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# DREDGED MATERIAL RESEARCH PROGRAM

TECHNICAL REPORT D-78-14

# COLONIAL BIRD USE AND PLANT SUCCESSION ON DREDGED MATERIAL ISLANDS IN FLORIDA

## VOL. I: SEA AND WADING BIRD COLONIES

by

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1. The technical report transmitted herewith represents the results of Work Unit 4F01C regarding vegetation succession and wildlife use of dredged material islands in Florida. This work unit was conducted as part of Task 4F (Island Habitat Development) of the Corps of Engineers' Dredged Material Research Program (DMRP). Task 4F was part of the Habitat Development Project of the DMRP and had as its objective the investigation, evaluation, and testing of methodologies for habitat creation and management on dredged material islands.

2. Island habitat development has been studied by the DMRP throughout the United States through the evaluation of vegetation succession and animal use of existing dredged material islands. The most significant wildlife aspect of these islands is their use by colonial nesting sea and wading birds such as gulls, terns, egrets, herons, ibises, and pelicans. This wildlife resource, although generally inadvertently created, presents a significant opportunity for habitat management and development that is consonant with continued dredged material disposal.

3. In the study reported herein (in two volumes), Work Unit 4F01C, 40 dredged material islands in Florida were selected for detailed analysis from the more than 250 in five specific study areas. These study areas were located in the vicinity of Tampa Bay, the Indian River, Yankeetown, the Pithlachascotee River, and the Caloosahatchee River. Vegetative colonization of dredged material islands proceeded from a bare substrate through a grass-herb stage characterized by species such as smooth cordgrass to a shrub and tree cover represented by Brazilian pepper, Australian pine, sabal palm, and mangroves. Approximately 50 percent of the colonial nesting sea and wading birds in Florida nest on dredged material, and many more species use the islands for feeding and roosting. Species of particular significance, because of their low numbers nationally, are the reddish egret, roseate spoonbill, least tern, black skimmer, and brown pelican (endangered).

4. From a local perspective, this study will be of direct value in managing and developing dredged material island habitats in Florida. A national perspective is presented in a report entitled "Development and Management of Avian Habitat on Dredged Material Islands" (4F03), which synthesizes island habitat research in Florida, the Great Lakes (4F01A), New Jersey (4F01D), North Carolina (4F02), Texas (4F01B), the Pacific Northwest (4F01E), and the Upper Mississippi River (4F01F).

JOHN L. CANNON
Colonel, Corps of Engineers
Commander and Director

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Bird use of dredged material islands in five areas of Florida was studied. The use of these islands by birds, particularly by colonial nesting sea and wading birds, was documented with two visits to each of 40 selected islands in five study areas in 1977. The islands were used as nesting habitat by 26 species of colonial and 8 species of noncolonial birds. The islands were also used extensively for feeding, loafing, and roosting by these and other species. Various species-habitat interactions and the significance of dredged material islands to colonial nesting sea and wading birds are discussed in detail.

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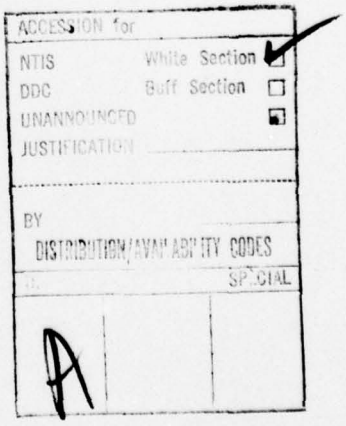

## SUMMARY

A study of colonial nesting sea and wading bird species use of dredged material islands was made along Corps-maintained waterways in Florida using five selected areas. Breeding use, use during migration, and overwintering use for feeding, loafing, and roosting of these islands were considered. Two surveys of birds nesting on each island were made in the five study areas.

An extensive literature search, combined with the results of 1977 bird nesting data, was used to determine the timing of the nesting cycle in Florida by species and geographic region. Florida sea and wading birds have an extended breeding cycle lasting in some species from late December to October. Several species nest throughout the entire period, but most nest during only part of it.

Approximately 50 percent of the 26 species of colonial nesting sea and wading birds in Florida nested on dredged material islands. At least eight noncolonial marine and other species also nested on the islands. All used the islands for feeding, loafing, roosting, and nesting to varying extents, especially during the fall, winter, and early spring. Species nesting on dredged material generally fell into two groups: tree nesters and ground nesters. Tree nesters were the brown pelican, double-crested cormorant, anhinga, 11 species of herons (including egrets), 2 species of ibises, and the roseate spoonbill. Ground nesters were primarily the least tern, laughing gull, and black skimmer.

The species were found nesting in three basic habitat types: (1) clear, sandy-rocky beach, berm and open areas, (2) sparsely vegetated areas of herbaceous plants and grasses, with or without low shrubs, and (3) mature areas with trees and shrubs. There were many herbaceous plants and many varied considerably in growth patterns. They were primarily species which occur in waste areas and old fields. The most important grasses were primarily Paspalum vaginatum and Spartina alterniflora. Tree species were dominated by Schinus terebinthifolius, Casuarina equisetifolia, Lugunculina racemosa, and Avicennia nitida. These three

habitat types were found on islands of varying ages with the first two generally only on islands less than 5 to 8 years old, or on the edges of older islands. Older islands providing similar three-shrub habitat may or may not have been used by colonial birds, and factors such as social stimulation and facilitation may have determined why the birds only nested on selected islands.

Extensive species accounts document the bird nesting seasons, nesting associations, and present data on which specific islands were used for nesting.

Bird use of dredged material islands as roosting, loafing, and feeding sites was documented. Such usage on dredged material islands was indicated to be very important to birds in Florida, especially during the fall, winter, and spring.

Aerial surveys were found to be an unreliable method of locating colonies of birds on the ground. Ground searches were found to be absolutely necessary in order to accurately locate all colonies, and these visits to the colonies were necessary in order to differentiate between species of birds and to obtain accurate census data.

The following management recommendations for nesting birds were made: (1) limit or totally restrict human usage of nesting islands, (2) prevent mammalian predators (rats, mice, raccoons, dogs, cats, etc.) access to islands and remove them if they do gain access to colonies, (3) designate active colony sites and roosting-loafing areas as Federal, state, or local sanctuaries and post them accordingly, (4) maintain and modify existing dredged material islands as colony sites to prevent erosion and to attain desired successional stages, and (5) create islands specifically for bird use, both as nesting sites and also roosting-loafing-feeding areas. As birds are forced off natural nesting sites by human intrusion in Florida, protected dredged material islands will become increasingly important to species of colonial nesting birds. All efforts at island creation for nesting colonies will be for naught if human intrusion is not prohibited.

## PREFACE

The work described in this report was performed as part of Contract No. DACW39-76-C-0161, between Seabird Research, Inc., Tampa, Florida, and the U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Mississippi. This contract was administered by the Environmental Laboratory (EL) of WES. The study was undertaken as part of the Dredged Material Research Program, Habitat Development Project, Dr. Hanley K. Smith, Manager. Contract Manager was Ms. Mary C. Landin. Dr. Robert F. Soots, Jr., served as a technical advisor. Technical review was provided by Ms. Landin, Dr. Soots, Dr. R. T. Huffman, Mr. C. V. Klimas, Ms. L. Jean Hunt, and Dr. H. K. Smith, WES. Dr. John Harrison, Chief, EL, provided general supervision of the study.

Dr. Ralph W. Schreiber was the principal investigator and, together with Ms. Elizabeth A. Schreiber, prepared the first draft of Volume I of this report. Ms. Landin prepared the final draft. Mr. Roy R. Lewis, III, and Ms. Carolyn S. Lewis prepared Volume II.

The current address of Seabird Research, Inc., is c/o Dr. Ralph W. Schreiber, 4610 Maytime Lane, Culver City, California 90230.

COL John L. Cannon was Director of WES during this study. Mr. F. R. Brown was Technical Director.

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CONVERSION FACTORS, U.S. CUSTOMARY TO METRIC (SI) AND METRIC (SI) TO U.S. CUSTOMARY UNITS OF MEASUREMENT

Units of measurement used in this report can be converted as follows:

| Multiply | by | To Obtain |
|---|---|---|
| **U.S. Customary to Metric (SI)** | | |
| inches | 2.54 | centimeters |
| feet | 0.3048 | meters |
| miles (U.S. statute) | 1.609344 | kilometers |
| acres | 0.4046856 | hectares |
| **Metric (SI) to U.S. Customary** | | |
| centimeters | 0.3937 | inches |
| meters | 3.2808 | feet |
| kilometers | 0.6214 | miles (U.S. statute) |
| hectares | 2.471 | acres |

# BIRD USE AND PLANT SUCCESSION ON DREDGED MATERIAL ISLANDS IN FLORIDA

Volume I: Sea and Wading Bird Colonies

## PART I: INTRODUCTION

### Background

1. Dredged material islands are important to the maintenance of many species of birds in the United States. These islands often provide nesting and roosting-loafing sites away from human disturbance. Over the past few decades human use of coastlines in Florida has increasingly limited the use of natural areas by colonial sea and wading birds, and dredged material islands offer important nesting sites. Management of these islands should include recognition of that use.

2. In Florida, 26 species of colonial sea and wading birds nest on dredged material islands, and more than 40 other species use these islands extensively for feeding and roosting-loafing sites, especially during the fall, winter, and early spring months. The relationships between "natural" and "dredged" habitat are poorly understood, but the former are rapidly being destroyed and the latter will thus become increasingly important. Continued disposal of dredged material in specific areas may be an essential part of long-term avian management techniques.

### Study Objectives and Literature Review

3. To accomplish the intended goal of determining use by colonial nesting birds of dredged material islands in Florida, several objectives were established. These are in harmony with the objectives established by the U.S. Army Engineer Waterways Experiment Station (WES) for the nationwide concept. These objectives were to:

a. Document past use of Florida dredged material islands and sites by colonial nesting sea and wading birds.

b. Document succession of vegetation on selected representative dredged material islands in Florida in five study areas.

c. Document use of Florida dredged material islands by colonial nesting sea and wading birds in 1977 by two visits to nesting sites.

d. Relate succession of vegetation to use by nesting birds in Florida.

e. Note any loafing and feeding use by birds (year-round, overwintering, or migrating).

4. An extensive survey of the literature was done to determine the historical nesting locations and seasons of colonial sea and wading birds in Florida. These data were used to help analyze the field data collected during this study. The published data, summarized along with the 1977 field data in Appendix A, were garnered from the following journals: Auk, Bird-Banding, Condor, Ibis, Wilson Bulletin, Florida Naturalist, Florida Field Naturalist, Bird Lore, Audubon Field Notes and American Birds, Quarterly Journal of the Florida Academy of Sciences, Research Reports of the National Audubon Society, Bulletin of the Florida State Museum, Ecological Monographs, Natural History, and several other individual publications and unpublished reports.

## PART II: DESCRIPTION OF STUDY

### Description of Study Area

5. The general area encompassed by this study included all waterways in Florida maintained by the Corps of Engineers. Five areas were selected for intensive study of dredged material islands. These are described below.

6. Study Area I was comprised of 69 islands in Tampa Bay, west coast Florida, from St. Joseph Sound, Pinellas County, south to Sarasota Pass, Manatee County. These islands ranged in size from 0.2 to 25 ha and were constructed from 1930 to 1965. They ranged from barely emergent shell-rock-sand piles to mature mangrove forest swamp. Most were within 0.5 km of the mainland but a few were up to 2 km away. The majority of the islands were along the Intracoastal Waterway or the Tampa Port channels. The highest elevation was *ca.* 6 m, but the height of most was less than 1 m. Several of these islands have been described in detail by Coastal Zone Resources Corporation (1977) and references therein.

7. Study Area II was comprised of 163 islands along the Intracoastal Waterway in the Indian River on the central east cost of Florida, from Oak Hill, Volusia County, to Wabasso, Indian River County. These islands were constructed between 1937 and 1974 and ranged in size from 0.04 to 13.2 ha (Table 1). They ranged from barely emergent rock-shell mounds to islands with 15-m-high Australian pine (Casuarina equisetifolia), and 5- to 8-m-high Brazilian pepper (Schinus terebinthifolius) and buttonwood (Conocarpus erecta). The highest elevation was ca. 3 m high, but most islands were less than 1 m in height. All were within 2 km of the mainland; most were much closer.

8. Study Area III consisted of 14 dredged material islands in Citrus County ranging in size from 0.2 to 24.3 ha (Table 1). The study islands extended westward from the mouth of the Cross Florida Barge Canal. One dredged material deposit was connected to the mainland on the north side of this channel. These islands were constructed between 1964 and 1967 and sizes decreased away from the mainland with Island III-1[c] barely emergent.

9. Study Area IV consisted of one island of 0.8 ha and two very small emergent rock pikes located several hundred meters west of the island along the south side of the dredged channels from the mouth of the Pithlachascotee River, just north of New Port Richey in Hernando County. This island was 1 km from the mainland and less than 0.6 m above the high tide. Several young Australian pines were growing on the island which was primarily covered with low grasses. There were large areas of bare sand.

10. Study Area V consisted of eight dredged material islands along the Intracoastal Waterway in the Caloosahatchee River at Fort Myers, Lee County. These islands ranged in size from 0.2 to 1.6 ha (Table 1). All were less than 1 km from the mainland. Island V-1 and V-8 were 40 years old and Islands V-2 through V-7 were 3 years old.

11. These study areas are illustrated in Figures 1-20, and the areas and ages of each of the islands are presented in Table 1.

## Selection of Islands for Study and Census Techniques

12. All dredged material islands within the study areas were examined for the presence of nesting and roosting-loafing birds. In late April and early May 1977 as many as possible of all birds present on all the islands were counted from a 17-ft* Boster Whaler. All islands, except those with active heron colonies, were visited on foot and searched for nesting activity. Individuals and nests were counted and notes made on the nesting substrate. Islands with heron colonies present were visited only if landing could be accomplished without disturbing the colony. In late May and early June all islands were revisited.

13. Bird activity was viewed through 7x and 8x binoculars. Two individuals made independent counts and if their counts differed the birds were recounted to derive a mutually satisfactory population estimate.

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* A table of factors for converting U. S. customary units of measurement to metric (SI) can be found on page 5.

14. Islands with bird colonies (25 of the 40 selected) were used for the bird population study. These included the following dredged material islands:

Study Area I: Islands 4, 14, 15, 25, 31, 49b, 58, 59, 61, 66.

Study Area II: Islands 62, 63, 65, 66, 113, 125, 152, 153, 154.

Study Area III: Islands 10, 11, 12, 13, 14.

Study Area IV: None.

Study Area V: Island 1 (attempted nesting).

Other islands within the study area supported single nests of species such as green heron (Butorides virescens), willet (Catoptrophorus semipalmatus), snowy plover (Charadrius alexandrinus) and Wilson's plover (Charadrius wilsonia), and American oystercatcher (Haematopus palliatus). These islands are noted in the species accounts in Appendix A.

## Performance of Field Work

15. The bird studies in this report were carried out by Ralph W. Schreiber and Elizabeth A. Schreiber. Specific data for Study Area I, Islands 58 and 59, were supplied by Frank M. Dunstan, warden-biologist for the National Audubon Society, who controls access to those islands. The field notes for the bird portion of the study are on file in the Ornithology Section, Natural History Museum of Los Angeles County, 900 Exposition Boulevard, Los Angeles, California 90007.

16. Data on vegetation were collected by Roy R. Lewis and Carolyn S. Lewis. Two of the original 40 islands selected for study of vegetation were not sampled (II-152 and II-153) because bird colonies could not be disturbed. Voucher specimens for each plant species were collected and sent to WES.

17. Volume I presents bird data and summarizes vegetation data of direct relevance to the bird populations on dredged material islands. The data from the study of vegetation are presented in Volume II, authored by Lewis and Lewis.

## PART III: RESULTS AND DISCUSSION

18. The data presented herein were derived from published and unpublished sources, field data gathered during two visits to colonies in 1977, and from visits made less formally during the past 8 years. A brief summary of the natural history of each species found nesting on dredged material islands during this study follows. More detailed accounts of each species are presented in Appendix A. Appendix B is a detailed account of the use of dredged material islands as roosting-loafing sites and the importance of this use. A complete listing of the species of birds found nesting on dredged material islands in Florida during this study appears in Table 2, and Table 3 shows the seasonality of nesting. The nesting season as defined here included courtship, nest building, incubation, and nestling period. Thus, for a given species, i.e., the brown pelican, November-September is given, which means that some nesting activity has been observed in all those months and all colonies were abandoned in October; but it is important to remember that changes in nesting seasons are frequent in Florida, and nesting by many species can occur in any month of the year.

### Species Accounts

#### Brown Pelican (Pelecanus occidentalis)

19. Forty-two brown pelican colonies are known to have recently existed in Florida, and approximately 20 percent of the nesting population occurred on dredged material islands. Nesting occurred predominantly in black mangroves (Avicennia nitida), although some nesting was reported in red mangroves (Rhizophora mangle) and on bare ground. Pelicans may nest at any time of the year in Florida, although they tend to nest in the winter-spring in the southernmost areas and grade into a spring-summer nesting season further north in the state.

Double-crested Cormorants (Phalacrocorax auritus)

20. Double-crested cormorants nested commonly on dredged material islands in Florida, usually high in mature mangrove and in Australian pine. In large colonies nests were also found lower in the vegetation. The timing of the nesting season has varied somewhat but generally has been from early December through late August with the bulk of nesting in April-June.

Anhinga (Anhinga anhinga)

21. The anhinga has nested throughout Florida but was especially abundant in the south and central regions. One or a few pairs have been found in most mature mangrove areas where pelicans, cormorants, and herons were nesting. They nested either high in Australian pine among the cormorants or just under the canopy in mangrove stands. Nesting occurred in the spring and summer in most of Florida although some nests have been found in February.

Herons and Egrets Family Ardeidae

22. Because of their similarities in nesting habitat and seasons these species are discussed as a group. All species of herons and egrets have sometimes nested in small colonies of their own species, but most bred primarily in large mixed species groups. They nested at all heights in mangrove, buttonwood, Brazilian pepper, cypress, willow, and Australian pine. The nesting seasón of herons and egrets is very extended, especially in the southern half of the state. This information is presented in Table 3.

White and Glossy Ibis
(Eudocimus albus and
Plegadis falcinellus)

23. These two species nested together, generally separate or adjacent to other small herons but not mixed with them. Nesting occurred in buttonwood, mangrove, and Brazilian pepper, usually just beneath the canopy. Their nesting season lasted from early March to early October.

Roseate Spoonbill (Ajaia ajaja)

24. Spoonbills nested in black mangrove in Florida and have been found nesting in all months of the year. The peak nesting period was December through September. They are extremely rare and were only found nesting on one island in this study (Study Area I, Island 58).

American Oystercatcher (Haematopus palliatus)

25. This species nested as isolated pairs along the gulf and east coasts of Florida. Nesting occurred from late March through July. Nests were located on dredged material islands in the early stages of succession generally at the bare beach-vegetation line.

Snowy Plover (Charadrius alexandrinus)

26. The snowy plover nested at a few scattered localities along the gulf coast and has become rare in the last several years. Nests were built in open areas with sparse vegetation, such as exists on relatively new dredged areas. Nesting occurred from March through early August.

Wilson's Plover (Charadrius wilsonia)

27. Wilson's plovers nested commonly on all Florida's coasts in open grassy areas. The nesting season extended from February through early August.

Willet (Catoptrophorus semipalmatus)

28. Willets nested in thick, short grass, near mudflats or beaches, and were common nesting birds along all Florida's coasts. The nesting season was from early April through August.

Laughing Gull (Larus atricilla)

29. Laughing gulls were found in Florida throughout the year on all coastal waters, but bred in only a few localities. Nests were located in or around paspalum grasses, (Paspalum spp.), dog fennel (Eupatorium capillifolium), and sand spur (Cenchrus sp.). Laughing gulls do not nest in open sandy areas or on older islands with tall vegetation. Their nesting season extended from late February through early September.

Least Tern (Sterna albifrons)

30. Least tern nesting colonies quickly became established on new sand-rock-coral fills. Once grasses became prominent the terns no longer nested in an area. They nested along all Florida's coasts in scattered colonies from late March through September.

Black Skimmer (Rynchops niger)

31. The black skimmer bred on scattered localities along the coasts of Florida. The nesting cycle in Florida was from May through August. Skimmers generally nested on open sandy beaches but were sometimes found nesting among short grasses.

## Bird Use of Dredged Material Islands as Roosting, Loafing, and Feeding Sites

32. Dredged material islands provided important roosting, loafing, and feeding sites for resident and migratory sea and wading birds. These islands, which apparently replaced disturbed natural habitats, provided a place for resting, preening, and other essential body maintenance activities, and also served as a social gathering place especially important for courtship activities. Numerous examples of this use were encountered in this study and these are documented in Appendix B. For example, over 3,500 individuals representing 23 species were observed loafing on 46 of the 163 islands in Study Area II during April of 1977. Table 4 indicates the use of dredged material islands by loafing brown pelicans in Boca Ciega Bay in 1975.

33. Few natural islands were available for undisturbed use by birds in Florida. A management scheme that protected dredged material islands from human disturbance would protect these important feeding and roosting sites for the birds.

## Noncolonial, Nonmarine Species

34. In addition to the species of birds discussed in this report as the major nesting species on dredged material islands, approximately

25 species of passerines and other birds might be expected to nest on dredged material islands in small numbers. It might be argued that several could be classed as colonial, i.e., the burrowing owl (Speotyto cunicularia), scrub jay (Aphelocoma coerulescens), and red-winged blackbird (Agelaius phoeniccus). However, the usual situation was for individual pairs to nest in widely scattered locations in proper habitat. Table 5 lists the most likely species (and several noncolonial species) known to nest on dredged material islands. Others may also occur, but no documentation could be found to indicate nesting at the present time; i.e., the smooth-billed ani (Crotophaga ani) which nested in disturbed habitat and were increasing in numbers in Florida.

35. Essentially all these species nested in the late winter or early spring-summer in Florida. Any management techniques employed for the colonial marine species would also benefit these species.

## Vegetation Succession on Dredged Material Islands

36. Succession of vegetation is the subject of Volume II of this report, but is briefly described here to provide background information for the subsequent discussion on the relation of vegetation to bird usage. Plant succession begins with the intertidal and supratidal deposition of dredged material. Typically, dredged material islands, after sorting by wind and water, have a sandy substrate. Marsh species may colonize the intertidal area within a couple years, and in 3 to 5 years herbs and grasses will have a good start over all the island (Figure 21, Table 6). Woody vegetation in the form of low shrubs will be well established by 5 to 10 years. In subsequent years, trees become established and may eventually replace all the shrubs as in some islands with mature Australian pine, cabbage palm (Sabal palmetto) or Brazilian pepper as the dominant species. Mangroves are less frequently a dominant community.

37. Vegetative succession varies on dredged material islands throughout Florida depending on climate, substrate, wave action, nearness of plant sources, human use, and other factors. It is extremely difficult to generalize on this topic. Even the climax communities will

vary so that it is almost impossible to predict, without visits to an island, what the vegetational succession will be. Upland succession for a number of sites in the United States, including Florida, has been discussed by the Coastal Zone Resources Corporation (1977) which provides a good further reference on the subject.

## Bird Species Nesting Associations by Habitat Characteristics

38. The successional stages listed in Figure 21 can be delimited for ease of discussion into three basic habitat types existing on dredged material islands in Florida: (1) clear, sandy or rocky beach and berms and open areas, (2) sparsely vegetated areas of grasses and low shrubs, and (3) islands with mangrove, Australian pine, Brazilian pepper, and accompanying undergrowth. In Table 7 the usual habitat type in which each bird species normally nests and the species associations within those habitats are listed.

39. The data presented in Table 7 are generalizations presented to provide a basic framework for management of habitat for the species of birds. Within each habitat individual bird species exhibit specific microhabitat preferences which vary from place to place. These are discussed in Appendix A.

40. Table 8 is a list of the bird species found nesting on each island in the five study areas. The number of adults present on each island as listed in the table is roughly twice the number of nests present but varies with species. A generalized statement of the habitat type in which each species nested on each island is given.

41. In Tables 9 and 10 bird species nesting associations in Florida are presented, distinguishing (1) those species which nest closely intermingled, (2) those which nest on the same island but not closely intermingled, and (3) those which may nest in either situation.

42. Some bird species are highly variable in their nesting requirements, especially between geographic regions. As one example, the majority of brown pelicans nest in black mangrove in Florida. However, they also nest in juniper on Cedar Key, Levy County, and on the ground

on Pelican Island, Indian River County. So far, it has been impossible to predict which islands will be used as nesting colonies for any particular species.

43. Several factors other than vegetational succession are important to usage of an area as a nesting colony. These are site tenacity of the bird species, nearness to a food supply, and lack of human disturbance. Several flourishing bird colonies in Florida have been deserted after being disturbed by humans (Schreiber and Schreiber, unpublished data). The large colony on I-58 and I-59 has been extremely successful due to the protection afforded by a National Audubon Society warden.

## PART IV: CONCLUSIONS AND RECOMMENDATIONS

### Comments on Aerial Surveys

44. Aerial surveys were conducted to help determine the location of nesting colonies in the five general survey areas. It was discovered during these aerial surveys that it was impossible to see all nesting activity. Islands with least tern colonies or roosts were completely undiscernible from the air. Laughing gull nesting colonies could not be distinguished from roosting areas. In heronries, only those birds nesting in the top of the canopy were visible, and then only if they were white or light-colored birds such as great or snowy egrets. Species such as cormorants and great blue herons could not be seen. The white herons and egrets could not be differentiated from the air, and the species composition of the colonies may be the single most important datum relevant to bird population stability.

45. These findings agree with the extensive work done by others in Florida (Nesbitt, 1977, personal communication; Kale, 1977, personal communication): air searches can be used to find some colonies of the larger tree nesting species, but to obtain useful, accurate census data, ground visits to the colonies must be made.

### Management Recommendations

46. Limit or totally restrict human usage of nesting and roosting areas. In the past 8 years of study of colonial nesting sea birds in Florida, Schreiber and Schreiber (unpublished data) have noted the frequent human disturbance and subsequent abandonment of several sea bird colonies. The restriction of human access to recently abandoned colony sites may permit these colonies to reestablish.

47. Human access to current colonies must be restricted to the nonnesting season, or totally restricted. Erecting fencing around some

islands with colonies and posting all sites with large signs may be the most cost-effective method of protection, but the best method may be to hire a full-time warden, at least during the nesting season.

48. Prevent mammalian predators (rats, mice, raccoons, dogs, cats, etc.) access to the islands and remove them if they gain access. These predators are known to totally destroy a colony in a short period of time.

49. Designate colony sites and prime roosting-loafing areas as sanctuaries. Post these sites with large signs easily visible from a distance. Roosting-loafing sites may be hard to determine since they change often due to human disturbance. If certain suitable sites were protected they probably would become permanent roosting-loafing areas.

50. Under present Federal (and state) regulations it is illegal to harrass or disturb wild birds, thus the legal means to protect these sites already exists. Ideally, wardens should be assigned to protect any designated sites.

51. Maintenance of existing dredged material islands and creation of new ones. Many existing dredged material islands with nesting birds were currently experiencing serious erosion. Examples of this were present on islands I-4, I-59, and I-61, II-125 and II-128, and III-14. The placement of new dredged material deposits on these islands would greatly extend their useful lives.

52. The designation of one end of a National Audubon Society Sanctuary (Island I-59) as a dredged material disposal site during the Tampa Harbor deepening project may be the first step in determining the feasibility of a management program. This project nourished a badly eroding protion of the island and created 94.7 ha of emergent material enclosing a lagoon. This initial bare sand area is expected to provide nesting habitat for least terns and black skimmers.

53. Further such experimental habitat creation should be attempted elsewhere in Florida with Corps of Engineers personnel working closely with knowledgeable ornithologists in the area from the planning stages through monitoring of vegetational succession and bird usage.

54. As birds are forced off natural nesting sites, dredged material islands will be increasingly important to nesting and roosting-loafing birds in an area.

## Comments on Management of Nesting Bird Habitat

55. It is easier to manage for bare sandy or rocky areas for species such as least terns and black skimmers and for grassy-low brush habitats for gulls, terns, and shorebirds, than for species requiring higher canopy. Even for the tree nesters though, it is possible to encourage the correct habitat and preserve it where it already exists. However, it should be pointed out that even though a certain managed habitat qualitatively looks and quantitatively measures precisely as the vegetation in an active colony, it is entirely possible that birds will not use the "created habitat." This is why islands on which birds are presently nesting should be maintained and managed for the desired bird species rather than attempting to create new habitat and trying to entice birds to use it. This may not be true for labile species such as terns and gulls, which change nesting areas rather easily. Managing habitat for gull nesting is probably inadvisable because of the potential aircraft hazard (Gauthreau 1974). Efforts to manage for least terns and black skimmers would be worthwhile and fairly straightforward to accomplish. Bare sand and bare rocky areas and lack of visual isolation are needed for nesting by these species. The management of islands presently being used by these species is advisable rather than the creation of new habitat and expecting the birds to move to it. The management of islands used in the recent past would also be worthwhile.

56. It is more difficult to manage for pelicans, cormorants, herons, and ibises since so little is known about the maintenance of mature mangroves (black, red, and white (Laguncularia racemosa), Brazilian pepper, groundsels (Baccharis spp.), and marsh elder (Iva spp.) communities. Probably selectively cutting such species as the palms and Australian pine, which can take over a whole island and are not used for nesting by many species,

would contribute to maturing and maintenance of the more desirable forest. Merely allowing succession to proceed on the older islands will result in habitat partially satisfactory for these species.

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Table 1

Area and Age of Dredged Material Islands in Florida, 1977

Study Area I

| Island Number | Area (ha) | Age (yrs) | Island Number | Area (ha) | Age (yrs) | Island Number | Area (ha) | Age (yrs) |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.2 | 5 | 24 | 0.2 | 15 | 47 | 0.3 | 15 |
| 2 | 0.2 | 5 | 25 | 1.7 | 15 | 48 | 0.4 | 15 |
| 3 | 0.1 | 5 | 26 | 0.1 | 15 | 49a | 0.5 | 15 |
| 4 | 0.3 | 15 | 27 | 0.2 | 15 | 49b | 13.4 | 17 |
| 5 | 0.4 | 15 | 28 | 0.5 | 15 | 50 | 0.8 | 10 |
| 6 | 0.4 | 15 | 29 | 0.2 | 15 | 51 | 0.6 | 10 |
| 7 | 0.5 | 15 | 30 | 0.8 | 15 | 52 | 1.8 | 20 |
| 8 | 0.7 | 15 | 31 | 0.1 | 15 | 53 | 2.1 | 20 |
| 9 | 0.6 | 20 | 32 | 0.9 | 15 | 54 | 4.9 | 20 |
| 10 | 0.8 | 20 | 33 | 0.3 | 15 | 55 | 0.7 | 20 |
| 11 | 2.1 | 15 | 34 | 0.2 | 15 | 56 | 1.3 | 20 |
| 12 | 1.3 | 15 | 35 | 0.6 | 15 | 57 | 1.9 | 20 |
| 13 | 1.3 | 15 | 36 | 1.2 | 15 | 58 | 4.7 | 46 |
| 14 | 1.3 | 30 | 37 | 3.9 | 15 | 59 | 10.1 | 16 |
| 15 | 1.3 | 30 | 38 | 1.5 | 15 | 60 | 6.8 | 20 |
| 16 | 0.5 | 15 | 39 | 1.2 | 15 | 61 | 2.3 | 12 |
| 17 | 0.3 | 15 | 40 | 1.5 | 15 | 62 | 0.9 | 12 |
| 18 | 0.4 | 15 | 41 | 0.4 | 15 | 63 | 4.7 | 12 |
| 19 | 0.4 | 15 | 42 | 1.4 | 15 | 64 | 3.6 | 10 |
| 20 | 0.5 | 15 | 43 | 0.3 | 15 | 65 | 0.2 | 3 |
| 21 | 1.6 | 15 | 44 | 0.2 | 15 | 66 | 24.7 | 8 |
| 22 | 1.7 | 15 | 45 | 0.3 | 15 | 67 | 1.0 | 15 |
| 23 | 0.6 | 15 | 46 | 0.04 | 15 | 68 | 1.4 | 15 |

Study Area II

| Island Number | Area (ha) | Age (yrs) | Island Number | Area (ha) | Age (yrs) | Island Number | Area (ha) | Age (yrs) |
|---|---|---|---|---|---|---|---|---|
| 1 | 6.8 | 25+ | 11 | 0.1 | 25+ | 21 | 0.9 | 25+ |
| 2 | 5.2 | 25+ | 12 | 1.2 | 25+ | 22 | 0.9 | 25+ |
| 3 | 0.9 | 25+ | 13 | 1.2 | 25+ | 23 | 0.9 | 25+ |
| 4 | 1.3 | 25+ | 14 | 0.08 | 25+ | 24 | 1.0 | 25+ |
| 5 | 0.2 | 25+ | 15 | 0.4 | 25+ | 25 | 0.7 | 25+ |
| 6 | 0.2 | 25+ | 16 | 0.6 | 25+ | 26 | 2.2 | 25+ |
| 7 | 0.04 | 25+ | 17 | 1.1 | 25+ | 27 | 0.04 | 25+ |
| 8 | 1.8 | 25+ | 18 | 1.5 | 25+ | 28 | 1.3 | 25+ |
| 9 | 0.08 | 25+ | 19 | 0.9 | 25+ | 29 | 1.3 | 25+ |
| 10 | 1.3 | 25+ | 20 | 0.08 | 25+ | 30 | 1.3 | 25+ |

(Continued)

Table 1 (Continued)

Study Area II (cont)

| Island Number | Area (ha) | Age (yrs) | Island Number | Area (ha) | Age (yrs) | Island Number | Area (ha) | Age (yrs) |
|---|---|---|---|---|---|---|---|---|
| 31 | 1.0 | 25+ | 73 | 0.2 | 15 | 115 | 0.2 | 20 |
| 32 | 0.7 | 25+ | 74 | 0.2 | 15 | 116 | 0.2 | 20 |
| 33 | 0.08 | 25+ | 75 | 1.1 | 15 | 117 | 3.2 | 20 |
| 34 | 1.6 | 25+ | 76 | 2.1 | 15 | 118 | 1.9 | 20 |
| 35 | 0.1 | 25+ | 77 | 0.6 | 25 | 119 | 0.02 | 20 |
| 36 | 0.3 | 25+ | 78 | 0.7 | 25 | 120 | 0.2 | 20 |
| 37 | 0.3 | 25+ | 79 | 0.2 | 25 | 121 | 0.04 | 20 |
| 38 | 0.1 | 25+ | 80 | 0.8 | 10 | 122 | 5.3 | 20 |
| 39 | 1.1 | 25+ | 81 | 0.1 | 10 | 123 | 2.1 | 20 |
| 40 | 1.1 | 25+ | 82 | 0.3 | 25 | 124 | 1.3 | 20 |
| 41 | 4.3 | 25+ | 83 | 0.2 | 25 | 125 | 1.3 | 20 |
| 42 | 0.1 | 25+ | 84 | 0.1 | 25 | 126 | 1.3 | 20 |
| 43 | 7.9 | 25+ | 85 | 0.04 | 25 | 127 | 1.2 | 20 |
| 44 | 7.6 | 25+ | 86 | 0.5 | 25 | 128 | 1.4 | 20 |
| 45 | 4.9 | 25+ | 87 | 1.1 | 40 | 129 | 1.2 | 3 |
| 46 | 1.3 | 25+ | 88 | 2.4 | 40 | 130 | 5.1 | 20 |
| 47 | 0.08 | 25+ | 89 | 4.5 | 14 | 131 | 2.0 | 20 |
| 48 | 0.9 | 25+ | 90 | 1.0 | 14 | 132 | 3.0 | 20 |
| 49 | 1.3 | 25+ | 91 | 1.8 | 14 | 133 | 3.0 | 20 |
| 50 | 0.7 | 25+ | 92 | 0.8 | 14 | 134 | 2.9 | 20 |
| 51 | 0.3 | 25+ | 93 | 0.4 | 14 | 135 | 4.1 | 20 |
| 52 | 4.8 | 25+ | 94 | 0.1 | 14 | 136 | 0.2 | 20 |
| 53 | 0.08 | 25+ | 95 | 0.04 | 14 | 137 | 0.3 | 20 |
| 54 | 1.4 | 25+ | 96 | 0.7 | 14 | 138 | 0.08 | 20 |
| 55 | 0.2 | 25+ | 97 | 0.8 | 14 | 139 | 3.2 | 20 |
| 56 | 4.7 | 25+ | 98 | 1.6 | 14 | 140 | 0.8 | 20 |
| 57 | 0.2 | 25+ | 99 | 0.2 | 20 | 141 | 1.0 | 20 |
| 58 | 4.1 | 25+ | 100 | 0.04 | 20 | 142 | 0.9 | 20 |
| 59 | 0.4 | 25+ | 101 | 1.0 | 20 | 143 | 0.9 | 20 |
| 60 | 1.3 | 25+ | 102 | 2.0 | 20 | 144 | 1.1 | 20 |
| 61 | 0.3 | 15 | 103 | 1.5 | 20 | 145 | 1.2 | 20 |
| 62 | 3.6 | 15 | 104 | 1.5 | 20 | 146 | 2.1 | 20 |
| 63 | 0.8 | 15 | 105 | 1.1 | 20 | 147 | 0.9 | 20 |
| 64 | 0.9 | 15 | 106 | 0.7 | 20 | 148 | 2.1 | 20 |
| 65 | 1.0 | 15 | 107 | 0.7 | 20 | 149 | 0.7 | 20 |
| 66 | 1.2 | 15 | 108 | 1.2 | 20 | 150 | 0.6 | 20 |
| 67 | 0.5 | 15 | 109 | 2.3 | 20 | 151 | 0.5 | 20 |
| 68 | 0.2 | 15 | 110 | 2.4 | 20 | 152 | 0.5 | 20 |
| 69 | 0.4 | 15 | 111 | 2.9 | 20 | 153 | 0.6 | 20 |
| 70 | 0.4 | 15 | 112 | 0.2 | 20 | 154 | 0.08 | 20 |
| 71 | 0.6 | 15 | 113 | 13.2 | 20 | 155 | 2.0 | 20 |
| 72 | 0.2 | 15 | 114 | 0.04 | 20 | 156 | 1.1 | 20 |

(Continued)

Table 1 (Concluded)

Study Area II (cont)

| Island Number | Area (ha) | Age (yrs) | Island Number | Area (ha) | Age (yrs) | Island Number | Area (ha) | Age (yrs) |
|---|---|---|---|---|---|---|---|---|
| 157 | 6.0 | 20 | 159 | 1.2 | 20 | 161 | 5.7 | 20 |
| 158 | 3.6 | 20 | 160 | 5.9 | 20 | 162 | 2.6 | 20 |
| | | | | | | 163 | 2.4 | 20 |

Study Area III

| Island Number | Area (ha) | Age (yrs) | Island Number | Area (ha) | Age (yrs) | Island Number | Area (ha) | Age (yrs) |
|---|---|---|---|---|---|---|---|---|
| 1 | * | 12 | 6 | * | 12 | 11 | * | 12 |
| 2 | * | 12 | 7 | 0.8 | 12 | 12 | 0.1 | 12 |
| 3 | * | 12 | 8 | 2.5 | 12 | 13 | 0.2 | 12 |
| 4 | * | 12 | 9 | * | 12 | 14 | * | 12 |
| 5 | * | 12 | 10 | * | 12 | 15 | * | 12 |

Study Area IV and V

| Island Number | Area (ha) | Age (yrs) | Island Number | Area (ha) | Age (yrs) | Island Number | Area (ha) | Age (yrs) |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 4 | | | | | | |
| 1 | 1.0 | 40 | 4 | 0.1 | 3 | 6 | * | 3 |
| 2 | * | 40 | 5 | * | 3 | 7 | 0.9 | 3 |
| 3 | * | * | | | | | | |

* These data not provided.

Table 2

Species of Birds Found Nesting on Dredged Material Islands in Florida

| Family | Common Name | Scientific Name | | Nesting Season |
|---|---|---|---|---|
| Pelecanidae | brown pelican | Pelecanus occidentalis | | November-September |
| Phalacrocoracidae | double-crested cormorant | Phalacrocorax auritus | | December-September |
| Anhingidae | anhinga | Anhinga anhinga | | February-August |
| Ardeidae | great white heron | Ardea occidentalis | | some year-round, most December-September |
| | great blue heron | Ardea herodias | South: | some year-round, most December-September |
| | | | North: | February-September |
| | green heron | Butorides striatus | | March-August |
| | little blue heron | Florida caerula | | March-August |
| | cattle egret | Bulbulcus ibis | | March-August |
| | reddish egret | Dichromanassa rufescens | | December-September |
| | great egret | Casmerodius albus | | February-September |
| | snowy egret | Egretta thula | | March-August |
| | Louisiana heron | Hydranassa violacea | | March-August |
| | black-crowned night heron | Nycticorax nycticorax | | March-August |
| | yellow-crowned night heron | Nyctanassa violacea | | March-August |
| Ciconiidae | wood stork | Mycteria americana | South: | December-August |
| | | | North: | February-September |

(Continued)

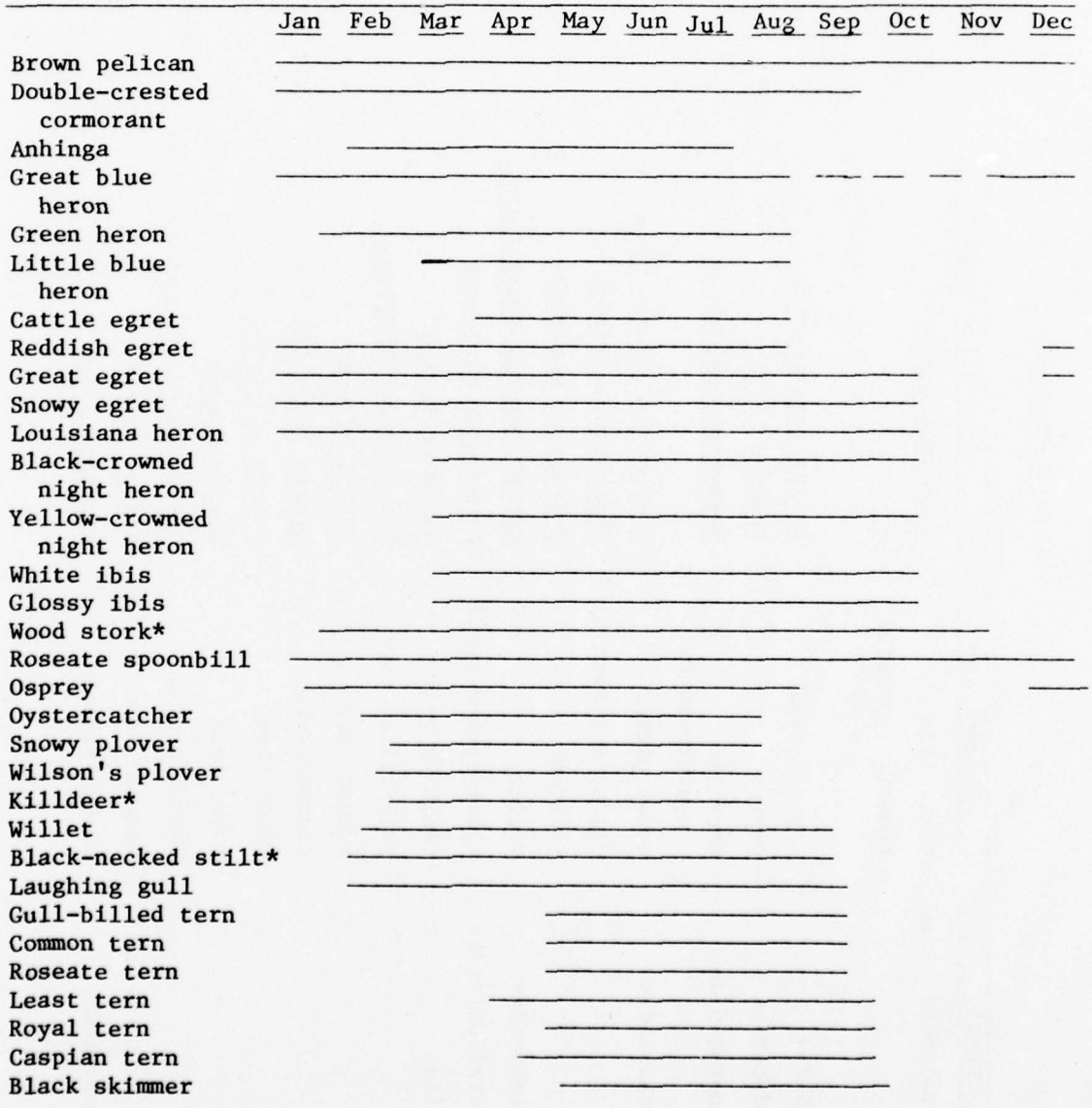
Table 2 (Concluded)

| Family | Common Name | Scientific Name | Nesting Season |
|---|---|---|---|
| Threskiornithidae | white ibis | Eudocimus albus | February-September |
| | roseate spoonbill | Ajaia ajaja | South: October-May |
| | | | North: February-October |
| Rallidae | clapper rail | Rallus longirostris | March-August |
| Pandionidae | osprey | Pandion haliaetus | March-August |
| Haematopodidae | American oystercatcher | Haematopus palliatus | March-August |
| Charadriidae | snowy plover | Charadrius alexandrinus | March-August |
| | Wilson's plover | Charadrius wilsonia | March-August |
| | killdeer | Charadrius vociferus | April-August |
| Scolopacidae | willet | Catoptrophorus semipalmatus | April-August |
| Recurvirostridae | black-necked stilt | Himantopus mexicanus | February-August |
| Laridae | laughing gull | Larus atricilla | March-September |
| | gull-billed tern | Gelochelidon nilotica | April-August |
| | common tern | Sterna hirundo | March-August |
| | roseate tern | Sterna dougallii | April-August |
| | least tern | Sterna albifrons | April-August |
| | royal tern | Sterna maxima | April-September |
| | sandwich tern | Sterna sandvicensis | April-August |
| | Caspian tern | Sterna caspia | April-September |
| Rynchopidae | black skimmer | Rynchops niger | May-September |

Table 3

Periods of Occupancy by Birds Nesting on Dredged Material Islands in Florida

Nesting is defined here as the presence on the "colony" island and involved in activities related to successful reproduction, whether courtship, incubation, feeding nestlings, or merely occupying space. Compiled from literature and personal observations.




* Not yet found on dredged material islands but included here for completeness.

Table 4

Proportion of the Total Brown Pelican Population of Boca Ciega Bay, Pinellas County, Florida, Found Loafing on Dredged Material Islands in 1975*

| Date | Total Population | Percent on Dredged Material |
|---|---|---|
| early January | 220 | 81 |
| late January | 469 | 41 |
| early February | 760 | 12 |
| late February | 700 | 8 |
| early March | 800 | 11 |
| late March | 900 | 0 |
| early April | 805 | 2 |
| late April | 633 | 0 |
| early May | 925 | 5 |
| late May | 872 | 7 |
| early June | 919 | 2 |
| late June | 704 | 6 |
| early July | 635 | 4 |
| late July | 1083 | 18 |
| early August | 1116 | 18 |
| late August | 1200 | 19 |
| early September | 951 | 11 |
| late September | 1100 | 12 |
| early October | 1130 | 14 |
| late October | 595 | 26 |
| early November | 393 | 51 |
| late November | 436 | 18 |
| early December | 402 | 20 |
| late December | 365 | 11 |

* These are bi-weekly summaries based on weekly population counts.

Table 5

Noncolonial, Nonmarine Species of Birds that Have Been Reported Nesting in Florida Habitats Similar to Those Found on Dredged Material Islands

| | |
|---|---|
| Ground dove* | *Columbigallina passerina* |
| Mangrove cuckoo | *Coccyzus minor* |
| Florida screech owl | *Otus asio* |
| Florida burrowing owl | *Speotyto cunicularia* |
| Chuck-wills-widow | *Caprimulgens carolinensis* |
| Common nighthawk* | *Chordeiles minor* |
| Eastern belted kingfisher | *Megaceryle alcyon* |
| Eastern kingbird | *Tyrannus tyrannus* |
| Gray kingbird | *T. dominicensis* |
| Blue jay | *Cyanocitta cristata* |
| Scrub jay | *Aphelocoma coerulescens* |
| Fish crow* | *Corvus ossifragus* |
| Carolina wren | *Thryothorus ludovicianus* |
| Long-billed marsh wren | *Cistothorus palutris* |
| Mockingbird | *Mimus polyglottos* |
| Black-whiskered vireo | *Vireo altiloquus* |
| Prairie warbler* | *Dendroica discolor* |
| Florida yellow-throat | *Geothlypis trichasignota* |
| Eastern meadowlark | *Sturnella magna* |
| Red-winged blackbird* | *Agelaius phoeniceus* |
| Cardinal | *Candinalis cardinalis* |
| Rufous-sided towhee | *Pipilo erythrophthalmus* |
| Seaside sparrow | *Ammospiza maritima* |

* Species found nesting on dredged material islands in this study.

Table 6

Island Ages at Which Major Plant Species Become Established

| Age in Years | Plant Species | |
|---|---|---|
| 3 | beach paspalum | *Paspalum vaginatum* |
| | finger grass | *Chloris glauca* |
| | Natal grass | *Rhyncheletrum repens* |
| | dropseed | *Sporobolus poiretii* |
| | dropseed | *S. domingensis* |
| | sandspur | *Cenchrus* sp. |
| | evening primrose | *Oenothera humifusca* |
| | golden daisy | *Heterotheca subaxillaris* |
| | sea blite | *Suaeda linearis* |
| | smooth cordgrass | *Spartina alterniflora* |
| 5 | | All the above plus: |
| | groundsel tree | *Baccharis halimifolia* |
| | Brazilian pepper | *Schinus terebinthifolius* |
| | marsh elder | *Iva frutescens* |
| | black mangrove | *Avicennia germinans* |
| | white mangrove | *Laguncularia racemosa* |
| 10 | groundsel tree | |
| | Brazilian pepper | |
| | golden daisy | |
| | evening primrose | |
| | cabbage palm | *Sabal palmetto* |
| | Australian pine | *Casuarina equisetifolia* |
| | black mangrove | |
| | white mangrove | |
| | red mangrove | *Rhizophora mangle* |
| | Brazilian pepper | |
| | cabbage palm | |
| | Australian pine | |
| 20 | black mangrove | |
| | white mangrove | |
| | red mangrove | |
| | buttonwood | *Conocarpus erecta* |
| 40+ | Australian pine | |
| | cabbage palm | |
| | Brazilian pepper | |
| | black mangrove | |
| | white mangrove | |
| | red mangrove | |

Table 7

Habitat Type in Which Bird Species Normally Nest and Bird Species Associations Within Those Habitats

---

Habitat: clear, sandy-rocky beach, berm, open areas.

Bird Associations:

A. least tern
B. black skimmer
C. snowy plover
D. wilson's plover

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

Habitat: sparsely vegetated areas of grass, with or without low shrubs.

Bird Associations:

A. American oystercatcher
B. laughing gull
C. royal tern
D. gull-billed tern
E. common tern
F. sandwich tern
G. Caspian tern
H. willet
I. black-necked stilt
J. oystercatcher, laughing gull, willet
K. laughing gull, royal tern
L. Any combination of B through G above.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

Habitat: "mature" island with trees and shrubs.

Bird Associations:

A. Canopy layer of trees:
   1. Brown pelican, double-crested cormorant, anhinga, great blue heron, great egret.
   2. Wood stork - rarely found with species in (1) above. Usually nests in large colonies with no other species. Not yet found on dredged material islands.
B. Below the canopy: green heron, little blue heron, reddish egret, Louisiana heron, black-crowned night heron, yellow-crowned night heron, white ibis, glossy ibis, roseate spoonbill.
C. Low shrub: clapper rail.

Table 8

Dredged Material Islands Used for Nesting by Colonial Birds, Numbers of Adults,* and the Habitat Type in Which Nests were Found in April and May 1977

| Island Number | Species | Number of Adults | Habitat Type |
|---|---|---|---|
| I-4 | least tern | 350 | rock-shell beach |
| I-14 | double-crested cormorant | 27 | mangrove/Casuarina |
| | great blue heron | 7 | Casuarina |
| | white ibis | 35 | mangrove/Casuarina |
| I-15 | double-crested cormorant | 9 | mangrove/Casuarina |
| | great blue heron | 3 | Casuarina |
| | little blue heron | 4 | mangrove/Schinus |
| | great egret | 30 | mangrove/Schinus |
| | snowy egret | 12 | mangrove/Schinus |
| | Louisiana heron | 4 | mangrove/Schinus |
| | black-crowned night heron | 10 | mangrove/Schinus |
| I-25 | black skimmer | 250 | sand beach |
| I-31 | least tern | 38 | sand, grass |
| | ground dove** | 4 | grass |
| I-43 | least tern | 38 | sand-shell beach |
| I-49b | laughing gull | 50,000 | sand, grass, under shrubs |
| | American oystercatcher** | 6 | grass |
| | willett** | 4 | grass |
| I-51 | green heron | 1 | low shrub |
| | American oystercatcher** | 2 | grass |
| | willet** | 4 | grass |
| | red-winged blackbird** | 2 | low shrub |
| I-53 | willet** | 6 | grass |
| | night hawk** | 4 | grass |
| I-58, | brown pelican | 1,000 | mangrove |
| 59 | double-crested cormorant | 400 | mangrove |
| | great blue heron | 200 | mangrove/shrub |
| | little blue heron | 500 | mangrove/shrub |
| | cattle egret | 300 | mangrove/shrub |
| | reddish egret | 25 | mangrove/shrub |
| | great egret | 300 | mangrove/shrub |
| | snowy egret | 600 | mangrove/shrub |
| | Louisiana heron | 600 | mangrove/shrub |
| | black-crowned night heron | 600 | mangrove/shrub |
| | yellow-crowned night heron | 650 | mangrove/shrub |
| | white ibis | 30,000 | Schinus |
| | glossy ibis | 300 | Schinus |
| | roseate spoonbill | 25 | mangrove |
| | laughing gull | 34 | grass |

(Continued)

Table 8 (Continued)

| Island Number | Species | Number of Adults | Habitat Type |
|---|---|---|---|
| I-60 | willet** | 6 | grass |
| I-61 | laughing gull | 1100 | grass, under mangrove |
| I-65 | Wilson's plover** | 2 | grass |
| I-66 | laughing gull | 7775 | grass |
| | black skimmer | 230 | sand beach |
| II-62 | little blue heron | 3 | shrub |
| | cattle egret | 25 | shrub |
| | snowy egret | 400 | shrub |
| | Louisiana heron | 400 | shrub |
| | white ibis | 200 | shrub |
| | glossy ibis | 5 | shrub |
| II-63 | great blue heron | 1 | Casuarina |
| | cattle egret | 22 | shrub |
| | great egret | 4 | top of shrub |
| | snowy egret | 200 | shrub |
| | Louisiana heron | 21 | shrub |
| | white ibis | 200 | shrub |
| | glossy ibis | 24 | shrub |
| | osprey** | 2 | Casuarina |
| II-65 | green heron | 1 | low in Casuarina |
| | cattle egret | 160 | shrub |
| | snowy egret | 20 | shrub |
| | Louisiana heron | 20 | shrub |
| | white ibis | 1 | shrub |
| | glossy ibis | 2 | shrub |
| | osprey** | 2 | Casuarina |
| II-66 | double-crested cormorant | 19 | Casuarina |
| | little blue heron | 8 | shrub |
| | cattle egret | 1100 | shrub |
| | great egret | 9 | top of shrub |
| | snowy egret | 50 | shrub |
| | Louisiana heron | 14 | shrub |
| II-72 | fish crow** | 2 | Casuarina |
| II-98 | fish crow** | 2 | Casuarina |
| II-109, II-110 | least tern | 47 | sand-shell beach |
| II-113 | double-crested cormorant | 59 | mangrove/Casuarina |
| | anhinga | 7 | mangrove/Casuarina |
| | great blue heron | 3 | Casuarina |
| | little blue heron | 18 | shrub |
| | cattle egret | 1100 | shrub |
| | snowy egret | 5 | shrub |
| | Louisiana heron | 16 | shrub |

(Continued)

Table 8 (Concluded)

| Island Number | Species | Number of Adults | Habitat Type |
|---|---|---|---|
| II-113 (cont) | white ibis | 54 | shrub |
| II-119 | American oystercatcher | 2 | sand-shell beach |
| | least tern | 22 | sand-shell beach |
| II-125 | green heron | 2 | mangrove |
| | fish crow** | 2 | Casuarina |
| II-152 | double-crested cormorant | 13 | Casuarina |
| | anhinga | 8 | Casuarina |
| | great blue heron | 4 | Casuarina |
| | little blue heron | 3 | mangrove |
| | cattle egret | 133 | mangrove |
| | snowy egret | 1 | shrub |
| | Louisiana heron | 12 | shrub |
| | white ibis | 7 | shrub |
| II-153 | double-crested cormorant | 47 | Casuarina/mangrove |
| | anhinga | 17 | Casuarina |
| | little blue heron | 12 | shrub |
| | cattle egret | 130 | shrub |
| | Louisiana heron | 12 | shrub |
| | white ibis | 5 | shrub |
| II-154 | least tern | 20 | sand-shell beach |
| III-9 | American oystercatcher** | 8 | low grasses |
| III-10 | American oystercatcher** | 18 | low grasses |
| III-11 | laughing gull | 42 | grass, under shrub |
| III-12 | laughing gull | 65 | grass, under shrub |
| | royal tern | 105 | rock-sand bare ground |
| III-13 | laughing gull | 130 | grass, under shrub |
| | royal tern | 76 | rock-sand bare ground |
| III-14 | laughing gull | 250 | grass, under shrub |
| IV-1 | American oystercatcher** | 2 | low grasses |

* The total number of adults is roughly equal to twice the number of nests.

** These are noncolonial species.

Table 9

Usual Bird Nesting Associations on Dredged Material Islands in Florida: Tree Nesters

| | |
|---|---|
| brown pelican | |
| + | double-crested cormorant |
| + + | anhinga |
| - * + | great blue heron |
| - - - - | green heron |
| - - + - - | little blue heron |
| - - + - - * | cattle egret |
| - - + - - * * | reddish egret |
| - - + + - - - + | great egret |
| - - + - - * * * * | snowy egret |
| - - + - - * * * * * | Louisiana heron |
| - - + - - + + + - + + | black-crowned night heron |
| - - + - - + + + - - - - | yellow-crowned night heron |
| - - + - - + + + - - - - - | white ibis |
| - - + - - + + + - - - - - * | glossy ibis |
| - - + - - + + + - + + + + + | roseate spoonbill |

* Intermingle, close association.

\- Nest on same island but not usually intermingled.

\+ Either of the above (* or -).

Table 10

Usual Bird Nesting Associations on Dredged Material Islands in Florida: Ground Nesters

| | |
|---|---|
| American oystercatcher | |
| - | snowy plover |
| - - | Wilson's plover |
| - - - | willet |
| - - - - | laughing gull |
| - - - - - | least tern |
| - - - - + - | royal tern |
| - - - - + - + | Caspian tern |
| - - - - - - - - - | black skimmer |

* Intermingle, close association.

\- Nest on same island but not usually intermingled.

\+ Either of the above (* or -).

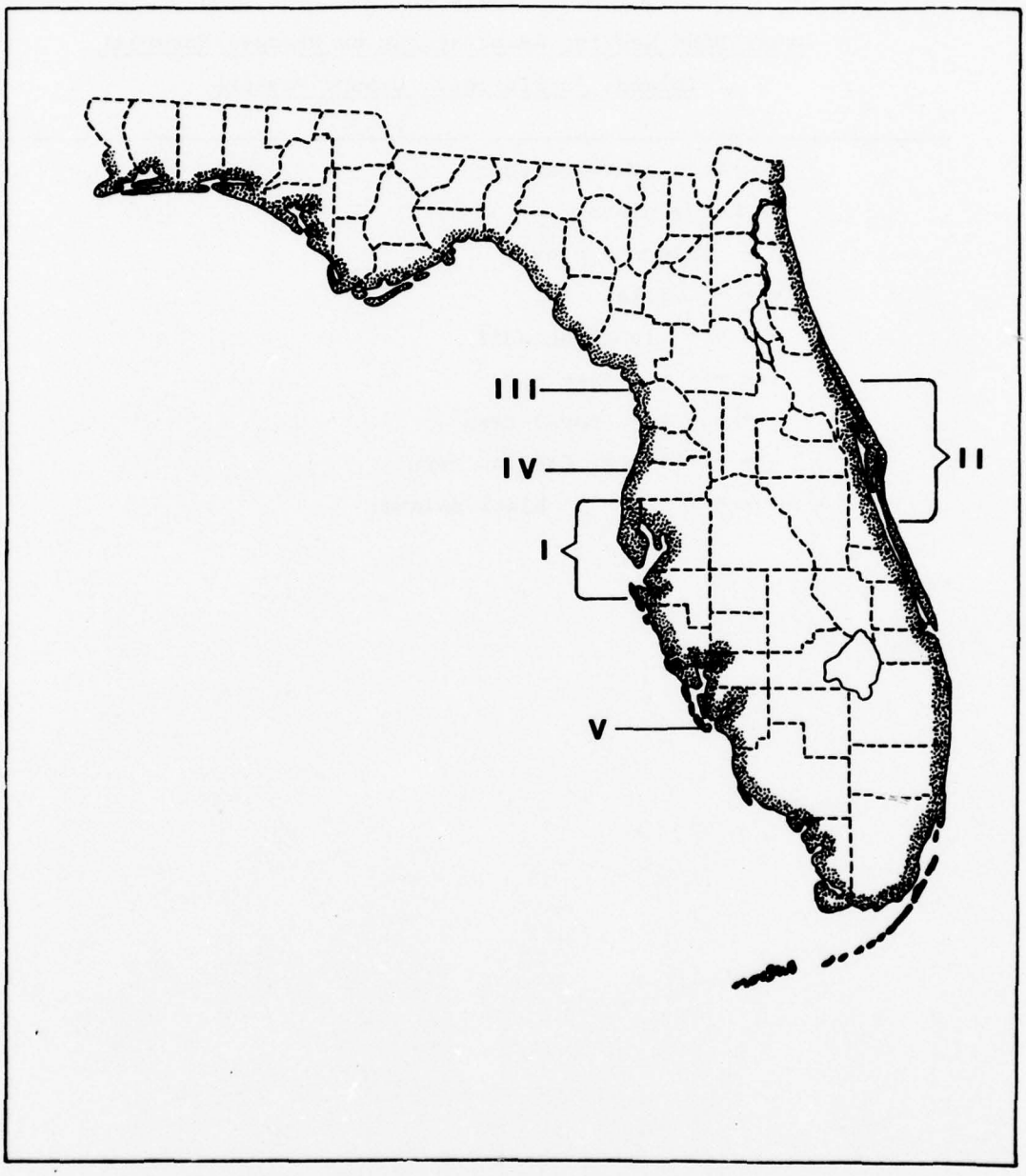



Figure 1. Specific study areas in Florida.

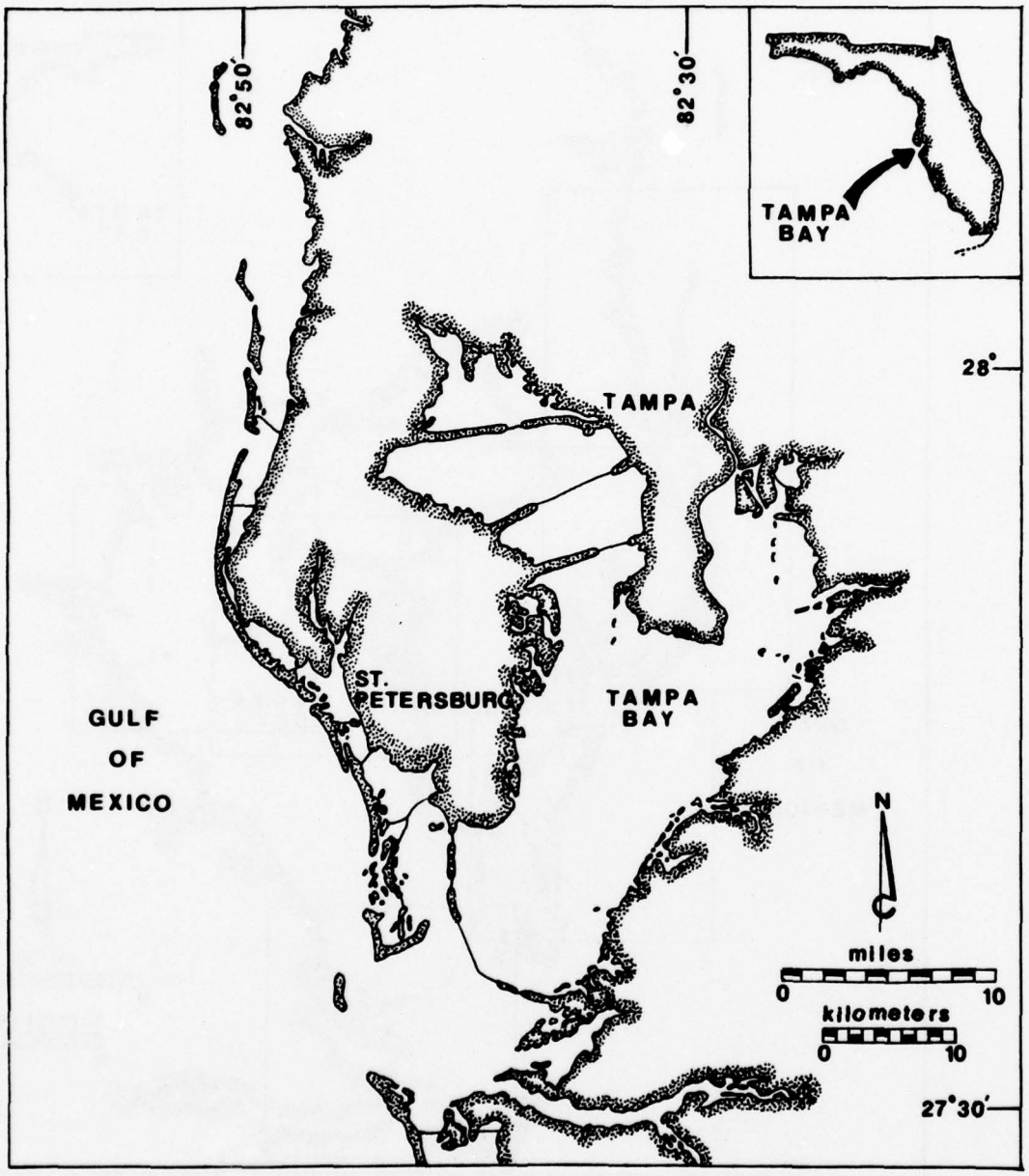



Figure 2. Specific study area I.

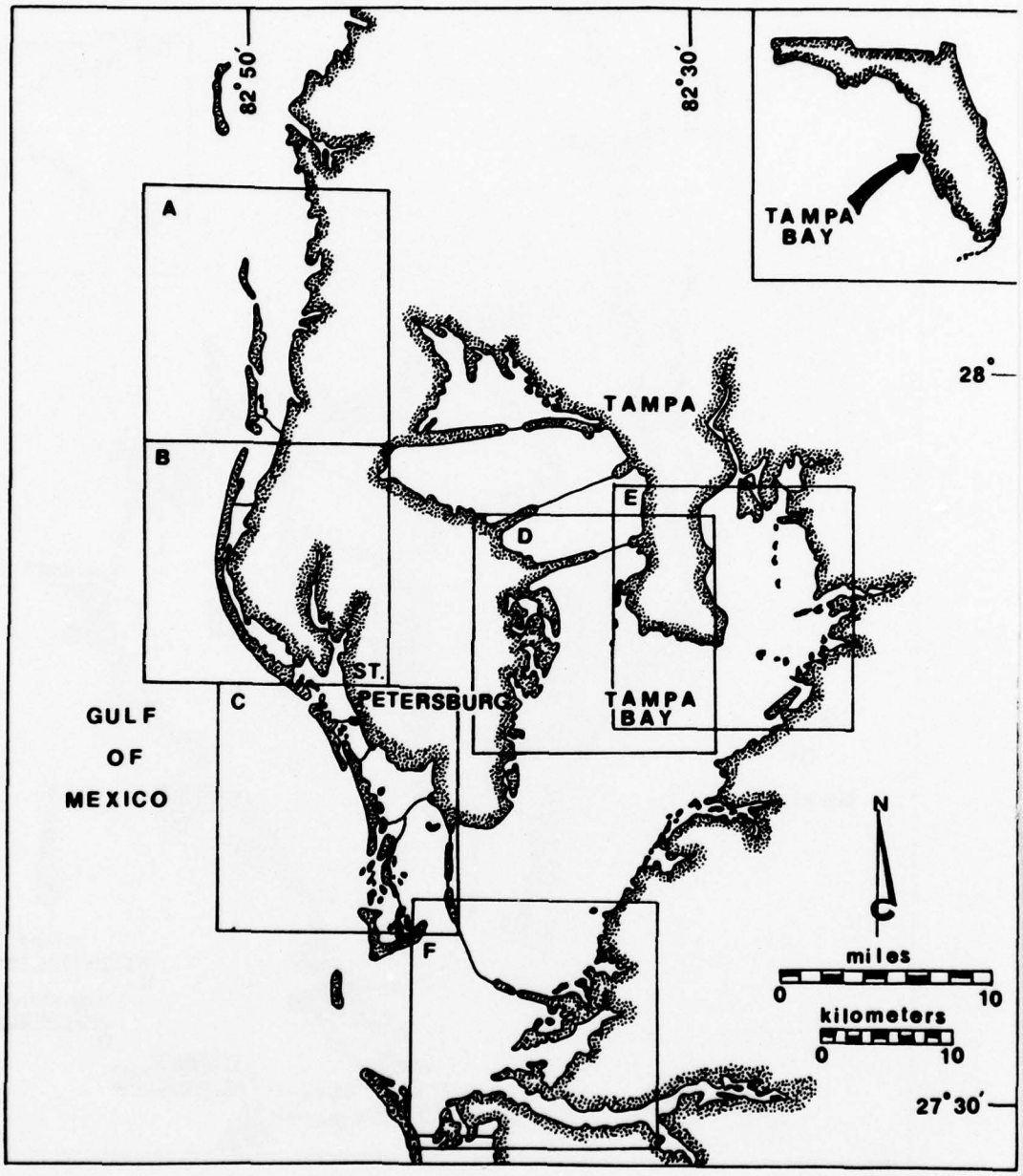



Figure 3. Insets, specific study area I.

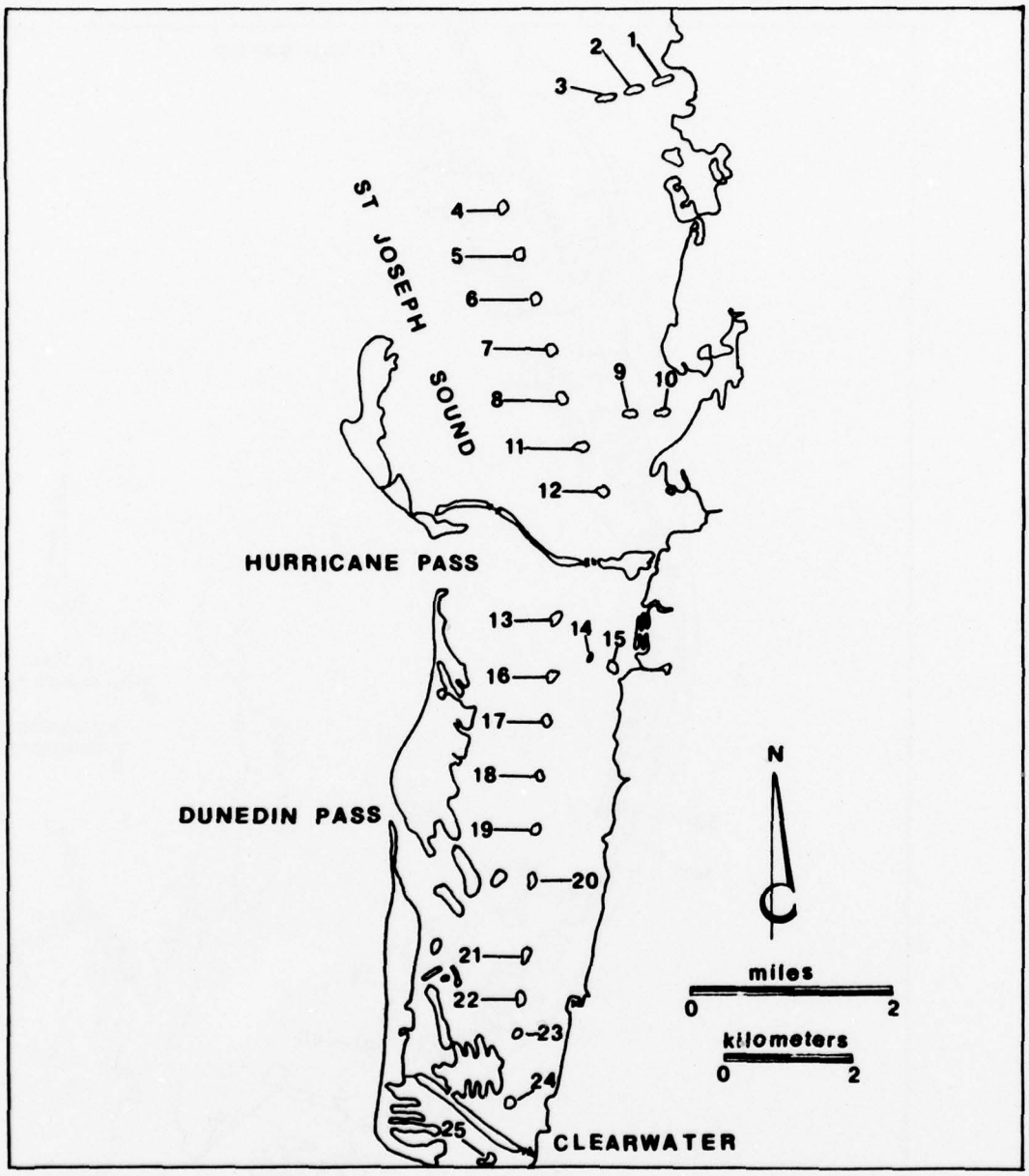



Figure 4. Inset A, specific study area I.

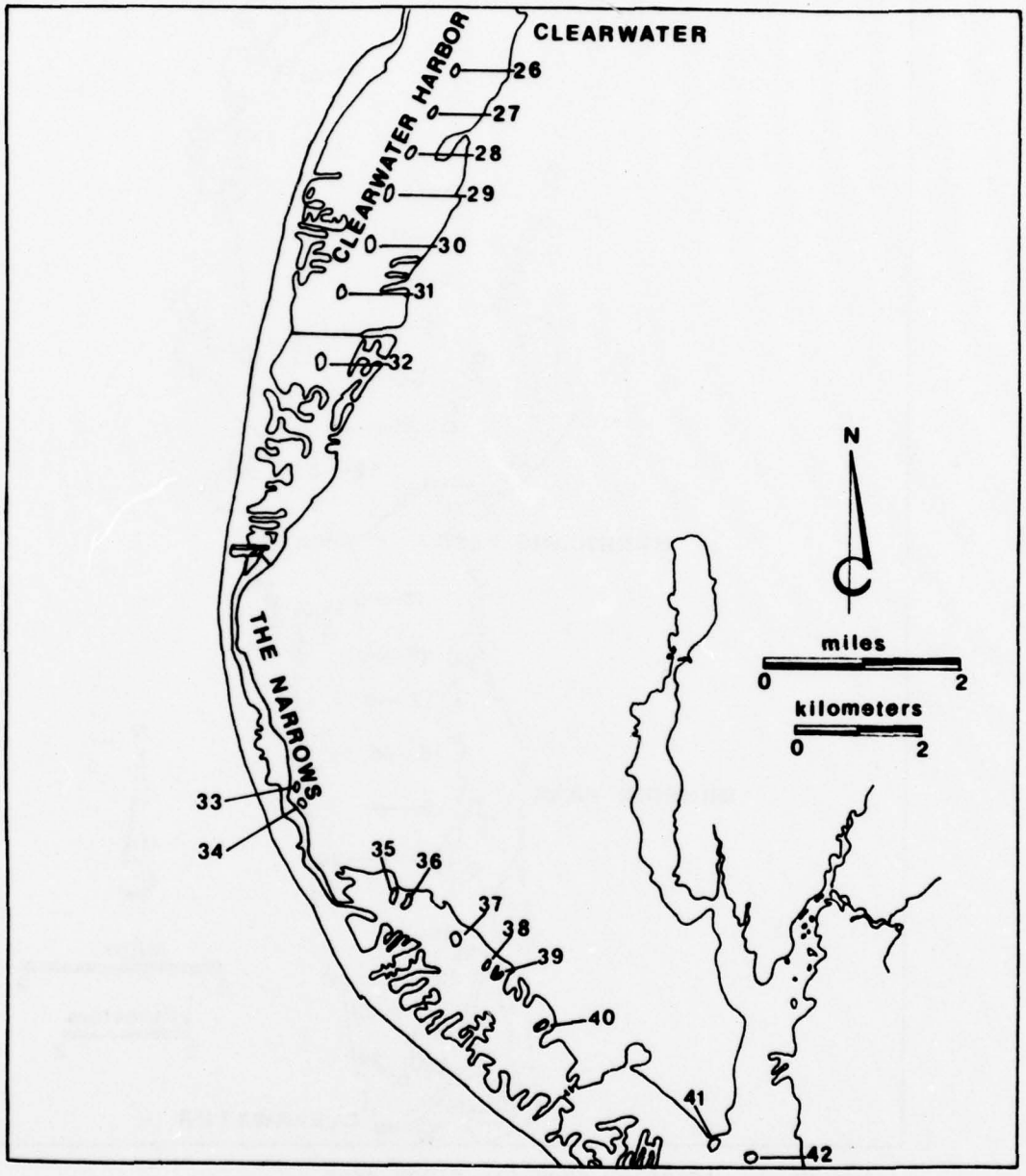



Figure 5. Inset B, specific study area I.

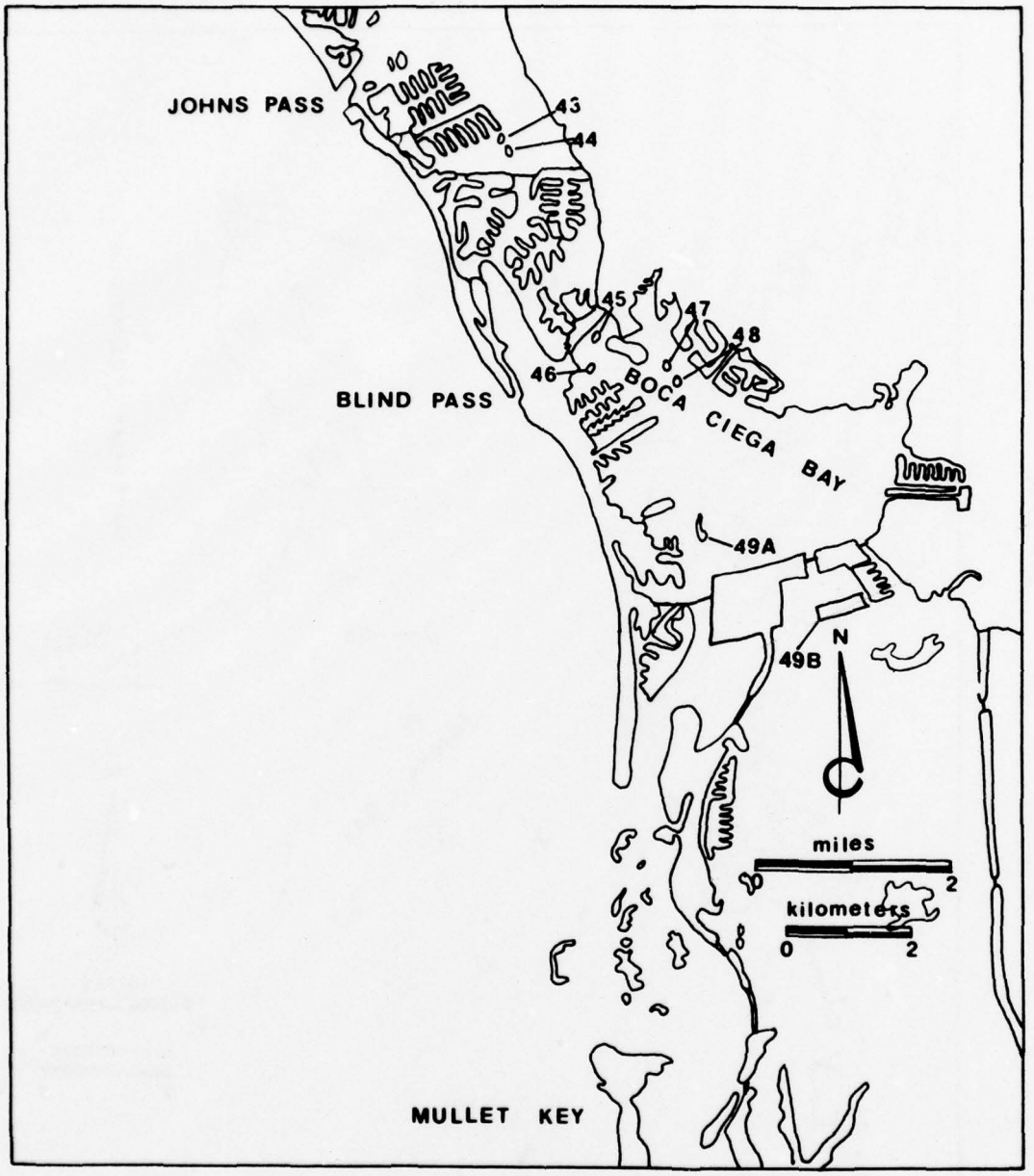



Figure 6. Inset C, specific study area I.

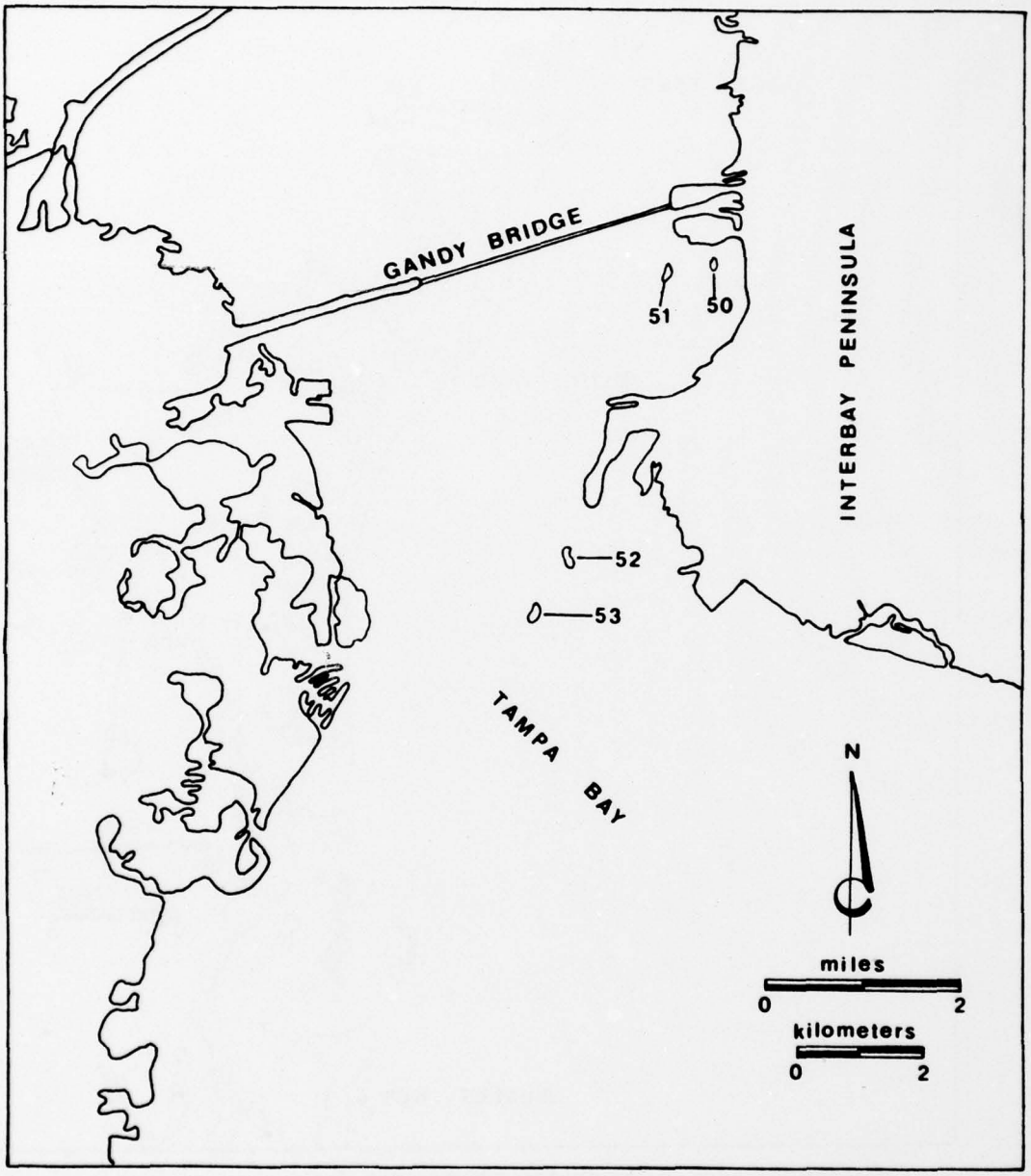



Figure 7. Inset D, specific study area I.

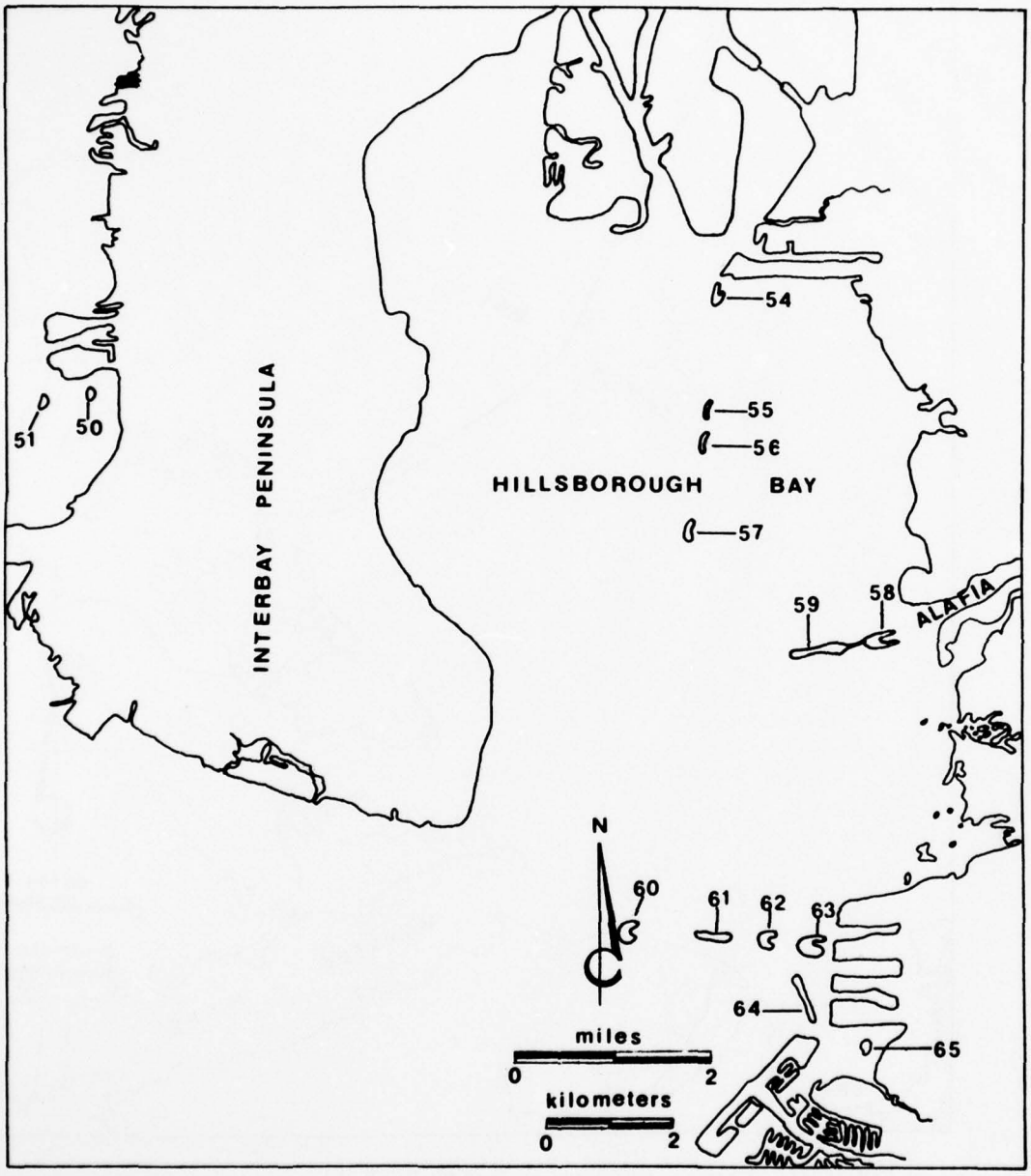



Figure 8. Inset E, specific study area I.

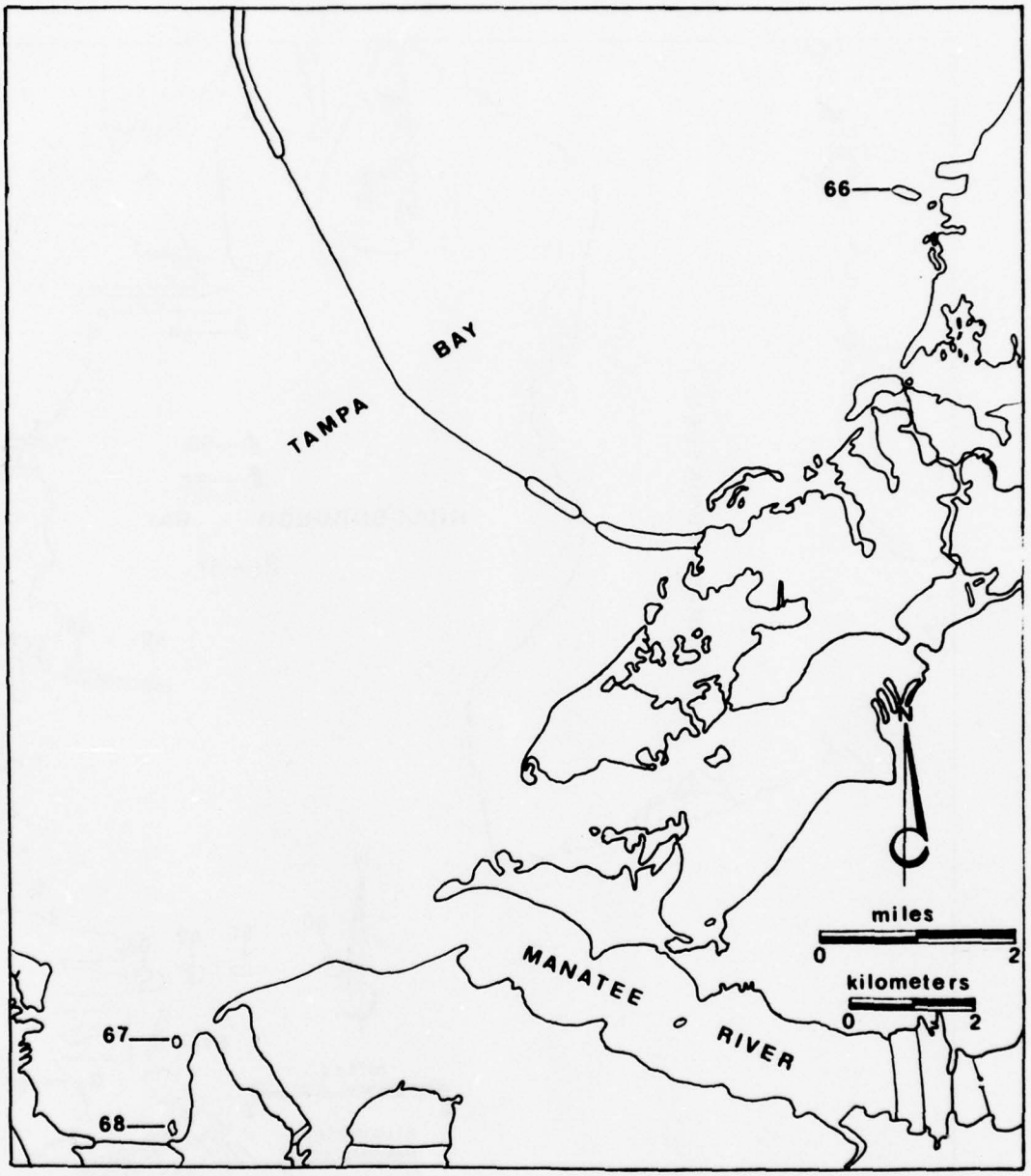



Figure 9. Inset F, specific study area I.

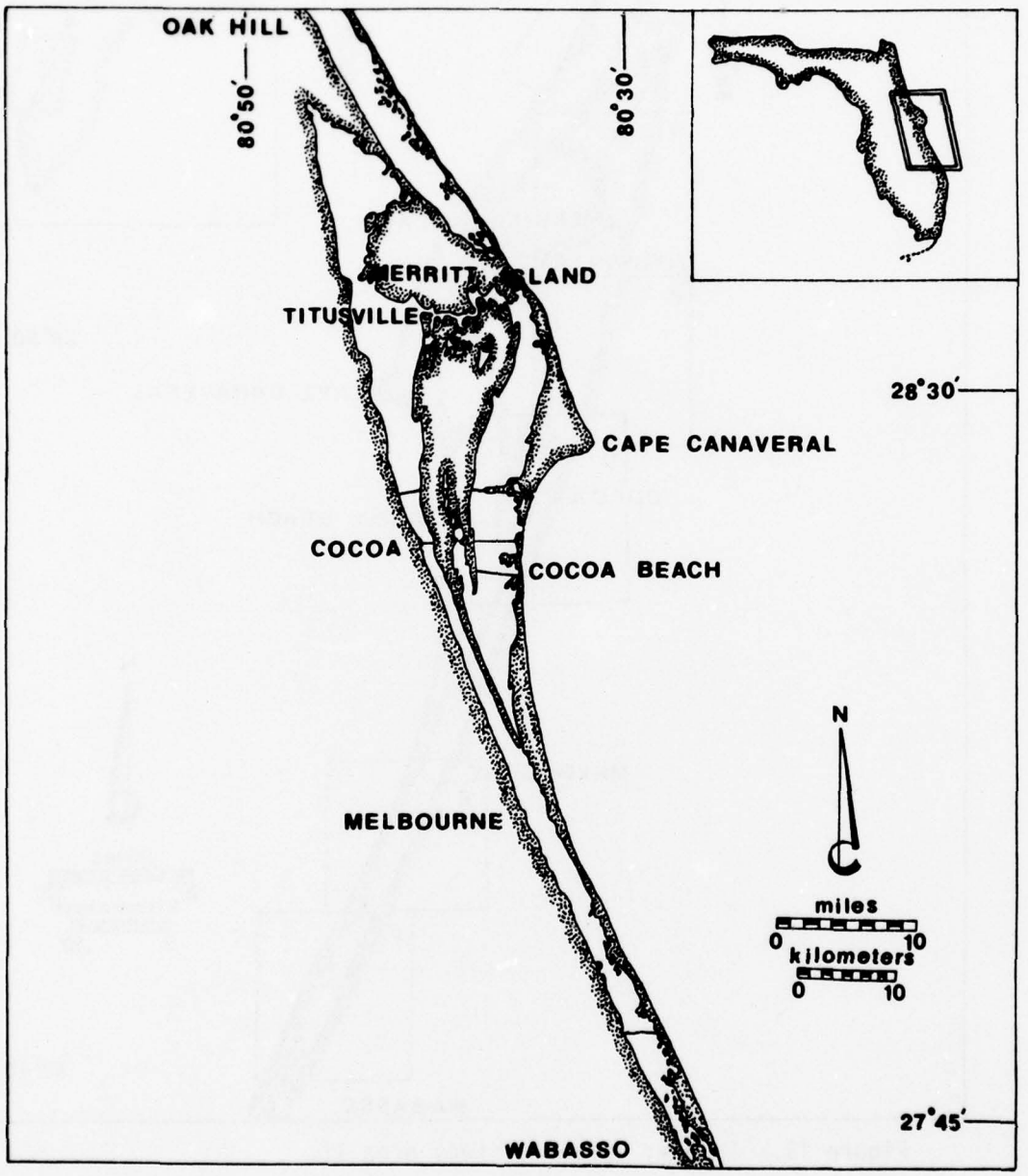



Figure 10. Specific study area II.

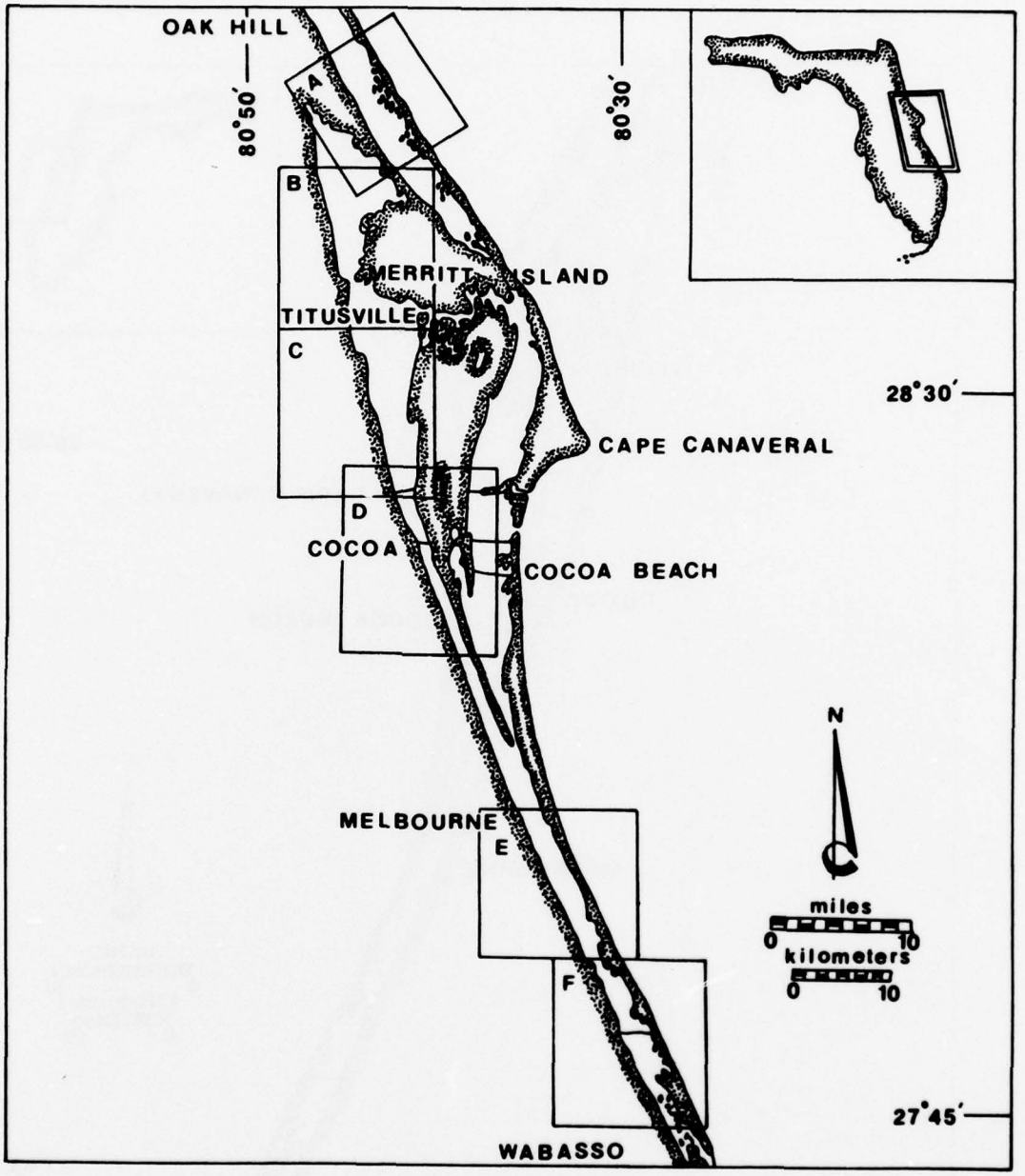



Figure 11. Insets, specific study area II.

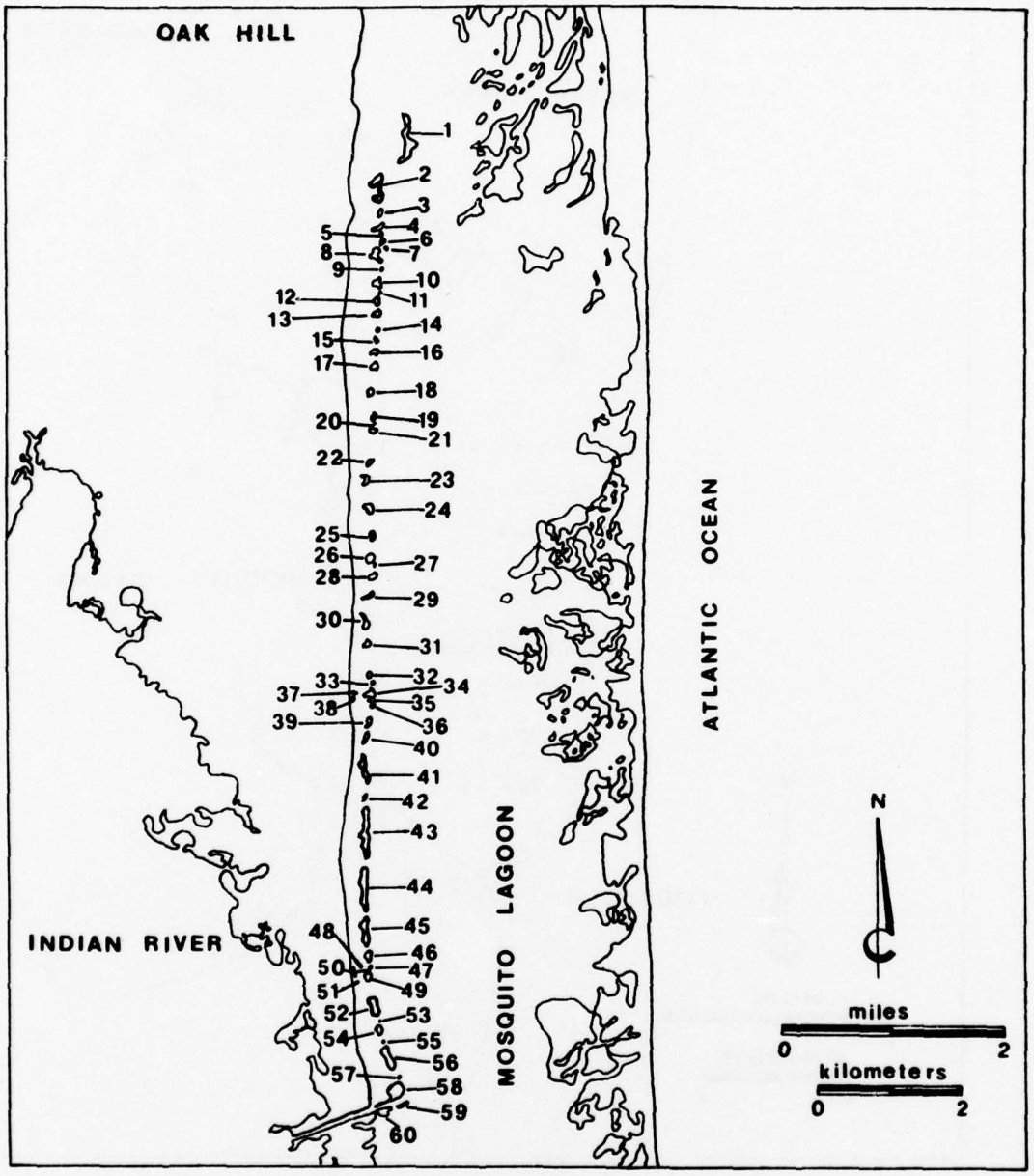



Figure 12. Inset A, specific study area II.

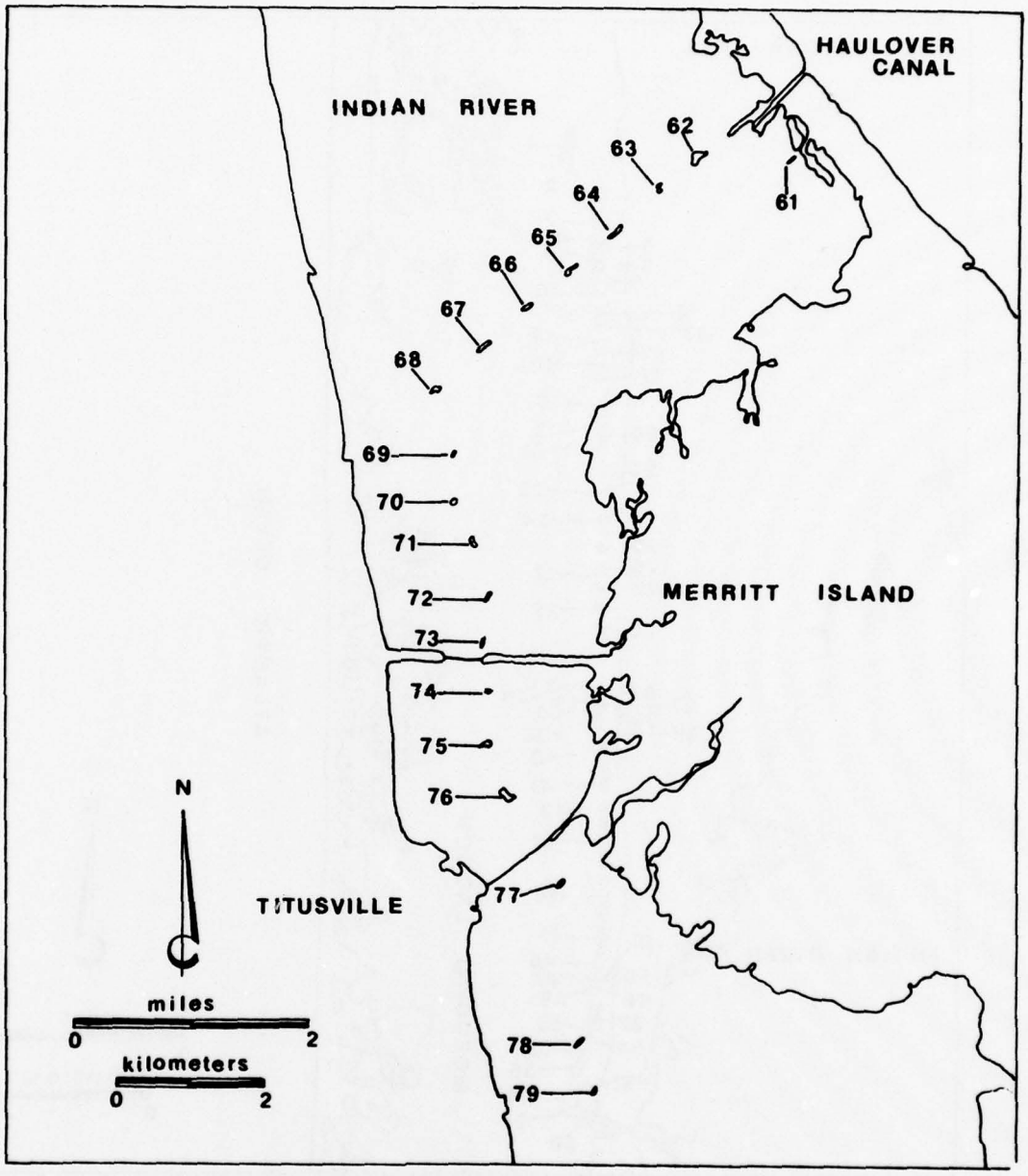



Figure 13. Inset B, specific study area II.

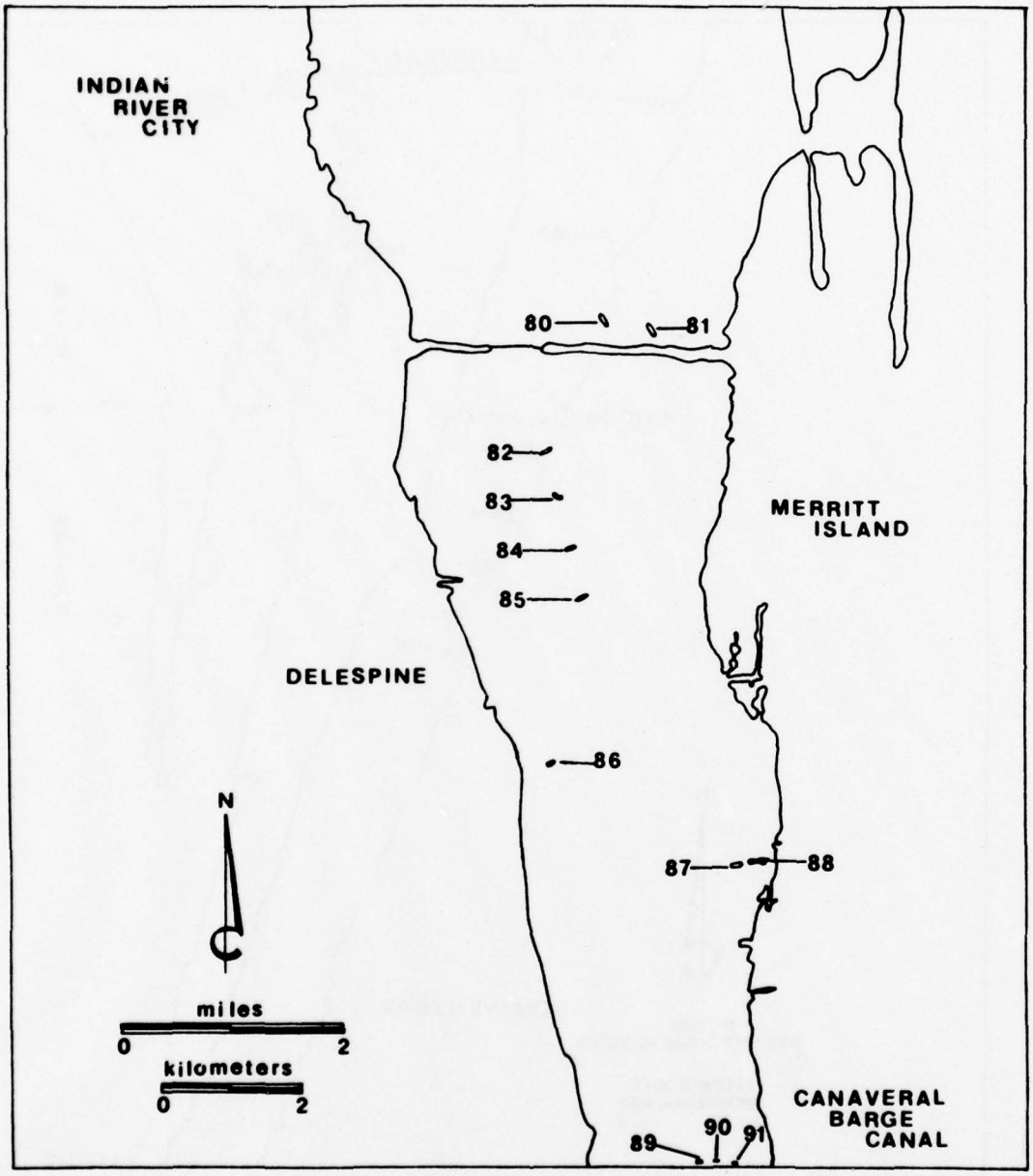



Figure 14. Inset C, specific study area II.

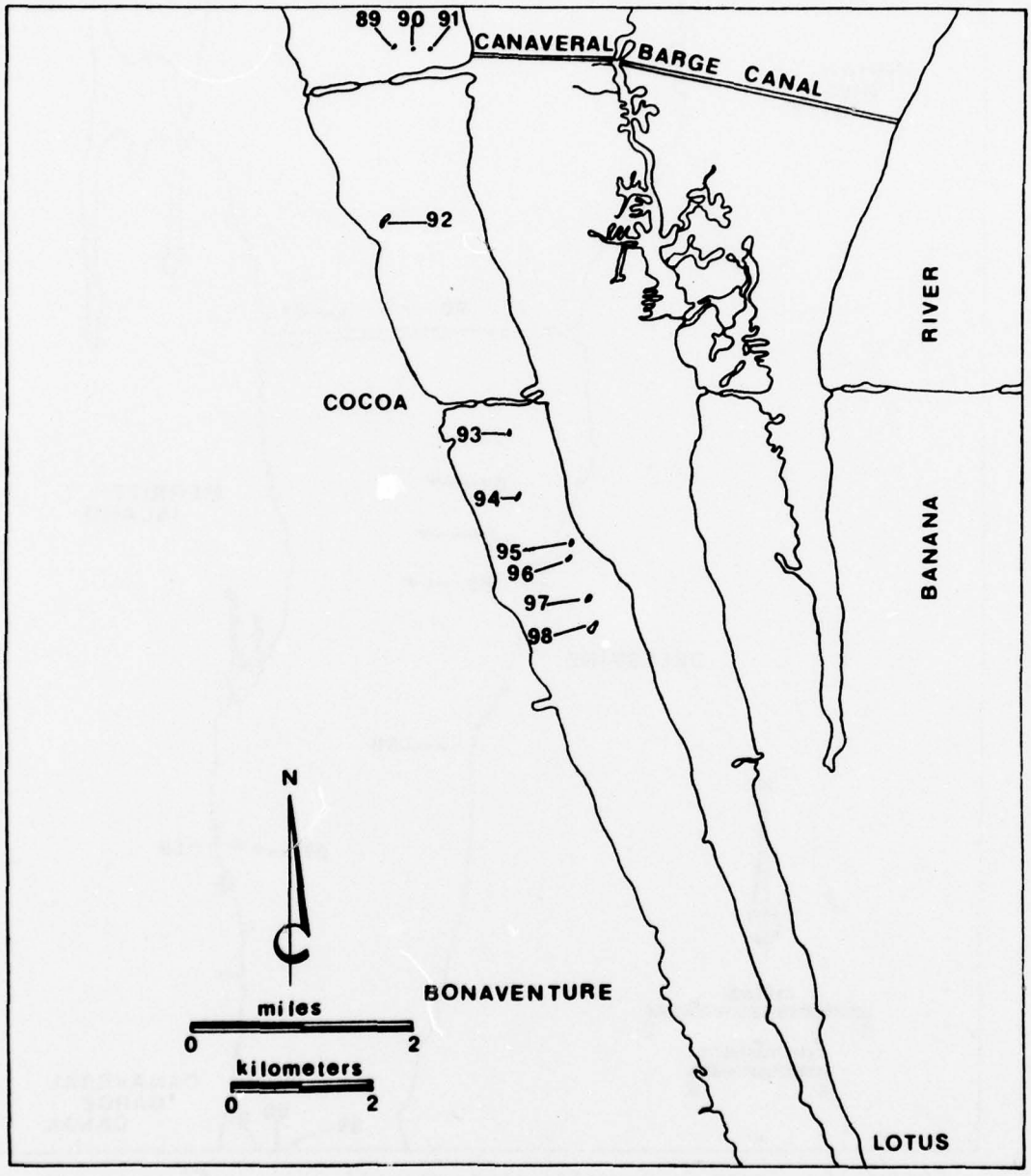



Figure 15. Inset D, specific study area II.

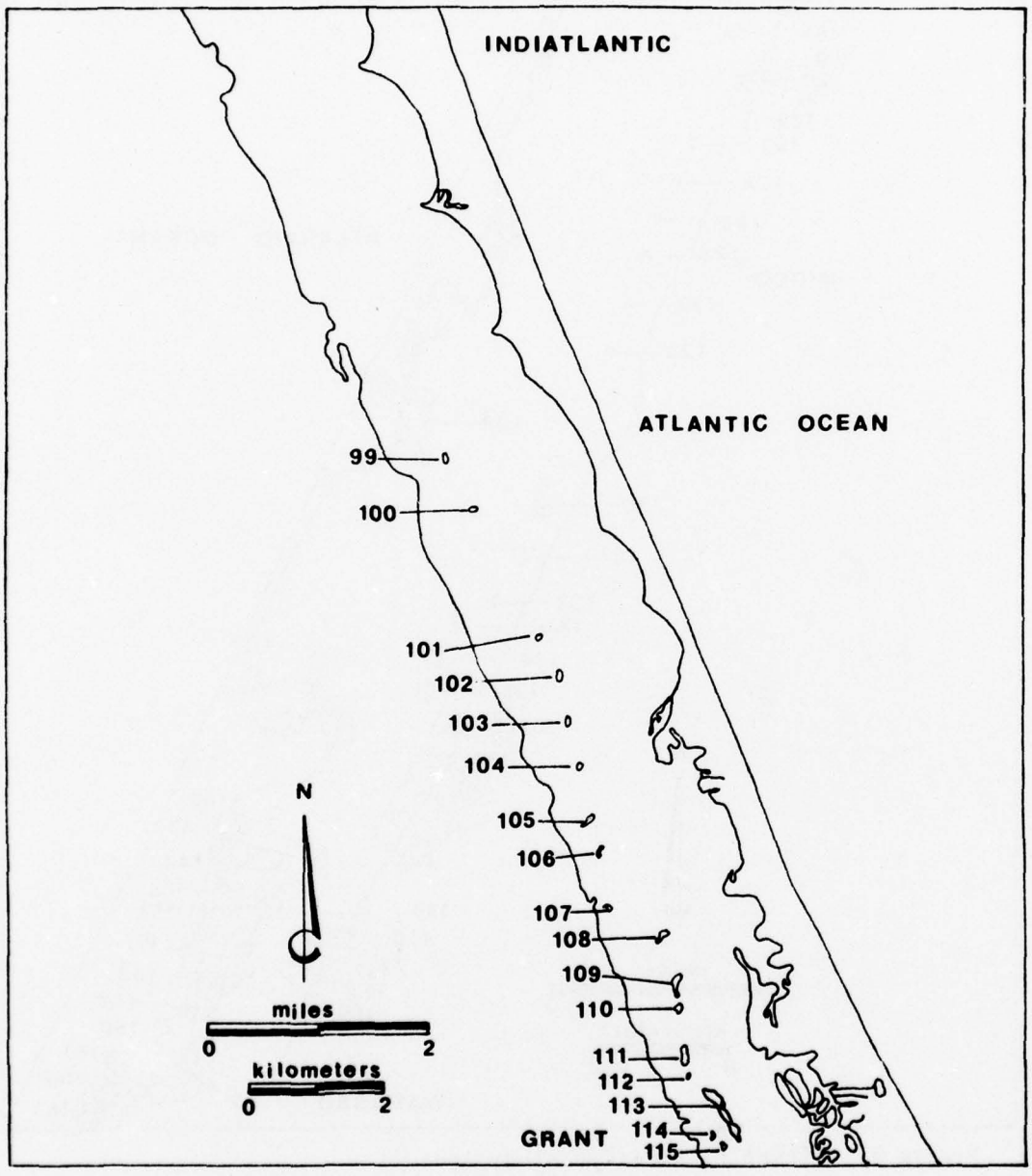



Figure 16. Inset E, specific study area II.

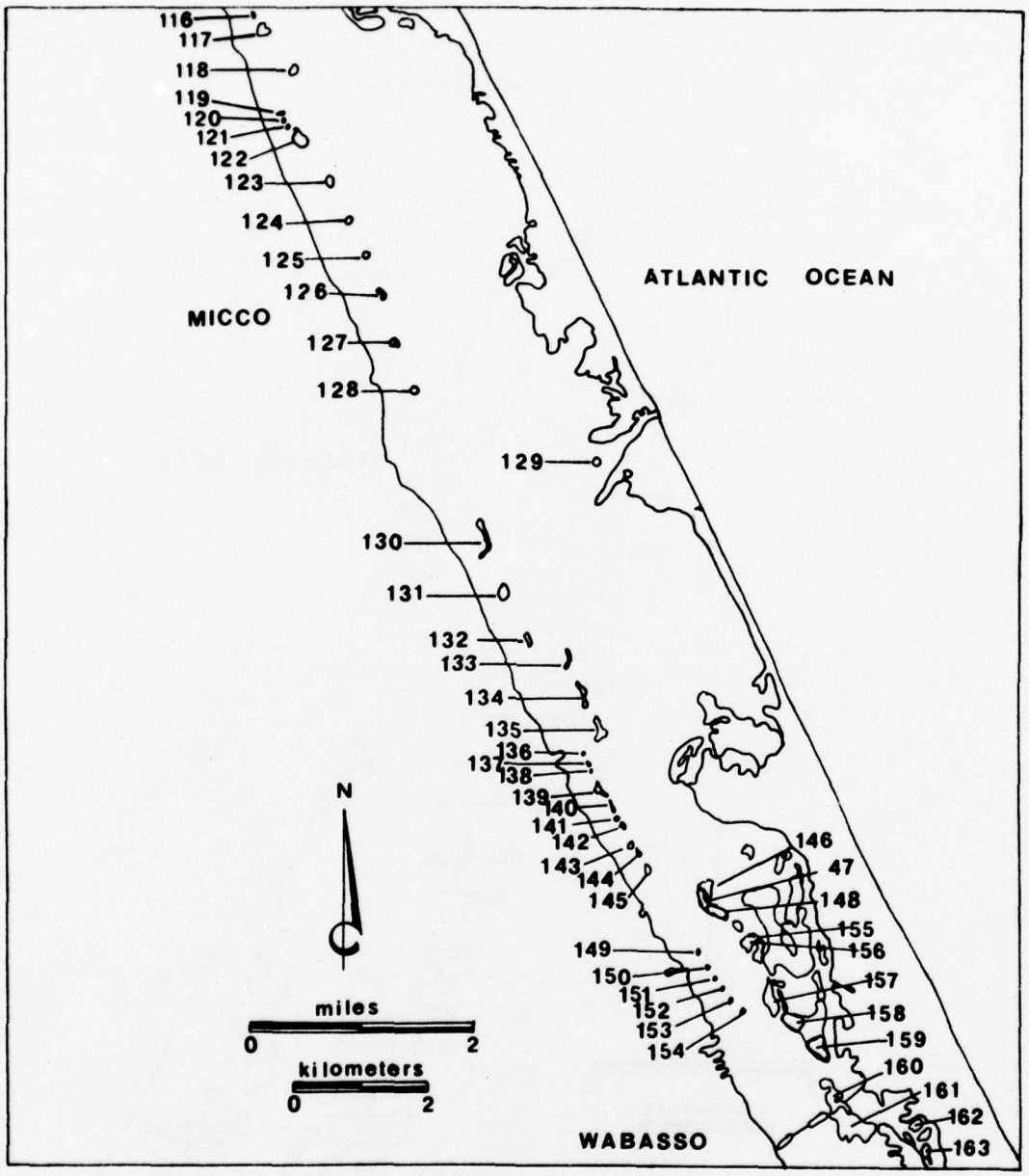



Figure 17. Inset F, specific study area II.

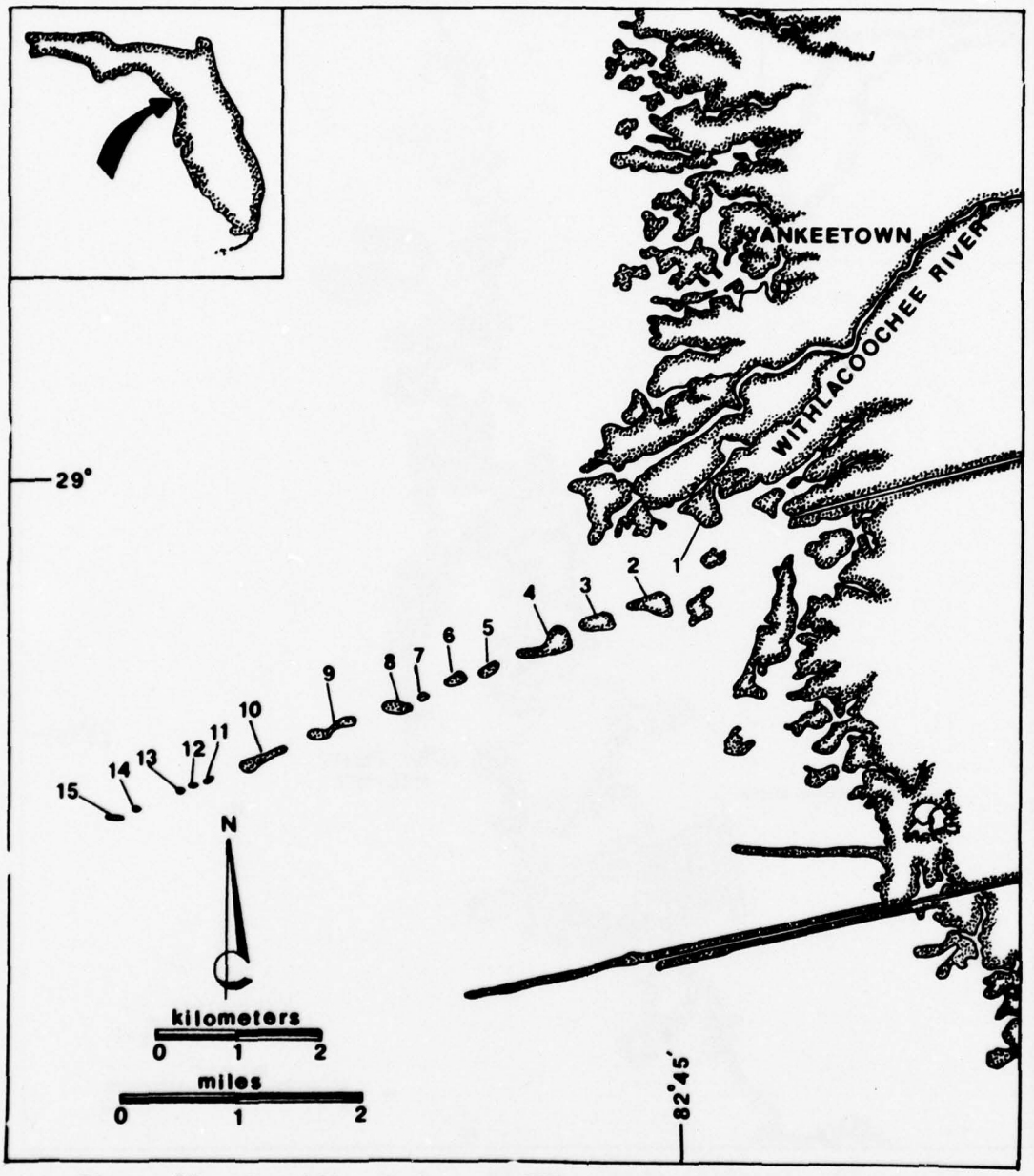



Figure 18. Specific study area III.

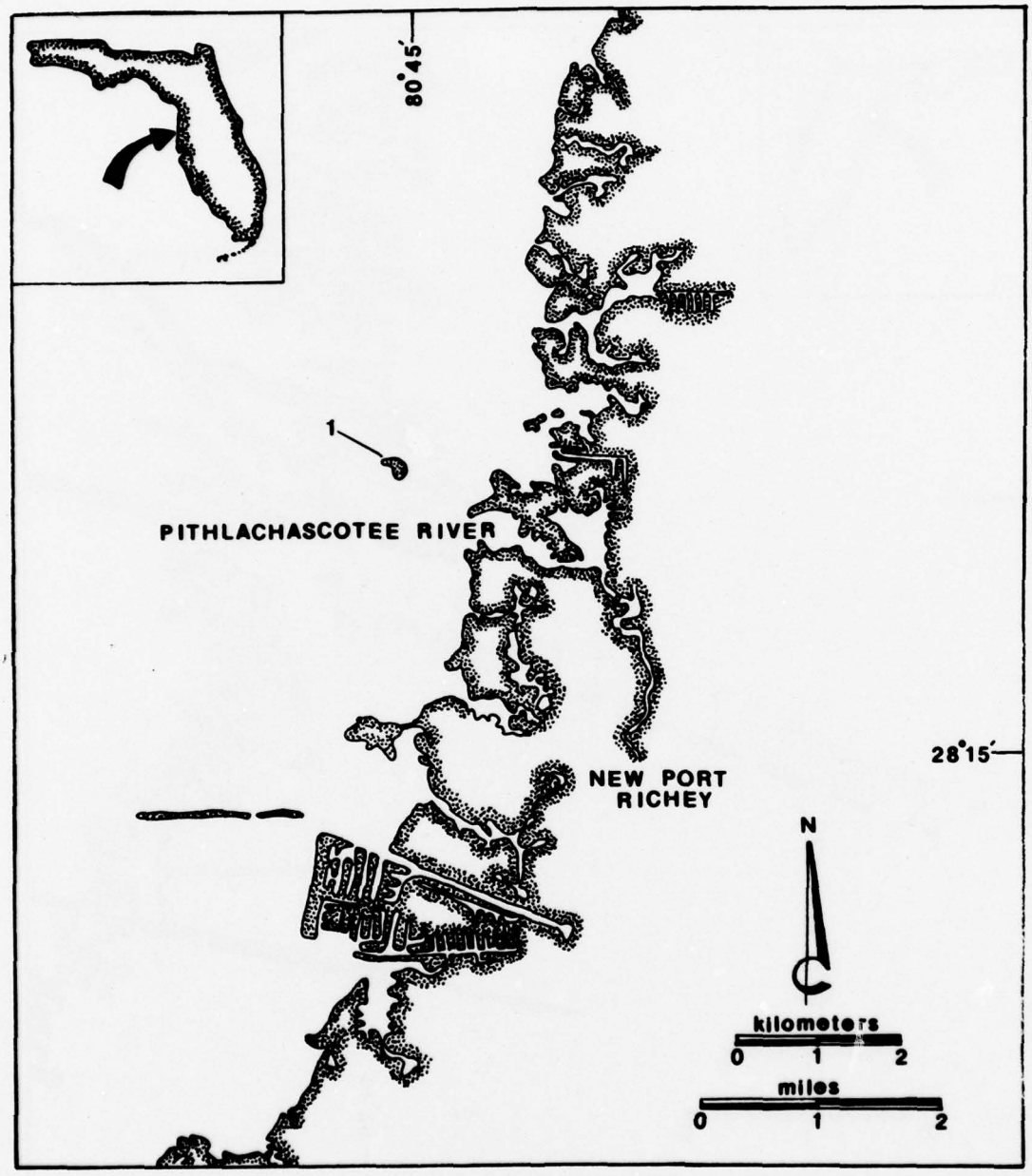



Figure 19. Specific study area IV.

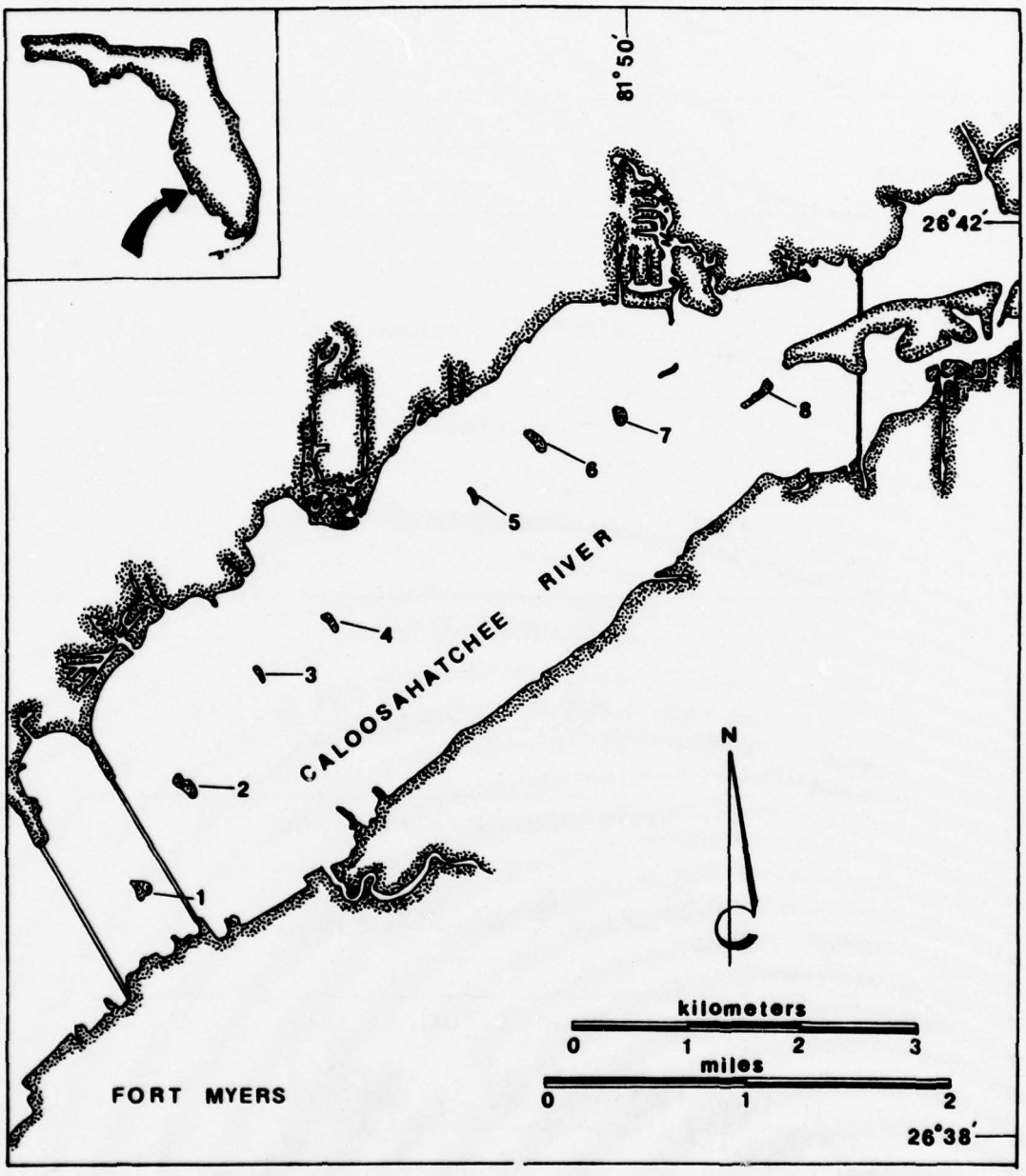



Figure 20. Specific study area V.

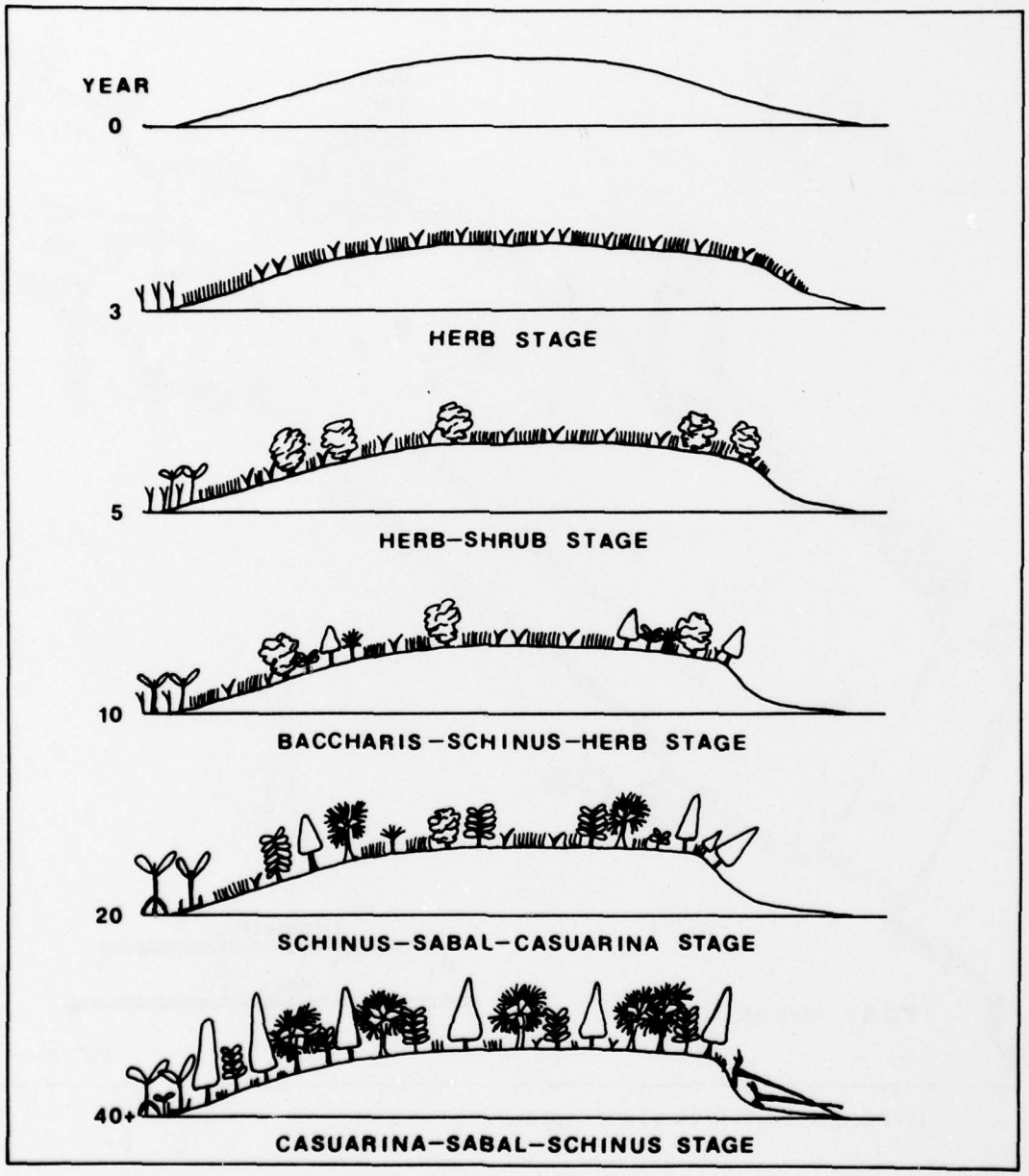



Figure 21. Theoretical succession of vegetation on dredged material islands in Florida (Continued)

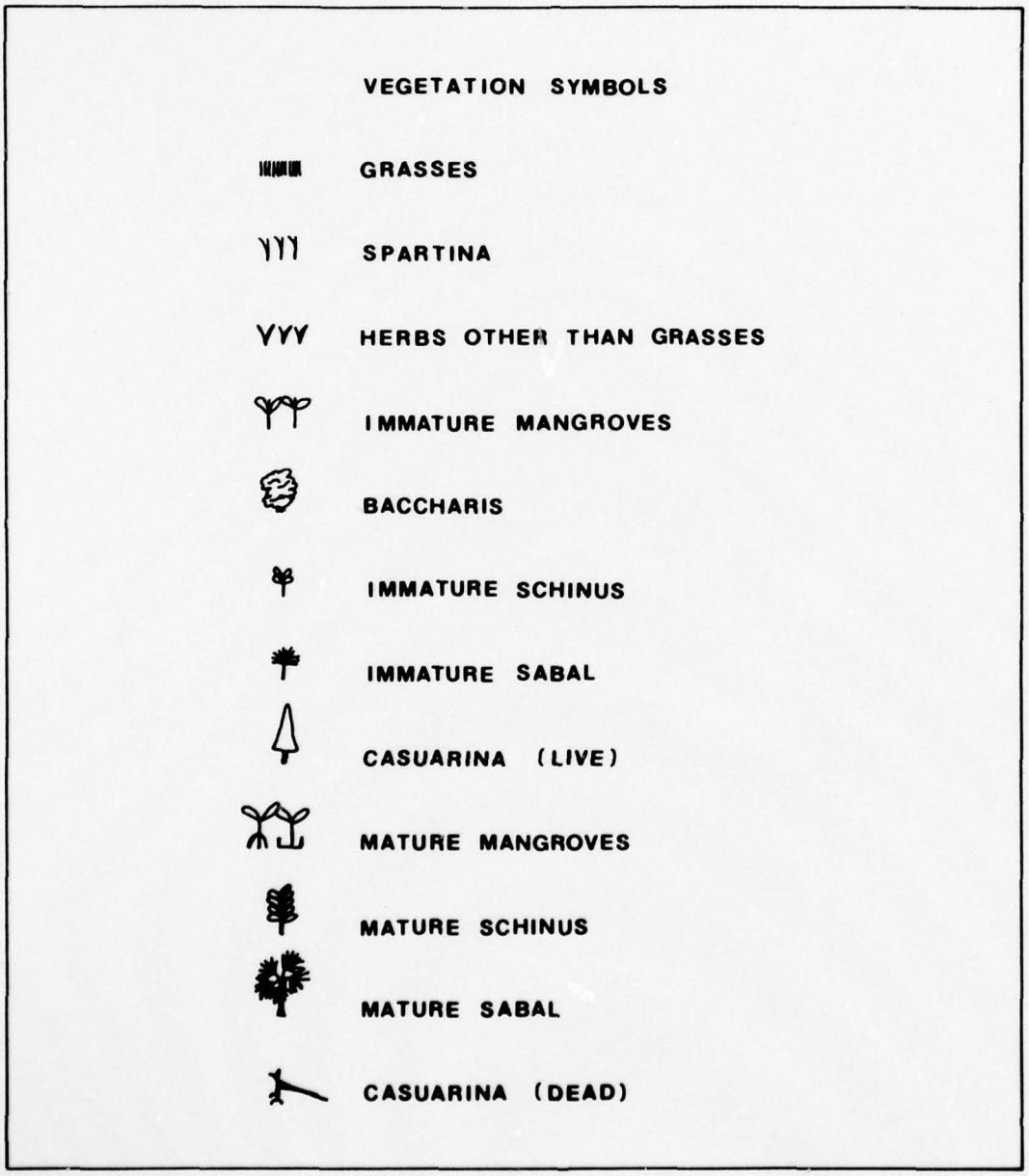



Figure 21. (Concluded)

# APPENDIX A: LITERATURE REVIEW AND 1977 FIELD DATA

## Introduction

1. Nearshore islands were important nesting sites for many species of sea and wading birds and this utilization has been documented in general (Welty 1975, Sprunt 1954).* In recent years, the use of dredged material islands by birds has been documented for the Texas coast by Barnes (1971), McMurry (1971), and Simersky (1971), for the North Carolina coast by Soots and Parnell (1975), but little has been published about their use in Florida. Maxwell and Kale (1974) described bird use of one island on the Florida east coast. Woolfenden and Schreiber (1973) indicated the importance of dredged material islands as habitat for the birds of the saline environments of the eastern Gulf of Mexico. Additionally, several papers dealing with individual species use of these islands appeared recently (Barbour et al. 1976, Dinsmore and Schreiber 1974, Dunstan et al. 1975, Dunstan 1976, Paul et al. 1975, Schreiber and Dinsmore 1972, Schreiber and Schreiber 1973), but little specific information is available for a large geographic area.

2. In the Tampa Bay region, colonial nesting birds were known to have nested on dredged material islands since their creation in the early 1930's (Mills 1934). In Tampa Bay, and elsewhere in Florida, these artificially created islands increased in importance for nesting birds as the alteration of natural islands and intertidal communities has occurred for human use (Lewis and Dunstan 1975).

3. Primary succession of vegetation proceeded with the creation of dredged material islands depending on the physical characteristics of the island, the biotic community of the region, and the distance of the islands from dispersal centers (Carlson 1972, Beaman 1973), and patterns of succession appear to vary between regions (Soots and Parnell 1975, CZRC 1977). Since dredged material islands were important to avifauna and the

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* All references are included in Literature Cited at the end of the main text.

plant succession on the specific islands influenced which species of birds would nest, it has become increasingly clear that creation of artificial habitat and maintenance thereof for the benefit of the birds demands a thorough understanding of the ecological relationships of the local area.

4. The published data summarized in this appendix were garnered from the following journals: Auk, Bird-Banding, Condor, Ibis, Wilson Bulletin, Florida Naturalist, Florida Field Naturalist, Bird Lore, Audubon Field Notes and American Birds, Quarterly Journal of the Florida Academy of Sciences, Research Reports of the National Audubon Society, Bulletin of the Florida State Museum, Ecological Monographs, Natural History, and several other individual publications. The nomenclature and sequence of the AOU Checklist (1957 and revisions) was followed.

5. From all these sources the data relevant to birds nesting on dredged material islands in Florida have been summarized. However, since little has been recorded on this specific subject, data for birds nesting elsewhere in Florida were used for information on the seasonality of the nesting season.

6. This review covers nesting distribution and seasonality of the nesting season. However, Florida was important as a wintering area for many species of birds, and dredged material islands played an important role during the 1977 season. Thus, some comments on roosting-loafing areas have also been included. The species accounts in this report are roughly arranged by distribution and seasonality.

7. The data obtained from the literature reviewed are contained in the species accounts which follow. However, Robertson and Kushlan (1974) published a major review paper that dealt with the birds found in Florida south of the Caloosahatchee and St. Lucie inlets of Lake Okeechobee. They reviewed breeding populations of south Florida birds and presented excellent discussions of feeding ecology and the seasonality of nesting. They also discussed various environmental impacts on bird populations.

8. Robertson and Kushlan clearly pointed out that 60 percent of the birds found in southern Florida are species which spend the winter in the state. This was considered when discussing use of dredged material islands

by birds: as nest sites these islands were valuable but the roosting and feeding areas these islands provided for wintering species (as well as permanent residents) were of major importance.

9. The Robertson and Kushlan paper received limited distribution and was difficult to obtain. It contained extensive data on the origins, affinities, and ecological considerations of Florida birds, and was a major contribution to the subject of bird utilization of dredged material islands. Additionally, no field studies for this report were conducted in south Florida. Thus, edited portions of the Robertson and Kushlan paper are included as follows:

> "About 400 species of birds have been reported to occur naturally in Southern Florida.
>
> "WINTERING AND MIGRANT BIRDS - About 60 percent of the bird species found more or less regularly in southern Florida occur principally in winter or during migration. Southern Florida wetlands are an important wintering ground for water birds, particularly in winters when water is high in the Everglades and coastal marshes, and weather severe far to the north. Water birds that winter in significant numbers include White Pelican (perhaps most of those that breed east of the continental divide), dabbling ducks, American Coot, Black Skimmer, many species of shorebirds, gulls and terns, and northern populations of many wading bird species that also breed in southern Florida.
>
> BREEDING BIRDS - Our comments focus on the 116 species that comprise the native breeding fauna. Of these at least five no longer breed in southern Florida: the extinct Carolina Parakeet, the nearly extinct Ivory-billed Woodpecker, Royal and Sandwich Terns, and the Zenaida Dove. In addition to the species considered extirpated, at least four others (American Oystercatcher, Snowy Plover, American Kestrel, Scrub Jay) have almost disappeared as breeding birds from southern Florida. And, finally, the evidence of breeding in southern Florida is scanty for at least six additional species (Willet, Ruby-throated Hummingbird, Rough-winged Swallow, Prothonotary Warbler, Grasshopper Sparrow, Bachman's Sparrow).
>
> WATER BIRDS - Water birds of more or less tropical affinity are strongly predominant among those breeding in southern Florida and the diversity of species exceeds that of most neighboring areas to the north. Five species that breed in southern Florida (Roseate Tern, Sooty Tern, Noddy Tern, the recent Magnificent Frigatebird and Fulvous Tree Duck) are not

known to breed elsewhere in Florida, and only five water bird species, known to breed in other parts of the state, have not been found nesting in southern Florida (Black Rail, American Woodcock, Black Skimmer, the recent Common Tern (Hallman 1961) and Caspian Tern.

## Ecological Considerations

WADING BIRDS - Ten species of herons (excluding Cattle egret), two ibises, a spoonbill and a stork nest in southern Florida. These species have a particular historical significance and ecological importance. Although the record is woefully incomplete, more quantitative information is available on their population levels than for any other group of birds. Wading bird populations have changed drastically over the past century due to human activities, primarily hunting and habitat alteration. The total number of wading birds in southern Florida at various times can be crudely estimated as:

| | |
|---|---|
| 1870 | 2,500,000 |
| 1910 | 500,000 |
| 1935 | 1,200,000 |
| 1960 | 300,000 |
| 1970 | 150,000 |

Robertson discussed the principal causes of these fluctuations. The late 1870's saw the end of the primeval abundance of wading birds with the initiation of commercial plume-hunting which lasted for 30 to 40 years. With the cessation of hunting but the wetland habitat largely intact, the remnant populations of most species rebounded, reaching a new peak of abundance in the 1930's when Robert P. Allen and the National Audubon Society began a detailed study of these birds. Since then, the progressive loss and deterioration of wetland habitat reduced wading bird numbers to about ten percent of the reported level of the 1930's. A generally complete survey of southern Florida by the National Park Service and the National Audubon Society in 1972 showed 128,400 breeding wading birds.

The underlying causes of these changes can be seen by comparing population levels in Florida Bay and coastal areas with those of the interior Everglades of Everglades National Park. Whereas birds nesting in estuarine areas have increased in the past 30 years and are probably near carrying capacity, those nesting in the interior wetlands of Everglades National Park have declined as their habitat became smaller and more unstable. Current and past population data on various species of wading birds follow.

The Roseate Spoonbill was severely reduced by plume hunting in the 1880's and thereafter. The Florida population was 513 birds in 1941 (Allen, 1942). The current population of about 2200 birds is restricted to Florida Bay and is stable or increasing slightly.

The White Ibis was historically and remains today the most abundant wading bird in southern Florida. As Kushlan and Kushlan describe the changing abundance of this species, it suffered little from plume hunters, although colony disruption occurred, and continued throughout the 1930's. In this period an average of 420,000 birds and a maximum of 660,000 birds nested in the southern Everglades. This represented 90 percent of the White Ibis nesting in 16 colonies throughout Florida. The population declines thereafter and the total southern Florida nesting population is about 60,000 birds, subject to considerable year to year variation.

The Glossy Ibis was rare in Florida as late as the 1930's. More recently it has increased in the state and also extended its range as far north as Long Island. The maximum southern Florida nesting population is probably less than 1500 birds of a Florida total of about 3500 birds.

The Wood Stork was little affected by plume hunting and remained abundant into the 1930's when the southern Florida nesting population exceeded 75,000 birds (Holt, 1933). The population declined irregularly through the 1950's in response to progressive loss of habitat. In the 20 years prior to 1961, nesting succeeded in 13 or 14 years, and, as of 1961, the total Florida population was more than 20,000 all but 2,000 of which nested in southern Florida colonies at Corkscrew Swamp and in the southern Everglades. Since the 1960-61 nesting season, the population has declined rapidly as few years had substantial reproductive out put. As of 1974, a successful year, the southern Florida breeding population was 5800 birds, a 93 percent reduction since the 1930's and a 69 percent reduction since 1961.

The egrets and small herons (Great Egret, Snowy Egret, Louisiana Heron, and Little Blue Heron) today number around 40,000-50,000 birds. All were reduced by plume-hunting, recovered and then declined due to environmental pressure. Unfortunately, few recent data are available for the species but they appear to be decreasing especially since the early 1960's, with the Snowy Egret probably declining most drastically.

The Reddish Egret was severely reduced and perhaps extirpated in Florida by plume-hunting and has increased slowly since the mid-1930's. Despite some evidence of recent return to its former Gulf Coast range (Bancroft, 1971), the Florida population of about 300 birds still nests primarily in Florida Bay.

OTHER RARE, ENDANGERED OR LOCALIZED SPECIES - Although quantitative information on wading birds is incomplete, much less is known about most other threatened species. In this subsection we review population data on species for which some information is available.

The Brown Pelican has declined in most parts of its North American range but appears generally stable in Florida with a statewide nesting population of about 16,000. A conservative estimate is of 1100 pairs nesting in 18 locations in the Keys and 1300 pairs for southern Florida as a whole. In an analysis of Christmas data, Schreiber and Schreiber (1973) found that the wintering population of Coot Bay has remained generally stable, but the species has apparently increased on the Keys.

The Sooty Tern occurs worldwide on warmer seas. The tropical Atlantic form of this pelagic species nests in the United States intermittently and in small numbers on islands off Texas and Louisiana and regularly at Dry Tortugas. Prior to protection in 1903, commercial egging and disturbance had reduced the population to around 5000 adults. The population increased thereafter and is now estimated to number 80,000 breeding adults.

## Ecology of Wading Birds

In this section we discuss the ecology of the long-legged wading birds of the order Ciconiiformes, namely the Wood Stork, White Ibis, Roseate Spoonbill, Great Blue, Green, Louisiana, Little Blue, Black-crowned and Yellow-crowned Night Herons, Great, Snowy, and Reddish Egrets, and Least and American Bitterns.

SEASONALITY - Distribution and activity of wading birds in southern Florida show a marked seasonality. Florida, especially southern Florida, supports substantially increased numbers of wading birds in winter. Great Blue Heron, Black-crowned Night Heron, Green Heron, and Least and American Bittern populations that nest throughout the East and Midwest winter in and south of Florida. Wintering White Ibis, Great and Snowy Egrets, Yellow-crowned Night, Little Blue and Louisiana Herons are derived from Atlantic and perhaps Gulf Coast breeding populations. These birds enter Florida in fall and migrate north again from February to April.

Other species migrate into southern Florida to nest. Wood Storks are present in numbers only in winter and spring, arriving in November and returning north after they complete nesting, as late as June. Roseate Spoonbills show similar

seasonality, arriving in late Spetember through October and nesting primarily from November through January. Unlike Wood Storks some adult and many juvenile Roseate Spoonbills remain in southern Florida through the summer. Reddish Egrets also remain throughout the year but additional birds from the West Indies apparently visit the Florida coast in summer. All North American ciconiiforms but one occur in southern Florida in winter and these, with the probable exception of the American Bittern, are also represented by nesting populations.

NESTING SEASONS - There is a general division of wading bird breeding populations into winter (November-February) and spring (March-June) nesters. Birds that nest and feed in Florida Bay and the larger species with prolonged development periods tend to nest in winter whereas smaller species of inland habitats nest in spring. Specifically, in Florida Bay, Roseate Spoonbills and Reddish Egrets begin nesting in October and December, respectively. Great White Herons and Great Blue Herons, which breed in Florida Bay in small numbers nearly year round, have their peak nesting in early winter with Great Whites peaking before Great Blues. Florida Bay Great Egrets also nest in December.

Larger species nesting at inland sites also nest in winter. Great Blue Herons and Great Egrets begin nesting in December but may continue establishing nests through April or May. Wood Storks traditionally nested in November and December, but have delayed nesting into spring in recent years. Smaller herons and White Ibis typically nest in spring.

FOOD AVAILABILITY - Conventional ecological wisdom holds that bird breeding seasons are timed so that maximum food resources are available to feed young. Although there is little information on food availability in Florida Bay, the winter nesting of herons and other piscivorous birds such as Osprey, Bald Eagles, Brown Pelicans, and most Double-crested Cormorants, implies that winter is the optimal nesting time there for birds using such resources. Alternatively, food may be nearly constant year-round and other factors may dictate nesting season. Inland wading bird nesting firmly supports the rule. The typical winter and spring nesting seasons of inland wading birds coincides with the drying of the vast interior wetlands of southern Florida.

Effects of Natural and Man-Caused Disturbances

> Recurring natural disturbances, particularly the extreme intensities of hurricanes, fires, floods, draughts and freezes dominate the southern Florida environment. Their influence doubtless long antedates man in the region, but modern man's activities have complicated (without truly controlling) the effects of some natural disturbances and man has introduced equally pervasive, if sometimes less obvious, environmental disturbances of his own. Concerning the natural disturbance, it is important to realize that the avifauna presumably evolved in their presence and is more or less adapted to them. Any species that were altogether intolerant of recurring disturbances by hurricanes, fires, etc., must have disappeared long ago.

10. Maxwell and Kale (1974) documented vegetation distribution and bird use of a dredged material island in Vero Beach, Indian River County, just south of Study Area II. This island was created in the 1940's and supplemented in the 1950's when the Intracoastal Waterway was deepened. The vegetation has developed undisturbed since then. Herons, cormorants, and anhingas began nesting in the early 1960's and pelicans began nesting in 1968. The pelican population increased to about 300 pairs by 1977 and Maxwell and Kale (1974) presented data on the population size of the other species in 1973. The populations in this study were estimated in mid-May 1977.

11. Maxwell and Kale indicated that some species numbers have increased since initial establishment of the island and others remained about the same. At least 13 species of birds, representing two orders and five families or about 2600 individual nesting pairs, used the island. A significant seasonal cycle of use of the island occurred, superimposed on the total spring-summer cycle: while most cattle egrets and white ibis used the colony late in the season, herons, cormorants, and pelicans used the island early in the year. The dominant plants on the island were black mangrove, white mangrove, and Australian pine, and the birds nested primarily in the former two species.

12. Maxwell and Kale also clearly indicated that aerial surveys were inadequate for determining the details and providing accurate data

on avian species nesting on islands with complicated vegetational patterns. A discussion of the aerial surveys conducted during this study is given in the main text.

13. Table 2 (main text) lists the species that have been found nesting on dredged material islands in Florida. Nesting seasons are illustrated in Table 3.

14. During 1976, the National Audubon Society conducted surveys of several wading bird colonies on the east coast of Florida. These data were provided by Dr. H. W. Kale, II, Staff Ornithologist of the Florida Audubon Society. Summaries have been included in this report for completeness. Table A1 gives the location of the colonies outside of Study Area II on the east coast and was included here to show the location of other colonies along the coast that must be considered in management schemes. In Table A2 Kale's 1976 data on the timing of the nesting cycle were summarized for the colonies listed in Table A1.

15. These data clearly indicated the spring-summer (March-August) nature of the breeding seasons of the colonial waders on the east coast in 1976. Other Kale (personal communication) data were included in the species accounts.

## Species Accounts

### Brown Pelican

16. This endangered species nested in 42 colonies in Florida. Nesting was almost exclusively in black mangrove, although some red mangrove was used, and a few nested on the bare ground. Colony size varied from 5 to 10 to 1500 pairs. The location of all colonies was reported as to the specific locality, county, and coordinates of the colonies known to be active at one time or another since 1950 on dredged material islands:

| | | |
|---|---|---|
| Port Orange | Volusia | 29°09' N - 81°54' W |
| New Smyrna | Brevard | 29°02' N - 80°55' W |
| Riomar | Indian River | 27°38' N - 80°22' W |
| Ft. Pierce | St. Lucie | 27°28' N - 80°19' W |

| | | |
|---|---|---|
| Bird Island (Study Area I, Island Number 58) | Hillsborough | 27°51' N - 82°25' W |
| Anclote Sound (Study Area I, Island Number 4) | Pinellas | 28°06' N - 82°49' W |

17. These islands supported approximately 20 percent of the pelican population nesting in the state of Florida, the only state in the country that had a relatively stable breeding population.

18. No dredged material island in Study Areas II, III, IV, and V was used for nesting by pelicans in 1977. However, the Riomar and Ft. Pierce colonies were on dredged material islands only 16 and 35 km south of Study Area II, respectively; four large colonies existed on natural islands within the study region. In all these colonies the pelicans nested in mature black mangrove, although some nests were placed on the ground on islands when the birds had apparently killed the trees (i.e., Pelican Island, L. Wineland 1977, personal communication). Maxwell and Kale (1974) described nesting on the Riomar dredged material islands. The following comments came from their study; this island was created in the 1940's, enlarged in the late 1950's, and development of vegetation has proceeded undisturbed since then. Pelicans began nesting in 1968 when 50 pairs did so. The number increased to 300 pairs by 1973 and that number remained through 1977 (Kale 1977, personal communication). Black mangrove, white mangrove, and Australian pine are the dominant plants on the island with pelican nests primarily in the black mangrove, 5 to 15 m high. Maxwell and Kale suggested that, except for the little blue heron, the number of herons decreased since the pelicans began nesting in 1968 and that the increase in number of pelicans coincided with the marked decrease in numbers using the Pelican Island National Wildlife Refuge, 19 km to the north. They pointed out the "importance of designating and preserving presently uninhabitated mangrove islands as future nesting sites in the vicinity of known nesting colonies."

19. In Study Area V no brown pelican nesting occurred on dredged material islands, but a natural island covered with black mangrove was used. The Florida Game and Freshwater Fish Commission annual surveys for brown pelican colonies did not report this nesting colony (Nesbitt 1977,

personal communication) and this study was the first report of nesting there, when 22 nests with nestlings 6 to 11 weeks old were found in mid-May.

20. In Study Area I brown pelican nesting occurred in 1977 only on Island 58. However, in 1968-1972, pelicans nested on I-4. This island decreased in size by about half since 1969 and the vegetation deteriorated in the past 8 years. The pelicans have not used the island for nesting since 1972.

21. The nesting season was highly irregular in Florida. In the Keys nesting occurred in December-January with young fledged by July, although some nesting occurred throughout the year. On the west coast a more spring-summer breeding cycle existed with the peak laying occurring in March-April of most years. However, at least two colonies began nesting in January in 1 or 2 years of the past 9 and a gradual shift toward earlier nesting was apparent in recent years. The cycle on the east coast was more irregular with some nesting reported in all months. In recent years nesting began on some colonies in November-December with a peak in February-March, first young fledged in February, and most were gone from the nesting islands by August. On the east coast the islands used for nesting were also used throughout the year as roosting and loafing areas. On the west coast several of the nesting islands were abandoned after the young fledged; however, I-58 was used throughout the year by pelicans.

Double-crested Cormorant

22. On mature successional stages of dredged material islands, double-crested cormorants nested high in mature mangrove and in Australian pine. The species also nested on natural islands and inland in Florida. Nests were frequently built in the tops of the vegetation. However, on traditional nesting sites, such as Pelican Island and Hall Island, nests were low, often not more than 1 m above the ground. Nesting association was generally with pelicans, anhingas, and great blue herons, but cormorants were found on only some of the islands on which these species nested on the coasts of Florida. On these islands the cormorants tended to nest somewhat later than the pelicans and large herons but at the same time as

the anhingas and smaller herons. However, the nestling stage was shorter than for pelicans so colonies tended to be deserted earlier than the pelican colonies. This species was widely distributed in Florida, both near salt water and inland.

23. Of the colonial nesters, cormorants probably had the least attention paid to them by ornithologists in Florida, and considerable study is warranted on this species.

24. The timing of the nesting season varied somewhat but generally was from early December through late September, with the bulk of nesting in April-June (Maxwell and Kale 1974; this study).

25. Cormorants were highly susceptible to human disturbance; the adults fled from their nests very early on approach, and fish crows (Corvus ossifragus) rapidly stole the eggs or the eggs were knocked from the nest by the adult cormorants as they flew away. Extreme caution should be used when studying this species or when studying other species when cormorants are nesting nearby. Probably no approach closer than 75 m should be made to nesting groups.

26. No nesting cormorants were found in Study Areas III, IV, and V during 1977. In Study Area I small numbers nested in Islands 14 and 15, and a large colony has existed on Island 58 for many years. Island 14 had 20 nests present through May 1977, all in the top of a lone Australian pine, 10 to 13 m high. Most looked like they had adults incubating eggs but four were empty and two had small nestlings (5-8 days old) in late May. These nests were placed as high in the Australian pines as was possible to build a nest, and they surrounded, but were generally slightly higher (1 m) than, a great blue heron nest in the same tree. Island 15 supported four nests in the top of a dying Australian pine and two nests in another live tree. Great blue heron nests were also in this tree. The cormorant nests were within a meter of each other, and again, 10-13 m high. Both these islands had small herons and white ibis nesting on Brazilian pepper, which seems to be associated with the large Australian pine on many islands. Island 58 supported approxiamtely 300 pairs of cormorants for the past 10 years. These nests were all in the tops of the black mangrove and nests were near to and scattered among those of brown pelicans.

27. In Study Area II cormorants were found nesting on four dredged material islands: 66, 113 (Grants Farm), 152, and 153. In late April on II-66 there were four nests in the tops of an Australian pine 16 m high, and the adults appeared to be incubating eggs. In mid-May on this island there were 16 nests, and no nestlings were seen. Scott Clark (1977, personal communication) noted that no cormorants were present here in February 1977, but large young were present on 13 June. In the Moore Creek region just southeast of Study Area II, Girard (1976) and Clark found cormorants gathering in December, earliest eggs laid in mid-January, first fledglings present in mid-May, and the colony primarily abandoned by mid-June. All those nests were in the tops of mangroves, where the cormorants nested significantly higher than the anhingas and the herons which also were nesting on the island. It thus appeared that the cormorants nesting in the Australian pines on the dredged material islands in Study Area II were doing so later in the season and it may be that these represent renesting attempts. No nests of cormorants were found on the nearby islands on which herons were nesting.

28. On II-113 in late April, there were 45 nests high in the Australian pines on both the southwest and southeast tips of the island, along with 12 nests high in the Australian pine in the midwest portion of the island just inland from the heron nesting. In mid-May approximately the same number of nests were present in the pines but an additional 11 nests had been built in the black mangrove on the west side, just above the heron nests. Most of the adults were incubating during April and mid-May 1977 and only on 16 May were eight nests counted with small chicks present. However, on 30 May, H. W. Kale counted 125 cormorant nests on this island indicating an increase in the population.

29. On II-152 in late April there were eight nests, 7 to 9 m high in the Australian pine and approximately 2 m apart. One nest was about 6 m from an anhinga nest. On 16 May there were 13 nests present in this same location. On II-153 in late May, there was one nest 8 m high in an Australian pine on the northeast part of the island. On 16 May there were 17 nests in these trees, about 1 m apart built as high as possible in the

tree, along with three nests about 6 m high in the tops of the highest Brazilian pepper on the north side of the island.

30. Cormorants had an extended nesting cycle on the east coast of Florida beginning in early December and continuing through at least August. Large numbers of nests were present on Pelican Island at the time of this study, probably 250-350, and larger numbers have been present in the past. There were no cormorants at the Riomar dredged material island on 16 May but several nests were present at Ft. Pierce, all on the tops of the 6- to 8-m-high black mangrove.

Anhinga

31. This pelecaniform species nested throughout Florida, but was especially abundant in the south and central regions. Anhingas nested around all types of water, expecially quiet, sheltered waters, and were more abundant around freshwater bodies than near salt water.

32. One or a few pairs of anhingas could be found in most mature mangrove areas where pelicans, cormorants, and the various herons were nesting. They often nested either high in the Australian pine among the cormorants or just under the canopy of shrubs where nests were difficult to find. The species nested on the Riomar colony on the east coast and nests were found on II-113, 152, and 153. In late April no nests were present on II-153, but three were present on II-152. In Mid-May there were four nests on II-153 with adults incubating and an additional 13 adults roosting nearby. The nests were scattered among the cormorant nests in the Australian pines. On II-153 there were eight nests present, and three of them had young present, estimated at about 2 to 3 weeks old. These nests were 10 m high in the Australian pines, about 2 m apart, and one was about 3 m from a great blue heron nest. On Island II-113 there were 7 nests in late April, and 18 nests in mid-May. All were in the Australian pine about 20 m high, most had only adults present, but at least five had large downy young in mid-May.

33. Girard (1976) found 15 nests in the Moore Creek region which averaged 3.9 m high and ranged from 2.5 to 5.1 m, both in the interior and the peripheral areas of the islands in white mangrove.

34. The only nesting by anhingas in Study Area I in 1977 was on Island I-58, where they nested in the black mangrove, either on the top or more usually just below the canopy.

35. Nesting occurred in the spring and summer in most localities, from mid-March through mid-May, although nests with eggs and young have been found in February in South Florida (Palmer 1962).

Herons and Egrets, Family Ardeidae
White and Glossy Ibis, Family Threskiornithidae

36. Because of their similarities in nesting habitat and seasons, these species were discussed as a group, pointing out specific differences as known. Eleven species of herons and two species of ibis nested on or near saline waters of Florida and the Ardeidae-Threskiornithidae formed the largest group nesting on mature dredged material islands. They were nearly wiped out as breeding species around 1900 due to the plume trade. All the heron species sometimes bred in small colonies of their own species, but most bred primarily in large or very large mixed species groups. Little published documentation on the species mix in Florida was available, with the exceptions of the papers by Bancroft (1969, 1971), Maxwell and Kale (1974), and Girard (1976), but considerable study has been done and is being done by several individuals and organizations in Florida at present. Unfortunately, human disturbance was a major problem in heron colonies, with visits of even short duration causing extreme mortality. Most nesting occurred in the spring although some variation did exist.

37. With the exception of the great white heron (Ardea occidentalis) and reddish egret, the other herons and egrets nested throughout the state, primarily in mangrove, buttonwood, Brazilian pepper, cypress, willow, and Australian pine.

38. In south Florida a marked seasonality of nesting occurred with two major periods of activity: a winter period (November through February) and a spring period (March through June) (Robertson and Kushlan 1974). Reddish egrets, great egrets, and great blue herons generally began nesting in December, but some nesting by the great blue herons and great white herons occurred throughout the year with great white herons exhibiting

a peak in early winter, somewhat earlier than the great blue heron. With the exception of one individual reported nesting in Charlotte Harbor (Bancroft 1969), the great white heron was restricted to the Florida Keys, Florida Bay, with a few in the Ten Thousand Islands. In South Florida, the great blue heron and great egret also established nests in April-May, although the major species nesting in this period (March through June) were the small herons and the white ibises.

39. The best data on timing of the nesting cycle of the herons outside of South Florida came from researchers Bancroft, Maxwell and Kale, and Girard. Bancroft (1969, 1971) summarized data for a large colony on Hemp Key in Charlotte Harbor 32 km west of Study Area V. His data indicated that the great blue herons began nesting there in December-January, the great egrets in late February-March, and the remainder of the herons and egrets in late March-April and May. By August, nesting was essentially completed (Schreiber, unpublished data), but the birds continued to roost there through September-October. The number of individuals and species composition on this island declined drastically in the past 3 or so years for unexplained reasons (Schreiber, unpublished data).

40. Maxwell and Kale (1974) provided nesting cycle data for the Riomar colony in Vero Beach, a dredged material island just south of Study Area II. On 7-8 May 1973, Louisiana herons and snowy egrets composed 66 percent of all pairs present, cattle egrets and brown pelicans composed 24 percent, and all other nine species composed only 10 percent of the total. On 7 June, Louisiana herons, snowy egrets, and cattle egrets were present in equal numbers, indicating an increase in the cattle egrets in late May. On 18 and 24 June, only one-fifth as many Louisiana herons and three-fifths as many snowy egrets were present as on 7 June, but the cattle egrets had doubled in numbers; white ibises and black-crowned night herons had also increased in numbers to the point that the white ibises and cattle egrets were the dominant species in the late portions of the nesting cycle.

41. Girard (1976) studied a large colony at Moore Creek, Merritt Island National Wildlife Refuge, Brevard County, just east of the northern third of Study Area II. This study was the most extensive study of heron nesting in Florida to date. The dominant vegetation was white mangrove ranging in height from 1.5 to 6.5 m. This colony contained the following nesting pairs: 20 great blue herons, 150 great egrets, 500 snowy egrets, 750 cattle egrets, 400 Louisiana herons, 30 little blue herons, 5 green herons, 20 black-crowned night herons, 60 glossy ibises, and 1000 white ibises along with cormorants, anhingas, and wood storks. Great egrets and some snowy egrets established territories in early February and nests with eggs were present on 8 February. On 15 February, a few Louisiana herons had laid. The first white ibis laid the last week of February, and the first glossy ibis laid in the last week of March. Green herons nested the second week of February. Little blue herons began nesting during the later half of March. Cattle egrets were the latest nesters, and the first nest building activity was observed on 25 March 1975. By the end of May most cattle egret nests contained eggs but many had young present. This species nested closely associated with snowy egrets. Girard found earlier nesting by snowy egrets, Louisiana herons, and white ibises, all which nested 2 weeks to a month earlier than had been reported previously, but the author noted that the extremely high January temperatures in the year of his study may have affected nesting dates. Girard found the great blue herons nesting highest in the white mangrove, almost 2 m higher than the great egrets, snowy egrets, Louisiana herons, and ibises which nested between 0.5 and 2.5 m high, with a mean of 1.6 m. Differences between Girard's results and other published data probably were from differences in the habitat in which the herons nested and indicated that nest height in these species was not stereotyped and specifics should not be generalized from location to location. Girard found that inter-nest differences between species varied somewhat with only the wood storks and white ibises exhibiting distinct clumping of nesting. He also found egg losses at between 15 and 65 percent of all eggs laid. It is suspected that an important part of this loss was caused by the investigators disturbance and these data confirm that heron-ibis colonies should be visited with extreme caution.

42. These data clearly indicated the difficulties of censusing these species based on only one or two visits to a colony and indicated the April-June nature of the nesting cycle for the heron species on the mid-east coast of Florida.

43. Cattle egrets and reddish egrets need to be discussed in more detail. The cattle egret is the least aquatic of the heron species and when two birds were sighted at Clewiston, Florida, in 1941, it was the first sighting in the United States (Palmer 1962). By 1953 the species was breeding and by 1955 the Florida population numbered several thousand, mostly in the Okeechobee area. By 1959 the species was common and widespread through the state and in 1977 this species was perhaps the most common breeding heron in Florida. Eggs were generally laid in April-May-June, somewhat later than other herons, with whom they possibly competed for nest sites, although probably not for food, since cattle egrets tended to feed inland.

44. The reddish egret was undergoing a reestablishment of nesting area in 1977. In the 1800's the species nested throughout southern Florida as far north as Anclote Key (Paul et al. 1975). By 1900 and through the 1960's the species was confined to the Keys, primarily eastern Florida Bay. On 13 March 1970 one pair nested on Hemp Key in Charlotte Harbor (Bancroft 1971). On 10 May 1974 the species was found nesting on Bird Island, Hillsborough County (Island Number 58, Study Area I), and young were still present on 26 August. Paul et al. (1975) suggested this nesting was part of a sustained reoccupation of the former range of the species. In the southern portion of its range, nest building and egg laying occurred in December and young were present through May. In the northern region laying occurred in May and young were present through August; the nesting season for this species in Florida was December through September.

45. During 1977 no herons or egrets were nesting in Study Areas III and IV. In Study Area V, about 20 Louisiana herons were found in the tops of the black mangrove on the southwest tip of Island 1, along with several yellow-crowned and black-crowned night herons. One reddish egret

was also present in this area but, as discussed elsewhere in this report, the amount of human disturbance on this island probably precluded successful nesting.

46. In Study Area I herons were nesting only on five islands in 1977. One pair of green herons built a nest about 2 m high in the mangrove on the mid-east side of Island I-51. Nesting also occurred on I-14, 15, 58, and 59. On I-14 and I-15 there were fewer than a dozen great blue herons nesting between 10 and 13 m high in the Australian pine, and three nests were in the top of Brazilian pepper on I-15. These nests were associated with cormorants and were constructed as high in the pines as possible. Young either fledged or ready to do so were present and no incubating behavior was noted. Approximately 100 nests of white ibis were constructed 1 to 5 m high in extremely thick Brazilian pepper on I-14. No young were seen or heard as late as 12 May but by 1 June the voices of young were heard. Several black-crowned night herons were also present on this island. Island I-15 supported more birds than I-14 but on both islands all nesting was below the canopy with only a few pairs of great egrets or snowy egrets visible from the air, although 35 great egret pairs were present along with an equal number of snowy egrets, little blue herons, and Louisiana herons who had young of fledgling size in mid-May. Approximmtely 10 pairs of black-crowned night herons were present with young just able to fly or ready to do so. The absence of cattle egrets from this colony was notable.

47. The succession of vegetation, history of the nesting colonies, and status of bird species on I-58 and I-59, Bird Island and Sunken Island, were summarized in CZRC (1977) and Dunstan and Lewis (1974). Dunstan and Lewis (1974) provided detailed vegetation analysis of these islands and noted the bird-plant nesting associations. On I-58, 90 percent of all nests were located in the mangrove community and the most common species present was the cattle egret, although large numbers of great egrets, snowy egrets, great blue herons, Louisiana herons, little blue herons, a few green herons, numerous yellow-crowned night herons, and several black-crowned night herons were also present, as were numerous glossy ibises.

48. On Island I-59 the dominant vegetation was cabbage palm and Brazilian pepper and the dominant bird species present was the white ibis, nesting in the Brazilian pepper with night herons also present in large numbers, but not nearly as common as the ibis. Glossy ibises, little blue herons, Louisiana herons, black-crowned night herons, and yellow-crowned night herons were also present and are listed in increasing numbers. The 6700 white ibises far out number the next most common species, the yellow-crowned night heron, at 800 pairs.

49. These islands together supported almost 30,000 pairs of birds and were by far the largest heron colony in this study.

50. In Study Area II herons and egrets were nesting on eight dredged material islands as listed in Table 5 along with counts and estimates of the numbers present during April and May 1977. Precise numbers of herons present were difficult to derive due to the necessity of not disturbing them. The data for II-152 and II-153 were precise counts.

51. As an example of the difficulty of comparing population estimates for these species, Dr. H. W. Kale has supplied counts he made at II-113 on 30 May 1977, 10 days after the second survey of the island was conducted for this report. No birds were chased from their nests, but individuals were counted and estimates of numbers were made from the boat for this study, since visits to these colonies would have had a highly deleterious effect on reproductive success that far outweighs the value of the data collected. However, Dr. Kale made his estimates based on observations similar to those done for this study but then visited the colony and counted nests. With the exception of the black-crowned night heron, which was nesting well hidden in the vegetation and not seen by these researchers, the two sets of data are within 10 percent of each other. The percent composition of species was almost exact between the two counts.

52. The data collected during this study were presented so that if and when management schemes for these species are carried out, investigators will be able to compare population sizes to the 1977 data and thus evaluate the management practices. One must consider the season of the

year when each count was made. Also, three counts during one nesting season would be the minimal number necessary to accurately determine seasonality and success of nesting attempts.

53. Great blue herons nested in small numbers and, for the most part, either had large young ready to fledge or were roosting on nests without young during April and May. One incubating bird was found. All nests were high in the Australian pine from 10 to 23 m, depending on the height of the trees on the individual islands.

54. Because of their small size, secretive nature, and lack of large colonies, green herons were difficult to detect. Probably a few pairs were present on each of the islands with heron colonies present. Two 2.3-m-high nests were found in buttonwood on the southwest and northwest edges of the interior pond of II-125. On 25 April three eggs were present in the southwest nest and a 13- to 17-day-old chick was found there on 16 May along with a nest with two eggs on the northwest side.

55. Little blue herons were the least common of the small herons and estimates indicated a decline in numbers between April and May, possibly indicating an earlier nesting cycle by this species. Little blue herons were nesting in either mangrove or Brazilian pepper, from 1.3 to 4 m high, mixed with cattle egrets, snowy egrets, and Louisiana herons. This species seemed about equally distributed north and south in the study area.

56. Cattle egrets were by far the most numerous heron observed. There was an apparent increase in numbers between mid-April and mid-May on II-152 and II-153 but the same estimates were derived for the more northern islands. This could be because the numbers were counted rather precisely on the southern islands, but the large numbers on the other islands lowered the accuracy of the counts. Most nests were being constructed or incubation was underway during the survey although some large young were noted on II-66 on 16 May. Nests were clumped with usually less than 1 m separating them and were constructed from 1 to 10 m high in the frost-damaged mangrove on II-113 or the buttonwood and Brazilian pepper on the other islands. While cattle egrets nested close together, little blue herons, snowy egrets, and Louisiana herons were scattered

among them. Whether this resulted from the cattle egrets crowding out the other herons or from the other herons actively nesting among the cattle egrets should be investigated. Maxwell and Kale's (1974) data indicate later nesting by the cattle egrets. Islands II-62 through II-66 provided interesting insight into cattle egret nesting. Island II-66 was the closest of these four to the mainland and cattle egrets were most numerous here. Their nesting cycle was somewhat advanced over that found on the other islands which were further from the mainland. The numbers of cattle egrets decreased on islands as the distance from the mainland increased. The upland-feeding cattle egrets probably started nesting on the nearest island and then "spilled over" onto the further islands as the season progressed and the more accessible optimum habitat was occupied. This observation should be examined along with data from the feeding locations of the cattle egrets in the region of these colonies.

57. In 1976, on II-153, Kale (1977, personal communication; Table A3) estimated numbers of species similar to the estimates of this study for 1977. On II-153 Kale (1977, personal communication; Table A4) estimated 400 nests in late May 1976, all pairs incubating. In mid-July he estimated 225 nests with feathered young and 180 fledglings present. Apparently the population and timing of nesting did not change appreciably between 1976 and 1977.

58. The great egret was the least common heron found in Study Area II and only five nests were found on II-66 and four on II-63. The lateness of the surveys may have reduced this number somewhat since the nests contained large young. Nests were on top of the buttonwood canopy.

59. Snowy egrets were common on the northern islands but decreased in abundance further south and were not nesting on II-152 and II-153. On II-113 they were mixed with cattle egrets in small numbers and on II-62 through II-66 were found from 1 to 7 m high in buttonwood and Brazilian pepper. Louisiana herons were closely associated with snowy egrets and almost the same numbers were present, except Louisiana herons were found on the southern islands. Some nests of Louisiana herons had young, which ranged in age from 2 to 3 weeks old to fledglings. Most nests on II-62 were among the cattle egrets and several were 1 to 2 m high in low branches

of Australian pine. These small herons were less common on islands where cattle egrets were very abundant, perhaps indicating the effects of competition with this recent immigrant. The form which this competition takes was open to question. Louisiana herons were present but snowy egrets were absent on II-152 and II-153.

60. White ibises nested in clumps separately from the small herons, but occasionally scattered with them. As with the snowy egret and Louisiana heron, this species was most numerous in northern Study Area II, on II-62 and II-63. It was found in only small numbers on II-152 and II-153. The complete absence from II-65 and II-66, where the cattle egrets were the most abundant species, also indicated that cattle egrets may have excluded the ibis from nesting. On II-113 the two species were distinctly separate. Nesting was in buttonwood, mangrove, and Brazilian pepper. On II-152 and II-153, where nesting did occur with cattle egrets, the few ibis nests present were distinctly higher in the bushes than those of the cattle egret, but still below the canopy. Many nests contained eggs but young from 2 to 3 weeks old to fledging were also present. Most nests were 7 to 9 m high in buttonwood on II-152 and 3 to 7 m high in Brazilian pepper on II-113.

61. Glossy ibises were found only in small numbers on II-62, II-63, and II-65 where nests appeared to be in widely scattered clumps among the white ibis nests.

Wood Stork

62. Kahl (1964) provided a map of the major breeding distribution of wood storks in Florida and indicated that most nesting occurred either inland or in the Everglades-mangrove areas. In recent years nesting occurred also on the Florida east coast, at Moore Creek on the Merritt Island National Wildlife Refuge (Girard 1976), and on Pelican Island, Indian River County (Ogden 1973), islands within the general geographic region of Study Area II. No nesting by the wood stork on dredged material islands has been observed, but with the maturing of the growth on older dredged material islands, it appears that suitable habitat will develop. Since wood storks are unusual, data were included on the timing of their nesting season.

63. Bent (1926) gave egg dates as from 8 December to 30 April. Palmer (1962) noted that laying varied from year to year but was generally from December through April. Nesting success of this species has been directly dependent on the decline in water levels to concentrate fish in smaller pools, but severe drought caused nesting failure (Robertson and Kushlan 1974).

64. Data for Pelican Island, in the southern portion of Study Area II, indicated that nesting began in February and most young were gone by September. In 1970 on 21 April 250 adults and 15 nests were present (Schreiber, unpublished data). On 28 April 1975, 50 young had hatched and were up to 2 weeks of age. Some immatures were present and many nestlings were ready to fledge, indicating that nesting had begun by December that year. On 12 March 1976, approximately 150 adults were incubating, only a few eggs had hatched. The oldest nestling was less than a week old. On 21 May 1976, 250 to 275 mainly large and downy young were present. In late April 1977, 56 nests and 89 adults were present on the east edge of the island and an estimated 400 nests were present on the whole island. Much nest building was occurring and young up to 3 weeks old were present. These data indicated an increase in the numbers of storks using Pelican Island for nesting and also the variability in the timing of nesting. However, a winter-spring cycle was present in Florida with latest nesting farthest north in the state.

Roseate Spoonbill

65. The breeding of the roseate spoonbill in Florida during the early 1900's was confined to Florida Bay, although the species formerly bred as far north as Tampa Bay on the west coast (Allen 1942). Immature birds have been seen along the gulf coast in spring and summer for many years.

66. In 1975 spoonbills were seen on the Bird Island, Alafia Banks (I-58). In late February and late April 1975 a nest was found, the first reported nesting in Florida outside of the Florida Keys since 1912 (Dunstan 1976). This nest was in black mangrove and the three young were about a week old on 28 April, so laying must have occurred in March.

Spoonbills were present through the fall (October), but young probably were fledged and independent by mid-July, and most fledged in May.

67. It was interesting that roseate spoonbills and reddish egrets have both been recorded nesting in the mid-1970's on the same island. These species seemed to be extending their breeding range northward in Florida, to what was perhaps their former breeding limit (Dunstan 1976). In 1976 and 1977, a few pairs nested in the black mangrove on I-58. No spoonbills were seen elsewhere in the study areas in 1977.

68. Nesting in the Keys began in October with a peak in January-February, and the colonies were deserted by May (Robertson and Kushlan 1974, Sprunt 1954), but in Tampa Bay the spoonbills were present February through October.

Clapper Rail

69. This rail was strictly saline, feeding and nesting in salt marshes and mangrove swamps along the entire coast of Florida. Nesting has not been reported specifically on dredged material islands and none were found in 1977, but they would be expected in mature mangrove areas or on islands maintained as salt grass communities. Nests were relatively difficult to find and have been reported from March through June with eggs (Howell 1932). An early spring-summer nesting season was indicated.

American Oystercatcher

70. This species nested as isolated pairs at a few localities along the gulf and east coasts of Florida, and they congregated in large numbers in the winter in Tampa Bay and Charlotte Harbor. Howell (1932) noted the species as formerly common throughout the states' beach areas and it previously bred on all coasts, but was rare at the time of his writing. Sprunt (1954) never saw the species in Florida but recorded reported nesting in mid-May at Clearwater, Pinellas County, and St. Augustine, St. Johns County. Ogden (1973) noted that "indications of nesting by American Oystercatchers is always of interest" and reported a pair with two young on dredged material near Vero Beach on 18 July and at Dunedin Beach, Pinnelas County, on 3 May.

71. On the west coast of Florida in 1969-1976, the authors found pairs present on many isolated beaches and dredged material islands, usually

only one pair on a small- to medium-sized island while a larger island with considerable visual isolation had more pairs; this was born out by this study.

72. In late April 1977 in Study Area II, individual adults were found on II-105, II-124, and II-133; a pair of adults sitting close together called loudly on approach to II-111; a pair with three small downy young (4-6 days old) were noted on II-119.

73. In Study Area III on 27 April there were single pairs on III-11 and III-13. In Study Area I in late April and early May there were pairs of adults on I-3, 4, 5, 6, 8, 16, 17, 20, 24, 25, 27, 28, 29, 31, 32, 44, 45, 47, 48, 50, 51, 54, 58, 61, 62, and two pairs on 49b and 63 but no nests were found.

74. On 16 May in Study Area II, one adult was present on II-151, one pair on II-106, two pairs on II-111, and the two adults and three young were still present on II-119 (which could probably fly on that date). A nest with two eggs was present on II-138. This nest was on the south end of the island in shell and rock, about 0.5 m above the waterline.

75. In mid-May in Study Area III, there were pairs of adults on III-8, 9, 12, and 13 and 12 pairs on III-10. All these birds were defending territories, calling loudly and remaining in the same areas, as a search for nests was conducted but none were found. Barbour et al. (1976) found 15 oystercatchers in this region during the summer of 1975 but also did not find any nests. This population was probably increasing in the region and nesting undoubtedly occurred in 1977.

76. On 17 May in Study Area IV two adults and three downy young (estimated at 6-10 days old) were present. None were seen in the Fort Myers area (Study Area V) in mid-April or mid-May.

77. In late May in Study Area I pairs of adults were still present on most islands reported for late April. Again, no nests were found but longer searches may have revealed one on each of the 27 dredged material islands on which oystercatchers were present.

78. On I-49b, one or two pairs have nested successfully for 5 of the past 8 years. For the other 3 years, nesting was probably attempted but

was unsuccessful. In 1975, three fledglings were present on 3 June, and in late April 1976 two adults with two young were seen. In both years young were seen on the island through mid-August.

79. These data indicated that nesting probably occurred in Florida from late March through early June. Some young were independent by early June but most young did not leave the islands until late August or early September. Large flocks have been seen in the Tampa Bay region throughout the winter months and this species used dredged material islands extensively for roosting, loafing, and feeding during all months of the year.

80. American oystercatchers were definitely more common on the west coast than the east coast of Florida in 1977. This species nested in early successional stages on dredged material islands, usually just at the boundary between bare shell-rock-rubble and the pioneering vegetation, primarily grasses, low shrubs, and succulents.

81. Based on these data, and in light of the apparent scarcity of nesting by oystercatchers in Florida in the past, it appeared that dredged material islands were providing an important nesting substrate for this shorebird.

Snowy Plover

82. The snowy plover nested at a few scattered localities along the gulf coast and became rare in the last several years (Robertson and Kushlan 1974). The species also spent the winters in Florida. The other breeding localities of the distinct subspecies that nested in Florida were in Louisiana and a few localities in the West Indies. The major limitation to breeding in Florida seemed to be habitat. Where sand fills were produced, the bird quickly moved in to nest. When vegetation forms or development occurred, the birds disappeared (Woolfenden and Schreiber 1973).

83. Nests with eggs and young were reported in May and June (Weston 1927) but also in April and July (Sprunt 1954), so the spring-summer cycle of the other species of the shorebirds occurred here also.

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84. A pair of snowy plovers was present on I-50 and I-51, in late April 1977, that were acting highly territorial and, although no nests were found, nesting probably occurred on both islands. These were the only locations in the study areas where such behavior was noted.

85. This species would readily respond to proper management of habitat: maintenance of open sandy areas with only very sparse vegetation.

Wilson's Plover

86. Wilson's plovers nested commonly on all Florida coasts (Howell 1932) and have been reported nesting on dredged material areas (Bailey 1931, Paige 1968). Eggs were reported in April and May and the birds would be gone from the nesting islands by August, although dredged material areas were used throughout the year for roosting, loafing, and feeding. Nests were placed in open grassy areas. In 1977, the only nesting activity noted in the study areas was on I-61, where a pair of adults with two young about 5 days old was present in late April.

Killdeer

87. Killdeer nested in proper habitat throughout the northern parts of Florida, in grassy, open, sandy areas, frequently on the mainland but also on dredged material areas. Nests with eggs were present in April through June and there could be considerable renesting. Young would be gone by August (Howell 1932, Dickie 1965, Truesdell 1970). In 1977 no nesting was noted as occurring on dredged material islands.

Willet

88. Willets nested in thick, short grass near mudflats and on beaches and were common nesting birds along all coasts of Florida. In past years, nests were found by the authors on dredged material islands on the west coast when eggs were present in early May. The nesting season was probably from April through August with most laying in late April and May, possibly into June (Howell 1932, Sprunt, 1954).

89. The willet was the only coastal sandpiper that bred in Florida. During 1977, nests or behavior indicating nesting, were found on I-19, 50, 51, 53, and 60. On I-19 and I-51 one and two pairs showed territorial behavior as did three pairs on I-53 and four pairs on I-60. On I-53 there was also one pair with two young about 1 week old and one nest with one

damp young, one pipped egg, and one whole egg on 28 April. On 5 May one nest with three eggs was present on I-60. No nests or territorial behavior were observed in the other study areas.

Black-necked Stilt

90. Stilts nested in selected locations along the coasts of Florida (Bailey 1931, Howell 1932, Paige 1968). They favored areas near shallow pools and protected embayments, where nesting occurred in grasses near the shoreline.

91. In 1930, stilts nested on a large, filled area in Biscayne Bay, and in 1968 nesting was reported on a filled campground in Flamingo. Nests were found in mid-February through June, most in April and May. Young were probably gone by August.

92. This species was a prime candidate for nesting on early successional stages of dredged material islands but these islands also served very importantly as feeding areas for them.

93. No evidence of nesting was found in 1977 on the dredged material islands of this study.

Laughing Gull

94. Sprunt (1954) summarized the distribution of laughing gulls in Florida as "occurs throughout the year on all coastal waters, but breeds in only a few localities." In 1866 the species nested on an island in the Halifax River, near Port Orange, Volusia County, and in colonies in Charlotte Harbor, Punta Rassa, and Key West (Scott 1887). In 1915 a few pairs nested on a small island about 3 km west of St. Marks Lighthouse, Wakulla County, and on 6 June they contained both eggs and newly hatched young. In 1927 a small colony was reported on Cape Sable, Monroe County, and on a mangrove key near Tavernier, Monroe County. Historically the largest colony existed on Passage Key, Hillsborough County, in Tampa Bay where over 1000 young were raised in 1912. However, the hurricane of October 1921 obliterated this island and many fewer gulls nested in Tampa Bay in following years. The species also was reported nesting in 1922 on Panama Key and on sandbars near Pass-a-Grille Beach, Pinellas County. In 1942 nests were found there on the beach on 1 July.

95. Dinsmore and Schreiber (1974) noted that nesting has primarily occurred on islands created by dredge and fill operations in Florida. However, White and Kushlan (1977) reported 15 colonies totaling 2800 pairs in Florida Bay and the Lower Florida Keys in 1976, none of which were on dredged material islands. In 1974, Lewis and Dunstan (in CZRC 1977) recorded nesting on Island I-61 of Study Area I, which was 9 years old at the time, where nesting was associated with vegetative cover of beach paspalum. Schultz (1935, 1936) and Mills (1934, 1935) reported similar usage of another island in upper Hillsborough Bay when 1000 pairs were present in 1934, 1500 pairs in 1935, and 2000 pairs in 1936. Lewis and Dunstan (CZRC 1977) noted that the island might still be in use by laughing gulls if vegetation had been managed to keep it suitable for them. Hallman (1968, 1971) noted nesting at Port St. Joe, Gulf County, when he found nests on 5 June 1953 and 21 May 1967. On 19 June 1971 fully feathered but non-flying young were present there. Ogden (1973) noted nesting on "spoil" inside National Aeronautics and Space Administration (NASA) land on Merritt Island, Orange County, where laughing gulls have nested each summer since them. Barbour et al. (1976) reported adults nesting in 1975 on the "spoil" islands which had been constructed between 1964 and 1967 at the mouth of the Cross Florida Barge Canal. This is Study Area III but it has not been possible to determine which islands were used in 1975, although probably they were III-14 and III-13. Schreiber and Schreiber (1975) reported nesting on a dredged material island in north Charlotte Harbor from 1973 through 1975 with numbers increasing each year. Nesting also occurred there in 1976 and 1977. Dunstan, Schreiber, and Dinsmore (1975) reported nesting on Island I-61 in 1974. By far the largest colony in the state was on I-49b, in Boca Ciega Bay, Pinellas County, reported on by Dinsmore and Schreiber (1974) and which contained some 15,000 to 20,000 pairs in 1975 through 1977.

96. The best data on the timing of the nesting cycle of laughing gulls in Florida were those of Dinsmore and Schreiber (1974, Table 1, page 421). Those data were summarized here along with pertinent notes for other nesting locations.

97. On I-49b the adults began to concentrate in the region of the colony in mid-April (Table A5). The peak of laying, based on 9 years of data, was usually the first week of May. The earliest nestlings were seen on 14 May in 1973. Incubation lasted 21 to 23 days. The peak of hatching was in the fourth week of May. By mid-June a few young were able to fly short distances and by late June most young left the territories to gather on the edges of the colony. Records of the latest nests still containing eggs were on 27 June 1972 and 22 June 1973, and in 1976 two fresh eggs were laid in a new nest on 5 June. However, the major laying was completed by 13 May. The year 1973 was a late year with the peak of laying in the second week of May and no young flying by 22 June. Most young fledged in June and by early August most left the colony. By late August most adults and young were gone from the colony region and by mid-September the colony was totally deserted.

98. The nesting cycle in the Tampa Bay region (Table A5) seemed to be characterized by rapid movement into the colony with laying within 2 weeks of occupying territories by adults. This cycle was in marked contrast to that on the dredged material island in northern Charlotte Harbor (Table A6) in which, during the 3 years (1974-1976) for which there were good data, the adults gathered in or around the colony actively claiming territories as early as 7 March. However, no scrapes were present that early although as many as 300 adults were present on the tiny island on 22 March and 13 April 1976. On 3 May 1976 there were 25 scrapes, 31 nests with one egg, 50 nests with two eggs, and 27 nests with three eggs, thus indicating earlier laying than in Tampa Bay that year. By 12 June 1976 none of the chicks present were over 3 weeks old, and most were less than a week old; few eggs were present. On 4 July, many young were on the beach and on 5 July, when 500 young were banded, approximately half the total present, the youngest chicks were 10 to 14 days old. Most were 4 to 5 weeks old; 50 to 100 young could fly. On 5 July eight nests were found with two eggs and five nests with one egg each, indicating that some late laying had occurred. On 25 July, most of the young had fledged. On 19 August, only about 25 young remained on the island and no adults were present.

In 1977, a visit on 30 April indicated a cycle of egg laying commencing in late April similar to other years in that region.

99. The only data available for the northwest Gulf panhandle nesting colony were from Hallman (1968, 1971) who noted 1 nest on 5 June 1953 and 80 nests on 21 May 1967. No mention was made of the state of nesting but it appeared that the cycle was somewhat later in that northern region than in the Tampa Bay region (Table A5).

100. The 1977 data for Study Area III (Table A7) indicated a similar rapid movement into the colony site as in Tampa Bay. In fact, it seemed, based only on two visits, to have occurred even faster in this more northern area. It was obvious that nesting began in early to mid-May and laying was continuing on 17 May. It was surprising to find as many nests and eggs present on that date since essentially no adults had been present 20 days earlier. It was obvious that nesting commenced on III-13 and III-14 and then continued on to III-11 and III-12, possibly as prefered habitat on the outer islands was fully occupied.

101. The laughing gulls nesting on Merritt Island, Brevard County, constructed 1050 nests in June 1974 (Ogden 1974), and 1350 in June 1975. Loftin and Sallas (1977) found one nest on Bird Island in Jacksonville in 1976. This nest contained two eggs on 30 May, but the eggs were awash under high tides on 8 June. The adults were still present. On 10 June, another nest nearby, noted as probably a renest, contained two eggs and on 25 July two downy young were present. These probably fledged, although they were not seen on or after 1 August. This was the first nesting of this species in northeast Florida and probably indicated that the species was beginning to expand its breeding range along that coast, from Merritt Island colony or from large colonies along the South Carolina coast, 150 miles to the north. The timing appeared to be later than elsewhere in the state but this may have been because it was an isolated nest.

102. No nesting was found on any dredged material islands in Study Area II. Nesting by approximately 1000 laughing gulls has been reported on dredged material on Merritt Island in 1977 where eggs and young were present on 28 May and a few eggs and mostly young were present on 14 June.

These colonies were apparently the same ones reported by Ogden (1974); the scanty data indicated a similar nesting cycle as on the west coast.

103. The laughing gulls nesting on I-59, I-61, and I-65 have all been in beach paspalum, and nests on I-49b and I-66 were associated with the clumps of groundsel, dog fennel, and sand spur. On all islands, but especially the latter two, the species clearly exhibited the visual isolation for nesting described by Burger (1972). Cleared or bare areas of sand and gravel were not used for nesting and low bushes that supplied visual isolation had nests clumped around them. In areas of low grasses without bushes, nests tended to be widely spaced with 2 to 3 m separating them. However, around a bush as many as four to five nests would be present within a square meter if the adults sitting on the nests could not see their neighbors. The density of nesting was measured on I-49b and I-61 and III-14 in mid-May 1977 and was found to be one nest/ 2 $m^2$ in areas of beach paspalum on both I-14 and I-61. A density of one nest/2 to 3 $m^2$ was measured on most of I-49b among groundsel and dog fennel but in the eastern section of the island, where prior to 1976 no nesting occurred and the vegetative cover was much less, a density of one nest/8 $m^2$ was measured.

104. An estimated 800 pairs of laughing gulls nested on I-61 and the data on timing of the nesting cycle for 1977 are given in Table A7. On I-66, more than 7800 adults nested in an area approximately 5 ha in the upland central region, consisting of rocky, uneven, eroded soil with scattered groundsel in low density grass cover. Fledgling juveniles were present in the area in early July.

Gull-billed Tern

105. The first reported breeding of gull-billed terns in Florida occurred in 1932 when two eggs were found near Pensacola on 10 July. Since then many nesting records have been reported from scattered localities throughout the state, primarily near St. Joe Bay, Gulf County (Hallman 1960, 1968); the Bayway, Pinellas County (Rohwer and Woolfenden 1968); in the mid-1970's a colony of a few hundred nests on Little Bird Island, Nassau Sound, Duval County (Ogden 1974); and 300 pairs on dredged material islands in the Banana River near the NASA Causeway (Bennett 1977

personal communication). Nesting occurred primarily on dredged material islands or sparsely vegetated fill-sand. Most eggs apparently were laid in mid-May or late May or early June, and presumably the yound had fledged from the colony area by late August.

106. This species was not observed during this study.

Common Tern

107. The common tern was reported nesting in two locations in the 1960's and 1970's, but was confined to the Dry Tortugas prior to the 1930's when they stopped breeding in that location (Robertson 1964, Hallman 1961, McGowan 1969, Hallman 1971). The recent locations were on a roof in Pampano Beach where large-sized young were found in mid-June 1969 and on a dredged material island in St. Joe Bay, Gulf County, where nesting occurred at least in 1961 and 1971 when eggs were found in June. Nests were associated with black skimmers, royal terns, sandwich terns, least terns, and laughing gulls.

108. This species was difficult to identify, especially molting subadults, and caution should be taken when searching for nesting which probably occurred with other larids in the summer months.

109. This species was not observed during this study.

Roseate Tern

110. This species nested primarily on the Dry Tortugas (Robertson 1964) with some nests reported in the Keys, primarily in Key West Harbor (Ogden 1973) and at Cocoa Plum Beach, Crawl Key, Monroe County. Nests were present from May to July with young reported in June and July. The total Florida population did not exceed 350 pairs (Robertson and Kushlan 1974). Nesting occurred on natural beaches and man-made bare ground, such as new fill and bare dredged material.

Least Tern

111. The least tern was the most facile of all the tern species, and perhaps of any marine type bird breeding in North America, and quickly became established on new sand-coral-rock fills. Once grasses became prominent, the least tern stopped nesting in an area. They nested readily on dredged material islands, and management for the early seral stages of vegetation succession (bare areas) necessary for nesting by this species was relatively simple and straightforward. Least terns nested

primarily in open sandy-rocky areas with some elevation above sea level but usually less than a meter. In 1975 the 2500 pairs of least terns, comprising 27 percent of the Florida population, were nesting on roofs of buildings, an obvious indication that suitable nesting habitat was absent in Florida (Fisk 1977, personal communication).

112. In April and May 1977 least terns were found nesting in five loosely classified situations:

a. On open sandy beaches, occasionally washed by waves or at high or spring tides.
b. Sandy areas with pebbles, broken shells with grain size less than 1 cm.
c. Sandy areas with large shells.
d. Rocky shell rubble, 1 to 8 cm grain size, with eggs laid among shells or the small grain areas.
e. In sandy soil areas with grasses and small shrubs present.

These latter nesting areas were unusual. Frequently if grasses, shrubs, and vines were present in the area behind and above the beach, the nests were placed in the area of integration of the vegetation down to the high waterline. Usually the eggs were merely laid on the existing substrate and no discernable nest existed, although occasionally a few shell pieces were placed in the nest cup.

113. In Study Area II nests were either on the open beach or rocky areas. In Study Area I nests were among the grasses and vines on I-31, on the sand and intergrade area on I-4, and on the sandy substrate with shells lining the nests on I-43. On the east coast in late April a total of 160 least terns were roosting on II-85, 92, 90, 99, 105, 109-110, 119, 129, 133, 134-135, and 154. Most were on territory, sitting or courting (carrying fish), and the only eggs on that date were present on II-154 when four egg clutches were found, with approximately 20 adults present. Closest nests were 60 cm apart on the west side of the island in the rocky rubble. This island was disturbed by the authors for less than 5 min, during which time the adults circled and called but gradually drifted away from the island so that by the time the authors returned to the boat and drew anchor, no least terns were in sight or could be heard. On 16 May no least terns were near this island. It is suspected that this disturbance caused the abandonment of the colony. This information

provided a good example of the need for isolated areas on which least terns can nest. The lack of disturbance may be most important during early courtship and egg-laying stages.

114. In mid-May, in the east coast study area nesting least terns were found only on two islands and no loafing birds elsewhere: the sandy spit between II-109 and II-110 had 27 definite nests with 20 more pairs actively courting. Nests were widely spread with at least 1 to 2 m between the closest; many were on the beach crest 1 m above the water and among the vegetation as noted above. Island II-119 had 24 nests and 26 adults were present. The nests were in the grass or rocks near driftwood on the crest of the islands, while others were on the beach and the sand spit to the west of the island.

115. In Study Area I over 400 least terns were present on I-4, 15, 25, 31, 32, 35, 42, 43, 44, 45, 47, 48, 49b, 54, 63, and 65. Nests were found on 4, 25, 31, 43, 48, and 63 and probably were present on 32 and 65.

116. On 4 May on I-4 200 adults were present; also present were 50 nests with eggs and 30 scrapes, eight two-egg and nine one-egg clutches. These nests were 30 to 60 cm apart in the open rocks of the northwest side of the island. On 25 May 300 nests were counted with 17 one-egg and one-chick nests, three nests with two chicks, and 10 chicks not associated with nests were counted. Nests were primarily on the north and west portion of the island and were from 0.5 m into the vegetation down to the shore. None were on the east sand spit or in the middle of the island. This is by far the largest least tern colony in the study area, all others contained fewer than 20 nests. It is suspected that the small size of this island and its relative isolation from boat traffic was the reason that the least terns were able to nest here.

117. Published records of the timing of nesting by least terns on the dredged material areas were uncommon. Available breeding cycle information is reported below. Weston (1927) reported the then earliest known nesting for the Pensacola region as hatching on 24 May, with seven nests present on 22 May. On 11 June, 23 nests and several downy young were present. Von Schmidt (1968) reported courtship activity on a beach

at Siesta Key, Sarasota County, on 3 May 1966 but no colony was noted as forming in the region. Paige (1968) reported eggs being inundated in May in the Flamingo, Monroe County, region.

118. On the Dry Tortugas, one juvenile and two nests with eggs were present on 1 July 1973 (Woolfenden and Robertson 1974) and Robertson (1964) has reviewed the history of the population of least terns on that island group.

119. Some dates were available for inland nesting attempts, and since similar timing probably occurred on dredged material islands along the coast, these inland data are presented here in some detail. Lohrer and Lohrer (1973) reviewed inland nesting and reported that on 24 June they discovered a colony in Highlands County when a newly fledged young was present whose flying ability had improved considerably by 25 June. On 30 June six nests contained two eggs and one nest contained one egg. Based on an incubation period of 20 to 21 days and a 17- to 20-day fledgling period, and with hatching occurring 5 to 11 July, laying began in the third week of June. They reported two laying periods of mid-May and mid-June to late June that year. In Jacksonville, Duval County, Loftin (1973) reported nests with eggs on 12 June, eggs and chicks on 14 June (laying occurred 22 to 24 May), and the young were last seen on 24 June. However, the presence of concerned adults on 3 July indicated the young were still present on that date.

120. Downing (1973) summarized the least tern nesting locations which he was able to locate. The following were occurring on dredged material:

FLORIDA GULF COAST, surveyed 8 to 14 May 1973:

| | |
|---|---|
| Pensacola: | Thirty pairs were on a canal, on the bay side of the beach. |
| Destin: | Three colonies which totalled 35 pairs. |
| Port St. Joe: | A colony of 60 pairs, with eggs, dredging. |
| St. George Island: | Twenty pairs were on a dredged material island near the mainland. Ten pairs were reported on the western tip of the island in June. |
| New Port Richey: | Twenty pairs were located on Gulf Harbor Development. |

Tampa-St. Petersburg: Ten pairs were located on the eastern end of I-75 Causeway. Four hundred pairs in four colonies were located south of St. Petersburg from the west end of Pinellas Bayway to DeSota State Park. Twenty-five pairs were on the Causeway on the south side of the Skyway.

Palm River: One hundred plus pairs were located.

Casey Key: Five pairs found on a beach.

Gasparilla Island: Thirty pairs found on islands near the Causeway.

Cayo Costa Island: One hundred pairs were located on a barrier island.

Ft. Meyers: One hundred pairs in two colonies on islands east of the old bridge were found.

Marco Island: Fifty to one hundred pairs on canal development near old access road were located.

FLORIDA KEYS, surveyed 15 May 1973:

Key Largo: Two hundred plus pairs in two colonies were located on hard coral development.

Plantation Key: Fifteen pairs located.

Long Key: Twenty pairs were found on the north end of coral development.

Big Pine Key: Fifty pairs were found in two colonies.

Cudjoe Key: Two hundred pairs were located in two colonies on coral development.

Sugarloaf, Saddlebunch, and Big Coppit Keys: Twenty-five pairs in three colonies were on coral development.

Geiger Key: Sixty pairs were on coral development.

FLORIDA ATLANTIC COAST, surveyed 16 to 17 May 1973:

Miami, Fair Isle: Fifty pairs were on development.

Virginia Key: Ten pairs were on old vegetated dredging material.

Hallandale: Fifty plus pairs were found on canal dredging near the race track.

North Palm Beach: Twenty-five pairs were located where the Inland Waterway enters Lake Worth. These were late nesters, most having only had one egg.

Stuart Beach: Fifty pairs in two colonies, one on the Causeway and one on construction material in the Indian River were found.

Vero Beach: Ten pairs on hard-packed construction material were found.

North Cocoa Beach: Twenty-five pairs were located.

Banana River Boulevard: Twenty pairs were behind a shopping center at Highway AIA and Highway 520.

New Smyrna Beach: Three to four hundred pairs were on new dredging material at the northern tip.

Duval County: A gravel pit colony of unreported size was found.

121. Downing further noted that of the 5,000 pairs of least terns in 103 colonies along the gulf and east coasts of the United States in May and June 1973, less than 20 percent were on natural beaches and dunes. The remaining 80 percent were on man-made areas, primarily material dredged for development or during channel maintenance. It was thus interesting to note that as far back as 1930 Bailey (1931) reported least terns nesting on fill next to a canal in Biscayne Bay. Dredged material islands and points of land obviously provided critical habitat for the least tern.

122. Ogden (1974) reported 80 nests on Little Bird Island in Nassau Sound and Jacksonville, and Barbour et al. (1976) reported 225 nests on two "spoil" islands in the Gulf of Mexico 2 km from the mouth of the Cross Florida barge canal in Citrus County (Study Area III).

123. The available data indicated that least terns may attempt renesting. Egg laying occurred primarily during May in Florida. A few eggs perhaps were laid in the last week of April, and some laying occurred in June and unusually into July. Most young were gone from the nesting islands by late June; young remaining until mid-August was unusual Nesting islands and other islands were used for roosting and loafing throughout the year. Dredged material islands provided important habitat for this species in Florida.

Royal Tern

124. The historical and recent nesting of royal terns in Florida was summarized by Barbour et al. (1976). Nesting occurred in scattered localities throughout the state, particularly on newly created dredged material islands, suggesting that the species was reestablishing itself along the coast after having nested in small numbers at widely scattered localities on the west coast at the turn of the century and in the 1930's. A small colony has existed in recent years at Shell Island, off Port St.

Joe on the northern gulf coast. Large colonies existed on either Bird Island or Little Bird Island, Nassau Sound, Duval County, where as many as 2100 birds were present in 1974 and on dredged material islands inside Merritt Island Refuge, Brevard County, where 200 nests existed in 1974. In 1975, besides those colonies, one pair nested on a dredged material island in Charlotte Harbor, Charlotte County, Florida (Schreiber and Schreiber 1975) and about 35 pairs nested on two of 13 dredged material islands in Citrus County (Study Area III).

125. At that site on 3 June 1975, 12 nests with eggs and about 45 flightless young were present (Barbour et al. 1976). In late April 1977 only 14 royal terns were observed in this area. On 17 May, royal terns were nesting only on III-13 where there were 21 nests with one egg each. The royal terns were nesting on the highest part of the island, about 2 to 3 m high, and all nests were closely packed with less than 40 cm separating each egg. On the beach on the south side of III-12, 75 adults were loafing and 30 adults were standing in an area higher up the beach where they may have eventually nested, but no eggs were present. No nests were found on other islands and no other royal terns were seen in this region. The rapidity with which royal terns moved into this region and commenced nesting in 1977 was intriguing.

126. In 1977 one pair of royal terns again nested among the numerous laughing gulls on the dredged material island in Charlotte Harbor.

Sandwich Tern

127. The sandwich tern has been reported nesting in only two locations in Florida during the 20th century: by Stevenson (1972) on an island near Port St. Joe when he found chicks and one nest with an egg on 31 July 1970 and by Downing (1973) in the same location when he found 25 pairs on 10 May. Loftin and Sutton (1975) found another colony on Little Bird Island, Nassau Sound, Duval County, when nests with eggs were present in June 1974. These nests were present with eggs through 7 July, but on 14 July no eggs were found, indicating that the new colony failed that year. Although the species was reported from several locations in Florida in the 1800's, the record by Stevenson was the first Florida

breeding reported in the 20th century, and Loftin and Sutton's 1974 report was the first known breeding of this species on the Atlantic coast south of South Carolina.

Caspian Tern

128. The first record of the caspian tern nesting in Florida was in 1962 when Woolfenden and Meyerriecks (1963) recorded a nest on sand fill along the Bayway, Pinellas County. Previously this species was an uncommon, but regular winter visitor, in the state (Howell 1932). The 1962 nest on the Bayway was first discovered on 13 June, the egg hatched between 8 and 11 July, and the chick was last seen on 1 September when it was fully capable of flight. Another nest was recorded in the same region of Pinellas County (Rohwer 1968) in 1967 with young ready to fledge on 21 June and still present on 27 June. Schreiber and Dinsmore (1972) summarized the species nesting in 1969, 1970, and 1972, in Pinellas County. Nests in these years were on a dredged material island in St. Joseph's Sound (Island 4, Study Area I).

129. In 1973 this species was reported nesting in Brevard County and on the Pinellas Bayway (Ogden 1973). In 1974 nesting occurred in Hillsborough County on a dredged material island (I-61). On 5 May, nests contained eggs, and on 4 June, 16 nests contained eggs or young. The first chick was found on 27 May. By 30 July all chicks that survived and the adults had abandoned the island. Also, that year a pair nested on a dredged material island in Charlotte Harbor, Charlotte County, when a chick about 3 weeks old was found on 20 July (Dunstan, Schreiber, and Dinsmore 1975). Nesting of this species has definitely increased in Florida and appeared to be associated with other larids in nesting attempts. No nesting was observed in the study areas in 1977.

Black Skimmer

130. The black skimmer bred in scattered, favored locations throughout Florida. Howell (1932) reported nesting on Amelia Island in Duval County near the mouth of the St. John River, on Coronado Beach at Mosquito Inlet, Brevard County, on Passage Key in Tampa Bay, Hillsborough County, and near Pensacola. Sprunt (1954) added nest sites in Charlotte Harbor, at Daytona inlet, with nests present containing eggs

on 6 June at Passage Key, Hillsborough County, 70 nests with eggs at Mosquito Inlet on 15 June, and nests with eggs near Pensacola on 24 June. Other nest sites included Marco Island Development, Port St. Joe, New Port Richey, Gulf Harbor Development, and several locations in the Tampa Bay region (Downing 1973). Ogden (1974) reported nesting on Little Bird Island, Nassau Sound, Duval County, in 1974; Barbour, Nesbitt, and Gilbert (1976) reported 250 nests on islets off the mouth of the Barge Canal in Citrus County in 1976; and Greene and Kale (1976) reported the first roof nesting of this species in Ft. Lauderdale in 1975. They reported abnormal behavior and indicated that adults first appeared on 14 June when two nests with eggs were found. A maximum number of 45 adults and 8 nests were present on 12 July and all were gone by mid-August.

131. This species nested the latest of all species considered in this report and renesting appeared to be common. Essentially all nesting has been on open sand beaches, construction fill, berms along highways, or dredged material islands. Black skimmer was highly susceptible to human disturbance.

132. The following summarizes the author's data on nesting on a natural sand islet in the Charlotte Harbor region surveyed monthly in 1975 and 1976. In 1975 none were observed prior to 13 June but on that date some 300 adults were gathered on the islet. On 11 July, 37 nests had eggs, 18 had chicks, 14 had eggs and chicks, and some 90 other nests were present. This indicated that nesting occurred in the last 2 weeks of June with most eggs laid between the 15th and 20th. On 1 August over 500 adults and 200 young were present on the island, with a few of the young able to fly. Very few small young and no eggs were present. On 11 September all skimmers were gone.

133. In 1976 on this same island no adults were present on 3 May, but on 29 May courtship activity was observed. On 11 June, 160 adults were present and on 4 July, 30 nests with eggs and 60 scrapes were present. On 24 July, no nests, no young, and only a few adults were present. Thus, a nesting failure occurred in 1976. On 19 August no skimmers were present.

134. These data indicated that in this region nesting began in

early June, although courtship activity may have begun in mid-May. By mid-September the species had moved out of the region, probably occupying other areas to roost and loaf, although migration undoubtedly occurred, also. In 1977, no nesting was attempted at this Charlotte Harbor site.

135. In the Tampa Bay region in 1975 skimmers were first noted on the gulf beaches on 12 May and along the west side of the Howard Franklin Bridge, Pinellas County, on 18 May, where they appeared to be sitting on nests. On 24 May, on the gulf sandbar, 83 adults were present and 25 scrapes: one nest with three eggs, one nest with two eggs, and three nests with one egg. Laying had just begun. On 7 June eight adults were on nests. There were 25 active scrapes and more scrapes that were abandoned. On 12 June, 100 scrapes were present but by 28 June, only one nest contained an egg and 18 adults were present. On 19 July, no skimmers were seen in this area. In 1976 essentially the same pattern was followed: no adults present on 22 April, 4 May, or 13 May, but on 27 May, 75 adults were present. On 4 June two nests were present, but on 11 and 26 June the adults were gone.

136. Along the Courtney Campbell Causeway on 18 June 1976 another colony contained 50 nests with the oldest young about 2 weeks old (only two of this age), and most of the nests had eggs. This colony did not appear to be active in April-May 1977.

137. Only two colonies existed in the study areas in 1977: I-25, in Clearwater Pass, and I-66, at Port Manatee. On I-25 nest building did not begin until mid-May but by 30 May there were 77 scrapes, 1 nest with four eggs, 9 nests with three eggs, 14 nests with two eggs, and 21 nests with one egg. All nests were in the sand along the beach on the northeast side of the island. It was doubtful that the colony produced any young in 1977 since it was disturbed very frequently by boaters. On I-66 between 230 and 250 adults nested in two areas on the southeast and southwest shores in high sandy beach. By early July there were many nearly fledged young present.

138. In the Banana River, just south of the NASA Parkway, near Study area II, there was a successful skimmer colony of about 150 pairs. On 1 July 1977, there were all stages of nesting from eggs to fledglings.

139. Small numbers of skimmers were found roosting on II-67 through II-131, I-50, V-5, III-5, and III-6. No courtship or nesting activity was noted in any of these locations.

140. These data indicated that the skimmer nesting cycle in Florida was mid-May through August.

141. This species was perhaps the least successful nester, closely followed by the least tern, that nested in Florida. This has been primarily due to human disturbance. The species was a prime candidate for management: to maintain the substrate in proper ungrasses condition and to keep people out of the colony so the species could nest successfully.

## Study of Bird Colonies

142. Because of the few islands involved in Study Areas III, IV, and V, a review of the 1977 data for these areas is presented in the following paragraphs. Where sufficient data existed, they were included in the species accounts as well.

143. On the first visit to Study Area III on 27 April few birds were observed and then only 14 royal terns and 25 laughing gulls loafing on III-15; 2 American oystercatchers, 1 sanderling, and 2 kingbirds on III-13; 3 American oystercatchers on III-11; and 4 adult and 1 immature brown pelican, 9 double-crested cormorants, and 1 willet on III-5. Also observed were 8 spotted sandpipers along the north side of the canal between its mouth and the boat launching ramp at the U.S. 19 bridge. The authors were surprised at the paucity of birds in this region on that day.

144. However, on the 17 May survey the bird populations were very different. Pairs of American oystercatchers were nesting on III-8, III-11, III-12, and III-13. Two pairs were on III-14, four pairs were on III-9, and ten paris were counted on III-10. No nests were found in the three American oystercatcher territories examined and presumably the territories were just being established; early incubation stages were present in mid-May. No birds were observed on III-1 through III-6, but one great blue heron was feeding on III-7. Two ruddy turnstones and two least terns were feeding on III-9; six black-bellied plovers were feeding

on III-10; forty black skimmers were loafing on the south side beach on III-11; fifteen ruddy turnstones and six black-bellied plovers were feeding on III-12; and one ruddy turnstone and one black-bellied plover were feeding on III-15.

145. The greatest change noted in bird populations was the presence of nesting laughing gulls and royal terns. On the west and south side of III-14, 200 pairs of laughing gulls were estimated with a density of 46 nests in a 2- by 28-m-strip, or 0.82 nests/$m^2$. On III-13 an estimated 75 pairs with a density of 24 nests in a 2- by 28-m-strip, or 0.43 nests/$m^2$ were estimated. On III-12, five nests with eggs and six scrapes were counted. All were widely scattered. When the adults were disturbed on III-12, they flew some distance away and did not return until the investigators had left the island, but on the other two islands the adult gulls circled overhead and many settled again on their nests while work progressed 15 to 20 m away. The following gives the clutch size of nests on the three islands and illustrates that nesting began on III-13 and III-14 and progressed to III-12. The large number of scrapes and incomplete clutches indicated that laying was still continuing on 17 May.

| Eggs per nest: | 3 | 2 | 1 | Scrapes |
|---|---|---|---|---|
| Island III-14 | 6 | 12 | 18 | 10 |
| Island III-13 | 7 | 12 | 2 | 3 |
| Island III-12 | 0 | 2 | 3 | 6 |

146. It was extremely interesting that on 27 April there were essentially no laughing gulls present in this region and that no territorial activity was in progress when 20 days later the birds were well established and egg laying had progressed to completion of several clutches. This was in sharp contrast with the progression of the nesting season in other gull colonies in Florida. Comparison of the timing of egg laying at this colony with the colonies in Study Area I indicated that in this slightly more northern location the onset of laying was delayed at least 1 week and the peak of laying was about 2 to 3 weeks later than further south. This timing and its causes would made an interesting study and would

contribute importantly to the understanding of gull biology in Florida.

147. In the evening of 17 May only one pair of American oystercatchers with three young about 5 to 8 days old was found nesting on Study Area IV. However, also roosting and loafing on the island were 30 double-crested cormorants, 5 ruddy turnstones, 8 willets, 2 knots, an immature great black-backed gull, 2 subadult ring-billed bulls, 5 adult and 18 subadult laughing gulls, 31 royal terns, and 15 female red-breasted mergansers (Mergus serrator).

148. At the time of the visits in late April and mid-May to Study Area V, all the islands had boats anchored on them and people were picnicking on them and water skiing around the area.

149. Island V-1 had 15 to 20 Louisiana herons, the only species noted, standing in the black mangrove and flying around on the southwest side. These birds were probably trying to nest but the amount of human usage in the immediate area undoubtedly prevented them from doing so. There were nine boats anchored around this island on 15 May and at least three groups of people walked directly under the area where the birds were gathered. The only other birds observed on the dredged material islands in Area V were 15 laughing gulls and 45 skimmers loafing on the north sand spit on Island V-5. Skimmers might attempt in future years to nest in this region, but if past levels of human disturbance continue they would not be successful.

150. Between dredged material Islands V-7 and V-8 at the east end of this study area was an apparently natural island covered with black mangrove up to 30 ft high. This was the Cody Island Sanctuary of the Florida Chapter, National Audubon Society, and thus apparently was protected, but at the time of the visit, a boater was disturbing the birds. The following birds were counted:

Brown pelican: A total of 22 nests were seen: nine with two nestlings, eight with one nestling and five with only adults visible. The nestlings were 6 to 11 weeks old. Five adults and eleven immatures were loafing on the edge of the colony. This was the first record of this nesting colony of pelicans and it was the closest to fresh water and the

| | |
|---|---|
| | furthest from open ocean of which the authors were aware. Nests were on top of the black mangrove canopy. |
| Great blue heron: | Eighteen nests with large downy young or feathered young were counted. Nests were on top of the mangrove. |
| Little blue heron: | Two adults flew out of the colony, which were undoubtedly nesting. |
| Cattle egret: | An estimated 400 nests, many with large chicks were found with all nests low and inside the mangroves, a typical area for this species. |
| Great egret: | A total of 75 adults were located, most with nests with large young on top of the mangrove canopy. |
| Snowy egret: | Ten to fifteen pairs were nesting. |
| Black-crowned night heron: | Two adults were seen which were undoubtly nesting, but no nests were observed. |
| White ibis: | A total of 100+ nests were present and young could be heard. In a typical situation under the canopy, it was difficult to see and impossible to count. |
| Turkey vulture: | One was loafing on the ground beside the colony. |

151. Except for the pelicans, great blue herons, and great egrets on the top of the canopy, this colony was especially difficult to see from the air and certainly the small herons and white ibises would have been missed entirely. The absence of cormorants from this colony was unusual.

152. The following data on birds nesting on the Alafia Banks (Islands 58, 59; Study Area I) were compiled by Susan Dunstan and Frank Dunstan for the warden's records of the National Audubon Society, who lease and control access to the islands.

153. The original Alafia Banks island complex was formed in 1931 when, it was thought, that at least three islands were created. The eastern dredged material island, Bird Island (Alafia Banks East, Island

I-59 in this study) was still emergent while the more western islands have eroded below the water surface prior to 1958. In 1961, Sunken Island (Alafia Banks West, Island I-58 in this study) was created during a channel deepening project. Bird species composition, density of nesting, and species habitat preferences along with island size, configuration, habitat types, plant succession, and island dynamics, were described by CZRC (1977).

154. National Audubon Society wardens began monitoring colonial bird utilization of the Alafia Banks in 1934. While National Audubon Society warden's logs, reports, and correspondence provided some insight into avian utilization for the past 44 years, these data did not meet the scientific criteria required for modern field studies. Nevertheless, these data represented the only link with historic avian utilization.

155. These data were in microfiche at the Florida Chapter of the National Audubon Society office and listed the history of each bird species. Some variability existed with respect to dates, category headings, and numbers, since considerable interpretation of original notes was necessary. For 1973 through 1976, excellent data was collected by Frank Dunstan. The details of the 1974 nesting season are reported in CZRC (1977). Notes and data for the 1977 nesting season were gathered collectively by Dunstan and James Rodgers, the present warden. All colonial bird nesting records for the years 1934-1977 were compiled in the species tables for convenience of analysis.

156. For 1931 to 1943, the Alafia Banks were utilized for nesting by least terns, laughing gulls, and black skimmers. Presumably, the islands were barren to grassy. Herbaceous plants with pioneering shrubs probably began appearing during the mid-1930's. In 1944, small herons began nesting on Island I-59 and it was suspected they nested in young mangroves, marsh elder, cabbage palm, and other shrubs. The present plant communities probably precluded the colonial ground nesters from utilizing the islands. During the mid-to-late 1950's, large white ibis nesting populations were reported in the mangroves as well as cabbage palm and other upland shrubs. Densities were so great at times that nests were placed in herbaceous plants on the ground.

157. In 1961, Island I-58 was created and during the 1960's laughing gulls nested there. Perhaps least terns and black skimmers also nested; however, no confirmation existed in the warden's reports. Probably because of the close proximity of the two islands, plant colonization and succession was much more rapid on Island I-58 than on Island I-59. Lantana, Brazilian pepper, and other shrubs were present by the late 1960's. Probably lantana was widespread and dominant. Mangroves were established only on a few spots of shoreline areas.

158. During the early 1970's Brazilian pepper and lantana formed two distinct habitats. The Brazilian pepper was increasingly shading out the lantana habitat in the mid-1970's. Cabbage palm, groundsel, and marsh elder were also present (CZRC, 1977).

159. In 1970, white ibises, yellow-crowned night herons, and Louisiana herons nested on Island I-58: the first year wading birds nested there. The white ibises probably utilized the lantana and Brazilian pepper habitats; Louisiana herons nested in the narrow fringes of mangrove; while yellow-crowned night herons probably scattered in a variety of shrubs (groundsel, Brazilian pepper, mangrove). By 1973, the number of species of wading birds nesting on Island I-58 had increased. Little blue herons, glossy ibises, and black-crowned night herons were present. During 1973-1976, a gradual shift of nesting wading birds from Island I-59 to I-58 was apparent, most obviously by little blue herons, glossy ibises, yellow-crowned and black-crowned night herons, and more subtly by Louisiana herons, snowy egrets, great blue herons, and great egrets. In 1976, both roseate spoonbills and reddish egrets nested on Island I-58 after they had been confined to Island I-59 in the previous 2 or 3 years.

160. In 1977, severe winter temperatures resulted in a partial defoliation of the mangrove community on Island I-59. As a result, nesting densities of wading birds in the mangrove habitat were reduced and many birds moved to Island I-58 to nest.

161. Brown pelicans, double-crested cormorants, and cattle egrets nested only on Island I-59. White ibises and laughing gulls nested only on Island I-58. All other colonial species nested on both islands.

Table A1

Colonial Nesting Sites on the East Coast of Florida, Outside Study Area II, Located by Dr. H. W. Kale in 1976

| Colony | Nearest Town | County | Latitude | Longitude |
|---|---|---|---|---|
| John's Island | Winter Beach | Indian River | 27'41" | 80'23" |
| Riomar | Vero Beach | Indian River | 27'38" | 80'22" |
| Round Island | Indrio | St. Lucie | 27'32" | 80'20" |
| Ft. Pierce | Ft. Pierce | St. Lucie | 27'28" | 80'19" |
| Seawall Pt. S. | Seawall Point | Martin | 27'11" | 80'11" |
| Seawall Pt. E. | Seawall Point | Martin | 27'11" | 80'11" |
| Palm City | Palm City | Martin | 27'10" | 80'15" |
| Fisherman's I. | West Palm Beach | Palm Beach | 26'40" | 80'02" |

Table A2

Stages of Nesting Cycle for Colonies Listed in Table A1. Visited in April, May, June, and July

| Species | Courting | Laying | Incubation | Nestlings | Fledglings |
|---|---|---|---|---|---|
| Brown Pelican | - | - | - | - | July |
| Cormorant | - | - | - | June | July |
| Anhinga | - | - | - | June-July | - |
| Cattle Egret | April | May | June-July | July-Aug | - |
| White Ibis | - | May | - | June-July | - |
| Snowy Egret | - | - | May-June | May-July | - |
| Louisiana Heron | - | - | May-June | June-July | - |
| Great Egret | - | - | June | June-July | - |
| Great Blue Heron | - | - | - | April-July | - |
| Little Blue Heron | - | - | May-June | July | - |
| Black-crowned Heron | - | - | June | July | - |
| Yellow-crowned Night Heron | - | - | June | - | - |

Table A3

Surveys of Birds Nesting on Island 153, Study Area II
by Dr. H. W. Kale in 1976, in mid-May and mid-July

| Species | Maximum number of nests | Season of Nesting Activity |
|---|---|---|
| Double-crested Cormorant | 60 | March-August |
| Anhinga | 11 | March-August |
| Little Blue Heron | 30 | March-August |
| Cattle Egret | 400 | March-August |
| Snowy Egret | 7 | March-August |
| Louisiana Heron | 125 | March-August |
| White Ibis | 45 | March-August |

Table A4

Surveys of Birds Nesting on Island 113, Study Area II,
by Dr. H. W. Kale in 1976, in mid-May and mid-July

| Species | Maximum number of nests | Season of Nesting Activity |
|---|---|---|
| Double-crested Cormorant | 25 | March-August |
| Anhinga | 16 | March-August |
| Great Blue Heron | 5 | February-June |
| Cattle Egret | 1200 | April-August |
| Great Egret | 50 | March-August |
| Snowy Egret | 100 | March-August |
| Louisiana Heron | 200 | March-August |
| Black-crowned Night Heron | 15 | March-August |
| White Ibis | 600 | April-August |

Table A5

Data on Breeding Season of Laughing Gulls on the Bayway, Pinellas County, Dredged Material Island 49b

| | | | | |
|---|---|---|---|---|
| | | 1974 | | |
| 7 April. | 5000 adults on beach and in water around island. | | | |
| 13 April. | A few adults sitting in the interior of the island and thousands on shore and in water. | | | |
| 20 April. | No scrapes present in the interior nesting area yet. | | | |
| 30 April. | 3 eggs | 2 eggs | 1 egg | |
| | 1 | 3 | 9 | 15 scrapes |
| 5 May. | 5 | 18 | 17 | 80 empty nests |
| 13 May. | 46 | 42 | 14 | 6 empty nests in the study area, indicating near completion of laying. |
| | | 1975 | | |
| 12 April. | Adults on ground in the colony, no scrapes present. | | | |
| 29 April. | Many adults in colony, on beaches, and in water. In study area: 4 nests with 1 egg and 7 scrapes. | | | |
| | 3 eggs | 2 eggs | 1 egg | |
| 1 May. | 1 | 4 | 18 | |
| 4 May. | 11 | 52 | 26 | |
| 8 May. | 70 | 18 | 2 | |
| 22 May. | First chicks hatched, 6 nests with eggs pipped, and 41 nests with eggs cracked. | | | |
| 31 May. | Almost all eggs in study area hatched. | | | |
| 2 July. | Many young-of-the-year flying. | | | |

(Continued)

Table A5 (Concluded)

| | |
|---|---|
| | 1976 |
| 8 March. | 100 adults on beach, 100 on water at colony, 900 more nearby. |
| 21 March. | A few pairs on the ground in the colony, whole beach filled with gulls, no scrapes. |
| 11 April. | A few scrapes in the colony, many matted down areas where individual pairs were standing. |
| 22 April. | Several empty nests, many scrapes, many adults still on beach, 1 nest with 3 eggs, 3 with 2 eggs, 4 with 1 egg. |
| 25 April. | Many nests with 1 egg, few with 3 eggs, adults still courting on beach, estimated 15,000 pairs total. |
| 22 May. | First eggs hatching, some birds still laying. |
| 5 June. | A few pairs still laying. |
| | 1977 |
| 21 April. | Thousands of adults on beach and on territories in colony. Only 5 nests with eggs (2 with 2 eggs, 3 with 1 egg) found in study areas from 1976. Many scrapes and empty nests on island present in usual locations. |
| 29 April. | Many adults still on beach courting. Counted 8 nests with 3 eggs, 20 with 2 eggs, 13 with 1 egg, indicating laying still proceeding. Most nests beside vegetation and a few in open areas. |
| 12 May. | Count of 211 nests found 33 percent with 3 eggs, 42 percent with 2 eggs, 16 percent with 1 egg, 6 percent with chicks. |

Table A6

Data on Breeding Season of Laughing Gulls on a Dredged Material Island in North Charlotte Harbor

| | | | | |
|---|---|---|---|---|
| | | 1976 | | |
| 7 March. | 2,000 adults present around the island, no activity in the colony. | | | |
| 22 March. | 3,000 adults present around the island, no scrapes. | | | |
| 13 April. | 800 to 1000 adults present in the colony and more around the island, no scrapes but many matted down areas where pairs were standing. | | | |
| 3 May. | 27 nests with 3 eggs, 50 with 2 eggs, 31 with 1 egg, 25 nests empty, in one area of colony. | | | |
| 4 July. | 50 to 100 fledged young, most young 4 to 5 weeks old, a few newly hatched young. | | | |
| 25 July. | Most young fledged. | | | |
| 19 August. | No adults present, only 25 young-of-the-year left on beach. | | | |
| | | 1977 | | |
| 30 April. | 3 eggs<br>1 | 2 eggs<br>4 | 1 egg<br>16 | Much courtship activity, many adults on water. Estimated 2,000 total adults. |

Table A7

Data on Breeding Season of Laughing Gulls

Nesting on Dredged Material in 1977

| Study Area | Island Number | Date | Number of Adults | Nests | | | Nest or Scrape | Nests with Chicks |
|---|---|---|---|---|---|---|---|---|
| | | | | 3 eggs | 2 eggs | 1 egg | | |
| I | 61 * | 5/5 | 1600 | 43 | 25 | 12 | 7 | 0 |
| | | 5/11 | 1600 | 23 | 17 | 1 | 0 | 0 |
| | | 5/24 | 1600 | 27 | 28 | 7 | 0 | 8 |
| III ** | 11 | 5/17 | | 0 | 0 | 2 | 2 | 0 |
| | 12 | 5/17 | 30 | 0 | 2 | 3 | 6 | 0 |
| | 13 | 5/17 | 150 | 7 | 12 | 2 | 3 | 0 |
| | 14 | 5/17 | 400 | 6 | 12 | 18 | 10 | 0 |
| | 15+ | 4/27 | 25 | | | | | |

* Nesting in paspalum. Nests were constructed of its branches and also under the edges of the mangrove.

** Birds on these islands were very "skiddish," especially on Islands 11 and 12, possibly due to recentness of colonization of this area.

\+ These were the only laughing gulls present in this study area on this visit. No nesting activity.

# APPENDIX B: BIRD USE OF DREDGED MATERIAL ISLANDS AS ROOSTING, LOAFING, AND FEEDING SITES

1. An important conclusion from this study of dredged material islands in Florida is that these islands are used extensively for roosting, loafing, and feeding by birds, especially shorebirds that migrate from the far north to winter in the southern United States, but also by pelicans, cormorants, gulls, terns, and other local nesting species. The following discussion is presented to illustrate this nonnesting use of dredged material islands, a factor which must be considered when determining dredging periods and management planning for the islands. The results of this survey are summarized, 1975 data for brown pelicans loafing in the Tampa Bay study area are presented, and surveys of loafing birds on four small dredged material islands in the Charlotte Harbor region are presented for 1975 and 1976.

2. The importance of undisturbed loafing, roosting, and feeding sites cannot be overemphasized. While few data exist on roosting (spending the night), considerable data exist on daytime use of the islands (loafing). This usage is important for preening and performing other body maintenance activity, as a place to rest undisturbed on solid ground, and probably also as a social gathering place.

3. The islands located in the north portion of Charlotte Harbor, Charlotte County, on the east side of the Intracoastal Waterway just south of Placida, provide an important site for birds in that section of Florida at all seasons of the year. Laughing gulls, royal terns, and Caspian terns have nested on one of the islands (Schrieber and Schrieber 1975). In Table B1 data are presented on the number of birds counted during the day on those islands in 1975 and 1976. Since the brown pelican is an endangered species and this is accorded special consideration in development plans as regards critical habitat, data are presented in Table B2 to document the extensive use by this species of dredged material islands during the nonnesting season.

4. The data in Tables B1 and B2 indicate the extensive use of these very small islands (none larger than 0.5 acre) by brown pelicans, white

pelicans (Pelecanus erthrorhynchos), and cormorants throughout the year, especially during the fall and winter months. Frequently during the non-nesting season 25 to 80 percent of the total brown pelican population in a given geographic area actually have been found using dredged material islands for loafing and roosting. Further details of this usage will be presented elsewhere, but it is obvious that these islands have been important to the Pelecaniform birds on the west coast of Florida, and especially so to the endangered brown pelican.

5. Use of the Charlotte Harbor Islands by gulls and terns is also obvious, especially during the winter months by herring gulls (Larus argentatus) and ring-billed gulls (Larus delawarensis). The reason for the low numbers of shorebirds using these islands is unknown.

6. In mid-April 1977 238 brown pelicans (196 adults, 2 subadults, 40 immatures) were found roosting and loafing on 30 dredged material islands in Study Area II on the east coast of Florida. One island supported about 100 birds, 3 islands had 25 or more, 25 islands had 5 or more pelicans, and 3 islands had only 1 bird each (3 immatures). Twenty percent of all the dredged material islands were being used by pelicans as loafing sites. All but two of these islands also had cormorants present. There were 438 cormorants on 28 islands. No island had fewer than 5 individuals and 19 islands had 15 or more. These data indicated the close association between pelicans and cormorants in the daily loafing areas. Including the two nesting colonies present within the study area fewer than 500 pelicans were counted in the whole region in April and May. Pelicans were loafing on the following islands: II-1, II-24, II-27, II-42, sandbar at mile marker 37, 55, 64, 68, 69, 74, 75, 78, 79, 80, 87, 90, 91, 100, 105, 109, sandbar at Sebastian Inlet, II-131, II-132, II-134 and II-135, and II-142 through II-143.

7. Twenty-nine black-bellied plovers (Squatarola squatarola) were found on 11 islands; 312 ruddy turnstones (Arenaria interpres) on 13 islands; 7 willets (Catoptrophorus semipalmatus) on 4 islands; 10 knots (Calidris canutus) on 1 island; 1000 sanderlings (Crocethia alba) on 8 islands; and 700 peeps on 10 islands. Shorebirds were present on 19 different islands and no island on which shorebirds were present had

fewer than three species. All islands that had shorebirds present also had brown pelicans and cormorants present. No shorebirds were seen in the region of Islands II-1 through II-69. The major islands on which shorebirds were loafing and feeding were II-72 through II-78, II-80, II-82 through II-86, II-90 through II-91, II-100, II-105, and the Sebastian Inlet sandbar. In May no large flocks of shorebirds were observed and since many of the flocks observed in April had actually been moving to the north, it was presumed that migration was underway in mid-April and had been essentially completed by mid-May.

8. There were 28 herring gulls (1 adult, 13 subadults, and 14 immatures) on 12 islands on the east coast. Five was the maximum (all immatures on Island II-77) on any one island. Herring gulls were present throughout the study area. This was the only gull species present on two islands. There were 99 ring-billed gulls (22 adults, 77 subadults) on 15 islands on the east coast. Thirty-nine was the maximum on any one island (II-77) and ring-billed gulls were present on ten islands without herring gulls and five with herring gulls. On eight islands this was the only gull present but they were never seen alone on an island as were herring gulls. There were 96 laughing gulls on 14 islands. Fourteen was the maximum on any one island (II-82), and on nine islands laughing gulls were present without herring gulls and on six with herring gulls. They were present on nine islands without ring-billed gulls and five with ring-billed gulls. On five islands this was the only gull present, but shorebirds were always present with the laughing gulls.

9. There were 450 royal terns present on 22 islands (300 on 1 island). Royal terns were present on only three islands without gulls present; usually the terns were with laughing gulls and they were absent from only one island that supported laughing gulls. There were ten Caspian terns present on four islands, always with royal terns and laughing gulls. There were 110 black skimmers on 5 islands (25 to 60 on Islands II-90, II-91, II-105, and the Sebastian Inlet Island). Skimmers were always with laughing gulls and royal terns. Since this region was surveyed prior to any skimmer nesting, their population

probably increased during the summer and nesting may have occurred on one or more of the dredged material islands in the study area.

10. There were ten great blue herons on one of eight islands. A black-necked stilt (Himantopus mexicanus) was present on Island II-77.

11. Over 3500 individuals of at least 23 species of birds were counted on 46 of 163 islands surveyed in April. One island supported 15 species, 3 islands had 9 or 10 species present, and 27 separate islands had 3 to 8 bird species present. During May birds were loafing on only 10 islands, indicating the extreme seasonal nature of this form of use of dredged material islands by migrant birds on the east coast of Florida.

12. On the Florida west coast (Study Area I) in late April and early May 1977 there were 127 brown pelicans loafing on 18 dredged material islands in Study Area I. Nine islands had five or more pelicans present, three islands had only one individual present. All but three of the islands also had cormorants present. Two hundred cormorants were loafing on 19 islands. Five of the islands had fewer than five individuals and eight had more than ten birds present. Brown pelicans were present on the following islands: I-1, I-14, I-16, I-19, I-20, I-24, I-25, I-26, I-30, I-31, I-46, I-48, I-49, I-50, I-54, I-57, I-63, and I-65.

13. There were 180 black-bellied plovers on 23 islands, 132 ruddy turnstones on 19 islands, 135 willets on 17 islands (including 5 islands on which at least 15 nests were present), 950 knots on 7 islands, 147 dunlins (Erolia alpina) on 4 islands, 123 sanderlings on 4 islands, and 60 peeps on 2 islands. There were shorebirds on 35 islands and none of these had fewer than 2 species present and 6 islands supported 4 or more species. The major loafing-feeding islands were I-1 through I-11, I-16, I-17, I-20, I-25, I-30, I-40, I-43 through I-49, and I-63.

14. There were 21 herring gulls on 8 islands, with 30 immatures present on 2 islands (I-62 and I-63). Twenty ring-billed gulls were counted on 6 islands but only 40 laughing gulls were on 10 islands. Over 25,000 laughing gulls were nesting on one island (I-49b) in the midst of this study area however, and this undoubtedly affected the numbers of individuals away from that colony. With this small number of gulls

present it was difficult to interpret these data. However, gulls were found on only one island (I-62) that did not also have pelicans, cormorants, and/or shorebirds also present.

15. There were 293 royal terns on 9 islands, all of them with gulls and shorebirds also present. Only 4 Caspian terns were seen on 2 islands with royal terns. There were 81 sandwich terns on 10 islands, usually with laughing gulls and royal terns. The largest flock had 50 birds on Island I-54, but this species was usually found in pairs or individuals mixed with other larids. Black terns (Sterna niger) were found on I-54 on 28 April. There were 16 great blue herons on 15 islands, indicating that this species was probably feeding solitarily on the dredged material islands.

16. There were 2900 individuals of at least 26 species loafing on 45 of 63 islands in April and May 1977. Two islands supported 12 species of birds (I-25 and I-63), 1 island had 11 species (I-20), 1 had 10 (I-54), and 2 islands had 9 species present. Five to eight species of birds were found on 9 different islands, 3 or 4 species were found on 10 different islands, 19 islands had 1 or 2 species present, but only 18 islands were not used at all for loafing during the survey days.

17. The 1977 April-May counts in the east and west coast study areas provided some interesting comparisons. It is dangerous to speculate based on only one survey and much further work is needed in this area. However, the data indicated that while on the east coast only 28 percent of the 163 islands surveyed in April were used for loafing and feeding, on the west coast 71 percent of 63 islands surveyed were being used. This probably indicated the lack of suitable natural islands on the west coast, a lack which probably had arisen from the heavy influx of people through use of the islands for recreational activities. Probably most of the potential loafing-roosting sites in Florida are almost continually disturbed by boaters; therefore, management of specific islands as roosting-loafing sites for birds would be a major contribution to bird conservation efforts.

18. In the shorebirds, black-bellied plovers, willets, and knots

were uncommon and dunlins were not seen on the east coast, while on the west coast these species comprised 7, 5, 5, 37, and 6 percent of the total loafing populations present in late April. Ruddy turnstones were present in about equal percentage on the two coasts. Sanderlings and peeps were the most common species on the east coast (100 and 700 individuals or 28 and 20 percent of the total) and they were quite uncommon on the west coast (123 and 60 individuals or 5 and 2 percent of the total). While the sanderlings were the most common species on the east coast, knots were the most common on the west coast. The effects of migration on these numbers and proportions must be considered; further study on these populations certainly is warranted.

19. Comparing the gulls, on the east coast the herring gulls were only one-fourth as common as the ring-billed gulls and laughing gulls while on the west coast the herring gulls and laughing gulls were twice as numerous as the ring-billed gulls. Royal terns were common on both coasts and sandwich terns were also common on the west coast, but none were seen on the east coast. Great blue herons were using dredged material islands commonly for feeding and loafing on both coasts, the only heron to do so.

20. Few natural islands are available for undisturbed use by birds in Florida. Based on these admittedly sketchy data, dredged material islands seem to be very important as roosting, loafing, and feeding sites for many species of birds, especially during the winter, from mid-August through April or early May. Any management scheme for these islands must consider this nonnesting use of the islands.

Table B1

Birds Loafing on Four Dredged Material Islands in North Charlotte Harbor, Charlotte County, Florida, in 1975 and 1976

| Species | 1975 | | | | | | | 1976 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | May | June | July | Aug | Sep | Oct | Nov | Jan | Feb | Mar | Apr | May | June | July | Aug |
| White Pelican | | 1 | 0 | 0 | 0 | 100 | 75 | 150 | 102 | 18 | 25 | 7 | 28 | 0 | 8 |
| Brown Pelican | 23 | 8 | 25 | 49 | 36 | 92 | 144 | 0 | 53 | 38 | 10 | 0 | 0 | 0 | 0 |
| Cormorant | 18 | 0 | 0 | 20 | 22 | 45 | 70 | 150 | 48 | 82 | 22 | 25 | 26 | 14 | 15 |
| Herons, Egrets | 0 | 0 | 0 | 0 | 1 | 4 | 2 | 1 | 0 | 0 | 0 | 2 | 2 | 11 | 0 |
| Turkey Vulture | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Herring Gull | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 6 | 2 | 3 | 0 | 0 | 0 | 0 | 0 |
| Ring-billed Gull | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 7 | 7 | 3 | 2 | 0 | 0 | 0 |
| Laughing Gull | 800 | + | + | 60 | 0 | 21 | 3 | 37 | 164 | 2044 | 1000 | + | + | + | 25 |
| Royal Tern | 0 | 18 | 0 | 0 | 40 | 4 | 8 | 0 | 0 | 0 | 35 | 23 | 50 | 32 | 0 |
| Least Tern | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| Caspian Tern | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sandwich Tern | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Black Tern | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oystercatcher | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 2 | 0 | 0 |
| Ruddy Turnstone | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 1 | 0 |
| Black-bellied Plover | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 0 |
| Willet | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |

+ indicates birds were present but counts were not made.

Table B2

Proportion of the Total Brown Pelican Population of Boca Ciega Bay, Pinellas County, Florida, Found Loafing on Dredged Material Islands in 1975 *

| Date | Total Population | Percent on Dredged Material |
|---|---|---|
| early January | 220 | 81 |
| late January | 469 | 41 |
| early February | 760 | 12 |
| late February | 700 | 8 |
| early March | 800 | 11 |
| late March | 900 | 0 |
| early April | 805 | 2 |
| late April | 633 | 0 |
| early May | 925 | 5 |
| late May | 872 | 7 |
| early June | 919 | 2 |
| late June | 704 | 6 |
| early July | 635 | 4 |
| late July | 1083 | 18 |
| early August | 1116 | 18 |
| late August | 1200 | 19 |
| early September | 951 | 11 |
| late September | 1100 | 12 |
| early October | 1130 | 14 |
| late October | 595 | 26 |
| early November | 393 | 51 |
| late November | 436 | 18 |
| early December | 402 | 20 |
| late December | 365 | 11 |

* These are biweekly summaries based on weekly population counts.

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Schreiber, Ralph W
Colonial bird use and plant succession on dredged material islands in Florida; Vol. I: Sea and wading bird colonies / by Ralph W. Schreiber, Elizabeth A. Schreiber, Seabird Research, Inc., Culver City, Calif. Vicksburg, Miss. : U. S. Waterways Experiment Station ; Springfield, Va. : available from National Technical Information Service, 1978.
63, 55, 8 p. : ill. ; 27 cm. (Technical report - U. S. Army Engineer Waterways Experiment Station ; D-78-14, v.1)
Prepared for Office, Chief of Engineers, U. S. Army, Washington, D. C., under Contract No. DACW39-76-C-0161 (DMRP Work Unit No. 4F01C)
Literature cited: p. 22-26.
1. Birds. 2. Dredged material. 3. Florida. 4. Habitats. 5. Islands (Landforms). 6. Seabirds. 7. Shore birds. 8. Succession. I. Schreiber, Elizabeth A., joint author. II. Seabird Research, Inc. III. United States. Army. Corps of Engineers. IV. Series: United States. Waterways Experiment Station, Vicksburg, Miss. Technical report ; D-78-14, v.1.
TA7.W34 no.D-78-14 v.1