

AD-A056 803

SEABIRD RESEARCH INC CULVER CITY CA
COLONIAL BIRD USE AND PLANT SUCCESSION ON DREDGED MATERIAL ISL--ETC(U).
APR 78 R R LEWIS, C S LEWIS

F/G 13/2

DACW39-76-C-0161

UNCLASSIFIED

WES-D-78-14-VOL-2

NL

1 OF 2
ADA
056803



AD A056803

AD NO.

DDC FILE COPY.

LEVEL III

A056086

DREDGED MATERIAL RESEARCH PROGRAM

18 WES

19

TECHNICAL REPORT D-76-14-VOL-2



6

COLONIAL BIRD USE AND PLANT SUCCESSION ON DREDGED MATERIAL ISLANDS IN FLORIDA. Volume II.

VOL. II PATTERNS OF PLANT SUCCESSION,

by

10

Roy R. Lewis III, Carolyn S. Lewis

Seaford Research, Inc.

4610 Maytime Lane

Culver City, Calif. 90230

11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100

DDC
FORM 1
JUL 18 1978
F

U.S. 1-4056 086

Report to Office, Chief of Engineers, U. S. Army

Washington, D. C. 20315

15
Contract No. DACW33-76-C-0061

(DDP Work UNIT 4001)

Hydrographical Laboratory

U. S. Army Engineer Research and Development Center

P. O. Box 243, Vicksburg, MS 39180

910-745

Destroy this report when no longer needed. Do not return
it to the originator.



DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS

P. O. BOX 631

VICKSBURG, MISSISSIPPI 39180

IN REPLY REFER TO: WESYV

15 June 1978

SUBJECT: Transmittal of Technical Report D-78-14 (Volume II)

TO: All Report Recipients

1. The technical report transmitted herewith represents the results of Work Unit 4F01C regarding vegetation succession and wildlife use of dredged material islands in Florida. This work unit was conducted as part of Task 4F (Island Habitat Development) of the Corps of Engineers' Dredged Material Research Program (DMRP). Task 4F was part of the Habitat Development Project of the DMRP and had as its objective the investigation, evaluation, and testing of methodologies for habitat creation and management on dredged material islands.
2. Island habitat development has been studied by the DMRP throughout the United States through the evaluation of vegetation succession and animal use of existing dredged material islands. The most significant wildlife aspect of these islands is their use by colonial nesting sea and wading birds such as gulls, terns, egrets, herons, ibises, and pelicans. This wildlife resource, although generally inadvertently created, presents a significant opportunity for habitat management and development that is consonant with continued dredged material disposal.
3. In the study reported herein (in two volumes), Work Unit 4F01C, 40 dredged material islands in Florida were selected for detailed analysis from the more than 250 in five specific study areas. These study areas were located in the vicinity of Tampa Bay, the Indian River, Yankeetown, the Pithlachascotee River, and the Caloosahatchee River. Vegetative colonization of dredged material islands proceeded from a bare substrate through a grass-herb stage characterized by species such as smooth cordgrass to a shrub and tree cover represented by Brazilian pepper, Australian pine, sabal palm, and mangroves. Approximately 50 percent of the colonial nesting sea and wading birds in Florida nest on dredged material, and many more species use the islands for feeding and roosting. Species of particular significance, because of their low numbers nationally, are the reddish egret, roseate spoonbill, least tern, black skimmer, and brown pelican (endangered).

78 07 18 027

WESYV

15 June 1978

SUBJECT: Transmittal of Technical Report D-78-14 (Volume II)

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

John L. Cannon

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

ACCESSION for		White Section <input checked="" type="checkbox"/>
NTIS	DDC	B. II Section <input type="checkbox"/>
UNANNOUNCED		<input type="checkbox"/>
JUSTIFICATION		
BY		
DISTRIBUTION/AVAILABILITY CODES		
Dist.	AVAIL.	SPECIAL
A		

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Technical Report D-78-14	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Colonial Bird Use and Plant Succession on Dredged Material Islands in Florida; Vol. II: Patterns of Plant Succession	5. TYPE OF REPORT & PERIOD COVERED Final report	
7. AUTHOR(s) Roy R. Lewis III Carolyn S. Lewis	6. PERFORMING ORG. REPORT NUMBER	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Seabird Research, Inc 4610 Maytime Lane Culver City, Calif. 90230	8. CONTRACT OR GRANT NUMBER(s) Contract No. DACW39-76-C-0161	
11. CONTROLLING OFFICE NAME AND ADDRESS Office, Chief of Engineers, U. S. Army Washington, D. C. 20314	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS DMRP Work Unit No. 4F01C	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) U. S. Army Engineer Waterways Experiment Station Environmental Laboratory P. O. Box 631, Vicksburg, Miss. 39180	12. REPORT DATE April 1978	
	13. NUMBER OF PAGES 175	
	15. SECURITY CLASS. (of this report) Unclassified	
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE	
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Birds Plants (Botany) Dredged material Seabirds Florida Shore birds Habitats Succession Islands (Landforms)		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This study was made to determine succession of vegetation on various aged dredged material islands in Florida. Forty islands in five selected study areas were intensively examined. An extensive literature review was conducted. Vertical aerial photographs and vegetation maps of each island are presented. A total of 141 plant species were found to occur on the islands. In Florida, typical island vegetation occurred through colonization by propagules from water-, wind-, and bird-carried sources. Marsh grasses (Continued)		

DDC
RECEIVED
JUL 28 1978
RESERVED
F

DD FORM 1 JAN 73 1473

EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

20. ABSTRACT (Continued).

such as smooth cordgrass preceded establishment by upland species such as Brazilian pepper, Australian pine, sabal palm, and herbaceous and grass cover. Bird use of the islands was directly related to the stage of plant succession, and bird fecal material was found to affect the vegetation both adversely and beneficially depending upon location. Recommendations for management include creation of new islands and enlargement and stabilization of existing eroding islands for bird use. Maintenance of unvegetated sites as critical habitat for terns and black skimmers is also recommended.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

SUMMARY

The importance of nearshore islands as nesting sites for many species of colonial seabirds and wading birds is well documented and their use has increased as natural islands and intertidal communities have been altered for man's use. Natural barrier islands and protected mangrove keys found in Florida were numerous and largely uninhabited in times past, and an abundance of wildlife has been associated with them and noted by naturalists since the late 1800s. Along with the natural habitats, colonial seabirds and wading birds are known to have nested on dredged material islands since their first creation in the early 1930s in Tampa Bay. The loss of 44% of the coastal wetlands bordering Tampa Bay and 20% of the open-water area of Biscayne Bay has occurred since the 1800s. Many of the barrier islands are now heavily used for residential buildings and the general trend has been a marked reduction in the available natural nesting habitat throughout Florida. The role of dredged material islands in providing nesting habitat for colonial species is closely tied to the plant species present and the future patterns of succession.

This study was designed to document these patterns of plant succession and their relation to avian utilization of dredged material islands in Florida. All dredged material islands in the five selected study areas were located, and forty islands were selected for intensive study. Aerial photographs were taken of each island and vegetation maps drawn of each. In the field, a general survey of plant communities was made, compared to photographs, and transects were established beginning at the island apex(s) and terminating at the edge of the shoreline vegetation. Two to four transects were used, and 1123 quadrats were sampled along the transects at specific intervals within various plant communities found on the islands. All plants in each quadrat were identified to species and voucher specimens were collected. The percent cover and height were estimated for each species and the rooted stems or trunks of shrubs or trees counted. A total of 141 species were found to occur on the islands studied.

In addition to phytosociological information, a soil sample,

representative of the upper 15 cm of soil in the quadrat, was collected at each point of all transects.

With the creation of dredged material islands primary succession of plant communities proceeds. Depending on the physiography of the island, biotic diversity of dispersal centers, and distance of the islands from the dispersal centers, various plant communities may establish. This process includes conditions which allow formation of a protected area on the lee side of an island or island placement in a location with little fetch or boat traffic. This protection is necessary in order to allow waterborne propagules time to establish root systems on the unstable, and often eroding shorelines, of dredged material islands. All three mangrove species in Florida have waterborne and strong wave action prevents establishment. This is widespread and can be seen on a number of islands in the general study area.

If the initial deposit of dredged material is elongate with one end facing the prevailing winds or boat wakes, erosion produces single spits. If the long side of the island is facing the winds, both ends of the island erode and the islands usually quickly disappears. If the initial deposit is round and in a protected area, then it may have a more or less uniform distribution of intertidal vegetation around its perimeter. This is an unusual condition, but does appear to have occurred. A more common condition is a round deposit that is eroding on one side and producing two spits on the lee side due to accretion of the same material. In extreme cases of erosion and accretion the island may appear to migrate due to continual erosion and accretion, and eventually the spits may curl and fuse to form a land-locked cove.

In Florida the pioneering species on protected shorelines may vary with latitude and distance from propagule sources. Under optimum conditions in south Florida, mangroves will pioneer on the shore if seeds are readily available. Red mangroves have historically been considered the pioneer species, but it has been noted that black mangroves and white mangroves are the true pioneers in disturbed natural areas and on new dredged material deposits. Along the central coasts of Florida, the intertidal pioneer plant is most commonly smooth cordgrass. Mangroves

gradually invade and replace the shade-intolerant cordgrass, which persists on older dredged material islands only as a fringe in the front of the outer band of red mangroves. In northern Florida, very few mangroves can survive the periodic freezes, and the pioneering cordgrass may persist or be replaced by black needlerush at higher elevations as sediments accumulate. Comparisons of islands 20 and 46 years old show that smooth cordgrass and black mangroves have approximately the same relative frequency on the younger islands. In contrast, on the older islands, mangroves are very abundant with no smooth cordgrass present except on the fringes.

If the appropriate physical conditions are not available, intertidal plant communities will not establish. This is a very common condition where a combination of high wave energy and low elevation of the initial deposit may prevent the formation of a lee side. Islands of this type are completely surrounded by a bare sandy beach and are usually experiencing heavy erosion. Certain specific islands were found that did not appear to fit this general pattern of succession.

Young islands show herbaceous communities dominant with finger grass, dune sandspur, and seaside paspalum being the most abundant species. Several have young Australian pines. Camphorweed, a common member of the 5- to 10-year herb community, appears first during the third or fourth growing season. The herbaceous and shrub communities are well mixed with groundsel-tree being the dominant shrub and dropseed, natal grass, camphorweed, and dog fennel the dominant herbs. The early stage dominants finger grass, sandspur, and seaside paspalum are much less abundant.

On 10- to 20-year-old islands, the Baccharis-Schinus herb seral stage is present. The major plant community is shrub dominated by groundsel-tree, marsh elder, Brazilian pepper, and shrub verbena. Larger shrubs (3 to 5 m), such as Brazilian pepper and sabal palms, also occur together with some herbaceous cover in open areas which typify the Schinus-Sabal-Casuarina (20-year) stage of succession.

The most common climax (40+ years) community for dredged material islands in Florida appears to be the Casuarina-Sabal-Schinus seral stage, a forest community with dominant Australian pine that may reach 30 m in height and averages 15 to 20 m. The sabal palm appears to compete well

with both Australian pine and Brazilian pepper, tolerates shading, and eventually forms a distinct community by growing up and through the Brazilian pepper canopy. The predominance of the exotic Australian pine and Brazilian pepper in the later seral stages is unique to dredged material islands in Florida. The maritime forest climax is rare and occurs only where other factors have prevented invasion of Australian pine and Brazilian pepper. The maritime forest climax may be more common on dredged material islands north of the general study area.

Birds may influence the invasion of plants to dredged material islands through transport of seeds. This may occur through internal or external transport, and may be important in plant propagule dispersal to natural islands in Florida. The very rapid succession of the Brazilian pepper community in Florida is probably due to passerine species eating fruits and transferring them.

A five-fold difference in ammonium and phosphate concentrations due to feces from nesting birds has been noted on Florida islands. Samples of interstitial water beneath the birds confirmed that levels of ammonium more than ten times higher than ambient extended to the mangrove roots resulting in increased growth. These differences were reported to disappear when the birds were absent. Qualitative observations show that the rapid and luxuriant growth of Brazilian pepper on very rocky soil and natal grass on similar soil appears to be due to avian fecal contributions of nutrients on islands with large colonial bird populations. An example of the destructive role of feces on vegetation can be seen in mangrove communities on some islands used as nesting habitats. Young seedlings are killed by fecal deposition when the canopy is heavily occupied by birds. The open understory of these mangrove communities may contribute to use of this zone by smaller herons and egrets which can easily enter and leave mangroves.

Actual destruction of mature plants can result from the removal of twigs or small limbs from trees and shrubs to be used as nest building material. This can modify the structure of the canopy, temporarily destroy certain ground cover communities, or reverse plant succession in a heavily used community.

The creation of any new dredged material island or the addition of dredged material to an existing island offers opportunities for bird use. The need for habitat should be determined prior to island creation. It may be advisable to maintain the dredged material deposit in an unvegetated state through periodic redeposits of dredged material or removal of vegetation. This would provide badly needed nesting habitat for royal terns, least terns, and black skimmers. Herons and egrets, pelicans, spoonbills, and ibises would require the rapid establishment of 2- to 3-m mangroves. The general pattern of bird use of islands shows a decrease in use once the island passes the herb-shrub stage and with a few exceptions no return to heavy use unless a mangrove community develops.

Erosion problems are seriously threatening many of the islands presently used for nesting. The addition of dredged material to islands could prolong their usefulness as nesting habitat and also provide the bare sand habitat favored by other ground nesting species. Each time a dredging project is anticipated, beneficial uses of the dredged material such as adding to an existing nesting island or depositing directly on an older island to create an earlier successional stage should be considered. Efforts should be made to maintain and protect existing or newly created nesting, feeding, or loafing areas.

PREFACE

The work described in this report was performed as part of Contract DACW 39-76-C-0161, Use of Dredged Material Islands by Colonial Seabirds and Wading Birds in Florida. This contract was administered by the Environmental Laboratory, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. The study was undertaken as part of the Dredged Material Research Program, Island Habitat Development Project, which is managed by Dr. H. K. Smith. Contract Manager was Mary C. Landin, without whose continued assistance and patience the project would not have been successful. Dr. Robert F. Soots, Jr., Campbell College, North Carolina, served as a technical adviser. Technical review was provided by Ms. Landin, Dr. Soots, Drs. R. T. Huffman and Gary Tucker, and Ms. L. Jean Hunt, WES.

Principal investigator for Seabird Research, Inc., was Dr. Ralph W. Schrieber. James E. Poppleton of Florida Technological University, Orlando, Florida, provided immeasurable assistance in the field sampling program and botanical identifications. Frank M. Dunstan and James A. Rodgers, of the National Audubon Society, provided assistance and advice concerning sampling in the National Audubon Society Sanctuary Islands in Tampa Bay. Aerial photography was carried out by Ron C. Reichenbaugh and D. M. Michaelis of A.C.E. Photography of Tampa.

Dr. L. M. Ehrhart of the Department of Biology, Florida Technological University, provided invaluable assistance in our initial orientation to the Mosquito Lagoon and Indian River ecosystems.

The botanical field work was conducted by R. R. Lewis III and Carolyn S. Lewis, and they prepared this report.

COL John L. Cannon, CE, was Commander and Director of the Waterways Experiment Station during the study. Mr. F. R. Brown was Technical Director.

Contents

	Page
Summary	i
Preface	vi
List of Figures	2
List of Tables	7
Introduction	10
Methods	12
Results	14
Discussion	15
Plant succession	15
Influence of birds on invasion of plants, vegetation, and patterns of succession	23
Management recommendations	25
Literature Cited	27

List of Figures

<u>No.</u>		<u>Page</u>
1	Specific study areas in Florida	32
2	Specific study area I	33
3	Insets, specific study area I	34
4	Inset A, specific study area I	35
5	Inset B, specific study area I	36
6	Inset C, specific study area I	37
7	Inset D, specific study area I	38
8	Inset E, specific study area I	39
9	Inset F, specific study area I	40
10	Specific study area II	41
11	Insets, specific study area II	42
12	Inset A, specific study area II	43
13	Inset B, specific study area II	44
14	Inset C, specific study area II	45
15	Inset D, specific study area II	46
16	Inset E, specific study area II	47
17	Inset F, specific study area II	48
18	Specific study area III	49
19	Specific study area IV	50
20	Specific study area V	51
21	Generalized habitat succession on dredged material islands in Florida	52
22	Key to vegetation symbols for Figure 21	53

List of Figures (Continued)

<u>No.</u>		<u>Page</u>
23	Vertical aerial photograph and vegetation map of dredged material island I-4	59
24	Vertical aerial photograph and vegetation map of dredged material island I-14	61
25	Vertical aerial photograph and vegetation map of dredged material island I-15	63
26	Vertical aerial photograph and vegetation map of dredged material island I-21	66
27	Vertical aerial photograph and vegetation map of dredged material island I-39	68
28	Vertical aerial photograph and vegetation map of dredged material island I-48	70
29	Vertical aerial photograph of dredged material island I-49B	73
30	Vegetation map of dredged material island I-49B	74
31	Vertical aerial photograph of dredged material island I-54	77
32	Vegetation map of dredged material island I-54	78
33	Vertical aerial photograph of dredged material island I-58	81
34	Vegetation map of dredged material island I-58	82
35	Vertical aerial photograph and vegetation map of dredged material island I-59	84
36	Vertical aerial photograph of dredged material island I-60	87
37	Vegetation map of dredged material island I-60	88
38	Vertical aerial photograph of dredged material island I-61	90
39	Vegetation map of dredged material island I-61	91

List of Figures (Continued)

<u>No.</u>		<u>Page</u>
40	Vertical aerial photograph and vegetation map of dredged material island I-65	93
41	Vertical aerial photograph of dredged material island I-66	95
42	Vegetation map of dredged material island I-66	96
43	Vertical aerial photograph and vegetation map of dredged material island I-68	98
44	Vertical aerial photograph and vegetation map of dredged material island II-12	100
45	Vertical aerial photograph of dredged material island II-26	103
46	Vegetation map of dredged material island II-26	104
47	Vertical aerial photograph of dredged material island II-64	106
48	Vegetation map of dredged material island II-64	107
49	Vertical aerial photograph and vegetation map of dredged material island II-66	110
50	Vertical aerial photograph of dredged material island II-67	112
51	Vegetation map of dredged material island II-67	113
52	Vertical aerial photograph and vegetation map of dredged material island II-80	116
53	Vertical aerial photograph and vegetation map of dredged material island II-87	118
54	Vertical aerial photograph of dredged material island II-88	121
55	Vegetation map of dredged material island II-88	122
56	Vertical aerial photograph of dredged material island II-89	124
57	Vegetation map of dredged material island II-89	125

List of Figures (Continued)

<u>No.</u>		<u>Page</u>
58	Vertical aerial photograph and vegetation map of dredged material island II-91	127
59	Vertical aerial photograph and vegetation map of dredged material island II-97	129
60	Vertical aerial photograph and vegetation map of dredged material island II-98	132
61	Vertical aerial photograph and vegetation map of dredged material island II-125	134
62	Vertical aerial photograph and vegetation map of dredged material island II-128	136
63	Vertical aerial photograph and vegetation map of dredged material island II-129	138
64	Vertical aerial photograph and vegetation map of dredged material island II-152	140
65	Vertical aerial photograph and vegetation map of dredged material island II-153	142
66	Vertical aerial photograph and vegetation map of dredged material island III-7	144
67	Vertical aerial photograph and vegetation map of dredged material island III-8	146
68	Vertical aerial photograph and vegetation map of dredged material island III-12	148
69	Vertical aerial photograph and vegetation map of dredged material island III-13	150
70	Vertical aerial photograph and vegetation map of dredged material island IV-1	152
71	Vertical aerial photograph of dredged material island V-1 .	154
72	Vegetation map of dredged material island V-1	155
73	Vertical aerial photograph and vegetation map of dredged material island V-4	157

List of Figures (Concluded)

<u>No.</u>		<u>Page</u>
74	Vertical aerial photograph of dredged material island V-7	159
75	Vegetation map of dredged material island V-7	160

List of Tables

<u>No.</u>		<u>Page</u>
1	Summary table for dredged material islands chosen for vegetation study	54
2	Key to vegetation maps Figures 23-75	56
3	General characteristics and summary of vegetation data for dredged material island I-4	58
4	General characteristics and summary of vegetation data for dredged material island I-14	60
5	General characteristics and summary of vegetation data for dredged material island I-15	62
6	General characteristics and summary of vegetation data for dredged material island I-21	64
7	General characteristics and summary of vegetation data for dredged material island I-39	67
8	General characteristics and summary of vegetation data for dredged material island I-48	69
9	General characteristics and summary of vegetation data for dredged material island I-49B	71
10	General characteristics and summary of vegetation data for dredged material island I-54	75
11	General characteristics and summary of vegetation data for dredged material island I-58	79
12	General characteristics and summary of vegetation data for dredged material island I-59	83
13	General characteristics and summary of vegetation data for dredged material island I-60	85
14	General characteristics and summary of vegetation data for dredged material island I-61	89
15	General characteristics and summary of vegetation data for dredged material island I-65	72

List of Tables (Continued)

<u>No.</u>		<u>Page</u>
16	General characteristics and summary of vegetation data for dredged material island I-66	94
17	General characteristics and summary of vegetation data for dredged material island I-68	97
18	General characteristics and summary of vegetation data for dredged material island II-12	99
19	General characteristics and summary of vegetation data for dredged material island II-26	101
20	General characteristics and summary of vegetation data for dredged material island II-64	105
21	General characteristics and summary of vegetation data for dredged material island II-66	108
22	General characteristics and summary of vegetation data for dredged material island II-67	111
23	General characteristics and summary of vegetation data for dredged material island II-80	114
24	General characteristics and summary of vegetation data for dredged material island II-87	117
25	General characteristics and summary of vegetation data for dredged material island II-88	119
26	General characteristics and summary of vegetation data for dredged material island II-89	123
27	General characteristics and summary of vegetation data for dredged material island II-91	126
28	General characteristics and summary of vegetation data for dredged material island II-97	128
29	General characteristics and summary of vegetation data for dredged material island II-98	130
30	General characteristics and summary of vegetation data for dredged material island II-125	133

List of Tables (Concluded)

<u>No.</u>		<u>Page</u>
31	General characteristics and summary of vegetation data for dredged material island II-128	135
32	General characteristics and summary of vegetation data for dredged material island II-129	137
33	General characteristics and summary of vegetation data for dredged material island II-152	139
34	General characteristics and summary of vegetation data for dredged material island II-153	141
35	General characteristics and summary of vegetation data for dredged material island III-7	143
36	General characteristics and summary of vegetation data for dredged material island III-8	145
37	General characteristics and summary of vegetation data for dredged material island III-12	147
38	General characteristics and summary of vegetation data for dredged material island III-13	149
39	General characteristics and summary of vegetation data for dredged material island IV-1	151
40	General characteristics and summary of vegetation data for dredged material island V-1	153
41	General characteristics and summary of vegetation data for dredged material island V-4	156
42	General characteristics and summary of vegetation data for dredged material island V-7	158
43	Major plant species associated with the generalized plant succession pattern on dredged material island in Florida ..	161
44	Plant species checklist	163

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

VOL. II: PATTERNS OF VEGETATION SUCCESSION

Introduction

1. The importance of nearshore islands as nesting sites for many species of colonial seabirds and wading birds is well documented (Pettingill, 1970). Natural barrier islands and protected mangrove keys found in Florida were numerous and largely uninhabited in times past, and an abundance of wildlife has been associated with them and noted by naturalists since the late 1800's (Howell, 1932). Along with the natural habitats, colonial seabirds and wading birds are known to have nested on dredged material islands since their first creation in the early 1930's in Tampa Bay (Mills, 1934).

2. The importance of these artificially created islands for nesting habitat has increased as natural islands and intertidal communities have been altered for man's use (Lewis and Dunstan, 1975a). Lewis (1977) documents the loss of 44% of the coastal wetlands bordering Tampa Bay between 1876 and 1976 and Chardon (1976) notes that approximately 20% of the open-water area of Biscayne Bay north of Bear Cut was filled between 1887 and 1974. Many of the barrier islands are now heavily used for residential buildings and the general trend has been a marked reduction in the available natural nesting habitat throughout Florida. The role of dredged material islands in providing nesting habitat for colonial seabirds and wading birds is closely tied to the plant species present and the future patterns of succession. This study was designed to begin to look

at these patterns of plant succession and their relation to avian utilization of dredged material islands in Florida.

3. With the creation of dredged material islands primary succession of plant communities proceeds. Depending on the physiography of the island, biotic diversity of dispersal centers, and distance of the island from the dispersal centers, various plant communities may establish (Whitehead and Jones, 1969). Carlson (1972) and Beaman (1973) have conducted studies of plant succession on dredged material islands in Sarasota Bay and Charlotte Harbor in Southwest Florida, and Dunstan and Lewis (1974) and Coastal Zone Resources Corporation (1977) have done similar work in Tampa Bay. Barnes (1971), McMurtry (1971), and Simersky (1970) have examined dredged material islands in Texas; Soots and Parnell (1975) have documented succession of vegetation and bird utilization of dredged material islands in North Carolina. A complete literature review of avian utilization of dredged material islands in Florida is contained in Appendix A, Volume I, of this report.

4. This phase of the study was undertaken to document the patterns of succession of vegetation on dredged material islands in Florida and relate physiography and rates of succession to the plant communities to usefulness of the islands as nesting habitat.

Methods

5. All dredged material islands in the five selected study areas (Figures 1-20) were located, assigned a number, and an aerial color slide taken of each. The final selection of which of the islands should receive further study was made jointly by the contractor, Contract Manager Ms. Mary C. Landin, and Dr. R. F. Soots, Jr., for study areas I and II. The contractor chose the islands in study areas III, IV, and V. Table 1 summarizes the information on the 40 islands chosen for vegetative analysis.

6. A vertical black and white aerial photograph, or series on larger islands, was taken of each of the 40 islands. In the field the apex of the island was located and marked on the photograph. A general survey of the plant communities was made and these also noted on the photograph. Transects were established beginning at the apex and running through the plant communities present on the island, terminating at the edge of the shoreline vegetation. On those islands with multiple apices or no apex, transects were chosen to sample all plant communities and generally ran from one side of the island to the other. This technique provided two to four transects per island.

7. Plant communities along the transects were sampled at specified intervals depending on the community type. Herbaceous communities were sampled at 3-m intervals with a 0.5- by 0.5-m quadrat. Shrub communities were sampled at 5-m intervals with a 2.0- by 2.0-m quadrat. Shrub communities were defined as those with dominant phanerophytes branched near the base of the stem (=caespitose) and of normal size (less than 2 m) as defined by Mueller-Dombois and Ellenberg (1974). Tree communities were sampled at 10-m intervals with 4.0- by 4.0-m quadrats. Tree communities were defined as those having dominant phanerophytes with single stems and more or less numerous lateral branches (=scapose) and a height greater than 2 m. Tall (2 to 5 m) shrub species such as Brazilian pepper (*Schinus terebinthifolius*) often become scapose at heights over 2 m, in which case a tree community sampling procedure was used. On

islands larger than 4.05 ha (10 acres), the distance between sampling points was doubled within each community.

8. A total of 1123 quadrats were established on 38 of the 40 vegetative study islands between February and August 1977. Due to contract requirements and a desire on the part of the investigators not to unduly disturb nesting colonial seabirds and wading birds, vegetative sampling was delayed, restricted, or for two islands, entirely prevented. In the latter case islands II-152 and II-153 had large numbers of nesting wading birds during both visits (April and August 1977) made to each. The vegetative map and plant species list for each was therefore generated from direct observation by boat from offshore of the islands to avoid disturbing the colony. It is not felt that these problems in any way compromised the validity of the data or the conclusions.

9. All plants in each quadrat were identified to species in the field, if possible, and specimens were collected for later identification or as voucher specimens, as needed. The percent cover and height were estimated for each species and the rooted stems or trunks of shrubs or trees counted. Where seedlings of trees or shrubs were present they were counted separately from mature members of that species. Within shrub or tree communities understory species were included in the sampling and data gathering. These data were entered on standardized field data sheets and later transferred to individual quadrat data sheets. Voucher specimens for all plants species identified on the islands, except protected or endangered species (e.g. sea oats, Uniola paniculata), were forwarded to the Contracting Officer's Representative.

10. References used for plant species identification were Hitchcock (1971), Lakela and Long (1970), Long and Lakela (1971), Radford et al. (1968), and Wunderlin (1974).

11. In addition to phytosociological information, a soil sample, representative of the upper 15 cm of soil in the quadrat, was collected at each point on all transects. Samples were placed in plastic bags, labeled as to transect point and island number, and forwarded to the Contracting Officer's Representative.

Results

12. Table 1 summarizes the general characteristics of the 40 dredged material islands chosen for vegetative analysis. Table 2 is a key for the vegetation maps. Tables 3-42 list the size, age, and date of photography for each island and provide a plant species list, relative frequency (frequency of a species/sum of frequencies of all species \times 100), and relative abundance using the categories listed below:

- a. Uncommon (U) - Not occurring in any other quadrat of all quadrats within a given community on a specific island.
- b. Infrequent (I) - occurring in 10% or less of all quadrats, but more than one quadrat, within a given community on a specific island.
- c. Abundant (A) - occurring in 30% or less, but more than one quadrat and more than 10%, of all quadrats within a given community on a specific island.
- d. Very Abundant (VA) - occurring in more than 30% of all quadrats, and more than one quadrat, within a given community on a specific island.

13. Figures 21 and 22 represent a postulated vegetation succession pattern for dredged material islands in Florida. These stages correspond to ages of 0, 3, 5, 10, 20, and 40+ years. Table 43 lists the dominant plant species expected at each particular stage of succession.

14. Vertical aerial photographs and vegetation maps for each of the 40 vegetation study islands are shown in Figures 23-75.

15. A complete plant species list of all 40 islands is contained in Table 44. The list notes the occurrence of 141 plant species on the islands.

Discussion

Plant succession

16. As noted by Mueller-Dombois and Ellenberg (1974), the classical division of this subject is into xerarch (upland or terrestrial) and hydrarch (aquatic or intertidal) succession, and each will be discussed separately. The emphasis will be a discussion of primary succession: that is, plant community changes with time on new dredged material deposits. Many of the islands in the general study area have received multiple deposits over a period of time. Records of the timing and location of these deposits are largely nonexistent because the actual location of private and public dredging and deposition sites was not required to be accurately located until recent years, and designated disposal sites often covered several square miles. Careful examination of old aerial photography has revealed some of the deposits, but not enough to realistically assess secondary succession.

17. Intertidal succession on dredged material islands has been previously discussed by Carlson (1972), Beaman (1973), Dunstan and Lewis (1974), and Lewis and Dunstan (1975a, 1975b). The pioneer community only establishes under appropriate physiographic conditions which include a protected area on the lee side of an island or island placement in a location with little fetch or boat traffic. This protection is necessary in order to allow waterborne propagules time to establish root systems on the unstable, and often eroding shorelines, of dredged material islands. Davis (1940) first recognized that all three mangrove species in Florida (red mangrove, Rhizophora mangle; black mangrove, Avicennia germinans; white mangrove, Laguncularia racemosa) have waterborne propagules and that "strong wave action prevents establishment."

18. Formation of a protected cove on the lee side of an island through erosion on the windward side was first mentioned by Carlson (1972) and documented for island I-58 in Tampa Bay by Lewis and Dunstan (1975a). This process is widespread and can be seen on a number of islands in the general study area (I-39, Fig. 27; I-54, Fig. 31; II-88, Fig. 54;

II-125, Fig. 61; II-128, Fig. 62; and V-1, Fig. 71). If the initial deposit of dredged material is elongate with one end facing the prevailing winds or boat wakes, erosion produces single spits (I-59, Fig. 35; I-61, Fig. 38). If the long side of the island is facing the winds, both ends of the island erode and the island usually quickly disappears. If the initial deposit is round and in a protected area, then it may have a more or less uniform distribution of intertidal vegetation around its perimeter. This is an unusual condition, but does appear to have occurred on II-26 (Fig. 45). A more common condition is a round deposit that is eroding on one side and producing two spits on the lee side due to accretion of the same material (I-39, Fig. 27; I-58, Fig. 33; II-88, Fig. 54). In extreme cases of erosion and accretion (see Lewis and Dunstan, 1975a), the island may appear to "migrate" due to continual erosion and accretion, and eventually the spits may curl and fuse to form a land-locked cove (II-125, Fig. 61).

19. Once the appropriate physical factors exist, waterborne propagules may establish. In Florida the pioneering species on protected shorelines may vary with latitude and distance from propagule sources. Under optimum conditions in south Florida, mangroves will pioneer on the shore if seeds are readily available. Red mangroves have historically been considered the pioneer species, but as Carlson (1972) noted, black mangroves and white mangroves are the true pioneers in disturbed natural areas and on new dredged material deposits.

20. Along the central coasts of Florida, the intertidal pioneer is more commonly smooth cordgrass (Spartina alterniflora) (Lewis and Dunstan, 1975b). Mangroves gradually invade and replace the shade-intolerant cordgrass, which persists on older dredged material islands only as a fringe in the front of the outer band of red mangroves.

21. In northern Florida, very few mangroves can survive the periodic freezes, and the pioneering cordgrass may persist or be replaced by black needlerush (Juncus roemerianus) at higher elevations as sediments accumulate. No published observations of this pattern of succession are known.

22. The vegetative analyses of islands in this study confirm the basic pattern as outlined for the central coasts of Florida. Comparison of Table 10 (I-54, 20 years old) with Table 11 (I-58, 46 years old) shows that smooth cordgrass and black mangroves have approximately the same relative frequency on the younger island. In contrast, on the older island, mangroves are very abundant with no smooth cordgrass present in any of the quadrats sampled. It is known to be present on the island, but only as a fringe in front of the mangrove forest where it can apparently withstand more inundation time than any of the mangrove species. The most dominant mangrove species on the older island is the black mangrove. This may be partly due to differences in elevation since this is known to greatly effect the distribution of mangrove species (Davis, 1940; Detweiler et al., 1975).

23. If the appropriate physical conditions are not available, intertidal plant communities will not establish. This is a very common condition where a combination of high wave energy and low elevation of the initial deposit may prevent the formation of a "lee" side. Islands of this type are completely surrounded by a bare sandy beach and are usually experiencing heavy erosion (I-4, Fig. 23; I-48, Fig. 28; I-60, Fig. 36; I-65, Fig. 40; II-80, Fig. 52; II-129, Fig. 63; III-7, Fig. 66; III-12, Fig. 68; III-13, Fig. 69; and V-4, Fig. 73).

24. Upland succession for a number of dredged material sites in the United States, including Florida, has been discussed by Coastal Zone Resources Corporation (1977). The report of Dunstan and Lewis (1974) provided most of the information about upland plant succession on those dredged material islands in Hillsborough Bay, Florida. The major conclusion of Coastal Zone Resources Corporation (1977) that a maritime forest represents the climax plant community on dredged material islands in Florida was not the conclusion of Carlson (1972), Beaman (1973), nor Dunstan and Lewis (1974).

25. Figure 21 illustrates the six stages in the generalized plant succession pattern for dredged material islands in Florida. The names of the stages were derived from the dominant plants or plant type occurring

in the upland plant communities. Intertidal communities, as previously mentioned, are often absent and quite variable depending on erosion patterns.

26. Table 43 lists the major plant species associated with each succession stage. Both Figure 21 and Table 43 are derived from the overall general pattern observed and indicated from data analysis.

27. Certain specific islands do not appear to fit this general pattern of succession. The two most important exceptions are the two vegetation study islands in the Mosquito Lagoon (Fig. 12) at the northern end of specific study area II (II-12 and II-26). These two islands are at least 25 years old and neither had any Brazilian pepper nor Australian pine (Casuarina equisetifolia) (Tables 17 and 18). These two introduced species generally become dominant on older dredged material islands in the general study area. Their absence on these two islands has allowed the native maritime forest climax community consisting of sabal palm (Sabal palmetto) and southern red cedar (Juniperus silicicola) to develop. Observations during sampling just after one of the worst freezes in Florida in 100 years (January 1977) indicate Australian pines are sensitive to freeze damage and its distribution north of the Indian River may be limited by its limited cold tolerance. Similar freeze damage to Brazilian pepper was observed, though not as severe as in Australian pine. It is also possible that both species have limited propagule sources near the islands. In general, further investigation is necessary to accurately determine succession patterns in both this part of Florida and northern Florida.

28. Another minor exception to the general pattern illustrated in Figure 21 is island I-58 in Tampa Bay. No Australian pine is present on this island and Brazilian pepper represents only a minor constituent of the upland plant community (Table 11). The lack of Australian pine is probably due to the early establishment of this island (1931), before this species was widespread in Florida, and its physiography, which may prevent seeds from reaching suitable substrates for germination.

29. Beaman (1973) indicates that Australian pine has been in Florida for only about 70 years and its spread throughout Florida has been greatly assisted by plantings for windbreaks in agricultural areas

and on public beaches to provide shade. Davis (1942) reports its spread on Loggerhead Key in the Dry Tortugas from plantings. He also notes that "it seems entirely possible that these plants will continue to grow whether or not they are cared for, and eventually they may replace some of the present vegetation, for after they have become large few plants can live under them." This aggressive growth form with very rapid increase in height (60 cm/yr) and elimination of smaller plant forms under its canopy is most obvious in disturbed plant communities or bare areas where it can establish and dominate other species. This may, in part, be due to its unique ability to fix atmospheric nitrogen, a characteristic found in at least 20 genera of nonleguminous angiosperms including the wax myrtle (Myrica cerifera) (Silver et al., 1966), a dominant plant species in the late-seral stages of succession on dredged material islands in North Carolina (Soots and Parnell, 1975). Australian pine also has negative geotropic curvature of its root system (Silver et al., 1966) which allows rapid uptake of intermittent rainfall moisture. Both of these characteristics adapt it well to xeric, nutrient-poor soils typical of most of the dredged material islands in Florida (Beaman, 1973).

30. In already well-established plant communities, this species may not be able to naturally establish and dominate native species (Craighead, 1971; Beaman, 1973). It is quite possible that both Australian pine and Brazilian pepper cannot compete with the native plant communities such as are present on island I-58, where a native plant community has existed for over 40 years. In contrast, island V-1 is approximately the same age, but is dominated by Australian pine (Table 40). The difference appears to be due to (1) the lower latitude of V-1 which is more ideally suited for this plant's growth and (2) V-1 appears to have had many species planted on it and may have been used as a residence. Island I-58 has been protected by the National Audubon Society since the early 1930's as a wildlife sanctuary and few if any plant species were ever planted on it.

31. Some authors feel that Australian pine seeds may survive immersion in seawater and be transported to some sites by water (Beaman, 1973), although there is apparently no experimental proof of this

hypothesis. The physiography of an island could be very important in controlling the dispersal of Australian pine if the seeds are waterborne, since a steep slope or erosion bluff could prevent seeds from reaching the uplands. This condition apparently exists on two dredged material islands in Sarasota Bay and has allowed a southern red cedar-sabal palm climax community to develop in an area with a good supply of seeds and ideal growing conditions for Australian pine (Beaman, 1973). A similar steep slope due to erosion has existed on island I-58 since its creation (Lewis and Dunstan, 1975a) and may have contributed to the lack of Australian pine on this island.

32. With these exceptions, Figure 21 does illustrate a pattern seen on most of the other islands. Very few young dredged material islands were present in the general study area, but I-65 (Table 15), II-129 (Table 32) and IV-1 (Table 39) do illustrate the very early herb stage of succession. On all three islands herbaceous communities were dominant with finger grass (Chloris glauca and Chloris petraea), dune sandspur (Cenchrus tribuloides), and seaside paspalum (Paspalum vaginatum) being the most abundant species. Several have young Australian pines and IV-1, being a year older than the rest (4 years), shows the beginning development of an intermediate community where herbs and other grasses become more dominant. Camphorweed (Heterotheca subaxillaris), a common member of the 5- to 10-year herb community, appears first during the third or fourth growing season. Soots and Parnell (1975) also reported this species' first appearance during year 3 in North Carolina. Its is also an important plant on young dredged deposits in Texas (Barnes, 1971).

33. The herb-shrub seral stage is best illustrated by island I-66 (Table 16). The herbaceous and shrub communities are well mixed with groundsel-tree (Baccharis halimifolia) being the dominant shrub and dropseed (Sporobolus domingensis), natal grass (Rhynchelytrum repens), camphorweed, and dog fennel (Eupatorium capillifolium) the dominant herbs. The early stage dominants finger grass, sandspur, and seaside paspalum are much less abundant.

34. Islands III-7 (Table 35), III-8 (Table 36), and III-12 (Table 37), although they are 12 years old, also illustrate this stage of succession. This is due to their distance from shore and propagule sources

and extreme open exposure to the open Gulf of Mexico and its periodic storms. This is an example of where extremes of physical stress can slow or stop plant succession on dredged material islands. Island I-4 (Table 3) is another example of this, where a 15-year-old island supports a dominant plant community characteristic of a very early seral stage.

35. The Baccharis-Schinus-herb seral stage (10 year) is present on islands I-39 (Table 7) and I-54 (Table 10). On I-39 the major plant community is shrub dominated by groundsel-tree and marsh elder (Iva frutescens). Brazilian pepper is also very abundant. On I-54 groundsel-tree and shrub verbena (Lantana camara) are dominant. Although I-54 is 20 years old, it has received a second dredged material deposit within the last 10 years. It is this second deposit that supports this plant community. This is one of the few examples of documentation of secondary deposits on dredged material islands in Florida.

36. Island I-59 (Table 12) has a dominant tree community of large (3 to 5 m) Brazilian pepper, sabal palms, shrubs (groundsel-tree, marsh elder, and shrub verbena) and some herbaceous cover in open areas. It is typical of the Schinus-Sabal-Casuarina (20-year) stage of succession. The Australian pine portion of the community is represented by scattered trees, but their ability to dominate a community with time means that ultimately they will increase and perhaps cover the entire island. The similar aggressive growth of Brazilian pepper has pushed it up through the shrub cover typically provided by groundsel-tree and it has largely replaced it. It is interesting to note that the only Brazilian pepper observed on island I-66 (herb-shrub seral stage) were small seedlings under mature groundsel-tree. The seedlings most likely developed from seeds dropped there in fecal deposits by birds roosting in the shrubs. Some nesting by red-winged blackbirds has also been noted in groundsel-tree on other dredged material islands in the general study area and these may contribute to the transfer of Brazilian pepper seeds to the islands (Dunstan and Lewis, 1974).

37. The most common "climax" (40+ years) community for dredged material islands in Florida appears on islands II-87 (Table 24), II-88

(Table 25), and V-1 (Table 40). The reasons for the exception of I-58 have already been discussed. The Casuarina-Sabal-Schinus seral stage is a forest community with dominant Australian pine that may reach 30 m in height and averages 15 to 20 m. The sabal palm appears to compete well with both Australian pine and Brazilian pepper, tolerates shading, and eventually forms a distinct community by growing up and through the Brazilian pepper canopy.

38. In summary, the generalized upland succession pattern on dredged material islands in Florida is very similar to that in North Carolina discussed by Soots and Parnell (1975). Unlike that study, however, no data exist on very early succession (years 1 to 3), and species of pines are very rare on dredged material islands in Florida. Oaks were never observed on any of the islands in the general study area and are assumed to be completely absent. Also, the predominance of the exotic Australian pine and Brazilian pepper in the later seral stages is unique to dredged material islands in Florida. The conclusion of Coastal Zone Resources Corporation (1977) that a maritime-like forest with oaks results if succession is allowed to proceed is not supported by this study. The maritime forest climax is rare and occurs only where other factors have prevented invasion of Australian pine and Brazilian pepper. The maritime forest climax may be more common on dredged material islands north of the general study area.

39. The numbers of plant species listed in Tables 3 through 42 are generally low in comparison with similar lists generated for some of the same islands by other studies. For example Coastal Zone Resources Corporation (1977) reports the presence of 70 species of plants on I-58 (Bird Island), while Table 11 in this report lists only 32. The difference is not due to changes in the plant community between 1974 and 1977 but to differences in sampling techniques. The larger species list was developed by two separate teams of botanists working over several seasons on the island and thus reflects an intensive effort to identify all plant species occurring on the island including many of the rare species. The smaller list was the result of identification of plants occurring

only within sampled quadrats during one visit to the island. Thus the less common species might not occur in a sampled quadrat or might not be present in the winter when this sampling took place. The only valid comparison of phytosociological data would be a comparison of data collected in a similar manner during the same season. There are marked changes in the plant communities following the typical heavy rainfall months of July and August, but these seasonal changes were not recorded during this study. The general conclusions about community types and plant succession on these islands are not altered by these seasonal changes, and as noted before the more intensive botanical sampling did not result in a better understanding of the upland succession patterns.

Influence of birds on invasion of plants, vegetation, and patterns of succession

40. Birds may influence the invasion of plants to dredged material islands through transport of seeds. This may occur through internal (endozoic) or external (ectozoic) transport. Darwin (1859) was probably the first to note avian transport of plant propagules when he proved viable seeds were present in mud adhering to birds feet. Davis (1942) suggests the endozoic transport of seeds of Scaevola, Coccoloba, Solanum, Lantana, and Opuntia and the extozoic transport of Cenchrus, Cyperus, Chamaesyce, Andropogon, and Borrchia may also be important in plant propagule dispersal to natural islands in Florida. Cruden (1966) felt that "mountain hopping" (=island hopping) by birds transporting seed was a viable hypothesis to explain long-distance dispersal of disjunct island groups. Proctor (1968) and Vlaming and Proctor (1968) have demonstrated the viable passage or regurgitation of seed of 33 plant species in a variety of birds including least sandpiper, lesser yellow-legs, and mockingbird. Plant species included are pepper grass (Lepidium virginicum), goosefoot (Chenopodium album), hackberry (Celtis laevigata), four species of Eleocharis, and two species of Cyperus. In addition they report the presence of seeds of Sida sp., Cenchrus sp., and Solanum

sp. in the digestive systems of killdeer shot in the field. The fruit of Brazilian pepper is bright red and commonly eaten by many passerine species. The very rapid succession of the Brazilian pepper community on I-59 is probably due to passerine species such as towhee and red-winged blackbird eating Brazilian pepper fruits on I-58 and the adjacent shore and transferring them to I-59. Similar transfer of wax myrtle seeds has been reported by Soots and Parnell (1975) by yellow-rumped warblers and tree swallows in North Carolina.

41. Increased fertility of soils on dredged material islands in North Carolina through fecal deposits has been reported by Soots and Parnell (1975). A five-fold increase in phosphorus and major increases in nitrogen were noted between dredged material with nesting and those without nesting. Onuf et al. (1977) compared water samples collected beneath a mangrove canopy on a dredged material island in the Indian River, Florida (south of study area II), that had nesting birds with an adjacent open-water area and recorded a similar five-fold difference in ammonium and phosphate. Samples of interstitial water beneath the birds confirmed that levels of ammonium more than ten times higher than ambient extended to the mangrove roots. These differences were reported to disappear when the birds were absent. Repeated measurements on red mangrove branches at the rookery site showed greater additions of leaves, reproductive parts, new lateral branches, and stem diameter. Herbivory by insects was also greatly increased and this reduced the expected increased biomass of leaves due to the increased soil fertility by one-half.

42. Qualitative observations show that the rapid and luxuriant growth of Brazilian pepper on very rocky soil on I-59 and natal grass on similar soil on I-66 appears to be due to avian fecal contributions of nutrients. Both islands have large colonial seabird and wading bird populations. Gillham (1956) notes that not only can fecal deposits encourage growth in what are termed "ornithocoprophilous vegetation" but can cause destruction or complete loss of other communities. An example of this destructive role can be seen in the mangrove communities on I-58

and I-66 where both are used as colonial nesting habitats for egrets and herons. The dominant black mangrove and white mangrove form a community with very few trunks (0.30 per m²) and a dense canopy. Seedlings may establish under this canopy during the major seed drop in August and September. These young plants are, however, killed by fecal deposition during January to May of each year when the canopy is heavily used for nesting. The open understory of these mangrove communities may contribute to use of this zone by smaller herons and egrets which can easily enter and leave the mangroves. Trunk densities in a mature mangrove community in Tampa Bay have been reported at 3.1 to 15.9 per m², depending on the species, by Detweiler et al. (1975). This particular community was not used as a colonial nesting site.

43. Actual destruction of mature plants can result from the removal of twigs or small limbs from trees and shrubs to be used as nest building material. This can modify the structure of the canopy, temporarily destroy certain ground cover communities, or reverse plant succession in a heavily used community (Gillham, 1963; Dunstan and Lewis, 1974; Wiese, 1977). The trampling of grasses (sandspur, natal grass, seaside paspalum) by laughing gulls may temporarily prevent early spring growth of these species on I-49B and I-66. However, the combination of fecal fertilization and summer rains after the end of the nesting season appears to offset this damage.

Management recommendations

44. Williams and Martin (1968) first suggested the creation of artificial islands for brown pelican rookeries in Florida and Carlson (1972) added additional suggestions. Lewis and Dunstan (1975a) have proposed a design for artificial rookery islands and this design is being incorporated into the dredged material disposal plan for the Tampa Harbor Deepening Project with two small islands of this design being created (Lewis, 1977). In addition one end of I-59 has received a recent dredged material deposit in order to add to the available habitat of that island and also to replace portions of the island lost to erosion.

45. The creation of any new dredged material island or the addition of dredged material to an existing island offers opportunities for bird usage. The type of habitat and location should be determined prior to island creation through consultation with local professional ornithologists. It may be advisable to maintain the dredged material deposit in an unvegetated state through periodic redeposits of dredged material or removal of vegetation. This would provide badly needed nesting habitat for species such as least terns and black skimmers. Proposed brown pelican or heron rookeries, on the other hand would require the rapid establishment of 2- to 3-m mangroves, which may require active planting and fertilization efforts. Although some species of birds have been observed using Australian pine for nesting (e.g. great blue heron, yellow-crowned night heron, double-crested cormorant) and large numbers of birds such as white ibis use Brazilian pepper for nesting on I-59, the general pattern of avian utilization of dredged material islands shows a decrease in usage once the island passes the herb-shrub stage (Figure 21) and with a few exceptions no return to heavy use unless a mangrove community develops.

44. Erosion problems are seriously threatening many of the islands presently used for nesting such as I-61 in Hillsborough Bay where a laughing gull colony has existed for a number of years. The addition of dredged material to the westerly end of the island could prolong its usefulness as nesting habitat and also provide the bare sand habitat favored by other ground nesting species. Each time a dredging project is anticipated beneficial uses of the dredged material such as adding to an existing nesting island or depositing directly on an older island to create an earlier successional stage should be considered. In addition the recommendations in Volume I of this report should be instituted to maintain and protect existing or newly created nesting, feeding, or loafing areas.

Literature Cited

- Barnes, D. J. 1971. Anatomy of a spoil island. Unpublished Master's Thesis. Texas A & I University, Kingsville, Texas. 70 pp.
- Beaman, B. 1973. Plant community structure and vegetational zones on spoil islands. New College, Sarasota, Florida. 69 pp.
- Carlson, P. R. 1972. Patterns of succession on spoil islands: a summary report. New College, Sarasota, Florida. 114 pp.
- Chardon, R. E. 1976. A geographical history of the Biscayne Bay area. Pages 235-245 in A. Thorhaug and A. Volker, eds. Biscayne Bay: past/present/future. University of Miami Sea Grant Special Report Number 5. University of Miami, Coral Gables, Florida. 315 pp.
- Coastal Zone Resources Corporation. 1977. A comprehensive study of successional patterns of plants and animals at upland disposal areas. Contract Report D-77-2. Environmental Effects Laboratory, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. 395 pp + appendices.
- Craighead, F. C. Sr. 1971. The trees of south Florida. Volume 1. University of Miami Press, Coral Gables, Florida. 212 pp.
- Cruden, R. W. 1966. Birds as agents of long term dispersal of disjunct plant groups of the temperate western hemisphere. *Evolution* 20:517-532.
- Darwin, C. 1859. On the origin of species. Facsimile of the first edition. Harvard University Press, Cambridge, Massachusetts. 502 pp.

- Davis, J. H. 1940. The ecology and geologic role of mangroves in Florida. Carnegie Inst. Wash. Pub. 517. Papers from Tortugas Lab. 32:303-412.
- Davis, J. H. 1942. The ecology of the vegetation and topography of the sand keys of Florida. Carnegie Inst. Wash. Pub. 524. Papers from Tortugas Lab. 33:113-195.
- Detweiler, T., F. M. Dunstan, R. R. Lewis, and W. K. Fehring. 1975. Patterns of secondary succession in a mangrove community in Tampa Bay. Pages 52-80 in R. R. Lewis, ed. Proceedings of the second annual conference on restoration of coastal vegetation in Florida. Hillsborough Community College, Tampa, Florida. 203 pp.
- Dunstan, F. M. and R. R. Lewis. 1974. Avian utilization and plant succession on dredged material islands in Tampa Bay, Florida. Contract report to Coastal Zone Resources Corporation, Wilmington, North Carolina. 73 pp.
- Gillham, M. E. 1956. Ecology of the Pembrokehire islands. V. Manuring by the colonial seabirds and mammals, with a note on seed distribution by gulls. J. Ecol. 44:429-454.
- Gillham, M. E. 1963. Some interactions of plants, rabbits and seabirds on south African islands. J. Ecol. 51:275-294.
- Hitchcock, A. S. 1971. Manual of the grasses of the United States. Second edition revised by A. Chase. Two Volumes. Dover Publications, Inc., New York. 1051 pp.
- Howell, A. H. 1932. Florida bird life. Coward-McCann, New York.
- Lakela, O. and R. W. Long. 1970. Plants of the Tampa Bay area. University of South Florida Department of Botany and Bacteriology. Contribution No. 56. 109 pp.

Lewis, R. R. 1977. Impact of dredging in the Tampa Bay estuary, 1876-1976. Pages 31-55 in E. L. Pruitt, ed. Proceedings of the second annual conference of the Coastal Society: Time-stressed coastal environments; Assessment and future action. The Coastal Society, Arlington, Virginia. 290 pp.

Lewis, R. R. and F. M. Dunstan. 1975a. Use of spoil islands in reestablishing mangrove communities in Tampa Bay, Florida. Pages 766-775 in G. Walsh et al., eds. Proceedings of the international symposium on biology and management of mangroves. Vol. II. Institute of Food and Agricultural Sciences. University of Florida, Gainesville, Florida. 877 pp.

Lewis, R. R. and F. M. Dunstan. 1975b. The possible role of Spartina alterniflora Loisel. in the establishment of mangroves in Florida. Pages 82-100 in R. R. Lewis, ed. Proceedings of the second annual conference on restoration of coastal vegetation in Florida. Hillsborough Community College, Tampa, Florida. 203 pp.

Long, R. W. and O. Lakela. 1971. A flora of tropical Florida. University of Miami Press, Coral Gables, Florida. 961 pp.

McMurray, S. L. 1971. Nesting and development of the Reddish Egret (*Dichromanassa rufescens* Gmelin) on a spoil bank chain in the Laguna Madre. Unpublished Master's Thesis. Texas A & I University, Kingsville, Texas. 78 pp.

Mills, H. R. 1934. Report on the Tampa Bay rookeries. Fla. Nat. 8(1): 1-4.

Mueller-Dombois, D. and H. Ellenberg. 1974. Aims and methods of vegetation ecology. John Wiley and Sons, New York. 547 pp.

- Onuf, C. P., J. M. Teal, and I. Valiela. 1977. Interactions of nutrients, plant growth and herbivory in a mangrove ecosystem. *Ecology* 58(3): 514-526.
- Pettingill, O. S. 1970. Ornithology in laboratory and field. Burgess Publishing Co., Minnesota. 524 pp.
- Proctor, V. W. 1968. Long-distance dispersal of seeds by retention in digestive tracts of birds. *Science* 160:321-322.
- Radford, A. E., H. E. Ahles, and C. R. Bell. 1968. Manual of the vascular flora of the Carolinas. University of North Carolina, Chapel Hill, North Carolina. 1183 pp.
- Silver, W. S., R. E. Bendana, and R. D. Powell. 1966. Root nodule symbiosis II. The relation of auxin to root geotropism in roots and root nodules of non-legumes. *Physiol. Plant.* 19:207-218.
- Simersky, B. L. 1970. Competition and nesting success of four species of herons on four spoil islands in the Laguna Madre. Unpublished Master's Thesis. Texas A & I University, Kingsville, Texas. 92 pp.
- Soots, R. F., Jr., and J. F. Parnell. 1975. Ecological succession of breeding birds in relation to plant succession on dredge islands in North Carolina estuaries. University of North Carolina Sea Grant Pub. UNC-SG-75-27. 91 pp.
- Vlaming, V. L. de, and V. W. Proctor. 1968. Dispersal of aquatic organisms: viability of seeds recovered from the droppings of captive killdeer and mallard ducks. *Amer. J. Bot.* 55:20-26.

- Weise, J. H. 1977. A study of the reproductive biology of herons, egrets, and ibis nesting on Pea Patch Island, Delaware. Interpretive report for the period March through September 1976. Manomet Bird Observatory, Manomet, Massachusetts. 179 pp.
- Whitehead, D. R. and C. E. Jones. 1969. Small islands and the equilibrium theory of insular biogeography. *Evolution* 23:171-179.
- Williams, L. E., Jr., and L. Martin. 1968. Nesting status of the Brown Pelican in Florida in 1968. *Quart. J. Fla. Acad. Sci.* 31(2):130-140.
- Wunderlin, R. P. 1974. Woody plants of the Tampa Bay area. University of South Florida, Department of Botany. Contribution No. 72. 49 pp.

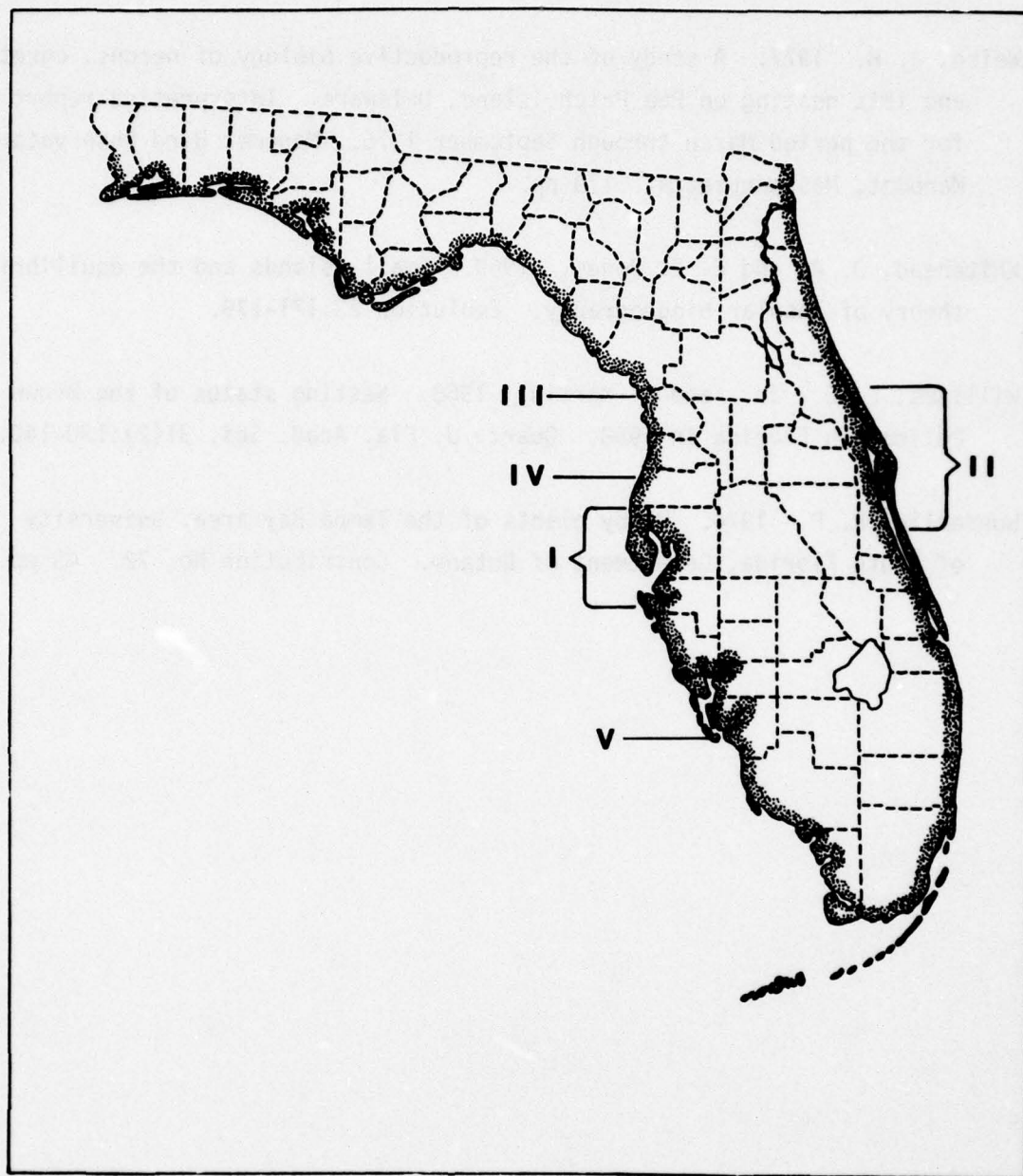


Figure 1. Specific study areas in Florida.

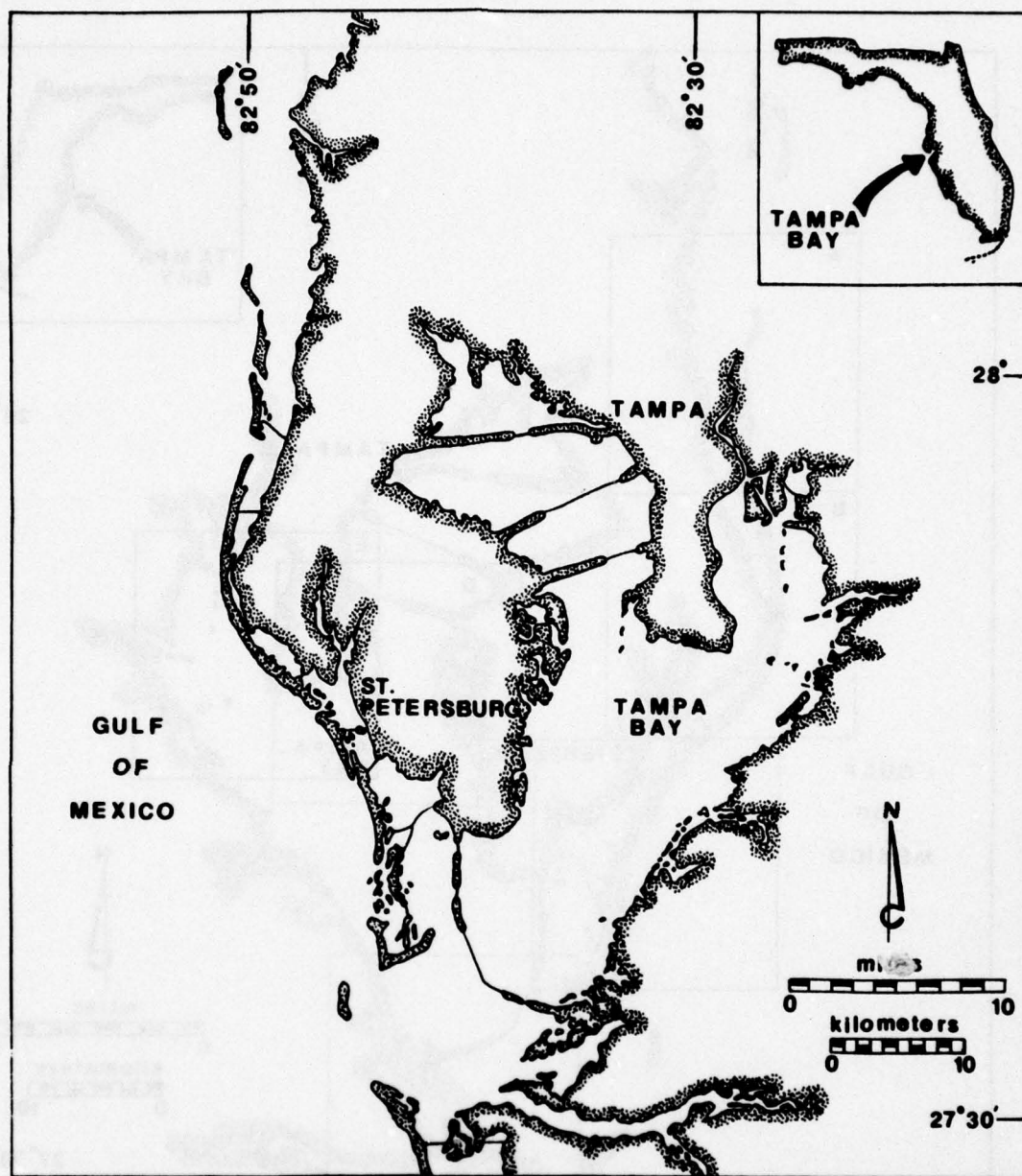


Figure 2. Specific study area I.

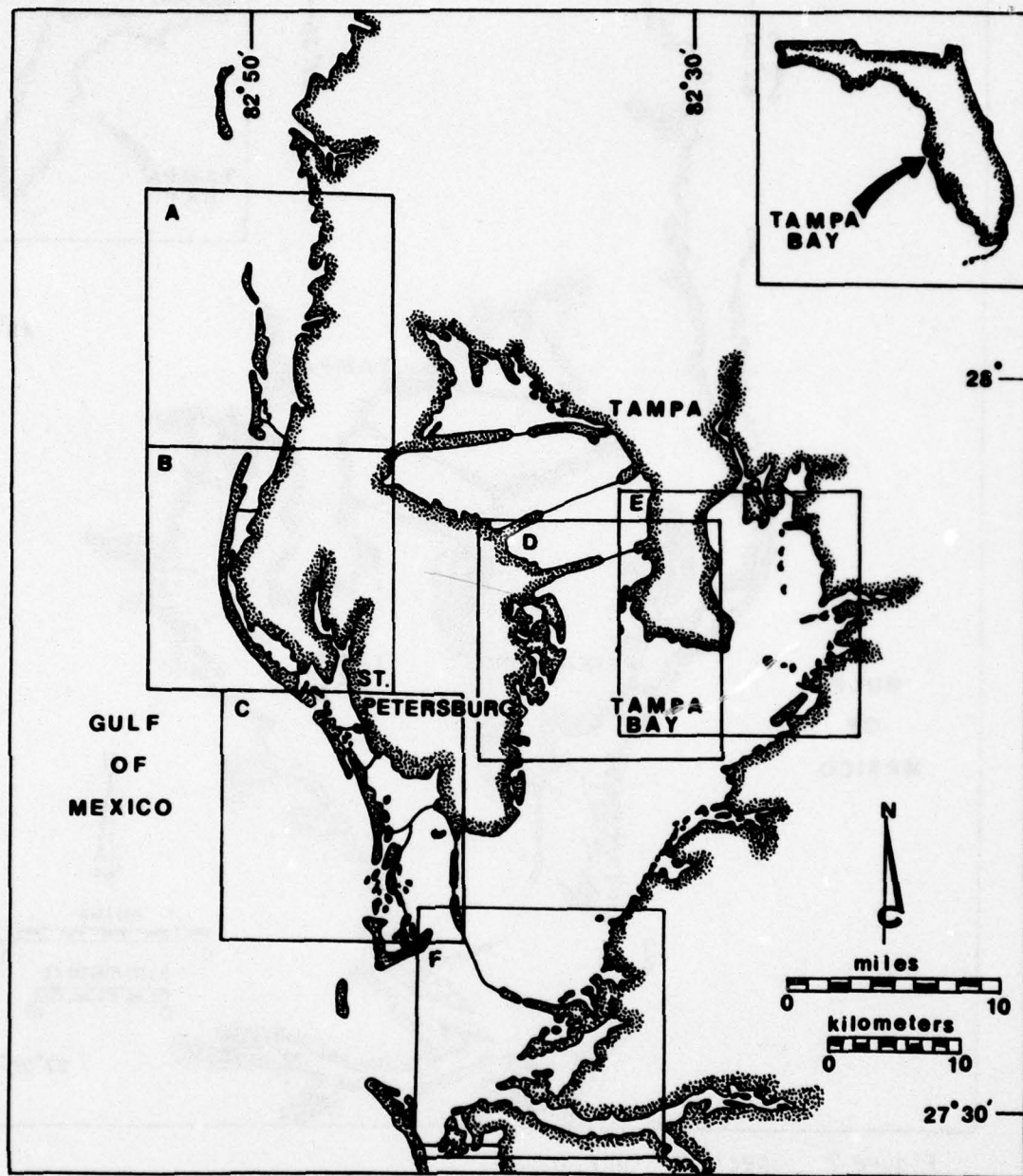


Figure 3. Insets, specific study area I.

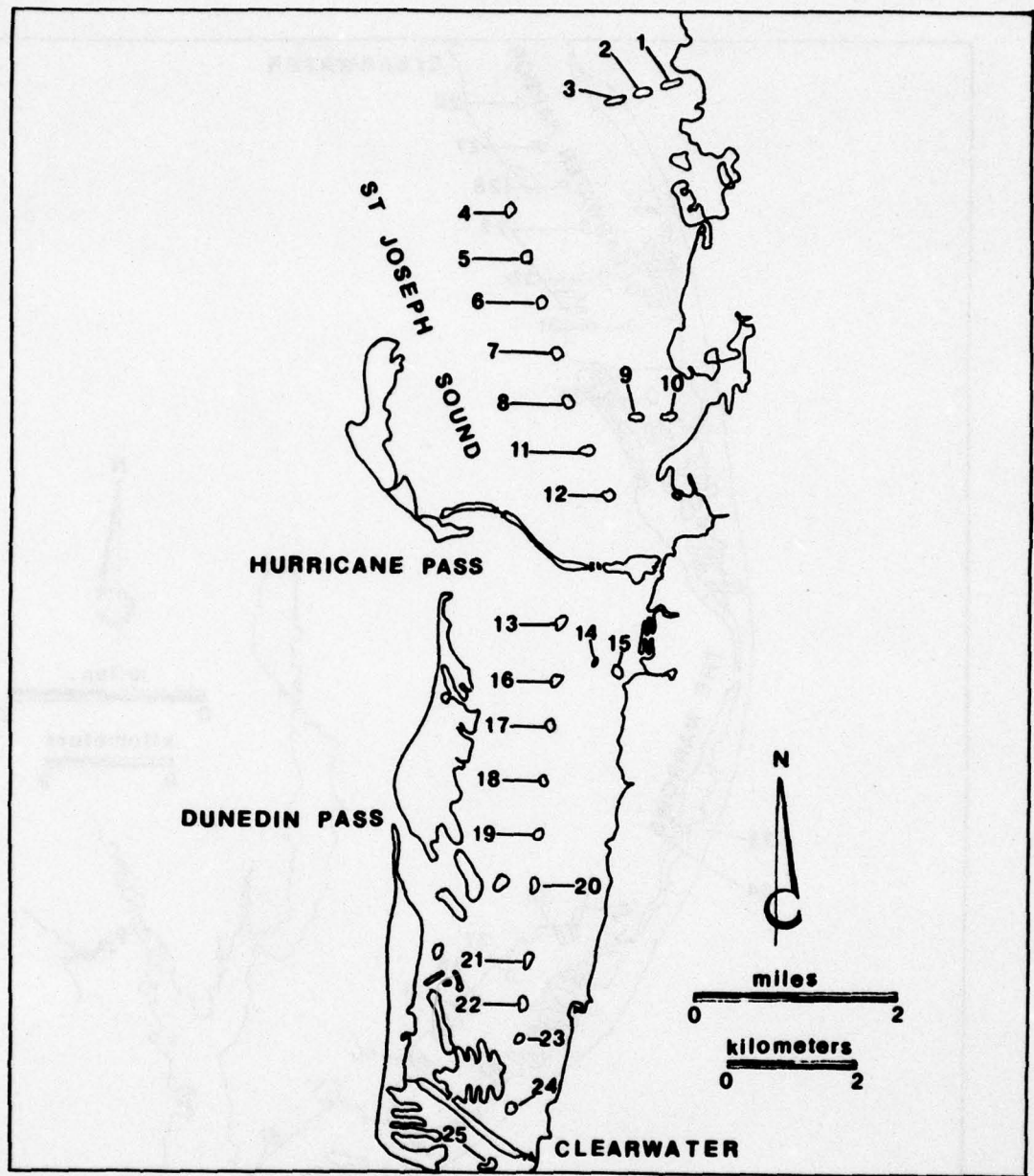


Figure 4. Inset A, specific study area I.

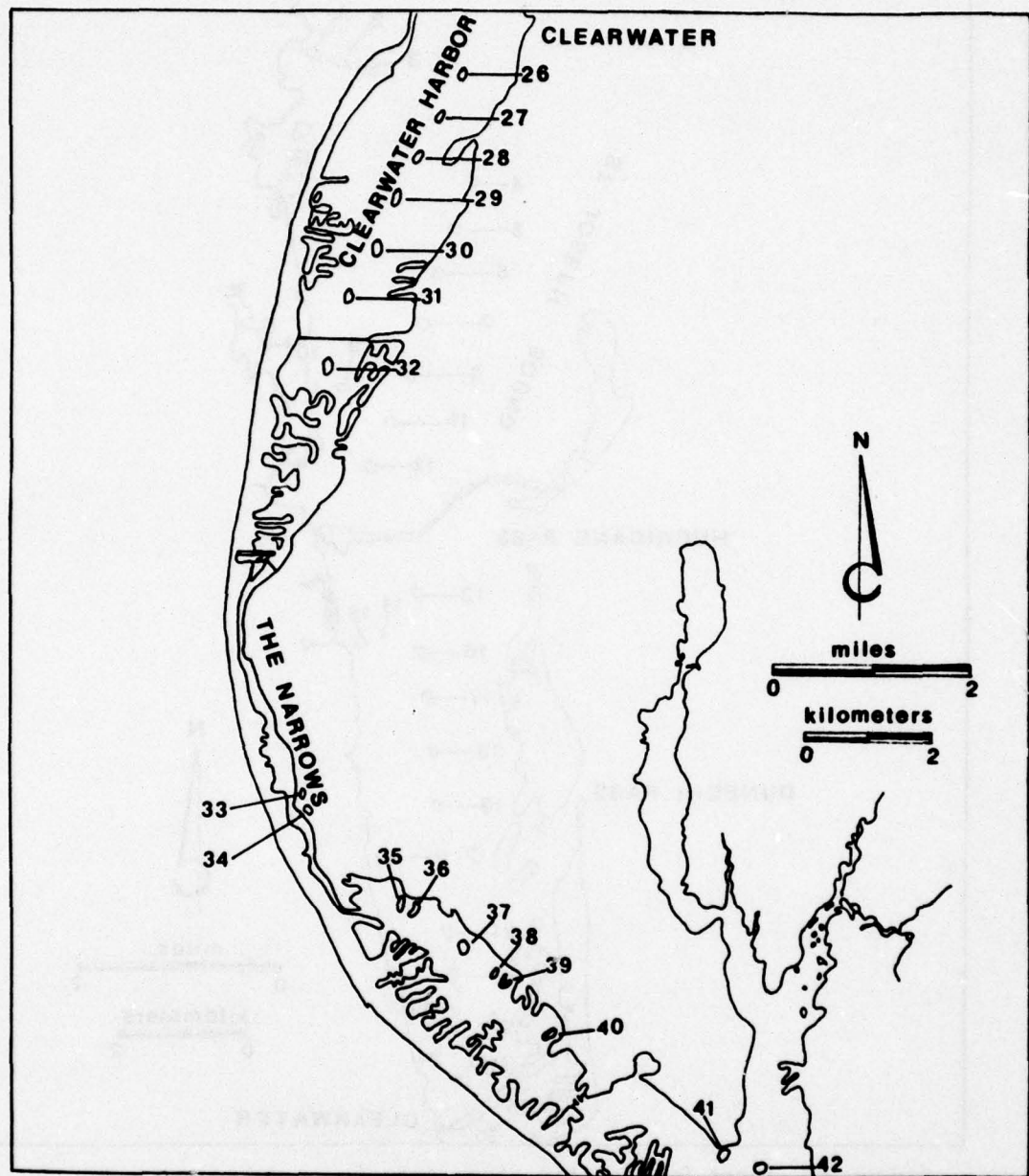


Figure 5. Inset B, specific study area I.

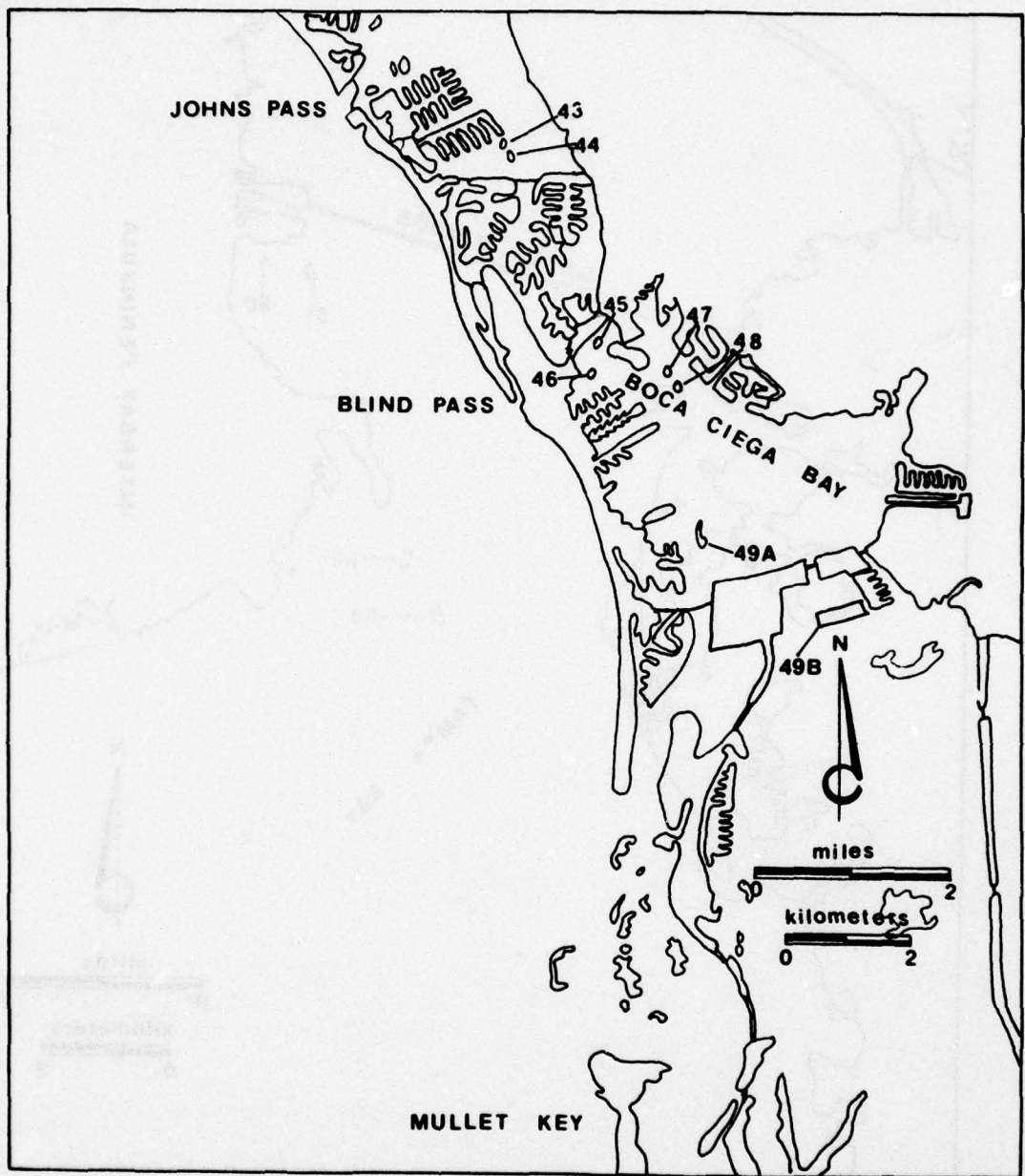


Figure 6. Inset C, specific study area I.

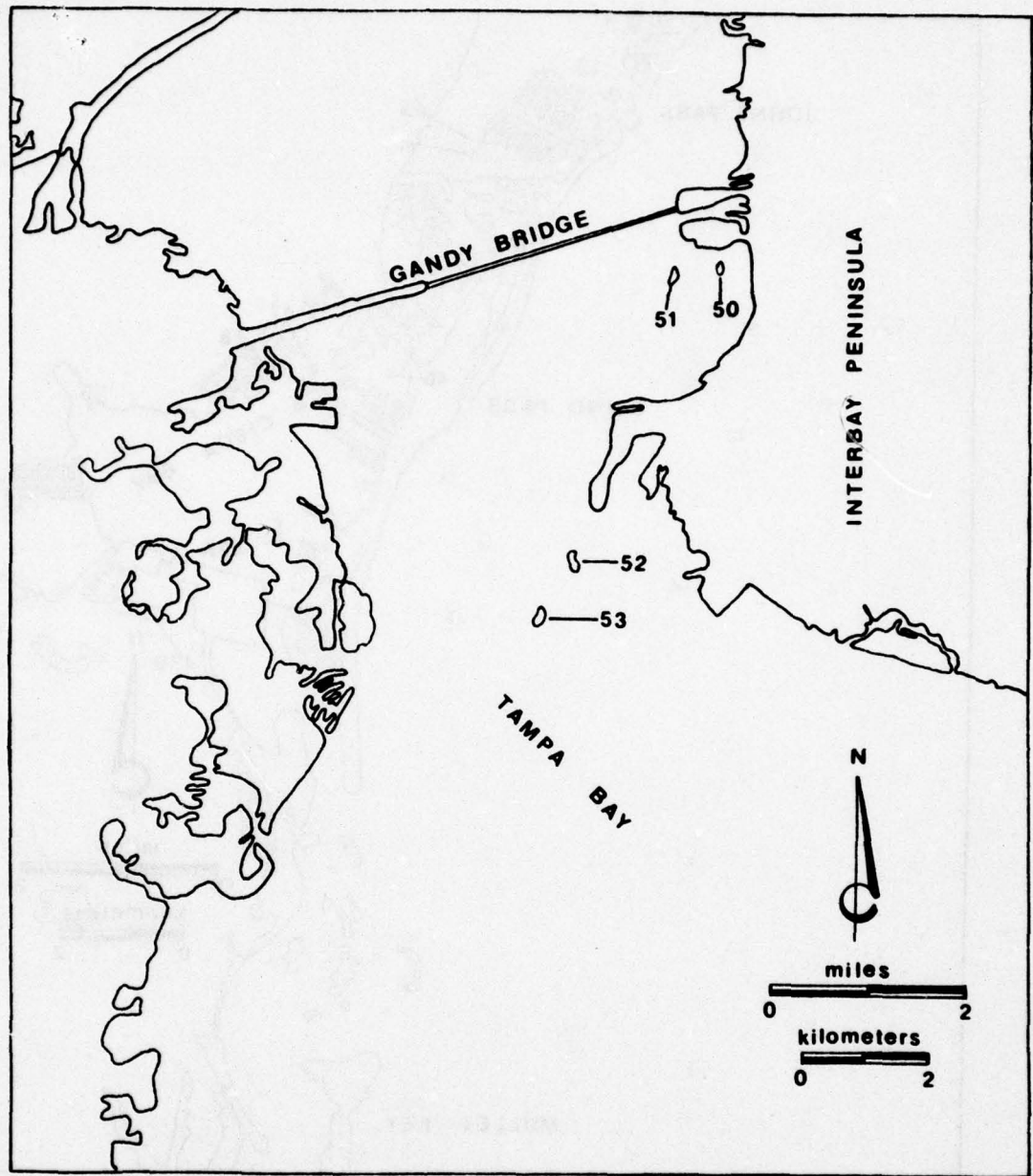


Figure 7. Inset D, specific study area I.

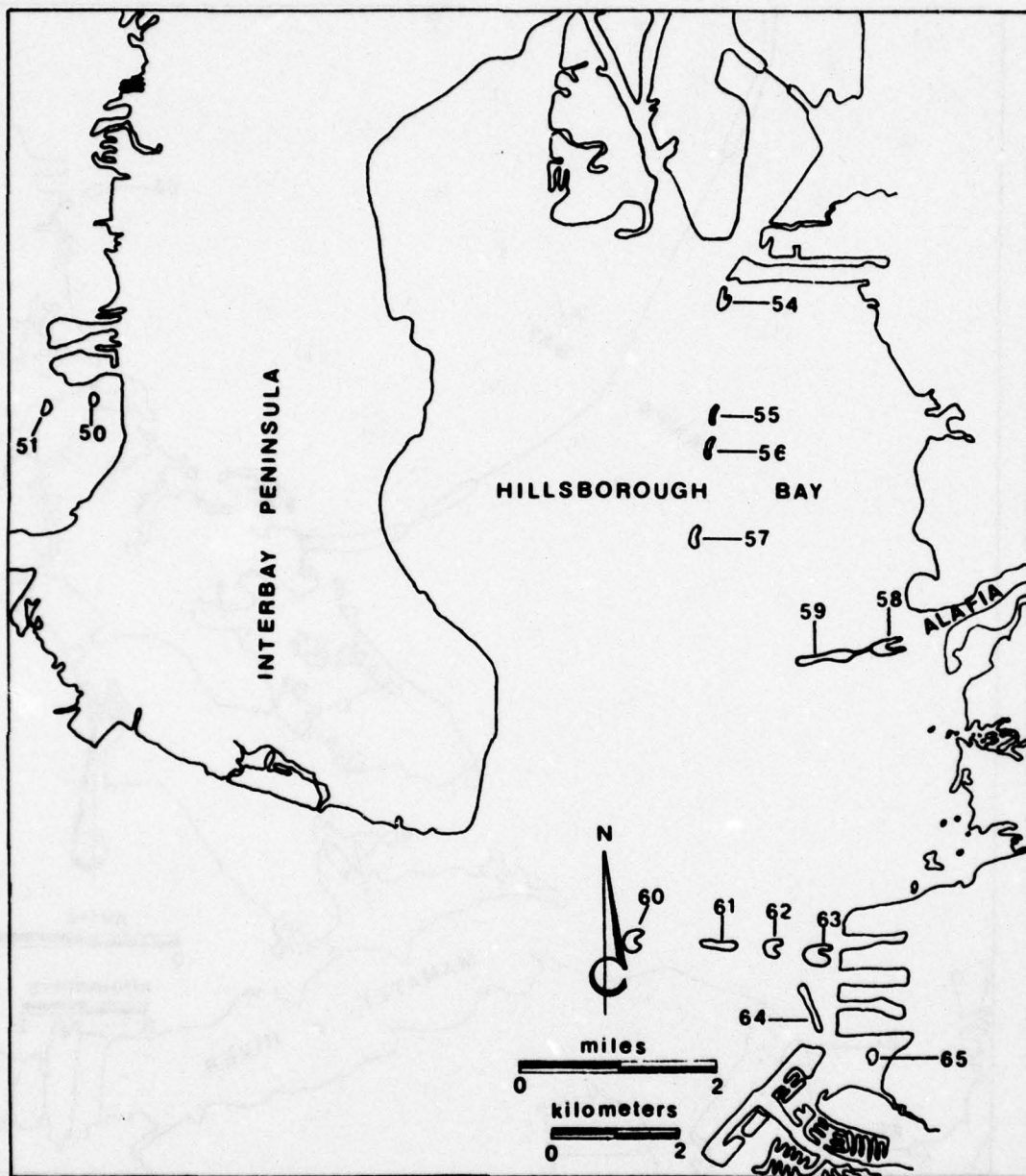


Figure 8. Inset E, specific study area I.

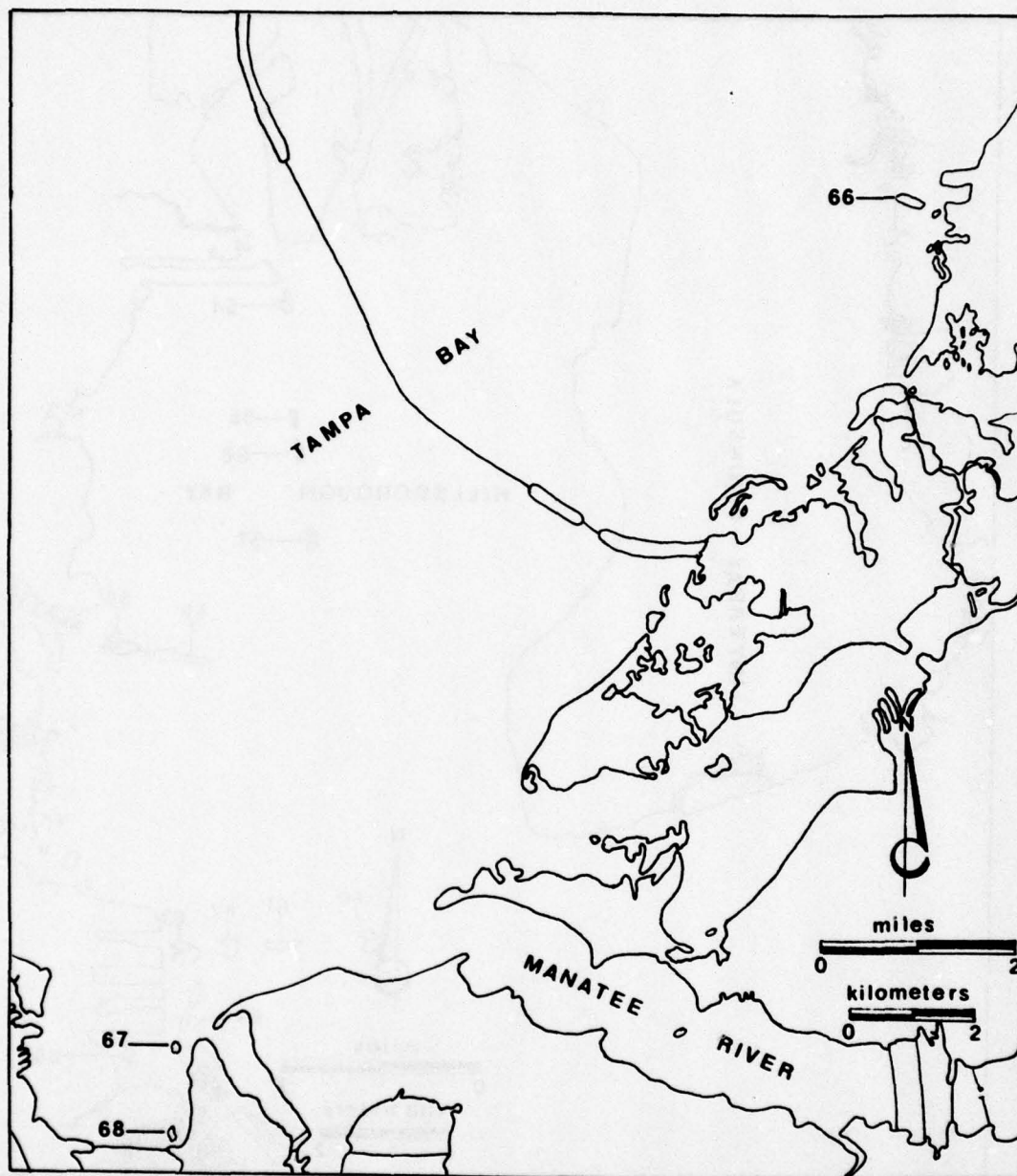


Figure 9. Inset F, specific study area I.

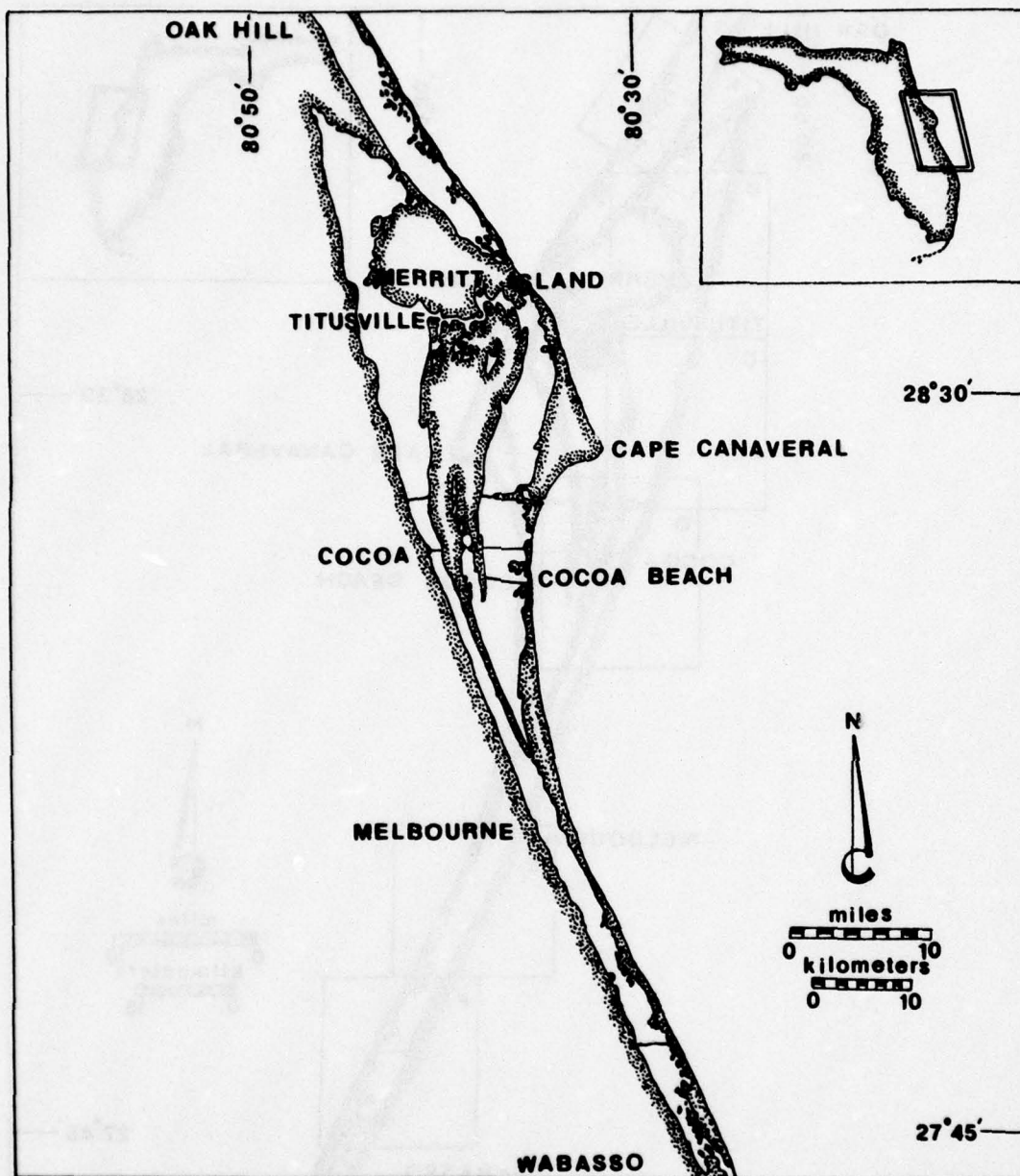


Figure 10. Specific study area II.

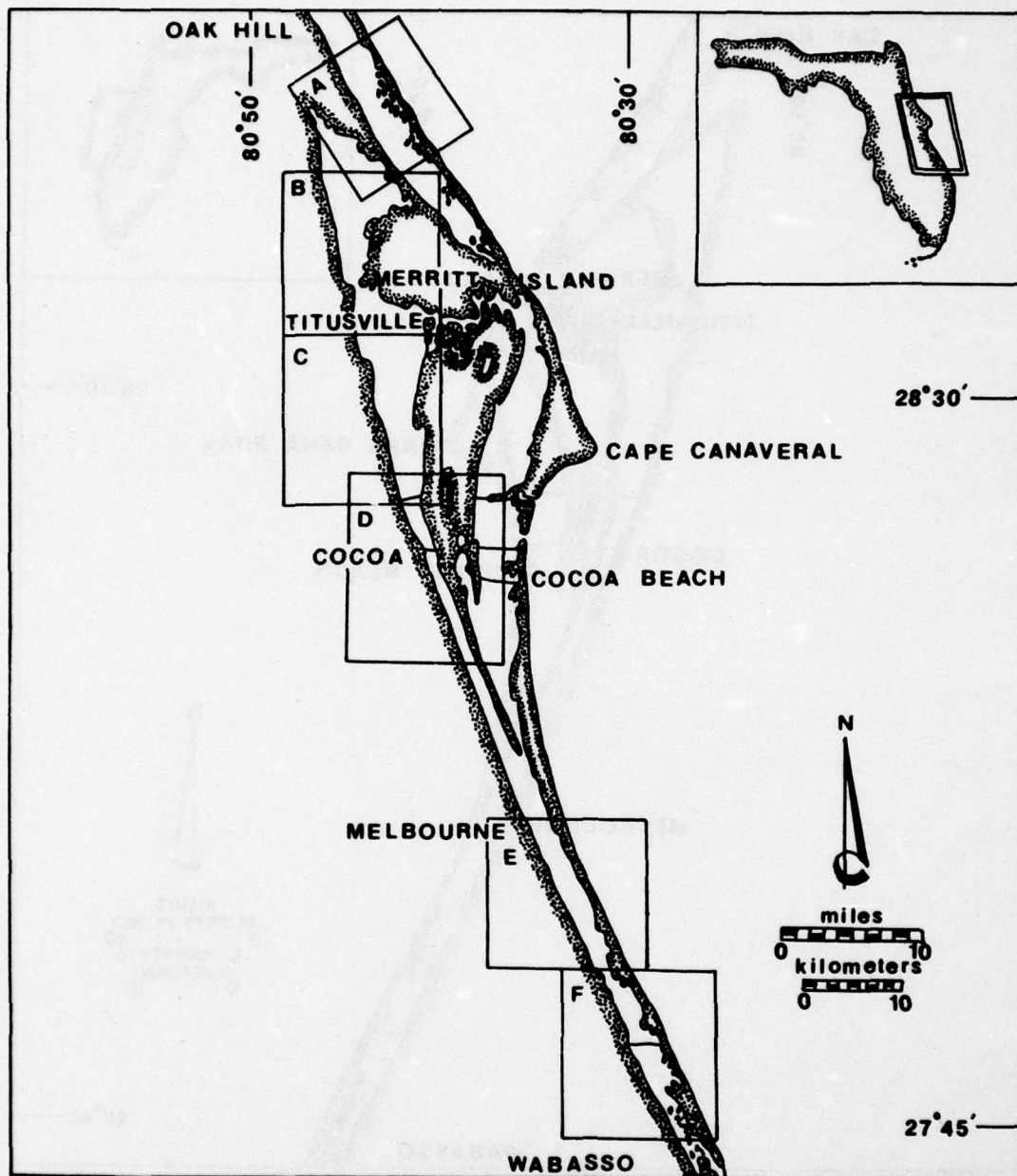


Figure 11. Insets, specific study area II.

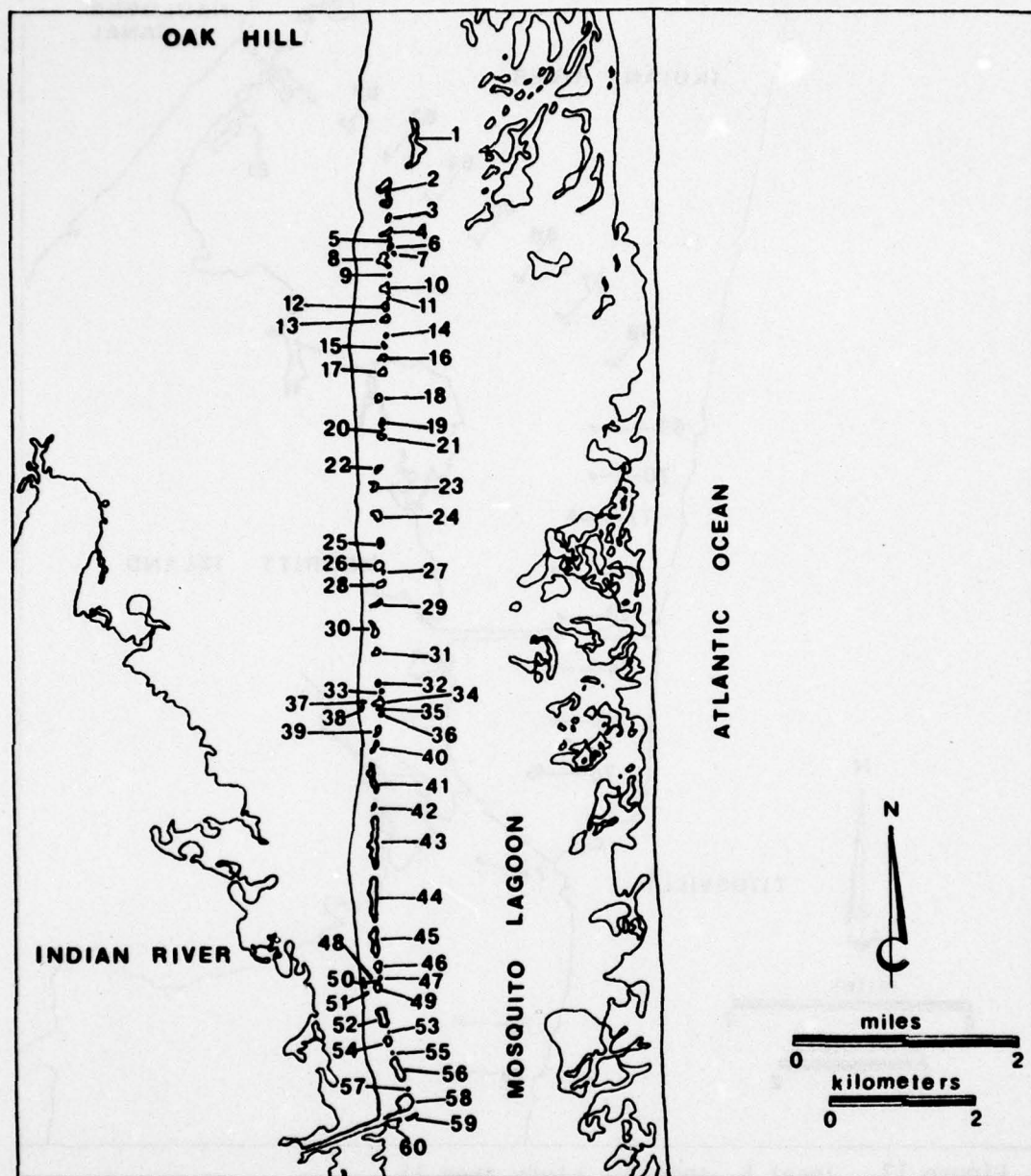


Figure 12. Inset A, specific study area II.

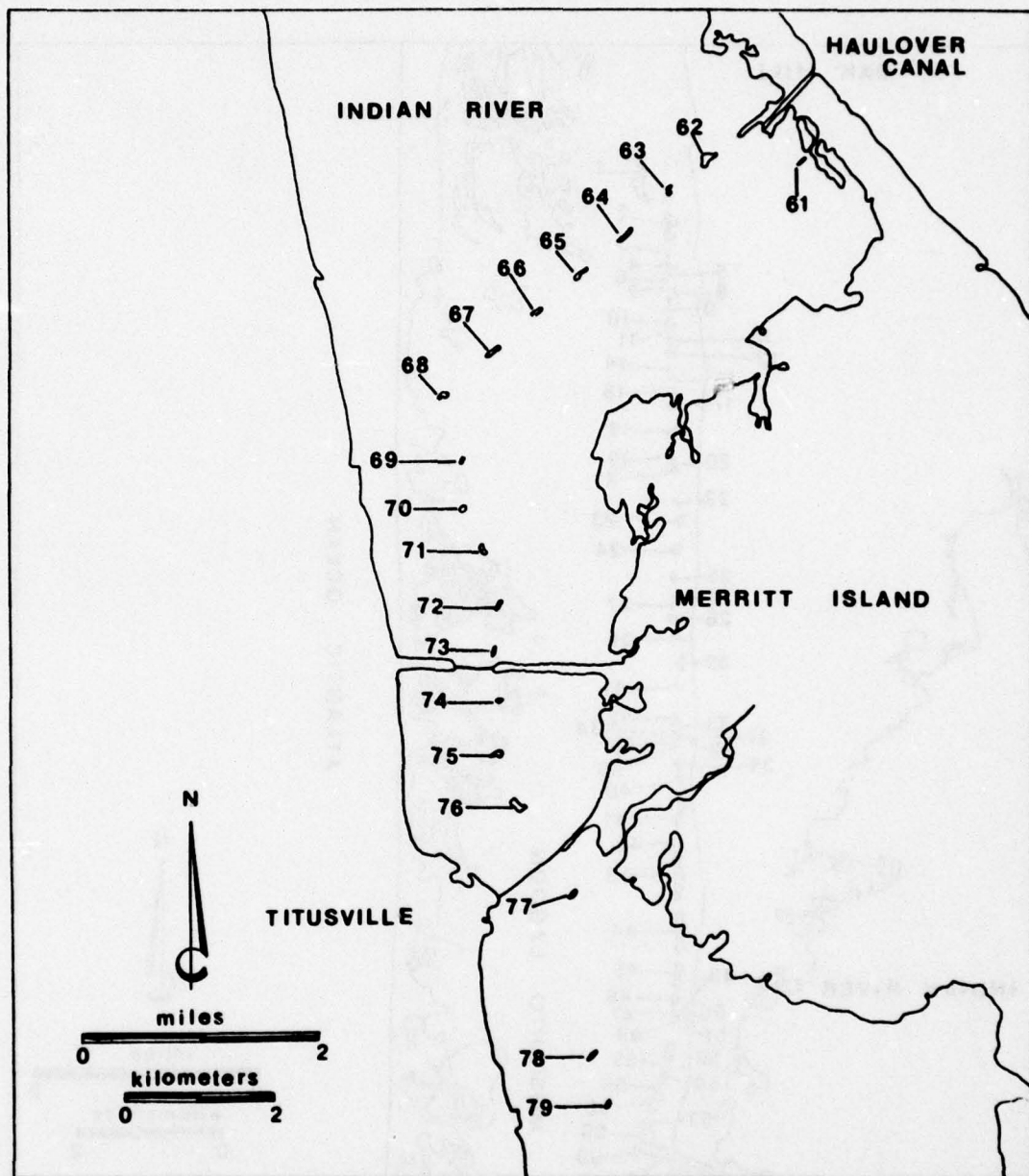


Figure 13. Inset B, specific study area II.

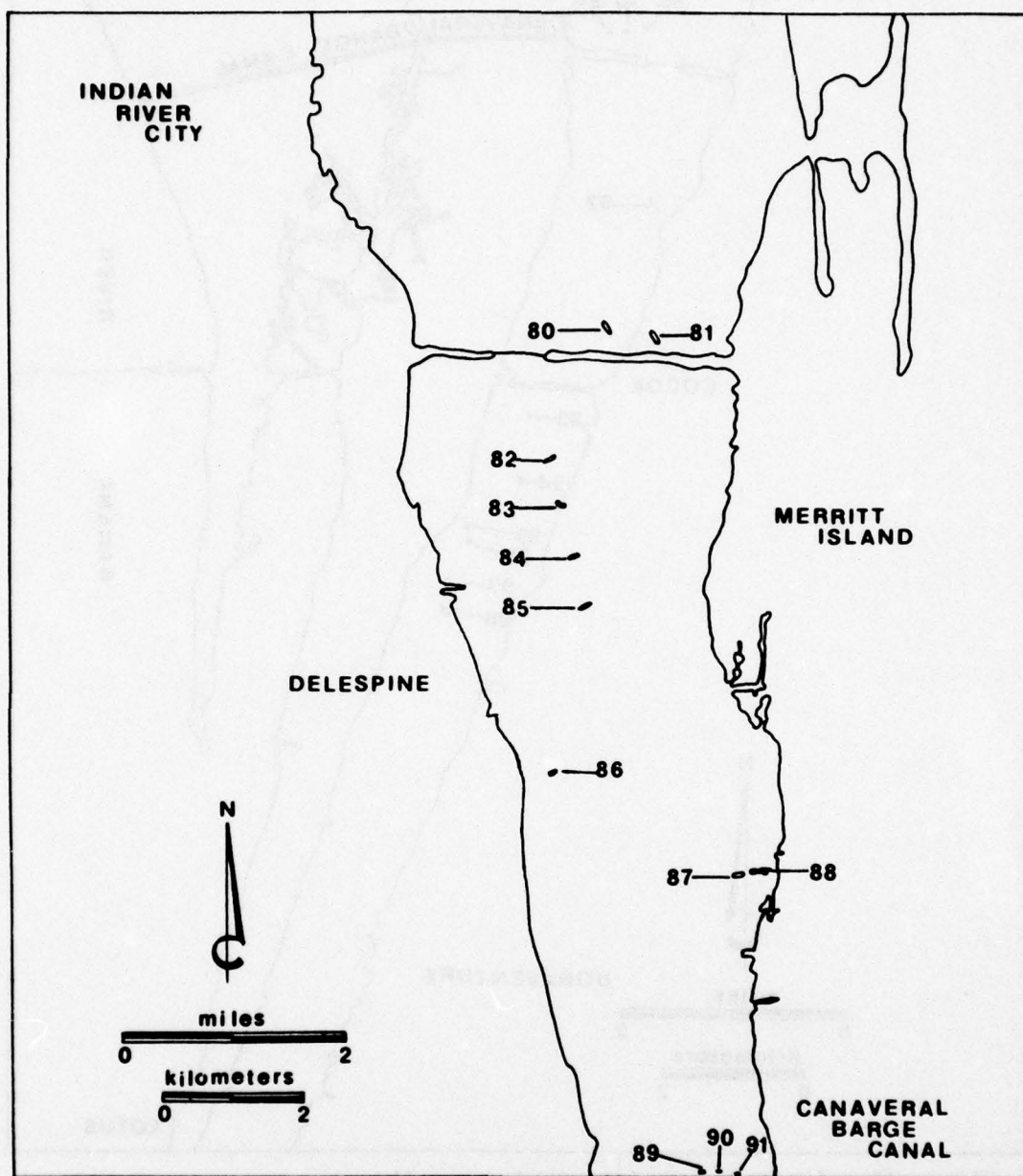


Figure 14. Inset C, specific study area II.

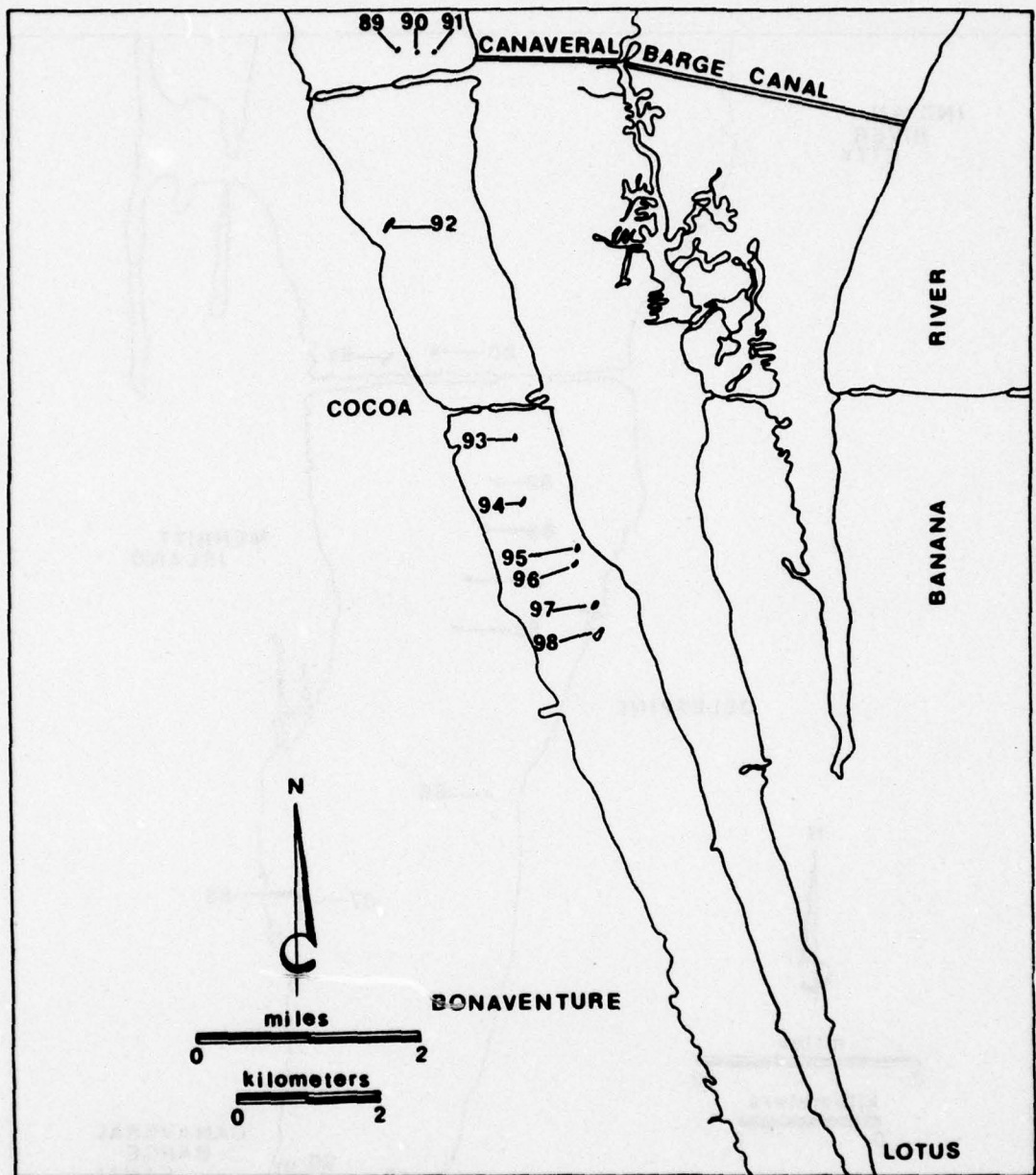


Figure 15. Inset D, specific study area II.

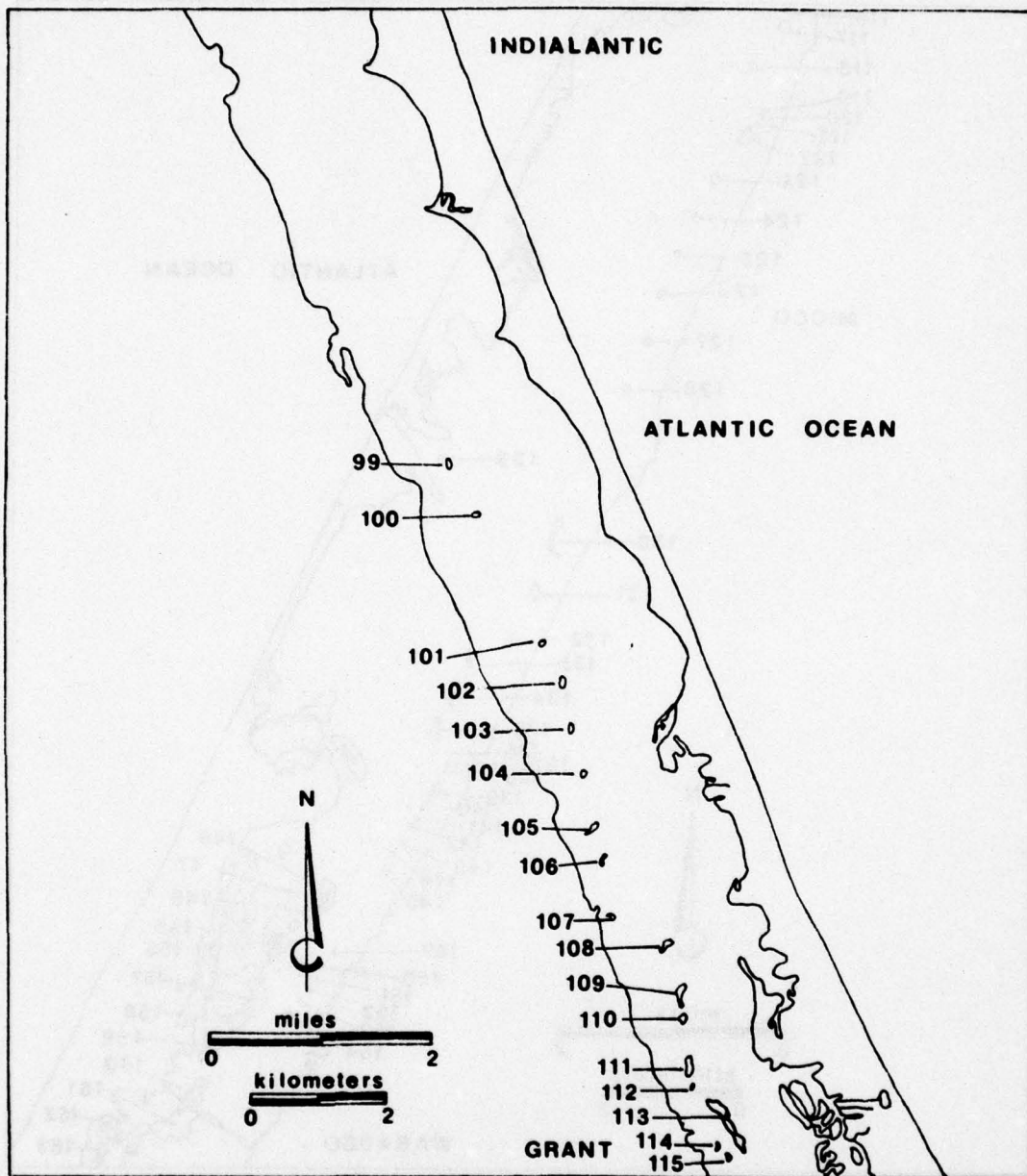


Figure 16. Inset E, specific study area II.

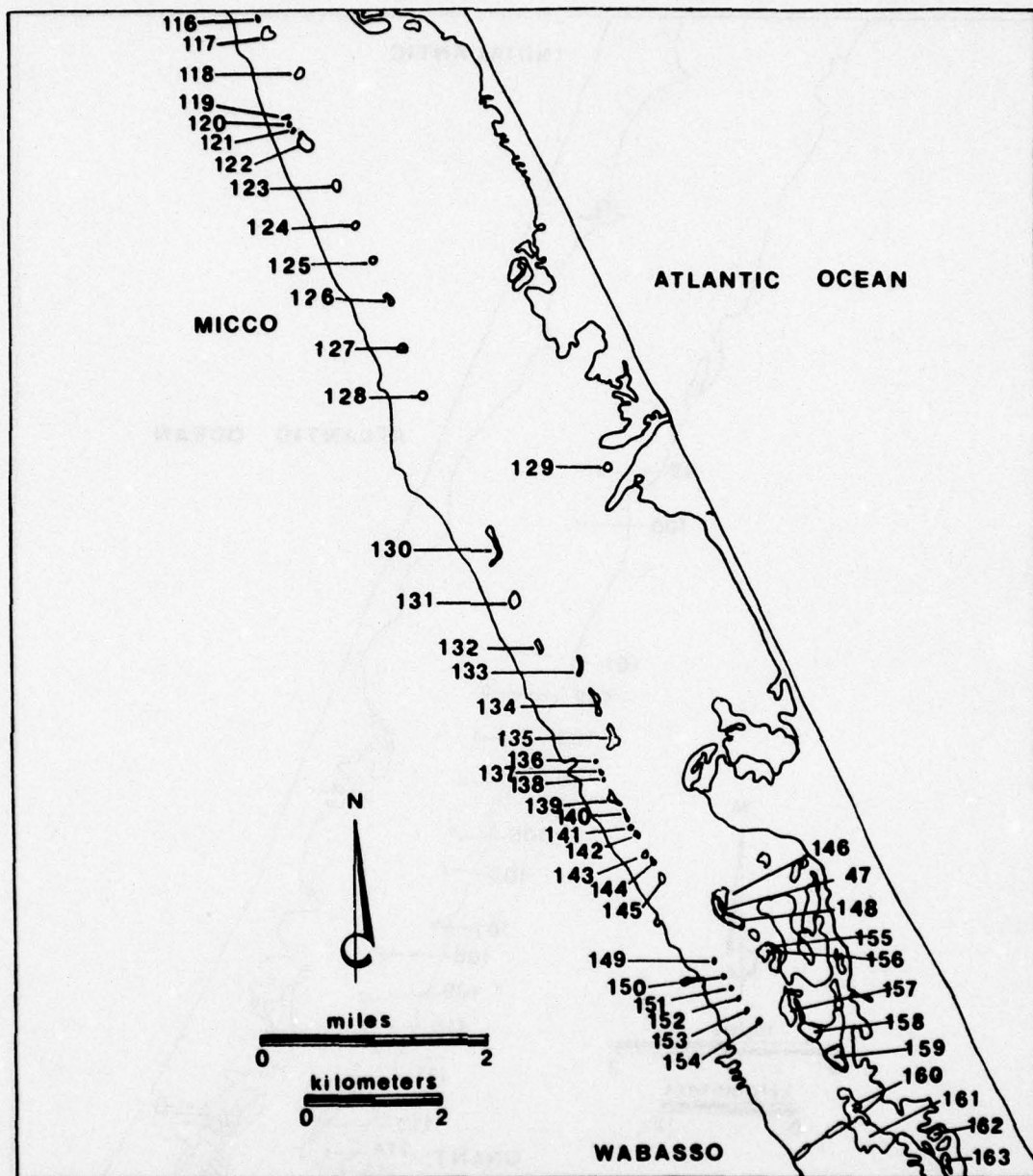


Figure 17. Inset F, specific study area II.

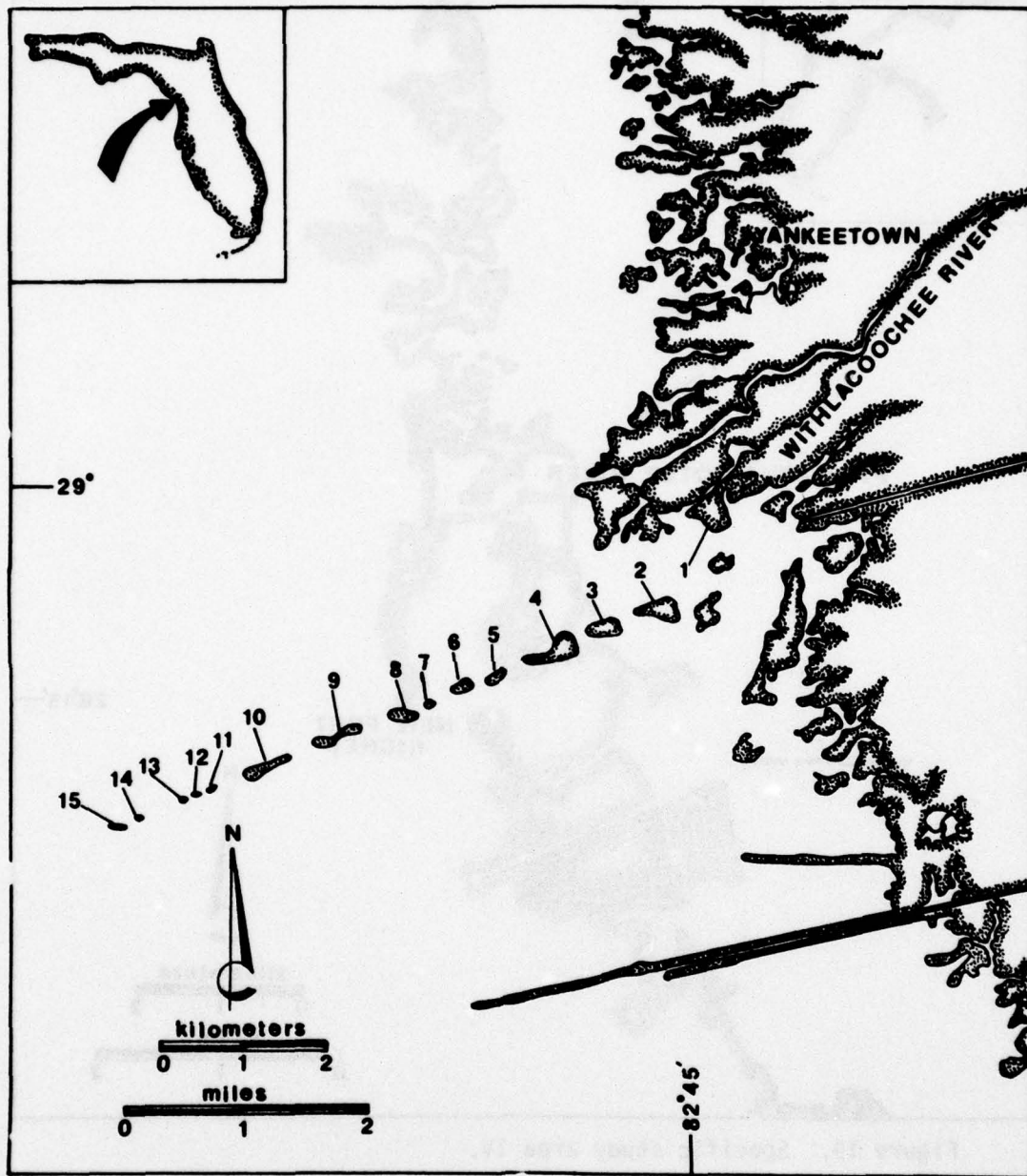


Figure 18. Specific study area III.

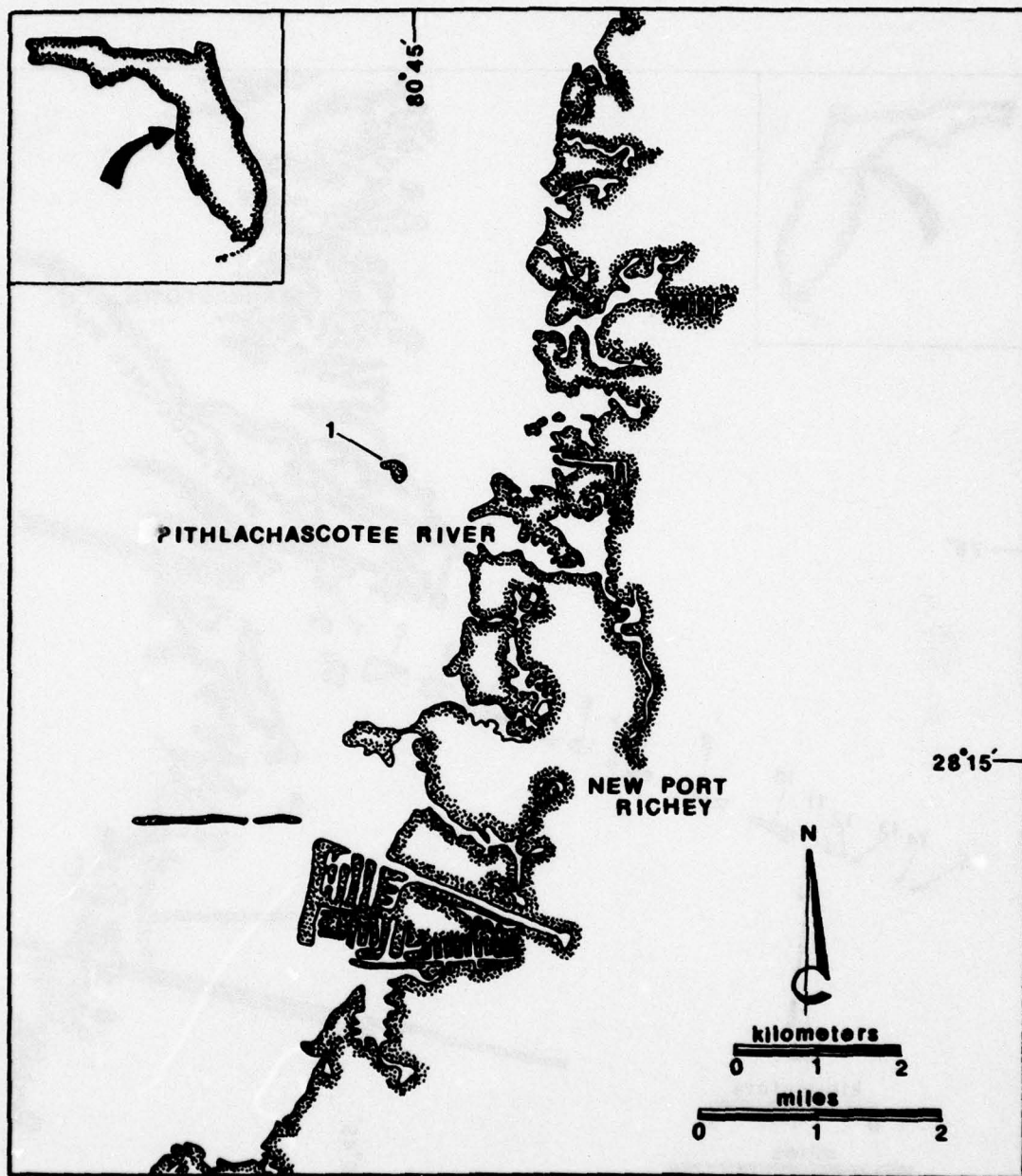


Figure 19. Specific study area IV.

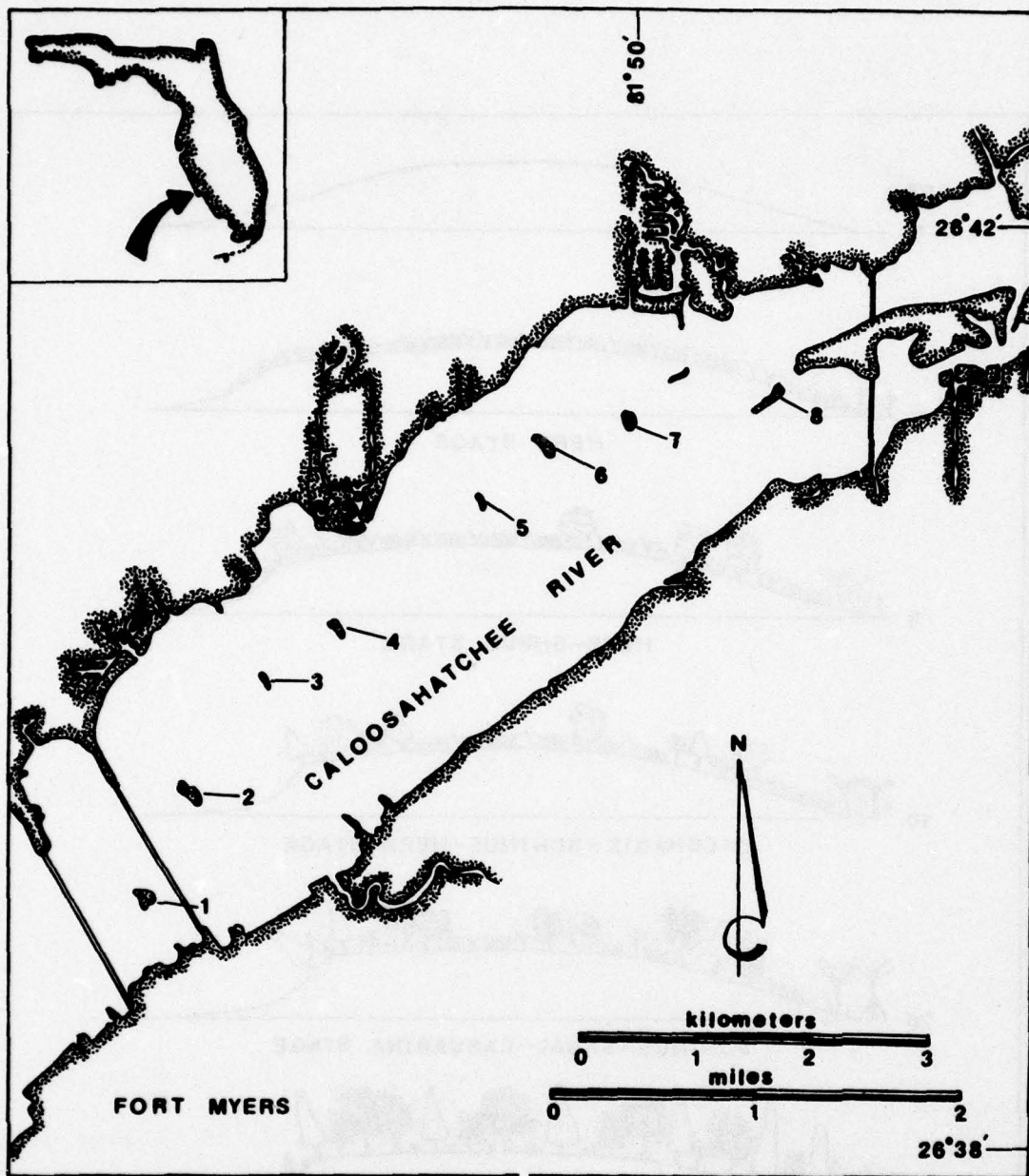


Figure 20. Specific study area V.

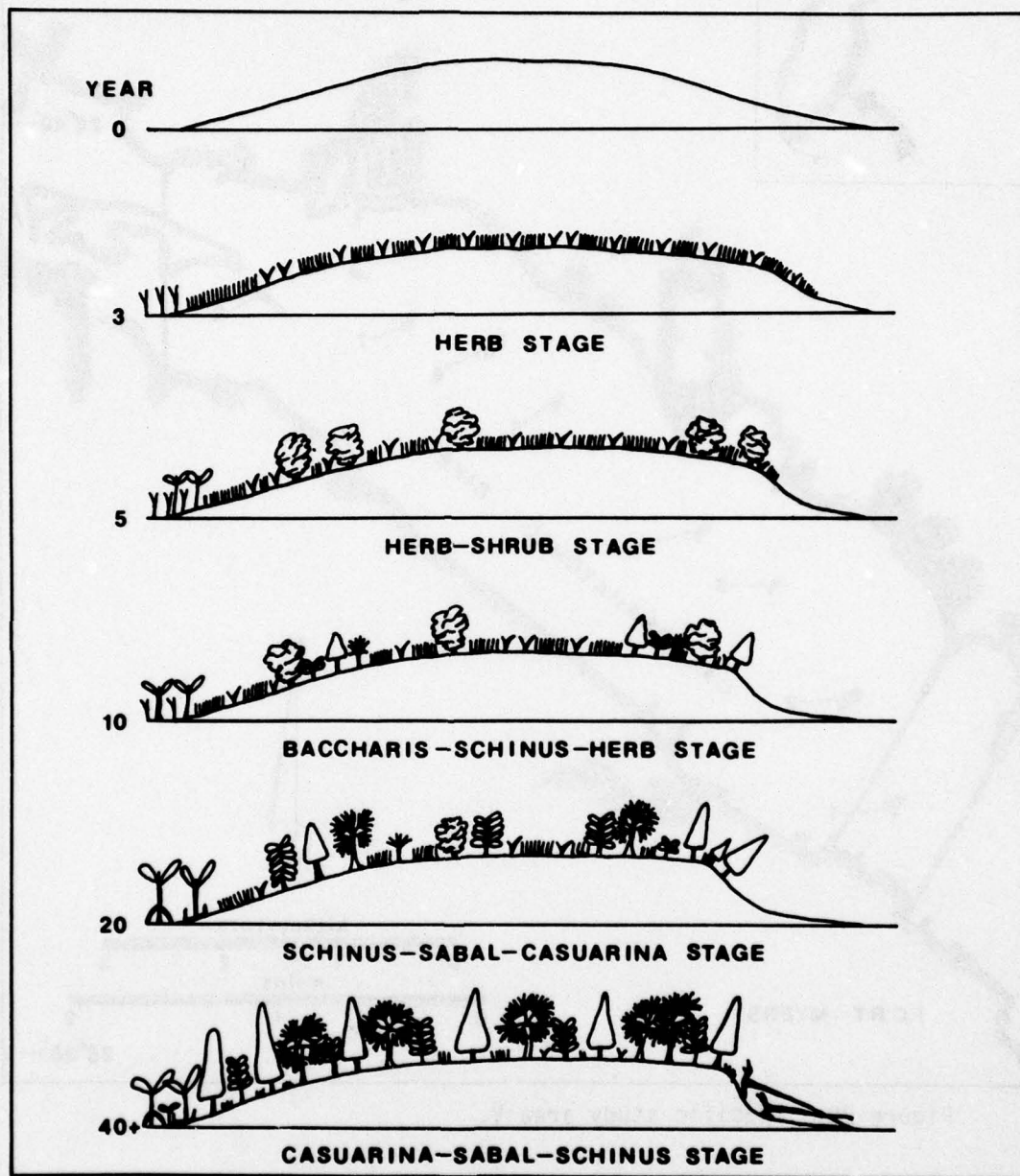


Figure 21. Generalized habitat succession on dredged material islands in Florida. See Figure 22 for vegetation key.













VEGETATION SYMBOLS	
	GRASSES
	SPARTINA
	HERBS OTHER THAN GRASSES
	IMMATURE MANGROVES
	BACCHARIS
	IMMATURE SCHINUS
	IMMATURE SABAL
	CASUARINA (LIVE)
	MATURE MANGROVES
	MATURE SCHINUS
	MATURE SABAL
	CASUARINA (DEAD)

Figure 22. Key to vegetation symbols for Figure 21.

Table 1
Summary Table for Dredged Material Islands Chosen For Vegetative Study

<u>Study Area</u>	<u>Island Number</u>	<u>Location Figure</u>	<u>Size (ha)</u>	<u>Age</u>	<u>Aerial Photograph and Map Figs.</u>
I	4	4	0.3	15	23
I	14	4	1.3	30	24
I	15	4	1.4	30	25
I	21	4	1.6	15	26
I	39	5	1.2	15	27
I	48	6	0.8	15	28
I	49B	6	13.4	17	29 & 30
I	54	8	4.7	20	31 & 32
I	58	8	4.7	46	33 & 34
I	59	8	10.1	16	35
I	60	8	6.8	20	36 & 37
I	61	8	2.3	12	38 & 39
I	65	8	0.4	3	40
I	66	9	24.7	8	41 & 42
I	68	9	1.4	15	43
II	12	12	1.2	25	44
II	26	12	2.2	25	45 & 46
II	64	13	0.9	15	47 & 48
II	66	13	2.3	15	49
II	67	13	0.5	15	50 & 51

(Continued)

Table 1 (Concluded)
Summary Table for Dredged Material Islands Chosen For Vegetative Study

Study Area	Island Number	Location Figure	Size (ha)	Age	Aerial Photograph and Map Figs.
II	80	14	1.8	10	52
II	87	14	1.4	40	53
II	88	14	2.4	40	54 & 55
II	89	14	4.5	14	56 & 57
II	91	14	1.8	14	58
II	97	15	0.9	14	59
II	98	15	1.9	14	60
II	125	17	1.3	20	61
II	128	17	1.4	20	62
II	129	17	1.2	3	63
II	152	17	0.5	20	64
II	153	17	0.6	20	65
III	7	18	0.8	12	66
III	8	18	2.5	12	67
III	12	18	0.1	12	68
III	13	18	0.2	12	69
IV	1	19	1.0	4	70
V	1	20	1.0	40	71 & 72
V	4	20	0.1	3	73
V	7	20	0.9	3	74 & 75

Table 2
Key to Vegetation Maps (Figures 23-75)

A	<i>Atriplex arenaria</i>
An	<i>Andropogon virginicus</i>
B	<i>Baccharis</i> sp.
Ba	<i>Batis maritima</i>
Bi	<i>Bidens pilosa</i>
Bo	<i>Borrchia frutescens</i>
B Sd	Bare sand
C	<i>Casuarina equisetifolia</i>
*	Single <i>Casuarina equisetifolia</i>
Ca	<i>Catharanthus roseus</i>
Ce	<i>Cenchrus</i> sp.
Ch	<i>Chloris</i> sp.
Co	<i>Commelina erecta</i>
Con	<i>Conocarpus erecta</i>
D	<i>Distichlis spicata</i> (found on island but not in transects)
Dal	<i>Dalbergia ecastophyllum</i>
Do	<i>Dodonaea viscosa</i>
Eu	<i>Eupatorium</i> sp.
H	<i>Heterotheca subaxillaris</i>
He	<i>Heliotropium</i> sp.
Herb	Herbaceous mixture other than grasses
I	<i>Iva</i> sp
Ir	<i>Iresine celosia</i>
J	<i>Juniperus silicicola</i>
L	Lagoon
Lan	<i>Lantana camara</i>
Li	<i>Lippia nodiflora</i>
Ly	<i>Lycium carolinianum</i>

(Continued)

Table 2 (Concluded)

M	Mangroves (<i>Avicennia germinans</i> , <i>Laguncularia racemosa</i> , <i>Rhizophora mangle</i>)
Md	Mud
P	<i>Paspalum vaginatum</i>
Pa	Palms other than <i>Sabal</i>
Ph	<i>Philoxerus vermicularis</i>
Pi	<i>Pinus elliottii</i>
Po	Poaceae - grass mixture
Rh	<i>Rhynchelytrum repens</i>
S	<i>Sabal palmetto</i>
Sal	<i>Salicornia</i> sp
Sam	<i>Sambucus simpsonii</i>
S B	Salt barren
Sc	<i>Schinus terebinthifolius</i>
Scr	<i>Scirpus robustus</i>
Se	<i>Sesuvium portulacastrum</i>
So	<i>Solidago sempervirens</i>
Sp	<i>Spartina</i> sp.
Spo	<i>Sporobolus</i> sp.
Su	<i>Suaeda linearis</i>
Ty	<i>Typha</i> sp. (found on island but not in transects)
U	<i>Uniola paniculata</i>

Table 3
General Characteristics and Summary of Vegetation Data
For Dredged Material Island I-4

Study Area: I	Island Number: 4
Size: 0.3 ha	Age: 15 years
Date of Aerial Photograph: 12 February 1977	

<u>Plant Species</u>	<u>Communities</u>			
	herbaceous		shrub	tree
	rel. freq.	N=11 abun.	N=0	N=0
Chloris petraea	10	A		
Lepidium virginicum	10	A		
Paspalum vaginatum	55	VA		
Sesuvium portulacastrum	10	A		
Sochus oleraceus	10	A		
Spartina patens	5	U		

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

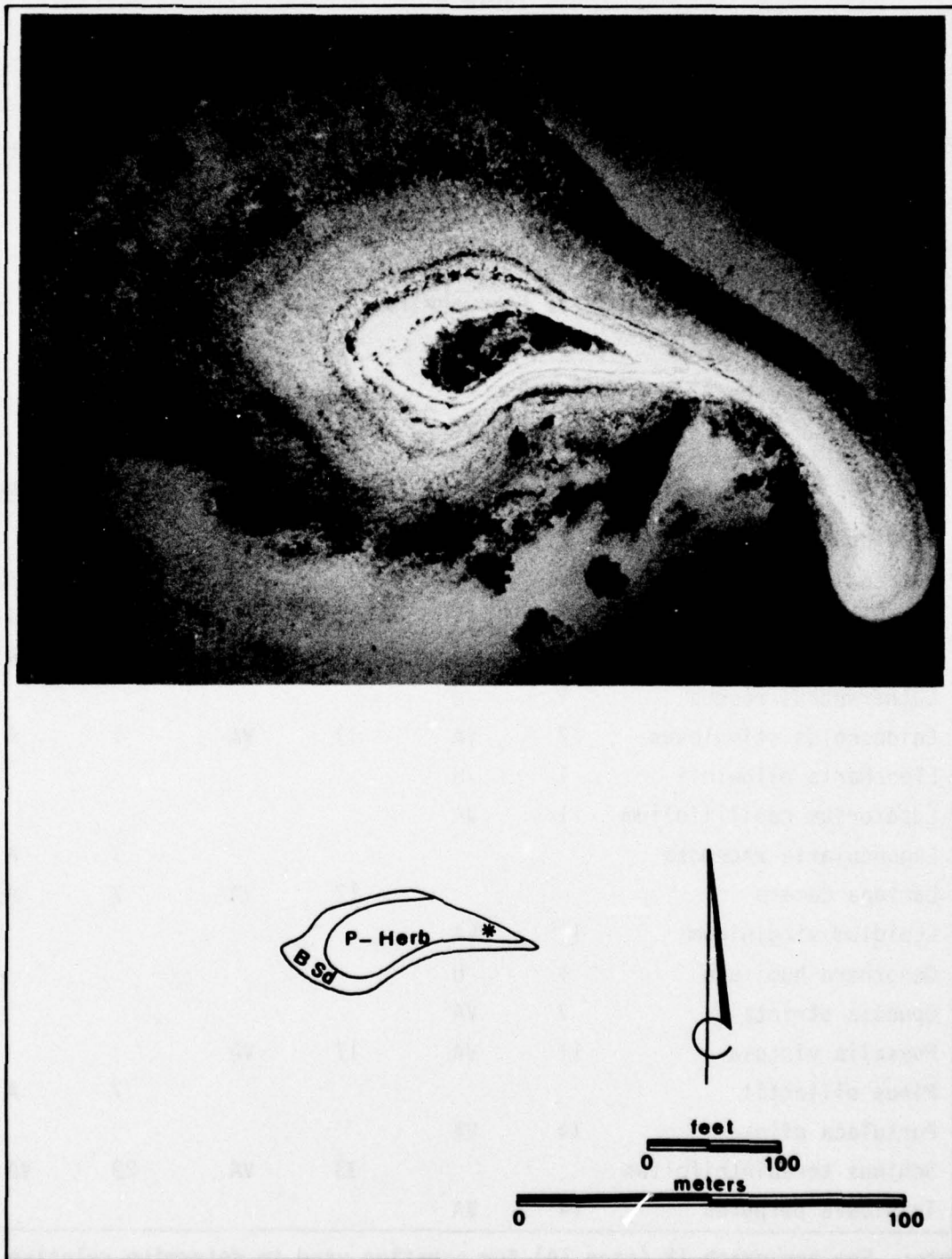


Figure 23. Vertical aerial photograph and vegetation map of dredged material island I-4.

Study Area: I	Island Number: 14
Size: 1.3 ha	Age: 30 years
Date of Aerial Photograph: 12 February 1977	

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

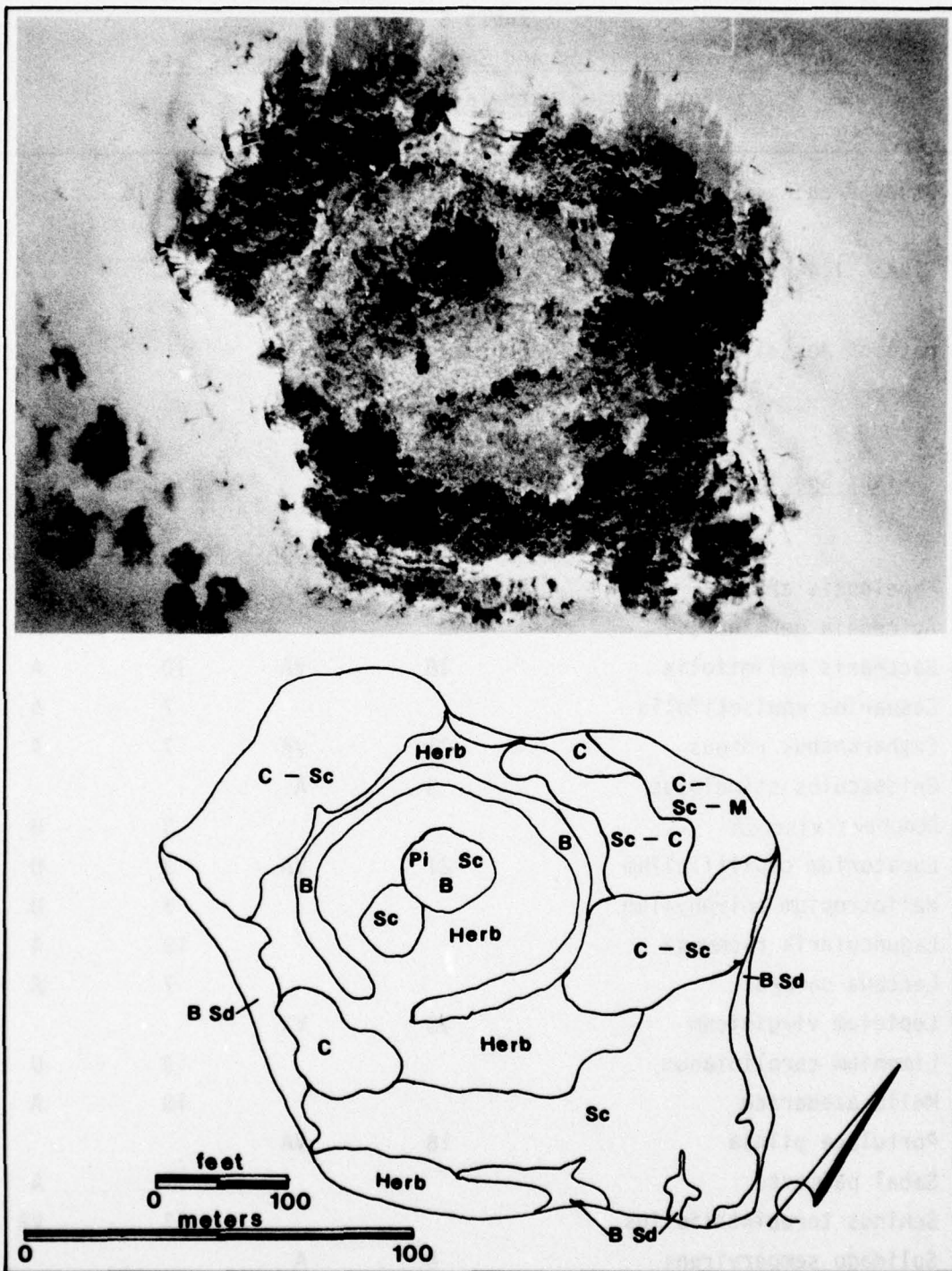


Figure 24. Vertical aerial photograph and vegetation map of dredged material island I-14.

Table 5
General Characteristics and Summary of Vegetation Data
For Dredged Material Island I-15

Study Area: I

Island Number: 15

Size: 1.4 ha

Age: 30 years

Date of Aerial Photograph: 12 February 1977

<u>Plant Species</u>	<u>Communities</u>					
	herbaceous		shrub		tree	
	N=0		N=8		N=13	
			rel. freq.	abun.	rel. freq.	abun.
<i>Ampelopsis arborea</i>		5		A	3	U
<i>Avicennia germinans</i>					7	A
<i>Baccharis halimifolia</i>		18		VA	10	A
<i>Casuarina equisetifolia</i>					7	A
<i>Catharanthus roseus</i>		21		VA	7	A
<i>Cnidosculus stimulosus</i>		3		A		
<i>Dodonaea viscosa</i>					3	U
<i>Eupatorium capillifolium</i>		21		VA	3	U
<i>Heliotropium polyphyllum</i>					3	U
<i>Laguncularia racemosa</i>					13	A
<i>Lantana camara</i>					7	A
<i>Lepidium virginicum</i>		10		VA		
<i>Limonium carolinianum</i>					3	U
<i>Melia azedarach</i>					10	A
<i>Portulaca pilosa</i>		18		VA		
<i>Sabal palmetto</i>					7	A
<i>Schinus terebinthifolius</i>					13	VA
<i>Solidago sempervirens</i>		5		A		
<i>Sophora tomentosa</i>					3	U

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

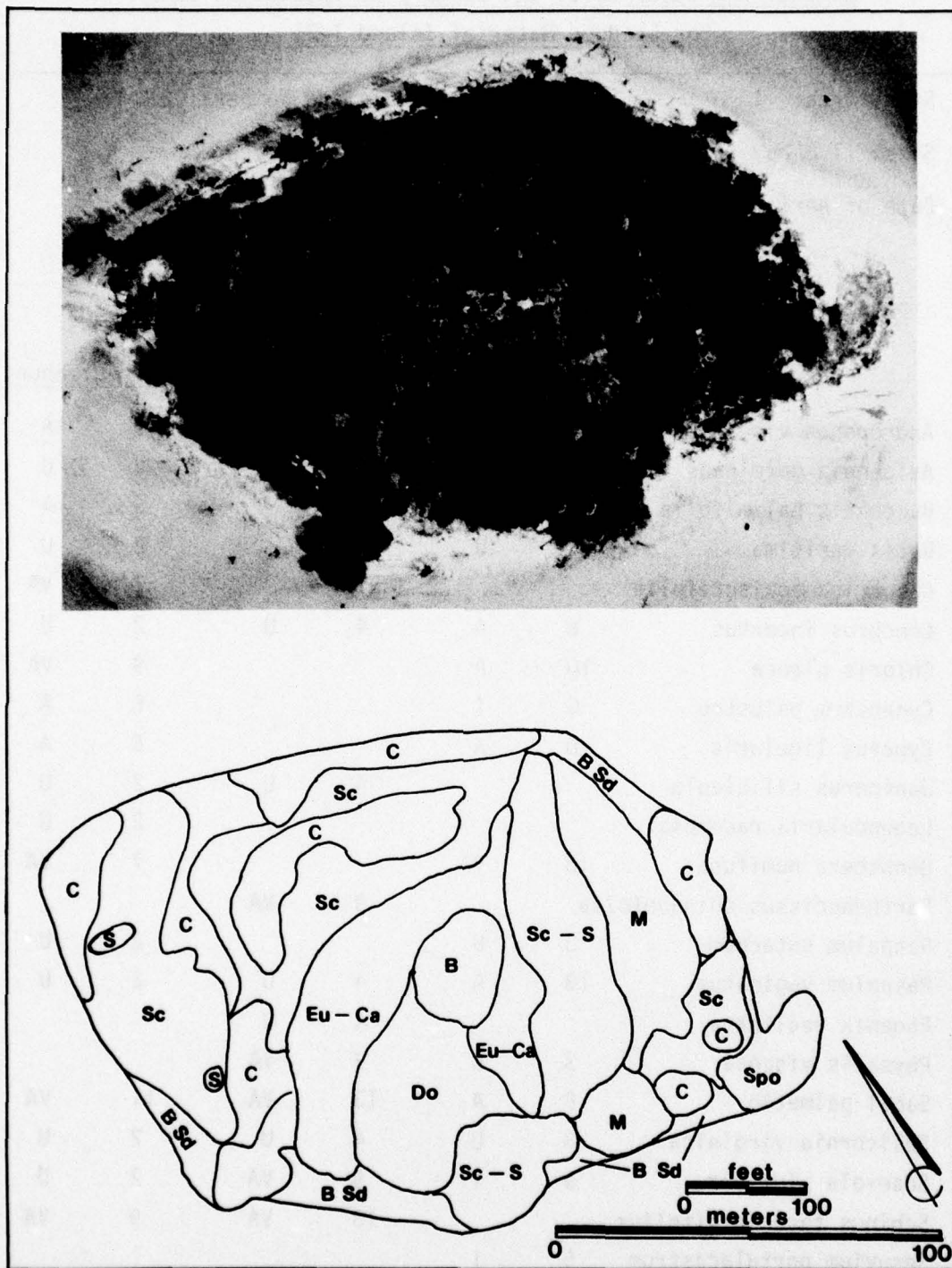


Figure 25. Vertical aerial photograph and vegetation map of dredged material island I-15.

Table 6
General Characteristics and Summary of Vegetation Data
For Dredged Material Island I-21

Study Area: I	Island Number: 21					
Size: 1.6 ha	Age: 15 years					
Date of Aerial Photograph: 12 February 1977						
	<u>Communities</u>					
<u>Plant Species</u>	herbaceous N=20		shrub N=4		tree N=7	
	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>
Andropogon virginicus			13	VA	5	A
Avicennia germinans					2	U
Baccharis halimifolia					5	A
Batis maritima	3	U			2	U
Casuarina equisetifolia					7	VA
Cenchrus incertus	8	A	4	U	2	U
Chloris glauca	10	A			9	VA
Cynanchum palustre	5	I			5	A
Cyperus ligularis	8	A			5	A
Juniperus silicicola			4	U	2	U
Laguncularia racemosa					2	U
Oenothera humifusa	18	VA			7	VA
Parthenocissus quinquefolia			9	VA		
Paspalum setaceum	3	U			2	U
Paspalum vaginatum	13	A	4	U	2	U
Phoenix reclinata			4	U		
Physalis viscosa	3	U	9	VA		
Sabal palmetto	8	A	13	VA	11	VA
Salicornia virginica	3	U	4	U	2	U
Scaevola plumieri	5	I	9	VA	2	U
Schinus terebinthifolius			13	VA	9	VA
Sesuvium portulacastrum	5	I				

(Continued)

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

Table 6 (Concluded)

<u>Plant Species</u>	<u>Communities</u>					
	herbaceous		shrub		tree	
	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>
<i>Solidago sempervirens</i>			9	VA	9	VA
<i>Spartina alterniflora</i>	8	A				
<i>Sporobolus virginicus</i>	3	U				
<i>Stenotaphrum secundatum</i>					5	A
<i>Suaeda linearis</i>	3	U			5	A
<i>Washingtonia robusta</i>			4	U		

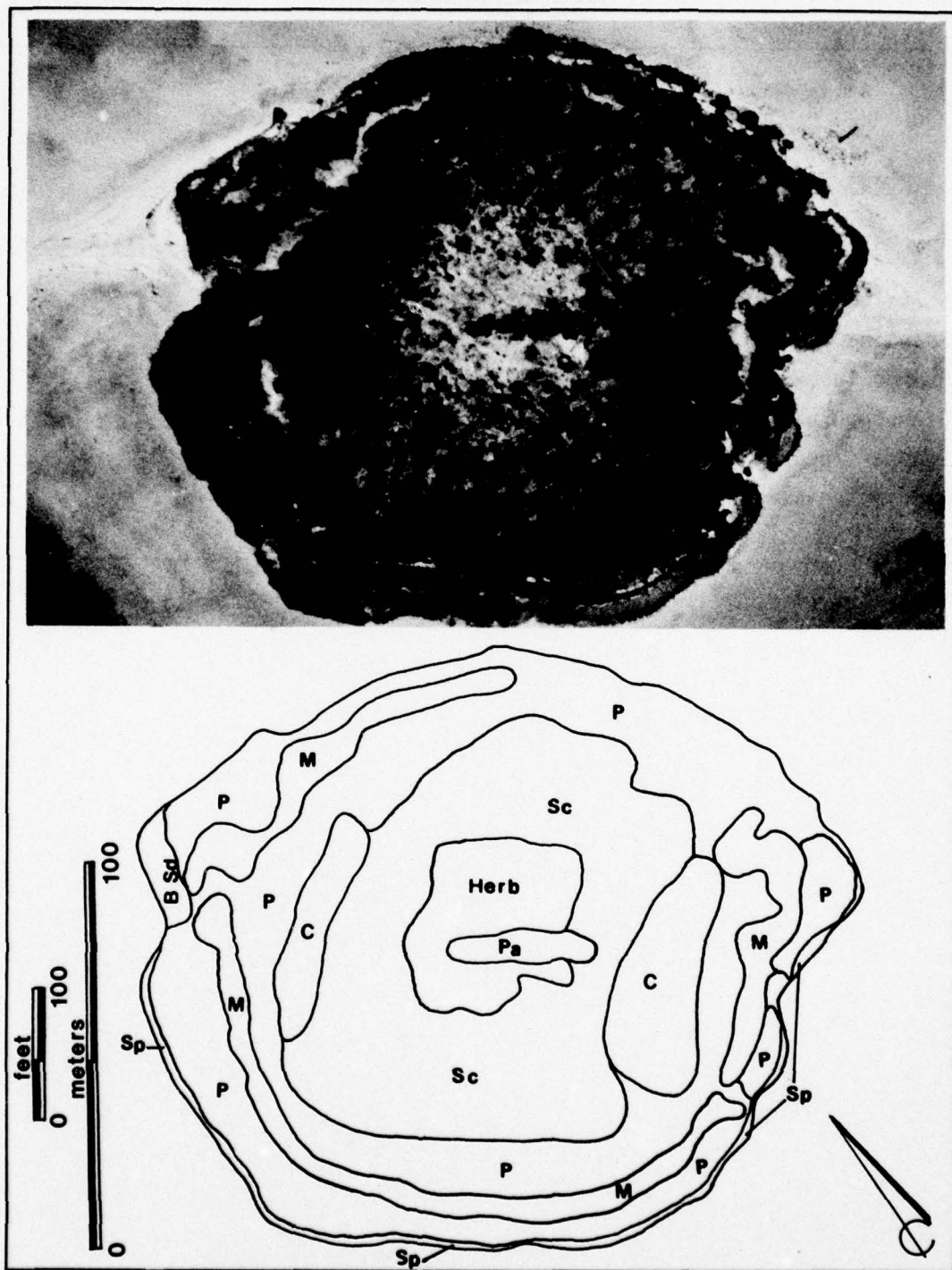


Figure 26. Vertical aerial photograph and vegetation map of dredged material island I-21

Table 7
General Characteristics and Summary of Vegetation Data
For Dredged Material Island I-39

Study Area: I

Island Number: 39

Size: 1.2 ha

Age: 15 years

Date of Aerial Photograph: 12 February 1977

<u>Plant Species</u>	<u>Communities</u>					
	herbaceous		shrub		tree	
	N=5		N=9		N=4	
	rel.freq.	abun.	rel.freq.	abun.	rel.freq.	abun.
<i>Andropogon virginicus</i>	17	A	11	VA	8	U
<i>Avicennia germinans</i>	6	U	3	U	17	VA
<i>Baccharis halimifolia</i>	11	I	11	VA	8	U
<i>Batis maritima</i>	11	I	6	A		
<i>Casuarina equisetifolia</i>					17	VA
<i>Cenchrus incertus</i>			3	U		
<i>Chamaesyce blodgettii</i>	11	I				
<i>Heliotropium curassavicum</i>					8	U
<i>Iva frutescens</i>			11	VA	8	U
<i>Laguncularia racemosa</i>			6	A	8	U
<i>Lepidium virginicum</i>	17	A	6	A		
<i>Oenothera humifusa</i>	6	U	3	U		
<i>Paspalum vaginatum</i>			6	A		
<i>Rhizophora mangle</i>					8	U
<i>Sabal palmetto</i>			3	U		
<i>Salicornia virginica</i>	11	I	6	A		
<i>Schinus terebinthifolius</i>	6	U	11	VA		
<i>Sesuvium portulacastrum</i>			6	A	8	U
<i>Solidago sempervirens</i>	6	U	9	VA	8	U

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

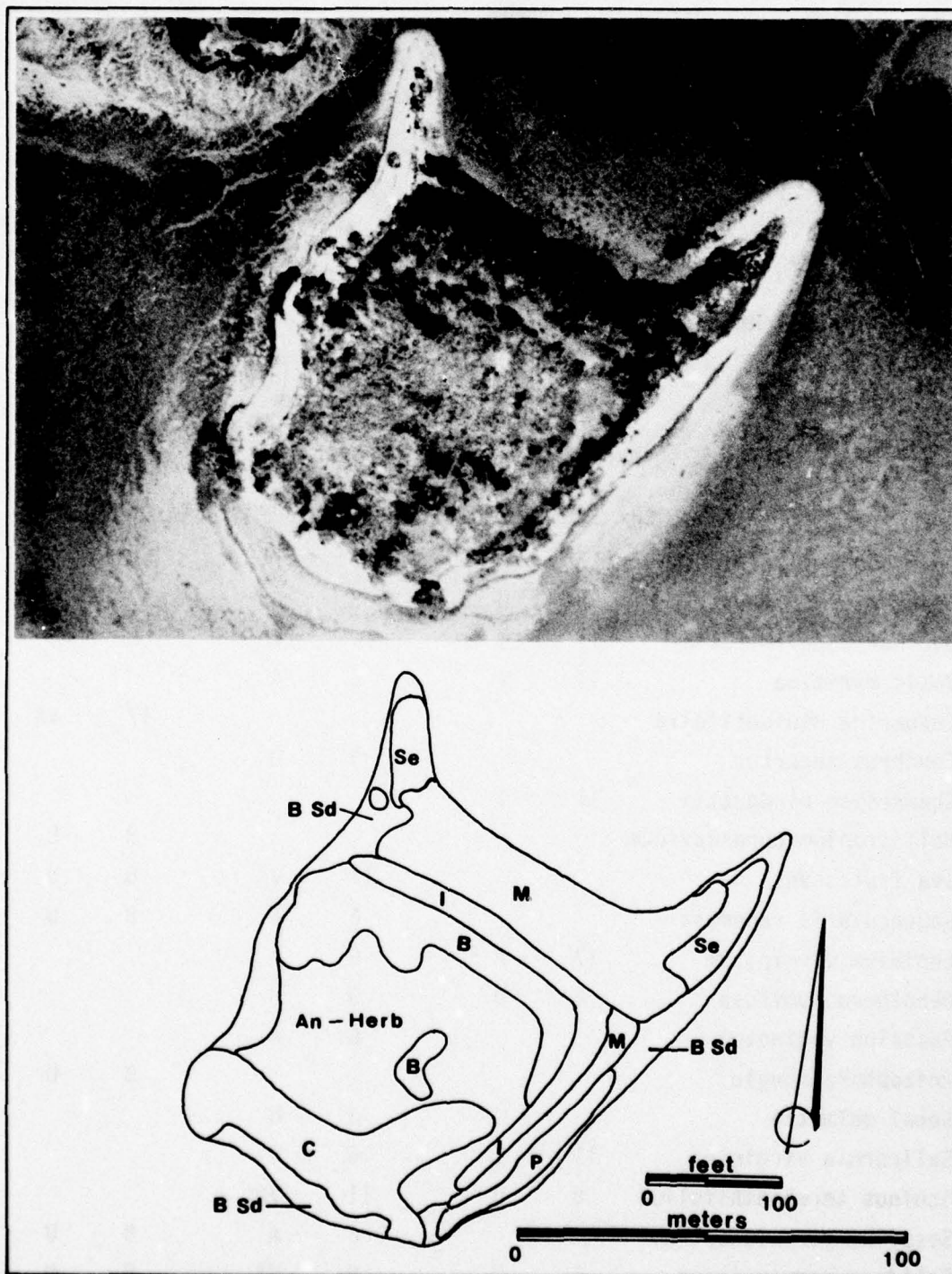


Figure 27. Vertical aerial photograph and vegetation map of dredged material island I-39.

Table 8
General Characteristics and Summary of Vegetation Data
For Dredged Material Island I-48

Study Area: I	Island Number: 48			
Size: 0.8 ha	Age: 15 years			
Date of Aerial Photograph: 12 February 1977				
<u>Plant Species</u>	<u>Communities</u>			
	herbaceous N=31		shrub	tree
	<u>rel. freq.</u>	<u>abun.</u>	<u>N=0</u>	<u>N=0</u>
Avicennia germinans	1	U		
Baccharis halimifolia	3	I		
Chloris glauca	3	I		
Cyperus ligularis	8	A		
Fimbristylis spadicea	1	U		
Ipomoea pes-caprae	1	U		
Iva frutescens	1	U		
Lippia nodiflora	16	VA		
Panicum amarum	1	U		
Paspalum vaginatum	37	VA		
Physalis viscosa	3	I		
Sabal palmetto	1	U		
Solidago sempervirens	16	VA		
Suaeda linearis	1	U		
Yucca aloifolia	3	I		

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

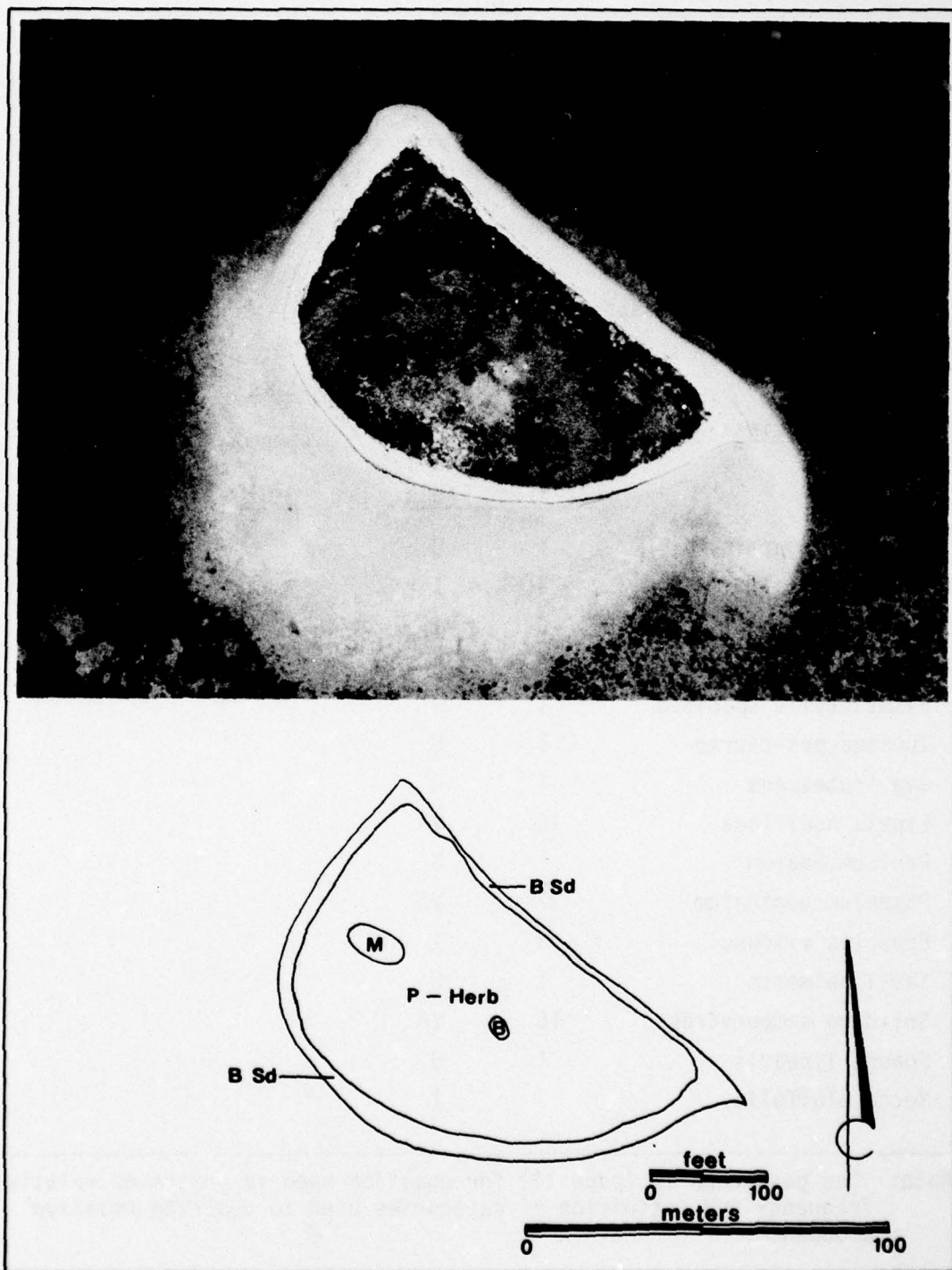


Figure 28. Vertical aerial photograph and vegetation map of dredged material island I-48.

Table 9
General Characteristics and Summary of Vegetation Data
For Dredged Material Island I-49B

Study Area: I	Island Number: 49B
Size: 13.4 ha	Age: 17 years
Date of Aerial Photograph: 12 February 1977	

<u>Plant Species</u>	<u>Communities</u>					
	herbaceous		shrub		tree	
	N=85		N=13		N=0	
	rel. freq.	abun.	rel. freq.	abun.		
Andropogon virginicus	9	A				
Avicennia germinans			5	A		
Baccharis halimifolia	2	I	7	A		
Batis maritima	1	U	5	A		
Bidens pilosa	3	I				
Casuarina equisetifolia	1	U				
Cenchrus pauciflorus	3	I	2	I		
Chloris glauca	10	A				
Cynanchum palustre	1	I	7	A		
Cynodon dactylon	3	I				
Cyperus ligularis			2	I		
Cyperus polystachyos			2	I		
Eupatorium capillifolium	5	I	9	A		
Heterotheca subaxillaris	12	A	5	A		
Ipomoea pes-caprae	2	I				
Iva frutescens			2	I		
Lepidium virginicum	7	A	7	A		
Lippia nodiflora	1	U				
Lycium carolinianum	1	U				
Melothria pendula	3	I				
Oenothera humifusa	7	A				

(Continued)

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

Table 9 (Concluded)

<u>Plant Species</u>	<u>Communities</u>				
	herbaceous		shrub		tree
	<u>rel. freq.</u>	<u>abun.</u>	<u>rel. freq.</u>	<u>abun.</u>	<u>N=0</u>
<i>Paspalum setaceum</i>	2	I			
<i>Paspalum vaginatum</i>	7	A	12	VA	
<i>Philoxerus vermicularis</i>	1	U			
<i>Physalis viscosa</i>	18	VA	12	VA	
<i>Phytolacca americana</i>	1	U			
<i>Sabal palmetto</i>			7	A	
<i>Schinus terebinthifolius</i>	1	I	5	A	
<i>Sesuvium portulacastrum</i>			2	U	
<i>Solidago sempervirens</i>			7	A	
<i>Spartina patens</i>	1	I			
<i>Suaeda linearis</i>	2	I	2	U	

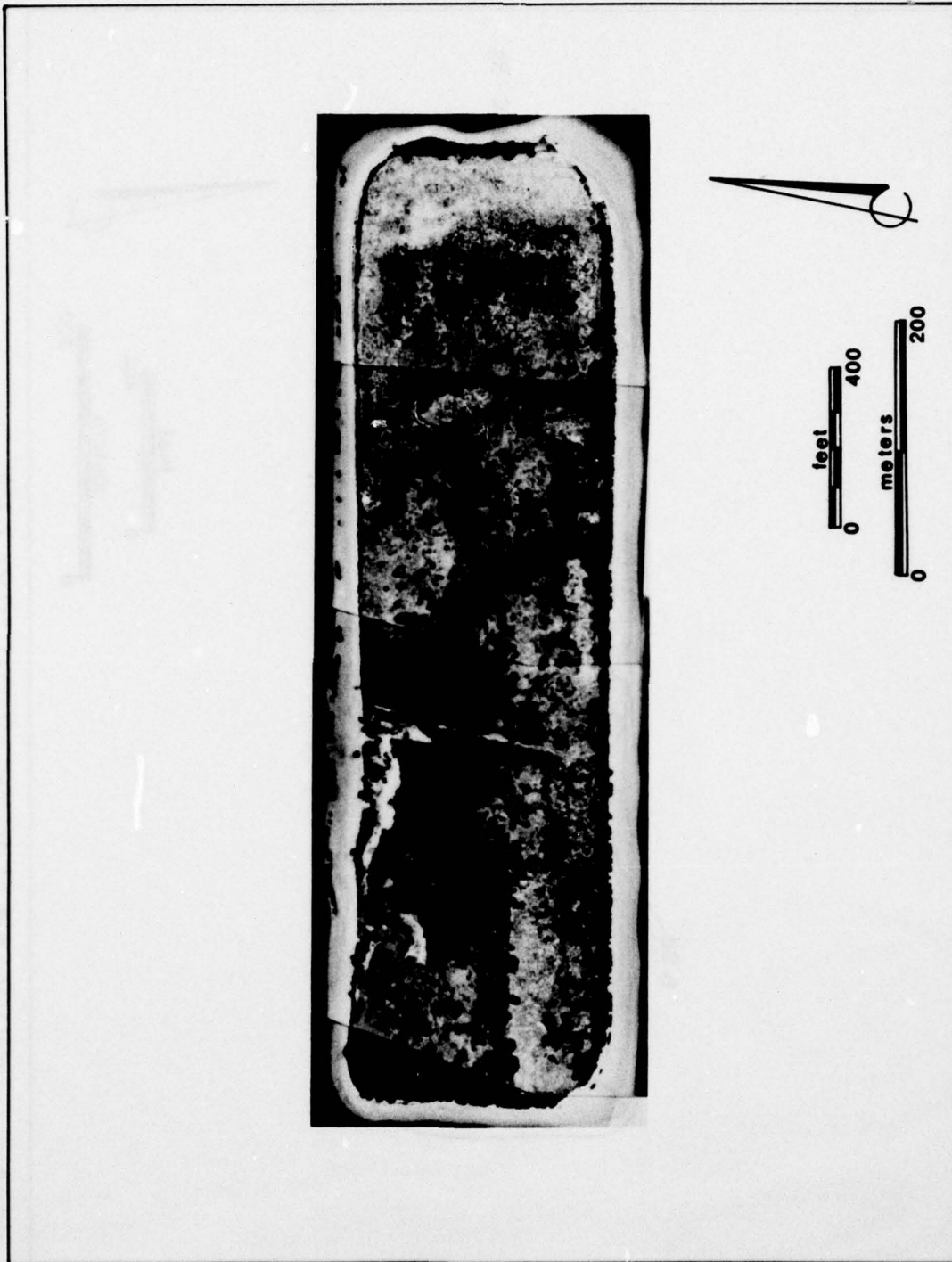


Figure 29. Vertical aerial photograph of dredged material island I-49B.

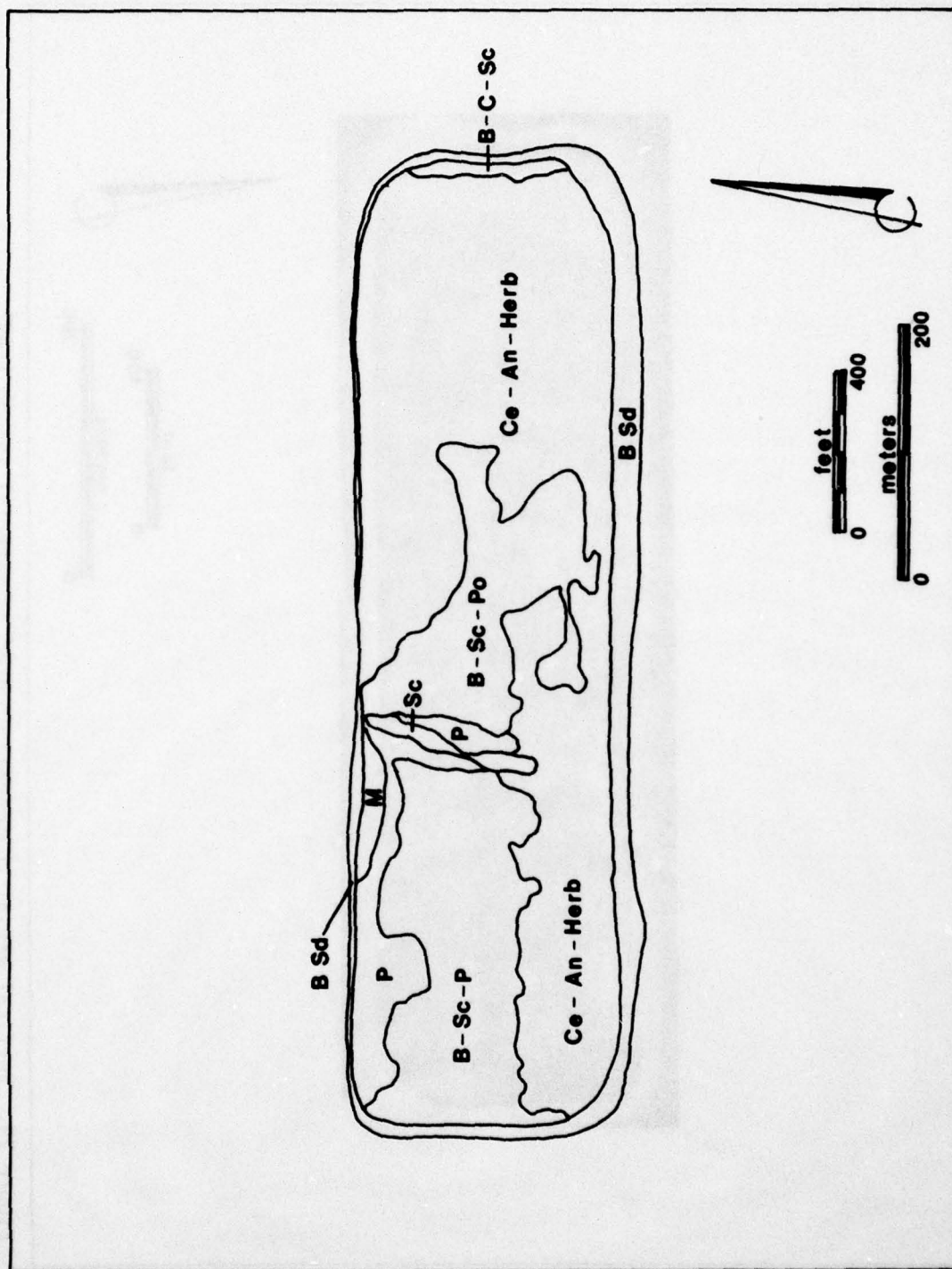


Figure 30. Vegetation map of dredged material island I-49B.

Table 10
General Characteristics and Summary of Vegetation Data
For Dredged Material Island I-54

Island Number: 54

Age: 20 years

Date of Aerial Photograph: 12 February 1977

Plant Species	Communities			
	herbaceous	shrub		tree
	N=0	rel. freq.	abun.	N=0
Andropogon virginicus		5	A	
Avicennia germinans		6	A	
Baccharis halimifolia		16	VA	
Canavalia rosea		1	I	
Cyperus ligularis		1	I	
Eupatorium capillifolium		8	A	
Heterotheca subaxillaris		2	I	
Iva frutescens		4	A	
Laguncularia racemosa		3	A	
Lantana camara		16	VA	
Lippia nodiflora		1	U	
Opuntia stricta		2	I	
Paspalum vaginatum		2	I	
Philoxerus vermicularis		2	I	
Physalis viscosa		1	U	
Phytolacca americana		1	U	
Pluchea purpurascens		1	U	
Portulaca pilosa		5	A	
Rhizophora mangle		1	I	
Rhynchelytrum repens		5	A	
Schinus terebinthifolius		4	A	

(Continued)

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

Table 10 (Concluded)

<u>Plant Species</u>	herbaceous	shrub		tree
	<u>N=0</u>	<u>rel. freq.</u>	<u>abun.</u>	<u>N=0</u>
Sesuvium portulacastrum		1	U	
Solidago sempervirens		9	VA	
Spartina alterniflora		5	A	
Sporobolus poiretii		1	U	
Vigna luteola		1	U	

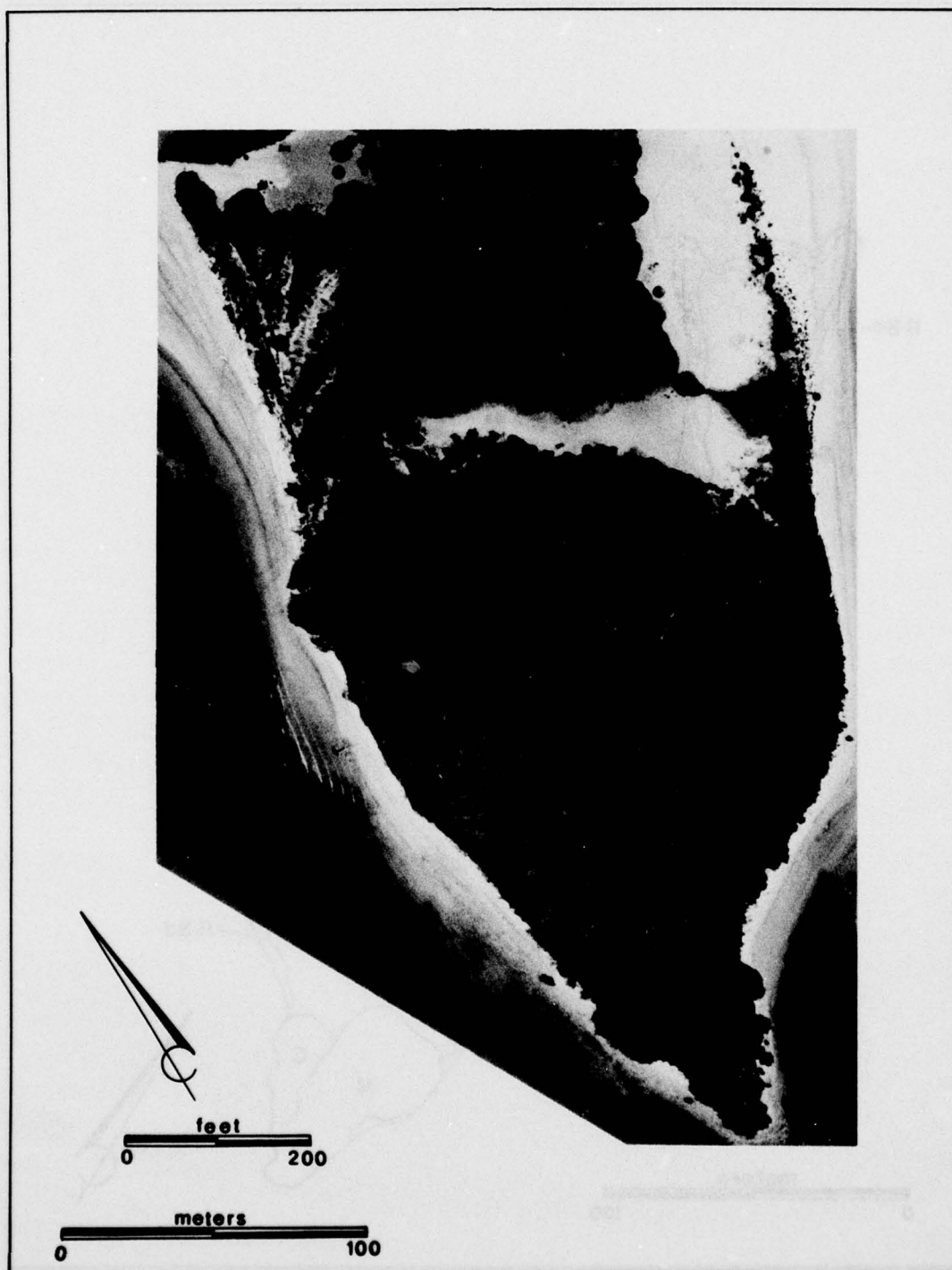


Figure 31. Vertical aerial photograph of dredged material island I-54.

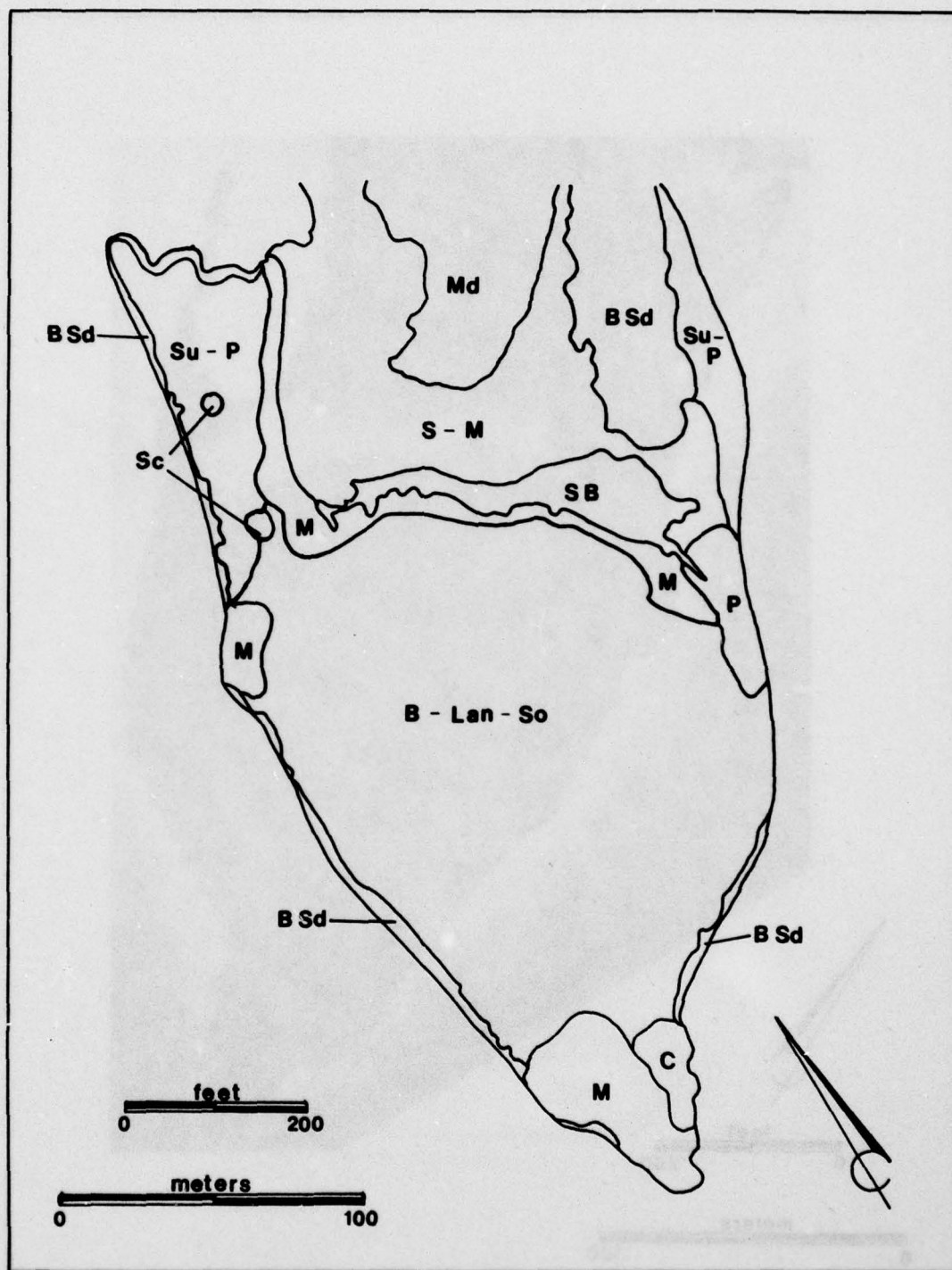


Figure 32. Vegetation map of dredged material island I-54.

Table 11
General Characteristics and Summary of Vegetation Data
For Dredged Material Island I-58

Study Area: I

Island Number: 58

Size: 4.7 ha

Age: 46 years

Date of Aerial Photograph: 12 February 1977

<u>Plant Species</u>	<u>Communities</u>					
	herbaceous		shrub		tree	
	N=25		N=11		N=25	
	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>
<i>Ambrosia artemisiifolia</i>	14	VA	15	VA		
<i>Ampelopsis arborea</i>	2	U				
<i>Avicennia germinans</i>					24	VA
<i>Baccharis halimifolia</i>			2	U		
<i>Bidens pilosa</i>	32	VA	15	VA		
<i>Caesalpinia crista</i>			8	VA		
<i>Citrus sinensis</i>					2	U
<i>Commelina erecta</i>	5	A	12	VA		
<i>Ficus aurea</i>					2	U
<i>Heterotheca subaxillaris</i>	2	U				
<i>Ipomoea alba</i>	2	U				
<i>Ipomoea sagittata</i>					3	I
<i>Iva frutescens</i>			4	A	6	A
<i>Laguncularia racemosa</i>					14	VA
<i>Lantana camara</i>	2	U	13	VA	11	A
<i>Morus rubra</i>					3	I
<i>Oenothera humifusa</i>	2	U				
<i>Oenothera laciniata</i>	2	U	4	A		
<i>Parietaria praetermissa</i>			4	A		
<i>Paspalum setaceum</i>	2	U				

(Continued)

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

Table 11 (Concluded)

<u>Plant Species</u>	<u>Communities</u>					
	herbaceous		shrub		tree	
	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>
<i>Paspalum vaginatum</i>	3	I				
<i>Passiflora lutea</i>	2	U	4	A	3	I
<i>Physalis viscosa</i>	17	VA	6	A		
<i>Phytolacca americana</i>			4	A	3	I
<i>Portulaca pilosa</i>	2	U				
<i>Rhizophora mangle</i>					14	VA
<i>Sabal palmetto</i>			9	VA	15	VA
<i>Sambucus simpsonii</i>	8	A				
<i>Schinus terebinthifolius</i>					2	U
<i>Solidago sempervirens</i>			2	U		
<i>Spartina patens</i>	6	A				
<i>Sporobolus poiretii</i>	2	U	2	U		

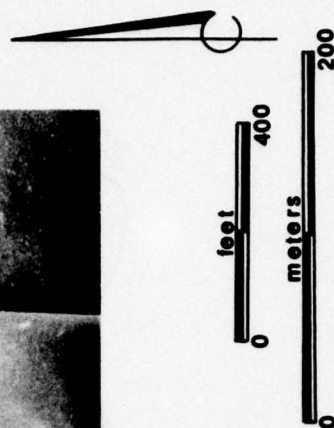


Figure 33. Vertical aerial photograph of dredged material island I-58.

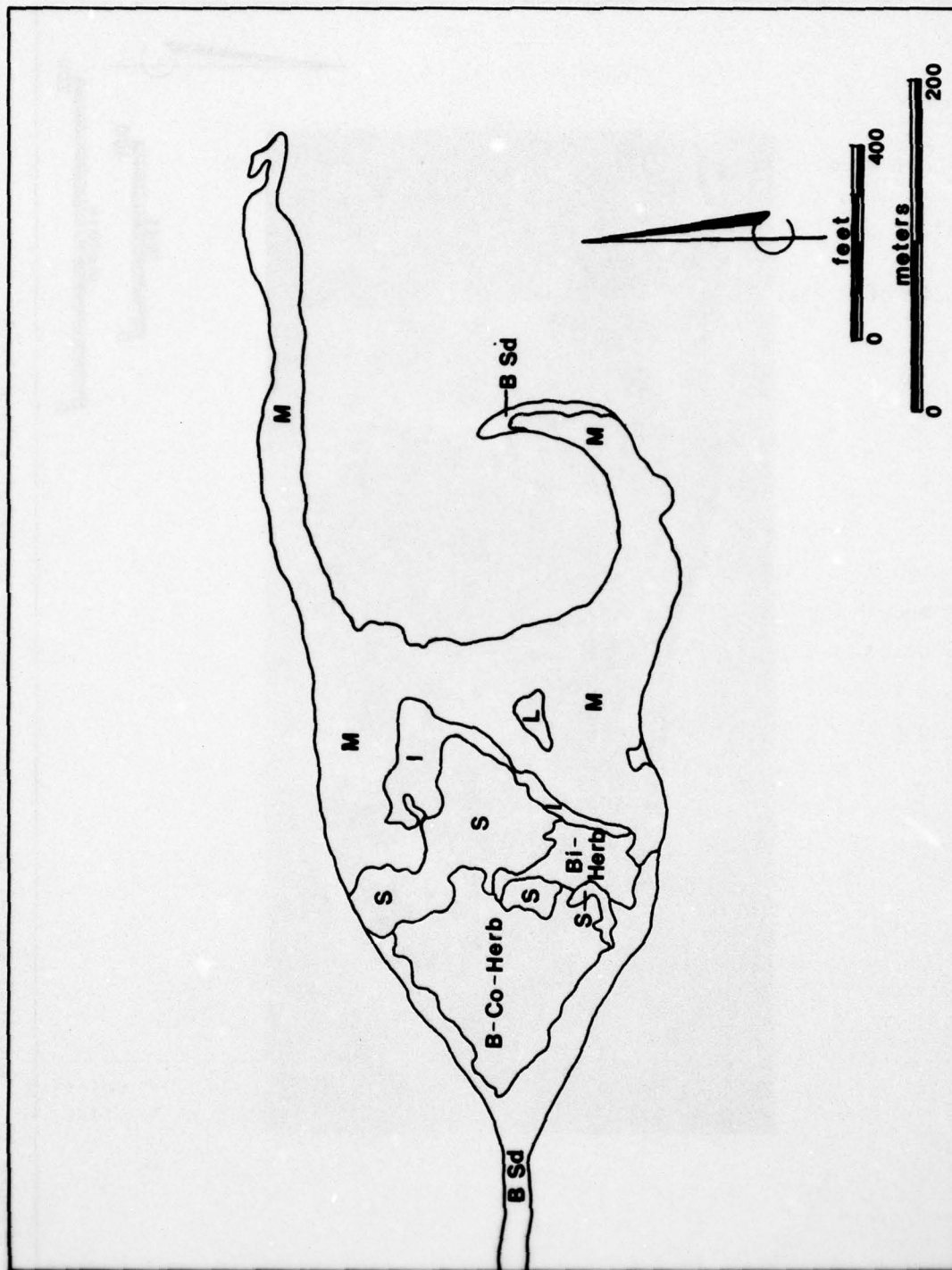


Figure 34. Vegetation map of dredged material island I-58.

Table 12
General Characteristics and Summary of Vegetation Data
For Dredged Material Island I-59

Study Area: I	Island Number: 59
Size: 10.1 ha	Age: 16 years
Date of Aerial Photograph: 12 February 1977	

<u>Plant Species</u>	<u>Communities</u>			
	herbaceous N=3		shrub N=0	tree N=30
	<u>rel.freq.</u>	<u>abun.</u>		<u>rel.freq.</u> <u>abun.</u>
Avicennia germinans				6 I
Baccharis halimifolia				2 U
Batis maritima				2 U
Casuarina equisetifolia				2 U
Eupatorium capillifolium				6 I
Iva frutescens				7 A
Laguncularia racemosa				6 I
Lantana camara				17 A
Paspalum vaginatum	100	VA		
Physalis viscosa				2 U
Phytolacca americana				4 I
Sabal palmetto				20 VA
Schinus terebinthifolius				29 VA

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

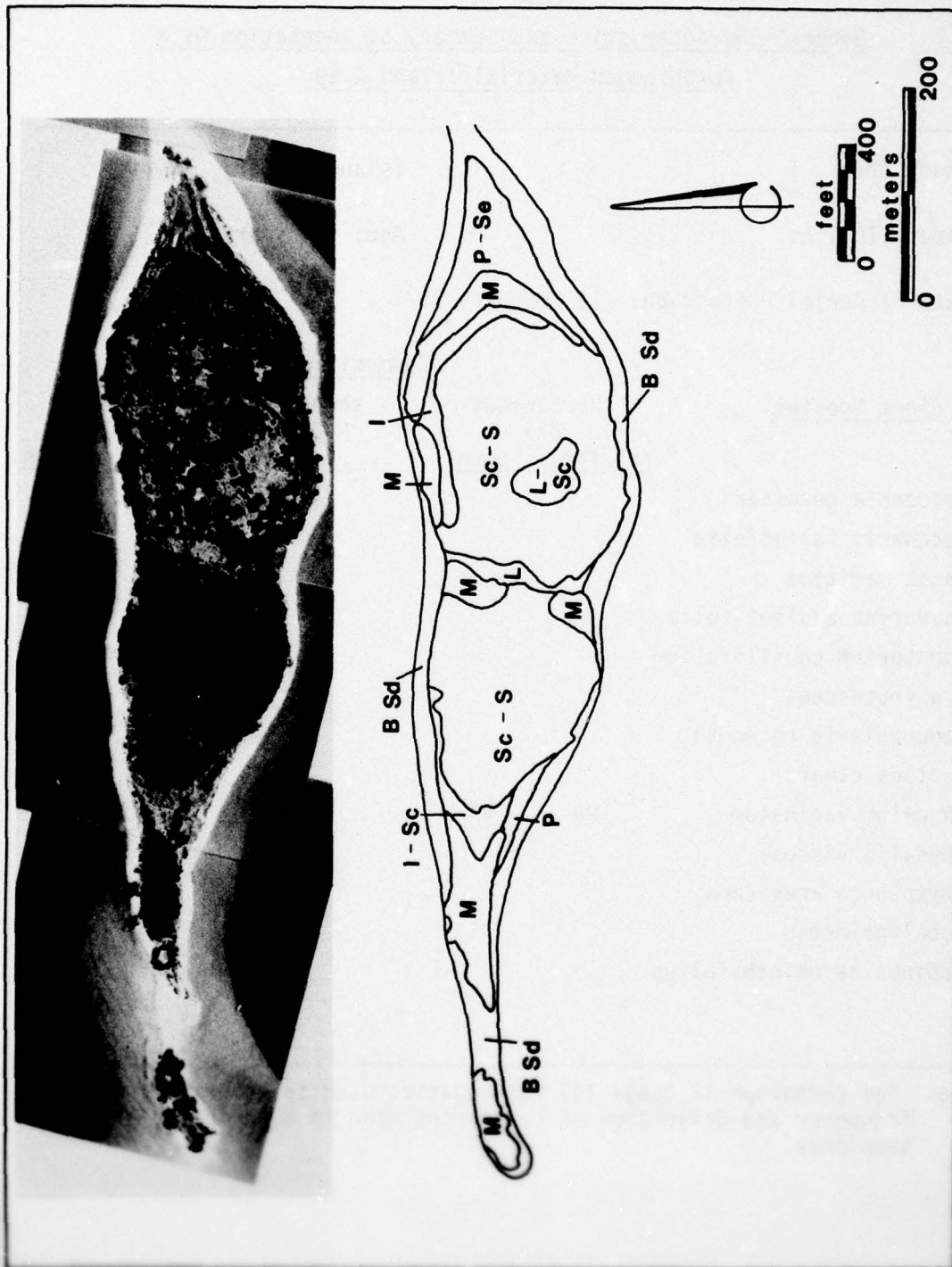


Figure 35. Vertical aerial photograph and vegetation map of dredged material island I-59.

AD-A056 803

SEABIRD RESEARCH INC CULVER CITY CA
COLONIAL BIRD USE AND PLANT SUCCESSION ON DREDGED MATERIAL ISL--ETC(U)
APR 78 R R LEWIS, C S LEWIS

F/G 13/2

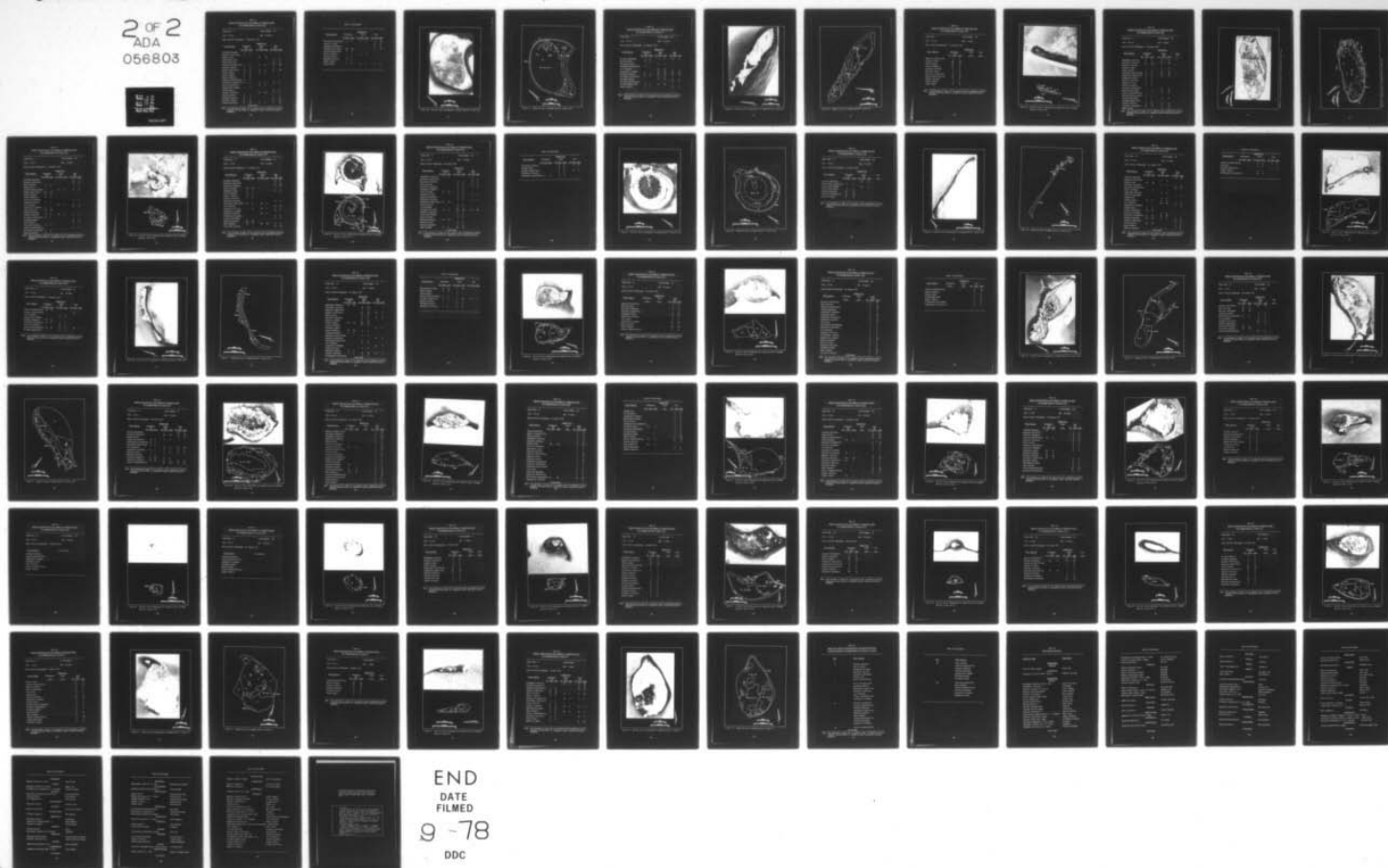
DACW39-76-C-0161

UNCLASSIFIED

WES-D-78-14-VOL-2

NL

2 OF 2
ADA
056803



END
DATE
FILMED
9-78
DDC

General Characteristics and Summary of Vegetation Data

Island Number: 60

Age: 20 years

Date of Aerial Photograph: 12 February 1977

Plant Species	Communities					
	herbaceous N=77		shrub N=2		tree N=5	
	rel.freq.	abun.	rel.freq.	abun.	rel.freq.	abun.
Avicennia germinans	1	U				
Baccharis halimifolia	3	I				
Bidens pilosa			15	VA		
Caesalpinia crista					4	A
Cakile fusiformis					4	A
Casuarina equisetifolia	1	U	8	U	19	VA
Cenchrus incertus	1	U				
Cenchrus pauciflorus	6	A	8	U	11	VA
Chloris glauca	6	A	8	U		
Chloris petraea	1	U				
Conyza canadensis	1	U				
Dalbergia ecastophyllum	2	I				
Heterotheca subaxillaris	6	A	8	U	4	A
Lactuca graminifolia			8	U		
Laguncularia racemosa	1	A				
Lantana camara					4	A
Lepidium virginicum			15	VA	4	A
Lippia nodiflora	5	I				
Oenothera humifusa	6	A			11	VA
Paspalum setaceum	2	I			11	VA
Paspalum vaginatum	20	VA	8	U	7	VA

(Continued)

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

Table 13 (Concluded)

<u>Plant Species</u>	<u>Communities</u>					
	herbaceous		shrub		tree	
	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>
<i>Philoxerus vermicularis</i>	3	I	8	U	7	VA
<i>Physalis viscosa</i>					4	A
<i>Phytolacca americana</i>					4	A
<i>Rhynchelytrum repens</i>	29	VA			4	VA
<i>Solidago sempervirens</i>	2	I				
<i>Sonchus oleraceus</i>			8	U		
<i>Spartina patens</i>	1	U				
<i>Sporobolus poiretii</i>	2	I				
<i>Suaeda linearis</i>	1	U				
<i>Vigna luteola</i>	2	I	8	U	4	A

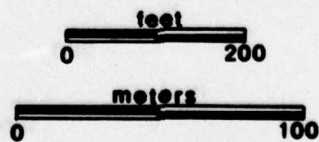
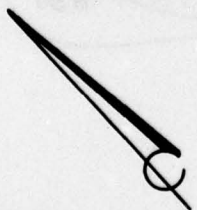


Figure 36. Vertical aerial photograph of dredged material island I-60.

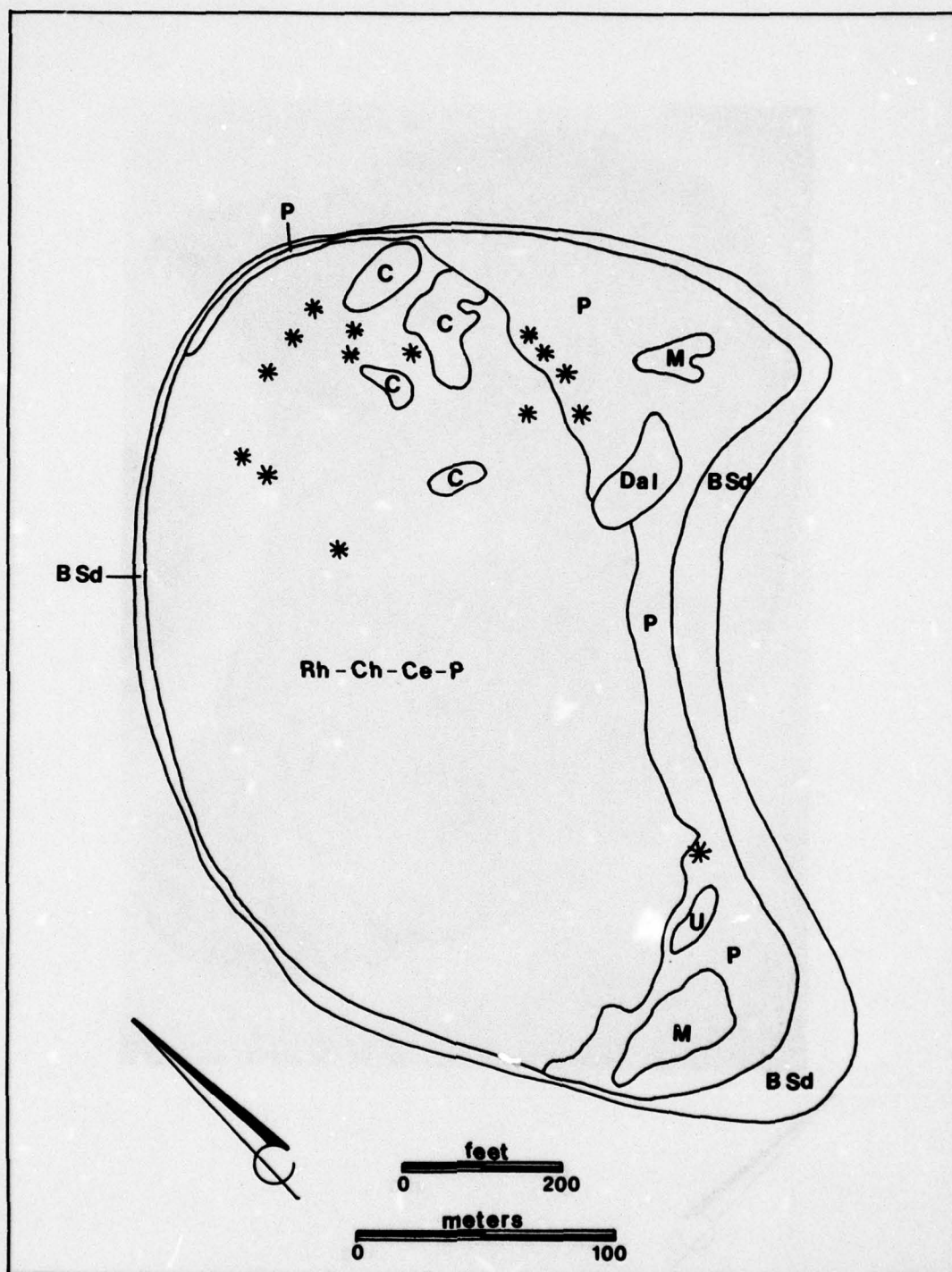


Figure 37. Vegetation map of dredged material island I-60.

Table 14
General Characteristics and Summary of Vegetation Data
For Dredged Material Island I-61

Study Area: I	Island Number: 61					
Size: 2.3 ha	Age: 12 years					
Date of Aerial Photograph: 12 February 1977						
<u>Plant Species</u>	<u>Communities</u>					
	herbaceous		shrub		tree	
	N=31		N=4		N=2	
	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>
Avicennia germinans	2	U	7	U	22	A
Batis maritima	8	I				
Conocarpus erecta			7	U		
Dalbergia ecastophyllum	5	I				
Iva frutescens			13	VA		
Laguncularia racemosa			13	VA	22	VA
Paspalum vaginatum	72	VA	27	VA	22	VA
Philoxerus vermicularis	5	I	7	U		
Rhizophora mangle			13	VA	11	U
Sesuvium portulacastrum					11	U
Solidago sempervirens	2	U	13	VA		
Suaeda linearis	5	I			11	U

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.



Figure 38. Vertical aerial photograph of dredged material island I-61.

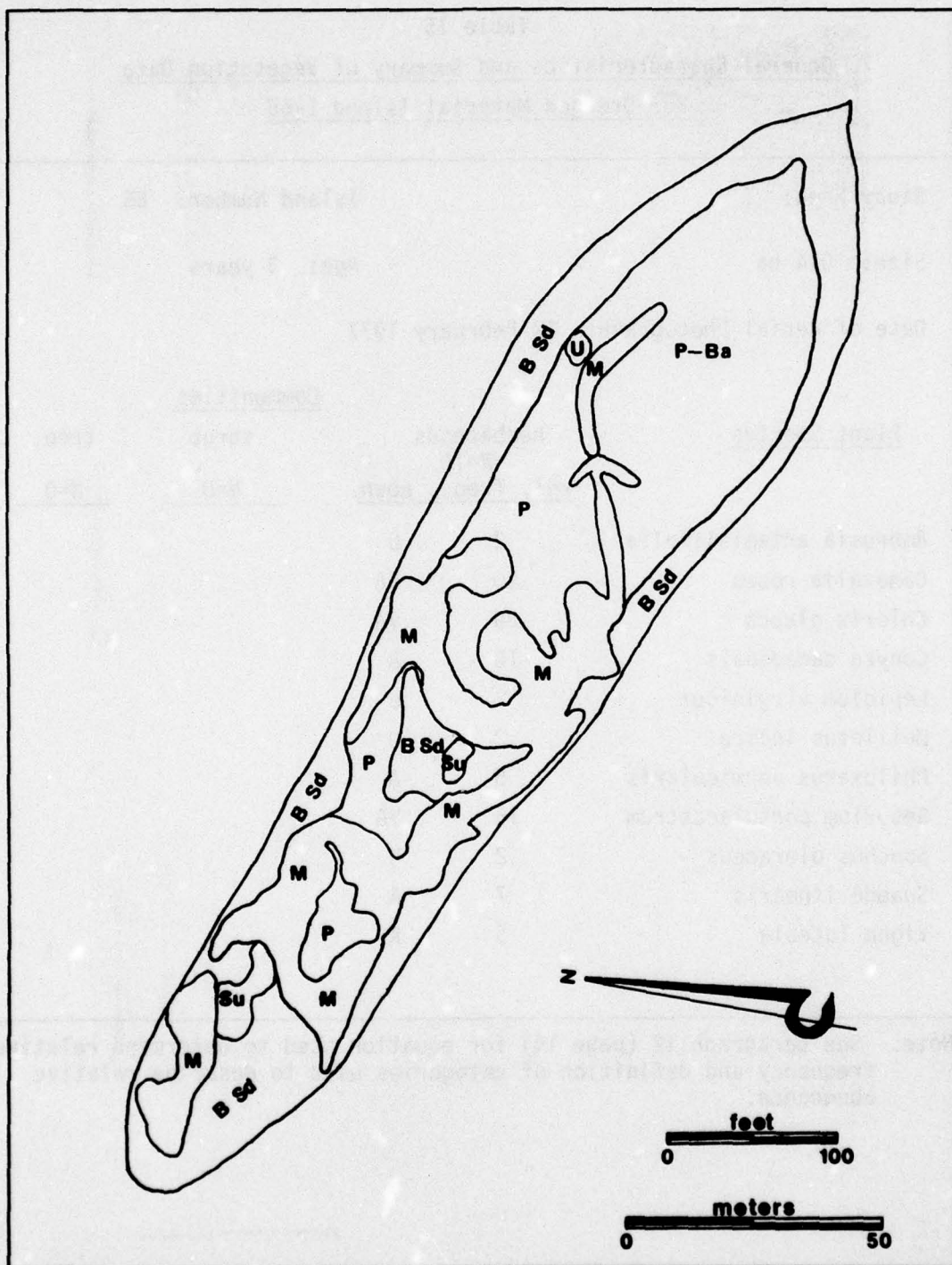


Figure 39. Vegetation map of dredged material island I-61.

Table 15
General Characteristics and Summary of Vegetation Data
For Dredged Material Island I-65

Study Area: I

Island Number: 65

Size: 0.4 ha

Age: 3 years

Date of Aerial Photograph: 12 February 1977

<u>Plant Species</u>	<u>Communities</u>			
	herbaceous		shrub	tree
	rel. freq.	abun.	N=0	N=0
Ambrosia artemisiifolia	2	U		
Canavalia rosea	20	VA		
Chloris glauca	29	VA		
Conyza canadensis	10	A		
Lepidium virginicum	2	U		
Melilotus indica	2	U		
Philoxerus vermicularis	5	A		
Sesuvium portulacastrum	15	VA		
Sonchus oleraceus	2	U		
Suaeda linearis	7	A		
Vigna luteola	5	A		

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

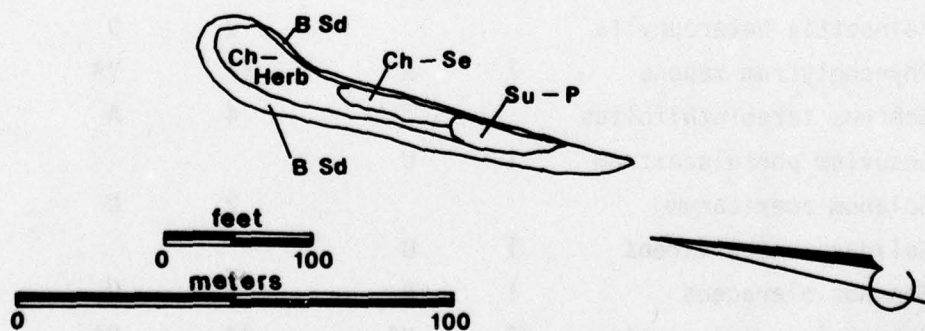


Figure 40. Vertical aerial photograph and vegetation map of dredged material island I-65.

Table 16
General Characteristics and Summary of Vegetation Data
For Dredged Material Island I-66

Study Area: I	Island Number: 66				
Size: 24.7 ha	Age: 8 years				
Date of Aerial Photograph: 12 February 1977					
	<u>Communities</u>				
<u>Plant Species</u>	herbaceous N=32		shrub N=14		tree N=0
	<u>rel. freq.</u>	<u>abun.</u>	<u>rel. freq.</u>	<u>abun.</u>	
<i>Andropogon virginicus</i>	6	A	6	A	
<i>Baccharis halimifolia</i>	20	VA	19	VA	
<i>Boerhavia coccinea</i>	1	U			
<i>Canavalia rosea</i>			4	A	
<i>Chloris glauca</i>	1	U	6	A	
<i>Eupatorium capillifolium</i>	3	I	10	VA	
<i>Heterotheca subaxillaris</i>	9	A	12	VA	
<i>Ipomoea pes-caprae</i>	1	U			
<i>Lepidium virginicum</i>	1	U			
<i>Paspalum urvillei</i>	11	A			
<i>Paspalum vaginatum</i>	1	U			
<i>Poinsettia heterophylla</i>			2	U	
<i>Rhynchelytrum repens</i>	7	A	17	VA	
<i>Schinus terebinthifolius</i>			4	A	
<i>Sesuvium portulacastrum</i>	1	U			
<i>Solanum americanum</i>			2	U	
<i>Solidago sempervirens</i>	1	U			
<i>Sonchus oleraceus</i>	1	U	2	U	
<i>Sporobolus domingensis</i>	33	VA	14	VA	
<i>Vigna luteola</i>			4	A	

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.



Figure 41. Vertical aerial photograph of dredged material island I-66.

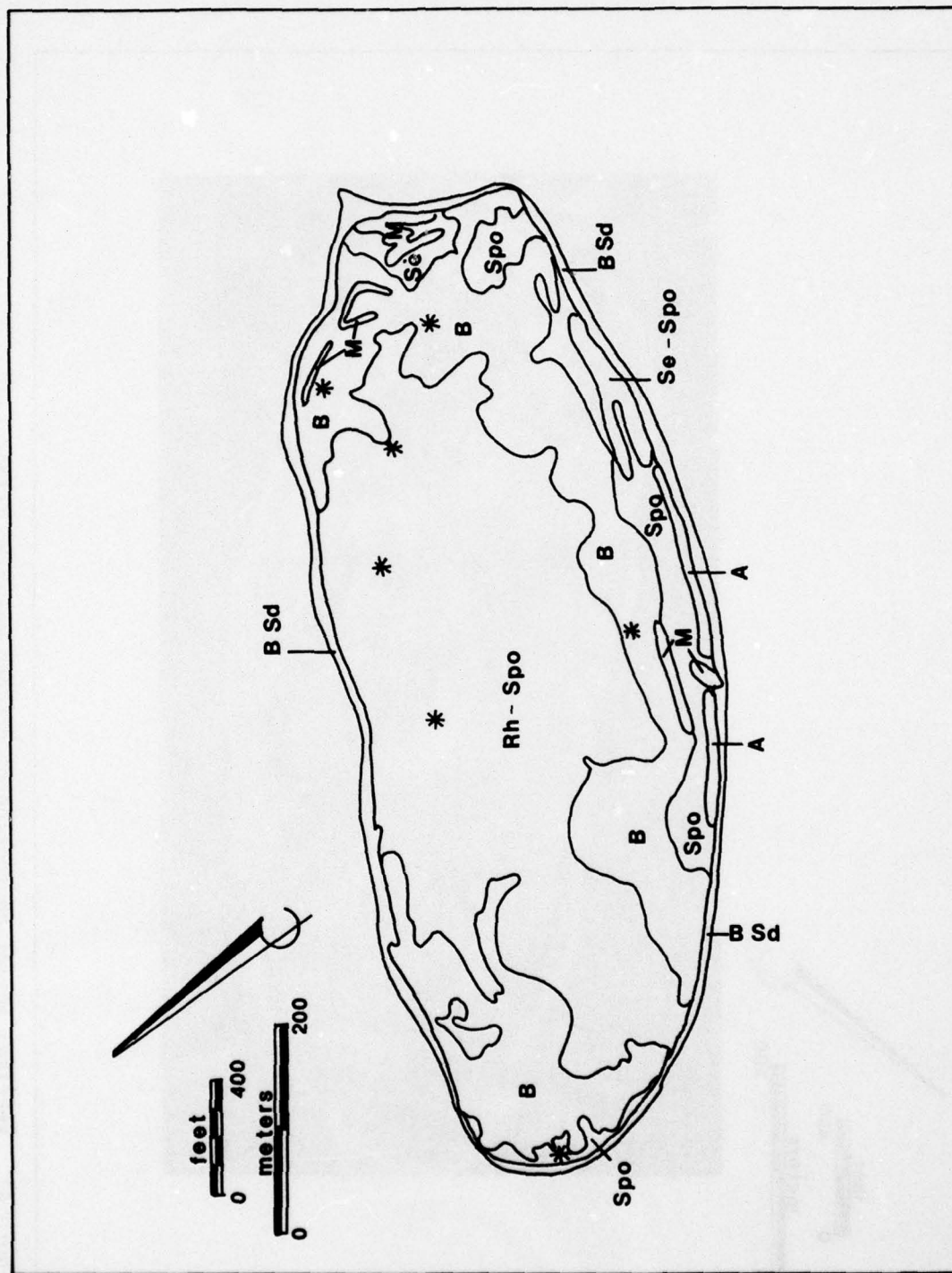


Figure 42. Vegetation map of dredged material island I-66.

Table 17
General Characteristics and Summary of Vegetation Data
For Dredged Material Island I-68

Study Area: I

Island Number: 68

Size: 1.4 ha

Age: 15 years

Date of Aerial Photograph: 12 February 1977

<u>Plant Species</u>	<u>Communities</u>					
	herbaceous		shrub		tree	
	N=28		N=1		N=2	
	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>
Avicennia germinans					9	U
Baccharis halimifolia					9	U
Batis maritima	5	A			9	U
Bidens pilosa	3	I				
Casuarina equisetifolia			33	U	9	U
Cenchrus pauciflorus	29	VA				
Chloris petraea	2	U				
Conyza canadensis	6	A				
Forestiera segregata					9	U
Ipomoea pes-caprae	5	A				
Iva frutescens			33	U	9	U
Laguncularia racemosa	3	I			9	U
Lippia nodiflora	25	VA				
Oenothera humifusa	3	I				
Paspalum vaginatum	5	A	33	U	9	U
Philoxerus vermicularis	3	I				
Rhizophora mangle					9	U
Sabal palmetto					9	U
Salicornia virginica	2	U				
Schinus terebinthifolius					9	U
Sesuvium portulacastrum	5	A				
Uniola paniculata	3	I				

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

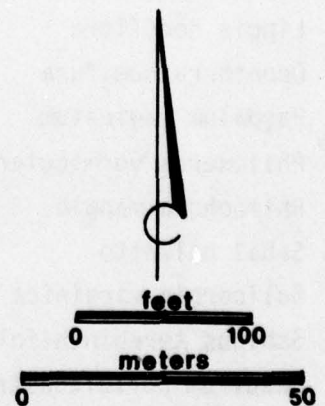
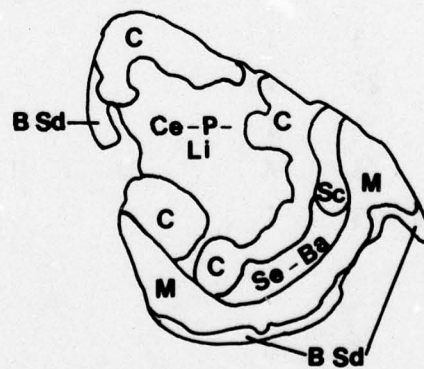
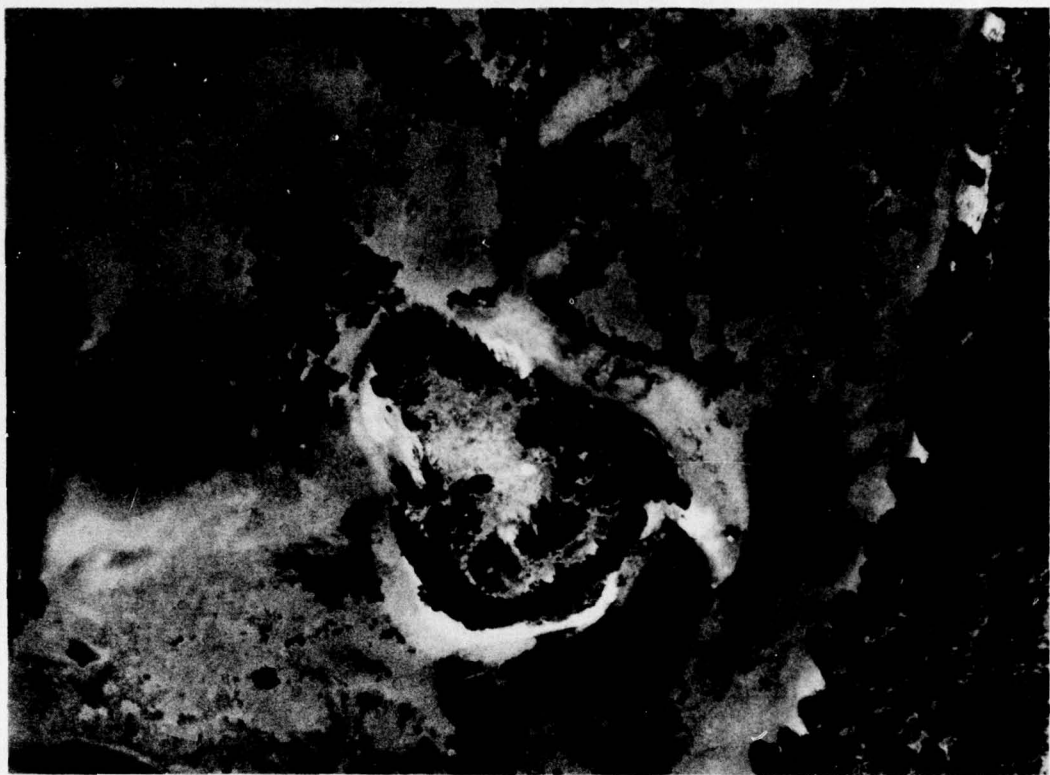


Figure 43. Vertical aerial photograph and vegetation map of dredged material island I-68.

Table 18
General Characteristics and Summary of Vegetation Data
For Dredged Material Island II-12

Study Area: II

Island Number: 12

Size: 1.2 ha

Age: 25 years

Date of Aerial Photograph: 22 January 1977

<u>Plant Species</u>	<u>Communities</u>					
	herbaceous		shrub		tree	
	N=20		N=2		N=3	
	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>
<i>Avicennia germinans</i>					6	U
<i>Baccharis halimifolia</i>					6	U
<i>Borrchia frutescens</i>					13	VA
<i>Chloris petraea</i>	29	VA				
<i>Conocarpus erecta</i>					6	U
<i>Conyza canadensis</i>	10	A				
<i>Cyperus ligularis</i>	3	U				
<i>Cyperus planifolius</i>	7	A				
<i>Eupatorium serotinum</i>					6	U
<i>Heterotheca subaxillaris</i>	16	A	20	U		
<i>Iva frutescens</i>					19	VA
<i>Juniperus silicicola</i>	7	A	20	U	6	U
<i>Laguncularia racemosa</i>					6	U
<i>Lepidium virginicum</i>			20	U		
<i>Limonium carolinianum</i>					6	U
<i>Lycium carolinianum</i>					6	U
<i>Oenothera humifusa</i>	20	VA				
<i>Sabal palmetto</i>	10	A	40	VA	6	U
<i>Salicornia virginica</i>					13	VA

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

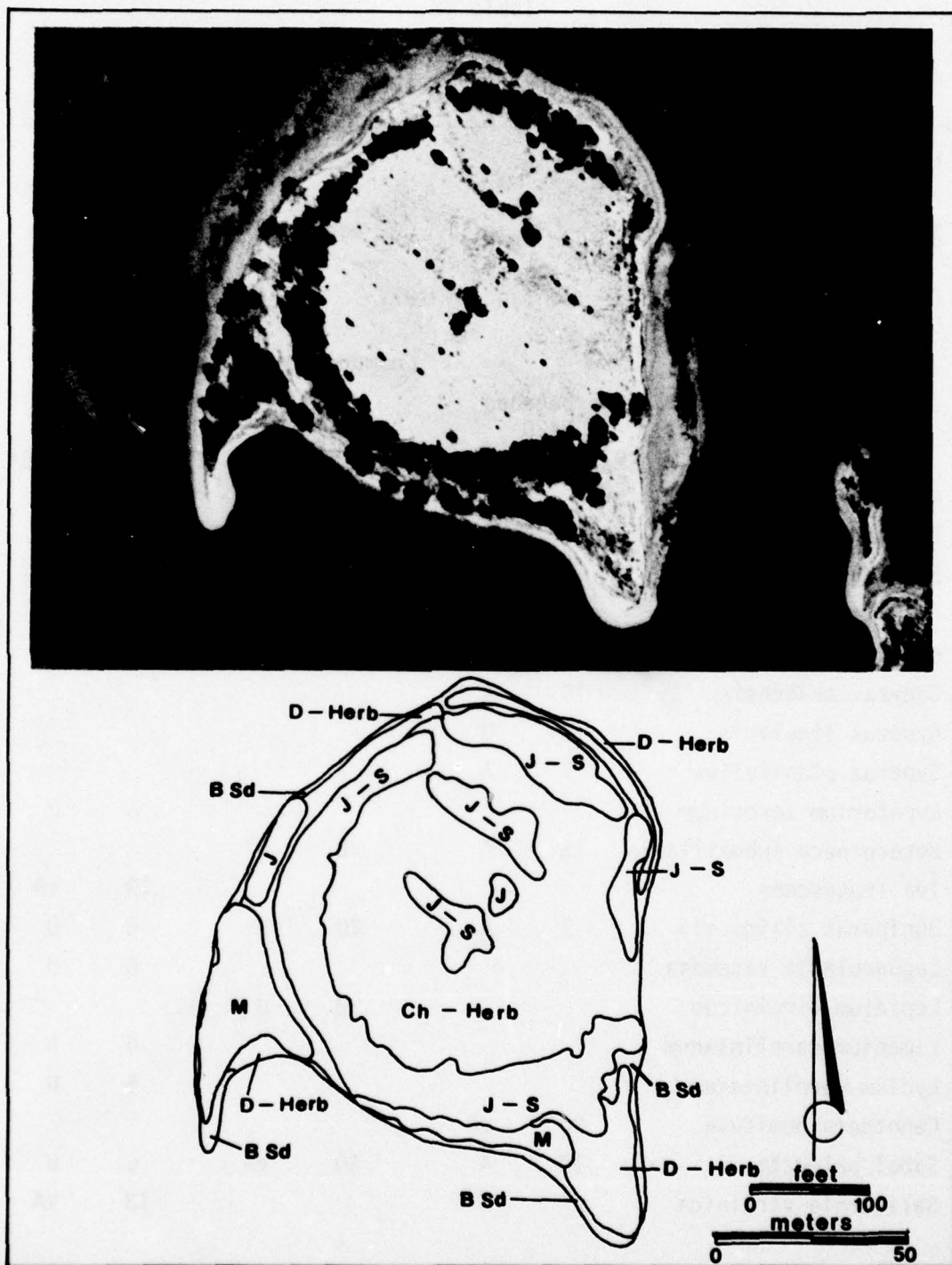


Figure 44. Vertical aerial photograph and vegetation map of dredged material island II-12.

Table 19
General Characteristics and Summary of Vegetation Data
For Dredged Material Island II-26

Study Area: II	Island Number: 26
Size: 2.2 ha	Age: 25 years
Date of Aerial Photograph: 22 January 1977	

<u>Plant Species</u>	<u>Communities</u>					
	herbaceous N=16		shrub N=16		tree N=4	
	rel.freq.	abun.	rel.freq.	abun.	rel.freq.	abun.
<i>Andropogon virginicus</i>	4	U				
<i>Baccharis angustifolia</i>					9	U
<i>Baccharis halimifolia</i>			4	A	9	U
<i>Batis maritima</i>			2	U	9	U
<i>Borrchia frutescens</i>			4	A	9	U
<i>Chamaesyce blodgettii</i>			2	U		
<i>Chloris petraea</i>	37	VA	2	U		
<i>Conocarpus erecta</i>			2	U	9	U
<i>Cyperus polystachyos</i>			2	U		
<i>Eupatorium serotinum</i>			2	U	9	U
<i>Heterotheca subaxillaris</i>	22	VA				
<i>Iresine celosia</i>			2	U		
<i>Iva frutescens</i>			2	U		
<i>Juniperus silicicola</i>	4	U	20	VA	27	VA
<i>Lepidium virginicum</i>			4	A		
<i>Lycium carolinianum</i>			2	U		
<i>Myrica cerifera</i>			2	U		
<i>Oenothera humifusa</i>	18	VA				
<i>Opuntia stricta</i>			2	U		
<i>Paspalum vaginatum</i>			2	U		
<i>Sabal palmetto</i>	8	A	24	VA		

(Continued)

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

Table 19 (Concluded)

<u>Plant Species</u>	<u>Communities</u>					
	herbaceous		shrub		tree	
	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>
Salicornia virginica			4	A	9	U
Serenoa repens			4	A		
Solidago sempervirens			2	U	9	U
Sporobolus virginicus			2	U		
Trichostema suffrutescens	8	A	8	A		

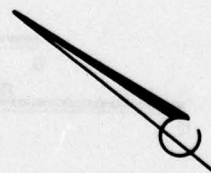
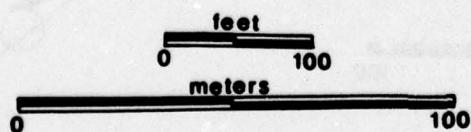
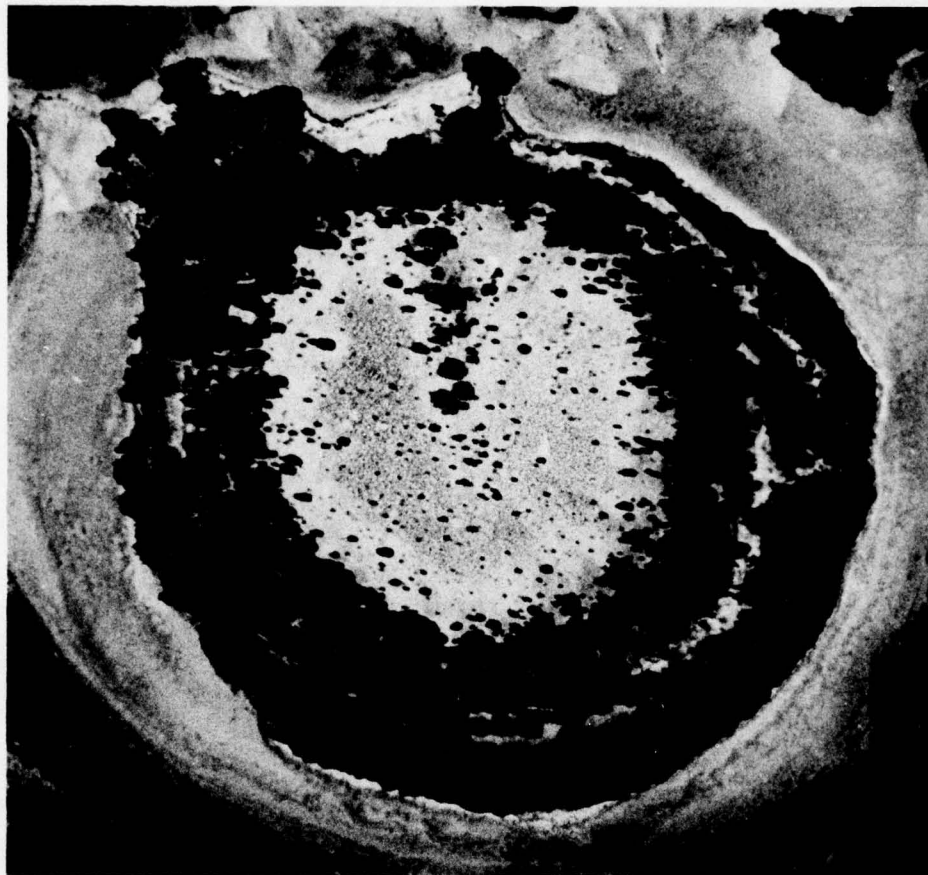


Figure 45. Vertical aerial photograph of dredged material island II-26.

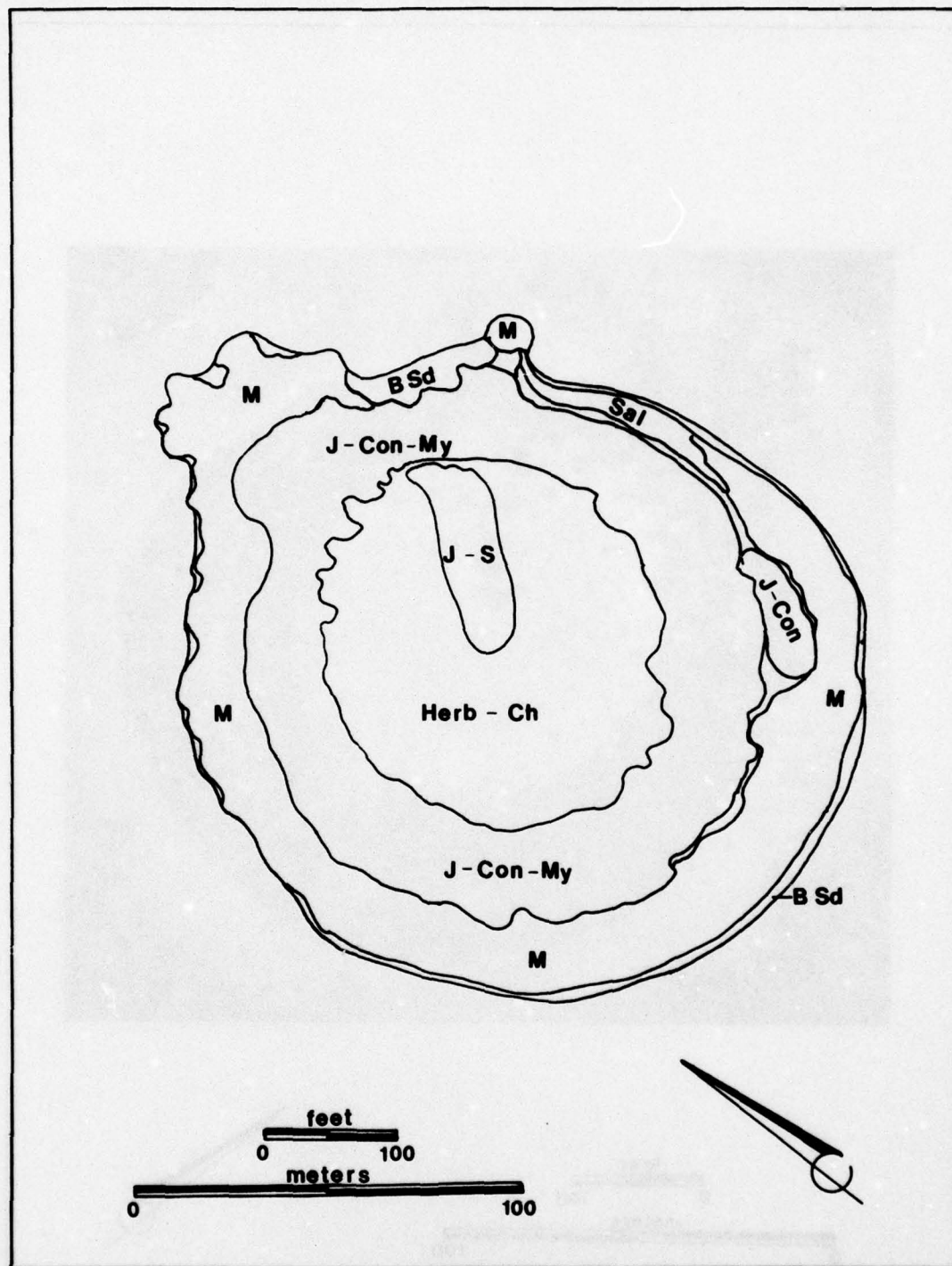


Figure 46. Vegetation map of dredged material island II-26.

Table 20
General Characteristics and Summary of Vegetation Data
For Dredged Material Island II-64

Study Area: II	Island Number: 64
Size: 0.9 ha	Age: 15 years
Date of Aerial Photograph: 22 January 1977	

<u>Plant Species</u>	<u>Communities</u>				
	herbaceous N=18		shrub N=1		tree
	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>	<u>N=0</u>
Avicennia germinans			50	U	
Heliotropium curassavicum	2	U			
Laguncularia racemosa			50	U	
Lycium carolinianum	9	A			
Paspalum vaginatum	41	VA			
Philoxerus vermicularis	34	VA			
Physalis viscosa	14	VA			

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

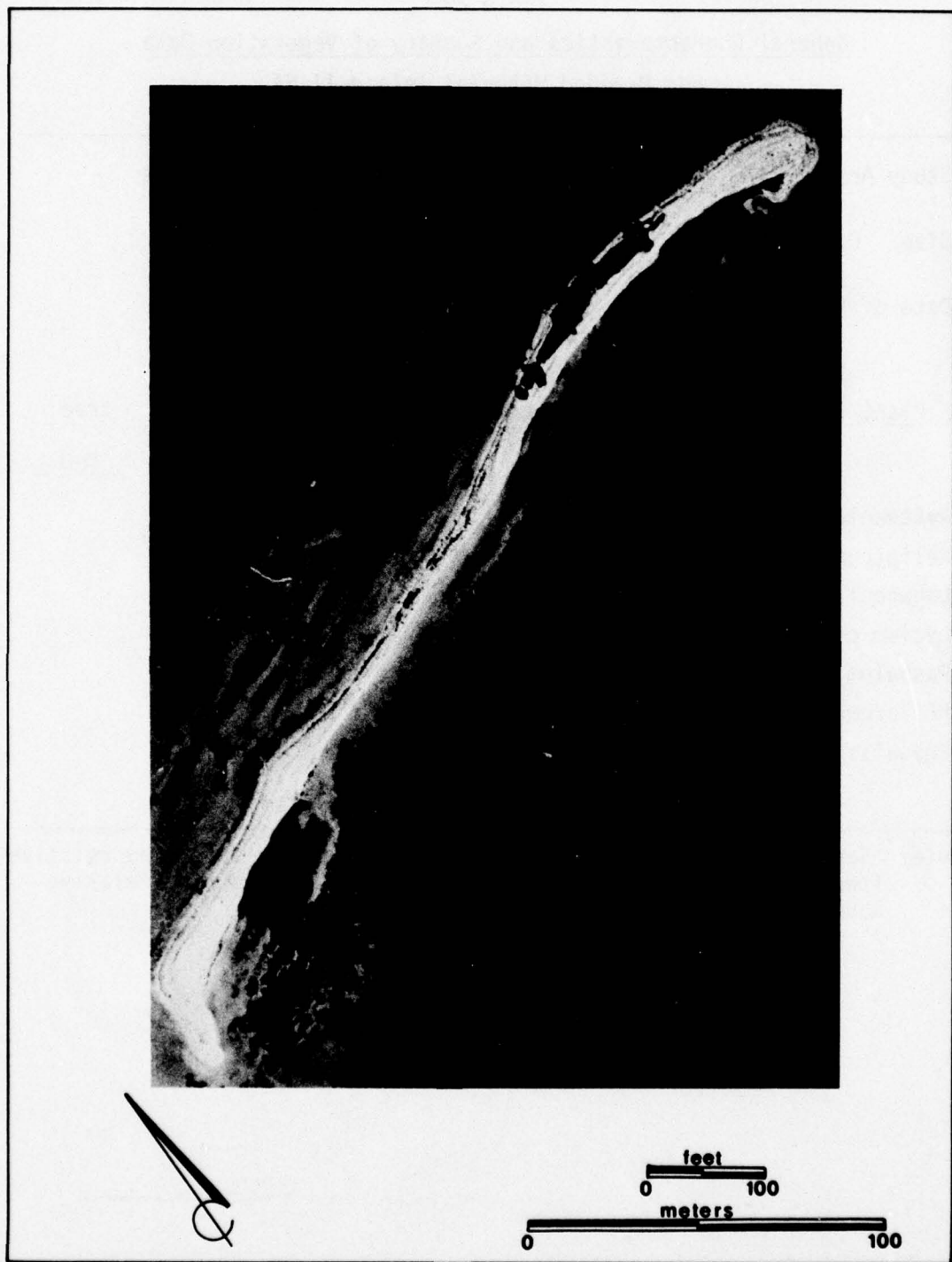


Figure 47. Vertical aerial photograph of dredged material island II-64.

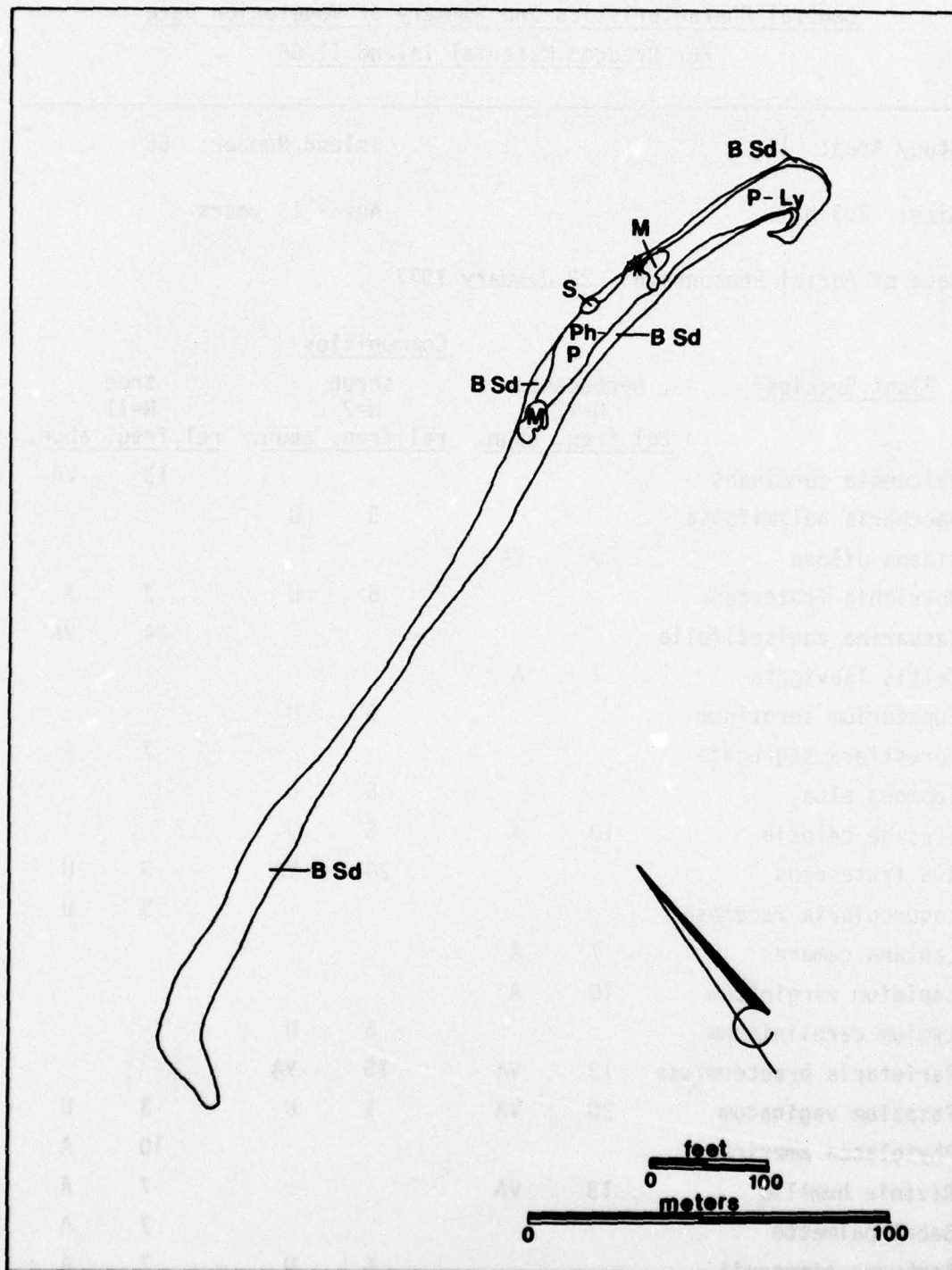


Figure 48. Vegetation map of dredged material island II-64.

Table 21
General Characteristics and Summary of Vegetation Data
For Dredged Material Island II-66

Study Area: II

Island Number: 66

Size: 2.3 ha

Age: 15 years

Date of Aerial Photograph: 22 January 1977

<u>Plant Species</u>	<u>Communities</u>					
	herbaceous		shrub		tree	
	N=12		N=7		N=11	
	rel.freq.	abun.	rel.freq.	abun.	rel.freq.	abun.
Avicennia germinans					13	VA
Baccharis halimifolia			5	U		
Bidens pilosa	20	VA				
Borrchia frutescens			5	U	7	A
Casuarina equisetifolia					24	VA
Celtis laevigata	7	A				
Eupatorium serotinum			5	U		
Forestiera segregata					7	A
Ipomoea alba			5	U		
Iresine celosia	10	A	5	U		
Iva frutescens			20	VA	3	U
Laguncularia racemosa					3	U
Lantana camara	7	A				
Lepidium virginicum	10	A				
Lycium carolinianum			5	U		
Parietaria praetermissa	13	VA	15	VA		
Paspalum vaginatum	20	VA	5	U	3	U
Phytolacca americana					10	A
Rivinia humilis	13	VA			7	A
Sabal palmetto					7	A
Sambucus simpsonii			5	U	7	A

(Continued)

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

Table 21 (Concluded)

<u>Plant Species</u>	<u>Communities</u>					
	herbaceous		shrub		tree	
	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>
Schinus terebinthifolius			5	U	3	U
Sida acuta			5	U		
Solidago sempervirens					7	A
Suaeda linearis			5	U		
Zanthoxylum clava-herculis			10	A		

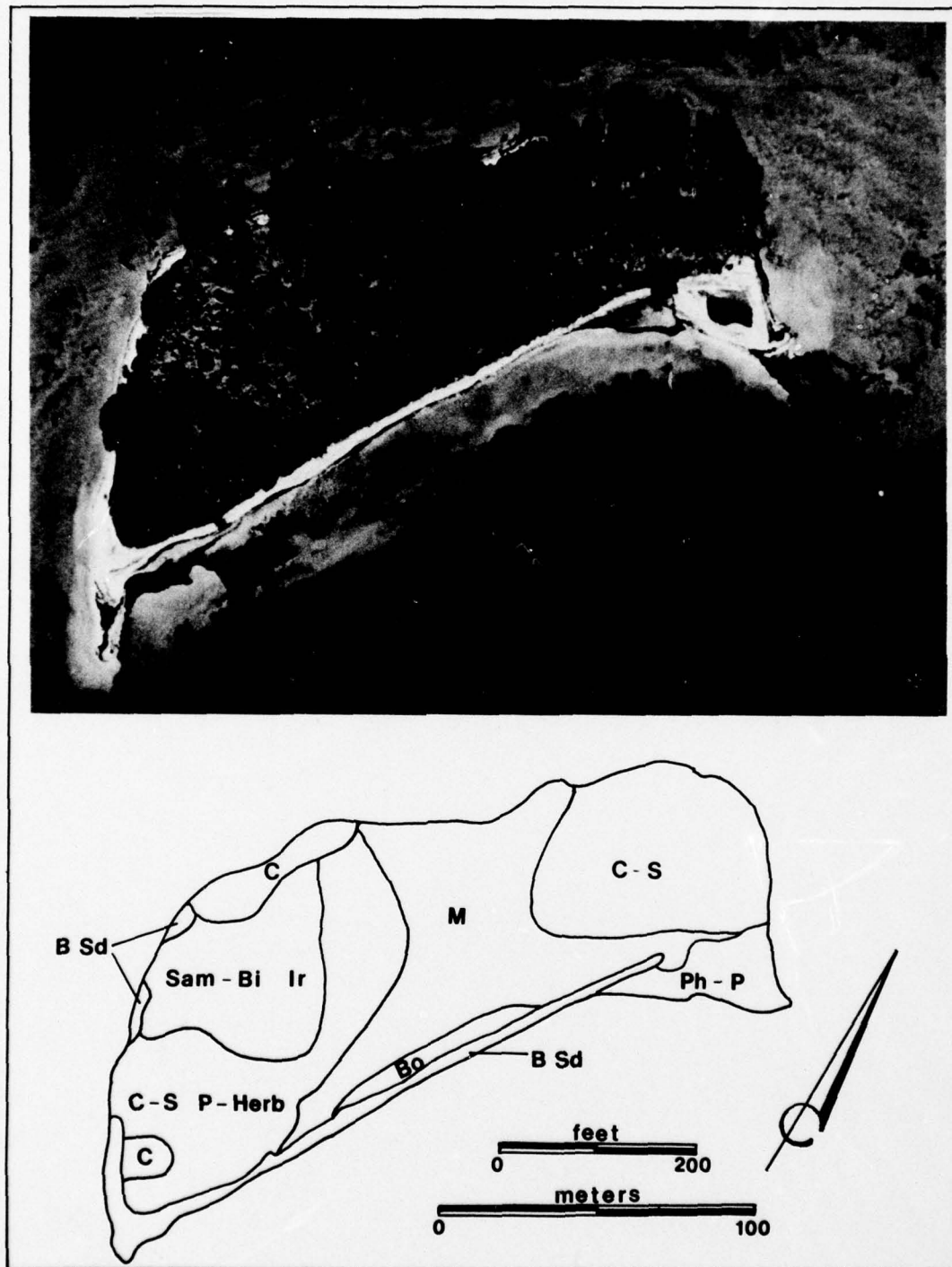


Figure 49. Vertical aerial photograph and vegetation map of dredged material island II-66.

Table 22
General Characteristics and Summary of Vegetation Data
For Dredged Material Island II-67

Study Area: II	Island Number: 67					
Size: 0.5 ha	Age: 15 years					
Date of Aerial Photograph: 22 January 1977						
<u>Plant Species</u>	<u>Communities</u>					
	herbaceous		shrub		tree	
	N=10		N=1		N=1	
	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>
Ambrosia artemisiifolia	22	VA				
Casuarina equisetifolia					50	U
Iva frutescens			17	U		
Laguncularia racemosa			17	U		
Paspalum vaginatum	39	VA				
Philoxerus vermicularis	4	U	17	U		
Salicornia virginica			17	U		
Sesuvium portulacastrum	35	VA	17	U	50	U
Solidago sempervirens			17	U		

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

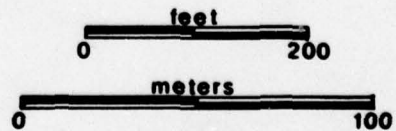


Figure 50. Vertical aerial photograph of dredged material island II-67.

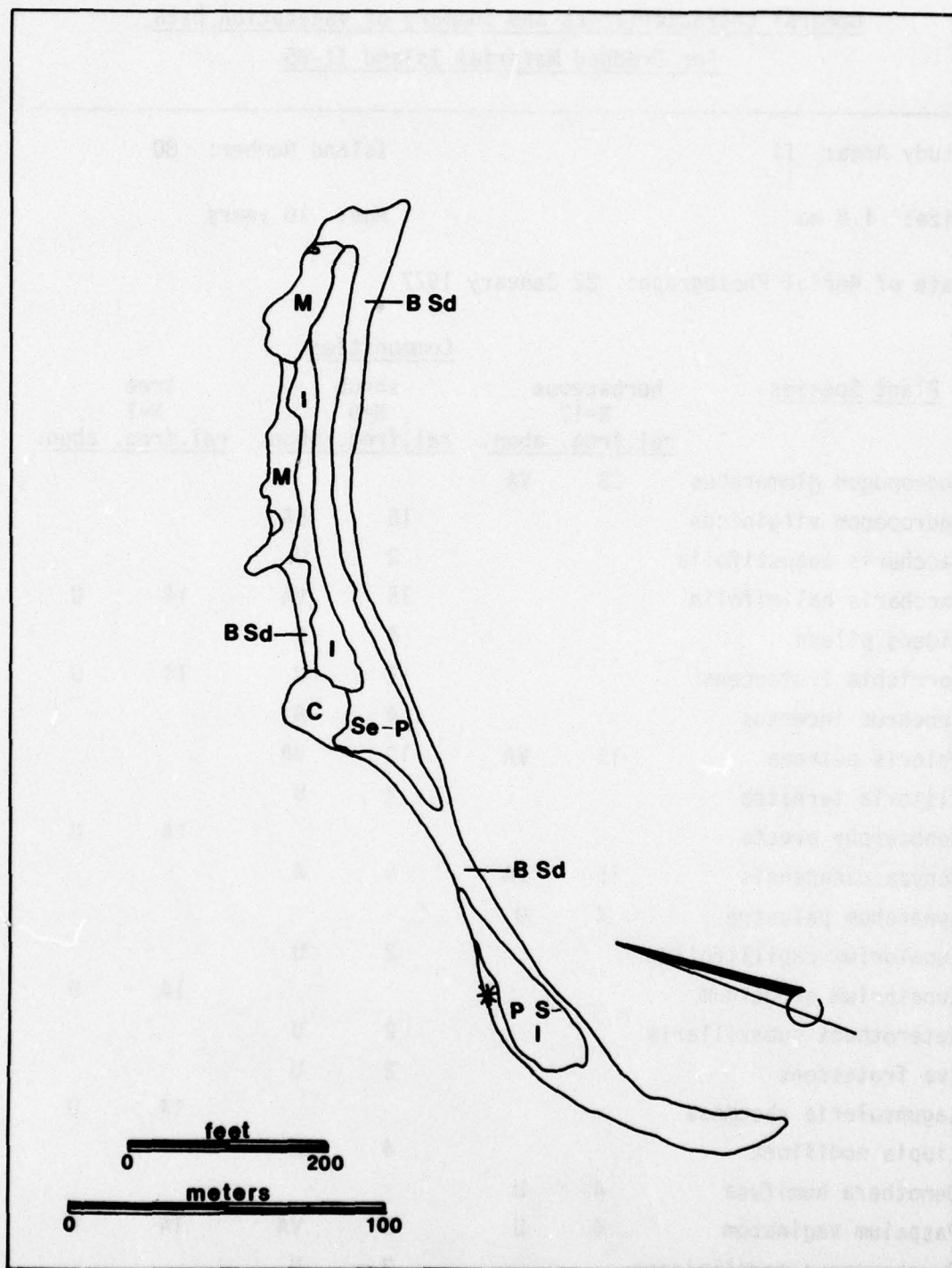


Figure 51. Vegetation map of dredged material island II-67.

Table 23
General Characteristics and Summary of Vegetation Data
For Dredged Material Island II-80

Study Area: II

Island Number: 80

Size: 1.8 ha

Age: 10 years

Date of Aerial Photograph: 22 January 1977

<u>Plant Species</u>	<u>Communities</u>					
	<u>herbaceous</u>		<u>shrub</u>		<u>tree</u>	
	N=12		N=9		N=1	
	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>
<i>Andropogon glomeratus</i>	23	VA				
<i>Andropogon virginicus</i>			15	VA		
<i>Baccharis angustifolia</i>			2	U		
<i>Baccharis halimifolia</i>			15	VA	14	U
<i>Bidens pilosa</i>			4	A		
<i>Borrchia frutescens</i>			2	U	14	U
<i>Cenchrus incertus</i>			4	A		
<i>Chloris petraea</i>	15	VA	10	VA		
<i>Clitoria ternatea</i>			2	U		
<i>Conocarpus erecta</i>					14	U
<i>Conyza canadensis</i>	15	VA	4	A		
<i>Cynanchum palustre</i>	4	U				
<i>Eupatorium capillifolium</i>			2	U		
<i>Eupatorium serotinum</i>					14	U
<i>Heterotheca subaxillaris</i>			2	U		
<i>Iva frutescens</i>			2	U		
<i>Laguncularia racemosa</i>					14	U
<i>Lippia nodiflora</i>			4	A		
<i>Oenothera humifusa</i>	4	U				
<i>Paspalum vaginatum</i>	4	U	8	VA	14	U
<i>Pyrrhopappus carolinianus</i>			2	U		

(Continued)

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

Table 23 (Concluded)

<u>Plant Species</u>	<u>Communities</u>					
	herbaceous		shrub		tree	
	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>
Rhynchelytrum repens	15	VA	6	VA		
Sabal palmetto	8	A				
Serenoa repens			2	U		
Sesuvium portulacastrum	4	U				
Solidago sempervirens	4	U	8	VA	14	U
Sonchus oleraceus			4	A		
Sporobolus poiretii			2	U		
Sporobolus virginicus	4	U	4	A		

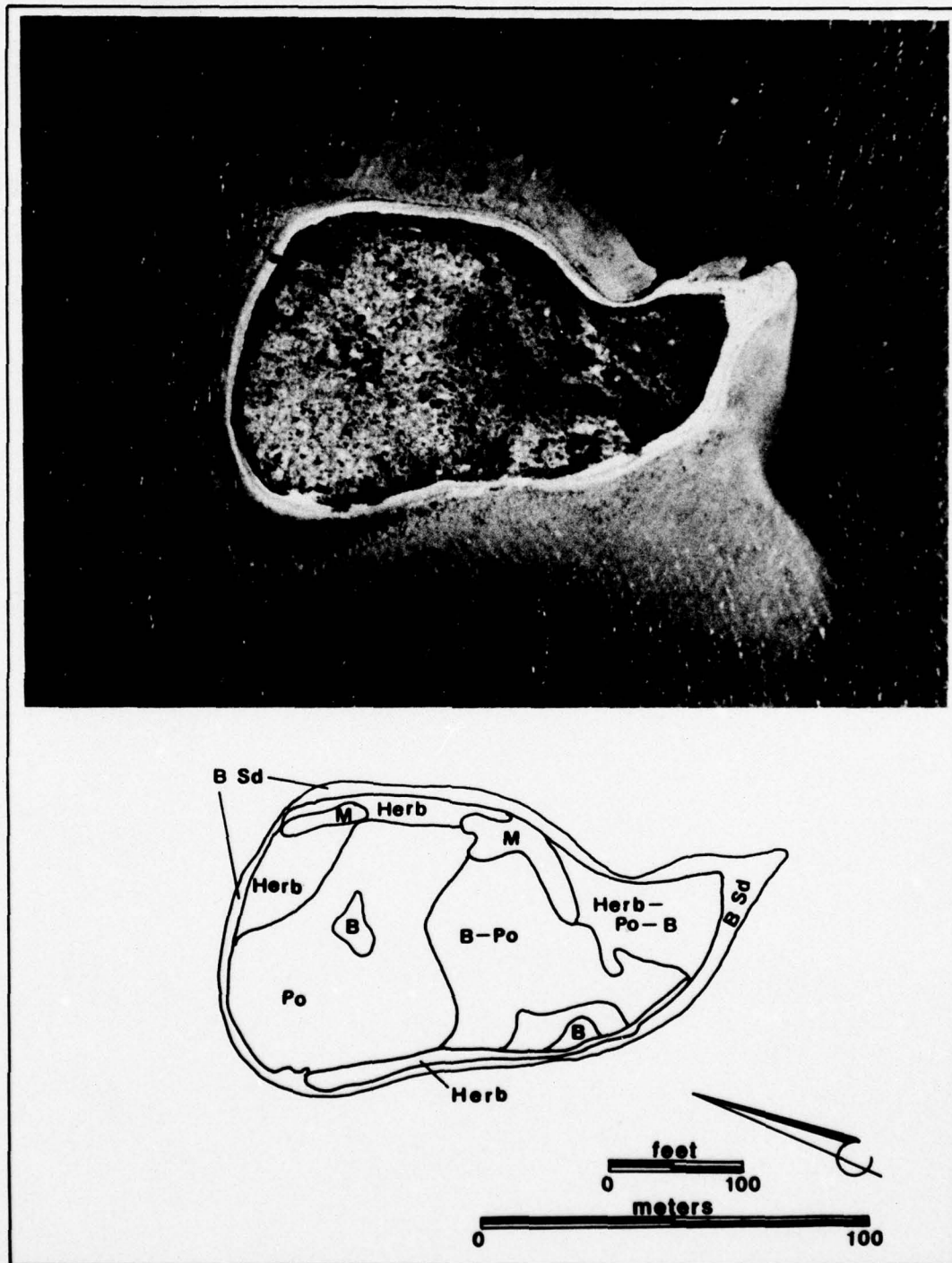


Figure 52. Vertical aerial photograph and vegetation map of dredged material island II-80.

Table 24
General Characteristics and Summary of Vegetation Data
For Dredged Material Island II-87

Study Area: II	Island Number: 87
Size: 1.4 ha	Age: 40 years
Date of Aerial Photograph: 22 January 1977	

<u>Plant Species</u>	<u>Communities</u>		
	herbaceous	shrub	tree
	<u>N=0</u>	<u>N=0</u>	<u>N=15</u> rel. freq. abund.
Baccharis halimifolia			3 U
Batis maritima			3 U
Borrchia frutescens			3 U
Casuarina equisetifolia			3 U
Conocarpus erecta			21 VA
Eupatorium serotinum			3 U
Ficus aurea			3 U
Laguncularia racemosa			21 VA
Myrica cerifera			3 U
Sabal palmetto			28 VA
Schinus terebinthifolius			7 A

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

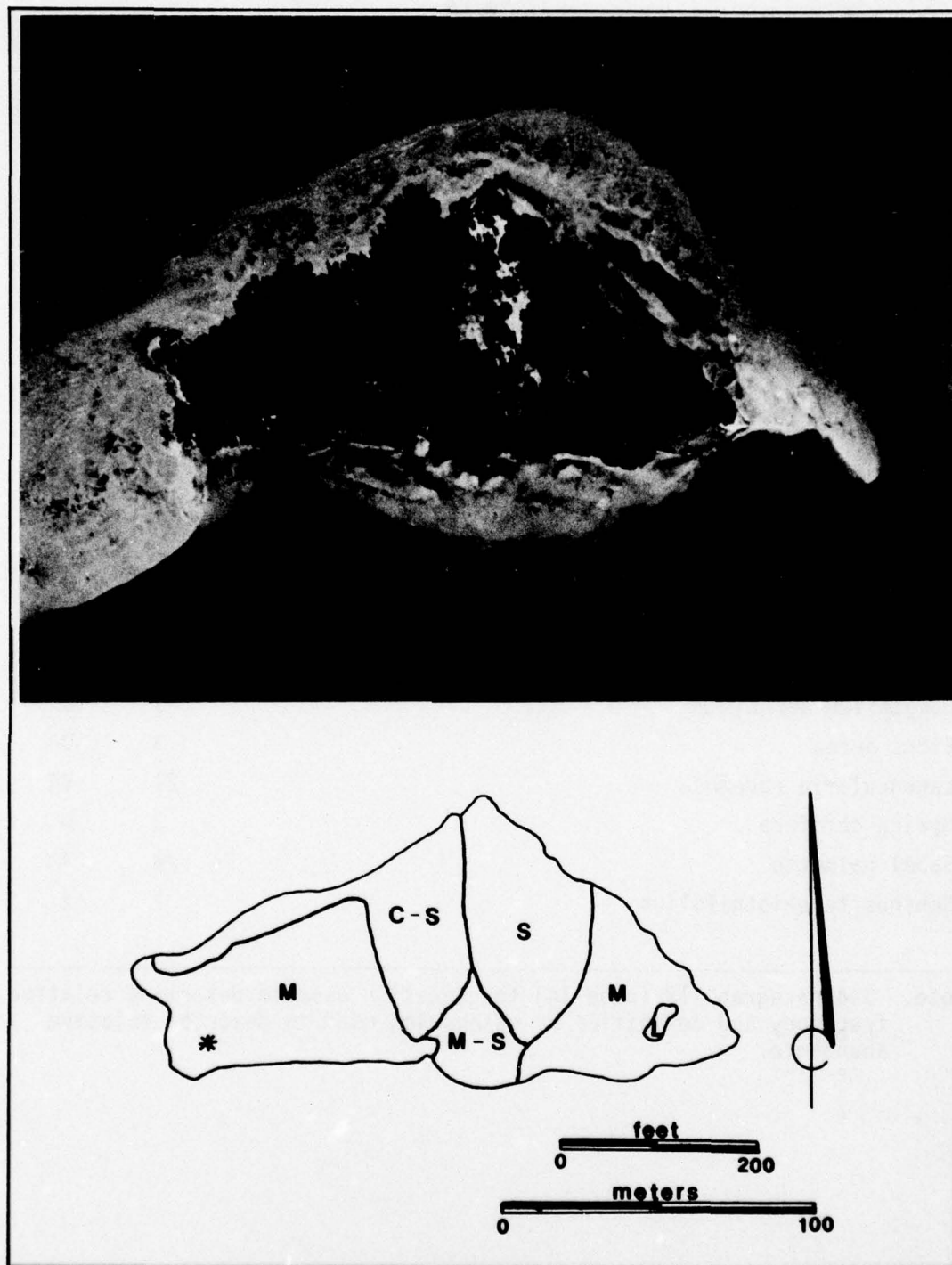


Figure 53. Vertical aerial photograph and vegetation map of dredged material island II-87.

Table 25
General Characteristics and Summary of Vegetation Data
For Dredged Material Island II-88

Study Area: II	Island Number: 88
Size: 2.4 ha	Age: 40 years
Date of Aerial Photograph: 22 January 1977	

<u>Plant Species</u>	<u>Communities</u>		
	herbaceous	shrub	tree
	N=0	N=0	N=15 rel. freq. abund.
Baccharis halimifolia			4 A
Batis maritima			4 A
Casuarina equisetifolia			11 VA
Cladium jamaicense			1 U
Cnidosculus stimulosus			1 U
Conocarpus erecta			6 VA
Erechtites hieracifolia			4 A
Eupatorium serotinum			7 VA
Ficus aurea			5 U
Heliotropium angiospermum			1 U
Hydrocotyle bonariensis			1 U
Iva frutescens			1 U
Juniperus silicicola			2 A
Kosteletzkya virginica			1 U
Laguncularia racemosa			6 VA
Melothria pendula			4 A
Myrica cerifera			2 A
Phytolacca americana			2 A
Rhizophora mangle			1 U
Sabal palmetto			13 VA
Salicornia bigelovii			1 U

(Continued)

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

Table 25 (Concluded)

<u>Plant Species</u>	<u>Communities</u>			
	herbaceous	shrub	tree	
	<u>N=0</u>	<u>N=0</u>	<u>rel. freq.</u>	<u>abun.</u>
Schinus terebinthifolius			6	VA
Senecio glabellus			4	A
Serenoa repens			1	U
Solanum americanum			1	U
Suaeda linearis			2	A
Trichostema suffrutescens			2	A
Zanthoxylum clava-herculis			4	A



Figure 54. Vertical aerial photograph of dredged material island II-88.

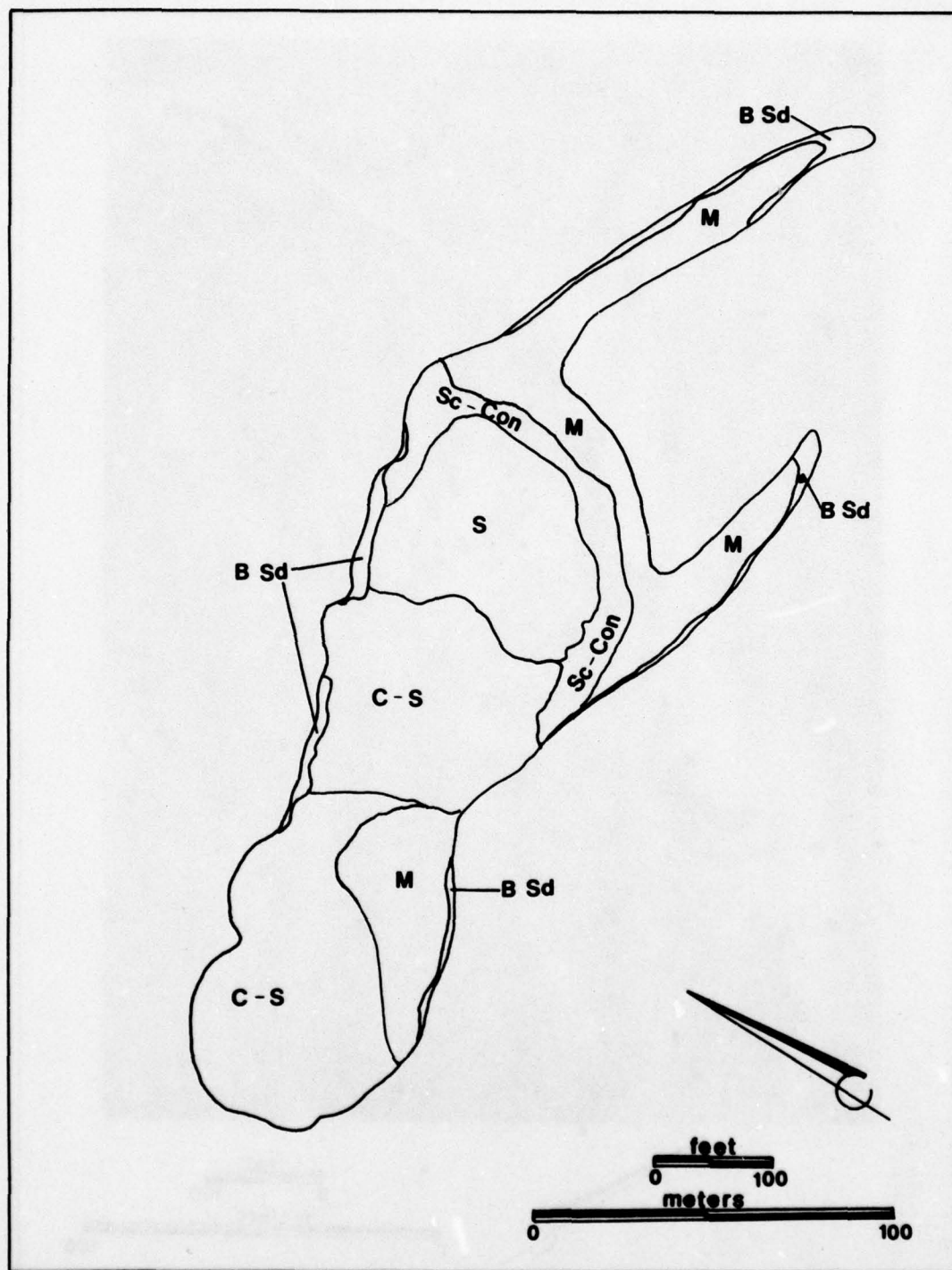


Figure 55. Vegetation map of dredged material island II-88.

Table 26
General Characteristics and Summary of Vegetation Data
For Dredged Material Island II-89

Study Area: II

Island Number: 89

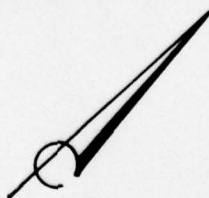
Size: 4.5 ha

Age: 14 years

Date of Aerial Photograph: 22 January 1977

<u>Plant Species</u>	<u>Communities</u>					tree N=0
	herbaceous N=14		shrub N=19			
	rel. freq.	abun.	rel. freq.	abun.		
Baccharis halimifolia	12	A	62	VA		
Batis maritima	24	VA				
Borrchia frutescens	20	VA				
Conocarpus erecta			3	U		
Heliotropium curassavicum	12	A	3	U		
Iva frutescens			3	U		
Juniperus silicicola			10	A		
Pluchea purpurascens			3	U		
Salicornia bigelovii	12	A				
Salicornia virginica	20	VA				
Schinus terebinthifolius			14	A		

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.



feet
0 200

meters
0 100

Figure 56. Vertical aerial photograph of dredged material island II-89.

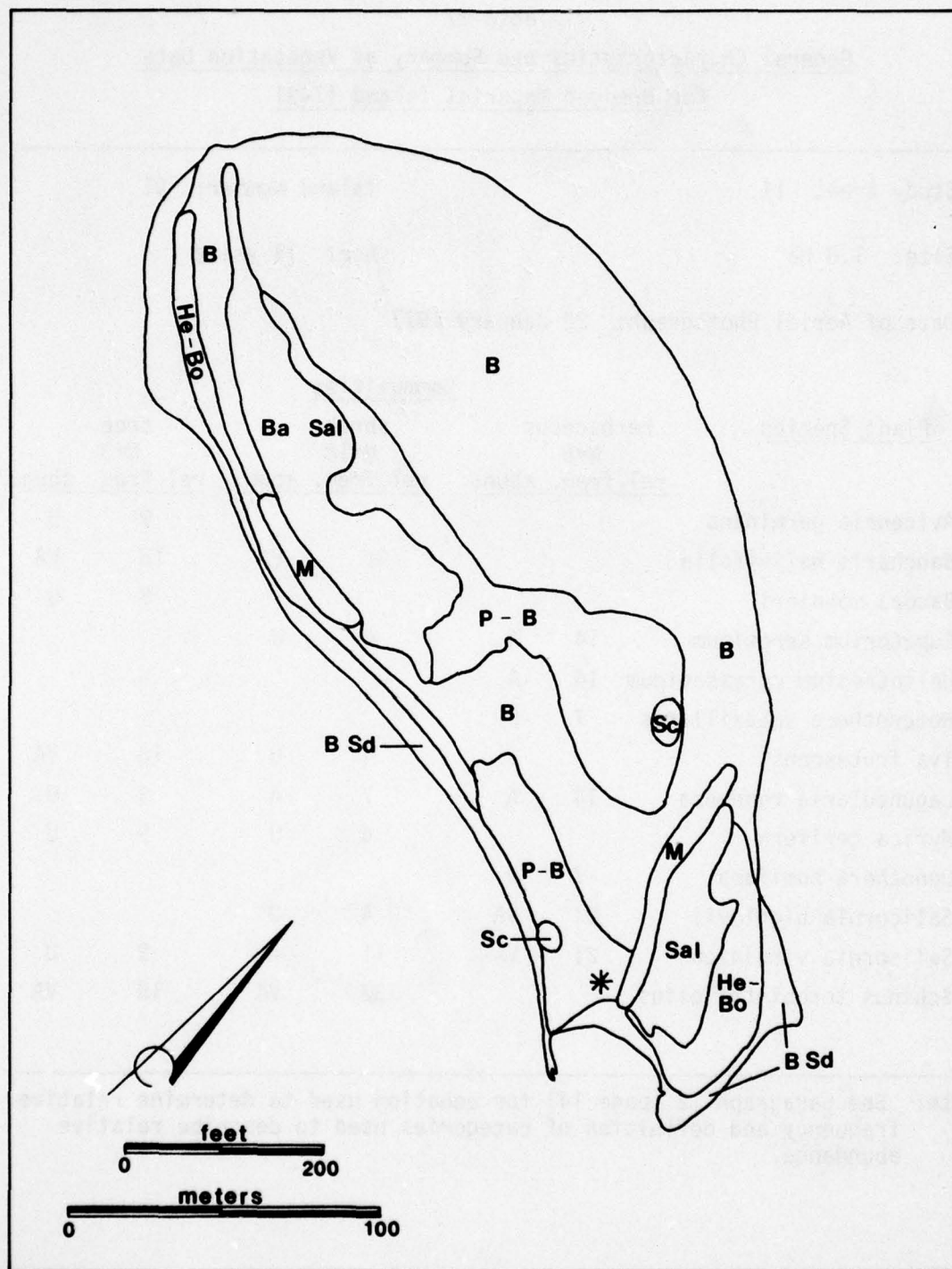


Figure 57. Vegetation map of dredged material island II-89.

Table 27
General Characteristics and Summary of Vegetation Data
For Dredged Material Island II-91

Study Area: II	Island Number: 91
Size: 1.8 ha	Age: 14 years
Date of Aerial Photograph: 22 January 1977	

<u>Plant Species</u>	<u>Communities</u>					
	herbaceous		shrub		tree	
	N=8		N=18		N=3	
	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>	<u>rel.freq.</u>	<u>abun.</u>
Avicennia germinans					9	U
Baccharis halimifolia			36	VA	18	VA
Bacopa monnieri					9	U
Eupatorium serotinum	14	A	4	U		
Heliotropium curassavicum	14	A				
Heterotheca subaxillaris	7	U				
Iva frutescens			4	U	18	VA
Laguncularia racemosa	14	A	7	A	9	U
Myrica cerifera			4	U	9	U
Oenothera humifusa	7	U				
Salicornia bigelovii	21	VA	4	U		
Salicornia virginica	21	VA	11	A	9	U
Schinus terebinthifolius			32	VA	18	VA

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

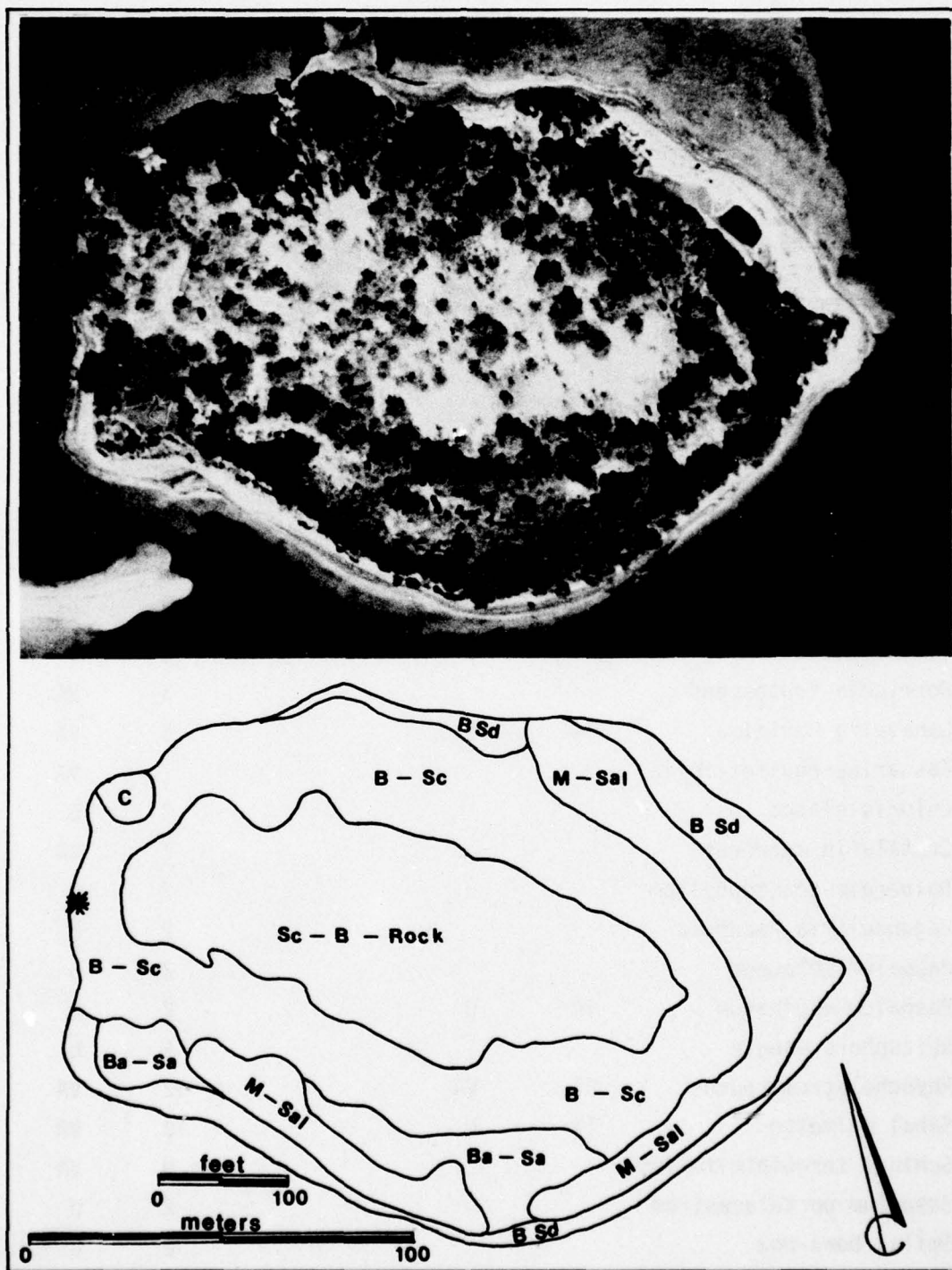


Figure 58. Vertical aerial photograph and vegetation map of dredged material island II-91.

Table 28
General Characteristics and Summary of Vegetation Data
For Dredged Material Island II-97

Study Area: II	Island Number: 97				
Size: 0.9 ha	Age: 14 years				
Date of Aerial Photograph: 22 January 1977					
	<u>Communities</u>				
<u>Plant Species</u>	herbaceous N=4		shrub N=0	tree N=6	
	<u>rel. freq.</u>	<u>abun.</u>	<u>N=0</u>	<u>rel. freq.</u>	<u>abun.</u>
Ambrosia artemisiifolia				7	VA
Andropogon glomeratus				5	VA
Andropogon virginicus				5	VA
Baccharis halimifolia				5	VA
Bidens pilosa				2	U
Borrichia frutescens				5	VA
Canavalia maritima	14	U		5	VA
Casuarina equisetifolia				7	VA
Chloris glauca				2	U
Crotalaria mucronata				7	VA
Dalbergia ecastophyllum				2	U
Laguncularia racemosa				2	U
Paspalum setaceum				2	U
Paspalum vaginatum	14	U		2	U
Rhizophora mangle				2	U
Rhynchelytrum repens	57	VA		12	VA
Sabal palmetto	14	U		12	VA
Schinus terebinthifolius				9	VA
Sesuvium portulacastrum				2	U
Smilax bona-nox				2	U
Vigna luteola				2	U

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

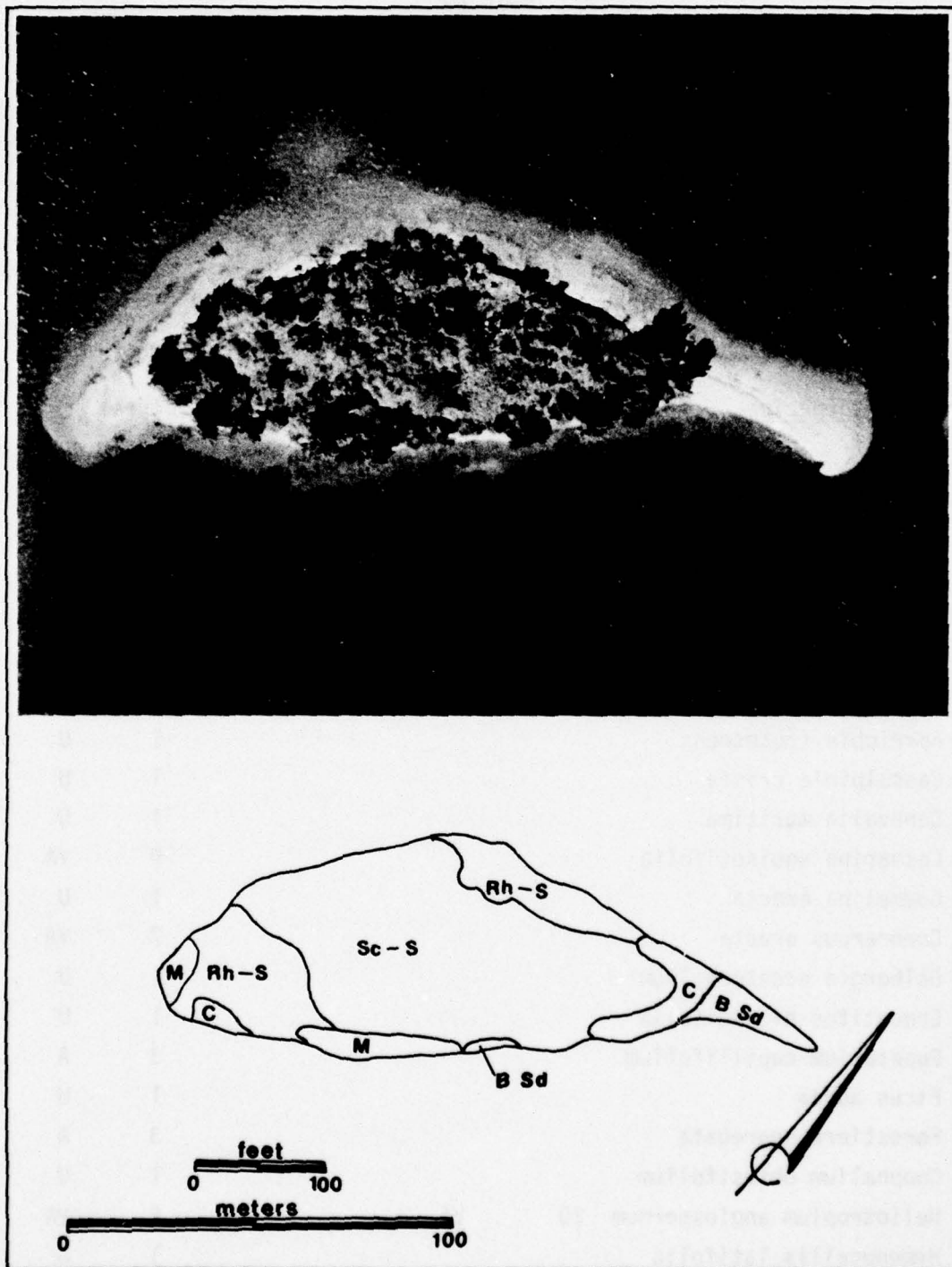


Figure 59. Vertical aerial photograph and vegetation map of dredged material island II-97.

Study Area: II Island Number: 98
Size: 1.6 ha Age: 14 years
Date of Aerial Photograph: 22 January 1977

Plant Species	Communities					
	herbaceous N=6		shrub N=0		tree N=14	
	rel.	freq. abund.	rel.	freq. abund.	rel.	freq. abund.
Abrus precatorious					1	U
Ambrosia artemisiifolia					1	U
Amorpha herbacea					3	A
Andropogon virginicus					1	U
Avicennia germinans					4	A
Bidens pilosa	50	VA			7	VA
Borrchia frutescens					1	U
Caesalpinia crista					1	U
Canavalia maritima					1	U
Casuarina equisetifolia					9	VA
Commelina erecta					1	U
Conocarpus erecta					7	VA
Dalbergia ecastophyllum					1	U
Erechtites hieracifolia					1	U
Eupatorium capillifolium					3	A
Ficus aurea					1	U
Forestiera segregata					3	A
Gnaphalium obtusifolium					1	U
Heliotropium angiospermum	20	VA			8	VA
Hymenocallis latifolia					1	U

(Continued)

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

Table 29 (Concluded)

<u>Plant Species</u>	<u>Communities</u>					
	herbaceous		shrub	tree		
	<u>rel. freq.</u>	<u>abun.</u>	<u>N=0</u>	<u>rel. freq.</u>	<u>abun.</u>	
<i>Ipomoea alba</i>				1	U	
<i>Iva frutescens</i>				1	U	
<i>Laguncularia racemosa</i>				3	A	
<i>Myrcianthes fragrans</i>				1	U	
<i>Oxalis stricta</i>				1	U	
<i>Parthenocissus quinquefolia</i>				1	U	
<i>Passiflora lutea</i>	10	A		1	U	
<i>Poinsettia heterophylla</i>				1	U	
<i>Psidium guajava</i>				1	U	
<i>Rhizophora mangle</i>				1	U	
<i>Sabal palmetto</i>				7	VA	
<i>Schinus terebinthifolius</i>	10	A		15	VA	
<i>Senecio glabellus</i>				1	U	
<i>Sida rhombifolia</i>	10	A				
<i>Solanum americanum</i>				3	A	
<i>Sophora tomentosa</i>				1	U	

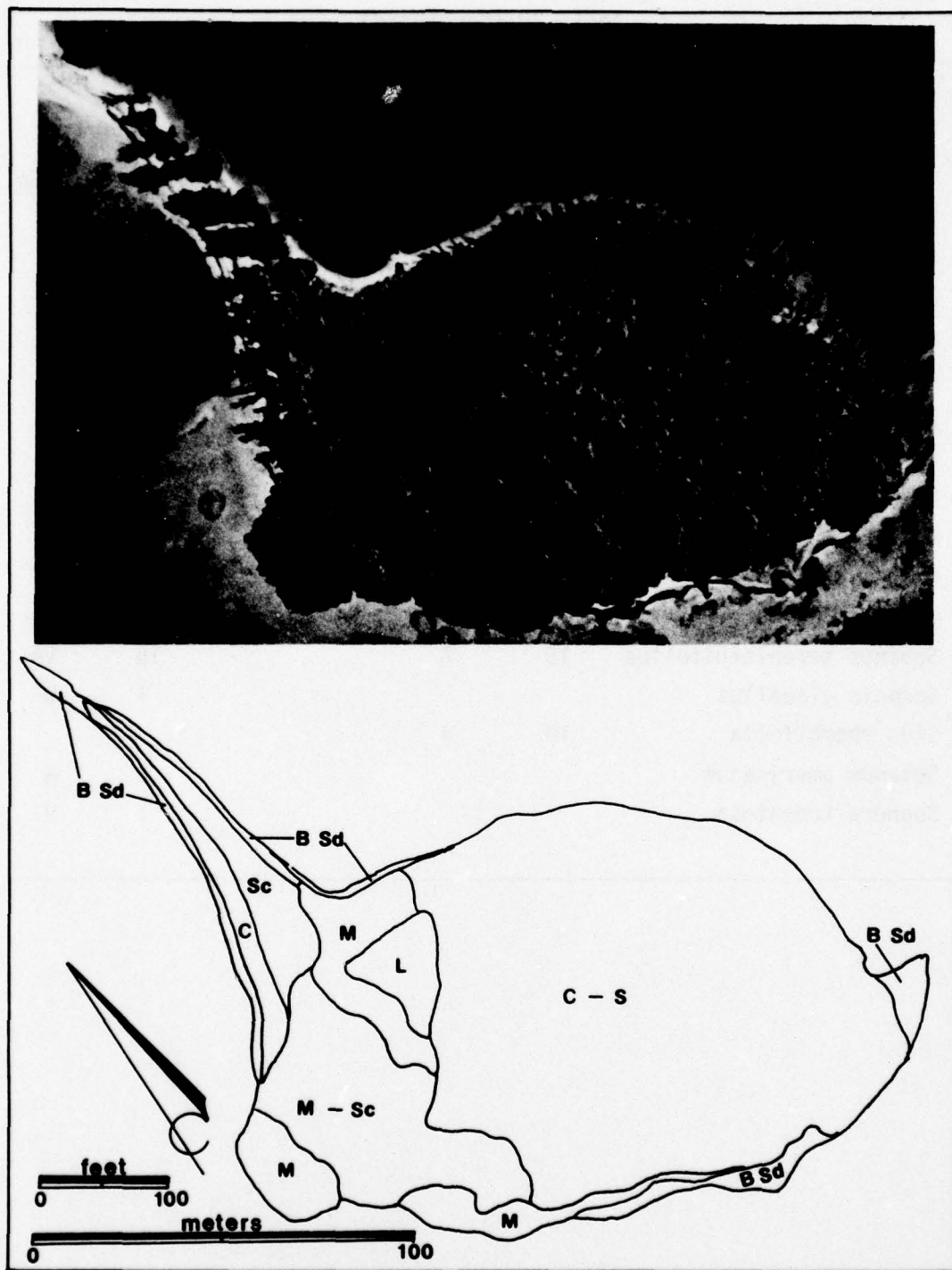


Figure 60. Vertical aerial photograph and vegetation map of dredged material island II-98.

Table 30
General Characteristics and Summary of Vegetation Data
For Dredged Material Island II-125

Study Area: II

Island Number: 125

Size: 1.3 ha

Age: 20 years

Date of Aerial Photograph: 22 January 1977

<u>Plant Species</u>	<u>Communities</u>					
	<u>herbaceous</u>		<u>shrub</u>		<u>tree</u>	
	N=6		N=0		N=4	
	<u>rel. freq.</u>	<u>abun.</u>			<u>rel. freq.</u>	<u>abun.</u>
Avicennia germinans					4	U
Bidens pilosa					13	VA
Casuarina equisetifolia					13	VA
Chloris petraea	14	U				
Dalbergia ecastophyllum					8	VA
Forestiera segregata					4	U
Iva imbricata					4	U
Laguncularia racemosa					4	U
Limonium carolinianum	14	U				
Momordica charantia					4	U
Paspalum vaginatum	44	VA			8	VA
Philoxerus vermicularis	14	U			4	U
Phytolacca americana					4	U
Rhizophora mangle					4	U
Sabal palmetto					8	VA
Schinus terebinthifolius					13	VA
Sonchus oleraceus					4	U
Suaeda linearis	14	U				

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

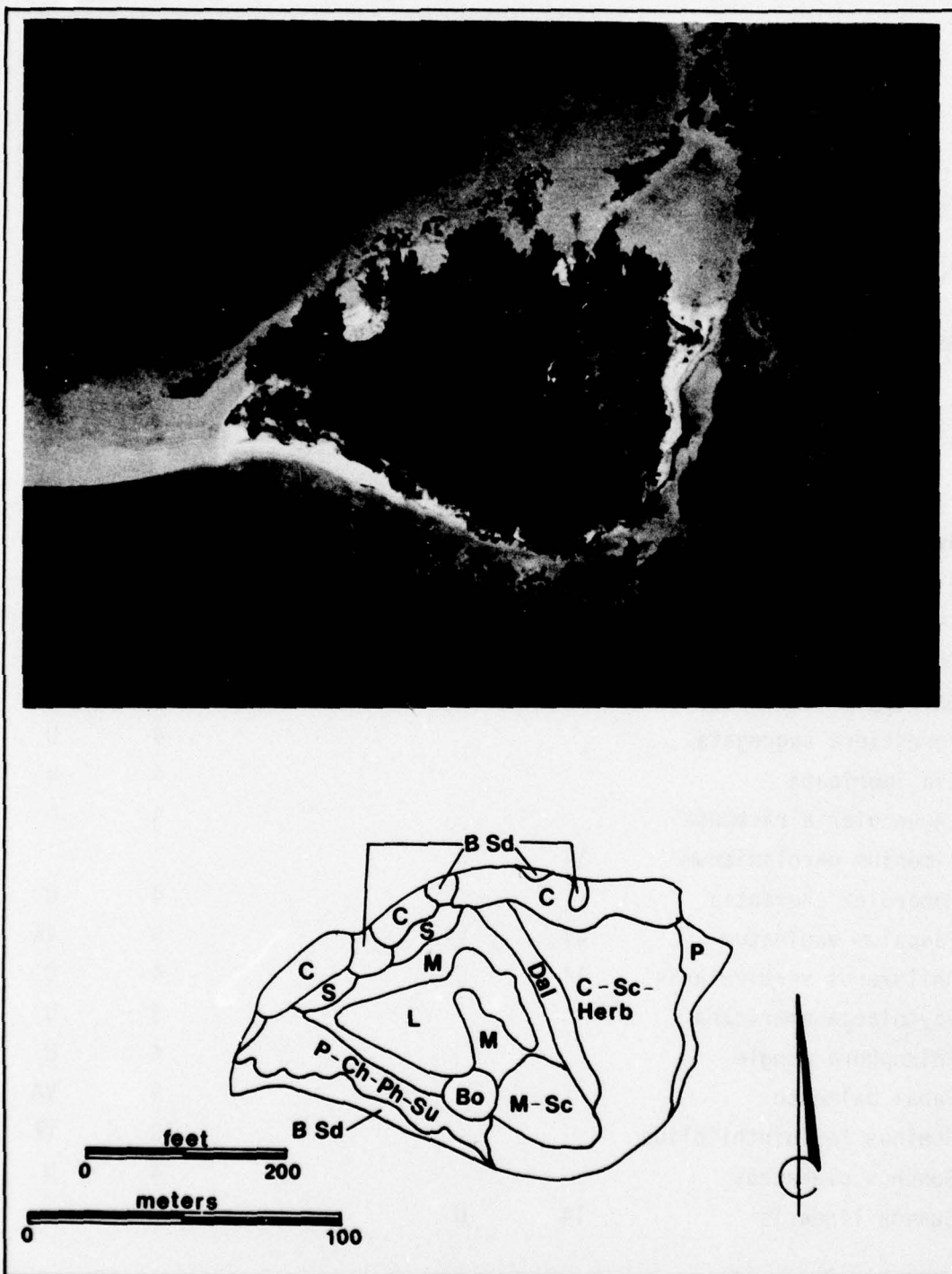


Figure 61. Vertical aerial photograph and vegetation map of dredged material island II-125.

Table 31
General Characteristics and Summary of Vegetation Data
For Dredged Material Island II-128

Study Area: II

Island Number: 128

Size: 1.4 ha

Age: 20 years

Date of Aerial Photograph: 22 January 1977

<u>Plant Species</u>	<u>Communities</u>					
	herbaceous		shrub		tree	
	N=8		N=0		N=3	
	rel.	freq. abund.			rel.	freq. abund.
Avicennia germinans	10	U				
Baccharis halimifolia					6	U
Borrchia frutescens					6	U
Casuarina equisetifolia	10	U			6	U
Cenchrus tribuloides					6	U
Chloris glauca					6	U
Dalbergia ecastophyllum					6	U
Forestiera segregata					6	U
Ipomoea pes-caprae	20	A			6	U
Oenothera humifusa	10	U				
Paspalum vaginatum	29	VA				
Philoxerus vermicularis	20	A			6	U
Rhizophora mangle					6	U
Rhynchelytrum repens					6	U
Sabal palmetto					6	U
Schinus terebinthifolius					22	VA
Sesuvium portulacastrum					6	U

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

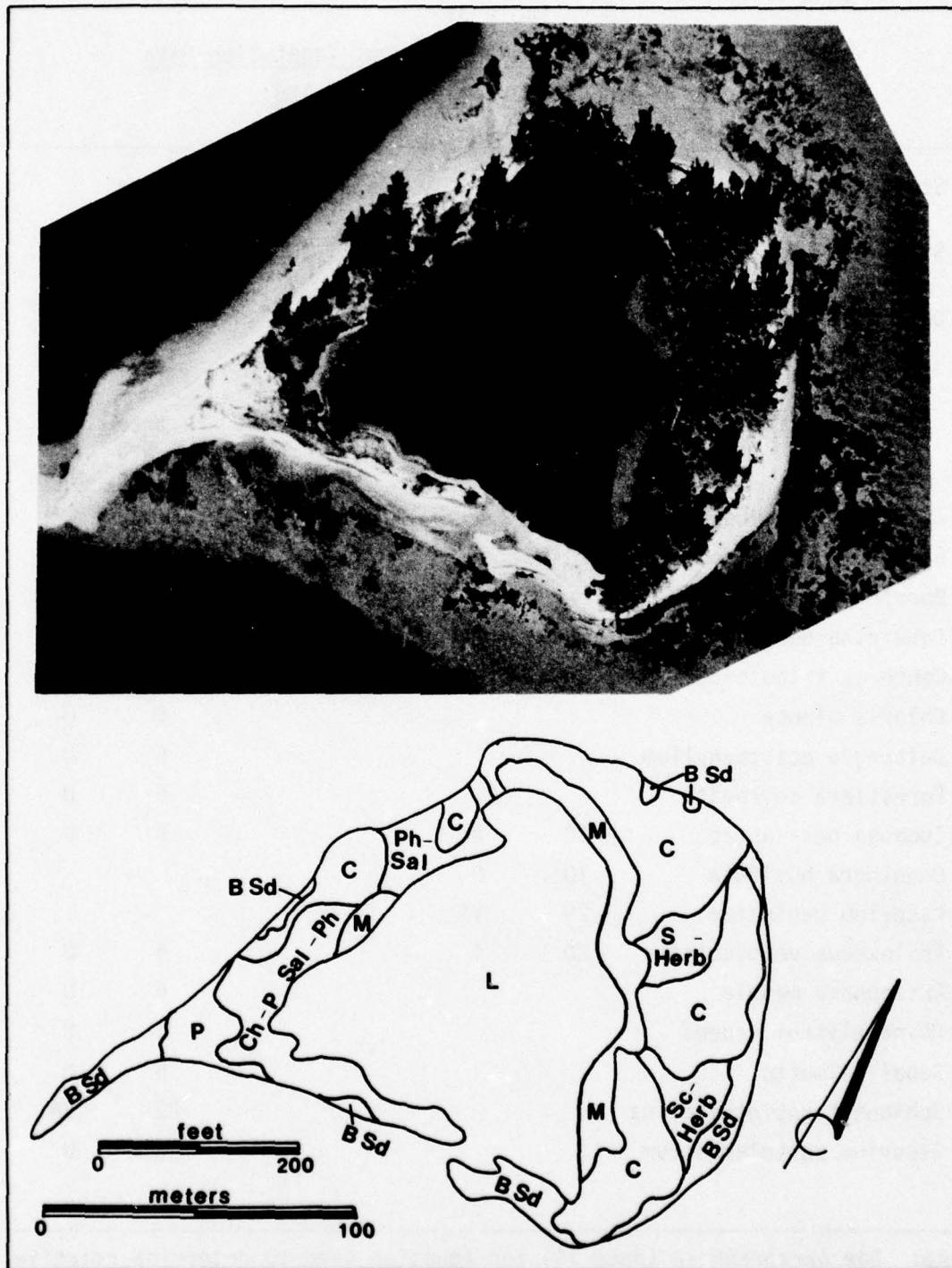


Figure 62. Vertical aerial photograph and vegetation map of dredged material island II-128.

Table 32
General Characteristics and Summary of Vegetation Data
For Dredged Material Island II-129

Study Area: II

Island Number: 129

Size: 1.2 ha

Age: 3 years

Date of Aerial Photograph: 22 January 1977

<u>Plant Species</u>	<u>Communities</u>			
	herbaceous		shrub	tree
	rel. freq.	abun.	N=0	N=0
<i>Atriplex arenaria</i>	3	U		
<i>Casuarina equisetifolia</i>	3	U		
<i>Cenchrus tribuloides</i>	15	A		
<i>Conyza canadensis</i>	3	U		
<i>Eupatorium capillifolium</i>	3	U		
<i>Ipomoea pes-caprae</i>	3	U		
<i>Iva imbricata</i>	9	A		
<i>Paspalum vaginatum</i>	32	VA		
<i>Sonchus oleraceus</i>	3	U		

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

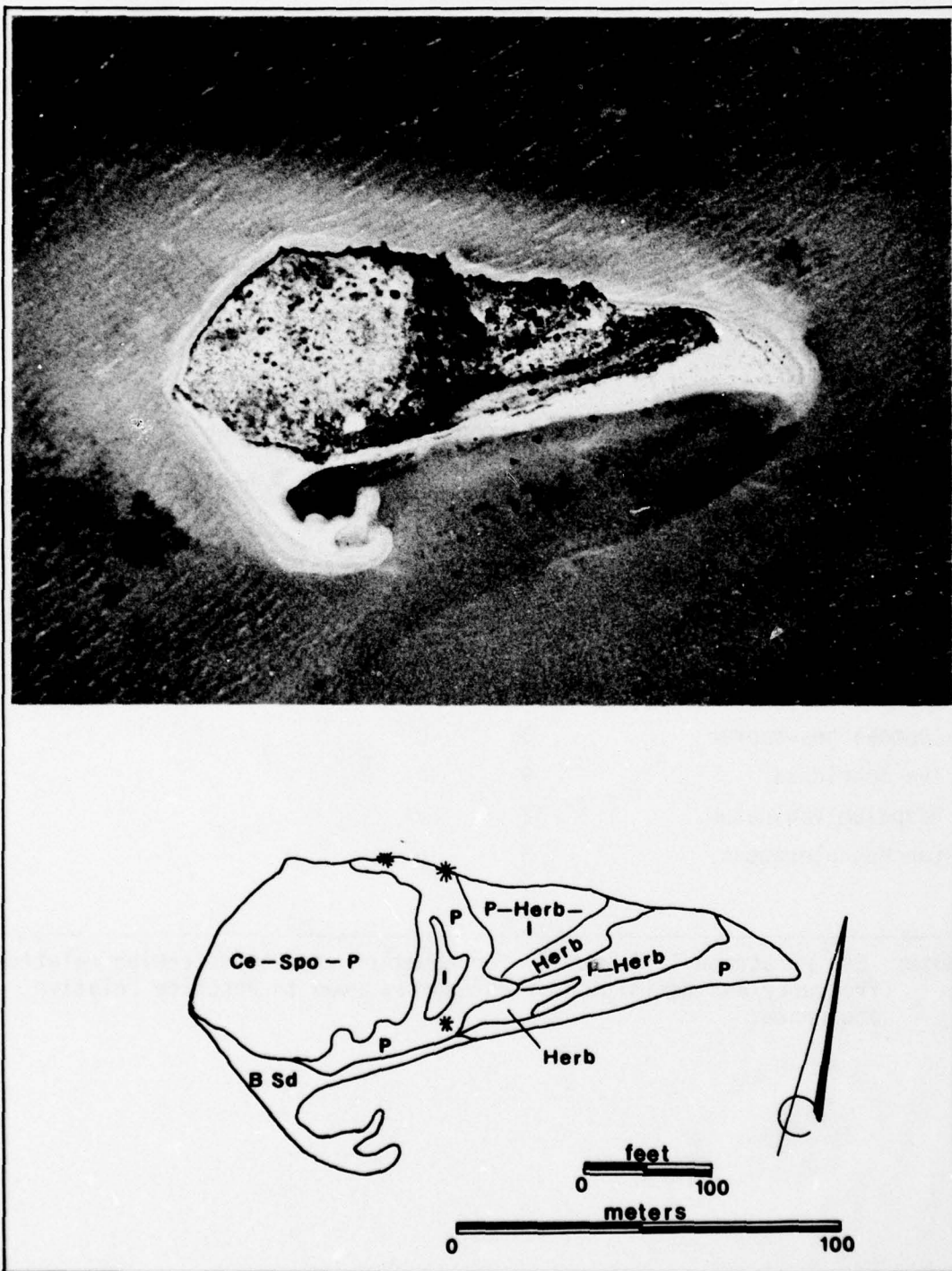


Figure 63. Vertical aerial photograph and vegetation map of dredged material island II-129.

Table 33
General Characteristics and Summary of Vegetation Data
For Dredged Material Island II-152

Study Area: II	Island Number: 152
Size: 0.5 ha	Age: 20 years
Date of Aerial Photograph: 22 January 1977	

<u>Plant Species</u>	No Transects
Avicennia germinans	
Casuarina equisetifolia	
Laguncularia racemosa	
Rhizophora mangle	
Sabal palmetto	
Schinus terebinthifolius	
Suaeda linearis	

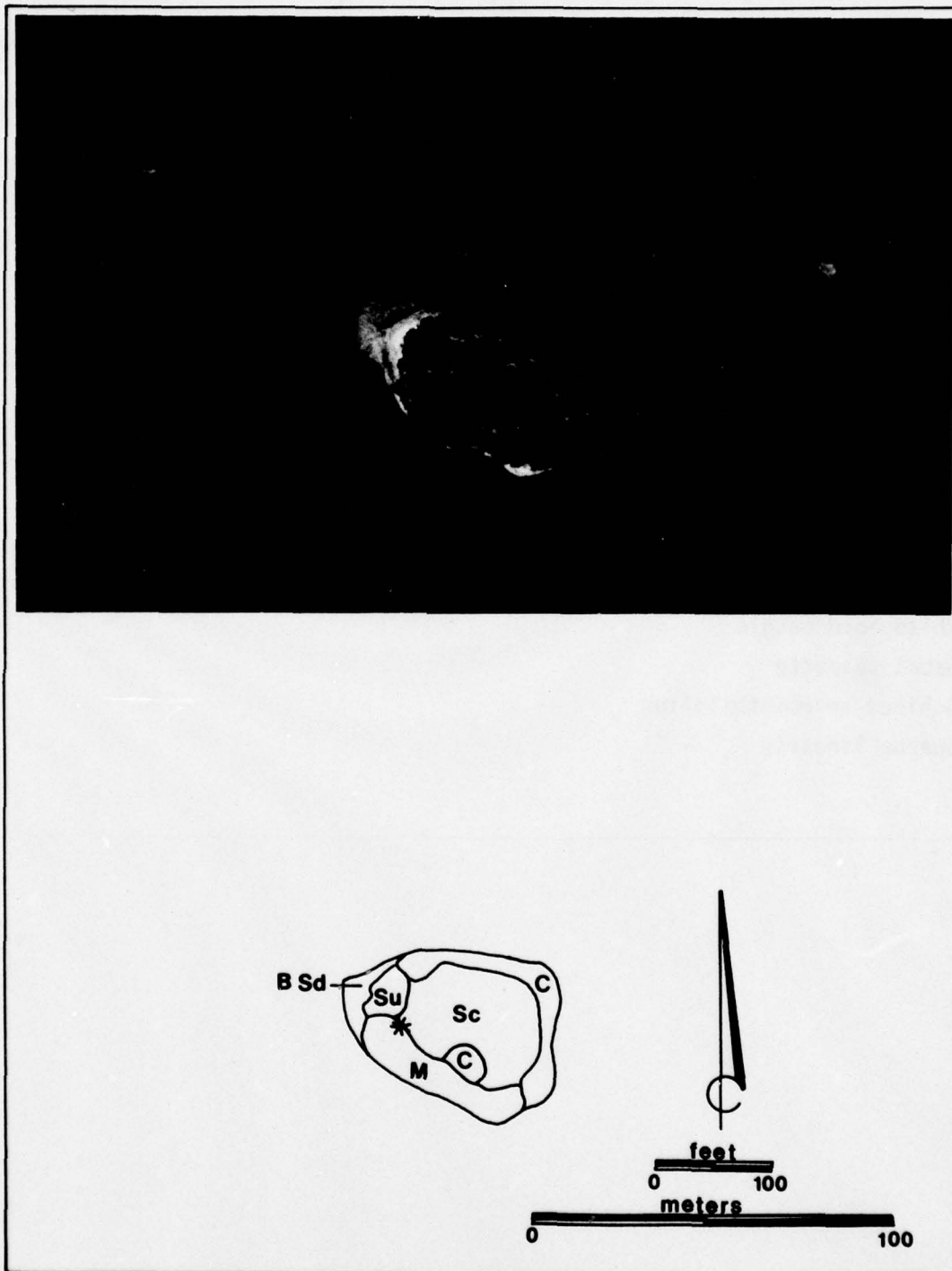


Figure 64. Vertical aerial photograph and vegetation map of dredged material island II-152.

Table 34
General Characteristics and Summary of Vegetation Data
For Dredged Material Island II-153

Study Area: II	Island Number: 153
Size: 0.6 ha	Age: 20 years
Date of Aerial Photograph: 22 January 1977	

<u>Plant Species</u>	No transects
Avicennia germinans	
Casuarina equisetifolia	
Laguncularia racemosa	
Rhizophora mangle	
Sabal palmetto	
Schinus terebinthifolius	
Suaeda linearis	

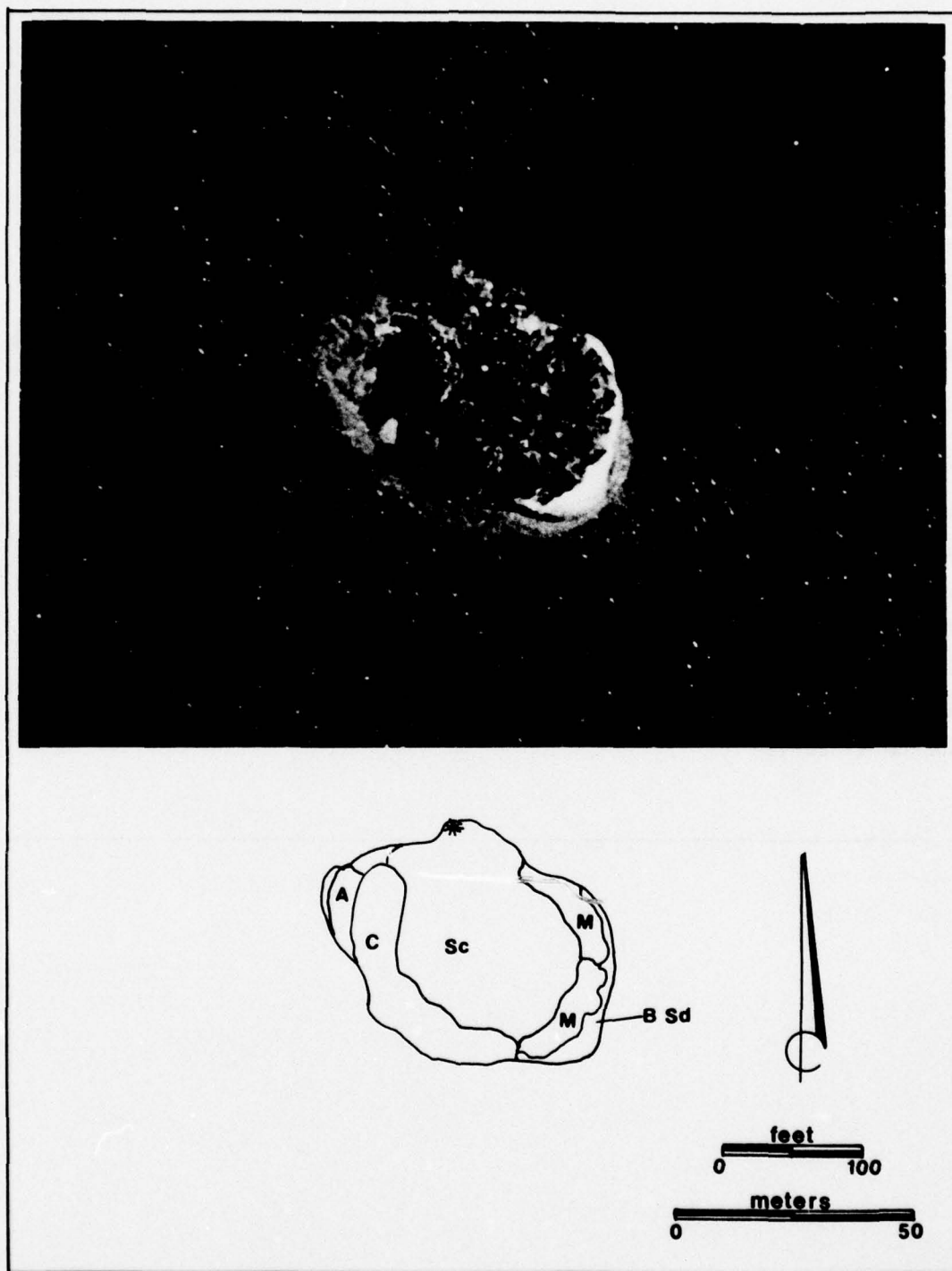


Figure 65. Vertical aerial photograph and vegetation map of dredged material island II-153.

Table 35
General Characteristics and Summary of Vegetation Data
For Dredged Material Island III-7

Study Area: III

Island Number: 7

Size: 0.3 ha

Age: 12 years

Date of Aerial Photograph: 26 March 1977

<u>Plant Species</u>	<u>Communities</u>			
	herbaceous		shrub	tree
	N=21		N=0	N=0
	<u>rel. freq.</u>	<u>abun.</u>		
<i>Andropogon virginicus</i>	9	A		
<i>Baccharis halimifolia</i>	3	U		
<i>Canavalia rosea</i>	3	U		
<i>Chloris glauca</i>	3	U		
<i>Eupatorium capillifolium</i>	6	I		
<i>Heterotheca subaxillaris</i>	37	VA		
<i>Oenothera humifusa</i>	17	A		
<i>Paspalum vaginatum</i>	9	A		
<i>Solanum americanum</i>	3	U		
<i>Sonchus oleraceus</i>	3	U		

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

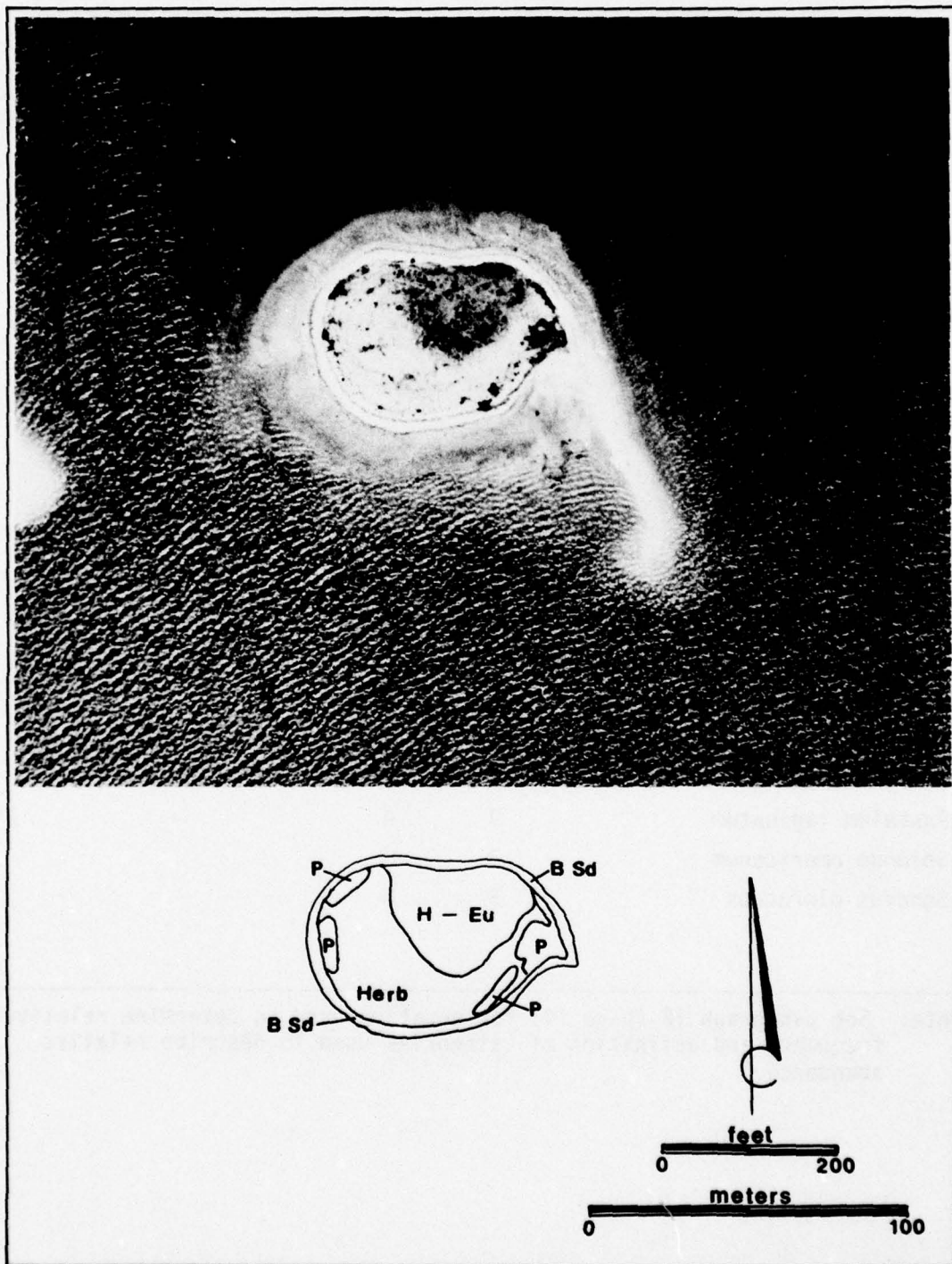


Figure 66. Vertical aerial photograph and vegetation map of dredged material island III-7.

Table 36
General Characteristics and Summary of Vegetation Data
For Dredged Material Island III-8

Study Area: III

Island Number: 8

Size: 2.5 ha

Age: 12 years

Date of Aerial Photograph: 26 March 1977

<u>Plant Species</u>	<u>Communities</u>			
	herbaceous		shrub	tree
	rel. freq.	abun.	N=0	N=0
Andropogon virginicus	14	A		
Baccharis halimifolia	12	A		
Chloris glauca	22	VA		
Eupatorium capillifolium	5	I		
Flaveria floridana	2	I		
Heterotheca subaxillaris	6	I		
Ipomoea sagittata	1	U		
Lippia nodiflora	1	U		
Oenothera humifusa	1	U		
Paspalum vaginatum	9	A		
Salicornia virginica	4	I		
Scirpus robusta	3	I		
Sesuvium portulacastrum	8	A		
Sonchus oleraceus	3	I		
Sporobolus virginicus	9	A		
Suaeda linearis	1	U		

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

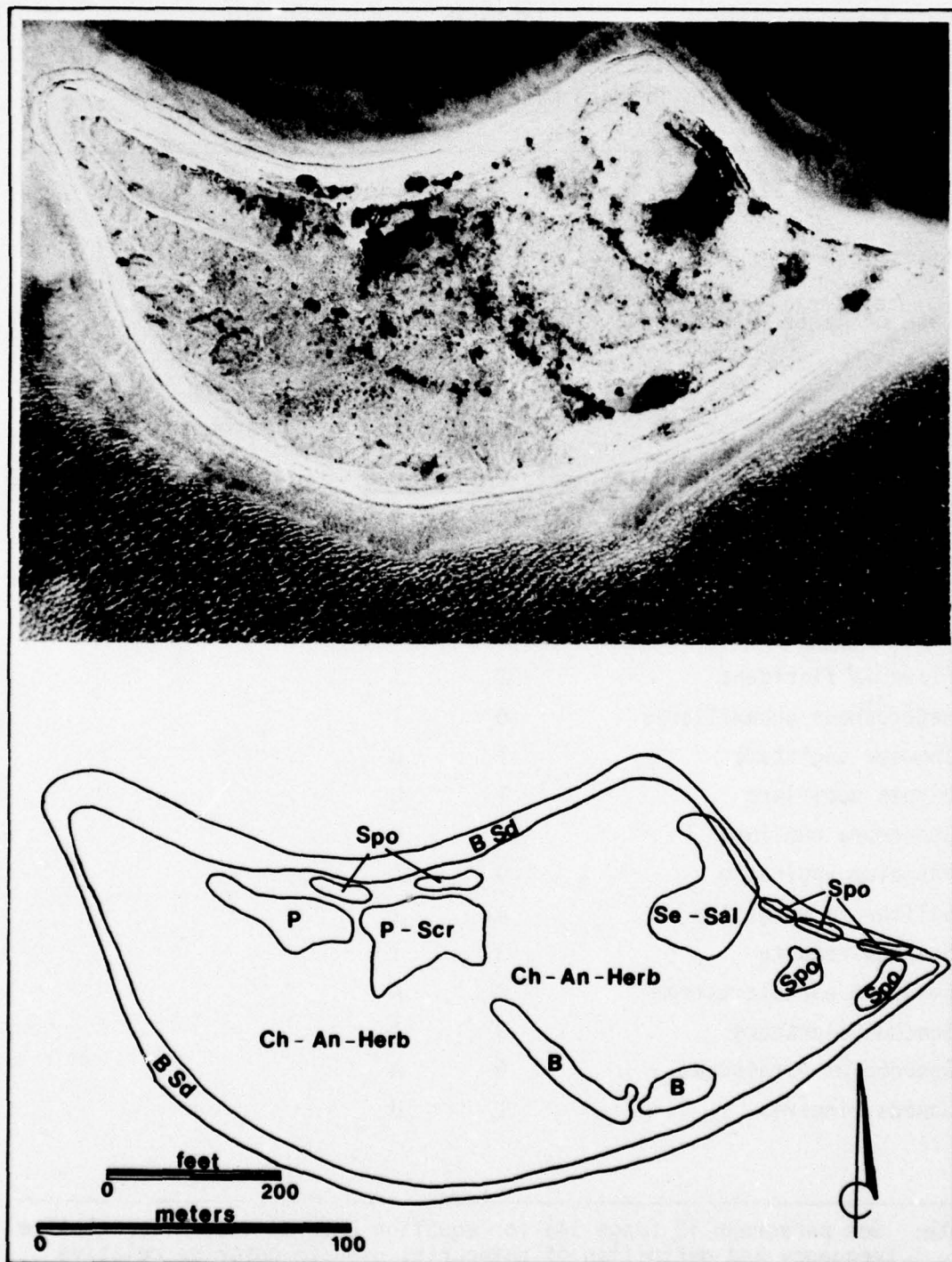


Figure 67. Vertical aerial photograph and vegetation map of dredged material island III-8.

Table 37
General Characteristics and Summary of Vegetation Data
For Dredged Material Island III-12

Study Area: III

Island Number: 12

Size: 0.1 ha

Age: 12 years

Date of Aerial Photograph: 26 March 1977

<u>Plant Species</u>	<u>Communities</u>			
	herbaceous N=17		shrub	tree
	<u>rel. freq.</u>	<u>abun.</u>	<u>N=0</u>	<u>N=0</u>
Baccharis halimifolia	4	U		
Boerhavia coccinea	12	A		
Chloris glauca	24	VA		
Erechtites hieracifolia	4	U		
Eupatorium capillifolium	12	A		
Sesuvium portulacastrum	4	U		
Sonchus oleraceus	12	A		
Sporobolus domingensis	28	VA		

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

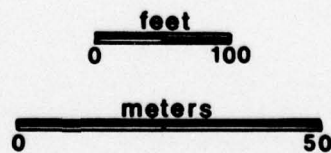
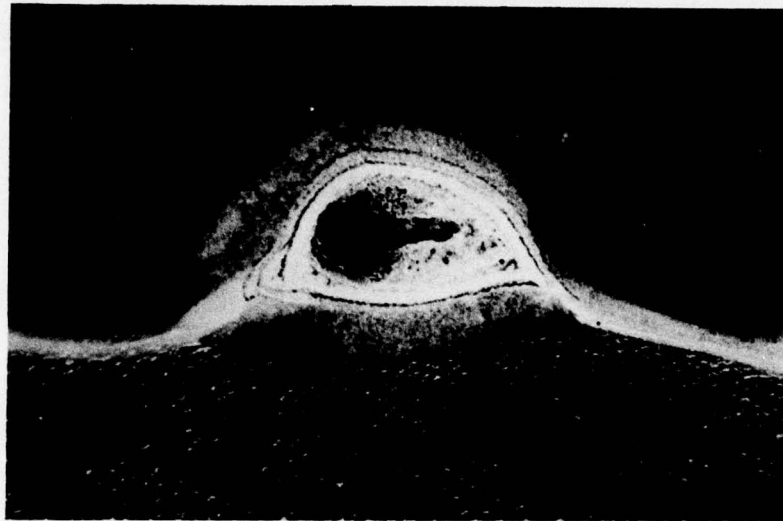


Figure 68. Vertical aerial photograph and vegetation map of dredged material island III-12.

Table 38
General Characteristics and Summary of Vegetation Data
For Dredged Material Island III-13

Study Area: III

Island Number: 13

Size: 0.2 ha

Age: 12 years

Date of Aerial Photograph: 26 March 1977

<u>Plant Species</u>	<u>Communities</u>				
	herbaceous N=4		shrub N=5		tree
	<u>rel. freq.</u>	<u>abun.</u>	<u>rel. freq.</u>	<u>abun.</u>	<u>N=0</u>
Baccharis halimifolia			21	VA	
Boerhavia coccinea	25	A	29	VA	
Eupatorium capillifolium			7	U	
Ipomoea trilobata			7	U	
Lepidium virginicum			7	U	
Sesuvium portulacastrum	75	VA			
Solanum americanum			7	U	
Sporobolus domingensis			7	U	
Stenotaphrum secundatum			14	VA	

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

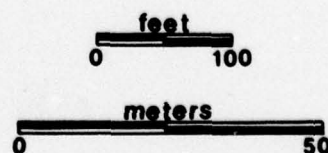
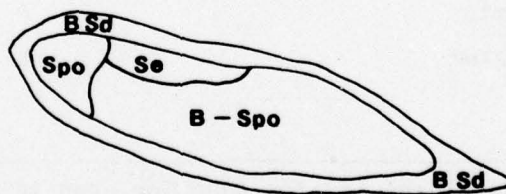


Figure 69. Vertical aerial photograph and vegetation map of dredged material island III-13.

Table 39
General Characteristics and Summary of Vegetation Data
For Dredged Material Island IV-1

Study Area: IV	Island Number: 1
Size: 1.0 ha	Age: 4 years
Date of Aerial Photograph: 27 March 1977	

<u>Plant Species</u>	<u>Communities</u>			
	herbaceous		shrub	tree
	rel. freq.	abun.	N=0	N=0
Atriplex arenaria	7	I		
Avicennia germinans	2	U		
Baccharis halimifolia	2	U		
Casuarina equisetifolia	2	U		
Chloris glauca	35	VA		
Heterotheca subaxillaris	24	VA		
Lepidium virginicum	2	U		
Paspalum vaginatum	2	U		
Portulaca pilosa	2	U		
Rhynchelytrum repens	15	A		
Sesuvium portulacastrum	2	U		
Sporobolus domingensis	4	I		

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

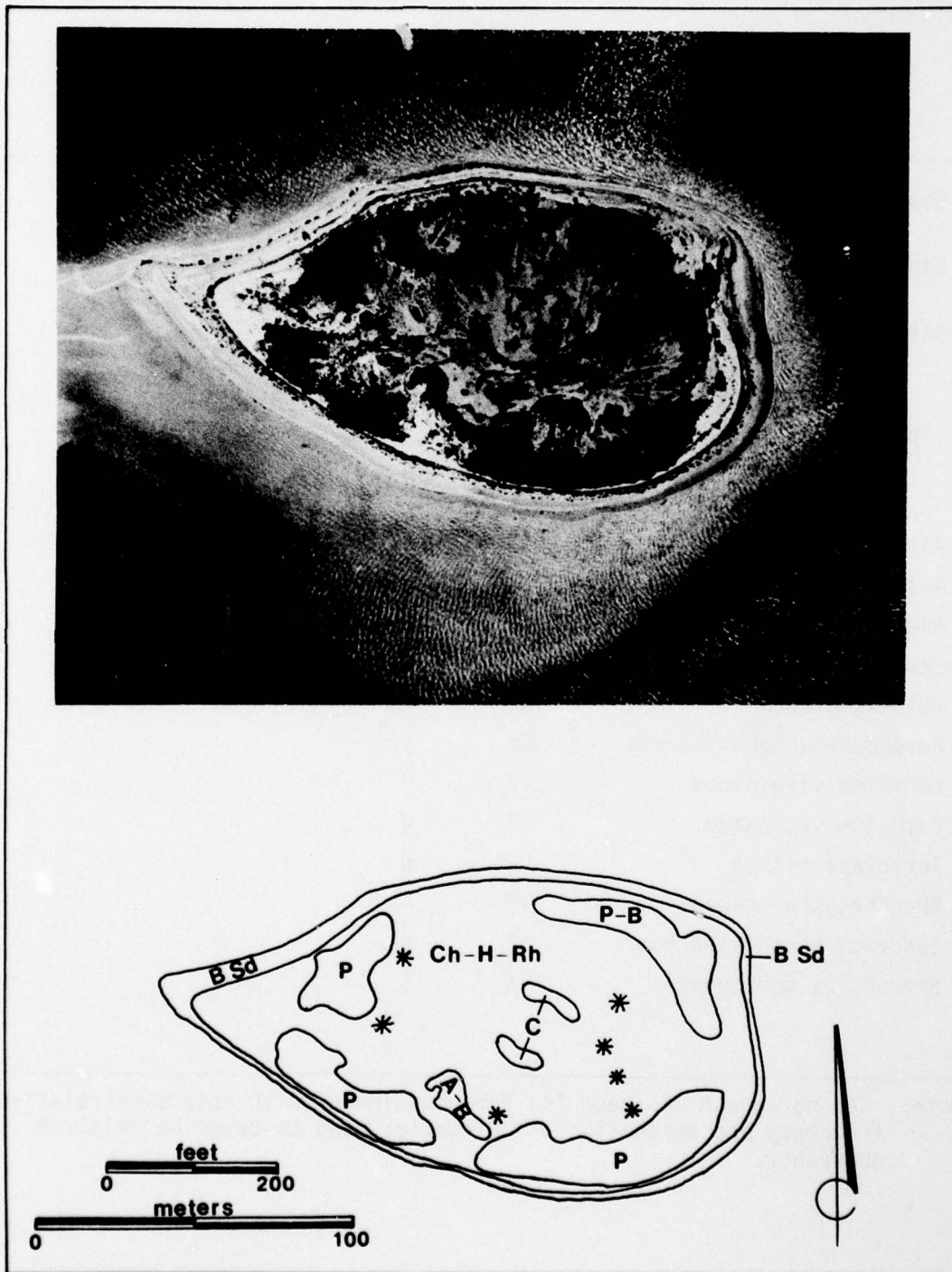


Figure 70. Vertical aerial photograph and vegetation map of dredged material island IV-1.

Table 40
General Characteristics and Summary of Vegetation Data
For Dredged Material Island V-1

Study Area: V	Island Number: 1			
Size: 1.0 ha	Age: 40 years			
Date of Aerial Photograph: 29 March 1977				
<u>Plant Species</u>	<u>Communities</u>			
	herbaceous	shrub	tree	
	<u>N=0</u>	<u>N=0</u>	<u>N=11</u>	
			rel. freq.	abun.
Bidens pilosa			5	A
Casuarina equisetifolia			12	VA
Cyperus ligularis			2	U
Dioscorea bulbifera			2	U
Ficus aurea			2	U
Ipomoea alba			5	U
Kalanchoe pinnata			19	VA
Laguncularia racemosa			5	A
Lantana camara			5	A
Parthenocissus quinquefolia			2	U
Poinsettia heterophylla			7	A
Rhizophora mangle			2	U
Rivina humilis			2	U
Sabal palmetto			7	A
Schinus terebinthifolius			17	VA
Solanum americanum			2	U
Terminalia catappa			2	U

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

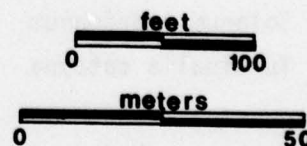


Figure 71. Vertical aerial photograph of dredged material island V-1.

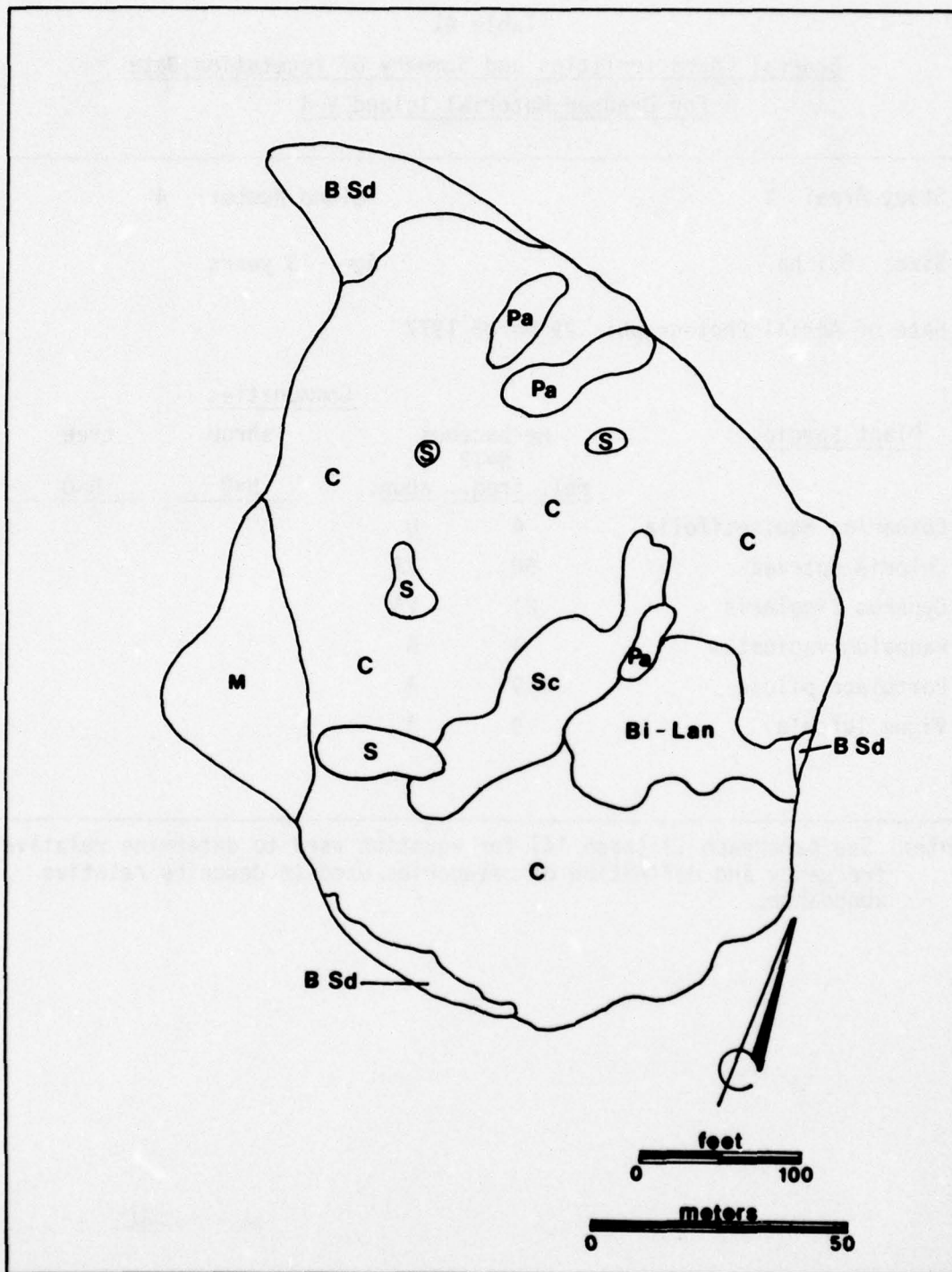


Figure 72. Vegetation map of dredged material island V-1.

Table 41
General Characteristics and Summary of Vegetation Data
For Dredged Material Island V-4

Study Area: V

Island Number: 4

Size: 0.1 ha

Age: 3 years

Date of Aerial Photograph: 29 March 1977

<u>Plant Species</u>	<u>Communities</u>		
	herbaceous N=12	shrub N=0	tree N=0
	rel. freq.	abun.	
Casuarina equisetifolia	4	U	
Chloris petraea	50	VA	
Cyperus ligularis	21	VA	
Paspalum vaginatum	9	A	
Portulaca pilosa	9	A	
Vigna luteola	9	A	

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

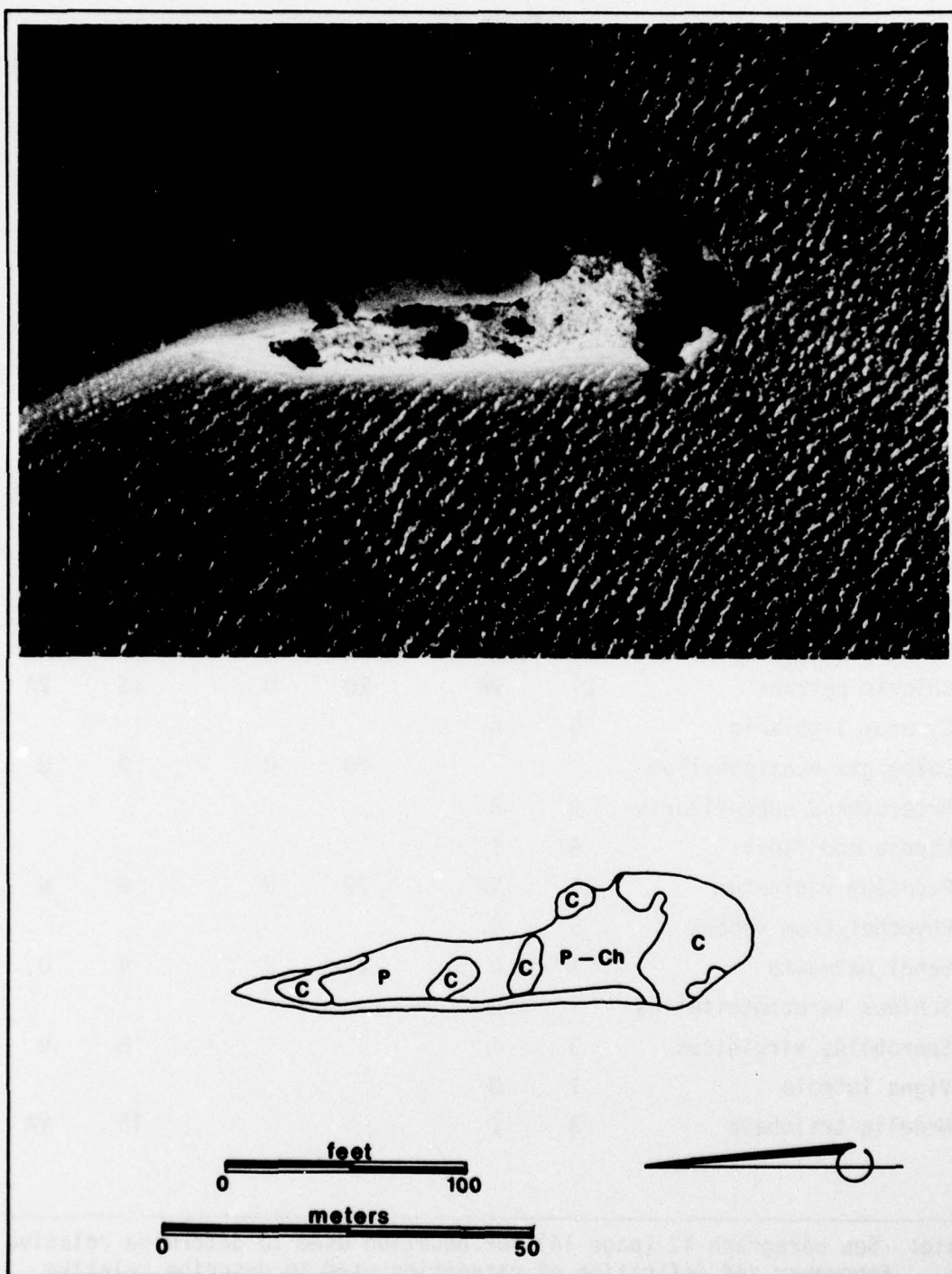


Figure 73. Vertical aerial photograph and vegetation map of dredged material island V-4.

Table 42
General Characteristics and Summary of Vegetation Data
For Dredged Material Island V-7

Study Area: V

Island Number: 7

Size: 0.9 ha

Age: 3 years

Date of Aerial Photograph: 29 March 1977

<u>Plant Species</u>	<u>Communities</u>					
	herbaceous		shrub		tree	
	N=29		N=1		N=2	
	rel.freq.	abun.	rel.freq.	abun.	rel.freq.	abun.
Andropogon virginicus			20	U	15	VA
Baccharis halimifolia					8	U
Casuarina equisetifolia	1	U			15	VA
Cenchrus tribuloides	25	VA				
Chloris petraea	21	VA	20	U	15	VA
Cyperus ligularis	5	A				
Dalbergia ecastophyllum			20	U	8	U
Heterotheca subaxillaris	9	A				
Lippia nodiflora	4	I				
Paspalum vaginatum	21	VA	20	U	8	U
Rhynchelytrum repens	6	A				
Sabal palmetto	1	U	20	U	8	U
Schinus terebinthifolius	1	U				
Sporobolus virginicus	3	I			8	U
Vigna luteola	1	U				
Wedelia trilobata	3	I			15	VA

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

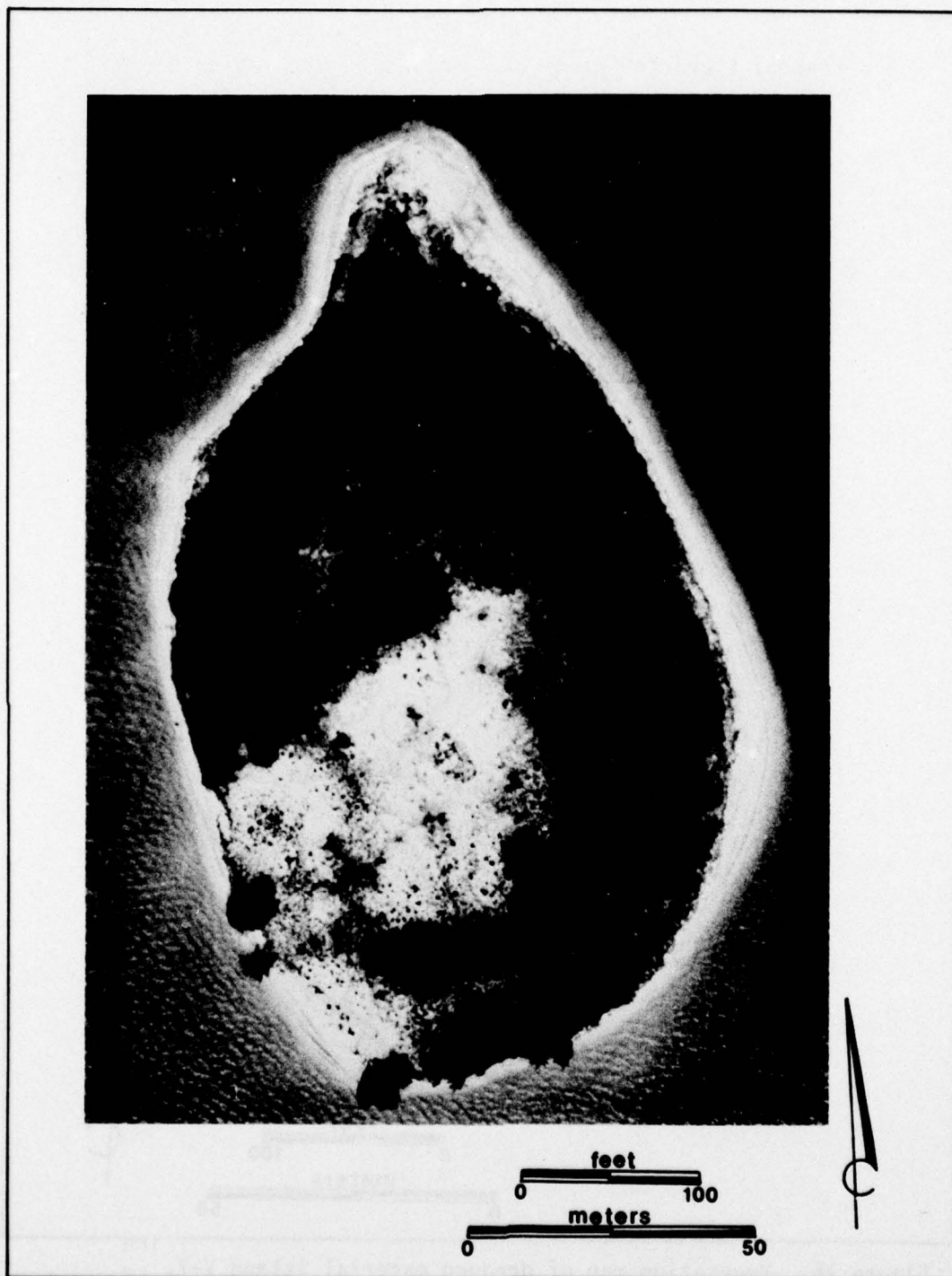


Figure 74. Vertical aerial photograph of dredged material island V-7.

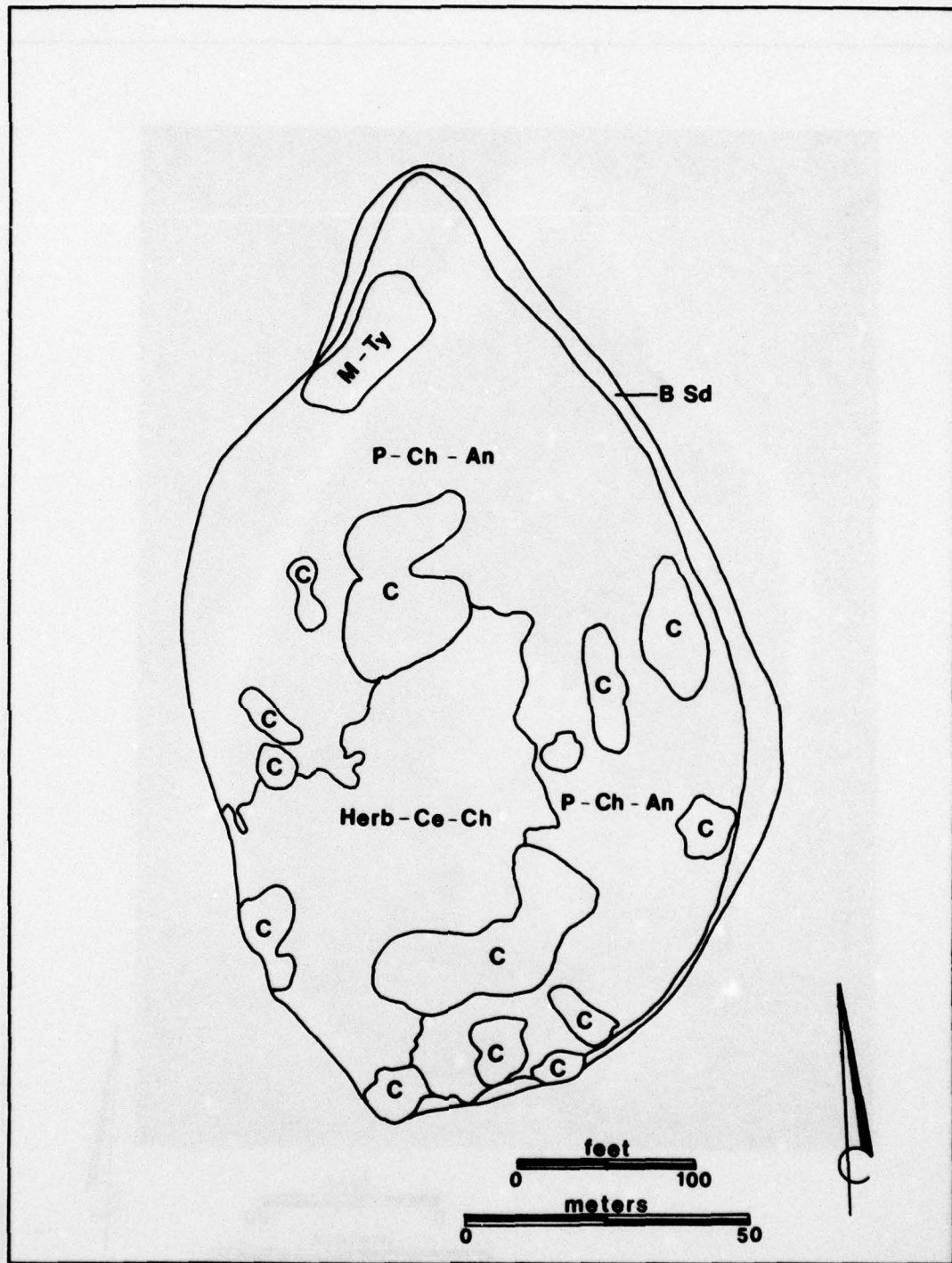


Figure 75. Vegetation map of dredged material island V-7.

Table 43
Major Plant Species Associated With The Generalized Plant
 Succession Pattern On Dredged Material Islands in Florida

<u>Year</u>	<u>Plant Species</u>
0	
3	Paspalum vaginatum Chloris glauca Rhyncheletrum repens Sporobolus poiretii Sporobolus domingensis Cenchrus spp. Spartina alterniflora
5	All of the above plus: Oenothera humifusa Heterotheca subaxillaris Baccharis halimifolia Iva frutescens Schinus terebinthifolius Laguncularia racemosa
10	Baccharis halimifolia Schinus terebinthifolius Paspalum vaginatum Heterotheca subaxillaris Oenothera humifusa Sabal palmetto Casuarina equisetifolia Avicennia germinans Laguncularia racemosa
20	Schinus terebinthifolius

(Continued)

Note: See paragraph 12 (page 14) for equation used to determine relative frequency and definition of categories used to describe relative abundance.

Table 43 (Concluded)

<u>Year</u>	<u>Plant Species</u>
20	Sabal palmetto
	Casuarina equisetifolia
	Paspalum vaginatum
	Avicennia germinans
	Laguncularia racemosa
	Rhizophora mangle
	Conocarpus erecta
40+	Casuarina equisetifolia
	Sabal palmetto
	Schinus terebinthifolius
	Avicennia germinans
	Laguncularia racemosa
	Rhizophora mangle

Table 44
Plant Species Checklist

Scientific Name

Common Name

GYMNOSPERMAE

PINACEAE

Pinus elliottii Englem.

Slash pine

CUPRESSACEAE

Juniperus silicicola (Small) Bailey

Southern red cedar

ANGIOSPERMAE

POACEAE

Andropogon glomeratus (Walt.) BSP

Bushy beard grass

Andropogon virginicus L.

Broomsedge

Cenchrus incertus M. A. Curtis

Coast sandspur

Cenchrus pauciflorus Benth.

Field sandspur

Cenchrus tribuloides L.

Dune sandspur

Chloris glauca (Chapm.) Wood

Finger grass

Chloris petraea Sw.

Finger grass

Cynodon dactylon Pers.

Bermuda grass

Panicum amarum Ell.

Beach grass

Paspalum setaceum Michx.

Paspalum

Paspalum urvillei Steud.

Vasey grass

Paspalum vaginatum Sw.

Seaside paspalum

Rhynchelytrum repens (Willd.) C. E. Hubbard

Natal grass

Spartina alterniflora Loisel.

Smooth cordgrass

Spartina patens (Ait.) Muhl.

Saltmeadow cordgrass

Sporobolus domingensis (Trin.) Kunth

Dropseed

Sporobolus poiretii (R. & S.) Hitch.

Smutgrass

Sporobolus virginicus (L.) Kunth

Virginia dropseed

(Continued)

Table 44 (Continued)

<i>Stenotaphrum secundatum</i> (Walt.) Kuntze	St. Augustine grass
<i>Triplasis purpurea</i> (Walt.) Chapm.	Purple sandgrass
<i>Uniola paniculata</i> L.	Sea oats

CYPERACEAE

<i>Cladium jamaicense</i> Crantz	Saw grass
<i>Cyperus ligularis</i> L.	Nutsedge
<i>Cyperus planifolius</i> Richard	Nutsedge
<i>Cyperus polystachyos</i> Rottb.	Nutsedge
<i>Eleocharis baldwinii</i> (Torr.) Chapm.	Spikerush
<i>Fimbristylis spadicea</i> (L.) Vahl.	Fringe grass
<i>Scirpus robustus</i> Pursh	Softstem bulrush

ARECACEAE

<i>Phoenix reclinata</i> L.	Reclinata palm
<i>Sabal palmetto</i> (Walt.) Lodd. ex Schultes	Cabbage palm
<i>Serenoa repens</i> (Bartr.) Small	Saw palmetto
<i>Washingtonia robusta</i> Wendl.	Washington palm

COMMELINACEAE

<i>Commelina erecta</i> L.	Slender dayflower
----------------------------	-------------------

SMILACACEAE

<i>Smilax bona-nox</i> L.	Greenbrier
---------------------------	------------

AGAVACEAE

<i>Yucca aloifolia</i> L.	Spanish bayonet
---------------------------	-----------------

AMARYLLIDACEAE

<i>Hymenocallis latifolia</i> (Mill.) Roem.	Spider lily
---	-------------

DIOSCOREACEAE

<i>Dioscorea bulbifera</i> L.	Air potato
-------------------------------	------------

CASUARINACEAE

<i>Casuarina equisetifolia</i> Forst.	Australian pine
---------------------------------------	-----------------

(Continued)

Table 44 (Continued)

	MYRICACEAE	
<i>Myrica cerifera</i> L.		Wax myrtle
	BATACEAE	
<i>Batis maritima</i> L.		Saltwort
	ULMACEAE	
<i>Celtis laevigata</i> Willd.		Hackberry
	MORACEAE	
<i>Ficus aurea</i> Nutt.		Strangler fig
<i>Morus rubra</i> L.		Red mulberry
	URTICACEAE	
<i>Parietaria praetermissa</i> Hinton		Pellitory
	CHENOPODIACEAE	
<i>Atriplex arenaria</i> Nutt.		Orach
<i>Chenopodium ambrosioides</i> L.		Mexican tea
<i>Salicornia bigelovii</i> Torr.		Bigelow's glasswort
<i>Salicornia virginica</i> L.		Woody glasswort
<i>Suaeda linearis</i> (Ell.) Mog.		Sea blite
	AMARANTHACEAE	
<i>Iresine celosia</i> L.		Bloodleaf
<i>Philoxerus vermicularis</i> (L.) R. Brown		Saltweed
	NYCTAGINACEAE	
<i>Boerhavia coccinea</i> Mill.		Red spiderling
	PHYTOLACCACEAE	
<i>Phytolacca americana</i> L.		Pokeweed
<i>Rivina humilis</i> L.		Rouge plant
	AZIOACEAE	
<i>Sesuvium portulacastrum</i> L.		Sea purselane
	PORTULACACEAE	
<i>Portulaca pilosa</i> L.		Pink purselane

(Continued)

Table 44 (Continued)

BRASSICACEAE		
<i>Cakile fusiformis</i> Greene		Sea rocket
<i>Lepidium virginicum</i> L.		Pepper grass
CRASSULACEAE		
<i>Kalanchoe pinnata</i> Pers.		Cathedral bells
FABACEAE		
<i>Abrus precatorious</i> L.		Crab's eye
<i>Amorpha herbacea</i> Walt.		Lead plant
<i>Caesalpinia crista</i> L.		Gray nicker bean
<i>Canavalia rosea</i> L.		Bay bean
<i>Clitoria ternatea</i> L.		Blue pea
<i>Crotalaria mucronata</i> Desv.		Rattlebox
<i>Dalbergia ecastophyllum</i> (L.) Benth.		Dalbergia
<i>Melilotus indica</i> L.		Sweet clover
<i>Sophora tomentosa</i> L.		Necklace pod
<i>Vigna luteola</i> (Jacq.) Benth.		Cow pea
OXALIDACEAE		
<i>Oxalis stricta</i> L.		Yellow wood sorrel
RUTACEAE		
<i>Citrus sinensis</i> (L.) Osbeck		Sweet orange
<i>Zanthoxylum clava-herculis</i> L.		Hercules club
MELIACEAE		
<i>Melia azedarach</i> L.		Chinaberry
EUPHORBIACEAE		
<i>Chamaesyce blodgettii</i> (Engelm. ex Hitchc.) Small		Spurge
<i>Cnidoscolus stimulosus</i> (Michx.) Engelm. & Gray		Tread softly
<i>Poinsettia heterophylla</i> (L.) Kl. and Gke.		Painted leaf
ANACARDIACEAE		
<i>Schinus terebinthifolius</i> Raddi		Brazilian pepper tree

(Continued)

Table 44 (Continued)

SAPINDACEAE		
<i>Dodonaea viscosa</i> (L.) Jacq.		Varnish leaf
VITACEAE		
<i>Ampelopsis arborea</i> (L.) Rusby		Pepper vine
<i>Parthenocissus quinquefolia</i> (L.) Planchon		Virginia creeper
MALVACEAE		
<i>Kosteletzkya virginica</i> Presl ex Gray		Salt marsh mallow
<i>Sida acuta</i> Burm.		False mallow
<i>Sida rhombifolia</i> L.		False mallow
PASSIFLORACEAE		
<i>Passiflora lutea</i> L.		Passion flower
CACTACEAE		
<i>Opuntia stricta</i> Haw.		Prickly pear cactus
RHIZOPHORACEAE		
<i>Rhizophora mangle</i> L.		Red mangrove
COMBRETACEAE		
<i>Conocarpus erecta</i> L.		Buttonwood
<i>Laguncularia racemosa</i> Gaertn. f.		White mangrove
<i>Terminalia catappa</i> L.		Indian almond
MYRTACEAE		
<i>Psidium guajava</i> L.		Guava
<i>Myricanthes fragrans</i> (Sw.) McVaugh		Nakedwood
ONOGRACEAE		
<i>Oenothera humifusa</i> Nutt.		Seaside evening primrose
<i>Oenothera laciniata</i> Hill.		Seaside evening primrose
APIACEAE		
<i>Hydrocotyle bonariensis</i> Lam.		Water pennywort
PLUMBAGINACEAE		
<i>Limonium carolinianum</i> (Walt.) Britt.		Sea lavender

(Continued)

Table 44 (Continued)

APOCYNACEAE	
Catharanthus roseus (L.) G. Don	Madagascar periwinkle
ASCLEPIADACEAE	
Cynanchum palustre (Pursh) Heller	Vine milkweed
CONVOLVULACEAE	
Ipomoea alba L.	White morning glory
Ipomoea pes-caprae (L.) R. Brown	Railroad vine
Ipomoea sagittaria Lam.	Glades morning glory
Ipomoea triloba L.	Morning glory
Ipomoea tuba L.	Morning glory
BORAGINACEAE	
Heliotropium angiospermum Murray	Heliotrope
Heliotropium curassavicum L.	Seaside heliotrope
Heliotropium polyphyllum Lehmann	Heliotrope
AVICENNIACEAE	
Avicennia germinans (L.) Stearn	Black mangrove
VERBENACEAE	
Lantana camara L.	Shrub verbena
Lippia nodiflora Michx	Capeweed
LAMIACEAE	
Trichostema suffrutescens Kearney	Blue curl
SOLANACEAE	
Lycium carolinianum Walt.	Christmas berry
Physalis viscosa L.	Ground cherry
Solanum americanum Mill.	Common nightshade
OLEACEAE	
Forestiera segregata (Jacq.) Krug and Urban	Florida privet
SCROPHULARIACEAE	
Bacopa monnieri (L.) Penn.	Monnier's hedge-hyssop

(Continued)

Table 44 (Concluded)

CAPRIFOLIACEAE		
<i>Sambucus simpsonii</i> Rehder		Florida elderberry
CUCURBITACEAE		
<i>Melothria pendula</i> L.		Creeping cucumber
<i>Momordica charantia</i> L.		Wild balsam apple
GOODENIACEAE		
<i>Scaevola plumieri</i> (L.) Vahl		
ASTERACEAE		
<i>Ambrosia artemisiifolia</i> L.		Common ragweed
<i>Baccharis angustifolia</i> Michx		Willow baccharis
<i>Baccharis halimifolia</i> L.		Groundsel-tree
<i>Bidens pilosa</i> L.		Beggar tick
<i>Borrchia frutescens</i> (L.) DC.		Sea ox-eye
<i>Conyza canadensis</i> (L.) Cronquist		White-topped aster
<i>Erechtites hieracifolia</i> (L.) Raf.		Fireweed
<i>Eupatorium capillifolium</i> (Lam.) Small		Dog fennel
<i>Eupatorium serotinum</i> Michx		Late-flowering thoroughwort
<i>Flaveria floridana</i> J. R. Johnston		Florida flavera
<i>Gnaphalium obtusifolium</i> L.		Rabbit tobacco
<i>Heterotheca subaxillaris</i> (Lam.) Britt and Rusby		Camphor Weed
<i>Iva frutescens</i> L.		Marsh elder
<i>Iva imbricata</i> Walt.		Seacoast marsh elder
<i>Lactuca graminifolia</i> Michx		Wild lettuce
<i>Pluchea purpurascens</i> (Sw.) DC.		Saltmarsh pluchea
<i>Pyrrhopappus carolinianus</i> (Walt.) DC.		False dandelion
<i>Solidago sempervirens</i> L.		Seaside goldenrod
<i>Senecio glabellus</i> Poir.		Golden ragwort
<i>Sonchus oleraceus</i> L.		Common sow thistle
<i>Wedelia trilobata</i> L.		

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.

Lewis, Roy R

Colonial bird use and plant succession on dredged material islands in Florida; Vol. II: Patterns of plant succession / by Roy R. Lewis III, Carolyn S. Lewis, Seabird Research, Inc., Culver City, Calif. Vicksburg, Miss. : U. S. Waterways Experiment Station ; Springfield, Va. : available from National Technical Information Service, 1978.

vi, 169 p. : ill. ; 27 cm. (Technical report - U. S. Army Engineer Waterways Experiment Station ; D-78-14, v.2)

Prepared for Office, Chief of Engineers, U. S. Army, Washington, D. C., under Contract No. DACW39-76-C-0161 (DMRP Work Unit No. 4F01C)

Literature cited: p. 27-31.

1. Birds. 2. Dredged material. 3. Florida. 4. Habitats. 5. Islands (Landforms). 6. Plants (Botany). 7. Seabirds. 8. Shore birds. 9. Succession. I. Lewis, Carolyn S., joint author. II. Seabird Research, Inc. III. United States. Army. Corps of Engineers. IV. Series: United States. Waterways Experiment Station, Vicksburg, Miss. Technical report ; D-78-14, v.2.

TA7.W34 no.D-78-14 v.2