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INVESTIGATIONS ON CLASSIFICATION CATEGORIES FOR WETLANDS OF CHESAPEAKE BAY USING REMOTELY SENSED DATA

ANNUAL REPORT

October 10, 1972 to October 9, 1973

Prepared Under Contract No. NAS6-1913 by
Chesapeake Bay Center For Environmental Studies
Smithsonian Institution

Prepared for
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WALLOPS FLIGHT CENTER
WALLOPS ISLAND, VIRGINIA 23337

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Francis S. L. Williamson

Francis S. L. Williamson
Principal Investigator

Staff

Susan Weck Welles
Deborah Ford
Barbara Rice

Consultants

Daniel Higman

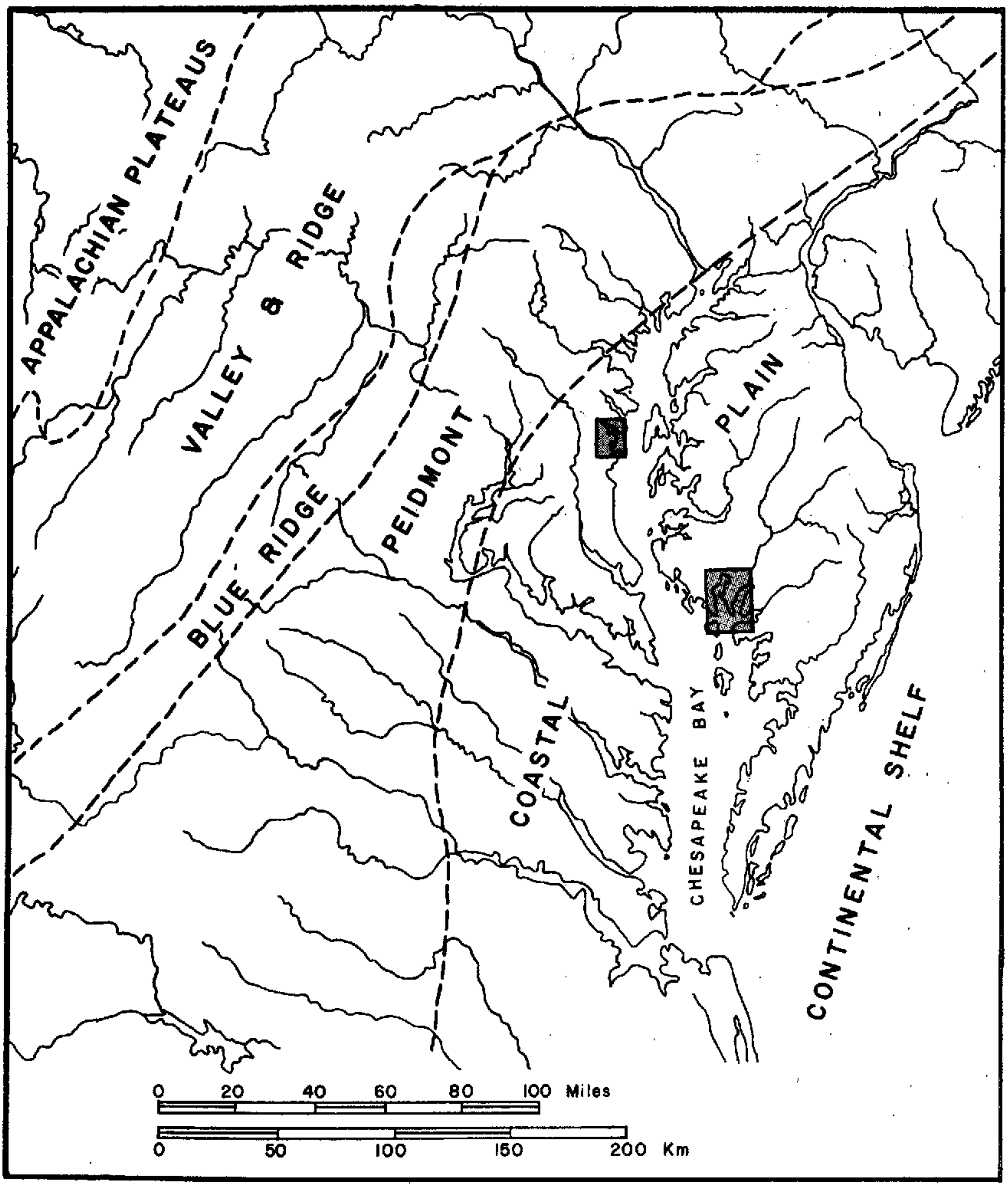
INTRODUCTION

For the past three years, the NASA/Wallops Flight Center and the Smithsonian's Chesapeake Bay Center for Environmental Studies (CBCES) have been engaged in developing remote sensing techniques that are useful to persons interested in Chesapeake Bay wetlands. The wetlands are part of the Atlantic Coastal Plain, which in Maryland consists of unconsolidated Pliocene and Pleistocene sediments composed of clay, marl, sand and gravel. The Plain is bounded by the Piedmont Plateau on the west, and by the edge of the continental shelf on the east (Shattuck, 1906). We have studied two areas on the Coastal Plain in Maryland: The Rhode, West, and South River marshes on the Western Shore, and selected parts of the marshes in Dorchester County on the Eastern Shore. The Chesapeake Bay drains both shores, and the location of the study sites in relation to the upland geology is seen in Figure 1. The Rhode, West, and South Rivers are actually subestuaries of Chesapeake Bay, into which many small fresh water creeks flow. None has a total length exceeding 16 Km. In contrast, the rivers in Dorchester County meander many miles inland and tidal influences are apparent over much larger areas. Eastern shore topography differs from that of the Western Shore in being flatter and more featureless. Because of this, in addition to the characteristics of the drainage systems, Western Shore marshes are relatively small and contain many fresh water floristic elements, while Eastern Shore marshes cover many square miles with vegetation which requires brackish or saline habitats.

Our goals this past year have been twofold:

1. To use data and remote sensing techniques developed from studies of Rhode River, West River, and South River salt marshes to develop a wetland classification scheme useful in other regions of Chesapeake Bay. To

Figure 1. Locations of mapped Western and Eastern Shore marshes in relation to the rest of the Chesapeake Bay watershed.



evaluate the classification system with respect to vegetation types, marsh physiography, man-induced perturbations, and salinity.

2. To develop a program using remote sensing techniques, for the extension of the classification to Chesapeake Bay salt marshes; and coordinate this program with the goals of the Chesapeake Research Consortium and the state of Maryland and Virginia.

In pursuit of our first goal, we developed a color-texture-physiography key for identifying salt marsh vegetation types of brackish, Western Shore marshes using 1828m (6000') aerial photos. This type of key, in simplified form, could be one method of classifying Chesapeake Bay salt marshes. Knowledge gained from this work has been used to modify the classification scheme.

The criteria chosen for definition of classes of Chesapeake Bay salt marshes were arrived at from discussions with scientists of the Rhode River Program, the Chesapeake Research Consortium, professional photointerpreters, ecologists studying marshes with remote sensing, from published and unpublished reports, and from actual field work. The criteria were deemed meaningful from both an ecological and managerial standpoint.

The second goal has been partially completed. Our findings could be applied in two ways. First, photointerpreters using techniques and information we have developed from color infrared aerial photographs, could get a rough estimate of the vegetative characteristics of Chesapeake Bay salt marshes. Second, the photointerpreters should then be able to generalize this information to much of the Bay marshes. Field work would be necessary to verify predictions, especially in less saline marshes where species diversity increases. Salinity measurements must also be obtained entirely <u>in situ</u>, as this parameter cannot be estimated from aerial photography.

As we see it, the real advantage of our work is that a fairly limited number of high altitude photographs could be used to analyze relatively large areas of interest. The 1973 NASA photographs are of fine enough quality to be magnified several times for detailed work. The 1973 photographs would have to be updated, however. Old photographs are misleading; there have been marked changes in some of the six test sites from 1970 to 1973 NASA photographs. Correct identification and classification depends heavily on three factors: the ability of the photointerpreter, the photointerpreter's knowledge of salt marsh ecology in general and Chesapeake Bay marshes in particular, and the extent and thoroughness of field work.

PHOTOINTERPRETATION AND MAPPING OF WESTERN SHORE VEGETATION TYPES

Introduction

Since 1972, salt marshes of the Rhode River estuary have been the focus of our research on the uses of aerial imagery for studying salt marsh ecology. Within the past year, NASA/Smithsonian interest has expanded to the development of a classification system based on high altitude imagery for salt marshes of the entire Chesapeake Bay. With this end in mind, remote sensing techniques and knowledge of marsh ecology were first generalized from Rhode River salt marshes to salt marshes of the two adjoining estuaries of West and South Rivers.

Photos of altitudes higher than previously used (1828m compared to 304m to 914m) were used for predicting marsh vegetation on South and West River estuaries. The photographs were examined with a hand stereoscope under fluorescent lighting, and the composition of vegetation patterns in the marshes predicted independently by two photointerpreters. Outlines of readily discernible areas of color and texture were made on acetate. The tracings were enlarged to a scale of 1:6000 for easier mapping. Photos from the same flight, over Rhode River marshes whose vegetation was already known, were used to aid prediction. This involved the recognition by knowledgeable photo-interpreters of the fact that vegetation types often are associated with a certain color and/or texture on a photograph. After identifications were completed, actual marsh vegetation was recorded in the field. This approach introduced the error of seasonal misidentification; the photos were taken in early fall, at the height of marsh plant growth, while the field work was largely completed in winter and early spring. The marshes were rechecked during the fall of 1973 for correction of possible errors due to changes in plant density and composition. Another source of error is successional changes in marsh vegetation from 1971 to 1973.

The method of classifying vegetation types in these marshes was initially based on the separation of discernible pattern and colors on the photographs. The patterns were traced onto acetate and then taken into the field for checking. In some areas, greater or fewer plant communities were found than indicated by the tracing. In such cases tracings were modified accordingly. Prediction and mapping of 12 selected marshes in South and West Rivers were completed in the spring of 1973, using the 23 x 23 cm natural color prints taken by Raytheon Corporation for the Maryland Department of Natural Resources. The prints were made from positive transparencies taken from a fixed-wing aircraft on 24 September 1971, at 1828m. The transparencies were taken with a Zeiss RMK-2 camera using an A2 lens, clear filter, #2445 film and printed at a scale of 1:12,000.

Results

The prediction, identification, and mapping of South and West River marshes enabled us to:

1. Test our ability to identify the composition of marsh vegetation from natural color aerial photography.

2. Obtain a broader data base for developing our classification of Chesapeake Bay marshes.

3. Provide detailed maps of marsh vegetation for ecological and land-use studies now being done by the Rhode River Program (of the Chesapeake Research Consortium) and for the Maryland Department of Natural Resources.

The marshes selected for study are currently important for land use planning studies by both the Maryland Department of Natural Resources and the Rhode River Program. Maps of the 12 marshes studied are included in this report (Appendix B), along with a map of Hog Island marsh which has been corrected for seasonal floristic changes, and differs slightly from the map of the 1972 annual report (Jenkins et al., 1972). These are the end product of classification attempts and field checking of vegetation.

Our identification accuracy for common marsh types is high for the 12 marshes considered in South and West Rivers (Table 1). The common vegetation types, communities of greater than or equal to 50% *Typha angustifolia*, *Spartina patens*/*Distichlis spicata*, *Iva frutescens*, shrubs and small trees, and mud/water, were identified correctly on the average of 86% of the time. The less common communities were encountered much less frequently and were therefore identified with less accuracy, since the photointerpreters were less familiar with the type, colors and textures. There is some possibility that plant succession has taken place in the marshes between the date of photography (1971) and the date of field work (1973). If this is the case, and species dominance (in terms of cover) has shifted, our identifications will be biased unfavorably. Table 2 represents common prediction errors for the 12 marshes. Misinterpretations of *Acorus calamus* and *Juncus*

Table I. Identification success for twelve marshes in West and South Rivers[1]

Community Type	Number of Marshes	No. of Communities	% Accuracy of Identification Photointerpreter #1	#2
50% :				
Typha angustifolia	9	92	91	67
Spartina patens/ Distichlis spicata	9	50	84	75
Iva frutescens	7	35	86	86
Shrubs and small trees	8	17	94	83
Mud/water	6	17	97	94
Scirpus olneyi	4	9	17	28
Phragmites communis	3	9	78	22
Spartina alterniflora	3	6	17	17
Panicum virgatum	2	3	67	17
Fresh marsh	1	3	0	0
Juncus roemerianus	1	3	0	0
Spartina cynosuroides	2	2	0	25

[1] Beard's Creek Marsh, Flat Creek Marsh, St. George Barber Creek Marsh, Deep Pond Marsh, Glebe Creek Marsh, Smith Creek Marsh, Lerch Creek Marsh, Long Point Marsh, Felicity Cove Marsh, Snug Harbor-Jack Creek Marsh, and South River Headwaters Marsh.

Table 2. Common prediction errors for twelve marshes in West and South Rivers.

ACTUAL VEGETATION	PREDICTED COMMUNITIES Mud/sand	Ivfr[1]	Pavi[1]	Tyan[1]	Shrubs	Ivfr/Pavi	Sppa/Disp[1]	Phco[1]	Spal[1]	Scol[1]	Disp
Acorus calamus	3										
Baccharis halimifolia	-	2									
Juncus roemerianus	-	-	3								
Hibiscus palustris	-	-	1	1							
Phragmites communis	-	7	-	-	2						
Spartina alterniflora	-	2	-	-	-	4					
Panicum virgatum	-	-	-	1	-	-	2				
Scirpus olneyi	-	2	-	7	-	-	-	2			
Typha angustifolia	-	4	5	-	-	1	-	-	2		
Iva frutescens	-	-	-	1	-	-	-	1	1	1	
Spartina cynosuroides	-	-	-	-	-	-	-	-	2	-	1
Spartina patens/ Distichlis spicata	-	-	2	6	-	-	-	1	2	3	-

[1] Ivfr = Iva frutescens; Pavi = Panicum virgatum; Tyan = Typha angustifolia; Sppa/Disp = Spartina patens/Distichlis spicata; Phco = Phragmites communis; Spal = Spartina alterniflora; Scol = Scirpus olneyi.

roemerianus are understandable since these types were encountered only once. Most errors occurred in separating Typha, Spartina/Distichlis, and Scirpus communities. The misinterpretations of Spartina/Distichlis as Typha (6 errors) is puzzling since the two plant communities are usually so distinct, both in color and texture. The misinterpretation of Scirpus as Typha (7 errors) is understandable since these two species have similar morphology, growth patterns, and color. The other very common error (7 errors) is the misidentification of Phragmites for Iva, which is also puzzling unless Phragmites has been replaced by Iva since the photographs were taken. It is possible that either or both of the above misinterpretations were caused by variation of the sun angle to vegetation and camera.

There are a number of biological and physical factors which act to confound the comparison of field data and vegetation images on film, and which could cause misidentification errors. Among these are: phenological stages of the plants, seasonal changes in dominance, successional changes, wind conditions, angle of the sun with respect to vegetation, angle of viewing platform with respect to the vegetation, and tide conditions. Any one or combination of these could have affected our identification accuracy. It should be noted that careful planning can eliminate some errors, but factors such as wind and tides are extremely difficult to correct for, as their effects vary and are often unpredictable.

MARSH VEGETATION TYPE KEY

In conjunction with this study, a key for identifying major salt marsh vegetation types of Western Shore brackish marshes was developed (Appendix A). The key was based on 18 marshes of Rhode, West, and South Rivers (Appendix B and Jenkins, et al. 1972) and is meant to be used with the 1:12,000 scale natural color prints taken for the Maryland Department of Natural Resources by Raytheon Corporation in September, 1971. The major criteria of the key are:

1. Color of the vegetation type according to the Munsell Color Classification System.
2. Texture of the vegetation type.
3. Shape of the vegetation growth pattern.
4. Location of the vegetation with respect to marsh physiography.

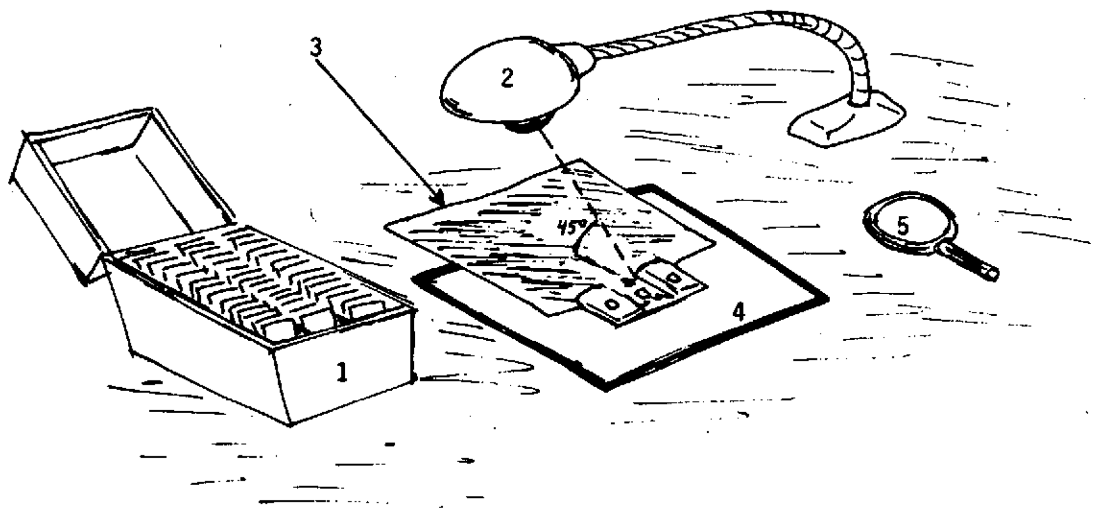
The key is a simple eliminative key with emphasis on relative geometry of ecological vegetation elements that can be seen on aerial photographs, such as shape, proximity of plant communities to shorelines, streams, uplands, and position with respect to other plant communities. O'Neill et al. (1950) developed a similar type of key for marshes of Chesapeake Bay using black and white panchromatic photography taken from one hundred to several thousand feet altitude. His key was necessarily limited to growth pattern, habitat, texture, and gray tones. We have found that color in photos of any altitude above 305 m is essential for successful differentiation of marsh vegetation types.

To use our key, an interpreter requires a set of Munsell Color Standards and should follow the methods recommended in the instruction manual. The type of illumination used to develop the color aspect of the key was a General Electric 100 W photoflood BCA bulb in a gooseneck lamp and should be used with the key. To compare the Munsell color chips with a portion of a print, a simple black paper mask can be made with pockets for two chips and a window to look at the print (Fig. 2). The area covered by the mask window = 23m^2.

The key itself is followed by a texture guide and vegetation color chart (Appendix A). The texture guide, while approximate, is meant to help standardize and explain the various textures encountered on the prints in question. The vegetation-color chart is to be used when the color chosen

Figure 2

SETUP FOR COLOR COMPARISON WITH MUNSELL CHIPS



COMPONENTS

1. Set of Munsell color chips
2. Gooseneck lamp with 100W blue photoflood lamp (#B1 superflood BCA)
3. Black paper mask with two pockets to hold Munsell color chips
4. Aerial photograph
5. Magnifier

from the key is found in two or more vegetation types; overlapping colors are indicated by asterisks in the key. The charts will not help to further differentiate between communities with color overlap, but will give some idea of how often a specified color occurred in the communities we studied and the range of colors possible in a single vegetation type. The charts are compiled data on the plant species within the various types. Munsell colors are listed in the first column by Hue, then by increasing Value with its associated Chroma. The percent cover of the type species in the community under consideration is in the second column, followed by percent cover of other components in columns three through eight. Column 10, Color Frequency (%), indicates the importance of a specific color in the vegetation type being described. The frequency was calculated by the following equation:

$$\frac{\text{number of times a specific color occurs}}{\text{total number of color samples taken from the community}} \times 100$$

For example, after the Phragmites communis communities had been located on the photos and checked in the field, they were viewed using the method described above. All observed colors within the community were recorded. For chart #4, there were 22 colors and 31 samples. The color 10 G 4/2 occurred once. Therefore, $\frac{1}{31} = 0.032 \times 100 = 3.2$.

The major drawback to this key is the plethora of possible color shades for a given vegetation type. The color differences are due to the following factors:

1. species composition, groupings, and dispersion pattern of the plant groups,
2. vigor of the component species,
3. amount and pattern of space between individual plants,
4. color of substrate showing through,
5. proportion of water vs. mud, dependent upon tide at time of overflight,
6. sun reflectance on water or substrate,

7. sun angle, varying from frame to frame,

8. variation in the film development,

9. subjective variability of the color assigner.

Even assuming the last factor is negligible, ample reasons remain for variation in the colors of a single vegetation type in different marshes or different places in the same marsh. Compounding these spatial difficulties are the temporal ones of continuing plant succession. Some discrepancies undoubtedly occur between the stage of succession at the time the photos were taken and at the time of field work. Additionally, any identifications in the future using the 1971 photos may be somewhat out of date, the amount depending on the rate of plant succession.

The key was tested on marsh ecologists with photointerpretive experience, marsh ecologists without photointerpretive experience, and non-scientists with no photointerpretive experience. Results were best with the first group and worst with the third group, as expected; this was due to problems with the mechanics of using the key, rather than to scientific or photointerpretive experience.

Since the key is both time-consuming and unwieldy, it is recommended for presurveys of western shore brackish marshes, to be supplemented later by ground checks. The major value in developing this key is that it provides a model for classifying marsh vegetation types of the entire Bay with high level photography.

Western Shore Classification Categories - Plant Cover by Species

When classifying vegetation from aerial photography, there are two elements which must be correlated. The first element is an image identifiable on film and the second is a plant group identifiable on the ground. The two entities are not necessarily counterparts, and the number of units separable in the field is usually greater than the number which can be distinguished by a photointerpreter. We have not determined whether a given species cover value of 50% or more can be distinguished on photos from the same species values of 49% or less. However, inspection of the plant type/color charts (Appendix A) indicates that such a distinction frequently cannot be made, and that a class will always contain varying amounts of several other class types. This difficulty can be circumvented by making the decision to classify a unit as "Type 1" if it shows predetermined photo characteristics of Type 1, regardless of the actual percentage cover of the type species. The classification may not be 100% correct unless every unit is ground checked; an alternative is to accept an undetermined level of error, for the sake of expediency. Since extremely detailed vegetation classification and mapping for research or management has to be done in the field anyway, there seems to be little point in defining very detailed classes for photointerpretive purposes. Larger classes serve better for the rapid surveys which can either be an end in themselves or preliminary to further work.

We have decided to use eight rather broad vegetation categories, into which most Western Shore phototypes can be classified (see Appendix B). The types are defined as containing 50% or more plant cover of the "vegetation type" species. They are determined on the basis of location with respect to waterways, texture on photos, and color. A given marsh may be assigned to a single type (based on the type covering the most area) or to more than one type, depending on the decision of the wetland manager. The eight types, criteria and type species are as follows:

Type 1. Definite edge along water; textures 1, 2, or 6; colors Yellow-Red, Yellow, Green-Yellow, Green, Blue-Green, Blue, Purple-Blue, or Neutral; vegetation type, _Iva frutescens_.

Type 2. Definite edge along water; textures 3, 4, or 7; colors Yellow-Red, Yellow, Green-Yellow, Green, Blue-Green, Purple-Blue, or Neutral; vegetation _Spartina alterniflora_.

Type 3. Position variable, may form various shaped patches; textures 1-8; colors Yellow, Green-Yellow, Green, or Blue-Green; vegetation type _Phragmites communis_.

Type 4. Forms patches of various shapes and sizes; textures 1-8; colors Red, Yellow-Red, Yellow, Green-Yellow, Green, Blue-Green, Purple-Blue, Purple, Neutral; vegetation type _Typha angustifolia_.

Type 5. Forms variably shaped patches; textures 4 or 7; colors Yellow-Red, Yellow, Green-Yellow, or Green; vegetation type _Scirpus olneyi_.

Type 6. Variably shaped patches, usually not adjacent to waterways; textures 4, 7, or 8; colors Yellow-Red, Yellow, Green-Yellow, Green, or Blue-Green; vegetation type _Spartina patens/Distichlis spicata_.

Type 7. Texture 8; colors Yellow-Red, Yellow, Green-Yellow; vegetation type _Acorus calamus_.

Type 8. Usually adjacent to water; textures 3, 4, or 7; colors Red, Yellow-Red, Yellow, Green-Yellow, Green, Blue-Green, Blue, Purple-Blue, Purple, or Neutral, type mud/water.

EASTERN SHORE MARSHES [goal 2]

Inventory and classification of wetlands has been a matter of concern to management agencies for some years. Most states on the eastern seaboard now have wetland legislation. Use of remotely sensed data for management purposes has increased, and New Jersey, Delaware, and Maryland are using remote sensing to delineate wetland boundaries, and in some cases, vegetation types.

For most needs natural color or false-color imagery is preferred (Russell and Wobber, 1972; Seher and Tueller, 1973; Pestrong, 1970). This permits classification of marsh vegetation into groups, the nature of which may be determined arbitrarily, by either experienced or inexperienced interpreters (Olson, 1964). The basis of the schemes are usually dependent upon the desired use of the scheme, or of the wetland in question. For example, when the primary parameter of interest is in waterfowl use of habitat, the concept of vegetation stands can be used in the classification system (Cowardin and Johnson, 1973). It must be noted that no one system is acceptable to biologists working in diverse habitats and therefore modifications are numerous (Cowardin and Johnson, 1973; Martin et al., 1953; Nicholson and Van Duesen, 1954). Time and cost factors are likewise of importance.

NASA/Smithsonian interest has centered primarily upon developing mapping and classification techniques for Chesapeake Bay wetlands. Because increasing the distance from sensor to the land area expands the area viewed, there is a potential advantage in increasing the altitude of overflights. NASA/Smithsonian have been using 23 x 23 cm color infrared positive transparencies taken at 18,300 m (60,000'). Klemas et al. (1973) have used automated analysis of 18,300 m (1:120,000) color infrared transparencies to prepare comprehensive maps of Delaware coastal marshes. Such small scale mapping delineates boundaries of wetlands and may be used as a base for larger scale maps. Russell and Wobber (1972) have shown the practicality of small scale photo maps for rapid inventory of endangered natural resources. NASA/Smithsonian's goal has been to evaluate the use of small scale (high altitude) imagery for classifying the wetlands of Chesapeake Bay with respect to vegetation types, marsh physiography, man-induced perturbations, and salinity.

Methods

Preparation for classifying the wetlands began early in the spring of 1973, with the initial predictions of the major marshes of Dorchester and Somerset Counties by two photointerpreters using imagery taken by a U2 aircraft from 18,300 m. The predictions were based on photointerpretive and field experience of Western Shore marshes and on published descriptions of the Dorchester marshes. This photointerpretive exercise was a test of our ability to generalize photointerpretive expertise from small brackish marshes to large saline marshes. The presence and/or absence of particular plants notwithstanding, the exercise was valuable. During the summer, six test sites, each 2.59 km^2 in size, were chosen for field work and for later analysis by automated data processing techniques. The test sites were examined for;

1. dominant plant species, as indicated by cover values,
2. marsh physiography (drainage patterns, flooding, ponds, dikes, general marsh shape, and relationship to surrounding land),
3. man-induced disturbances (dredging, diking, filling, and burning),
4. salinity.

With the exception of the last factor, all of the above can hypothetically be determined and evaluated with remote sensing. In conjunction with other scientists at Rhode River, we hope to determine the role of different marsh types, with different levels of primary productivity, in producing organisms of higher trophic levels. This kind of information is essential to the wise management of Chesapeake Bay wetlands by responsible governing units.

The five criteria were chosen after lengthy literature perusal and discussions with members of the Rhode River Program, the Chesapeake Research Consortium, other photointerpreters and marsh ecologists. Specific recommendations came from Dr. R. Reimold of the University of Georgia and from Dr. V. Klemas of the University of Delaware, both of whom are working on remote sensing of wetlands (Reimold, 1971; Klemas et al., 1973).

Identification of Dorchester County wetlands were made using positive 23 x 23 cm transparencies of NASA's 18,300 m color infrared photography. The transparencies were first enlarged 2.5X using a Beseler Century VU-graph, and superimposed on U.S.G.S. 1:24,000 scale maps. Major color and textural features were traced onto paper and U.S.G.S. maps. The tracings were used in conjunction with the transparencies in the identification process to record the areas studied. The photointerpeters had varying experience in both remote sensing and marsh field ecology. The table below illustrates the experience of each photointerpreter.

	Photointerpretive Experience	Marsh field ecology experience
Photointerpreter 1	extensive	extensive
2	some	extensive

The photos provided to the Chesapeake Bay Center from the Wallops Flight Center were 1:60,000 color infrared transparencies and 1:120,000 natural color transparencies, both taken in September, 1970. More recent film (18,300 m, 1:120,000 natural color infrared) was taken in January, 1973 before the identifications began but was not available to CBCES for some time. The natural color transparencies proved almost useless for identifications because of haze and small scale. The color infrared was therefore used exclusively, but coverage was partial for Wingate quadrangle peninsula and nearly absent for Elliott Island peninsula. As a result, identifications were completed for only 2 of our 6 test sites and partially for 2 others. Table 3 illustrates the success of the identifications of the two photointerpreters.

Results and Discussion

Consistent with our findings on Western shore marshes, recognition of trees and shrubs and Spartina/Distichlis was high (72% - 100% accuracy). These vegetation types accounted for less than 5 - 10% of the total site area.

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Table 3. Identification Success for Eastern Shore Marsh Vegetation.

VEGETATION TYPE	FARM CREEK MARSH areas predicted n	FARM CREEK MARSH type cover %	FARM CREEK MARSH identified correctly %	RACCOON CREEK MARSH areas predicted n	RACCOON CREEK MARSH type cover %	RACCOON CREEK MARSH identified correctly %
Spartina patens/ Distichlis spicata	11	10		4	10	
photointerp. 1			92			75
" 2			92			75
Scirpus olneyi	5	25		6	15	
photointerp. 1			60			12
" 2			60			0
Juncus roemerianus	10	60		-	-	
photointerp. 1			55			-
" 2			78			-
Spartina alterniflora/ water	1	< 5		-	-	
photointerp. 1			100			-
" 2			100			-
Mixed: Sppa/Disp, Scol, Spal, water[1]	-	-		15	70	
photointerp. 1			-			31
" 2			-			15
Spartina cynosuroides (stream border)	-	-		-	-	
photointerp. 1			-			-
" 2			-			-
Trees & Shrubs	2	< 5		-	-	
photointerp. 1			100			-
" 2			100			-

[1] Sppa/Disp = Spartina patens/Distichlis spicata; Scol = Scirpus olneyi; Spal = Spartina alterniflora.

Table 3 Cont.

VEGETATION TYPE	TEST SITE: GREAT MARSH areas predicted n	type cover %	identified correctly %	GRAYS ISLAND MARSH areas predicted n	type cover %	identified correctly %
Spartina patens/ Distichlis spicata	-	-		-	-	
photointerp. 1			-			-
" 2			-			-
Scirpus olneyi	-	-		-	-	
photointerp. 1			-			-
" 2			-			-
Juncus roemerianus	-	-		-	-	
photointerp. 1			-			-
" 2			-			-
Spartina alterniflora/ water	-	-		-	-	
photointerp. 1			-			-
" 2			-			-
Mixed: Sppa/Disp, Scol, Spal, water[1]	1	15		-	-	
photointerp. 1			0			-
" 2			0			-
Spartina cynosuroides (stream border)	1	25		1	<5	
photointerp. 1			100			100
" 2			-			-
Trees & Shrubs	-	-		1	10	
photointerp. 1			-			-
" 2			-			100

[1] Sppa/Disp = Spartina patens/Distichlis spicata; Scol = Scirpus olneyi; Spal = Spartina alterniflora.

Strips of Spartina cynosuroides along streams, though almost invisible on the high altitude photos, were also correctly identified. Similarly, the small areas of S. alterniflora/water (less than 5%) were correctly identified (100% accuracy). There was moderate success in predicting Scirpus olneyi and Juncus vegetation types (0 - 78%) which comprised 15 - 60% of total test site areas. The most difficulty, understandably, came in predictions of mixed marsh species (0 -31% accuracy). This fairly significant component of Great Marsh and Raccoon Creek Marsh (15 - 70% of the test sites) will probably always pose a problem for interpreters because of its heterogeneity. Prior ground experience with an area would certainly increase the likelihood of successful identification of the component species.

The two photointerpreters performed similarly; the interpreter (#1) with the most marsh and photointerpretive experience did slightly better than the inexperienced one.

MAPPING OF EASTERN SHORE MARSHES

Methods

After the preliminary identifications were completed, a low-level flight (150 m - 300 m) was made over the Dorchester County salt marshes; vegetation was observed from the plane using 1:24,000 scale U.S.G.S. maps for reference. This method enabled us to get an overview of the marsh vegetation, to make a preliminary general map of the area, and to examine confusing vegetation types more closely. As with the Western Shore marshes, a map of each test site had been prepared, with vegetation boundaries derived from color-infrared imagery. After the vegetation was field checked alterations were made to correct boundaries and/or vegetation identifications, if necessary.

Summer field work commenced in mid-July and ended by mid-September. The work was planned to coincide with the maturing of marsh vegetation. The field work was based on six, 2.59 km^2 test sites in Dorchester County: three on Wingate Peninsula and three in the Elliott Island Marsh. The sites were chosen for accessibility by car and/or boat and for variety of vegetation types indicated by diverse color patterns on the 18,300 m photographs. On each test site, marsh vegetation was categorized by percent plant cover by species, and the amount of mud/water was noted. Salinity measurements were made at low and high tides in the major creek running through a given test site (Appendix C). Burning, muskrat activity, and plant vigor were also noted.

Results and Discussion

After completing the 1973 summer field work, we were able to identify a number of vegetation types on the 18,000 m photographs with a fair amount of accuracy. Appendix D contains the vegetation maps resulting from the field work.

We have found that Spartina cynosuroides frequently borders creeks and streams in the marshes. This plant is not always visible on the 18,300 m imagery since it grows in a narrow strip 1 to 10 meters wide. Next to the Spartina cynosuroides, a zone of Spartina/Distichlis is usually found. This community is readily distinguished by its light color and location in the marsh. Patches of Spartina/Distichlis that occur away from the creeks are also distinguishable by color. Combinations of Scirpus olneyi, Spartina/Distichlis, and Spartina alterniflora, whether as mixtures or as adjacent pure patches, are detectable by their checkerboard growth pattern, their location next to the Spartina/Distichlis community, and their yellow-green color. Shrubs and trees in the marsh grow in discrete patches, appear reddish, and exhibit a coarse, clumpy texture on the aerial photographs. Juncus roemerianus is detectable on the photos by its dark green color and, in patches up to 200 m diameter, by its circular growth pattern. This pattern is also sometimes shared by S. olneyi. Water is detectable by specular reflection (silver on photos) or by its dark color, as well as by its shape, in the form of ponds and streams. Table 4 summarizes these findings.

Of the two film types examined while identifying marsh characteristics, some proved more useful than others. A summary of the films used is given in Table 5.

While the low level (1828 m) photos studied are good for small areas, the 19,800 m photos studied were the best for distinguishing large areas of homogeneous vegetation and, using magnification, streams of $\geq$1 m width. The color infrared is invariably superior to natural color film because of minimal haze effect on the former.

A tentative classification for Eastern Shore wetland vegetation types has been developed using color infrared imagery (Table 6). The categories were designed to contain the same vegetation types as the Western Shore system; three types (3, 4, & 7) were not observed and two additional types (9, 10) are included. The system is extremely subjective, as it was developed by one person, using one set of transparencies and no color standards. However, subjectivity and experience of photointerpreters have been and remain serious problems when classifying vegetation from aerial photography. In an attempt to circumvent this situation we are currently attempting to develop a wetlands classification system using automated data processing techniques on color infrared imagery.

In sum, homogeneous marsh vegetation types can be distinguished on high level photography. The other criteria for classifying wetlands: salinity, physiography, and man-induced perturbations, will be discussed here.

Table 4. Identifying features of marsh vegetation and water. From the correlation of field data with 18,300 m color infrared aerial transparencies. + indicates a moderately important, and ++ a very important feature.

Plant Community or Physiographic Feature	Color	Texture	Shape of Growth Pattern or Physiographic Feature	Location with respect to Marsh Physiography
Spartina patens/ Distichlis spicata	++		+	+
Juncus roemerianus	+		++	
Spartina cynosuroides				++
Combinations of: Spartina/Distichlis, Scirpus olneyi, Spartina alterniflora	++		++	+
Shrubs & trees	++	++	++	
Ponds & streams	++		++	

Table 5. Comparison of various films used to map wetlands boundaries.

Feature	Film Type Natural Color	 Color Infrared	 Color Infrared (73-014C)
Date	Sept. 1970	Sept. 1970	Jan. 1973
Altitude	60,000 ft.	60,000 ft.	65,000 ft.
Film	2445	2443	2443
Scale	1:120,000	1:60,000	1:130,000
Filter	2 E	W 21	W12
Color Quality	Haze problems	too green	not uniform (sun angle or processing)
Vignetting	---	very little	---
Community Definition:			
Spartina/ Distichlis	fair	fair	good
Spartina alterniflora	poor	---	poor
Spartina cynosuroides	poor	---	poor
Juncus roemerianus	poor	fair-poor	good-fair
Scirpus olneyi	poor	---	poor
mixtures	poor	poor	---
streams	poor	fair	good
trees & shrubs	poor	---	good
general comment	Small scale bad; Juncus, Scirpus & S. alterniflora hard to differentiate.	Good; Juncus & mixture not always separable.	Center of photo has best definition; Juncus & Scirpus hard to separate.

Table 5. Continued.

Feature	Color Infrared (72-147)	Natural Color	Color Infrared
		Film Type	
Date	August 1973	Sept. 1973	Sept. 1973
Altitude	65,000 ft.	6,000 ft.	6,000 ft.
Film	2443	SO-397	2443
Scale	1:130,000	1:12,000	1:12,000
Filter	?	CAV & haze	12 AV & CC10M
Color Quality	Dark, bad sun reflections	very dark	very dark
Vignetting	---	very bad	very bad
Community Definition:			
Spartina/ Distichlis	good	good	good
Spartina alterniflora	good	good	fair-poor
Spartina cynosuroides	---	good	good
Juncus roemerianus	good-fair	good	good
Scirpus olneyi	fair	good	good
mixtures	poor	poor	---
streams	good	fair	good
trees & shrubs	good-fair	good-fair	good
general comment	Burns do not show up, mud/water & S. alterniflora hard to separate from Juncus.	Large scale may give too much detail.	Confusion between S. cynosuroides & S. alterniflora along streams; S. alterniflora may be hard to separate from mud/water.

Table 6. Classification system developed from NASA U-2 mission 73-197, Dec. 1, 1973 for Eastern Shore wetland vegetation.

Type 1.	Borders streams; texture 1; colors yellow-red, yellow, and greenish-yellow-red; vegetation type *Spartina cynosuroides*, and occasionally *Iva frutescens*.
Type 2.	Textures 6, 7, & 8; colors blue-green, green, green-yellow, blue, and light blue-green with some brown mixed in; vegetation type *Spartina alterniflora*.
Type 3.	Not observed (*Phragmites communis*).
Type 4.	Not observed (*Typha angustifolia*).
Type 5.	Textures 8, & "smooth"; colors brown-red, yellow-red, purple-brown; vegetation type *Scirpus olneyi*.
Type 6.	Near edges of streams, fingering into other vegetation types; textures "smooth"; colors neutral, yellow, green-yellow, yellow-red, almost white; vegetation type *Spartina patens/Distichlis spicata*.
Type 7.	Not observed (*Acorus calamus*).
Type 8.	Texture "smooth"; colors neutral, blue, blue-green, purple-blue; Type mud/water.
Type 9.	Abrupt edge of vegetation type; textures 2, "patchy"; colors red, purple; vegetation type *Juncus roemerianus*.
Type 10.	Circular shapes (individuals); textures 1, "lumpy"; color red, brown-red; vegetation type trees & shrubs.

Salinity measurements are strictly ground measurements and are fairly straightforward. They add no information which may be related to aerial photos. Marsh physiography is readily visible in any good high level photo. Small streams over 1 meter in width can be seen with the naked eye and, under 1 meter width can often be distinguished by means of the boundary vegetation (usually *S. cynosuroides*) and with the aid of a hand lens. Major man-induced perturbations are for the most part quite visible on high level photos (i.e., mosquito ditches, ponds, dredge spoil, fill). The most difficult parameter to detect is burning, which is a common practice on the Eastern Shore marshes.

The ability to identify burned areas may bear directly on the problem of detecting productivity, and of accurately separating vegetation types. Since chlorophyll reflects about 40% of the incident radiation in the infrared region (.760 μ - 1.0 μ), red color differences on high altitude color infrared imagery are largely due to relative amounts of exposed, living chlorophyllous plant tissue. This would explain why freshly burned *Juncus roemerianus* (dead leaves removed) reflects the same color as dense patches of *Scirpus olneyi*. Old unburned *Juncus* patches, on the other hand, image the same color as *S. alterniflora*/mud/water when the mud/water component of the latter type is $\geq$ 40%. The assumption that red photo color is due to reflection from chlorophyllous tissue leads to some problems in determining productivity. The habit of *J. roemerianus* to retain dead leaves that bend over living leaves and of *Spartina patens* and *Distichlis* leaves to bend over other living leaves (of the same plant) would result in reduced reflection of living tissue actually present.

APPLICATIONS FOR USERS

With the criteria for classifying wetlands established and the extent to which remote sensing can be used for this classification determined, a program for use of this system can be readily implemented.

There are two spheres in which the system can be applied: 1. the training of the users and 2. the development of automated techniques to help eliminate some of the human variability involved.

For the first sphere of application, we would recommend that users be generally familiar with the type of vegetation to be analyzed. For the type of interpretation we have done, we have found that a few preliminary ground checks are essential to correct interpretations. High quality infrared photography is also essential. Preferably, photos should be taken with minimal sun angle effect. The altitude and scale to be used are dependent on the intended use. For classification of large areas, the 18,300 m - 19,800 m (1:60,000 - 1:130,000) altitude/scale combinations are preferable. 9,100 m and less should be required only where a very detailed map is needed or when the area in question is less than 0.65 km^2.

The problems of distinguishing productivity, vegetation, or burn effects from film color will have to be dealt with as well as possible. Ground measurements would help clarify questionable situations.

The second sphere of application, the use of automated analysis techniques, is presently being investigated.

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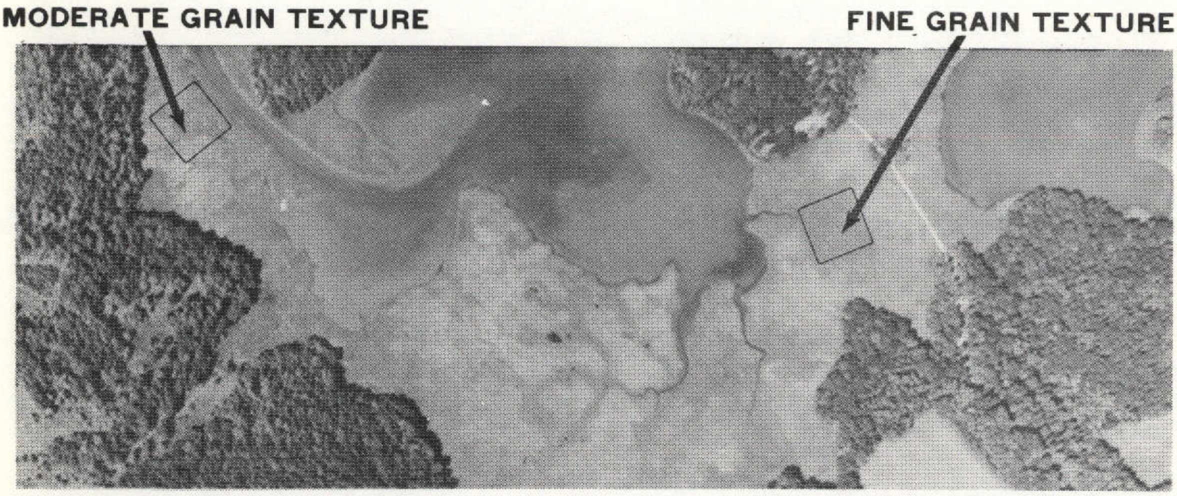
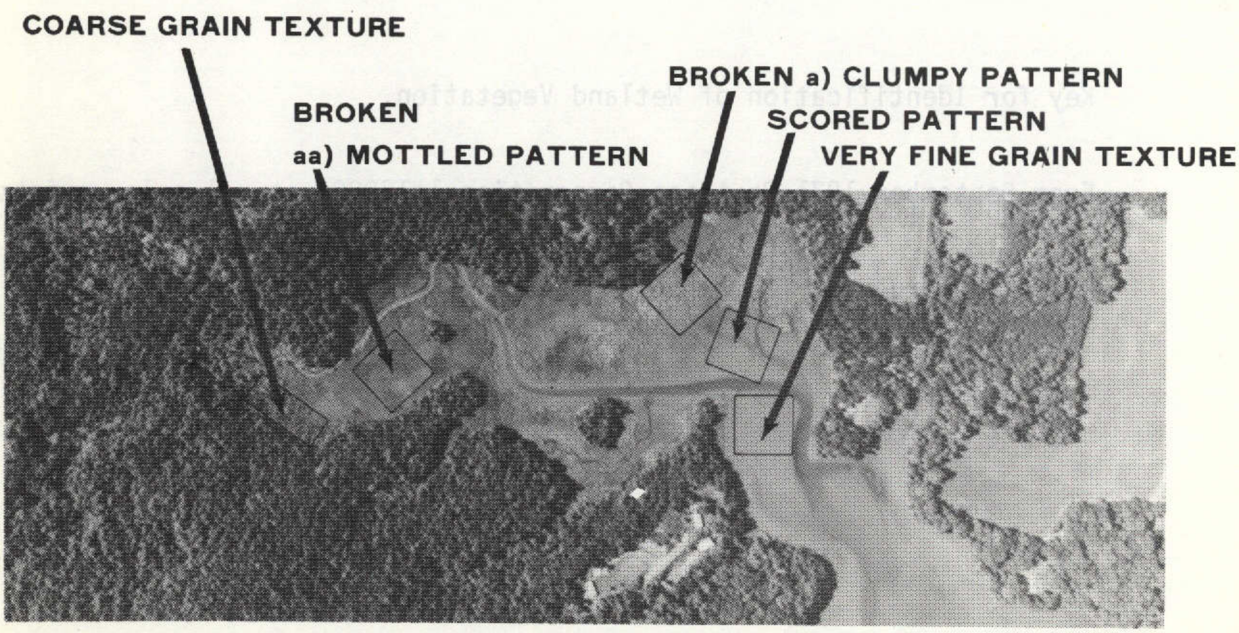
APPENDIX A

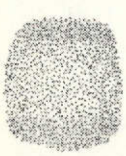
Key for Identification of Wetland Vegetation.

From September 1971 Raytheon Corporation 1:12000 natural color prints.

Based on survey of 18 marshes on Rhode, South, and West Rivers.







EXAMPLES OF TEXTURES AND PATTERNS
USED IN MARSH VEGETATION KEY.

Appendix A

MARSH VEGETATION KEY

Western Shore Marshes

1. Follows or borders streams or waterways.

    2. A definite edge following a stream.

        3. Texture: Moderate Grain, Coarse Grain.

        Pattern: Broken (Mottled)

        Munsell Colors: Iva frutescens - See Chart #1.

        5 YR 4/1; 7.5 YR 4/2; 10 YR 4/1, 4/2, 5/2; 2.5 Y 5/2; 5 Y 3/1, 4/1, 4/2, 5/2, 6/1, 6/2; 7.5 Y 4/2, 5/2, 6/2, 7/4; 10 Y 4/1, 5/1, 5/2, 6/2; 2.5 GY 5/2, 6/2; 5 GY 3/1, 4/1, 4/2, 5/2, 6/2; 7.5 GY 4/2, 5/2, 6/2; 10 GY 3/1, 4/1, 4/2, 5/2, 6/2; 2.5 G 3/2, 4/2, 5/2; 5 G 4/1, 4/2, 5/2; 7.5 G 4/2, 4/4, 5/2; 10 G 3/1, 4/1, 4/2, 5/2; 2.5 BG 4/2; 5 BG 3/1, 3/2, 4/1, 4/2, 4/4; 7.5 BG 3/2, 4/2, 4/4; 10 BG 3/1, 3/2, 4/2; 2.5 B 3/2; 10 B 2/2, 3/1; 5 PB 2/1, 3/1; N 8.5/.

        33. Texture: Very Fine Grain, Fine Grain.

        Pattern: Scored and continuous

        4. Munsell Colors: Spartina alterniflora - See Chart #2.

        7.5 YR 5/2*; 10 YR 3/1*, 4/1*, 4/2*; 5 Y 3/1*, 4/1*; 7.5 Y 5/2*, 6/2*; 10 Y 3/1*, 3/2*, 4/1*; 2.5 GY 4/2*, 5/2, 5/4, 6/2, 7/2; 5 GY 3/1*, 4/1*, 5/2, 6/2*; 7.5 GY 4/2*, 5/2; 10 GY 4/1, 4/2*; 2.5 G 4/2*; 5 G 3/1, 4/1; 10 G 4/1*; 2.5 BG 3/2, 4/2; 5 PB 3/1*, 4/1; N 7.5/.

        * Colors overlap with those of Mud/Water: See Chart #9.

        44. Munsell Colors: Mud/Water - See Chart #3.

        10 R 3/1; 5 YR 3/1, 4/1; 7.5 YR 4/2; 10 YR 5/1, 5/2, 6/1, 6/2, 7/1, 7/2; 2.5 Y 4/2, 5/2, 6/2; 5 Y 5/1, 5/2, 6/1, 6/2, 7/1; 10 Y 5/1, 5/2, 6/1, 6/2, 7/1, 7/2; 5 GY 4/2, 6/1; 10 G 3/1, 5/4; 2.5 BG 5/4; 10 BG 3/1; 5 B 4/1; 5 PB 2/1; 10 PB 3/1; 10 P 3/1; N 4.0/; N 4.5/.

22. Not a definite edge along a stream. Might extend from a stream to an upland area.

5. Texture: Fine Grain, Moderate Grain, Coarse Grain.

Pattern: Broken (clumpy) and sometimes continuous

6. Munsell Colors: Phragmites communis: See Chart #4.

5 Y 5/1; 5 GY 6/2, 7/2; 7.5 GY 5/2*, 6/2*; 10 GY 6/1, 6/2; 2.5 G 6/2; 5 G 5/2; 7.5 G 4/2, 5/2, 6/2; 10 G 4/2, 5/2*; 2.5 BG 3/2, 4/2; 5 BG 3/2, 4/2, 5/1, 5/2; 7.5 BG 4/2; 10 BG 4/1.

* Colors overlap with those of Typha angustifolia.

66. Munsell Colors: Typha angustifolia - See Chart #5.

5 R 3/1, 4/1; 10 R 4/1; 2.5 YR 5/2; 5 YR 3/1, 4/1, 4/2, 5/2, 5/4; 7.5 YR 4/2, 5/2, 6/2, 6/4; 10 YR 3/1, 4/1, 4/2, 5/1, 5/2, 5/4, 6/1, 6/2, 6/4, 7/2; 2.5 Y 4/2, 5/2, 6/2; 5 Y 3/1, 4/1, 4/2, 5/2, 6/1, 6/2, 7/1; 7.5 Y 5/2, 6/2; 10 Y 3/1, 4/1, 5/1, 5/2, 7/1; 2.5 GY 4/2; 5 GY 3/1, 4/1, 4/2, 5/2, 6/1; 7.5 GY 4/2, 6/4; 10 GY 3/1, 4/2, 5/1, 5/2; 2.5 G 4/2; 5 G 4/2; 10 G 3/1, 4/1; 5 BG 3/1; 10 BG 3/1; 5 PB 3/1; 10 PB 3/1; 10 P 3/1; N 4.0/; N 4.5/.

55. Texture: Very Fine Grain

Pattern: Broken (Mottled), and Scored

7. Munsell Colors: Spartina patens/ Distichlis spicata - See Chart #6.

5 YR 4/1*, 5/2*; 7.5 YR 4/2*, 5/2*; 10 YR 3/1*, 4/1*, 4/2*, 5/2*, 6/2*; 2.5 Y 5/2*, 6/2*, 7/2; 5 Y 4/1*, 4/2*, 5/1, 5/2*, 6/1*, 6/2*, 7/2, 7/4; 7.5 Y 4/2, 5/2*, 6/2*, 6/4, 7/2, 7/4; 10 Y 3/1*, 4/1*, 5/1*, 5/2*, 6/2, 7/2, 7/4, 8/4; 2.5 GY 4/2*, 5/2, 6/2, 6/4, 7/2; 5 GY 3/1*, 4/1*, 5/2*, 6/2, 6/4, 7/2; 7.5 GY 4/2*, 5/2*, 6/2*; 10 GY 3/1*, 4/1, 4/2*, 5/2*, 6/2; 2.5 G 4/2*, 5/2; 5 G 3/1, 4/1, 4/2*, 5/2; 7.5 G 4/2, 5/2; 10 G 4/1*, 5/1, 5/2*; 2.5 BG 4/2; 5 BG 3/2, 4/1, 4/2; 7.5 BG 3/2, 4/2; 10 BG 3/2, 4/2.

* Colors overlap with those of Typha angustifolia.

77. Munsell Colors: Typha angustifolia - See Chart #5.

5 R 3/1, 4/1; 10 R 4/1; 2.5 YR 5/2; 5 YR 3/1, 4/2, 5/4; 7.5 YR 6/2, 6/4; 10 YR 5/1, 5/4, 6/1, 6/4, 7/2; 2.5 Y 4/2; 5 Y 3/1, 7/1; 10 Y 7/1; 5 GY 4/2, 6/1; 7.5 GY 6/4; 10 GY 5/1; 10 G 3/1; 5 BG 3/1; 10 BG 3/1; 5 PB 3/1; 10 PB 3/1; 10 P 3/1; N 4.0/; N 4.5/.

11. Does not follow or border streams. Upland marsh areas.

2. Enclosed or nearly surrounded by shrubby, upland vegetation.

3. Texture: Very Fine Grain, Fine Grain

Pattern: Broken (Mottled) and continuous

Munsell Colors: Acorus Calamus - See Chart #7.

10 YR 7/4; 2.5 Y 7/2, 8/2, 8/4; 2.5 GY 6/2.

33. Texture: Moderate Grain

Pattern: Broken (clumpy)

Munsell Colors: Phragmites communis - See Chart #4.

5 Y 4/1; 5 GY 6/2, 7/2; 7.5 GY 5/2, 6/2; 10 GY 6/1, 6/2; 2.5 G 6/2; 5 G 5/2; 7.5 G 4/2, 5/2, 6/2; 10 G 4/2, 5/2; 2.5 BG 3/2, 4/2; 5 BG 3/2, 4/2, 5/1, 5/2; 7.5 BG 4/2; 10 BG 4/1.

22. Marsh interior not enclosed by shrubby, upland vegetation.

4. Has a circular shape with a well defined border.

5. Texture: Moderate Grain

Pattern: Broken (clumpy)

Munsell Colors: Phragmites communis - See Chart #4.

5 Y 5/1; 5 GY 6/2, 7/2; 7.5 GY 5/2, 6/2; 10 GY 6/1, 6/2; 2.5 G 6/2; 5 G 5/2; 7.5 G 4/2, 5/2, 6/2; 10 G 4/2, 5/2; 2.5 BG 3/2, 4/2; 5 BG 3/2, 4/2, 5/1, 5/2; 7.5 BG 4/2; 10 BG 4/1.

55. Texture: Very Fine Grain, or fine grain

Pattern: Scored and continuous

Munsell Colors: Scirpus Olneyi - See Chart #8.

5 YR 4/1, 5/2; 7.5 YR 4/2, 5/2, 5/4; 10 YR 3/1, 4/1, 4/2, 5/2, 6/2; 2.5 Y 4/2, 5/2, 6/2, 7/2, 5 Y 4/1, 4/2, 5/1, 5/2, 6/2; 7.5 Y 4/2, 5/2, 7/2, 7/4; 10 Y 4/1, 5/2, 6/2, 7/2; 2.5 GY 4/2, 5/2, 6/2, 7/2; 5 GY 5/2; 7.5 GY 4/2, 5/2; 10 GY 5/1, 6/2; 2.5 G 4/2, 5/2; 5 G 4/1, 4/2.

44. No definite shape with borders mixed or blended, sometimes well defined.

6. Texture: Very Fine Grain or Fine grain.

Pattern: Broken (Mottled)

Munsell Colors: The following are common to Spartina patens/Distichlis spicata, Typha angustifolia, and Scirpus Olneyi.

5 YR 4/1, 5/2; 7.5 YR 4/2, 5/2; 10 YR 3/1, 4/1, 4/2, 5/2, 6/2; 2.5 Y 5/2 6/2; 5 Y 4/1, 4/2, 5/2, 6/2; 7.5 Y 5/2; 10 Y 4/1, 5/2; 2.5 GY 4/2; 5 GY 5/2; 7.5 GY 4/2, 5/2; 2.5 G 4/2; 5 G 4/2.

Munsell Colors: Typha angustifolia - See Chart #5.

5 R 3/1, 4/1; 10 R 4/1; 2.5 YR 5/2; 5 YR 3/1, 4/2, 5/4; 7.5 YR 6/2, 6/4; 10 YR 5/1, 5/4, 6/1, 6/4, 7/2; 2.5 Y 4/2*; 5 Y 3/1, 6/1**, 7/1; 7.5 Y 6/2**; 10 Y 3/1**, 5/1**, 7/1; 5 GY 3/1**, 4/1**, 4/2, 6/1; 7.5 GY 6/2**, 6/4; 10 GY 3/1**, 4/2**, 5/1*, 5/2**; 10 G 3/1, 4/1**, 5/2**; 5 BG 3/1; 10 BG 3/1; 5 PB 3/1; 10 PB 3/1; 10 P 3/1; N 4.0/; N 4.5/.

* Colors overlap with those of Scirpus Olneyi.

**Colors over lap with those of Spartina patens/Distichlis spicata.

Munsell Colors: Spartina patens/Distichlis spicata/Scirpus Olneyi - See Chart #10.

7.5 YR 4/2, 5/2; 10 YR 5/2, 6/2; 2.5 Y 5/2, 6/2, 7/2; 5 Y 4/1, 4/2, 5/1, 5/2, 6/2; 7.5 Y 4/2, 5/2, 7/2; 10 Y 4/1, 5/2, 6/2, 7/2; 2.5 GY 4/2, 5/2, 6/2, 7/2; 2.5 G 4/2, 5/2; 5 G 4/1, 4/2.

Munsell Colors: Spartina patens/Distichlis spicata - See Chart #6.

5 Y 7/2, 7/4; 7.5 Y 6/4, 7/4; 10 Y 7/4, 8/4; 2.5 GY 6/4; 5 GY 6/2, 6/4, 7/2; 10 GY 4/1, 6/2; 5 G 3/1, 5/2; 7.5 G 4/2, 5/2; 10 G 5/1; 2.5 BG 4/2; 5 BG 3/2, 4/1, 4/2; 7.5 BG 3/2, 4/2; 10 BG 3/2, 4/2.

Munsell Colors: Scirpus Olneyi - See Chart #8.

7.5 YR 5/4; 7.5 Y 7/4; 10 GY 6/2.

66. Texture: Coarse Grain.

Pattern: Broken (mottled)

Munsell Colors: Typha angustifolia - See Chart #5.

5 R 3/1, 4/1; 10 R 4/1; 2.5 YR 5/2; 5 YR 3/1, 4/1*, 4/2, 5/2*, 5/4; 7.5 YR 4/2*, 5/2*, 6/2, 6/4; 10 YR 3/1*, 4/1*, 4/2*, 5/1, 5/2*, 5/4, 6/1, 6/2*, 6/4, 7/2; 2.5 Y 4/2*, 5/2*, 6/2*; 5 Y 4/1, 4/1*, 4/2*, 5/2*, 6/1, 6/2*, 7/1; 7.5 Y 5/2*, 6/2; 10 Y 3/1, 4/1*, 5/1, 5/2*, 7/1; 2.5 GY 4/2*; 5 GY 3/1, 4/1, 4/2, 5/2*, 6/1; 7.5 GY 4/2*, 5/2*, 6/2, 6/4; 10 GY 3/1, 4/2, 5/1*, 5/2; 2.5 G 4/2*; 5 G 4/2*; 10 G 3/1, 4/1, 5/2; 5 BG 3/1; 10 BG 3/1; 5 PB 3/1; 10 PB 3/1; 10 P 3/1; N 4.0/; N 4.5/.

* Colors overlap with those of Scirpus Olneyi.

Munsell Colors: Scirpus Olneyi - See Chart #8.

7.5 YR 5/4; 2.5 Y 7/2; 5 Y 5/1; 7.5 Y 4/2, 7/2, 7/4; 10 Y 6/2, 7/2; 2.5 GY 5/2, 6/2, 7/2; 10 GY 6/2; 2.5 G 5/2; 5 G 4/1.

CHART A-1 - Iva frutescens community

Munsell color	Iva	M/W	Sp/D	% of constituents: Sp.alt.	Sp.cyno.	Scirp.	Typha	Other	Color Frequency(%)
5 YR 4/1	20-50	-	50-60	-	-	0-10	-	-	.5
7.5YR 4/2	10-50	10-40	-	-	-	-	50-60	-	.9
10 YR 4/1	50-60	40-50	-	-	-	-	-	-	.5
" " 4/2	50	0-25	-	-	-	0-30	-	-	.5
" " 5/2	70	0-30	0-15	0-10	-	0-15	-	-	.9
2.5 Y 5/2	10-50	0-40	0-40	-	-	-	0-60	-	1.4
5 Y 3/1	50-80	0-30	0-40	0-30	0-10	-	-	-	.5
" " 4/1	40-80	0-30	0-40	0-30	-	0-30	-	-	1.4
" " 4/2	10-80	0-40	-	-	-	-	0-60	-	.9
" " 5/2	40	-	0-40	-	0-40	-	-	-	.5
" " 6/1	40-60	40-50	0-10	0-10	-	-	-	-	.5
" " 6/2	50-80	0-30	0-40	0-30	0-10	-	-	-	.5
7.5 Y 4/2	50	0-25	-	-	-	0-30	-	-	.5
" " 5/2	50-70	0-25	0-50	-	-	0-30	-	-	.9
" " 6/2	30-80	0-25	20-50	-	-	-	-	-	1.4
" " 7/4	50	0-25	-	-	-	0-30	-	-	.5
10 Y 4/1	30-50	0-25	0-40	-	-	-	-	-	1.4
" " 5/1	30-70	0-20	0-50	-	-	-	-	-	.9
" " 5/2	40-80	0-20	10-50	-	-	-	-	-	1.9
" " 6/2	40-70	0-20	30-50	-	-	-	-	-	3.8
2.5GY 5/2	40	-	0-40	-	0-40	-	-	-	.5
" " 6/2	40-80	0-20	0-40	-	-	-	-	-	2.3
5 GY 3/1	50-80	0-30	0-40	0-30	0-10	-	-	-	.5
" " 4/1	50-70	0-25	15-50	-	-	-	-	-	.5
" " 4/2	50-70	0-30	0-15	0-10	-	0-30	-	-	.9
" " 5/2	40-100	0-25	0-40	-	-	-	-	-	2.8
" " 6/2	70-100	-	-	-	-	-	-	-	.5
7.5GY 4/2	50-80	0-30	10-50	-	-	-	-	-	4.2
" " 5/2	30-70	0-40	0-40	-	-	-	0-60	-	2.3
" " 6/2	50	-	50	-	-	-	-	-	.5
10 GY 3/1	50-80	0-30	0-40	0-30	0-10	-	-	-	.5
" " 4/1	40-80	0-20	10-50	0-30	0-10	-	-	-	3.2
" " 4/2	50-80	0-25	10-50	-	-	-	-	-	6.0
" " 5/2	35-80	0-30	0-50	-	-	-	-	-	2.8
" " 6/2	20-50	-	50-60	-	-	0-10	-	-	.5
2.5 G 3/2	50-70	0-25	15-50	-	-	-	-	-	.9
" " 4/2	60-90	0-25	10-50	-	-	-	-	-	3.8
" " 5/2	70-80	0-30	0-30	-	-	-	-	-	2.8

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CHART A-1 - continued

Munsell Color	Iva	M/W	Sp/D	% of constituents: Sp.alt.	Sp.cyno.	Scirp.	Typha	Other	Color Frequency(%)
5 G 4/1	30-80	0-25	0-50	0-30	0-10	0-10	-	-	2.8
" " 4/2	60-100	0-30	0-40	-	-	-	-	-	4.6
" " 5/2	50-80	0-30	0-40	0-20	-	-	-	-	2.3
7.5 G 4/2	50-100	0-20	0-40	-	-	-	-	-	3.2
" " 4/4	90-100	-	0-10	-	-	-	-	-	.5
" " 5/2	50-90	0-20	0-40	-	-	-	-	-	1.4
10 G 3/1	60-90	0-20	10-40	-	-	-	-	-	1.4
" " 4/1	60-90	0-20	10-40	-	-	-	-	-	2.3
" " 4/2	60-100	0-20	0-20	-	-	-	-	-	1.9
" " 5/2	60-90	0-20	10-40	-	-	-	-	-	.9
2.5BG 4/2	60-90	0-20	10-40	-	-	-	-	-	2.8
5 BG 3/1	60-90	0-20	10-40	-	-	-	-	-	.5
" " 3/2	50-90	0-20	10-40	-	-	-	-	-	3.2
" " 4/1	60-90	0-20	10-40	-	-	-	-	-	1.4
" " 4/2	60-90	0-20	10-40	-	-	-	-	-	3.2
" " 4/4	60	0-30	0-10	-	-	-	-	shrubs	.5
7.5BG 3/2	50-70	0-20	0-40	-	-	-	-	-	2.3
" " 4/2	55-80	0-20	0-45	-	-	-	-	-	2.3
" " 4/4	60	0-30	0-10	-	-	-	-	shrubs	.5
10 BG 3/1	50-60	40-50	-	-	-	-	-	-	1.4
" " 3/2	40-70	0-20	0-50	-	-	-	-	-	.9
" " 4/2	40-70	0-20	30-50	-	-	-	-	-	.5
2.5 B 3/2	70-100	0-20	0-20	-	-	-	-	-	.9
10 B 2/2	70-100	0-20	0-20	-	-	-	-	-	.5
" " 3/1	60	0-30	0-10	-	-	-	-	shrubs	.5
5 PB 2/1	50-80	0-30	0-40	0-30	0-10	-	-	-	.5
" " 3/1	50-60	40-50	-	-	-	-	-	-	.5
N 8.5/	50-60	40-50	-	-	-	-	- mostly sand		.9

CHART A-2 - Spartina alterniflora community

Munsell Color	Sp.alt.	M/W	Sp/D	Iva	Sp.cyno.	Typha	Other		Color Frequency(%)
	% of constituents:								
7.5YR 5/2	80-100	0-50	-	-	-	-	& sand		1.6
10 YR 3/1	40-80	20-40	0-20	-	-	-	-		1.6
" " 4/1	30-50	30-40	20-40	-	-	-	-		1.6
" " 4/2	50	20-40	-	0-20	0-10	0-15	-		1.6
5 Y 3/1	40-100	0-50	0-20	-	-	-	-		6.5
" " 4/1	30-80	0-50	0-40	-	-	-	-		4.8
7.5 Y 5/2	10-40	0-40	20-50	-	-	-	-		1.6
" " 6/2	10-40	0-40	20-50	-	-	-	-		1.6
10 Y 3/1	40-80	20-50	0-20	0-15	-	-	-		3.2
" " 3/2	40-50	20-50	-	10-15	-	-	-		1.6
" " 4/1	30-50	30-40	20-40	-	-	-	-		3.2
2.5GY 4/2	30-50	20-50	0-20	0-15	-	-	-		3.2
" " 5/2	60-100	-	-	-	-	-	-		1.6
" " 5/4	60-100	-	-	-	-	-	-		1.6
" " 6/2	80-100	0-50	-	-	-	-	& sand		1.6
" " 7/2	80-100	0-50	-	-	-	-	& sand		1.6
5 GY 3/1	40-80	20-40	0-20	-	-	-	-		8.1
" " 4/1	40-80	20-40	0-30	-	-	-	-		6.5
" " 5/2	50	20-40	-	0-20	0-10	0-15	-		3.2
" " 6/2	40-80	0-50	0-20	-	-	-	-		3.2
7.5GY 4/2	50	20-40	-	0-20	0-10	0-15	-		1.6
" " 5/2	40-50	20-50	-	0-20	0-10	0-15	-		4.8
10 GY 4/1	80-100	0-50	-	-	-	-	& sand		3.2
" " 4/2	40-80	0-50	-	-	-	-	-		4.8
2.5 G 4/2	40-100	0-50	-	0-10	-	0-10	-		8.0
5 G 3/1	80-100	0-50	-	-	-	-	& sand		1.6
" " 4/1	50-90	0-50	-	0-20	0-10	0-15	-		3.2
10 G 4/1	50	20-40	-	0-20	0-10	0-15	-		1.6
2.5BG 3/2	60-70	-	10-20	20-30	-	-	-		1.6
" " 4/2	60-90	0-50	10-20	10-30	-	-	-		4.8
5 PB 3/1	80-100	0-50	-	-	-	-	& sand		1.6
" " 4/1	80-100	0-50	-	-	-	-	& sand		1.6
N 7.5/	80-100	0-50	-	-	-	-	& sand		1.6

CHART A-3 - Mud/Water community

Munsell Color	M/W	Iva	Typha	Sp/D	Scirp.	Hib.	Sp.alt.		Color Frequency(%)
		% of constituents:							
10 R 3/1	60-100	-	-	0-40	0-40	-	-		.7
5 YR 3/1	40-70	0-15	0-80	0-40	0-40	0-20	0-50		1.3
" " 4/1	20-70	0-15	0-80	-	-	0-20	0-50		1.3
7.5YR 4/2	40-75	-	0-50	-	0-20	0-40	-		1.3
" " 5/2	40-70	0-60	0-50	0-50	0-50	0-40	0-40		2.7
10 YR 3/1	20-50	0-15	0-80	0-20	0-20	0-40	0-60		2.7
" " 4/1	40-75	0-15	0-50	0-40	-	0-15	0-50		3.4
" " 4/2	20-50	0-15	0-80	-	-	0-20	0-50		2.7
" " 5/1	50-100	-	0-60	-	-	-	-		2.7
" " 5/2	40-80	0-15	0-80	0-40	0-60	-	-		8.1
" " 6/1	60-100	-	0-50	-	-	0-15	-		2.0
" " 6/2	30-50	0-60	0-60	0-50	0-70	-	0-40		1.3
" " 7/1	100	-	-	-	-	-	-		1.3
" " 7/2	40-50	0-60	0-60	0-20	-	-	0-40		.7
2.5 Y 4/2	30-70	-	30-70	-	-	-	-		.7
" " 5/2	20-50	0-15	0-80	0-50	0-70	0-20	0-50		1.3
" " 6/2	100	-	-	-	-	-	-		.7
5 Y 3/1	20-50	0-15	0-80	0-20	-	0-20	0-70		2.7
" " 4/1	30-40	0-40	-	0-40	-	0-50	0-15		2.0
" " 5/1	0-40	-	-	20-50	0-70	-	0-40		.7
" " 5/2	0-40	-	-	20-50	0-70	-	0-40		.7
" " 6/1	50-100	0-15	15-50	0-20	-	-	-		5.4
" " 6/2	30-70	-	30-70	-	-	-	-		.7
" " 7/1	50-75	-	15-50	-	-	0-15	-		.7
7.5 Y 5/2	20-50	0-15	0-80	0-50	0-70	0-20	0-50		1.3
" " 6/2	0-40	-	-	20-50	0-70	-	0-40		.7
10 Y 3/1	20-50	0-15	0-80	0-20	-	0-20	0-60		2.7
" " 3/2	20-50	0-15	0-80	-	-	0-20	0-50		.7
" " 4/1	30-75	0-30	0-60	0-40	-	-	-		5.4
" " 5/1	50-100	0-15	0-70	0-20	-	-	-		8.7
" " 5/2	30	30-40	-	0-15	0-15	-	-		.7
" " 6/1	100	-	-	-	-	-	-		1.3
" " 6/2	30-70	0-40	-	0-50	0-70	-	0-40		2.0
" " 7/1	60-100	-	0-50	-	-	0-15	-		2.0
" " 7/2	0-40	0-40	-	0-15	0-15	-	-		.7
2.5GY 4/2	20-50	0-60	0-80	0-20	-	0-20	0-50		1.3
5 GY 3/1	20-40	0-60	0-60	0-20	0-70	-	30-70		3.4
" " 4/1	20-50	-	0-60	0-20	-	-	0-70		4.7

CHART A-3 - continued

Munsell Color	M/W	Iva	Typha	% of constituents: Sp/D	Scirp.	Hib.	Sp.alt.		Color Frequency(%)
5 GY 4/2	20-50	0-15	0-80	-	-	0-20	0-50		.7
" " 6/1	50-75	-	15-50	-	-	0-15	-		.7
" " 6/2	40-50	0-60	0-60	0-20	-	-	0-40		.7
7.5GY 4/2	40-50	0-60	0-60	0-20	-	-	0-40		.7
10 GY 4/2	20-50	0-60	0-80	0-20	-	0-20	0-50		1.3
2.5 G 4/2	40-75	0-60	0-60	0-20	-	0-15	0-40		1.3
10 G 3/1	20-50	0-15	0-80	-	-	0-20	0-50		.7
" " 4/1	20-50	0-15	0-80	-	-	0-20	0-50		.7
" " 5/4	60	-	15-20	-	-	-	0-25		.7
2.5BG 5/4	60	-	15-20	-	-	-	0-25		.7
10 BG 3/1	20-50	0-15	0-80	-	-	0-20	0-50		1.3
5 B 4/1	60-100	-	-	0-40	0-40	-	-		.7
5 PB 2/1	60-100	-	-	0-40	0-40	-	-		1.3
" " 3/1	60-100	-	15-50	0-40	0-40	-	-		2.7
10 PB 3/1	0-40	-	-	20-50	0-70	-	0-40		.7
10 P 3/1	50-75	-	15-50	-	-	0-15	-		.7
N 4.0/	50-75	-	15-50	-	-	0-15	-		.7
N 4.5/	50-75	-	15-50	-	-	0-15	-		.7

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CHART A-4 - Phragmites communis community

Munsell color	Phrag.	M/W	Iva	Hib.	Sp/D				Color Frequency(%)
5 Y 5/1	90-100	-	-	-	-				3.2
5 GY 6/2	70-100	0-30	-	-	-				3.2
" " 7/2	70-100	0-30	-	-	-				6.5
7.5GY 5/2	100	-	-	-	-				9.7
" " 6/2	100	-	-	-	-				9.7
10 GY 6/1	100	-	-	-	-				3.2
" " 6/2	100	-	-	-	-				3.2
2.5 G 6/2	70-100	0-30	-	-	-				3.2
5 G 5/2	60-100	0-20	-	0-20	-				6.5
7.5 G 4/2	100	-	-	-	-				3.2
" " 5/2	90-100	-	-	-	-				6.5
" " 6/2	100	-	-	-	-				3.2
10 G 4/2	100	-	-	-	-				3.2
" " 5/2	100	-	-	-	-				3.2
2.5BG 3/2	60-70	0-20	-	10-20	-				3.2
" " 4/2	60-70	0-20	-	10-20	-				3.2
5 BG 3/2	100	-	-	-	-				3.2
" " 4/2	100	-	-	-	-				9.7
" " 5/1	80-100	-	0-20	-	0-10				3.2
" " 5/2	80-100	-	0-20	-	0-10				3.2
7.5BG 4/2	100	-	-	-	-				3.2
10 BG 4/1	100	-	-	-	-				3.2

CHART A-5 - Typha angustifolia community

Munsell Color	Typha	M/W	Hib.	Sp/D	Iva	Sp.alt.			Color Frequency(%)
			% of constituents:						
5 R 3/1	60-90	0-30	0-30	0-20	10-20	-			.4
" " 4/1	60-90	0-30	0-30	0-20	10-20	-			.4
10 R 4/1	60-100	0-30	0-20	-	-	-			.8
2.5YR 5/2	70-90	0-10	0-20	-	-	-			.4
5 YR 3/1	30-80	0-50	-	-	-	0-50			.8
" " 4/1	60-100	0-40	0-30	0-20	0-25	-			5.0
" " 4/2	60-90	0-30	0-30	0-20	0-30	-			1.9
" " 5/2	60-100	0-20	0-20	-	-	-			3.5
" " 5/4	60-100	0-25	0-30	0-20	0-20	-			.8
7.5YR 4/2	50-80	0-40	0-40	0-15	0-25	0-10			2.7
" " 5/2	60-100	0-30	0-20	0-20	0-25	-			3.9
" " 6/2	80-100	0-20	0-10	-	-	-			.8
" " 6/4	70-100	0-30	0-20	-	-	-			.4
10 YR 3/1	50-100	0-40	0-30	0-20	0-20	-			2.7
" " 4/1	40-90	0-30	0-20	0-15	0-20	0-5			5.4
" " 4/2	50-100	0-50	0-30	0-15	0-20	0-5			6.2
" " 5/1	30-70	20-70	0-15	-	-	-			.8
" " 5/2	50-100	0-40	0-20	0-15	0-10	0-5			13.5
" " 5/4	70-100	0-30	0-20	-	-	-			.4
" " 6/1	15-50	50-75	0-15	-	-	-			.4
" " 6/2	60-100	0-40	0-20	0-15	0-15	0-5			3.9
" " 6/4	60-100	0-30	0-20	0-15	-	0-10			3.5
" " 7/2	50-80	0-40	0-40	-	0-40	-			.8
2.5 Y 4/2	60-80	0-40	0-20	0-20	-	-			.8
" " 5/2	60-100	0-30	0-30	-	-	-			3.1
" " 6/2	50-80	0-20	0-20	-	0-10	-			1.2
5 Y 3/1	50-90	0-50	0-20	-	-	-			1.5
" " 4/1	50-90	0-40	0-20	-	-	-			1.2
" " 4/2	40-70	0-40	0-40	0-20	0-30	-			1.2
" " 5/2	70-80	0-15	0-20	-	-	-			.8
" " 6/1	30-60	20-60	0-15	-	-	-			1.2
" " 6/2	30-70	30-70	-	-	-	-			.4
" " 7/1	15-50	50-75	0-15	-	-	-			.4
7.5 Y 5/2	50-90	0-50	0-20	-	-	-			.8
" " 6/2	70-100	0-30	0-20	-	-	-			.4
10 Y 3/1	50-80	0-50	0-20	-	-	-			1.2
" " 4/1	40-90	0-50	0-15	0-20	0-20	-			2.3
" " 5/1	30-60	0-60	0-20	-	0-25	-			.8

CHART A-5 - continued

Munsell Color	% of constituents: Typha	M/W	Hib.	Sp/D	Iva	Sp.alt.			Color Frequency(%)
10 Y 5/2	60-90	0-30	0-30	0-20	10-20	-			.4
" " 7/1	15-50	50-75	0-15	-	-	-			.4
2.5GY 4/2	60-80	0-25	0-20	0-20	0-30	-			.8
5 GY 3/1	60-70	0-10	0-10	-	-	-			.4
" " 4/1	40-100	0-50	0-30	0-20	-	0-20			4.2
" " 4/2	40-70	0-30	10-60	-	-	-			1.5
" " 5/2	60-90	0-10	0-20	-	-	-			1.5
" " 6/1	15-50	50-75	0-15	-	-	-			.4
7.5GY 4/2	40-70	0-20	0-20	0-20	-	-			.8
" " 5/2	30-60	0-40	0-40	0-20	0-30	0-20			2.3
" " 6/2	40-50	5-10	-	-	-	-			.4
" " 6/4	70-90	0-10	0-20	-	-	-			.4
10 GY 3/1	60-90	0-30	0-30	0-20	10-20	-			.4
" " 4/2	60-100	0-20	0-20	-	-	-			1.5
" " 5/1	70-100	0-30	0-20	-	-	-			.4
" " 5/2	40-60	0-30	0-30	-	0-25	0-20			.8
2.5 G 4/2	50-80	0-50	0-15	0-20	-	-			.8
5 G 4/2	70-80	0-20	10-20	10-20	-	-			.4
10 G 3/1	50-80	20-50	-	-	-	-			.4
" " 4/1	60-90	0-40	0-20	-	-	-			.8
" " 5/2	70-100	0-30	0-20	-	-	-			.4
5 BG 3/1	40-90	0-40	0-30	-	-	-			.8
10 BG 3/1	50-80	20-50	-	-	-	-			.8
5 PB 3/1	30-80	0-50	0-30	0-20	0-20	-			.8
10 PB 3/1	60-90	0-30	0-30	0-20	10-20	-			.8
10 P 3/1	30-80	30-75	0-30	0-20	0-20	-			.8
N 4.0/	15-50	50-75	0-15	-	-	-			.4
N 4.5/	15-50	50-75	0-15	-	-	-			.4

CHART A-6 - Spartina patens/Distichlis spicata community

Munsell color	Sp/D	M/W	Iva	% of constituents Scirp.O.	Sp. alt.	Hib.	Typha		Color Frequency(%)
5 YR 4/1	50-80	0-20	0-40	0-25	-	-	-		.6
" " 5/2	60-100	0-40	-	-	-	-	-		.3
7.5YR 4/2	30-70	0-20	0-35	0-25	-	-	-		.6
" " 5/2	40-70	0-20	0-25	0-40	0-20	-	-		.9
10YR 3/1	90-100	0-10	-	0-10	-	-	-		.3
" " 4/1	60-100	0-20	0-30	0-40	0-30	-	-		2.5
" " 4/2	90-100	0-10	-	0-10	-	-	-		.3
" " 5/2	20-60	0-40	0-60	0-70	0-40	-	-		1.2
" " 6/2	30-60	0-40	0-50	0-60	0-40	-	-		.6
2.5 Y 5/2	40-90	0-30	0-40	0-50	0-40	-	-		1.2
" " 6/2	40-70	-	0-50	0-50	-	-	-		1.5
" " 7/2	35-50	0-30	-	35-50	-	-	-		.6
5 Y 4/1	50-90	0-30	0-30	0-40	0-50	-	-		1.8
" " 4/2	60-100	0-10	0-30	0-30	-	0-20	-		1.2
" " 5/1	20-50	0-40	0-55	0-70	0-40	-	-		.3
" " 5/2	50-100	0-30	0-30	0-40	0-40	0-20	-		2.8
" " 6/1	50	-	-	-	-	25	25		.3
" " 6/2	60-100	0-20	0-30	0-40	-	-	-		4.3
" " 7/2	60-100	-	-	-	-	-	-		.3
" " 7/4	60-100	-	-	-	-	-	-		.9
7.5 Y 4/2	20-40	0-10	0-30	30-50	-	0-20	-		.3
" " 5/2	30-100	0-20	0-40	0-50	0-25	0-20	-		3.1
" " 6/2	60-100	0-20	0-30	0-20	-	-	-		5.2
" " 6/4	60-90	0-20	0-30	0-40	-	-	-		.6
" " 7/2	60-100	0-20	0-30	0-40	-	-	-		3.4
" " 7/4	60-100	-	-	-	-	-	-		2.1
10 Y 3/1	90-100	0-10	-	0-10	-	-	-		.3
" " 4/1	30-90	0-20	0-30	0-50	0-50	0-20	-		2.5
" " 5/1	30-50	0-20	0-70	0-50	-	-	-		.3
" " 5/2	30-70	0-30	0-50	0-50	-	-	-		1.8
" " 6/2	50-100	0-20	0-50	0-50	-	-	-		7.1
" " 7/2	60-100	0-10	-	0-40	-	-	-		4.0
" " 7/4	60-100	-	-	-	-	-	-		1.8
" " 8/4	60-100	-	-	-	-	-	-		.3
2.5GY 4/2	40-70	0-20	0-40	0-40	0-25	-	-		1.2
" " 5/2	40-100	0-20	0-40	0-40	0-25	-	-		2.8
" " 6/2	60-100	0-20	0-40	0-40	-	-	-		5.0
" " 6/4	60-100	-	-	-	-	-	-		.3

CHART A-6 - continued

Munsell color	Sp/D	M/W	Iva	Scirp. O.	Sp.alt.	Hib.	Typha		Color Frequency(%)
	% of constituents								
2.5GY 7/2	50-100	0-15	-	0-40	-	-	-		2.1
5 GY 3/1	40-70	0-30	0-50	0-70	0-30	-	-		.6
" " 4/1	50-100	0-20	0-30	0-40	-	-	-		1.5
" " 5/2	50-100	0-20	0-50	0-40	-	-	-		5.2
" " 6/2	60-100	0-20	0-30	0-40	-	-	-		5.0
" " 6/4	70-100	0-10	-	0-10	-	-	-		.6
" " 7/2	60-100	-	-	-	-	-	-		.3
7.5GY 4/2	30-70	0-40	0-50	0-55	0-40	-	-		.6
" " 5/2	30-80	0-30	0-40	0-55	0-40	-	-		.6
" " 6/2	50-80	-	20-50	-	-	-	-		.9
10 GY 3/1	60-90	0-20	0-30	0-40	-	-	-		.3
" " 4/1	30-90	0-20	0-50	0-45	-	-	-		3.1
" " 4/2	30-80	0-20	0-60	0-60	0-40	-	-		1.8
" " 5/2	50-90	0-10	0-50	0-10	-	-	-		.9
" " 6/2	50-60	-	0-50	0-10	-	-	-		.3
2.5 G 4/2	20-50	0-20	0-50	0-50	-	0-20	-		1.2
" " 5/2	30-70	0-10	0-30	0-50	-	0-20	-		.6
5 G 3/1	60-90	0-20	0-30	0-40	-	-	-		.3
" " 4/1	30-90	0-20	0-50	0-45	-	-	-		1.5
" " 4/2	50	-	50	-	-	-	-		.3
" " 5/2	30-50	0-20	0-70	0-50	-	-	-		.3
7.5 G 4/2	30-70	0-20	0-60	0-50	-	-	-		.9
" " 5/2	30-80	0-20	0-55	0-50	-	-	-		.6
10 G 4/1	60-100	0-20	0-40	0-25	-	-	-		1.2
" " 5/1	60-100	-	-	-	-	-	-		.3
" " 5/2	90	0-10	-	0-10	-	-	-		.3
2.5BG 4/2	30-50	0-20	0-70	0-50	-	-	-		.6
5 BG 3/2	30-50	0-20	0-70	0-50	-	-	-		.6
" " 4/1	60-100	-	-	-	-	-	-		.3
" " 4/2	30-50	0-20	0-70	0-50	-	-	-		.9
7.5BG 3/2	30-50	0-20	0-70	0-50	-	-	-		.3
" " 4/2	30-50	0-20	0-70	0-50	-	-	-		.6
10 BG 3/2	30-50	0-20	0-70	0-50	-	-	-		.3
" " 4/2	30-50	0-20	0-70	0-50	-	-	-		.3

CHART A-7 - Acorus Calamus community

Munsell color	Acorus Calamus								Frequency(%)
10 YR 7/4	90-100								28.6
2.5 Y 7/2	"								28.6
" " 8/2	"								14.3
" " 8/4	"								14.3
2.5GY 6/2	"								14.3

CHART A-8 - Scirpus Olneyi community

				% of constituents:					Color
Munsell color	Scirp.O.	M/W	Sp/D	Iva	Hib.	Typha			Frequency(%)
5 YR 4/1	50-80	20-50	-	-	-	-			1.1
" " 5/2	50-100	0-50	-	-	-	-			1.1
7.5YR 4/2	40-80	0-60	0-50	0-30	-	-			2.2
" " 5/2	40-100	0-50	0-50	-	-	-			2.2
" " 5/4	50-100	0-50	-	-	-	-			1.1
10 YR 3/1	80	-	-	-	10	10			1.1
" " 4/1	40-80	0-60	-	-	0-10	0-10			2.2
" " 4/2	50-80	0-40	0-20	0-20	0-20	-			4.3
" " 5/2	40-80	0-40	0-50	0-30	0-10	0-10			7.5
" " 6/2	40-80	0-45	0-50	-	-	-			2.2
2.5 Y 4/2	50-80	0-30	0-20	0-15	0-15	-			3.2
" " 5/2	40-100	0-40	0-50	-	-	-			4.3
" " 6/2	35-65	0-15	0-50	-	-	-			4.3
" " 7/2	35-50	0-15	35-50	-	-	-			2.2
5 Y 4/1	50-100	-	0-20	0-30	-	-			2.2
" " 4/2	40-50	0-10	20-50	0-30	-	-			1.1
" " 5/1	40-70	0-40	20-50	-	-	-			1.1
" " 5/2	40-90	0-30	0-50	0-30	-	-			8.6
" " 6/2	35-75	0-15	0-50	-	-	-			5.4
7.5 Y 4/2	40-50	0-10	20-50	0-30	-	-			1.1
" " 5/2	30-80	0-20	0-45	0-10	-	-			5.4
" " 7/2	35-50	0-15	35-50	-	-	-			3.2
" " 7/4	70-90	10-30	-	-	-	-			1.1
10 Y 4/1	30-40	10	20-40	0-10	10-20	-			1.1
" " 5/2	35-50	-	-	-	-	-			2.2
" " 6/2	40-70	0-40	20-50	-	-	-			4.3
" " 7/2	35-60	0-30	20-50	-	-	-			3.2
2.5GY 4/2	40-80	0-10	0-50	-	0-30	-			3.2
" " 5/2	40-80	0-10	0-40	0-30	-	-			3.2
" " 6/2	40	10-20	40	-	0-10	-			1.1
" " 7/2	35-50	0-15	35-50	-	-	-			1.1
5 GY 5/2	70-90	0-30	0-30	-	-	-			2.2
7.5GY 4/2	70-80	-	-	-	20-30	-			1.1
" " 5/2	70-90	10-30	-	-	-	-			1.1
10 GY 5/1	50-80	20-50	-	-	-	-			1.1
" " 6/2	50-80	20-50	-	-	-	-			1.1
2.5 G 4/2	30-40	10	20-40	0-10	10-20	-			2.2
" " 5/2	30-40	10	20-40	0-10	10-20	-			1.1

CHART A-8 - continued

Munsell color	Scirp. O.	M/W	Sp/D	Iva	Hib.	Typha			Color Frequence(%)
5 G 4/1	50-80	20-50	-	-	-	-			1.1
" " 4/2	50-80	20-50	-	-	-	-			2.2

CHART A-9 - Spartina alterniflora & Mud/Water communities combined.

Munsell color	Sp.alt.	M/W	Sp/D	Iva	Typha				
	% of constituents:								
7.5YR 5/2	40-80	20-60	-	-	-				
10 YR 3/1	40-80	20-50	0-20	-	-				
" " 4/1	30-50	40-70	0-40	-	-				
" " 4/2	50	20-50	-	0-20	0-10				
5 Y 3/1	40-100	0-50	0-20	-	-				
" " 4/1	30-80	20-50	0-40	-	-				
7.5 Y 5/2	10-50	20-50	10-50	-	-				
" " 6/2	10-40	0-40	20-50	-	-				
10 Y 3/1	40-70	20-50	0-20	0-15	-				
" " 3/2	40-50	20-50	-	0-15	-				
" " 4/1	30-50	30-70	0-40	0-15	0-10				
2.5GY 4/2	30-50	20-50	0-20	0-30	-				
5 GY 3/1	40-80	20-40	0-20	-	-				
" " 4/1	40-80	20-40	0-30	-	-				
" " 6/2	40-80	20-50	0-20	-	-				
7.5GY 4/2	50	20-50	0-10	0-30	0-15				
10 GY 4/2	40-80	20-50	0-10	0-15	0-10				
2.5 G 4/2	40-100	0-50	0-10	0-15	0-15				
10 G 4/1	50	20-40	-	0-20	0-20				
5 PB 3/1	0-100	0-100	0-20	-	0-25				

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CHART A-10 - Some - Spartina patens/Distichlis spicata combined with Scirpus Olneyi communities

Munsell color	Sp/D	Scirp. O.	M/W	Iva	Hib.	Typha			
7.5YR 4/2	30-50	25-60	0-40	0-30	-	-			
" " 5/2	40-60	40-60	0-30	0-10	-	-			
10 YR 5/2	20-50	40-80	0-40	0-45	0-5	0-5			
" " 6/2	30-50	40-80	0-30	0-25	-	-			
2.5 Y 5/2	30-60	40-70	0-30	0-20	-	-			
" " 6/2	40-70	30-60	0-10	0-25	-	-			
" " 7/2	35-50	35-60	0-30	-	-	-			
5 Y 4/1	20-60	40-80	0-15	0-30	-	-			
" " 4/2	20-70	30-50	0-10	0-20	0-20	-			
" " 5/1	20-50	40-70	0-40	0-25	-	-			
" " 5/2	40-70	30-60	0-30	0-30	0-10	-			
" " 6/2	40-80	20-60	0-15	0-15	-	-			
7.5 Y 4/2	20-50	30-50	0-10	0-30	0-10	-			
" " 5/2	30-80	20-70	0-20	0-20	0-10	-			
" " 7/2	50-80	20-50	0-15	0-15	-	-			
10 Y 4/1	30-80	20-50	0-15	0-25	0-20	-			
" " 5/2	30-70	30-50	0-20	0-25	-	-			
" " 6/2	40-90	10-60	0-30	0-25	-	-			
" " 7/2	50-90	10-50	0-30	-	-	-			
2.5GY 4/2	30-60	40-70	0-15	0-20	0-15	-			
" " 5/2	40-80	20-60	0-15	0-25	-	-			
" " 6/2	60-100	0-40	0-20	0-20	0-10	-			
" " 7/2	45-90	10-40	0-15	-	-	-			
2.5 G 4/2	20-50	30-50	0-20	0-30	0-20	-			
" " 5/2	20-70	30-50	0-10	0-20	0-20	-			
5 G 4/1	30-80	20-70	0-20	0-25	-	-			
" " 4/2	20-50	50-80	-	-	-	-			

APPENDIX B

Anne Arundel County Wetland Vegetation

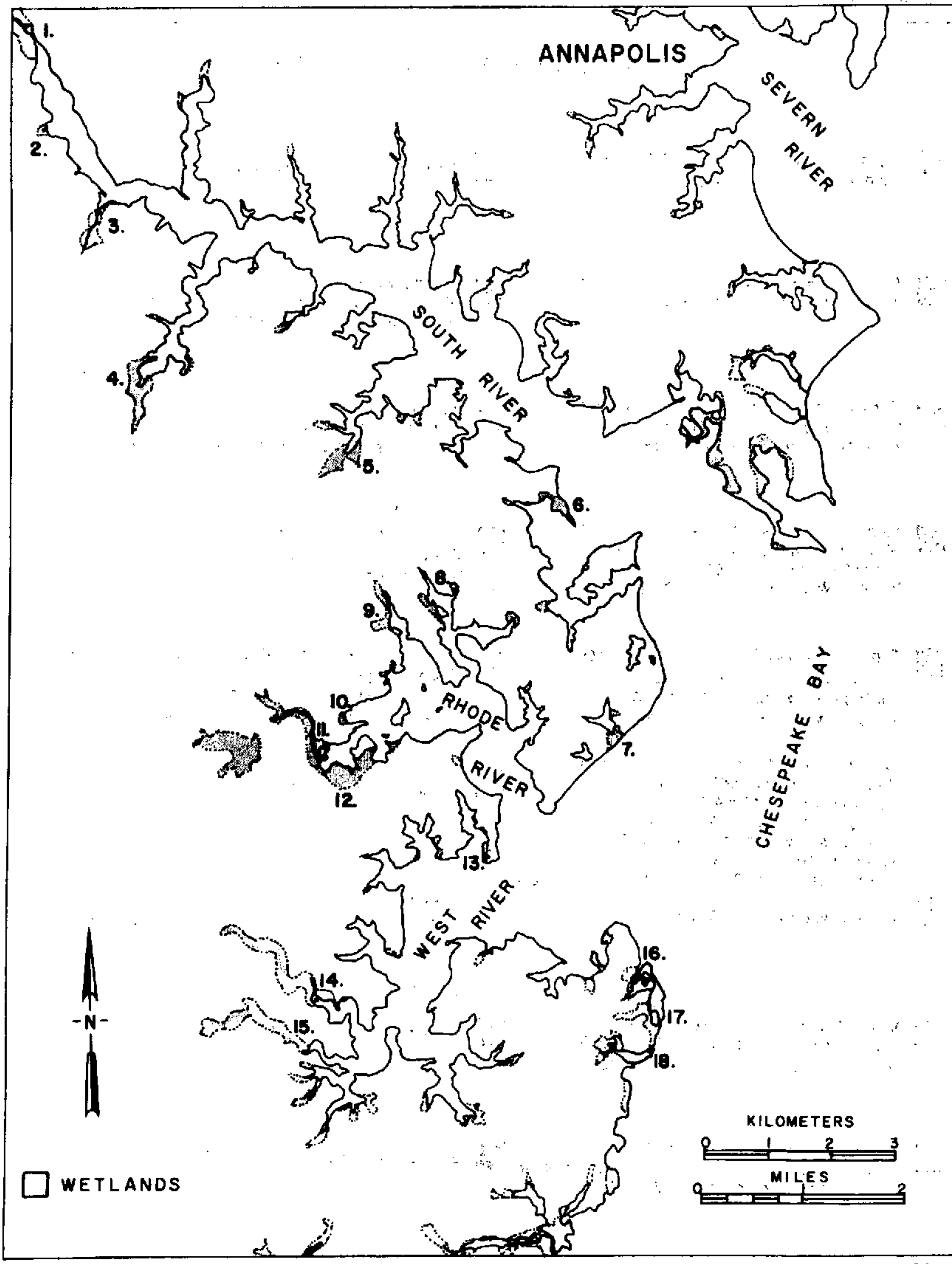
Appendix B

WETLANDS MAPPED in the CHESAPEAKE BAY, SOUTH, RHODE and WEST RIVERS

1. South River Headwaters
2. St. George Barber Creek Marsh
3. Flat Creek Marsh
4. Beards Creek Marsh
5. Glebe Creek Marsh
6. Long Point Marsh
7. Deep Pond Marsh
8. Bear Neck Creek Marshes*
9. Sellman Creek Marsh *
10. Fox Creek Marsh *
11. Hog Island Marsh *
12. Kirkpatrick Marsh*
13. Cheston Point Marsh *
14. Lerch Creek Marsh
15. Smith Creek Marsh
16. Jack Creek Marsh
17. Felicity Cove Marsh
18. Snug Harbor Marsh

* These maps were included in the 1972 Annual Report (NASA CR-62094).

Appendix B


ANNAPOLIS
SEVERN RIVER
SOUTH RIVER
RHODE RIVER
WEST RIVER
CHESEPEAKE BAY
1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
17.
18.
N
WETLANDS
KILOMETERS
0 1 2 3
MILES
0 1 2

Appendix B

SOUTH RIVER HEADWATERS

Typha angustifolia 70-100%
Mud / Water 0-30%

Typha angustifolia 50-80%
Mud / Water 20-50%

Typha angustifolia 50-100%
Mud / Water 0-40%
Hibiscus palustris 0-30%

Typha angustifolia 60-90%
Hibiscus palustris/Polygonum arifolium 0-30%
Mud / Water 0-30%

Typha angustifolia 60-90%
Hibiscus palustris 0-30%
Polygonum sp. 0-30%
Mud / Water 0-20%

Typha angustifolia 30-50%
Onoclea sensibilis/Thelypteris palustris 0-40%
Polygonum sp. 0-20%
Hibiscus palustris 0-20%
Scirpus sp. 0-20%
Juncus sp. 0-20%, Mud/Water 0-20%

Mud / Water 100%

Mud / Water 50-75%
Typha angustifolia 15-50%
Hibiscus palustris 0-15%

Spartina patens 50%
Hibiscus palustris, Scirpus robustus & *Typha angustifolia* 50%

Phragmites communis 100%

Phragmites communis 60-70%
Hibiscus palustris 10-20%
Mud / Water 0-20%

Scirpus sp. 50%
Typha angustifolia 30%
Hibiscus palustris/Asclepias incarnata 20%

Scirpus robustus/Spartina alterniflora 40-50%
Typha angustifolia 30-40%
Mud / Water 0-20%

Hibiscus palustris/Rosa palustris 50-60%
Typha angustifolia 30-40%
Mud / Water 10-20%
Acnida cannabina 0-10%

Fresh Marsh : See Figure

Trees & Shrubs :
Alnus sp., Acer rubrum & *Rosa palustris*

Upland Grasses 100%

Sand & Shale Flat 100%

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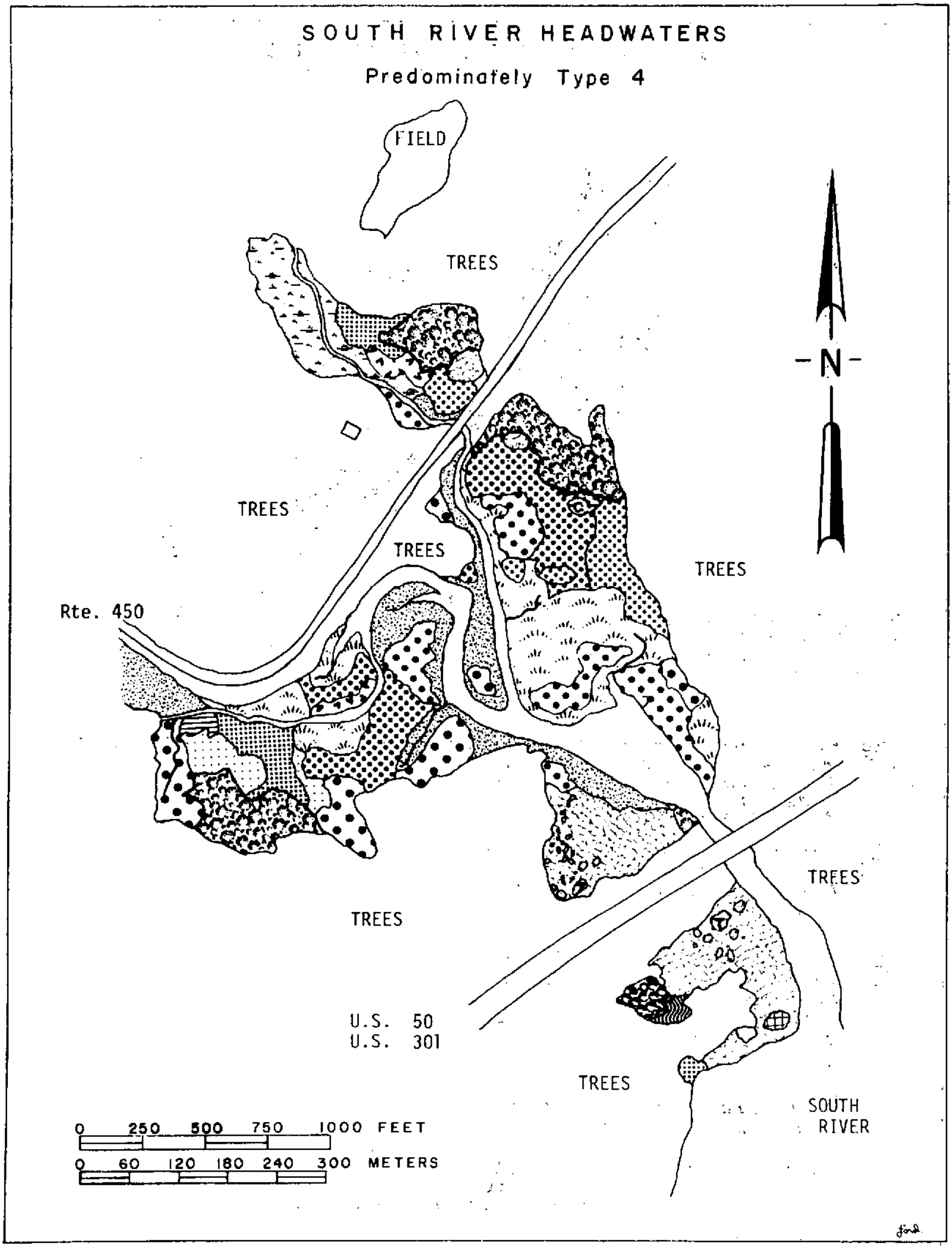

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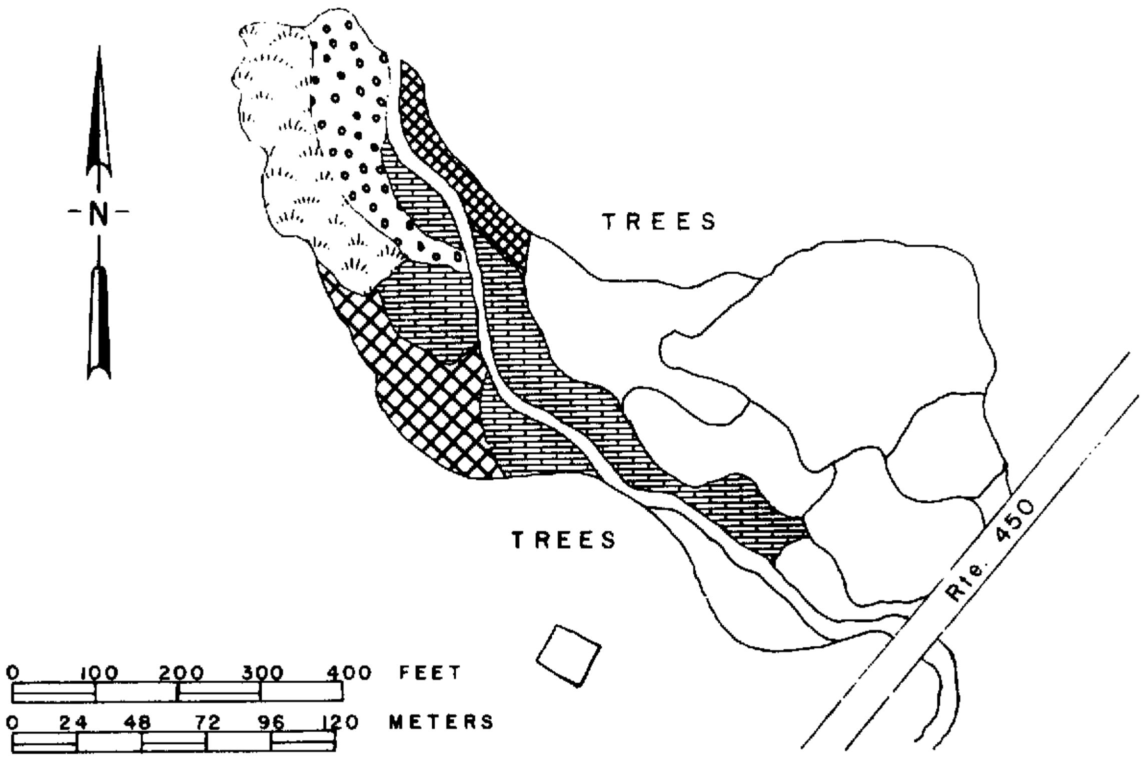
Appendix B

SOUTH RIVER HEADWATERS
Detail of Fresh Marsh Portion



Polygonum arifolium, P. sagittatum, P. hydropiperoides 70 - 80 %
Impatiens biflora 10 - 20 %
Peltandra virginica 0 - 10 %
Ludwigia palustris 0 - 10 %
Mud / Water 0 - 10 %

Impatiens biflora 80 %
Aster simplex 10 - 20 %
Polygonum arifolium 0 - 10 %
Mud / Water 0 - 5 %

Impatiens biflora 30 - 40 %
Aster simplex 20 - 50 %
Polygonum arifolium 15 %
Upland Grasses 0 - 10 %
Mud / Water 0 - 10 %

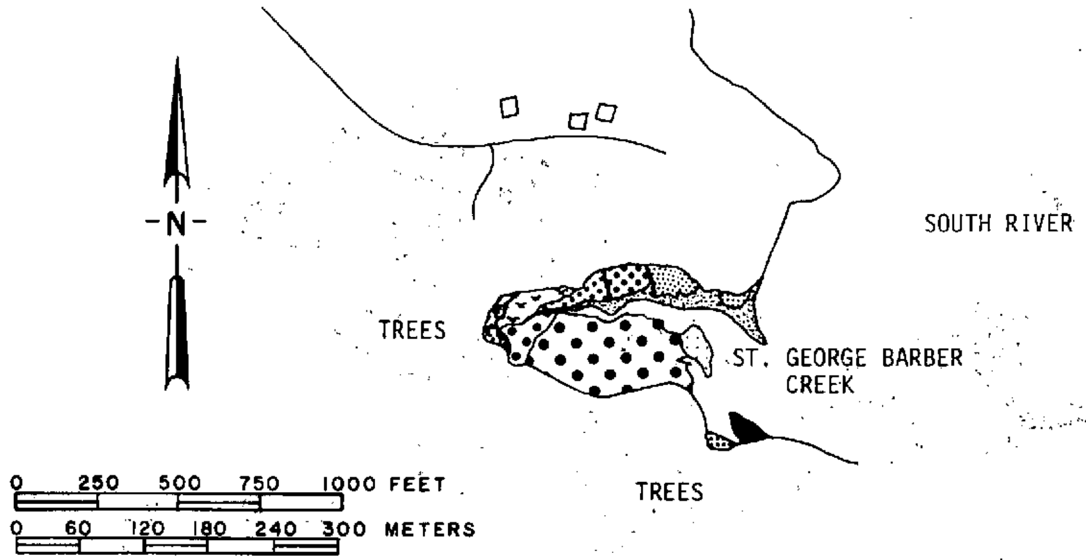
Aster simplex 60 %
Impatiens biflora 30 %
Peltandra virginica 0 - 10 %
Mud / Water 0 - 10 %

Upland Grasses 40 - 60 %
Impatiens biflora 20 - 40 %
Asclepias incarnata, Polygonum arifolium 10 - 20 %
Peltandra virginica 10 %
Mud / Water 0 - 10 %

Appendix B

ST. GEORGE BARBER CREEK MARSH

Predominately Type 4



Typha angustifolia 90-100 %
Hibiscus palustris 0-5 %
Mud / Water 0-5 %

Typha angustifolia 80-90 %
Mud / Water 10-20 %

Typha angustifolia 70 %
Hibiscus palustris 15 %
Mud / Water 15 %

Typha angustifolia 60-70 %
Shrubs 30 %
Hibiscus palustris, Thelypteris palustris & Polygonum sagittatum 0-10 %
Mud / Water 0-10 %

Typha angustifolia 50-60 %
Mud / Water 40-50 %

Typha angustifolia 40 %
Juncus sp. 40 %

Typha angustifolia 40 %
Mud / Water 40 %
Hibiscus palustris 20 %

Mud / Water 70 %
Typha angustifolia 30 %

Mud / Water

Mud / Water 40-50 %
Spartina alterniflora 40 %
Phragmites communis 20 %

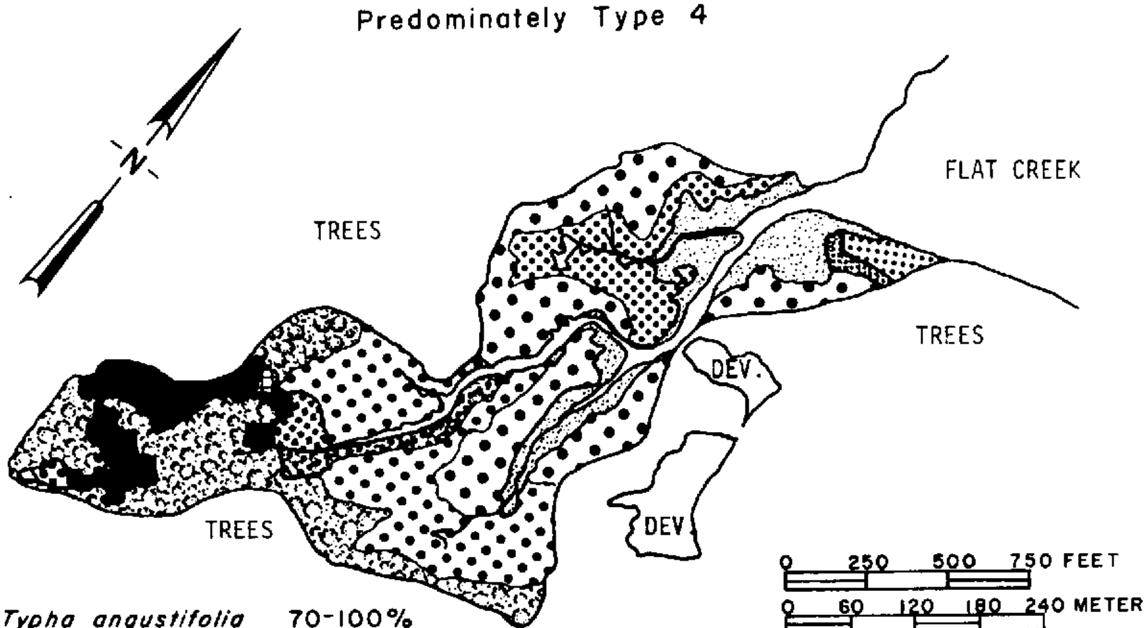
Rosa palustris 30-40 %
Typha angustifolia 20-30 %
Mud / Water 20 %
Hibiscus palustris, Polygonum sagittatum & Onoclea sensibilis 10-20 %

Shrubs:
Mikania scandens & Rosa palustris

Appendix B

FLAT CREEK MARSH

Predominately Type 4



Typha angustifolia 70-100%
Mud/Water 0-30%

Typha angustifolia 70-90%
Hibiscus palustris 0-10%
Thelypteris palustris 0-10%
Onoclea sensibilis 0-10%
Mud/Water 0-10%

Typha angustifolia 50-70%
Mud/Water 30-50%

Typha angustifolia 50%
Kosteletzkya virginica 20%
Mud/Water 20%
Hibiscus palustris/Iva frutescens 10%

Typha angustifolia 40-50%
Onoclea sensibilis 30-40%
Rosa palustris 10-20%
Mud/Water 5-10%

Mud/Water

Mud/Water 60%
Spartina alterniflora 25%
Typha angustifolia 15%

Typha latifolia 70%
Acorus Calamus 30%

Scirpus robustus 100%

Onoclea sensibilis/Polygonum sagittatum 100%

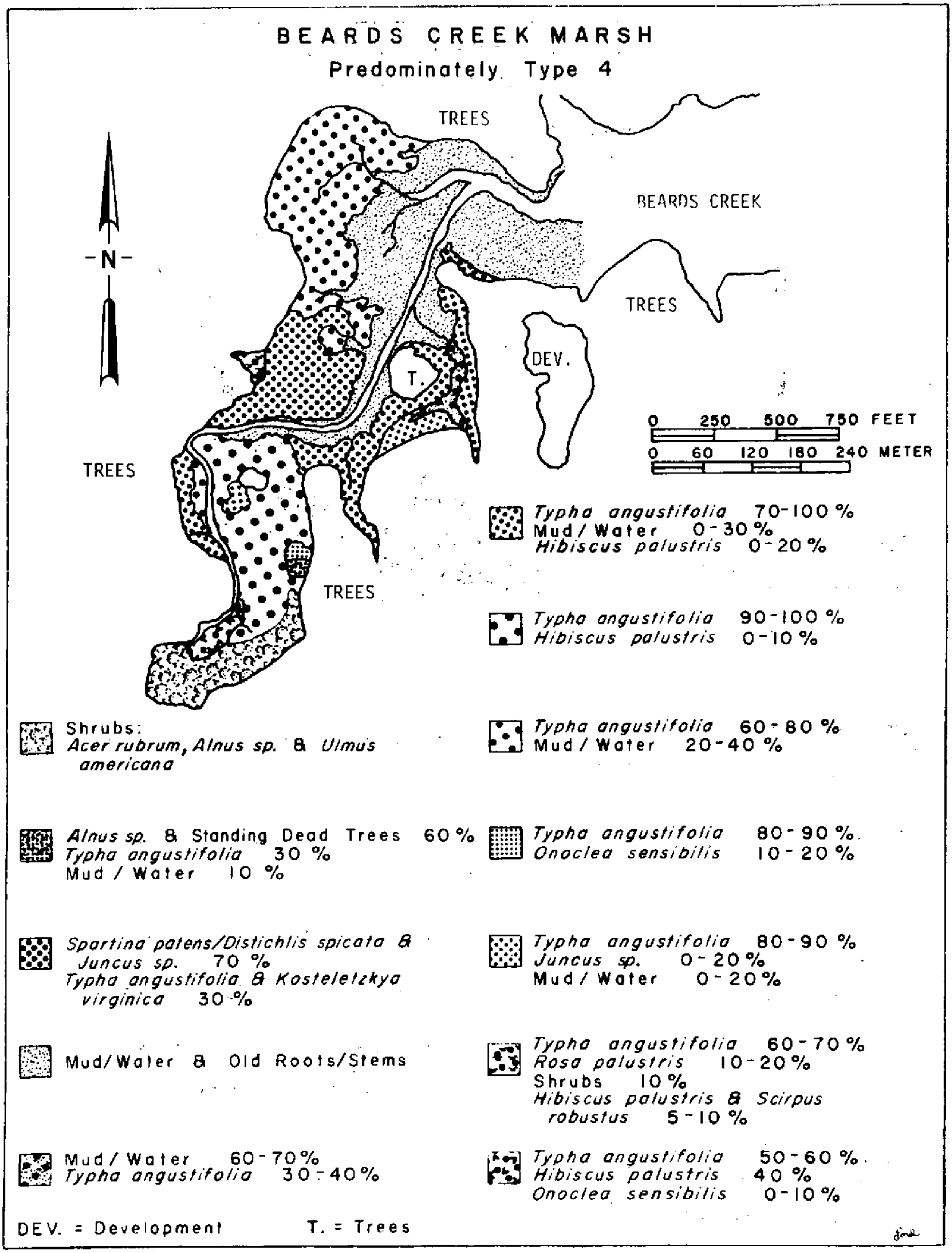
Acorus Calamus 90-100%

Rosa palustris 30-40%
Typha angustifolia 30-40%
Baccharis halimifolia & Shrubs 0-10%
Mud/Water 0-10%
Onoclea sensibilis/Thelypteris palustris 0-10%

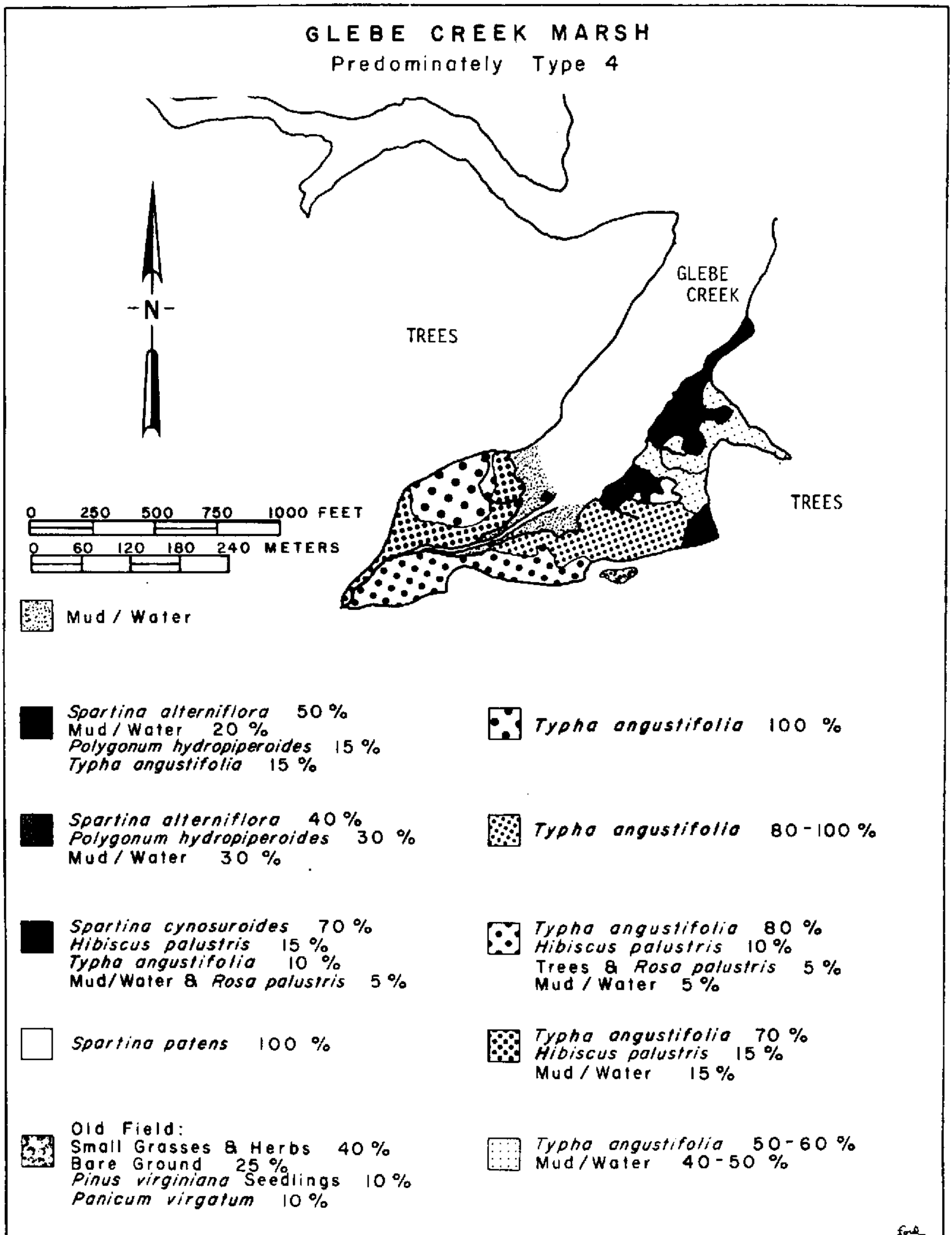
Shrubs:
Rosa palustris, Acer rubrum & *Alnus sp.* 80%
Mud/Water 10-30%
Grasses, *Typha angustifolia* & *Juncus sp.* 10-20%

DEV. = Development

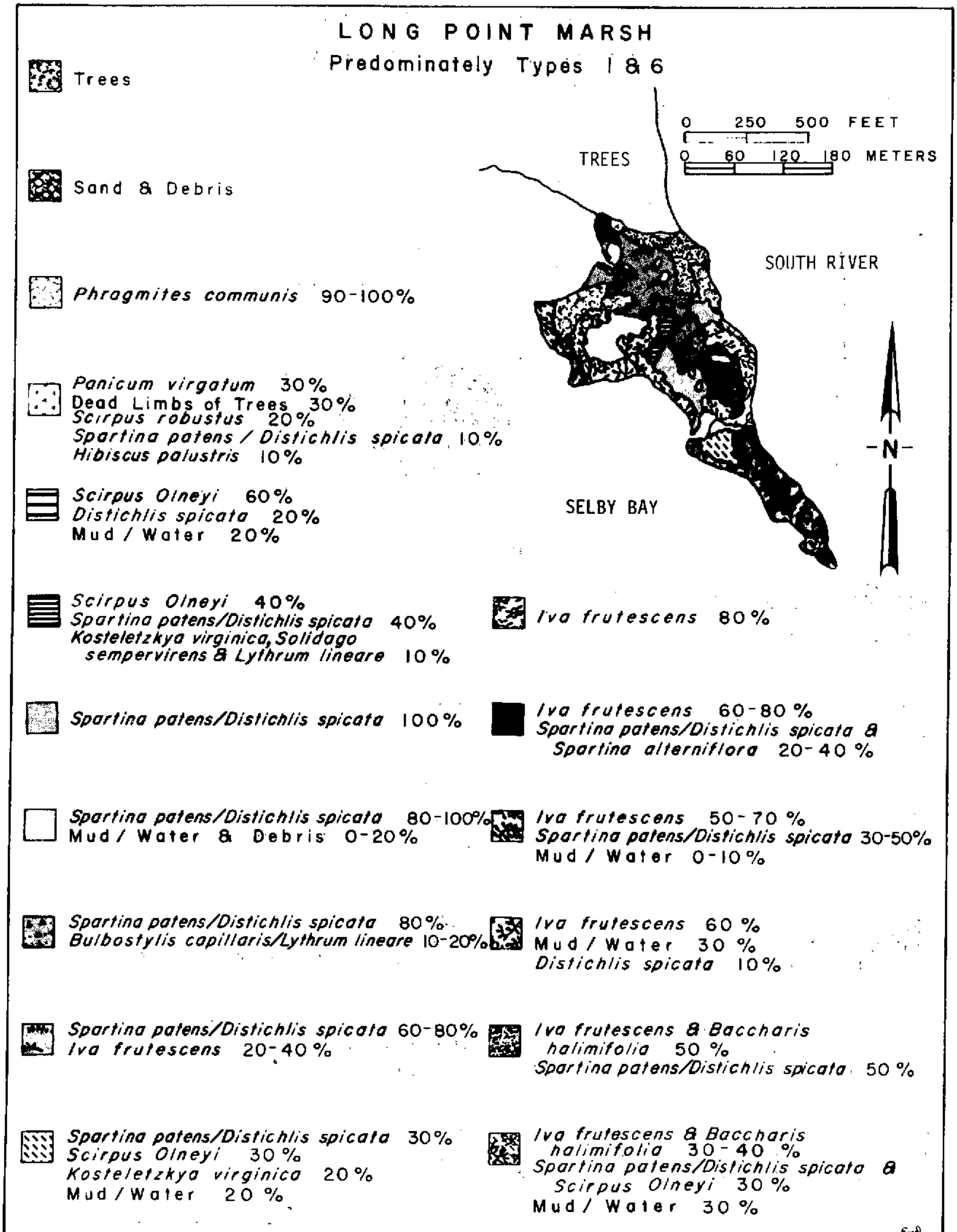
Appendix B


BEARDS CREEK MARSH
Predominately Type 4
TREES
BEARDS CREEK
TREES
-N-
DEV.
T.
0 250 500 750 FEET
0 60 120 180 240 METER
TREES
TREES
Typha angustifolia 70-100 %
Mud / Water 0-30 %
Hibiscus palustris 0-20 %
Typha angustifolia 90-100 %
Hibiscus palustris 0-10 %
Shrubs:
Acer rubrum, Alnus sp. & Ulmus americana
Typha angustifolia 60-80 %
Mud / Water 20-40 %
Alnus sp. & Standing Dead Trees 60 %
Typha angustifolia 30 %
Mud / Water 10 %
Typha angustifolia 80-90 %
Onoclea sensibilis 10-20 %
Spartina patens/Distichlis spicata & Juncus sp. 70 %
Typha angustifolia & Kosteletzkya virginica 30 %
Typha angustifolia 80-90 %
Juncus sp. 0-20 %
Mud / Water 0-20 %
Mud/Water & Old Roots/Stems
Typha angustifolia 60-70 %
Rosa palustris 10-20 %
Shrubs 10 %
Hibiscus palustris & Scirpus robustus 5-10 %
Mud / Water 60-70 %
Typha angustifolia 30-40 %
Typha angustifolia 50-60 %
Hibiscus palustris 40 %
Onoclea sensibilis 0-10 %
DEV. = Development
T. = Trees

Appendix B


GLEBE CREEK MARSH
Predominately Type 4
GLEBE CREEK
TREES
TREES
-N-
0 250 500 750 1000 FEET
0 60 120 180 240 METERS
Mud / Water
Spartina alterniflora 50 %
Mud / Water 20 %
Polygonum hydropiperoides 15 %
Typha angustifolia 15 %
Spartina alterniflora 40 %
Polygonum hydropiperoides 30 %
Mud / Water 30 %
Spartina cynosuroides 70 %
Hibiscus palustris 15 %
Typha angustifolia 10 %
Mud/Water & Rosa palustris 5 %
Spartina patens 100 %
Old Field:
Small Grasses & Herbs 40 %
Bare Ground 25 %
Pinus virginiana Seedlings 10 %
Panicum virgatum 10 %
Typha angustifolia 100 %
Typha angustifolia 80-100 %
Typha angustifolia 80 %
Hibiscus palustris 10 %
Trees & Rosa palustris 5 %
Mud / Water 5 %
Typha angustifolia 70 %
Hibiscus palustris 15 %
Mud / Water 15 %
Typha angustifolia 50-60 %
Mud/Water 40-50 %

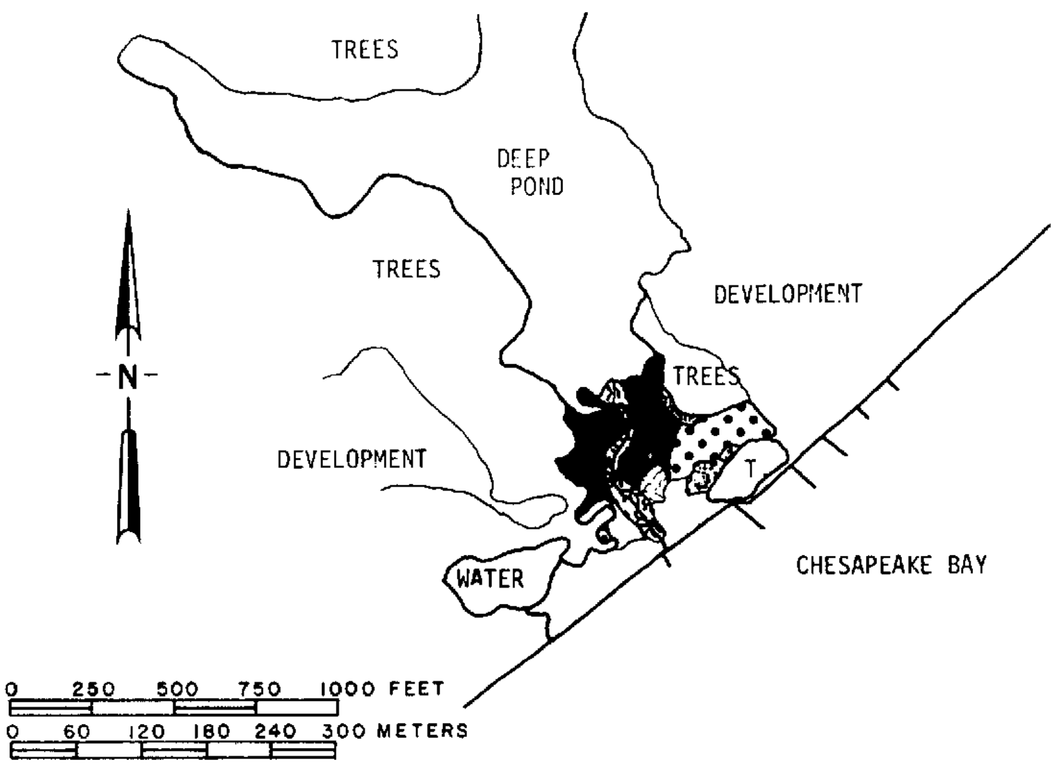
Appendix B


LONG POINT MARSH
Predominately Types I & 6
Trees
Sand & Debris
Phragmites communis 90-100%
Panicum virgatum 30%
Dead Limbs of Trees 30%
Scirpus robustus 20%
Spartina patens / Distichlis spicata 10%
Hibiscus palustris 10%
Scirpus Olneyi 60%
Distichlis spicata 20%
Mud / Water 20%
Scirpus Olneyi 40%
Spartina patens/Distichlis spicata 40%
Kosteletzkya virginica, Solidago sempervirens & Lythrum lineare 10%
Spartina patens/Distichlis spicata 100%
Spartina patens/Distichlis spicata 80-100%
Mud / Water & Debris 0-20%
Spartina patens/Distichlis spicata 80%
Bulbostylis capillaris/Lythrum lineare 10-20%
Spartina patens/Distichlis spicata 60-80%
Iva frutescens 20-40%
Spartina patens/Distichlis spicata 30%
Scirpus Olneyi 30%
Kosteletzkya virginica 20%
Mud / Water 20%
0 250 500 FEET
0 60 120 180 METERS
TREES
SOUTH RIVER
SELBY BAY
-N-
Iva frutescens 80%
Iva frutescens 60-80%
Spartina patens/Distichlis spicata & Spartina alterniflora 20-40%
Iva frutescens 50-70%
Spartina patens/Distichlis spicata 30-50%
Mud / Water 0-10%
Iva frutescens 60%
Mud / Water 30%
Distichlis spicata 10%
Iva frutescens & Baccharis halimifolia 50%
Spartina patens/Distichlis spicata 50%
Iva frutescens & Baccharis halimifolia 30-40%
Spartina patens/Distichlis spicata & Scirpus Olneyi 30%
Mud / Water 30%

Appendix B

DEEP POND MARSH

Predominately Types 1 & 6

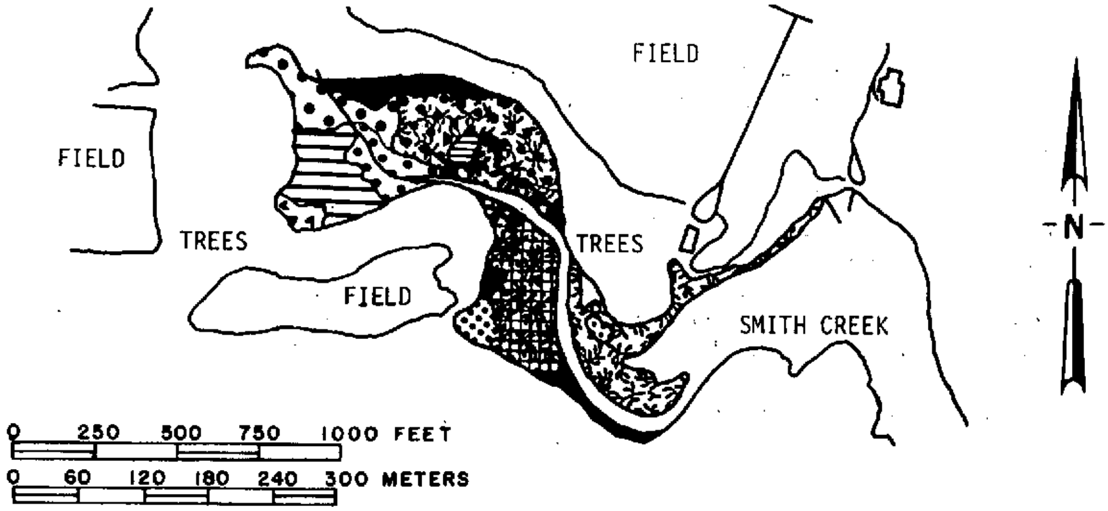


- *Spartina patens* 100 %
- *Spartina patens/Distichlis spicata* 100%
- *Spartina alterniflora* 30-50 %, *Spartina patens* 20-40 %, Mud / Water 30-40 %
- *Typha angustifolia* 70-80 %, *Hibiscus palustris* 10-20 %, Mud / Water 0-20 %
- *Typha angustifolia* 50 %, *Hibiscus palustris* 25 %, *Iva frutescens, Distichlis spicata* & *Panicum virgatum* 25 %
- *Phragmites communis* 100 %
- *Iva frutescens* 90-100 %, *Baccharis halimifolia* 0-10 %
- Mud / Water 60 %, *Typha angustifolia* 20 %, *Phragmites communis* 20 %
- Shrubs (young trees), *Panicum virgatum*, Sand
- Upland Beach & Grasses

Appendix B

SMITH CREEK MARSH

Predominately Types I & 6



Typha angustifolia 70-80%
Hibiscus palustris 10-30%
Mud / Water 0-10 %

Typha angustifolia 30-70 %
Mud / Water 30-70 %

Typha angustifolia 50-60 %
Iva frutescens 10-50 %
Mud / Water 0-40 %

Typha angustifolia 60 %
Mud / Water 25 %
Spartina cynosuroides 15 %

Typha angustifolia 60 %
Iva frutescens 30 %
Distichlis spicata 10%

Scirpus Olneyi 70-80 %
Hibiscus palustris 20-30 %

Scirpus Olneyi 50-60 %
Mud / Water 20-30 %
Hibiscus palustris & *Iva frutescens* 20%

Iva frutescens 70 %
Mud / Water 10-30 %
Spartina alterniflora/Distichlis spicata 10%
Acnida cannabina 0-10 %

Iva frutescens 50 %
Scirpus robustus 25 %
Mud / Water 25 %

Iva frutescens 40-60 %
Mud / Water 40-50 %
Spartina patens/Distichlis spicata &
Spartina alterniflora 10-20 %
Acnida cannabina 10 %
Hibiscus palustris 10 %

Spartina patens/Distichlis spicata 70 %
Iva frutescens 30 %

Spartina cynosuroides 50 %
Hibiscus palustris 30 %
Rosa palustris & Mud/Water 20%

Spartina alterniflora 40-50 %
Mud / Water 20-50 %
Iva frutescens 10-15 %
Pluchea camphorata 0-15%

Hibiscus palustris 40 %
Mud / Water 40 %
Scirpus Olneyi & *Acnida cannabina* 20%

LERCH CREEK MARSH

- *Iva frutescens* 70-80%
  Spartina patens/Distichlis spicata 10-20%
  Mud / Water 10-20%

- *Iva frutescens* 50-70%
  Spartina patens/Distichlis spicata 15-25%
  Mud / Water 15-25%
  Hibiscus palustris 0-5%

- *Iva frutescens* 30-35%
  Spartina patens/Distichlis spicata 20-50%
  Panicum virgatum 20-30%

- *Spartina patens/Distichlis spicata* 90-100%
  Scirpus Olneyi 0-10%

- *Spartina patens/Distichlis spicata* 45-70%
  Scirpus Olneyi 30-40%
  Pluchea camphorata 0-20%
  Mud / Water 0-5%

- *Spartina patens/Distichlis spicata* 60-70%
  Iva frutescens 30-40%

- *Spartina patens/Distichlis spicata* 60%
  Panicum virgatum 20%
  Scirpus Olneyi 10%
  Spartina cynosuroides 10%

- *Typha angustifolia* 80%
  Hibiscus palustris 20%

- *Typha angustifolia* 40-70%
  Mud / Water 20-50%
  Hibiscus palustris 0-20%

- *Typha angustifolia* 40-60%
  Hibiscus palustris 40-60%
  Mud / Water 0-20%

- *Typha angustifolia* 50%
  Spartina cynosuroides 50%

- *Hibiscus palustris* 30%
  Mud / Water 30%
  Iva frutescens 25%
  Spartina patens/Distichlis spicata 5%
  Spartina cynosuroides 5%
  Typha angustifolia 5%

- *Hibiscus palustris* 30%
  Mikania scandens 30%
  Rosa palustris & Smilax sp. 30%
  Mud / Water 10%

- *Scirpus Olneyi* 80%
  Typha angustifolia 10%
  Hibiscus palustris 10%

- *Scirpus Olneyi* 70%
  Spartina patens/Distichlis spicata 30%

- *Scirpus Olneyi* 40-50%
  Spartina patens/Distichlis spicata 30-50%
  Iva frutescens 0-20%
  Mud / Water 0-10%

- *Panicum virgatum* 100%

- *Panicum virgatum* 50%
  Spartina patens/Distichlis spicata & Water 30%
  Iva frutescens 20%

- *Panicum virgatum* 40%
  Upland Grasses - Tall 40%
  Upland Grasses - Short 20%

- *Panicum virgatum/Scirpus Olneyi* 50%
  Spartina patens/Distichlis spicata & Water 30%
  Typha angustifolia/Spartina cynosuroides 20%

- *Phragmites communis* 100%

- *Asclepias sp.* 70%
  Juncus effusus 20%
  Acnida cannabina 5%
  Mud / Water 5%

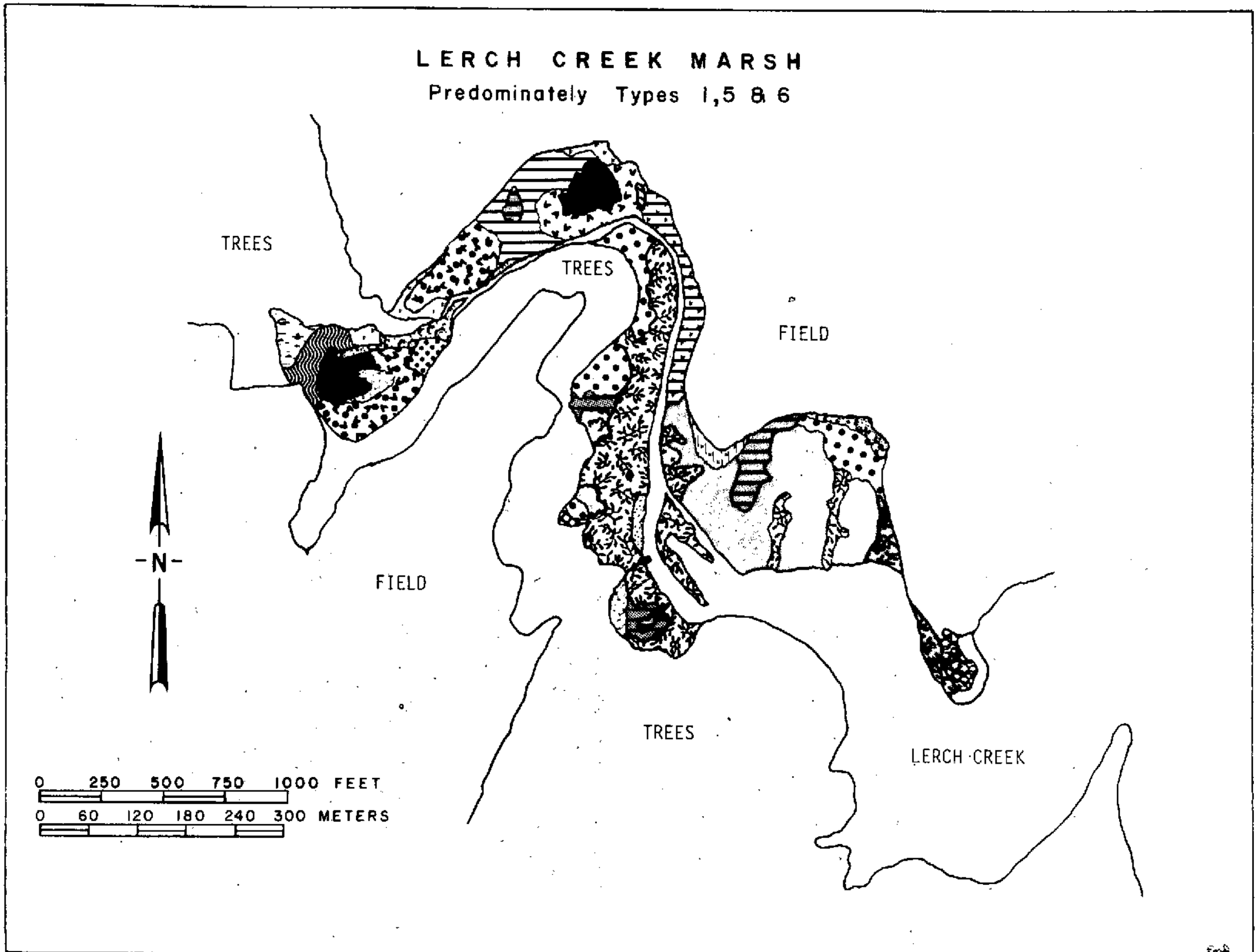
- Contains Clumps of:
  Spartina patens, Typha angustifolia, Spartina cynosuroides, Mud/Water & *Acnida cannabina*

- Shrubs:
  Alnus sp. & Smilax sp.

- Destroyed Marsh

- Mud / Water

Appendix B


LERCH CREEK MARSH
Predominately Types 1,5 & 6
TREES
TREES
FIELD
FIELD
TREES
LERCH CREEK
N
0 250 500 750 1000 FEET
0 60 120 180 240 300 METERS

Appendix B

JACK CREEK & FELICITY COVE MARSHES

Iva frutescens 70-100 %
Spartina patens/Distichlis spicata 0-20%
Mud / Water 0-20 %

Iva frutescens 60-90 %
Spartina patens/Distichlis spicata 10-40 %
Mud / Water 0-20 %

Iva frutescens 40-70 %
Spartina patens/Distichlis spicata 30-50%
Mud / Water 0-20 %

Iva frutescens 60-70%
Spartina cynosuroides 20-30 %
Spartina patens/Distichlis spicata 0-10 %

Juxtaposed Communities:
Iva frutescens 50-60%, Sand/Shells 40-50
Spartina alterniflora 80-100%

Iva frutescens 30%
Solidago sempervirens 25 %
Panicum virgatum & Unknown 25 %
Mud / Water 20 %

Spartina patens/Distichlis spicata 90-100%
Mud / Water 0-10

Spartina patens/Distichlis spicata 60-90 %
Iva frutescens 0-30 %
Mud / Water 0-20 %
Scirpus Olneyi 0-10 %

Spartina patens/Distichlis spicata 60-90%
Scirpus Olneyi 10-40 %

Spartina patens/Distichlis spicata 40-90 %
Mud / Water 10-30 %
Spartina alterniflora 0-30 %

Spartina patens/Distichlis spicata 50-60 %
Iva frutescens 20-50 %
Solidago sempervirens 0-20%
Scirpus Olneyi 0-10 %

Scirpus Olneyi 40-70 %
Spartina patens/Distichlis spicata 20-50 %
Mud / Water 0-40 %

Scirpus Olneyi 30-40 %
Spartina patens/Distichlis spicata 20-40%
Hibiscus palustris/Solidago sempervirens 10-20%
Mud / Water 10 %
Iva frutescens 0-10%

Scirpus Olneyi 60-70 %
Iva frutescens 20-30 %
Spartina patens/Distichlis spicata 10-20%

Juncus sp. 80-100 %

Juncus sp. 40%
Iva frutescens 20-30%
Spartina patens/Distichlis spicata 10-20%
Dredge Spoil 0-20 %

Typha angustifolia 80-100%
Spartina patens/Distichlis spicata 0-20%
Mud / Water 0-10 %

Typha angustifolia 70-80 %
Spartina patens/Distichlis spicata 10-20%
Mud / Water 0-10 %

Spartina alterniflora 80-100 %
Sand / Mud / Water 0-10 %

Spartina alterniflora 60-70 %
Iva frutescens 20-30 %
Spartina patens/Distichlis spicata 10-20 %

Juxtaposed Communities:
Spartina alterniflora 80-100%
Sand/Shells 50-90%, *Spartina alterniflora* 10-50 %

Hibiscus palustris 50-60 %
Solidago sempervirens 15-25 %
Phragmites communis 15-20 %
Spartina patens/Distichlis spicata 10-15 %

Hibiscus palustris 40-60 %
Spartina patens/Distichlis spicata 20-30 %
Scirpus Olneyi 10-20 %

Phragmites communis 80-100 %
Iva frutescens 0-20 %
Spartina patens/Distichlis spicata 0-10 %

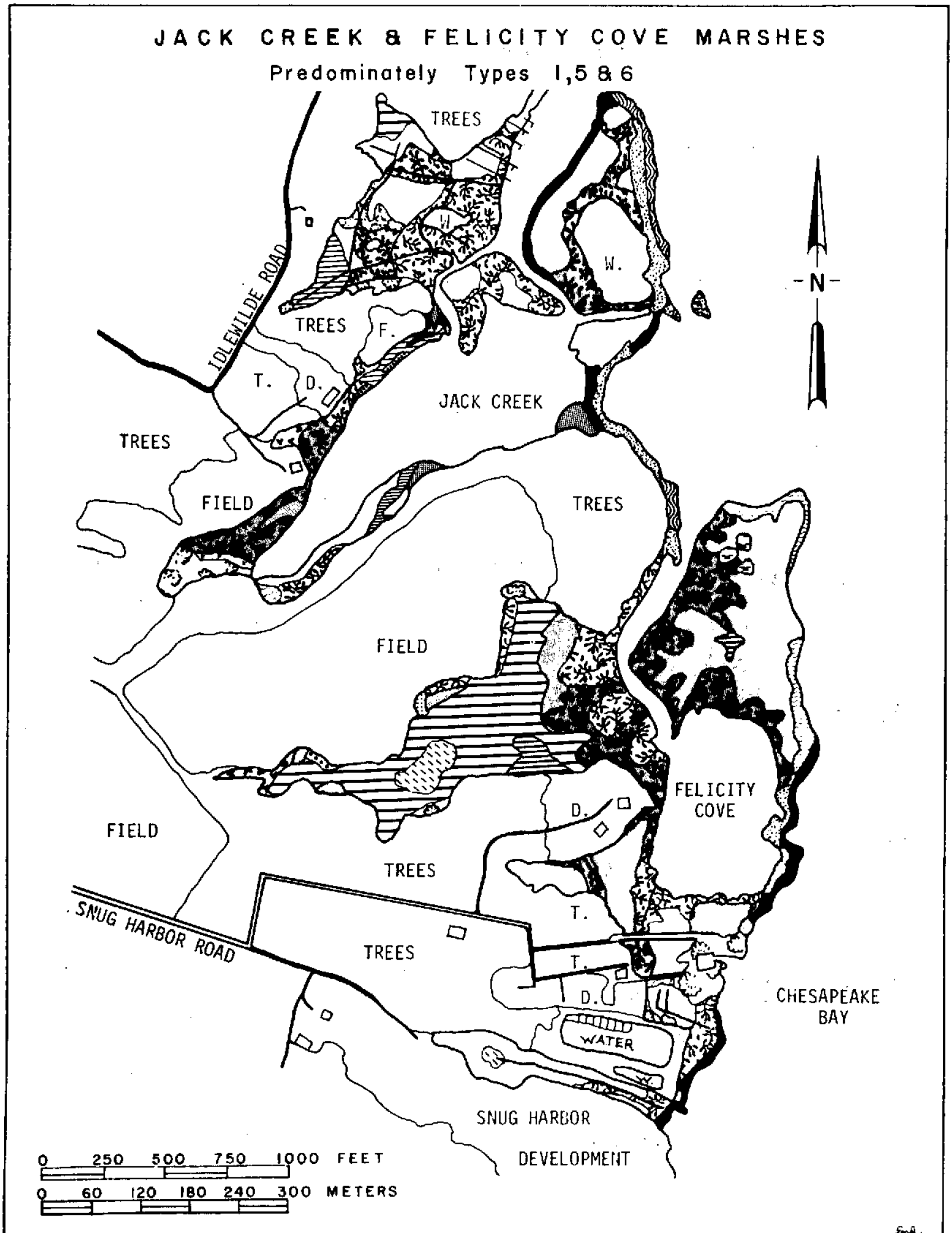
Mud / Water with hummocks composed of the same constituents as the adjacent community.

Shrubs:
Iva frutescens 60 %
Baccharis halimifolia, Asparagus officinalis, Juniperus virginiana & Robinia Pseudoacacia 40 %

Upland Forbs, *Panicum virgatum*, Grasses & Dredge Spoil

Sand / Shell Beach 100%

Appendix B


JACK CREEK & FELICITY COVE MARSHES
Predominately Types 1,5 & 6
TREES
W.
W.
IDLEWILDE ROAD
TREES
F.
T.
D.
JACK CREEK
N
TREES
FIELD
TREES
FIELD
FIELD
D.
FELICITY COVE
TREES
T.
SNUG HARBOR ROAD
TREES
T.
D.
WATER
CHESAPEAKE BAY
SNUG HARBOR DEVELOPMENT
0 250 500 750 1000 FEET
0 60 120 180 240 300 METERS

Appendix B

SNUG HARBOR MARSH

Spartina patens/Distichlis spicata 90 %
Scirpus sp. 0-10 %
Mud / Water 0-10 %

Spartina patens/Distichlis spicata 60-70%
Spartina alterniflora 10-25 %
Mud / Water 5-20%

Spartina patens/Distichlis spicata 60-90%
Iva frutescens 0-30 %
Mud / Water 0-10 %

Spartina patens/Distichlis spicata 20-50%
Spartina alterniflora 10-40 %
Mud / Water 0-40 %

Spartina patens/Distichlis spicata 50-60%
Phragmites communis 30-40 %
Iva frutescens 0-20 %

Spartina patens/Spartina alterniflora 70 %
Iva frutescens 10-20 %
Mud / Water 5-10 %

Iva frutescens 50-80 %
Spartina patens/Distichlis spicata 0-40%
Spartina alterniflora 0-30 %
Mud / Water 0-30 %
Spartina cynosuroides 0-10 %

Iva frutescens 60 %
Spartina patens/Distichlis spicata 20-30 %
Typha angustifolia 10-20 %

Phragmites communis 100 %

Typha angustifolia 80-100 %
Mud / Water 0-20 %

Typha angustifolia 60-90 %
Iva frutescens 10-20 %
Spartina patens/Distichlis spicata 0-20 %
Mud / Water 0-10 %

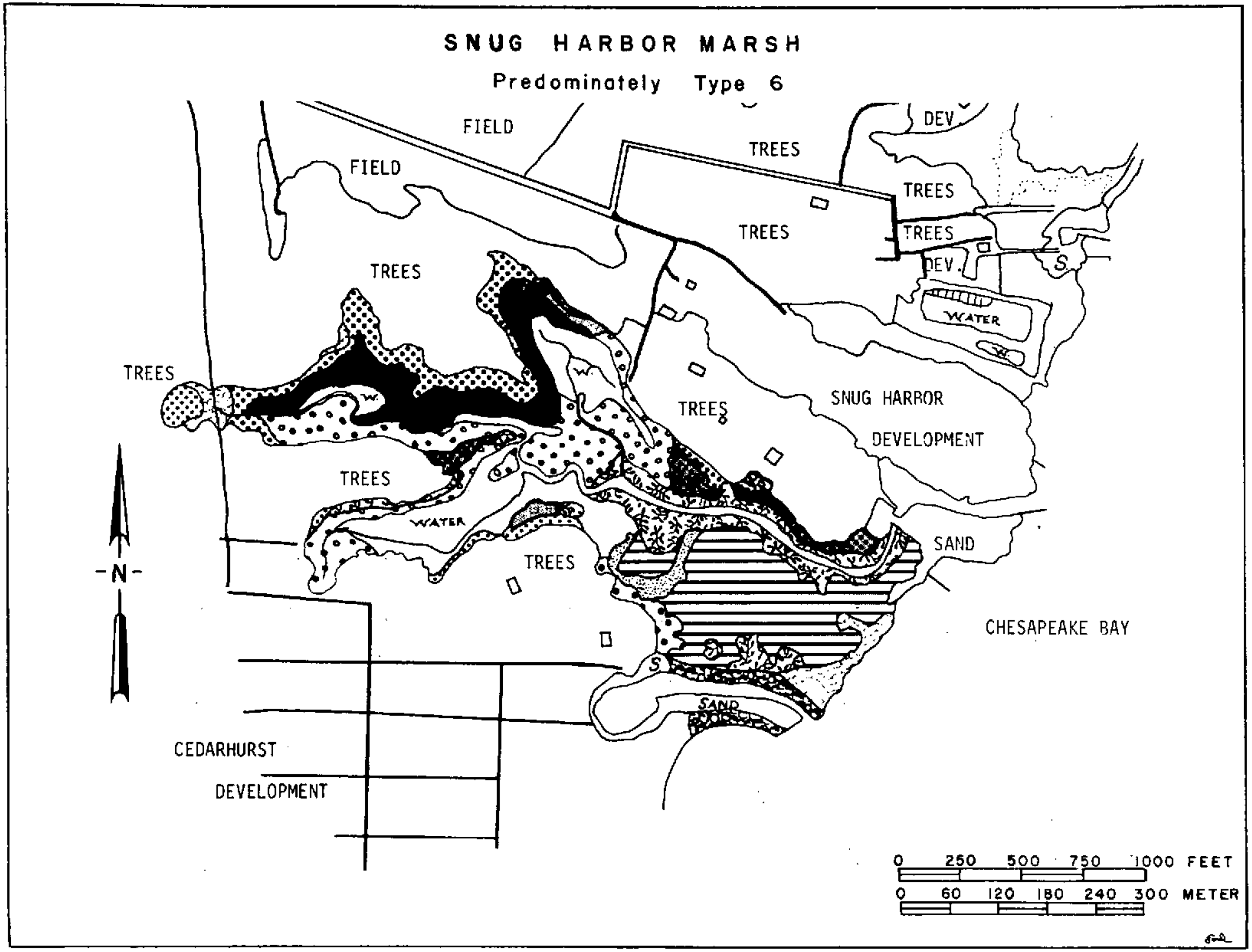
Typha angustifolia 60-80 %
Mud / Water 15-20 %
Spartina patens/Distichlis spicata 0-15 %
Spartina alterniflora 5-10 %

Spartina alterniflora 60-80 %
Spartina patens/Distichlis spicata 10-30 %
Mud / Water 0-20 %

Spartina alterniflora 40-80 %
Mud / Water 20-40 %
Spartina patens/Distichlis spicata 0-20 %

Mud / Water 40-50 %
Spartina alterniflora 30-40 %
Spartina patens/Distichlis spicata 20 %

Dredge Spoil:
Spartina patens, Panicum sp.,
Iva frutescens, Upland Forbs & Sand


SNUG HARBOR MARSH
Predominately Type 6
FIELD
FIELD
TREES
DEV.
TREES
TREES
TREES
TREES
DEV.
WATER
S
TREES
TREES
W.
W.
SNUG HARBOR
DEVELOPMENT
TREES
WATER
TREES
SAND
CHESAPEAKE BAY
-N-
S
SAND
CEDARHURST
DEVELOPMENT
0 250 500 750 1000 FEET
0 60 120 180 240 300 METER

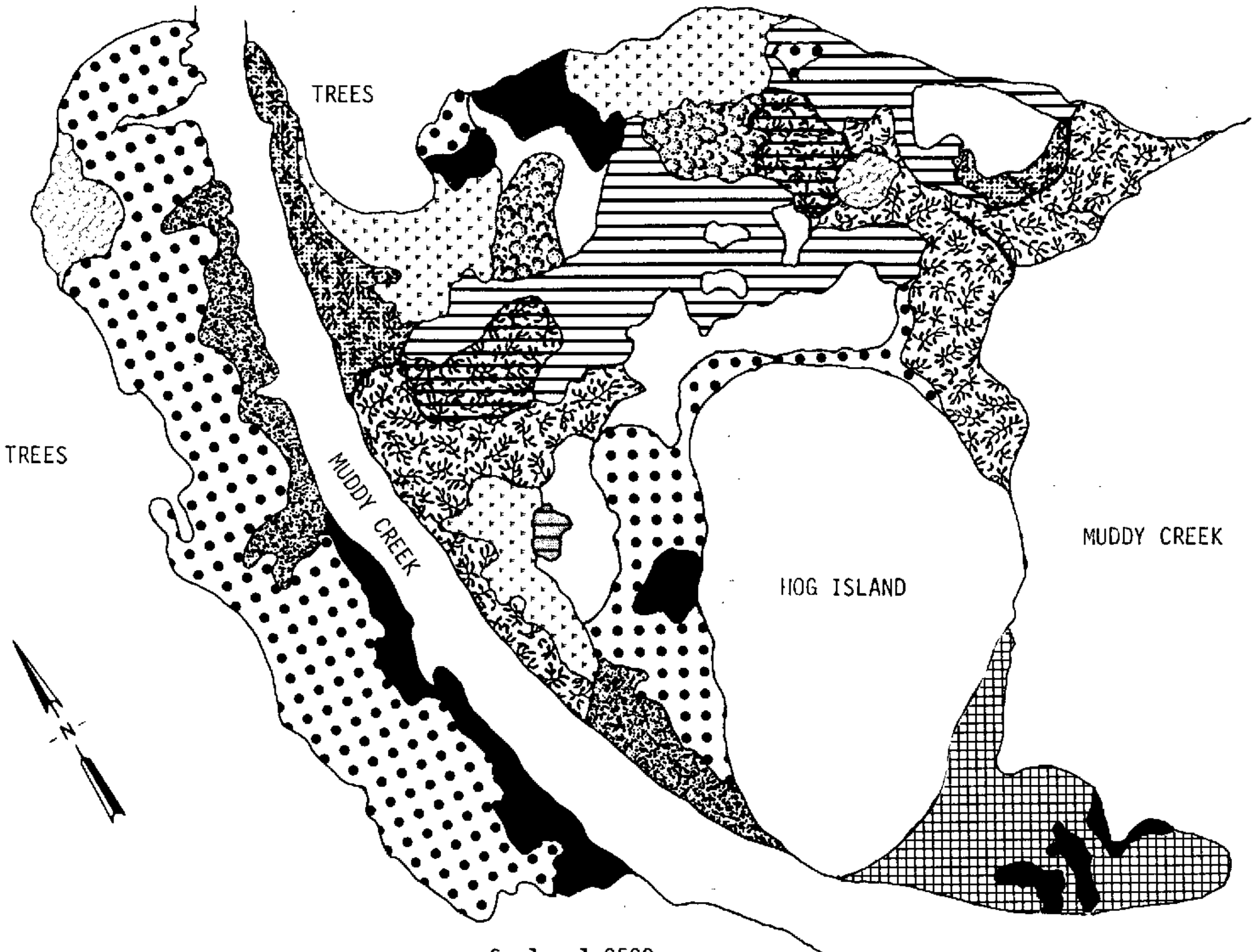
Appendix B

HOG ISLAND MARSH - EARLY SUMMER KEY

- Typha angustifolia 70 - 100%
- Spartina alterniflora 60 - 100%
- Spartina alterniflora 50%, Iva frutescens 20%, mud/water 20%, Spartina cynosuroides 10%
- Iva frutescens 50 - 100%
- Spartina cynosuroides 80 - 100%
- Iva frutescens 40%, Spartina cynosuroides 40%
- Scirpus Olneyi 70 - 90%
- Iva frutescens 50%, Scirpus Olneyi 30%
- Distichlis spicata/Spartina patens 60 - 100%
- Distichlis spicata/Spartina patens 60%, Scirpus Olneyi 40%
- Phragmites communis 80 - 100%
- Panicum virgatum 80 - 100%
- Shrubs and small trees
- Scirpus robustus 80-100%

Appendix B

HOG ISLAND MARSH - EARLY SUMMER ASPECT



Scale 1:2500

APPENDIX C

Salinity Measurements of Six Dorchester County Test Site Creeks

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SALINITY DATA

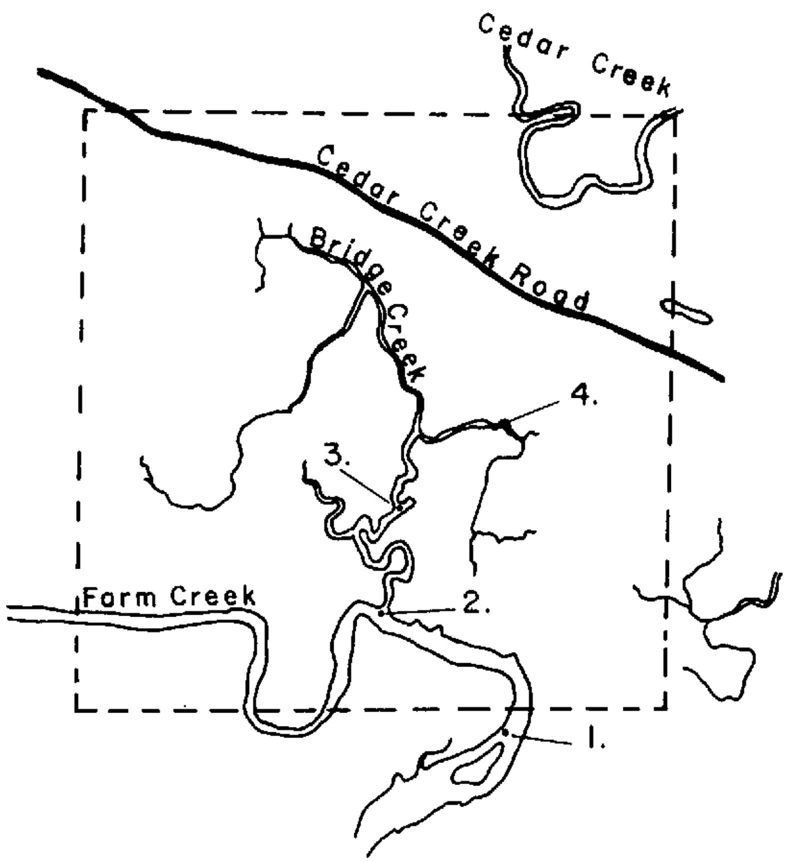
LOCATION		DATE	TIME EDT	WATER TEMP. °C	SALINITY ppt.	TIDE DESCRIPTION
Farm Creek Marsh:	#1	July 25, 1973	9:55 am	25	9.5	-
	#2	" "	10:15	25	9.5	-
	#3	" "	10:25	25	9.5	-
	#4	" "	10:35	25	9.0	-
	#1	" "	2:50 pm	25	10.0	-
	#2	" "	2:55	25	10.0	-
	#3	" "	3:15	25	10.0	-
	#4	" "	3:30	25	10.0	-
	#1	" 26	10:00 am	25.4	9.0	Ebb
	#2	" "	10:20	25	9.0	"
	#3	" "	10:30	25	9.0	"
	#4	" "	10:40	25.4	9.0	"
	#4	" "	3:15 pm	27	10.0	Flood
	#3	" "	3:35	27	10.0	"
	#2	" "	3:55	27	10.0	"
	#1	" "	4:05	27	10.0	"
Raccoon Creek Marsh:	#1	July 27	1:05 pm	-	10.0	High
	#2	August 1	11:45 am	-	6.5	- just rained
	#3	" "	12:20 pm	-	7.5	-
	#4	" "	5:15	-	9.5	Very High
	#5	" "	5:30	-	8.0	-

SALINITY DATA, CONTINUED

LOCATION		DATE	TIME EDT	WATER TEMP. °C	SALINITY ppt.	TIDE DESCRIPTION
Raccoon Creek Marsh:	#5	August 2	10:00 am	-	7.5	High
	#6	" "	10:30	-	8.5	"
	#3	" "	12:30 pm	-	8.0	Ebbing Fast
	#7	" "	4:00	-	8.5	High, Flooding
	#5	" 3	10:15 am	-	7.0	Mid, Ebbing
	#8	" "	12:30 pm	-	7.0	Dead Low
	#5	" 7	9:15 am	-	8.0	Ebbing
	#5	" "	10:45 am.	-	8.0	Mid
	#4	" 8	9:45 am	-	8.0	High, Ebbing
Beckers Island Marsh:	#1	August 8	12:15 pm	-	8.0	Mid-High, Ebbing
	#1	" "	3:30	-	8.0	Mid
	#1	" 14	1:05	-	7.3	-
	#2	" "	4:10	-	7.3	Flood
Grays Island Marsh:	#1	August 21	11:05 am	24.4	6.8	-
	#1	" "	1:35 pm	24	6.4	Ebbing
	#2	" 28	10:30 am	28	4.5	Dead Low
	#2	" "	2:00 pm	-	5.5	High, Flooding
	#3	" "	5:30	29	5.0	High, Ebbing
Great Marsh:	#1	August 28	5:30 pm	29	5.0	High, Ebbing
	#2	" 29	10:00 am	27	4.5	Dead Low
	#3	" "	3:00 pm	30	4.0	High, Flooding
	#4	September 11	9:25 am	22.4	5.0	High (1 ft. below)
	#4	" "	3:15 pm	23.2	6.5	High

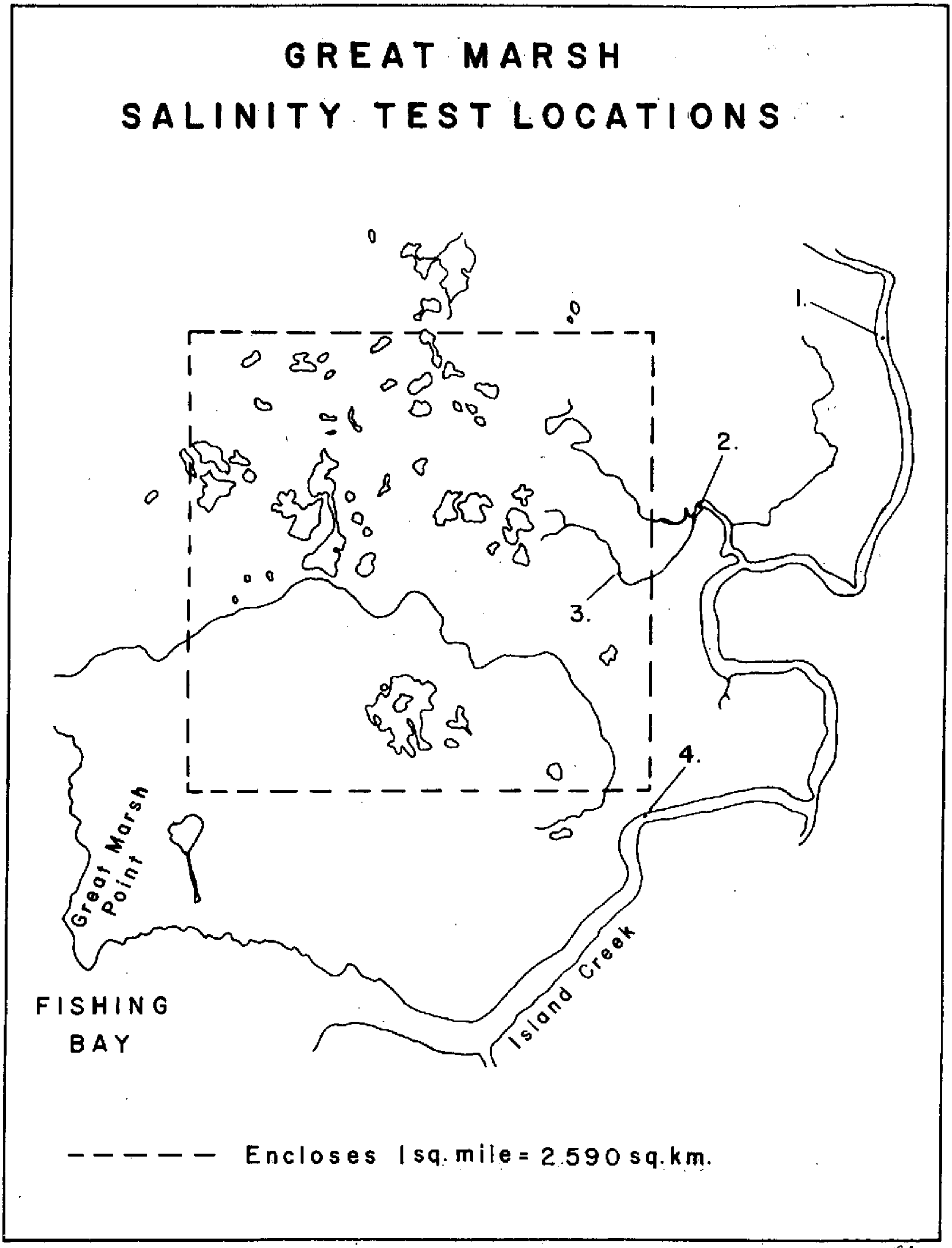
Appendix C

FARM CREEK MARSH
SALINITY TEST LOCATIONS

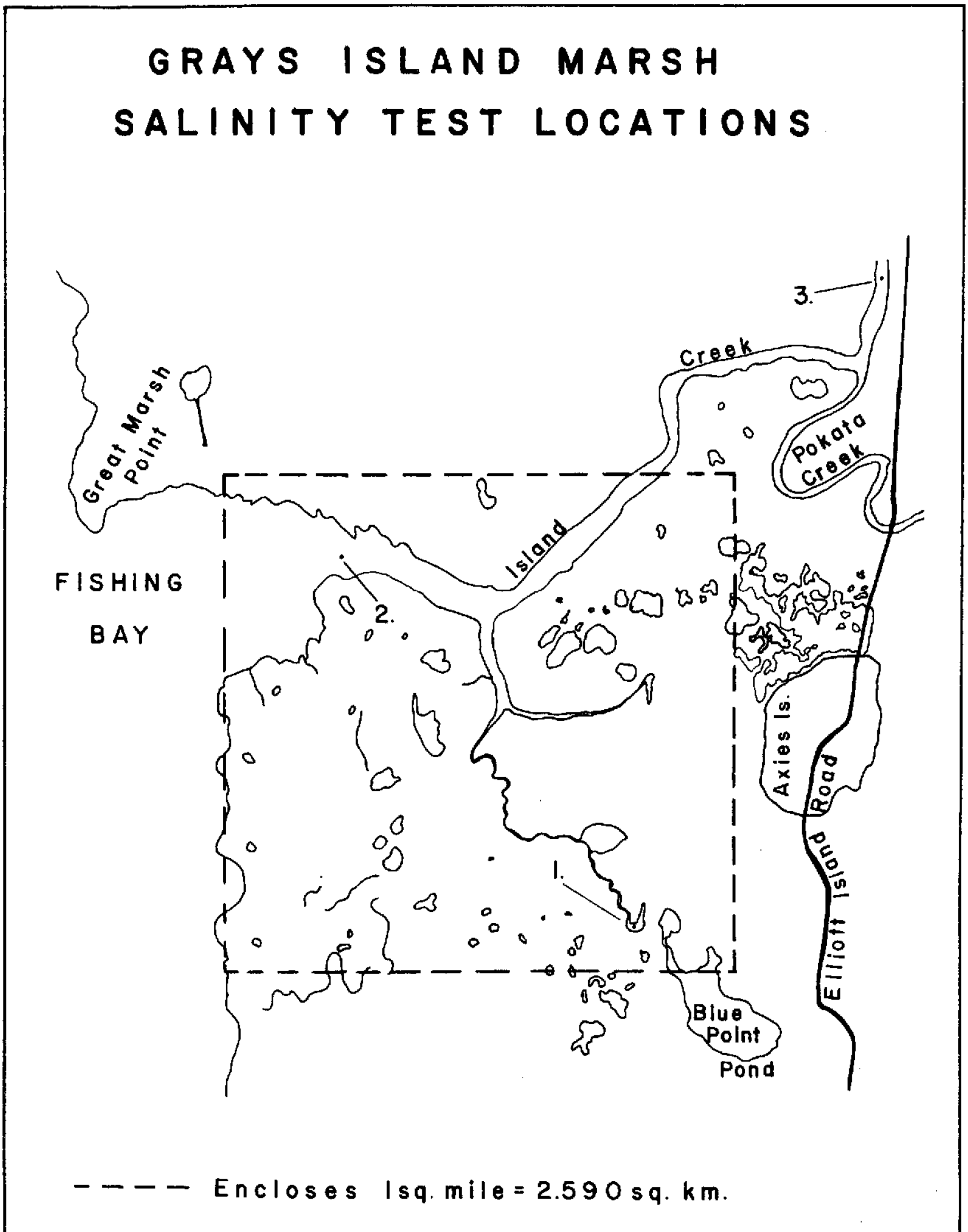


---- Encloses 1sq. mile = 2.590 sq. km.

Appendix C


GREAT MARSH
SALINITY TEST LOCATIONS
1.
2.
3.
4.
Great Marsh Point
FISHING BAY
Island Creek
Encloses 1 sq. mile = 2.590 sq. km.

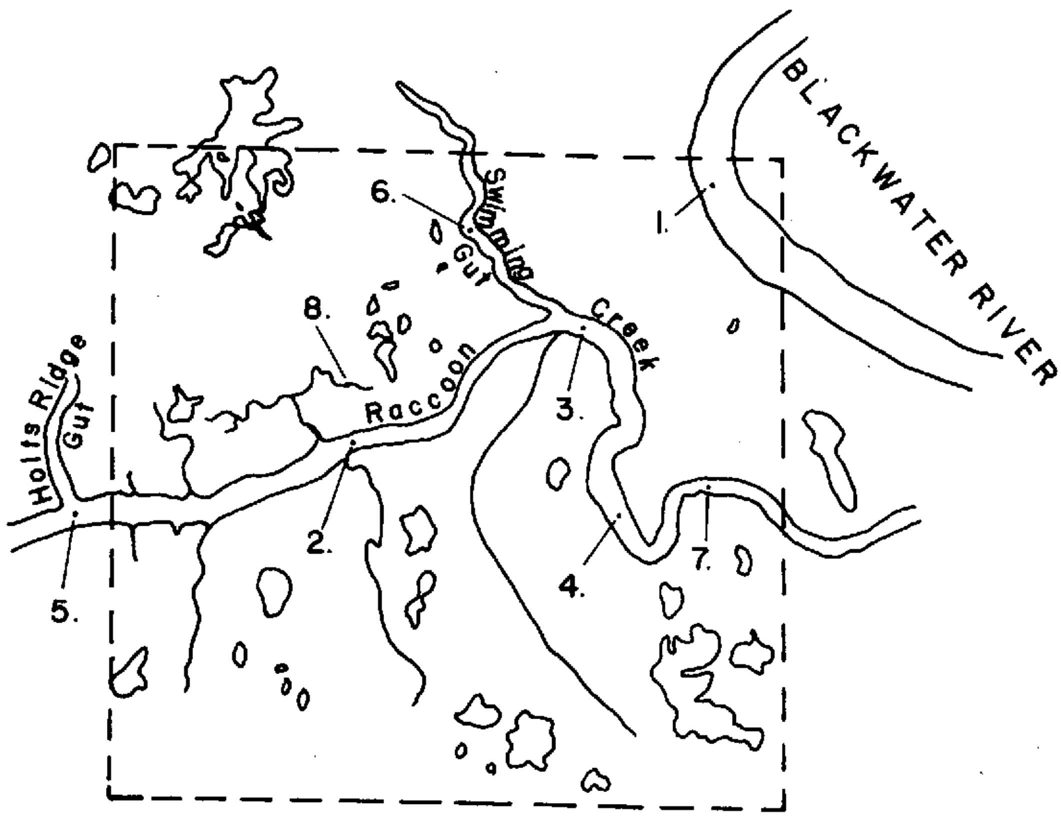
Appendix C



GRAYS ISLAND MARSH
SALINITY TEST LOCATIONS
3.
Creek
Great Marsh Point
Pokata Creek
Island
FISHING
BAY
2.
Axies Is.
Road
1.
Elliott Island
Blue Point Pond
---- Encloses 1sq. mile = 2.590 sq. km.

Appendix C

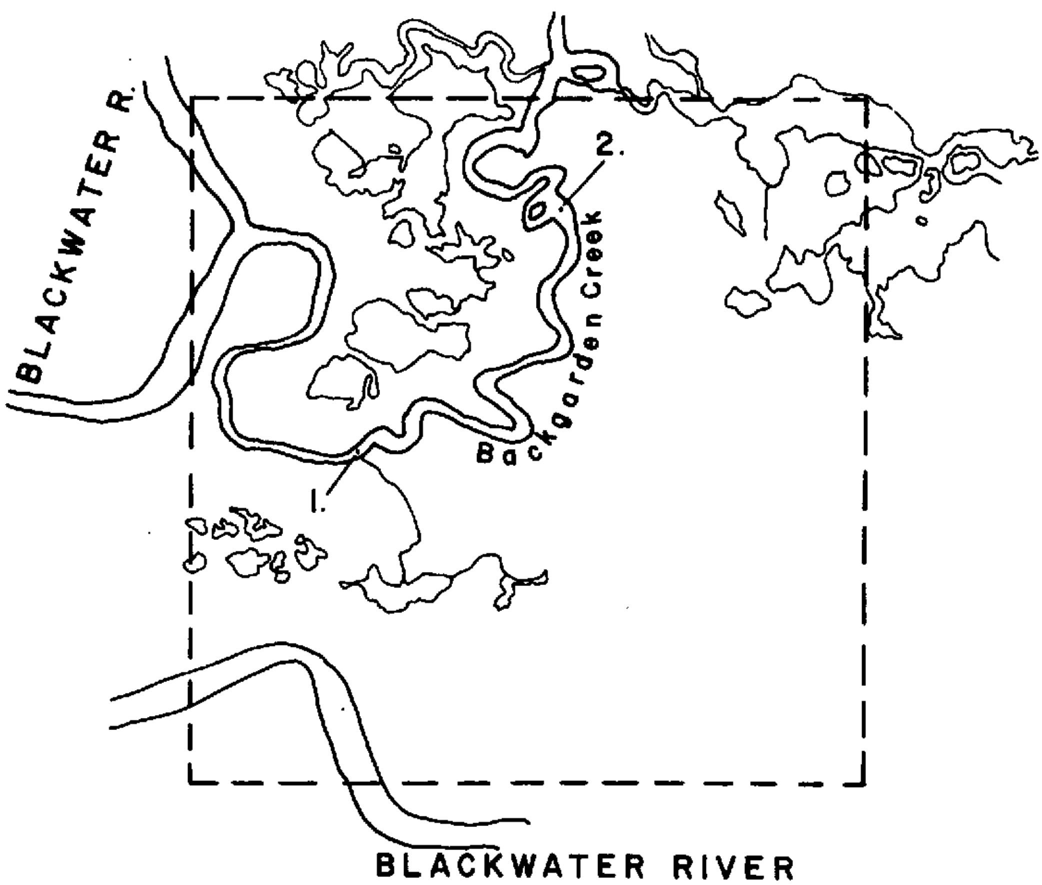
RACCOON CREEK MARSH
SALINITY TEST LOCATIONS



------ Encloses 1 sq. mile = 2.590 sq. km.

Appendix C

BECKER ISLAND MARSH
SALINITY TEST LOCATIONS

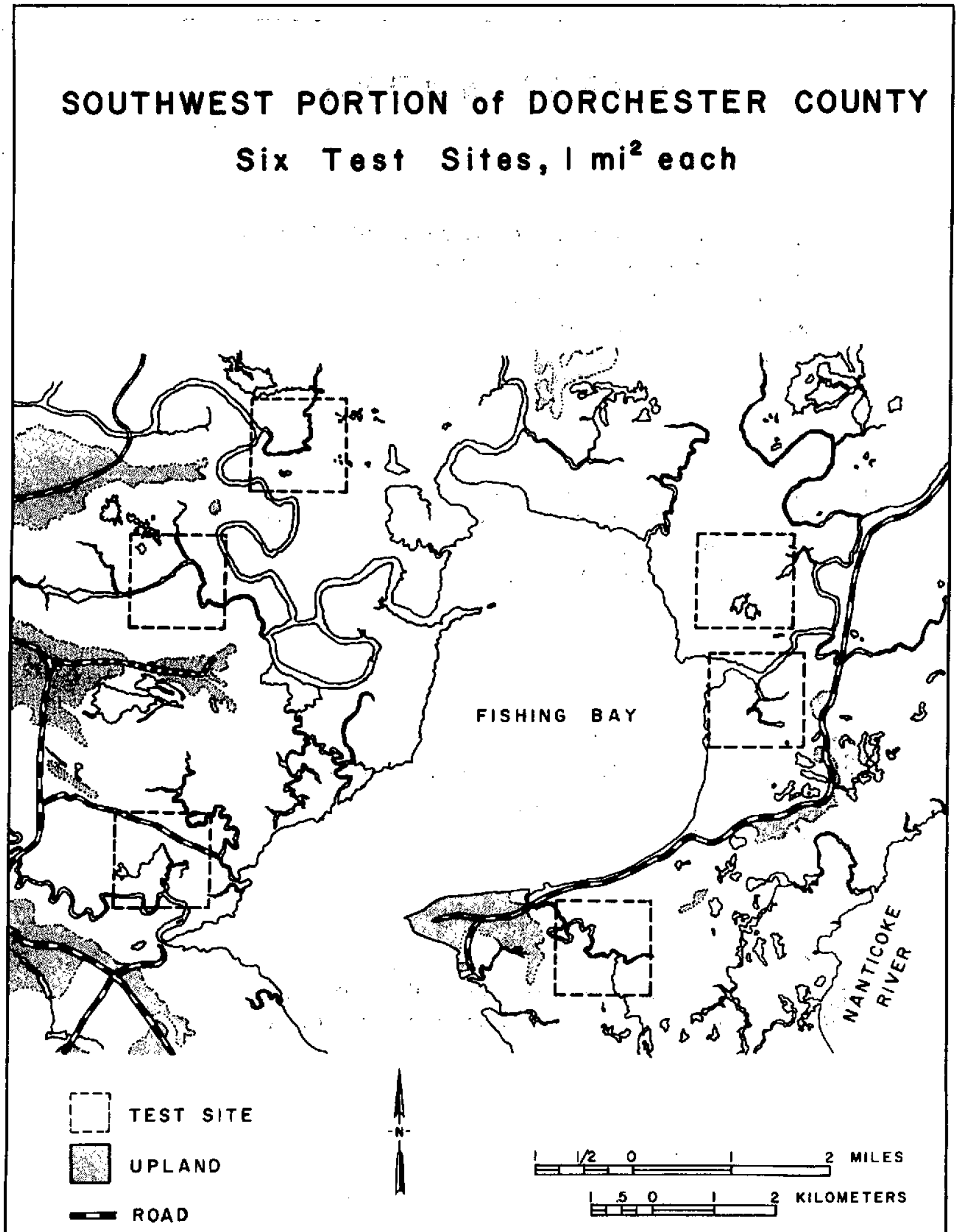


------ Encloses 1 sq. mile = 2.590 sq. km.

APPENDIX D

Dorchester County

Test Area Vegetation Maps



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Appendix D

GREAT MARSH

Spartina patens/Distichlis spicata 50-100% (mostly 80-100%)
Spartina alterniflora 0-40%
Scirpus Olneyi 0-40%
Mud/Water 0-20%

Spartina alterniflora 20-90%
Spartina patens/Distichlis spicata 0-100%
Mud/Water 0-30%
Scirpus Olneyi 0-10%

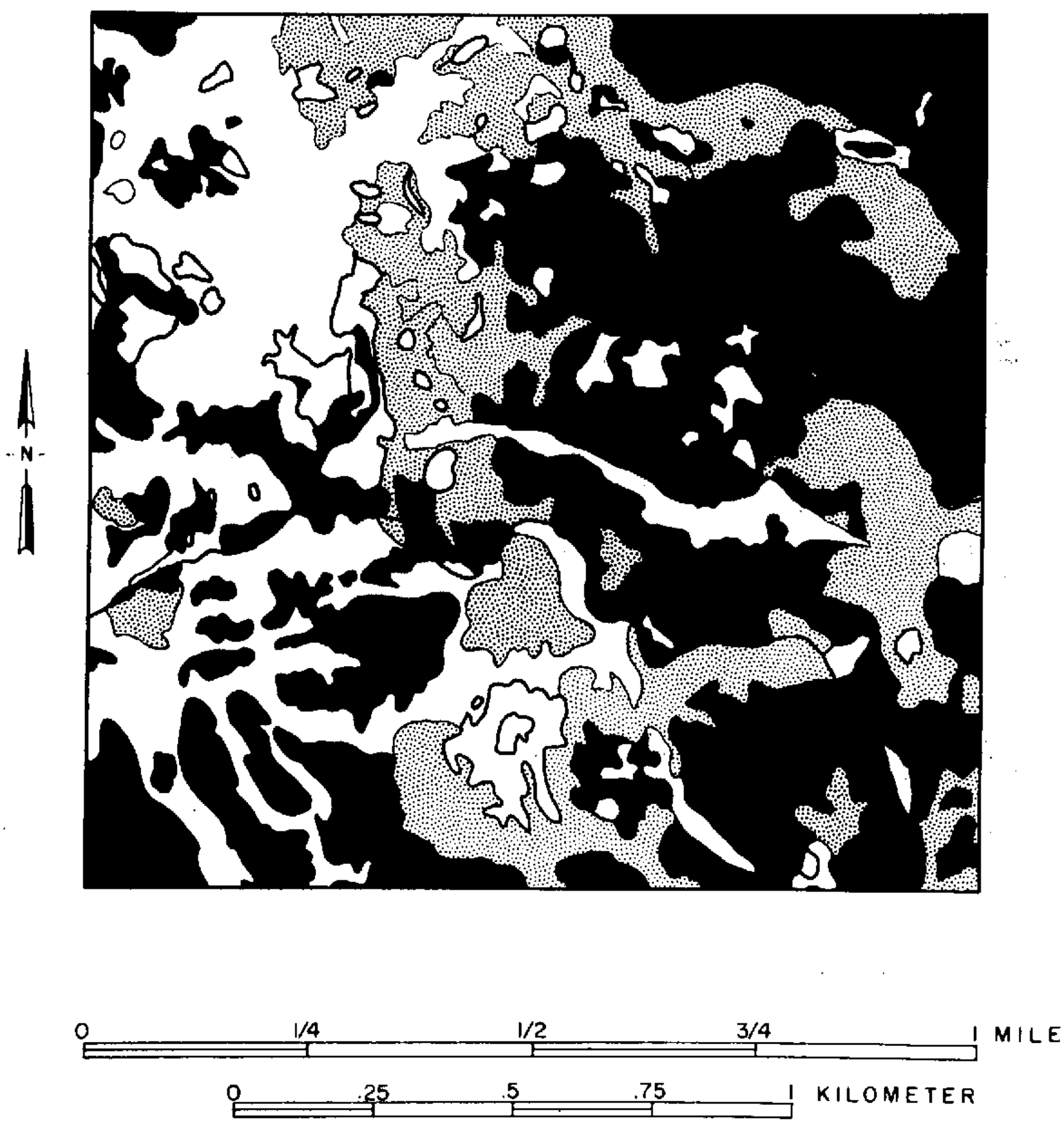
Spartina alterniflora 0-100%
Spartina patens/Distichlis spicata 0-60%
Scirpus Olneyi 0-70%
Mud/Water 10-40%

Spartina alterniflora (tall form - 3') 20-90%
Spartina patens/Distichlis spicata 10-80%
Mud/Water 0-30%

Appendix D

GREAT MARSH

Predominately Types 2 & 6



FARM CREEK MARSH

Spartina patens/Distichlis spicata 80-100 %
Mud / Water 0-20%

Spartina alterniflora 20 %
Mud / Water 80 %

Spartina patens/Distichlis spicata 0-100 %
Scirpus Olneyi 0-100 %
Juncus Roemerianus 0-100 %
Spartina alterniflora 0-50 %
Scirpus robustus 0-30 %
Mud / Water 0-30 %

Spartina cynosuroides 100 %

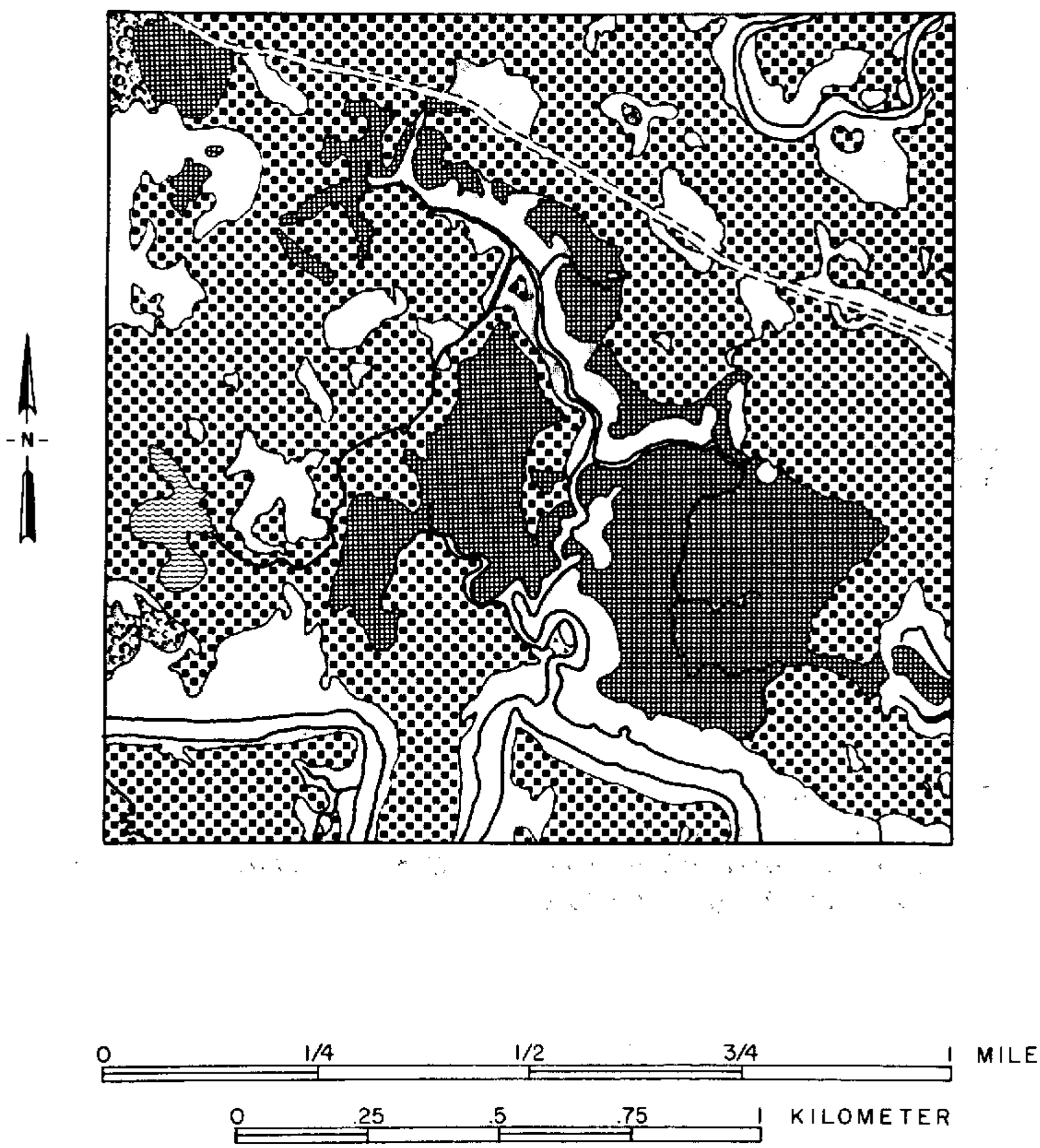
Juncus Roemerianus 100 %
Scattered ponds

Trees & Shrubs

Appendix D

FARM CREEK MARSH

Predominately Type 9



BECKER ISLAND MARSH

Spartina patens/Distichlis spicata 0-100 %
Spartina alterniflora 0-80 %
Mud / Water 0-40 %

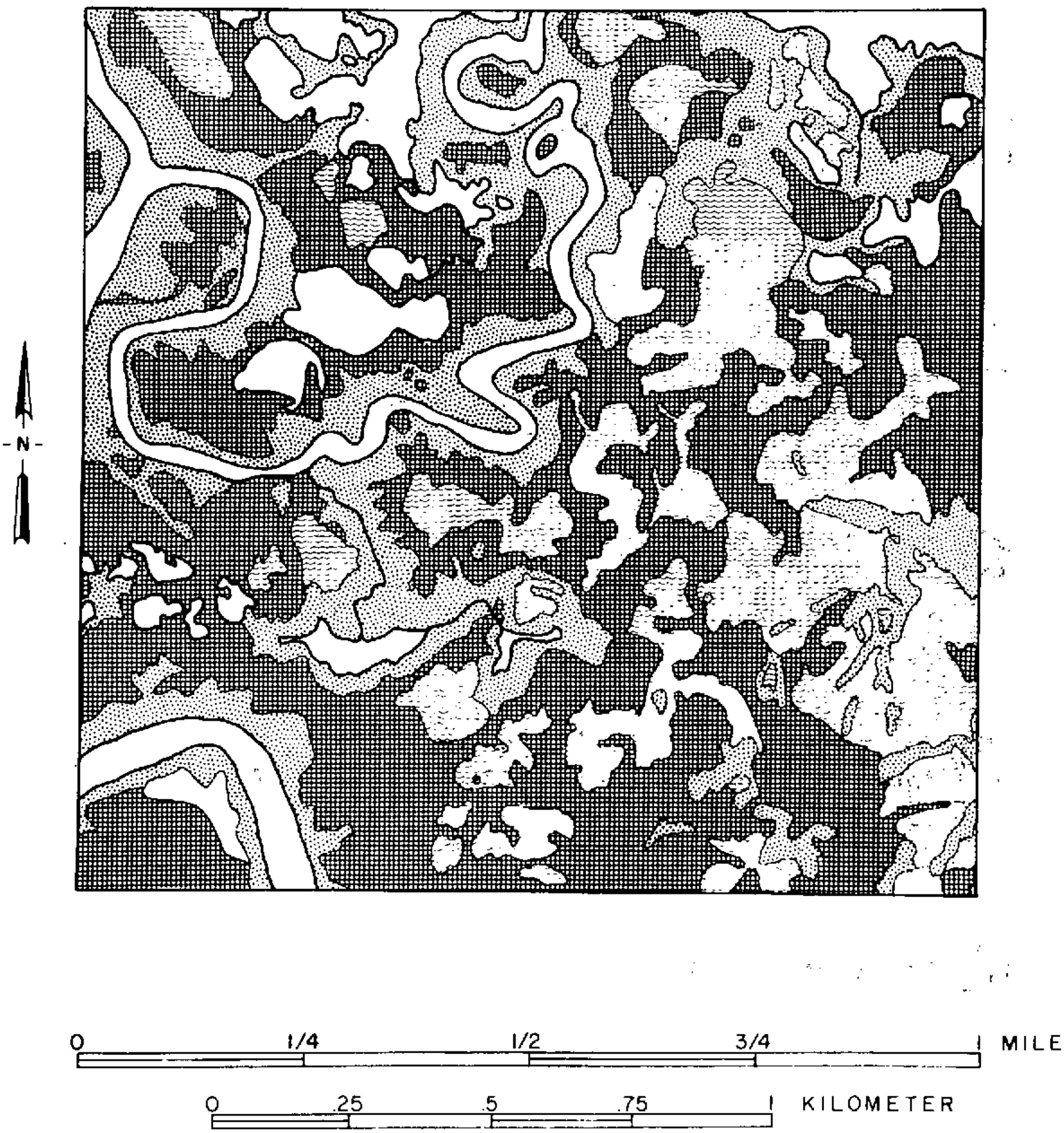
Scirpus Olneyi 60-75 %
Spartina patens/Distichlis spicata 20-30 %
Mud / Water 5-30 %
Spartina alterniflora 0-30%

Mud / Water 30-90 %
Containing hummocks of:
Spartina alterniflora, Spartina patens/Distichlis spicata &/or
Scirpus Olneyi 10-70%

Appendix D

BECKER ISLAND MARSH

Predominately Types 5,6 & 8



Appendix D

ELLIOTT CREEK MARSH

Spartina patens/Distichlis spicata 80-100%
Mud / Water 0-20%

Spartina patens/Distichlis spicata 20-100%
Spartina alterniflora 20-100%
Mud / Water 0-20%

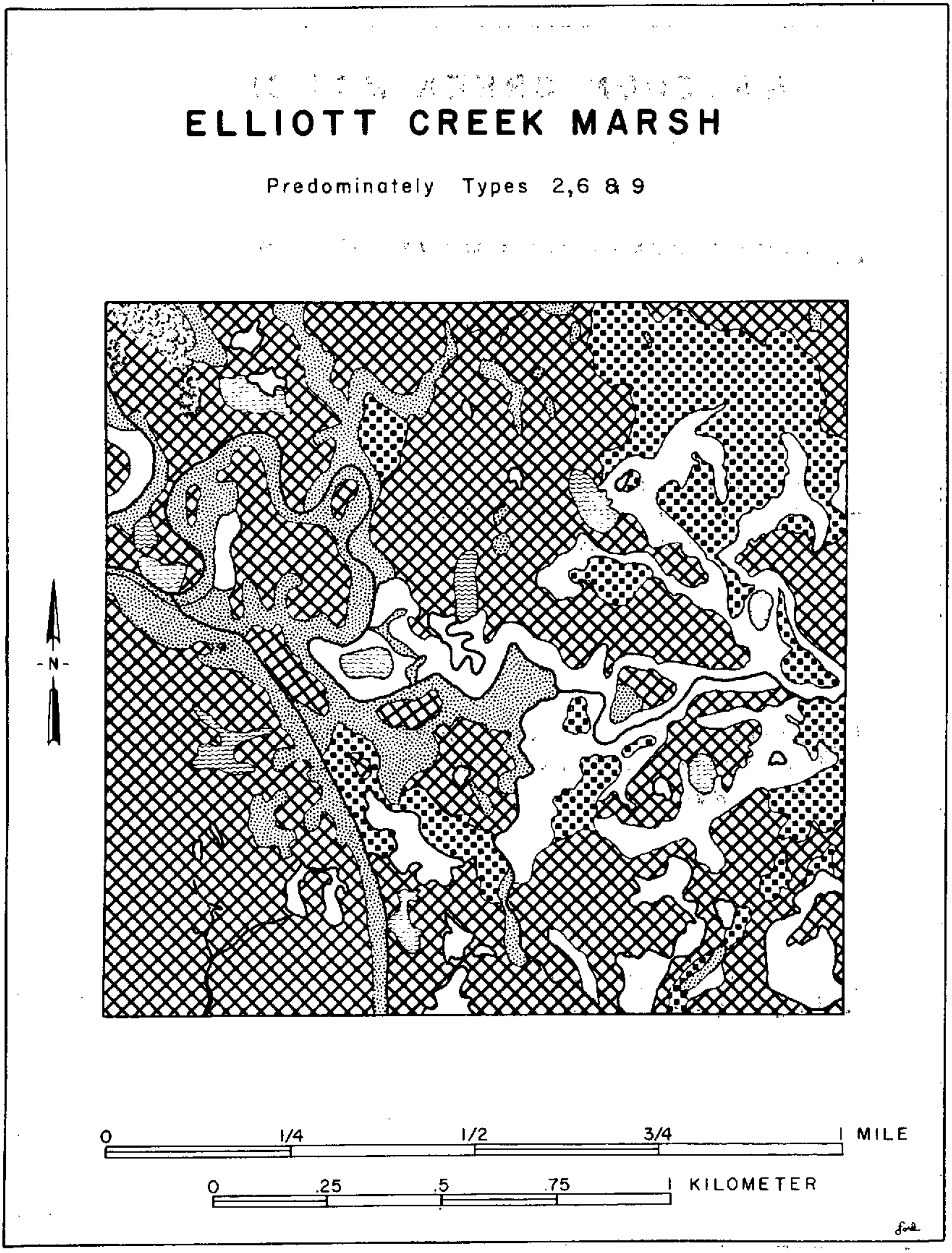
Mud / Water 70-100%
With hummocks of:
Spartina alterniflora & *Spartina patens/Distichlis spicata* 80-100%
Juncus Roemerianus 0-20%

Juncus Roemerianus 60-100% or *Scirpus Olneyi* 50-80%
Spartina alterniflora 0-50%
Spartina patens/Distichlis spicata 0-40%
Mud / Water 0-10%

Juncus Roemerianus 40-100%
Spartina patens/Distichlis spicata & *S. alterniflora* 0-60%
Scirpus Olneyi 0-20%
Mud / Water 0-20%

Trees & Shrubs

Appendix D


ELLIOTT CREEK MARSH
Predominately Types 2,6 & 9
N
0
1/4
1/2
3/4
1 MILE
0
.25
.5
.75
1 KILOMETER

Appendix D

RACCOON CREEK MARSH

Spartina patens/Distichlis spicata 90-100%

Spartina patens/Distichlis spicata 20-80%
Spartina alterniflora 20-80%
Mud/Water 0-20%

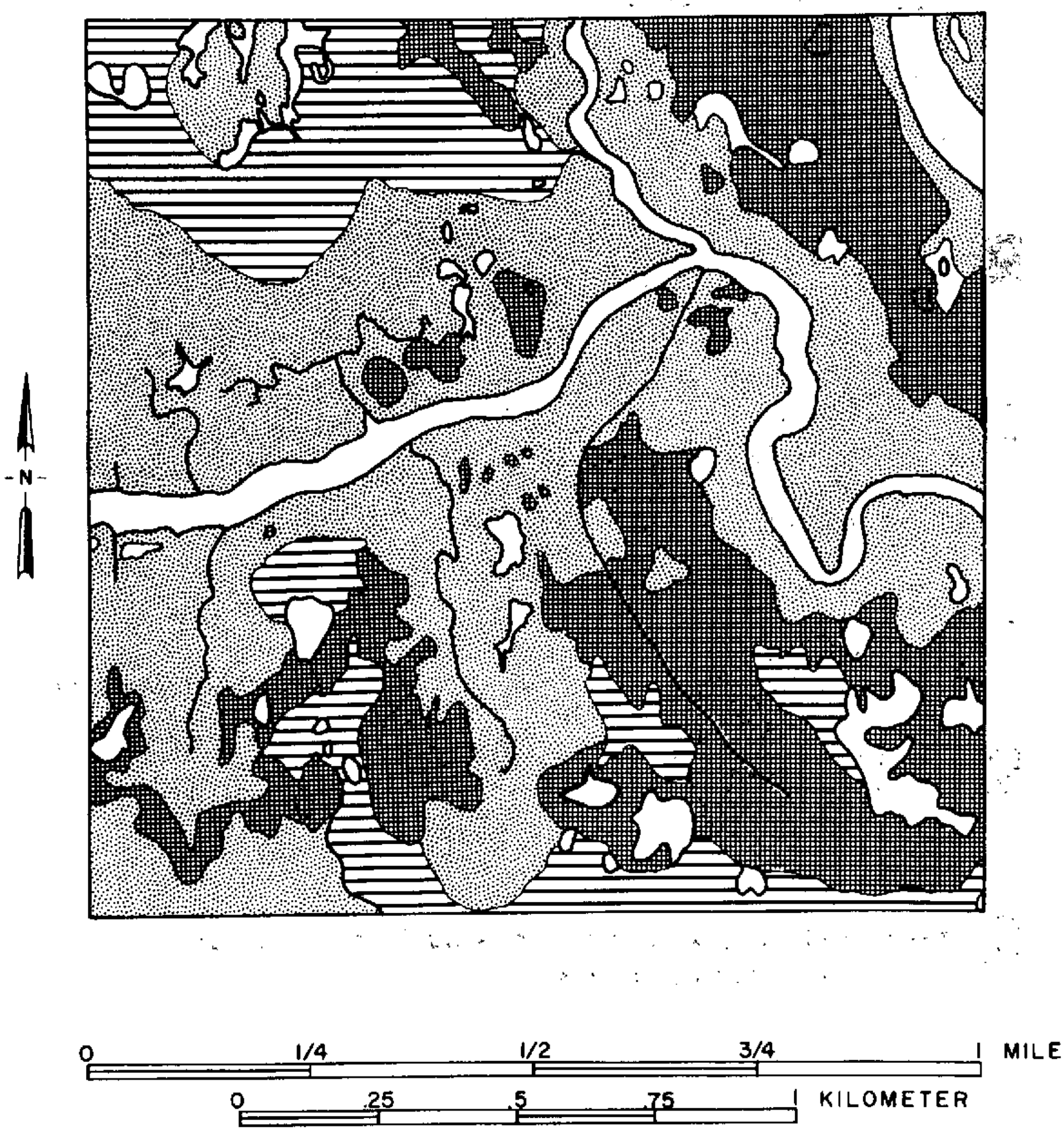
Scirpus Olneyi 60% &/or *Spartina alterniflora* 70%
Spartina patens/Distichlis spicata 10-20%
Mud/Water 20%

Scirpus Olneyi 80-100%
Mud/Water 0-20%

Appendix D

RACCOON CREEK MARSH

Predominately Types 2,5 & 6



GRAYS ISLAND MARSH

Spartina patens/Distichlis spicata 80-100 %
Sometimes interdigitated with:
Spartina alterniflora 60-80 %
Mud / Water 0-40 %

Spartina patens/Distichlis spicata 60 %
Spartina alterniflora 30 %
Mud / Water 10 %

Spartina alterniflora 40-70 %
Mud / Water 20-60 %
Spartina patens/Distichlis spicata 10-30 %

Spartina alterniflora 0-100 %
Scirpus Olneyi 0-100 %
Spartina patens/Distichlis spicata 0-80 %
Mud / Water 0-20 %

Spartina cynosuroides
& scattered *Iva frutescens* 80-100 %
Sometimes interdigitated with:
Spartina alterniflora, Scirpus Olneyi or *Spartina patens/D. spicata*

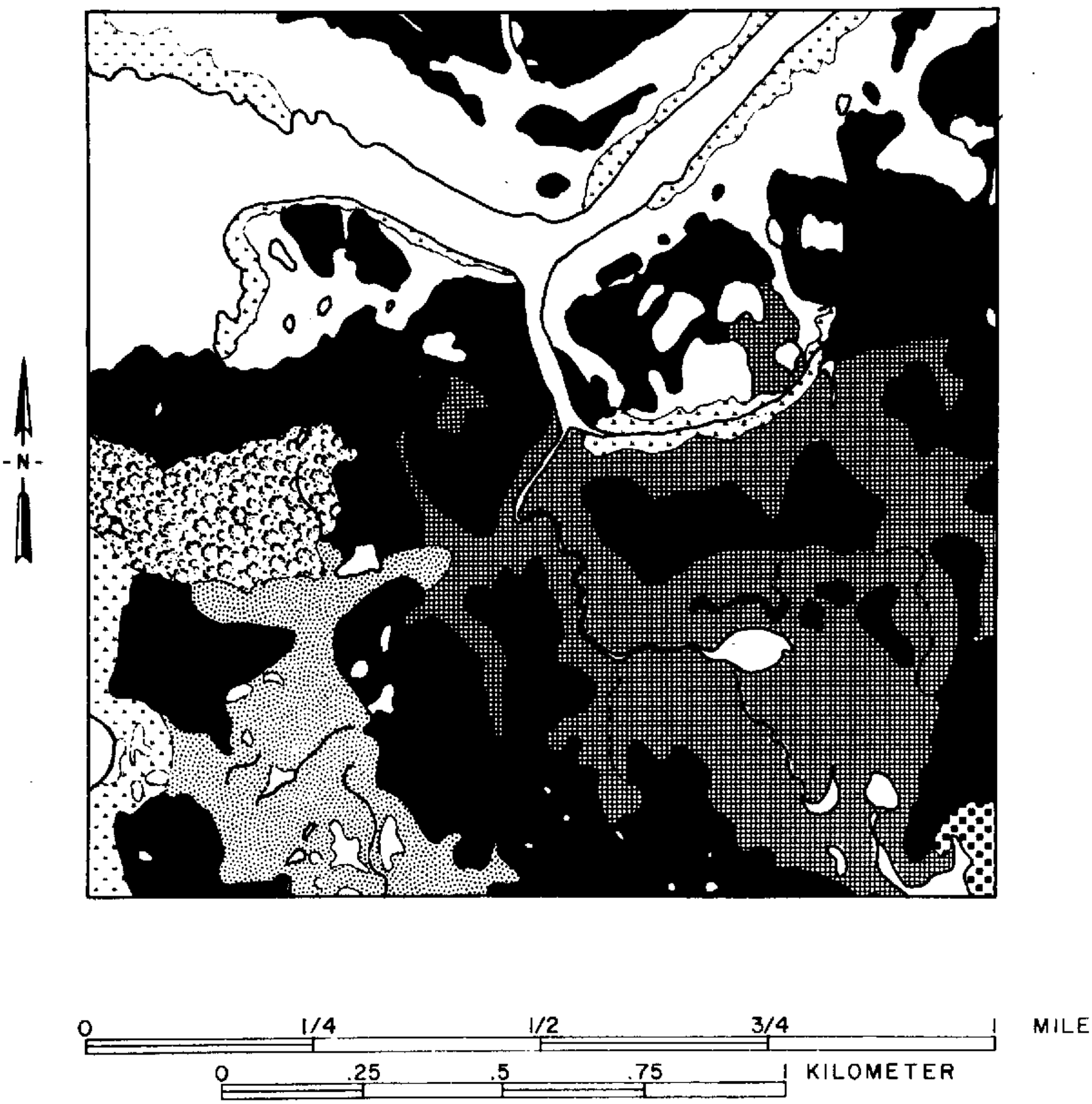
Juncus Roemerianus 80-100 %
Mud / Water 0-20 %

Trees / Shrubs with *Baccharis halimifolia, Panicum virgatum* & *Phragmites communis*

Appendix D

GRAYS ISLAND MARSH

Predominately Types 1,2,5,6 & 10



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