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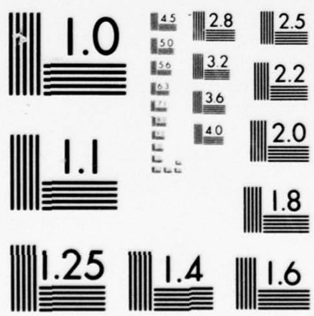

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DREDGED MATERIAL RESEARCH PROGRAM

(9) Final TECHNICAL REPORT D-78-9

(6) A COMPARISON OF PLANT SUCCESSION AND BIRD UTILIZATION ON DIKED AND UNDIKED DREDGED MATERIAL ISLANDS IN NORTH CAROLINA ESTUARIES.

by

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DEPARTMENT OF THE ARMY
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IN REPLY REFER TO: WESYV 15 June 1978

SUBJECT: Transmittal of Technical Report D-78-9

TO: All Report Recipients

1. The technical report transmitted herewith represents the results of Work Unit 4F02 regarding a comparison of plant succession and wildlife use of diked and undiked dredged material islands in North Carolina. 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, Work Unit 4F02, the vegetation succession and avian use of North Carolina's 395 diked and undiked dredged material islands were studied. In 1977, 78 percent of all colonial waterbirds in North Carolina nested on dredged material. Few diked islands in this state are older than six years, and long-term effects of diking on colonial bird use are difficult to assess. Generally, nesters preferred undiked islands. Young diked islands provided a greater diversity of habitats and attracted more total bird species (nonnesting). It is anticipated that as diked islands are filled and mature vegetatively, they will provide less attractive nesting habitat than undiked islands.

4. From a local perspective, this study will be of direct value in managing and developing dredged material island habitats in North Carolina. General comparisons of diked and undiked dredged material islands in New Jersey, Florida, and Texas are also provided in this report. A national perspective is presented in a report entitled "Development and Management

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of Avian Habitat on Dredged Material Islands" (4F03), which synthesizes island habitat research in North Carolina, the Great Lakes (4F01A), New Jersey (4F01D), Florida (4F01C), Texas (4F01B), the Pacific Northwest (4F01E), and the Upper Mississippi River (4F01F).

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

Unclassified

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This report has also been designated as University of North Carolina at Wilmington Contribution in Marine Sciences Number 797.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Birds	Islands (Landforms)	Waste disposal sites
Dredged material	North Carolina	
Ecological succession	Plants (botany)	
Estuaries	Succession	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This project consisted of a comparison of plant succession and bird utilization on diked and undiked dredged material islands in North Carolina estuaries. After a site is diked, deposition of dredged material may be delayed for several years or it may occur immediately. Unfilled diked islands that were studied had a complex topographic zonation. Plant succession was highly variable on these unfilled sites, with topography, substrate particle size, and availability of water being major causative factors. Plant succession on diked

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20. ABSTRACT (Continued).

and filled sites was similar to that on undiked islands except that dikes tended to vegetate more quickly than did the deposits on outer portions of undiked sites.

Only the least and gull-billed terns were found nesting predominantly on diked sites, with most nesting gulls and terns locating the majority of their breeding colonies on undiked sites. Fifteen to 30 years will be required for thickets suitable for wading bird colonies to develop on diked islands in North Carolina. Based on observations in New Jersey, it is expected that wading birds will use diked sites when appropriate habitat becomes available. No positive values of dikes relative to nesting colonial birds were discovered.

One hundred forty-two species of shorebirds, waterfowl, and land birds were recorded on diked islands, while 94 species were found on undiked sites. Heaviest use was during fall migration. The increased avian diversity of diked over undiked sites paralleled the increased temporary diversity of habitats on diked sites.

Habitat diversity is expected to decrease on mature diked islands as such sites continue to receive dredged material. Such mature islands will likely not be as suitable for nesting colonial birds as either undiked or young diked islands. It is recommended that diking not be used on islands heavily used by nesting waterbirds or wading birds.

Appendices A-D present soils, vegetation, bird, and cartographic data, respectively.

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SUMMARY

This research project compared plant succession and bird utilization on diked and undiked dredged material islands in North Carolina estuaries. Earlier research of coastal North Carolina had demonstrated that undiked dredged material islands are very important nesting sites for colonially nesting waterbirds (gulls, terns, skimmers, herons, egrets, and ibises) in North Carolina. A previous research project estimated that in 1973 over 82 percent of all ground-nesting gulls, terns, and skimmers in North Carolina were nesting on dredged material islands. A large proportion of the wading birds (herons, egrets, and ibises) were also known to be using these man-made sites.

Dredged material islands have also proven to be important nesting sites for colonial wading birds in other areas. In 1976, it was estimated that sizable portions of the Florida and Texas coastal populations were on man-made islands, with smaller proportions occurring on dredged material islands in Virginia and Maryland and adjacent to Long Island, New York. Current studies funded by the U. S. Army Engineer Waterways Experiment Station are demonstrating further the importance of dredged material islands to colonial birds in New Jersey, Florida, Texas, the Great Lakes, the Pacific Northwest, and the Upper Mississippi River.

During the period of the research project establishing the importance of dredged material islands to birds (carried out between 1971 and 1974), the practice of diking dredged material islands began to increase in North Carolina. As diking became more widespread, it began to appear that diked sites had different characteristics from undiked sites and that the positive values of undiked islands could be lost when they were diked.

Diking is an established practice in New Jersey, where many dredged material islands are diked. Diking is also occurring on the gulf coast of Florida and along the Texas coast. In both regions, dredged material islands have proven to be important nesting sites for colonial birds, but the effects of diking are largely unknown.

The current project was then conceived to evaluate this process relative to an established importance of undiked sites to coastal birdlife.

This research involved four major methodologies. For the first methodology, vegetation was analyzed along a series of transects across all topographic zones on four site configurations: (a) undiked, (b) diked but without deposition of material behind the dikes, (c) diked and influenced by the deposition of dredged material behind the dike but without deep coverage at the study site, and (d) diked with the subsequent deposition of dredged material on the study site. Soil samples were collected along selected transects and analyzed for particle size, soil chemistry, and water-holding capacity, and the data were used to support the findings relative to the pattern and rate of plant succession. For the second methodology, the use of all major habitat types by birds involved periodic bird censuses in sample units of all major habitat types at all seasons. The third methodology involved documentation of the use of diked and undiked dredged material islands as nesting sites for colonial water birds (gulls, terns, skimmers) and wading birds (herons, egrets, and ibises) throughout North Carolina estuaries. The fourth methodology related the findings in North Carolina to selected other regions (New Jersey, Florida, and Texas) where diking is or is likely to become an important practice associated with dredging.

The vegetation analysis indicated that the general pattern of plant succession on diked and filled islands was similar to that on undiked islands. Dikes did generally vegetate more rapidly than did the lower portions of undiked islands. The major differences in plant species composition and succession on diked and undiked islands were related to the fact that dikes were often constructed one or more years before the deposition of dredged material, and, when material was added, often only a small portion of the diked site was covered by new substrate materials. This has resulted in a very complex pattern of plant succession on such sites. Vegetative growth was usually most rapid on diked sites in those places where fine particles settled after deposition of dredged material and where soil moisture content was high. This usually occurred in the low areas just inside the dikes. On the slopes and domes, the pattern and rate of succession were similar to those found on undiked islands.

The process of diking created several new avian habitats such as borrow pits, ponds, dozer scrapes, mudflats, and dead thickets. Such habitats increased the diversity of diked islands, in turn leading to an increased diversity of bird species using such islands. Ninety-four species of birds were recorded in 7 major habitat types on undiked islands, while 142 species were recorded from 24 diked island habitats.

In 1977, 78 percent (39,898 nests) of all colonial nesting water and wading bird nests in North Carolina were on dredged material islands. Of these, 75 percent (29,884 nests) were on undiked sites, and 25 percent (10,014 nests) were on diked sites. Most species of gulls, terns, and skimmers were found nesting to some extent on diked sites, but only the gull-billed and least terns nested predominantly on diked sites. No colonies of wading birds were located behind dikes. Diking and subsequent deposition of dredged material generally destroy the thickets preferred by these species, and colony sites have been purposely excluded from diking. Diking is not yet old enough in North Carolina for thickets to have redeveloped behind dikes.

Because diking has been used in North Carolina for only about 6 years, it was not possible to determine the characteristics of older diked islands. It has therefore not been possible to predict the final effect of diking on estuarine birdlife. The colonial ground-nesting gulls, terns, and skimmers will use young diked islands if other factors are favorable. It is suspected, however, that diking will produce sites less suitable for several species. It is expected that herons, egrets, and ibises will use thickets behind dikes when these have had time to develop. Land birds used appropriate habitats on undiked or diked islands apparently without regard to dikes. The new ephemeral aquatic habitats on diked islands were heavily used by shorebirds, waterfowl, and wading birds, especially during the migrations.

It is anticipated that older diked islands, filled to capacity, will be quite different from the presently young, partly filled islands. Much of the habitat diversity of young diked islands will be lost as diked sites are filled with dredged material. They are expected to be high in elevation with relatively steep outer dike slopes. Such islands will likely vegetate slowly, especially on the slopes and domes, and will be subject to considerable wind erosion. These sites are not expected to be as suitable for birds as either younger diked islands or undiked islands. A very careful monitoring of the development of diked sites should continue. Until further study has been accomplished, diking should be avoided in areas such as inlets and river mouths where especially heavy use by colonial waterbirds occurs.

Diked islands along the coasts of New Jersey, west Florida, and Texas have many similarities to North Carolina islands in terms of the physical form and vegetative structure. The New Jersey islands are the most similar. It is expected that the findings of this study will relate closely to diked sites on the mid-Atlantic Coast and reasonably well to diked gulf coast sites.

PREFACE

The study described herein was performed under Contract No. DACW39-76-C-0134, dated 13 August 1976, between the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss., and the University of North Carolina at Wilmington (UNCW), Wilmington, N. C. The research was conducted as a part of the Dredged Material Research Program (DMRP) under DMRP Work Unit No. 4F02. The DMRP is sponsored by the Office, Chief of Engineers, U. S. Army, and is being managed by the Environmental Laboratory (EL), WES. This report is also designated as UNCW Contribution in Marine Sciences Number 797.

The study was carried out and this report written by James F. Parnell, David M. DuMond, and Robert N. Needham of the Biology Department, UNCW. Field research was conducted during the period between 13 August 1976 and 1 September 1977.

The contract was managed by Ms. Mary C. Landin, Habitat Development Project (HDP), EL, under the general supervision of Dr. Hanley K. Smith, Project Manager, and Dr. John Harrison, Chief of EL. Dr. Robert F. Soots, Jr., HDP, was Contract Advisor. Technical review was provided by Ms. Landin, Dr. Soots, Dr. R. T. Huffman, Dr. B. R. Wells, Dr. G. Tucker, Mr. C. V. Klimas, and Ms. L. Jean Hunt, WES.

Director of WES during the conduct of this study and the preparation and publication of this report was COL John L. Cannon, CE. Technical Director was Mr. F. R. Brown.

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

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
inches	25.4	millimetres
miles (U. S. statute)	1.609344	kilometres
knots (international)	1.852	kilometres per hour
Fahrenheit degrees	5/9	Celsius degrees or Kelvins*

* To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use the following formula: C = (5/9)(F - 32). To obtain Kelvin (K) readings, use: K = (5/9)(F - 32) + 273.15.

A COMPARISON OF PLANT SUCCESSION AND BIRD UTILIZATION ON DIKED AND UNDIKED DREDGED MATERIAL ISLANDS IN NORTH CAROLINA ESTUARIES

PART I: INTRODUCTION

Background

1. In May 1971, the U. S. Army Engineer Waterways Experiment Station (WES) was assigned the tasks of defining and assessing the problems of the environmental impacts of dredging and dredged material disposal operations and of developing a research program to determine the major benefits, effects, and uses of dredged material in the harbors and waterways maintained by the U. S. Army Corps of Engineers. As a result, the Dredged Material Research Program (DMRP) was developed, and research was initiated by WES in March 1973. An important focus of the DMRP has been the study of the overall ecological factors influencing habitat change on dredged material islands. WES is playing a major role in the coordination and synthesis of research on dredged material islands and wildlife throughout the United States.

2. Until relatively recently, disposal of dredged material was carried out with little thought given to either short- or long-term results of such deposition on the environment. Although previously existing habitats may be largely displaced, new habitats are made available for invasion by an often highly characteristic set of organisms.

3. It has become apparent only in recent years that dredged material disposal sites are of great importance to wildlife. A wide variety of bird species including wading birds, colonial water birds such as gulls and terns, shorebirds, migratory waterfowl, and even small perching birds make use of disposal areas for nesting, feeding, cover, and resting.

4. Along the North Carolina coast, suitable habitat used most intensively by colonial bird species occurs on disposal islands constructed along maintained waterways. Increased human use of nesting habitat on natural beaches and dunes has discouraged the continued use of these areas for nesting gulls, terns, skimmers, and shorebirds. Often disposal islands in adjacent sounds and along waterways have provided suitable alternate habitat for nesting and the raising of young (Soots and Parnell 1975).

5. Disposal island vegetative coverage increases and plant species composition changes over a period of years. The increase in cover and the change in plant species content eliminate habitat for some bird species, while enhancing habitat for other species (Soots and Parnell 1975).

6. Each successive disposal of fresh dredged material causes a return to an earlier vegetation stage. This creation of an ecologically younger system may result in return use by species of birds that use bare or very sparsely vegetated habitat (Soots and Parnell 1975).

7. Two basic types of dredged material disposal island situations have been created in North Carolina: diked and undiked. Undiked disposal areas were used almost exclusively until the late 1960's and early 1970's. During this time, a concern for siltation of estuarine waters promoted a change to use of diked disposal areas. Dredged material slurry deposited behind dikes is held until suspended solids settle out. The slurry water is then decanted back into the ambient system.

8. It became apparent soon after the onset of diking that there were major differences in habitat development between unconfined and confined dredged material disposal islands. The dike retains all materials whether coarse or fine. This retention generally causes a decrease in horizontal distribution of various particle sizes and an increase in their vertical distribution. After settling, the finer particles come to rest at the surface, drastically changing the root zone environment for pioneer plants characteristically found on uncon-

fined disposal islands.

9. Not only was it noticed that plant species composition differed between diked and undiked islands, but it also seemed that the rate of plant succession was increased by the presence of a dike. This raised concern that the duration of use of diked islands by those species requiring bare or nearly bare substrate may be shortened.

10. If colonial waterbird populations, as well as other bird populations, are to be optimized within the estuarine system along the North Carolina coast, management of dredged material disposal will be critical. Deposition of dredged material must be made compatible with the maintenance of adequate nesting habitat for each species. This is especially crucial to those birds that depend totally on estuarine breeding sites. In 1973, an estimated 82 percent of all colonial ground-nesting seabirds in North Carolina nested on dredged material islands (Soots and Parnell 1975). Diking is a process of such magnitude and impact that it must be evaluated and modified if necessary to assure the continued availability of those habitats necessary for the maintenance of seabird populations.

Purposes

11. This study was designed to compare habitat development on diked and undiked dredged material islands and to evaluate the effects of these differences on bird utilization. A major purpose of this project will be to recommend management guidelines designed to assure that populations of birds using dredged material islands can be maintained at present or increased levels of diversity and numbers.

Orientation of the Project

12. By August 1976, when project authorization was received, the overall project area (Figure 1) was already well defined. An

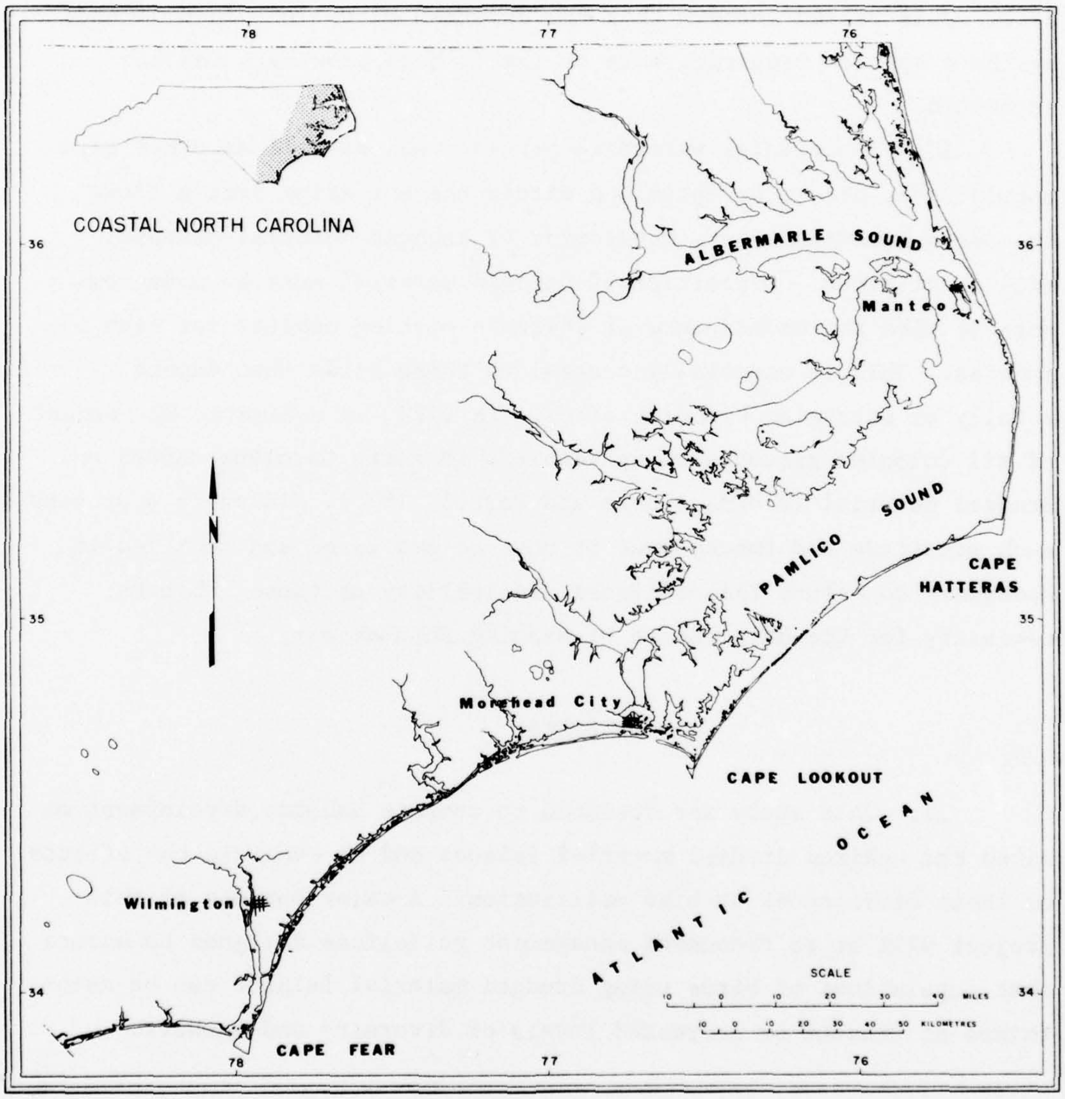

Figure 1. Map of the North Carolina coast including the project area

early survey of dredged material disposal islands was made between Cape Lookout and the South Carolina-North Carolina state line, largely along the Atlantic Intracoastal Waterway (AIWW), and a series of islands was chosen that represented the range of existing vegetational stages on diked disposal islands. Vegetation sampling was well under way by the end of August 1976. A second vegetation sampling was carried out between July and September of 1977.

13. By the end of August 1976, a second series of islands had been chosen between Morehead City and the South Carolina-North Carolina state line along the AIWW. Monthly bird surveys began in September and continued through the winter, spring, and summer of 1977. In addition, censuses of all colonial waterbird nesting colonies on dredged material islands were made in the spring and summer of 1977 throughout the North Carolina estuaries.

14. Soil sampling and analysis were carried out between November 1976 and May 1977. Information on elevations and slopes was gathered following first sampling.

Literature Review

15. In North Carolina, most dredging is related to the construction and maintenance of channels through estuaries and inlets. A major source of material has been the construction and maintenance of the AIWW. The first section of the AIWW to be constructed in North Carolina was the Norfolk, Virginia, to Morehead City, North Carolina, stretch. This section was authorized in 1912. The final stretch extending from the Cape Fear River to Winyah Bay, South Carolina, was not authorized until 1930 (U. S. Army Engineer District, Wilmington 1972). Other projects related to construction and maintenance of deep draft ship channels, harbors, and spur channels have also generated substantial amounts of dredged material on a regular basis.

16. The process of diking dredged material sites is relatively new. Until the 1940's, diking was used only when it was necessary to

prevent the spread of dredged material onto adjacent property (Boyd et al. 1972). Since that time, containment of dredged material has increased greatly. Three factors are primarily responsible: (1) diking often is economically desirable as it generally reduces maintenance dredging volumes, (2) diking may reduce the loss of marsh or estuarine bottom habitats, and (3) diking assists in containing polluted dredged material (Boyd et al. 1972). In 1972, about 30 percent of all of the Corps of Engineers' projects utilized diked disposal areas for all or a part of their dredged material disposal (Boyd et al. 1972).

17. The first construction of diked disposal islands on a regular basis in North Carolina was begun by the U. S. Army Engineer District, Wilmington, in 1971 (Personal Communication, 15 July 1977, J. L. Wells, Chief, Dredging Section, Navigation Branch, Wilmington District, Corps of Engineers, Wilmington, North Carolina). Since that time, diking has become an important aspect of dredging in the North Carolina estuaries. By 1977, almost all dredged material removed from the AIWW and the Wilmington and Morehead City harbors was being placed behind dikes. Only dredged material removed from channels associated with the inlets into Pamlico Sound and the section of the AIWW passing through the Camp Lejeune Marine Corps Base is still regularly placed on undiked sites.

18. Fisheries biologists and aquatic ecologists have generally considered the deposition of dredged material in the estuaries to be harmful. Ringer (1975) provided an example of this concern when he indicated that the North Carolina Division of Marine Fisheries would oppose any undiked dredged material disposal in North Carolina estuaries due to the covering of natural bottoms by dredged material reentering the estuaries from undiked sites.

19. Urner recognized very early the potential of dredged material islands as nesting sites for birds. He suggested that such islands could be created in the New Jersey estuary to provide nesting sites for birds displaced from the beaches by summer homes (Urner 1926). The first mention of birds nesting on disposal islands in North Carolina was by Quay (1947), who in 1946 reported black skimmers

(Rynchops niger), common terns (Sterna hirundo), gull-billed terns (Gelochelidon nilotica), least terns (Sterna albifrons), and Wilson's plovers (Charadrius wilsonia) nesting near Beaufort on a "dredge heap island."

20. In his thesis on the maritime summer birds of southeastern North Carolina, Funderburg (1956) commented on the importance of "disposal islands" as nesting sites for colonial birds; Funderburg and Quay (1959) indicated that "disposal islands" were among the nesting sites utilized by birds in this same region.

21. In 1969, Buckley and Buckley (1972) began work on the reproductive biology of the royal tern (Sterna maxima) in North Carolina. In 1969 and 1970, they studied colonies of royal terns in Oregon, Hatteras, and Ocracoke inlets in northeastern North Carolina. At least two of these colony sites were on dredged material islands.

22. In 1971, Parnell and Soots began a study of the succession of birds and vascular plants on dredged material islands in North Carolina (Soots and Parnell 1975). During this 4-year study the first regional effort was made to systematically evaluate the use of dredged material islands by birds and to relate this use to plant succession. This study indicated that in 1973, 82.5 percent of all ground-nesting seabirds in the North Carolina estuary were nesting on man-made islands. This was the first real indication that dredged material islands had become very important nesting sites for coastal birds.

23. The Corps of Engineers began the first comparative evaluation of diked and undiked disposal in 1971 (Windom et al. 1972). This study was concerned primarily with the effect of dredging on salt marshes and aquatic communities rather than the development of dredged material islands.

24. In 1973, Downing conducted a survey of least terns along the Gulf and South Atlantic coasts from Mississippi to New Jersey. He noted the occurrence of least tern nesting colonies on a number of dredged material island sites (Downing 1973), including some in North Carolina.

25. In May 1974, a conference on the management of dredged material islands in North Carolina estuaries was held at Atlantic

Beach, North Carolina. This conference pointed out the importance of these islands to wildlife and discussed many of the problems associated with island management (Parnell and Soots 1975). This conference appears to have marked the beginning of federal agency interest in the importance of dredged material islands as nesting sites for colonial birds.

26. In 1975, a study was begun in North Carolina to determine breeding population levels of all colonial nesting birds in the North Carolina estuaries. The first report from this work was a thesis by Jernigan (1977), which noted that in 1976 there was a breeding population of approximately 1500 pairs of adult least terns in North Carolina and that about 72 percent of these birds were nesting on dredged material islands. The report also discussed the details of colony placement, substrate, vegetation parameters, and associations with other bird species.

27. In October 1976, the first North American Wading Bird Conference was held in Charleston, South Carolina. At this meeting, Parnell and Soots presented a paper that pointed out that in North Carolina in 1976, 92 percent of all herons, egrets, and ibises nested on dredged material islands. It also provided data from other Atlantic and Gulf Coast States showing that dredged material islands were very important sites for wading birds in some states, while in others very few wading birds utilized such sites. No effort was made to relate usage to availability of dredged material islands (Parnell and Soots, In Press).

28. It thus appears that dredged material islands in North Carolina have been used by birds as nesting sites since the islands first became readily available. Dependence has increased to the point where the majority of the gulls, terns, skimmers, herons, egrets, and ibises that nest in the North Carolina estuaries are now utilizing these man-made islands.

29. Until the initiation of the DMRP, there has been neither a regional effort to evaluate the importance of dredged material islands to birds nor any effort to compare diked and undiked islands as bird habitats outside the North Carolina estuaries.

30. There have been a number of regional bird surveys such as those conducted by the National Audubon Society along the Florida and gulf coasts and the U. S. Fish and Wildlife Service on the east coast. These surveys have generally not been published and often have not differentiated between natural and man-made island sites.

31. A number of studies have been conducted on vegetation and the biology of bird species nesting on dredged material islands. Some of these studies have indicated the importance of dredged material islands as nesting sites while others were concerned totally with the biology of the species involved.

32. At about the same time that Parnell and Soots began studies in North Carolina, students in both Texas and Florida began studies on the vegetation and birdlife of dredged material islands. In 1970, a group of students at Texas A. & I. University at Kingsville began a series of research projects on a group of dredged material islands in Laguna Madre, Texas. Five theses were subsequently completed dealing with the birdlife of these islands. Other studies are continuing.

33. Barnes (1971) made a study of the vegetational composition of a single dredged material island in Laguna Madre over a period of two growing seasons (1970 and 1971) and related vegetational zonations to elevation and salinity content of the soil. The island was reused for disposal approximately every 2 years, so only very young stages of plant succession could be examined.

34. McMurry (1971) studied the breeding biology of the reddish egret (Dichromanassa rufescens) and Simersky (1971) studied competition and nesting success of the snowy egret (Egretta thula), reddish egret, Louisiana heron (Hydranassa tricolor), and great blue heron (Ardea herodius). Mendoza and Ortiz (1974) completed a study comparing vegetation and bird utilization of dredged material islands in the Laguna Madre. This study found that island size, soil composition, the distribution and composition of vegetation, and human activity were primary factors influencing the use of these islands by birds. Some islands studied were diked, but no comparisons were made between the use of diked and undiked islands.

35. In 1971, a group of students at New College in Sarasota, Florida, began studies of dredged material islands in Sarasota Bay and Charlotte Harbor, Florida. Reports by Carlson (1972) and Beaman (1973) emphasized the successional trends of vegetation on dredged material islands, and Carlson, in particular, reported the results of soils analyses, soil anthropod studies, and bird utilization of the islands. Some basic differences between the soils of diked and undiked islands were also noted. Both studies noted the characteristic concentric ring pattern of plant succession. Carlson found 55 species of birds using the study islands and reported that 30 were known to breed on the islands.

36. In southern Louisiana, Olsen and Noble (1974) studied the use of "spoil banks" along the Superior Canal in Rockefeller Wildlife Refuge in Cameron Parish from late February 1973 to mid-April 1974. They recorded bird utilization at all seasons, correlating usage with topography and vegetation. They found 7 species nesting and a total of 75 bird species utilizing the study islands. They related the relatively high level of bird use to dense cover and high ground. This study made no mention of diked containments.

37. Monte (1974) studied vegetational succession on dredged material disposal sites in Bayou Lafourche Basin, southern Louisiana. Vegetative changes and differences were related to the strong influences of salinity and flooding as well as overall seral development through time.

38. In 1974, a study of successional patterns of plants and animals at five upland disposal sites was performed by Coastal Zone Resources Corporation (CZRC). The report from this study (CZRC 1977) provides lists of birds found using islands in Florida, Louisiana, Texas, Oregon, and Connecticut. None of these islands was entirely diked. Existing vegetational conditions as well as future seral changes were provided for each of the five areas, and past as well as future avian utilization was hypothesized for each. Portions of these studies were published in American Birds as Breeding Bird Surveys (Atkins et al. 1977).

39. In 1973, Buckley and Buckley compared the use of dredged

material island sites and natural sites by colonial nesting wading birds and seabirds in national seashores in New York and North Carolina. They found that in New York at the Fire Island National Seashore, all colonial waders and seabirds were nesting on dredged material, while at the Gateway National Recreation Area only 34 percent used dredged material sites. At the Cape Hatteras National Seashore in North Carolina, they estimated that 95 percent of all wading birds and seabirds were utilizing dredged material for breeding sites (Buckley and Buckley 1975).

40. In 1976, Buckley and Buckley prepared a set of guidelines for the protection and management of colonial nesting waterbirds. This report, designed primarily for use in national parks, discussed a wide range of protection and management suggestions and provided a series of recommendations concerning dredging and dredged material islands (Buckley and Buckley 1976).

41. The literature contains a number of reports of birds making use of dredged material islands both on the Atlantic and gulf coasts. Those not dealing with specific studies of dredged material islands have not been included.

PART II: THE STUDY AREA

Generalized Biophysical Setting

42. The outer coastal portions of North Carolina may best be characterized as an expanse of sounds, marshes, and small natural and dredged material islands bounded on the west by the mainland and on the east by a series of barrier islands (Figure 1). Sounds in the northern half of the state are generally wide (Back, Core, Pamlico, Roanoke, and Currituck sounds), while the distance between barrier islands and the mainland is considerably narrower from Morehead City south to the North Carolina-South Carolina state line. Three major estuarine river systems (Chowan, Pamlico, and Neuse rivers) empty into Pamlico and Currituck sounds, while the New, White Oak, Cape Fear, Lockwood's Folly, and Shallotte rivers pass through the southern portion of the study area and directly into the Atlantic Ocean.

43. A count made in July 1977 using maps and aerial surveys indicated that approximately 395 dredged material islands were located in the greater project area. Dredged material islands occurred as lines of islands that paralleled known channels, as well as in marsh or open water, often on preexisting islands. The presence of dikes on islands or island groups was an aid to positive identification of disposal islands. Isolated, undiked islands, especially if they were old, were sometimes difficult to identify. In such cases personnel at the Wilmington District were consulted. For a few islands such as the Battery Island complex, it was not possible with existing information to be sure that all portions of the site had received dredged material.

44. Dredged material islands have often been constructed in chains paralleling channels. Each unit along the chain was considered a separate island if surrounded by low marsh dominated by tall smooth cordgrass (Spartina alterniflora) or some other such positive indication of regular flooding at mean high tide.

45. As the process of diking has become the more common method of construction of dredged material disposal islands, the total number

of islands has decreased because of the habit of joining several undiked islands to form a single diked disposal area. Of the 395 dredged material islands estimated in North Carolina in 1977, 308 were undiked and 87 were diked. It is estimated that roughly 30 percent of the dredged material island surface in North Carolina estuaries was behind dikes. This percentage should increase as the process of diking continues.

46. The process of diking is at present highly regional within the state. There were approximately 54 dredged material islands between the North Carolina-Virginia state line and Beaufort, N. C., a distance of approximately 240 km. Only three of these were diked. Between Cape Lookout and Camp Lejeune, a distance of 60 km, there were 83 dredged material islands, of which 15 were diked. There were approximately 37 dredged material islands along the AIWW through Camp Lejeune, a distance of 25 km. None were diked. In the 100 km between the southern border of Camp LeJeune and Southport, N. C., there were 267 dredged material islands, of which 81 were diked. Along the 50 km of the AIWW between Southport and the North Carolina-South Carolina state line, there were about 73 dredged material islands, of which 26 were diked.

47. It is clear that diking is more common in the southern portion of the North Carolina estuaries where the process is commonly associated with maintenance of the AIWW and the Cape Fear River channels. Indications are that the process of diking will continue to spread northward (Personal Communication, September 1977, J. L. Wells, Chief, Dredging Section, Navigation Branch, Wilmington District, Corps of Engineers, Wilmington, North Carolina).

Major Factors Influencing Biophysical Make-Up of Dredged Material Islands

48. Four sets of factors influence the general biophysical make-up of dredged material islands in the project area: (1) climate and weather factors, (2) maritime, estuarine, and riverine factors, (3) soil factors, and (4) botanical factors. The importance of these

sets of factors and their effects on the islands within the greater project area are discussed in the following paragraphs.

Climate and weather factors

49. The climate in eastern North Carolina has been characterized as humid subtropical with warm summers and rain distributed throughout the year (Finch and Trewartha 1949). Weather data available for the coastal portions of the state show a mean monthly temperature of about 63°F* and a mean annual low and high of 54°F and 71°F, respectively (averaged between Cape Hatteras and Wilmington, N. C., U. S. Weather Bureau stations from Environmental Data Service 1976a and b).

50. Precipitation is spread fairly evenly throughout the year (about 55 in. per year), but there is somewhat greater rainfall during June, July, August, and September (Environmental Data Service 1976a and b). The increased rainfall during these months is due largely to the increased occurrence of summer thunderstorms, some of which are quite violent. In spite of increased rainfall during these months, standing water is less abundant because of greater summer evapotranspiration rates. The average length of the freeze-free period (growing season) along the coast varies from 240 days near New River to more than 280 at Cape Hatteras (Hardy and Hardy 1971).

51. Incidences of tropical storms passing through areas included within the greater study area have been well documented (Carney and Hardy 1967). The regularity with which tropical storms and hurricanes have passed over the Outer Banks during historical times, strongly influencing island biogeography, has been discussed by Engels (1942). Past storms have had a profound influence on the present shape of outer coastal islands and location of inlets. Historically, the locations of inlets have changed due either to slow migration resulting from longshore currents or to rapid filling and opening during tropical storms (Stick 1958). There have been no significant tropical storms or hurricanes through the greater project area within the last decade.

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* A table of factors for converting U. S. customary units of measurement to metric (SI) units is presented on page 10.

52. As far as plant growth and bird utilization of islands in the greater project are concerned, a more severe weather element may be the occurrence of sustained periods of northeast winds in excess of 20 knots. Though some portions of the project area are more susceptible than others, northeast winds generally cause higher than normal tidal ranges. Prolonged flooding and shoreline erosion usually accompany these periods of severe weather.

Maritime, estuarine, and riverine factors

53. As ocean waters meet the waters of estuaries and the tidal rivers that feed them, there is a slow shift in salinities from seawater (about 35 parts per thousand) at or near inlets to fresh water well within riverine systems. Estuaries are the areas within which the salinity transitions occur.

54. Bottom substrate materials that enter and settle in estuaries are derived from three major sources: (1) shell formed by living organisms in the estuary, (2) shell and sand brought into estuaries by strong tidal currents, and (3) silts and clays derived within estuaries or deposited by coastal rivers. Generally, between an inlet (a high energy area) and a river mouth (a somewhat lower energy area), there will be a transition of bottom substrate material from coarse to fine, respectively. Dredged material derived from these bottom substrates may reflect the relative tidal energy regimes of the area. The sizes of substrate particles in turn strongly influence the pattern of plant succession and bird utilization on dredged material disposal islands (CZRC 1977).

55. Salinity conditions in both water (Chapman 1964) and wind-driven salt spray (Boyce 1954) function as limiting factors to the establishment of plants on coastal islands. Most saline dredged material, depending upon texture and permeability, deposited in upland situations well above the level of normal high tides tends to lose salt rather rapidly to the groundwater table by the process of leaching. Repeated deposits of saline or brackish material will kill back vegetation intolerant of salt water, similar to the action of storm overwash. These effects will, of course, vary with the relative salt tolerance of the species.

56. Islands close enough to maritime environments receive varying amounts of wind-driven saltwater spray. The major effect of salt spray on plants is damage to foliar and twig tissues rather than to root tissues (Boyce 1954). Though salt spray lands on the surface of the soil in areas not heavily covered by vegetation, it is generally rapidly leached by rain, at least in sandy soils. Heavier soils composed of substantial quantities of silt and clay may impede rapid leaching. In the latter case, residual salt limits the growth of non-halophytic plants.

57. Flooding is a complex estuarine factor dependent on an interplay of wind and lunar tidal conditions. Tides within southern estuarine sections of North Carolina are predominantly lunar, but in certain areas, such as Currituck and Pamlico sounds, tides above a few inches are wind driven. Wind speed, direction, and fetch across open water influence flooding or draining of areas where wind tides dominate lunar tides and may augment the range of dominant lunar tides. Flooding of low unprotected islands in large bodies of water (Pamlico Sound, for example) occurs commonly, and may be enhanced in the vicinity of inlets where oceanic tides are more influential in estuarine tidal regimes. During periods of spring tides, the probability of flooding is increased. For instance, a northeast wind in excess of 15 knots, blowing at the time of a spring tide near Ocracoke Inlet (between Ocracoke and Portsmouth islands), causes severe flooding on the relatively unprotected estuarine islands in that portion of Pamlico Sound.

58. Island erosion is another factor promoted by strong winds of long duration. Strong northeast winds of sustained duration are generally thought of as being very damaging along most of the North Carolina coast.

Soil factors

59. Dredged material disposal island soils are derived from several sources. Sands are the resorted quartz remains of eroded mountains. Silt and clay particles are carried from inland sources into estuaries by rivers and streams, though some fine particles may be marine or estuarine in origin. Organic detritus is brought in by

rivers and streams and washed from brackish, freshwater, and salt-water marshes. Shell originates in both marine and estuarine environment.

60. Dredged material as a soil medium for the growth of plants and the development of vegetation exhibits a significant degree of variability in physical and chemical composition. These variables are the products of other factors: (1) geographic origin of dredged material, e.g. sounds, rivers, inlets, marshes, etc.; (2) derivation of the material from original construction or later maintenance of a channel, basin, or harbor; (3) disposal area construction (i.e., diked or undiked); (4) dredged material surface age; (5) uses made of the disposal area by organisms; and (6) frequency of fresh disposal on the area.

61. The effects of geographic origin of dredged material on particle size and salinity were discussed in the previous section. Geographic location also affects turbidity and sedimentation. In addition, organic material appears to be more commonly associated with bottom sediments in coastal riverine environments. Sediment loads are deposited at rates relative to water velocity and salinity. Turbidity decreases with decreasing wind speeds and increasing salinities (McCoy and Johnston 1964). As a silt-laden freshwater river enters along an estuarine halocline, the increasing salinity causes an increase in the rate of particle precipitation (McCoy et al. 1963).

62. The nature of substrate materials on disposal islands is controlled partially by whether the dredged material is derived through original construction or during the course of maintenance. Boyd et al. (1972) indicate that dredged material from original construction generally contains a greater proportion of coarse particles (sand and shell), while maintenance dredged material tends to be of finer texture (fine sand or silt and clay). Channels or basins may function as traps or backwater areas when the accumulation of fine materials is enhanced by reduced current velocities.

63. Both construction methodology and the resulting structures of diked versus undiked disposal islands have a bearing on particle size distribution and substrate chemistry. Since the beginning of

construction of the AIWW in North Carolina, dredging has been performed along the major portion of the coast, by use of hydraulic dredges. The configuration of undiked deposits constructed by slurry discharge from the pipe has been described by Soots and Parnell (1975) as "... a wide, inverted, cone-shaped mound." There is a resulting distribution of particle sizes ranging, generally, from shells, pebbles, and coarse sand on the dome and upper slopes to medium to fine sand on the lower slopes. Under most circumstances, fine particulate matter (very fine sand, silt, and clay) is washed off the emergent dome into the adjacent water. The slope of the emergent island and the coarse texture of the substrate cause most mobile soil nutrients to quickly leach downward to the water table, where they are moved slowly away from the site and become unavailable to most vascular plants.

64. The use of dikes has drastically changed the chemical and particle size composition of dredged material. Dike construction usually involves inclusion of a drop-log weir that is opened by removal of boards at the time the slurry water is decanted. Decanting of the water takes place after most of the fine particulate materials with their adsorbed complement of chemicals have settled out. Thus, relatively greater concentrations of fine particulates and various chemical components remain behind dikes after the slurry water has been decanted. Preexisting soil surfaces such as inner dike slopes, dozer scrapes, borrow pits, or older dredged material, are frequently altered either by saline or brackish water or by a veneer of fines and associated chemicals.

65. Dike construction usually involves the movement or redistribution of older dredged material. Depending on whether a dragline or a bulldozer is used to construct the dike, a borrow pit or a dozer scrape is created, respectively. Construction of these new topographic features results in a well-drained dike surrounding a relatively poorly drained borrow pit or dozer scrape. If the disposal area remains unused for a time, or if it is used and abandoned, the borrow pit may come under the influence of tidal water that enters via the abandoned weir. Under such conditions, a marsh containing halophytic graminoides or forbs may develop. Standing fresh water may accumulate from rain

in either borrow pits or dozer scrapes. Frequently the fresh water is made brackish by mixing with saline water seepage under the dike or via the weir.

66. When slopes and domes result from the deposit of dredged material behind dikes, subsequent wash and leaching by rainwater percolation or sheet flow along the slope may tend to deposit materials and nutrients around the inner base of the dike. Where textures are coarse along slopes, most fines and/or nutrients probably are lost to the water table by leaching.

67. Thus, soil physical and chemical environments vary considerably between diked and undiked disposal islands, influenced by activities before and after disposal takes place.

68. The ages of dredged material surfaces are generally uniform over the entire deposit on undiked disposal areas. On diked disposal areas, the ages of substrate surfaces vary considerably due to construction and disposal methodology. In this study, dikes and their borrow pits or dozer scrapes are considered the same age unless a dike has been rebuilt for a subsequent disposal. In such a situation, the age of a dike may vary, while the borrow pit or dozer scrape is the same age as the most recent dike surface. Since diking and subsequent disposal may be separated in time by several growing seasons, the surfaces of the dike and the deposit may not be the same age. The same potential age discrepancy holds true for the surfaces of borrow pits and inner swales, the surfaces of preexisting slopes and dozer scrapes or borrow pits, and the surfaces of any two deposits within a single dike where the periods of disposal were not carried out in the same year. This study has made no effort to systematically account for the ages of dredged material surfaces in units of less than 1 year (or one growing season).

69. Major uses made of disposal areas by organisms other than man are considered to be plant growth, bird nesting, and perhaps bird roosting. These largely biological factors may effect a change of the nutrient status of dredged material by a contribution of organic matter and nutrients from dead plant material and bird fecal material. Other biotic factors are discussed in the following sections.

70. Certain ranges of maintained channels or basins may require frequent maintenance dredging while other ranges may never need maintenance. Thus, some disposal areas are used more frequently than others. The frequency of disposal affects the soil surfaces, vegetational associations, and bird utilization. Frequently used disposal islands near inlets exhibit an ecological regime similar to that found along overwash areas on barrier islands. Soils on slopes are usually coarse sand and shell and devoid of vegetation or only sparsely covered by vegetation.

Botanical factors

71. Hypothetically, the study area is situated along a section of the eastern limits of the Nearctic zoogeographic region and the eastern deciduous forest biome. Practically, biota within the project area are not strictly classifiable to biogeographic region. The strong maritime-estuarine influence and the insularity of the area obscure most greater biogeographical affinities.

72. Botanically, the dredged material seres most resemble vegetational sequences described for barrier islands, as noted by Soots and Parnell (1975). Floras of barrier islands along the North Carolina coast were examined by two investigators, Lewis (1917) and Burk (1962). Vegetational conditions and ecological processes have received more intense examination along the entire Outer Banks (Brown 1959), in the vicinity of Shackleford and Core Banks (Hosier 1973, Au 1969), and near Cape Lookout National Seashore area (Godfrey and Godfrey 1976). Late successional stages of dredged material vegetation development have been compared with maritime forests (Soots and Parnell 1975) as the latter was described for the Outer Banks by Bourdeau and Oosting (1959).

73. The results of vegetation succession on undiked islands older than the oldest disposal islands along the AIWW have not been observed in the North Carolina estuaries. Diked island disposal areas older than 6 years were not found within the project area. Most diked islands are 4 years old or less.

74. Throughout the lower coastal plain of North Carolina in and around the project area, there are several major plant communities that provide or originally provided the seed source from which plant species characteristic of dredged material islands were derived. The major community types are (1) mixed pine-hardwood forest, (2) maritime forest, (3) longleaf pine-turkey oak-wiregrass woodlands, and (4) dune-marsh complex. These communities are discussed in general terms in the following paragraphs.

75. Mixed pine-hardwood forest is one of the more important forest types found on the mainland landscape, particularly west of the northern portions of the project area. Dominant canopy species are loblolly pine (*Pinus taeda*) along with various species of oaks (*Quercus* spp.), hickories (*Carya* spp.), sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), and black gum (*Nyssa sylvatica*). Swamplands dominated by red maple, gums, bald cypress (*Taxodium distichum*), and ashes (*Fraxinus* spp.) occur along stream and river floodplains. Pond pine (*Pinus serotina*), red maple, and three species of bay trees (*Persea borbonia*, *Magnolia virginiana*, and *Gordonia lasianthus*) are characteristic of pocosin vegetation found in broad upland flats where soils are dominated by perched water tables. Species more commonly found in early successional or weedy phases of this forest type constitute some of the dominant dredged material plant species. Examples are crabgrass (*Digitaria sanguinalis*), camphorweed (*Heterotheca subaxillaris*), horseweed (*Erigeron canadensis*), wild lettuce (*Lactuca canadensis*), peppergrass (*Lepidium virginicum*), dayflower (*Commelina communis*), and others.

76. Maritime forest is probably most nearly like the forests that have developed on very old dredged material islands. Canopy dominance in these maritime forests varies from place to place, but the following species are usually common: loblolly pine, live oak (*Quercus virginiana*), red cedar (*Juniperus virginiana*), red bay (*Persea borbonia*), sweetgum, red maple, laurel oak (*Quercus laurifolia*), hickories, and occasionally hackberry (*Celtis laevigata*) and ironwood (*Carpinus caroliniana*). Important large shrubs are wax myrtle (*Myrica cerifera*), yaupon (*Ilex vomitoria*), American olive

(Osmanthus americanus), and devil's-walking-stick (Aralia spinosa). Understory trees are often younger individuals of the canopy species as well as flowering dogwood (Cornus florida). Several species of woody vines are habitually found interlaced in all woody plant strata. The most common are briars (Smilax bona-nox, Smilax auriculata), rattan (Berchemia scandens), muscadine (Vitis rotundifolia), fall grape (V. aestivalis), poison ivy (Rhus radicans), Virginia creeper (Parthenocissus quinquefolia), and pepper vine (Ampelopsis arborea).

77. Several important herbaceous species found in maritime forests by Bourdeau and Oosting (1959) were elephant's-foot (Elephantopus tomentosus), twin-flower (Mitchella repens), ebony spleenwort (Asplenium platyneuron), bedstraw (Galium pilosum), and galactia (Galactia macreei).

78. Several of the characteristic plant species of maritime forest occur regularly on older or even relatively young dredged material disposal islands. A few examples are loblolly pine, red cedar, live oak, all the woody vines mentioned previously, wax myrtle, ebony spleenwort, bedstraw, and galactia.

79. Longleaf pine-turkey oak-wiregrass woodlands frequently dominate upland sites on the mainland having coarse sandy soils. The major dominants, as implied by the name, are longleaf pine (Pinus palustris), turkey oak (Quercus laevis), and wiregrass (Aristida stricta). A considerable amount of variation exists in this forest type dependent on the frequency of fire, slope, and exposure. Some of the species in common with this woodland type (or its more disturbed phases) and dredged material islands are dog-fennel (Eupatorium capillifolium), camphorweed, peppergrass, dayflower, yucca (Yucca filamentosa), sandgrass (Triplasis purpurea), lovegrass (Eragrostis capillaris), and stipulicida (Stipulicida setacea).

80. The dune-marsh complex of the outer coastal strand of barrier islands is both ecologically and floristically similar to young dredged material islands in the North Carolina estuaries. By far, the largest numbers of species occupying both wet and dry dredged material sites have been derived from this complex. Many of the habitat characteristics of dredged material islands may be compared

to overwashed barrier beaches. The sequence of recognized vegetation units along a generalized barrier island transect progresses from the foreshore area through low marsh to the rear of the island. The major ecosystem units and their dominant plant species as outlined in Godfrey and Godfrey (1976) for barrier island overwash areas are presented as follows:

Foreshore :	Bare sand of surf and beach face
Backshore :	Bare berm crest and berm
Dunes :	Salt-meadow cordgrass (*Spartina patens*) Sea oats (*Uniola paniculata*) Sand grass Dwarf horseweed (*Erigeron pusillus*) Pennyroyal (*Hydrocotyle bonariensis*)
Open grassland of overwash pass and fan:	Saltmeadow cordgrass Seaside goldenrod (*Solidago sempervirens*) Lovegrass
Closed grassland :	Species of open grassland plus Pennyroyal Broomsedge (*Andropogon virginicus*) Muhly grass (*Muhlenbergia capillaris*) Fimbristylis (*Fimbristylis spadicea*)
High marsh :	Black needlerush (*Juncus roemerianus*) Sea oxeye (*Borrichia frutescens*) Fimbristylis Saltmeadow cordgrass
Salt pannes and low marsh:	Smooth cordgrass Glasswort (*Salicornia perennis*) Sea lavender (*Limonium carolinianum*) Salt grass (*Distichlis spicata*)
Tidal creek :	Aquatic fauna and flora

81. If the low barrier island landscape is viewed as an ecosystem more or less regularly disturbed by oceanic (saltwater) overwash, it becomes comparable in many respects to undiked dredged material islands, or to portions of diked island disposal areas subject to more or less regular disposal as a result of channel maintenance dredging. The greatest exceptions to this comparison occur on diked island disposal areas.

Avifaunal factors

82. The study area lies within the Atlantic flyway, a major migratory route for both water and land birds passing to more northern

breeding grounds in spring and returning each fall to southern wintering areas. The estuary, barrier beaches, and inshore ocean waters are major passage routes for waterfowl, gulls, terns, shorebirds, waders, and raptors in both spring and fall.

83. In autumn, winds from the northwest and a northeast to southwest orientation of the coastline combine to bring migrating land birds to the coast as they move southward. This combination of factors results in a massing of land birds along the immediate coast. At such times the edge of the continent becomes a narrow corridor where tremendous numbers of small land birds mix with the hordes of water birds moving south. At this season, coastal islands become very important resting and feeding sites.

84. In spring, southeasterly winds push migrants northward and tend to scatter them over broad inland stretches. Thus, concentrations of land birds seldom occur along the coast in spring, and utilization of coastal islands is less spectacular.

85. Many workers have studied the bird life of the North Carolina coastal zone, but relatively few have accomplished broad regional evaluations. Much of the early work was done by Pearson, Brimley and Brimley (1919). More recently Quay (1959) studied the vertebrates of the Cape Hatteras National Seashore and characterized the bird life of the major park communities. The tremenduous volume and diversity of the fall migration of land birds along the Outer Banks was documented by Sykes (1967). He recorded 149 species of land birds on Bodie Island during the fall of 1965. Further south Quay (1947) characterized the colonial breeding birds of the Beaufort region, and in 1959 Funderburg and Quay reported on the breeding birds of the estuary of southeastern North Carolina. Needham (1966) studied the migration of shorebirds along the coast at Wrightsville Beach, and Parnell and Adams (1971) reported on the birdlife of a barrier island complex (Smith Island). Soots and Parnell (1975) added to an understanding of the regional colonial seabird populations with their recent work on community succession on dredged material islands in North Carolina. Many other workers have published observations on coastal birdlife, and this accumulated body of information has pro-

vided a general framework of understanding of the major patterns of movement and regional occurrences of birds in the North Carolina coastal zone.

86. These regional studies indicate that the North Carolina estuaries are extremely important to water birds at all seasons. The diversity of birdlife, and in many cases population levels, are often spectacular. The estuarine islands, dredged and natural, are important components of the system. Land-bird populations are less spectacular, except during the fall migration, and, generally, species composition is similar to, although often somewhat less diverse than, that found in similar mainland habitats.

87. The avifauna of dredged material islands does not relate closely to the birdlife of the nearby mainland but rather to that of barrier islands. Most gulls, terns, and skimmers in eastern North Carolina are birds of the estuary and barrier beaches and seldom venture far inland. Some gulls will travel inland to feed in plowed fields or to scavenge garbage dumps, but their use of local inland habitats is minimal.

88. Some wading birds, particularly the cattle egret (Bubulcus ibis) and white ibis (Eudocimus albus) regularly move from nesting and roosting sites in the estuary to mainland feeding sites. In these cases both habitats form a part of the necessary environment of the species. Most wading birds, however, spend the greatest amount of their time in the estuary.

89. Movement of local land birds between the mainland coastal islands is also minimal, but there are exceptions. Fish crows (Corvus ossifragus), red-winged blackbirds (Agelaius phoeniceus), and boat-tailed (Quiscalus major) and common (Quiscalus quiscula) grackles regularly move back and forth between mainland and estuarine habitats. Mockingbirds (Mimus polyglottos), cardinals (Cardinalis cardinalis), and a few other small songbirds adapted to thicket habitats occur throughout the year on small thicketed estuarine islands and move regularly back and forth between mainland and island habitats. Such islands appear to be natural extensions of mainland habitats. Land bird communities in the maritime forest on the larger coastal islands

resemble those in similar mainland habitats.

90. In fall and winter, coastal islands become important habitats for land birds. During the fall migration, the vegetated islands provide shelter and sometimes food and water to large numbers of birds moving southward. Many of these remain throughout the winter occupying appropriate habitats both on the mainland and along the coast. For example, the yellow-rumped warbler (Dendroica coronata) winters in the wax myrtle thickets along the southeastern coast and is especially abundant in thickets on coastal islands. Several species of sparrows are also regular winter residents on estuarine islands.

91. Thus, it is apparent that vegetational and avifaunal associations of existing dredged material islands are most similar to those found along the barrier islands of the outer coastal portion of North Carolina. The phenomenon of overwash can be compared to recurrent dredged material disposal in defining habitat for certain groups of plants and birds. Older dredged material islands (undiked) may support maritime forest-like vegetation where the effects of recurrent disposal and/or overwash are not important. The total diversity of bird species using such relatively mature forest stands, though not documented in the literature, should be similar to that for maritime forest on natural barrier islands.

PART III: METHODS

92. The primary thrust of this research project was to evaluate the use of diked dredged material islands by birds and to relate this utilization to that of undiked dredged material islands. From previous studies it was known that bird use of dredged material islands related strongly to vegetation and to substrate (Soots and Parnell 1975). Studies designed to provide comparative information on substrate, vegetation, and bird utilization of diked and undiked islands were thus begun. The methodology involved is discussed in this part.

93. Throughout the course of the project it was occasionally necessary to modify existing ecological techniques and to devise new ones to better suit field conditions or to facilitate data collection, synthesis, and analysis. In some cases a terminology has developed to aid in communication concerning dredged material islands. This terminology along with the various analysis and data storage techniques will be dealt with in the following sections.

Transect Terminology

94. There are two basic disposal area island types: diked and undiked. Undiked islands, which retain some semblance of their original form, are low dome-shaped features, usually no more than 2 to 5 m above mean high water. Though well-defined topographic zones are frequently obscured on most older undiked islands, young islands generally have six zones: (1) lower drift ridge, (2) lower swale, (3) upper drift ridge, (4) upper swale, (5) slope, and (6) dome (Figure 2). Lower and upper drift ridges form during periods of spring and storm tides, respectively. These features result from deposition of various floatable materials and wind-eroded sand from the dome and slope. One swale is formed between the two ridges and another between the upper ridge and the beginning of the slope. Ridges and swales are secondary features, while the slope and dome are largely primary topographic features (Soots and Parnell 1975).

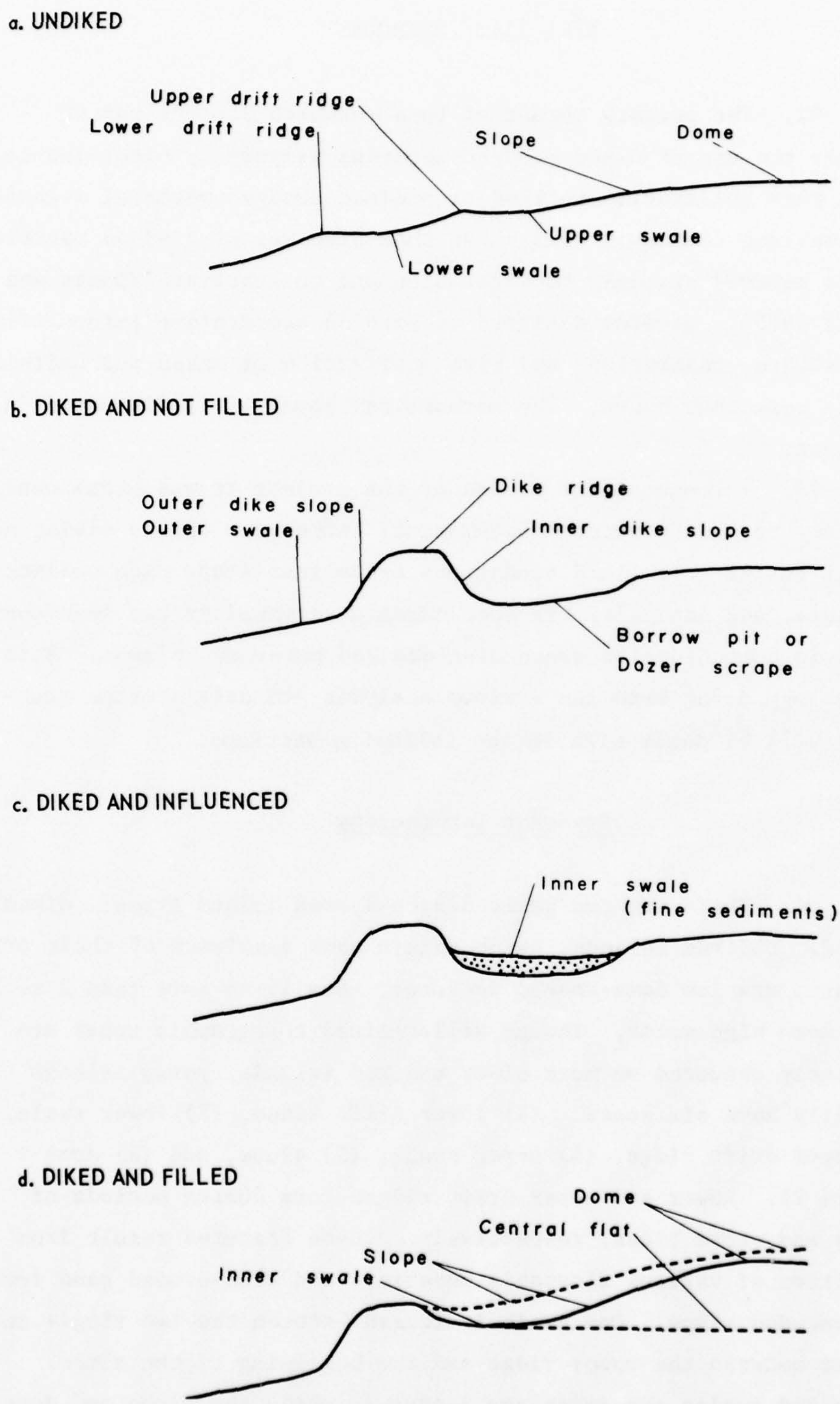

Figure 2. Topographic zones of diked and undiked dredged material islands

95. Diked islands present a somewhat different set of topographic (or transect) zones (Figure 2). Original dikes are usually constructed of previously dredged material deposited on undiked islands. Reconstructed or refurbished dikes are built from materials disposed behind original dikes. Dikes are constructed with either dragline or bulldozer, and material is moved outward from the center of the island, frequently well into the surrounding smooth cordgrass marsh. Before disposal of dredged material, a transect was termed diked and not filled and exhibited the following zones: (1) outer swale (usually, smooth cordgrass marsh), (2) outer dike slope, (3) dike ridge, (4) inner dike slope, and (6) dozer scrape or (7) borrow pit (Figure 3). The remaining area inside the dike was either old

Figure 3. Typical diked but not filled site along the AIWW near Wrightsville Beach, N. C.

dredged material, or if movement of machinery had disrupted the older dredged material surface, the term (8) disturbed ecotone was applied (though data were not collected in this zone).

96. Zones 1 through 4 were usually present on diked islands unless they had been eroded beyond recognition by wind or water. In certain cases, the dozer scrape or borrow pit had been modified as a result of the movement of slurry containing silts and clays downslope, away from the end of a discharge pipe on another end of the island. If the veneer of dredged material remained in the dozer scrape or the borrow pit, the transect type was termed diked and influenced. The dozer scrape or borrow pit with its veneer of dredged material was termed zone 5, inner swale (Figures 2c and 4).

Figure 4. Typical diked and influenced site along the AIWW near Wrightsville Beach, N. C.

97. Where dredged material spread over the entire surface inside the dike, a central flat, zone 9, developed if the material was largely fines. Where coarser material was discharged, slopes and domes were formed, and an undiked configuration often developed. Transects across dredged material deposited within a dike were termed diked and filled (Figures 2d and 5). Table 1 summarizes the four transect types and their attendant transect zones.

Sampling and Analysis Techniques

98. The various sampling and analysis techniques employed during the course of the project are outlined in the following paragraphs. Sampling times and general locations of various types of sampling were discussed in Part I.

Figure 5. Typical diked and filled site on the Cape Fear River between Wilmington and Southport

Table 1

Transect Types and Attendant Transect Zones with Number Codes

Transect Type	Code Number	Transect Zone	Code Number
Undiked	1	Beach	(1)
		Lower drift ridge	(2)
		Lower swale	(3)
		Upper drift ridge	(4)
		Upper swale	(5)
		Slope	(6)
		Dome	(7)
Diked and not filled	2	Outer swale	(1)
		Outside dike slope	(2)
		Dike ridge	(3)
		Inside dike slope	(4)
		Dozer scrape	(6)
		Borrow pit	(7)
		Disturbed ecotone	(8)
Diked and filled	3	Outer swale	(1)
		Outside dike slope	(2)
		Dike ridge	(3)
		Inside dike slope	(4)
		Inner swale	(5)
		Central flat	(9)
		Lower slope	(10)
		Upper slope	(11)
		Dome	(12)
Diked and influenced	4	Outer swale	(1)
		Outer dike slope	(2)
		Dike ridge	(3)
		Inner dike slope	(4)
		Inner swale	(5)

Soils and gradient sampling and analysis

99. Soil samples were taken along permanent vegetation sampling transects on diked islands to a depth of 15 cm at random points within each transect zone, or in the case of undiked transects, at the low, middle, and upper portions of each transect zone. Soil samples from undiked islands were collected by Soots and Parnell as a part of an earlier study of dredged material island ecology. No young undiked islands were available for sampling at the time of the present study. Samples were returned to the laboratory, dried, ground with mortar and pestle, and passed through a 2-mm (-1 phi) sieve. Each sample was divided into three subsamples which were either retained for hydrometric analyses or sent away for chemical tests* and water holding capacity analyses**. Hydrometric analyses for particle size determination were made using methodology established by Day (1950) and Bouyoucos (1962).

100. Elevational ranges and soil sample elevations were calculated from zone lengths and slope measurements made with an Abney level.

Vegetation sampling and analysis

101. Vegetation sampling transects were established perpendicular to dikes on diked islands, and along slopes on undiked islands. Each transect began at mean high water, usually in smooth cordgrass marsh. The transect terminated at the top of the dome on undiked islands, and at or near the center of the new disposal area on diked islands.

102. Data recorded along each transect consisted of percent cover and frequency (overall, as well as by species) for herbaceous species. Percent cover, frequency, and density were recorded for woody species. Areas dominated by a cover of shrubs were sampled using a 16-sq-m quadrat (4 by 4). All other areas were sampled with a

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* Chemical analyses were prepared by the Soil Testing Division. North Carolina Department of Agriculture, Raleigh.

** Water holding capacity analyses were directed by Dr. Keith Cassell, Department of Soil Science, North Carolina State University, Raleigh.

0.5-sq-m (1 by 0.5) quadrat frame (Figure 6). Data were recorded for every other metre along the transect except over dikes or drift ridges. Every metre was sampled over these topographic features.

103. Data were punched directly onto computer cards from field sheets, and summarized as two-factor importance values (I.V. = relative frequency plus relative cover) for herbaceous species, and as three factor importance values (I.V. = relative frequency plus relative density plus relative cover) for woody species other than vines. A total I.V. of 200 was possible for herbaceous species; 300 was possible for woody species.

Bird sampling and analysis

104. The major goal of the bird study was to determine the species composition and abundance of birds using diked disposal islands throughout the year and to compare this usage with that of undiked disposal islands.

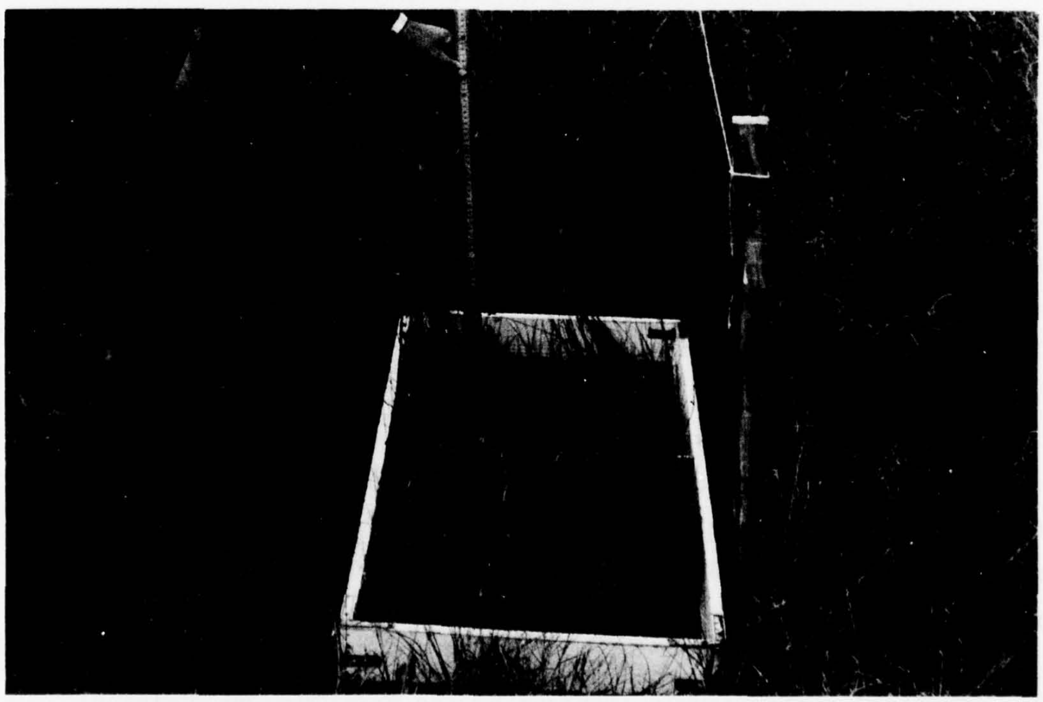

Figure 6. Half-metre quadrat used for vegetation sampling (frame 1 by 0.5 m)

105. The study was divided into two segments. The first consisted of a comparison of bird utilization of selected habitats on undiked, diked and not filled, diked and influenced, and diked and filled sites at all seasons. The second segment involved censusing all dredged material islands in the North Carolina estuaries for colonial nesting waterbirds.

106. During the first segment of study, all major habitat types present on dredged material islands were sampled. An attempt was made to replicate samples in each major habitat type at least three times. However, this was not possible in several cases due to the unavailability of multiple units of some habitats and also due to the destruction of some selected units during the course of the study as new dredged material was deposited. The study sites were spread throughout the region between Morehead City and the North Carolina-South Carolina state line. Sites were loosely grouped into three units by location: Morehead City to Swansboro, New River Inlet to Carolina Beach Inlet, and the Cape Fear River to the North Carolina-South Carolina state line (Figures D1 and D2, Appendix D).

107. Each habitat was sampled monthly during periods of relatively stable bird populations (December-February, 15-30 May, June and August) and twice monthly during the migration periods (March, April, 1-14 May, and September-November) when populations were expected to fluctuate due to the passage of migrants.

108. Each census involved direct counts of all birds observed within selected habitat types present on each study island. Time of day and weather were unmeasured variables. Time spent in each habitat varied with the size of the unit and was sufficient to allow the location and identification of all birds visible to the observer as he passed slowly through the habitat unit. Each habitat unit was subsequently measured, and bird usage was converted to units of density (birds per hectare). These were summarized by season and habitat type for each of the four island types (Tables C1-C16, Appendix C). During the nesting season there were searches for nests as verification of breeding status of birds observed. No effort was made to find all nests of solitary nesters. Total nest counts were

made of colonial nesters in each habitat type at the peak of the nesting period. These censuses were usually conducted late in the incubation period when nesting numbers had reached a maximum, but before young were large enough to leave nests.

109. The second unit of study was designed to compare utilization of undiked and diked dredged material islands by colonial nesters throughout North Carolina estuaries. This effort was closely correlated with an ongoing research project funded by the North Carolina Sea Grant Program designed to establish population levels for all colonial waterbirds and wading birds nesting in North Carolina estuaries.

110. This phase of research began with an aerial survey of North Carolina estuaries. During this flight, using a fixed-wing aircraft, all nesting colonies of colonial birds were located. Each colony was then visited at least once and often two or more times by four-wheel-drive vehicles or by boat.

111. At each colony site, actual counts were made of all active nests. For the ground-nesting waterbirds, this process usually involved having several people walk slowly through the colony counting all active nests within a strip of designated width. The width of this strip varied with nest visibility. Stripping was continued until a total count was achieved. Colony damage was minimized by using work crews of from three to eight people and by working only when temperatures were such that the absence of the parent birds did not cause undue stress on embryos or chicks. Most colonies could be thus censused in 15 to 30 minutes. In larger colonies up to two to three hours were needed but adults were not kept away from nests in any particular section of the colony for more than 15 to 30 minutes.

112. Censusing the wading birds was more difficult for as many as nine species sometimes nested together in dense thickets. It was also very difficult to separate the eggs and nests of Louisiana herons, little blue herons (Florida caerulea), snowy egrets, and cattle egrets under field conditions. The small white young of snowy egrets, little blue herons, and cattle egrets were also difficult to identify unless sufficient time was available for a

close detailed examination. The basic census methodology was the same as for the ground nesters, however, except that unknown eggs and unknown young were recorded separately. After the colony was stripped and a total count of nests of each species and a number of unknown nests were obtained, sample counts were taken of the adults present over the colony site. During previous testing in small colonies, it was found that during incubation there is an approximate one-to-one ratio between adults and nests. Unknown nests were thus apportioned according to the proportions of adults present.

113. Most heronries were visited twice during the season, with the second visit coming about 30 days after the first. On the second visit, only nests with eggs were counted since these would have been started since the last visit. The incubation period for most species of wading birds that breed in North Carolina is between 19 and 26 days (Palmer 1962). There may have been some duplication of nest counts, as some of the birds counted on the second census may have been renesters that were also counted in the first census. This duplication should be offset by late nesters that were not recorded on either of the first two censuses. In North Carolina only the cattle egret appears regularly to spread its nesting period over very long periods (May until September). Most other species begin a large majority of their nesting within a relatively short period unless bad weather results in extensive nest failures and massive renesting.

114. During some censuses conducted late in the nesting period, it was necessary to count nests without regard to determining species and to apportion all nests on the basis of adult estimates. This method was made necessary when many large nestlings were present at the time of the census. Under these conditions young birds will readily fall or jump from nests if approached too closely. Such young seldom regain the safety of the nests and usually die.

Specimen Preparation and Deposition

115. Dried and pressed plants collected as sample vouchers specimens will be labeled and deposited at WES. Soil samples were

discarded after analyses. No other specimens were collected.

Data Deposition

116. Bird and vegetation data not presented in the report have been stored at the Triangle Universities Computation Center, Research Triangle Park, N. C., and in the Department of Biology, University of North Carolina at Wilmington.

Nomenclature

117. All plant species nomenclature follows that found in Radford et al. (1968). Bird names are based on the 5th edition of the American Ornithologists' Union Checklist (AOU 1957) and its thirty-second (AOU 1973) and thirty-third (AOU 1976) supplements.

Cartography

118. The maps in Appendix D were adapted from national charts of the National Oceanic and Atmospheric Administration, U. S. Department of Commerce.

PART IV: RESULTS

Characteristics of Soils on Dredged Material Islands

119. Soils on dredged material islands are basically azonal, and lack sufficient horizonation to be strictly classified. They can be considered young soils, and in this respect they have some of the profile characteristics of entisols and inseptisols (Buol et al. 1973). More appropriately, dredged material is a form of parent material that has become subject to soil-forming processes as a result of discharge in an upland situation. Even the oldest dredged material islands have not had enough time for development of more than a thin layer of organic material in what could be considered an A_1 horizon. Horizonation seen in dredged material profiles is largely an artifact of slurry discharge, not natural soil-forming processes.

120. Physical and chemical data obtained from soil samples collected on diked (Tables A1-A5, Appendix A) and undiked (Tables A6 and A7, Appendix A) dredged material islands reflect some of the topographic variations within each of the four island types. In a general sense, it is possible to compare any two of the four island types. In a specific sense, close zone-for-zone comparison was possible only between like zones. For example, dikes could not be compared with any specific feature found on undiked islands. Likewise, inner swales, borrow pits, dozer scrapes, and central flats on diked islands had no comparable features on undiked islands.

121. Ages of undiked islands at the time of soil sampling are given in the following columns:

Island No.	Chemistry data (sample island ages in years)	Textural data (sample island ages in years)
36 - 14	7	6
37 - 02	4	3
37 - 12	3	2
39 - 34	4	4

All samples were collected by Soots and Parnell prior to the widespread implementation of diking in the study area in order to provide samples from young undiked sites.

122. It was not appropriate to assign ages to entire diked islands, as dikes were often constructed one or more years before the deposition of dredged material behind the dikes. Thus, the ages of dikes, borrow pits, and dozer scrapes may differ from topographic features resulting from the deposition of materials behind dikes. Ages were thus assigned independently to the surface of each zone on diked islands.

123. Means of chemical and physical parameters for soils on diked disposal islands reflected some of the expected trends in silt and clay percentages and water holding capacity (Tables 2 and 3). Organic matter content was higher in the soils of inner swales and central flats than in dikes. No other trends were readily defined by the data, though the slightly higher means of calcium, magnesium, potassium, and sodium content in inner swales may be significant. Generally, one would expect finer textured soils to contain greater concentrations of these minerals. The value for pH on deposit slopes may indicate a slightly higher shell content. The correlation between high silt and clay content and high summation cation content is shown in Table 4.

124. Cation content, pH, and silt and clay content showed no clear changes when considered as a function of age (Table 5). The same lack of any clear trend was true of water-soluble chloride content of soils on dikes, inner swales, and deposit slopes (Table 6). Nitrate nitrogen was almost absent from soils on diked islands, occurring occasionally in swales and central flats in association with clays and silts (Table A5, Appendix A).

125. Undiked islands were usually composed of coarser materials than diked islands (Table A6, Appendix A), but the relatively low amounts of silt and clay that were present correlated well with values for swales that acted as catchment for fine particulate matter containing organic matter, potassium, and magnesium (Table 2). Values for pH on domes and slopes of undiked islands ranged from 7.1 to 7.7.

Table 2

Means of Chemical and Physical Data from Soil Samples Collected Along All Transects on Undiked Islands

Soil Parameter	Lower Drift Ridge	Lower Swale	Upper Drift Ridge	Upper Swale	Slope	Dome
pH in water	8.0	8.0	7.9	7.7	7.7	7.1
Organic matter, percent by weight	0.76	1.0	0.7	1.5	0.7	0.8
Potassium, $meq/100cm^3$	0.04	1.2	0.07	0.2	0.04	0.02
Calcium, $meq/100cm^3$	34.6	35.1	31.3	38.3	41.2	34.4
Magnesium, $meq/100cm^3$	0.64	1.43	0.58	2.02	0.47	0.33
Soil test phosphorus, mg/dm^3	404.3	134.6	234.5	176.7	138.7	193.0
Water-holding capacity, percent water by weight at 15 bars	1.7	3.5	2.0	4.0	1.8	1.2
Silt and clay, percent by weight	0.05	0.20	0.05	0.11	0.06	0.03

Table 3

<u>Means of Chemical and Physical Data from Soil Samples Collected Along Transects on Diked Dredged Material Islands</u>

Soil Parameter	Outside Dike Slope	Dike Ridge	Inside Dike Slope	Inner Swales & Central Flats	Deposit Slopes
Sums of extractable minerals,[a] (meq/100cm^3)	27.8	30.57	27.51	39.44	31.40
Soil test phosphorus, mg/dm^3	225.5	225.1	204.8	97.1	174.4
pH in water	7.7	7.8	7.5	7.5	8.1
Silt and clay, percent by weight	9.9	12.2	12.3	40.7	7.0
Water-holding capacity, percent water by weight at 15 bars	2.9	3.2	3.7	16.4	1.7

[a] Summed values for calcium, magnesium, potassium, and sodium.

Table 4

Physical and Chemical Values of Soil Samples Collected from Deposit Slopes on Diked Dredged Material Islands

Island Number	Transect Number	Age (yr)	Silt & Clay (%)	pH	Total K, Ca, Mg, Na meq/100 cm^3
22-44	2	1	7.6	8.4	41.1
36-13	3	1	4.0	8.1	40.4
36-14	3	1	8.0	8.3	39.9
37-09	2	1	7.2	8.0	40.0
43-09	1	1	8.0	8.5	43.5
43-09	2	1	8.6	8.4	41.8
18-14	1	2	5.6	8.3	23.5
22-25	4	2	6.7	8.3	32.6
22-26	1	2	8.6	8.4	43.0
39-33	2	2	5.5	8.3	34.9[a] 19.7[b]
39-23	1	3	6.6	6.9	1.8
39-23	2	3	7.0	6.8	1.3
Average values			7.0	8.1	31.0

[a] Lower slope.

[b] Upper slope.

Table 5

Comparison of Soil Physical and Chemical Values Between Selected Dikes and Inner Swales and Central Flats on Diked Dredged Material Islands

		Average Physical & Chemical Values for Dikes					Physical & Chemical Values for Inner Swales & Central Flats				
Island Number	Transect Number	Age (yr)	Silt & Clay (%)	Organic Matter (%)	pH	Total K, Ca, Mg, Na meq/100cm^3	Age (yr)	Silt & Clay (%)	Organic Matter (%)	pH	Total K, Ca, Mg, Na meq/100cm^3
22-25	3	2	7.4	0.0	8.3	17.7	2	70.4	1.9	7.6	37.6
39-28	1	2	15.7	2.3	7.1	17.1	2	78.0	4.4	6.9	37.7
40-01	2	2	15.0	0.2	6.5	5.1	1	83.0	6.5	7.5[a]	91.0
18-14	1	2	7.6	0.0	8.4	31.2	2	6.0	0.0	8.4	19.4
39-23	1	3	8.5	0.0	5.2	0.9	3	20.0	0.5	6.5	4.3
28-01	1	5	41.0	1.2	7.1	24.0	3	88.6	3.9	5.1[a]	24.2
23-07	1	6	6.7	0.1	8.1	36.8	6	6.6	0.0	8.1	47.0
Total average values			14.6	0.5	7.2	18.97		50.4	2.5	7.2	37.3

[a]Inner swale only.

Table 6

Water-Soluble Chloride Content of Various Topographic Features Along Selected Transects on Diked Dredged Material Islands

		Dikes[a]		Inner Swales		Deposit Slopes	
Island Number	Transect Number	Age (yr)	Water-soluble Chloride (mg/dm^3)	Age (yr)	Water-soluble Chloride (mg/dm^3)	Age (yr)	Water-soluble Chloride (mg/dm^3)
37-09	2	1	52.7	--	--	1	1.5
36-14	3	1	8.3	--	--	1	5.0
18-14	1	2	9.0	2	14.0	2	9.0
22-25	3	2	0.3	2	71.0	--	--
22-25	4	2	2.5	--	--	2	0.0
40-01	2	2	67.0	1	6720.0	--	--
39-28	1	2	21.3	2	265.0	--	--
39-23	1	3	0.0	3	0.0	3	0.0
28-01	1	5	94.5	3	346.0	3	139.0
23-07	1	6	23.0	6	681.0	--	--
Total average values			27.9		1156.7		25.8

[a] Average of outer slope, ridge, and inner slope data.

Slopes of diked dredged material ranged from 6.8 to 8.5. Since most domes and slopes of undiked islands were older than domes and slopes occurring behind dikes, this difference in pH may be a function of time. Values for pH showed a steady decrease toward neutrality upslope on undiked islands. Steady leaching of exchangeable cations (calcium, magnesium, etc.) derived from weathered shell fragments may have been responsible for this pH decrease.

126. The general lack of clear trends as functions of age, topography, and geography of diked islands may have resulted from inadequate sampling of the high range of variability of chemical makeup of dredged material. It is probable that samples taken repeatedly from the same sites over a time span of several years would have reflected more definite trends in dredged material soil composition.

Vegetation Sampling

127. The primary goal of the vegetation studies section of this project was to compare patterns and rates of plant succession on diked dredged material islands with those on undiked islands and to relate these to the observed patterns of usage of diked and undiked islands by birds. To accomplish this goal, 4580 0.5-sq-m vegetation plots were sampled during the growing seasons of 1976 and 1977. These plots were sampled along 133 transects on 33 islands between Cape Lookout, N. C., and the North Carolina-South Carolina state line.

128. Tables B1-B15 (Appendix B) provide importance values for all plant species occurring along the 133 transects. Importance values are presented by topographic zone and age for both undiked and diked sites.

129. Tables 7 and 8 include a list of the dominant plant species occurring in each topographic zone on diked and undiked islands, respectively, at varying ages from 1 through 40 years, based on the data in Tables B1-B15. The placement of species in these tables was based on an evaluation of the complete set of importance values found in Tables B1-B15. The species in Tables 7 and 8 are those that occur most regularly in each topographic zone during each age class and

Table 7

Importance Values of Dominant Plant Species Occurring Along Transects on Diked Islands

Species	Outer Swale	Outer Dike Slope	Dike Ridge	Inner Dike Slope	Inner Swale	Dozer Scrape	Borrow Pit	Central Flat	Slope and Dome
					Year 1				
Borrichia frutescens[a]	105	119	83	--	--	--	--	--	--
Spartina alterniflora	41	--	--	--	--	40	--	--	--
Distichlis spicata	29	--	--	--	--	--	93	--	--
Limonium carolinianum	25	--	--	--	--	--	--	--	--
Spartina patens	--	34	21	23	--	--	27	--	--
Fimbristylis spadicea	--	--	--	--	--	--	27	--	--
Solidago sempervirens	--	--	--	18	35	--	--	--	--
Strophostyles helvola	--	--	35	28	--	--	--	--	--
Erigeron canadensis	--	--	--	--	--	--	27	--	37
Heterotheca subaxillaris	--	--	--	--	39	43	--	--	--
Chenopodium ambrosioides	--	--	--	19	--	--	--	--	--
Digitaria sanguinalis	--	--	--	30	24	--	--	--	--
Triplasis purpurea	--	--	--	--	21	55	--	--	55
Oenothera humifusa	--	--	--	--	--	--	27	--	26
					Year 2				
Spartina alterniflora	30	--	--	--	--	--	--	--	--
Spartina patens	24	36	35	29	25	--	23	--	--
Strophostyles helvola	--	--	--	--	--	22	28	--	--
Heterotheca subaxillaris	--	--	--	--	--	38	--	--	--
Triplasis purpurea	--	--	--	--	--	52	44	--	48
Aster subulatus	--	--	--	--	--	--	--	39	--
Chenopodium ambrosioides	--	--	--	--	20	--	--	--	--

[a] Shrub.

Table 7 (continued)

Species	Outer Swale	Outer Dike Slope	Dike Ridge	Inner Dike Slope	Inner Swale	Dozer Scrape	Borrow Pit	Central Flat	Slope and Dome
Elusine indica	--	--	--	--	27	--	--	--	--
Iva imbricata[a]	--	--	--	--	--	129	--	--	--
Euphorbia polygonifolia	--	--	--	--	--	22	--	--	--
Cenchrus tribuloides	--	--	--	--	--	25	--	--	--
Oenothera humifusa	--	--	--	--	--	--	--	--	21
Diodia teres	--	--	--	--	--	--	34	--	--
Phragmites communis	--	--	--	--	--	--	--	83	--
Erigeron canadensis	--	--	--	--	--	--	--	--	19
Uniola paniculata	--	--	--	--	--	--	--	--	32
	Year 3								
Spartina patens	42	52	40	--	26	28	56	--	--
Distichlis spicata	28	--	--	--	--	--	--	--	--
Spartina alterniflora	19	--	--	--	--	--	--	--	--
Iva imbricata [a]	--	--	--	--	--	138	--	--	--
Triplasis purpurea	--	--	35	25	--	20	57	--	45
Heterotheca subaxillaris	--	--	--	23	--	39	--	--	20
Aster subulatus	--	--	--	--	50	--	--	104	--
Strosphostyles helvola	--	--	--	--	--	33	--	--	--
Uniola paniculata	--	--	--	--	--	--	21	--	--
	Year 4								
Spartina patens	61	32	36	45	--	29	--	--	--
Baccharis halimifolia	--	--	--	--	--	--	--	147	--
Yucca filamentosa	--	27	23	25	--	--	--	--	--
Heterotheca subaxillaris	--	--	19	23	--	--	--	--	27
Smilax auriculata	--	--	45	--	--	--	--	--	--

Table 7 (concluded)

Species	Outer Swale	Outer Dike Slope	Dike Ridge	Inner Dike Slope	Inner Swale	Dozer Scrape	Borrow Pit	Central Flat	Slope and Dome
Aster subulatus	--	--	--	--	62	--	--	--	--
Phragmites communis	--	--	--	--	31	--	--	--	--
Andropogon virginicus	--	--	--	--	--	27	--	--	--
Erigeron canadensis	--	--	--	--	--	--	--	--	25
Strophostyles helvola	--	--	--	--	--	--	--	--	21
Panicum virgatum	--	--	--	--	--	--	--	--	32
Triplasis purpurea	--	--	--	--	--	--	--	--	29
Fimbristylis spadicea	--	--	--	--	--	--	--	19	--
Scirpus americana	--	--	--	--	--	--	--	20	--
					Year 5				
Spartina patens	60	43	61	39	--	49	--	--	25
Heterotheca subaxillaris	--	--	--	--	--	--	--	--	42
Solidago sempervirens	--	--	--	--	--	--	--	--	22
					Year 6				
Borrichia frutescens [a]	122	--	--	--	--	--	--	--	--
Phragmites communis	29	--	--	--	--	--	--	--	--
Spartina patens	25	23	32	23	50	--	--	--	--
Hydrocotyle bonariensis	19	--	--	--	--	--	--	--	--
Solidago sempervirens	--	--	17	--	--	--	--	--	17
Strophostyles helvola	--	--	17	--	--	--	--	--	54
Distichlis spicata	--	--	--	--	44	--	--	--	--
Heterotheca subaxillaris	--	--	--	--	--	--	--	--	30
Andropogon virginicus	--	--	--	--	--	--	--	--	19

Table 8

Importance Values of Dominant Plant Species Occurring Along Transects on Undiked Islands

Species	Lower Drift Ridge	Lower Swale	Upper Drift Ridge	Upper Swale	Slopes	Dome
			Year 3			
Cakile harperi	--	61	79	70	--	--
Cenchrus tribuloides	--	139	97	130	200	--
			Year 4			
Fimbristylis spadicea	28	27	--	18	--	--
Panicum amarulum	29	--	--	--	--	--
Spartina patens	19	25	56	21	45	18
Scirpus americanus	--	30	--	--	--	--
Erigeron canadensis	--	--	18	--	--	--
Solidago sempervirens	--	--	30	19	--	--
Strophostyles helvola	--	--	29	--	--	--
Phragmites communis	--	--	--	62	54	--
Heterotheca subaxillaris	--	--	--	--	--	34
Oenothera humifusa	--	--	--	--	--	25
Triplasis purpurea	--	--	--	--	--	73
			Year 5			
Strophostyles helvola	42	--	--	--	52	--
Solidago sempervirens	33	--	--	--	25	--
Erigeron canadensis	--	--	--	--	26	--
Heterotheca subaxillaris	--	--	--	--	24	--
Triplasis purpurea	--	--	--	--	60	--

Table 8 (continued)

Species	Lower Drift Ridge	Lower Swale	Upper Drift Ridge	Upper Swale	Slopes	Dome
	Year 7					
Borrichia frutescens[a]	--	120	--	--	--	--
Panicum virgatum	44	--	--	--	--	--
Solidago sempervirens	35	--	31	29	29	31
Fimbristylis spadicea	--	42	--	--	--	--
Spartina patens	--	82	51	32	20	--
Strophostyles helvola	--	--	19	23	21	--
Andropogon virginicus	--	--	--	34	--	21
Heterotheca subaxillaris	--	--	--	--	64	--
Rhus radicans	--	--	--	--	39	--
Phragmites communis	--	--	--	--	20	--
Triplasis purpurea	--	--	--	--	21	55
Erigeron canadensis	--	--	--	--	--	25
Oenothera humifusa	--	--	--	--	--	30
Diodia teres	--	--	--	--	--	25
	Year 8					
Borrichia frutescens[a]	--	--	147	--	--	--
Spartina patens	--	--	--	--	54	28
Heterotheca subaxillaris	--	--	--	--	--	63
Oenothera humifusa	--	--	--	--	--	32
Triplasis purpurea	--	--	--	--	--	45
	Year 9					
Iva imbricata	--	--	154	116	144	--
Spartina patens	--	--	106	73	--	--

[a]Shrub.

Table 8 (concluded)

Species	Lower Drift Ridge	Lower Swale	Upper Drift Ridge	Upper Swale	Slopes	Dome
Solidago sempervirens	--	--	--	19	56	24
Erigeron canadensis	--	--	--	--	24	24
Heterotheca subaxillaris	--	--	--	--	20	19
Triplasis purpurea	--	--	--	--	24	95
	Year 11					
Heterotheca subaxillaris	--	--	--	--	82	38
Oenothera humifusa	--	--	--	--	36	26
Spartina patens	--	--	--	--	28	32
Erigeron canadensis	--	--	--	--	--	49
Triplasis purpurea	--	--	--	--	--	38
	Year 40					
Borrichia frutescens[a]	132	--	--	--	--	--
Solidago sempervirens	32	--	--	--	--	--
Spartina alterniflora	25	--	--	--	--	--
Spartina patens	22	--	--	--	49	--
Triplasis purpurea	90	--	--	--	--	--
Festuca octoflora	--	--	--	--	38	--
Distichlis spicata	--	--	--	--	22	--

appear to represent the best characterization of the zone during a particular year.

130. The greater range of topographic conditions (Figure 2), soil particle size range (Tables A2 and A6, Appendix A), and availability of fresh or mildly brackish water trapped behind dikes resulted in an increased diversity of habitats on diked islands. During this study, 166 plant species were recorded on diked and undiked islands. Of the 166 species, two are listed in the North Carolina list of plant species of special concern, meriting attention because of their relative rareness in the state (Cooper et al. 1977). Both species, Agalinis maritima (Grisbach) Nash and Parietaria floridana Nuttall, were found growing on diked islands. An annotated list of plant species recorded is included in Table B16 (Appendix B).

131. Table 9 lists the numbers of species occurring in each zone at each age for both diked and undiked islands. The most important values are the totals by age and island type. This table shows that the increased diversity of conditions associated with diking resulted in an increased diversity of plant species on diked sites over that of undiked sites.

132. Table 10 provides an evaluation of vegetation cover relative to transect age and zone for both diked and undiked transects. The values are coverage percentages by plant species, averaged for all quadrats in each zone. These values allow a comparison of the rate of vegetative growth on diked and undiked sites.

Seasonal Avian Utilization of Diked and Undiked Dredged Material Sites

133. A series of censuses were conducted in the major habitat types found on dredged material islands in eastern North Carolina to obtain information on the utilization of diked and undiked islands by birds throughout the year. Censuses were conducted in 113 habitat units of 25 types on 22 study islands. Table D1 (Appendix D) indicates the island numbers and coordinates of all islands studied. Figures D1 through D17 (Appendix D) show the locations of all study islands.

Table 9

Plant Species Diversity Relative to Topographic Zone and Age on Diked and Undiked Transects

Zone	Age (yr)					
	1	2	3	5	5	6
Diked Sites	Numbers of species					
Outer swale	27	47	38	52	51	35
Outside dike slope	43	58	43	43	55	44
Dike ridge	30	43	31	28	38	39
Inside dike slope	22	42	46	31	54	48
Inner swale	13	33	27	18	--	25
Central flat	0	32	20	29	--	--
Dozer scrape	8	8	8	46	58	--
Borrow pit	5	14	9	--	--	--
Slope and dome	6	13	31	19	15	30

	Age (yr)							
	3	4	5	7	8	9	11	40
Undiked Sites	Numbers of species							
Lower drift ridge	--	14	15	14	--	--	--	--
Lower swale	--	31	--	11	--	--	--	--
Upper drift ridge	4	17	--	17	--	--	--	--
Upper swale	--	30	--	21	19	9	--	--
Slope	1	36	13	33	27	12	10	27
Dome	0	15	--	8	9	8	7	--

Table 10

Average Percent Cover by Topographic Zone and Age for Diked and Undiked Transects

Zone	Age (yr)					
	1[a]	2	3	4	5	6
Diked Sites						
Outer swale	29	40	51	49	50	39
Outside dike slope	26	26	45	67	58	47
Dike ridge	22	13	10	83	32	49
Inside dike slope	14	14	14	30	35	65
Inner swale	1	11	30	33	--	40
Central flat	0	32	39	16	--	--
Dozer scrape	1	32	16	41	38	--
Borrow pit	1	7	8	--	--	--
Slope and dome	1	1	2	11	22	39
Undiked Sites						
Lower drift ridge	4	38	--	61	59	32
Lower swale	2	39	--	52	--	54
Upper drift ridge	30	23	30	33	--	42
Upper swale	6	16	25	43	--	59
Slope	1	1	1	53	43	19
Dome	1	1	0	9	--	6

[a]Cover percentages for undiked islands were adapted from raw data gathered by Soots and Parnell (1975).

134. The eight habitat types sampled on undiked islands included most of the major habitat types to be expected. The diking process created several new habitat types including the dike itself. Dikes were divided into several cover classes. Bare dikes were devoid of vegetation. Dikes with a light covering of mixed grasses and herbs generally with less than 50 percent coverage were considered sparse. When coverage of grasses and herbs reached 50 percent, sites were considered dense. Common reed (Phragmites communis) created a special situation. It often dominated dikes by providing a cover of dense grasses of well over a meter in height. When shrubs began to invade a dike it was categorized as mixed grasses and shrubs. No dikes were completely dominated by shrubs.

135. Dikes were built by either dragline or bulldozer. Dragline construction created shallow borrow pits along the inner dike perimeter. They were attractive to waterfowl, wading birds, and shorebirds when filled with water. As they dried out, bird utilization diminished. Borrow pits were therefore separated into wet and dry habitats. Drain ponds were created when there were areas within the dike system which did not drain properly through the outlet weirs. In some cases these ponds persisted for several years and in other cases only a few weeks or months. Usage again depended upon the presence of water, and the habitat was divided into wet and dry units.

136. Dikes were usually built by bulldozers when the island to be diked was composed primarily of sands at relatively high elevations. In such cases, shallow scrapes replaced the borrow pits created by draglines. Such scrapes were sometimes dry from the beginning and sometimes held water temporarily. Again, designations of wet and dry scrapes were used.

137. Other diked habitats were less widespread but occurred with enough regularity to merit sampling. Often small marshes or mud flats were captured by dikes. In other cases mud flats rather than drain ponds were created in slight depressions within dikes. Salt marshes sometimes persisted within dikes if outflow weirs were low enough to be flooded by spring tides. These habitats were used by

birds, and units were sampled.

138. During the process of building dikes with bulldozers, small thickets were often pushed into rubbish piles to allow the bulldozers to reach the clean substrate easily. The tangled thickets that usually developed in these piles were regularly occupied by birds. These were separated from dead standing thickets left when dredged material was redeposited directly onto live thickets or old undiked islands or when brackish water was allowed to stand in live thickets after materials had been dumped behind a dike. Such dead thicket habitats were often extensive when old islands were diked.

139. Other habitats were created by the diking process but were either too small or too infrequent to be of consequence to bird populations. All of these habitats discussed are ephemeral except those associated with the dike itself. Most will have lives of only a few months or years, but as seen in Table 11, all were utilized to some extent by birds.

140. Tables C1-C16 (Appendix C) present seasonal summaries of the use of dredged material island habitats by birds in the form of bird density values for each species in each habitat unit occupied. The use of densities is quite suitable for summer and winter periods when populations are stable. Densities for the spring and fall migration periods were also calculated. It is realized, however, that with constantly shifting populations one can make only the most general comparisons with densities determined during more stable periods. Table 11 presents a summary of total bird densities in all habitats at all seasons and allows comparisons of species usage and total bird densities by habitat and site condition.

141. One hundred fifty-three species of birds were found on dredged material islands during the 12-month period of this study (1 September 1976-1 September 1977). One hundred forty-two species were recorded from diked islands, and 94 from undiked islands. The increase in diversity on diked sites appeared to be due to the presence of an increased diversity of habitats.

Table 11

Summary of Seasonal Bird Densities on Dredged Material Island Sites[a]

Season	Number species	Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Mixed Grasses & Shrubs	Live Thickets	Beach	Salt Marsh Fringe	Tidal Mud Flat	Dike, Bare	Dike, Sparse Grasses	Dike, Dense Grasses	Dike, Phragmites	Dike, Mixed Grasses and Shrubs	Dead Thickets	Interior Marsh	Interior Mud Flat	Rubbish Pile	Bulldozer Scrape, Wet	Bulldozer Scrape, Dry	Borrow Pit, Wet	Borrow Pit, Dry	Drain Pond, Wet	Drain Pond, Dry
Undiked Sites																									
Fall	50	3	6	12	77	*	102	17	12	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Winter	32	4	19	19	27	*	284	13	6	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Spring	38	3687[c]	9	4	23	*	16	45	23	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Summer	22	2752[c]	115	2	64	*	18	1026[c]	12	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Diked But Not Filled Sites																									
Fall	74	*	9	24	*	60	319	*	*	*	*	2	40	*	*	*	59	46	87	*	0	35	*	*	*
Winter	28	*	5	19	*	36	395	*	*	*	*	3	25	*	*	*	15	13	73	*	0	40	*	*	*
Spring	36	*	2	5	*	2	47	*	*	*	*	2	14	*	*	*	4	38	33	*	0	16	*	*	*
Summer	32	*	1	11	*	17	70	*	*	*	*	2	14	*	*	*	6	60	94	*	0	33	*	*	*
Diked and Influenced Sites																									
Fall	68	*	*	*	41	*	96	*	*	*	14	*	29	*	*	187	*	*	*	39	2	111		97	1
Winter	31	*	*	*	2	*	179	*	*	*	30	*	50	*	*	304	*	*	*	11	11	37	*	0	6
Spring	45	*	*	*	5	*	8	*	*	*	48	*	19	*	*	34	*	*	*	4	2	71	*	*	1
Summer	35	*	*	*	2	*	10	*	*	*	18	*	7	*	*	41	*	*	*	0	2	86	*	*	2
Diked and Filled Sites																									
Fall	97	7	7	58	79	51	*	181	16	54	16	29	25	31	13	60	*	1	*	6	*	11	*	31	*
Winter	50	1	9	12	102	44	*	112	51	101	6	17	47	17	15	77	*	1	*	5	*	6	*	18	*
Spring	80	8	11	9	32	17	*	12	14	10	2	6	12	13	4	37	*	7	*	2	*	24	*	62	*
Summer	60	15	46	1	233	141	*	42	16	26	19	8	8	45	6	59	*	5	*	31	*	30	*	36	*

[a]Values are in birds per hectare.

[b]Asterisks denote that habitat units are absent.

[c]Large numbers are due to presence of breeding colony within study site.

Colonial Waterbird Nesting Populations

142. During the 1977 nesting season, all North Carolina colonies of nesting waterbirds were located and censused as part of this project and a related study of the total populations of nesting colonial waterbirds in the North Carolina estuaries. A total of 201 nesting colonies were located. One hundred twenty-eight of these were on dredged material islands. Eighty-six of the colony sites on dredged material islands were not diked, while 42 sites were behind dikes (Table 12). Two colonies (07-02 and 07-04) were on man-made islands within the north pond at the Pea Island National Wildlife Refuge (Figure D3, Appendix D). These islands were within a large shallow impoundment designed to provide waterfowl habitat. They were included in this report since the sites were man-made and quite similar to dredged material islands. Although the islands were within dikes, they were considered undiked as the dikes were not on the islands utilized by the nesting herons and egrets, and the upland features were those of old undiked islands.

143. There were approximately 51,000 pairs of colonial waterbirds nesting in North Carolina in 1977. The 128 colonies on dredged material islands contained an estimated 39,898 nests, or 78 percent of the total nesting population. Seventy-five percent of the birds nesting on dredged material sites were found on undiked sites, while 25 percent were behind dikes (Table 12).

144. There were distinct differences in the utilization of dredged material islands by the wading birds (herons, egrets, and ibises) and the ground nesting waterbirds (gulls, terns, and skimmers). All 15 of the mixed species heronries (a heronry consisted of at least four nests) on dredged material islands were on undiked sites, although two heronries were on undiked parts of diked islands (Table 13).

145. This total occurrence on undiked sites was due to the fact that diking generally destroys the shrub thicket vegetation preferred by waders, and diking is not yet old enough in North Carolina for suitable thickets to have developed behind dikes. The senior

Table 12

Summary of 1977 Colonial Waterbird Nesting Populations on Dredged Material Islands in North Carolina Estuaries

Species	Diked Sites	Undiked Sites	Total
Herons, egrets, and ibises			
number colonies	0	15[a]	15
percent colonies	0	100	100
number nests	0	7,565	7,565
percent nests	0	100	100
Gulls, terns, and skimmers			
number colonies	42	74[b]	116
percent colonies	36	64	100
number nests	10,014	22,319	32,333
percent nests	31	69	100
Total colonial waterbirds			
number colonies	42	89	131
percent colonies	32	68	100
number nests	10,014	29,884	39,898
percent nests	25	75	100

[a] A single colony of herons, egrets, or ibises consisted of one to several species nesting together.

[b] A colony of gulls, terns, or skimmers consisted of one species at a site. Two species nesting at the same site were considered separate colonies.

Table 13

Summary of 1977 Wading Bird Nesting Populations on Dredged Material Islands in North Carolina Estuaries[a]

Species[b]	Number of Sites	Number of Nests
White ibis	3	1951
Louisiana heron	12	1465
Cattle egret	8	1371
Snowy egret	12	999
Little blue heron	13	702
Great egret	12	434
Glossy ibis	9	383
Black-crowned night heron	10	223
Green heron	6	35
Yellow-crowned night heron	1	2
Totals	15[c]	7565

[a] All colonies were on undiked sites.

[b] Scientific names for bird species are listed in Table C19 (Appendix C).

[c] The total number of islands with nesting colonies (at least four pairs were required to be considered a colony). Most colonies consisted of several species.

author has also actively worked with the Wilmington District to prevent the diking of active colony sites.

146. Table C17 (Appendix C) shows the location, species composition, and number of nests of each species at each of the 16 sites on dredged material and man-made islands. Figures D3-D17 (Appendix D) provide map locations for each site.

147. The ground-nesting gulls, terns, and skimmers nested on both diked and undiked sites. Of 116 single-species colonies, 64 percent were on undiked sites and 36 percent were behind dikes. Colonies on undiked sites averaged slightly larger than those on diked sites with 69 percent of all nests on undiked sites and 31 percent behind dikes (Table 12).

148. Table C18 (Appendix C) shows the location, species composition, site condition relative to diking, and numbers of nests on each of the 59 dredged material sites occupied by colonies of gulls, terns, and skimmers. Figures D3-D17 (Appendix D) provide map locations for each site. Table 14 summarizes this information by species.

149. Table D1 (Appendix D) lists all dredged material islands on which there were bird nesting colonies, land bird studies, or vegetative studies. The work accomplished on each island is indicated, and each island is keyed to a regional map.

150. Table C19 (Appendix C) provides a list of all birds recorded on dredged material islands during the study. This table also indicates the residence status of each species in the study area based on the local experience of the senior author. In many cases small numbers of a species may occur at seasons other than that indicated.

Table 14

Summary of 1977 Nesting Populations of Gulls, Terns, and Skimmers on Dredged Material Islands in North Carolina Estuaries[a]

Species[b]	Diked Sites	Undiked Sites	Total
Herring gull			
number colonies	0	7	7
percent colonies	0	100	100
number nests	0	457	457
percent nests	0	100	100
Laughing gull			
number colonies	2	11	13
percent colonies	18	82	100
number nests	2,599	5,629	8,228
percent nests	32	68	100
Gull-billed tern			
number colonies	4	10	14
percent colonies	29	71	100
number nests	368	157	525
percent nests	70	30	100
Great black-backed gull			
number colonies	0	0	0
percent colonies	0	0	0
number nests	0	10	10
percent nests	0	100	100
Caspian tern			
number colonies	0	1	1
percent colonies	0	100	100
number nests	0	10	10
percent nests	0	100	100
Royal tern			
number colonies	3	5	8
percent colonies	37	63	100
number nests	4,359	10,963	15,322
percent nests	28	72	100
Sandwich tern			
number colonies	1	4	5
percent colonies	20	80	100
number nests	478	1,369	1,847
percent nests	26	74	100

[a] A colony consisted of at least 4 nests.

[b] Scientific names for bird species are listed in Table C19 (Appendix C).

Table 14 (concluded)

Species			
Forster's tern			
number colonies	0	6	6
percent colonies	0	100	100
number nests	0	278	278
percent nests	0	100	100
Common tern			
number colonies	8	16	24
percent colonies	33	67	100
number nests	890	2,265	3,155
percent nests	28	72	100
Least tern			
number colonies	19	3	22
percent colonies	86	14	100
number nests	893	376	1,269
percent nests	70	30	100
Black skimmer			
number colonies	5	11	16
percent colonies	31	69	100
number nests	427	805	1,232
percent nests	35	65	100
Total			
number colonies	42	74	116
percent colonies	36	64	100
number nests	10,014	22,319	32,333
percent nests	31	69	100

PART V: DISCUSSION OF RESULTS

151. Dredged material island construction in North Carolina has resulted in the development of two basic patterns that relate to maintenance dredging regimes: island chains and isolated island groups. Along the AIWW, shoaling occurs at a relatively slow rate, and many dredged material islands constructed when the waterway was built have not received subsequent deposits. This low shoaling rate has led to long chains of small islands often vegetated with well developed maritime shrub thickets or incipient maritime forests. Dredging has been much more frequent along navigation channels in the lower reaches of coastal rivers and along channels leading from ocean inlets into the sounds. Dredged material islands of the latter areas are usually in short chains or isolated groups. Most dredged material islands along such channels receive deposits frequently, and vegetation has generally been maintained in early stages of succession.

152. The process of diking began in North Carolina primarily in the southern portion of the state where dredged material was generally of a finer texture than those in the northern part of the state. Most diking has occurred along the AIWW from the North Carolina-South Carolina state line to just north of Morehead City (Figure 1). Along the AIWW, each dike usually incorporated several small undiked islands into one large diked island. These islands are normally surrounded by extensive tidal marshes and are separated from the mainland only by the AIWW (Figure D10, Appendix D). Many of the large diked islands have received only small amounts of dredged material. The first deposition of dredged material, however small, usually results in the temporary ponding of brackish water within the diked portion of the island. This brackish water either completely or partially kills back the vegetation. Thus, most diked sites have had preexisting maritime thickets killed back so that succession is starting again. The available substrate for new growth varies, however, from new dredged material to old surfaces often covered by a thin veneer of saline silt and clay and the debris of the previous vegetative communities.

153. Along the river channels and around the inlets, dredged material islands tend to occur in small clusters or short chains. Dredged material in such environments generally consists of sand with little silt or clay. Some of these islands in the lower reaches of the Cape Fear and New rivers have been diked, but most islands north of Morehead City have not been diked. The islands north of Morehead City tend to be isolated from the shoreline and not to be surrounded by extensive marshes (Figure D7, Appendix D). The establishment of vegetation on diked islands varies depending on island location and the presence or absence of newly deposited dredged material.

Vegetation Response to Dredged Material Island Zonation

154. It has become apparent during the project that the major factors controlling vegetation zonation on dredged material islands relate to topography and soils. Though it is not the aim of this study to relate the chemistry of soils to plant growth and development, a zone-by-zone discussion of plant-soil and plant-topography relationships on diked and undiked islands will be useful while discussing the topic of seral relationships.

155. Transects established through vegetation on diked and undiked dredged material islands in the North Carolina estuaries were sampled during the growing seasons of 1976 and 1977. Data are presented in Tables B1-B15 (Appendix B) and Tables 7-10. Generalized successional trends on a stylized diked island are illustrated in Figure 7.

156. One very apparent discrepancy in the vegetation data is a result of seasonality. Sampling the first year extended from late July to mid-October. During the second year, vegetative sampling was started in late June and was terminated by the end of the first week in August. Several habitats had not developed the full extent of cover sampled the first year by the time sampling was performed the second year. This effect is particularly visible when comparing the total average percentages of cover for central flats of 3- and

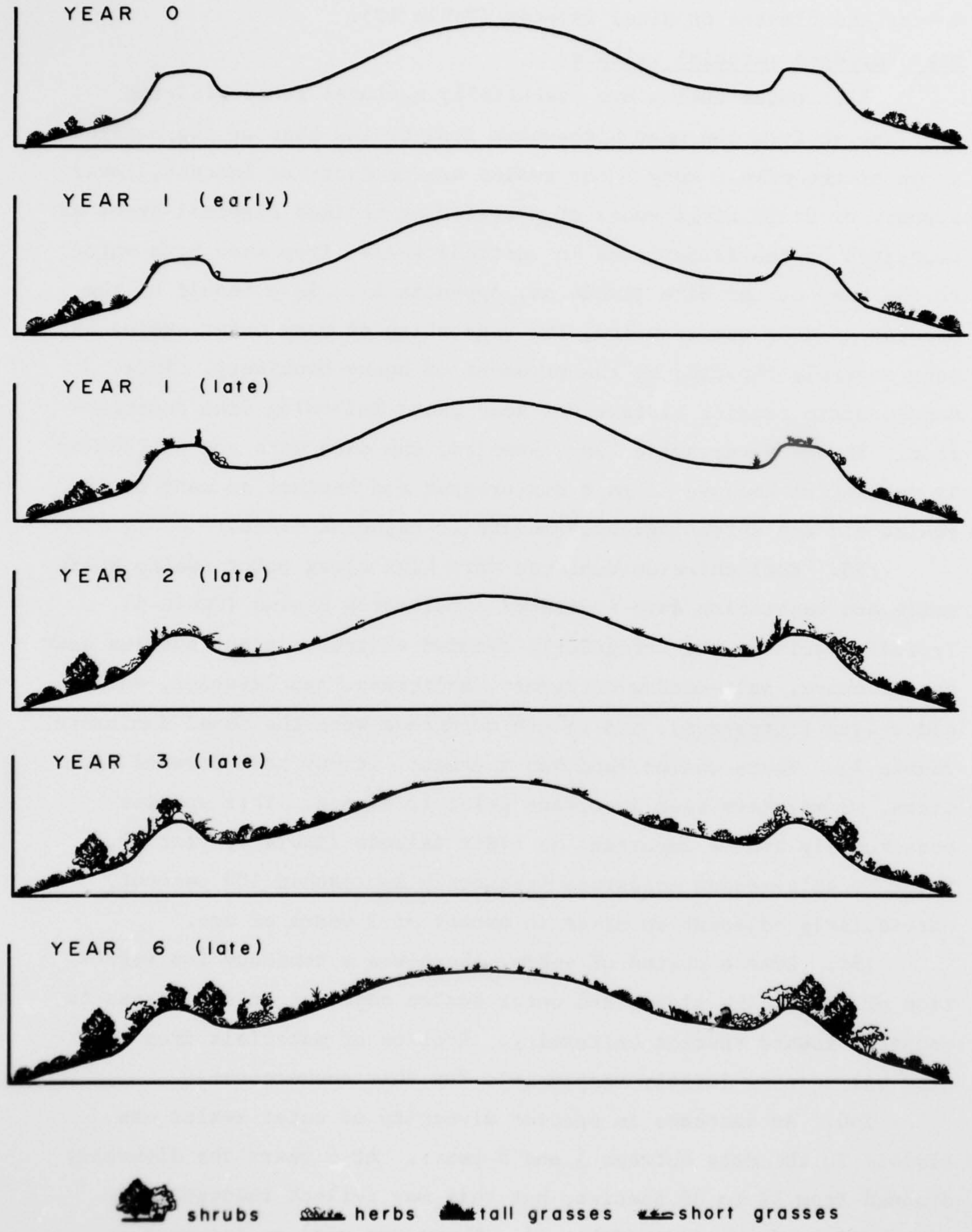

Figure 7. Plant succession on diked dredged material islands

4-year age classes on diked islands (Table 10).

Diked dredged material islands

157. Outer swales are essentially ecotonal zones bridging tidal marsh from the mean high-water line to the base of the outside slope of the dike. Many outer swales are remnants of beaches, lower slopes, or drift ridge zones of preexisting undiked disposal areas as suggested by the differences in vertical relief from mean high water to the base of the dike (Table A1, Appendix A). As a result of the process of dike construction, the vegetation of many outer swales has been severely impacted by the movement of heavy machinery. This damage often remains visible for some years following dike construction. Though outer swales were sampled, the data were not particularly meaningful because of past disturbance and because so many outer swales did not chronologically relate to adjacent dikes.

158. Soil chloride contents were high along outer swales where soils and vegetation data indicated a saltmarsh regime (Table 6). Typical regularly and irregularly flooded saltmarsh plant species such as sea oxeye, salt-meadow cordgrass, saltgrass, sea lavender, marsh elder (Iva frutescens), and smooth cordgrass were the usual dominants (Table 7). Where common reed was abundant, it may have invaded from dikes, or may have been important prior to diking. This species occasionally became important on older islands (Table 7, year 6). Cover by salt-meadow cordgrass frequently approached 100 percent, particularly adjacent to dikes in excess of 3 years of age.

159. Over a period of years, there was a tendency for vegetation of outer dike slopes and outer swales adjacent to dike bases to converge toward species uniformity. Erosion of materials from the dike was seen as largely responsible for this convergence.

160. An increase in species diversity of outer swales was visible in the data between 1 and 5 years. At 6 years the diversity dropped from 51 to 35 species, but this may reflect inadequacy or seasonality of sampling (Table 7). There was also an increase in average percent cover between years 1 and 5 and a decrease in year 6.

161. Few or no long-term seral changes were indicated by the data; but it would appear that given time and the natural processes

of aggradation, outer swales would develop a vegetation cover similar to that found, although infrequently, along the lower drift ridge zones and upper perimeters of undiked deposits. With continued intervention of either storm tides and/or erosion, seral stages would be maintained at low shrub-grass levels or would revert to tidal marsh.

162. Outer dike slopes were the first portions of newly constructed dikes to vegetate. They were usually constructed on portions of preexisting lower slopes of undiked dredged material islands just above mean high water or at the upper ends of outer swales. The first plant species to gain dominance on outer dike slopes was salt-meadow cordgrass. This species seemed to respond positively to the stress imposed when culms and rhizomes were covered by the lower edges of dikes. Some increase in vigor may have been aided by seepage of fresh water, impounded behind dikes prior to dumping, from under the outside toe of the dike. Beach pea (*Strophostyles helvola*) and seaside goldenrod also seemed to respond positively to this stress, though not as vigorously or as rapidly (Table B2, Appendix B).

163. The ages, and hence the successional status, of dikes were frequently confused by wind erosion of sand where dikes were covered by sand originating from some other place on the island, or where dikes themselves were eroded. Confusion also resulted where reconstruction or refurbishment of dikes had taken place. In the latter process, dredged material from a deposit subsequent to the first dike was used to increase the height and width of the original dike. Shrubs such as marsh elder or grasses such as common reed often were not killed back enough to retard their growth significantly. They quickly regained dominance over or codominance with salt-meadow cordgrass.

164. Dike soils were relatively free from salt water contamination (Table 6); low in silt and clay content, organic matter content, and summed cation content (Table 3); but high in phosphorus (Table A5, Appendix A). The source of the high amounts of phosphorus may at times be a limiting factor in the growth of coastal dune vegetation. Phosphate in molecular or ionic form is very soluble and is quickly washed from porous sands into the ground water.

If phosphorus is limiting the growth of plants on dredged material, the higher content in dikes may have influenced the initial rapid revegetation of slopes and ridges following dike construction. The fact that dikes usually contained a high number of viable plant propagules and that they were not usually subject to flooding by saline water may also explain the relatively rapid growth of vegetative cover (Table 10).

165. Outside dike slopes were found to support a much greater diversity of plant species in the first year following construction than did ridges and inner slopes (Table 9). Along with the low diversity of inner slopes, there was a parallel lower percent cover (Table 10). Since all inner dike slopes were lumped in the data whether they were from diked and filled, diked and not filled, or diked and influenced sites, the presence of fresh saline slurry probably promoted a reduction in both diversity and cover values for this topographic zone.

166. Dikes older than 6 years are not known to exist in the North Carolina estuaries. The oldest dikes found had heavy covers of salt-meadow cordgrass and shrubs, silverling (Baccharis halimifolia), and sea oxeye. These dikes were low (less than 1.5 m) and did not contain nearly a maximum capacity of dredged material. If such dikes remained unused indefinitely, it is assumed that they would eventually support largely arborescent growth composed of shrubs and small trees.

167. Borrow pits and dozer scrapes resulted directly from the dike construction process. They were considered short-lived zones since dike construction was generally followed by dredged material deposition within a year. A few borrow pits as old as 3 years were sampled. No dozer scrapes were older than 5 years (Table 7). Temporary impoundment of fresh or mildly saline water in borrow pits and dozer scrapes was not unusual during periods of heavy rain. Such moist habitats occasionally supported rich assemblages of plant species and acted as slow-release reservoirs for the lower toe of the outside dike slope. The areas of the highest diversities of plant species were found in 5-year-old dozer scrapes and 2-year-old outer dike

slopes. Fifty-eight species were found in sample plots within each zone (Table 9).

168. Dozer scrapes or borrow pits were sampled where they were dry and/or supported vegetation. Many borrow pits were not sampled because they contained only water. Salt-meadow cordgrass, camphor weed, and sandgrass were the most important plant species in dozer scrapes throughout the range of ages sampled. Seaside primrose (Oenothera humifusa) and salt-meadow cordgrass were common in all ages of borrow pits sampled.

169. Both dozer scrapes and borrow pits were characterized by low plant species diversities (Table 9) and low cover percentages in the first year following dike construction. This may be attributed to a lack of plant propagules and to the presence of standing water throughout much of the year.

170. Soils of borrow pits and dozer scrapes were not well sampled due to occurrence of standing or intermittent water. The five samples analyzed came only from dry zones and showed no unusual characteristics (Tables A1-A7, Appendix A). Those samples composed of greater than 90 percent sand were only moderately high in phosphorus compared with samples from dikes, but were relatively high in calcium (Table A4, Appendix A). The high calcium content probably resulted from higher concentration of weathered shell material.

171. Borrow pits and dozer scrapes behind dikes will be short-lived structures since their capacity to support vegetative cover changes with the deposition of a small amount of dredged material. Should they be allowed to persist for a long period of time (more than 20 years), they would probably gain a heavy cover of wax myrtle that would eventually be broken by an oak-pine overstory.

172. Inner swales were formed by light or heavy deposition of dredged material in a borrow pit or dozer scrape.* Subsequent de-

* The distinction between borrow pits and inner swales is made depending on the absence or presence, respectively, of dredged material. Strict adherence to this distinction is applied only to the sampling and analysis of vegetation and soils.

position altered the initial form according to the amounts of material deposited. Inner swales retain the form of the original borrow pit or may become a low flat adjacent to the dike.

173. Inner swales usually held moisture to a greater extent than any other zone along diked and filled or diked and influenced transects. The increased water-holding capacity was proportional to a higher content of silt and clay particles in the dredged material deposited in inner swales (Tables A2 and A3, Appendix A). A wide range of textures related to levels of disposal area filling was found in inner swales and was interpreted as the major factor influencing plant species dominance. Young, fine-textured material usually remained unvegetated for the first year. The first plants appeared in heavy soil following drying and formation of polygonal cracks in the first 4 to 8 inches of the dredged material surface. Several species of the family Asteracere including sow thistle (Sonchus oleraceus), an aster (Aster subulatus), and horseweed were characteristic pioneers in heavy dredged material soils. These plants often grew in configurations reflecting the polygonal cracks in which their seeds germinated. Common species found in drier coarser textured soil were camphor weed, seaside goldenrod, Mexican tea (Chenopodium ambrosioides), and salt-meadow cordgrass (Table 7).

174. Most of the older inner swales sampled were either behind comparatively full dikes or behind dikes where brackish or saline water was trapped at high tide or during storm tides. Table B5, Appendix B, shows presence of the shrubs sea oxeye, silverling, and marsh elder. A mixed shrub stratum may be the intermediate, if not the ultimate, seral stage of development in inner swales, assuming, of course, that an importance of these species in later years in some inner swales establishes a successional trend.

175. Inner swales may also be compared to the perimeters and swales of undiked islands as described by Soots and Parnell (1975), though the analogous relationship is not as strong as with outer swales. Without successive periods of disposal, inner swales may be subject to siltation from adjacent deposit slopes or ridges and inner slopes of dikes, thus increasing their capacity to support

species capable of growing in more xeric sites. This sedimentation would probably encourage intermediate or eventual dominance by wax myrtle if saline or brackish water intrusion were at a minimum.

176. In all likelihood most diked disposal sites eventually will be filled to the level at which inner swales cease to be significant. At this point dike vegetation will simply be a lower segment of the deposit slope vegetation continuum, creating, in effect, an undiked island with very steep lower slopes.

177. Central flats were very similar to inner swales in that a high concentration of silt and clay usually predominated among younger age classes (Table A2, Appendix A; Tables 3 and 5). Often brackish water or slurry spreading out from a primary discharge point caused a dieback of plant material throughout the entire diked disposal site, leaving a forest of standing dead, tree and shrub stems. As saline slurry spread over vegetated soil surfaces, most above-ground portions of plants were killed, but shrubs such as wax myrtle, sea oxeye, marsh elder, and silverling often regenerated from root stocks and rhizomes.

178. The oldest central flat found in the project area was 4 years old. Vegetation samples taken across a first-year central flat contained no plants (Tables 7 and 10). In some central flats, the spread of common reed may actually have been stimulated following a brief initial dieback. Important species on older flats were aster (_Aster subulatus_), Mexican tea, pokeweed (_Phytolacca americana_), and seaside goldenrod. Trends of plant species diversity and vegetation cover are shown in Tables 9 and 10.

179. Central flats occurred only in partially filled sites. There was no visible trend for long-term vegetative cover. The oldest site sampled had a scattered shrub cover, and the presence of wax myrtle at this site indicated that a heavy shrub canopy might eventually predominate. Beyond this, it is extremely difficult to predict further vegetative succession because of the newness of this kind of habitat on dredged material islands in the North Carolina estuaries.

180. Deposit slopes and domes have been combined largely because: (1) no well defined differences appeared between them,

(2) they were not deposited as such, and (3) many slopes existing behind dikes had been reworked by heavy machinery or wind so that elevations were reduced and shapes were modified. The most important plant species were horseweed, camphor weed, seaside primrose, salt-meadow cordgrass, and sandgrass (Table 7). Common reed was sporadically abundant, depending on the presence and general condition of populations in adjacent zones. This species did not usually grow in the drier, coarser sands of upper slopes.

181. Much of what has been said regarding slopes and domes on undiked islands (Soots and Parnell 1975) also applied to these features on diked islands. The general trend of plant species diversity and cover on slopes and domes ranging in age from 1 to 6 years indicated a slow, steady increase in vegetative cover with age (Tables 7 and 10). It is strongly suspected that this relatively slow increase in plant cover is related to low silt and clay content and low water-holding capacity (Table 3).

182. There was generally a slow movement of vegetation cover upslope and away from the peripheries of deposit slopes. The major difference between the establishment of cover on diked deposits and that of undiked islands was that often there was no pronounced obconical structure to the deposits on diked sites. The use of dikes blocked what would ordinarily be a more or less even flow along the slopes to the water, and the use of machinery to level drier material shortly following its deposit resulted in the presence of more level surfaces behind dikes. This difference influenced the somewhat earlier establishment of plants such as camphor weed, horseweed, and seaside primrose on diked sites (Table 7) compared with that on undiked sites (Soots and Parnell 1975). The data for 4 year-old deposits on diked islands (Table 7) show an early invasion by beach pea and panic grass (Panicum virgatum). The data in Table 7 show that salt-meadow cordgrass, which spreads largely by growth of rhizomes, became important in year 5 on diked island slopes and domes. Soots and Parnell (1975) found that approximately the same was true for undiked sites.

183. As the practice of diking and reuse of diked sites con-

tinues in the North Carolina estuaries, the construction of deposits with low central relief will continue. The long-term result of this practice could be to increase somewhat the rate of plant succession on deposits with low elevations. On deposits with high elevations, the effects of wind, erosion, and low moisture content will probably slow the rate of succession. Only two such islands were seen; one near Morehead City contained only scattered clumps of sea oats. The other received new material at least once each year and material within dikes was unvegetated.

Undiked dredged material islands

184. Young undiked dredged material islands were not available for soils or vegetation analyses. Data gathered during the course of the present project was supplemented by preexisting data gathered during sampling performed by Soots and Parnell (1975). Topographic zones on undiked islands used in the earlier study have been applied in the present study. Vegetation work by Soots and Parnell was restricted to an area between New Inlet and Southport, N. C., with most study islands located close to their base of operations in Wilmington. The present study added data from undiked islands along the AIWW between Morehead City and Swansboro, N. C. just north of Bogue Inlet (Figure 1; Figure D11, Appendix D). In addition, several of the undiked islands near Wilmington sampled by Soots and Parnell were resampled during the present study to expand further age-vegetation relationships (Figure 8).

185. Slopes constitute the longest-lived topographic elements of undiked dredged material islands, although erosion obscures domes and lowers the overall elevations, reducing the angle of the slopes of the islands. The oldest remaining islands sampled during the course of the present project were constructed more than 40 years ago along the AIWW. Several undiked islands have developed mixed pine-hardwood forests resembling maritime forest (Soots and Parnell 1975). Such forests were not sampled during the course of the present study, as they were not comparable with the oldest vegetation types on diked islands.

186. The major differences between vegetation successional

Figure 8. Undiked island in Cape Fear River sampled by Soots and Parnell and during the present study

patterns on undiked islands observed during the present study and those addressed by Parnell and Soots dealt with low undiked islands subject to overwash. Three islands dating approximately from the time of construction of the AIWW just north of Bogue Inlet were sampled, and the data are presented as year 40 in Appendix B (Tables B10 and B14) and summarized in Table 8. All three islands were subject to storm overwash by brackish water, and as a result, supported only a thick cover of grasses (fescue (Festuca octoflora), saltgrass, and salt-meadow cordgrass). It is assumed that these islands have remained in their present state of seral development a long time and that they will never succeed to maritime shrub thickets because of frequent disturbance. Soils on such islands were not sampled, but they doubtless would have high chloride contents and fairly high silt and clay contents.

187. Plant species diversity by zone and average plant cover by zone are summarized in Tables 9 and 10, respectively, for island ages between 1 and 40 years. Generalized successional trends are illustrated in Figure 9.

188. Soils from undiked islands reflected the presence and regimes of the various topographic zones (Table 2). Perhaps the most outstanding differences were those between drift ridges and swales. Even though minor in the cases of some factors, the ridge and swale regimes could be followed in terms of organic matter, potassium, calcium, magnesium, phosphorus, water-holding capacity, and silt and clay content. Slopes and domes showed more or less the same trends toward low water-holding capacity and silt and clay content as shown for slopes on diked islands.

189. Beach or perimeter zones surrounding the upland portions of young undiked islands were usually subject to normal and mild storm tides. Such areas were dominated in younger years by smooth cordgrass, or remained as bare sand or mud flats when exposed at low tide. On older undiked islands, wind and rain erosion from upslope has caused a buildup of these areas on some islands to the extent that plant dominance has shifted slowly to high marsh or upland species such as salt-meadow cordgrass, seaside goldenrod, panic grass, camphor weed,

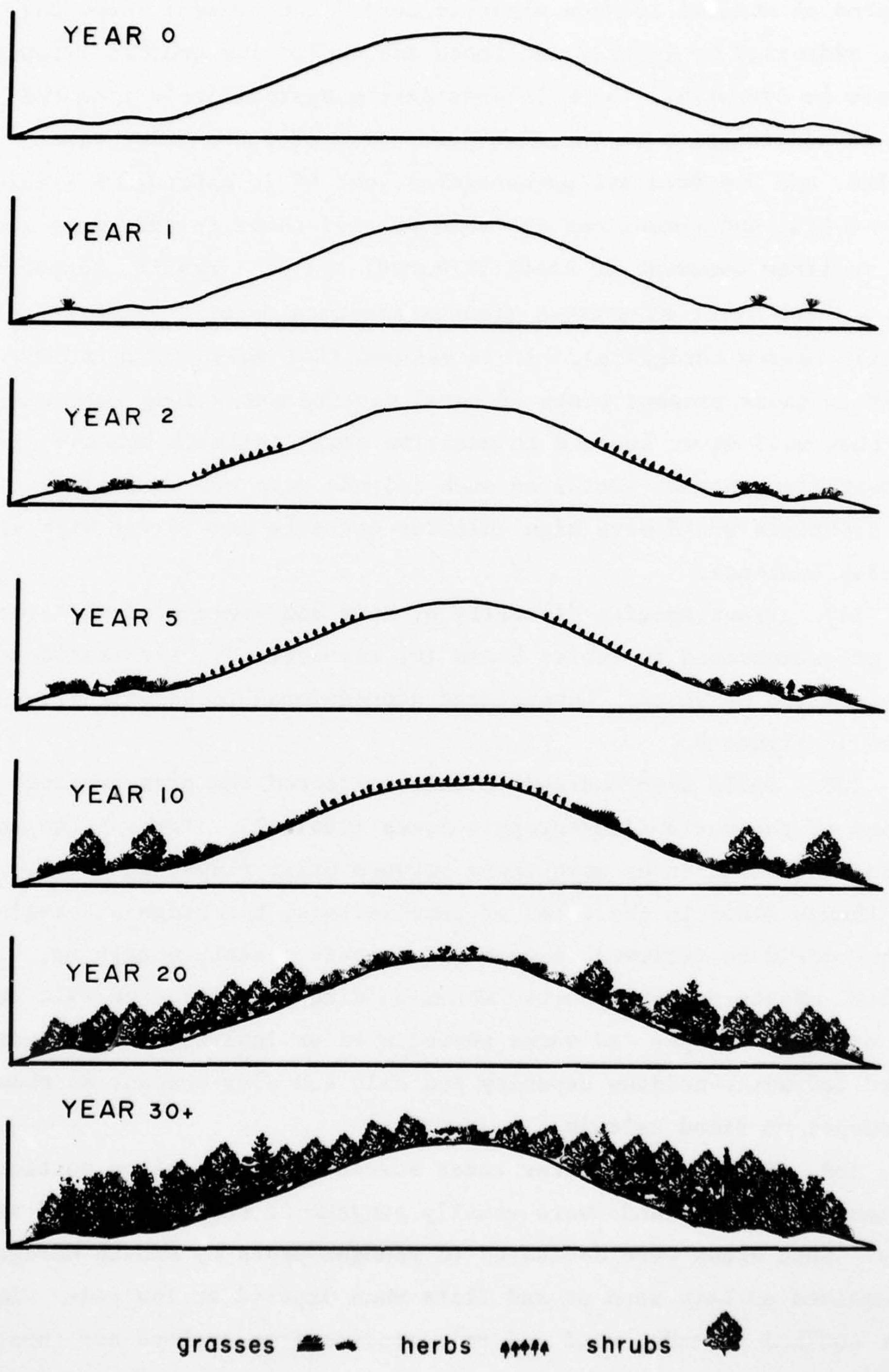

Figure 9. Plant succession on undiked dredged material islands (Soots and Parnell 1975)

silverling, and other species more characteristic of lower slopes and swales. Often the original beach or perimeter soils were eroded, and there was no easy way to determine if the substrate was dredged material or reworked and transported sediments. Beach or perimeter vegetation was not sampled during the course of this study. Sampling was usually started at the next zone above the perimeter, the lower drift ridge.

190. Drift ridges that formed shortly after deposition of dredged material as a result of normal spring and storm high-tide drift line deposition were short-lived structures subject to both erosion and sedimentation. It was rare to find either upper or lower drift ridges on islands in excess of 5 years cf age. Drift ridge lines sometimes did not form, or only one ridge formed if no storm tides occurred during the early months of the island's existence. Drift ridges provided suitable habitat for germination and growth of seeds and other propagules of waterborne pioneer species, including sea rocket (Cakile harperi), sandspur (Cenchrus tribuloides), saltgrass, seabeach orach (Atriplex arenaria), and smooth cordgrass (Soots and Parnell 1975). From the drift ridges, from upper portions of island perimeters, and from swales, the growth of plants spread up the deposit slope.

191. It was interesting to note the high phosphorus levels in upper and lower drift ridge soils. It will be recalled that drift ridges were the areas along which plants first became established on undiked islands, as were dikes on diked sites. These zones on both island types were very high in phosphorus, the source of which has not been identified.

192. Swales were located on the upper side of the upper and lower drift ridges, and were generally just as short lived as ridges. Swales also were noted to act as catchment basins (Soots and Parnell 1975) where small amounts of organic debris and seeds and other plant propagules collected, germinated, and grew. Swales were found by Soots and Parnell to constitute the initial areas for the establishment of shrubs such as wax myrtle and marsh elder on undiked islands. Other important plant species of swales were salt-meadow cordgrass,

seaside goldenrod, sea oxeye, fimbristylis, scirpus (*Scirpus americanus*), beach pea, and broom sedge. The last species mentioned is a good indicator of the slightly moister soils that occur in swales.

Utilization of Diked and Undiked Islands by Birds

193. The comparison of utilization of diked and undiked dredged material island habitats was designed to show whether or not differences in bird diversity and/or density might occur as the proportion of diked islands increases and to evaluate diked islands as breeding sites for colonial waterbirds.

194. The deposition of dredged material has created two rather different kinds of diked islands. Along the AIWW, large areas have been diked, but, to date, little material has been deposited. This diking practice has created large islands with very complex plant communities (Figure 10). Such islands are usually surrounded by tidal marshes, are close to the mainland, and often harbor mammalian predators. Even though there was suitable nesting habitat for colonial ground-nesting birds, the islands were used infrequently other than by least terns.

195. Around the inlets and in the river channels, the annual volumes of dredged material are relatively much greater but islands are fewer. Thus the available islands are used frequently for deposition of large amounts of dredged material. Such islands tend to be maintained at ecologically young stages of succession (Figure 11). These islands seldom develop large adjacent marshes and are often well separated from the mainland. They are not likely to maintain populations of mammalian predators. These young isolated islands are much more attractive to colonial nesting waterbirds. The location of such islands in river mouths and at inlets adds to their attractiveness as such regions provide especially good food sources (Parnell and Soots, In Press).

196. The results of 12 months of censuses demonstrated that there was clearly a greater number and diversity of birds using diked dredged material islands than undiked islands. By averaging

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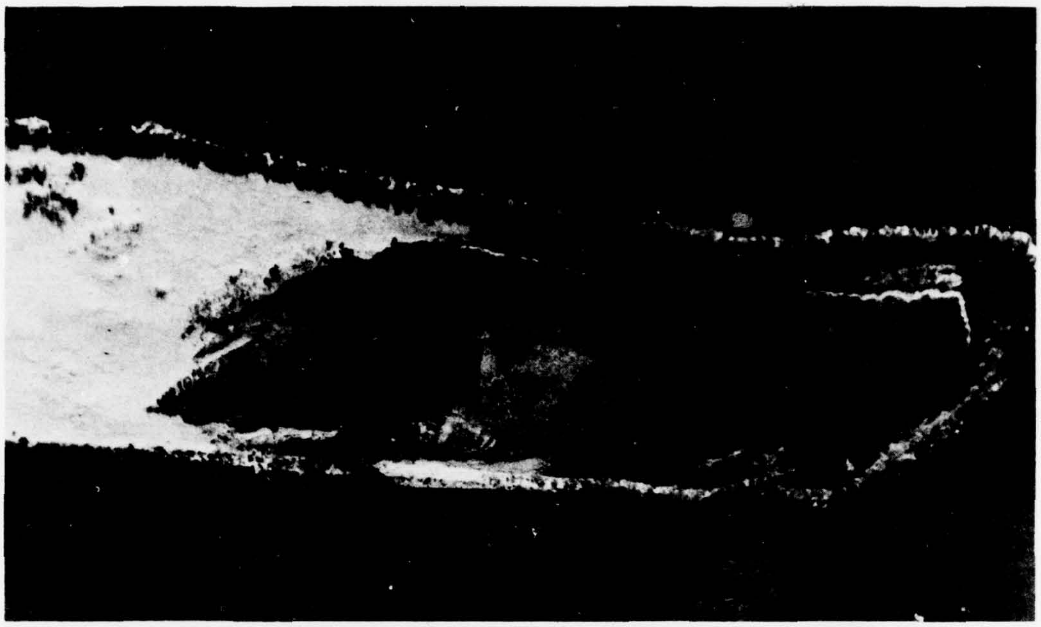

Figure 10. Island adjacent to AIWW near Wilmington showing complexity of topographic and vegetative conditions in a single diked island

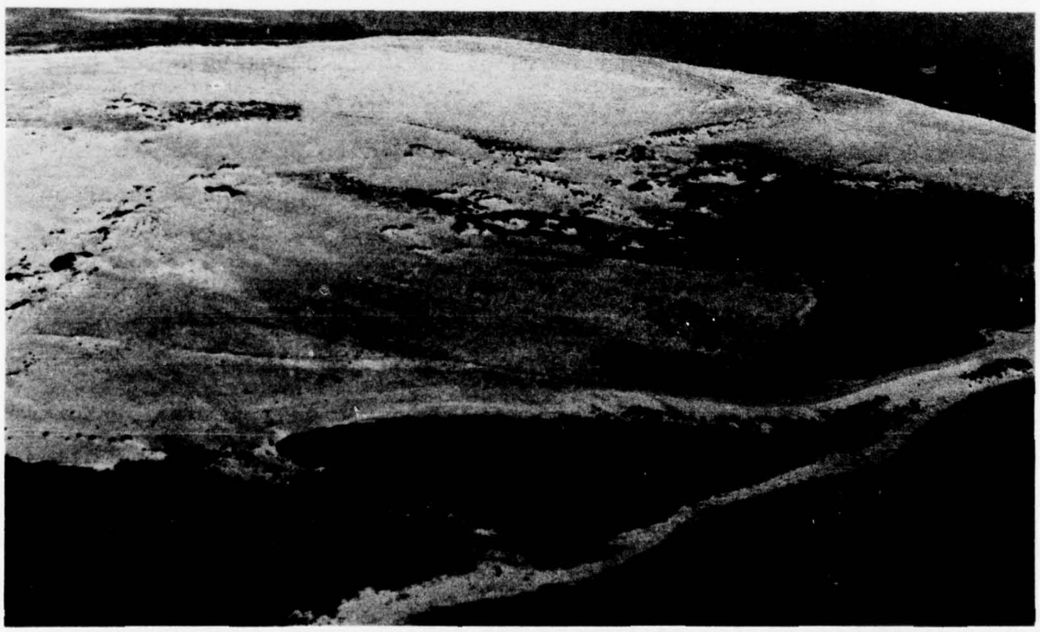

Figure 11. Elevated diked island with very unstable wind-blown substrate near Morehead City

the number of species found during each of the four seasons, it was found that undiked sites averaged 35 species per season; diked but not filled, 42; diked and influenced, 45; and diked and filled, 72. The greater diversity and numbers of birds appeared to be the direct result of a greater diversity of habitats associated with diked islands. Of special importance were the aquatic habitats, mud flats, and dead thickets not presently found on undiked islands.

197. From Table 11 the average number of bird species seen per habitat during the year of censuses was calculated for each of the four major site conditions: undiked, diked and influenced, diked and not filled, and diked and filled. The resulting data show an average of 5.0 species per habitat in the seven undiked habitat types, 3.8 species per habitat in the 11 diked and not dumped habitat types, 4.5 species per habitat in the 10 diked and influenced habitat types, and 4.0 species per habitat in the 18 diked and dumped habitat types. These data indicate that the average number of birds per habitat was about the same in each case with differences in actual total numbers of species being a reflection of habitat diversity.

198. The new diked habitats were particularly interesting. The borrow pits* and ponds provided fresh or slightly brackish water habitats that were completely new to the North Carolina estuaries (Figures 3 and 4). These new habitats appeared to provide fresh water, food, and refuge during times of severe weather and were often heavily used by a variety of birds (Tables C1-C16, Appendix C). Most often the species recorded in these habitats were those that would usually be found associated with the aquatic estuarine habitats.

199. During fall and winter these small shallow freshwater units were often utilized by waterfowl. Prior to this study, over 1000 blue-winged teal (Anas discors) were observed on a single shallow borrow pit about 100 m in length. Duck hunters in southeastern North Carolina quickly learned of the use of these habitats by waterfowl,

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* Considered borrow pits as long as the shallow canal configuration was maintained, whether or not water was present and whether or not small amounts of silt had lined the bottoms. This definition overlaps with swales as described in the vegetation section.

and they are now hunted regularly, often with good success.

200. It should be noted, however, that the heaviest use of these aquatic habitats was during the first few months after construction. Borrow pits were usually lined with a layer of fine sediments that slowed the loss of water to the coarser sediments below. Once these bottoms dried out, the fine silts cracked open, often exposing sands below. Subsequent rains drained quickly into the coarser sediments and the ponding effect was much shortened. Avian utilization then dropped, often dramatically, to lower levels.

201. These ponds, borrow pits, and mud flats were also attractive to shorebirds and waders (herons, egrets, and ibises), especially during periods of migration. They were utilized most heavily at high tide when traditional feeding areas were unavailable. It was not uncommon to see 10 to 20 species of shorebirds and wading birds feeding in a single drain pond or borrow pit.

202. A major attraction for the shorebirds appeared to be the multitudes of mosquito larvae that appeared in late summer and early fall. In some parts of eastern North Carolina, mosquito control methods are now being applied to these sites. This practice appeared to reduce the level of use by shorebirds.

203. The freshwater communities also provided drinking water for many species of land birds. The relatively high levels of land bird use indicated for these habitats in Tables C6 and C7 (Appendix C) were primarily the result of land birds drinking from these freshwater sources.

204. These interesting intermittently aquatic communities are, however, even more ephemeral than most habitats on dredged material islands. All are created by diking and destroyed by the deposition of dredged material. The Wilmington District considers the useful life of the present diked islands to be about 15 years (Personal Communication, August 1977, J. L. Wells). Because most of the aquatic communities will be destroyed well before the dikes are completely filled with dredged material, the average life of such habitats can be only a few years.

205. Mature diked islands are not expected to have the

diversity of habitat presently associated with younger diked islands. The aquatic habitats will be eliminated by deposition of dredged material, and island topography will approach that of elevated undiked sites. The level of avian diversity is then expected to return to a level similar to that presently found on undiked islands.

206. Birds in terrestrial island habitats are closely associated with substrate (either bare ground or some form of vegetation). Some species prefer open ground for their activities while others prefer the physical structure provided by vegetation. On islands without vegetation the difference between diked and undiked sites is a topographic difference: primarily the presence of the dike itself; the presence of borrow pits, dozer scrapes, or ponds; or perhaps a flattening of the central part of the island. On such islands without vegetation, topographic differences other than those providing new habitats appear unimportant. During the fall, winter, and spring, groups of shorebirds and wading birds regularly utilized such bare islands, both diked and undiked, as loafing sites. The only difference appeared to be that these groups often utilized the dikes as windbreaks during severe winter weather.

207. Several species of birds nest on the bare dredged material islands, especially if the substrate is primarily sand and shell. Such sites were particularly attractive to royal terns, sandwich terns (Sterna sandvicensis), least terns, black skimmers, Wilson's plovers, and American oystercatchers (Figure 12). All of these species were observed nesting successfully on diked sites. While one nesting season is insufficient for a critical evaluation, evidence to date indicates that these species will utilize diked sites if other factors, such as island location, substrate, and topography, are appropriate.

208. It is clear, however, that on many islands, especially where dikes were built on older islands where there was a ready source of plant propagules in the dike material, growth of vegetation on the dikes was especially rapid (Table 7). Under these conditions a new dredged material deposit quickly becomes a bare dome surrounded by a dike covered by dense vegetation often a metre or

Figure 12. Royal tern colony on nearly bare undiked site in Cape Fear River near Wilmington

more in height. While evidence is not yet available to prove this point clearly, it is suspected that royal and sandwich terns will not find such islands as suitable as undiked sites. This is due to the fact that these terns appear to prefer nesting islands that have sandy beaches that are easily accessible to the nonflying juveniles.

209. Only one royal tern colony was seen established behind a dike. In this case (island 17-01), the dike consisted of very coarse sandy materials, and vegetation growth was relatively slow. Here the young birds were able to traverse the dike to reach the beach. Royal terns usually nest regionally in a few very large colonies (the largest in North Carolina contained 5071 nests in 1977 on island 39-32). Such sites are very important, and special care should be taken not to disturb them. Such sites containing large colonies of ground-nesting birds should not be diked until it becomes clear that diked sites do provide suitable habitat over a reasonable period of time.

210. As vegetation on dredged material islands becomes established, avian succession parallels the pattern of plant succession (Soots and Parnell 1975). This pattern appears to be similar in its basic aspect on diked and undiked sites. The pattern and rate of plant establishment and movement across newly deposited dredged material has been discussed in detail earlier in this report. Bird species utilization of vegetated habitats is closely correlated with the development of vegetation.

211. Birds readily shift from one part of an island to another as the preferred habitat shifts. With the establishment of a light cover of herbaceous plants (beginning on the dike or drift ridges and spreading eventually to the domes), sparrows, mourning doves (Zenaida macroura), and other seed-eating ground birds begin to utilize the islands. Their utilization of diked and undiked sites appears to be similar. The birds are attracted to a particular habitat type that develops at different rates and with a somewhat different pattern depending on a number of factors.

212. During the breeding season, habitats with spare vegetation become attractive nesting sites for willets, common terns, and gull-billed terns (Figure 13). Black skimmers, least terns, and even royal

and sandwich terns may linger as a light vegetation cover develops (see Soots and Parnell 1975 for a discussion of the nesting cover preferred by the colonial ground-nesting waterbirds). These birds appeared to relate primarily to substrate and to the physical form of the vegetation, and the presence of a dike was not in itself a deterrent. However, the appropriate conditions for common and gull-billed terns and black skimmers often developed first along the outer and inner swales on diked sites. These were the places on diked islands that were most subject to flooding (the outer swale by storm tides and the inner swale by heavy rains). In 1976, there were suspected colony losses to both kinds of flooding. As the appropriate vegetation moves upslope, these birds would be expected to move their nesting sites to areas less likely to flood.

213. As the herbaceous plant cover increases, sites become less attractive to the species mentioned previously. Densely grassed areas then become attractive nesting sites for laughing gulls (Larus atricilla), and in northeastern North Carolina to gadwalls (Anas strepera) and black ducks (Anas rubripes). Laughing gulls have nested behind dikes at only one North Carolina site (island 39-28), where they have been successful for several years (Figure 14). Apparently dikes are not a deterrent for this species, but again further observations are needed.

214. In either 1976 or 1977, colonies of laughing gulls, common terns, gull-billed terns, least terns, and black skimmers were recorded nesting in appropriate habitats behind dikes heavily covered with vegetation. Data comparing the nesting success of such colonies behind bare dikes or on undiked islands were not available. Such comparisons are needed, and conclusions at this time must be very tentative. It is thought at present, however, that these species will generally not be adversely affected by dikes as they generally do not move their young to exposed beaches as do royal and sandwich terns.

215. Herring gulls (Larus argentatus), great black-backed gulls (Larus marinus), and Caspian terns (Sterna caspia), which nest on bare sites or sites with sparse vegetation, have not yet been

Figure 13. Common tern nests in sparse cover of salt-meadow cordgrass

Figure 14. Colony of laughing gulls in dense mixed grasses and herbs behind dike on island in the Cape Fear River

observed nesting behind dikes in North Carolina. These species, especially the latter two, nest in very small numbers in North Carolina (Table 14) and are presently restricted to the northern portion of the coast where there has been little diking to date. Based on limited observations in New Jersey, herring gulls should be able to tolerate bare dikes. They appear, however, to regularly move their flightless young to open beaches in North Carolina, and the presence of heavily vegetated dikes may be a deterrent. Presumably great black-backed gulls would respond in a manner similar to herring gulls as the two species appear very much alike in their nesting habits.

216. Caspian terns nesting in North Carolina do not appear to move their young to the beaches as do royal terns. While evidence is based on observations of only a few young, this species may be less affected by dikes with dense vegetation than the similar royal tern.

217. Dredged material islands become attractive to many species of land birds with the establishment of shrub thickets. During the fall migration, such thickets provide food and shelter for many species of migrating land birds. Table 11 shows that those thickets were heavily utilized during the fall of 1976. As barrier islands and the outer fringe of the mainland continue to be more and more heavily developed, these thickets will increase in importance. Several species, such as the yellow-rumped warbler and song sparrow (*Melospiza melodia*), also spend the winter in large numbers in dredged material island thickets. Note that winter densities of yellow-rumped warblers reached 371 birds per hectare in some such thickets (Table C6, Appendix C).

218. In summer these thickets were utilized as nesting sites for several species of passerine birds, especially red-winged blackbirds and boat-tailed grackles. Thickets are also the preferred nesting habitat in North Carolina for the herons, egrets, and ibises (Figure 15). Most colonies reported from dredged material islands were located in thickets dominated by wax myrtle and silverling.

219. Diking and deposition of dredged material generally kills

Figure 15. Aerial view of mixed-species heronry in live oak and yaupon thicket at Battery Island near Southport

back existing thickets, and the six year period during which diking has been taking place in North Carolina has not provided sufficient time for such thickets to redevelop behind dikes (regrowth takes at least 15 to 30 years on undiked islands (Soots and Parnell 1975). Therefore, such thickets have not developed on diked islands in North Carolina. In 1977 in New Jersey, however, heronries were seen in thickets on several old diked islands; and there is no reason to suspect that when thickets develop on diked islands in North Carolina, they will not provide suitable sites for heronries. This is not to say that thicketed islands should be diked without regard to heronry sites.

220. If the current avian occupants are displaced, 15 to 30 years will be required before suitable habitat redevelops, assuming no filling after the initial use. If diking continues to be heavily utilized in North Carolina, it is possible that most thickets may be destroyed before new ones have time to develop behind dikes.

221. A shortcoming of this study is that the succession of plant and bird communities cannot be evaluated beyond about 6 years. It is not yet known what diked islands will be like when they are completely filled with dredged material. It is suspected that several things will happen that will make the islands generally quite different from the islands that have been studied for the past year.

222. Mr. James Wells (Personal Communication, August 1977) of the Wilmington Corps District has indicated that most diked islands will reach substantially greater elevations than undiked islands although maximum elevations cannot be predicted at present. When this happens, water availability at or near the surface will decline, especially where sands dominate. These higher elevations will also expose surfaces to greater wind velocities. The decreased availability of soil moisture and the greater movement of surface materials would be expected to slow the rate of plant establishment and growth. It may then be found that an island will consist of a ring of dense vegetation on the outer slope of the dike with a band of vegetation moving very slowly upslope, reproducing primarily by vegetative means, in a manner similar to that now found on undiked sites. The

shifting surface substrates on especially high islands may never be completely stabilized. While it has not been possible to observe succession to this point, it is expected that such islands will resemble high undiked sites and many of the differences described in this study will disappear. The nearest approach to the possible future trend is found on Brant Island (20-26) at Morehead City, N. C.. The vegetation on this large diked island is recovering very slowly. The deposited materials are primarily sands. The dike is over 3 m in height and the maximum island elevation is over 8 m. Most dikes in North Carolina are 1 to 2 m high and most islands are less than 4 m in elevation. Brant Island has received dredged material very frequently and the sands are constantly windblown and very unstable. This condition emphasizes the fact that only the early effects of diking on vegetation and birdlife have been evaluated. As diked islands mature the comparisons may change. Dense maritime thickets may not develop on high-elevation diked sites. Should this happen, habitat suitable for heronries and migrating land birds may become more limited than at present. On the other hand, a slowed rate of plant succession may prolong the period of time that such islands are useful for those ground-nesting birds requiring bare or nearly bare nesting sites. It is also known, however, that the ground-nesting colonial birds are less successful on sites where the substrate is loose and unstable. These species prefer and are most successful on bare sites with a surface containing shell fragments that increase stability (Soots and Parnell 1975).

223. If the islands being diked at present are expected to be filled to capacity in 15 years, it will be very important to reevaluate their use by birds in the late 1980's. At that time predictions and recommendations may be possible that will be useful for a much longer period of time than those made at present.

224. It appears that there are few positive values of dikes to birds. There is an increase in diversity of habitats, but generally the new habitats are not considered crucial. They are also short-lived and will not persist as dikes are filled with dredged material. There are no apparent advantages of dikes to colonial nesting birds.

While dikes may prevent some flooding caused during storm tides, the gain is offset by the flooding caused during heavy rains. It appears that the best that can be hoped for is that the negative effects will be minimal and that as dikes are filled the islands will perhaps once again take on most of the qualities of undiked sites.

225. Though this research project was carried out in the North Carolina estuaries, it was desired that recommendations relative to diking be as widely applicable as possible. Therefore, the senior author visited three states where dredged material islands were known to be important to birds and where diking has occurred. In New Jersey, many islands were diked, and most were quite similar to those along the AIWW in southeastern North Carolina. Common reed was perhaps a more widespread dominant on the New Jersey islands than it was in North Carolina. Most of the New Jersey islands were relatively low in elevation, not having received large deposits of dredged material since diking. It appears that the findings of this study relative to diking in North Carolina will apply well to New Jersey islands and probably to most Mid-Atlantic States, assuming that New Jersey is regionally representative.

226. Prior to the project, the senior author visited dredged material island sites in Tampa Bay, Fla., and during the project visited sites in east Florida. Substrates in east Florida appeared to be quite different from those in North Carolina, containing more cemented calcareous sands. Substrates in Tampa Bay were also primarily calcareous sands but resembled the sandy substrates of northeastern North Carolina.

227. Few colonies of ground-nesting waterbirds were seen in Florida, but colonies of wading birds occurred frequently on dredged material islands in both east Florida and in Tampa Bay. Diking of islands containing wading bird colonies would likely have results similar to those expected for North Carolina. Wading bird colonies in Florida were primarily either in Australian pine (Casuarina equisetifolia) on island uplands or in mangroves along island perimeters. Diking with subsequent ponding of saline waters would be expected to kill upland plant communities. The placement of the dike

would be critical in determining its effect on mangroves, and a more detailed knowledge of local conditions would be necessary to predict the outcome of diking. Given time, diked islands would likely develop both mangrove fringes and internal upland plant communities capable of supporting colonies of wading birds.

228. Dredged material islands along the Texas coast contained large numbers of both ground-nesting waterbirds and wading birds. A few islands have been diked. Island form and topography of the Texas islands was similar to that found in North Carolina. In the Galveston Bay area, the form of vegetation was similar. Further south in the Laguna Madre most plant communities appeared to be arrested in a form similar to young dredged material islands in North Carolina. The diking of dredged material islands in Texas should produce results similar to those found in North Carolina, except that vegetation growth following diking would be expected to be much slower in the Laguna Madre, thus causing slower changes in habitat.

PART VI: CONCLUSIONS AND RECOMMENDATIONS

229. Dredged material islands have become very important to the well-being of many species of coastal birds. Often they represent the last available nesting habitat in an environment being more and more heavily utilized by people. In North Carolina the importance of these islands should not be underestimated. Earlier work by Soots and Parnell and the present study clearly point out their importance to colonial birds. The present study also indicates a heavy use of these islands, especially during the fall migration by land birds, shorebirds, wading birds, and waterfowl.

230. It has not been possible with one breeding season's data, however, to reach firm conclusions about the effect of diking on nesting colonial waterbirds. Most species of gulls, terns, and the black skimmer will nest on young diked deposits. Because the nature of older diked islands cannot be clearly determined, the relationship between older diked islands and colonial birds cannot be predicted with confidence. Indications are, however, that mature diked islands will not be as suitable as present undiked or young diked sites. Further study over a much longer period of time will be necessary before long-range evaluations are possible.

231. The first recommendation must be that every effort be made to maintain dredged material islands in a state usable to coastal birds. Management as nesting sites for colonial birds should take precedence over other avian uses. Dredged material islands are often the last resort for these species, most natural sites being unusable due to intense human use. Management for other birds must be secondary. Migrating land birds still have mainland thickets for resting and feeding sites during migration, but these sites are rapidly being lost, and dredged material islands will assume greater importance in the future. Waterfowl, shorebirds, and wading birds also utilize dredged material island habitats as feeding and resting sites supplementary to natural estuarine habitats. This use too may become more important with future development of the coastal zone.

232. Dredged material islands should be managed for different

groups of birds according to island locations. Islands in river mouths and near inlets should be managed for the colonial ground-nesting birds and wading birds. Islands along the AIWW well away from inlets will be more important as nesting and feeding areas for land birds. There will be exceptions to this concept, particularly with regard to least terns and to a lesser extent to black skimmers, both of which will readily nest some distance from inlets if the preferred habitat is present. Ground nesters such as willets (Catoptrophorus semipalmatus) and American oystercatchers (Haematopus palliatus) will nest in suitable habitat anywhere along the estuary. Wading birds will also be occasionally expected to utilize islands well away from inlets.

233. A key management tool should be the maintenance of habitat diversity on dredged material islands on a local basis. Dredging schedules and deposition site usage should be manipulated to ensure bare sites, sites with spare vegetation, densely grassed sites, and thicketed sites at each locality. This will help to ensure adequate appropriate habitat for a variety of species. In North Carolina, however, no dike building or deposition of dredged material on known active sites should take place between 1 April and 31 August to avoid disturbance during courtship, mating, nesting, and the rearing of young.

234. Dredging can be used selectively during the nonbreeding season to manage vegetation on dredged material islands for colonial nesting birds. See Soots and Parnell (1975) and earlier sections of this report for a vegetative time frame for diked and undiked sites.

235. Thickets on islands associated with river mouths or inlets should not be covered by newly deposited dredged material if at all possible. Thickets are not common on these young islands and they are especially important as nesting sites for herons, egrets, and ibises. It is especially important that these islands not be diked as the ponding associated with deposition will destroy the thickets even if they are not covered with fresh dredged material.

236. There appear to be several potential adverse effects of diking on coastal birdlife. The diking of long stretches of old

thicket-covered islands may significantly reduce the amount of this type of locally available habitat for several years. Diking also creates sites that appear less favorable for nesting royal and sandwich terns and may reduce the time of use by other ground nesters preferring bare or nearly bare sites. Diking may also increase the incidence of colony flooding resulting from heavy rains.

237. The best solution to the problems of the colonial nesting birds is not to dike those islands having nesting colonies or having a strong potential for use by these birds. It is thus recommended that islands near river mouths or inlets not be diked, at least until further study can be accomplished.

238. Dikes appear to serve their primary function during the first few weeks after the deposition of dredged material. If portions of dikes are removed after drying of the new dredged material or if islands are only partially diked, it may be possible to eliminate the potential adverse effect of dikes on the ground-nesting terns. Either of these practices would allow access by young birds to island beaches.

239. The present practice of diking most islands along the AIWW in southeastern North Carolina has resulted in significant changes in the nature of dredged material islands. Of particular importance have been (1) a reduction in the number of thicketed islands present and (2) the creation of more complex vegetation patterns on the diked islands. The immediate impact of the loss of thicketed islands should be minimized by either diking in smaller units or by separating the larger diked islands into smaller units with cross dikes. Thus, when small volumes of dredged material are deposited, existing vegetation will be killed back in smaller units, leaving some living thickets on each island until successive units are utilized. Some islands should remain undiked at least until thickets have become established on diked islands.

240. When old islands containing thickets or forests are diked, the standing vegetation should be cut or bulldozed prior to the deposition of dredged material. This practice will provide a bare substrate lacking dead stems protruding from the new surface. These

debris-free sites will be much more likely to be used by ground-nesting birds.

241. Diking does create a series of new habitats that are attractive to a variety of bird species. The ephemeral aquatic situations, while used heavily by birds, appear not to be critical at present. The practice of constructing cross dikes would prolong the life of borrow pits and other freshwater sumps on the segments not immediately filled by dredged material and would thus increase the time of usability of these aquatic habitats.

242. As islands become higher than 3 to 4 m in elevation, wind erosion becomes a significant factor and surfaces fail to stabilize. A major potentially adverse effect of diking appears to be the evolution of the present relatively low islands to much taller steeper sided islands that will revegetate slowly, if at all, and that will have very unstable surfaces. Such islands will pose serious limitations for nesting birds, and the building of islands to elevations of over 5 to 6 m should be avoided, especially near inlets and river mouths.

243. In summary, most conclusions and recommendations about diking and birds must be very tentative. One year of study of 6 years of community succession on diked islands is insufficient to allow many firm conclusions.

244. At present, however, there are few positive values of dikes to nesting birds and several possible adverse effects. It is recommended that the practice be minimized, especially in those areas where undiked sites have proven so important to estuarine bird life.

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APPENDIX A: SOILS DATA

NOTE: See Table 1, main text for explanation of transect types and zones.

Table A1

Diked Island Topographic Characteristics

Island Number	Transect Number	Transect Type	Zone Type	Zone Length (m)	Elevational Range (m)[a]
18-14	1	3	1	8.70	0 - 0.46
			2	13.70	0.46 - 2.60
			3	3.00	2.60 - 2.50
			4	1.50	2.50 - 2.29
			5	9.00	2.29 - 2.13
			10	43.70	2.13 - 2.89
	2	2	2	3.70	0 - 1.02
			3	3.25	1.02 - 1.02
			4	4.90	1.02 - (-)0.17
			7	25.45	(-)0.17 - 1.16
22-25	1	2	1	13.80	0.- 0.24
			2	3.50	0.24 - 1.55
			3	0.90	1.55 - 1.53
			4	5.85	1.53 - 0.02
	2	4	1	2.68	0 - 0.14
			2	3.82	0.14 - 1.38
			3	1.16	1.38 - 1.42
			4	3.04	1.42 - 0.28
			5	3.10	0.28 - 0.42
	3	4	1	8.24	0 - 0.14
			2	2.43	0.14 - 1.17
			3	1.82	1.17 - 1.17
			4	3.60	1.17 - (-)0.29
			2	2.50	(-)0.29 - 0.36
			4	2.43	0.36 - (-)0.59
			5	14.84	(-)0.59 - (-)0.59
	4	3	2	6.55	0 - 1.36
			4	6.50	1.36 - 0.91
			10	16.15	0.91 - 1.19
22-26	1	3	1	12.10	0 - 0
			2	2.28	0 - 1.14
			3	5.72	1.14 - 1.44
			4	1.85	1.44 - 1.25
			10	36.76	1.25 - 1.89
			10	1.30	1.89 - 3.81

[a]Metres above mean high water.

Table A1 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Zone Length (m)	Elevational Range (m)
22-44	1	4	1	4.22	0 - 0.37
			2	3.54	0.37 - 1.64
			3	2.28	1.64 - 1.84
			4	5.00	1.84 - 0.46
			5	22.00	-- --
	2	3	1	5.04	0 - 0.35
			2	5.30	0.35 - 2.34
			3	5.50	2.34 - 3.01
			4	2.52	3.01 - 2.66
			10	59.62	2.66 - 2.66
23-07	1	4	1	3.72	0 - 0.52
			2	1.71	0.52 - 1.35
			3	0.57	1.35 - 1.35
			4	2.67	1.35 - 0.10
			5	12.32	0.10 - 0.32
	2	4	1	4.49	0 - 0.39
			2	2.39	0.39 - 1.40
			3		
			4	2.65	1.40 - 0.32
			5	14.34	0.32 - 0.19
28-01	1	3	1	7.95	0 - 0.28
			2	3.47	0.28 - 2.32
			3	0.83	2.32 - 2.25
			4	3.30	2.25 - 0.65
			5	19.00	0.65 - 0.82
			9	58.65	0.82 - 1.84
36-13	1	2	1	29.25	0 - 0.60
			2	4.00	0.60 - 2.84
			3	2.34	2.84 - 3.04
			4	5.30	3.04 - 0.80
			6	48.00	0.80 - 1.64
	2	2	1	19.90	0.80 - 1.49
			2	2.80	1.49 - 2.84
			3	2.27	2.84 - 2.88
			4	4.50	2.88 - 1.36
			6	21.20	1.36 - 1.36
	3	3	1	24.00	0 - 0.42
			2	4.60	0.42 - 2.72
			3	2.00	2.72 - 2.82

Table A1 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Zone Length (m)	Elevational Range (m)
			4	3.00	2.82 - 2.09
			11	78.83	2.09 - 3.47
36-14	1	4	1	10.10	0 - 0.26
			2	3.20	0.26 - 1.91
			3	2.40	1.91 - 1.89
			4	2.90	1.89 - 0.35
			7	18.60	0.35 - 1.00
	2	2	1	25.60	0 - 0.89
			2	2.40	0.89 - 1.87
			3	2.50	1.87 - 1.96
			4	3.30	1.96 - 0.46
			7	4.20	0.46 - 0.46
	3	3	2	4.80	0 - 1.40
			3	2.50	1.40 - 1.44
			4	2.00	1.44 - 1.27
			10	17.00	1.27 - 1.86
			11	17.00	1.86 - 2.45
			12	3.70	2.45 - 2.45
37-09	1	4	1	6.35	0 - 0.10
			2	3.25	0.10 - 1.80
			3	1.40	1.80 - 1.95
			4	2.80	1.95 - 0.56
			7	under water	under water
	2	3	1	39.00	0 - 0.61
			2	2.40	0.61 - 1.86
			3	1.22	1.86 - 1.86
			4	2.00	1.86 - 1.42
			10	16.00	1.42 - 1.42
			11	23.80	1.42 - 1.79
	3	4	1	4.67	0 - 0.33
			2	3.00	0.33 - 1.86
			3	1.25	1.86 - 1.80
			4	2.45	1.80 - 0.39
			7	under water	under water
39-23	1	3	1	1.60	0 - 0.17
			2	3.67	0.17 - 1.78
			3	1.47	1.78 - 1.88
			4	3.92	1.88 - 0.07

Table A1 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Zone Length (m)	Elevational Range (m)
			5	58.57	0.07 - 0.07
			10	24.66	0.07 - 0.50
	2	3	1	16.15	0 - 0
			2	5.86	0 - 2.20
			4	1.34	2.20 - 1.92
			10	86.15	1.92 - 0.42
39-28	1	3	1	6.50	0 - 0.45
			2	3.87	0.45 - 2.88
			3	2.03	2.88 - 2.81
			4	3.43	2.81 - 1.09
			9	79.24	1.09 - 1.69
	2	3	1	6.11	0 - 0.21
			2	4.00	0.21 - 2.42
			4	4.75	2.42 - 0.72
			9	92.66	0.72 - 1.53
39-33	1	2	1	13.00	0 - 0.45
			2	4.54	0.45 - 2.37
			3	1.51	2.37 - 2.29
			4	4.52	2.29 - 0.52
			9	47.46	0.52 - 0.11
	2	3	1	12.92	0 - 0.45
			2	5.76	0.45 - 2.70
			3	10.12	2.70 - 3.58
			4	1.42	3.58 - 3.44
			10	42.60	3.44 - 5.30
			11	35.47	3.50 - 6.85
	2	3	1	12.92	0 - 0.45
			2	5.76	0.45 - 2.70
			3	10.12	2.70 - 3.58
			4	1.42	3.58 - 3.44
			10	42.60	3.44 - 5.30
			11	35.47	3.50 - 6.85
40-01	1	3	1	8.82	0 - 0.23
			2	4.55	0.23 - 2.19
			3	2.16	2.19 - 2.15
			4	2.90	2.15 - 0.92
			5	24.00	0.92 - 0.92
			9	24.00	0.92 - 1.17

Table A1 (concluded)

Island Number	Transect Number	Transect Type	Zone Type	Zone Length (m)	Elevational Range (m)
	2	3	1	1.00	0 - 0
			2	7.60	0 - 1.90
			3	2.34	1.90 - 1.90
			4	3.30	1.90 - 0.83
			9	51.88	0.83 - 0.38
40-46	1	2	1	10.12	0 - 0.53
			2	1.81	0.53 - 1.44
			3	0.62	1.44 - 1.44
			4	3.29	1.44 - 0.53
			5	13.46	0.53 - 0.41
			5	15.95	0.41 - 0.97
			2	3.96	0.97 - 2.71
			3	0.92	2.71 - 2.82
			4	4.25	2.82 - 1.47
			6	58.13	1.47 - 3.00
43-09	1	3	1	5.00	0 - 0.39
			2	2.68	0.39 - 1.91
			3	1.56	1.91 - 1.98
			4	1.08	1.98 - 1.42
			9	37.57	1.42 - 1.45
			2	10.38	1.45 - 5.51
			4	2.51	5.51 - 4.73
			10	29.05	4.73 - 5.24
	2	3	1	9.00	0 - 0.31
			2	6.15	0.31 - 4.14
			3	1.94	4.14 - 4.11
			4	1.92	4.11 - 3.68
			10	37.00	3.68 - 3.68

Table A2

Texture Characteristics of Soils Collected Along Transects on Diked Islands

Island Number	Transect Number	Transect Type	Zone Type	Soil Sample Elevation (m)[a]	Coarse Fraction[b]	Soil Texture (%)		
						Sand	Silt	Clay
18-14	1	3	1	0.19	0.2	87.4	3.6	9.0
			2	0.66	0.0	91.0	0.0	9.0
			3	2.56	5.1	92.0	0.0	8.0
			4	2.32	0.1	94.0	0.0	6.0
			5	2.15	0.2	94.0	0.0	6.0
			10	2.53	0.2	94.4	0.0	5.6
	2	2	2	0.47	0.1	94.4	1.3	4.3
			3	1.02	0.2	94.0	3.3	2.7
			4	0.24	0.3	94.4	0.3	5.3
			7	-0.17	0.2	93.0	1.0	6.0
22-25	1	2	1	0.22	0.2	95.0	2.3	2.7
			2	1.37	2.7	88.0	6.0	6.0
			3	1.54	1.2	89.4	4.6	6.0
			4	0.45	0.1	86.0	4.0	10.0
	2	4	1	0.09	0.1	87.4	2.6	10.0
			2	0.31	1.1	87.4	2.6	10.0

[a] Metres above mean high water.

[b] Percent coarse fractions are based on weights of original soil samples, not on weights of subsampled fractions (50 g) used in the hydrometric test data presented as the sand, silt, and clay fractions. The coarse fraction is larger than -1 phi (2 mm sieve size), and consists of shell and pebbles.

Table A2 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Soil Sample Elevation (m)	Coarse Fraction	Soil Texture (%) Sand	Silt	Clay
			3	1.42	4.6	92.0	2.0	6.0
			4	1.04	6.3	93.0	0.0	7.0
			5	0.28	0.5	84.4	4.6	11.0
	3	4	1	0.0	0.0	94.4	1.6	4.0
			2	1.07	1.3	93.0	2.0	5.0
			3	1.27	5.4	90.4	0.0	9.6
			4	0.78	2.7	94.4	1.3	4.3
			2	0.78	15.2	68.0	12.0	20.0
			5	-0.59	0.1	29.6	28.0	42.4
	4	3	2	0.47	0.0	90.4	0.6	9.0
			4	0.92	0.1	90.4	2.3	7.3
			10	1.08	7.0	93.3	2.0	4.7
22-26	1	3	1	0.04	7.0	90.0	2.0	8.0
			2	0.63	0.0	90.4	0.6	9.0
			3	1.46	70.3	76.8	8.2	15.0
			4	1.24	0.0	91.3	4.0	4.7
			10	1.47	46.9	91.4	0.0	8.6
22-44	1	4	1	0.27	0.9	87.4	1.6	11.0
			2	1.08	0.2	65.4	15.6	19.0
			3	1.79	1.7	78.0	10.0	12.0
			4	0.80	0.5	81.0	1.0	18.0
	2	3	1	0.18	0.0	93.0	2.0	5.0
			2	0.78	0.0	93.0	0.0	7.0

Table A2 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Soil Sample Elevation (m)	Coarse Fraction	Soil Texture (%)		
						Sand	Silt	Clay
			3	2.41	0.0	91.0	0.0	9.0
			4	2.54	0.0	94.3	1.0	4.7
			10	2.66	0.1	92.4	0.0	7.6
23-07	1	4	1	0.27	0.0	95.7	0.3	4.0
			2	0.70	0.7	91.6	0.4	8.0
			3	1.34	1.9	95.7	0.3	4.0
			4	0.39	0.8	92.4	1.6	6.0
			5	0.18	0.6	93.4	0.6	6.0
	2	4	1	0.31	0.0	89.0	3.0	8.0
			2	1.07	0.0	91.0	2.0	7.0
			4	0.49	0.0	91.6	1.4	7.0
			5	0.24	0.8	93.4	2.6	4.0
28-01	1	3	1	0.01	0.0	83.4	5.6	11.0
			2	0.70	0.3	88.4	0.6	11.0
			3	2.25	0.2	62.2	33.0	4.8
			4	1.53	0.1	36.4	20.6	43.0
			5	0.85	0.0	11.4	30.6	58.0
			9	1.34	0.0	16.0	30.0	54.0
36-13	1	2	1	0.21	0.2	90.4	0.0	9.6
			2	1.83	1.3	93.0	0.0	7.0
			3	3.03	5.1	92.4	2.0	5.6
			4	1.24	6.0	86.2	1.0	12.8
			6	0.36	15.7	91.4	0.0	8.6

Table A2 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Soil Sample Elevation (m)	Coarse Fraction	Soil Texture (%) Sand	Silt	Clay
	2	2	1	0.93	0.6	93.0	0.0	7.0
			2	2.66	2.8	91.6	1.0	7.4
			3	2.88	2.0	95.0	2.3	2.7
			4	2.30	1.3	95.4	1.6	3.0
			6	1.09	0.5	91.3	3.0	5.7
	3	3	1	0.31	0.1	92.0	1.0	7.0
			2	2.37	0.1	93.3	2.0	4.7
			3	2.82	0.2	92.3	2.0	5.7
			4	2.17	0.4	93.4	0.0	6.6
			11	2.59	2.2	96.0	0.0	4.0
36-14	1	4	1	0.10	0.0	91.0	2.0	7.0
			2	1.17	0.7	92.0	0.0	8.0
			3	1.89	0.9	87.0	4.0	9.0
			4	1.04	0.0	84.2	3.0	12.8
	2	2	1	0.10	5.0	81.0	11.0	8.0
			2	1.2	3.9	93.0	1.0	6.0
			3	1.95	4.1	93.0	2.0	5.0
			4	0.47	5.1	93.3	1.0	5.7
			7	0.46	4.0	94.4	1.3	4.3
	3	3	2	0.71	0.1	93.0	0.0	6.0
			3	1.45	0.5	94.0	3.3	2.7
			4	1.21	0.2	93.0	1.0	6.0
			10	1.82	1.9	91.4	0.0	8.6

Table A2 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Soil Sample Elevation (m)	Coarse Fraction	Soil Texture (%)		
						Sand	Silt	Clay
			11	2.12	0.3	91.6	1.0	7.4
			12	2.45	1.0	92.6	0.0	7.4
37-09	1	4	1	0.01	0.0	93.0	1.3	5.7
			2	0.69	9.4	87.6	0.0	12.4
			3	1.90	8.7	86.4	4.3	9.3
			4	1.57	25.7	87.4	4.6	8.0
	2	3	1	0.42	0.1	79.4	3.6	17.0
			2	1.23	0.0	94.4	1.6	4.0
			3	1.86	0.1	73.6	6.0	20.4
			4	1.73	0.0	92.0	0.0	8.0
			10	1.42	0.1	91.6	0.0	8.4
			11	1.76	0.1	94.0	0.0	6.0
	3	4	1	0.32	0.2	93.0	2.3	4.7
			2	0.61	0.2	87.4	3.3	9.3
			3	1.86	0.1	89.6	0.0	10.4
			4	0.37	0.1	92.0	2.3	5.7
39-23	1	3	1	0.21	0.4	85.4	4.6	10.0
			2	1.28	0.9	91.4	0.6	8.0
			3	1.87	1.9	91.6	0.0	8.4
			4	1.77	3.1	90.4	0.6	9.0
			5	0.07	0.0	80.0	6.0	14.0
			10	0.45	0.3	93.4	0.0	6.6

Table A2 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Soil Sample Elevation (m)	Coarse Fraction	Soil Texture (%)		
						Sand	Silt	Clay
	2	3	1	0.0	0.0	92.0	0.0	8.0
			2	0.16	0.7	92.0	0.0	8.0
			4	1.92	0.0	92.0	0.0	8.0
			10	0.60	0.4	93.0	1.0	6.0
39-28	1	3	1	0.0	0.0	88.4	4.6	7.0
			2	0.45	0.0	90.4	2.6	7.0
			3	2.88	0.1	88.4	4.6	7.0
			4	2.81	0.0	74.0	8.0	18.0
			9	1.09	0.0	22.0	20.0	58.0
	2	3	1	0.0	0.0	65.0	8.0	27.0
			2	0.33	0.0	89.7	4.3	6.0
			4	2.06	0.3	92.7	0.3	7.0
			9	1.08	0.0	69.0	7.3	23.7
39-33	1	2	1	0.19	0.0	94.0	0.0	6.0
			2	0.74	0.8	95.7	0.3	4.0
			3	2.39	0.7	94.0	0.0	6.0
			4	1.18	0.4	94.0	0.0	6.0
			9	0.52	0.6	93.7	0.3	6.0
	2	3	1	0.27	0.0	93.7	0.3	6.0
			2	0.59	0.4	96.7	0.0	3.3
			3	2.74	0.3	93.0	0.0	7.0
			4	3.42	2.5	94.0	0.0	6.0
			10	4.68	0.4	94.0	0.0	6.0
			11	6.70	0.9	95.0	0.0	5.0

Table A2 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Soil Sample Elevation (m)	Coarse Fraction	Soil Texture (&) Sand	Silt	Clay
40-01	1	3	1	0.0	0.1	87.0	4.0	9.0
			2	1.47	0.0	89.0	4.0	7.0
			3	2.29	0.2	91.4	0.0	8.6
			4	1.69	0.0	87.4	2.6	10.0
			5	0.92	0.0	8.0	32.0	60.0
			9	1.17	0.0	21.0	30.0	49.0
	2	3	1	0.0	0.0	76.0	5.0	19.0
			2	0.46	0.0	79.4	3.6	17.0
			3	1.91	0.0	96.2	2.0	1.8
			4	1.65	0.0	79.4	4.6	16.0
			9	0.76	0.0	17.0	32.0	51.0
40-46	1	2	1	0.05	10.3	84.4	2.6	13.0
			2	1.10	55.8	84.8	2.2	13.0
			3	1.44	77.4	84.4	3.6	12.0
			4	0.60	0.5	92.0	0.0	8.0
			5	0.46	0.1	91.0	0.0	9.0
			5	0.68	0.5	90.0	1.0	9.0
			2	2.71	0.3	90.4	0.6	9.0
			3	2.82	0.6	93.0	0.0	7.0
			4	2.51	5.6	92.3	2.0	5.7
			6	2.16	0.2	90.4	0.0	9.6
43-09	1	3	1	1.16	0.3	85.4	4.6	10.0
			2	1.26	0.1	80.4	7.6	12.0
			3	1.81	1.5	58.0	16.0	26.0

Table A2 (concluded)

Island Number	Transect Number	Transect Type	Zone Type	Soil Sample Elevation (m)	Coarse Fraction	Soil Texture (%)		
						Sand	Silt	Clay
			4	1.42	1.5	35.4	17.6	47.0
			9	1.69	2.1	89.0	3.0	8.0
			2	4.71	4.6	92.4	0.0	7.6
			4	4.86	0.7	92.4	0.0	7.6
			10	4.94	22.0	92.0	0.0	8.0
	2	3	1	0.23	0.0	92.0	0.0	8.0
			2	2.21	0.0	94.4	1.6	4.0
			3	4.07	0.0	91.4	0.6	8.0
			4	4.00	0.0	90.0	0.0	10.0
			10	3.39	0.0	91.4	0.0	8.6

Table A3

Chemical Data from Soils Collected Along Diked Island Transects (Part 1)

Island Number	Transect Number	Transect Type	Zone Type	Water-Holding Capacity[a] 0.1 bar	Water-Holding Capacity[a] 15 bars	Organic Matter (%)	Weight per Volume (g/cc)[b]	pH in Water
18-14	1	3	1	8.33	4.46	1.4	1.37	7.3
			2	2.92	2.26	0.0	1.46	8.2
			3	1.64	1.13	0.0	1.60	8.4
			4	1.85	1.29	0.0	1.63	8.4
			5	2.05	1.25	0.0	1.65	8.4
			10	2.11	1.40	0.0	1.61	8.3
	2	2	2	2.43	1.47	0.0	1.57	8.2
			3	2.32	1.70	0.0	1.54	8.1
			4	2.25	1.64	0.0	1.54	8.2
			7	2.82	1.86	0.0	1.60	8.2
22-25	1	2	1	6.25	4.98	0.8	1.25	7.9
			2	6.86	2.54	0.0	1.43	8.3
			3	9.16	3.08	0.0	1.41	8.2
			4	4.97	2.87	0.0	1.39	8.2
	2	4	1	4.23	3.33	0.0	1.38	8.1
			2	5.98	2.07	0.0	1.40	8.0
			3	2.64	1.54	0.0	1.47	8.2
			4	2.46	1.66	0.0	1.48	8.1
			5	21.12	12.01	0.5	1.45	7.9

[a] Percent water by weight.

[b] Grams per cubic centimetre.

Table A3 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Water-Holding Capacity 0.1 bar	Water-Holding Capacity 15 bars	Organic Matter (%)	Weight per Volume (g/cc)	pH in Water
	3	4	1	4.76	3.90	0.1	1.33	7.8
			2	3.21	1.20	0.0	1.51	8.3
			3	2.91	1.66	0.0	1.52	8.3
			4	4.66	2.26	0.0	1.50	8.3
			2	16.22	8.98	0.1	1.54	8.1
			5	43.81	21.62	1.9	1.09	7.6
	4	3	2	2.72	2.68	0.0	1.35	8.3
			4	15.73	7.11	0.0	1.45	7.7
			10	3.62	2.09	0.0	1.48	8.3
22-26	1	3	1	7.01	5.40	0.6	1.38	8.0
			2	3.56	2.48	0.0	1.46	8.3
			3	10.86	4.88	1.5	1.34	7.6
			4	6.18	2.02	0.0	1.44	8.2
			10	4.01	1.63	0.0	1.50	8.4
22-44	1	4	1	5.79	3.88	0.8	1.47	7.9
			2	23.14	5.05	1.2	1.38	4.6
			3	4.97	2.47	0.7	1.51	7.7
			4	13.07	4.01	0.0	1.52	7.1
	2	3	1	6.46	5.57	1.3	1.33	7.9
			2	4.01	2.09	0.0	1.50	8.4
			3	5.88	1.54	0.0	1.46	8.3
			4	2.48	2.24	0.0	1.50	8.5
			10	2.53	2.24	0.0	1.48	8.4

Table A3 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Water-Holding Capacity 0.1 bar	Water-Holding Capacity 15 bars	Organic Matter (%)	Weight per Volume (g/cc)	pH in Water
23-07	1	4	1	4.27	4.83	1.1	1.43	7.6
			2	3.55	3.34	0.0	1.49	8.1
			3	3.90	2.60	0.0	1.51	8.1
			4	4.68	3.69	0.3	1.44	8.2
			5	4.76	3.26	0.0	1.49	8.1
	2	4	1	7.89	6.61	1.3	1.34	7.5
			2	7.69	4.06	0.1	1.43	7.8
			4	5.14	3.35	0.3	1.43	7.2
			5	5.64	4.18	0.5	1.43	7.4
28-01	1	3	1	13.68	7.21	1.1	1.26	6.7
			2	7.60	3.22	0.1	1.39	7.8
			3	37.71	14.72	1.7	1.18	7.7
			4	33.83	17.78	1.7	1.18	5.8
			5	60.72	27.69	3.9	0.88	5.1
			9	53.29	25.31	3.9	0.83	3.6
36-13	1	2	1	4.29	3.50	0.0	1.41	7.0
			2	2.97	2.48	0.0	1.51	8.3
			3	2.80	2.48	0.0	1.59	8.3
			4	2.49	1.77	0.0	1.59	8.4
			6	2.75	2.07	0.0	1.67	8.4
	2	2	1	3.58	3.41	0.0	1.46	8.0
			2	2.72	2.49	0.0	1.52	8.2
			3	2.86	2.51	0.0	1.51	8.1

Table A3 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Water-Holding Capacity 0.1 bar	Water-Holding Capacity 15 bars	Organic Matter (%)	Weight per Volume (g/cc)	pH in Water
			4	2.78	2.76	0.0	1.48	8.0
			6		2.32	0.0	1.47	8.3
	3	3	1	2.98	2.53	0.0	1.54	8.6
			2	2.52	2.60	0.0	1.48	8.0
			3	3.07	2.68	0.0	1.46	8.3
			4	3.26	2.04	0.0	1.56	7.9
			11	2.53	1.95	0.0	1.56	8.1
36-14	1	4	1	6.75	5.84	1.4	1.30	4.9
			2	3.36	2.55	0.0	1.51	7.2
			3	5.93	3.32	0.3	1.43	7.2
			4	6.00	3.15	0.2	1.32	6.5
	2	2	1	4.45	3.74	1.1	1.42	7.9
			2	1.74	1.48	0.0	1.62	8.3
			3	2.01	1.44	0.0	1.63	8.3
			4	1.87	1.42	0.0	1.61	8.4
			7	2.02	1.68	0.0	1.63	8.5
	3	3	2	2.75	2.41	0.0	1.49	8.3
			3	2.73	1.65	0.0	1.48	8.1
			4	2.58	2.19	0.0	1.48	8.3
			10	3.24	1.76	0.0	1.58	8.2
			11	3.66	1.86	0.0	1.50	8.3
			12	2.32	2.12	0.0	1.51	8.3

Table A3 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Water-Holding Capacity 0.1 bar	Water-Holding Capacity 15 bars	Organic Matter (%)	Weight per Volume (g/cc)	pH in Water
37-09	1	4	1	4.49	2.99	0.0	1.37	8.4
			2	15.81	5.61	0.0	1.39	8.2
			3	11.45	4.01	0.0	1.41	8.1
			4	7.52	2.55	0.0	1.49	8.1
	2	3	1	16.17	7.62	1.3	1.18	8.1
			2	2.89	2.13	0.0	1.41	7.7
			3	13.63	5.61	0.5	1.26	7.5
			4	3.63	2.45	0.0	1.33	8.2
			10	3.26	2.04	0.0	1.39	8.0
			11	3.33	1.86	0.0	1.41	8.0
	3	4	1	4.29	2.43	0.0	1.36	7.8
			2	8.86	2.44	0.0	1.25	7.5
			3	6.52	1.75	0.0	1.29	7.2
			4	8.05	2.31	0.0	1.28	7.6
39-23	1	3	1	8.09	5.90	1.4	1.38	5.9
			2	2.44	1.31	0.0	1.52	5.0
			3	2.76	1.45	0.0	1.54	5.2
			4	2.61	1.61	0.0	1.54	5.5
			5	19.02	7.44	0.5	1.48	6.5
			10	2.42	1.32	0.0	1.54	6.9
	2	3	1	7.08	5.33	1.0	1.40	5.7
			2	5.41	4.61	1.0	1.36	6.9
			4	2.34	2.08	0.0	1.54	6.9
			10	1.68	1.19	0.0	1.59	6.8

Table A3 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Water-Holding Capacity 0.1 bar	Water-Holding Capacity 15 bars	Organic Matter (%)	Weight per Volume (g/cc)	pH in Water
39-28	1	3	1	8.80	5.42	1.1	1.25	4.6
			2	5.41	3.60	0.7	1.44	7.6
			3	3.62	2.40	0.4	1.45	7.8
			4	19.53	9.49	2.5	1.18	5.8
			9	68.11	41.18	4.4	0.89	6.9
	2	3	1	38.13	15.83	3.9	1.06	3.3
			2	4.64	2.79	0.6	1.44	6.4
			4	5.05	2.31	0.6	1.47	4.6
			9	21.17	10.10	1.3	1.26	7.9
39-33	1	2	1	2.01	1.52	0.0	1.56	7.8
			2	1.74	1.34	0.0	1.58	8.2
			3	2.49	1.43	0.0	1.56	8.2
			4	1.82	1.47	0.0	1.59	8.2
			9	2.28	1.86	0.0	1.62	8.3
	2	3	1	4.03	2.31	0.0	1.52	8.0
			2	2.20	1.92	0.1	1.59	8.0
			3	1.91	1.73	0.0	1.61	8.1
			4	1.47	1.24	0.0	1.62	8.3
			10	1.50	1.34	0.0	1.58	8.3
			11	1.39	1.34	0.0	1.59	8.3
40-01	1	3	1	8.73	6.30	1.3	1.25	7.2
			2	4.60	2.68	0.4	1.41	6.7
			3	3.04	1.91	0.0	1.43	7.3

Table A3 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Water-Holding Capacity 0.1 bar	Water-Holding Capacity 15 bars	Organic Matter (%)	Weight per Volume (g/cc)	pH in Water
			4	7.46	3.99	0.1	1.45	5.9
			5	72.34	43.16	4.1	0.73	7.5
			9	77.44	45.31	--	0.75	7.6
	2	3	1	21.66	11.85	1.4	1.19	5.2
			2	27.51	10.56	0.5	1.33	7.4
			3	12.94	7.07	0.2	1.44	6.9
			4	16.50	6.90	0.0	1.44	5.3
			9	65.86	38.89	6.5	0.86	7.5
40-46	1	2	1	15.40	5.80	1.0	1.14	8.1
			2	6.43	2.96	0.5	1.27	8.2
			3	7.39	3.14	0.0	1.34	8.3
			4	3.23	3.11	0.0	1.45	8.3
			5	3.34	2.98	--	--	--
			5	4.55	3.76	0.6	1.38	8.0
			2	2.92	2.29	0.0	1.49	8.2
			3	2.82	2.42	0.0	1.46	8.2
			4	3.07	1.94	0.0	1.48	8.3
			6	3.24	2.68	0.0	1.47	8.0
43-09	1	3	1	5.28	3.28	0.1	1.42	8.2
			2	11.50	4.09	0.9	1.33	8.0
			3	20.13	8.45	1.0	1.36	7.9
			4	32.58	23.67	2.0	1.24	7.6
			9	6.60	2.97	0.0	1.51	8.5
			2	2.48	2.15	0.0	1.55	8.4

Table A3 (concluded)

Island Number	Transect Number	Transect Type	Zone Type	Water-Holding Capacity 0.1 bar	Water-Holding Capacity 15 bars	Organic Matter (%)	Weight per Volume (g/cc)	pH in Water
			4	2.43	1.97	0.0	1.51	8.3
			10	2.03	1.39	0.0	1.63	8.5
	2	3	1	5.19	4.09	0.5	1.34	8.2
			2	4.50	3.00	0.0	1.37	8.2
			3	3.62	2.75	0.0	1.41	8.2
			4	3.35	2.72	0.0	1.43	8.3
			10	3.19	2.39	0.0	1.41	8.4

Table A4

Chemical Data from Soils Collected Along Diked Island Transects (Part 2)

Island Number	Transect Number	Transect Type	Zone Type	Extractable Minerals (me/100cc)[a]				Sums of Extractable Minerals (me/100cc)
				Potassium	Calcium	Magnesium	Sodium	
18-14	1	3	1	0.16	34.00	1.45	1.18	36.8
			2	0.05	23.00	0.26	0.21	23.5
			3	0.01	40.50	0.13	0.36	41.0
			4	0.01	28.50	0.27	0.26	29.0
			5	0.01	19.00	0.20	0.18	19.4
			10	0.01	23.00	0.24	0.22	23.5
	2	2	2	0.02	32.00	0.18	0.30	32.5
			3	0.02	34.50	0.18	0.32	35.0
			4	0.02	39.50	0.18	0.36	40.1
			7	0.02	34.50	0.19	0.32	35.0
22-25	1	2	1	0.20	7.50	1.50	0.82	10.0
			2	0.08	35.50	0.77	0.29	36.6
			3	0.11	32.00	0.86	0.28	33.3
			4	0.09	21.00	0.62	0.22	21.9
	2	4	1	0.18	8.00	1.10	0.74	10.0
			2	0.12	10.50	0.68	0.15	11.4
			3	0.00	10.00	0.31	0.02	10.3
			4	0.04	9.00	0.37	0.12	9.5
			5	0.17	12.50	1.25	0.27	14.2

[a]Milliequivalents per 100 cubic centimetres.

Table A4 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Extractable Minerals (me/100cc) Potassium	Calcium	Magnesium	Sodium	Sums of Extractable Minerals (me/100 cc)
	3	4	1	0.18	7.50	1.25	1.42	10.3
			2	0.02	13.50	0.30	0.13	14.0
			3	0.03	17.50	0.42	0.16	18.1
			4	0.03	20.50	0.44	0.19	21.2
			2	0.11	24.00	1.10	0.21	25.4
			5	0.29	33.00	3.06	1.26	37.6
	4	3	2	0.06	35.00	0.85	0.33	36.2
			4	0.04	24.00	0.82	0.22	25.1
			10	0.03	31.50	0.80	0.27	32.6
22-26	1	3	1	0.20	24.90	1.80	2.62	29.5
			2	0.04	36.50	0.85	0.33	37.7
			3	0.12	37.00	1.50	0.30	38.9
			4	0.04	34.00	0.73	0.27	35.0
			10	0.03	42.00	0.70	0.29	43.0
22-44	1	4	1	0.16	10.50	1.86	3.60	16.1
			2	0.08	7.80	1.50	0.29	9.7
			3	0.06	11.10	0.80	0.15	12.1
			4	0.06	10.20	0.61	0.36	11.2
	2	3	1	0.10	18.90	2.58	1.06	22.6
			2	0.02	39.50	0.70	0.34	40.6
			3	0.03	39.50	0.81	0.32	40.7
			4	0.01	41.00	0.75	0.33	42.1
			10	0.02	40.00	0.75	0.36	41.1

Table A4 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Extractable Minerals (me/100cc) Potassium	Calcium	Magnesium	Sodium	Sums of Extractable Minerals (me/100cc)
23-07	1	4	1	0.14	7.00	1.35	1.60	10.1
			2	0.07	43.00	0.55	0.35	44.0
			3	0.05	39.00	0.40	0.35	39.8
			4	0.11	29.00	1.00	0.76	30.9
			5	0.22	39.00	2.16	5.58	47.0
	2	4	1	0.16	4.25	1.75	1.76	7.9
			2	0.11	16.00	0.49	0.21	16.8
			4	0.06	10.50	0.56	0.19	11.3
			5	0.23	22.00	2.16	4.90	29.3
28-01	1	3	1	0.26	3.05	2.00	1.94	7.3
			2	0.10	14.50	0.38	0.16	15.1
			3	0.33	23.50	0.37	0.42	24.6
			4	0.76	24.50	6.30	0.83	32.4
			5	0.91	12.00	6.30	5.00	24.2
			9	0.73	13.50	9.88	3.02	27.1
36-13	1	2	1	0.31	13.50	4.50	8.35	26.7
			2	0.05	39.00	0.39	0.40	39.8
			3	0.04	39.50	0.34	0.37	40.2
			4	0.04	40.00	0.33	0.38	40.7
			6	0.02	38.50	0.35	0.35	39.2
	2	2	1	0.03	35.50	0.34	0.37	36.2
			2	0.07	38.50	0.42	0.40	39.4
			3	0.03	38.50	0.40	0.36	39.3

Table A4 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Extractable Minerals (me/100cc) Potassium	Calcium	Magnesium	Sodium	Sums of Extractable Minerals (me/100cc)
			4	0.04	39.50	0.42	0.38	40.3
			6	0.02	39.50	0.50	0.37	40.4
	3	3	1	0.03	30.50	0.75	0.25	31.5
			2	0.06	31.00	0.40	0.36	31.8
			3	0.06	37.50	0.45	0.38	38.4
			4	0.02	40.00	0.47	0.40	40.9
			11	0.01	39.50	0.50	0.38	40.4
36-14	1	4	1	0.04	8.00	3.60	10.19	21.7
			2	0.07	31.00	0.40	0.46	31.9
			3	0.16	26.00	0.50	0.35	27.0
			4	0.24	27.50	0.38	0.38	28.5
	2	2	1	0.17	29.50	1.75	2.62	34.0
			2	0.01	32.00	0.18	0.29	32.5
			3	0.02	37.00	0.20	0.34	37.6
			4	0.02	38.00	0.22	0.33	38.6
			7	0.03	38.00	0.20	0.32	38.6
	3	3	2	0.05	31.00	0.70	0.39	32.1
			3	0.12	27.00	0.55	0.33	28.0
			4	0.03	38.50	0.71	0.41	39.6
			10	0.02	39.00	0.58	0.48	40.1
			11	0.02	38.50	0.66	0.43	39.6
			12	0.02	40.50	0.70	0.49	41.7

Table A4 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Extractable Minerals (me/100cc) Potassium	Calcium	Magnesium	Sodium	Sums of Extractable Minerals (me/100cc)
37-09	1	4	1	0.28	40.00	1.55	4.10	45.9
			2	0.09	41.00	0.79	0.50	42.4
			3	0.07	38.50	0.59	0.43	39.6
			4	0.10	39.00	0.65	0.39	40.1
	2	3	1	0.63	36.00	4.77	18.23	59.6
			2	0.03	40.00	0.90	0.39	41.3
			3	0.23	35.00	1.98	1.60	38.8
			4	0.06	38.00	1.30	0.43	39.8
			10	0.03	37.00	0.87	0.38	38.3
			11	0.03	40.50	0.85	0.37	41.7
	3	4	1	0.16	31.00	0.84	1.24	33.2
			2	0.12	29.50	0.98	0.46	31.1
			3	0.05	26.00	0.93	0.31	27.3
			4	0.18	31.00	0.61	1.52	33.3
39-23	1	3	1	0.12	0.95	0.84	0.40	2.3
			2	0.06	0.45	0.18	0.04	0.7
			3	0.08	0.60	0.27	0.04	1.0
			4	0.05	0.65	0.36	0.04	1.1
			5	0.12	3.20	0.94	0.05	4.3
			10	0.02	1.55	0.21	0.04	1.8
	2	3	1	0.19	1.05	1.10	1.32	3.7
			2	0.09	1.60	1.45	0.27	3.4
			4	0.06	1.45	0.14	0.04	1.7
			10	0.02	1.05	0.17	0.03	1.3

Table A4 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Extractable Minerals (me/100cc) Potassium	Calcium	Magnesium	Sodium	Sums of Extractable Minerals (me/100cc)
39-28	1	3	1	0.32	7.50	3.60	4.70	16.1
			2	0.22	9.00	1.80	0.82	11.8
			3	0.26	21.00	0.92	0.14	22.3
			4	0.34	15.00	1.50	0.50	17.3
			9	0.66	27.00	6.30	3.76	37.7
	2	3	1	0.47	6.50	6.48	13.80	27.3
			2	0.22	0.95	0.82	0.80	2.8
			4	0.28	0.40	0.25	0.11	1.0
			9	0.41	32.00	3.75	3.78	39.9
39-33	1	2	1	0.05	20.00	0.51	0.19	20.7
			2	0.04	26.00	0.59	0.20	26.8
			3	0.04	33.00	0.71	0.24	34.0
			4	0.05	25.50	0.60	0.18	26.3
			9	0.05	19.50	0.60	0.16	20.3
	2	3	1	0.14	33.50	1.25	0.35	35.2
			2	0.06	32.00	0.66	0.25	33.0
			3	0.05	21.00	0.62	0.15	21.8
			4	0.02	35.50	0.73	0.26	36.5
			10	0.01	34.00	0.72	0.22	34.9
			11	0.01	19.00	0.52	0.16	19.7
40-01	1	3	1	0.47	28.50	3.00	7.92	39.9
			2	0.02	40.50	0.75	0.48	41.7
			3	0.02	38.00	0.44	0.28	38.7

Table A4 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Extractable Minerals (me/100cc) Potassium	Calcium	Magnesium	Sodium	Sums of Extractable Minerals (me/100cc)
			4	0.01	16.50	0.40	0.26	17.2
			5	1.24	29.10	8.71	42.38	81.4
			9	--	29.40	8.06	--	--
	2	3	1	0.30	10.20	3.60	7.33	21.4
			2	0.19	6.00	1.74	0.88	8.8
			3	0.08	4.00	0.61	0.07	4.8
			4	0.07	2.75	0.44	0.12	3.4
			9	1.08	30.00	10.66	49.25	91.0
40-46	1	2	1	0.56	39.00	4.00	15.48	59.0
			2	0.06	43.00	0.76	0.67	44.5
			3	0.04	41.00	0.70	0.38	42.1
			4	0.09	40.00	0.79	0.31	41.2
			5	0.05	40.00	0.71	0.30	41.1
			2	0.05	39.00	0.59	0.27	39.9
			3	0.04	39.50	0.57	0.28	40.4
			4	0.02	38.00	0.60	0.28	38.9
			6	0.04	41.00	0.66	0.35	42.1
43-09	1	3	1	0.18	18.00	1.50	0.32	20.0
			2	0.16	27.00	0.99	0.19	28.3
			3	0.40	37.00	2.16	0.56	40.1
			4	0.60	38.00	2.88	0.82	42.3
			9	0.12	42.00	1.25	0.78	44.1
			2	0.03	41.50	0.70	0.27	42.5

Table A4 (concluded)

Island Number	Transect Number	Transect Type	Zone Type	Extractable Minerals (me/100cc) Potassium	Calcium	Magnesium	Sodium	Sums of Extractable Minerals (me/100cc)
			4	0.03	41.50	0.75	0.26	42.5
			10	0.03	42.50	0.66	0.29	43.5
	2	3	1	0.32	41.00	1.20	0.37	42.9
			2	0.15	41.50	1.30	0.33	43.3
			3	0.30	40.50	0.95	0.10	41.9
			4	0.09	40.50	0.94	0.29	41.8
			10	0.06	40.50	0.98	0.27	41.8

Table A5

Chemical Data from Soils Collected Along Diked Island Transects (Part 3)

Island Number	Transect Number	Transect Type	Zone Type	Soil Test Phosphorus (mg/dm^3)[a]	Nitrate Nitrogen (mg/dm^3)	Ammonium Nitrogen (mg/dm^3)	Water-Soluble Chloride (mg/dm^3)	Soluble Salts (mhos/cc)[b]
18-14	1	3	1	40	0	25	76	0.85
			2	43	0	17	0	0.12
			3	26	0	12	0	0.10
			4	48	0	23	27	0.09
			5	48	0	21	14	0.08
			10	55	0	21	9	0.08
	2	2	2	57	0	23	11	0.09
			3	63	0	22	11	0.10
			4	26	0	15	10	0.10
			7	61	0	15	7	0.10
22-25	1	2	1	344	0	27	58	0.39
			2	325	0	19	0	0.15
			3	354	0	21	0	0.16
			4	374	0	27	1	0.16
	2	4	1	407	0	32	34	0.40
			2	250	0	35	0	0.15
			3	298	0	24	0	0.10
			4	307	0	20	0	0.12
			5	354	0	29	4	0.28

[a] Milligrams per cubic decimetre.

[b] Micromhos per cubic centimetre.

Table A5 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Soil Test Phosphorus (mg/dm^3)	Nitrate Nitrogen (mg/dm^3)	Ammonium Nitrogen (mg/dm^3)	Water-Soluble Chloride (mg/dm^3)	Soluble Salts (mhos/cc)
	3	4	1	453	0	28	149	0.75
			2	199	0	22	0	0.12
			3	206	0	19	0	0.11
			4	250	0	20	1	0.10
			5	59	0	30	71	1.60
	4	3	2	250	0	25	5	0.15
			4	307	0	18	0	0.15
			10	385	0	15	0	0.10
22-26	1	3	1	298	0	20	346	1.40
			2	192	0	14	5	0.12
			3	73	13	18	0	0.37
			4	325	0	14	0	0.13
			10	175	0	14	0	0.15
22-44	1	4	1	138	0	16	576	2.25
			2	124	0	30	83	1.50
			3	99	0	22	3	0.28
			4	164	0	21	74	1.65
	2	3	1	325	0	33	41	0.50
			2	142	0	20	0	0.14
			3	127	0	17	0	0.13
			4	92	0	16	0	0.15
			10	134	0	8	0	0.10

Table A5 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Soil Test Phosphorus (mg/dm^3)	Nitrate Nitrogen (mg/dm^3)	Ammonium Nitrogen (mg/dm^3)	Water-Soluble Chloride (mg/dm^3)	Soluble Salts (mhos/cc)
23-07	1	4	1	325	3	18	66	0.53
			2	146	0	10	0	0.18
			3	325	0	13	0	0.15
			4	344	0	14	69	0.45
			5	298	0	11	681	3.50
	2	4	1	222	0	13	214	0.75
			2	492	0	12	0	0.22
			4	466	0	12	0	0.32
			5	364	0	21	813	3.00
28-01	1	3	1	84	1	37	185	0.65
			2	240	0	19	46	0.16
			3	192	0	34	--	0.30
			4	108	0	45	143	2.25
			5	25	0	40	346	3.50
			9	23	0	60	139	4.00
36-13	1	2	1	930	6	35	1789	4.50
			2	597	2	37	39	0.19
			3	264	0	25	0	0.14
			4	316	0	32	0	0.12
			6	138	0	23	0	0.15
	2	2	1	580	2	22	0	0.13
			2	418	0	30	0	0.13
			3	407	0	36	0	0.12

Table A5 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Soil Test Phosphorus (mg/dm^3)	Nitrate Nitrogen (mg/dm^3)	Ammonium Nitrogen (mg/dm^3)	Water-Soluble Chloride (mg/dm^3)	Soluble Salts (mhos/cc)
			4	479	3	29	0	0.14
			6	146	0	28	2	0.15
	3	3	1	108	1	32	0	0.14
			2	757	0	35	2	0.14
			3	453	0	38	3	0.14
			4	108	0	27	0	0.11
			11	89	0	26	3	2.25
36-14	1	4	1	534	0	68	1655	6.00
			2	534	0	36	60	0.22
			3	651	0	49	14	0.36
			4	836	0	46	31	0.50
	2	2	1	54	0	49	42	1.25
			2	61	0	34	23	0.11
			3	55	0	33	0	0.11
			4	55	0	30	14	0.11
			7	43	0	33	0	0.10
	3	3	2	836	0	33	13	0.12
			3	782	0	36	5	0.16
			4	520	0	28	7	0.12
			10	520	0	43	10	0.14
			11	597	0	36	0	0.13
			12	597	0	28	0	0.20

Table A5 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Soil Test Phosphorus (mg/dm^3)	Nitrate Nitrogen (mg/dm^3)	Ammonium Nitrogen (mg/dm^3)	Water-Soluble Chloride (mg/dm^3)	Soluble Salts (mhos/cc)
37-09	1	4	1	186	0	29	51	2.50
			2	222	0	27	28	0.24
			3	534	0	34	0	0.17
			4	114	0	28	7	0.26
	2	3	1	73	0	42	2549	5.10
			2	396	0	26	5	0.15
			3	453	0	32	149	1.25
			4	335	0	27	4	0.18
			10	597	0	22	0	0.15
			11	492	0	21	3	0.16
	3	4	1	651	0	29	136	1.10
			2	580	0	30	13	0.80
			3	632	0	30	9	0.40
			4	670	0	32	177	1.30
39-23	1	3	1	19	0	28	1	0.13
			2	18	0	10	0	0.07
			3	17	0	12	0	0.06
			4	15	0	15	0	0.08
			5	55	0	19	0	0.25
			10	28	0	10	0	0.08
	2	3	1	34	0	27	148	0.75
			2	21	0	21	10	0.24

Table A5 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Soil Test Phosphorus (mg/dm^3)	Nitrate Nitrogen (mg/dm^3)	Ammonium Nitrogen (mg/dm^3)	Water-Soluble Chloride (mg/dm^3)	Soluble Salts (mhos/cc)
			4	31	0	15	0	0.07
			10	29	0	9	0	0.05
39-28	1	3	1	108	0	34	641	3.50
			2	124	6	22	62	0.60
			3	87	0	21	0	0.22
			4	52	0	36	2	1.10
			9	8	14	41	265	2.50
	2	3	1	34	0	56	1280	12.00
			2	20	2	37	60	0.43
			4	30	0	30	3	0.20
			9	18	7	28	443	1.80
39-33	1	2	1	59	0	26	15	0.25
			2	48	0	19	0	0.11
			3	50	0	22	3	0.11
			4	55	0	21	3	0.11
			9	50	0	25	9	0.10
	2	3	1	47	0	21	2	0.22
			2	36	0	19	0	0.16
			3	55	0	17	0	0.14
			4	35	0	14	0	0.13
			10	20	0	13	0	0.12
			11	42	0	10	0	0.11

Table A5 (continued)

Island Number	Transect Number	Transect Type	Zone Type	Soil Test Phosphorus (mg/dm^3)	Nitrate Nitrogen (mg/dm^3)	Ammonium Nitrogen (mg/dm^3)	Water-Soluble Chloride (mg/dm^3)	Soluble Salts (mhos/cc)
40-01	1	3	1	35	0	33	778	4.25
			2	5	0	22	122	1.70
			3	15	0	19	10	0.65
			4	16	0	25	27	1.90
			5	1	0	32	7800	14.00
			9	1	--	27	--	--
	2	3	1	20	0	53	1590	6.00
			2	25	0	33	126	1.05
			3	23	0	24	8	0.30
			4	19	0	24	12	0.70
			9	1	0	27	6720	22.50
40-46	1	2	1	4	0	10	3516	8.40
			2	2	0	2	4	0.45
			3	3	0	9	0	0.22
			4	19	0	16	2	0.16
			5	24	0	17	0	0.17
			2	18	0	13	0	0.12
			3	18	0	14	0	0.12
			4	10	0	16	0	0.11
			6	15	0	17	8	0.11
43-09	1	3	1	94	3	22	2	0.20
			2	59	3	36	1	0.22
			3	35	0	23	3	0.50

Table A5 (concluded)

Island Number	Transect Number	Transect Type	Zone Type	Soil Test Phosphorus (mg/dm^3)	Nitrate Nitrogen (mg/dm^3)	Ammonium Nitrogen (mg/dm^3)	Water-Soluble Chloride (mg/dm^3)	Soluble Salts (mhos/cc)
			4	22	4	21	3	1.00
			9	8	0	14	45	0.43
			2	13	0	12	0	0.14
			4	24	0	14	0	0.11
			10	31	0	12	0	0.12
	2	3	1	19	0	10	2	0.19
			2	13	0	9	3	0.15
			3	16	0	9	1	0.15
			4	19	0	22	1	0.14
			10	20	0	16	0	0.12

Table A6

Textural Characteristics and Water-Holding Capacities of Soils Collected Along Transects on Undiked Islands

Island Number	Transect Zone	Soil Sample Elevations[a]	Soil Texture[b]			Water-Holding Capacity[d]	
			Coarse[c]	Sand	Silt & Clay	0.1 bar	15 bars
36-14	4	0.45	2.0	98.0	0.0	1.73	1.67
	5	0.08	2.0	97.3	0.3	6.16	4.83
	6	0.21	1.5	97.8	0.1	4.75	3.50
	6	0.46	1.5	98.4	0.1	2.55	1.70
	6	1.21	0.3	99.7	0.0	1.95	1.26
	6	1.62	1.2	98.8	0.0	1.95	1.40
	7	3.65	1.3	98.7	0.0	1.59	1.30
	6	2.21	0.4	99.5	0.1	1.91	1.27
	6	1.06	10.1	89.8	0.1	2.34	1.68
	6	0.67	0.4	99.5	0.1	2.48	1.92
	6	0.45	10.3	89.7	0.0	3.37	2.73
	5	0.10	0.3	99.4	0.3	6.38	4.33
37-02	3	0.56	30.6	69.1	0.3	10.47	5.07
	5	0.74	18.2	81.8	0.0	5.67	2.64
	6	1.20	--	--	--	8.25	4.17

[a] Metres above mean high water.

[b] Percent by weight.

[c] Pebbles and shells larger than -2 phi.

[d] Percent water by weight.

Table A6 (continued)

Island Number	Transect Zone	Soil Sample Elevations	Soil Texture Coarse	Soil Texture Sand	Soil Texture Silt & Clay	Water-Holding Capacity 0.1 bar	Water-Holding Capacity 15 bars
	6	1.53	1.3	98.7	0.0	2.26	1.29
	7	2.27	12.2	87.8	0.0	1.85	1.09
	6	1.11	5.6	94.3	0.1	1.97	1.32
	6	0.56	2.2	97.6	0.2	3.20	3.08
	5	0.47	0.0	100.0	0.0	3.74	3.11
37-12	2	0.36	0.1	99.8	0.1	2.55	1.46
	3	0.39	6.5	92.4	0.1	3.71	1.92
	4	0.57	0.0	99.9	0.1	2.16	1.45
	6	0.65	0.1	99.9	0.0	2.59	1.41
	7	1.85	0.1	99.9	0.0	2.42	1.50
	6	1.22	0.0	99.9	0.1	3.22	1.81
	6	0.34	0.0	100.0	0.0	3.39	3.13
	4	0.59	0.2	99.8	0.0	2.82	1.89
	2	0.45	0.2	99.8	0.0	3.17	1.96
	1	0.19	0.1	99.8	0.1	3.90	2.04
39-34	4	0.98	0.0	99.9	0.1	3.27	2.26
	5	0.85	--	--		6.34	4.21
	5	0.73	0.0	99.9	0.1	4.23	2.55
	5	0.68	3.1	96.7	0.2	2.73	1.55
	6	0.85	0.9	99.1	0.0	2.67	1.58
	6	0.97	1.3	98.5	0.2	1.82	1.29
	6	1.31	0.5	99.5	0.0	1.55	0.98
	7	1.50	3.0	96.9	0.1	1.34	0.97
	6	--	1.7	98.2	0.1	2.26	1.09
	6	--	0.6	99.3	0.1	1.65	0.68

Table A6 (concluded)

Island Number	Transect Zone	Soil Sample Elevations	Soil Texture			Water-Holding Capacity	
			Coarse	Sand	Silt & Clay	0.1 bar	15 bars
	6	--	0.4	99.6	0.0	1.97	1.01
	5	--	41.1	58.9	0.0	8.39	3.69
	5	--	9.5	90.5	0.0	16.96	8.75
	4	--	--	--	--	8.90	2.76
	1	--	--	--	--	12.73	4.57

Table A7

<u>Chemical Data from Soils Collected Along Transects on Undiked Islands</u>

Island Number	Zone Type	pH in Water	Organic Matter[a]	Nitrate Nitrogen	Extractable Minerals (me/100cc)[b] Potassium	Calcium	Magnesium	Phosphorus[c]
36-14	6	7.7	0.8	0.0	0.02	48.10	0.36	113
	6	7.8	0.6	0.0	0.03	48.10	0.43	20
	6	7.9	0.6	0.0	0.03	46.80	0.41	25
	6	8.0	0.6	0.0	0.04	44.20	0.23	52
	7	7.1	0.8	0.0	0.01	46.80	0.34	60
	6	8.1	0.7	0.0	0.02	45.50	0.43	143
	6	7.9	0.6	0.0	0.02	45.50	0.32	41
	6	8.0	0.6	0.0	0.04	44.20	0.36	34
	6	7.9	0.7	0.0	0.06	44.20	0.53	58
	5	7.7	1.5	0.0	0.18	34.45	2.86	378
37-02	3	7.8	2.0	0.0	0.39	41.60	4.42	6
	4	8.1	0.6	0.0	0.11	31.85	1.69	279
	5	7.6	2.3	0.0	0.37	39.65	2.21	54
	6	7.9	1.1	0.0	0.16	43.55	1.95	19
	6	7.8	0.7	0.0	0.09	42.90	0.75	180
	6	7.4	0.6	0.0	0.05	43.55	0.54	117
	7	6.2	0.8	0.0	0.02	40.70	0.15	23
	6	7.0	0.7	0.0	0.02	39.05	0.23	68
	6	7.5	0.7	0.0	0.02	40.15	0.22	71
	6	7.5	0.6	0.0	0.02	40.15	0.20	72
	6	7.7	0.7	0.0	0.03	41.80	0.42	199

[a] Percent by weight.

[b] Milliequivalents per 100 cubic centimetres.

[c] Kilograms per hectare.

Table A7 (concluded)

Island Number	Zone Type	pH in in Water	Organic Matter	Nitrate Nitrogen	Extractable Minerals (me/100cc) Potassium	Calcium	Magnesium	Phosphorus
	5	7.9	0.7	0.0	0.06	40.70	0.98	98
	3	8.1	0.6	0.0	0.06	40.70	1.50	203
37-12	2	8.2	0.8	0.0	0.07	39.60	1.40	499
	2	8.2	0.8	0.0	0.06	36.30	0.72	431
	2	8.0	0.8	0.0	0.03	35.75	0.40	248
	2	8.2	0.0	0.0	0.03	40.70	0.41	225
	3	8.3	0.8	0.0	0.03	41.25	0.47	120
	3	8.1	0.9	0.0	0.03	40.70	0.44	297
	4	8.1	0.8	0.0	0.03	38.50	0.41	195
	6	8.3	0.9	0.0	0.02	36.85	0.55	513
	7	8.3	0.8	0.0	0.03	42.35	0.58	462
	7	8.2	0.9	0.0	0.02	41.25	0.52	384
	6	6.8	0.8	0.0	0.02	40.15	0.55	417
	6	7.5	0.8	0.0	0.06	39.05	0.50	473
	4	7.6	0.8	0.0	0.03	39.60	0.45	419
	2	7.8	0.7	0.0	0.04	38.20	0.50	480
	2	8.0	0.7	0.0	0.04	40.15	0.50	378
	.	8.0	0.7	0.0	0.02	40.15	0.63	554
		7.9	0.7	0.0	0.06	34.10	0.72	635
39-34	2	7.7	0.7	0.0	0.04	6.00	0.52	189
	3	7.5	0.7	0.0	0.09	11.25	0.33	47
	4	7.5	0.6	0.0	0.15	6.50	0.30	45
	6	7.5	0.9	0.0	0.02	8.00	0.11	21
	7	5.8	0.7	0.0	0.03	1.10	0.08	36

APPENDIX B: VEGETATION DATA

Table B1

Importance Values for Plant Species Occurring Along Transects Across Outer Swales on Diked Dredged Material Islands[a]

	Surface Age (yrs)					
Species	1	2	3	4	5	6
Sesuvium portulacastrum	--	--	--	1	--	--
Iresine rhizomatosa	--	--	--	2	--	--
Rhus radicans	--	--	--	--	1	--
Hydrocotyle bonariensis	--	1	2	8	10	19
Ptilimnium capillaceum	--	--	1	--	--	3
Cynanchum palustre	< 1	< 1	--	--	--	--
Ambrosia artemisiifolia	--	--	1	1	5	--
Aster subulatus	--	--	--	--	--	1
Aster tenuifolius	13	6	1	9	6	--
Baccharis angustifolia*	12	4	--	--	--	--
Baccharis halimifolia*	--	2	9	5	2	13
Borrichia frutescens*	105	76	36	97	104	122
Erechtites hieracifolia	--	--	--	< 1	--	--
Erigeron canadensis	3	< 1	1	1	--	1
Erigeron quercifolius	--	--	--	< 1	2	--
Erigeron strigosus	--	--	--	--	< 1	--
Eupatorium capillifolium	--	--	2	--	--	--
Gnaphalium obtusifolium	< 1	--	--	--	1	--
Gnaphalium purpureum	--	--	--	1	--	--
Heterotheca subaxillaris	3	5	2	3	1	--
Iva frutescens*	7	39	75	3	6	6
Iva imbricata*	--	3	5	--	2	--
Lactuca sp.	--	< 1	--	--	--	2
Lactuca canadensis	--	1	--	1	2	--
Mikania scandens	--	--	--	11	1	1
Solidago altissima	--	--	--	2	--	--
Solidago sempervirens	2	9	8	2	7	8
Lepidium virginicum	--	--	--	1	< 1	--
Sambucus canadensis	--	--	--	--	< 1	--
Atriplex arenaria	--	--	--	--	< 1	--
Atriplex patula	--	1	5	--	--	1
Chenopodium ambrosioides	--	--	--	< 1	1	--
Salicornia virginica	12	5	3	4	4	4

[a] Importance values are combined values for relative frequency and relative cover (200 maximum). Importance values for shrubs* include relative density (300 maximum).

Table B1 (continued)

Species	Surface Age (yrs) 1	2	3	4	5	6
Suaeda linearis	1	1	1	5	2	1
Commelina communis	--	--	1	4	2	--
Ipomoea sagittata	--	--	--	2	4	--
Melothria pendula	--	--	--	< 1	--	--
Juniperus virginiana	--	--	--	--	5	1
Carex sp.	--	--	--	< 1	--	--
Cyperus sp.	--	1	--	1	--	--
Cyperus compressus	--	< 1	2	--	--	--
Cyperus esculentus	--	1	--	--	--	--
Cyperus filicinus	--	--	--	< 1	< 1	--
Fimbristylis spadicea	9	14	8	6	< 1	13
Scirpus americanus	--	< 1	--	--	1	2
Scirpus robustus	--	1	--	1	1	3
Scirpus validus	--	--	--	--	--	1
Croton punctatus	--	< 1	--	--	--	--
Amorpha fruticosa	--	--	--	1	--	--
Strophostyles helvola	--	12	2	< 1	1	1
Sabatia stellaris	< 1	1	--	--	--	--
Juncus roemerianus	--	5	11	5	1	2
Lythrum lineare	--	--	--	1	--	--
Kosteletskya virginica	--	1	--	2	< 1	--
Myrica cerifera	1	--	--	15	18	2
Oenothera biennis	--	--	--	1	--	--
Oenothera humifusa	3	< 1	1	1	--	--
Phytolacca americana	--	< 1	1	--	--	--
Limonium carolinianum	25	10	5	4	1	3
Poa sp.	< 1	--	--	--	1	1
Andropogon virginicus	5	1	2	4	2	--
Cenchrus tribuloides	--	2	1	--	--	--
Chloris petraea	3	1	--	--	--	1
Distichlis spicata	29	16	28	7	5	8
Echinochloa crusgalli	--	--	--	< 1	--	--
Elymus virginicus	--	--	--	--	1	--
Festuca octoflora	--	--	9	--	5	--
Panicum amarum	--	--	--	1	2	--
Panicum virgatum	3	3	3	5	9	5
Paspalum distichum	--	11	6	--	--	--

Table B1 (concluded)

Species	Surface Age (yrs) 1	2	3	4	5	6
Phragmites communis	--	< 1	--	--	9	29
Setaria geniculata	--	1	--	--	< 1	--
Spartina alterniflora	41	30	19	11	8	8
Spartina cynosuroides	--	--	--	--	< 1	6
Spartina patens	15	24	42	61	60	25
Triplasis purpurea	--	3	3	1	--	--
Polygonum sp.	--	--	--	--	--	1
Rumex acetosella	--	--	--	--	< 1	--
Rumex verticillatus	--	--	1	--	--	--
Prunus serotina	--	--	--	--	< 1	--
Rubus sp.	--	--	--	1	--	--
Rubus flagellaris	--	--	2	< 1	--	--
Diodia teres	--	1	1	--	--	--
Galium sp.	--	--	1	--	< 1	--
Galium hispidulum	--	--	--	--	--	2
Galium tinctorium	--	--	1	--	--	--
Agalinis sp.	1	--	--	--	--	--
Agalinis fasciculata	3	< 1	--	--	--	--
Agalinis purpurea	1	1	--	--	--	--
Physalis viscosa	1	1	--	--	--	--
Typha angustifolia	--	--	--	< 1	--	--
Typha domingensis	--	--	--	2	--	--
Lippia nodiflora	--	--	--	1	2	--
Verbena brasiliensis	--	--	--	--	< 1	--
Parthenocissus quinquefolia	--	--	--	--	--	2
Vitis sp.	--	--	1	--	--	--
Vitis aestivalis	--	1	--	--	--	--
Unknown herbaceous species	--	1	--	--	1	--
Unknown succulent species	--	--	--	--	--	1
Number of plots sampled	61	82	58	91	73	40

Table B2

Importance Values for Plant Species Occurring Along Transects Across Outside Dike Slopes on Diked Dredged Material Islands[a]

Species	Surface Age (yrs)					
	1	2	3	4	5	6
Irisine rhizomatosa	--	< 1	--	--	--	--
Alternanthera philoxeroides	--	--	--	--	--	2
Rhus radicans	--	--	--	--	1	3
Hydrocotyle bonariensis	11	12	9	5	13	2
Ptilimnium capillaceum	--	--	--	--	--	1
Cynanchum palustre	1	--	--	2	--	--
Ambrosia artemisiifolia	--	--	--	3	4	6
Aster tenuifolius	1	1	--	--	1	--
Baccharis halimifolia*	16	26	6	77	8	4
Borrichia frutescens*	119	97	54	5	103	113
Erechtites hieracifolia	1	< 1	--	--	--	1
Erigeron canadensis	3	2	3	6	6	11
Erigeron quercifolius	--	--	--	1	3	3
Eupatorium capillifolium	4	1	2	3	1	9
Eupatorium serotinum	--	2	3	--	--	--
Gaillardia pulchella	--	1	--	--	1	--
Gnaphalium purpureum	--	--	--	1	--	--
Heterotheca subaxillaris	7	4	8	10	6	9
Iva frutescens*	3	4	17	--	3	9
Iva imbricata*	--	6	43	--	14	--
Lactuca sp.	--	--	--	--	1	--
Lactuca canadensis	--	--	--	1	1	1
Mikania scandens	--	6	1	--	--	--
Pluchea purpurascens	--	< 1	--	--	--	--
Solidago sempervirens	11	10	5	4	7	15
Lepidium virginicum	--	< 1	1	1	1	2
Atriplex arenaria	--	--	--	1	--	3
Atriplex patula	--	2	< 1	--	1	--
Chenopodium album	7	1	--	--	--	1
Chenopodium ambrosioides	7	1	2	8	4	1
Salicornia virginica	1	< 1	--	--	1	--
Salsola kali	--	--	1	--	--	--
Suada linearis	--	1	--	--	--	--

[a] Importance values are combined values for relative frequency and relative cover (200 maximum). Importance values for shrubs* include relative density (300 maximum).

Table B2 (continued)

Species	Surface Age (yrs)					
	1	2	3	4	5	6
Commelina communis	3	2	3	11	3	--
Commelina virginica	--	--	--	--	<1	--
Ipomoea sagittata	1	3	2	5	3	--
Melothria pendula	--	<1	--	--	--	--
Juniperus virginiana*	--	<1	4	--	1	6
Carex sp.	1	--	--	--	1	--
Cyperus sp.	--	--	--	1	--	--
Cyperus compressus	--	1	7	1	--	--
Cyperus esculentus	--	3	--	--	--	--
Cyperus strigosus	--	--	--	--	--	1
Fimbristylis spadicea	6	4	3	3	4	5
Scirpus americanus	5	1	--	--	--	--
Scirpus robustus	1	--	--	--	--	--
Scirpus validus	--	1	--	--	--	--
Croton punctatus	--	1	--	--	<1	--
Euphorbia polygonifolia	1	2	3	--	<1	2
Amorpha fruticosa	--	--	--	4	--	--
Daubentonia punicea*	--	--	--	--	9	9
Persea borbonia*	--	--	--	5	--	--
Strophostyles helvola	17	5	4	1	2	10
Juncus roemerianus	--	1	3	--	--	--
Sassafras albidum*	--	--	1	--	--	--
Smilax auriculata	--	1	--	17	1	--
Smilax bona-nox	--	--	1	--	2	--
Yucca filamentosa	--	--	--	27	1	--
Kosteletskya virginica	--	--	--	--	1	--
Myrica cerifera*	3	--	7	1	6	4
Oenothera humifusa	4	3	2	1	1	1
Oenothera laciniata	--	1	--	--	1	--
Phytolacca americana	1	7	13	--	--	3
Limonium carolinianum	1	1	--	--	--	1
Poaceae sp.	1	--	--	--	--	--
Andropogon virginicus	2	1	--	8	3	3
Cenchrus tribuloides	--	3	7	--	--	--
Chloris petraea	1	--	--	--	--	2
Cynodon dactylon	1	--	--	--	--	--
Digitaria sanguinalis	5	--	1	3	<1	--

Table B2 (concluded)

Species	Surface Age (yrs) 1	2	3	4	5	6
Distichlis spicata	7	16	6	--	5	7
Echinochloa crusgalli	1	--	--	--	--	--
Elymus virginicus	1	--	--	1	--	1
Eragrostis capillaris	--	--	--	1	--	--
Festuca octoflora	--	<1	1	--	--	--
Panicum amarum	--	--	--	10	8	--
Panicum virgatum	2	2	1	5	--	--
Paspalum distichum	4	4	2	--	<1	3
Phragmites communis	1	1	--	--	3	15
Poa sp.	--	--	--	--	1	1
Setaria geniculata	--	--	<1	--	--	--
Spartina alterniflora	4	6	2	--	3	1
Spartina patens	34	36	52	32	43	23
Triplasis purpurea	1	5	10	7	1	2
Uniola paniculata	--	--	1	--	--	--
Rumex acetosella	--	--	--	1	--	--
Rubus sp.	--	--	--	3	--	--
Rubus flagellaris	--	1	3	3	--	--
Diodia teres	--	5	5	1	<1	1
Galium sp.	--	--	--	--	<1	--
Galium hispidulum	--	--	--	1	<1	--
Salix nigra	1	<1	--	--	--	--
Agalinis fasciculata	--	--	--	1	--	--
Physalis viscosa	2	1	<1	10	<1	1
Solanum americanum	--	<1	--	--	--	--
Typha domingensis	2	--	--	--	--	--
Typha latifolia	--	1	--	--	--	--
Boehmeria cylindrica	--	<1	--	--	--	--
Lippia nodiflora	--	--	--	10	14	--
Verbena sp.	--	--	--	--	--	1
Verbena brasiliensis	--	--	--	--	<1	--
Ampelopsis arborea	--	1	3	--	1	2
Parthenocissus quinquefolia	--	--	--	--	1	1
Number of plots sampled	84	143	98	39	90	43

Table B3

Importance Values for Plant Species Occurring Along Transects Across Dike Ridges on Diked Dredged Material Islands[a]

Species	Surface Age (yrs) 1	2	3	4	5	6
Sesuvium maritimum	--	--	1	--	--	--
Sesuvium portulacastrum	--	--	3	--	--	--
Alternanthera philoxeroides	--	--	--	--	--	1
Rhus radicans	--	--	--	--	2	2
Hydrocotyle bonariensis	3	6	2	--	5	1
Ptilimnium capillaceum	--	--	--	--	--	1
Cynanchum palustre	4	1	--	--	1	1
Ambrosia artemisiifolia	--	--	--	--	1	8
Aster subulatus	--	1	--	--	--	--
Aster tenuifolius	--	--	--	--	4	--
Baccharis halimifolia*	23	1	--	86	2	9
Borrichia frutescens*	83	86	107	--	118	119
Carduus sp.	--	--	--	--	1	--
Erechtites hieracifolia	9	--	--	--	--	--
Erigeron canadensis	9	5	9	12	6	10
Erigeron quercifolius	--	--	--	--	--	1
Eupatorium capillifolium	2	--	--	14	1	5
Eupatorium serotinum	--	--	5	--	--	--
Gaillardia pulchella	--	1	--	--	--	--
Heterotheca subaxillaris	12	16	12	19	12	13
Iva frutescens*	--	37	3	--	4	11
Iva imbricata*	--	--	1	--	--	--
Lactuca canadensis	--	1	--	1	1	--
Mikania scandens	--	1	--	--	--	--
Solidago altissima	--	--	--	--	1	--
Solidago sempervirens	4	7	11	3	12	17
Lepidium virginicum	--	2	--	1	2	2
Atriplex arenaria	--	--	--	--	1	1
Atriplex patula	--	--	--	--	2	--
Chenopodium album	7	1	--	--	--	1
Chenopodium ambrosioides	6	1	4	--	1	1
Suaeda linearis	--	1	--	--	--	--
Commelina communis	3	5	1	3	9	--

[a] Importance values are combined values for relative frequency and relative cover (200 maximum). Importance values for shrubs* include relative density (300 maximum).

Table B3 (continued)

Species	Surface Age (yrs)					
	1	2	3	4	5	6
Calystegia sepium	--	--	1	--	--	--
Ipomoea sagittata	--	--	1	3	3	--
Juniperus virginiana	--	1	--	--	--	3
Cyperus compressus	--	--	5	--	--	--
Fimbristylis spadicea	3	1	4	4	5	1
Scirpus americanus	--	--	--	--	--	2
Scirpus validus	--	1	--	--	--	--
Croton punctatus	--	1	--	--	--	--
Euphorbia polygonifolia	--	5	8	2	--	2
Daubentonia punicea*	--	--	--	--	--	4
Strophostyles helvola	35	7	6	1	4	17
Smilax auriculata	--	--	--	45	1	--
Smilax bona-nox	--	--	1	--	5	--
Yucca filamentosa	2	1	--	23	4	--
Myrica cerifera*	9	--	--	--	--	--
Oenothera biennis	--	--	--	1	--	1
Oenothera humifusa	7	8	2	2	3	1
Oenothera laciniata	--	1	--	--	1	--
Phytolacca americana	6	2	1	--	2	4
Andropogon virginicus	3	1	--	5	2	4
Cenchrus tribuloides	--	5	13	--	--	--
Chloris petraea	1	--	--	1	--	2
Cynodon dactylon	6	18	--	--	--	--
Digitaria sanguinalis	8	--	--	1	1	--
Distichlis spicata	14	10	--	--	6	7
Eleusine indica	--	1	--	--	--	--
Panicum amarum	--	--	--	6	2	--
Panicum virgatum	--	--	2	3	--	--
Paspalum distichum	8	2	4	--	--	4
Phragmites communis	3	3	--	--	--	7
Setaria geniculata	1	4	--	--	--	--
Spartina alterniflora	3	--	--	--	--	--
Spartina patens	21	35	40	36	61	32
Stenotaphrum secundatum	--	1	--	--	--	--
Triplasis purpurea	--	11	35	12	2	2
Polygonum sp.	--	--	--	--	--	1
Rumex acetosella	--	--	--	1	--	--

Table B3 (concluded)

Species	Surface Age (yrs)					
	1	2	3	4	5	6
Portulaca sp.	--	1	--	--	--	--
*Prunus serotina**	--	1	--	--	--	--
Rubus sp.	--	--	--	4	--	--
Diodia teres	--	5	10	2	--	1
Galium sp.	--	--	--	--	1	--
Physalis viscosa	4	3	1	3	4	1
Solanum americanum	--	--	--	--	--	2
Lippia nodiflora	--	--	--	3	9	--
Verbena sp.	--	--	--	--	--	1
Ampelopsis arborea	--	1	1	--	--	--
Vitis aestivalis	1	--	--	--	--	--
Unknown herbaceous species	--	--	1	--	--	--
Number of plots sampled	38	92	43	23	47	33

Table B4

Importance Values for Plant Species Occurring Along Transects Across Inside Dike Slopes on Diked Dredged Material Islands[a]

Species	Surface Age (yrs)					
	1	2	3	4	5	6
Acer rubrum*	--	--	--	--	--	1
Sesuvium maritimum	--	--	4	--	--	--
Alternanthera philoxeroides	--	--	--	--	--	1
Rhus radicans	--	--	--	--	1	1
Hydrocotyle bonariensis	7	10	3	--	6	1
Ptilimnium capillaceum	--	--	5	--	< 1	1
Ilex vomitoria*	--	--	--	--	--	1
Cynanchum palustre	1	--	--	--	1	--
Ambrosia artemisiifolia	--	8	1	6	1	6
Aster subulatus	--	14	1	--	2	1
Aster tenuifolius	--	1	--	--	3	1
Baccharis angustifolia*	--	--	--	--	--	3
Baccharis halimifolia*	--	1	--	93	11	33
Borrichia frutescens*	2	109	91	--	100	104
Carduus sp.	--	--	--	1	< 1	--
Erigeron canadensis	3	6	6	15	8	8
Erigeron quercifolius	--	--	1	--	1	--
Eupatorium capillifolium	--	3	--	1	7	4
Eupatorium serotinum	--	--	6	--	--	--
Gaillardia pulchella	--	1	--	--	1	--
Gnaphalium purpureum	--	--	--	--	< 1	--
Heterotheca subaxillaris	11	5	23	23	12	14
Iva frutescens*	--	--	20	--	5	15
Iva imbricata*	--	1	2	--	--	--
Lactuca sp.	--	2	--	--	--	--
Lactuca canadensis	--	--	2	--	1	1
Solidago altissima	--	--	--	--	1	1
Solidago sempervirens	18	8	16	1	9	12
Sonchus oleraceus	--	--	1	--	--	--
Lepidium virginicum	--	1	--	--	1	2
Stellaria sp.	--	--	--	--	< 1	--
Atriplex arenaria	--	1	--	1	1	--
Atriplex patula	--	--	--	--	1	1

[a] Importance values are combined values for relative frequency and relative cover (200 maximum). Importance values for shrubs* include relative density (300 maximum).

Table B4 (continued)

Species	Surface Age (yrs) 1	2	3	4	5	6
Chenopodium album	--	1	--	--	--	1
Chenopodium ambrosioides	19	1	4	14	3	1
Salicornia virginica	--	--	--	--	1	--
Salsola kali	--	2	--	--	--	--
Commelina communis	3	5	4	5	7	--
Calystegia sepium	--	--	1	--	--	--
Juniperus virginiana *	--	--	--	--	--	1
Carex albolutescens	--	--	1	--	--	--
Cyperus sp.	--	--	1	--	--	--
Cyperus compressus	1	--	3	--	--	--
Cyperus filicinus	--	--	--	--	1	--
Cyperus strigosus	--	--	--	--	--	2
Fimbristylis spadicea	1	1	4	3	3	2
Scirpus americanus	2	--	--	--	--	1
Scirpus validus	--	1	--	--	--	--
Croton punctatus	--	1	--	--	--	--
Euphorbia polygonifolia	--	4	4	6	--	2
Daubentonia punicea *	--	--	--	--	4	8
Sesbania exaltata	--	--	3	2	--	--
Strophostyles helvola	28	17	11	7	9	6
Sabatia stellaris	--	--	--	--	< 1	2
Smilax auriculata	--	--	--	3	< 1	--
Smilax bona-nox	--	--	--	--	2	--
Yucca filamentosa	--	1	--	25	2	--
Lythrum lineare	--	--	--	--	< 1	--
Myrica cerifera *	--	--	--	--	15	4
Oenothera humifusa	--	6	4	9	4	2
Oenothera laciniata	--	--	1	--	1	--
Phytolacca americana	--	--	2	--	1	3
Limonium carolinianum	--	--	--	--	--	1
Andropogon virginicus	--	--	1	7	6	7
Cenchrus tribuloides	--	6	4	--	--	--
Chloris petraea	--	1	1	9	3	2
Cynodon dactylon	9	11	--	--	--	--
Digitaria sanguinalis	30	2	--	--	2	--
Distichlis spicata	6	4	1	--	5	9
Eleusine indica	--	1	--	--	--	--

Table B4 (concluded)

Species	Surface Age (yrs) 1	2	3	4	5	6
Eragrostis sp.	--	--	--	1	--	--
Festuca octoflora	--	--	1	--	--	--
Panicum virgatum	--	--	2	4	1	--
Paspalum distichum	11	1	1	--	--	4
Phragmites communis	8	5	--	--	--	1
Setaria geniculata	--	3	1	1	--	--
Spartina alterniflora	11	1	--	--	< 1	--
Spartina patens	23	29	17	45	39	23
Triplasis purpurea	2	13	25	6	7	4
Uniola paniculata	--	--	7	1	--	--
Polygonum sp.	--	--	--	--	--	1
Rumex acetosella	--	--	--	1	--	--
Portulaca sp.	--	1	--	--	--	--
*Prunus serotina**	--	--	--	--	1	--
Rubus sp.	--	--	--	1	--	--
Rubus flagellaris	--	--	2	--	--	--
Diodia teres	--	4	5	2	2	1
Galium hispidulum	1	1	--	--	1	--
Galium tinctorium	--	--	1	--	--	2
Agalinis purpurea	--	--	1	--	--	--
Physalis viscosa	3	10	4	4	3	1
Lippia nodiflora	--	--	--	2	2	--
Verbena sp.	--	--	--	--	--	1
Ampelopsis arborea	--	--	2	--	--	1
Number of plots sampled	61	89	62	34	67	36

Table B5

Importance Values for Plant Species Occurring Along Transects Across Inner Swales on Diked Dredged Material Islands[a]

Species	Surface Age (yrs) 1	2	3	4	5	6
Sesuvium portulacastrum	--	6	--	--	--	--
Rhus radicans	--	--	1	--	--	--
Hydrocotyle bonariensis	--	9	4	--	--	--
Ptilimnium capillaceum	--	--	2	2	--	--
Cynanchum palustre	--	1	--	--	--	3
Aster subulatus	--	--	50	62	--	--
Aster tenuifolius	--	--	--	--	--	1
Baccharis halimifolia*	--	113	10	70	--	20
Borrichia frutescens*	--	1	--	--	--	92
Erigeron canadensis	--	--	5	10	--	2
Erigeron quercifolius	--	1	--	--	--	--
Eupatorium capillifolium	--	--	7	13	--	--
Eupatorium serotinum	--	2	--	4	--	--
Gnaphalium purpureum	--	--	--	--	--	2
Heterotheca subaxillaris	39	4	3	11	--	4
Iva frutescens*	--	--	96	62	--	19
Lactuca canadensis	--	--	3	3	--	--
Solidago sempervirens	35	13	6	2	--	13
Sonchus oleraceus	--	5	--	2	--	--
Atriplex arenaria	--	--	1	--	--	--
Atriplex patula	--	8	--	--	--	--
Chenopodium ambrosioides	--	20	6	10	--	--
Salicornia virginica	--	--	--	--	35	2
Salsola kali	--	1	--	--	--	--
Juniperus virginiana*	--	--	--	--	--	2
Cyperus sp.	--	2	--	--	--	5
Cyperus compressus	--	2	--	--	--	--
Cyperus filicinus	7	--	--	--	--	--
Fimbristylis spadicea	14	--	--	--	--	8
Euphorbia polygonifolia	--	5	--	--	--	2
Sesbania exaltata	--	--	7	5	--	--
Strophostyles helvola	7	3	18	--	--	--

[a] Importance values are combined values for relative frequency and relative cover (200 maximum). Importance values for shrubs* include relative density (300 maximum).

Table B5 (concluded)

Species	Surface Age (yrs)					
	1	2	3	4	5	6
Sabatia stellaris	--	--	1	--	--	--
Juncus roemerianus	--	1	--	--	--	--
Myrica cerifera*	--	--	--	--	--	10
Oenothera biennis	--	2	--	--	--	--
Oenothera humifusa	7	--	--	--	--	4
Phytolacca americana	7	8	2	7	--	--
Limonium carolinianum	--	--	--	--	--	4
Andropogon virginicus	--	--	--	2	--	8
Cenchrus tribuloides	7	3	--	--	--	--
Chloris petraea	12	--	--	--	--	4
Digitaria sanguinalis	24	3	1	--	--	--
Distichlis spicata	8	2	--	--	13	44
Echinochloa crusgalli	--	1	--	--	--	--
Eleusine indica	--	27	--	--	--	--
Festuca octoflora	--	1	--	--	--	--
Panicum dichotomiflorum	--	--	1	--	--	--
Panicum virgatum	--	6	14	--	--	2
Paspalum distichum	--	5	1	--	--	1
Paspalum vaginatum	--	--	3	--	--	--
Phragmites communis	--	--	10	31	--	--
Setaria geniculata	--	9	1	--	--	--
Spartina alterniflora	--	--	--	--	132	--
Spartina patens	12	25	26	--	20	50
Triplasis purpurea	21	3	17	--	--	1
Rumex acetosella	--	--	--	3	--	--
Diodia teres	--	5	--	--	--	--
Galium sp.	--	1	--	--	--	--
Physalis viscosa	--	--	--	--	--	2
Unknown herbaceous species	--	--	--	3	--	--
Number of plots sampled	67	82	65	19	11	33

Table B6

Importance Values for Plant Species Occurring Along Transects Across Dozer Scrapes on Diked Dredged Material Islands[a]

Species	Surface Age (yrs) 1	2	3	4	5
Hydrocotyle bonariensis	--	--	--	1	2
Ptilimnium capillaceum	--	--	--	--	6
Ambrosia artemisiifolia	--	--	--	6	6
Baccharis angustifolia*	--	--	--	3	4
Baccharis halimifolia*	--	--	--	111	24
Carduus sp.	--	--	--	1	--
Carduus smallii	--	--	--	--	1
Erigeron canadensis	--	--	18	8	10
Erigeron quercifolius	--	--	--	3	3
Erigeron strigosus	--	--	--	--	< 1
Eupatorium capillifolium	--	--	--	6	2
Eupatorium serotinum	--	--	--	--	< 1
Gnaphalium purpureum	8	--	--	< 1	1
Heterotheca subaxillaris	43	38	39	14	10
Iva frutescens*	--	--	--	--	4
Iva imbricata*	--	129	138	--	--
Lactuca sp.	--	--	15	--	--
Lactuca canadensis	--	5	--	--	--
Solidago altissima	--	--	--	< 1	--
Solidago sempervirens	15	--	--	11	12
Cakile harperi	--	--	--	--	< 1
Lepidium virginicum	--	--	--	< 1	1
Stellaria media	--	--	--	--	1
Chenopodium ambrosioides	--	--	--	--	2
Commelina communis	--	--	--	< 1	< 1
Juniperus virginiana*	--	--	--	--	1
Fimbristylis spadicea	16	--	--	5	5
Scirpus americanus	15	--	--	--	1
Euphorbia polygonifolia	--	22	--	< 1	--
Strophostyles helvola	--	22	33	--	2
Sabatia stellaris	--	--	--	< 1	1
Juncus megacephalus	--	--	--	1	3
Hypericum sp.	--	--	--	< 1	--

[a] Importance values are combined values for relative frequency and relative cover (200 maximum). Importance values for shrubs* include relative density (300 maximum).

Table B6 (continued)

Species	Surface Age (yrs)				
	1	2	3	4	5
Smilax auriculata	--	--	--	4	< 1
Smilax bona-nox	--	--	--	--	4
Yucca filamentosa	--	--	--	--	< 1
Lythrum lineare	--	--	--	5	2
Myrica cerifera*	--	--	--	5	80
Oenothera biennis	--	--	--	--	< 1
Oenothera humifusa	--	--	--	11	5
Ludwigia palustris	--	--	--	< 1	--
Spiranthes vernalis	--	--	--	--	< 1
Pinus taeda*	--	--	--	--	< 1
Poaceae sp.	--	--	--	1	--
Andropogon scoparius	--	--	--	3	--
Andropogon virginicus	--	--	--	27	16
Aristida stricta	--	--	--	2	--
Cenchrus tribuloides	--	25	9	--	--
Chloris petraea	--	--	--	14	5
Cynodon dactylon	--	--	--	< 1	--
Eragrostis sp.	--	--	--	--	5
Eragrostis capillaris	--	--	--	3	1
Festuca octoflora	--	--	--	--	< 1
Panicum sp.	--	--	--	--	< 1
Panicum amarum	--	--	--	--	< 1
Panicum clandestinum	8	--	--	--	--
Panicum virgatum	--	--	--	--	3
Phragmites communis	--	--	--	< 1	--
Spartina patens	40	8	28	29	49
Triplasis purpurea	55	52	20	12	6
Uniola paniculata	--	--	--	1	< 1
Poaceae sp.	--	--	--	--	1
Diodia teres	--	--	--	3	< 1
Galium sp.	--	--	--	--	1
Galium hispidulum	--	--	--	2	< 1
Salix nigra	--	--	--	1	7
Agalinis fasciculata	--	--	--	1	1
Physalis viscosa	--	--	--	2	1
Solanum gracile	--	--	--	< 1	--
Typha angustifolia	--	--	--	1	< 1

Table B6 (concluded)

Species	Surface Age (yrs) 1	2	3	4	5
Lippia nodiflora	--	--	--	<1	<1
Verbena scabra	--	--	--	<1	--
Ampelopsis arborea	--	--	--	--	<1
Unknown herbaceous species	--	--	--	<1	<1
Number of plots sampled	37	6	7	71	95

Table B7

Importance Values for Plant Species Occurring Along Transects Across Borrow Pits on Diked Dredged Material Islands[a]

Species	Surface Age (yrs) 1	2	3
Erigeron canadensis	27	6	--
Heterotheca subaxillaris	--	8	--
Lepidium virginicum	--	4	--
Salsola kali	--	2	--
Commelina communis	--	4	7
Fimbristylis spadicea	27	--	--
Euphorbia polygonifolia	--	17	13
Strophostyles helvola	--	28	3
Oenothera humifusa	27	12	6
Distichlis spicata	93	9	--
Spartina patens	27	23	56
Triplasis purpurea	--	44	57
Uniola paniculata	--	7	21
Diodia teres	--	34	10
Physalis viscosa	--	4	--
Number of plots sampled	14	26	13

[a] Importance values are combined values for relative frequency and relative cover (200 maximum). Importance values for shrubs include relative density (300 maximum).

Table B8

Importance Values for Plant Species Occurring Along Transects Across Central Flats on Diked Dredged Material Islands[a]

Species	Surface Age (yrs) 1	2	3	4
Rhus radicans	--	--	1	--
Amaranthus cannabinus	--	3	--	--
Ambrosia artemsiifolia	--	--	--	2
Hydrocotyle bonariensis	--	<1	1	--
Aster subulatus	--	39	104	13
Carduus sp.	--	--	1	--
*Baccharis halimifolia**	--	8	49	147
*Borrichia frutescens**	--	99	83	--
Erechtites hieracifolia	--	<1	--	4
Erigeron canadensis	--	1	14	11
Eupatorium capillifolium	--	1	8	16
Eupatorium serotinum	--	1	9	1
Heterotheca subaxillaris	--	1	2	7
*Iva frutescens**	--	--	5	6
Lactuca canadensis	--	14	--	--
Mikania scandens	--	--	--	4
Pluchea purpurascens	--	--	--	2
Solidago sempervirens	--	2	6	16
Solidago altissima	--	--	2	--
Sonchus asper	--	--	--	1
Sonchus oleraceus	--	5	--	4
Chenopodium album	--	1	4	--
Chenopodium ambrosioides	--	4	6	2
Salicornia virginica	--	<1	1	--
Ipomoea sagittata	--	5	--	--
Cyperus compressus	--	<1	1	--
Fimbristylis spadicea	--	--	--	19
Scirpus americanus	--	--	--	20
Scutellaria sp.	--	--	--	1
Myrica cerifera *	--	--	--	4
Oenothera humifusa	--	--	--	1
Phytolacca americana	--	14	1	1

[a] Importance values are combined values for relative frequency and relative cover (200 maximum). Importance values for shrubs* include relative density (300 maximum).

Table B8 (concluded)

Species	Surface Age (yrs) 1	2	3	4
Andropogon virginicus	--	--	--	2
Cynodon dactylon	--	<1	--	--
Digitaria sanguinalis	--	1	--	--
Distichlis spicata	--	--	--	1
Echinochloa crusgalli	--	--	--	1
Elymus virginicus	--	2	--	--
Panicum virgatum	--	<1	--	--
Phragmites communis	--	83	--	--
Spartina alterniflora	--	2	--	--
Spartina patens	--	3	--	1
Triplasis purpurea	--	1	2	10
Polygonum lapathifolium	--	2	--	--
Rubus flagellaris	--	4	--	--
Salix nigra*	--	--	--	4
Solanum americanum	--	3	--	--
Celtis laevigata*	--	<1	--	2
Unknown herbaceous species		1		1
Number of plots sampled	20	161	63	63

Table B9

Importance Values for Plant Species Occurring Along Transects Across Slopes and Domes on Diked Dredged Material Islands[a]

Species	Surface Age (yrs) 1	2	3	4	5	6
Sesuvium portulacastrum	--	1	--	--	--	--
Rhus radicans	--	--	--	--	--	--
Ambrosia artemisiifolia	--	--	3	1	--	1
Aster subulatus	--	--	--	2	--	--
*Baccharis halimifolia**	--	--	101	--	--	44
*Borrichia frutescens**	--	--	--	--	92	62
Carduus sp.	--	--	--	--	--	--
Coreopsis lanceolata	--	--	--	--	3	--
Erechtites hieracifolia	--	--	--	--	--	1
Erigeron canadensis	37	19	13	25	16	6
Eupatorium capillifolium	--	--	1	16	--	7
Eupatorium serotinum	--	--	6	--	--	--
Gnaphalium obtusifolium	--	--	--	--	--	<1
Gnaphalium purpureum	--	--	--	--	--	1
Heterotheca subaxillaris	15	16	20	27	42	30
*Iva frutescens**	--	--	--	--	--	2
Lactuca canadensis	--	--	--	1	--	--
Solidago altissima	--	--	--	--	--	--
Solidago sempervirens	--	--	7	13	22	17
Sonchus asper	--	--	--	--	--	--
Sonchus oleraceus	--	--	--	--	--	--
Cakile harperi	--	1	--	--	--	--
Stipulicida setacea	--	--	--	5	--	--
Atriplex arenaria	--	--	1	--	--	--
Chenopodium album	--	--	1	--	--	--
Chenopodium ambrosioides	--	1	1	2	--	7
Salsola kali	--	3	--	--	--	--
Commelina communis	--	8	3	--	--	--
Carex sp.	--	--	1	--	--	--
Cyperus sp.	--	--	--	--	--	1
Cyperus strigosus	--	--	--	1	--	--
Fimbristylis spadicea	4	1	--	--	12	--
Scirpus americanus	--	--	--	--	--	4

[a] Importance values are combined values for relative frequency and relative cover (200 maximum). Importance values for shrubs* include relative density (300 maximum).

Table B9 (continued)

Species	Surface Age (yrs)					
	1	2	3	4	5	6
Euphorbia polygonifolia	7	17	10	--	--	1
Daubentonia punicea*	--	--	17	102	--	--
Sesbania exaltata	--	--	2	4	--	--
Strophostyles helvola	--	--	6	21	--	54
Myrica cerifera*	--	101	--	2	--	--
Oenothera humifusa	26	21	10	--	--	8
Oenothera laciniata	--	1	--	--	--	--
Phytolacca americana	--	--	2	--	--	--
Andropogon virginicus	--	--	--	--	--	19
Cenchrus tribuloides	--	3	--	--	--	--
Chloris petraea	3	1	--	--	--	1
Cynodon dactylon	--	--	--	--	--	4
Digitaria sanguinalis	--	--	--	--	3	--
Distichlis spicata	3	1	--	--	5	--
Echinochloa crusgalli	--	--	1	--	--	--
Eleusine indica	--	--	1	--	--	--
Elymus virginicus	--	--	--	--	3	--
Eragrostis capillaris	--	--	1	2	--	5
Panicum sp.	--	--	--	--	4	<1
Panicum amarulum	--	--	--	1	--	--
Panicum dichotomiflorum	--	--	14	5	--	1
Panicum virgatum	--	--	6	32	--	1
Paspalum vaginatum	--	--	1	--	--	--
Phragmites communis	13	5	5	10	--	--
Setaria geniculata	--	--	--	--	1	--
Spartina alterniflora	3	--	1	--	1	--
Spartina patens	6	6	3	--	25	9
Triplasis purpurea	55	48	45	29	--	9
Uniola paniculata	7	32	--	--	--	--
Polygonum sp.	--	--	--	--	3	--
Rumex acetosella	--	--	--	3	--	--
Prunus serotina*	--	--	--	--	--	2
Rubus flagellaris	--	--	--	--	--	--
Diodia teres	--	12	13	--	--	--
Salix nigra*	--	--	--	--	68	--
Solanum americanum	--	--	--	--	--	<1
Celtis laevigata*	--	--	--	--	--	--

Table B9 (concluded)

Species	Surface Age (yrs)					
	1	2	3	4	5	6
Parthenocissus quinquefolia	--	--	1	--	--	--
Vitis aestivalis	--	--	--	--	--	2
Unknown seedling	13	--	2	--	--	--
Number of plots sampled	241	333	249	76	28	82

Table B10

Importance Values for Plant Species Occurring Along Transects Across Lower Drift Ridges on Undiked Dredged Material Islands[a]

Species	Surface Age (yrs) 4	5	7	40
Aster tenuifolius	--	3	--	--
Baccharis angustifolia*	--	--	25	--
Baccharis halimifolia*	3	--	48	--
Borrichia frutescens*	71	32	57	132
Carduus sp.	2	--	--	--
Erigeron canadensis	4	3	--	--
Heterotheca subaxillaris	2	11	--	--
Iva frutescens*	--	57	--	--
Iva imbricata*	65	89	--	--
Krigia sp.	--	1	--	--
Lactuca canadensis	--	2	4	--
Solidago sempervirens	15	33	35	32
Chenopodium album	--	2	--	--
Commelina communis	--	--	4	--
Fimbristylis spadicea	28	--	4	--
Scirpus americanus	15	--	16	--
Strophostyles helvola	8	42	17	--
Sabatia stellaris	--	--	4	--
Myrica cerifera*	--	--	11	--
Ammophila breviligulata	10	--	--	--
Distichlis spicata	13	7	--	--
Panicum amarulum	29	11	--	--
Panicum virgatum	--	--	44	--
Spartina alterniflora	--	--	--	25
Spartina patens	19	6	13	22
Triplasis purpurea	--	3	--	90
Uniola paniculata	15	--	--	--
Agalinis fasciculata	--	--	17	--
Number of plots sampled	13	26	4	2

[a] Importance values are combined values for relative frequency and relative cover (200 maximum). Importance values for shrubs* include relative density (300 maximum).

Table B11

Importance Values for Plant Species Occurring Along Transects Across Lower Swales on Undiked Dredged Material Islands[a]

	Surface Age (yrs)		
Species	3	4	7
Ptilimnium capillaceum	--	1	--
Aster tenuifolius	--	--	2
Baccharis angustifolia*	--	1	--
Baccharis halimifolia*	--	107	--
Borrichia frutescens*	--	10	120
Carduus sp.	--	1	--
Erigeron canadensis	--	5	--
Gaillardia pulchella	--	2	--
Heterotheca subaxillaris	--	3	--
Iva frutescens*	--	1	--
Iva imbricata*	--	14	--
Lactuca canadensis	--	1	--
Solidago sempervirens	--	17	17
Sonchus asper	--	2	--
Cakile harperi	61	--	--
Lepidium virginicum	--	1	--
Salicornia virginica	--	--	5
Commelina virginica	--	1	--
Calystegia sepium	--	1	--
Fimbristylis spadicea	--	27	42
Scirpus americanus	--	30	2
Strophostyles helvola	--	8	--
Vicia sativa	--	5	--
Limonium carolinianum	--	1	13
Ammophila breviligulata	--	12	--
Andropogon virginicus	--	5	--
Cenchrus tribuloides	139	--	--
Distichlis spicata	--	10	5
Elymus virginicus	--	1	--
Panicum amarulum	--	7	--
Panicum virgatum	--	--	8
Spartina alterniflora	--	1	3

[a] Importance values are combined values for relative frequency and relative cover (200 maximum). Importance values for shrubs* include relative density (300 maximum).

Table B11 (concluded)

Species	Surface Age (yrs) 3	4	7
Spartina patens	--	25	82
Triplasis purpurea	--	1	--
Uniola paniculata	--	1	--
Agalinis sp.	--	1	--
Number of plots sampled	2	35	9

Table B12

Importance Values for Plant Species Occurring Along Transects Across Upper Drift Ridges on Undiked Dredged Material Islands[a]

Species	Surface Age (yrs) 3	4	7	8	9
Hydrocotyle bonariensis	--	--	2	--	--
Baccharis halimifolia*	--	--	--	17	--
Borrichia frutescens*	--	--	83	147	--
Erigeron canadensis	--	18	--	--	--
Eupatorium sp.	--	2	--	--	--
Gnaphalium obtusifolium	--	1	2	--	--
Gnaphalium purpureum	--	--	2	--	--
Heterotheca subaxillaris	--	16	--	--	--
Iva frutescens*	--	--	--	70	28
Iva imbricata*	--	109	31	--	154
Lactuca canadensis	--	--	2	--	--
Solidago sempervirens	--	30	31	14	12
Sonchus asper	--	1	--	--	--
Cakile harperi	79	--	--	--	--
Atriplex patula	--	--	--	14	--
Commelina communis	--	--	5	--	--
Commelina virginica	--	2	--	--	--
Fimbristylis spadicea	--	10	13	--	--
Scirpus americanus	--	2	9	--	--
Strophostyles helvola	--	29	19	--	--
Myrica cerifera*	--	--	--	21	--
Oenothera humifusa	--	1	5	--	--
Ammophila breviligulata	--	2	--	--	--
Andropogon virginicus	--	--	9	--	--
Cenchrus tribuloides	97	--	--	--	--
Distichlis spicata	--	2	--	--	--
Panicum virgatum	--	--	10	17	--
Pennisetum glaucum	11	--	--	--	--
Phragmites communis	--	4	12	--	--
Spartina patens	--	56	51	--	106
Triplasis purpurea	--	12	--	--	--
Polygonum sp.	13	--	--	--	--

[a] Importance values are combined values for relative frequency and relative cover (200 maximum). Importance values for shrubs* include relative density (300 maximum).

Table B12 (concluded)

Species	Surface Age (yrs)				
	3	4	7	8	9
Agalinis fasciculata	--	--	12	--	--
Number of plots sampled	6	16	8	2	5

Table B13

Importance Values for Plant Species Occurring Along Transects Across Upper Swales on Undiked Dredged Material Islands[a]

Species	Surface Age (yrs)				
	3	4	7	8	9
Rhus radicans	--	--	--	4	--
Hydrocotyle bonariensis	--	--	2	--	--
Ambrosia artemisiifolia	--	1	4	2	--
Baccharis angustifolia*	--	--	43	--	--
Baccharis halimifolia*	--	41	22	--	23
Borrichia frutescens	--	--	22	92	12
Erigeron canadensis	--	14	5	2	--
Eupatorium sp.	--	2	--	--	--
Eupatorium capillifolium	--	--	5	--	--
Gnaphalium obtusifolium	--	<1	16	--	--
Heterotheca subaxillaris	--	7	--	--	--
Iva frutescens*	--	--	--	36	25
Iva imbricata*	--	53	--	--	116
Lactuca canadensis	--	<1	--	10	--
Solidago sempervirens	--	19	29	12	19
Sonchus asper	--	2	--	--	--
Cakile harperi	70	--	--	--	--
Lepidium virginicum	--	--	--	--	--
Atriplex arenaria	--	--	--	2	--
Commelina virginica	--	--	--	3	--
Calystegia sepium	--	1	--	--	--
	--	4	--	--	--
Juniperus virginiana*	--	--	--	2	--
Cyperus sp.	--	--	--	--	14
Cyperus compressus	--	--	--	--	7
Fimbristylis spadicea	--	18	8	2	--
Scirpus americanus	--	2	5	--	--
Euphorbia polygonifolia	--	2	--	--	--
Strophostyles helvola	--	8	23	5	--
Trifolium sp.	--	--	2	--	--
Kosteletskya virginica	--	<1	--	--	--
Myrica cerifera*	--	11	24	96	--
Oenothera humifusa	--	3	2	--	--
Ludwigia sp.	--	--	3	--	--

[a] Importance values are combined values for relative frequency and relative cover (200 maximum). Importance values for shrubs* include relative density (300 maximum).

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A COMPARISON OF PLANT SUCCESSION AND BIRD UTILIZATION ON DIKED --ETC(U)
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Table B13 (concluded)

Species	Surface Age (yrs) 3	4	7	8	9
Andropogon virginicus	--	<1	34	8	10
Cenchrus tribuloides	130	1	--	--	--
Digitaria sanguinalis	--	5	--	--	--
Distichlis spicata	--	1	--	--	--
Elymus virginicus	--	4	--	2	--
Panicum virgatum	--	--	9	9	--
Phragmites communis	--	62	5	--	--
Spartina alterniflora	--	1	--	--	--
Spartina patens	--	21	32	4	73
Triplasis purpurea	--	10	--	--	--
Prunus serotina*	--	--	--	7	--
Salix caroliniana*	--	3	--	--	--
Agalinis fasciculata	--	--	5	--	--
Physalis viscosa	--	--	--	2	--
Tamarix gallica*	--	2	--	--	--
Number of plots sampled	1	73	6	12	14

Table B14

Importance Values for Plant Species Occurring Along Transects Across Deposit Slopes on Undiked Dredged Material Islands[a]

Species	Surface Age (yrs) 3	4	5	7	8	9	11	40
Rhus copallina*	--	--	--	--	5	--	--	--
Rhus radicans	--	--	--	39	4	--	--	--
Ilex vomitoria*	--	--	--	--	1	--	--	--
Asplenium platyneuron	--	--	--	--	2	--	--	--
Ambrosia artemisiifolia	--	3	--	3	10	--	--	--
Aster pilosus	--	--	--	1	2	--	--	--
Aster tenuifolius	--	--	--	--	--	--	--	8
Baccharis halimifolia*	--	103	51	--	100	2	--	<1
Borrichia frutescens*	--	--	--	--	1	--	--	102
Erigeron canadensis	--	12	26	5	3	24	--	3
Eupatorium sp.	--	<1	--	--	--	--	--	--
Eupatorium capillifolium	--	<1	1	4	1	7	--	1
Gaillardia pulchella	--	2	--	--	4	--	--	--
Gnaphalium obtusifolium	--	2	--	--	--	--	--	--
Gnaphalium purpureum	--	--	--	3	--	1	--	--
Heterotheca subaxillaris	--	7	24	64	9	20	82	<1
Iva frutescens*	--	--	50	--	1	--	--	18
Iva imbricata*	--	--	--	13	--	144	--	--
Krigia sp.	--	3	--	--	--	--	--	--
Lactuca sp.	--	--	--	--	3	--	--	--
Lactuca canadensis	--	2	1	5	3	--	--	--
Lactuca hisuta	--	<1	--	--	--	--	--	--
Solidago altissima	--	--	--	--	2	--	--	--
Solidago sempervirens	--	12	25	29	10	56	--	7
Sonchus asper	--	1	--	--	--	--	--	--
Cakile harperi	--	<1	--	--	--	--	--	--
Lepidium virginicum	--	3	--	1	1	--	--	--
Salicornia virginica	--	--	--	--	--	--	--	6
Salsola kali	--	<1	--	--	--	--	--	--
Commelina communis	--	--	--	2	--	--	8	--
Juniperus virginiana*	--	--	--	--	--	--	--	<1
Carex albolutescens	--	--	--	--	--	--	--	<1

[a] Importance values are combined values for relative frequency and relative cover (200 maximum). Importance values for shrubs* include relative density (300 maximum).

Table B14 (continued)

Species	Surface Age (yrs)							
	3	4	5	7	8	9	11	40
Fimbristylis spadicea	--	1	--	2	--	--	--	8
Scirpus americanus	--	3	--	1	--	--	--	--
Euphorbia polygonifolia	--	4	--	4	--	--	--	--
Galactia macreei	--	--	--	--	--	--	--	<1
Strophostyles helvola	--	13	52	21	13	10	--	<1
Vicia sativa	--	<1	--	--	1	--	--	--
Juncus roemerianus	--	--	--	--	--	--	--	6
Yucca filamentosa	--	--	--	--	--	--	4	--
Kosteletskya virginica	--	--	--	--	--	--	--	<1
Myrica cerifera*	--	2	--	--	46	--	--	<1
Oenothera humifusa	--	5	--	11	--	--	36	--
Ludwigia sp.	--	--	--	1	--	--	--	--
Pinus taeda*	--	--	--	1	--	--	--	--
Limonium carolinianum	--	--	--	--	--	--	--	5
Poaceae sp.	--	1	--	2	--	--	--	--
Agrostis perennans	--	--	1	--	--	--	--	--
Andropogon virginicus	--	2	--	3	15	4	--	3
Cenchrus tribuloides	200	1	--	6	--	--	--	--
Chloris sp.	--	2	--	--	1	--	--	--
Chloris petraea	--	--	--	--	--	--	9	--
Distichlis spicata	--	--	<1	--	--	--	--	22
Elymus virginicus	--	1	--	--	--	--	--	--
Eragrostis capillaris	--	--	--	1	1	--	--	--
Festuca octoflora	--	2	--	--	--	--	--	38
Panicum amarulum	--	3	7	--	--	--	--	--
Panicum virgatum	--	--	--	--	10	--	5	14
Phragmites communis	--	54	--	20	--	--	--	--
Spartina alterniflora	--	--	--	--	--	--	--	5
Spartina patens	--	45	--	20	54	7	28	49
Triplasis purpurea	--	9	60	21	--	24	12	--
Uniola paniculata	--	--	--	4	--	--	--	--
Berchemia scandens	--	--	--	--	--	2	--	--
Prunus serotina*	--	--	--	--	1	--	--	--
Diodia teres	--	--	--	3	--	--	--	--
Galium hispidulum	--	--	--	--	--	--	4	--
Agalinis sp.	--	3	--	1	--	--	--	--
Agalinis fasciculata	--	--	--	3	--	--	--	2

Table B14 (concluded)

Species	Surface Age (yrs)							
	3	4	5	7	8	9	11	40
Agalinis purpurea	--	--	<1	--	--	--	--	--
Physalis viscosa	--	--	--	--	1	--	12	--
Verbena sp.	--	--	--	--	--	--	--	<1
Ampelopsis arborea	--	<1	--	1	--	--	--	<1
Parthenocissus quinquefolia	--	--	--	1	--	--	--	--
Unknown herbaceous species	--	1	--	--	--	--	--	--
Number of plots sampled	28	136	106	61	43	28	7	78

Table B15

Importance Values for Plant Species Occurring Along Transects Across Domes on Undiked Dredged Material Islands[a]

Species	Surface Age (yrs) 3	4	7	8	9	11
Rhus radicans	--	1	--	--	--	--
Erigeron canadensis	--	14	25	10	24	49
Eupatorium capillifolium	--	--	--	7	--	--
Gaillardia pulchella	--	--	--	4	--	--
Heterotheca subaxillaris	--	34	--	63	19	38
Solidago sempervirens	--	3	31	8	24	--
Campsis radicans	--	--	--	--	4	--
Lepidium virginicum	--	3	--	--	--	--
Euphorbia polygonifolia	--	8	--	--	--	--
Strophostyles helvola	--	3	4	3	13	--
Oenothera humifusa	--	25	30	32	--	26
Poaceae sp.	--	--	--	--	4	--
Agrostis perennans	--	1	--	--	--	--
Andropogon virginicus	--	--	21	--	17	--
Cenchrus tribuloides	--	4	--	--	--	--
Chloris sp.	--	8	--	--	--	--
Chloris petraea	--	--	--	--	--	9
Panicum amarulum	--	1	--	--	--	--
Spartina patens	--	18	9	28	--	32
Triplasis purpurea	--	73	55	45	95	38
Diodia teres	--	--	25	--	--	--
Physalis viscosa	--	3	--	--	--	9
Number of plots sampled	12	99	12	12	20	5

[a] Importance values are combined values for relative frequency and relative cover (200 maximum). Importance values for shrubs include relative density (300 maximum).

Table B16

Annotated List of Plant Species Found on Dredged Material Islands in North Carolina Estuaries

Aceraceae

[a]*Acer rubrum* L. Red maple. Occasional in mature maritime shrub thickets on undiked islands.

Aizoaceae

[b]**Sesuvium maritimum* (Walter) BSP. Sea purslane. Occasional on sandy, brackish soil flats and dikes.

**Sesuvium portulacastrum* L. Sea purslane. Occasional on sandy, brackish soil flats and dikes.

Amaranthaceae

Amaranthus cannabinus (L.) J. D. Sauer. Water-hemp. Infrequent in brackish to nearly fresh water perimeters and outer swales.

Alternanthera philoxeroides (Martius) Grisebach. Alligator weed. Infrequent component of drift material from rivers.

Iresine rhizomatosa Standley. Frequent in brackish soils of perimeters and outer swales.

Anacardiaceae

**Rhus copallina* L. Winged sumac. Frequent on older dikes and undiked slopes.

Rhus radicans L. Poison ivy. Frequent on older dikes and undiked slopes.

Apiaceae

**Hydrocotyle bonariensis* Lam. Pennyroyal. Abundant along outer swales and outer dike bases in brackish sandy soil.

**Ptilimnium capillaceum* (Michaux) Raf. Frequent in all brackish habitats.

Aquifoliaceae

Ilex vomitoria Aiton. Yaupon. Frequent on older dikes and mature shrub thickets.

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[a]Nomenclature follows that used in Radford, A. E., H. Ahles, and C. R. Bell. 1968. Manual of the vascular flora of the Carolinas. Univ. N. C. Press, Chapel Hill. 1183 pp.

[b]Species preceded by an asterisk (*) have been collected as voucher specimens.

Table B16 (continued)

Araliaceae

Aralia spinosa L. Devil's walking stick. Infrequent on old slopes of undiked islands.

Asclepiadaceae

*Cynanchum palustre (Pursh) Heller. Climbing milkweed. Common in all grass-shrub habitats.

Aspleniaceae

Asplenium platyneuron (L.) Oakes. Ebony spleenwort. Frequent herb under canopy of older maritime shrub thickets.

Asteraceae

*Ambrosia artemisiifolia L. Ragweed. Common in all open habitats not influenced by brackish water.

*Aster pilosus Willd. Frost aster. Frequent on older dikes and open slopes of undiked islands.

*Aster subulatus Michaux. Aster. Common to abundant in inner swales and central flats.

*Aster tenuifolius L. Marsh aster.

Baccharis angustifolia Michaux. False willow. Common in all young shrub thickets.

*Baccharis halimifolia L. Silverling. Abundant in all young shrub thickets.

*Borrichia frutescens (L.) DC. Sea oxeye. Abundant in most sandy brackish habitats and on dikes.

Carduus lanceolatus L. Bull thistle. Infrequent on grassy undiked slopes and infrequent in other dry habitats.

*Carduus smallii (Britton) Ahles. Thistle. Common on grassy undiked slopes.

Coreopsis lanceolata L. Coreopsis. Rare in dry, open sandy soil.

Eclipta alba (L.) Hasskarl. Rare in maritime shrub thickets.

*Erechtites hieracifolia (L.) Raf. Fireweed. Common in open grassy slopes and on dikes.

*Erigeron canadensis L. Horseweed. Abundant in all open habitats not influenced by brackish water.

Table B16 (continued)

*Erigeron quercifolius Lam. Daisy fleabane. Common in lightly shaled habitats of slopes and older dikes.

*Erigeron strigosus Muhl. ex Willd. Daisy fleabane. Infrequent in open grassy habitats.

*Eupatorium capillifolium (Lam.) Small. Dog-fennel. Common in all open upland habitats.

*Eupatorium serotinum Michaux. Thoroughwort. Common in central flats and inner swales.

*Gaillardia pulchella Foug. Ox-eye daisy. Common in open dry sandy soils.

*Gnaphalium obtusifolium L. Rabbit tobacco. Common along grassy slopes of undiked islands.

*Gnaphalium purpureum L. Everlasting. Common along grassy slopes of undiked islands.

*Heterotheca subaxillaris (Lam.) Britton & Rusby. Camphorweed. Abundant herbaceous dominant of dry sandy soils.

*Iva frutescens L. Marsh elder. Abundant in shrub habitats in brackish soil habitats.

*Iva imbricata Walter. Common along dryer slopes and older dikes.

*Lactuca canadensis L. Wild lettuce. Common on grassy slopes of undiked islands and frequent on central flats of diked islands.

Lactuca hirsuta Muhl. Wild lettuce. Infrequent in shrub thicket borders.

*Mikania scandens (L.) Willd. Climbing hempweed. Common in moist shrub habitats.

Pluchea purpurascens (Swartz) DC. Camphorweed. Common on older undiked slopes and in dozer scrapes.

*Pyrrhopappus carolinianus (Walter) DC. Infrequent in early summer along open grassy slopes.

Solidago altissima L. Infrequent along older open grassy slopes.

*Solidago sempervirens L. Seaside goldenrod. Abundant in all habitats.

Sonchus asper (L.) Hill. Spiny-leaved sow-thistle. Uncommon in central flats and inner swales.

Sonchus oleraceus L. Common sow-thistle. Common in central flats and inner swales.

Bignoniaceae

Campsis radicans (L.) Seeman. Trumpet creeper. Infrequent along maritime shrub thicket borders.

Brassicaceae

*Cakile harperi Small. Sea rocket. Common early successional herb of sandy drift ridges.

*Lepidium virginicum L. Pepper grass. Common herb in upland sands.

Cactaceae

Opuntia compressa (Salisbury) Macbride. Prickly pear. Frequent along upper slopes and domes of open, undiked sites.

Campanulaceae

Specularia perfoliata (L.) A. DC. Venus' looking-glass. Infrequent in low, grassy, moist (freshwater) sands.

Caprifoliaceae

Lonicera japonica Thunberg. Japanese honeysuckle. Infrequent in openings in mature maritime shrub thickets on undiked islands.

Sambucus canadensis L. Elderberry. Infrequent near moist, freshwater situations with other shrubs or tall herbs.

Caryophyllaceae

Stellaria media (L.) Cyrillo. Chickweed. Rare in moist shaded shrub thickets and openings in upper slopes and domes of old undiked islands.

Stipulicida setacea Michaux. Pinweed. Infrequent in dry upland sands.

Chenopodiaceae

*Atriplex arenaria Nuttall. Seabeach orach. Common on young, sandy soils.

*Atriplex patula L. Orach. Common on young, sandy soils.

Chenopodium album L. Pigweed. Common on young upland sands.

*Chenopodium ambrosioides L. Mexican-tea. Common in young upland sands of dikes and slopes.

Salicornia bigelovii Torrey. Glasswort. Rare in north coastal saline swales.

Salicornia virginica L. Glasswort. Common in outer swales and salt marshes.

Salsola kali L. Russian thistle. Common in north coastal young, sandy, upland soils; rare elsewhere.

*Suaeda linearis (Ell.) Moq. Common in saline soils of dikes and swales.

Commelinaceae

*Commelina communis L. Dayflower. Common in young sandy soils of dikes and slopes.

Commelina virginica L. Dayflower. Uncommon in shaded shrub habitats in upland situations.

Convolvulaceae

*Calystegia sepium (L.) R. Brown. Hedge bindweed. Uncommon in upland shrub thickets.

*Ipomoea sagittata Cav. Morning glory. Common in upland shrub thickets.

Cucurbitaceae

Melothria pendula L. Creeping cucumber. Rare in shaded old upland shrub thickets.

Cupressaceae

Juniperus virginiana L. Red cedar. Common on older undiked deposits containing much shell.

Cyperaceae

*Carex albolutescens Schweinitz. Sedge. Infrequent in moist freshwater swales.

Cyperus compressus L. Sedge. Frequent in silty soils.

Cyperus esculentus L. Nut grass. Infrequent in silty soils.

Cyperus filicinus Vahl. Sedge. Infrequent in silty soils of inner swales and central flats.

*Cyperus odoratus L. Sedge. Infrequent in silty soils of inner swales and central flats.

*Cyperus strigosus L. Sedge. Frequent in dry to moist soils of dikes and inner swales.

*Fimbristylis spadicea (L.) Vahl. Abundant.

*Scirpus americanus Persoon. Infrequent in moist, freshwater soils.

*Scirpus robustus Pursh. Frequent in outer swales and perimeters.

*Scirpus validus Vahl. Rare in brackish big marsh swales and perimeters.

Euphorbiaceae

*Croton punctatus Jacquin. Croton. Common on older dikes and lower slopes.

*Euphorbia polygonifolia L. Spurge. Common on dikes and sparsely vegetated lower slopes.

Fabaceae

*Amorpha fruticosa L. Amorpha. Infrequent on dikes and older outer swales.

*Daubentonia punicea (Cav.) DC. Partridge pea. Common on dikes and inner swales.

*Galactia macreei M. A. Curtis. Common on dikes.

*Sesbania exaltata (Raf.) Rydberg ex A. W. Hill. Sesbania. Infrequent in inner swales.

*Strophostyles helvola (L.) Ell. Beach pea. Common throughout.

Vicia angustifolia Reichard. Vetch. Uncommon in shaded habitation in the spring.

Vicia sativa L. Vetch. Uncommon in shaded habitats in the spring.

Fagaceae

Quercus virginiana Miller. Live oak. Common on domes and slopes of old undiked sites.

Gentianaceae

*Sabatia stellaris Pursh. Sabatia. Common in wet, grassy dozer scrapes and inner swales.

Juncaceae

Juncus coriaceus Mackenzie. Uncommon in wet dozer scrapes.

*Juncus roemerianus Scheele. Black needle rush. Common high marsh species of outer swales and perimeters.

Juncaginaceae

*Triglochin striata R. & P. Arrow grass. Rare or frequently overlooked salt marsh species of outer swales and perimeters.

Lauraceae

Persea borbonia (L.) Sprengel. Red bay. Uncommon on old, undiked islands.

Sassafras albidum (Nuttall) Nees. Sassafras. Uncommon on old, undiked islands.

Liliaceae

Smilax auriculata Walter. Common on old undiked slopes and domes.

*Smilax bona-nox L. Common on old undiked slopes and domes.

*Yucca filamentosa L. Bear grass. Common on older slopes and dikes.

Lythraceae

*Lythrum lineare L. Loosestrife. Common in moist dozer scrapes.

Malvaceae

*Kosteletskya virginica (L.) Presl. Seashore mallow. Common high marsh species of outer swales and other mildly brackish situations.

Moraceae

Morus rubra L. Red mulberry. Uncommon in older shrub thickets on undiked islands.

Myricaceae

*Myrica cerifera L. Wax myrtle. Common throughout.

Myrica pensylvanica Loisel. Bayberry. Uncommon in northern coastal sections on older islands.

Onagraceae

*Gaura angustifolia Michaux. Infrequent on older dikes.

Oenothera biennis L. Primrose. Infrequent on older dikes and lower slopes.

*Oenothera humifusa Nuttall. Seaside primrose. Common throughout in open, dry sandy soils.

Table B16 (continued)

Oenothera laciniata Hill. Primrose. Uncommon on grassy dikes and slopes.

Oenothera perennis L. Sundrops. Uncommon on grassy dikes and slopes.

Orchidaceae

*Spiranthes vernalis Engelm. & Gray. Spring ladies' tresses. Uncommon in low, grassy, moist, freshwater situations.

Phytolaccaceae

*Phytolacca americana L. Pokeweed. Common throughout upland situations.

Pinaceae

Pinus taeda L. Loblolly pine. Common dominant on old undiked islands.

Plumbaginaceae

*Limonium carolinianum (Walter) Britton. Sea lavender. Common salt marsh species of outer swales and perimeters.

Poaceae

Agrostis perennans (Walter) Tuckerman. Bent grass. Uncommon in thickets and borders.

Ammophila breviligulata Fernald. Beach grass. Uncommon with sea oats (Uniola paniculata) in dune habitats.

Andropogon scoparius Michaux. Little bluestem. Uncommon on slopes of undiked islands.

*Andropogon virginicus L. Broom sedge. Common in moist freshwater soils.

*Brachiaria platyphylla (Grisebach) Nash. Rare; one location on 2-year dike.

*Cenchrus tribuloides L. Sandspur. Common in loose sands of dikes and slopes.

*Chloris petraea Swartz. Finger grass. Common in sands of slopes.

*Cynodon dactylon (L.) Persoon. Bermuda grass. Uncommon on sandy dikes and slopes.

*Digitaria sanguinalis (L.) Scopoli. Crab grass. Frequent on dikes and sandy swales.

*Dichtichlis spicata (L.) Greene. Salt grass. Common high marsh species of outer swales, or other saline situations.

*Echinochloa colonum (L). Link. Uncommon in moist areas influenced by fresh water.

*Echinochloa crusgalli (L.) Beauvois. Barnyard grass. Uncommon on fairly sandy low slopes and sandy central flats.

*Eleusine indica (L.) Gaertner. Goose grass. Common in sandy flats and lower slopes.

*Elymus virginicus L. Wild rye-grass. Frequent in grassy swales and dikes.

*Eragrostis capillaris (L.) Nees. Love grass. Common in dry sands of lower slopes and dozer scrapes.

Festuca octoflora Walter. Fescue. Common in mixed dense grasses of lower slopes and dikes.

Lolium multiflorum Lam. Rye-grass. Uncommon along grassy dikes and lower slopes.

Melica mutica Walter. Melic grass. Uncommon along grassy dikes and lower slopes.

Muhlenbergia capillaris (Lam.) Trinius. Uncommon on shaded slopes and thickets.

*Panicum amarum Ell. Common but sporadic on dikes and slopes.

Panicum amarulum Hitchcock & Chase. Uncommon in dry inner swales and lower slopes.

Panicum clandestinum L. Infrequent along older shrub thicket borders in areas escaping brackish water.

*Panicum dichotomiflorum Michaux. Common on sandy flats and dikes.

*Panicum virgatum L. Common throughout.

*Paspalum distichum L. Uncommon in inner dike slopes and ridges.

Paspalum vaginatum Swartz. Uncommon mildly brackish to freshwater aquatic or on moist soils.

*Phragmites communis Trinius. Common reed. Common throughout, especially silty-sandy central flats.

*Setaria geniculata (Lam.) Beauvois. Foxtail grass. Common on grassy dikes and lower slopes.

Setaria magna Grisebach. Giant foxtail grass. Uncommon in sandy-silty inner swales and central flats.

*Spartina alterniflora Loisel. Smooth cordgrass. Common marsh grass of outer swales and perimeters.

*Spartina cynosuroides (L.) Roth. Giant cordgrass. Infrequent in central flats and inner swales.

*Spartina patens (Aiton) Muhl. Salt meadow cordgrass. Common throughout.

Stenotophrum secundatum (Walter) Kuntze. St. Augustine grass. Rare; found on one dike.

*Triplasis purpurea (Walter) Chapman. Sand grass. Common dominant or co-dominant of dry sandy slopes.

*Uniola paniculata L. Sea oats. Common on shifting dune-like slopes of older islands.

Polygonaceae

Polygonum sp. Knotweed. Uncommon in moist sandy soils.

Polygonum lapathifolium L. Knotweed. Uncommon in central flats.

*Polygonum pennsylvanicum L. Knotweed. Uncommon in moist sandy soils.

*Polygonum persicaria L. Knotweed. Uncommon in moist sandy soils.

Polygonum punctatum Ell. Knotweed. Infrequent in moist fresh-water inner swales.

Rumex acetosella L. Sour-grass. Common spring species of lower slopes and older dikes.

Rumex crispus L. Sorrel. Uncommon on older undiked slopes.

Rumex hastatulus Baldwin ex Ell. Sorrel. Uncommon on older, shaded lower dike slopes.

*Rumex verticillatus L. Swamp dock. Uncommon in older inner swales.

Rhammaceae

Berchemia scandens (Hill) K. Koch. Rattan. Uncommon in well developed maritime thickets.

Rosaceae

Prunus serotina Ehrhart. Black cherry. Uncommon on older dikes; more common on older slopes and domes of undiked deposits.

*Rubus flagellaris Willd. Dewberry. Common on dikes and dry outer swales and lower slopes of older undiked islands.

Rubiaceae

*Diodia teres Walter. Poor Joe. Common in dry sands of dikes and slopes.

*Galium hispidulum Michaux. Bedstraw. Infrequent in moist to somewhat dry soils of dozer scrapes and dikes.

*Galium tinctorium L. Bedstraw. Uncommon in shaded, moist areas.

Rutaceae

Zanthoxylum clava-herculis L. Hercules' club. Uncommon on slopes and domes of old undiked islands.

Salicaceae

*Salix nigra Marshall. Black willow. Infrequent in older freshwater swales and dozer scrapes.

Scrophulariaceae

Agalinis fasciculata (Ell.) Raf. Gerardia. Uncommon in moist dozer scrapes.

*Agalinis maritima (Raf.) Raf. Gerardia. Uncommon in moist, somewhat brackish sands.

Agalinis purpurea (L.) Pennell. Gerardia. Uncommon in moist, sandy, freshwater swale soils.

Linaria canadensis (L.) Dumont. Toad-flax. Infrequent spring and early summer herb of dryish, sandy soils.

Solanaceae

*Physalis viscosa (M. A. Curtis) Waterfall. Ground cherry. Common in sandy soils of dikes and lower slopes.

*Solanum americanum Miller. Uncommon on dikes.

Solanum carolinense L. Horse nettle. Uncommon on dikes.

*Solanum gracile Link. Uncommon on dikes.

Table B16 (continued)

Tamaricaceae

*Tamarix gallica L. Tamarisk. Rare and sporadically found in sandy soils of older slopes.

Typhaceae

Typha angustifolia L. Narrow-leaved cat-tail. Uncommon in brackish marsh.

Typha domingensis Persoon. Uncommon in brackish marsh.

Typha latifolia L. Common cat-tail. Uncommon in freshwater marsh.

Ulmaceae

Celtis laevigata Willd. Hackberry. Common on old undiked slopes.

Celtis occidentalis L. Sugarberry. Rare on old undiked slopes.

Urticaceae

Boehmeria cylindrica (L.) Swartz. False nettle. Uncommon in moist freshwater soils.

*Parietaria floridana Nuttall. Rare; one dike ridge.

Verbenaceae

Callicarpa americana L. American beauty-berry. Uncommon low shrub of old undiked islands.

*Lippia nodiflora (L.) Michaux. Frog fruit. Sporadic on dikes and moist dozer scrapes.

Verbena bonariensis L. Verbena. Infrequent in dikes and dozer scrapes.

Verbena brasiliensis Vellozo. Verbena. Uncommon on older dikes and grassy undiked island slopes.

*Verbena scabra Vahl. Verbena. Uncommon on older undiked slopes.

Vitaceae

Ampelopsis arborea (L.) Koehne. Pepper vine. Common woody vine of older diked and undiked shrubby areas.

*Parthenocissus quinquefolia (L.) Planchon. Virginia creeper. Common in shrub thickets of older undiked islands.

*Vitis aestivalis Michaux. Fall grape. Infrequent on older diked and undiked sites.

Table B16 (concluded)

Vitis rotundifolia Michaux. Muscadine. Infrequent on older diked and undiked sites.

APPENDIX C: BIRD DATA

Table C1

Summary of Fall Migrant Birds Associated with Undiked Dredged Material Islands in North Carolina Estuaries[a]

Species	Habitats						
	Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Live Thickets	Salt Marsh Fringe	Beach
Great blue heron	--	--	0.3	--	--	--	--
Green heron	--	--	--	--	0.4	--	--
Least bittern	--	--	--	--	--	0.7	--
American bittern	--	--	--	--	--	0.7	--
White ibis	--	--	--	--	--	0.7	0.2
Sharp-shinned hawk	--	--	--	--	0.9	--	--
Clapper rail	--	--	0.2	--	--	--	--
Semipalmated plover	0.5	--	--	--	--	--	1.9
Black-bellied plover	--	--	--	--	--	--	0.6
Short-billed dowitcher	--	--	--	--	--	--	0.3
Great black-backed gull	0.1	--	--	--	--	--	0.2
Herring gull	--	--	--	--	--	--	4.2
Laughing gull	--	--	--	--	--	--	4.3
Royal tern	1.1	--	--	--	--	--	5.8
Black skimmer	--	0.1	--	--	--	--	--
Mourning dove	--	0.5	1.1	--	1.4	--	--
Common flicker	--	0.1	--	--	1.8	--	--
Eastern phoebe	--	--	0.3	--	0.5	--	--
Blue jay	--	--	--	--	1.8	--	--
Fish crow	--	--	--	--	0.9	--	--
House wren	--	--	--	--	3.4	--	--
Wren (species unidentified)	--	--	0.5	--	0.4	--	--
Carolina wren	--	--	--	--	0.4	--	--
Long-billed marsh wren	--	--	--	--	0.2	--	--
Short-billed wren	--	--	0.2	--	0.5	0.7	--
Mockingbird	--	--	0.2	--	7.9	--	--
Catbird	--	--	--	--	3.4	--	--
Brown thrasher	--	--	--	--	0.7	--	--

[a]Values are in birds per hectare.

Table C1 (concluded)

Species	Habitats						
	Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Live Thickets	Salt Marsh Fringe	Beach
Warbler (species unidentified)	--	0.8	0.6	--	1.4	--	--
Yellow warbler	--	0.1	0.2	--	0.2	--	--
Yellow-rumped warbler	--	--	0.2	--	52.1	--	--
Prairie warbler	--	--	--	--	0.4	--	--
Palm warbler	--	0.5	0.3	--	2.0	--	--
Yellowthroat	--	0.1	0.3	12.9	6.1	0.7	--
Redstart	--	--	0.2	--	0.2	--	--
Meadowlark	--	0.4	--		0.4	--	--
Red-winged blackbird	--	--	--	48.4	0.4	0.7	--
Boat-tailed grackle	0.5	0.1	--	3.2	0.5	--	--
Grackle (species unidentified)	--	--	--	--	0.2	--	--
Cardinal	--	--	--	--	1.4	--	--
Painted bunting	--	--	--	--	0.4	--	--
Rufous-sided towhee	--	--	--	--	1.6	--	--
Sparrow (species unidentified)	0.5	1.6	2.9	3.2	1.3	1.4	--
Savannah sparrow	--	1.5	3.7	3.2	0.7	--	--
Sharp-tailed sparrow	--	--	--	--	0.4	0.7	--
Seaside sparrow	--	--	0.2	--	0.4	6.1	--
Field sparrow	--	--	--	--	0.4	--	--
Swamp sparrow	--	--	0.3	--	4.9	--	--
Song sparrow	--	--	0.6	6.5	2.3	--	--
Snow bunting	--	0.2	--	--	--	--	--
Total birds/hectare	2.6	6.1	12.3	77.4	102.3	12.4	17.5

Table C2

Summary of Fall Migrant Birds Associated with Diked and Not Filled Dredged Material Islands in North Carolina Estuaries[a]

Species	Habitats Similar to Those Occurring on Undiked Islands				Habitats Restricted to Diked Islands						
	Sparse Mixed Grasses	Dense Mixed Grasses	Mixed Grasses and Shrubs	Live Thickets	Dike, Sparse Grasses	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Dry	Interior Marsh	Interior Mudflat	Rubbish Pile
Pied-billed grebe	--	--	--	--	--	--	2.1	--	--	--	--
Great blue heron	0.2	--	--	--	--	0.3	1.4	--	--	1.6	--
Green heron	--	--	2.0	--	--	--	0.2	--	--	--	--
Little blue heron	--	--	--	--	--	--	0.7	--	--	--	--
Great egret	--	--	1.5	--	--	--	0.2	--	--	--	1.1
Snowy egret	--	--	12.6	--	--	--	0.9	--	3.7	1.6	--
Louisiana heron	--	--	0.5	--	--	--	0.7	--	--	--	--
Black-crowned night heron	0.1	--	--	--	--	--	0.5	--	--	1.6	--
Yellow-crowned night heron	--	--	--	--	--	--	0.5	--	--	--	--
White ibis	<0.1	--	4.6	47.0	--	--	7.3	--	--	--	--
Mallard	--	--	--	--	--	--	2.7	--	--	--	--
Black duck	--	--	--	--	--	--	0.2	--	--	--	--
Blue-winged teal	--	--	--	--	--	--	0.2	--	--	--	--

[a]Values are in birds per hectare.

Table C2 (continued)

Species	Habitats Similar to Those Occurring on Undiked Islands				Habitats Restricted to Diked Islands						
	Sparse Mixed Grasses	Dense Mixed Grasses	Mixed Grasses and Shrubs	Live Thickets	Dike, Sparse Grasses	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Dry	Interior Marsh	Interior Mudflat	Rubbish Pile
Common goldeneye	--	--	--	--	--	--	0.2	--	--	--	--
Marsh hawk	--	--	0.5	--	--	--	--	--	--	--	--
American kestrel	--	--	0.5	--	--	--	--	--	--	--	--
Clapper rail	--	--	--	1.3	--	0.2	--	--	--	--	--
Sora	--	--	--	--	--	--	0.2	--	3.7	--	--
Rail (species unidentified)	--	--	--	--	--	0.2	--	--	3.7	--	--
Semipalmated plover	--	--	--	--	--	--	0.2	--	--	--	--
Common snipe	--	--	--	--	--	--	--	--	3.7	--	--
Spotted sandpiper	--	--	--	--	--	0.2	1.4	--	--	--	--
Greater yellowlegs	--	--	--	--	--	--	2.1	--	--	--	--
Peep (species unidentified)	--	--	--	--	--	--	0.2	--	--	7.9	--
Pectoral sandpiper	--	--	--	--	--	--	--	--	--	6.4	--
Least sandpiper	--	--	--	--	--	--	1.1	--	7.4	12.7	--
Short-billed dowitcher	--	--	--	--	--	--	6.2	--	--	--	--
Semipalmated sandpiper	--	--	--	--	--	--	--	--	--	1.6	--
Western sandpiper	--	--	--	--	--	--	--	--	--	4.8	--
Herring gull	<0.1	--	--	--	--	--	--	--	--	--	--

Table C2 (continued)

Species	Habitats Similar to Those Occurring on Undiked Islands				Habitats Restricted to Diked Islands						
	Sparse Mixed Grasses	Dense Mixed Grasses	Mixed Grasses and Shrubs	Live Thickets	Dike, Sparse Grasses	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Dry	Interior Marsh	Interior Mudflat	Rubbish Pile
Ring-billed gull	--	--	--	--	--	--	0.9	--	--	--	--
Laughing gull	0.1	--	--	--	--	--	--	--	--	--	--
Mourning dove	<0.4	--	0.5	--	--	0.4	0.2	--	--	--	9.9
Ground dove	--	--	1.5	--	--	--	--	--	--	--	--
Short-eared owl	<0.1	--	--	--	--	--	--	--	--	--	--
Belted kingfisher	--	--	0.5	1.3	--	0.3	0.2	--	--	--	1.1
Common flicker	--	--	1.0	1.3	--	--	--	--	--	--	3.3
Western kingbird	--	0.2	--	--	--	--	--	--	--	--	--
Eastern phoebe	<0.1	--	--	1.3	--	0.2	--	--	--	--	--
Fish crow	2.2	--	2.5	18.8	--	--	--	--	--	--	1.1
House wren	--	--	1.0	--	--	--	--	--	--	--	3.3
Long-billed marsh wren	--	1.8	--	--	--	0.7	--	--	3.7	1.6	--
Short-billed marsh wren	<0.1	1.4	--	--	--	0.9	--	--	3.7	--	--
Wren (species unidentified)	<0.1	--	--	--	--	0.4	--	--	--	--	--
Mockingbird	--	--	3.0	1.3	--	0.2	--	--	--	--	11.0
Gray catbird	--	--	--	4.0	--	--	--	--	--	--	--
Brown thrasher	--	--	0.5	--	--	--	--	--	--	--	--

Table C2 (continued)

Species	Habitats Similar to Those Occurring on Undiked Islands				Habitats Restricted to Diked Islands						
	Sparse Mixed Grasses	Dense Mixed Grasses	Mixed Grasses and Shrubs	Live Thickets	Dike, Sparse Grasses	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Dry	Interior Marsh	Interior Mudflat	Rubbish Pile
Golden-crowned kinglet	--	--	--	1.3	--	--	--	--	--	--	--
Ruby-crowned kinglet	--	--	0.5	1.3	--	--	--	--	--	--	--
Black and white warbler	--	--	0.5	1.3	--	--	--	--	--	--	--
Warbler (species unidentified)	0.1	0.8	2.5	--	--	2.1	--	--	--	--	--
Yellow warbler	--	0.2	--	1.3	--	--	--	--	--	--	1.1
Yellow-rumped warbler	0.3	--	10.1	203.0	--	5.3	2.3	--	--	--	28.7
Prairie warbler	--	--	--	1.3	--	--	--	--	--	--	--
Palm warbler	1.2	3.0	1.0	6.7	0.4	1.8	--	--	--	--	--
Common yellowthroat	<0.1	1.0	--	5.4	--	2.7	--	--	--	--	--
American redstart	--	0.2	--	1.3	--	--	--	--	--	--	--
Eastern meadowlark	<0.1	--	--	--	--	--	--	--	--	--	--
Boat-tailed grackle	3.6	--	4.1	1.3	0.8	--	1.8	--	--	--	--
Indigo bunting	--	--	1.0	--	--	--	--	--	--	--	--
Painted bunting	--	--	1.0	1.3	--	0.3	--	--	--	--	--
Rufous-sided towhee	--	--	0.5	--	--	--	--	--	--	--	--
Sparrow (species unidentified)	0.2	6.0	2.0	4.0	0.4	3.7	--	--	11.1	1.6	--
Savannah sparrow	0.5	3.8	1.5	--	0.4	7.2	--	--	--	--	7.7

Table C2 (concluded)

Species	Habitats Similar to Those Occurring on Undiked Islands				Habitats Restricted to Diked Islands						
	Sparse Mixed Grasses	Dense Mixed Grasses	Mixed Grasses and Shrubs	Live Thickets	Dike, Sparse Grasses	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Dry	Interior Marsh	Interior Mudflat	Rubbish Pile
Grasshopper sparrow	--	0.6	--	--	--	--	--	--	--	--	--
Sharp-tailed sparrow	--	0.4	--	--	--	1.2	--	--	11.1	4.8	--
Seaside sparrow	--	0.4	--	--	--	0.4	--	--	7.4	--	--
Vesper sparrow	--	0.4	--	--	--	--	--	--	--	--	--
Field sparrow	--	0.8	--	--	--	--	--	--	--	--	--
White-crowned sparrow	--	--	--	--	--	0.3	--	--	--	--	--
White-throated sparrow	--	--	--	4.0	--	--	--	--	--	--	--
Swamp sparrow	--	0.2	0.5	8.1	--	5.6	--	--	--	--	3.3
Song sparrow	--	2.6	2.5	1.3	--	5.5	0.2	--	--	--	15.5
Total birds/hectare	8.8	23.8	60.4	319.2	2.0	40.1	34.8	0.0	59.2	46.2	87.1

Table C3

Summary of Fall Migrant Birds Associated with Diked and Influenced Dredged Material Islands in North Carolina Estuaries[a]

Species	Habitats									
	Phragmites	Live Thickets	Dead Thickets	Dike, Bare	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Wet	Bulldozer Scrape, Dry	Drain Pond, Wet	Drain Pond, Dry
Pied-billed grebe	--	--	--	--	--	--	--	--	0.8	--
Great blue heron	--	0.5	--	0.5	--	1.1	--	--	--	--
Green heron	--	0.5	--	--	--	--	--	--	0.8	--
Little blue heron	--	--	--	--	--	12.0	--	--	0.8	--
Great egret	--	8.8	--	--	--	12.7	--	--	--	--
Snowy egret	--	24.9	--	--	--	38.5	--	--	--	--
Louisiana heron	--	6.9	--	--	--	11.6	--	--	--	--
Black-crowned night heron	--	--	--	--	--	3.2	--	--	2.3	--
Yellow-crowned night heron	--	0.5	--	--	--	0.9	--	--	--	--
White ibis	--	3.7	--	--	--	6.8	--	--	--	--
Mallard	--	--	--	--	--	1.7	--	--	--	--
Gadwall	--	--	--	--	--	--	--	--	0.8	--
Pintail	--	--	--	--	--	--	--	--	0.8	--
Green-winged teal	--	--	--	--	--	--	--	--	5.4	--
Canvasback	--	--	--	--	--	--	--	--	0.8	--

[a]Values are in birds per hectare.

Table C3 (continued)

Species	Habitats									
	Phragmites	Live Thickets	Dead Thickets	Dike, Bare	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Wet	Bulldozer Scrape, Dry	Drain Pond, Wet	Drain Pond, Dry
Blue-winged teal	--	--	--	--	--	2.1	--	--	65.9	--
American wigeon	--	--	--	--	--	--	--	--	0.8	--
Sharp-shinned hawk	--	--	--	--	--	0.2	--	--	--	--
Clapper rail	--	--	--	1.0	--	--	--	--	--	--
Sora	--	--	--	0.5	--	--	--	--	--	--
Rail (species unidentified)	--	--	--	--	--	--	--	--	0.8	--
Semipalmated plover	--	--	--	--	--	1.7	--	--	2.3	--
Black-bellied plover	--	--	--	1.0	--	--	--	--	--	--
Spotted sandpiper	--	--	--	0.6	--	2.5	--	--	--	--
Greater yellowlegs	--	--	--	--	--	1.3	--	--	--	--
Lesser yellowlegs	--	--	--	--	--	0.6	--	--	--	--
Peep (species unidentified)	--	--	--	--	--	1.3	--	--	--	--
Pectoral sandpiper	--	--	--	--	--	0.4	--	--	--	--
Least sandpiper	--	--	--	3.6	--	1.9	--	--	3.1	--
Dunlin	--	--	--	--	--	2.1	--	--	--	--
Western sandpiper	--	--	--	--	--	0.6	--	--	3.1	--
Semipalmated sandpiper	--	--	--	--	--	5.3	--	--	0.8	--

Table C3 (continued)

	Habitats									
	Phragmites	Live Thickets	Dead Thickets	Dike, Bare	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Wet	Bulldozer Scrape, Dry	Drain Pond, Wet	Drain Pond, Dry
Herring gull	--	--	--	--	--	1.3	--	--	3.9	--
Ring-billed gull	--	--	--	--	--	--	--	--	0.8	--
Mourning dove	--	0.9	--	1.0	--	--	--	--	--	--
Ground dove	--	--	--	--	1.6	--	--	--	--	--
Belted kingfisher	--	--	--	1.6	--	0.6	--	--	1.6	--
Common flicker	--	--	8.0	--	--	--	--	--	--	--
Eastern phoebe	--	--	3.2	--	--	0.2	--	--	--	--
Fish crow	--	2.8	--	--	--	0.2	--	--	--	--
House wren	--	--	0.8	--	2.3	--	--	--	--	--
Wren (species unidentified)	0.9	0.5	--	--	0.8	--	--	--	--	--
Carolina wren	--	0.5	--	--	--	--	--	--	--	--
Long-billed marsh wren	--	--	0.8	--	--	--	--	--	--	--
Short-billed marsh wren	--	--	0.8	--	0.8	--	--	--	--	--
Mockingbird	--	2.3	--	--	0.8	--	--	--	--	0.4
Gray catbird	--	--	3.2	--	--	0.4	--	--	--	--
Brown thrasher	--	0.5	--	--	--	--	--	--	--	--
Ruby-crowned kinglet	--	--	--	--	1.6	--	--	--	--	--
Warbler (species unidentified)	7.3	--	0.8	--	6.2	--	--	2.3	--	--

Table C3 (concluded)

Species	Habitats									
	Phragmites	Live Thickets	Dead Thickets	Dike, Bare	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Wet	Bulldozer Scrape, Dry	Drain Pond, Wet	Drain Pond, Dry
Yellow warbler	0.9	0.5	--	--	--	--	--	--	--	--
Yellow-rumped warbler	--	29.0	115.4	--	1.6	--	--	--	--	--
Prairie warbler	--	1.4	--	--	--	--	--	--	--	--
Palm warbler	0.9	--	7.2	1.6	--	--	--	--	--	--
Northern waterthrush	--	--	0.8	--	--	--	--	--	--	--
Common yellowthroat	3.6	6.9	8.0	--	6.2	--	14.3	--	--	--
American redstart	--	--	0.8	--	--	--	--	--	--	--
Red-winged blackbird	18.2	1.8	2.4	--	--	--	--	--	--	--
Boat-tailed grackle	0.9	0.5	--	0.5	--	0.2	--	--	1.6	--
Rufous-sided towhee	--	0.9	0.8	--	--	--	--	--	--	--
Sparrow (species unidentified)	7.3	--	7.2	1.0	0.8	--	--	--	--	--
Savannah sparrow	0.9	--	2.4	--	1.6	--	7.2	--	--	--
Sharp-tailed sparrow	--	--	--	1.6	--	--	--	--	--	--
Field sparrow	--	0.5	--	--	--	--	--	--	--	--
White-throated sparrow	--	0.5	3.2	--	--	--	--	--	--	--
Swamp sparrow	--	0.9	12.7	--	3.1	--	16.1	--	--	--
Song sparrow	--	--	8.8	--	1.6	--	1.8	--	--	--
Total birds/hectare	40.9	96.2	187.3	14.5	29.0	111.4	39.4	2.3	97.2	0.4

Table C4

Summary of Fall Migrant Birds Associated with Diked and Filled Dredged Material Islands in North Carolina Estuaries[a]

Species	Habitats Similar to Those Occurring on Undiked Islands								Habitats Restricted to Diked Islands									
	Bare	Mixed Grasses Sparse	Mixed Grasses Dense	Phragmites	Mixed Grasses and Shrubs	Beach	Salt Marsh Fringe	Tidal Mudflat	Dike, Bare	Dike, Sparse Grasses	Dike, Dense Grasses	Dike, Phragmites	Dike, Mixed Grasses & Shrubs	Bulldozer Scrape, Wet	Borrow Pit, Wet	Drain Pond, Wet	Interior Mudflat	Dead Thickets
Pied-billed grebe	--	--	--	--	--	--	1.0	--	--	--	--	--	--	0.4	--	--	--	--
Double-crested cormorant	--	--	--	--	--	0.1	--	--	--	--	--	--	--	--	--	--	--	--
Great blue heron	0.1	0.1	--	--	0.3	--	0.4	0.6	--	0.8	--	--	--	--	--	--	0.1	0.7
Green heron	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	--	--	0.3
Little blue heron	--	--	--	--	--	--	0.4	0.6	--	0.4	--	--	--	--	<0.1	--	--	--
Great egret	<0.1	--	--	--	--	--	--	--	0.6	0.4	--	--	--	--	<0.1	--	--	--
Snowy egret	--	--	--	--	--	--	--	1.6	--	1.3	--	--	--	--	--	--	--	--
Louisiana heron	--	--	--	--	--	--	0.2	0.6	--	0.2	--	--	--	--	--	--	--	--
Black-crowned night heron	--	--	--	--	--	--	0.2	--	--	--	--	--	--	--	--	--	--	6.6
Yellow-crowned night heron	--	--	--	--	--	--	0.2	--	--	--	--	--	--	--	--	--	0.1	--
Least bittern	--	--	--	--	--	--	0.2	--	--	--	--	--	--	--	--	--	--	--
White ibis	0.6	--	--	--	--	--	--	--	--	15.7	--	--	--	0.4	--	--	--	--
Mallard	--	--	--	--	--	--	1.0	--	--	--	--	--	--	--	--	0.1	--	--
Black duck	--	--	--	--	--	--	--	1.6	--	--	--	--	--	--	--	--	--	--
Green-winged teal	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.6	<0.1	--	--
Blue-winged teal	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.1	0.4	--	--
Northern shoveler	--	--	--	--	--	--	0.4	--	--	--	--	--	--	--	--	0.1	--	--
Turkey vulture	<0.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cooper's hawk	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<0.1	--	--	--
Peregrine falcon	<0.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
American kestrel	--	--	--	--	0.3	--	--	--	--	--	--	--	--	--	--	--	--	0.1
Rail (species unidentified)	--	--	--	--	0.3	--	0.2	--	--	--	--	0.4	--	0.4	--	--	--	--

[a] Values are in birds per hectare.

Table C4 (continued)

Species	Habitats Similar to Those Occurring on Undiked Islands								Habitats Restricted to Diked Islands									
	Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Mixed Grasses and Shrubs	Beach	Salt Marsh Fringe	Tidal Mudflat	Dike, Bare	Dike, Sparse Grasses	Dike, Dense Grasses	Dike, Phragmites	Dike, Mixed Grasses & Shrubs	Bulldozer Scrape, Wet	Borrow Pit, Wet	Drain Pond, Wet	Interior Mudflat	Dead Thickets
Virginia rail	--	--	--	--	--	--	--	1.1	--	--	--	--	--	--	--	--	--	--
Sera rail	--	--	--	1.1	--	--	0.6	2.2	--	--	--	--	--	--	0.2	--	--	--
American oystercatcher	0.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Semipalmated plover	0.9	--	--	--	--	4.8	--	14.8	--	--	--	--	--	2.0	0.1	4.6	--	--
Ruddy turnstone	--	--	--	--	--	0.1	--	--	--	--	--	--	--	--	--	--	--	--
Common snipe	<0.1	--	--	--	--	--	0.8	2.7	--	--	--	--	--	--	--	--	--	--
Whimbrel	--	--	--	--	--	0.1	--	--	--	--	--	--	--	--	--	--	--	--
Spotted sandpiper	--	--	--	--	--	--	--	--	--	--	--	--	--	0.8	0.4	--	--	--
Willet	--	--	--	--	--	0.4	--	--	--	--	--	--	--	--	--	--	--	--
Yellowlegs (species unidentified)	0.3	--	--	--	--	--	--	3.3	--	--	--	--	--	--	0.2	0.3	--	--
Greater yellowlegs	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4	--	--	--
Lesser yellowlegs	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<0.1	--	--	--
Peep (species unidentified)	<0.1	--	--	--	--	2.6	--	--	--	--	--	--	--	--	0.9	14.0	0.3	--
Pectoral sandpiper	--	--	--	--	--	--	--	0.6	--	--	--	--	--	--	0.1	--	--	--
Least sandpiper	--	--	--	--	--	--	--	1.1	--	--	--	--	--	0.8	0.3	--	--	--
Dunlin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5	--	--
Short-billed dowitcher	0.8	--	--	--	--	0.1	--	7.1	--	--	--	--	--	--	0.1	<0.1	--	--
Semipalmated sandpiper	--	--	--	--	--	--	--	0.6	--	--	--	--	--	--	0.4	1.5	--	--
Western sandpiper	<0.1	--	--	--	--	--	--	3.3	--	--	--	--	--	0.4	0.3	--	--	--
Sanderling	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--
Great black-backed gull	0.1	--	--	--	--	2.9	--	--	--	--	--	--	--	--	--	--	--	--
Herring gull	2.8	--	--	--	--	91.2	--	--	4.0	--	--	--	--	--	--	8.3	--	--
Ring-billed gull	<0.1	--	--	--	--	3.8	--	--	--	--	--	--	--	--	--	--	--	--
Laughing gull	0.4	0.1	--	--	--	71.5	--	--	0.3	--	--	--	--	--	--	0.4	--	--

Table C4 (continued)

Species	Habitats Similar to Those Occurring on Undiked Islands: Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Mixed Grasses and Shrubs	Beach	Salt Marsh Fringe	Tidal Mudflat	Habitats Restricted to Diked Islands: Dike, Bare	Dike, Sparse Grasses	Dike, Dense Grasses	Dike, Phragmites	Dike, Mixed Grasses & Shrubs	Bulldozer Scrape, Wet	Borrow Pit, Wet	Drain Pond, Wet	Interior Mudflat	Dead Thickets
Forster's tern	--	--	--	--	--	0.9	--	--	--	--	--	--	--	--	--	--	--	--
Common tern	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--	--	--	--	--
Royal tern	0.1	--	--	--	--	0.1	--	--	--	--	--	--	--	--	--	--	--	--
Caspian tern	<0.1	--	--	--	--	2.9	--	--	--	--	--	--	--	--	--	--	--	--
Mourning dove	0.2	2.4	8.6	7.8	--	--	--	--	--	0.6	--	--	--	--	1.3	--	--	5.6
Ground dove	--	--	--	--	5.3	--	--	--	--	--	--	--	--	--	--	--	--	0.1
Belted kingfisher	--	--	--	--	--	0.1	0.4	--	--	0.6	--	0.4	--	--	<0.1	--	--	0.3
Common flicker	--	--	--	--	--	--	--	--	0.3	--	--	--	--	--	--	--	0.1	0.4
Hairy woodpecker	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4
Downy woodpecker	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1
Western kingbird	--	--	--	--	0.3	--	--	--	--	--	--	--	--	--	--	--	--	--
Eastern phoebe	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3
Fish crow	0.5	--	--	--	--	--	--	--	0.6	1.9	--	--	--	--	--	--	--	0.8
Wren (species unidentified)	--	--	0.7	1.1	--	--	--	--	--	0.6	--	--	--	--	--	--	--	--
House wren	--	0.2	0.7	--	2.2	--	--	--	--	--	1.1	--	--	--	0.1	--	--	1.9
Carolina wren	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3
Long-billed marsh wren	--	--	--	--	0.3	--	1.6	1.1	--	--	--	0.4	--	--	<0.1	--	--	--
Short-billed marsh wren	--	--	--	--	--	--	0.6	--	--	0.4	--	0.4	--	--	--	--	--	--
Mockingbird	--	0.3	--	--	3.4	--	--	--	--	0.2	--	--	2.2	--	<0.1	--	--	1.2
Gray catbird	--	--	0.7	--	--	--	--	--	--	--	--	0.4	--	--	--	--	--	0.3
Brown thrasher	--	--	--	--	0.3	--	--	--	--	--	--	--	--	--	--	--	--	--
Ruby-crowned kinglet	--	--	--	--	0.8	--	--	--	--	--	--	--	--	--	--	--	--	--
Water pipit	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--
Starling	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4	--	1.7
White-eyed vireo	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table C4 (continued)

Species	Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Mixed Grasses and Shrubs	Beach	Salt Marsh Fringe	Tidal Mudflat	Dike, Bare	Dike, Sparse Grasses	Dike, Dense Grasses	Dike, Phragmites	Dike, Mixed Grasses & Shrubs	Bulldozer Scrape, Wet	Borrow Pit, Wet	Drain Pond, Wet	Interior Mudflat	Dead Thickets
	Habitats Similar to Those Occurring on Undiked Islands								Habitats Restricted to Diked Islands									
Black-and-white warbler	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3
Warbler (species unidentified)	--	0.2	3.6	2.2	--	--	--	--	--	0.4	0.5	1.5	--	--	<0.1	--	--	0.9
Yellow warbler	--	--	--	6.7	--	0.9	--	--	--	--	--	2.2	--	--	--	--	--	0.8
Yellow-rumped warbler	--	--	--	--	9.0	--	--	8.2	7.1	--	3.3	--	--	--	--	--	--	26.0
Prairie warbler	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.7
Palm warbler	--	0.4	5.0	2.2	1.7	--	--	--	1.4	1.5	1.1	1.8	--	--	0.3	--	0.4	3.2
Northern waterthrush	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3
Common yellowthroat	--	--	4.3	1.1	2.0	--	1.0	--	--	--	1.6	3.3	2.2	--	0.1	--	--	2.8
American redstart	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5
Bobolink	--	--	--	1.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Eastern meadowlark	--	--	--	--	--	--	0.8	--	--	--	--	0.4	--	--	--	--	--	--
Red-winged blackbird	--	<0.1	14.3	20.0	2.0	--	2.2	0.6	0.3	--	1.6	--	--	--	<0.1	--	--	0.4
Boat-tailed grackle	<0.1	0.2	--	--	--	--	0.2	--	0.3	1.7	--	--	--	0.4	--	--	0.1	0.7
Cardinal	--	--	--	--	0.3	--	--	--	--	--	--	--	--	--	--	--	--	0.1
Rufous-sided towhee	--	--	--	--	0.3	--	--	--	--	--	--	--	--	--	--	--	--	--
Sparrow (species unidentified)	--	1.1	11.4	11.1	2.2	--	0.8	--	0.3	0.6	6.5	4.7	--	0.4	0.4	--	--	0.5
Savannah sparrow	<0.1	1.4	2.1	5.6	1.1	--	--	--	0.3	0.8	1.6	1.5	--	--	0.6	0.3	--	0.8
Sharp-tailed sparrow	--	--	--	--	--	--	--	2.2	--	--	--	--	--	--	--	--	--	--
Seaside sparrow	--	--	--	--	--	--	0.6	0.6	--	--	--	--	--	--	--	--	--	--
Field sparrow	--	0.9	--	--	7.0	--	0.6	--	--	--	1.6	--	--	--	--	--	--	--
White-crowned sparrow	--	--	--	--	0.3	--	--	--	0.3	--	--	--	--	--	--	--	--	--
White-throated sparrow	--	--	--	--	--	--	--	--	--	--	--	--	2.2	--	--	--	--	--
Swamp sparrow	--	<0.1	2.9	8.9	5.0	--	1.2	--	--	0.2	2.7	9.5	--	--	0.9	--	--	0.8

Table C4 (concluded)

Species	Habitats Similar to Those Occurring on Undiked Islands								Habitats Restricted to Diked Islands									
	Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Mixed Grasses and Shrubs	Beach	Salt Marsh Fringe	Tidal Mudflat	Dike, Bare	Dike, Sparse Grasses	Dike, Dense Grasses	Dike, Phragmites	Dike, Mixed Grasses & Shrubs	Bulldozer Scrape, Wet	Borrow Pit, Wet	Drain Pond, Wet	Interior Mudflat	Dead Thickets
Song sparrow	--	0.2	3.6	10.0	6.2	--	--	--	0.6	0.8	3.3	4.0	6.7	--	0.3	--	--	0.5
Snow bunting	<0.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total birds/hectare	7.5	7.3	57.9	78.9	50.9	182.8	15.6	54.5	16.4	29.1	24.9	30.9	13.3	6.0	11.4	30.6	1.2	60.4

Table C5

Summary of Winter Bird Populations Associated with Undiked Dredged Material Islands in North Carolina Estuaries[a]

	Habitats						
Species	Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Live Thickets	Salt Marsh Fringe	Beach
Great blue heron	--	--	0.9	--	--	--	--
Accipiter (species unidentified)	--	--	0.3	--	--	--	--
American kestrel	--	--	--	--	0.7	--	--
Killdeer	--	--	--	--	--	1.1	--
Common snipe	--	--	--	5.4	--	3.4	--
Great black-backed gull	--	0.4	--	--	--	--	0.6
Herring gull	--	2.0	--	--	--	--	3.2
Ring-billed gull	--	0.8	0.3	--	--	--	9.6
Short-eared owl	--	--	0.3	--	--	--	--
Belted kingfisher	--	--	--	--	0.4	--	--
Common flicker	--	--	--	--	0.4	--	--
Wren (species unidentified)	--	--	--	--	0.4	--	--
House wren	--	--	--	--	2.5	--	--
Short-billed marsh wren	--	--	0.6	--	--	--	--
Mockingbird	--	--	--	--	1.4	--	--
Brown thrasher	--	--	--	--	0.7	--	--
American robin	--	--	--	--	1.8	--	--
Ruby-crowned kinglet	--	--	--	--	1.1	--	--
Yellow-rumped warbler	--	--	--	--	257.1	--	--
Palm warbler	--	--	--	--	0.4	--	--
Red-winged blackbird	--	5.9	--	5.4	1.8	--	--
Boat-tailed grackle	1.1	--	--	--	--	--	--
Cardinal	--	--	--	--	0.7	--	--
American goldfinch	--	0.8	3.7	--	--	--	--
Rufous-sided towhee	--	--	--	--	0.7	--	--
Sparrow (species unidentified)	--	0.2	0.9	5.4	0.7	1.1	--
Savannah sparrow	3.2	6.5	8.5	--	--	--	--

[a]Values are in birds per hectare.

Table C5 (concluded)

Species	Habitats: Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Live Thickets	Salt Marsh Fringe	Beach
Seaside sparrow	--	--	0.3	--	--	--	--
Field sparrow	--	1.0	--	--	2.8	--	--
Swamp sparrow	--	0.2	1.5	10.8	4.2	--	--
Song sparrow	--	1.0	1.5	--	6.7	--	--
Total birds/hectare	4.3	18.8	18.8	27.0	284.5	5.6	13.4

Table C6

Summary of Winter Bird Populations Associated with Diked and Not Filled Dredged Material Islands in North Carolina Estuaries[a]

Species	Habitats Similar to Those Occurring on Undiked Islands				Habitats Restricted to Diked Islands						
	Sparse Mixed Grasses	Dense Mixed Grasses	Mixed Grasses and Shrubs	Live Thickets	Dike, Sparse Grasses	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Dry	Interior Marsh	Interior Mudflat	Rubbish Pile
Pied-billed grebe	--	--	--	--	--	--	0.5	--	--	--	--
Great blue heron	0.2	--	--	--	--	--	0.5	--	--	--	2.2
Duck (species unidentified)	--	--	--	--	--	--	0.9	--	--	--	--
Mallard	--	--	--	--	--	--	1.9	--	--	6.4	--
Redhead	--	--	--	--	--	--	0.5	--	--	--	--
Hooded merganser	--	--	--	--	--	--	4.2	--	--	--	--
Sharp-shinned hawk	--	--	--	--	--	--	--	--	--	--	2.2
Killdeer	0.1	--	--	--	--	--	0.5	--	--	3.2	--
Greater yellowlegs	--	--	--	--	--	--	--	--	--	3.2	--
Herring gull	--	--	--	--	--	--	0.5	--	--	--	--
Belted kingfisher	--	--	--	--	--	--	0.5	--	--	--	--
Common flicker	--	--	1.0	5.4	--	--	--	--	--	--	2.2
Wren (species unidentified)	--	--	--	2.7	--	--	--	--	--	--	--

[a]Values are in birds per hectare.

Table C6 (concluded)

Species	Habitats Similar to Those Occurring on Undiked Islands				Habitats Restricted to Diked Islands						
	Sparse Mixed Grasses	Dense Mixed Grasses	Mixed Grasses and Shrubs	Live Thickets	Dike, Sparse Grasses	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Dry	Interior Marsh	Interior Mudflat	Rubbish Pile
House wren	--	--	--	--	--	--	--	--	--	--	2.2
Long-billed marsh wren	--	--	--	--	--	0.6	--	--	--	--	--
Short-billed marsh wren	--	1.2	--	--	--	0.6	--	--	--	--	--
Mockingbird	--	--	--	2.7	--	--	--	--	--	--	--
Gray catbird	--	--	--	2.7	--	--	--	--	--	--	--
American robin	--	--	--	8.1	--	--	--	--	--	--	--
Yellow-rumped warbler	1.1	1.9	12.2	371.0	1.5	5.9	25.8	--	--	--	50.8
Common yellowthroat	--	--	1.0	--	--	--	--	--	--	--	--
Red-winged blackbird	0.1	--	1.0	--	--	--	3.3	--	14.8	--	--
American goldfinch	3.4	--	--	--	--	--	--	--	--	--	--
Sparrow (species unidentified)	0.1	0.4	1.0	--	--	0.9	--	--	--	--	--
Savannah sparrow	--	2.7	19.3	--	--	4.4	--	--	--	--	2.2
Sharp-tailed sparrow	--	--	--	--	--	0.3	--	--	--	--	--
Swamp sparrow	--	9.7	--	2.7	--	2.7	--	--	--	--	2.2
Song sparrow	--	3.1	1.0	--	1.5	10.1	0.9	--	--	--	8.8
Total birds/hectare	5.0	19.0	36.5	395.3	3.0	25.5	40.0	0.0	14.8	12.8	72.8

Table C7

Summary of Winter Bird Populations Associated with Diked and Influenced Dredged Material Islands in North Carolina Estuaries[a]

Species	Habitats									
	Phragmites	Live Thickets	Dead Thickets	Dike, Bare	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Wet	Bulldozer Scrape, Dry	Drain Pond, Wet	Drain Pond, Dry
Great blue heron	--	--	--	--	--	0.8	--	--	--	--
Great egret	--	--	--	--	--	0.4	--	--	--	--
Louisiana heron	--	--	--	--	--	0.4	--	--	--	--
White ibis	--	--	--	0.9	--	0.8	--	--	--	--
Mallard	--	--	--	--	--	0.4	--	--	--	--
Black duck	--	--	--	--	--	1.1	--	--	--	--
Redhead	--	--	--	--	--	0.4	--	--	--	--
Bufflehead	--	--	--	--	--	1.5	--	--	--	--
Sharp-shinned hawk	--	--	1.6	--	--	--	--	--	--	--
Killdeer	--	--	--	--	--	3.0	--	--	--	--
Common snipe	--	--	--	--	--	0.4	--	--	--	--
Greater yellowlegs	--	--	--	--	--	0.8	--	--	--	--
Least sandpiper	--	--	--	--	--	0.4	--	--	--	--

[a] Values are in birds per hectare.

Table C7 (continued)

Species	Habitats									
	Phragmites	Live Thickets	Dead Thickets	Dike, Bare	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Wet	Bulldozer Scrape, Dry	Drain Pond, Wet	Drain Pond, Dry
Belted kingfisher	--	--	--	--	--	0.4	--	--	--	--
Wren (species unidentified)	--	--	1.6	--	--	--	--	--	--	--
Long-billed marsh wren	--	--	--	1.7	--	--	--	--	--	--
Catbird	--	--	1.6	--	--	--	--	--	--	--
American robin	--	--	3.2	--	--	--	--	--	--	2.3
Hermit thrush	--	--	1.6	--	--	--	--	--	--	--
Yellow-rumped warbler	--	170.6	265.7	25.0	23.4	25.1	3.6	--	--	--
Palm warbler	--	--	--	--	--	--	--	--	--	0.8
Common yellowthroat	--	--	--	1.7	--	--	--	--	--	--
Eastern meadowlark	--	--	--	--	--	--	--	--	--	0.8
Red-winged blackbird	--	--	1.6	--	--	--	--	--	--	--
Cardinal	--	0.8	--	--	--	--	--	--	--	--
American goldfinch	--	--	15.9	--	--	--	--	--	--	--
Rufous-sided towhee	--	1.6	--	--	--	--	--	--	--	--
Sparrow (species unidentified)	1.8	1.6	--	0.9	7.8	0.4	3.6	1.5	--	--
Savannah sparrow	--	--	--	--	--	--	--	3.1	--	--

Table C7 (concluded)

Species	Habitats									
	Phragmites	Live Thickets	Dead Thickets	Dike, Bare	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Wet	Bulldozer Scrape, Dry	Drain Pond, Wet	Drain Pond, Dry
White-throated sparrow	--	1.6	--	--	--	--	--	--	--	--
Swamp sparrow	--	0.8	1.6	--	7.8	--	--	6.1	--	--
Song sparrow	--	1.6	9.6	--	10.9	0.4	3.6	--	--	2.3
	1.8	178.6	304.0	30.2	49.9	36.7	10.8	10.7	0.0	6.2

Table C8

Summary of Winter Birds Associated with Diked and Filled Dredged Material Islands in North Carolina Estuaries[a]

Species	Habitats Similar to Those Occurring on Undiked Islands								Habitats Restricted to Diked Islands									
	Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Mixed Grasses and Shrubs	Beach	Salt Marsh Fringe	Tidal Mudflat	Dike, Bare	Dike, Sparse Grasses	Dike, Dense Grasses	Dike, Phragmites	Dike, Mixed Grasses & Shrubs	Bulldozer Scrape, Wet	Borrow Pit, Wet	Drain Pond, Wet	Interior Mudflat	Dead Thickets
Pied-billed grebe	--	--	--	--	--	--	1.1	--	--	--	--	--	--	--	--	--	--	--
Great blue heron	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.7
Little blue heron	--	--	--	--	--	--	--	1.1	--	--	--	--	--	0.8	--	--	--	--
White ibis	--	--	--	--	--	--	0.4	--	--	--	--	--	--	--	--	--	--	--
Mallard	--	--	--	--	--	--	0.4	--	--	--	--	--	--	--	--	--	--	--
Black duck	--	--	--	--	--	--	2.0	--	--	--	--	--	--	--	0.3	--	--	--
Black scoter	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--	--	--	--	--
Cooper's hawk	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3
Red-tailed hawk	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.7
Marsh hawk	--	--	--	--	0.4	--	--	--	--	--	--	--	--	--	--	--	--	--
American kestrel	--	0.3	--	--	0.4	--	--	--	--	--	--	--	--	--	--	--	--	0.3
Sora	--	--	--	--	--	--	--	1.1	--	--	--	--	--	--	--	--	--	--
American coot	--	--	--	--	--	--	1.5	--	--	--	--	--	--	--	--	--	--	--
Semipalmated plover	--	--	--	--	--	5.5	--	--	--	--	--	--	--	--	--	0.2	--	--
Piping plover	--	--	--	--	--	0.8	--	--	--	--	--	--	--	--	--	--	--	--
Killdeer	0.1	0.1	--	--	--	--	--	1.1	--	0.4	--	--	--	0.8	--	--	--	--
Black-bellied plover	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--	0.7	--	--	--
Ruddy turnstone	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--	--	--	--	--
Common snipe	--	--	--	2.2	0.9	--	--	2.2	--	--	--	--	3.7	--	0.1	0.1	--	--
Greater yellowlegs	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--
Peep (species unidentified)	0.3	--	--	--	--	1.5	--	--	--	--	--	--	--	--	--	--	--	--
Dunlin	--	--	--	--	--	7.3	--	--	--	--	--	--	--	--	--	--	--	--

[a]Values are in birds per hectare.

Table C8 (continued)

	Habitats Similar to Those Occurring on Undiked Islands								Habitats Restricted to Diked Islands									
	Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Mixed Grasses and Shrubs	Beach	Salt Marsh Fringe	Tidal Mudflat	Dike, Bare	Dike, Sparse Grasses	Dike, Dense Grasses	Dike, Phragmites	Dike, Mixed Grasses & Shrubs	Bulldozer Scrape, Wet	Borrow Pit, Wet	Drain Pond, Wet	Interior Mudflat	Dead Thickets
Short-billed dowitcher	0.1	--	--	--	--	--	---	--	--	--	--	--	--	--	--	--	--	--
Western sandpiper	--	--	--	--	--	1.3	---	--	--	--	--	--	--	--	--	--	--	--
Sanderling	--	--	--	--	--	12.8	---	--	--	--	--	--	--	--	--	--	--	--
Great black-backed gull	--	--	--	--	--	2.3	---	--	--	--	--	--	--	--	--	--	--	--
Herring gull	0.2	--	--	--	--	65.7	---	--	--	--	--	--	--	--	--	--	--	--
Ring-billed gull	--	--	--	--	--	14.3	---	--	--	--	--	--	--	--	--	--	--	--
Mourning dove	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5
Ground dove	--	--	--	--	--	--	--	--	--	0.8	--	--	--	--	--	--	--	--
Common flicker	--	2.1	--	--	1.8	--	--	--	--	--	--	--	--	--	--	--	--	--
Wren (species unidentified)	--	--	--	--	--	--	0.4	--	--	0.4	--	--	--	--	--	--	--	0.3
House wren	--	--	--	--	0.9	--	--	--	--	--	1.0	--	--	--	--	--	--	1.0
Carolina wren	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5
Long-billed marsh wren	--	--	--	--	--	--	2.3	--	--	--	--	--	--	--	0.1	--	--	--
Short-billed marsh wren	--	--	--	--	--	--	0.8	--	--	0.4	--	0.7	--	--	0.1	--	--	--
Mockingbird	--	--	--	--	0.4	--	--	--	--	--	--	--	--	--	--	--	--	--
Brown thrasher	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5
Starling	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.2
Yellow-rumped warbler	0.2	--	--	--	21.2	--	35.7	92.9	1.4	7.6	3.9	--	--	3.2	0.3	17.6	--	57.8
Common yellowthroat	--	--	--	--	0.9	--	--	--	--	0.8	--	1.5	--	--	--	--	--	--
Eastern meadowlark	--	--	--	--	--	--	0.4	--	--	--	--	--	--	--	--	--	--	--
Red-winged blackbird	--	0.3	--	--	2.2	--	--	1.1	1.4	--	--	0.7	--	--	--	--	--	6.0
Cardinal	--	--	--	--	--	--	--	--	--	--	--	--	3.7	--	--	--	--	0.5
American goldfinch	--	1.0	--	--	--	--	--	--	--	--	15.6	--	--	--	--	--	--	--
Sparrow (species																		0.3
unidentified)	--	0.8	1.2	2.2	0.4	--	1.1	--	--	--	3.9	4.4	3.7	--	1.0	--	--	0.3

Table C8 (concluded)

	Habitats Similar to Those Occurring on Undiked Islands								Habitats Restricted to Diked Islands									
	Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Mixed Grasses and Shrubs	Beach	Salt Marsh Fringe	Tidal Mudflat	Dike, Bare	Dike, Sparse Grasses	Dike, Dense Grasses	Dike, Phragmites	Dike, Mixed Grasses & Shrubs	Bulldozer Scrape, Wet	Borrow Pit, Wet	Drain Pond, Wet	Interior Mudflat	Dead Thickets
Savannah sparrow	--	3.5	--	4.4	--	--	0.4	--	--	4.2	2.0	--	--	--	--	--	--	--
Sharp-tailed sparrow	--	--	--	--	--	--	0.8	--	--	--	--	--	--	--	--	--	--	--
Seaside sparrow	--	--	--	--	--	--	1.1	--	--	--	--	--	--	--	--	--	--	--
White-throated sparrow	--	--	--	2.2	0.4	--	--	--	--	--	--	--	--	--	0.7	--	--	--
Swamp sparrow	--	0.4	2.4	42.2	4.0	--	1.9	1.1	2.3	0.8	7.8	4.4	3.7	--	1.7	--	--	2.0
Song sparrow	0.1	0.7	8.3	48.9	10.2	--	0.4	--	1.4	2.1	12.7	5.8	--	--	1.0	--	1.1	1.7
Total birds/hectare	0.7	9.2	11.9	102.1	44.1	112.4	50.7	100.6	6.5	17.5	46.9	17.5	14.8	4.8	6.0	18.0	1.1	77.3

Table C9

Summary of Spring Migrant Birds Associated with Undiked Dredged Material Islands in North Carolina Estuaries[a]

	Habitats						
Species	Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Live Thickets	Salt Marsh Fringe	Beach
American oystercatcher	12.2	0.2	--	--	--	--	1.3
Wilson's plover	--	0.2	--	--	--	--	--
Black-bellied plover	--	--	--	--	--	--	1.0
Common snipe	--	--	--	--	--	1.3	--
Willet	--	0.1	--	--	--	--	--
Peep (species unidentified)	--	--	--	--	--	--	1.9
Short-billed dowitcher	--	--	--	--	--	--	2.3
Sanderling	--	--	--	--	--	--	1.0
Herring gull	--	--	--	--	--	--	4.4
Ring-billed gull	1.3	--	--	--	--	--	5.4
Laughing gull	21.8	0.1	--	--	--	--	4.2
Bonaparte's gull	--	--	--	--	--	--	0.2
Gull-billed tern	--	0.2	--	--	--	--	--
Common tern	--	1.2	--	--	--	--	--
Royal tern	3648.0[b]	0.1	--	--	--	--	23.7
Sandwich tern	1.3	--	--	--	--	--	--
Black skimmer	--	1.7	--	--	--	--	--
Common nighthawk	--	0.1	--	--	--	--	--
Common flicker	--	--	--	--	0.2	--	--
House wren	--	--	--	--	0.2	--	--
Carolina wren	--	--	--	--	0.4	--	--
Long-billed marsh wren	--	--	--	--	--	0.7	--
Mockingbird	--	--	--	--	0.4	--	--
Gray catbird	--	--	--	--	0.4	--	--
Brown thrasher	--	--	--	--	0.2	--	--
Yellow-rumped warbler	--	--	--	--	4.0	--	--
Prairie warbler	--	--	--	--	0.6	--	--

[a]Values are in birds per hectare.
[b]Large numbers due to presence of breeding colony within study site.

Table C9 (concluded)

Species	Habitats: Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Live Thickets	Salt Marsh Fringe	Beach
Northern water thrush	--	--	--	--	0.2	--	--
Common yellowthroat	--	--	--	--	0.6	--	--
Eastern meadowlark	--	--	0.2	--	0.2	--	--
Red-winged blackbird	--	0.2	1.8	22.6	4.0	18.9	--
Boat-tailed grackle	--	--	--	--	1.1	--	--
Cardinal	--	--	--	--	0.8	--	--
Rufous-sided towhee	--	--	--	--	0.6	--	--
Sparrow (species unidentified)	--	--	--	--	0.4	0.7	--
Savannah sparrow	2.6	4.6	1.1	--	--	--	--
Seaside sparrow	--	--	0.2	--	--	1.3	--
Field sparrow	--	0.3	--	--	1.5	--	--
Swamp sparrow	--	--	0.5	--	0.2	--	--
Song sparrow	--	0.1	0.2	--	0.4	--	--
Total birds/hectare	3687.2	9.1	4.0	22.6	16.4	22.9	45.4

Table C10

Summary of Spring Migrant Birds Associated with Diked and Not Filled Dredged Material Islands in North Carolina Estuaries[a]

Species	Habitats Similar to Those Occurring on Undiked Islands				Habitats Restricted to Diked Islands						
	Sparse Mixed Grasses	Dense Mixed Grasses	Mixed Grasses and Shrubs	Live Thickets	Dike, Sparse Grasses	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Dry	Interior Marsh	Interior Mudflat	Rubbish Pile
Great blue heron	0.1	--	--	--	--	--	--	--	--	--	--
Green heron	--	--	--	--	--	--	0.3	--	--	--	--
White ibis	--	--	--	--	--	--	0.6	--	--	--	--
Mallard	--	--	--	--	--	--	2.5	--	--	--	--
Black duck	--	--	--	--	--	--	0.3	--	--	--	--
Gadwall	--	--	--	--	--	--	0.3	--	--	--	--
Green-winged teal	--	--	--	--	--	--	0.3	--	--	--	--
Redhead	--	--	--	--	--	--	2.5	--	--	--	--
Ring-necked duck	--	--	--	--	--	--	0.3	--	--	--	--
Marsh hawk	0.1	--	--	--	--	--	--	--	--	--	--
Rail (species unidentified)	--	--	--	--	--	--	--	--	1.9	--	--
Sora	--	--	--	--	--	0.2	--	--	--	--	--
American oystercatcher	--	--	--	--	1.4	--	--	--	--	--	--

[a]Values are in birds per hectare.

Table C10 (continued)

Species	Habitats Similar to Those Occurring on Undiked Islands				Habitats Restricted to Diked Islands						
	Sparse Mixed Grasses	Dense Mixed Grasses	Mixed Grasses and Shrubs	Live Thickets	Dike, Sparse Grasses	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Dry	Interior Marsh	Interior Mudflat	Rubbish Pile
Wilson's plover	--	--	0.6	--	--	0.2	--	--	--	--	--
Common snipe	--	--	--	--	--	--	0.8	--	1.9	--	--
Willet	0.1	--	--	--	--	0.7	--	--	1.9	--	--
Yellowlegs (species unidentified)	--	--	--	--	--	--	0.3	--	--	--	--
Greater yellowlegs	--	--	--	--	--	--	0.6	--	--	--	--
Peep (species unidentified)	--	--	--	--	--	--	0.6	--	--	--	--
Least sandpiper	--	--	--	--	--	--	0.6	--	--	--	--
Short-billed dowitcher	--	--	--	--	--	--	0.6	--	--	--	--
Ring-billed gull	--	--	--	--	--	--	2.5	--	--	--	--
Mourning dove	0.2	--	1.2	--	--	0.7	0.3	--	--	--	--
Common flicker	0.1	--	--	--	--	--	--	--	--	--	--
Fish crow	--	--	--	--	0.5	--	--	--	--	--	4.0
House wren	--	--	--	1.6	--	--	--	--	--	--	--
Short-billed marsh wren	--	0.2	--	--	--	0.2	--	--	--	--	--
Starling	--	--	--	--	--	0.2	--	--	--	--	--
Yellow-rumped warbler	0.1	0.2	--	14.5	--	0.7	1.1	--	--	--	--
Common yellowthroat	--	0.5	--	1.6	--	--	--	--	--	--	--

Table C10 (concluded)

Species	Habitats Similar to Those Occurring on Undiked Islands				Habitats Restricted to Diked Islands						
	Sparse Mixed Grasses	Dense Mixed Grasses	Mixed Grasses and Shrubs	Live Thickets	Dike, Sparse Grasses	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Dry	Interior Marsh	Interior Mudflat	Rubbish Pile
Red-winged blackbird	1.1	1.4	--	11.3	--	0.7	0.3	--	--	--	6.6
Boat-tailed grackle	0.1	--	--	9.7	--	0.4	--	--	--	--	18.5
American goldfinch	0.8	--	--	--	--	--	--	--	--	--	--
Sparrow (species unidentified)	--	--	--	1.6	--	2.3	0.6	--	--	1.9	2.6
Savannah sparrow	0.1	1.9	--	--	--	5.9	0.3	--	4.4	30.5	1.3
Seaside sparrow	--	--	--	--	--	0.2	--	--	--	--	--
Swamp sparrow	--	0.5	--	3.2	--	0.5	--	--	--	--	--
Song sparrow	--	0.2	--	3.2	--	1.4	0.8	--	--	--	--
Total birds/hectare	2.5	4.9	1.8	46.7	1.9	14.3	16.5	0.0	4.4	38.1	33.0

Table C11

Summary of Spring Migrant Birds Associated with Diked and Influenced Dredged Material Islands in North Carolina Estuaries[a]

Species	Habitats									
	Phragmites	Live Thickets	Dead Thickets	Dike, Bare	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Wet	Bulldozer Scrape, Dry	Drain Pond, Wet	Drain Pond, Dry
Great blue heron	--	--	--	--	--	0.2	--	--	Covered over in January 1977	--
Snowy egret	--	--	--	1.0	--	0.2	--	--		--
White ibis	--	--	--	1.6	--	--	--	--		--
Mallard	--	--	--	--	--	0.5	--	--		--
Black duck	--	--	--	--	--	1.1	--	--		--
Gadwall	--	--	--	--	--	0.5	--	--		--
Green-winged teal	--	--	--	--	--	1.8	--	--		--
Blue-winged teal	--	--	--	--	--	9.3	--	--		--
American wigeon	--	--	--	--	--	3.6	--	--		--
Bufflehead	--	--	--	--	--	0.5	--	--		--
Red-breasted merganser	--	--	--	--	--	0.2	--	--		--
Sharp-shinned hawk	1.1	--	--	--	--	--	--	--		--
American oystercatcher	--	--	--	2.1	--	--	--	--		--
Common snipe	--	--	--	--	--	0.9	--	--		--

[a] Values are in birds per hectare.

Table C11 (continued)

Species	Phragmites	Live Thickets	Dead Thickets	Dike, Bare	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Wet	Bulldozer Scrape, Dry	Drain Pond, Wet	Drain Pond, Dry
Whimbrel	--	--	--	0.5	--	0.2	--	--	Covered over in January 1977	--
Spotted sandpiper	--	--	--	--	--	0.7	--	--		--
Solitary sandpiper	--	--	--	--	--	0.2	--	--		--
Willet	--	--	--	4.7	--	3.4	--	--		--
Yellowlegs (species unidentified)	--	--	--	--	--	0.2	--	--		--
Greater yellowlegs	--	--	--	--	--	1.1	--	--		--
Pectoral sandpiper	--	--	--	--	--	0.2	--	--		--
Least sandpiper	--	--	--	--	--	10.7	--	--		--
Short-billed dowitcher	--	--	--	--	--	12.3	--	--		--
Semipalmated sandpiper	--	--	--	--	--	8.4	--	--		--
Herring gull	--	--	--	1.6	--	--	--	--		--
Ring-billed gull	--	--	--	2.1	--	0.9	--	--		--
Bonaparte's gull	--	--	--	--	--	0.2	--	--		--
Mourning dove	--	--	--	--	1.9	--	--	--		--
Rough-winged swallow	--	--	1.9	--	--	--	--	--		--
Fish crow	--	--	--	2.1	--	0.5	--	--		--
Short-billed marsh wren	--	--	--	--	0.9	--	--	--		--
Starling	--	--	--	--	--	0.9	--	--		--

Table C11 (concluded)

Species	Habitats									
	Phragmites	Live Thickets	Dead Thickets	Dike, Bare	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Wet	Bulldozer Scrape, Dry	Drain Pond, Wet	Drain Pond, Dry
Yellow-rumped warbler	--	1.9	10.5	8.8	--	4.6	--	--	Covered over in January 1977	--
Prairie warbler	--	1.0	--	--	--	--	--	--		--
Palm warbler	--	--	--	--	--	0.2	--	--		--
Common yellowthroat	--	1.0	--	--	--	--	--	--		--
Red-winged blackbird	4.4	--	11.5	2.1	0.9	2.3	--	--		0.5
Boat-tailed grackle	--	0.5	--	8.8	--	4.8	--	--		--
Cardinal	--	0.5	--	--	--	--	--	--		--
Painted bunting	--	0.5	--	--	--	--	--	--		--
Rufous-sided towhee	--	1.0	--	--	--	--	--	--		--
Sparrow (species unidentified)	--	--	1.9	--	--	--	2.2	0.9		--
Savannah sparrow	--	--	1.0	11.4	0.9	0.5	--	--		--
Seaside sparrow	--	--	1.0	0.5	--	0.2	--	--		--
White-throated sparrow	--	1.4	--	--	--	--	--	--		--
Swamp sparrow	--	--	6.7	--	--	--	2.2	0.9		--
Song sparrow	--	--	--	--	6.5	--	--	--		--
Total birds/hectare	5.5	7.8	34.5	48.3	18.6	71.3	4.4	1.8	0.0	0.5

Table C12

Summary of Spring Migrant Birds Associated with Diked and Filled Dredged Material Islands in North Carolina Estuaries[a]

Species	Habitats Similar to Those Occurring on Undiked Islands								Habitats Restricted to Diked Islands									
	Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Mixed Grasses and Shrubs	Beach	Salt Marsh Fringe	Tidal Mudflat	Dike, Bare	Dike, Sparse Grasses	Dike, Dense Grasses	Dike, Phragmites	Dike, Mixed Grasses & Shrubs	Bulldozer Scrape, Wet	Borrow Pit, Wet	Drain Pond, Wet	Interior Mudflat	Dead Thickets
Great blue heron	--	--	--	--	--	--	0.7	--	--	--	--	--	--	--	--	--	--	0.3
Green heron	--	--	--	--	0.3	--	--	--	--	--	--	--	--	--	--	0.1	--	--
Little blue heron	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1
Snowy egret	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--	0.6
Louisiana heron	--	--	--	--	--	--	0.2	--	--	--	--	--	--	--	--	--	--	--
Black-crowned night heron	--	--	--	--	--	--	0.9	--	--	--	--	--	--	--	--	--	--	--
Least bittern	--	--	--	--	--	--	0.2	--	--	--	--	--	--	--	--	--	--	--
Glossy ibis	--	--	--	--	--	--	0.2	--	--	--	--	--	--	--	--	--	--	--
White ibis	--	--	--	--	--	--	0.2	--	--	--	--	--	--	--	0.3	--	--	2.8
Black duck	--	--	--	--	--	--	1.4	--	--	--	--	--	--	--	--	--	--	--
Gadwall	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	--	--	--
Pintail	--	--	--	--	--	--	0.2	--	--	--	--	--	--	--	--	--	--	--
Green-winged teal	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.7	--	--	--
Blue-winged teal	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.5	1.8	--	--
American wigeon	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	--	--	--
Ruddy duck	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--	--
Hooded merganser	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--
Marsh hawk	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1
Osprey	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.2
American kestrel	--	--	--	--	0.3	--	--	--	--	0.3	--	--	--	--	--	--	--	--
Bobwhite	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0
Rail (species unidentified)	--	--	--	--	--	--	0.2	--	--	--	--	--	--	--	--	--	--	--

[a]Values are in birds per hectare.

Table C12 (continued)

Species	Habitats Similar to Those Occurring on Undiked Islands								Habitats Restricted to Diked Islands									
	Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Mixed Grasses and Shrubs	Beach	Salt Marsh Fringe	Tidal Mudflat	Dike, Bare	Dike, Sparse Grasses	Dike, Dense Grasses	Dike, Phragmites	Dike, Mixed Grasses & Shrubs	Bulldozer Scrape, Wet	Borrow Pit, Wet	Drain Pond, Wet	Interior Mudflat	Dead Thickets
American coot	--	--	--	--	--	--	0.7	--	--	--	--	--	--	--	--	--	--	--
American oystercatcher	0.3	0.6	--	--	--	0.9	0.2	--	0.3	--	--	--	--	--	--	0.1	--	--
Semipalmated plover	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.6	16.4	0.2	--
Wilson's plover	0.1	--	--	--	--	0.2	--	2.0	0.3	--	--	--	--	--	--	--	--	--
Black-bellied plover	0.7	--	--	--	--	0.9	--	--	--	--	--	--	--	--	--	0.2	--	--
Common snipe	--	--	--	--	--	--	0.2	--	--	--	--	--	--	--	0.3	--	0.3	--
Whimbrel	--	--	--	--	--	0.2	--	--	--	--	--	--	--	--	--	--	--	--
Spotted sandpiper	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.6	--	--	--
Solitary sandpiper	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	--	--	--
Willet	0.1	0.2	0.7	--	1.1	0.2	0.7	--	0.3	1.0	--	--	--	0.9	0.4	0.1	--	--
Yellowlegs (species unidentified)	--	--	--	--	--	--	--	0.7	--	--	--	--	--	--	0.1	--	--	--
Greater yellowlegs	--	--	--	--	--	--	--	--	--	--	--	--	--	0.5	0.1	0.5	--	--
Lesser yellowlegs	--	--	--	--	--	--	--	0.7	--	--	--	--	--	--	2.1	0.7	--	--
Peep (specied unidentified)	0.1	--	--	--	--	--	0.7	--	--	--	--	--	--	--	--	0.3	4.0	3.7
White-rumped sandpiper	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--	--
Least sandpiper	--	--	--	--	--	--	--	2.0	--	--	--	--	--	--	3.0	1.1	--	--
Dunlin	--	--	--	--	--	--	0.2	--	--	--	--	--	--	--	0.1	19.4	--	--
Short-billed dowitcher	0.4	--	--	--	--	0.2	0.5	--	--	--	--	--	--	--	7.8	--	1.9	1.2
Semipalmated sandpiper	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0	21.9	--	--
Sanderling	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--	--	--	--	--
Northern phalarope	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--
Herring gull	1.5	--	--	--	--	0.8	--	--	--	--	--	--	--	--	--	--	--	--
Ring-billed gull	--	0.3	--	--	--	3.8	--	--	--	--	--	--	--	--	0.1	--	--	--
Laughing gull	0.1	7.6	--	--	--	1.4	--	--	--	--	--	--	--	--	0.7	--	--	--
Gull-billed tern	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table C12 (continued)

Species	Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Mixed Grasses and Shrubs	Beach	Salt Marsh Fringe	Tidal Mudflat	Dike, Bare	Dike, Sparse Grasses	Dike, Dense Grasses	Dike, Phragmites	Dike, Mixed Grasses & Shrubs	Bulldozer Scrape, Wet	Borrow Pit, Wet	Drain Pond, Wet	Interior Mudflat	Dead Thickets
	Habitats Similar to Those Occurring on Undiked Islands								Habitats Restricted to Diked Islands									
Common tern	0.1	0.1	--	--	--	0.3	--	--	--	--	--	--	--	--	--	--	--	--
Least tern	4.0	--	--	--	--	3.0	--	--	--	--	--	--	--	--	--	--	--	--
Royal tern	0.9	0.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Black skimmer	0.1	--	--	--	--	--	--	--	1.3	--	--	--	--	--	--	--	--	--
Mourning dove	--	--	0.7	--	--	--	--	--	--	0.5	--	--	--	--	--	0.1	--	1.3
Ground dove	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3
Common nighthawk	--	--	0.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Belted kingfisher	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--	--
Common flicker	--	--	--	--	0.8	--	--	--	--	--	--	--	--	--	--	--	--	0.3
Red-bellied woodpecker	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1
Downy woodpecker	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1
Fish crow	0.2	0.1	--	--	--	--	0.7	--	--	--	--	--	--	0.9	--	--	--	0.3
Long-billed marsh wren	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--	--
Short-billed marsh wren	--	--	--	--	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--
Mockingbird	--	--	--	--	0.3	--	--	--	--	--	--	--	--	--	--	--	--	--
Brown thrasher	--	--	--	--	0.8	--	--	--	--	--	--	--	--	--	--	--	--	--
Starling	--	--	--	--	1.6	--	--	--	--	--	--	--	--	--	--	--	--	8.5
Yellow-rumped warbler	--	--	--	--	0.3	--	--	1.3	--	--	--	--	--	--	0.3	--	--	6.8
Prairie warbler	--	--	--	--	0.5	--	--	--	--	--	--	--	2.2	--	--	--	--	--
Palm warbler	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4
Common yellowthroat	--	--	--	--	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--
Red-winged blackbird	--	0.8	5.7	12.0	2.4	--	0.2	--	--	0.8	4.1	7.9	--	--	0.3	--	--	5.1
Boat-tailed grackle	--	--	0.7	12.0	0.8	0.2	0.5	2.0	0.3	1.0	1.2	0.4	--	--	0.5	--	0.2	1.6
Cardinal	--	--	--	--	--	--	--	--	--	--	--	--	2.2	--	--	--	--	0.1
Painted bunting	--	--	--	--	--	--	--	--	--	--	--	--	2.2	--	--	--	--	--

Table C12 (concluded)

Species	Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Mixed Grasses and Shrubs	Beach	Salt Marsh Fringe	Tidal Mudflat	Dike, Bare	Dike, Sparse Grasses	Dike, Dense Grasses	Dike, Phragmites	Dike, Mixed Grasses & Shrubs	Bulldozer Scrape, Wet	Borrow Pit, Wet	Drain Pond, Wet	Interior Mudflat	Dead Thickets
	Habitats Similar to Those Occurring on Undiked Islands								Habitats Restricted to Diked Islands									
Rufous-sided towhee	--	--	--	--	0.3	--	--	--	--	--	--	--	--	--	--	--	--	--
Sparrow (species unidentified)	--	--	--	4.0	0.5	--	0.2	--	--	0.5	--	3.1	--	--	0.5	--	--	0.4
Savannah sparrow	--	0.6	0.7	--	2.4	--	2.7	1.3	--	1.0	0.6	--	--	--	0.2	--	0.2	0.3
Sharp-tailed sparrow	--	--	--	--	--	--	0.5	--	--	--	--	--	--	--	--	--	--	--
Seaside sparrow	--	--	--	--	--	--	--	--	--	--	--	0.4	--	--	--	--	--	--
Field sparrow	--	--	--	--	1.6	--	--	--	--	--	5.3	--	--	--	--	--	--	--
White-throated sparrow	--	0.2	--	--	0.5	--	--	--	--	--	--	--	--	--	--	--	--	0.6
Swamp sparrow	--	--	--	1.3	1.1	--	1.6	--	--	--	0.6	0.4	--	--	1.2	--	--	--
Song sparrow	--	--	--	2.7	1.9	--	--	--	--	--	--	0.4	--	--	0.1	--	--	--
Total birds/hectare	8.2	10.8	9.2	32.0	17.5	12.4	13.8	10.0	2.5	5.7	11.8	12.6	4.4	2.3	23.9	62.5	6.8	37.2

Table C13

Summary of Summer Birds Associated with Undiked Dredged Material Islands in North Carolina Estuaries[a]

Species	Habitats						
	Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Live Thickets	Salt Marsh Fringe	Beach
Brown pelican	3.2	5.5	1.0	--	--	--	2.6
Great egret	--	--	--	--	0.3	--	--
Clapper rail	--	--	--	--	--	2.2	--
American oystercatcher	5.3	0.3	--	--	--	--	0.6
Wilson's plover	--	0.5	--	--	--	--	--
Willet	--	0.3	--	--	0.3	--	--
Herring gull	--	--	--	--	--	--	0.3
Laughing gull	10.7	0.2	--	--	--	--	1.0
Gull-billed tern	--	0.3	--	--	--	--	--
Common tern	--	19.0	--	--	--	--	--
Royal tern	2732.8[b]	79.2	--	--	--	--	1021.8
Black skimmer	--	8.7	--	--	--	--	--
Mourning dove	--	0.8	--	21.5	0.3	--	--
Long-billed marsh wren	--	--	--	21.5	--	4.5	--
Mockingbird	--	--	--	--	0.6	--	--
Warbler (species unidentified)	--	--	--	--	0.6	--	--
Prairie warbler	--	--	--	--	0.6	--	--
Eastern meadowlark	--	--	0.2	--	--	--	--
Red-winged blackbird	--	--	0.5	21.5	9.0	2.2	--
Boat-tailed grackle	--	--	0.2	--	2.3	1.1	--
Cardinal	--	--	--	--	1.4	--	--
Rufous-sided towhee	--	--	--	--	2.0	--	--
Seaside sparrow	--	--	--	--	0.3	2.2	--
Total birds/hectare	2752.0	114.8	1.9	64.5	17.7	12.2	1026.3

[a]Values are in birds per hectare.

[b]Large numbers due to presence of breeding colony within study site.

Table C14

Summary of Summer Birds Associated with Diked and Not Filled Dredged Material Islands in North Carolina Estuaries[a]

Species	Habitats Similar to Those Occurring on Undiked Islands				Habitats Restricted to Diked Islands						
	Sparse Grasses	Dense Mixed Grasses	Mixed Grasses and Shrubs	Live Thickets	Dike, Sparse Grasses	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Dry	Interior Marsh	Interior Mudflat	Rubbish Pile
Great blue heron	--	--	0.8	--	--	--	0.4	--	--	--	--
Green heron	--	--	--	2.0	--	--	3.2	--	--	2.4	--
Little blue heron	--	--	--	2.0	--	--	0.7	--	--	--	6.6
Great egret	--	--	--	--	--	--	0.4	--	--	--	6.6
Snowy egret	--	--	3.0	--	--	--	0.4	--	--	--	8.3
Louisiana heron	--	--	--	--	--	--	--	--	--	--	1.7
Black-crowned night heron	--	--	--	--	--	--	0.4	--	--	--	--
Yellow-crowned night heron	--	--	--	2.0	--	--	--	--	--	--	--
White ibis	--	--	--	4.0	--	--	1.1	--	--	--	1.7
Mallard	--	--	--	--	--	--	0.7	--	--	--	--
Clapper rail	--	--	--	--	--	0.2	--	--	--	--	--
American oystercatcher	0.1	--	--	--	--	1.1	--	--	--	--	--
Wilson's plover	0.3	--	--	--	--	0.7	--	--	--	4.8	--

[a]Values are in birds per hectare.

Table C14 (continued)

Species	Habitats Similar to Those Occurring on Undiked Islands				Habitats Restricted to Diked Islands						
	Sparse Mixed Grasses	Dense Mixed Grasses	Mixed Grasses and Shrubs	Live Thickets	Dike, Sparse Grasses	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Dry	Interior Marsh	Interior Mudflat	Rubbish Pile
Spotted sandpiper	--	--	--	--	--	0.2	1.4	--	--	2.4	--
Willet	--	0.3	--	--	--	3.3	2.5	--	--	4.8	3.3
Greater yellowlegs	--	--	--	--	--	--	1.1	--	--	--	--
Peep (species unidentified)	--	--	--	--	--	--	4.9	--	--	--	--
Least sandpiper	--	--	--	--	--	--	0.4	--	--	4.8	--
Short-billed dowitcher	--	--	--	--	--	--	0.4	--	--	--	--
Semipalmated sandpiper	--	--	--	--	--	--	0.4	--	--	--	--
Ring-billed gull	--	--	--	--	--	--	0.4	--	--	--	--
Gull-billed tern	--	--	--	--	--	--	0.7	--	--	--	--
Common tern	--	--	--	--	--	--	0.4	--	--	--	--
Black skimmer	--	--	--	--	--	--	0.4	--	--	--	--
Mourning dove	0.3	--	3.8	20.2	0.6	0.4	2.8	--	--	--	1.7
Ground dove	--	--	--	--	--	0.2	--	--	--	--	--
Common nighthawk	--	0.3	--	--	--	--	0.4	--	--	2.4	--
Fish crow	--	--	1.5	--	--	--	--	--	--	--	--
Mockingbird	--	--	5.3	--	1.1	--	--	--	--	--	16.6
Red-winged blackbird	0.1	6.3	1.5	26.2	--	7.3	2.1	--	--	28.6	23.2

Table C14 (concluded)

Species	Habitats Similar to Those Occurring on Undiked Islands				Habitats Restricted to Diked Islands						
	Sparse Mixed Grasses	Dense Mixed Grasses	Mixed Grasses and Shrubs	Live Thickets	Dike, Sparse Grasses	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Dry	Interior Marsh	Interior Mudflat	Rubbish Pile
Boat-tailed grackle	--	3.8	0.8	14.1	--	0.4	6.0	--	--	4.8	24.8
Cardinal	--	--	0.8	--	--	--	--	--	--	--	--
Seaside sparrow	--	0.6	--	--	--	--	--	--	5.6	4.8	--
Total birds/hectare	0.8	11.3	17.5	70.5	1.7	13.8	33.0	0.0	5.6	59.8	94.5

Table C15

Summary of Summer Birds Associated with Diked and Influenced Dredged Material Islands in North Carolina Estuaries[a]

Species	Habitats									
	Phragmites	Live Thickets	Dead Thickets	Dike, Bare	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Wet	Bulldozer Scrape, Dry	Drain Pond, Wet	Drain Pond, Dry
Little blue heron	--	--	--	--	--	2.3	--	--	Covered over in January 1977	--
Great egret	--	--	--	1.3	1.7	--	--	--		--
Snowy egret	--	--	--	--	8.0	--	--	--		--
Louisiana heron	--	--	--	--	1.1	--	--	--		--
Yellow-crowned night heron	--	--	--	--	1.7	--	--	--		--
White ibis	--	--	--	--	11.7	--	--	--		--
Mallard	--	--	--	--	0.6	--	--	--		--
Clapper rail	--	--	--	0.6	--	--	--	--		--
American oystercatcher	--	--	--	1.3	--	--	--	--		--
Semipalmated plover	--	--	--	--	0.3	--	--	--		--
Wilson's plover	--	--	--	1.3	0.6	--	--	--		--
Black-bellied plover	--	--	--	--	0.3	--	--	--		--
Ruddy turnstone	--	--	--	--	0.3	--	--	--		--
Spotted sandpiper	--	--	--	--	4.0	--	--	--		--

[a]Values are in birds per hectare.

Table C15 (continued)

Species	Habitats									
	Phragmites	Live Thickets	Dead Thickets	Dike, Bare	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Wet	Bulldozer Scrape, Dry	Drain Pond, Wet	Drain Pond, Dry
Willet	--	--	--	2.6	--	3.7	--	--	Covered over in January 1977	--
Greater yellowlegs	--	--	--	--	--	1.1	--	--		--
Lesser yellowlegs	--	--	--	--	--	1.1	--	--		--
Pectoral sandpiper	--	--	--	--	--	1.1	--	--		--
Peep (species unidentified)	--	--	--	--	--	3.4	--	--		--
Least sandpiper	--	--	--	--	--	3.7	--	--		--
Dunlin	--	--	--	--	--	0.3	--	--		--
Short-billed dowitcher	--	--	--	--	--	10.5	--	--		--
Semipalmated sandpiper	--	--	--	--	--	11.4	--	--		--
Western sandpiper	--	--	--	--	--	12.2	--	--		--
Black skimmer	--	--	--	--	--	0.3	--	--		--
Mourning dove	--	1.2	--	0.6	1.2	0.3	--	--		--
Mockingbird	--	--	--	--	1.2	0.3	--	--		0.6
Prairie warbler	--	0.6	--	--	--		--	--		--
Common yellowthroat	--	5.4	--	--	--		--	2.3		--
Red-winged blackbird	1.8	0.6	35.8	5.8	4.7	1.7	--	--		0.6
Boat-tailed grackle	--	0.6	3.6	1.3	--	2.3	--	--		--
Cardinal	--	--	--	--	--	--	--	--		0.6

Table C15 (concluded)

Species	Habitats									
	Phragmites	Live Thickets	Dead Thickets	Dike, Bare	Dike, Dense Grasses	Borrow Pit, Wet	Bulldozer Scrape, Wet	Bulldozer Scrape, Dry	Drain Pond, Wet	Drain Pond, Dry
Painted bunting	--	1.2	--	--	--	--	--	--		--
Rufous-sided towhee	--	0.6	--	--	--	--	--	--		--
Seaside sparrow	--	--	1.2	3.2	--	0.3	--	--		--
Total birds/hectare	1.8	10.2	40.6	18.0	7.1	86.3	0.0	2.3		1.8

Table C16

Summary of Summer Birds Associated with Diked and Filled Dredged Material Islands in North Carolina Estuaries[a]

	Habitats Similar to Those Occurring on Undiked Islands								Habitats Restricted to Diked Islands									
Species	Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Mixed Grasses and Shrubs	Beach	Salt Marsh Fringe	Tidal Mudflat	Dike, Bare	Dike, Sparse Grasses	Dike, Dense Grasses	Dike, Phragmites	Dike, Mixed Grasses & Shrubs	Bulldozer Scrape, Wet	Borrow Pit, Wet	Drain Pond, Wet	Interior Mudflat	Dead Thickets
Great blue heron	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4
Green heron	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2
Little blue heron	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--	2.1
Great egret	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.5
Snowy egret	--	--	--	--	--	0.2	--	--	--	0.4	--	--	--	--	0.1	--	--	6.8
Louisiana heron	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4
Black-crowned night heron	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.2
Yellow-crowned night heron	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.1	--	--	0.4
White ibis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.8
Blue-winged teal	--	--	--	--	--	--	1.0	--	--	--	--	--	--	--	--	--	--	--
Red-breasted merganser	--	--	--	--	--	0.2	--	--	--	--	--	--	--	--	--	--	--	--
Osprey	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.2
Clapper rail	--	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--	--	--	--
American oystercatcher	0.5	0.4	--	--	--	0.6	--	0.8	1.0	0.4	--	--	--	--	--	0.1	0.5	--
Semipalmated plover	1.2	--	--	--	--	2.0	0.3	0.8	--	--	--	--	--	1.8	--	0.5	--	--
Piping plover	--	--	--	--	--	0.4	--	--	--	--	--	--	--	--	--	--	--	--
Wilson's plover	0.5	--	--	--	--	0.2	--	9.0	0.7	0.4	--	--	--	1.2	--	0.2	1.9	--
Black-bellied plover	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	--	--
Ruddy turnstone	--	--	--	--	--	0.2	--	--	--	--	--	--	--	--	--	1.4	--	--
Whimbrel	--	--	--	--	--	--	--	--	--	0.4	--	--	--	--	--	--	--	--
Spotted sandpiper	0.1	--	1.2	--	--	--	1.6	1.6	--	--	--	1.5	--	2.4	0.8	0.5	--	--
Solitary sandpiper	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	--	--

[a]Values are in birds per hectare.

Table C16 (continued)

Species	Habitats Similar to Those Occurring on Undiked Islands								Habitats Restricted to Diked Islands									
	Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Mixed Grasses and Shrubs	Beach	Salt Marsh Fringe	Tidal Mudflat	Dike, Bare	Dike, Sparse Grasses	Dike, Dense Grasses	Dike, Phragmites	Dike, Mixed Grasses & Shrubs	Bulldozer Scrape, Wet	Borrow Pit, Wet	Drain Pond, Wet	Interior Mudflat	Dead Thickets
Willet	0.1	0.7	--	--	0.8	0.6	1.0	2.5	0.3	0.4	1.0	--	--	--	--	0.3	0.7	--
Greater yellowlegs	--	--	--	--	--	0.8	0.3	--	--	--	--	--	--	--	--	1.3	--	--
Lesser yellowlegs	--	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--	1.1	--	--
Peep (species unidentified)	0.1	--	--	--	--	0.2	2.3	9.0	--	--	--	--	--	--	--	1.4	--	--
Pectoral sandpiper	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	--	--
White-rumped sandpiper	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4	--	--
Least sandpiper	--	--	--	--	--	--	1.9	--	--	0.4	--	--	--	3.6	--	0.1	--	--
Short-billed dowitcher	--	--	--	--	--	--	3.9	0.8	--	--	--	--	--	--	--	0.4	--	--
Semipalmated sandpiper	--	--	--	--	--	1.6	--	0.8	--	--	--	--	--	--	--	8.9	--	--
Western sandpiper	--	--	--	--	--	1.0	--	--	--	--	--	--	--	15.4	0.4	2.7	1.0	--
Sanderling	--	--	--	--	--	0.6	--	--	--	--	--	--	--	--	--	1.4	--	--
Herring gull	--	--	--	--	--	5.1	--	--	--	--	--	--	--	--	--	0.8	--	--
Ring-billed gull	--	--	--	--	--	3.6	--	--	--	--	--	--	--	--	--	0.3	--	--
Laughing gull	--	44.5	--	222.2	126.0	8.3	--	--	0.7	--	--	36.4	--	--	27.5	1.5	--	--
Gull-billed tern	0.2	--	--	--	--	0.4	--	--	--	--	--	--	--	--	--	0.1	--	--
Common tern	0.9	--	--	--	--	6.5	--	--	2.3	--	--	--	--	--	--	3.5	--	--
Least tern	8.5	0.3	--	--	--	8.7	--	--	--	--	--	--	--	--	--	--	--	--
Royal tern	--	--	--	--	--	0.4	--	--	--	--	--	--	--	--	--	--	--	--
Black skimmer	2.7	--	--	--	--	0.6	0.3	--	12.8	--	--	--	--	--	--	8.4	--	--
Mourning dove	0.1	0.1	--	--	7.3	--	--	--	--	0.8	--	--	--	3.6	0.1	--	1.4	7.0
Ground dove	--	0.3	--	--	1.2	--	--	--	--	--	--	--	--	0.6	--	--	--	0.6
Common nighthawk	0.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4
Common flicker	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2
Fish crow	--	--	--	--	--	--	--	--	0.3	--	--	--	--	--	--	--	--	2.5
Mockingbird	--	--	--	--	--	--	--	--	--	0.8	--	--	--	--	--	--	--	5.6

Table C16 (concluded)

Species	Bare	Mixed Grasses, Sparse	Mixed Grasses, Dense	Phragmites	Mixed Grasses and Shrubs	Beach	Salt Marsh Fringe	Tidal Mudflat	Dike, Bare	Dike, Sparse Grasses	Dike, Dense Grasses	Dike, Phragmites	Dike, Mixed Grasses & Shrubs	Bulldozer Scrape, Wet	Borrow Pit, Wet	Drain Pond, Wet	Interior Mudflat	Dead Thickets
	Habitats Similar to Those Occurring on Undiked Islands								Habitats Restricted to Diked Islands									
Brown thrasher	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.8
Loggerhead shrike	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.6
Starling	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.4
Prairie warbler	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2
Common yellowthroat	--	--	--	--	--	--	--	--	--	--	--	0.7	--	--	--	--	--	1.4
Red-winged blackbird	0.1	0.1	--	11.1	1.6	--	1.6	--	1.0	3.8	5.8	5.8	--	0.6	0.8	--	--	7.9
Orchard oriole	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2
Boat-tailed grackle	0.1	--	--	--	2.4	--	--	--	--	--	1.0	0.7	--	1.8	--	--	--	6.2
Common grackle	--	--	--	--	0.8	--	--	--	--	--	--	--	--	--	--	--	--	1.0
Cardinal	--	--	--	--	1.2	--	--	--	--	--	--	--	--	--	--	--	--	0.8
Painted bunting	--	--	--	--	--	--	--	--	--	--	--	--	5.6	--	--	--	--	--
Savannah sparrow	--	--	--	--	--	--	0.6	--	--	0.4	--	--	--	--	--	--	--	--
Seaside sparrow	--	--	--	--	--	--	0.3	0.8	--	--	--	--	--	--	--	--	--	0.2
Total birds/hectare	14.8	46.4	1.2	233.3	141.3	42.2	15.7	26.1	19.1	8.2	7.8	45.1	5.6	31.0	29.9	36.2	5.5	59.0

Table C17

Dredged Material Island Heronry Locations and Numbers of Nests in North Carolina Estuaries[a]

Island Number	Coordinates Latitude	Coordinates Longitude	Species Present	Total Nests
03-05	35° 48'	75° 35'	Louisiana heron	101
			Cattle egret	79
			Snowy egret	64
			Glossy ibis	55
			Little blue heron	34
			Black-crowned night heron	26
			Great egret	23
07-02	35° 43'	75° 30'	Little blue heron	10
			Great egret	9
			Yellow-crowned night heron	2
			Louisiana heron	1
			Snowy egret	1
07-04	35° 43'	75° 30'	Snowy egret	86
			Little blue heron	52
			Black-crowned night heron	50
			Louisiana heron	49
			Glossy ibis	35
			Cattle egret	5
			Great egret	5
06-10	35° 12'	75° 36'	Snowy egret	16
			Glossy ibis	4
			Louisiana heron	4
			Little blue heron	2
14-02	34° 59'	76° 15'	Little blue heron	94
			Glossy ibis	71
			Louisiana heron	62
			Snowy egret	58
			Great egret	33
			Black-crowned night heron	19
			Cattle egret	18
16-01	34° 54'	76° 17'	Cattle egret	190
			Louisiana heron	98
			Glossy ibis	34
			Great egret	19

[a]All sites were undiked.

Table C17 (continued)

Island Number	Coordinates Latitude	Longitude	Species Present	Total Nests
			Black-crowned night heron	16
			Snowy egret	9
			Little blue heron	8
17-01	34° 40'	76° 32'	Snowy egret	62
			Louisiana heron	48
			Little blue heron	23
			Great egret	8
			Glossy ibis	2
			Black-crowned night heron	1
21-03	34° 44'	76° 42'	Glossy ibis	24
			Louisiana heron	16
			Little blue heron	15
			Black-crowned night heron	6
			Snowy egret	6
			White ibis	3
			Great egret	1
21-04	34° 44'	76° 41'	Cattle egret	159
			Great egret	50
			Louisiana heron	29
			Little blue heron	15
			Snowy egret	9
			Black-crowned night heron	1
22-41	34° 40'	77° 02'	Louisiana heron	449
			Little blue heron	362
			Cattle egret	220
			Snowy egret	151
			Great egret	138
			Green heron	17
			Black-crowned night heron	1
27-03	34° 30'	77° 25'	Green heron	4
27-04	34° 30'	77° 25'	Green heron	4
27-06	34° 30'	77° 25'	Green heron	3
			Little blue heron	2
27-07	34° 30'	77° 25'	Great egret	1
			Green heron	1

Table C17 (concluded)

Island Number	Coordinates Latitude	Longitude	Species Present	Total Nests
39-46	33^{o} 54'	78^{o} 01'	White ibis	1946
			Louisiana heron	240
			Snowy egret	87
			Glossy ibis	72
			Little blue heron	72
			Black-crowned night heron	28
			Cattle egret	7
			Green heron	6
			Great egret	3
39-51	33^{o} 54'	78^{o} 01'	Cattle egret	693
			Snowy egret	450
			Louisiana heron	368
			Great egret	144
			Glossy ibis	86
			Black-crowned night heron	75
			Little blue heron	13
			White ibis	2

Table C18

Dredged Material Island Gull, Tern, and Skimmer Colony Locations, Site Conditions, and Numbers of Nests in North Carolina Estuaries[a]

Island Number	Coordinates		Site Condition	Species Present	Total Nests
	Latitude	Longitude			
03-04	35° 50'	75° 36'	Undiked	Herring gull	1
03-05	35° 48'	75° 35'	Undiked	Laughing gull	926
				Herring gull	180
				Great black-backed gull	3
03-06	35° 50'	75° 36'	Undiked	Herring gull	114
				Laughing gull	99
				Great black-backed gull	2
03-07	35° 48'	75° 35'	Undiked	Herring gull	48
				Laughing gull	19
				Caspian tern	5
				Black skimmer	5
				Great black-backed gull	3
03-08	35° 54'	75° 37'	Diked	Least tern	4
03-09	35° 49'	75° 35'	Undiked	Laughing gull	280
				Herring gull	85
				Great black-backed gull	1
05-06	35° 46'	75° 34'	Undiked	Royal tern	2366
				Least tern	45
				Gull-billed tern	22
				Common tern	11
				Herring gull	1
06-02	35° 46'	75° 35'	Undiked	Common tern	550
				Sandwich tern	422
				Black skimmer	241
				Royal tern	232
				Laughing gull	102
				Gull-billed tern	4
				Caspian tern	3
06-04	35° 45'	75° 35'	Undiked	Herring gull	1

[a]Sites ordered generally from north to south. See Figures D3-D17 for site locations.

Table C18 (continued)

Island Number	Coordinates Latitude	Longitude	Site Condition	Species Present	Total Nests
06-07	35° 45'	75° 35'	Undiked	Great black-backed gull	1
				Herring gull	1
06-08	35° 46'	75° 35'	Undiked	Black skimmer	103
				Common tern	38
				Gull-billed tern	21
				Herring gull	3
				Caspian tern	2
06-09	35° 42'	75° 46'	Undiked	Common tern	191
				Black skimmer	63
				Gull-billed tern	4
06-10	35° 12'	75° 36'	Undiked	Royal tern	2988
				Sandwich tern	897
				Laughing gull	506
				Common tern	65
				Forster's tern	45
				Herring gull	1
06-11	35° 12'	75° 43'	Undiked	Common tern	148
				Gull-billed tern	13
				Black skimmer	7
06-23	35° 46'	75° 35'	Undiked	Black skimmer	47
				Common tern	34
				Gull-billed tern	4
09-03	35° 13'	75° 45'	Diked	Common tern	490
				Least tern	313
				Forster's tern	136
				Black skimmer	119
				Gull-billed tern	36
				Laughing gull	5
09-04	35° 12'	75° 46'	Undiked	Black skimmer	177
				Common tern	49
				Laughing gull	9
				Gull-billed tern	8
11-05	35° 06'	76° 03'	Undiked	Royal tern	305
				Common tern	76
				Sandwich tern	32
				Herring gull	18
				Forster's tern	4

Table C18 (continued)

Island Number	Coordinates Latitude	Longitude	Site Condition	Species Present	Total Nests
14-02	34° 59'	76° 12'	Undiked	Laughing gull	160
				Herring gull	4
14-04	34° 52'	76° 20'	Diked	Common tern	292
				Black skimmer	169
				Gull-billed tern	85
				Royal tern	33
14-10	34° 51'	76° 20'	Undiked	Common tern	398
				Forster's tern	33
				Royal tern	1
14-14	34° 35'	76° 30'	Undiked	Common tern	8
				Black skimmer	4
				Gull-billed tern	2
				Least tern	1
16-01	34° 54'	76° 17'	Undiked	Laughing gull	3511
				Herring gull	2
16-02	34° 52'	76° 17'	Undiked	Forster's tern	36
				Laughing gull	12
				Herring gull	1
17-01	34° 40'	76° 32'	Diked	Royal tern	4319
				Sandwich tern	478
17-01	34° 40'	76° 32'	Undiked	Laughing gull	1871
17-03	34° 39'	76° 32'	Undiked	Common tern	64
				Black skimmer	11
				Gull-billed tern	2
17-07	34° 40'	76° 31'	Undiked	Black skimmer	28
				Common tern	16
				Least tern	14
17-08	34° 40'	76° 31'	Undiked	Common tern	32
18-13	34° 43'	76° 40'	Diked	Common tern	1
20-02	34° 43'	76° 41'	Diked	Least tern	11
				Common tern	5

Table C18 (continued)

Island Number	Coordinates Latitude	Longitude	Site Condition	Species Present	Total Nests
20-03	34° 43'	76° 41'	Diked	Common tern	133
				Black skimmer	30
				Least tern	30
				Gull-billed tern	6
20-06	34° 42'	76° 42'	Diked	Common tern	426
				Black skimmer	182
				Gull-billed tern	100
				Least tern	62
21-01	34° 44'	76° 42'	Diked	Least tern	6
22-08	34° 43'	76° 57'	Undiked	Common tern	116
				Least tern	9
22-25	34° 41'	77° 00'	Diked	Least tern	23
22-26	34° 41'	77° 01'	Diked	Least tern	8
22-40	34° 41'	77° 03'	Diked	Least tern	32
22-44	34° 40'	77° 05'	Diked	Least tern	2
22-45	34° 40'	77° 06'	Diked	Least tern	6
				Common tern	1
23-10	34° 41'	77° 06'	Diked	Least tern	152
26-07	34° 43'	77° 21'	Diked	Least tern	2
				Common tern	1
29-25	34° 24'	77° 37'	Diked	Least tern	20
33-15	34° 15'	77° 46'	Diked	Least tern	4
36-03	34° 12'	77° 49'	Diked	Least tern	7
36-13	34° 12'	77° 51'	Diked	Least tern	1
37-10	34° 06'	77° 52'	Diked	Least tern	30
37-18	34° 04'	77° 53'	Undiked	Least tern	3
39-26	34° 03'	77° 56'	Diked	Gull-billed tern	164
				Common tern	22
				Black skimmer	18

Table C18 (concluded)

Island Number	Coordinates Latitude	Longitude	Site Condition	Species Present	Total Nests
39-28	34° 00'	77° 57'	Diked	Laughing gull	728
				Royal tern	1
39-32	33° 59'	77° 57'	Undiked	Royal tern	5071
				Sandwich tern	18
39-33	33° 58'	77° 57'	Diked	Least tern	7
39-37	33° 56'	77° 51'	Undiked	Gull-billed tern	34
				Common tern	4
43-06	33° 55'	78° 22'	Diked	Least tern	12
43-09	33° 55'	78° 23'	Diked	Least tern	427
				Black skimmer	28
				Gull-billed tern	19
				Common tern	9
45-07	33° 53'	78° 27'	Diked	Least tern	3
47-01	33° 53'	78° 32'	Diked	Least tern	35
48-06	34° 52'	78° 30'	Undiked	Least tern	1
48-07	33° 53'	78° 31'	Diked	Least tern	9

Table C19

Birds Recorded on Dredged Material Islands in North Carolina Estuaries Between 1 September 1976 and 15 August 1977

Species	Residence Status[a]				
	PR[b]	SR[c]	WR[d]	T[e]	A[f]
Common loon (*Gavia immer*)			x		
Pied-billed grebe (*Podilymbus podiceps*)			x		
Brown pelican (*Pelecanus occidentalis*)	x				
Double-crested cormorant (*Phalacrocorax auritus*)			x		
Great blue heron (*Ardea herodias*)	x				
Green heron (*Butorides striatus*)		x			
Little blue heron (*Florida caerulea*)		x			
Cattle egret (*Bubulcus ibis*)		x			
Great egret (*Casmerodius albus*)	x				
Snowy egret (*Egretta thula*)	x				
Louisiana heron (*Hydranassa tricolor*)					
Black-crowned night heron (*Nycticorax nycticorax*)	x				
Yellow-crowned night heron (*Nyctanassa violacea*)	x				
Least bittern (*Ixobrychus exilis*)		x			
American bittern (*Botaurus lentiginosus*)			x		
Wood stork (*Mycteria americana*)					x
Glossy ibis (*Plegadis falcinellus*)		x			
White ibis (*Eudocimus albus*)	x				
Mallard (*Anas platyrhynchos*)			x		
Black duck (*Anas rubripes*)	x				
Gadwall (*Anas strepera*)	x				
Pintail (*Anas acuta*)			x		
Green-winged teal (*Anas crecca*)			x		
Blue-winged teal (*Anas discors*)				x	
American wigeon (*Anas americana*)			x		
Northern shoveler (*Anas clypeata*)			x		
Redhead (*Aythya americana*)			x		
Ring-necked duck (*Aythya collaris*)			x		
Canvasback (*Aythya valisineria*)			x		
Common goldeneye (*Bucephala clangula*)			x		

[a] Residence status based on primary level of occurrence in the region.
[b] Permanent resident.
[c] Summer resident.
[d] Winter resident.
[e] Transient.
[f] Accidental.

Table C19 (continued)

Species	Residence Status				
	PR	SR	WR	T	A
Bufflehead (*Bucephala albeola*)			x		
Black scoter (*Melanitta nigra*)				x	
Ruddy duck (*Oxyura jamaicensis*)			x		
Hooded merganser (*Lophodytes cucullatus*)			x		
Red-breasted merganser (*Mergus serrator*)			x		
Turkey vulture (*Cathartes aura*)	x				
Sharp-shinned hawk (*Accipiter striatus*)				x	
Cooper's hawk (*Accipiter cooperii*)				x	
Red-tailed hawk (*Buteo jamaicensis*)	x				
Marsh hawk (*Circus cyaneus*)			x		
Osprey (*Pandion haliaetus*)		x			
Peregrine falcon (*Falco peregrinus*)				x	
Merlin (*Falco columbarius*)				x	
American kestrel (*Falco sparverius*)			x		
Bobwhite (*Colinus virginianus*)	x				
Clapper rail (*Rallus longirostris*)	x				
Sora (*Porzana carolina*)				x	
American coot (*Fulica americana*)			x		
American oystercatcher (*Haematopus palliatus*)	x				
Semipalmated plover (*Charadrius semipalmatus*)			x		
Piping plover (*Charadrius melodus*)			x		
Wilson's plover (*Charadrius wilsonia*)		x			
Killdeer (*Charadrius vociferus*)	x				
Black-bellied plover (*Pluvialis squatarola*)			x		
Ruddy turnstone (*Arenarius interpres*)			x		
Common snipe (*Capella gallinago*)			x		
Whimbrel (*Numenius phaeopus*)				x	
Spotted sandpiper (*Actitis macularia*)				x	
Solitary sandpiper (*Tringa solitaria*)				x	
Willet (*Catoptrophorus semipalmatus*)	x				
Greater yellowlegs (*Tringa melanoleucus*)				x	
Lesser yellowlegs (*Tringa flavipes*)				x	
Pectoral sandpiper (*Calidris melanotos*)				x	
White-rumped sandpiper (*Calidris fuscicollis*)					x
Least sandpiper (*Calidris minutilla*)				x	
Dunlin (*Calidris alpina*)			x		
Short-billed dowitcher (*Limnodromus griseus*)			x		

Table C19 (continued)

Species	Residence Status				
	PR	SR	WR	T	A
Semipalmated sandpiper (*Calidris pusillus*)				x	
Western sandpiper (*Calidris mauri*)			x		
Marbled godwit (*Limosa fedoa*)			x		
Sanderling (*Calidris alba*)			x		
American avocet (*Recurvirostra americana*)			x		
Black-necked stilt (*Himantopus mexicanus*)	x				
Northern phalarope (*Lobipes lobatus*)				x	
Great black-backed gull (*Larus marinus*)			x		
Herring gull (*Larus argentatus*)	x				
Ring-billed gull (*Larus delawarensis*)			x		
Laughing gull (*Larus atricilla*)		x			
Bonaparte's gull (*Larus philadelphia*)			x		
Gull-billed tern (*Gelochelidon nilotica*)		x			
Forster's tern (*Sterna forsteri*)	x				
Common tern (*Sterna hirundo*)		x			
Sooty tern (*Sterna fuscata*)					x
Least tern (*Sterna albifrons*)		x			
Royal tern (*Sterna maxima*)	x				
Sandwich tern (*Sterna sandvicensis*)		x			
Caspian tern (*Sterna caspia*)	x				
Black skimmer (*Rynchops niger*)	x				
Mourning dove (*Zenaida macroura*)	x				
Ground dove (*Columbina passerina*)	x				
Yellow-billed cuckoo (*Coccyzus americanus*)		x			
Short-eared owl (*Asio flammeus*)			x		
Common nighthawk (*Chordeiles minor*)		x			
Chimney swift (*Chaetura pelagica*)		x			
Belted kingfisher (*Megaceryle alcyon*)	x				
Common flicker (*Colaptes auratus*)	x				
Red-bellied woodpecker (*Melanerpes carolinus*)	x				
Hairy woodpecker (*Picoides villosus*)	x				
Downy woodpecker (*Picoides pubesens*)	x				
Eastern kingbird (*Tyrannus tyrannus*)		x			
Western kingbird (*Tyrannus verticalis*)				x	
Eastern phoebe (*Sayornis phoebe*)	x				
Tree swallow (*Iridoprocne bicolor*)			x		
Rough-winged swallow (*Stelgidopteryx ruficollis*)		x			

Table C19 (continued)

Species	Residence Status PR	SR	WR	T	A
Barn swallow (*Hirundo rustica*)		x			
Blue jay (*Cyanocitta cristata*)	x				
Fish crow (*Corvus ossifragus*)	x				
House wren (*Troglodytes aedon*)			x		
Carolina wren (*Thryothorus ludovicianus*)	x				
Long-billed marsh wren (*Cistothorus palustris*)	x				
Short-billed marsh wren (*Cistothorus platensis*)			x		
Mockingbird (*Mimus polyglottos*)	x				
Gray catbird (*Dumetella carolinensis*)	x				
Brown thrasher (*Toxostoma rufum*)	x				
American robin (*Turdus migratorius*)	x				
Hermit thrush (*Catharus guttatus*)			x		
Blue-gray gnatcatcher (*Polioptila caerulea*)		x			
Golden-crowned kinglet (*Regulus satrapa*)			x		
Ruby-crowned kinglet (*Regulus calendula*)			x		
Water pipit (*Anthus spinoletta*)			x		
Loggerhead shrike (*Lanius ludovicianus*)	x				
Starling (*Sturnus vulgaris*)	x				
White-eyed vireo (*Vireo griseus*)		x			
Black-and-white warbler (*Mniotilta varia*)				x	
Yellow warbler (*Dendroica petechia*)				x	
Yellow-rumped warbler (*Dendroica coronata*)			x		
Prairie warbler (*Dendroica discolor*)		x			
Palm warbler (*Dendroica palmarum*)				x	
Northern waterthrush (*Seiurus noveboracensis*)				x	
Common yellowthroat (*Geothlypis trichas*)	x				
American redstart (*Setophaga ruticilla*)				x	
Bobolink (*Dolichonyx oryzivorus*)				x	
Eastern meadowlark (*Sturnella magna*)	x				
Red-winged blackbird (*Agelaius phoeniceus*)					
Orchard oriole (*Icterus spurius*)		x			
Boat-tailed grackle (*Quiscalus major*)	x				
Common grackle (*Quiscalus quiscula*)	x				
Cardinal (*Cardinalis cardinalis*)		x			
Indigo bunting (*Passerina cyanea*)					
Painted bunting (*Passerina ciris*)		x			
American goldfinch (*Carduelis tristis*)			x		

Table C19 (concluded)

	Residence Status				
	PR	SR	WR	T	A
Rufous-sided towhee (*Pipilo erythrophthalmus*)	x				
Savannah sparrow (*Passerculus sandwichensis*)			x		
Grasshopper sparrow (*Ammodramus savannarum*)				x	
Sharp-tailed sparrow (*Ammospiza caudacuta*)			x		
Seaside sparrow (*Ammospiza maritima*)	x				
Vesper sparrow (*Pooecetes gramineus*)			x		
Field sparrow (*Spizella pusilla*)			x		
White-crowned sparrow (*Zonotrichia leucophrys*)					x
White-throated sparrow (*Zonotrichia albicollis*)			x		
Swamp sparrow (*Melospiza georgiana*)			x		
Song sparrow (*Melospiza melodia*)	x				
Snow bunting (*Plectrophenax nivalis*)			x		

APPENDIX D: CARTOGRAPHIC DATA

Table D1

Locations of Dredged Material Study Islands in North Carolina Estuaries

Island Number	Latitude	Longitude	Map Letter[a]	Research Site
03-04	35° 50'	75° 36'	A	C[b]
03-05	35° 48'	75° 35'	A	C
03-06	35° 50'	75° 36'	A	C
03-07	35° 48'	75° 35'	A	C
03-08	35° 54'	75° 37'	A	C
03-09	35° 49'	75° 35'	A	C
05-06	35° 46'	75° 34'	A	C
06-02	35° 46'	75° 35'	A	C
06-04	35° 45'	75° 35'	A	C
06-07	35° 45'	75° 35'	A	C
06-08	35° 46'	75° 35'	A	C
06-09	35° 42'	75° 46'	B	C
06-10	35° 12'	75° 36'	C	C
06-11	35° 12'	75° 43'	C	C
06-23	35° 46'	75° 35'	A	C
07-02	35° 43'	75° 30'	A	C
07-04	35° 43'	75° 30'	A	C
09-03	35° 13'	75° 45'	C	C
09-04	35° 12'	75° 46'	C	C
11-05[c]	35° 06'	76° 03'		C
14-02	34° 60'	76° 13'	D	C
14-04	34° 52'	76° 20'	D	C
14-10	34° 51'	76° 20'	D	C
14-14	34° 35'	76° 30'	E	C
16-01	34° 54'	76° 17'	D	C
16-02	34° 54'	76° 17'	D	C
17-01	34° 40'	76° 32'	E	CV[d]
17-03	34° 39'	76° 32'	E	C
17-07	34° 40'	76° 31'	E	C
17-08	34° 40'	76° 31'	E	C
18-13	34° 43'	76° 40'	F	CVB[e]

[a] Maps A through Q.
[b] C = Bird colonies.
[c] This island is not represented on a vicinity map, but it is located just within Ocracoke Inlet (see Figure D1).
[d] V = Vegetation analyses.
[e] B = Bird surveys.

Table D1 (continued)

Island Number	Latitude	Longitude	Map Letter	Research Site
18-14	34° 43'	76° 39'	F	VB
20-02	34° 43'	76° 41'	G	C
20-03	34° 43'	76° 41'	G	CB
20-06	34° 42'	76° 42'	G	CB
21-01	34° 44'	76° 42'	G	C
21-03	34° 44'	76° 42'	G	C
21-04	34° 44'	76° 41'	G	C
22-08	34° 43'	76° 57'	H	C
22-22	34° 42'	76° 60'	G	V
22-25	34° 41'	77° 00'	H	CVB
22-26	34° 41'	77° 01'	H	CVB
22-39	34° 41'	77° 01'	H, I	VB
22-40	34° 41'	77° 03'	I	C
22-41	34° 40'	77° 02'	I	C
22-44	34° 40'	77° 05'	I	CVB
22-45	34° 40'	77° 06'	I	C
23-07	34° 41'	77° 07'	I	V
23-10	34° 41'	77° 06'	I	CV
23-23	34° 42'	76° 60'	H	V
26-07	34° 43'	77° 21'	H	C
27-03	34° 30'	77° 25'	J	C
27-04	34° 30'	77° 25'	J	C
27-06	34° 30'	77° 25'	J	C
27-07	34° 30'	77° 25'	J	C
28-01	34° 29'	77° 29'	K	VB
29-25	34° 24'	77° 37'	L	CVB
29-29	34° 23'	77° 38'	L	V
29-43	34° 19'	77° 43'	L	V
33-15	34° 15'	77° 46'	M	C
36-03	34° 12'	77° 49'	M	CB
36-13	34° 12'	77° 51'	M	CVB
36-14	34° 09'	77° 51'	M	VB
37-01	34° 08'	77° 52'	M	V
37-09	34° 06'	77° 53'	M	VB
37-10	34° 06'	77° 52'	M	C
37-12	34° 06'	77° 53'	M	V
37-18	34° 04'	77° 53'	N	C
39-23	34° 00'	77° 57'	N	CVB

Table D1 (concluded)

Island Number	Latitude	Longitude	Map Letter	Research Site
39-25	34° 01'	77° 56'	N	B
39-26	34° 03'	77° 56'	N	C
39-28	34° 00'	77° 57'	N	CVB
39-29	34° 00'	77° 56'	N	B
39-32	33° 59'	77° 57'	N	CVB
39-33	33° 58'	77° 57'	N	CVB
39-34	33° 57'	77° 58'	N	V
39-35	33° 56'	77° 59'	N	V
39-37	33° 56'	77° 51'	N	C
39-46	33° 54'	78° 01'	N	C
39-51	33° 54'	78° 01'	N	C
40-01	33° 35'	78° 02'	N	VB
40-46	33° 56'	78° 13'	O	VB
43-04	33° 55'	78° 21'	P	V
43-05	33° 55'	78° 22'	P	V
43-06	33° 54'	78° 22'	P	CV
43-09	33° 55'	78° 23'	P	CV
43-10	33° 55'	78° 21'	P	V
45-07	33° 53'	78° 27'	Q	C
47-01	33° 53'	78° 32'	Q	C
48-06	33° 52'	78° 30'	Q	C
48-07	33° 53'	78° 31'	Q	C

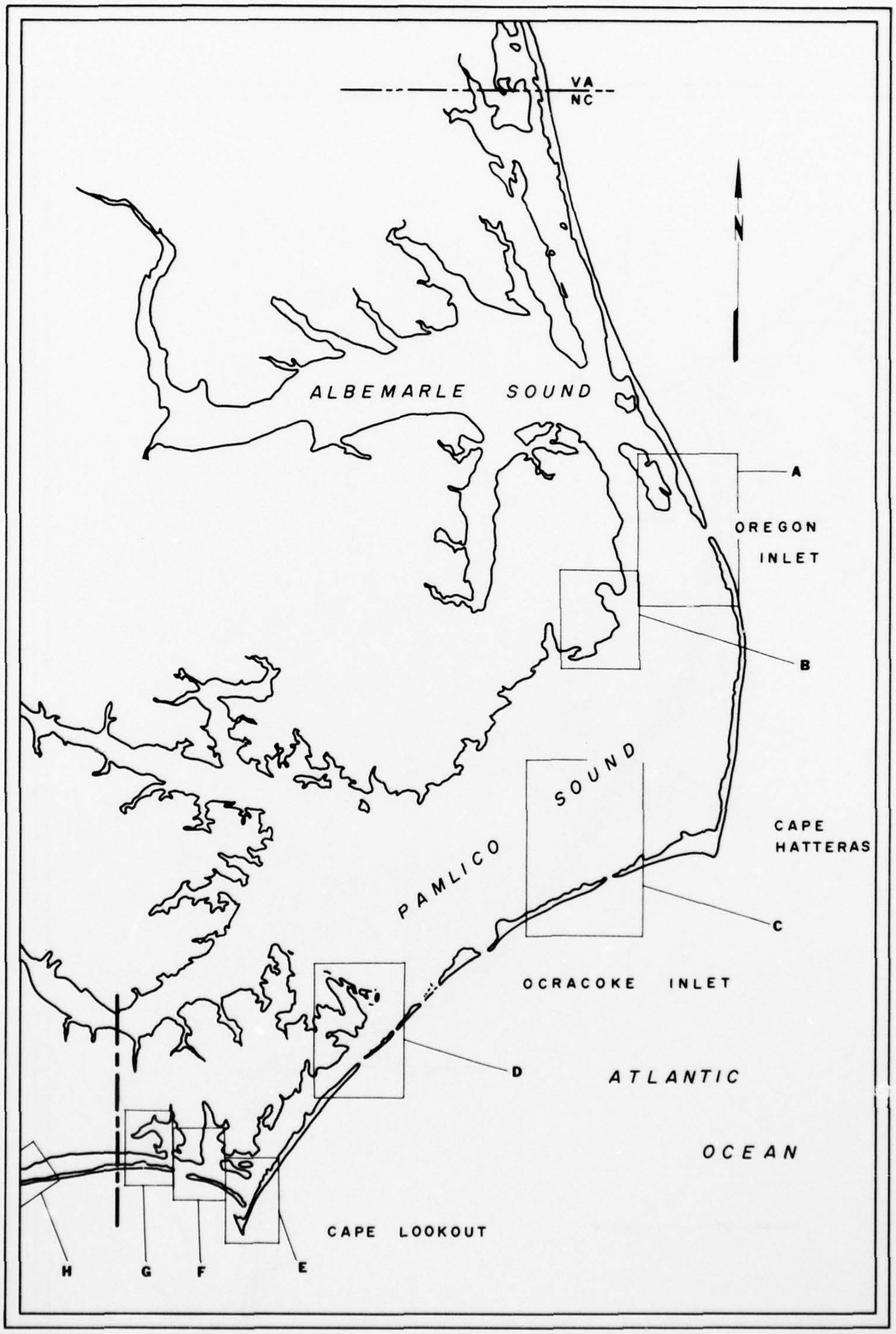

Figure D1. Index to maps A through H

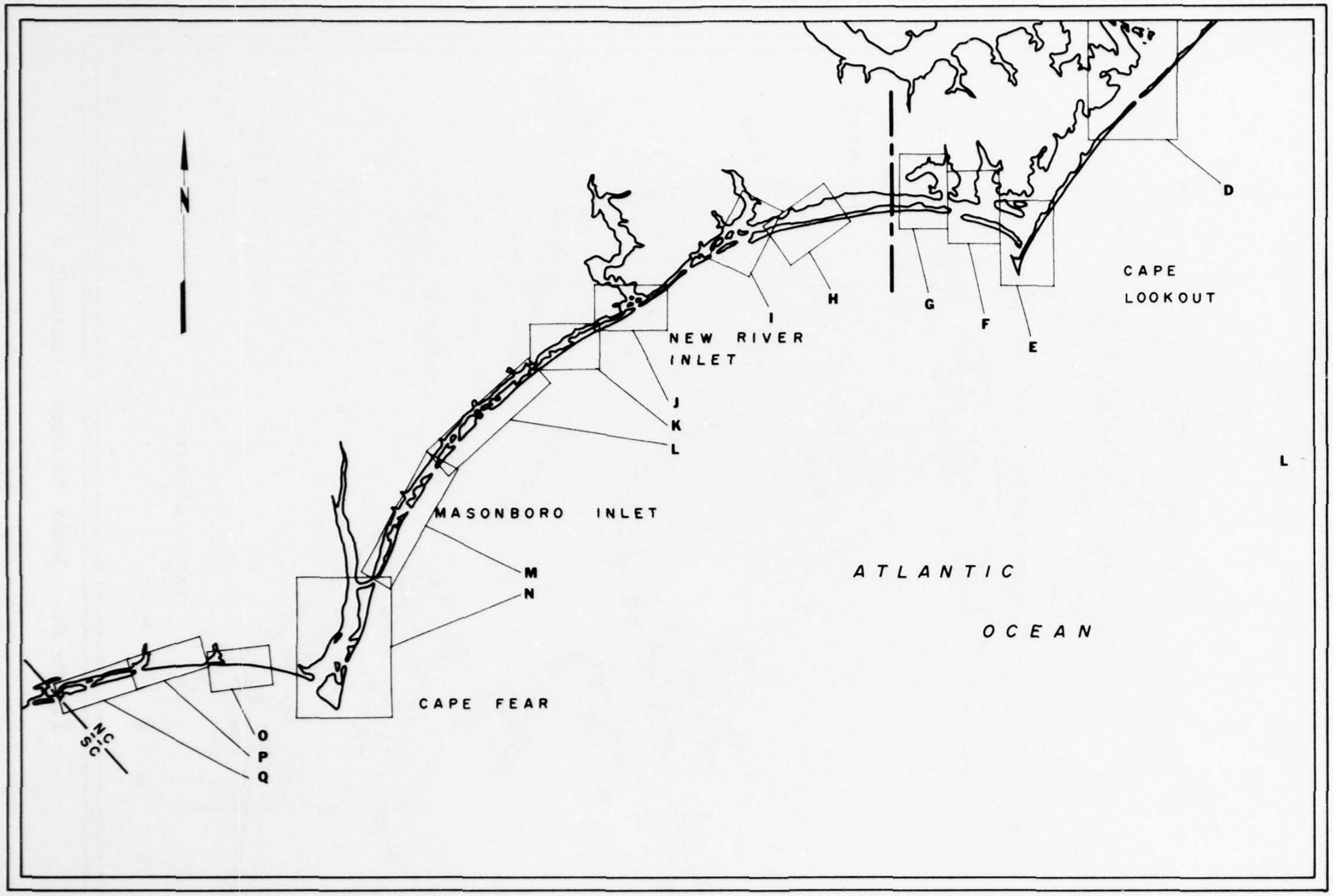

Figure D2. Index to maps D through Q

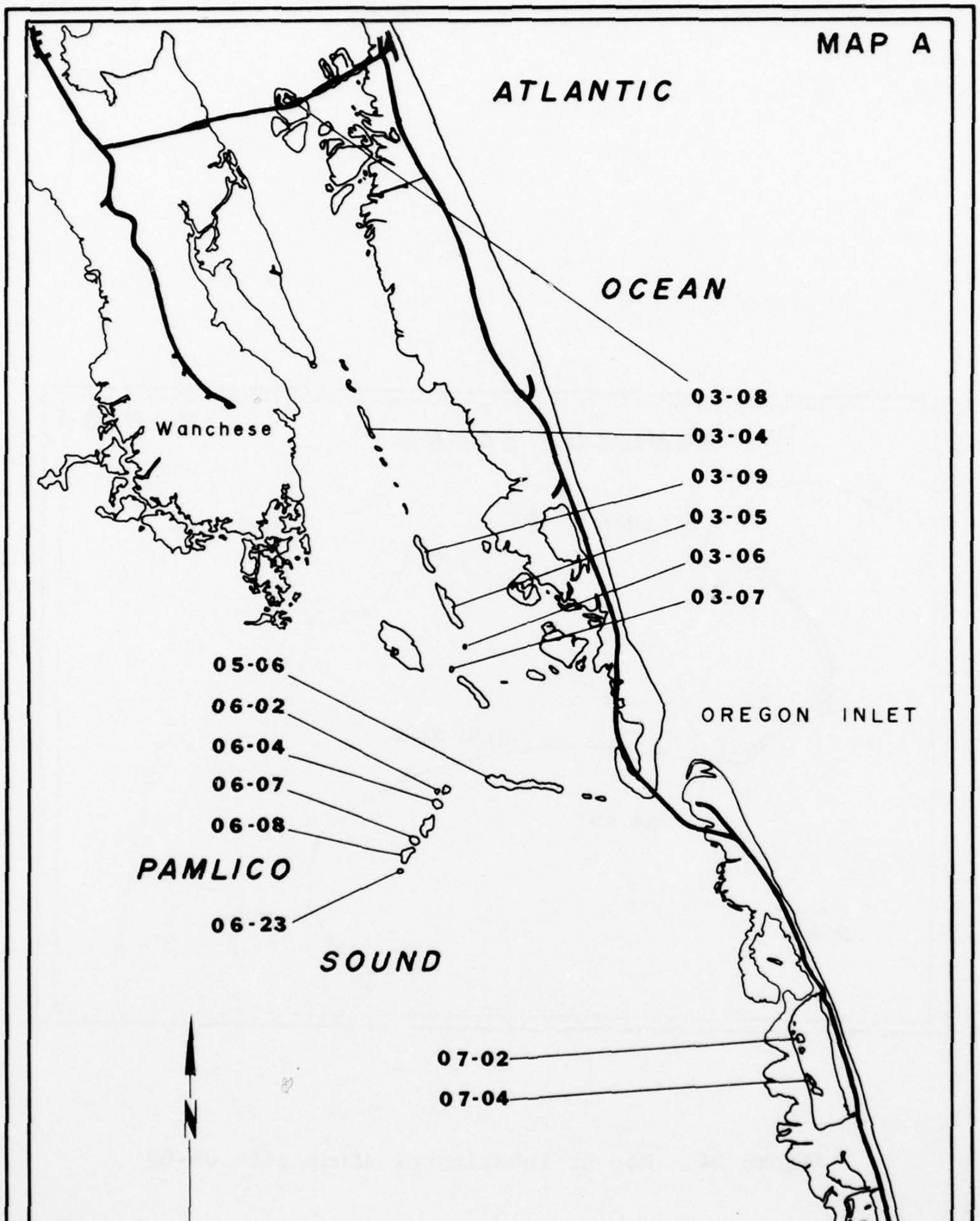

Figure D3. Map A, locations of study sites 03-04 through 07-04

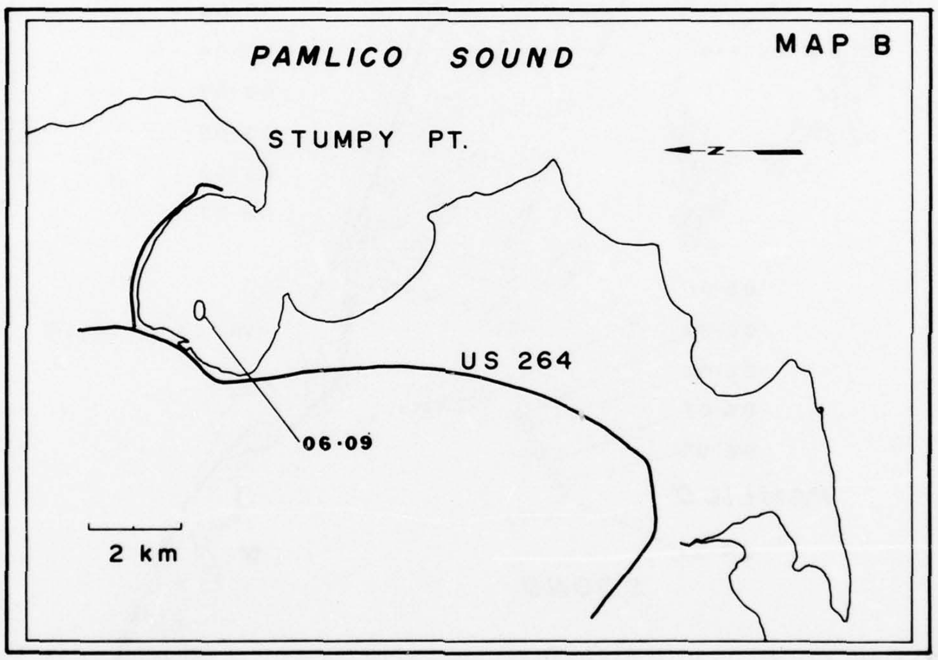

Figure D4. Map B, location of study site 06-09

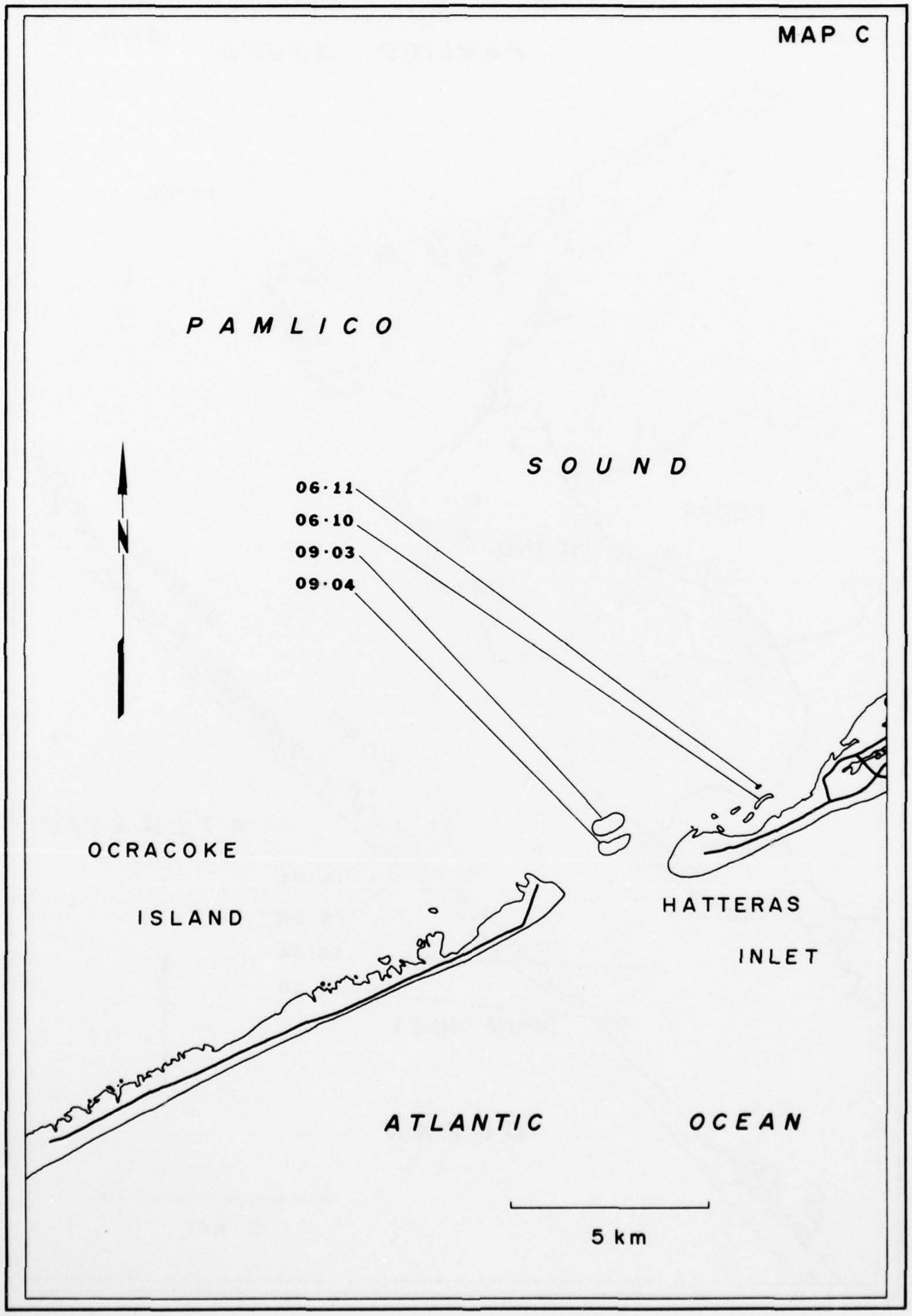

Figure D5. Map C, locations of study sites 06-10 through 09-04

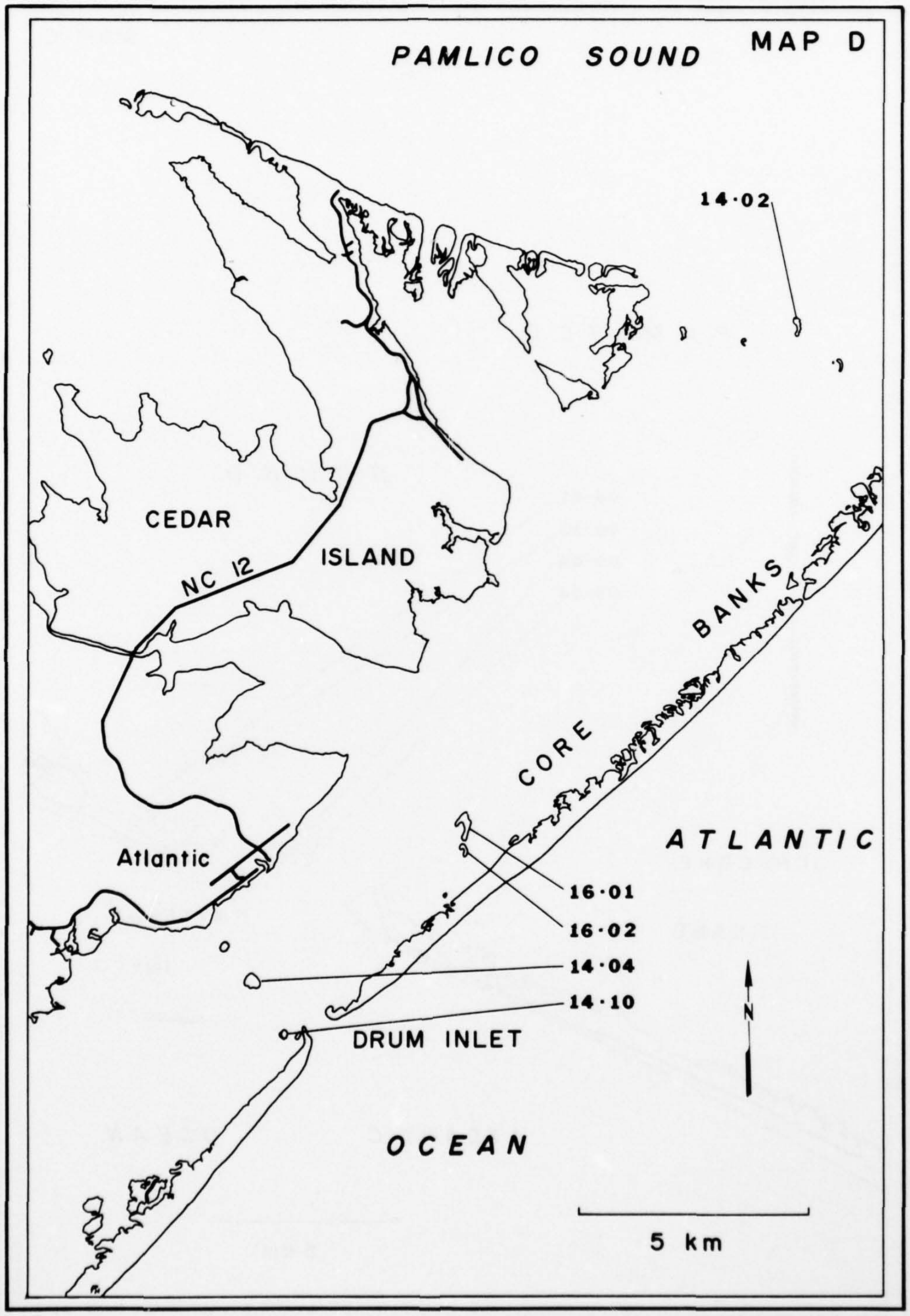

Figure D6. Map D, locations of study sites 14-02 through 16-02 (see Figure D7 for 14-14)

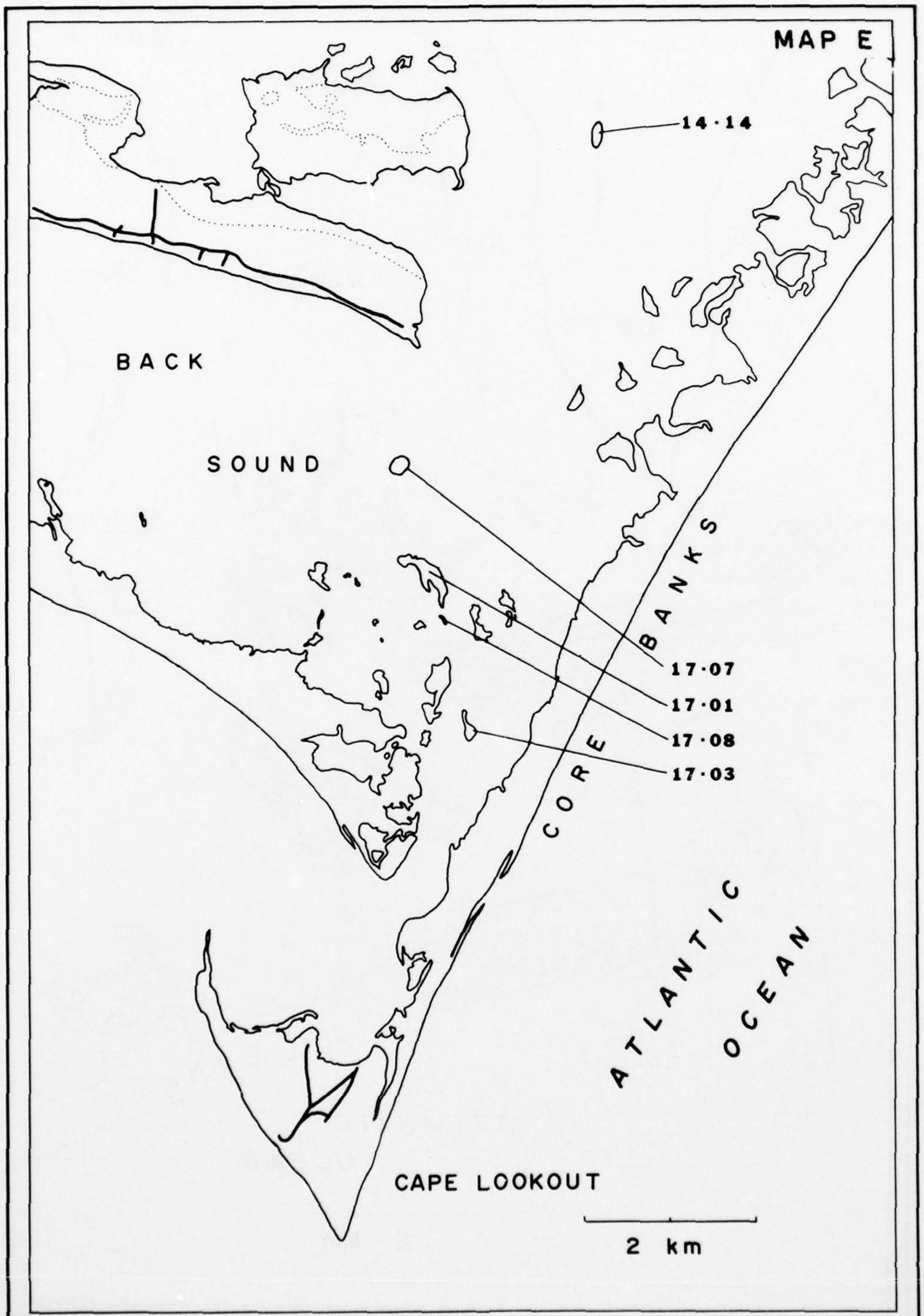

Figure D7. Map E, locations of study sites 14-14 and 17-01 through 17-08

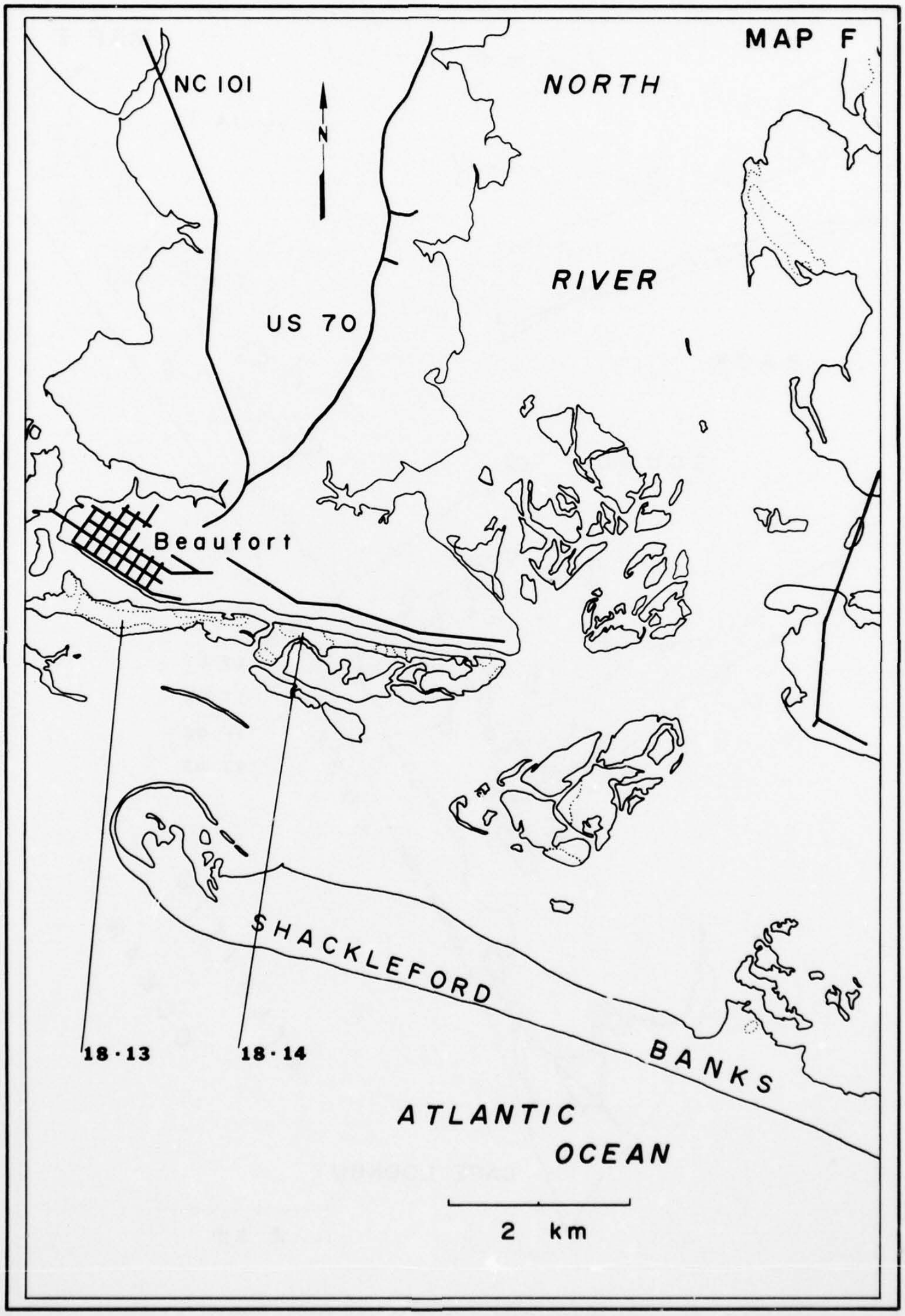

Figure D8. Map F, locations of study sites 18-13 and 18-14

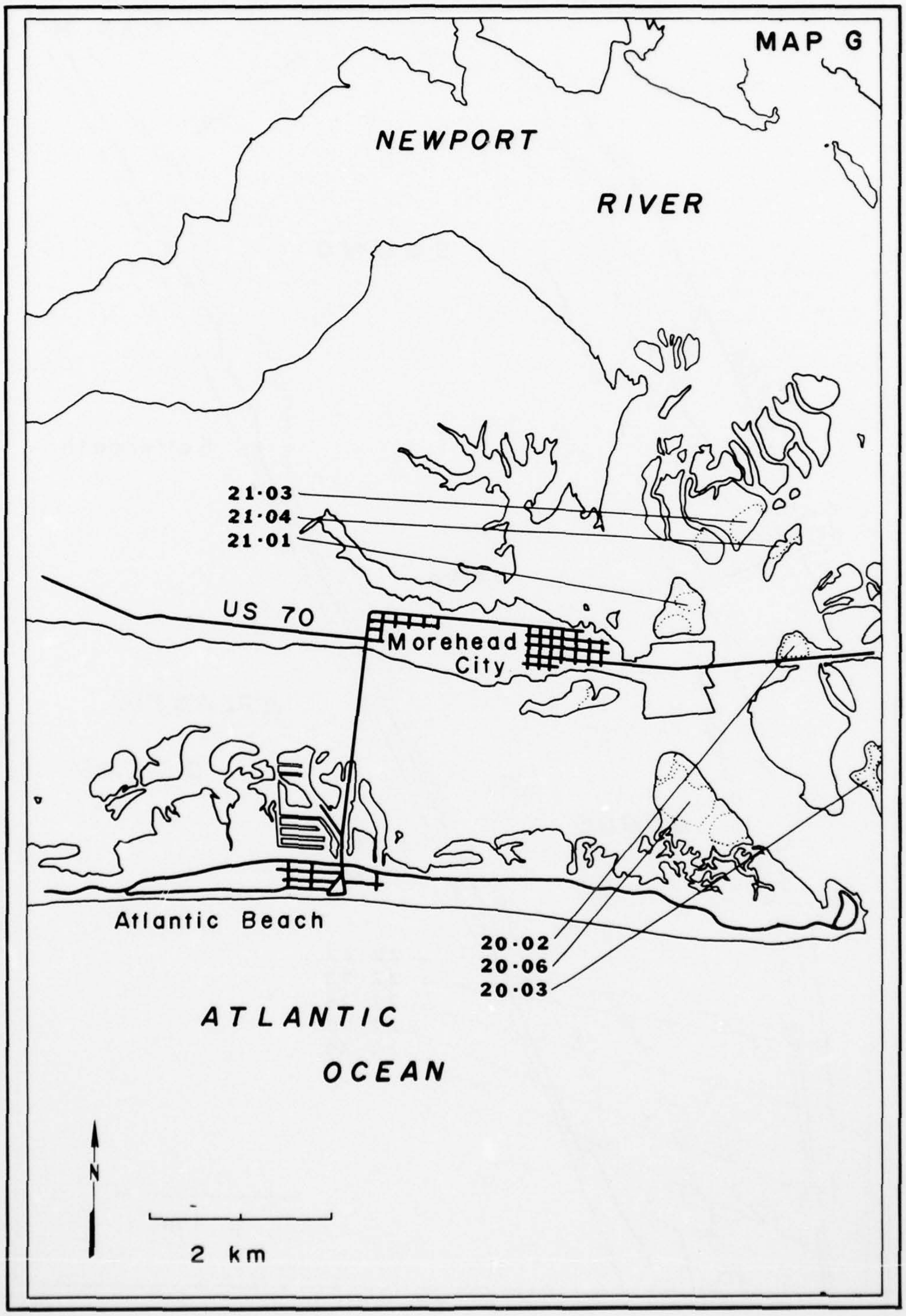

Figure D9. Map G, locations of study sites 20-02 through 21-04

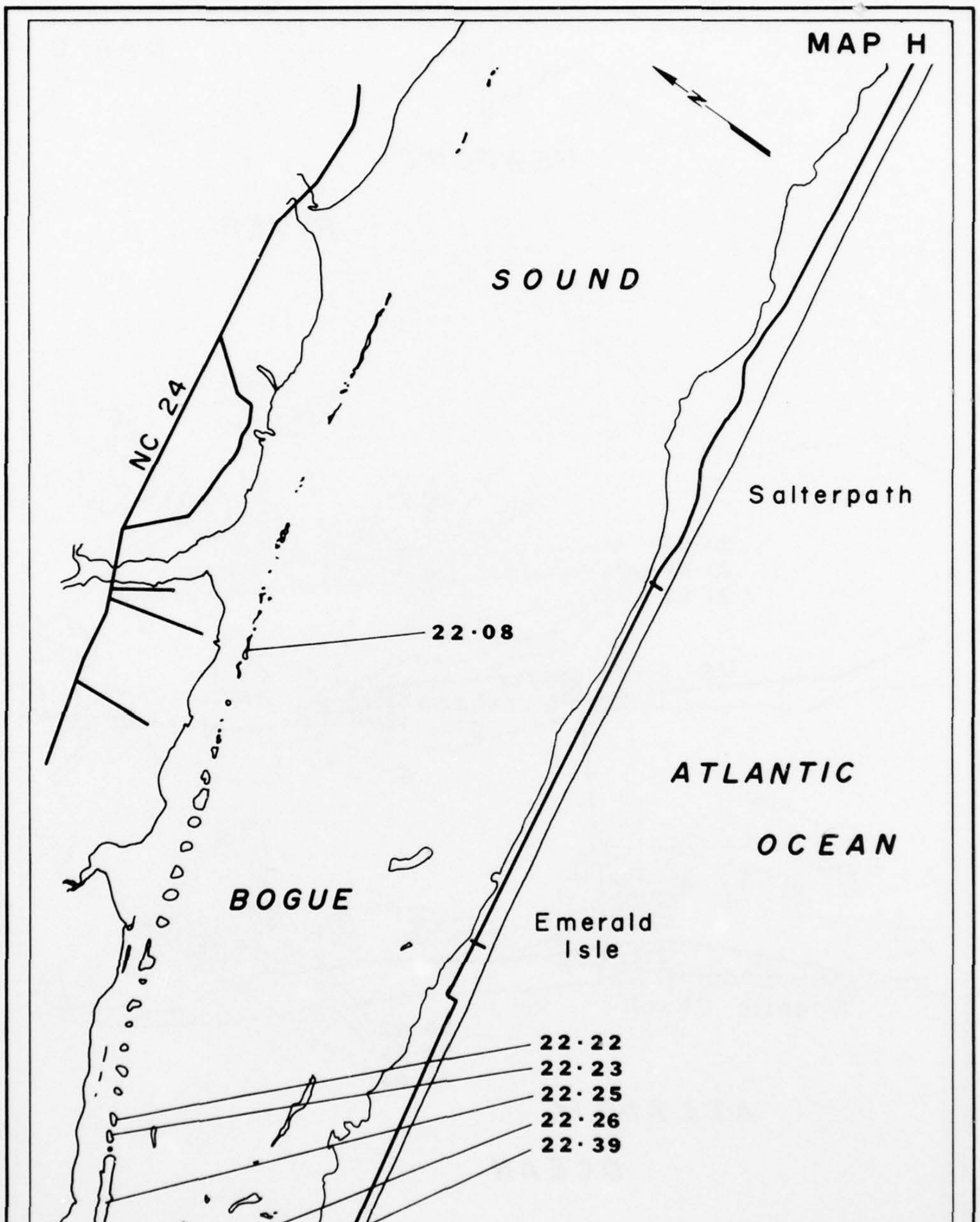

Figure D10. Map H, locations of study sites 22-08 through 22-39

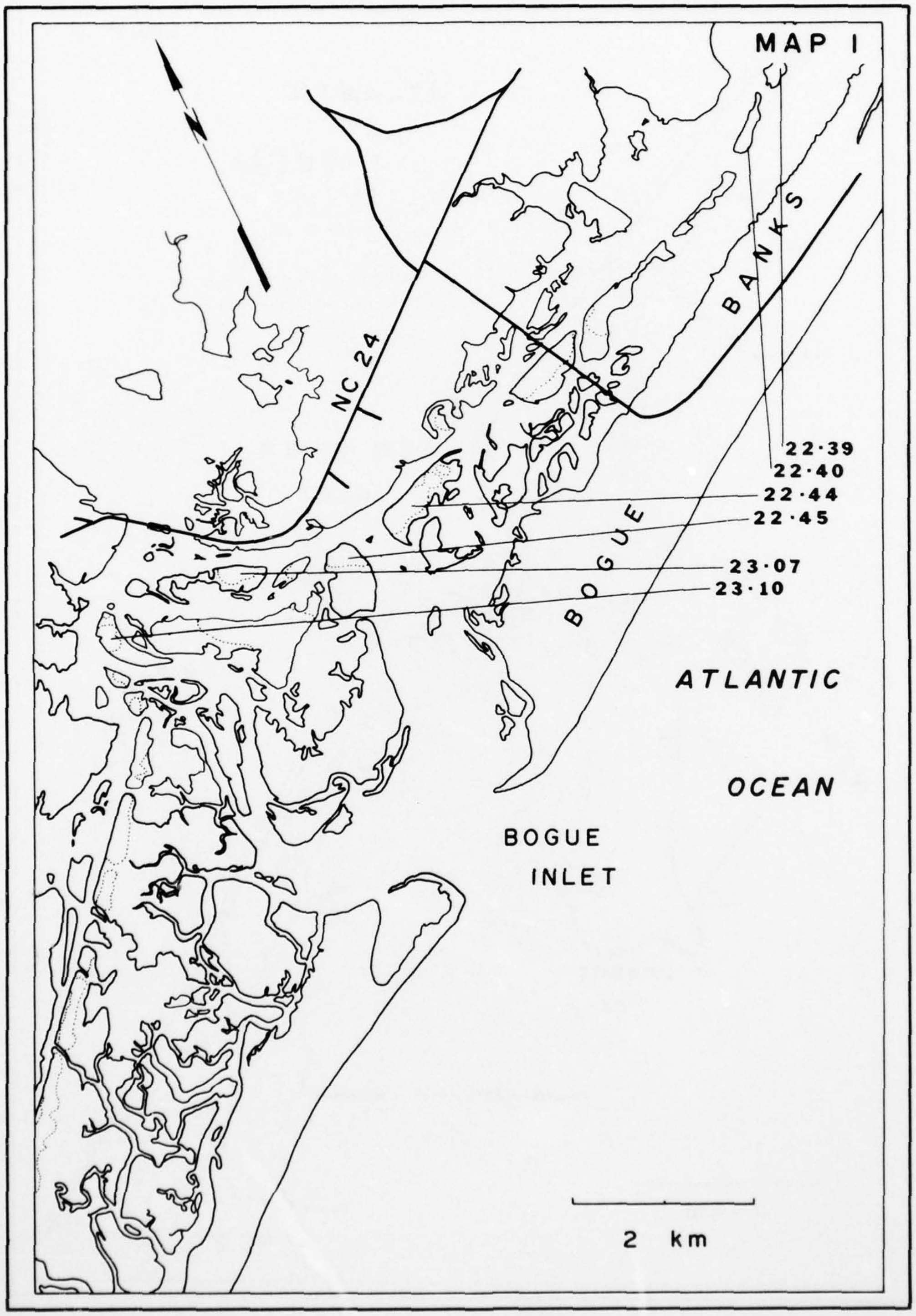

Figure D11. Map I, locations of study sites 22-39 through 23-10

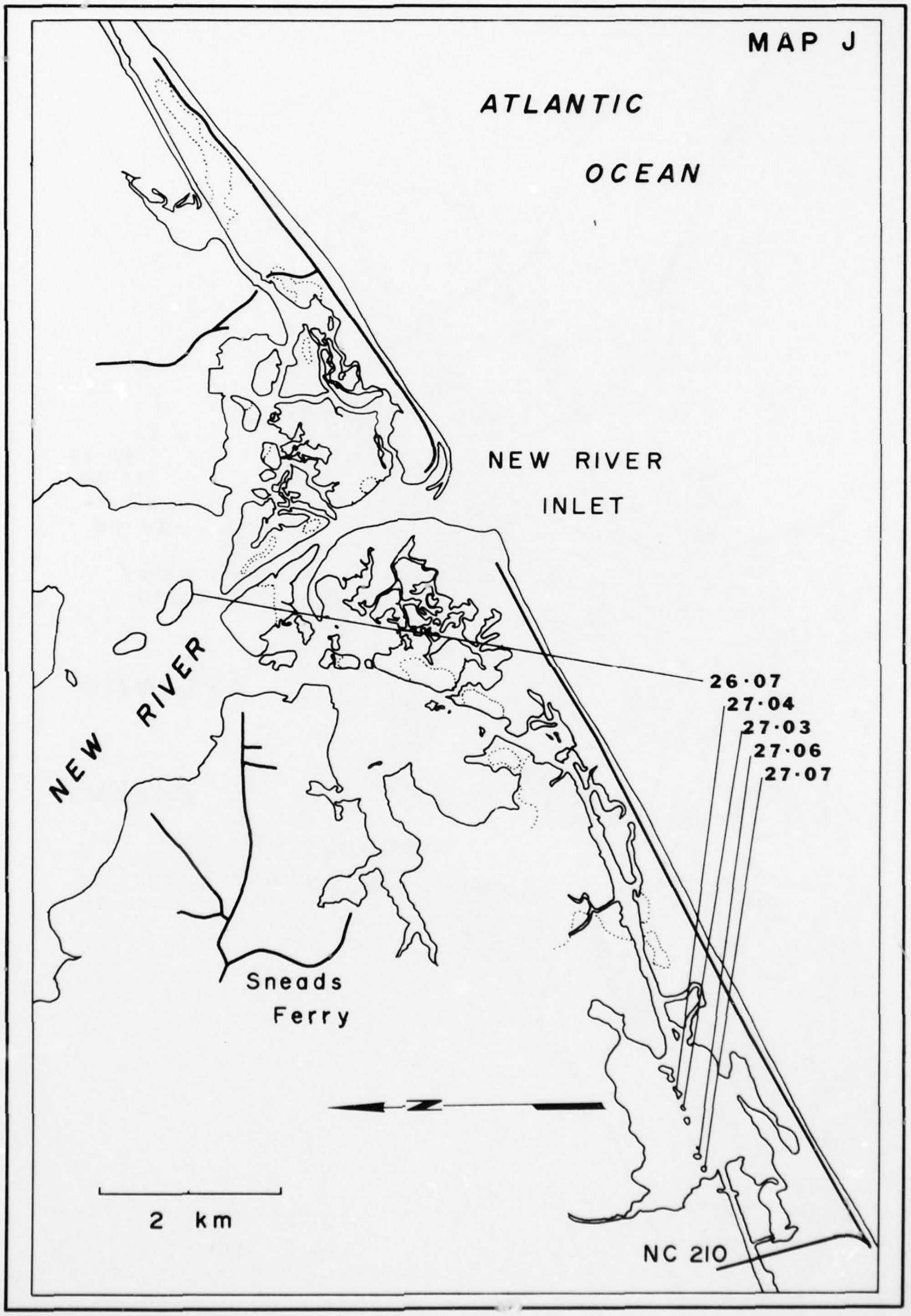

Figure D12. Map J, locations of study sites 26-07 through 27-07

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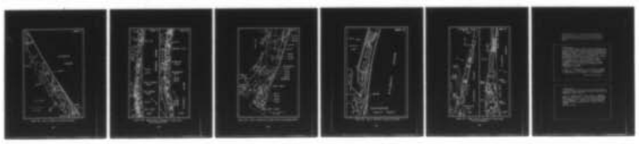

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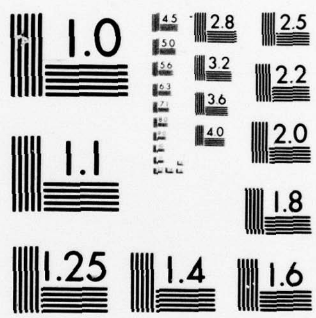

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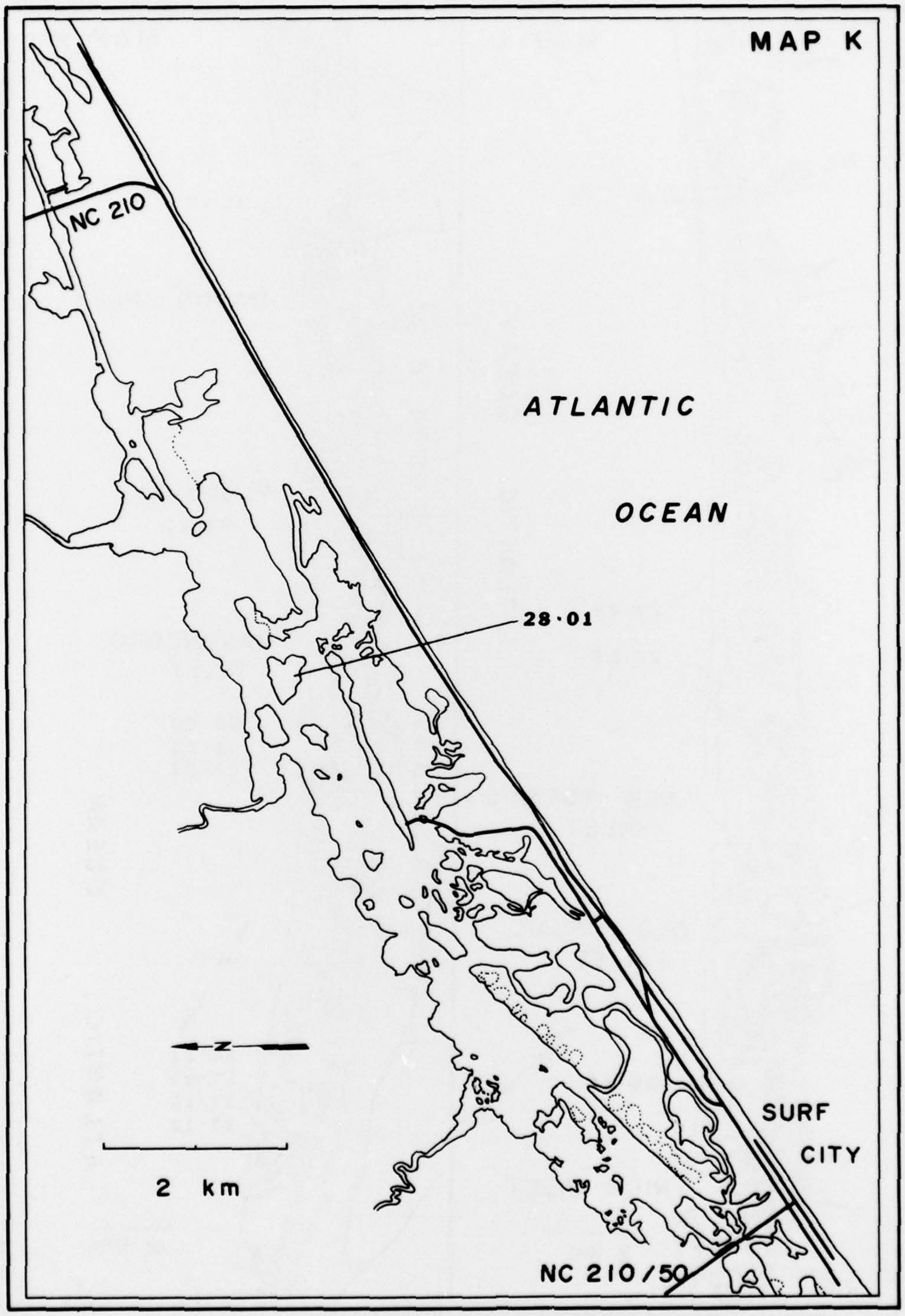

Figure D13. Map K, location of study site 28-01

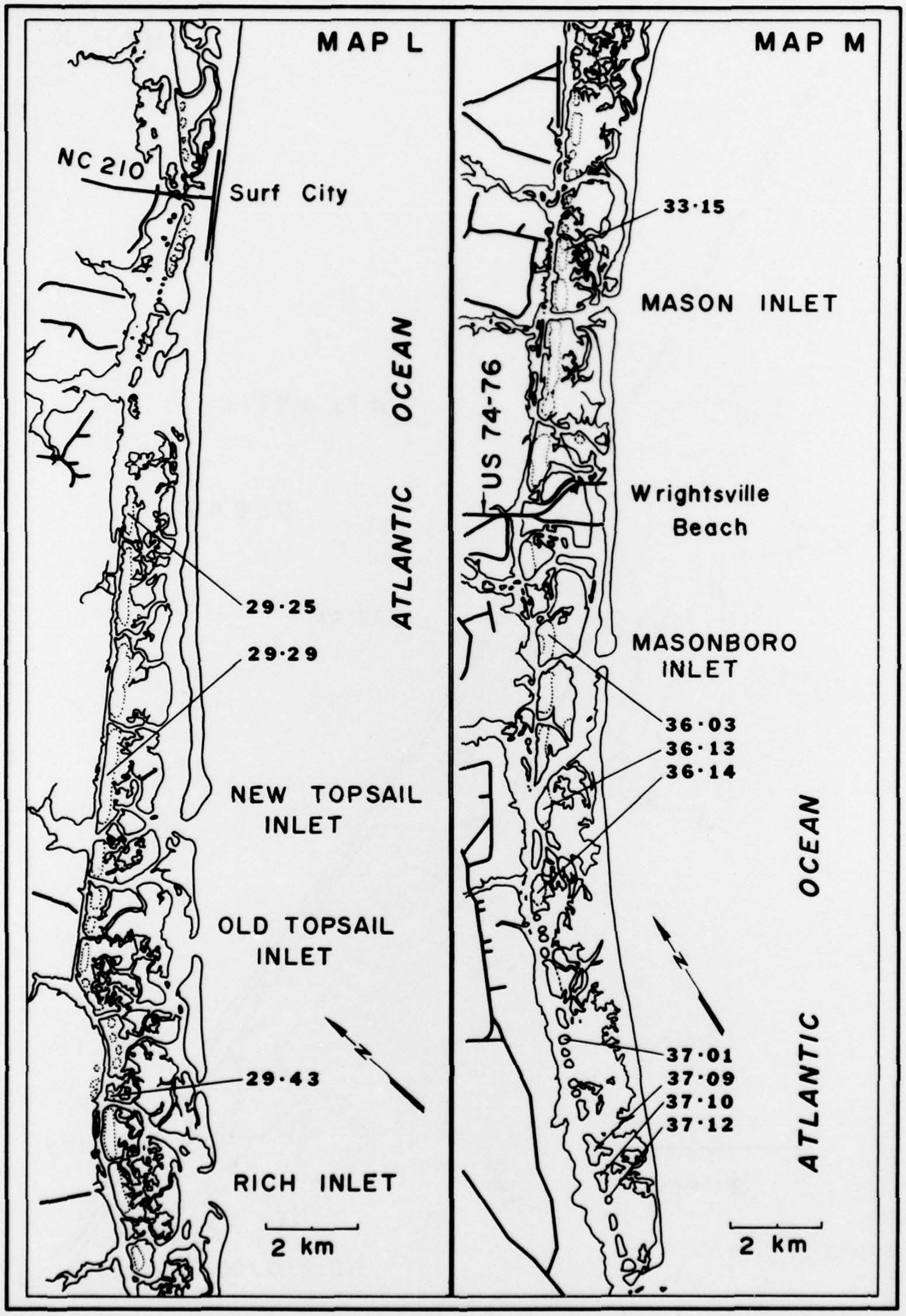

Figure D14. Maps L and M, locations of study sites 29-25 through 37-12

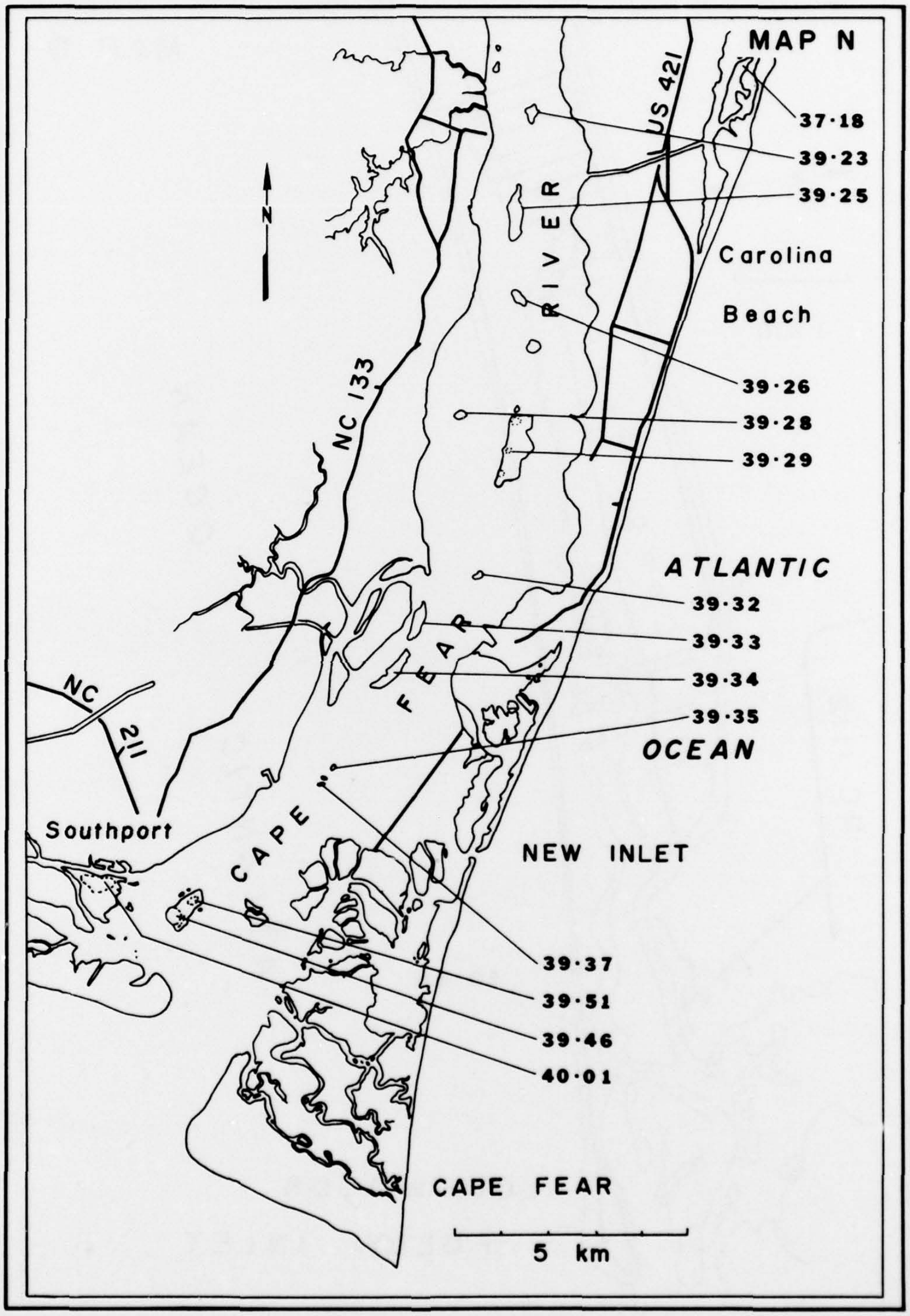

Figure D15. Map N, locations of study sites 37-18 through 40-01

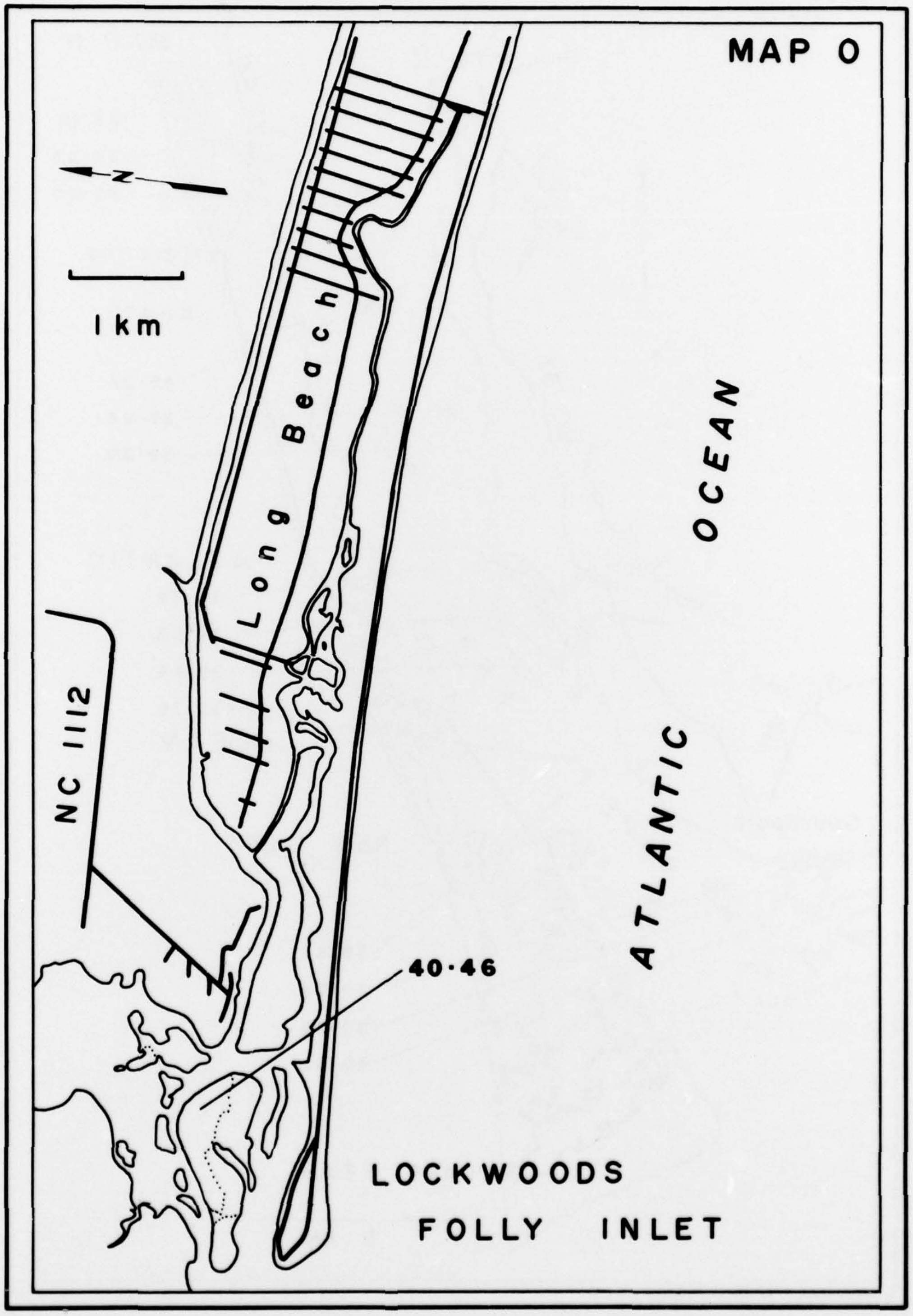

Figure D16. Map O, location of study site 40-46

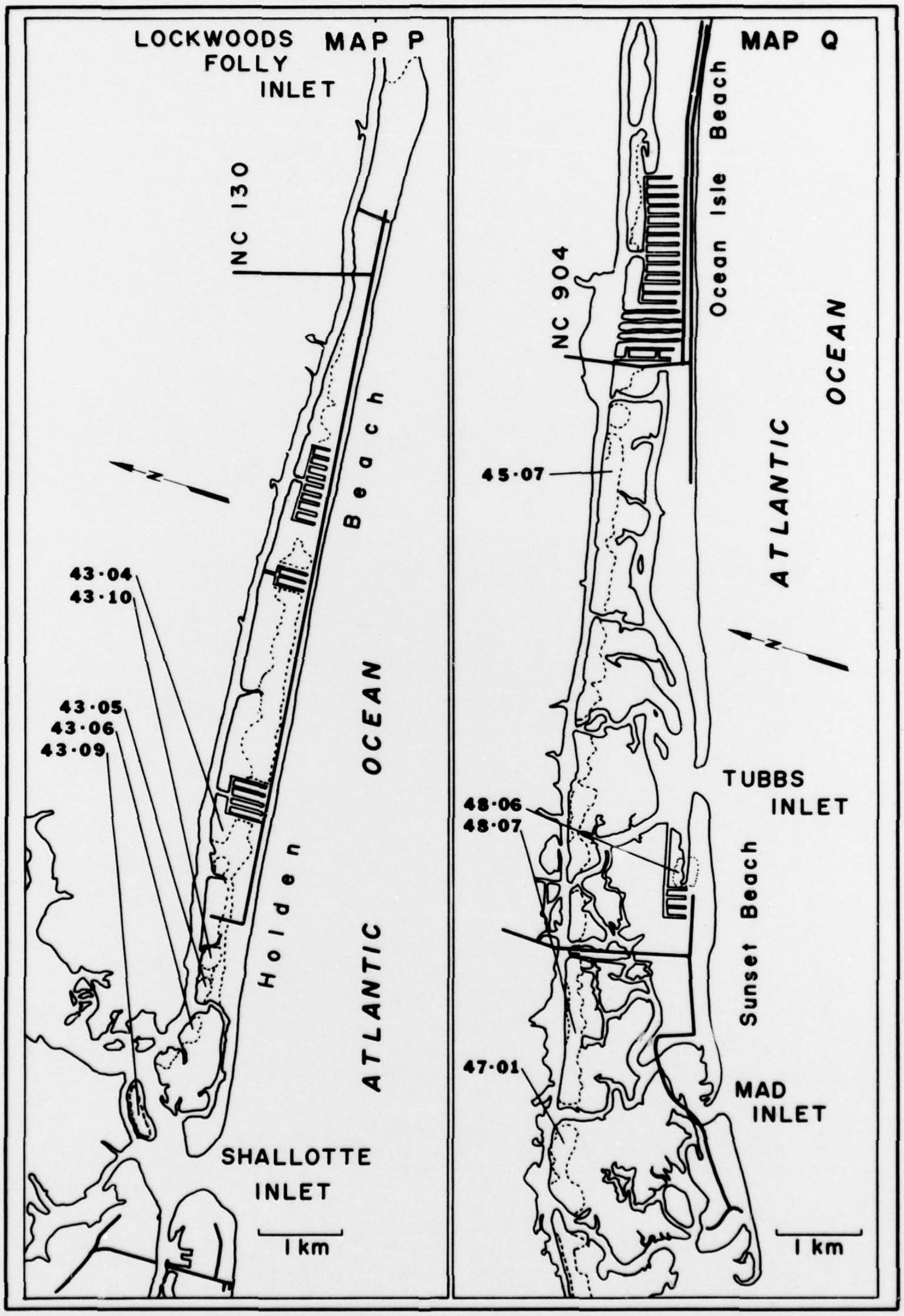

Figure D17. Maps P and Q, locations of study sites 43-04 through 48-07

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.

Parnell, James F
A comparison of plant succession and bird utilization on diked and undiked dredged material islands in North Carolina estuaries / by James F. Parnell, David M. DuMond, Robert N. Needham, Department of Biology, University of North Carolina at Wilmington, Wilmington, N. C. Vicksburg, Miss. : U. S. Waterways Experiment Station ; Springfield, Va. : available from National Technical Information Service, 1978.
113, [174] p. : ill. ; 27 cm. (Technical report - U. S. Army Engineer Waterways Experiment Station ; D-78-9)
Prepared for Office, Chief of Engineers, U. S. Army, Washington, D. C., under Contract No. DACW39-76-C-0134 (DMRP Work Unit No. 4F02)
References: p. 109-113.

1. Birds. 2. Dredged material. 3. Ecological succession. 4. Estuaries. 5. Islands (Landforms). 6. North Carolina. 7. Plants (Botany). 8. Succession. 9. Waste disposal

(Continued on next card)

Parnell, James F
A comparison of plant succession and bird utilization on diked and undiked dredged material islands in North Carolina estuaries ... 1978. (Card 2)

sites. I. DuMond, David M., joint author. II. Needham, Robert N., joint author. III. North Carolina. University at Wilmington. Dept. of Biology. IV. United States. Army. Corps of Engineers. V. Series: United States. Waterways Experiment Station, Vicksburg, Miss. Technical report ; D-78-9.
TA7.W34 no.D-78-9