989.

Density Categories

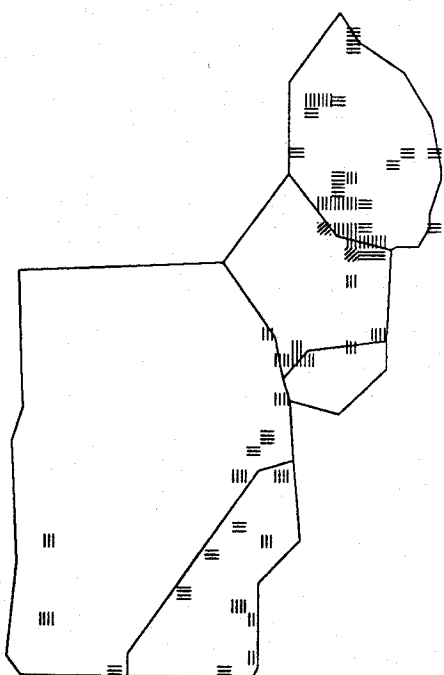
Birds per Square Kilometer



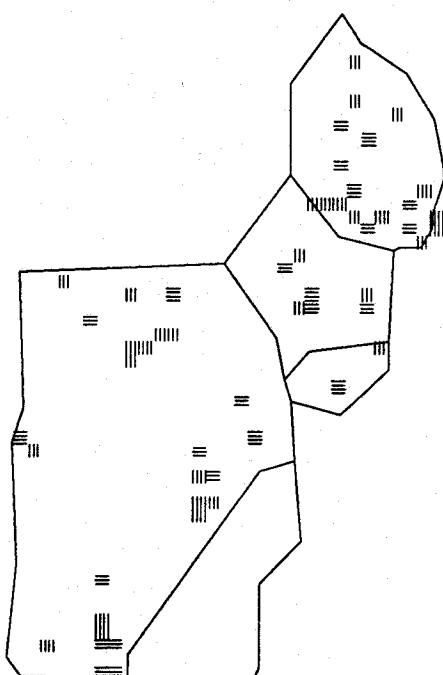
April 1989



May 1989



June 1989

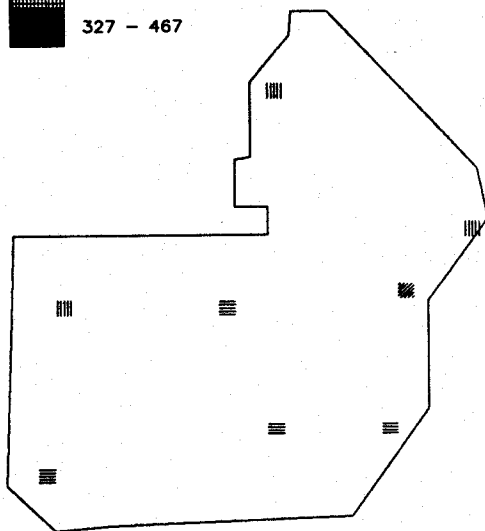
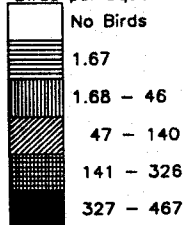


August 1989

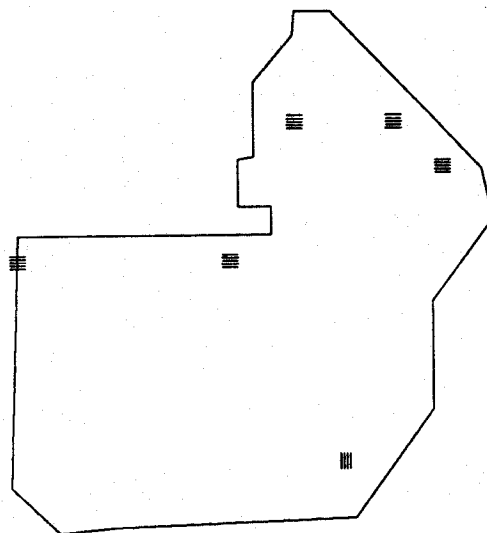
Figure 22b. The distribution of small white herons in the Water Conservation Areas in April, May, June and August 1989.

Density Categories

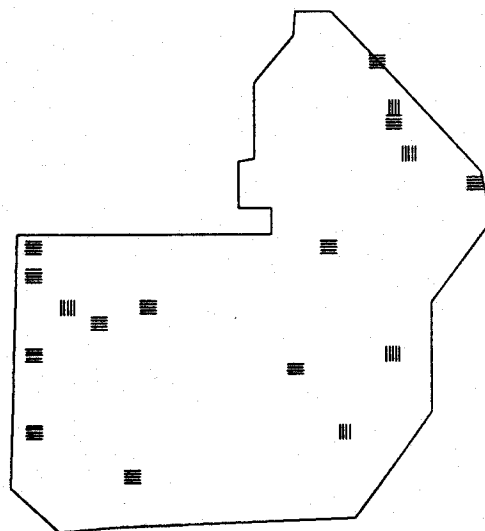
Birds per Square Kilometer



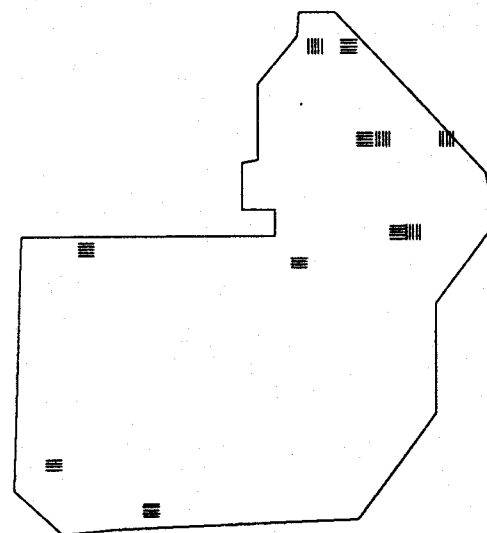
December 1988



January 1989



February 1989

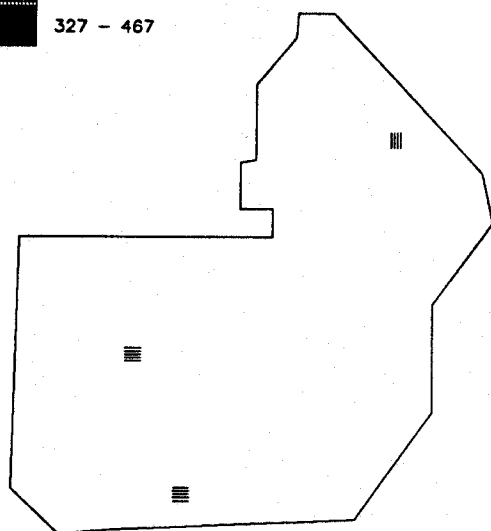
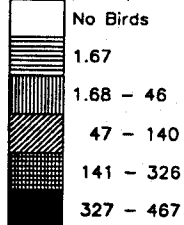


March 1989

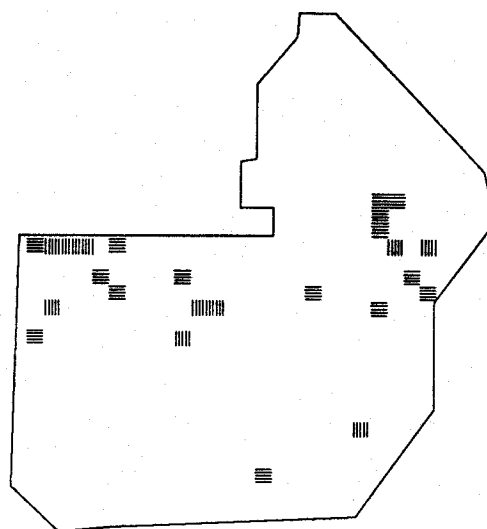
Figure 22c. The distribution of small white herons in the Everglades Agricultural Area in December 1988, and January, February, March 1989.

Density Categories

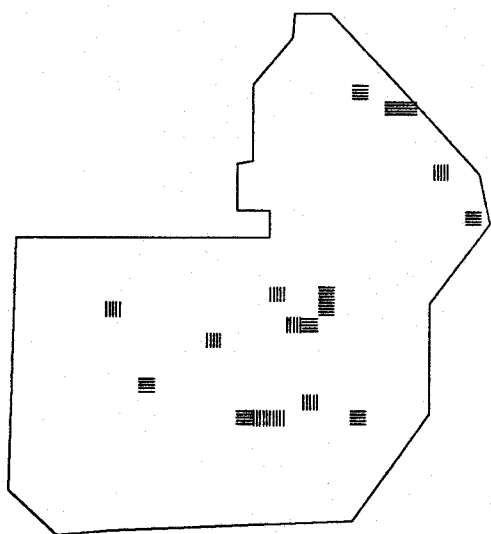
Birds per Square Kilometer



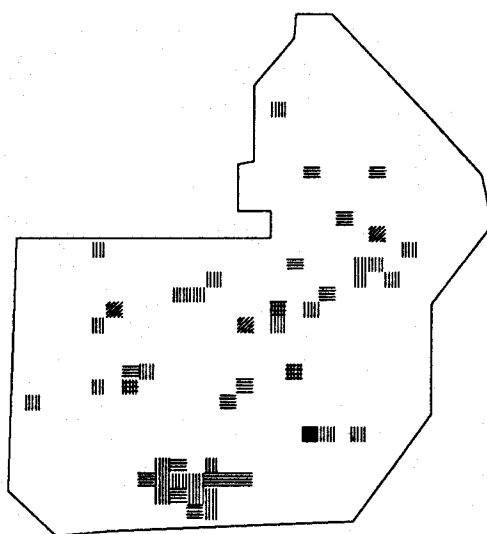
April 1989



May 1989



June 1989



August 1989

Figure 22d. The distribution of small white herons in the Everglades Agricultural Area in April, May, June and August 1989.

Wood Stork (*Mycteria americana*)- Wood Stork numbers for the dry-season ranged from 140 in June to 7874 in March (Table 7). The estimates for March and April are significantly higher than the December, May, June and August estimates (Fig. 23). In the total survey area, the estimates for March and April are significantly higher than December, May and June, but not August (Fig. 24).

In the earlier surveys of December and January, WCA 2A contained most of the birds (Table 7). By February, the population center had shifted to WCA 2B, however, most of these birds were not observed foraging, but were seen in several large roosts in *Melaleuca* tree islands. Although it had been thought that nesting might occur on these tree islands, none was observed. WCA 3A ranked first for the months March, April and May with WCA 3B ranked second for each month. The June survey contained very few Wood Storks and they were only found in WCA 2A and 2B. In the EAA, only a few isolated birds or none were present for all the dry-season surveys through May. Bird numbers never exceeded 1% until June when 52.1% of all Wood Storks seen were in the EAA. However, since the total estimated population for the entire survey area was only 140 birds, most Wood Storks had clearly left the survey area.

The Wood Stork distribution maps are shown in Figure 25. They are scaled on a maximum estimated density of 570 birds/km² (= 342 birds recorded in one cell). Wood Storks were found in the east-central part of WCA 1 in December. In January and February, birds shifted south as the area dried out. By March, Wood Storks had left WCA 1 and use was minimal to non-existent. In WCA 2A, birds were located in the east-central portion of the area in December. As the area dried

Table 7. Estimated abundance of Wood Storks in 1988-1989 surveys.

Month	Water Conservation Areas						Everglades Agricultural Areas		
	1	2A	2B	3A	3B	Total	North	South	Total
December	820	1113	207	60	7	2207	0	13	2220
January	1167	2167	127	1193	47	4701	0	33	4734
February	733	920	1607	253	47	3560	0	0	3560
March	93	527	187	4067	3000	7874	0	0	7874
April	7	7	20	5373	1533	6940	0	0	6940
May	13	0	7	720	353	1093	0	7	1100
June	0	40	27	0	0	67	0	73	140
August	7	0	0	0	0	7	700	2713	3420

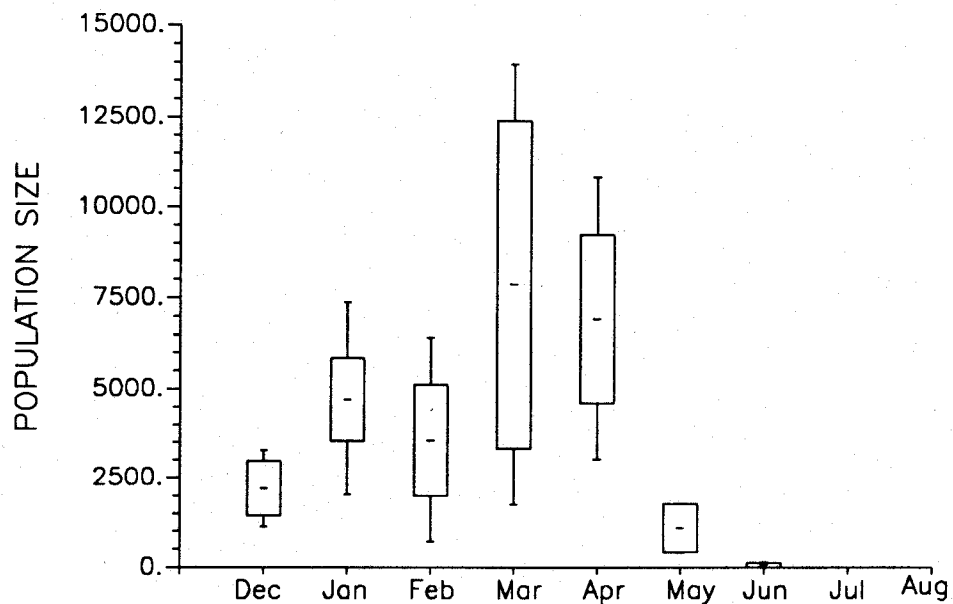


Figure 23. Estimated population of Wood Storks using the Water Conservation Areas during each month.

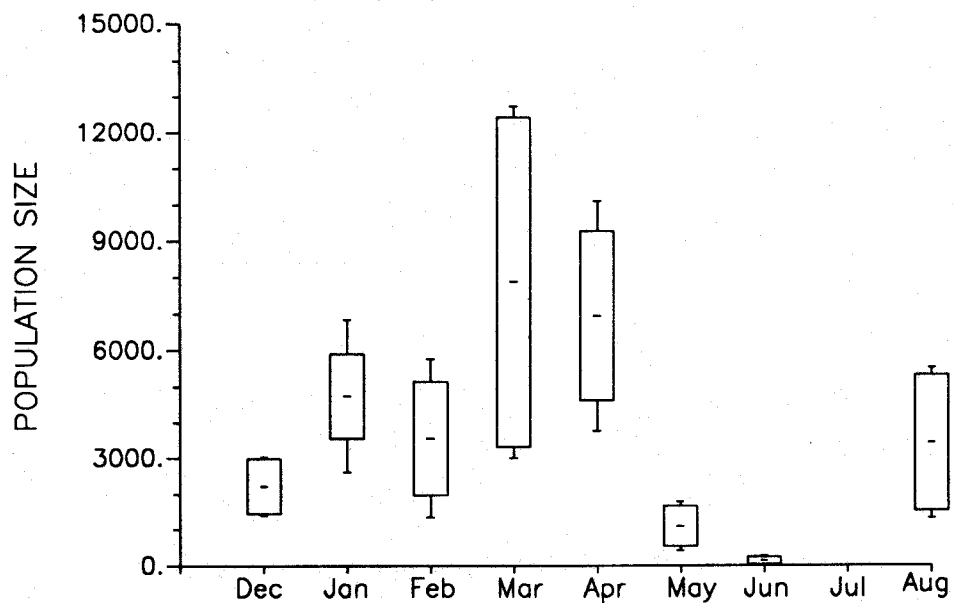


Figure 24. Estimated population of Wood Storks using the total survey area during each month.

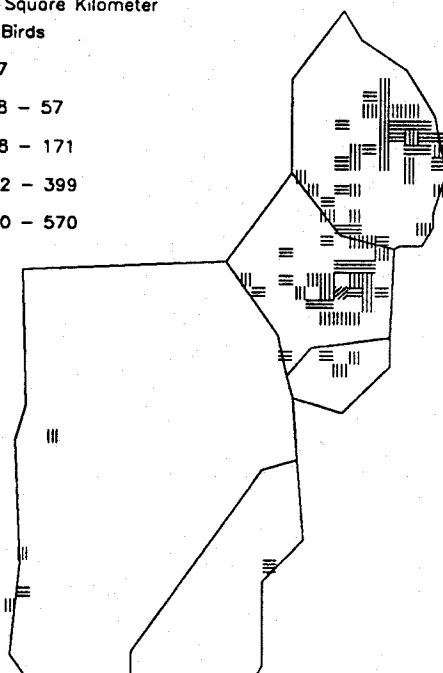
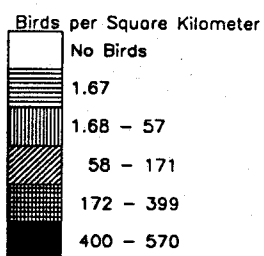
The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances.

out, bird use shifted to the south during the January, February and March surveys. By the April survey, Wood Storks had mostly left WCA 2A for the remainder of the surveys. WCA 2B was used only to a small extent in most surveys except for the February survey. Large roosts of Wood Storks were observed in the southern portion of the area as well as large numbers of foraging birds. WCA 2A was little used until the March survey when large numbers of storks were observed foraging in the southern part of the area as well as along the L-67A levee. By April, large numbers of birds were again found foraging in the southern portion of WCA 3A and along the L-67A levee. A small number of birds were also found near the L-28 gap. Although the May survey showed substantially fewer birds in the area, their distribution was still much like the pattern seen in May. By the June survey, Wood Storks had largely left the WCAs and WCA 2A contained no Wood Storks. WCA 3B was used minimally by Wood Storks for all surveys except the March survey. The Everglades Agricultural Area was used minimally or not at all by Wood Storks during all dry-season surveys.

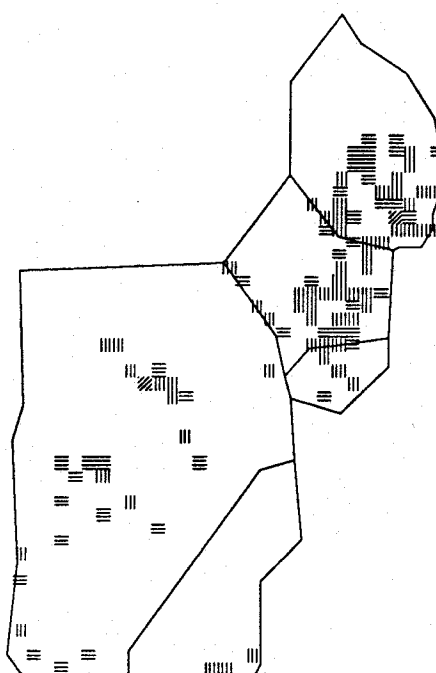
The wet-season survey in August, however, showed a much different pattern. While the WCAs were nearly devoid of Wood Storks, the EAA contained an estimated population of slightly over 3400 birds (Table 7). These birds were mostly flocked and usually found standing in groups in rice paddies or flooded fields, or standing in long lines along small ditches. A large numbers of storks were also observed roosting in a large Cattle Egret colony in the north end of the Everglades Agricultural Area.



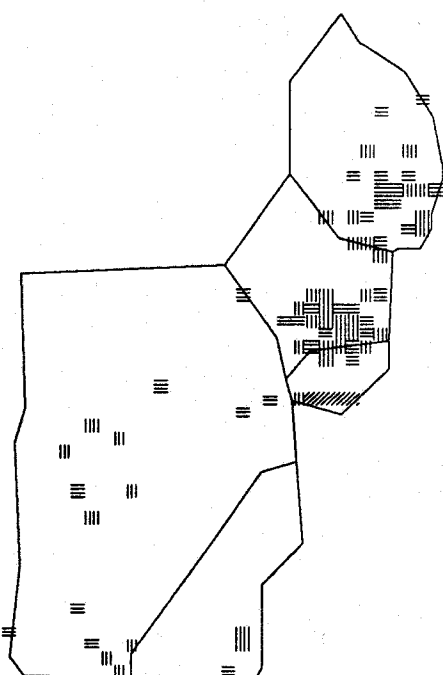
Density Categories



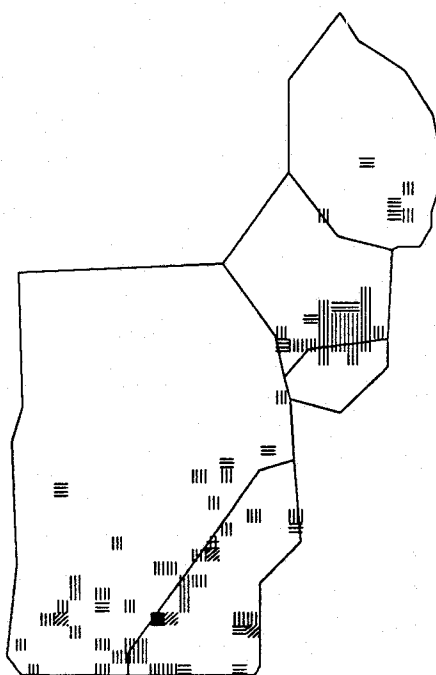
December 1988



January 1989



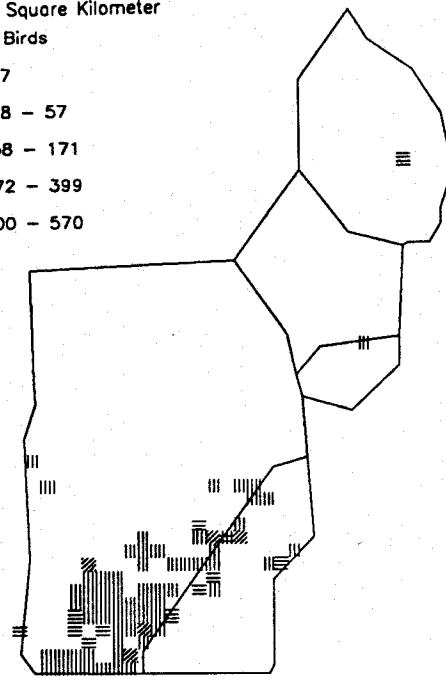
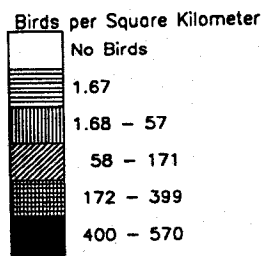
February 1989



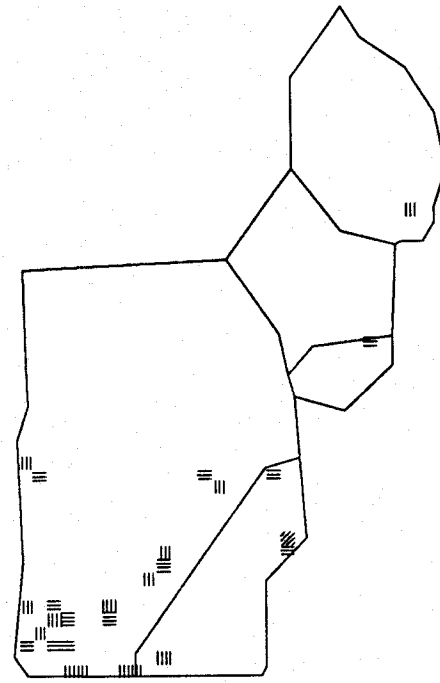
March 1989

Figure 25a. The distribution of Wood Storks in the Water Conservation Areas in December 1988, and January, February, March 1989.

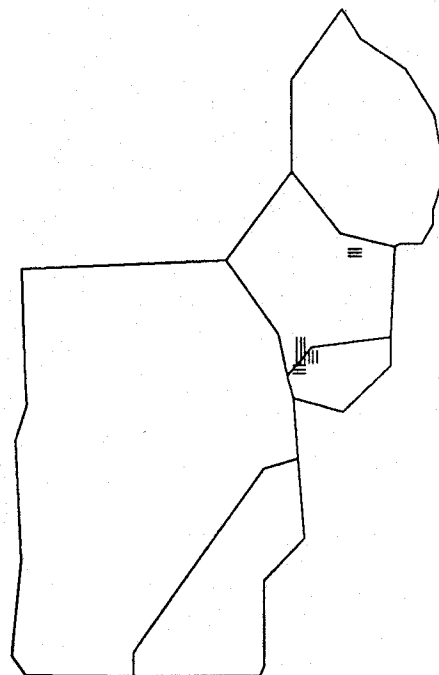
Density Categories



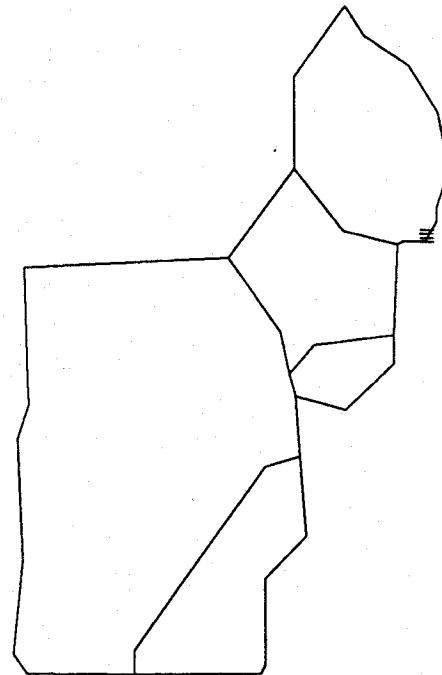
April 1989



May 1989



June 1989



August 1989

Figure 25b. The distribution of Wood Storks in the Water Conservation Areas in April, May, June and August 1989.

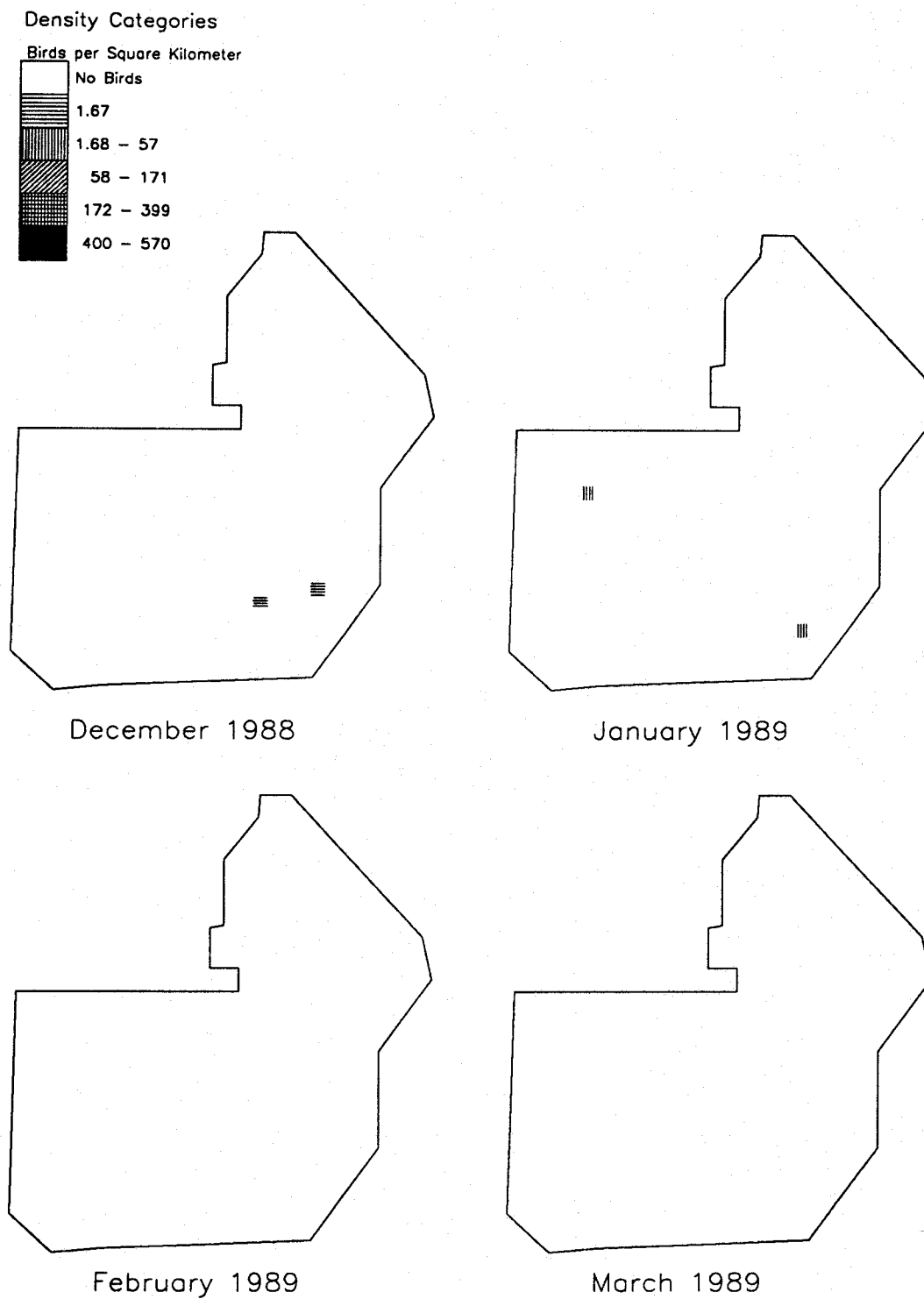
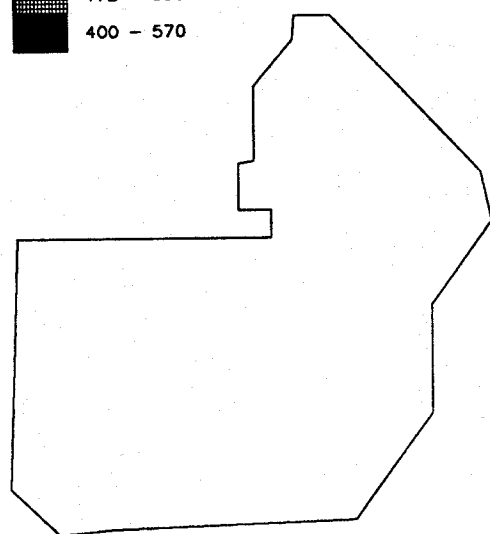
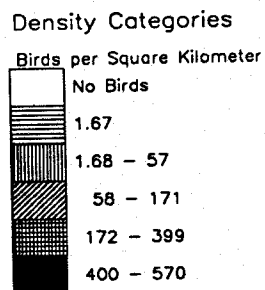
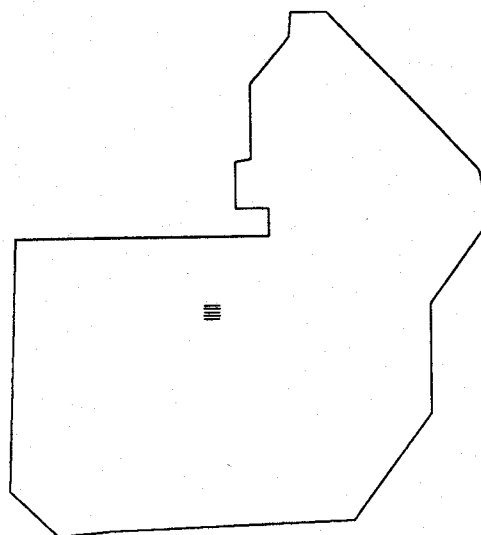


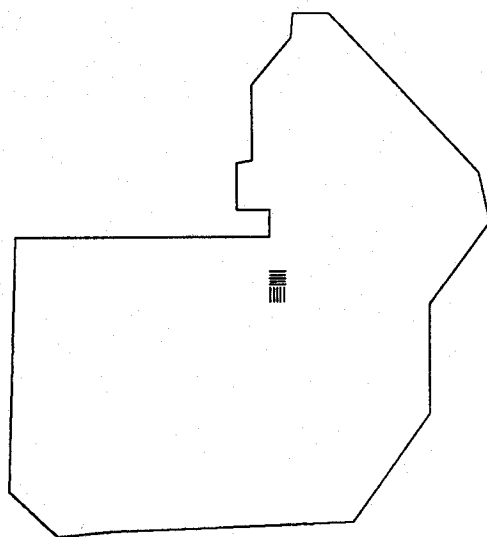
Figure 25c. The distribution of Wood Storks in the Everglades Agricultural Area in December 1988, and January, February, March 1989.



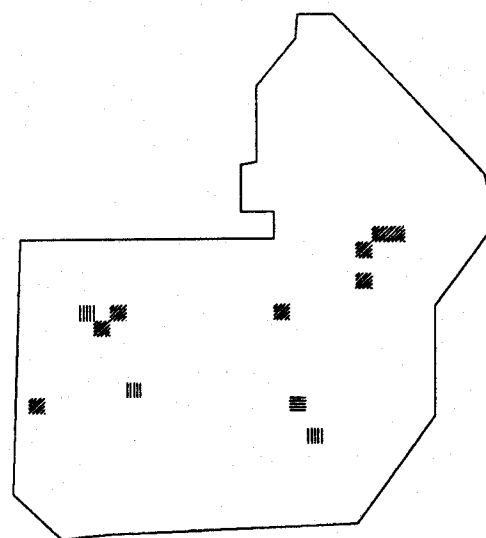
April 1989



May 1989



June 1989



August 1989

Figure 25d. The distribution of Wood Storks in the Everglades Agricultural Area in April, May, June and August 1989.

White Ibis (*Eudocimus albus*).- White Ibises were the most numerous wading bird in the entire survey area during all months of the dry season except June when they were outnumbered by both Cattle Egrets and Great Egrets. In the Water Conservation Areas alone, White Ibises were always the most numerous wading bird during each month of the dry-season surveys (Table 8). Dry-season estimates for the WCAs ranged from 3860 birds in June to 78,239 birds in March. The ranges for the entire survey area vary from 4873 birds in June to the same high estimate of 78,239 birds in March. The estimates for January, February and March are significantly higher than the remaining dry-season surveys for both the WCAs and the total area (Fig. 26; Fig. 27). The June estimate was significantly lower than all other months for both total area and WCAs alone.

Water Conservation Area 3A ranked first in five of the seven dry-season surveys (Table 8). It ranked third in December and fourth at the height of the drought in June. Use of the other Water Conservation Areas was more ambiguous. No area was used consistently from month to month, thus demonstrating the highly mobile nature of foraging flocks of this species. The average estimated number of White Ibises (mean = 45,980) in the dry-season surveys for 1989 was significantly higher than the average number of White Ibises using the WCAs in the previous two years (mean = 33,691) (Hoffman, Sawicki and Bancroft, 1988; Bancroft, Hoffman and Sawicki, 1987; ob. cit.).

White Ibis use of the Everglades Agricultural Area was extremely low in all dry-season surveys until June (Table 8). All estimates were less than 0.5% of total estimated numbers. The June estimate of 20.8% showed a significant rise in the percentage as well as magnitude of White Ibises using the EAA.

Table 8. Estimated abundance of White Ibises in 1988-1989 surveys.

Month	Water Conservation Areas						Everglades Agricultural Areas		
	1	2A	2B	3A	3B	Total	North	South	Total
December	21487	12727	2227	3833	80	40354	100	33	40487
January	7600	11840	2140	38660	5360	65600	0	0	65600
February	2173	3360	14793	41013	6773	68112	0	7	68119
March	593	3207	1533	51633	21273	78239	0	0	78239
April	940	493	87	32073	3900	37493	133	7	37633
May	773	140	287	26527	473	28200	40	40	28280
June	100	1967	1700	93	0	3860	40	973	4873
August	253	127	0	4687	0	5067	20	9893	14980

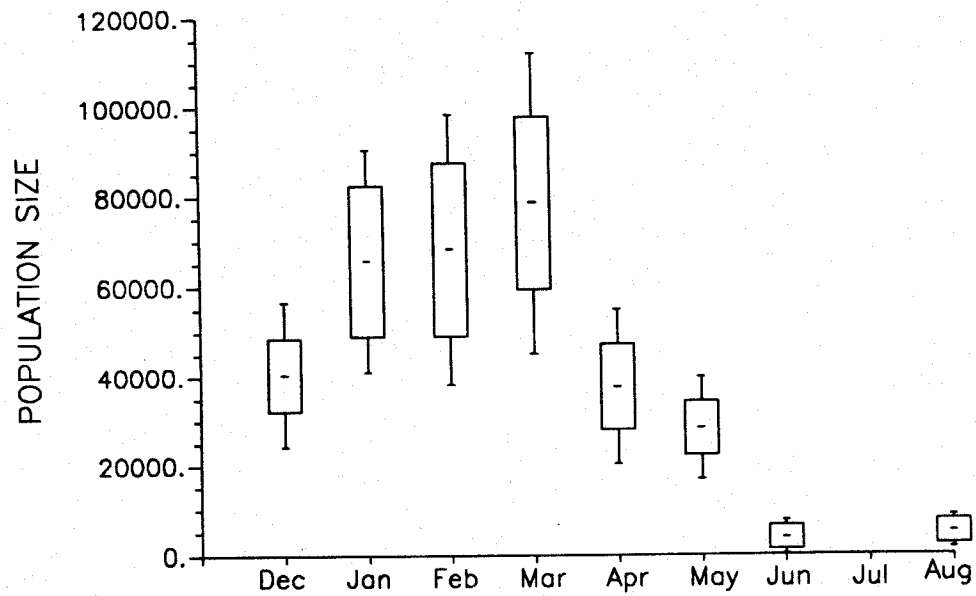


Figure 26. Estimated population of White Ibises using the Water Conservation Areas during each month.

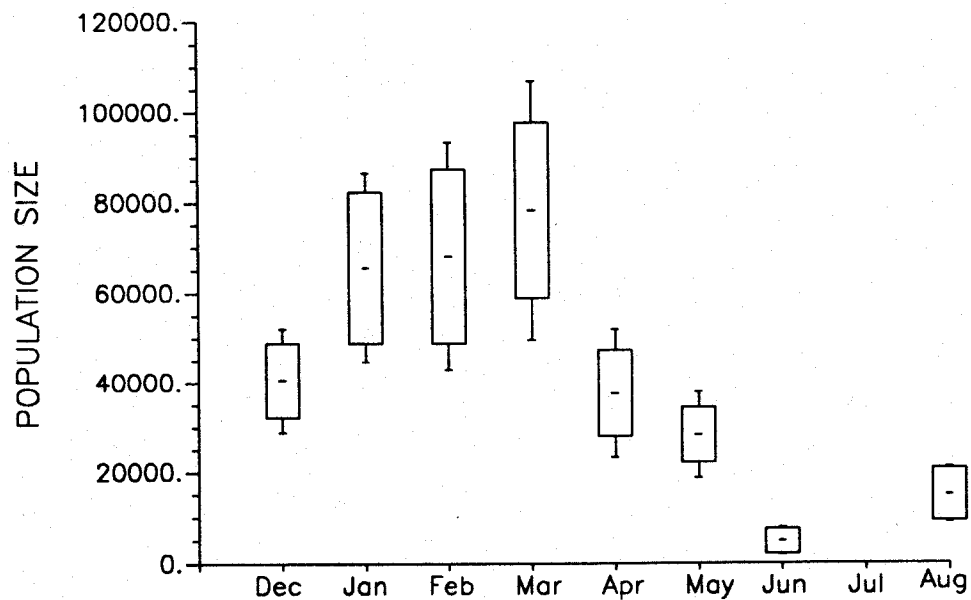


Figure 27. Estimated population of White Ibises using the total survey area during each month.

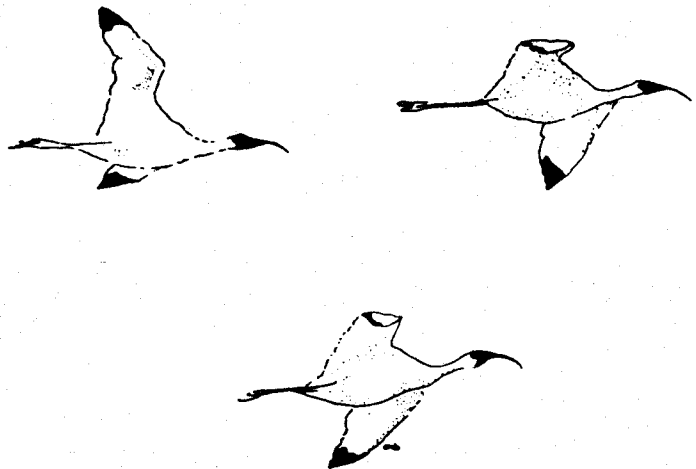
The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances.

The wet season survey showed moderate numbers of White Ibises back in WCA 3A (N = 4687). However, 66.2% of all estimated White Ibises were observed in the EAA. This total (9913) was substantially larger than all dry-season totals, but yet represents approximately 30% of the average number of "resident" White Ibises found in the Water Conservation Areas during April and May surveys. Clearly a large portion of the south Florida White Ibis population had left the survey area.

The White Ibis maps (Fig. 28) are scaled from a maximum estimated density of 1317 birds/km² (= 790 birds recorded in one 4 km² cell). White Ibises are quite social foragers and, as the maps indicate, there are comparatively few instances of single birds occupying a 4 km² cell. In the Water Conservation Areas in December, White Ibises were largely confined to the southern half of WCA 1 and the central portion of WCA 2A. Only small numbers of birds were observed in the L-28 gap area and in WCA 2B. By January the distribution of White Ibises had shifted its center of foraging activity into WCA 3A. A large area of foraging birds was observed in the west-central portion of WCA 3A east of the L-28 gap. Birds had shifted south in both WCA 1 and 2A. In addition, large flocks of birds were observed along the airboat trail at the southeast corner of WCA 3B. In February, the distribution in WCA 3A began to shift south and slightly east, and a larger portion of the southeastern corner of WCA 3B was occupied. Along with other species, large numbers of ibises were feeding in the southern tip of WCA 2B. The distribution of birds in WCA 1 and 2A was similar to that seen in January. By March, birds had shifted into the deeper sloughs along the L-67A levee in WCA 3A and were also found throughout WCA 3B. There were fewer birds in WCAs 1 and 2A and the birds in WCA 2B were located primarily at the northern end. The April map shows White Ibises foraging heavily along the L-67A levee, predominantly in WCA 2A, but also in WCA 3B. WCA 1 and 2A have smaller numbers of birds located at the southern ends. In May, the White Ibis distribution had shifted further south along the L-67A levee. An area of heavy use was also evident extending south from the L-28 gap, continuous with the foraging populations at the south end of WCA 3A. By the June survey, few White Ibises remained in the WCAs. Only the extreme southern ends of WCA 1, 2A and the sloughs east of the L-28 gap were being used.

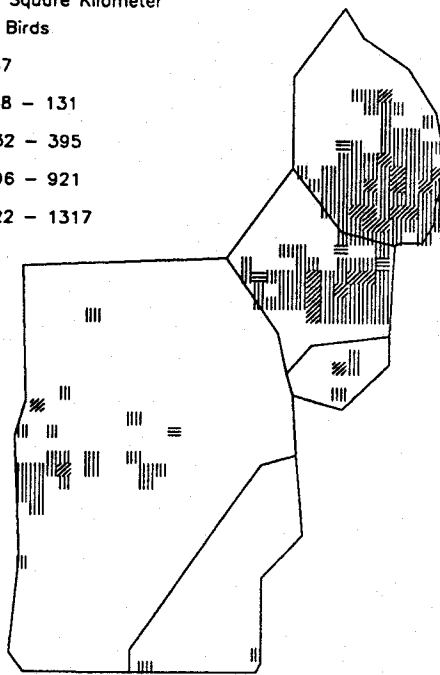
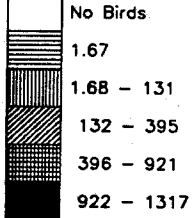
The wet-season survey in August also showed small numbers of White Ibises in the system. Birds were scattered except for a small concentration in the reflooded burns north of Alligator Alley and east of the Miami Canal.

White Ibises were observed in the Everglades Agricultural Area in very small numbers until the June survey. Although numbers had increased, use of the area was still scattered. Rice paddies and flooded fields seemed to be the preferred habitats. In the wet-season survey, White Ibis use of the area was still scattered in rice paddies and flooded fields. Only one area of concentration was noted in the reflooded marshes of Holey Land.

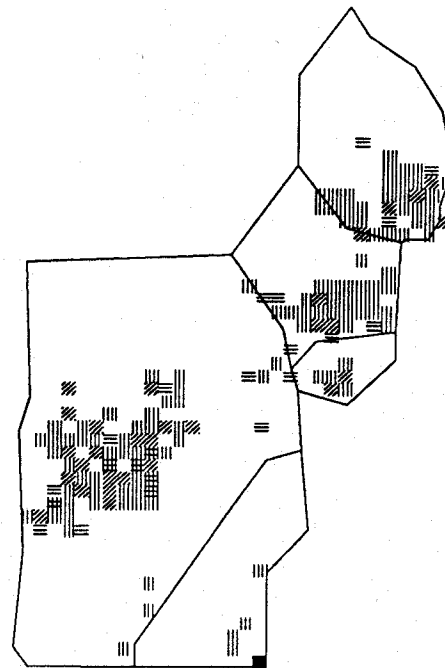


Density Categories

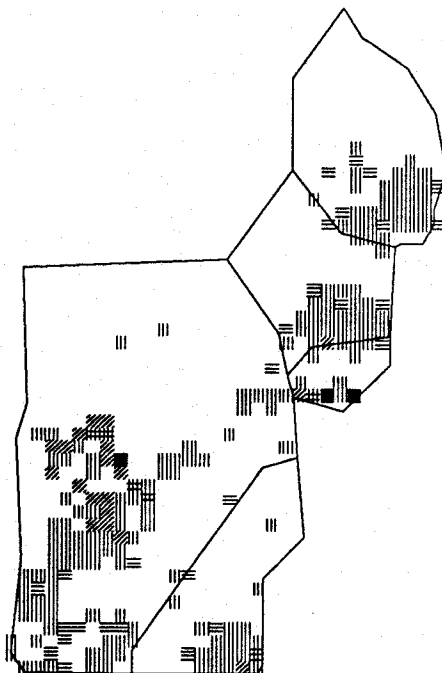
Birds per Square Kilometer



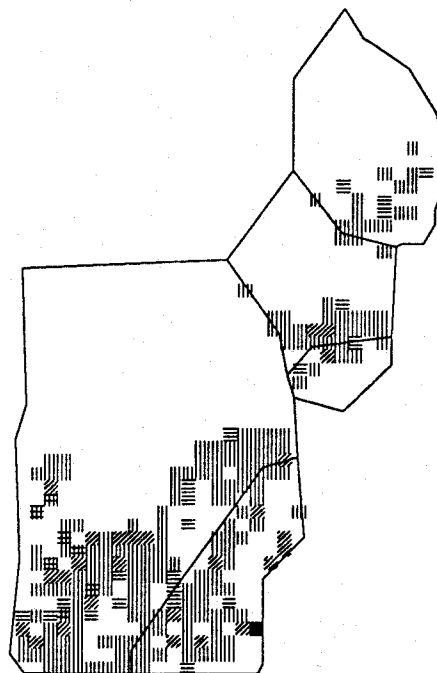
December 1988



January 1989



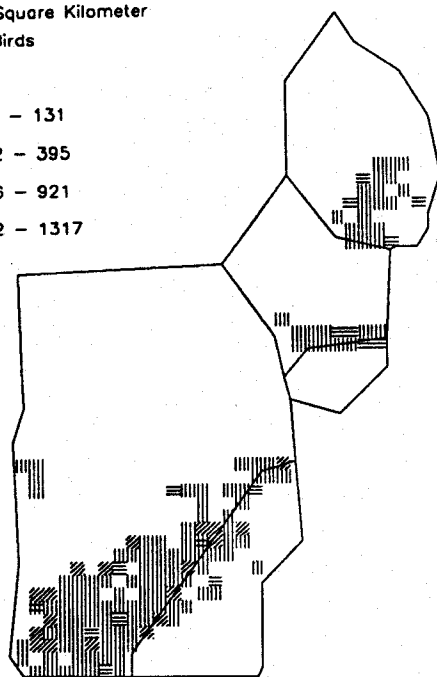
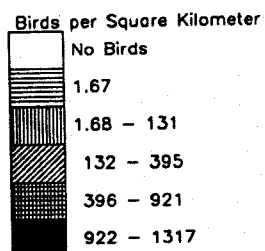
February 1989



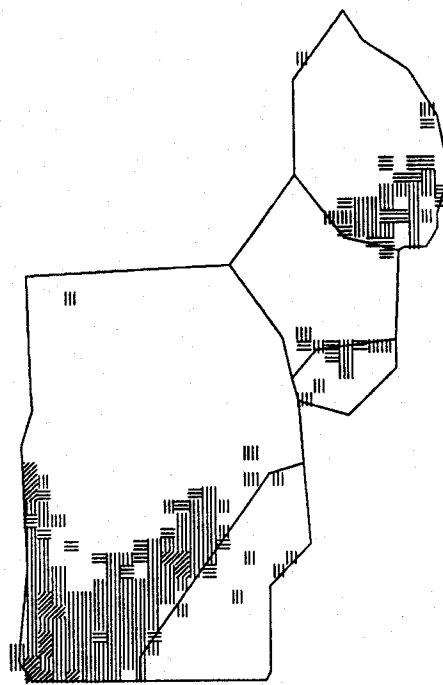
March 1989

Figure 28a. The distribution of White Ibises in the Water Conservation Areas in December 1988, and January, February, March 1989.

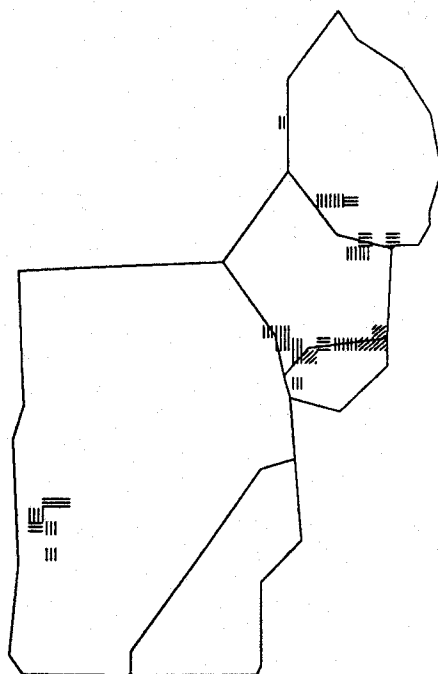
Density Categories



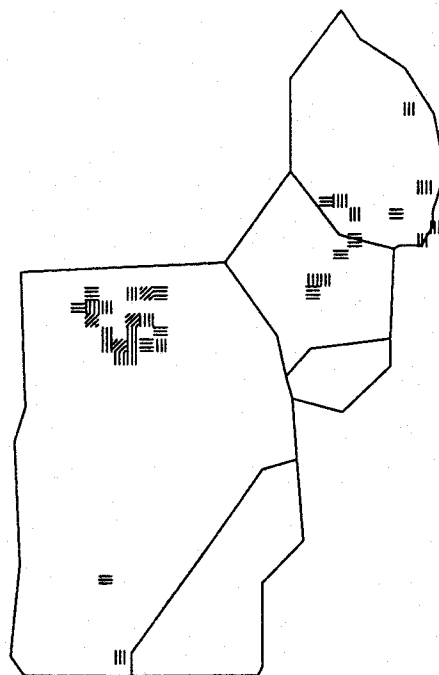
April 1989



May 1989



June 1989



August 1989

Figure 28b. The distribution of White Ibises in the Water Conservation Areas in April, May, June and August 1989.

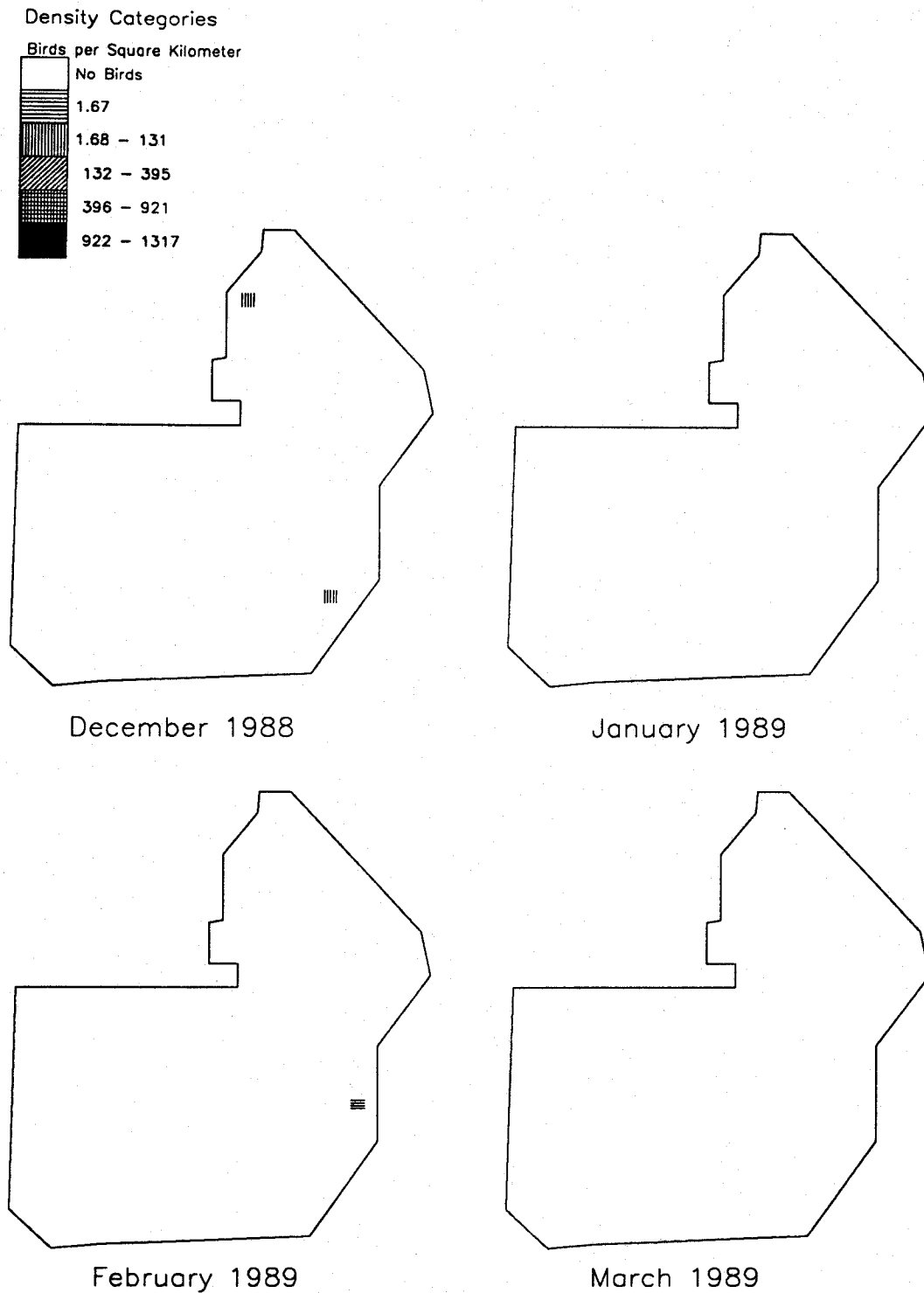
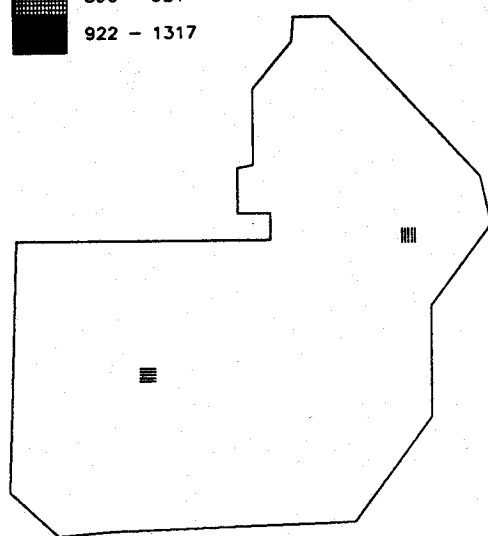
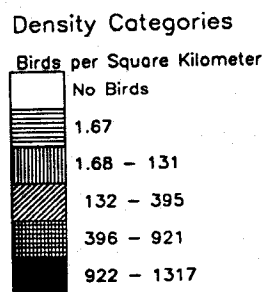
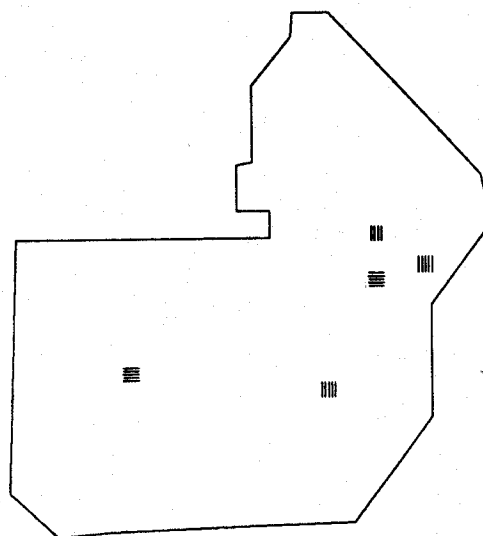


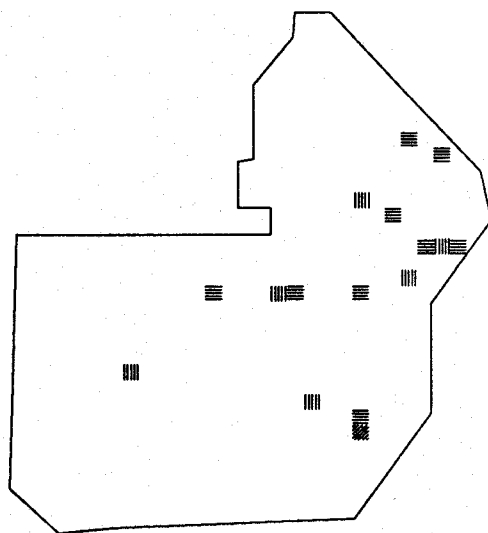
Figure 28c. The distribution of White Ibises in the Everglades Agricultural Area in December 1988, and January, February, March 1989.



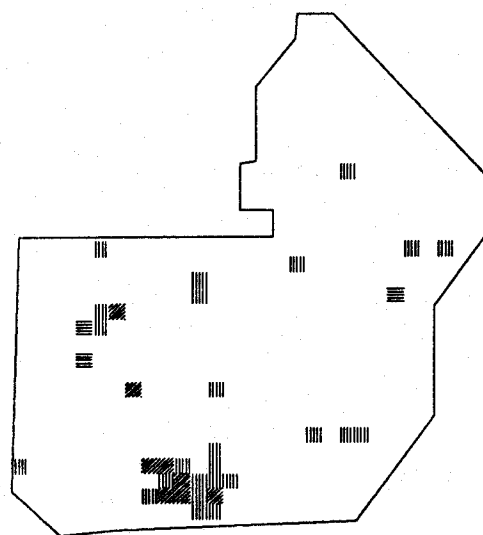
April 1989



May 1989



June 1989



August 1989

Figure 28d. The distribution of White Ibises in the Everglades Agricultural Area in April, May, June and August 1989.

Glossy Ibis (*Plegadis falcinellus*).- Population estimates for Glossy Ibises in the dry season ranged from 587 birds in June to 6040 birds in January for the entire survey area (Table 9). Population estimates did not vary significantly for December through May (Fig. 30). Only the June survey was significantly lower than any other month of the dry season. Although the population estimates for the August survey appear substantially higher than any dry-season survey, they were significantly higher than only May and June. In the Water Conservation Areas alone the estimates for the period December through April did not vary significantly from each other (Fig. 29). However, the May and June estimates, as well as the August wet-season estimate were significantly lower than all other estimates. In contrast to the last two year's surveys WCA 3A ranked first in four of the dry season surveys (Table 9). WCA 1 and WCA 2A ranked first in December and January, respectively. WCA 2A ranked second more than any other survey and apparently remained an important foraging area as in previous years' surveys (Hoffman, Sawicki and Bancroft, 1988; Bancroft, Hoffman and Sawicki, 1987; ob. cit.). Use of the other Water Conservation Areas is more irregular and no area consistently ranked the same. The 1989 dry-season average (mean = 3110) was significantly higher than any previous survey (Hoffman, W., G.T. Bancroft and R. Sawicki. 1989. Wading Bird Populations and Distributions in the Conservation Areas of the Everglades: 1985 through 1988. Comprehensive Report to the South Florida Water Management District, West Palm Beach, Florida. 170 pp). Indeed, the 1989 average was nearly twice the combined average of the last two years' surveys (Hoffman, Bancroft and Sawicki, 1988; Bancroft, Hoffman and Sawicki, 1987; ob. cit.).

Table 9. Estimated abundance of Glossy Ibises in 1988-1989 surveys.

Month	Water Conservation Areas						Everglades Agricultural Areas		
	1	2A	2B	3A	3B	Total	North	South	Total
December	1440	1027	13	233	0	2713	13	707	3433
January	1447	1880	200	633	213	4373	0	1667	6040
February	760	907	840	2960	67	5534	0	0	5534
March	193	827	273	1033	913	3239	0	0	3239
April	140	247	7	4293	100	4787	0	0	4787
May	40	0	53	1033	0	1126	7	953	2086
June	0	0	0	0	0	0	7	580	587
August	60	0	0	533	0	593	67	11073	11733

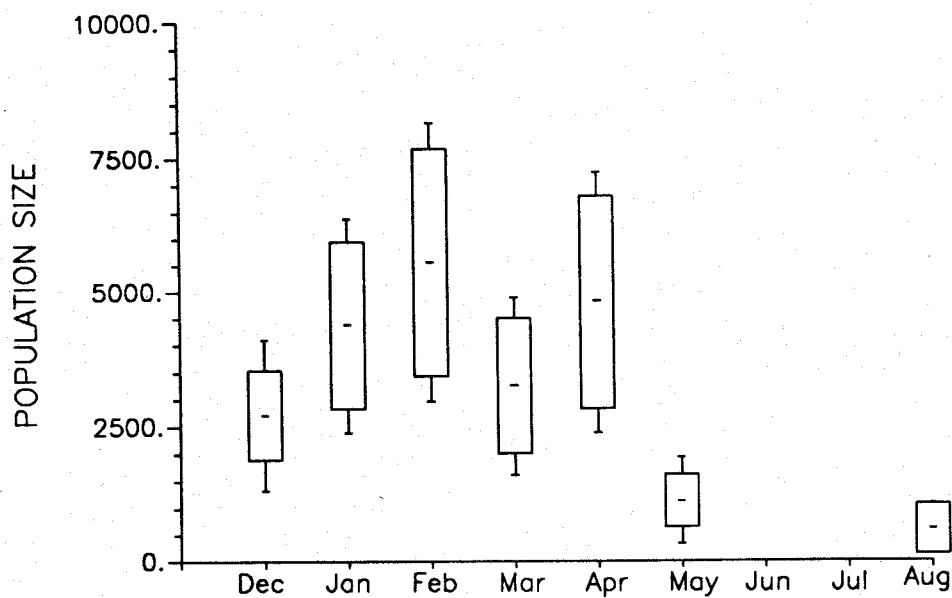


Figure 29. Estimated population of Glossy Ibises using the Water Conservation Areas during each month.

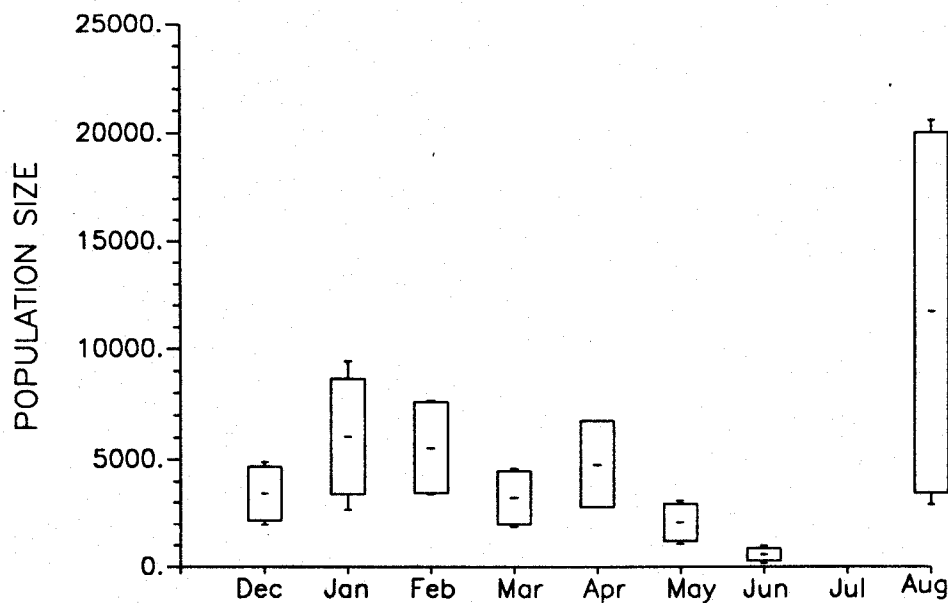


Figure 30. Estimated population of Glossy Ibises using the total survey area during each month.

The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances.

Use of the Everglades Agricultural Area in the 1989 surveys was irregular. Glossy Ibises tended to use the EAA early in the surveys (December and January) and abandon them for the Water Conservation Areas in February through April (Table 9). In December, 20.9% of all Glossy Ibises were in the EAA while in January the percentage was 27.6%. In February through April, no Glossy Ibises were observed in the EAA. By May, Glossy Ibises were leaving the WCAs and the percentage of birds in the EAA had increased to 46%. In the June survey, although no birds were observed in the WCAs, the total estimated population for the EAA was only 587 birds. Clearly many Glossy Ibises had left the survey area.

The August wet-season survey was quite different. Although nearly 700 birds were estimated for the WCAs, over 11,000 Glossy Ibises were estimated for the Everglades Agricultural Area (Table 9). These birds were often found in large flocks and using habitats such as rice paddies, flooded fields and sod farms.

The maps of Glossy Ibis distribution (Fig. 31) are scaled from a maximum estimated cell density of 825 birds/km² (= 495 birds observed in one 4 km² cell). In the December survey, Glossy Ibises were found in the southwestern corner of WCA 1 and scattered throughout the central portion of WCA 2A. By January, bird distribution in WCA 1 was similar but birds in WCA 2A had moved farther south. In addition, birds were starting to move into WCA 2B, 3A and 3B. The February map shows birds at the southern edges of WCA 1, 2A and 2B. Bird use of WCA 3A and 3B was scattered with ibises associating mainly with transitional water conditions. By March, most birds had left WCA 1, were located mainly along the southern edge of WCA 2A, and were beginning to feed closer to the L-67 levee, again in predominantly transitional water conditions. In April, the distribution was heaviest at the south end of WCA 3A and along the L-67 levee. Small numbers of birds were found at the southern ends of WCAs 1 and 2A. By May, most Glossy Ibises were located at the south end of WCA 3A. Only remnant foraging flocks were found in WCA 1 and 2B. In June, no Glossy Ibises were observed in any of the Water Conservation Areas. In the August survey, only small numbers of Glossy Ibises had returned to the WCAs. These birds were in the southwest corner of WCA 1 and, along with other wading birds, were using the reflooded burns in WCA 3A, north of Alligator Alley, and east of the Miami Canal.

Except for scattered sightings of birds in December and January, Glossy Ibises did not use the Everglades Agricultural Area to any extent until May when scattered flocks were observed in

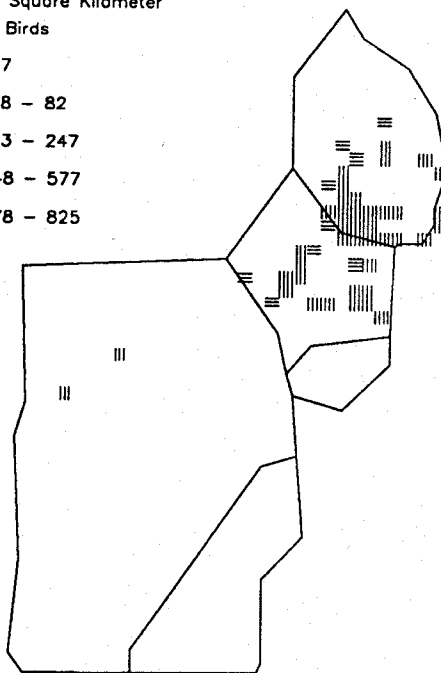
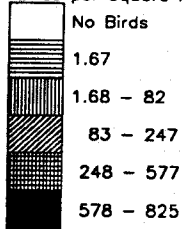
flooded fields and rice paddies, predominantly. Fewer birds were present in June, but habitat use was similar. In the August survey, large numbers of birds moved into the EAA. Glossy Ibises continued to use flooded fallow fields and rice paddies as well as flooded sod fields.

Glossy Ibises, like White Ibises, are highly mobile in their foraging tactics. Many more were apparently taking advantage of the highly favorable foraging conditions present in the deeper sloughs of WCA 3A than normally use the system. The EAA was apparently used by large flocks of Glossy Ibises at certain times of the year, particularly when foraging conditions were poor in the Water Conservation Areas.

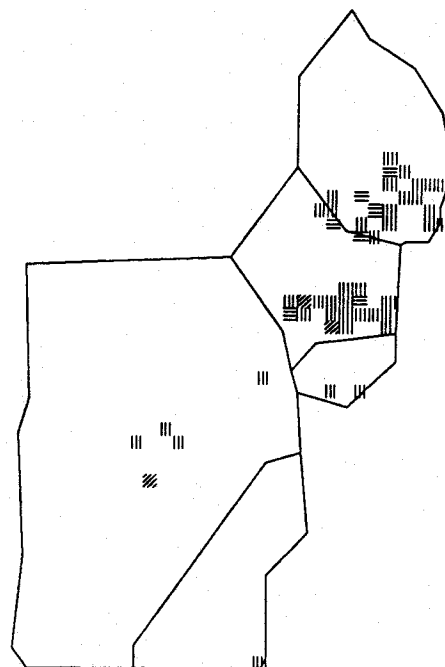


Density Categories

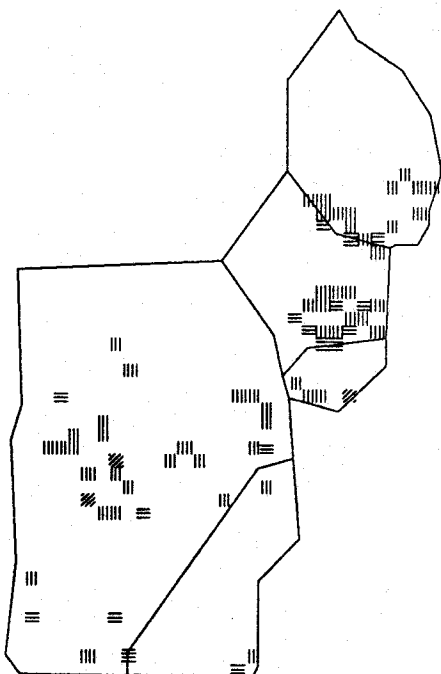
Birds per Square Kilometer



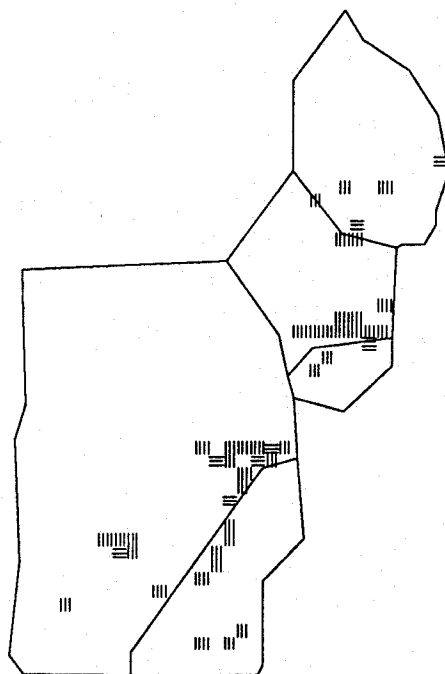
December 1988



January 1989



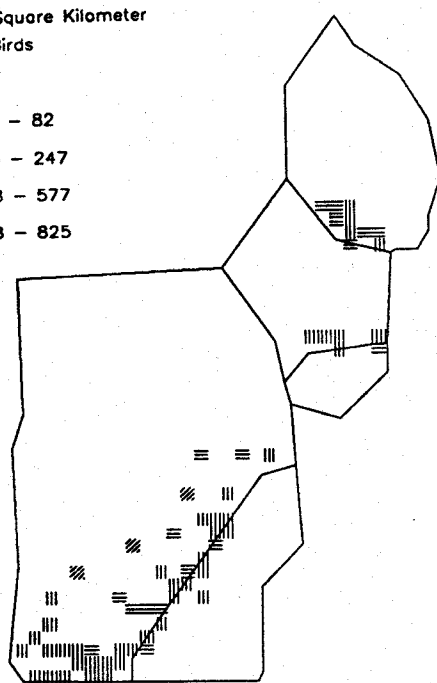
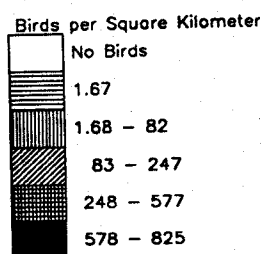
February 1989



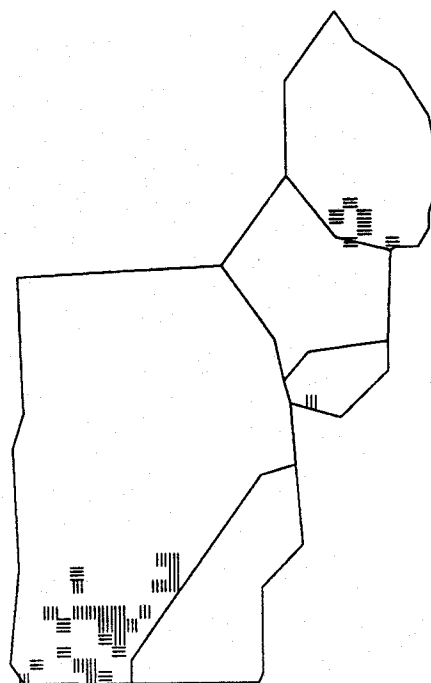
March 1989

Figure 31a. The distribution of Glossy Ibises in the Water Conservation Areas in December 1988, and January, February, March 1989.

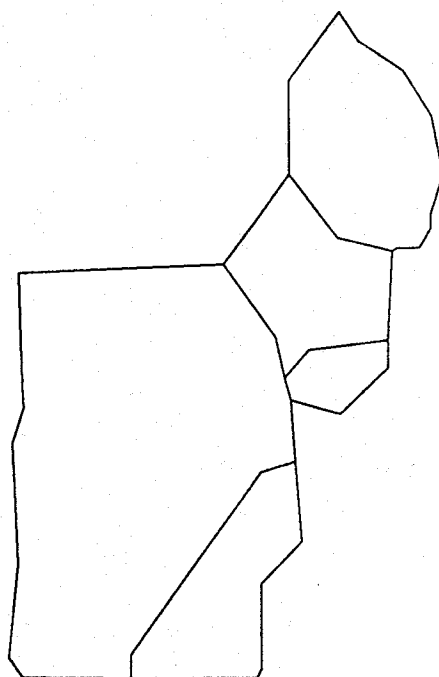
Density Categories



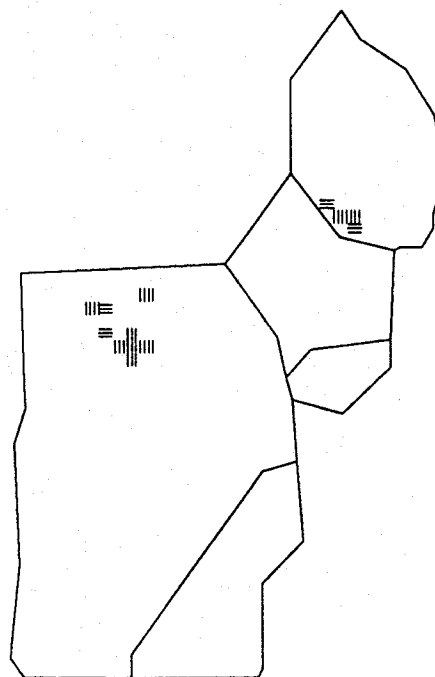
April 1989



May 1989



June 1989



August 1989

Figure 31b. The distribution of Glossy Ibises in the Water Conservation Areas in April, May, June and August 1989.

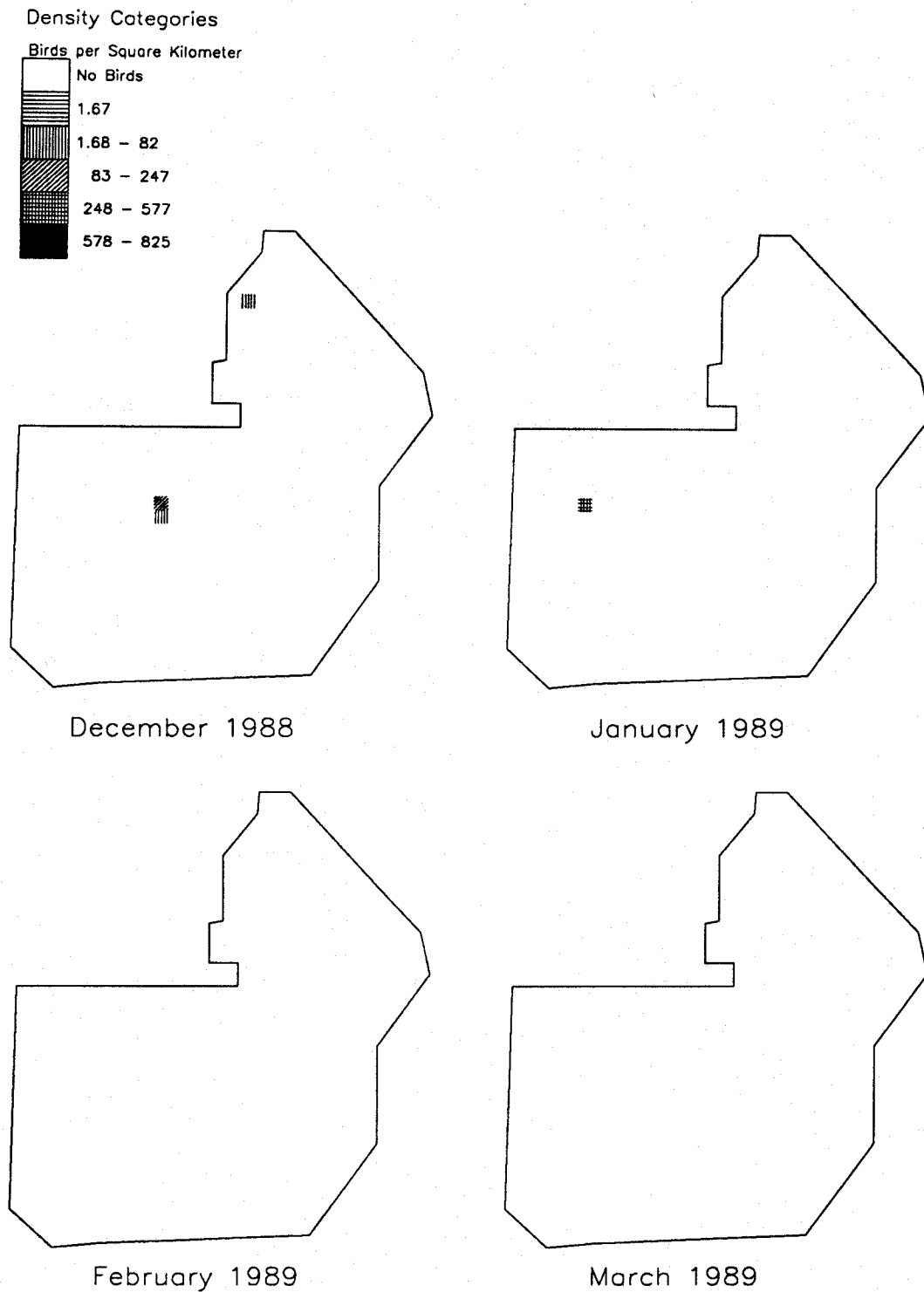
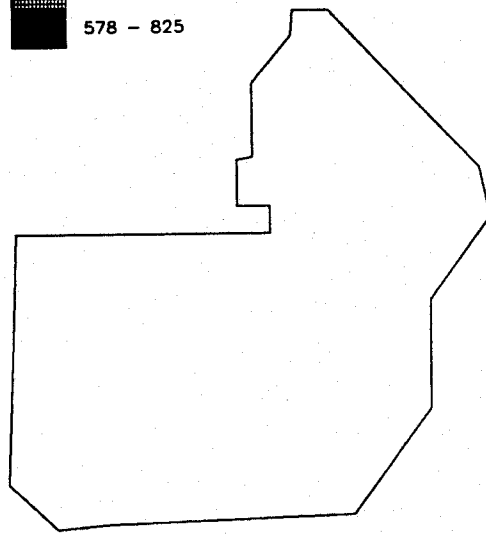
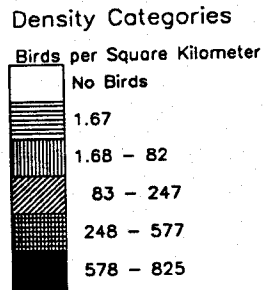
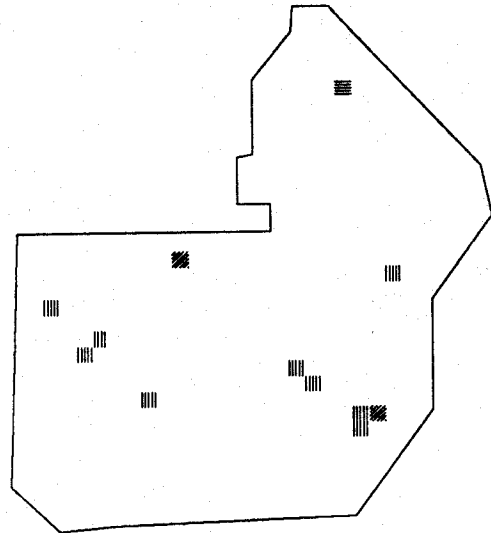


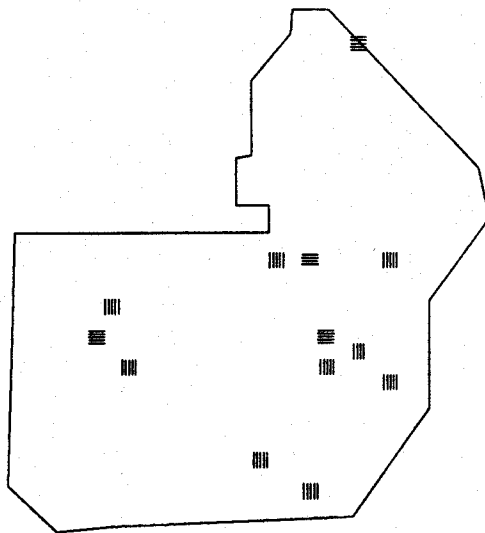
Figure 31c. The distribution of Glossy Ibises in the Everglades Agricultural Area in December 1988, and January, February, March 1989.



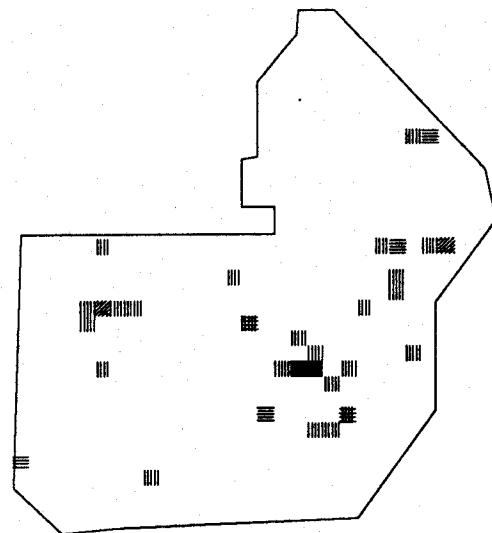
April 1989



May 1989



June 1989



August 1989

Figure 31d. The distribution of Glossy Ibises in the Everglades Agricultural Area in April, May, June and August 1989.

Cattle Egret (*Bulbulcus ibis*).- For this year's report, we have separated Cattle Egrets from native small white herons for our analyses. Since estimates for Cattle Egrets were usually substantially higher in the Everglades Agricultural Area than the estimates for other small white herons, separate analyses permit a more distinct distributional mapping of these diverse species.

Population estimates for Cattle Egret in the dry season ranged from 7559 birds in March to 33260 birds in the December survey (Table 10). Although indigenous wading bird populations often peak in March, Cattle Egrets peaked in December during the dry season and that estimates for this species were lowest in March. We believe that northern migrants make up a large proportion of the March population of indigenous wading birds. Apparently this trend is not occurring in the naturalized Cattle Egrets. Any "migratory" habits of Cattle Egrets apparently occur on a different time scale from native birds. Since much of their range includes urban areas and other areas not covered by our surveys, it is difficult to determine what percentage of the population is resident and what percentage may be "migratory."

In the WCAs, population estimates for Cattle Egrets did not vary significantly for any month of the surveys (Fig. 32). In the total survey area, however, the curve appears bimodal. The March and April estimates are significantly lower than all months except February, while the August estimates are significantly higher than every other month (Fig. 33).

Cattle Egret use of the WCAs is minimal. Most observations are of birds flying over the areas, standing along levees or roads such as U.S. 27, and along the edges of areas adjacent to the EAA. No area is used consistently, but WCA 1 most often ranks first in total number of birds. Only the May and June surveys had estimated populations greater than 1000 birds (Table 10).

Table 10. Estimated abundance of Cattle Egrets in 1988-1989 surveys.

Month	Water Conservation Areas					Total	Everglades Agricultural Areas		Total
	1	2A	2B	3A	3B		North	South	
December	547	0	0	33	0	580	14613	18067	33260
January	13	20	0	0	0	33	2953	16727	19713
February	0	0	0	0	0	0	2060	11087	13147
March	500	13	0	140	0	653	2673	4233	7559
April	60	53	0	80	0	193	3040	6180	9413
May	1013	87	0	0	0	1100	5113	12320	18533
June	2187	47	0	13	13	2260	4733	19573	26566
August	607	47	0	267	0	921	10887	77000	88808

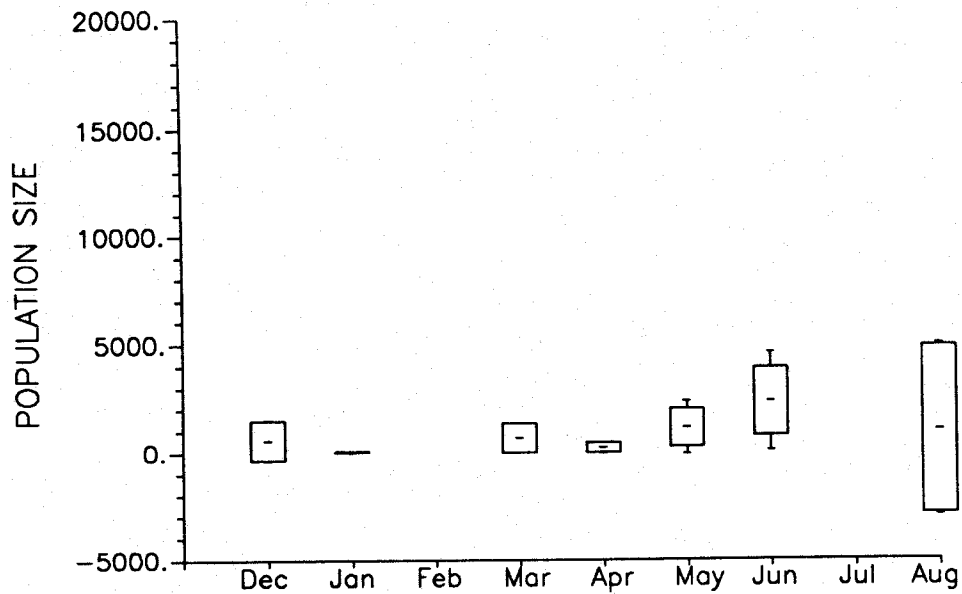


Figure 32. Estimated population of Cattle Egrets using the Water Conservation Areas during each month.

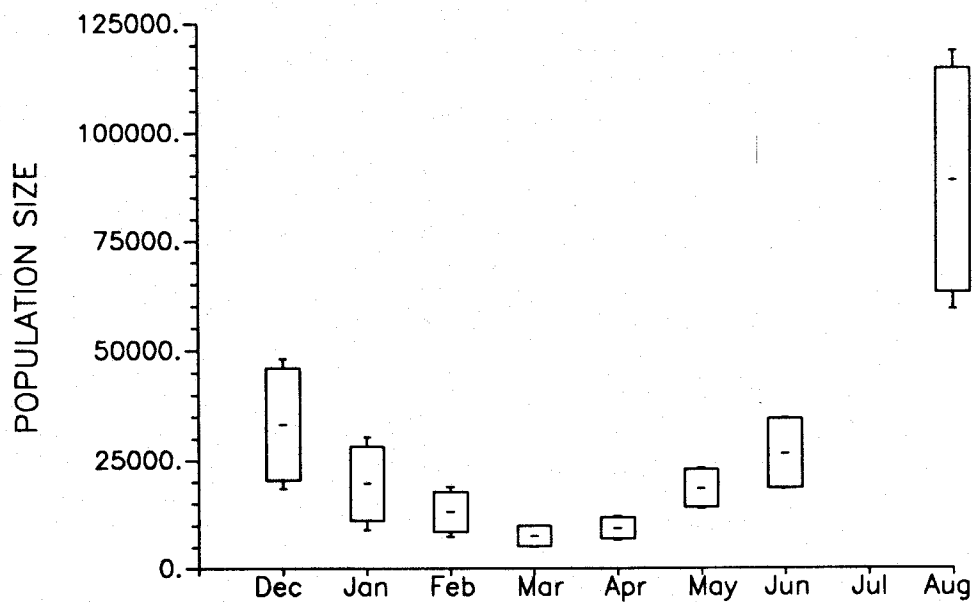


Figure 33. Estimated population of Cattle Egrets using the total survey area during each month.

The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances.

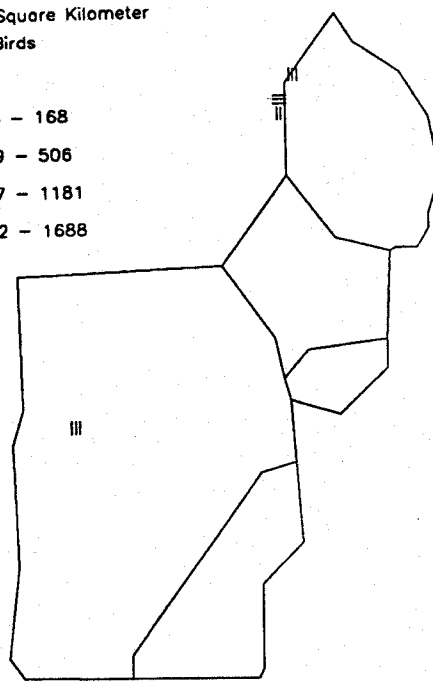
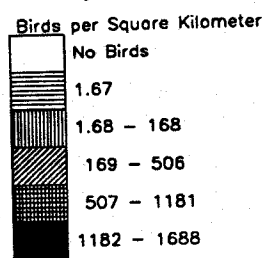
Most of the Cattle Egret population is located in the EAA. In every dry-season survey, greater than 90% of all estimated Cattle Egrets were located here.

The wet-season survey in August showed similar trends. Although small numbers of Cattle Egrets were observed in the WCAs, very large numbers of birds had moved into the EAA. The August total of 87,887 birds (Table 10) is nearly five times the average numbers of Cattle Egrets present during all dry-season surveys (mean = 17,625).

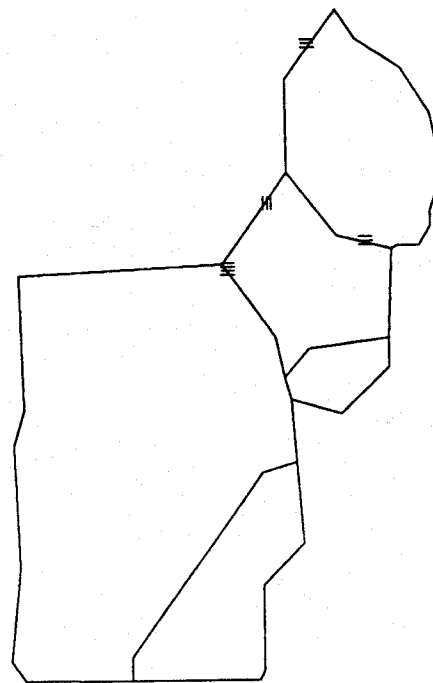
The maps of Cattle Egret distribution (Fig. 34) are scaled from a maximum estimated cell density of 1688 birds/km² (= 1013 birds recorded in one 4 km² cell). From December through April observations of Cattle Egrets in the WCAs were most often associated with an edge bordering the EAA. Although some sightings may have been of birds in cells overlapping both areas and placed in a WCA pool, other sightings were of birds flying near the EAA. In May and June, however, Cattle Egrets were observed foraging in recently burned high marsh in the northwestern edge of WCA 1. In the wet season survey of August, birds were again associated with the western edges of WCAs 1 and 2A. In addition, a small number of birds were foraging in the burned dense sawgrass north of Alligator Alley and east of the Miami Canal.

In all months of the dry season, the Everglades Agricultural Area contains large numbers of Cattle Egrets. Distribution during December through March was scattered. The southwest corner of the area was largely avoided. Birds were most often associated with sod farms and plowed fields. After March, the distribution becomes much more continuous in each succeeding month. By the August survey, most of the EAA was being used by Cattle Egrets. Only Brown's Farm Wildlife Management Area and the Holey Land were largely avoided. The pastureland in the southwest corner of the EAA was also used heavily for the first time in any survey.

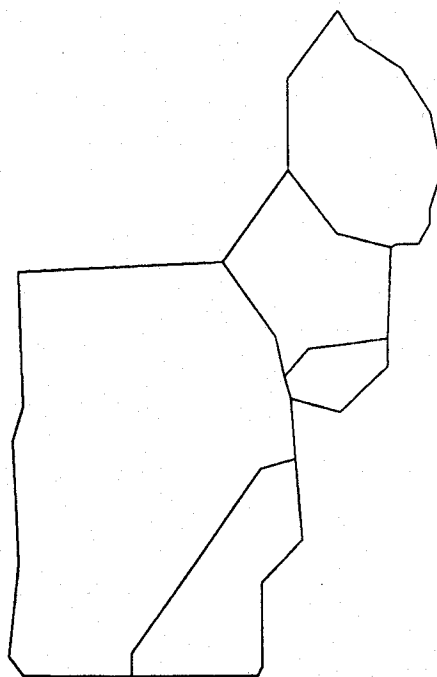
Density Categories



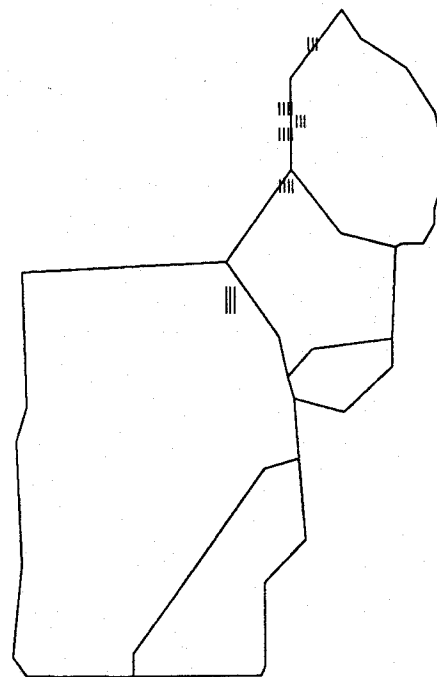
December 1988



January 1989



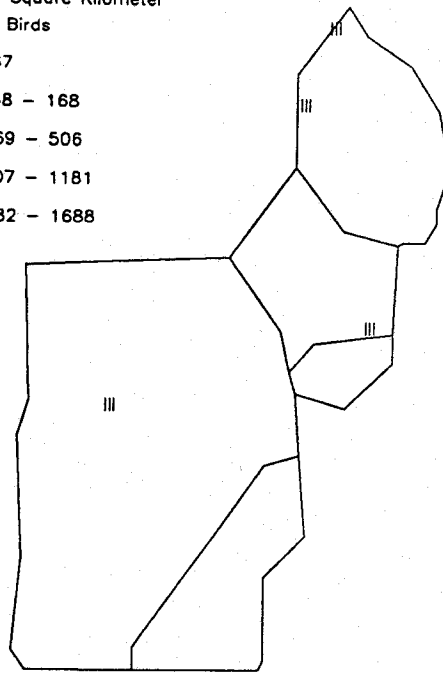
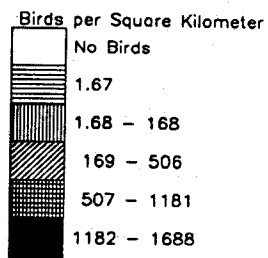
February 1989



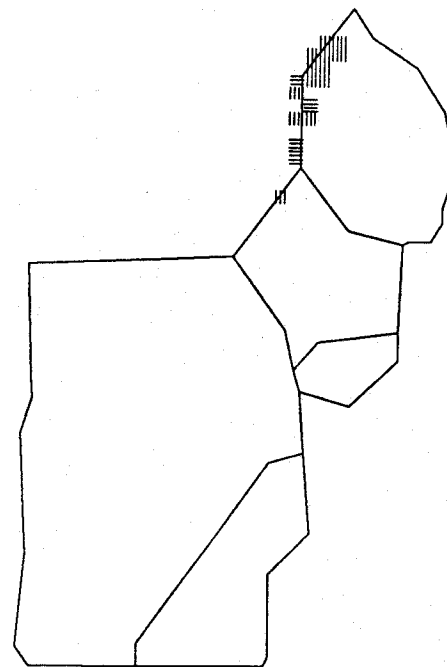
March 1989

Figure 34a. The distribution of Cattle Egrets in the Water Conservation Areas in December 1988, and January, February, March 1989.

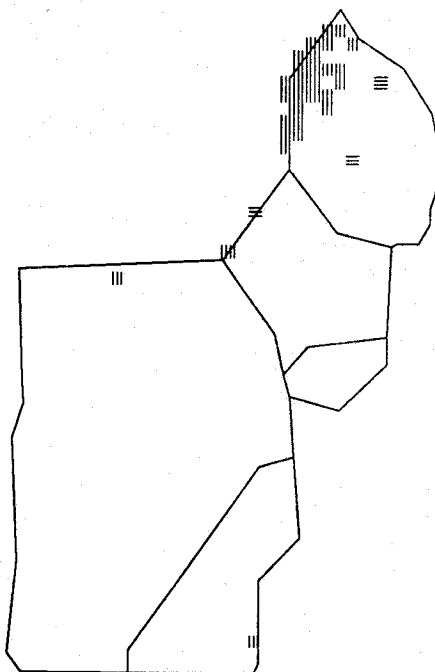
Density Categories



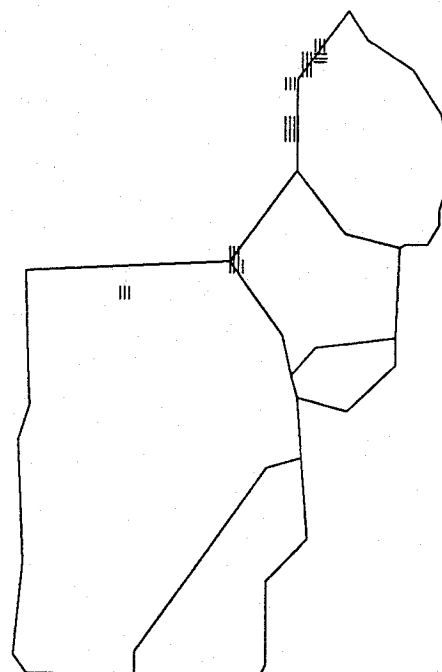
April 1989



May 1989



June 1989

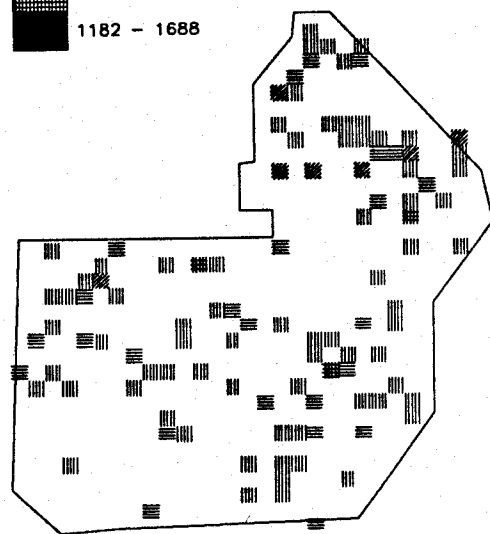
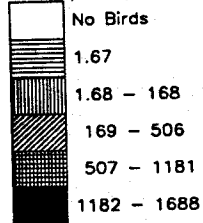


August 1989

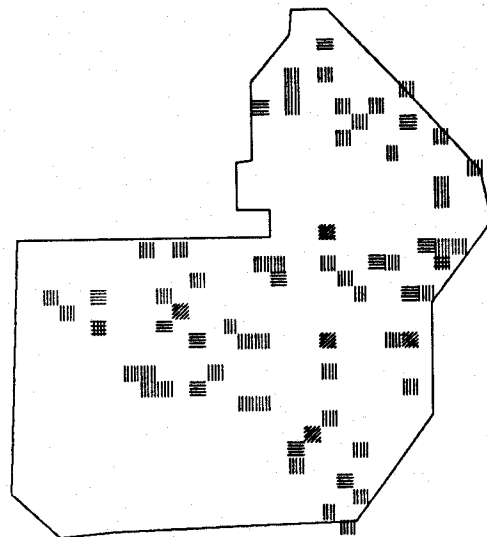
Figure 34b. The distribution of Cattle Egrets in the Water Conservation Areas in April, May, June and August 1989.

Density Categories

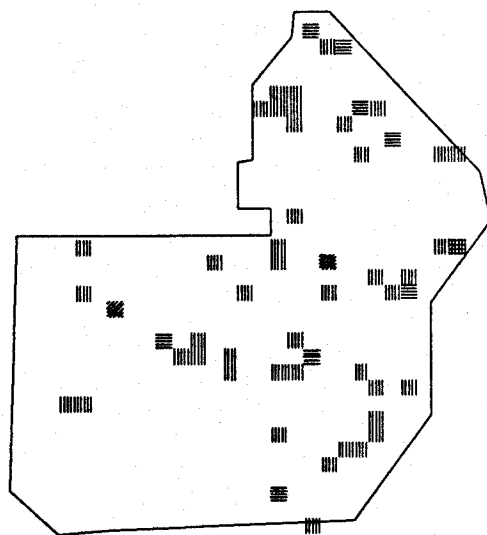
Birds per Square Kilometer



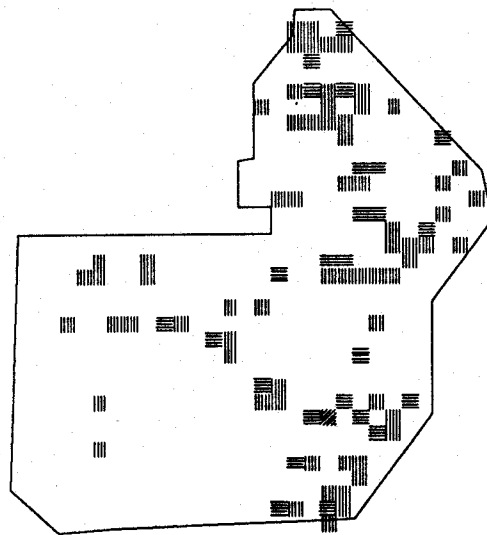
December 1988



January 1989



February 1989



March 1989

Figure 34c. The distribution of Cattle Egrets in the Everglades Agricultural Area in December 1988, and January, February, March 1989.

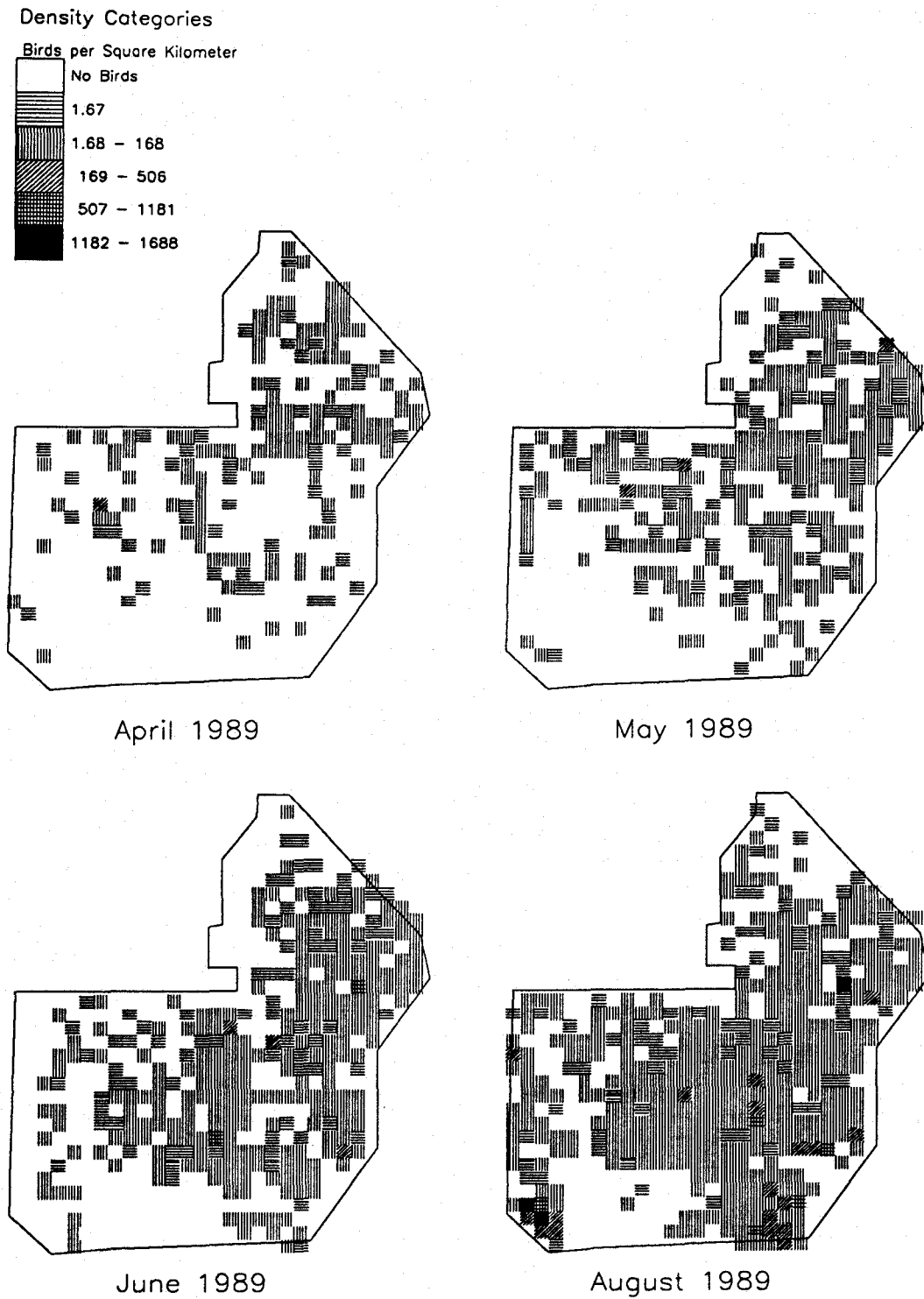


Figure 34d. The distribution of Cattle Egrets in the Everglades Agricultural Area in April, May, June and August 1989.

Roseate Spoonbill (*Ajaia ajaja*).- Roseate Spoonbills are normally restricted to marine and estuarine environments in south Florida. Although a few individuals and small groups occasionally are observed in the Water Conservation Areas, this year was an exception in the unusually large numbers seen. This large influx of birds is, in all likelihood, due to two factors: 1) highly favorable foraging conditions created by the extreme dry down and 2) a very successful breeding season with high post-fledging survival.

During all dry-season surveys, spoonbills were only found in the Water Conservation Areas. Population estimates ranged from 0-986 birds (Table 11). The April estimate was significantly higher than all other months in the WCAs (Fig. 35) and significantly higher than all months but August in the total survey area (Fig. 36). Use of various areas was sporadic, but WCA 2A and 3A were used most frequently. The largest period of spoonbill activity in the WCAs occurred during April and May. During the peak month of April, approximately 300 spoonbills were estimated for each of WCAs 2A, 3A and 3B. By May, most of the spoonbills were observed in WCA 3A, but the overall population estimates had dropped to 266 birds. By June, there were no spoonbills in the WCAs.

We have only presented distribution maps for April and May (Fig. 37). During all other dry-season months, spoonbill numbers were low or non-existent, and distributional shifts are not apparent at such a low magnitude. The Roseate Spoonbill maps were scaled from a maximum estimated density of 60 birds/km² (= 36 birds recorded in one 4 km² cell). The April map shows spoonbills along the L-67 levee, the base of WCA 3A and the southern edge of WCA 2A. This pattern is similar to other species for that time period, but has a more patchy appearance.

Table 11. Estimated abundance of Roseate Spoonbills in 1988-1989 surveys.

Month	Water Conservation Areas					Total	Everglades Agricultural Areas		Total
	1	2A	2B	3A	3B		North	South	
December	0	60	0	0	0	60	0	0	60
January	0	20	0	100	0	120	0	0	120
February	0	7	0	0	0	7	0	0	7
March	0	0	0	0	0	0	0	0	0
April	0	313	13	387	273	986	0	0	986
May	0	53	13	200	0	266	0	0	266
June	0	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	220	220

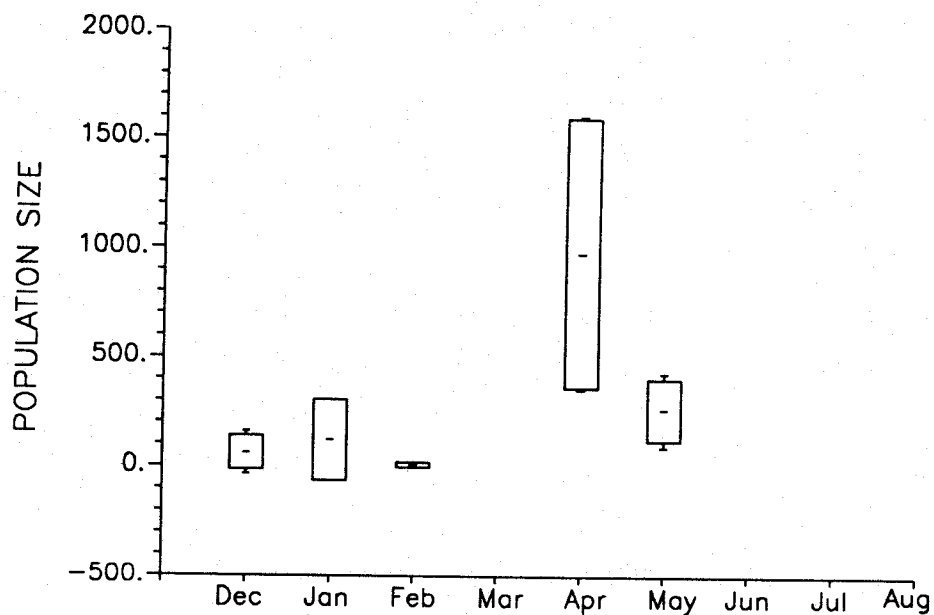


Figure 35. Estimated population of Roseate Spoonbills using the Water Conservation Areas during each month.

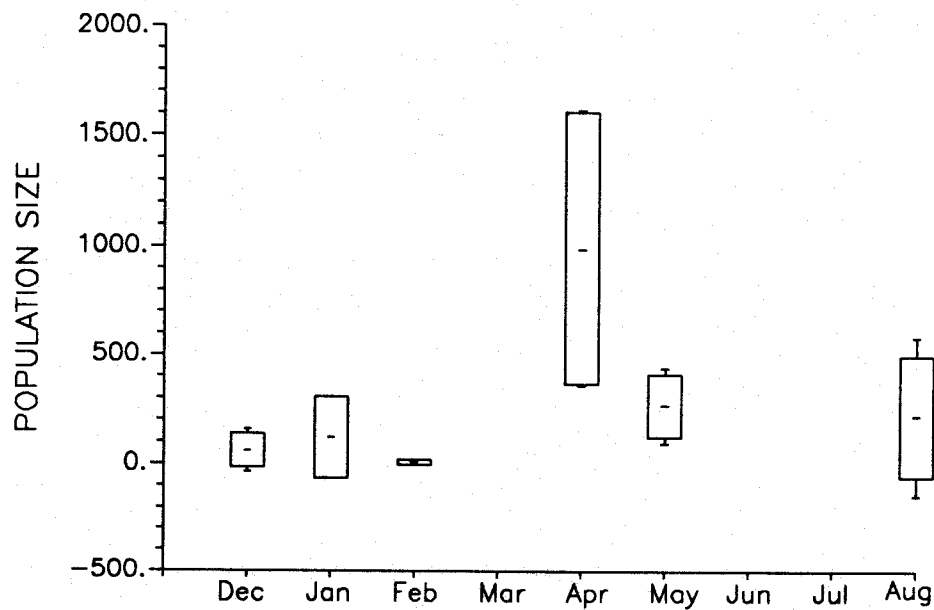


Figure 36. Estimated population of Roseate Spoonbills using the total survey area during each month.

The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances.

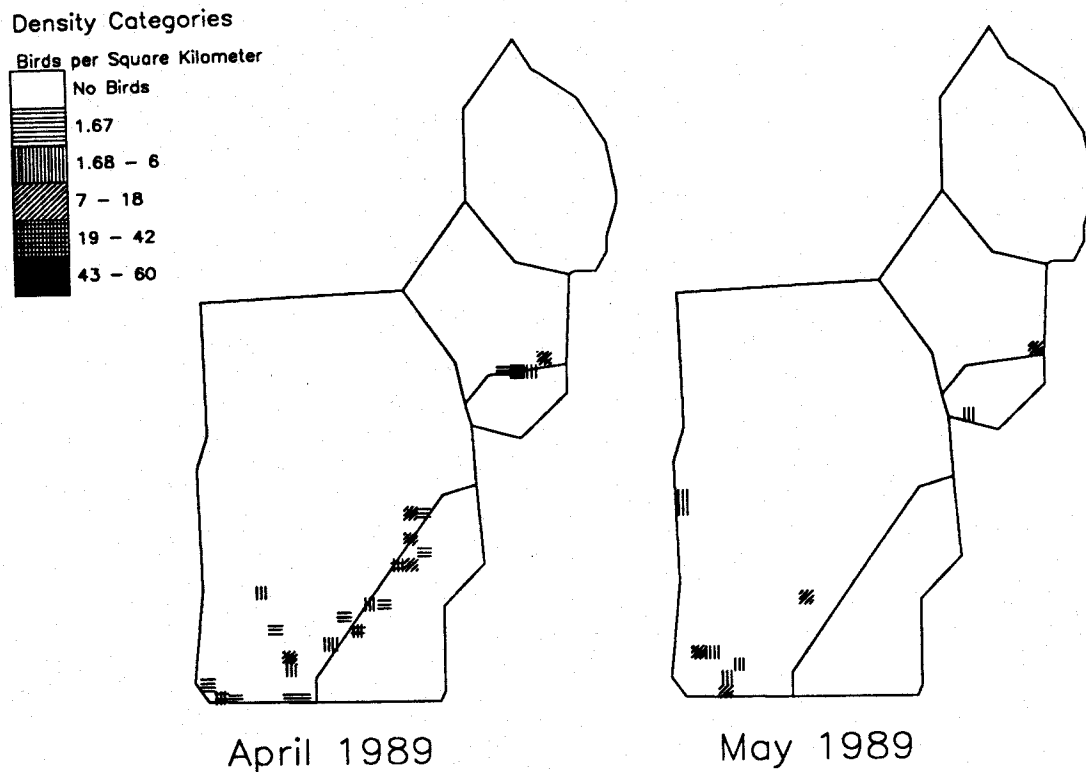


Figure 37. The distribution of Roseate Spoonbills in the Water Conservation Areas in April and May 1989.

By May, spoonbill numbers had dropped considerably. Birds were located primarily at the south end of WCA 3A and near the L-28 gap.

During the wet-season survey in August, no spoonbills were observed in the Water Conservation Areas. However, two groups of spoonbills were observed in the Everglades Agricultural Area. One flock contained 30 birds. Both observations of spoonbills were of birds in flooded fields.

Great White Heron (*Ardea herodias occidentalis*).- Great White Herons are usually restricted to marine and estuarine habitats in south Florida. Recent studies indicate that post-fledging and post-breeding dispersal of this species to freshwater foraging sites occurs regularly, but does not involve large numbers of birds.

Estimates of Great White Herons ranged from 14 birds in April to 70 birds in December during the dry season for the total survey area (Table 12). In the WCAs, the range was 14 birds in April to 57 birds in December. In the August survey, no birds were estimated for the WCAs, while 33 birds were estimated for the EAA. Estimates in the WCAs do not vary significantly for any month of the survey; however, when the EAA is included, the December estimates are significantly larger than the January and April estimates (Figs. 38 and 39).

Great White Heron occurrence in the WCAs is sporadic. There is no clear preference for any one pool within the WCAs. This ambiguity is understandable since we are working with a very small sample size. WCAs 3A and 3B were, however, used more frequently than the other pools (Table 12), similar to the distribution seen in 1988. Use of the EAA was also irregular, but our surveys showed that the northern portion of the area was avoided. We have not produced distribution maps for this species since no patterns of distributional shifts are evident. We have also chosen not to run the log-linear analyses of interactions with water conditions and vegetation categories, again, because the small sample size would render the results meaningless.

Table 12. Estimated abundance of Great White Herons in 1988-1989 surveys.

Month	Water Conservation Areas						Everglades Agricultural Areas		Total
	1	2A	2B	3A	3B	Total	North	South	
December	0	7	0	40	13	57	0	13	70
January	7	0	0	13	0	20	0	0	20
February	0	0	0	13	7	20	0	20	40
March	0	0	0	7	20	27	0	0	27
April	0	0	7	7	0	14	0	0	14
May	7	0	0	7	7	21	0	20	41
June	7	7	7	0	27	48	0	7	55
August	0	0	0	0	0	0	0	33	33

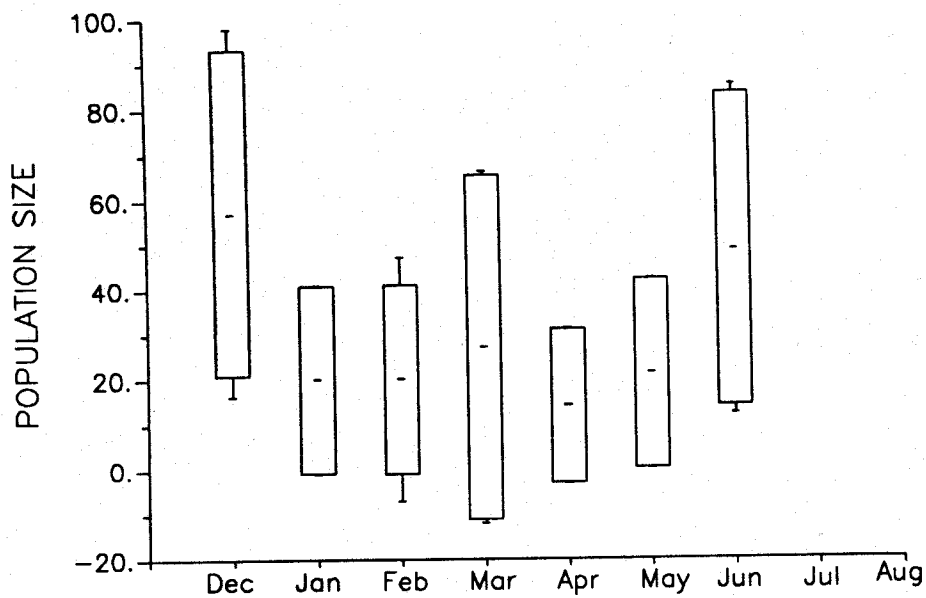


Figure 38. Estimated population of Great White Herons using the Water Conservation Areas during each month.

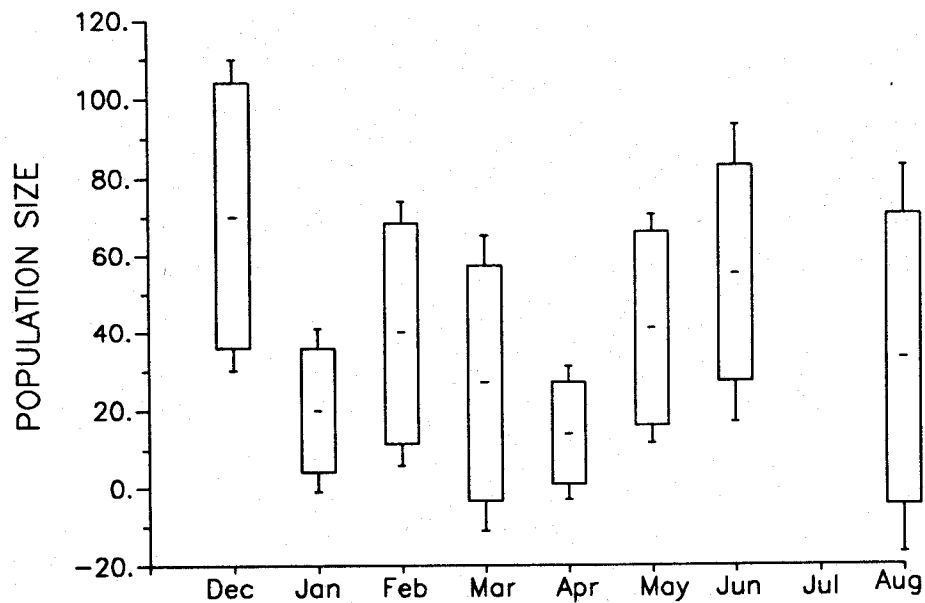


Figure 39. Estimated population of Great White Herons using the total survey area during each month.

The box represents the 95% confidence interval around the estimate using cell-based variances. The vertical line represents the 95% confidence interval using transect-based variances.

Correlates of Abundance and Distribution. Tables 13, 14, 15 and 16 present the results of our log-linear analyses of the influences of water conditions and vegetation categories on Great Egret, Great Blue Heron, Wood Stork and White Ibis distributions, respectively. The tables include Likelihood Ratio χ^2 values for the third-order interaction and the two second-order interactions involving birds. The other second-order interaction (water condition x vegetation) is not presented, but was always highly significant. This is to be expected, as the different vegetation types are located in part by their hydroperiod preferences.

For Great Egrets (Table 13), the 3-way interaction was significant only in December. As this was the only significant 3-way interaction found among the 42 tests run, it may well be a spurious result (we expect one type 1 error - an incorrect finding of significance - per 20 tests, by chance alone). Examination of the 3-way matrix did not elucidate this finding as the only significant coefficients were on matrix terms involving Shrub Strand habitats. The bird x vegetation interactions were highly significant in all surveys except June. In June habitat choice was so constrained by lack of water, and birds were so sparse, that no pattern emerged. In the seven surveys with significant bird x vegetation interactions, Great Egrets always avoided Dense Grass habitats. They tended to select Open Grass habitats, but occurred in them predominantly in small groups. In the bird x water condition comparisons the interactions were highly significant in all months. Great Egrets always tended to avoid dry areas, and tended to be widespread, but also occurred in low densities in wet areas. The majority of birds occurred in transitional areas and no strong patterns of group size were evident.

Table 13. Patterns of interaction between Great Egret distribution, vegetation, and water conditions.

Month	Likelihood Ratio χ^2 Values		
	GE x Wat x Veg (36 D.F.)	GE x Veg (18 D.F.)	GE x Wat (6 D.F.)
December 1988	61.662***	101.033***	198.453***
January 1989	22.430	154.292***	383.896***
February 1989	21.658	173.118***	570.187***
March 1989	21.849	114.335***	444.398***
April 1989	22.226	94.332***	301.372***
May 1989	20.348	129.914***	220.262***
June 1989	4.259	17.215	58.780***
August 1989	10.454	75.423***	148.245***

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

The Great Blue Heron analyses (Table 14) were fairly similar. The 3-way interactions were never significant. The bird x vegetation interactions were highly significant from December through April, but were non-significant in May, June, and August, when birds were sparse and the area was very dry. In the five months of significant interactions, Great Blue Herons avoided Dense Grass habitats and also tended to avoid Open Grass and Shrub Strand. The preferred habitats, therefore, were the Tree-island habitats. The birds x water condition analyses were significant in all months. Great Blue Herons avoided dry areas, and in the dryer months preferred wet conditions over dry and over transitional.

We only ran Wood Stork analyses for the months December through May (Table 15) because storks were too rare in June and August. The three-way interactions were never significant. The bird x vegetation interactions were not significant in January, but were significant in February and May, and were highly significant in December, March and April. Wood Storks avoided Dense Grass and sometimes Open Grass habitats in favor of habitats with tree islands or cypress. The birds x water condition comparisons were all highly significant, and Wood Storks tended to avoid dry areas, and to be found more frequently in wet areas. In December 1988, however, they avoided wet areas (preferring transitional sites).

Table 14. Patterns of interaction between Great Blue Heron distribution, vegetation, and water conditions.

Month	Likelihood Ratio χ^2 Values		
	GBH x Wat x Veg (96 D.F.)	GBH x Veg (32 D.F.)	GBH x Wat (12 D.F.)
December 1988	19.904	76.001***	64.575***
January 1989	37.732	66.234***	101.697***
February 1989	11.997	93.508***	173.438***
March 1989	37.503	89.942***	224.154***
April 1989	13.124	76.419***	159.081***
May 1989	11.780	27.704	70.602***
June 1989	6.388	10.110	36.379***
August 1989	4.429	28.538	38.856***

* P < 0.05, ** P < 0.01, *** P < 0.001

Table 15. Patterns of interaction between Wood Stork distribution, vegetation, and water conditions.

Likelihood Ratio χ^2 Values			
Month	WS x Wat x Veg (36 D.F.)	WS x Veg (18 D.F.)	WS x Wat (6 D.F.)
December 1988	17.316	46.488***	102.538***
January 1989	25.998	23.440	81.236***
February 1989	6.474	29.677*	98.871***
March 1989	15.547	43.635***	106.550***
April 1989	10.478	62.040***	126.209***
May 1989	5.717	29.407*	37.277***
June 1989	-	-	-
August 1989	-	-	-

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

The White Ibis analyses were run for all eight surveys (Table 16). None of the 3-way interactions were significant. The birds x vegetation comparisons were highly significant except for June and August. In the six months with significant interactions, White Ibises avoided Dense Grass, and sometimes avoided Open Grass habitats. In May, when the predominant foraging habitat remaining was in the L-67 slough area (coded Open Grass) they were very common, but dispersed, in Open Grass. The birds x water condition comparisons were significant in all months, and the birds showed the usual tendency to avoid dry areas, and to prefer transitional conditions. In June, however, when conditions were driest, ibises were common throughout the few remaining wet areas.

Table 16. Patterns of interaction between White Ibis distribution, vegetation, and water conditions.

Likelihood Ratio χ^2 Values			
Month	WI x Wat x Veg (36 D.F.)	WI x Veg (18 D.F.)	WI x Wat (6 D.F.)
December 1988	32.341	80.286***	171.839***
January 1989	20.511	51.993***	184.239***
February 1989	29.048	74.298***	266.308***
March 1989	25.297	109.212***	388.172***
April 1989	19.606	120.817***	312.911***
May 1989	10.910	218.207***	390.330***
June 1989	8.033	21.383	88.700***
August 1989	1.469	16.482	15.160*

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

DISCUSSION

The 1988-1989 survey year was unique among all SRF survey years for the severity and longevity of the dry season drought. The 1988 wet season ended early, in September. A warmer than normal winter produced higher than average evaporation rates. The winter saw fewer rain-producing cold fronts than usual, creating a long, sustained drought and a rapid and complete dry-down.

In response to this dry-down, wading birds foraged in the Water Conservation Areas in large numbers. Abundance of all species were substantially higher than in previous years. Clearly, in drought years available habitat outside the Everglades system is much reduced. The WCAs probably received many birds from Everglades National Park as well, since SRF surveys there indicated significantly reduced estimates of birds (M. Fleming, pers. comm.). As in most years, total numbers of wading birds peaked with the March survey. This peak is consistent with the hypothesis that this influx of birds represents northern migrants which are en route to breeding areas farther north. The consistent peak in March would suggest that 1) birds are stopping to forage while en route from wintering areas farther south or 2) foraging conditions in other parts of peninsular Florida are not as favorable in March as they are in the WCAs and that large numbers of birds stage in the WCAs before returning north to breed. The first hypothesis has been discussed in the 1987 and 1988 reports (Bancroft, Hoffman and Sawicki, 1987; Hoffman, Bancroft and Sawicki, 1988; ob. cit.). The second hypothesis presumes that foraging conditions during an "average" February through March period are consistently better than they are elsewhere in Florida. It also supposes that it is energetically productive for a wading bird to fly "south" to the WCAs before returning north. Ultimately, these questions can only be answered through more extensive surveys farther north or through following radio-tagged individuals.

In 1989, more than any other survey year, numbers of foraging wading birds in the WCAs seemed to be bolstered by birds from surrounding areas. Higher than average estimates of all species were observed from December through April indicating very favorable conditions for at least a five-month period of time. As in previous surveys, White Ibises comprised a large portion of this influx of birds. During the period December through May, approximately 50% of all birds occupying the WCAs were White Ibises. In comparison to the last two years' surveys, the overall percentages

of White Ibises in the December through May surveys remained quite constant around this percentage suggesting sustained, productive foraging conditions. In previous surveys, the percentage of White Ibises often fluctuated widely between months, reflecting the nomadic foraging tactics of this species.

Although overall numbers of wading birds were up in 1989, particular species should be noted here. Wood Storks were present in numbers far above any previous survey. Wood Stork estimates did not drop below 1000 birds until June. The highest numbers were observed in March and April and could potentially represent half of the entire North American Wood Stork population (Bancroft, G.T., W. Hoffman, R. Sawicki, J. Ogden. The importance of the Water Conservation Areas in the Everglades to the endangered Wood Stork [*Mycteria americana*]. in prep.). The Water Conservation Areas, then, represent important pre-breeding wood Stork foraging habitat, particularly during drought years.

Roseate Spoonbills are rarely found in the WCAs and then in very small numbers. During 1989, many spoonbills were observed in the south end of WCA 3A. Since large numbers of Roseate Spoonbills fledged from Florida Bay colonies during the winter of 1988-1989, it was interesting to observe their heavy use of inland, fresh water foraging areas. Little information is available on post-fledging and post-breeding dispersal patterns of Roseate Spoonbills in Florida.

Glossy Ibis is another species whose presence in large numbers in 1989 can be directly attributable to the drought. Although normally found in the WCAs in moderate numbers during most dry season months, they are largely restricted to drier habitats, particularly dry transitional. In 1989, Glossy Ibises were not only present in great numbers, but their distribution was much more widespread. The south end of WCA 3A, in particular, was used heavily in April and May. These deeper slough areas are not available to Glossy Ibises during most years.

This shift of birds to the deeper sloughs at the south end of WCA 3A and along the L-67 levee was notable for all species. Although there is a shift of foraging distributions to the south of WCA 3A during most dry seasons, most of the shorter-legged waders are never able to use the deeper sloughs, as are Great Egrets and Great Blue Herons. In 1989, particularly during the peak drought months of April and May, wading birds had abandoned much of the WCAs for the abundant transitional wetland habitat at the south end of WCA 3A. By June, however, WCA 3A was nearly dry and birds had either shifted to the small pool of water at the southern end of WCA 2A, were found in small numbers in rehydrated sloughs in WCA 1, or had left the system entirely.

The analyses of correlates of abundance and distribution provided a similar picture of habitat preferences to those described in previous reports. The birds again showed strong tendencies to avoid Dense Grass habitats, and weak tendencies to prefer Tree-island dominated habitats over Open Grass habitats. These patterns were maintained in this drought year until water levels were very low, and bird numbers were much reduced. The consistency of these patterns over a wide range of water conditions strengthens the conclusion that these represent fundamental habitat preferences, rather than proximate consequences of hydrological conditions.

In 1989, the Everglades Agricultural Area was included in our survey for the first time. We had hoped that surveys in this extensive area of former Everglades marsh would reveal whether wading birds are using the area when they are not able to forage in the WCAs. During the period December through May, we found little use of the EAA by indigenous wading birds. Observations were most often single birds standing along ditches or flying. Beginning with the June survey, however, we found small flocks of mixed wading bird species foraging in rice paddies as well as in flooded fallow fields. Although rice production had begun before May, these fields were not used to any extent until birds began to abandon the WCAs. By the August wet-season survey we observed moderate to large flocks of wading birds foraging in these same crop fields as well as reflooded portions of Holey Land marsh. Combined estimates of WCA and EAA indigenous wading bird species in August reveal a population of 55,000 birds foraging in these areas. This estimate is very close to the number of resident birds in the WCAs during the dry season surveys (Bancroft, Hoffman and Sawicki, 1987; Hoffman, Sawicki and Bancroft, 1988). It appears that the EAA may contain important foraging habitat for a large portion of the south Florida wading bird population when the WCAs are either too wet or too dry to use. Wood Storks, particularly, used the area in large numbers in August. However, we can not be sure at this time whether birds consistently use this area because it is productive or whether they use it because there is simply no place else to go.

Cattle Egrets are recent immigrants found in large numbers in the EAA. During all months, estimates of Cattle Egrets far outnumber the native wading bird populations. However, there is a very distinct spatial separation between these two groups based upon habitat selection. Although Cattle Egrets were seen in small numbers in rice paddies and reflooded Holey Land marsh, they were largely restricted to drier habitats. Conversely, native wading birds are rarely found in dry

sites. Cattle Egrets rarely use the WCAs. In 1989, however, Cattle Egrets were observed using high marsh habitats adjacent to the EAA only after the areas had dried out and particularly after the areas had burned.

The importance of the Everglades Agricultural Area to wading birds deserves further comment. The dominant crop in the area, sugar cane, is used very little by wading birds other than Cattle Egrets, and Cattle Egrets appear not to use sugar cane as commonly as they use other habitats. The second largest crop, sod grass, is used extensively by Cattle Egrets, but rarely by other wading birds. The best wading bird habitats in the EAA occupy relatively small acreages. These are rice paddies and flooded fallow row-crop fields. These habitats are certainly attractive to the birds but we should perhaps be concerned about the quality of the food they provide. The possibility must be entertained, whenever birds are feeding in areas of modern, intensive agriculture, that the birds are experiencing deleterious effects of agricultural chemicals. We suspect that this is less of a problem than it would have been two decades ago, in the heyday of persistent chlorinated hydrocarbon insecticides. Even so, we consider the use of the EAA by wading birds in summer extensive enough that chemical analyses of birds and their prey are advisable.

