

US Army Corps of Engineers
Waterways Experiment Station

December 2000

DISTRIBUTION AND ABUNDANCE OF WADING BIRDS IN THE BIG CYPRESS NATIONAL PRESERVE, 2000



by David A. Nelson and Craig T. Theriot

U. S. Army Corps of Engineers
Waterways Experiment Station (CEWES-ER-C)
3909 Halls Ferry Rd.
Vicksburg, MS 39180-6199

Prepared for U. S. Army Corps of Engineers, Jacksonville District

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EXECUTIVE SUMMARY

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

Surveys were flown with a fixed winged aircraft at an altitude of 60 meters along 29 parallel transects with 2 km spacing in the Big Cypress National Preserve. Wading birds were enumerated, their positions recorded, entered into a database, and summarized into tables. Densities of each species were separated into 4 km² cells and plotted onto maps of the study area.

The monthly percent of wet cells for the 2000 survey months declined from 72 % wet cells in January to 10 % in May and 18 % in June. The percent of wet cells in April increased in April to 31% with a major rain event during this month. The general pattern of decreasing wet cells from winter to late spring in 2000 was similar to the 1999 pattern for the Big Cypress National Preserve.

The population estimates for wading birds during 2000 followed the same pattern as 1999 declining from highs in January and February to lows in May and June. Wading bird average monthly relative abundance was 8.7 % lower in 2000 (18,774) than in 1999 (20,412). Great Blue Herons, Great Egrets, small dark herons and Glossy Ibises had higher average monthly relative abundance in 2000 than in 1999. While small white herons, White Ibises, Wood Storks and Cattle Egrets had lower average monthly relative abundance in 2000 than in 1999.

The areas with greatest densities of wading birds in Big Cypress National Preserve were the southeast corner, the southwest corner, and east-central (L-28 Gap area). These areas tended to remain wet. In addition, large flocks of roosting birds were observed in the northern five or six transects. The average monthly density of wading birds in Big Cypress National Preserve for 2000 (5.83 birds/km²) was lower than average monthly densities for WCA 1 (26.17 birds/km²), WCA 2A (11.47 birds/km²) and WCA 3A (18.69 birds/km²) but higher than WCA 3B(5.43 birds/km²) and WCA 2A(1.80 birds/km²). Extensive areas of dry habitat in central Big Cypress were not used by wading birds. However, the cypress trees in northern big Cypress National Preserve are used by large numbers of wading birds for roosting particularly prior to the breeding season.

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INTRODUCTION

Major changes in water management that are currently being proposed or implemented will alter the hydrology of the Big Cypress National Preserve and, consequently, the use of these areas by wading birds. The Big Cypress National Preserve support huge concentrations of foraging wading birds (Hoffman et al. 1994) and the largest percentage of the remaining nesting wading birds in the Everglades (Ogden 1994).

Since it is critical that we investigate and monitor the relationship between modified hydrologic patterns in the Everglades system and the distribution and abundance of these wading birds, monthly systematic reconnaissance flights (SRF) were conducted in the Big Cypress National Preserve from January to June 2000. This document presents the results of these surveys. These data, when combined with survey data from other parts of the Everglades/South Florida Ecosystem, will provide a synoptic view of distribution and abundance of wading birds.

BACKGROUND

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

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

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



Figure 1. Cessna 182 aircraft flown at 60m elevation for the systematic aerial surveys.

approximately 90% of the wading birds nested along the interfaces between the freshwater Everglades and the mangrove-estuaries (Ogden 1994). By the 1980s, the majority of nesting wading birds had shifted to nesting in the interior freshwater Everglades, principally in the Water Conservation Areas (WCA) (Ogden 1994). These changes were presumably the result of extensive hydrological alterations (water flow and volume) in the Everglades system (Ogden 1994, Bancroft 1989).

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

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

METHODS

Systematic Reconnaissance Flights

Similar to Bancroft and Sawicki (1995), we examined the effect that changes in hydrology in the Big Cypress National Preserve may have on the distribution and abundance of wading birds. We estimated the number and distribution of foraging wading birds using a systematic aerial transect method (Norton-Griffiths 1978) as modified by the National Audubon Society (Bancroft and Sawicki 1995). Using identical survey parameters (height, ground speed, strip width, transect spacing) as Bancroft and Sawicki (1995), we flew surveys in the areas consisting of east-west transects spaced at 2 km intervals. Transects were flown in a Cessna 182 at 61 m (200 ft) altitude and a ground speed of 145-185 km/h (80-100 nautical mph)(Figure 1). Two observers, one on each side of the airplane recorded all wading birds observed within 150 m wide strips paralleling the plane's path (Figure 2). When birds were sighted in the strips, the longitude was recorded from a Global Positioning System receiver. The species, number, behavior, and longitude were recorded for all sightings within the strips.

We identified to species Great Blue Herons (*Ardea herodias*), Great Egrets, Wood Storks, White Ibises, and Glossy Ibises (*Plegadis falcinellus*). Because of the difficulty of identifying Tricolor herons (*Egretta tricolor*) and Little blue herons (*Egretta caerulea*) within a large mix flock, these species were identified as "small dark herons". Snowy Egrets (*Egretta thula*) and first-year Little Blue Herons that could not be correctly identified were classified into a group called "small white herons" (Bancroft and Sawicki 1995).



Figure 2. Wading birds counted along transects out of each side of the aircraft.

Water Analyses

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

Study Areas

During 2000 systematic transects were flown in Big Cypress National Preserve from January to June (Figure 3). McPherson (1973) described nine habitats based on vegetation for Big Cypress National Preserve. These included the dominant habitats cypress, prairies, pine forests, mixed swamp forests and inland marshes. He also identified the less dominant habitats hammock forests, coastal forests, coastal marshes, and agricultural/disturbed areas.

Cypress habitats which cover the greatest portion of Big Cypress National Preserve were often dominated by large bald cypress before logging reduced their numbers. Removal of this shading cypress canopy left a mixed swamp forest of pond cypress (*Taxodium ascendens*), maple (*Acer rubrum*), pop ash (*Fraxinus caroliniana*), dahoon holly (*Illex casine*), myrsine (*Myrsine guianensis*), willow (*Salix caroliniana*), and swamp bay (*Persea palustris*) (Duever et al., 1986). The pine forest habitats have an overstory predominantly of slash pine (*Pinus elliotii*) with understory species dominated by either saw palmetto (*Serenoa repens*) or mixed grasses (Duever et al. 1986). The dry

prairie habitats usually have saw palmettos and wire grass (*Aristida* spp.). They may also contain wax myrtle, gallberry, and staggerbush shrubs. The marsh habitats contain a large variety of species but a location may be dominated by pickerel weed (*Pontederia* spp), arrowhead (*Sagittaria* spp.), sawgrass, fire flag (*Thallia geniculata*), cattail (*Typha* spp.) and/or bulrush (*Scirpus* spp.)(Duever et al. 1986). For a more detailed description of the vegetation and vegetation associations see Duever et al. (1986).

Big Cypress

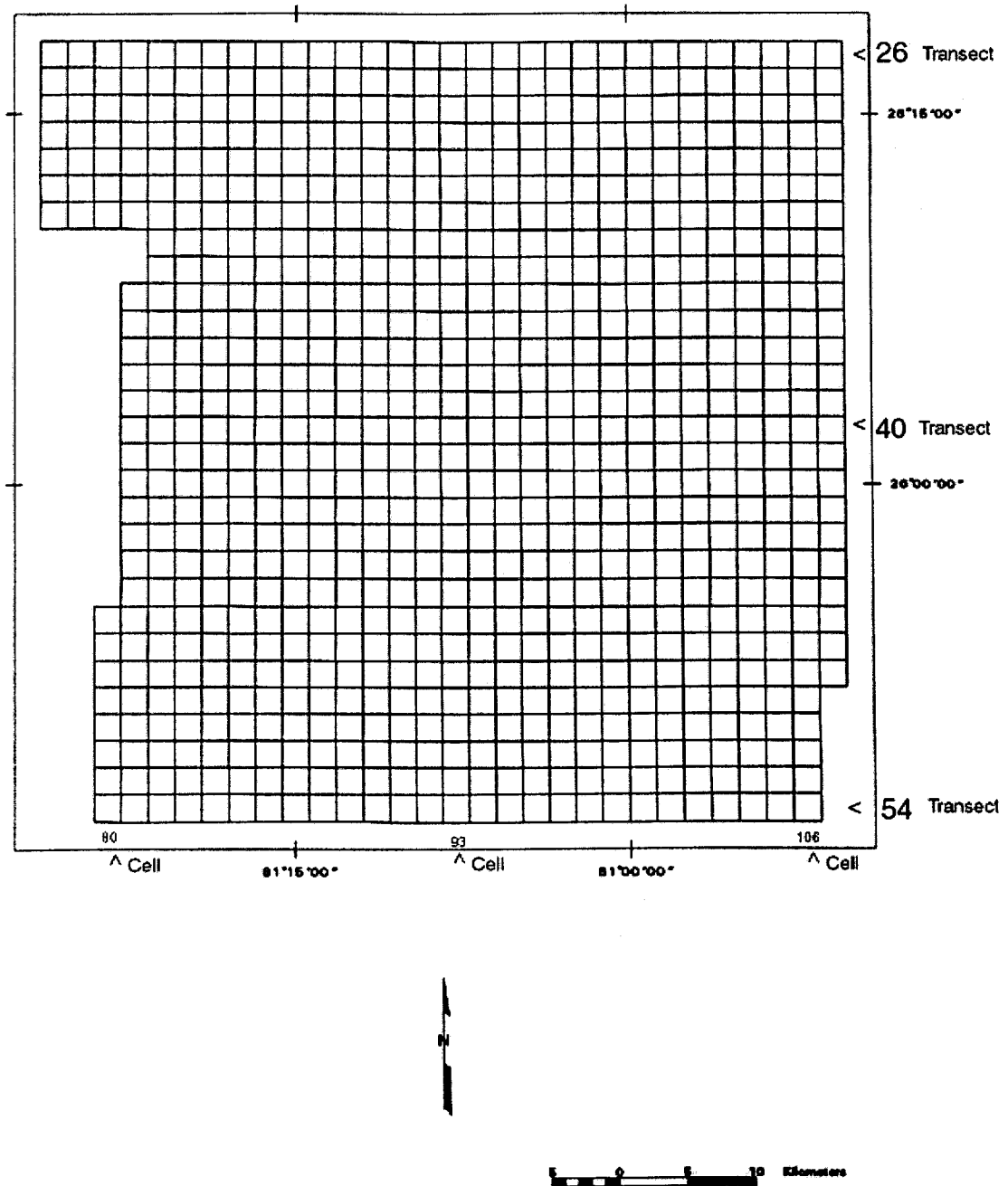


Figure 3. Study area consisting of transects and cells (adapted from Sawicki et al. 1995).

Table 1. Dates and completed transects for 2000.

Month	Dates	WCAs	Holey Land	Dates	Big Cypress
Jan	24-26	5 through 54	18 through 23	27-28	26 through 54
Feb	23-25	5 through 54	18 through 23	28-29	26 through 54
Mar	22-24	5 through 54	18 through 23	27-28	26 through 54
Apr	18-20	5 through 54	18 through 23	21-22	26 through 54
May	22-24	5 through 54	18 through 23	25-26	26 through 54
Jun	26-28	5 through 54	18 through 23	22-23	26 through 54

Survey Personnel

In 2000, David Nelson occupied the right front seat of the airplane, counted birds, and recorded water conditions on the right side of the plane. Craig Theriot and Bob Metzger occupied the left rear seat and counted birds on the left side of the plane. The pilots for the surveys were Ron Arrangur and Justin Lundstendt.

Data Management

Data were entered into handheld computers during the flights. The data was then entered from the computer into a spreadsheet software and corrected for entry errors. The data was then entered into a data management system developed by Dave Buker of ENP and modified by Mr. Chuck Dickerson. For a more detailed description of the database see Sawicki et al. (1995).

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

Data Analysis

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

Map Production

ARCINFO Geographic Information System was used to produce maps of the

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

RESULTS

Water Conditions for the Big Cypress National Preserve

The water conditions for the Big Cypress National Preserve decreased from 72 % wet cells during January to 13% wet cells during March. With a large influx of rain during April the percent of wet cells increased to 31 %. The percent of wet cells decreased again in May (10 %) then increased a little in June (18 %).

Water Levels for the Big Cypress National Preserve

Water level data is being analyzed and will be included at a later date.

Wading Bird Abundance and Distribution for the Big Cypress National Preserve

The population estimates for wading birds in the Big Cypress National Preserve during 2000 followed the same pattern as 1999. The population estimates for wading birds declined from a high in January (49,433) to lows in May (5,420) and June (5,789) (Table 2). When the population estimates of wading birds were adjusted for area (relative densities), the highest density was in January (15.3 birds per square km). The lowest relative densities were in May (1.7 birds per square km) and June (1.8 birds per square km) (Table 3).

So that the two areas would be comparable, the same density categories for the Water Conservation Areas were used for Big Cypress National Preserve. Wading bird (species combined) distribution maps were scaled to a maximum 1,837 birds per square km which provided the highest density category of 1,287 to 1,837 birds per km² (Appendix B).

Table 2. Estimated abundance of wading birds within Big Cypress from Jan-Jun 2000 (foraging birds).

Species	Jan	Feb	Mar	Apr	May	Jun
Great Blue Herons	247	353	313	107	73	20
Great Egrets	16,920	13,773	9,733	3,520	1,260	673
Small Dark Herons	200	73	40	167	60	0
Small White Herons	533	160	233	407	287	0
White Ibises	29,493	7,960	2,620	4,507	1,720	4,313
Glossy Ibises	67	113	13	113	0	20
Wood Storks	1,180	773	1,647	133	1,253	40
Cattle Egrets	793	1,507	1,380	2,340	767	720
Total Abundance	49,433	24,732	15,979	11,294	5,420	5,789

Table 3. Estimated densities of wading birds within Big Cypress from Jan-Jun 2000 (foraging birds).

Species	Jan	Feb	Mar	Apr	May	Jun
Great Blue Herons	0.08	0.11	0.10	0.03	0.02	0.01
Great Egrets	5.25	4.28	3.02	1.09	0.39	0.21
Small Dark Herons	0.06	0.02	0.01	0.05	0.02	0.00
Small White Herons	0.17	0.05	0.07	0.13	0.09	0.00
White Ibises	9.16	2.47	0.81	1.40	0.53	1.34
Glossy Ibises	0.02	0.04	0.00	0.04	0.00	0.01
Wood Storks	0.37	0.24	0.51	0.04	0.39	0.01
Cattle Egrets	0.25	0.47	0.43	0.73	0.24	0.22
Totals	15.35	7.68	4.96	3.51	1.68	1.80

Table 4. Estimated abundance of wading birds within Big Cypress from Feb-Jul 1999 (foraging birds).

Species	Feb	Mar	Apr	May	Jun	Jul
Great Blue Herons	147	167	187	127	7	40
Great Egrets	8,960	8,240	9,013	1,933	720	2,207
Small Dark Herons	93	100	53	87	7	107
Small White Herons	1,807	453	460	700	200	60
White Ibises	35,760	26,187	5,373	3,160	1,120	1,067
Glossy Ibises	0	7	0	0	0	0
Wood Storks	787	2,767	1,840	500	300	33
Cattle Egrets	287	20	660	1,173	1,680	3,880
Total Abundance	47,841	37,941	17,586	7,680	4,034	7,394

Table 5. Estimated densities of wading birds within Big Cypress from Feb-Jul 1999 (foraging birds).

Species	Feb	Mar	Apr	May	Jun	Jul
Great Blue Herons	0.05	0.05	0.06	0.04	0.00	0.01
Great Egrets	2.78	2.56	2.80	0.60	0.22	0.69
Small Dark Herons	0.03	0.03	0.02	0.03	0.00	0.03
Small White Herons	0.56	0.14	0.14	0.22	0.06	0.02
White Ibises	11.11	8.13	1.67	0.98	0.35	0.33
Glossy Ibises	0.00	0.00	0.00	0.00	0.00	0.00
Wood Storks	0.24	0.86	0.57	0.16	0.09	0.01
Cattle Egrets	0.09	0.01	0.20	0.36	0.52	1.20
Totals	14.86	11.78	5.46	2.39	1.25	2.30

The highest density category observed in Big Cypress National Preserve was 552 to 1,286 during January, March and June 2000.

Species Accounts for the Big Cypress National Preserve

Great Blue Heron (*Ardea herodias herodias*). Great Blue Herons were generally observed singularly when feeding, roosting, and nesting. Overall Great Blue Heron numbers are very low in the Big Cypress National Preserve with the average relative abundance for the 2000 survey of 185 Great Blue Herons per month. In 2000, estimated abundance of Great Blue Herons increased from January (247) to a high in February (353) then decreased each month to a low in June (20) (Table 2). In 2000, Great Blue Heron numbers were generally higher each month than comparable months for 1999. The average relative abundance for 1999 survey was 112 Great Blue Herons per month (Table 4).

The relative density of Great Blue Herons for 2000 was highest in February (0.11 birds/km²) and lowest in June (0.1 birds/km²) (Table 3). The highest density category for Great Blue Herons in Big Cypress National Preserve was 16-35 birds/km². The 16-35 birds/km² category was observed during January, February, March and April (Appendix C).

Great Egret (*Casmerodius albus*). Great Egrets were the most commonly observed individual bird and the second most abundant bird observed. White ibis were more abundant but were usually observed in large flocks. While Great Egrets were often observed singularly when feeding, groups of 3 or more individuals were also observed feeding, at times, in close proximity to each other. The estimated abundances for Great Egrets were at the highest during January (16,920) decreasing each month of the survey to a low in June (673) (Table 2). Great Egret average monthly relative abundance was 47.7 % higher in 2000 (7,646) than in 1999 (5,178).

The relative density of Great Egrets for 2000 was highest in January (5.25

birds/km²) and lowest in June (0.21 birds/km²)(Table 3). The highest density category of Great Egrets in Big Cypress National Preserve was 401-933 birds/km²(Appendix D). The 401-933 birds/km² category was observed during January and March. The higher densities of Great Egrets tended to be found in the eastern edge of Big Cypress Preserve.

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

The estimated abundances for the small dark herons were at relatively low levels during all months of the survey in Big Cypress National Preserve. During the 2000 surveys, small dark heron numbers were highest in January (200) and April (167) and lowest in June (0)(Table 2). Small dark heron average monthly relative abundance was 20.8 % higher in 2000 (90) than in 1999 (74).

The relative density of small dark herons for 2000 was highest in January (0.06 birds/km²) and lowest in June (0.0 birds/km²)(Table 3). The highest density category of small dark herons in Big Cypress National Preserve was 11-23 birds/km² (Appendix E). The 11-23 birds/km² category was observed during January.

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

The estimated abundances of small white herons were highest in January (533) and April (407) and lowest in June (0)(Table 2). Small white heron average monthly relative

abundance was 127.1 % lower in 2000 (270) than in 1999 (613).

The relative density of small white herons for 2000 was highest in January (0.17 birds/km²) and lowest in June (0.0 birds/km²)(Table 3). The highest density category of small white herons in Big Cypress National Preserve was 21-47 birds/km² (Appendix F). The 21-47 birds/km² category was observed during January, April and May.

White Ibis (*Eudocimus albus*). White Ibises were most commonly observed in large flocks roosting, feeding and flying. These birds were commonly observed in mixed flocks with Glossy Ibises, Little Blue Herons, and/or Tricolored Herons. White ibises were the most abundant bird observed during the surveys. White Ibises used the trees in Big Cypress extensively for roosting. The population estimates for White Ibises was highest in January (29, 493) and lowest in May (1,720) (Table 2.). White Ibis average monthly relative abundance was 43.5 % lower in 2000 (8,435) than in 1999 (12,111).

The relative density of White Ibis for 2000 was highest in January (9.16 birds/km²) and lowest in May (0.53 birds/km²)(Table 3). The highest density category of White Ibis in Big Cypress National Preserve was 476-1108 birds/km² (Appendix G). The 476-1108 birds/km² category was observed during January and June. The higher densities of White Ibises tended to be found in the northern and eastern edge of Big Cypress National Preserve.

Glossy Ibis (*Plegadis facinellus*). Glossy Ibises were the least abundant species observed in the Big Cypress N.P. The population estimates for Glossy Ibises was highest in February (113) and April (113) and lowest in May (0) (Table 2.). Glossy Ibis average monthly relative abundance was higher in 2000 (54) than in 1999 (1).

The relative density of Glossy Ibis for 2000 was highest in February (0.04 birds/km²) and April (0.04 birds/km²) and lowest in May (0.0 birds/km²)(Table 3). The

highest density category of Glossy Ibis in Big Cypress National Preserve was 11-30 birds/km² (Appendix H). The 11-30 birds/km² category was observed during February and April. The densities of Glossy Ibises was very low in Big Cypress National Preserve.

Wood Stork (*Mycteria americana*). Wood Storks were observed roosting and feeding singularly or in small groups and sometimes flying in mixed flocks with other individuals and species. The estimated abundances for the Wood Storks was highest in March (1647) and lowest in June (40) (Table 2.). Wood Stork average monthly relative abundance was 23.9 % lower in 2000 (837) than in 1999 (1,037).

The relative density Wood Storks for 2000 was highest in March (0.51 birds/km²) and lowest in June (0.01 birds/km²) (Table 3). The highest density category of Wood Stork in Big Cypress National Preserve was 51-117 birds/km² (Appendix I). The 51-117 birds/km² category was observed during March and May. The higher densities of Wood Storks tended to be found in the southeast corner and east-central edge of Big Cypress National Preserve.

Other Species of Wading Birds. Cattle Egrets were observed during all months of the survey. Cattle Egrets were most commonly observed in the agricultural areas in the north-west and north-central border of Big Cypress Natural Preserve. The estimated abundances for Cattle Egrets were highest in April (2,340)(Table 2). The least number of Cattle Egrets were observed during June (720). Cattle Egret average monthly relative abundance was 2.6 % lower in 2000 (1,251) than in 1999 (1,283).

DISCUSSION

The monthly percent of wet cells for the 2000 survey months declined from 72 % wet cells in January to 10 % in May and 18 % in June. The percent of wet cells in April increased in April to 31% with a major rain event during this month. The general pattern of decreasing wet cells from winter to late spring in 2000 was similar to the 1999 pattern for the Big Cypress National Preserve.

The population estimates for wading birds during 2000 followed the same pattern as 1999 declining from highs in January to lows in May and June. Wading bird average monthly relative abundance was 8.7 % lower in 2000 (18,774) than in 1999 (20,412). Great Blue Heron, Great Egret, small dark herons and Glossy Ibis had higher average monthly relative abundance in 2000 than in 1999. While small white herons, White Ibis, Wood Storks and Cattle Egrets had lower average monthly relative abundance in 2000 than in 1999.

The areas with greatest densities of wading birds in Big Cypress National Preserve were the southeast corner, the southwest corner, and east-central (L-28 Gap area). These areas tended to remain wet. In addition, large flocks of roosting birds were observed in the northern five or six transects. The average monthly density of wading birds in Big Cypress National Preserve for 2000 (5.83 birds/km²)(Table 3) was lower than average monthly densities for WCA 1 (26.17 birds/km²), WCA 2A (11.47 birds/km²) and WCA 3A (18.69 birds/km²) but higher than WCA 3B(5.43 birds/km²) and WCA 2A(1.80 birds/km²)(Nelson and Theriot, 2000). Extensive areas of dry habitat in central Big Cypress were not used by wading birds. However, the cypress trees in northern big Cypress National Preserve are used by large numbers of wading birds for roosting particularly prior to the breeding season.

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APPENDIX A: Transect latitudes and west and east boundary latitudes in the Big Cypress National Preserve, 2000.

Appendix A. Transect latitudes, western-and eastern-most cell longitudes^a (see Fig. 3).

Transect	Latitude ^b (Deg/Min)	W. Longitude ^c (Min)	E. Longitude ^c (Min)
26	26° 17.40	81° 26.46	80° 50.41
27	16.31	26.46	50.42
28	15.23	26.46	50.42
29	14.15	26.46	50.42
30	13.06	26.46	50.42
31	11.98	26.43	50.42
32	10.90	26.43	50.42
33	09.81	22.00	50.43
34	08.73	22.00	50.43
35	07.65	22.25	50.43
36	06.56	22.50	50.43
37	05.48	22.50	50.43
38	04.40	22.30	50.43
39	03.31	22.25	50.43
40	02.23	22.50	50.43
41	01.15	22.50	50.44
42	00.06	22.30	50.44
43	25° 58.98	22.30	50.44
44	57.90	22.50	50.44
45	56.81	22.70	50.44
46	55.73	22.50	50.44
47	54.65	23.50	50.45
48	53.56	23.50	50.45
49	52.48	23.50	50.45
50	51.40	23.50	51.65
51	50.31	23.50	51.65
52	49.23	23.50	51.65
53	48.15	23.50	51.65
54	47.06	23.50	51.65

^a Longitudes listed are western edge of the western-most cell and eastern edge of the eastern-most cell. It should be noted that only birds within the perimeter levees of Big Cypress were counted (see Fig. 3).

^b Transect latitudes pass through the center of each cell.

^c All Western boundary longitudes contained within the 81° meridian and all Eastern longitudes contained within the 80° meridian.

**APPENDIX B: Monthly Density Maps of Wading Birds
(species combined) in the Big Cypress National Preserve,
January to June 2000.**

B1. Density maps of wading birds (species combined) in the Big Cypress National Preserve, January 2000.

B2. Density maps of wading birds (species combined) in the Big Cypress National Preserve, February 2000.

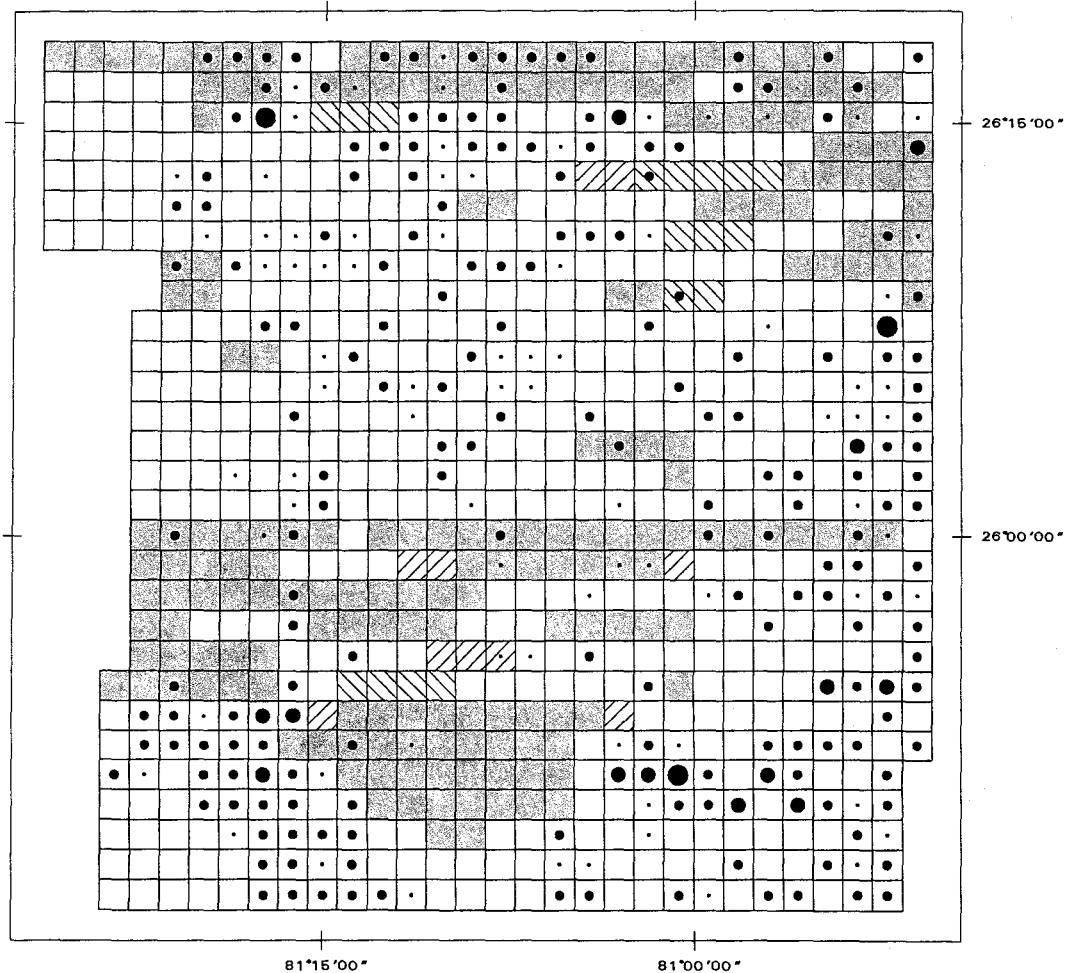
B3. Density maps of wading birds (species combined) in the Big Cypress National Preserve, March 2000.

B4. Density maps of wading birds (species combined) in the Big Cypress National Preserve, April 2000.

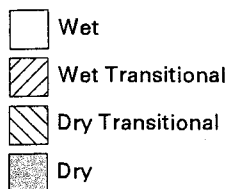
B5. Density maps of wading birds (species combined) in the Big Cypress National Preserve, May 2000.

B6. Density maps of wading birds (species combined) in the Big Cypress National Preserve, June 2000.

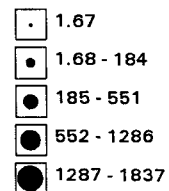
Combined Species Big Cypress January 2000



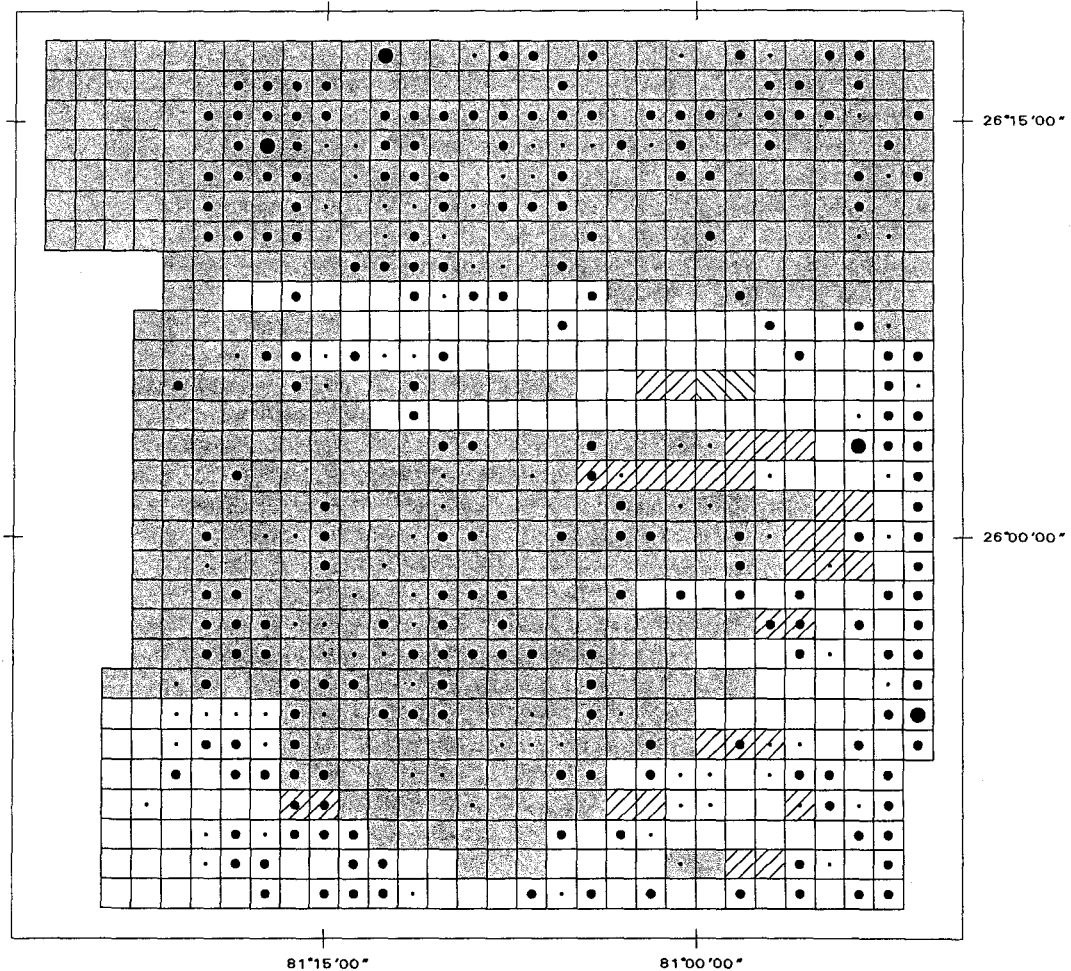
Water Conditions



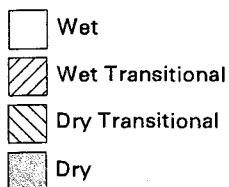
Density Categories Birds Per Square Km



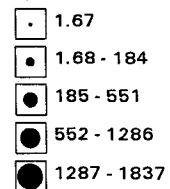
Combined Species Big Cypress February 2000



Water Conditions

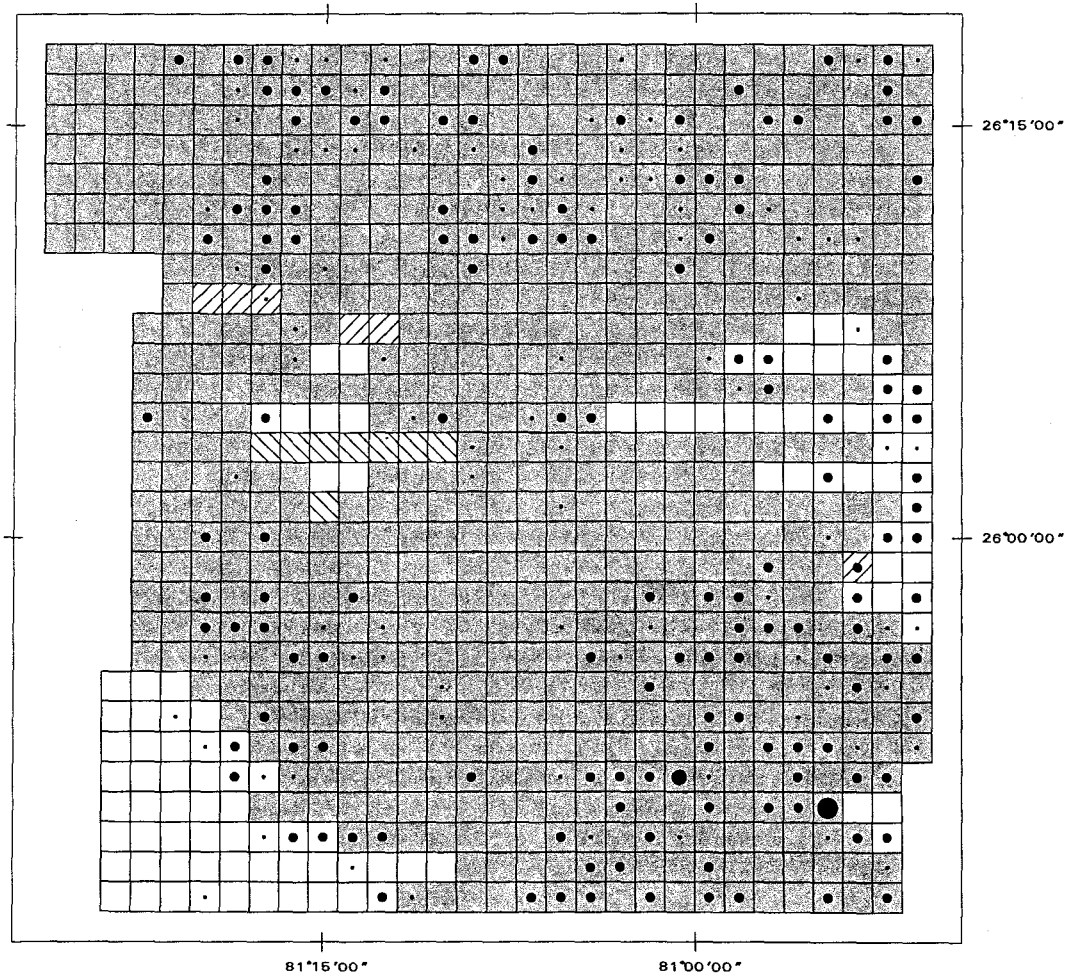


Density Categories Birds Per Square Km

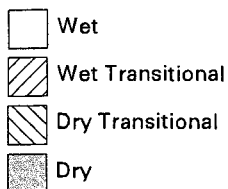


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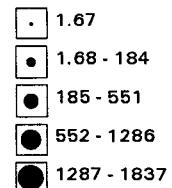
Combined Species Big Cypress March 2000



Water Conditions

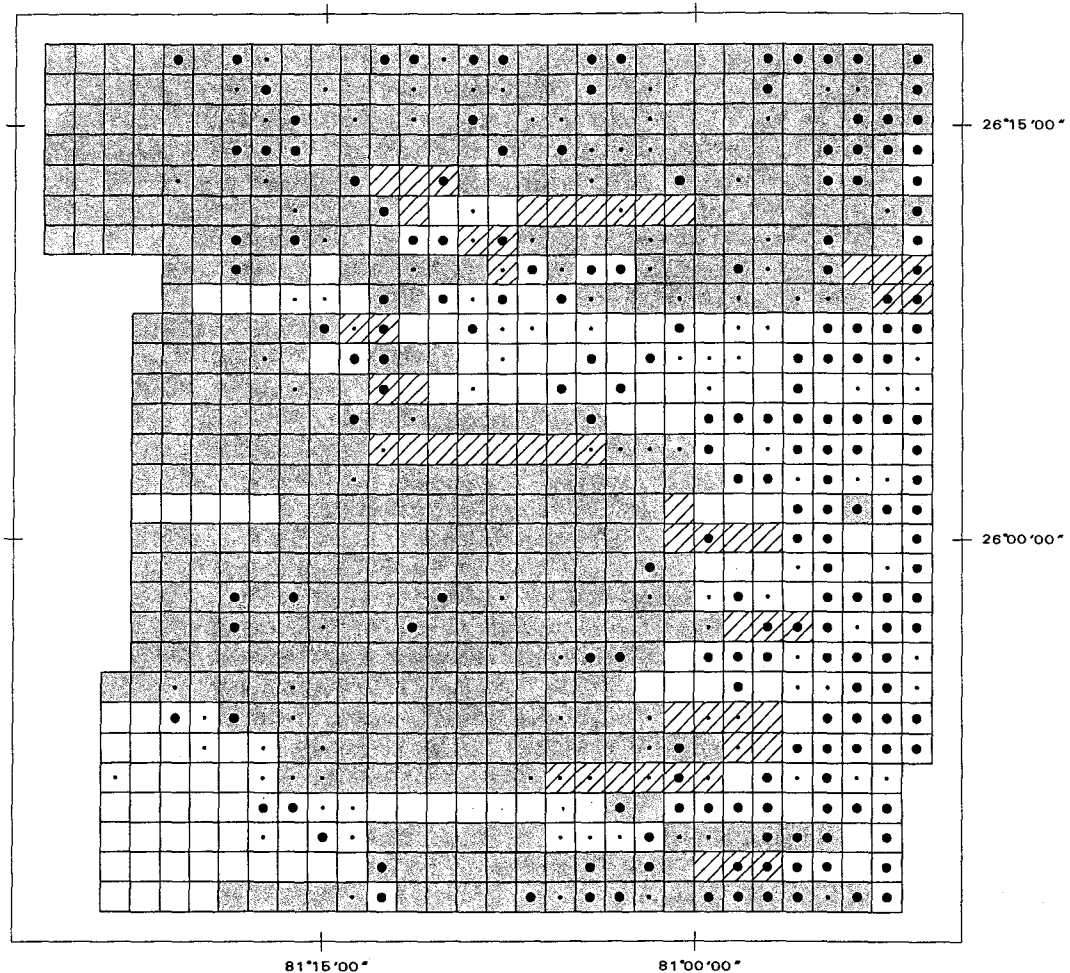


Density Categories Birds Per Square Km

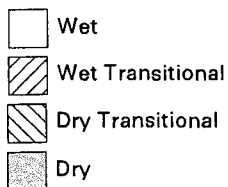


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Combined Species Big Cypress April 2000

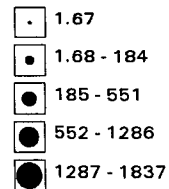


Water Conditions



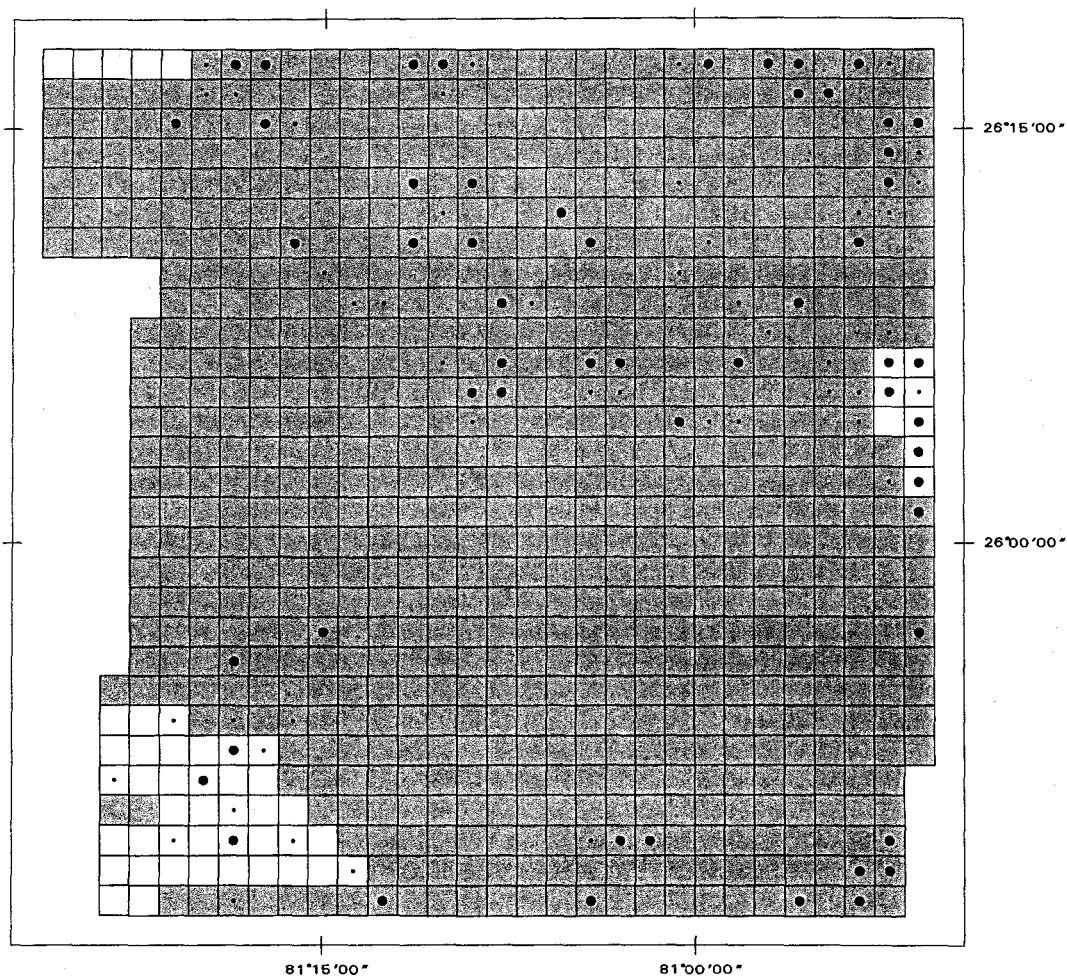
Density Categories

Birds Per Square Km

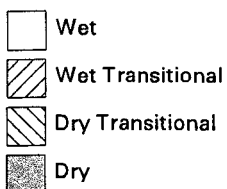


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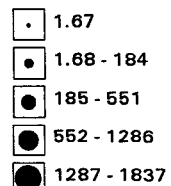
Combined Species Big Cypress May 2000



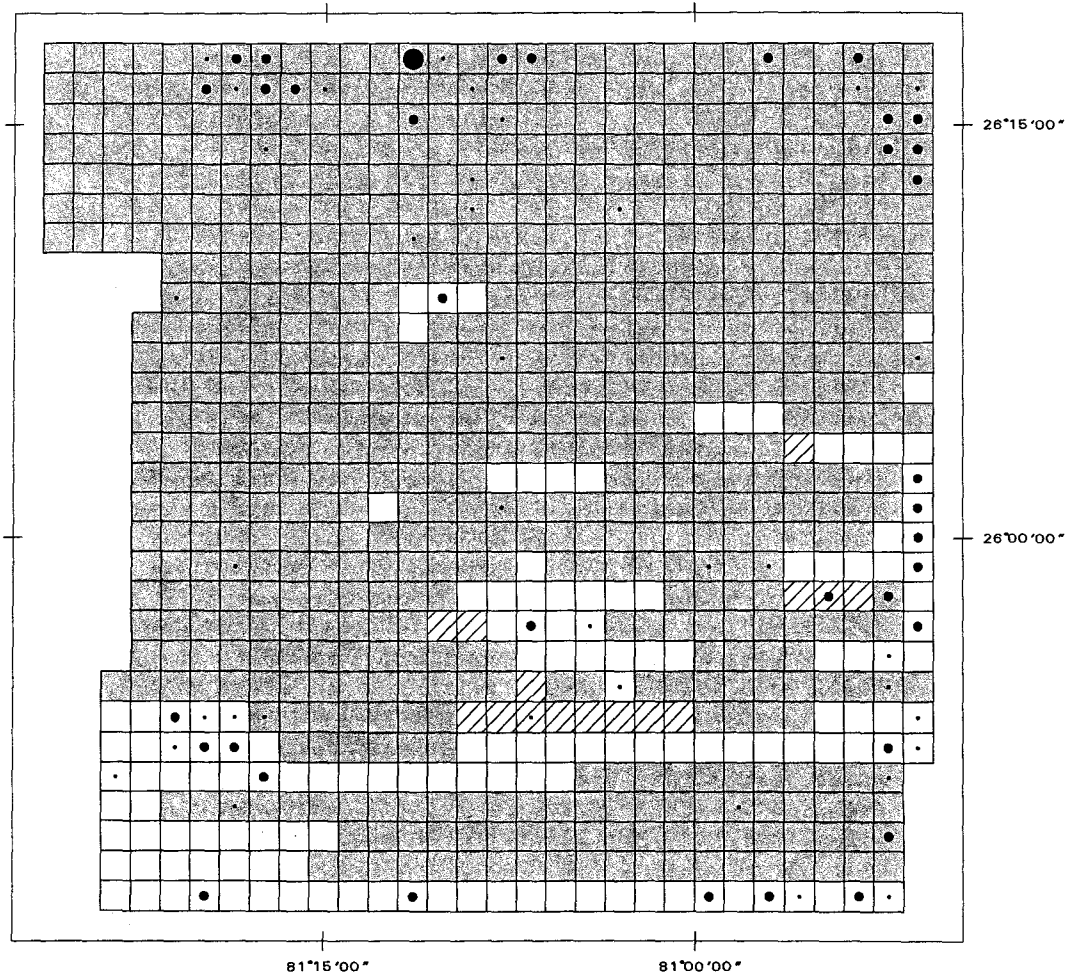
Water Conditions



Density Categories Birds Per Square Km



Combined Species Big Cypress June 2000



Water Conditions

-  Wet
-  Wet Transitional
-  Dry Transitional
-  Dry

Density Categories Birds Per Square Km

-  1.67
-  1.68 - 184
-  185 - 551
-  552 - 1286
-  1287 - 1837



5 0 5 10 Kilometers

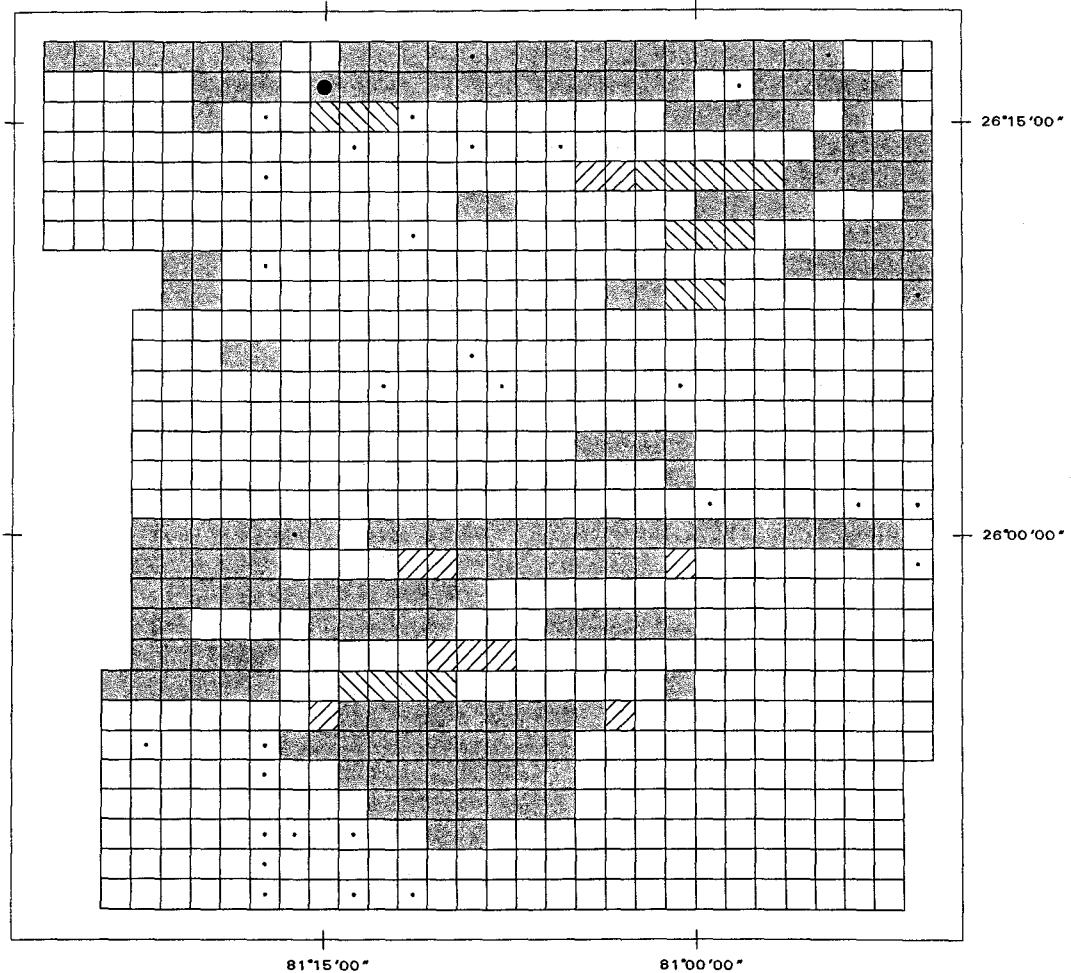
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- C5. Density maps of Great Blue Herons in the Big Cypress National Preserve, May 2000.
- C6. Density maps of Great Blue Herons in the Big Cypress National Preserve, June 2000.

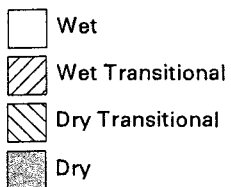
Great Blue Herons

Big Cypress

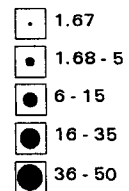
January 2000



Water Conditions



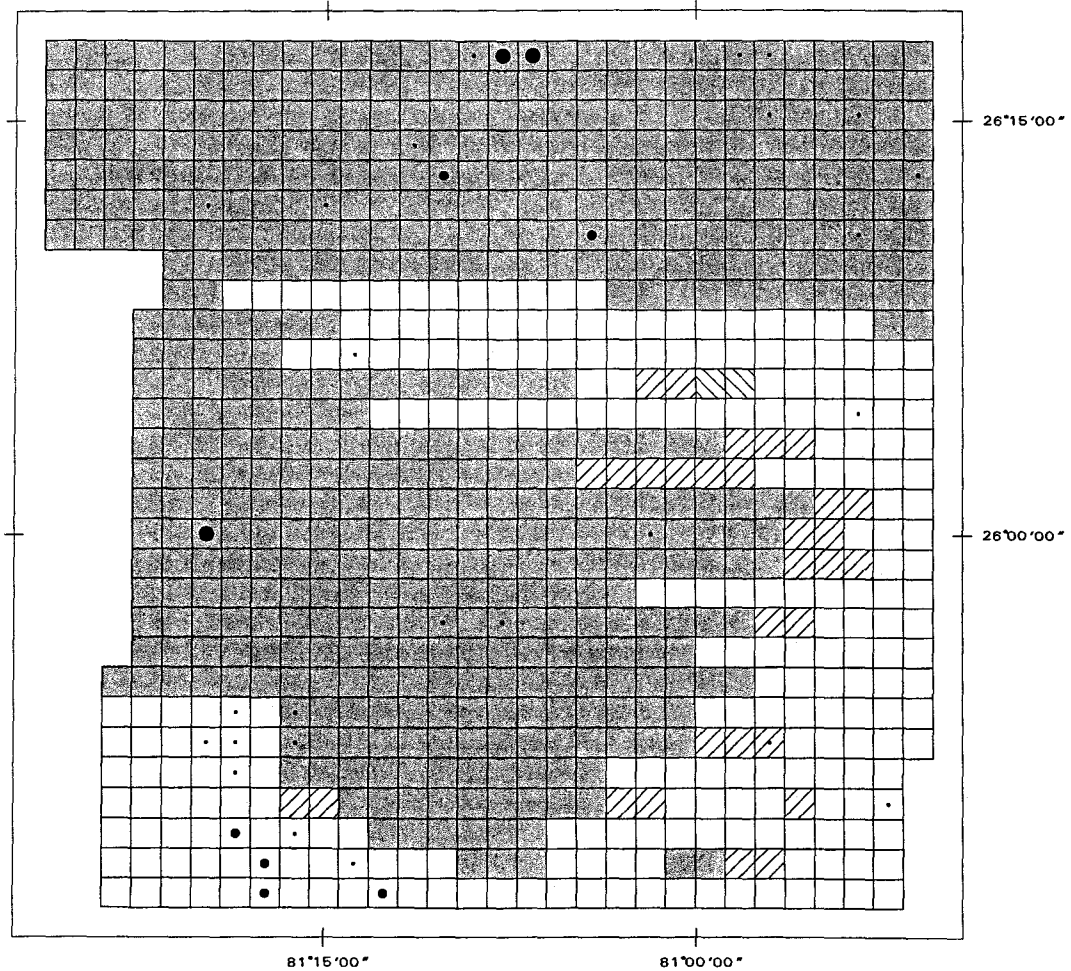
Density Categories Birds Per Square Km



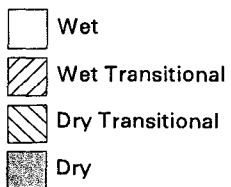
Great Blue Herons

Big Cypress

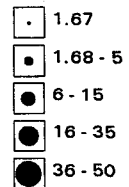
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Water Conditions



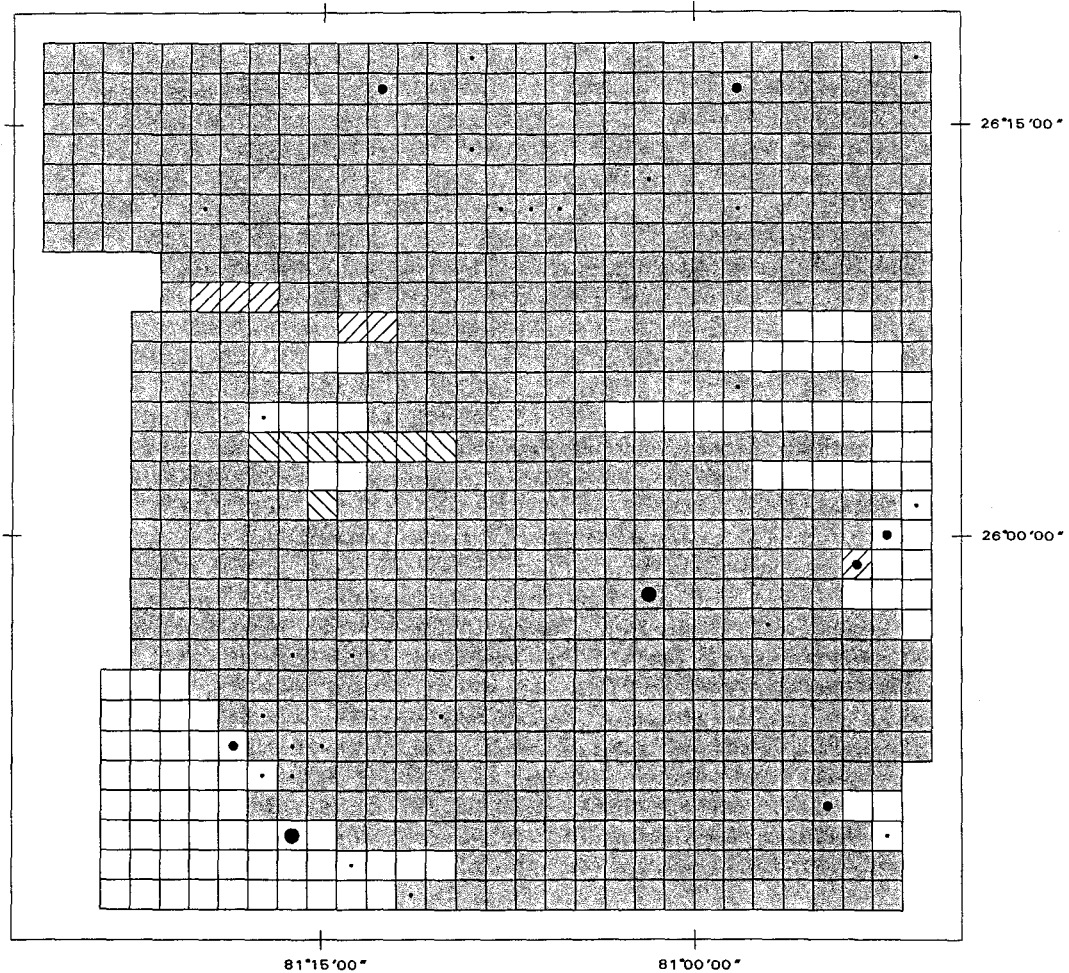
Density Categories Birds Per Square Km



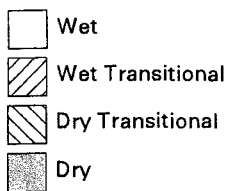
Great Blue Herons

Big Cypress

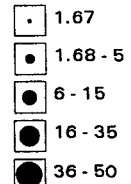
March 2000



Water Conditions



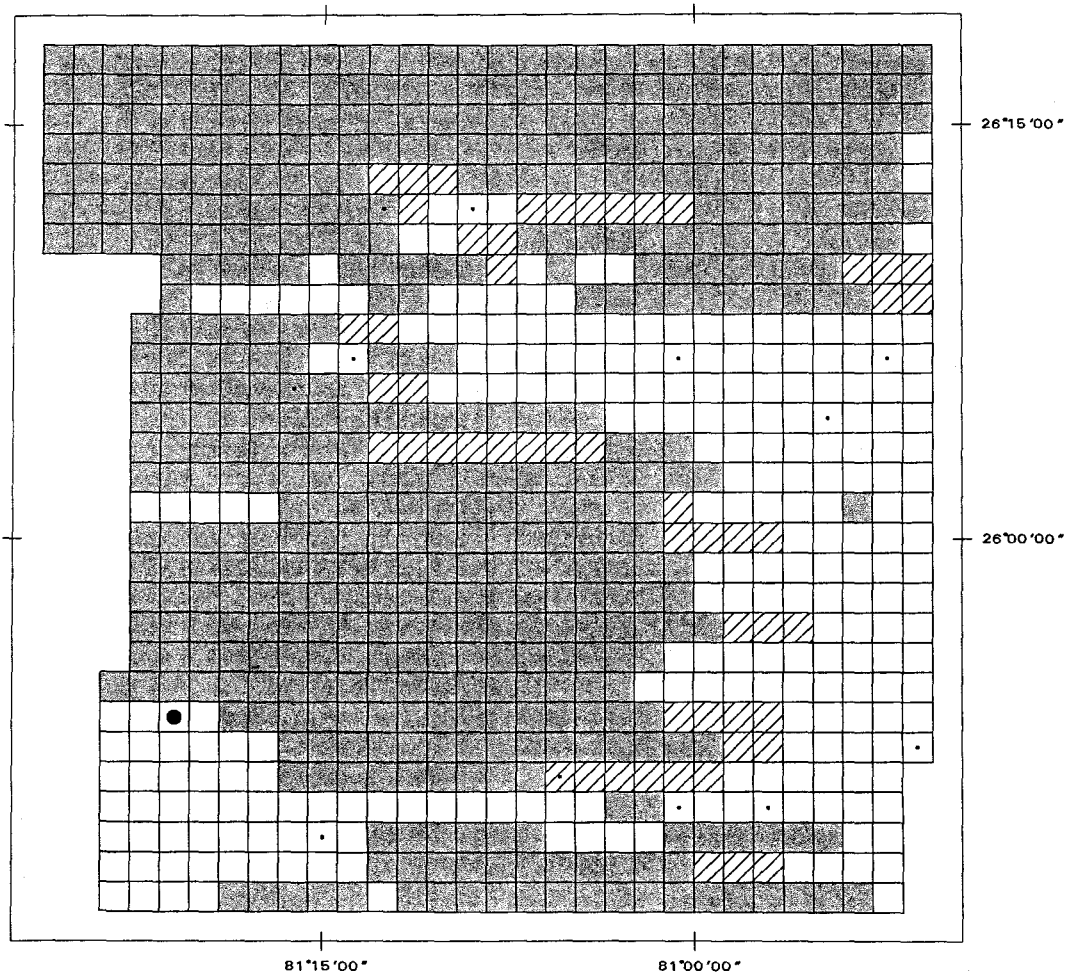
Density Categories Birds Per Square Km



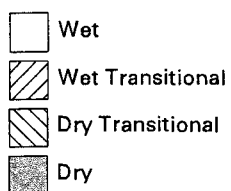
Great Blue Herons

Big Cypress

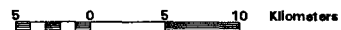
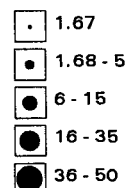
April 2000



Water Conditions



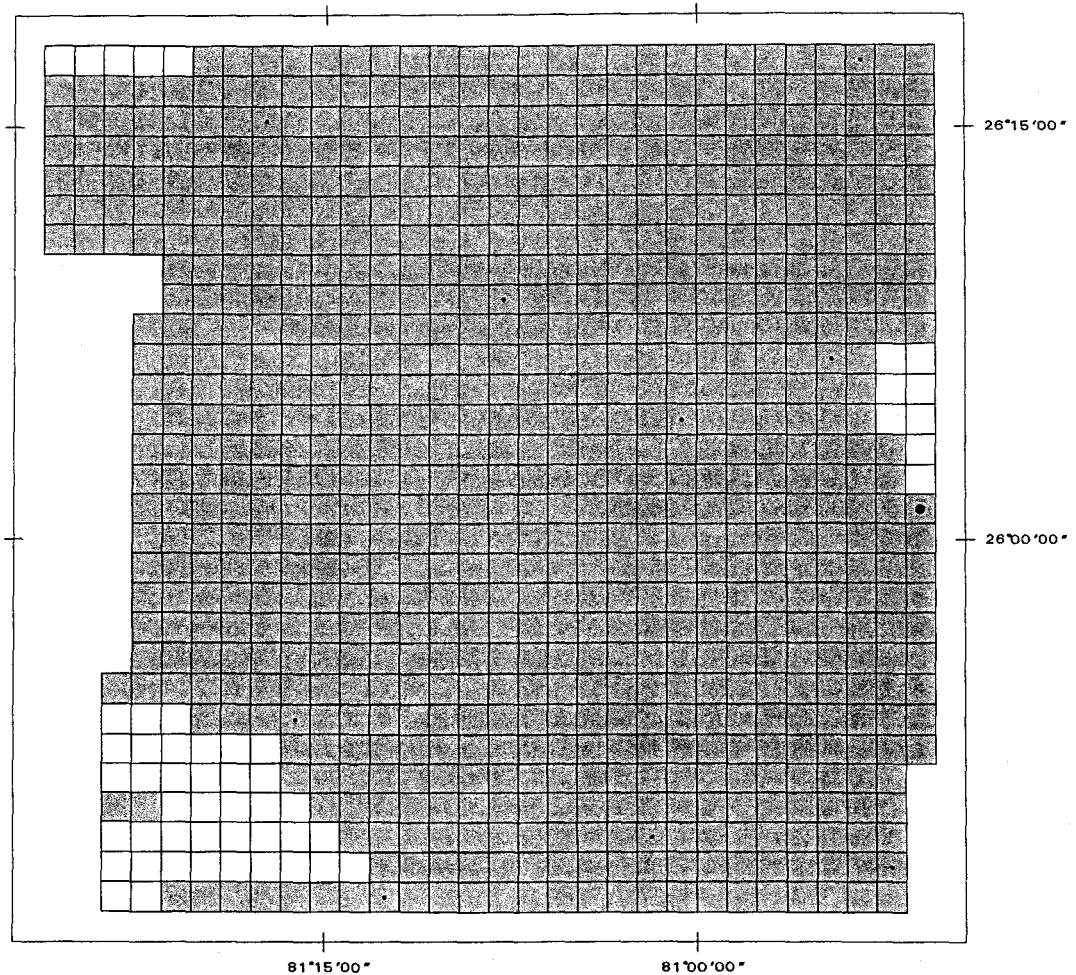
Density Categories Birds Per Square Km



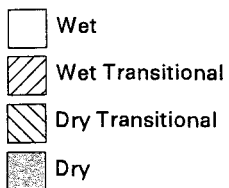
Great Blue Herons

Big Cypress

May 2000

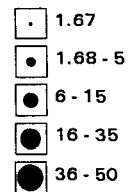


Water Conditions



Density Categories

Birds Per Square Km

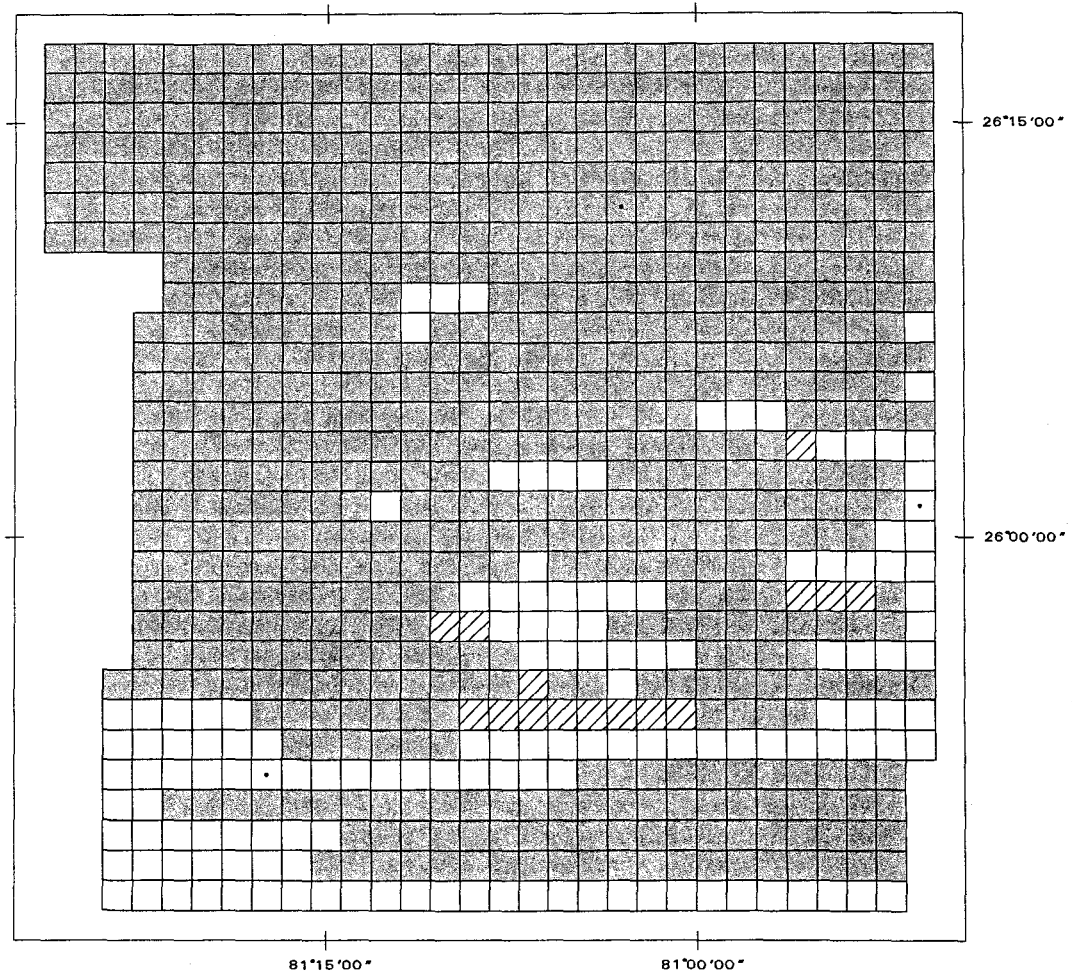


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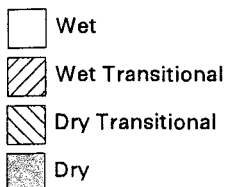
Great Blue Herons

Big Cypress

June 2000

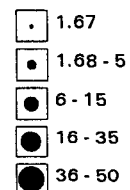


Water Conditions



Density Categories

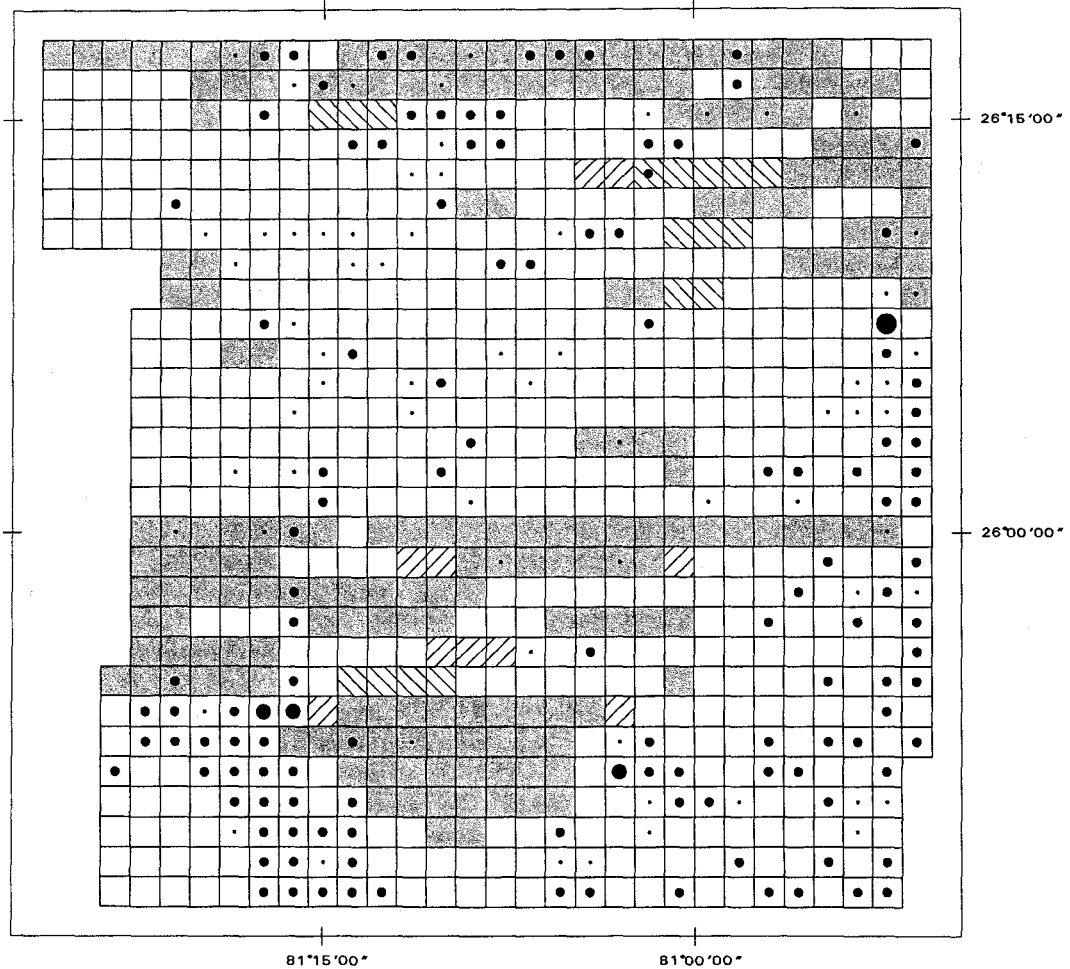
Birds Per Square Km



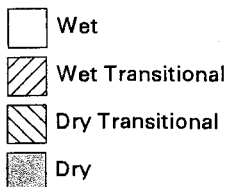
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- D6. Density maps of Great Egrets in the Big Cypress National Preserve, June 2000.

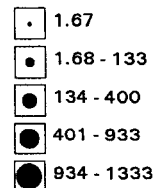
Great Egrets Big Cypress January 2000



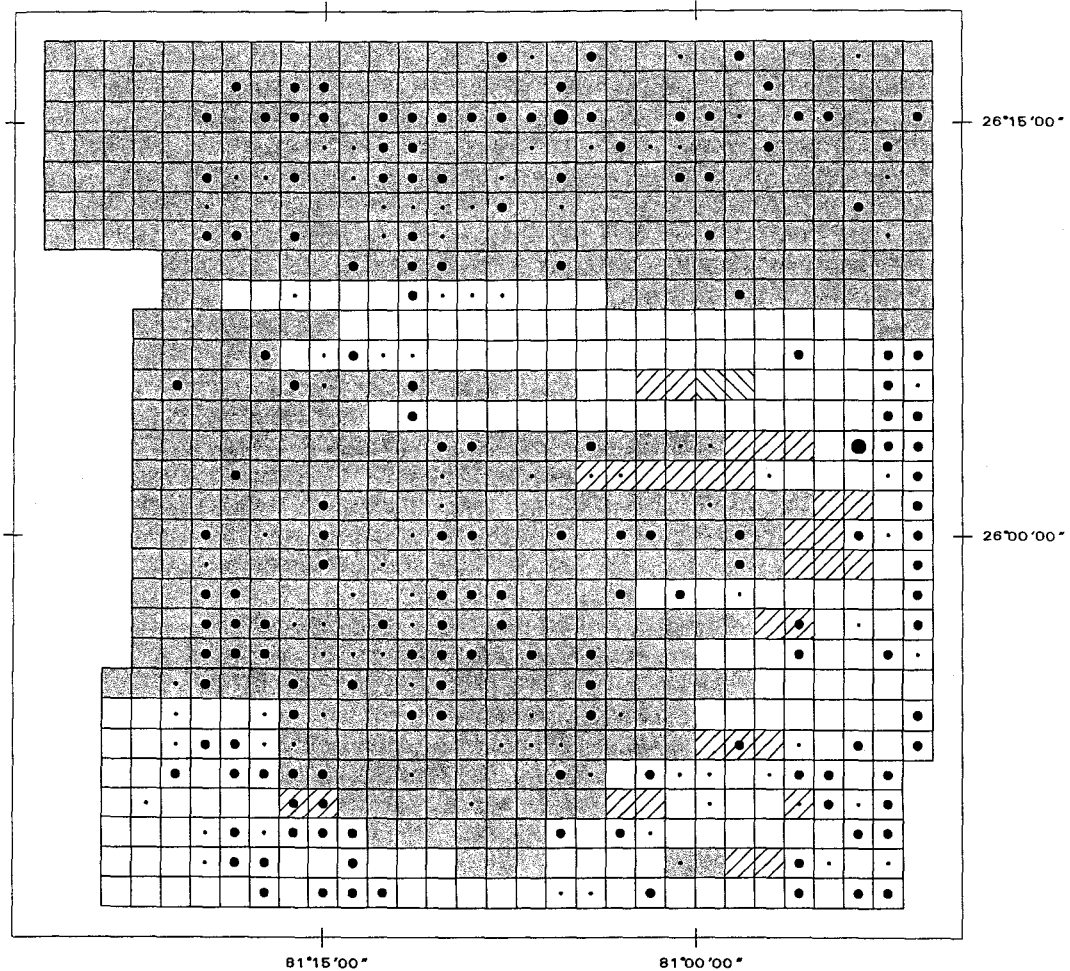
Water Conditions



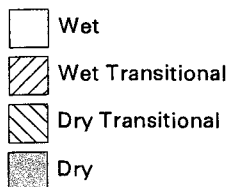
Density Categories Birds Per Square Km



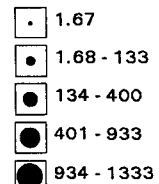
Great Egrets Big Cypress February 2000



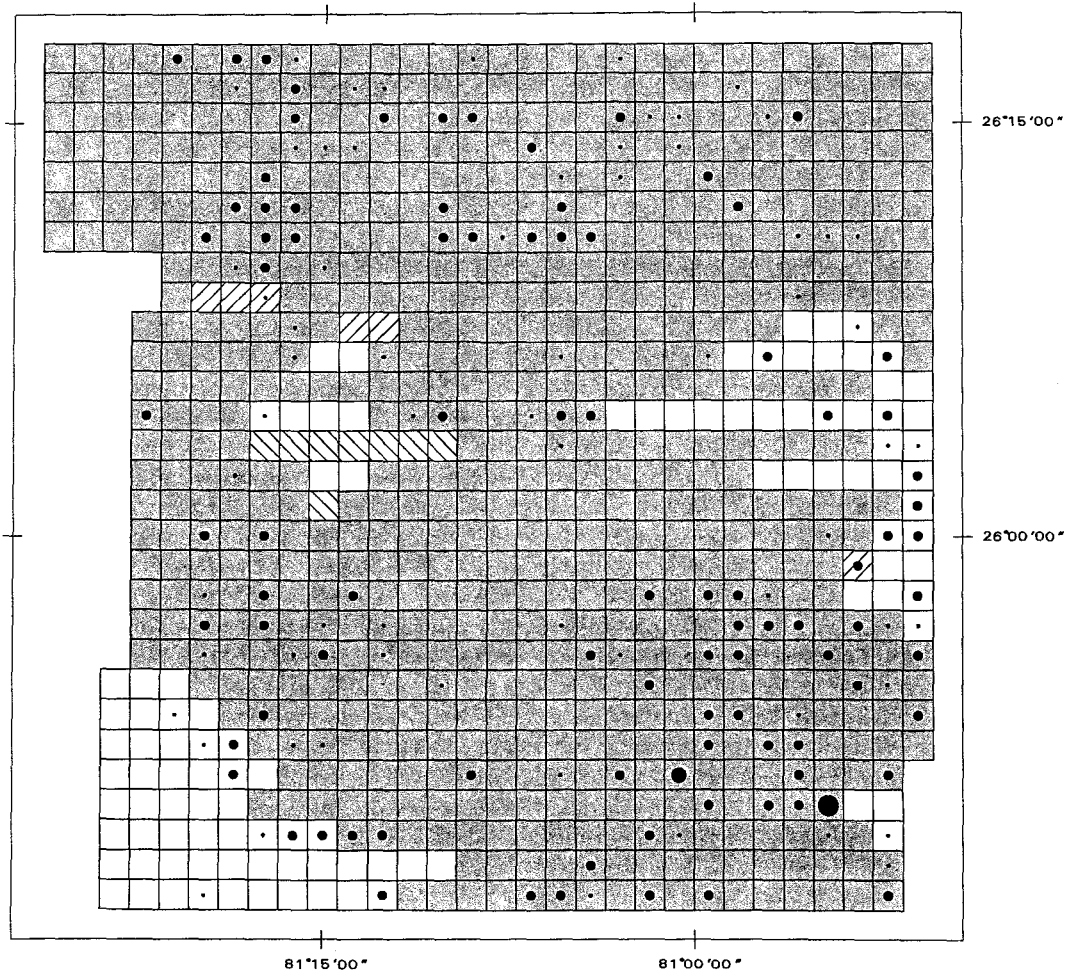
Water Conditions



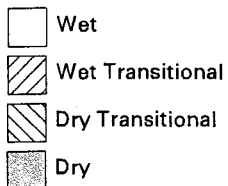
Density Categories Birds Per Square Km



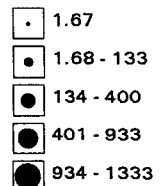
Great Egrets Big Cypress March 2000



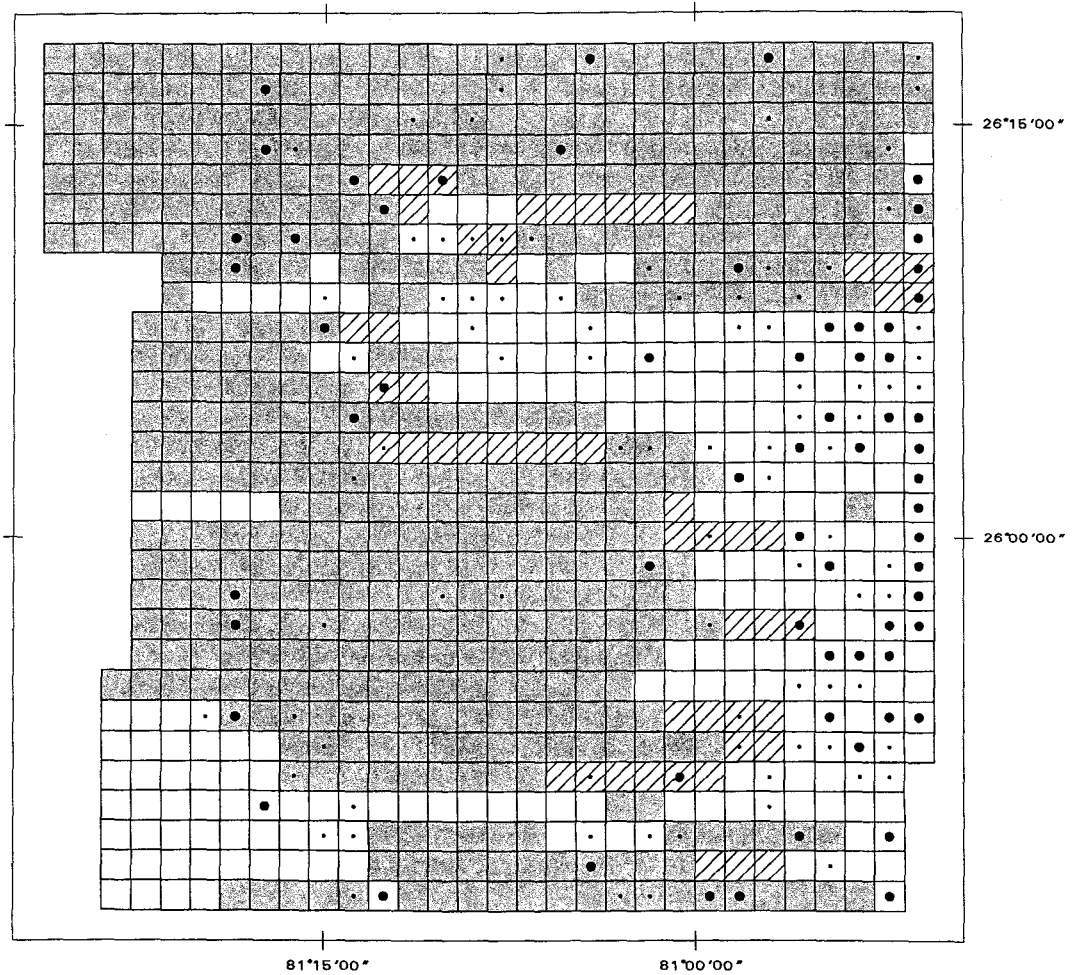
Water Conditions



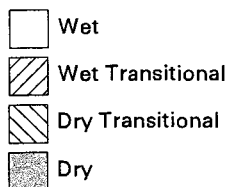
Density Categories Birds Per Square Km



Great Egrets Big Cypress April 2000

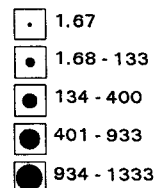


Water Conditions

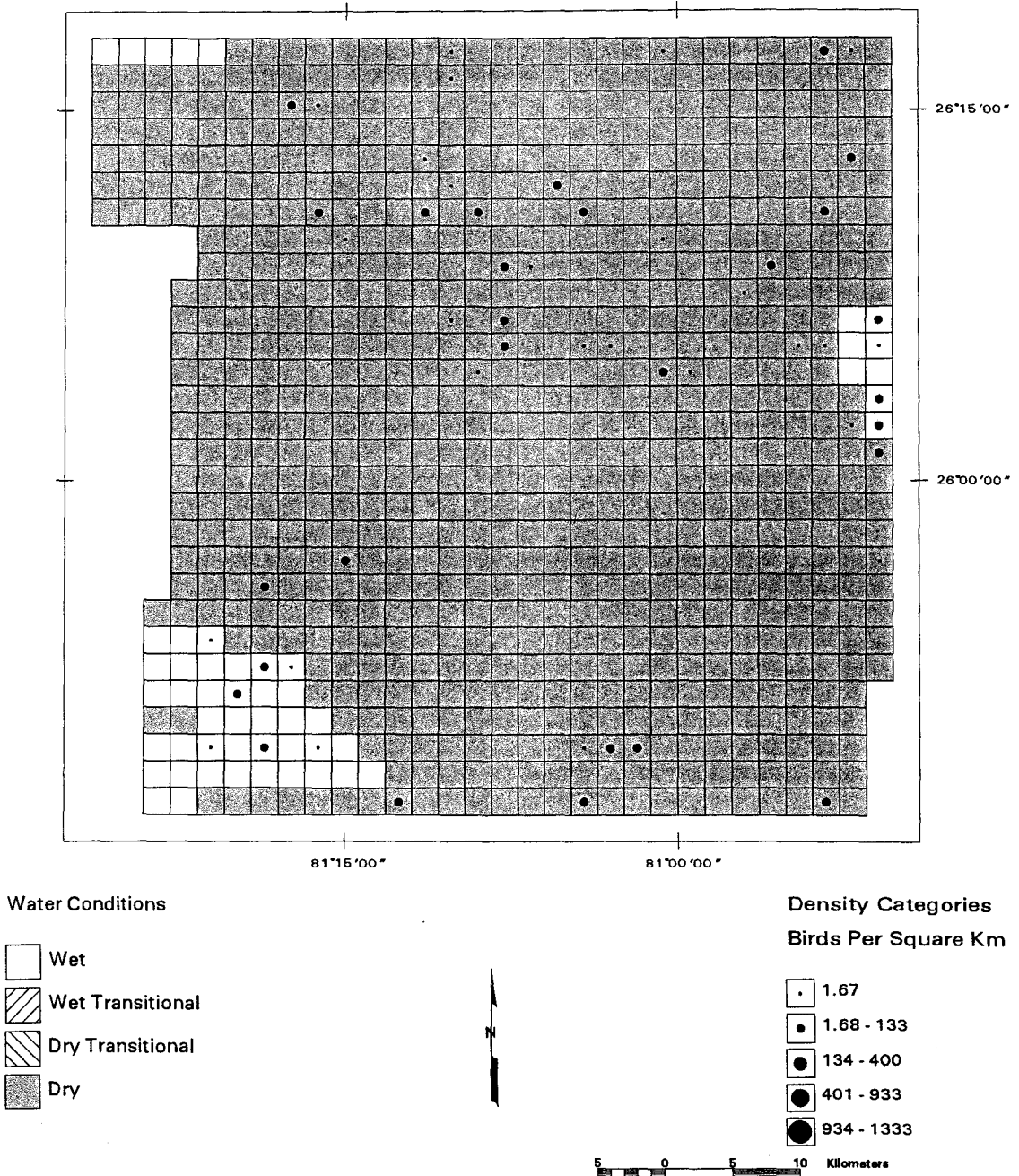


Density Categories

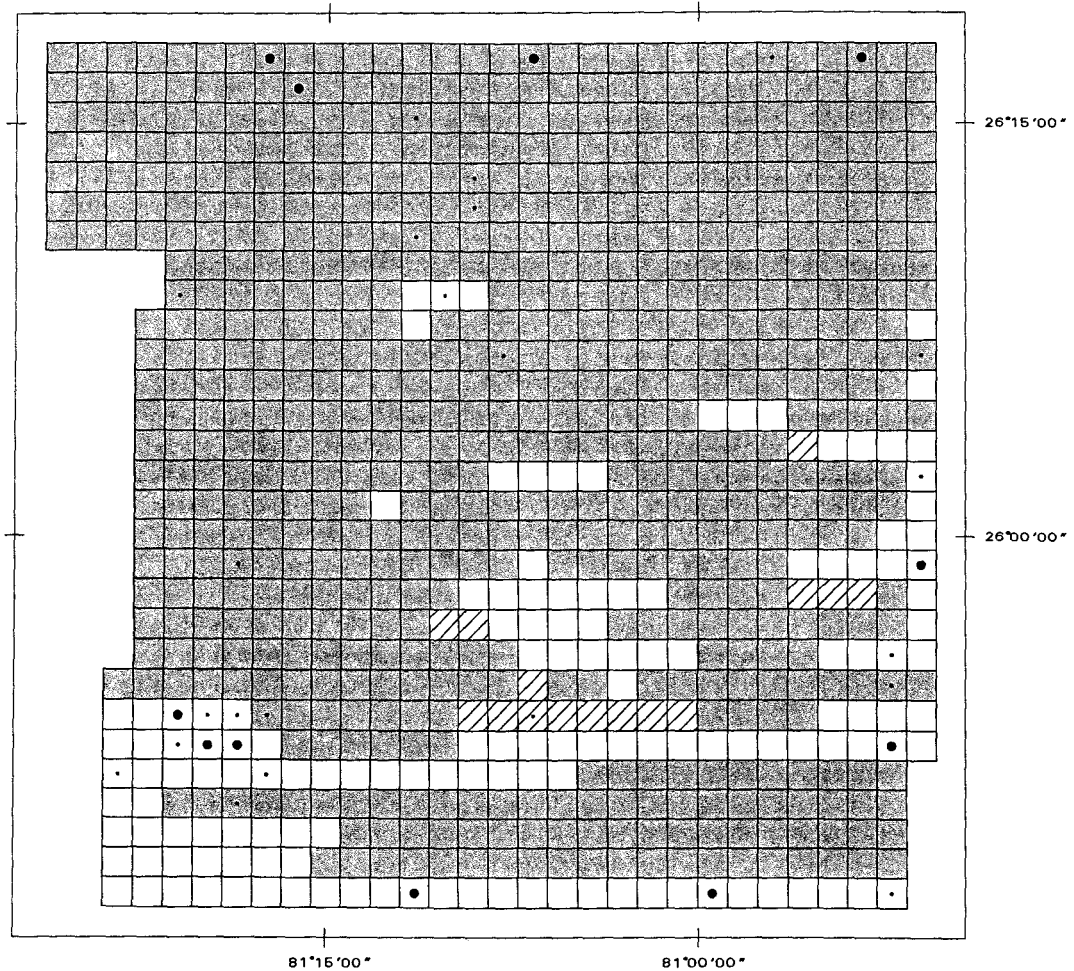
Birds Per Square Km



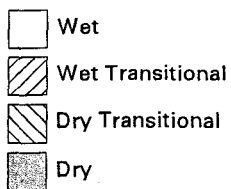
Great Egrets
Big Cypress
May 2000



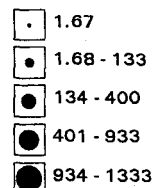
Great Egrets Big Cypress June 2000



Water Conditions



Density Categories Birds Per Square Km



APPENDIX E: Monthly Density Maps of Small Dark Herons in the Big Cypress National Preserve, January to June 2000.

E1. Density maps of small dark herons in the Big Cypress National Preserve, January 2000.

E2. Density maps of small dark herons in the Big Cypress National Preserve, February 2000.

E3. Density maps of small dark herons in the Big Cypress National Preserve, March 2000.

E4. Density maps of small dark herons in the Big Cypress National Preserve, April 2000.

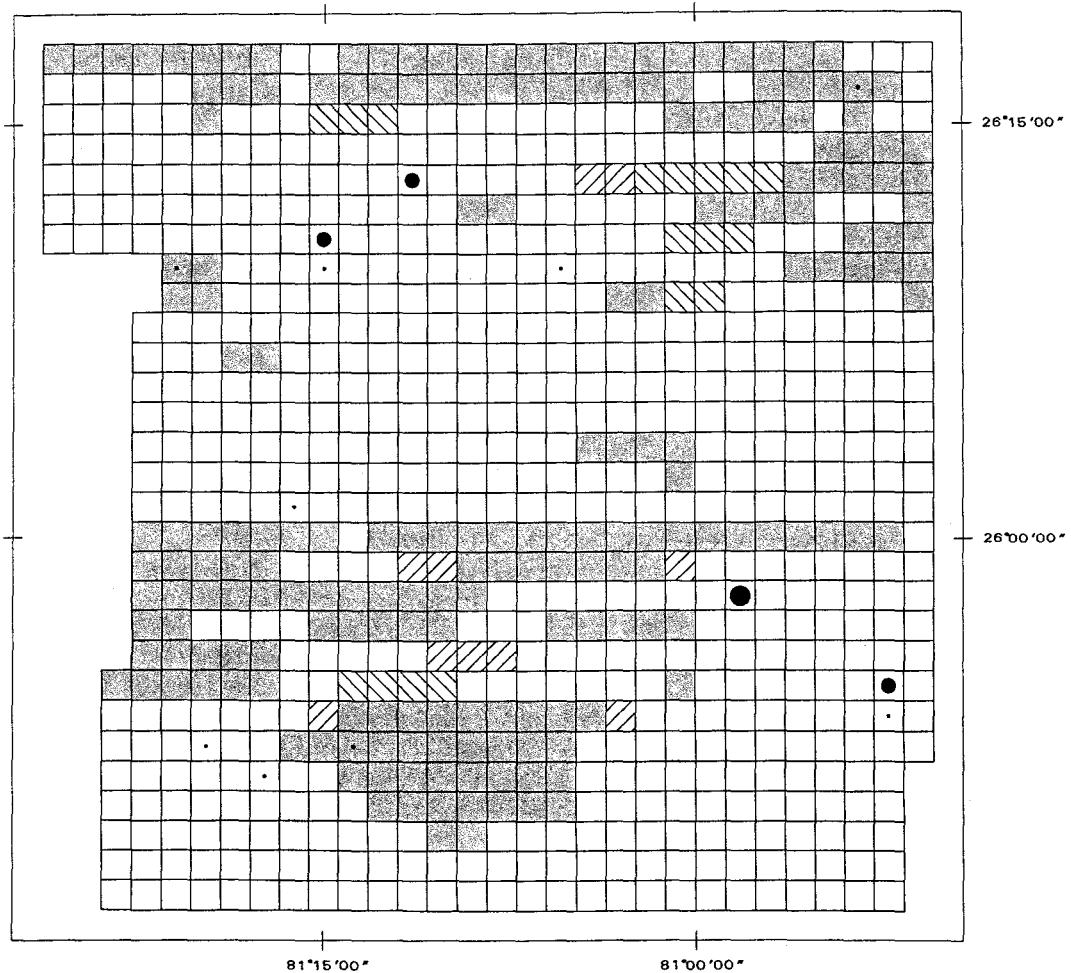
E5. Density maps of small dark herons in the Big Cypress National Preserve, May 2000.

E6. Density maps of small dark herons in the Big Cypress National Preserve, June 2000.

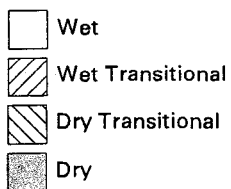
Small Dark Herons

Big Cypress

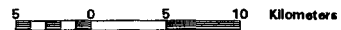
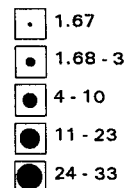
January 2000



Water Conditions



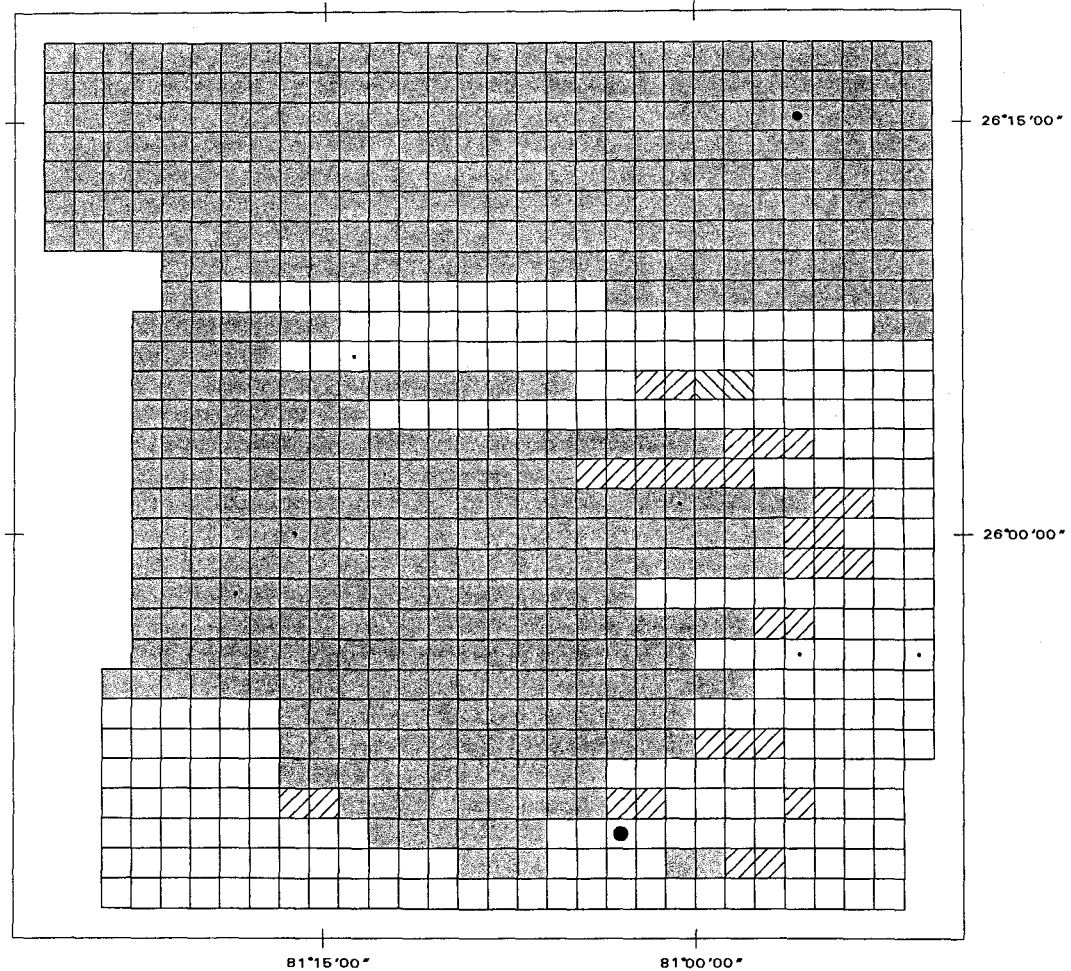
Density Categories Birds Per Square Km



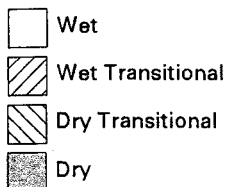
Small Dark Herons

Big Cypress

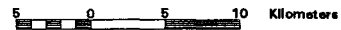
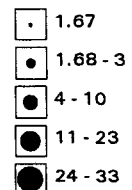
February 2000



Water Conditions



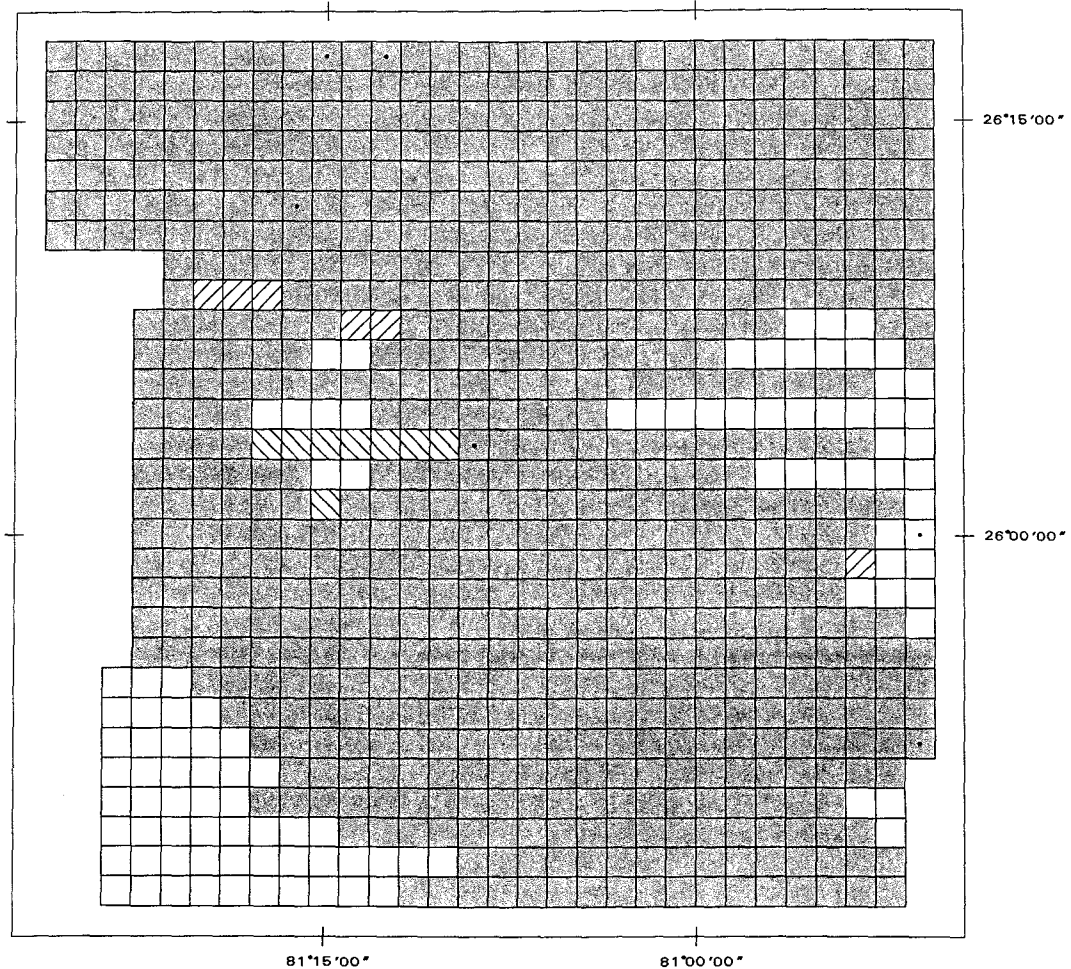
Density Categories Birds Per Square Km



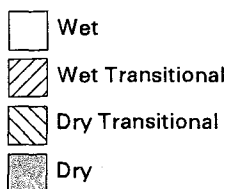
Small Dark Herons

Big Cypress

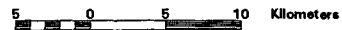
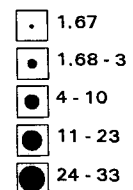
March 2000



Water Conditions



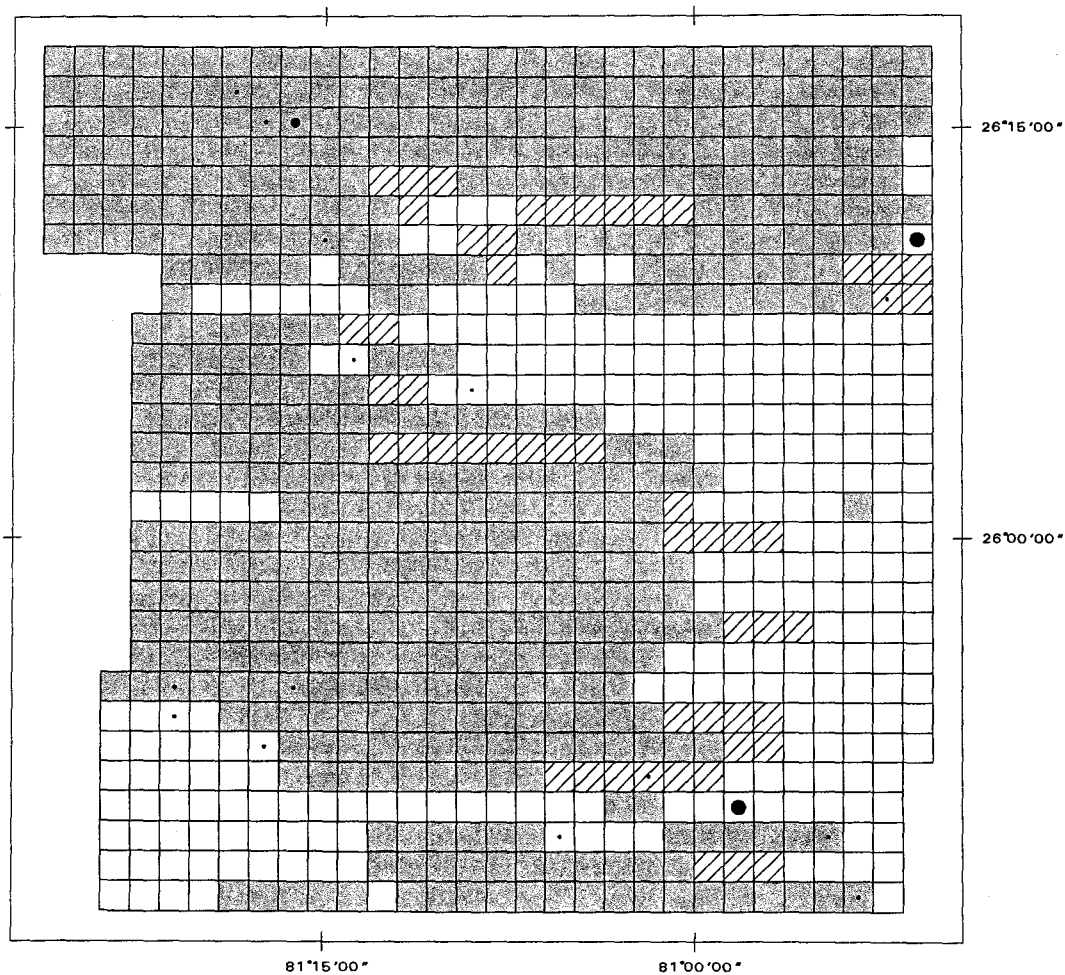
Density Categories Birds Per Square Km



Small Dark Herons

Big Cypress

April 2000



Water Conditions

-  Wet
-  Wet Transitional
-  Dry Transitional
-  Dry

Density Categories Birds Per Square Km

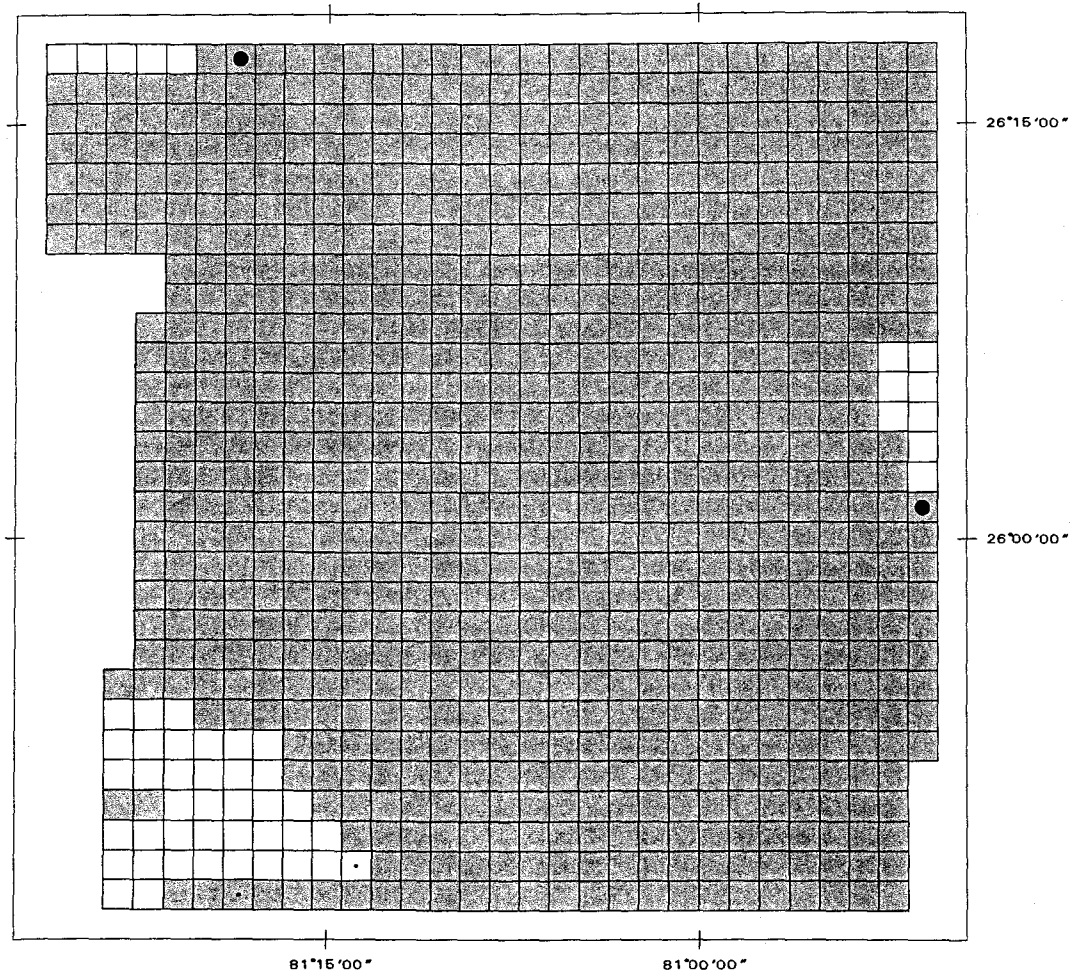
-  1.67
-  1.68 - 3
-  4 - 10
-  11 - 23
-  24 - 33

5 0 5 10 Kilometers

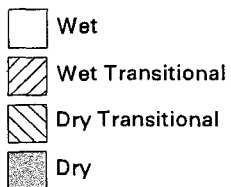
Small Dark Herons

Big Cypress

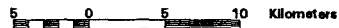
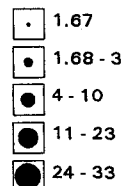
May 2000



Water Conditions



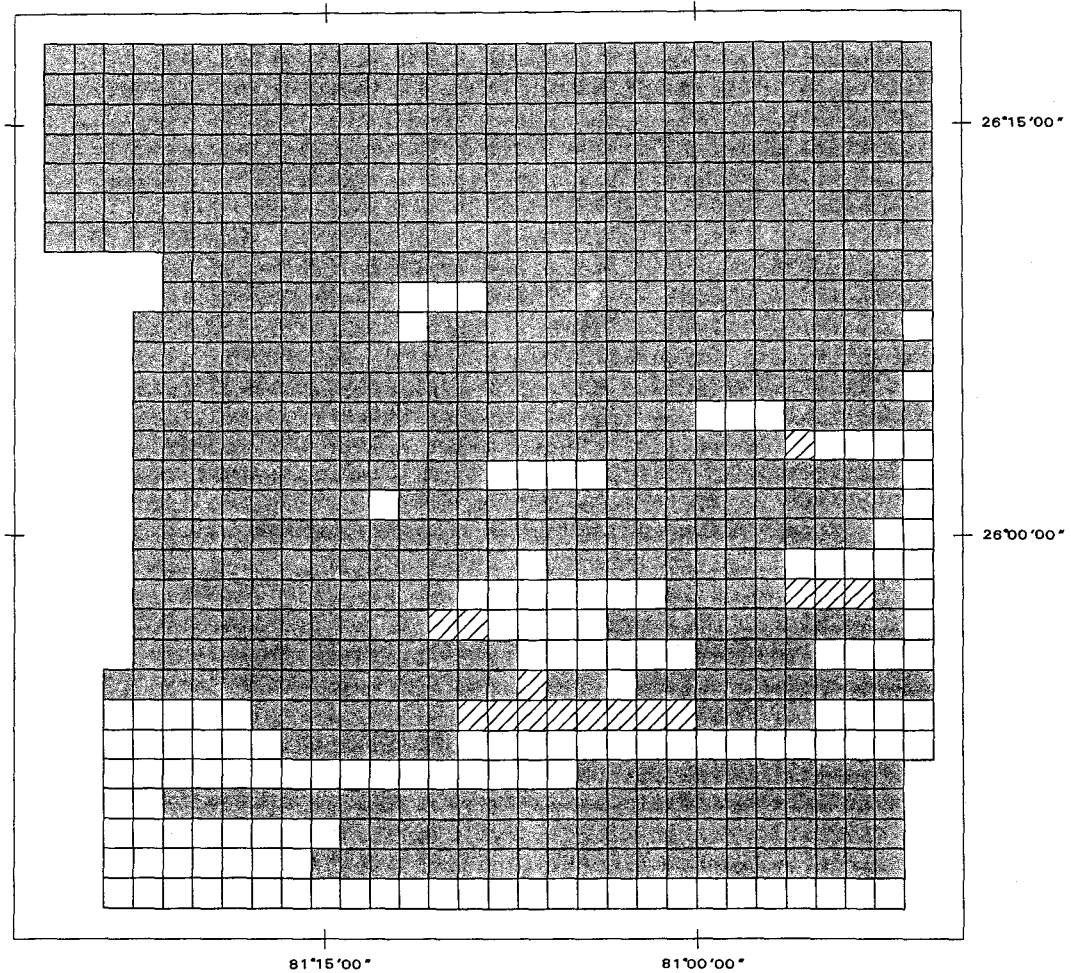
Density Categories Birds Per Square Km



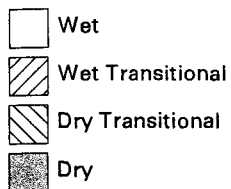
Small Dark Herons

Big Cypress

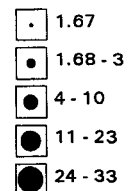
June 2000



Water Conditions



Density Categories Birds Per Square Km



APPENDIX F: Monthly Density Maps of Small White Herons in the Big Cypress National Preserve, January to June 2000.

F1. Density maps of small white herons in the Big Cypress National Preserve, January 2000.

F2. Density maps of small white herons in the Big Cypress National Preserve, February 2000.

F3. Density maps of small white herons in the Big Cypress National Preserve, March 2000.

F4. Density maps of small white herons in the Big Cypress National Preserve, April 2000.

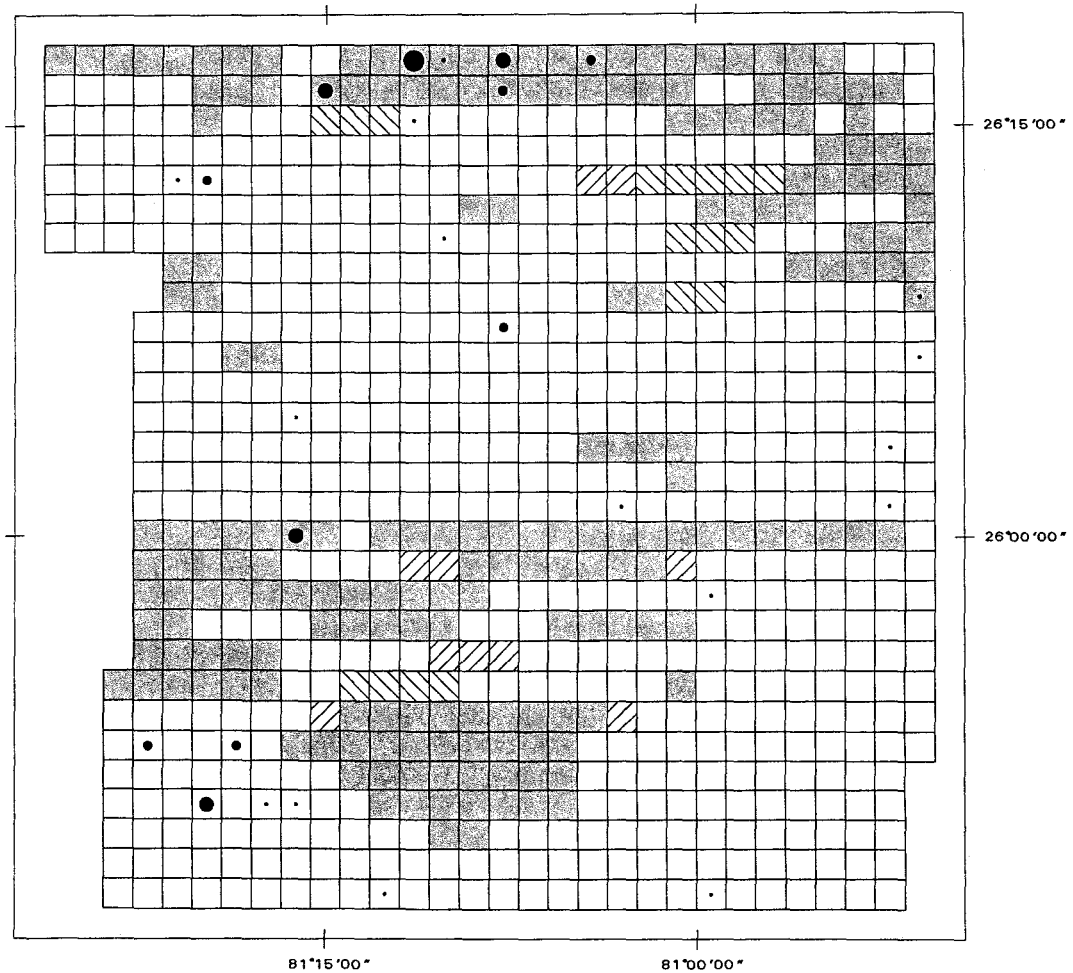
F5. Density maps of small white herons in the Big Cypress National Preserve, May 2000.

F6. Density maps of small white herons in the Big Cypress National Preserve, June 2000.

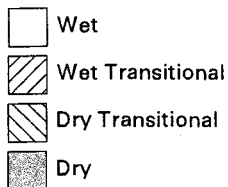
Small White Herons

Big Cypress

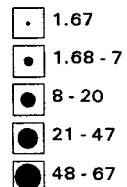
January 2000



Water Conditions



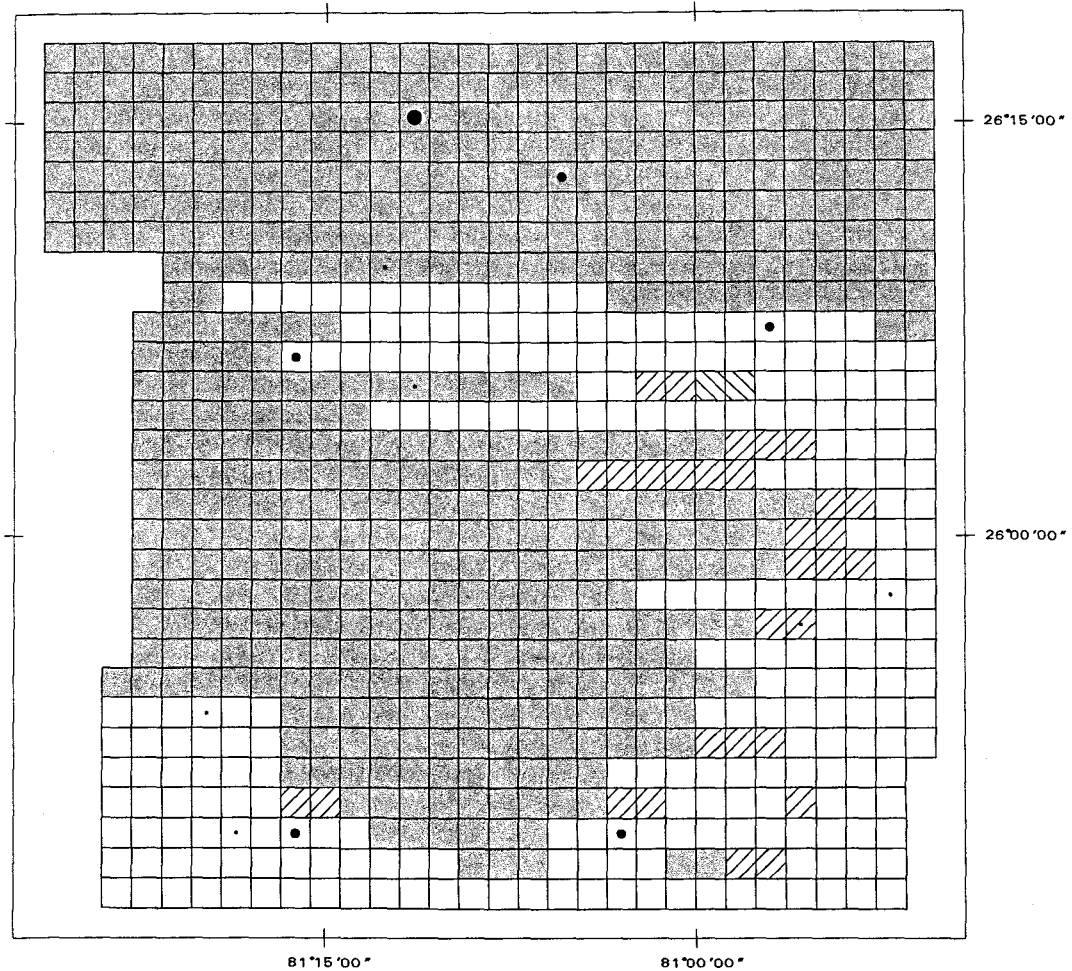
Density Categories Birds Per Square Km



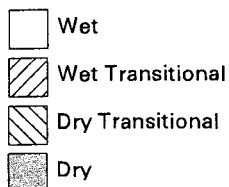
Small White Herons

Big Cypress

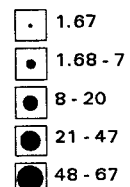
February 2000



Water Conditions



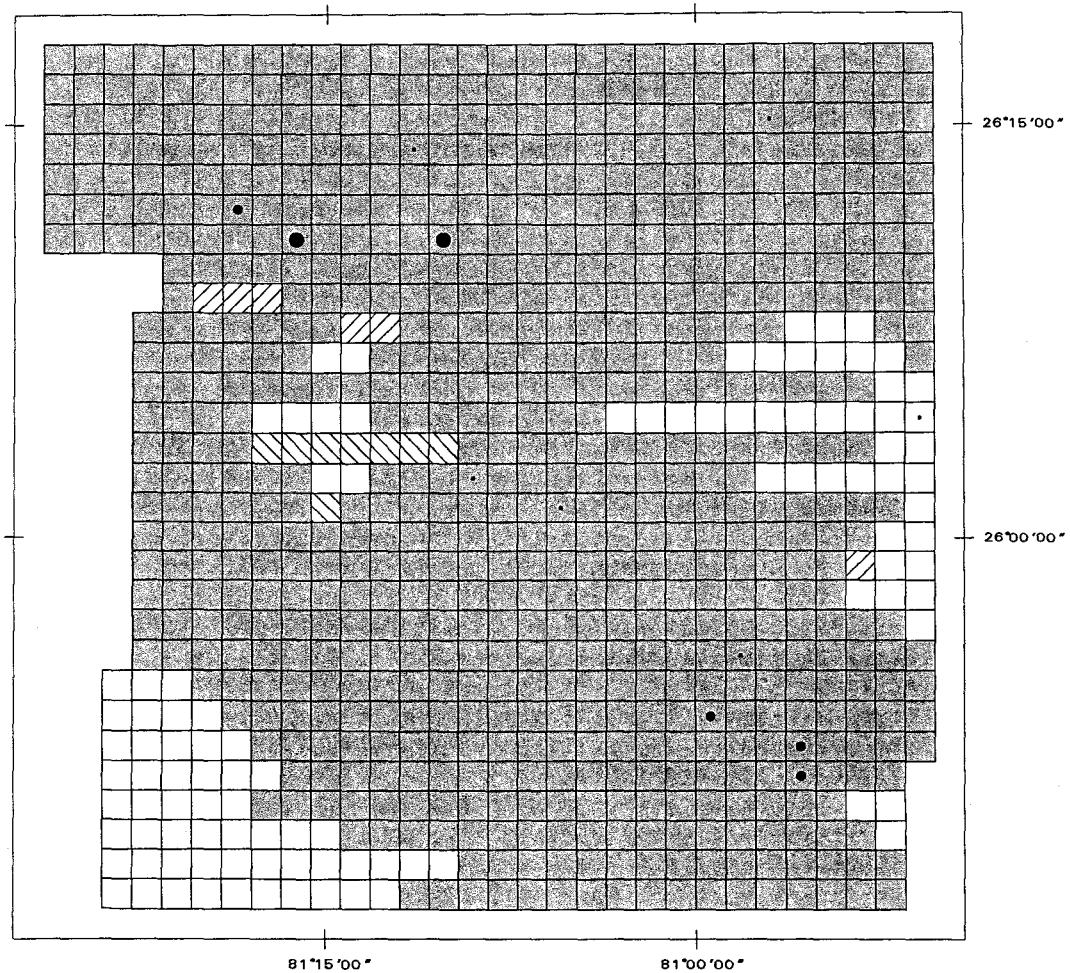
Density Categories Birds Per Square Km



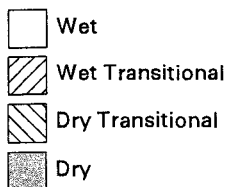
Small White Herons

Big Cypress

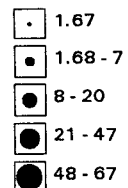
March 2000



Water Conditions



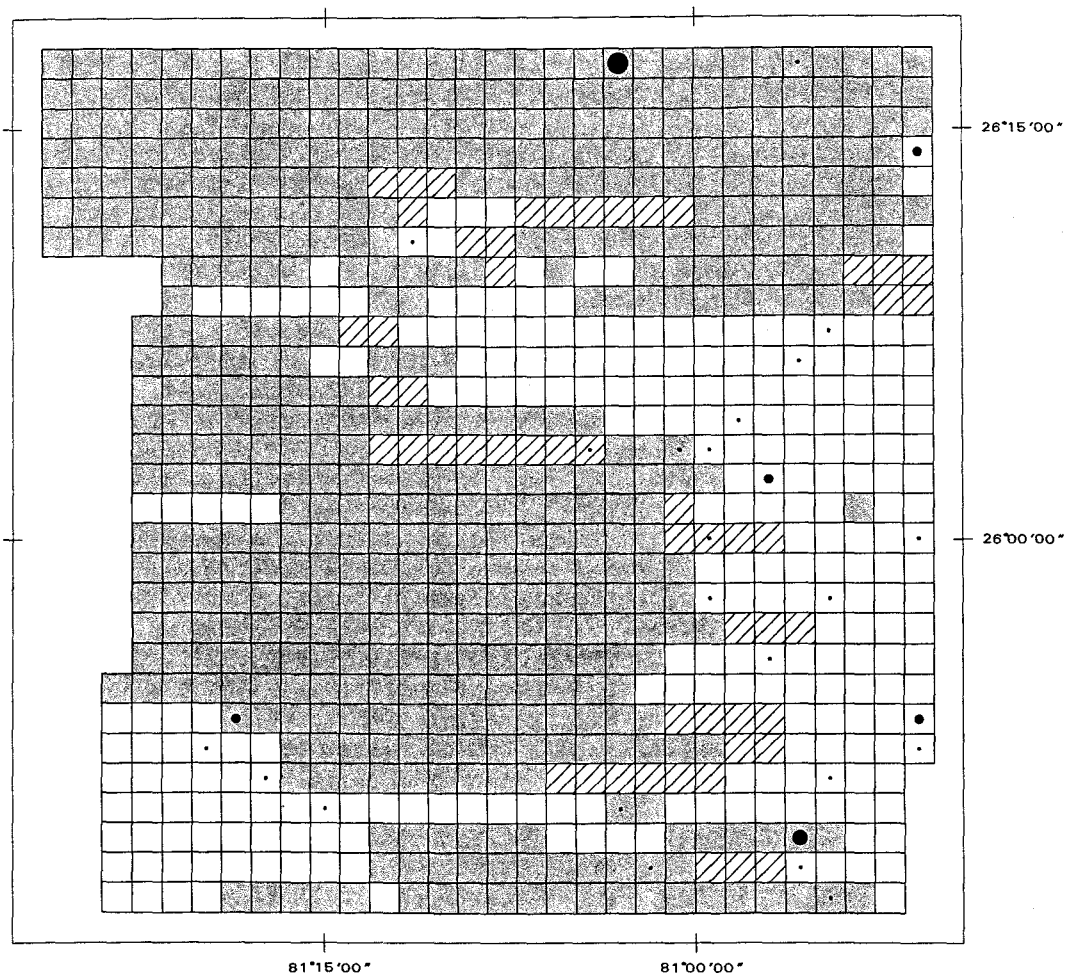
Density Categories Birds Per Square Km



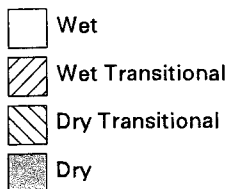
Small White Herons

Big Cypress

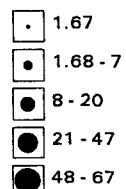
April 2000



Water Conditions



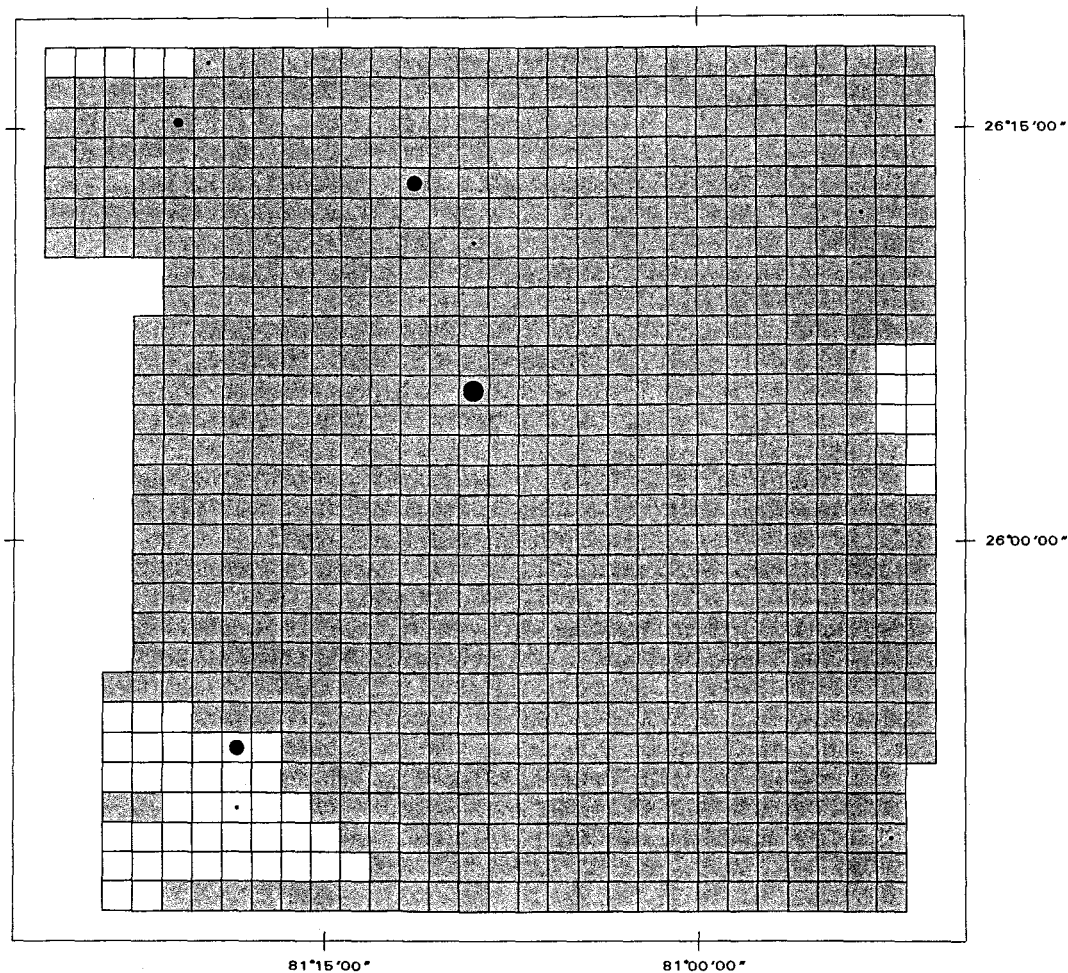
Density Categories Birds Per Square Km



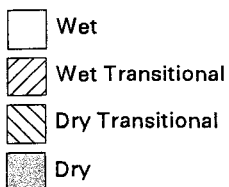
Small White Herons

Big Cypress

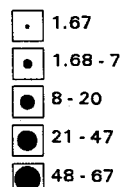
May 2000



Water Conditions



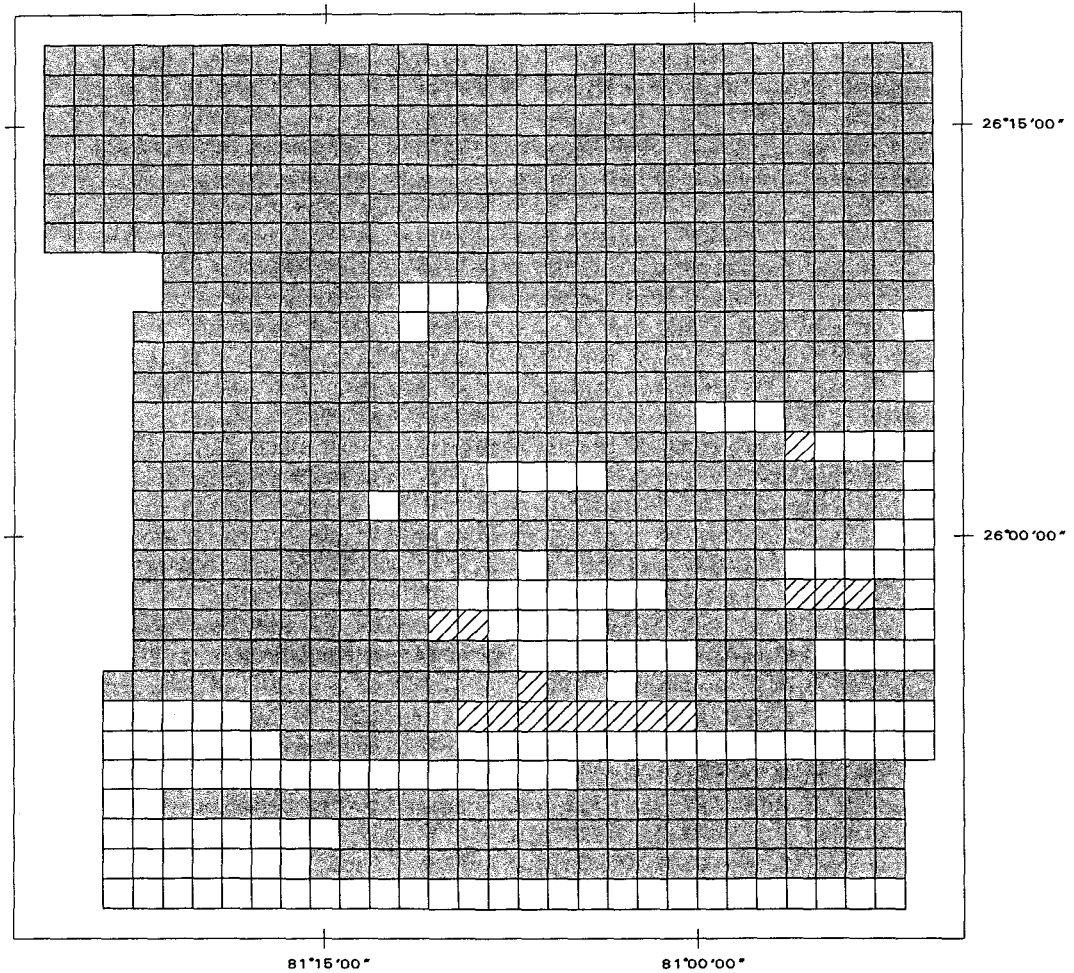
Density Categories Birds Per Square Km



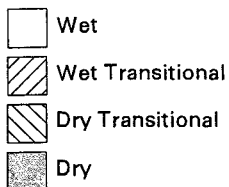
Small White Herons

Big Cypress

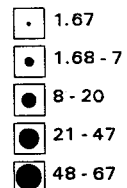
June 2000



Water Conditions



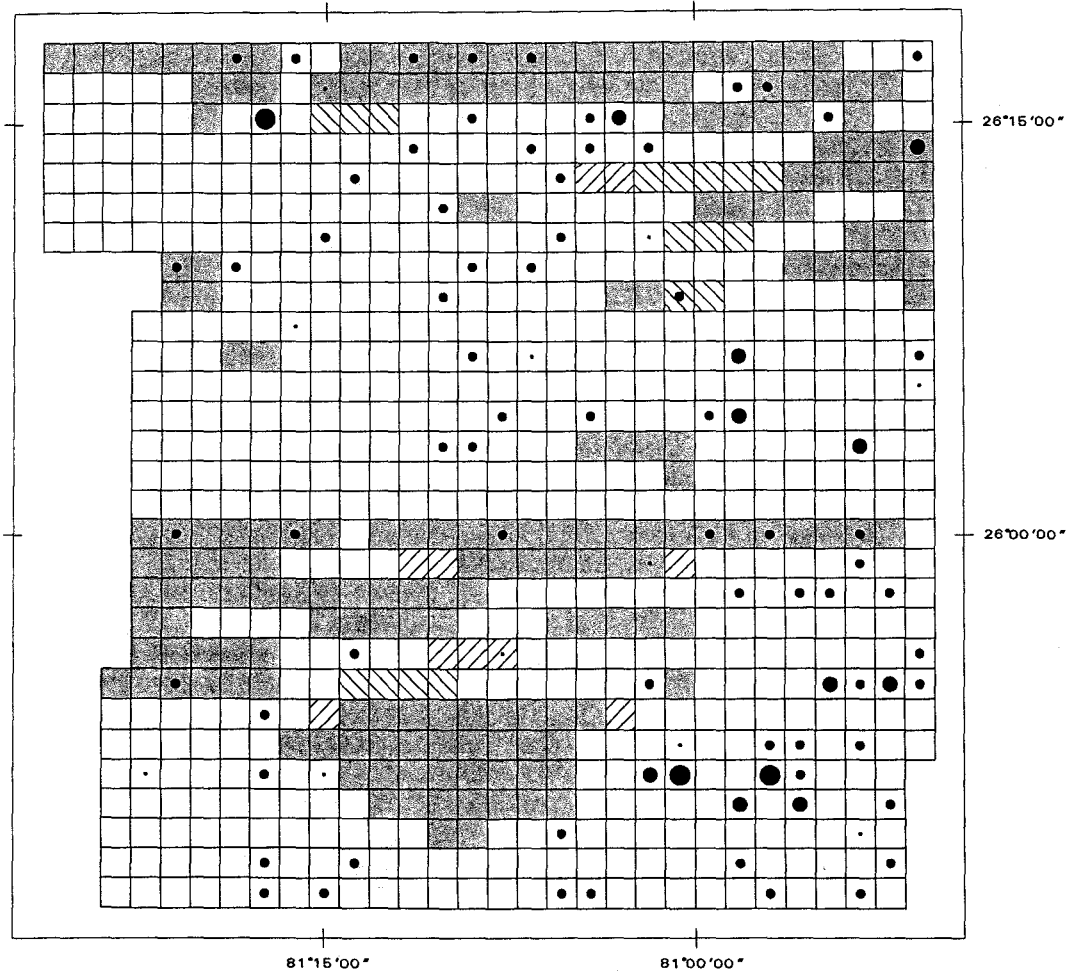
Density Categories Birds Per Square Km



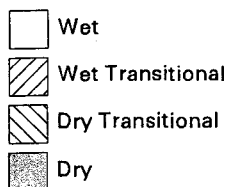
APPENDIX G: Monthly Density Maps of White Ibises in the Big Cypress National Preserve, January to June 2000.

- G1. Density maps of White Ibises in the Big Cypress National Preserve, January 2000.
- G2. Density maps of White Ibises in the Big Cypress National Preserve, February 2000.
- G3. Density maps of White Ibises in the Big Cypress National Preserve, March 2000.
- G4. Density maps of White Ibises in the Big Cypress National Preserve, April 2000.
- G5. Density maps of White Ibises in the Big Cypress National Preserve, May 2000.
- G6. Density maps of White Ibises in the Big Cypress National Preserve, June 2000.

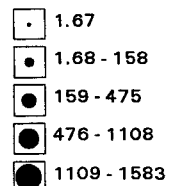
White Ibises Big Cypress January 2000



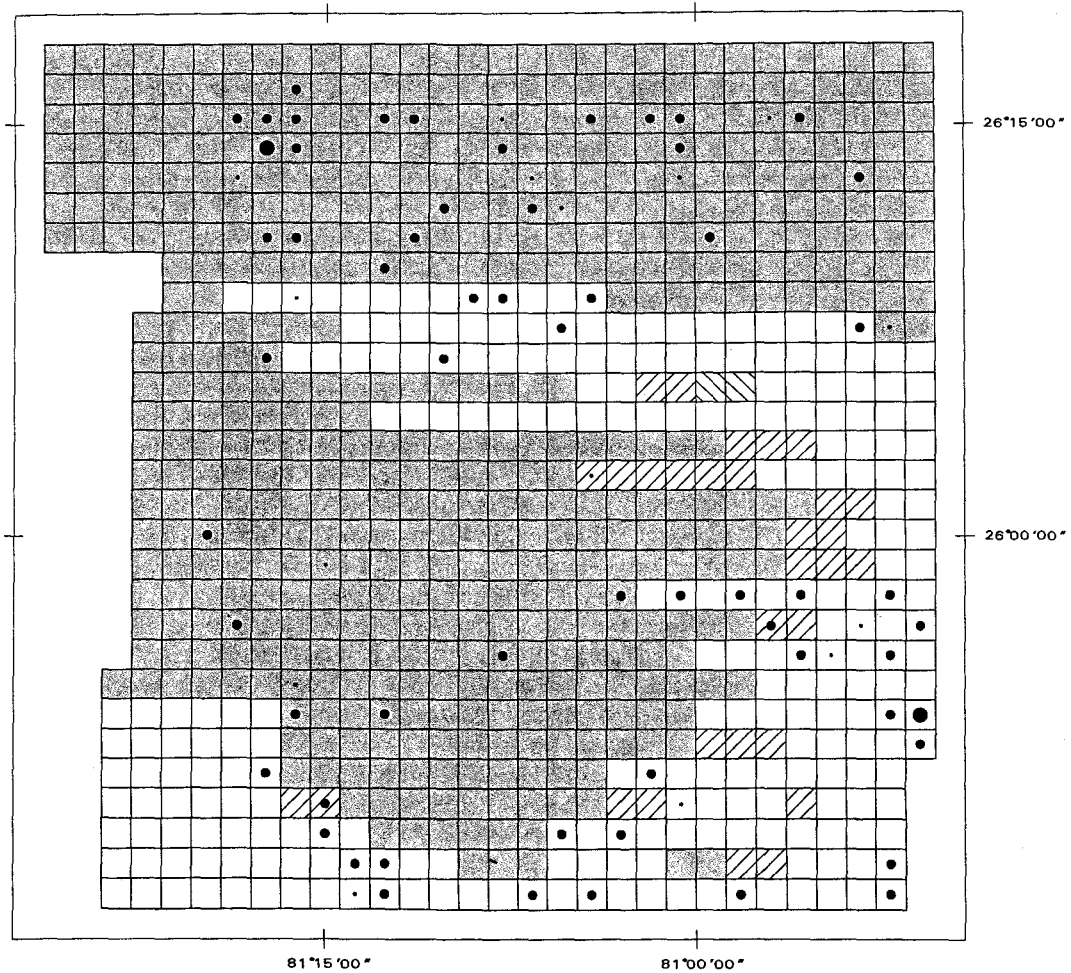
Water Conditions



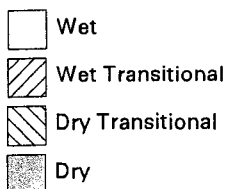
Density Categories Birds Per Square Km



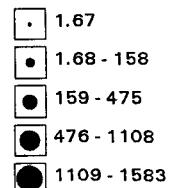
White Ibises Big Cypress February 2000



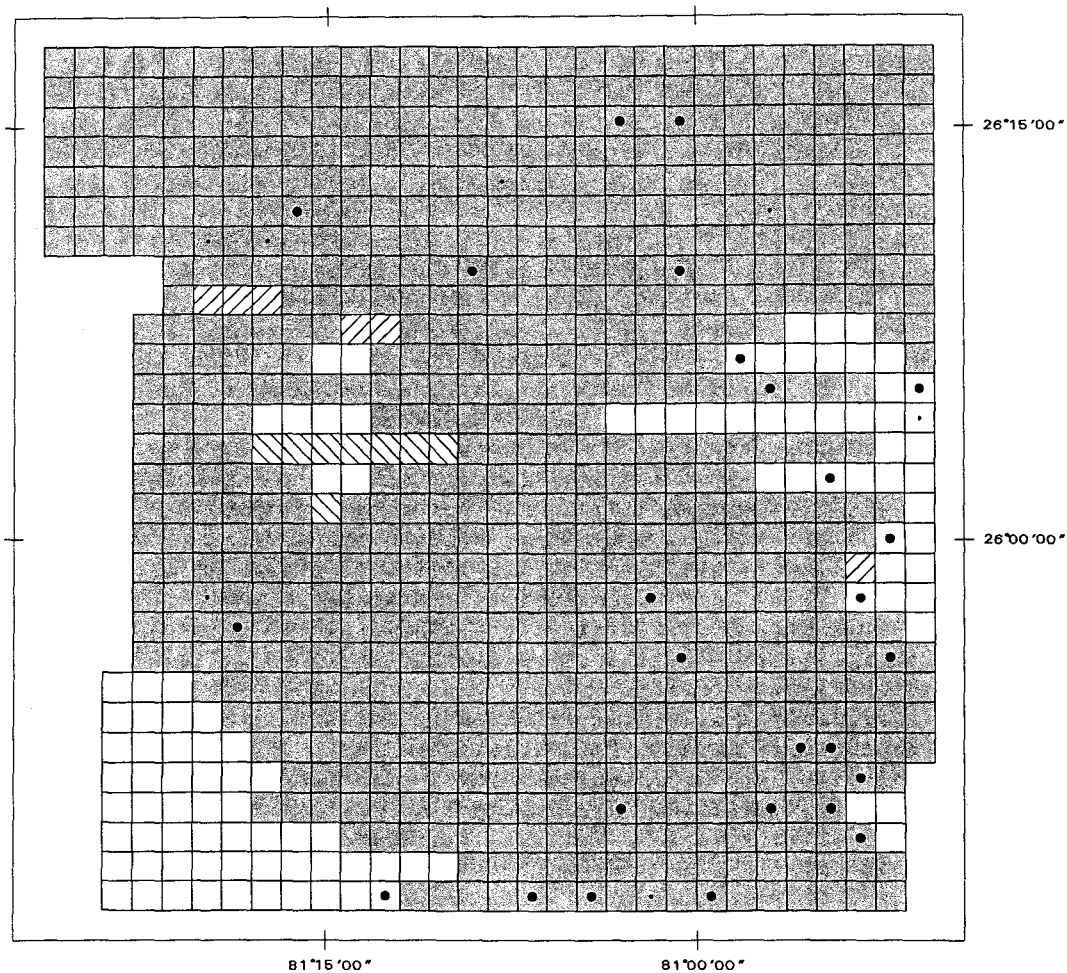
Water Conditions



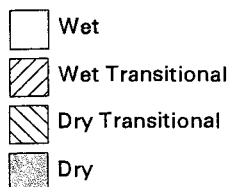
Density Categories Birds Per Square Km



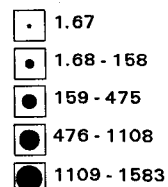
White Ibises Big Cypress March 2000



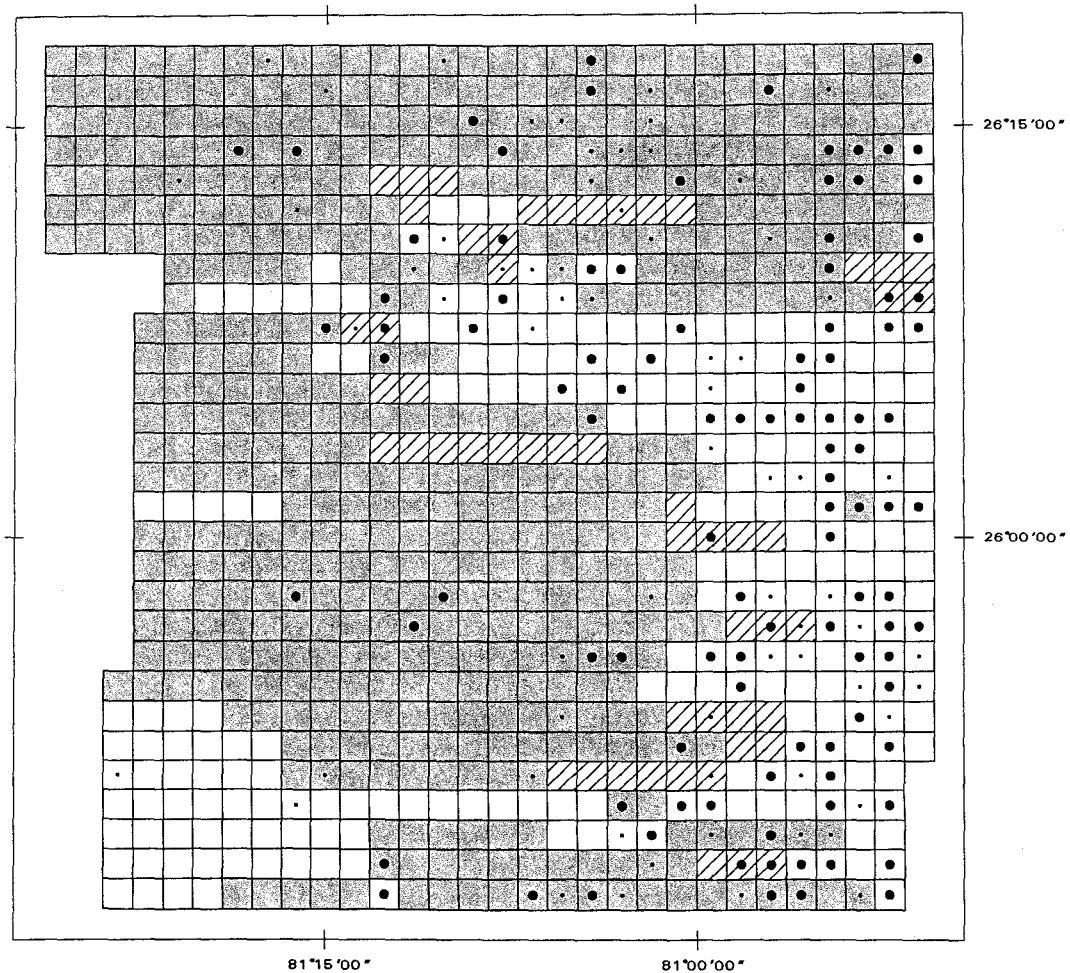
Water Conditions



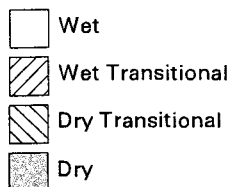
Density Categories Birds Per Square Km



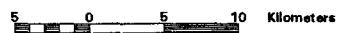
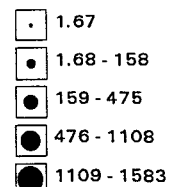
White Ibises Big Cypress April 2000



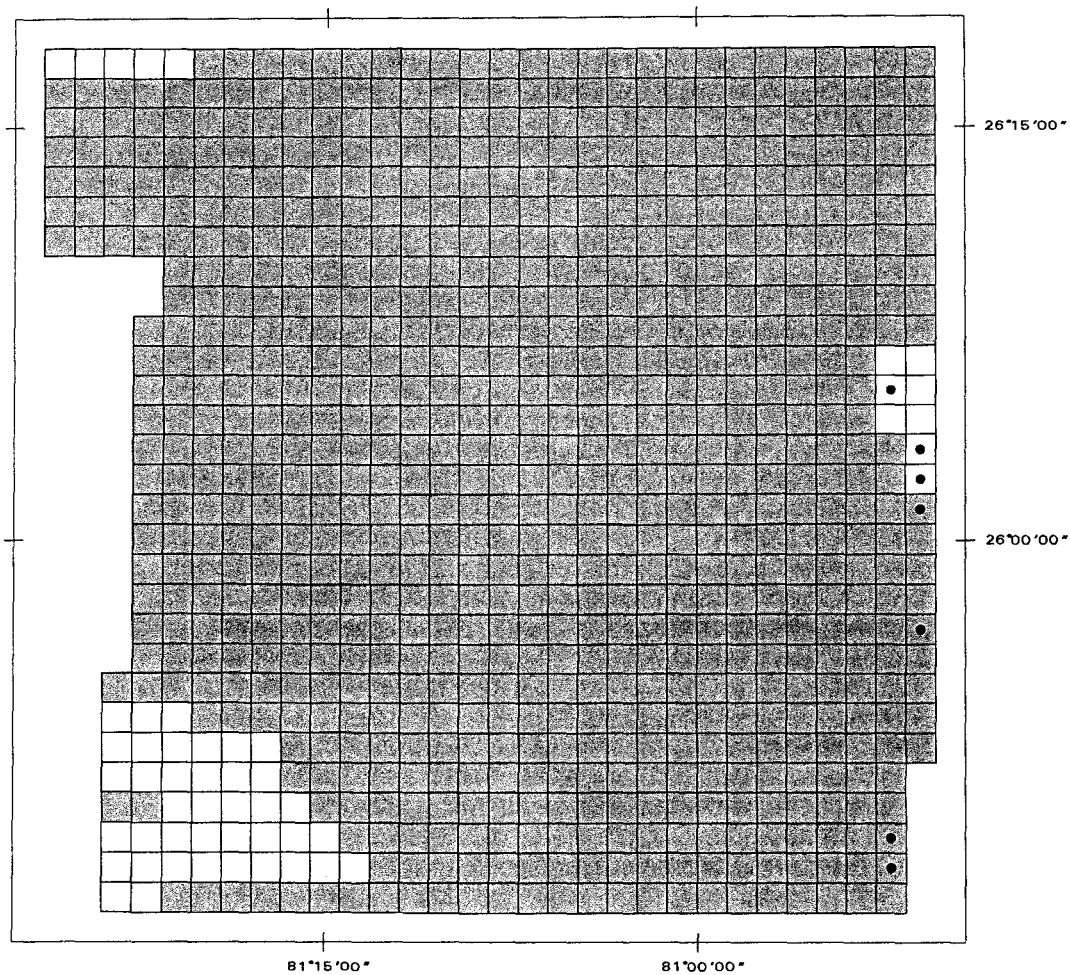
Water Conditions



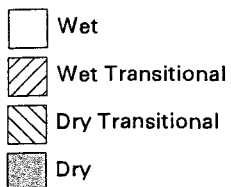
Density Categories Birds Per Square Km



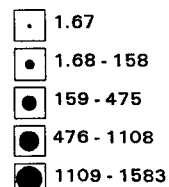
White Ibises Big Cypress May 2000



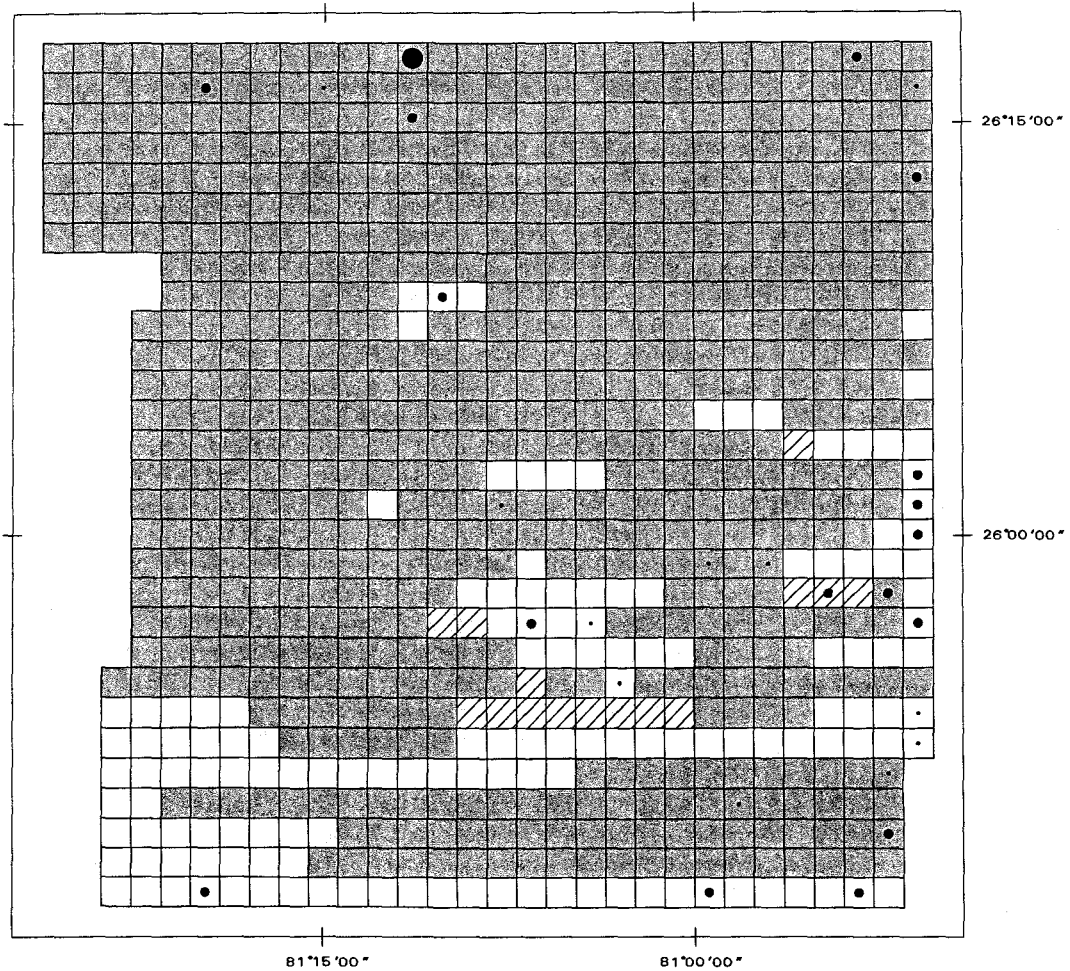
Water Conditions



Density Categories Birds Per Square Km



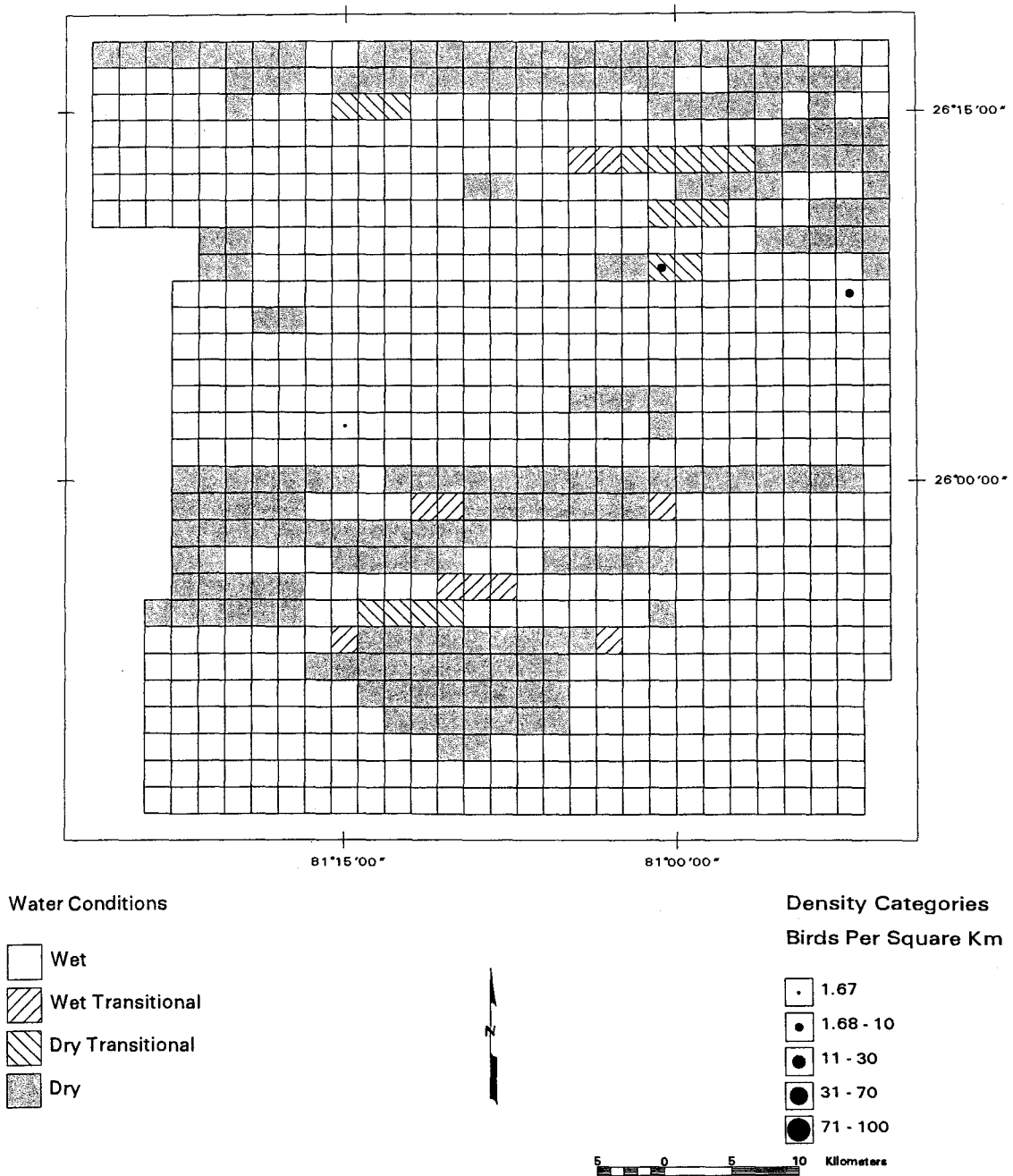
White Ibises Big Cypress June 2000



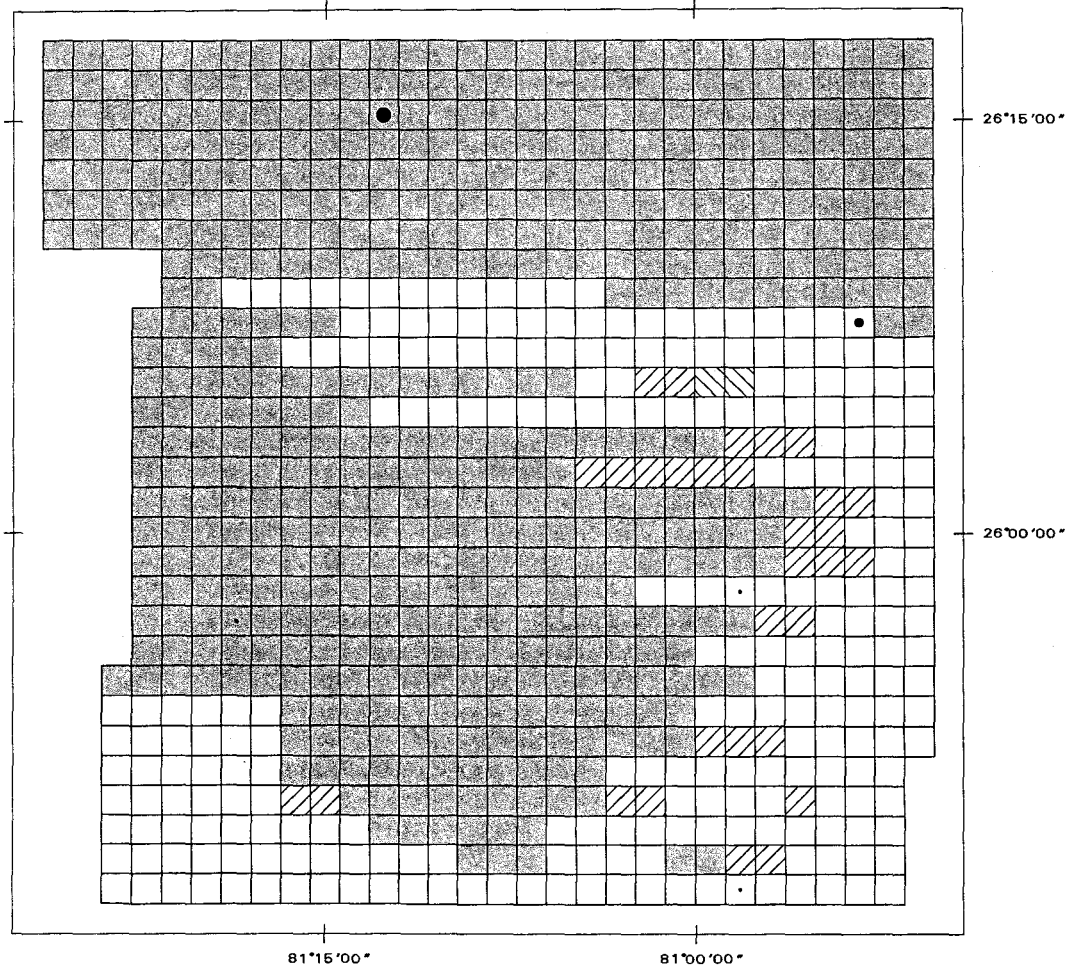
APPENDIX H: Monthly Density Maps of Glossy Ibises in the Big Cypress National Preserve, January to June 2000.

- H1. Density maps of Glossy Ibises in the Big Cypress National Preserve, January 2000.
- H2. Density maps of Glossy Ibises in the Big Cypress National Preserve, February 2000.
- H3. Density maps of Glossy Ibises in the Big Cypress National Preserve, March 2000.
- H4. Density maps of Glossy Ibises in the Big Cypress National Preserve, April 2000.
- H5. Density maps of Glossy Ibises in the Big Cypress National Preserve, May 2000.
- H6. Density maps of Glossy Ibises in the Big Cypress National Preserve, June 2000.

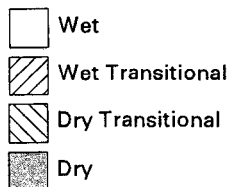
Glossy Ibises Big Cypress January 2000



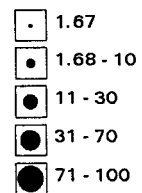
Glossy Ibises Big Cypress February 2000



Water Conditions

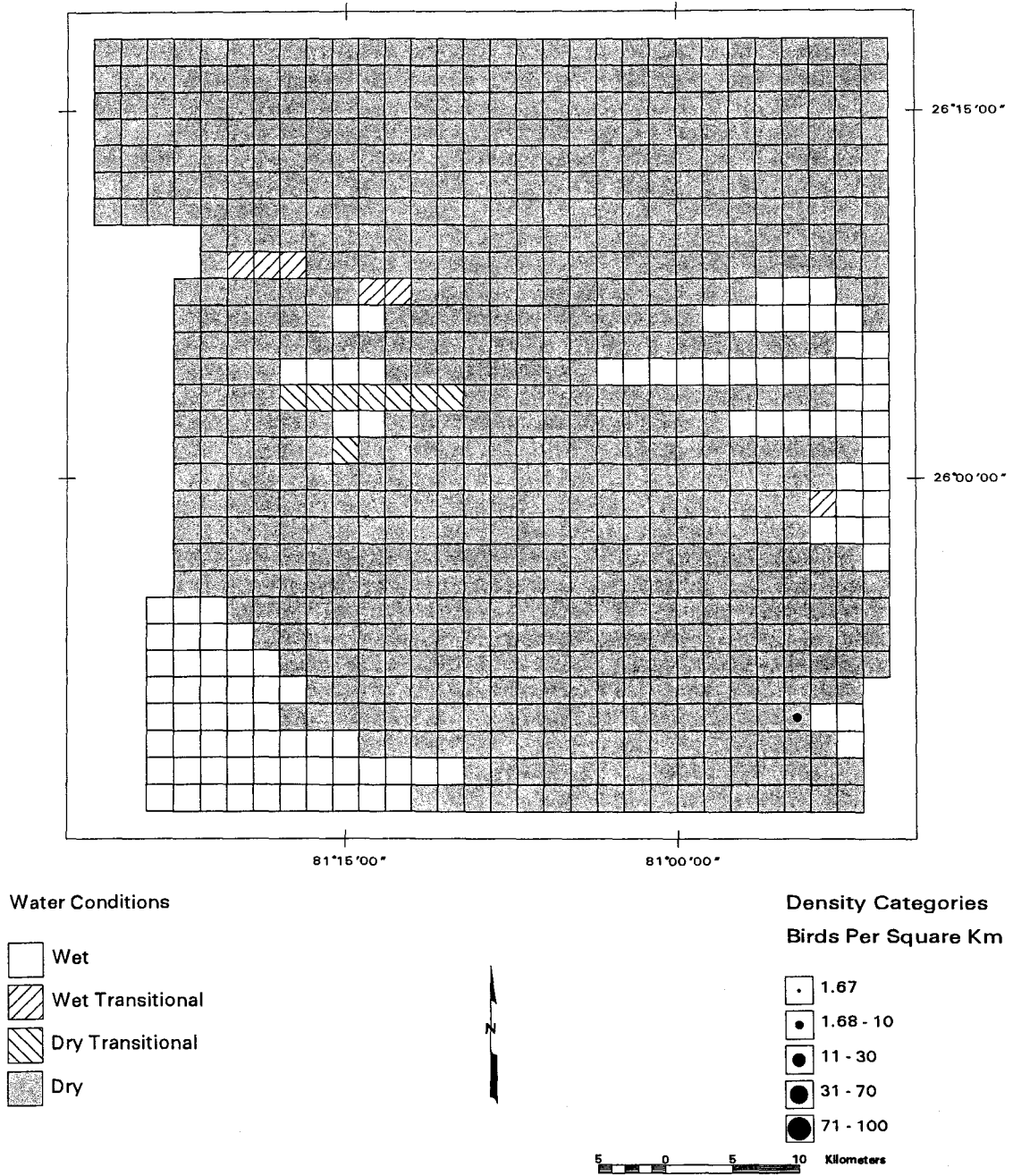


Density Categories Birds Per Square Km



5 0 5 10 Kilometers

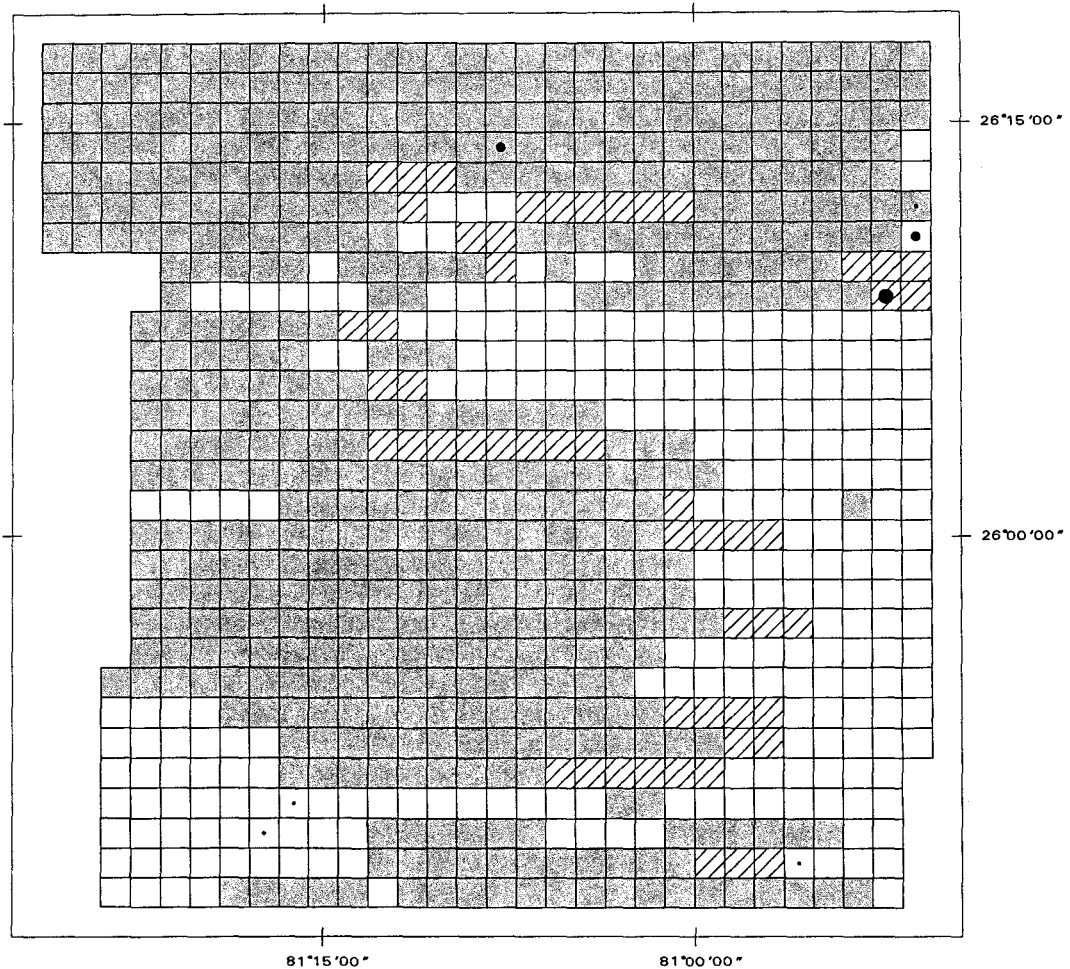
Glossy Ibises Big Cypress March 2000



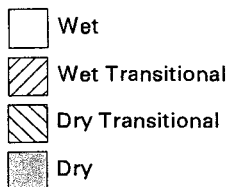
Glossy Ibises

Big Cypress

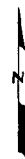
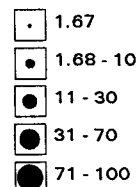
April 2000



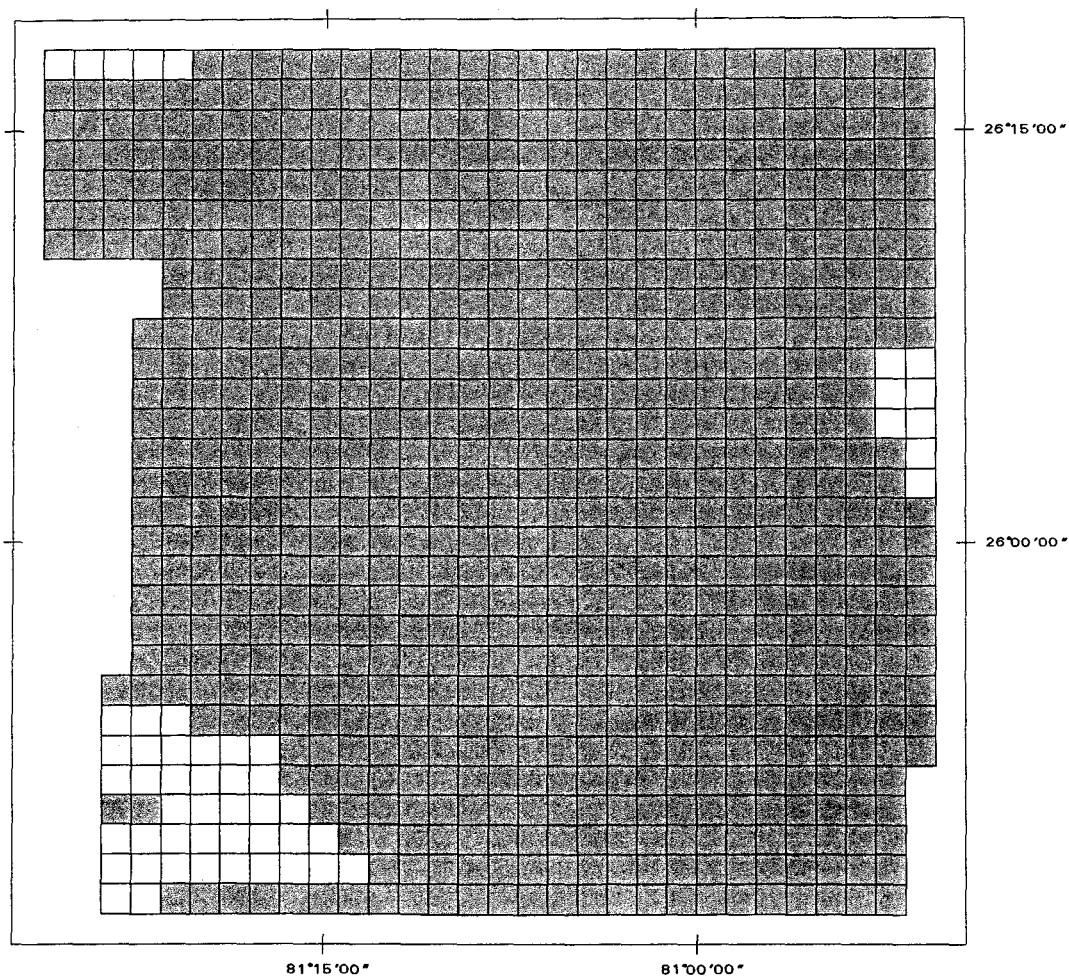
Water Conditions



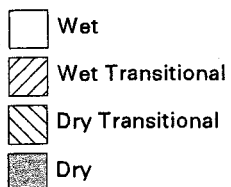
Density Categories Birds Per Square Km



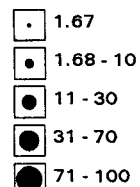
Glossy Ibises Big Cypress May 2000



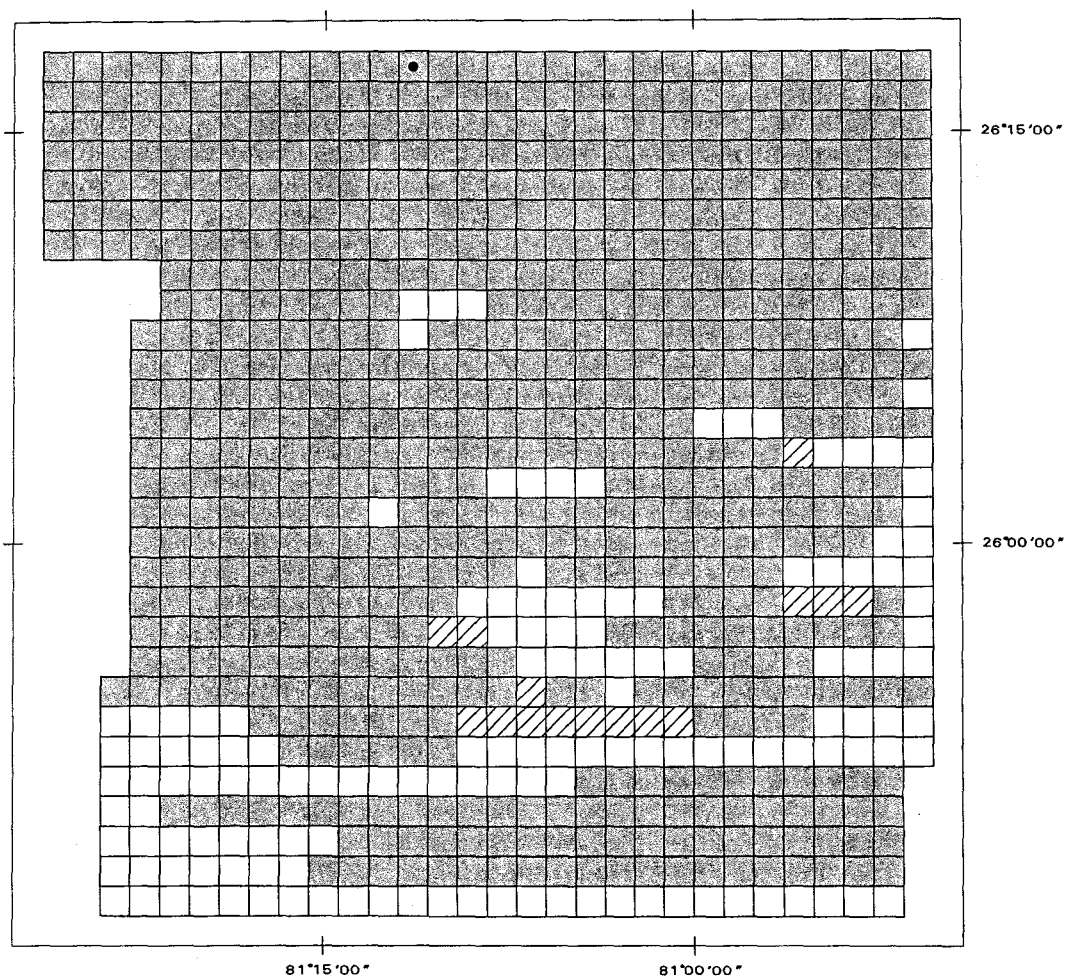
Water Conditions



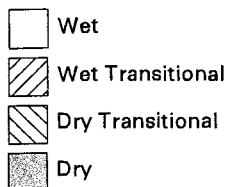
Density Categories Birds Per Square Km



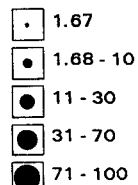
Glossy Ibises Big Cypress June 2000



Water Conditions



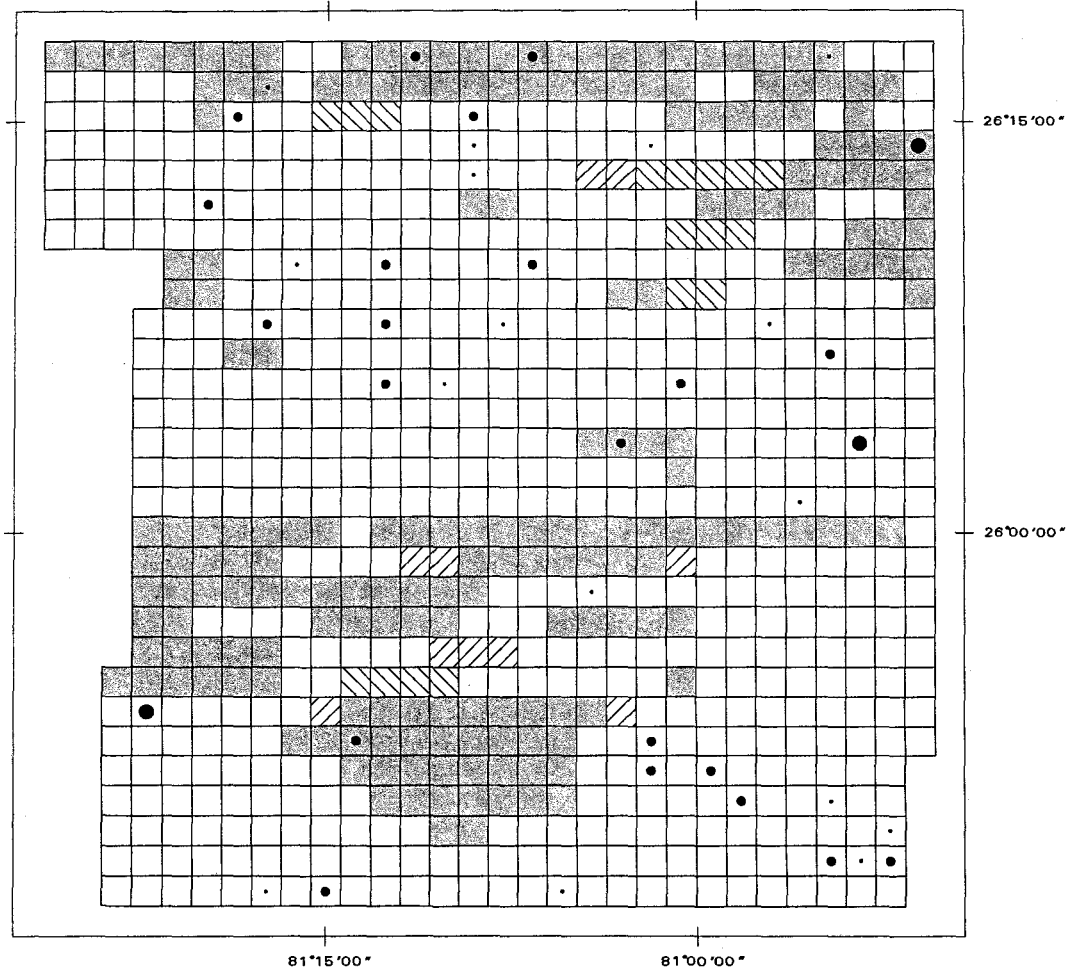
Density Categories Birds Per Square Km



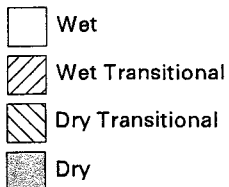
APPENDIX I: Monthly Density Maps of Wood Storks in the Big Cypress National Preserve, January to June 2000.

- I1. Density maps of Wood Storks in the Big Cypress National Preserve, January 2000.
- I2. Density maps of Wood Storks in the Big Cypress National Preserve, February 2000.
- I3. Density maps of Wood Storks in the Big Cypress National Preserve, March 2000.
- I4. Density maps of Wood Storks in the Big Cypress National Preserve, April 2000.
- I5. Density maps of Wood Storks in the Big Cypress National Preserve, May 2000.
- I6. Density maps of Wood Storks in the Big Cypress National Preserve, June 2000.

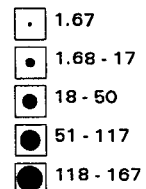
Wood Storks Big Cypress January 2000



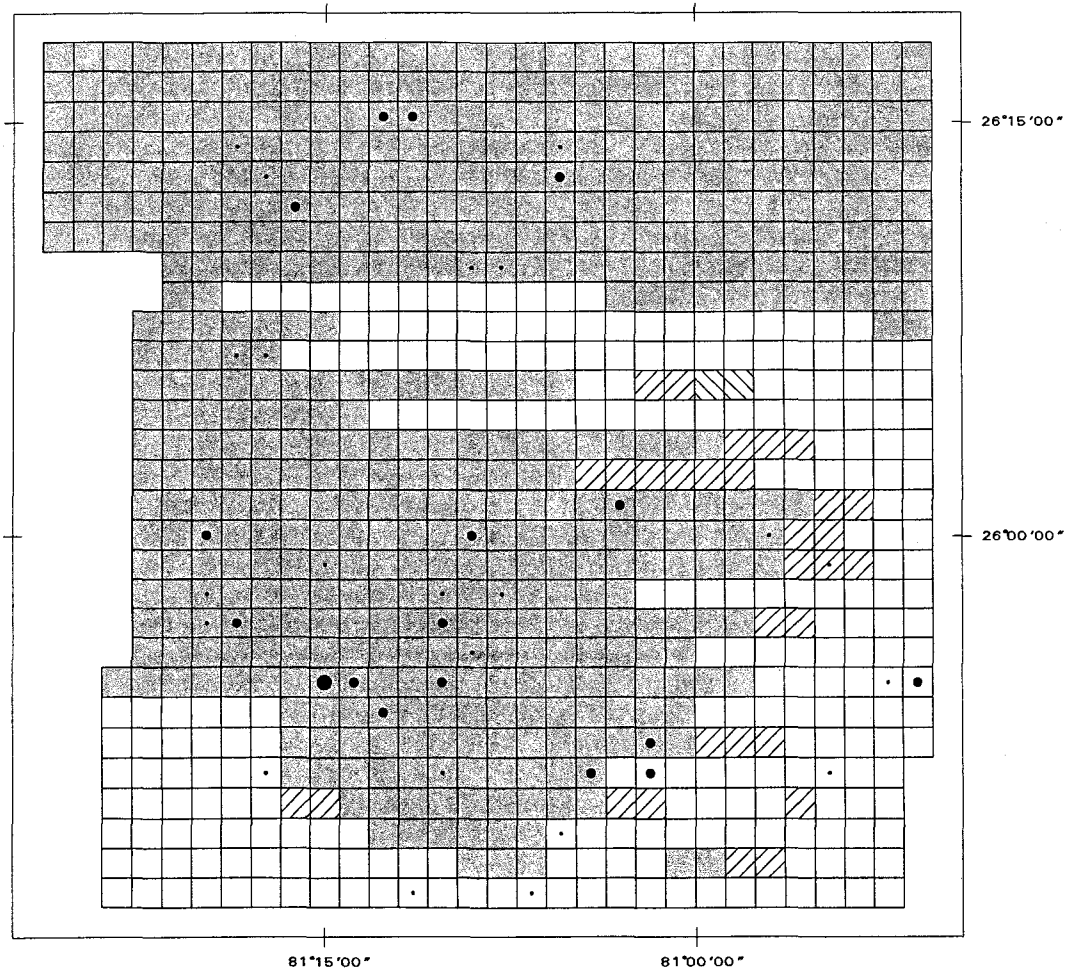
Water Conditions



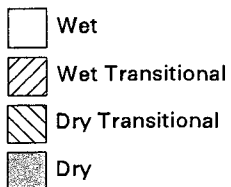
Density Categories Birds Per Square Km



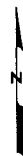
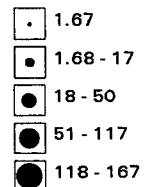
Wood Storks Big Cypress February 2000



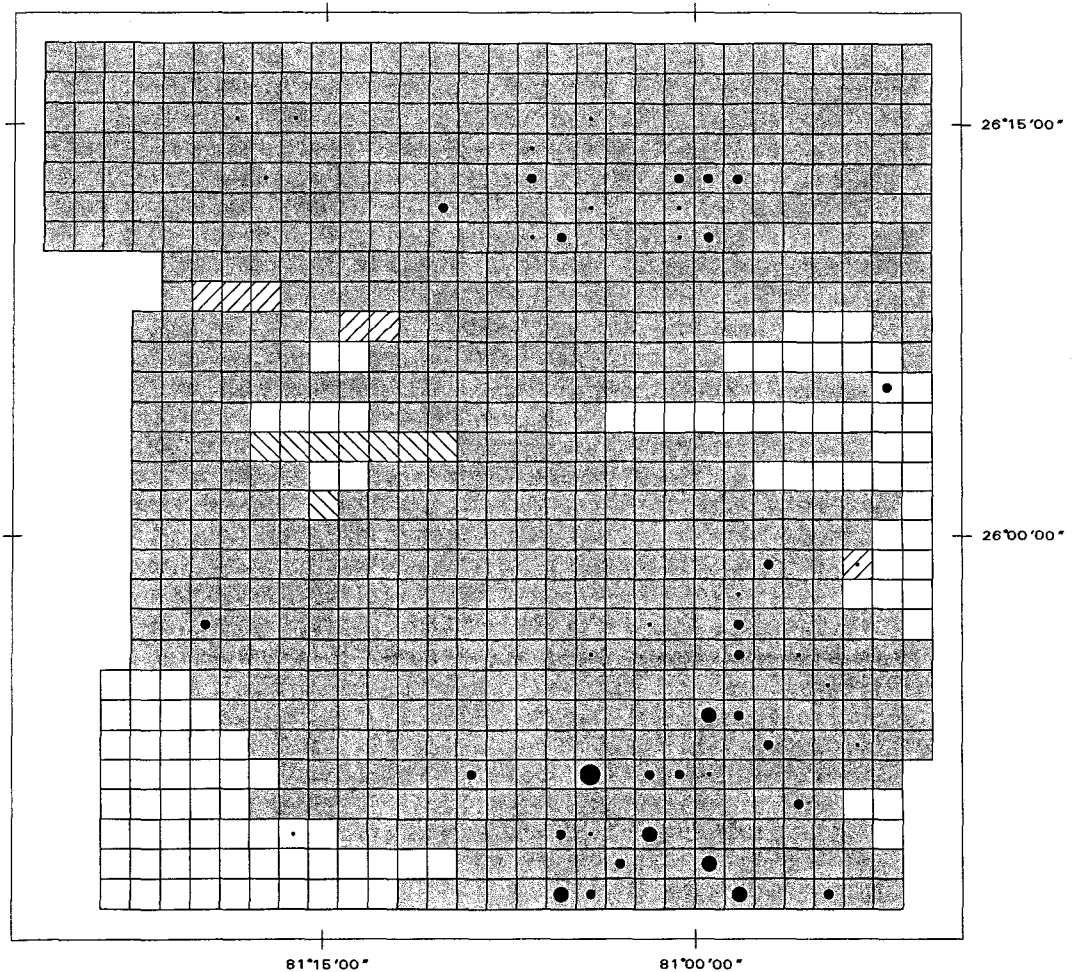
Water Conditions



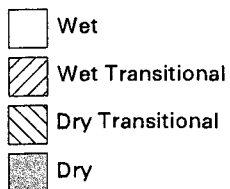
Density Categories Birds Per Square Km



Wood Storks Big Cypress March 2000

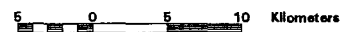
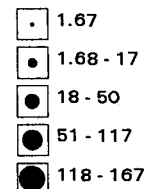


Water Conditions

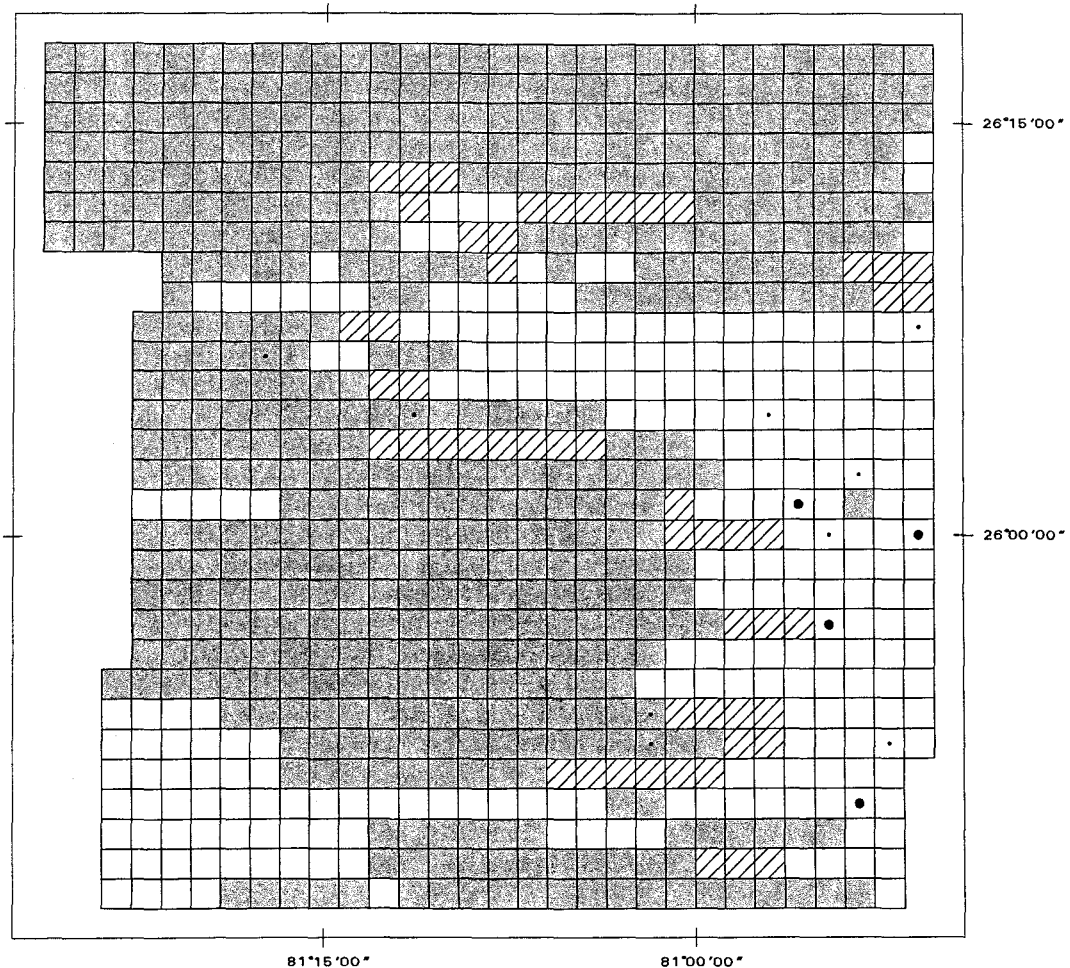


Density Categories

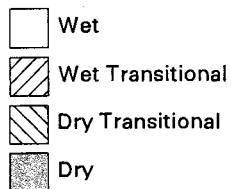
Birds Per Square Km



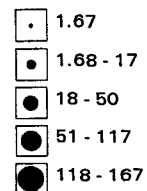
Wood Storks Big Cypress April 2000



Water Conditions

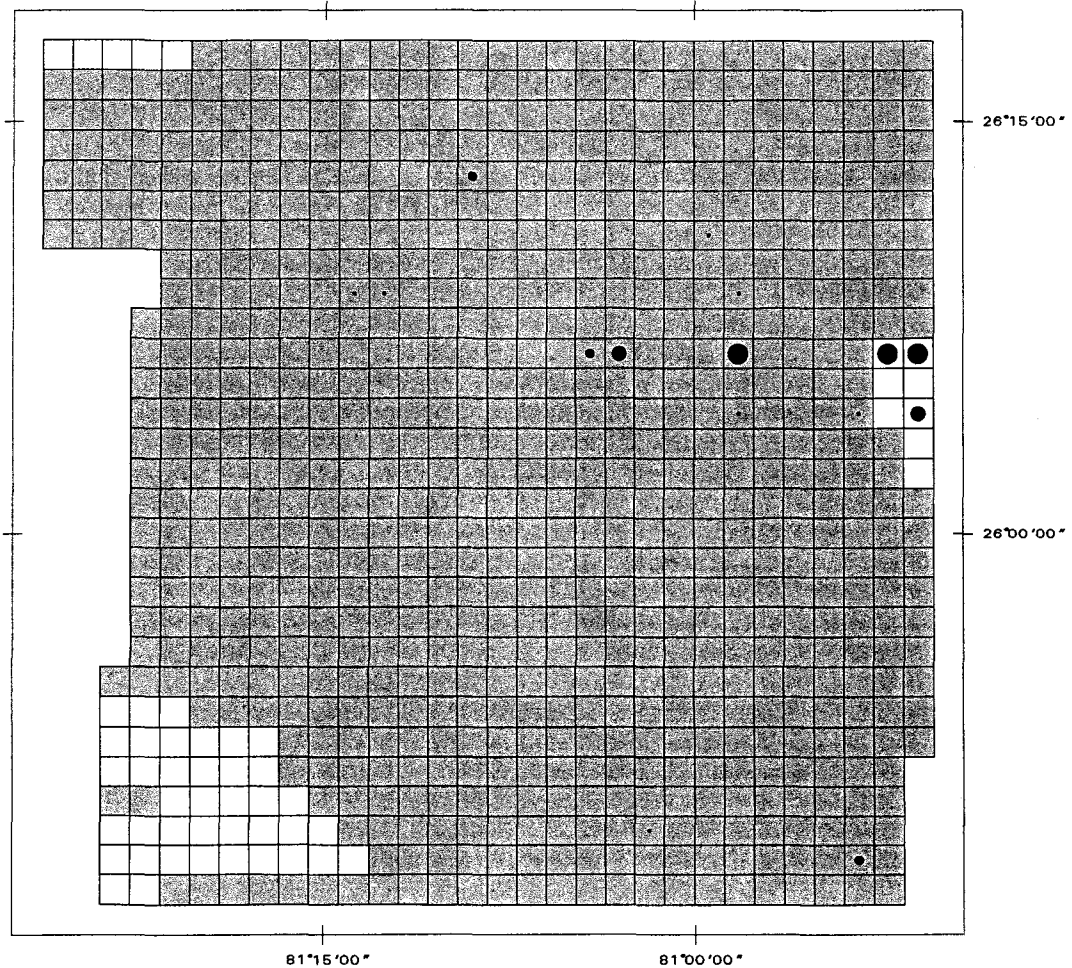


Density Categories Birds Per Square Km

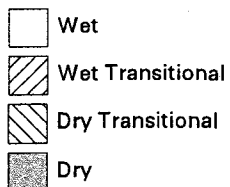


5 0 5 10 Kilometers

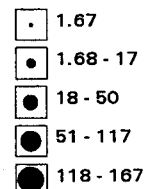
Wood Storks Big Cypress May 2000



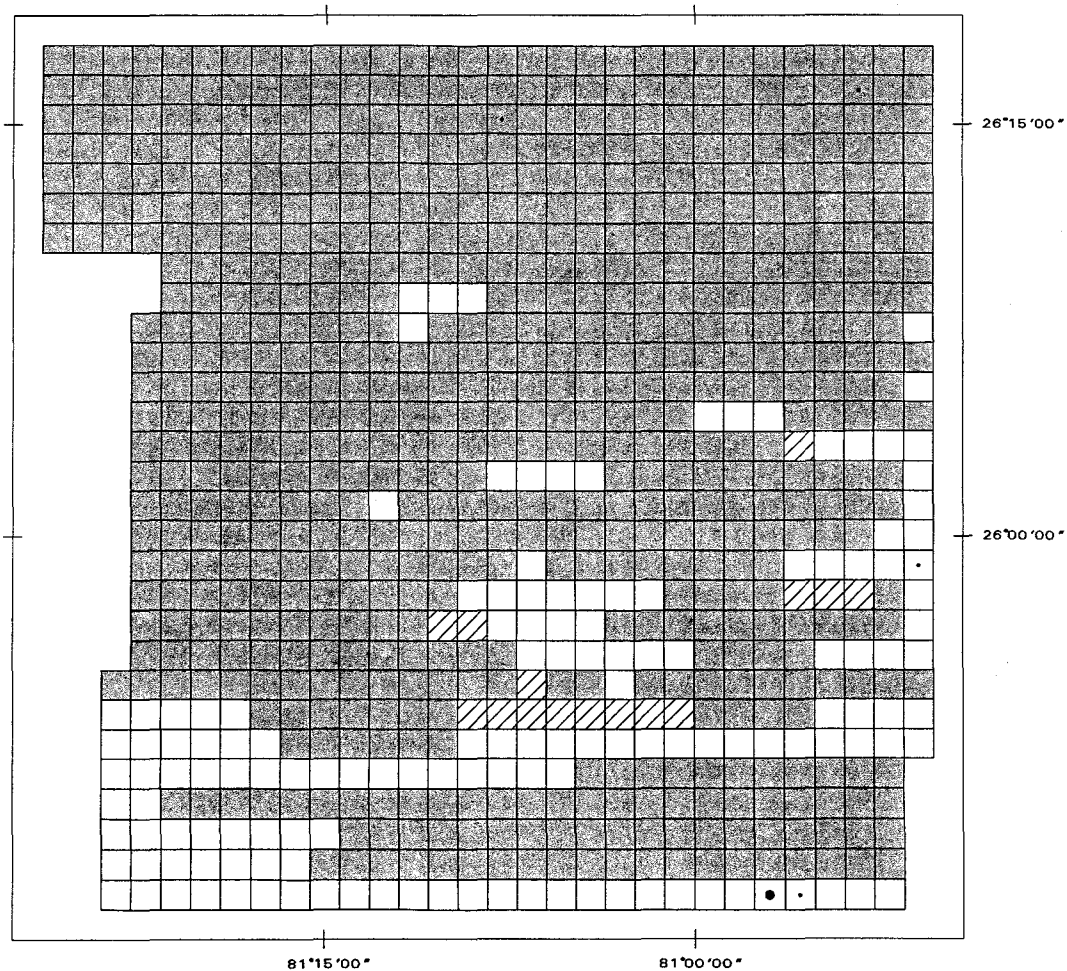
Water Conditions



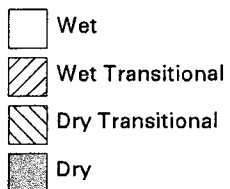
Density Categories Birds Per Square Km



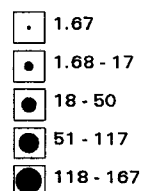
Wood Storks Big Cypress June 2000



Water Conditions



Density Categories Birds Per Square Km



5 0 5 10 Kilometers