DREDGED MATERIAL RESEARCH PROGRAM

TECHNICAL REPORT D-78-25

HABITAT DEVELOPMENT FIELD INVESTIGATIONS
NOTT ISLAND UPLAND HABITAT DEVELOPMENT SITE
CONNECTICUT RIVER, CONNECTICUT

APPENDIX B: SURVEY OF TERRESTRIAL ECOLOGY AND PRELIMINARY BOTANICAL MONITORING

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July 1978

Final Report

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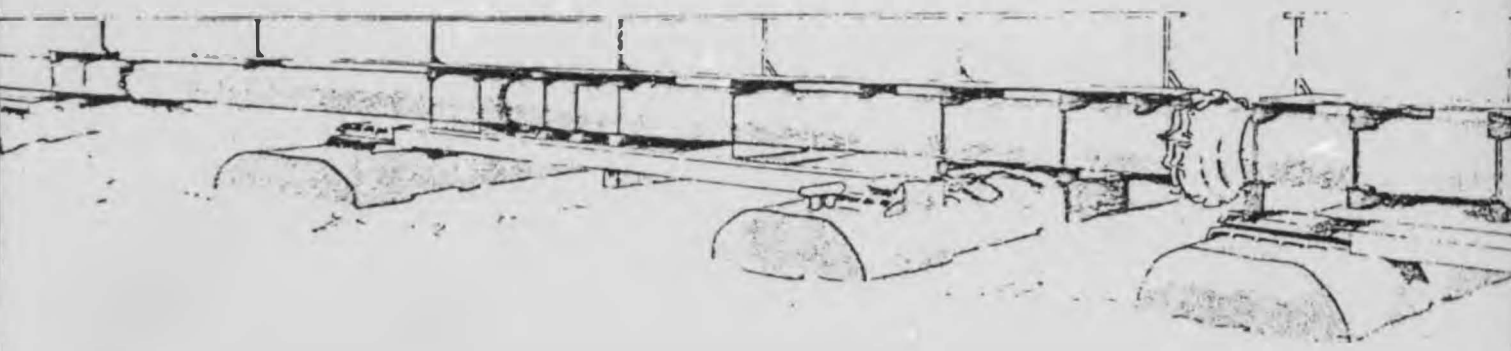

Prepared for Office, Chief of Engineers, U. S. Army
Washington, D. C. 20314

Under Contract No. DACW33-76-C-0017
(DMRP Work Unit No. 4B04E)

Monitored by Environmental Laboratory
U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Miss. 39180

HABITAT DEVELOPMENT FIELD INVESTIGATIONS, NOTT ISLAND UPLAND HABITAT DEVELOPMENT SITE, CONNECTICUT RIVER, CONNECTICUT

APPENDIX A: PRELIMINARY TERRESTRIAL ECOLOGICAL SURVEY

APPENDIX B: SURVEY OF TERRESTRIAL ECOLOGY AND PRELIMINARY BOTANICAL MONITORING

APPENDIX C: POSTPROPAGATION MONITORING OF VEGETATION AND WILDLIFE

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: Technical Report D-78-25	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)*: HABITAT DEVELOPMENT FIELD INVESTIGATIONS, NOTT ISLAND UPLAND HABITAT DEVELOPMENT SITE, CONNECTICUT RIVER, CONNECTICUT; APPENDIX B: SURVEY OF TERRESTRIAL ECOLOGY AND PRELIMINARY BOTANICAL MONITORING	5. TYPE OF REPORT & PERIOD COVERED: Final report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): R. Scott Warren, William A. Niering, William J. Barry, Allen C. Carroll	8. CONTRACT OR GRANT NUMBER(s): Contract No. DACW33-76-C-0017
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Connecticut College, New London, Conn. 06320	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: DMRP Work Unit No. 4B04E
11. CONTROLLING OFFICE NAME AND ADDRESS: Office, Chief of Engineers, U. S. Army, Washington, D. C. 20314	12. REPORT DATE: July 1978 13. NUMBER OF PAGES: 62
14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*: U. S. Army Engineer Waterways Experiment Station, Environmental Laboratory, P. O. Box 631, Vicksburg, Miss. 39180	15. SECURITY CLASS. *(of this report)*: Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

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

Biota	Habitats
Dredged material	Nott Island, Conn.
Dredged material disposal	Terrestrial habitats
Field investigations	Vegetation establishment
Habitat development	Waste disposal sites

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

A survey of the biota that occurred after dredged material disposal and prior to reclamation was conducted on Nott Island, Connecticut, a site selected for upland habitat development under the Dredged Material Research Program. The study included vegetation, floristics, habitat use by small mammals and nesting birds, and occurrence of larger mammals and bird visitors. Biota in the disposal area as well as on the rest of the island are described.

(Continued)

20. ABSTRACT (Continued).

Fourteen major vegetation associations in shrublands, grasslands, estuarine wetlands, and disturbed areas were delineated. A total of 253 species of plants were identified. Three species of small mammals and 70 species of birds were observed. This appendix also includes preliminary observations on experimental plantings of grasses and legumes at different levels of lime application.

SUMMARY

Research at the Nott Island upland habitat development site involved efforts in data collection and monitoring at the various operational phases. This report discusses efforts to describe biota on the island after disposal and prior to reclamation. It also presents initial observations on the establishment of experimental plots planted within the disposal area.

The biotic description includes vegetation, floristics, small mammals, and breeding birds. Note was made of occurrence of larger mammals and bird visitors. To develop the vegetation description, a detailed map was prepared using aerial photography and information obtained from field sampling. A total of 974 quadrats, 5 m in diameter were established; a complete species list and cover estimates for each species were taken in all quadrats. From this data, fourteen major vegetation associations were identified. These associations include four of shrubland, four of grassland, and five of estuarine marsh. The fourteenth category, disturbed vegetation, was for areas subjected to equipment traffic during the dredging and disposal operations. A total of 253 species of plants was identified on the island.

The dominant mammals in the upland areas of Nott Island, as determined by live trapping on a 15-m grid, were the meadow vole (*Microtus pennsylvanicus*), the meadow jumping mouse (*Zapus hudsonius*), and the short-tailed shrew (*Blarina brevicauda*). Statistically, neither the meadow vole nor the meadow jumping mouse showed a preference for shrubland, grassland, or wetland habitat. Other mammals occurring on Nott Island included white-tailed deer (*Odocoileus virginianus*), eastern mole (*Scalopus aquaticus*), muskrat (*Ondatra zibethicus*), and Norway rat (*Rattus norvegicus*).

Fifty-one species of birds were observed in 1976, 60 in 1975, and 70 over both years. In 1976, the breeding bird population was estimated to be 121 pairs comprising 18 species for a total density of 4.25 per ha. This represents a slight decline from 1975 when 145 pairs of 23 species were counted for a density of 5.09 per ha. Fifteen species nested both

years, with the most common being, in order, the red-winged blackbird (*Agelaius phoeniceus*), song sparrow (*Melopiza melodia*), long-billed marsh wren (*Cistothorus palustris*), yellow warbler (*Dendroica petechia*), and common yellowthroat (*Geothlypis trichas*). The highest density of breeding birds was found in the estuarine wetlands; however, the greatest diversity was in the upland areas where vegetation diversity and cover were greater.

Experimental plots to study growth of grasses and legumes at different levels of lime application were planted in August 1976. Four grasses including tall fescue (*Festuca elatior*), orchard grass (*Dactylis glomerata*), timothy (*Phleum pratense*), and perennial ryegrass (*Lolium perenne*) and two legumes - red clover (*Trifolium pratense*) and white clover (*Trifolium repens*) were planted with three replicates each of four lime treatments (control, and 3.6, 5.4, and 7.2 metric tons per 0.4 ha). From observations made about six weeks later it was clear that lime improved coverage and growth of all species. However, it was too early to evaluate optimal lime levels for any of the test species.

PREFACE

The work described in this report was performed under Contract No. DACW33-76-C-0017 between Connecticut College, New London, Connecticut, and the U. S. Army Engineer Division, New England, which administered the contract for the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Mississippi. The research was sponsored by the Office, Chief of Engineers, under the Dredged Material Research Program (DMRP).

The principal investigators were Drs. R. Scott Warren and William A. Niering for vegetation and floristics and Dr. William J. Barry for wildlife, all of Connecticut College. Field work for vegetation and floristics was under the immediate supervision of Mr. Mark J. McDonnell, now of the University of New Hampshire. The breeding bird study was done by Mr. Allen Carroll of East Haddam, Connecticut. This report was written by R. Scott Warren, William A. Niering, William J. Barry, and Allen L. Carroll with the extensive and invaluable editorial assistance of Mrs. Nancy C. Olmstead of the Connecticut Arboretum. The vegetation maps of Nott Island in Figures 3 and 4 were drafted by Ms. Lisa Bandazian of Canterbury, Connecticut.

The authors would like to thank the team of undergraduate field assistants: Richard Carr, Nora Holmquist, Daniel Murch, Anthony Nelson, Richard Newbold, Tina Siewers, Joan Tabachnick, Emily Wolfe, and Joan Zaprzalka. Without their careful and dedicated work, this study would not have been possible. Finally, Mrs. Rose Fishman and Mrs. Margaret Serluca, secretaries of the Botany and Zoology Departments, deserve thanks for their careful typing and preparation of the manuscript.

The report was prepared for the Habitat Development Project (HDP) of the DMRP (Dr. Hanley K. Smith, Manager) as part of Task 4B, "Terrestrial Habitat Development." The contract was managed by Ms. L. Jean Hunt who deserves special thanks for her help, encouragement, and patience throughout the course of this study. The contract was under the general supervision of Dr. J. Harrison, Chief of the Environmental Laboratory, WES.

Directors of WES during the study and preparation of this report were COL G. H. Hilt, CE, and COL J. L. Cannon, CE. Mr. F. R. Brown was Technical Director.

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AND PRELIMINARY BOTANICAL MONITORING

PART I: INTRODUCTION

Background

1. Nott Island, comprising about 31 ha, is located 11.2 km upstream from the mouth of the Connecticut River along the eastern shore of the main channel. Nearly 17 ha is upland, consisting of a mosaic of shrublands, grasslands, and unvegetated sand. A large, nearly 12 ha, estuarine wetland covers the southern portion of the island. The remaining space is the diked disposal area chosen for the upland habitat development field site.

2. From the colonial period until the early 1950's, the island was used for agriculture, principally as an area for hay crops and cattle pasture. The first disposal took place in 1936, and since then has occurred eight more times. In 1968, Nott Island was acquired by the State of Connecticut as a hunting preserve, and since then it has been under the management of the Wildlife Division of the Connecticut Department of Environmental Protection.

3. In February 1975, a sand dike enclosing the 3.1-ha site planned for the habitat development study was constructed in the north central portion of the island (Figure 1). The vegetation within the dike was primarily a switchgrass (*Panicum virgatum*) grassland, but also included a small black locust (*Robinia Pseudo-Acacia*) clone and other scattered trees. From February to April 1975 sandy dredged material was pumped into the disposal site. A view of the disposal site during filling is shown in Figure 2.

Previous Study

4. Prior to dredging and disposal, a detailed analysis of vegetation and a flora for the disposal area were prepared (Warren and Niering 1978). Preliminary small mammal trapping studies were conducted in

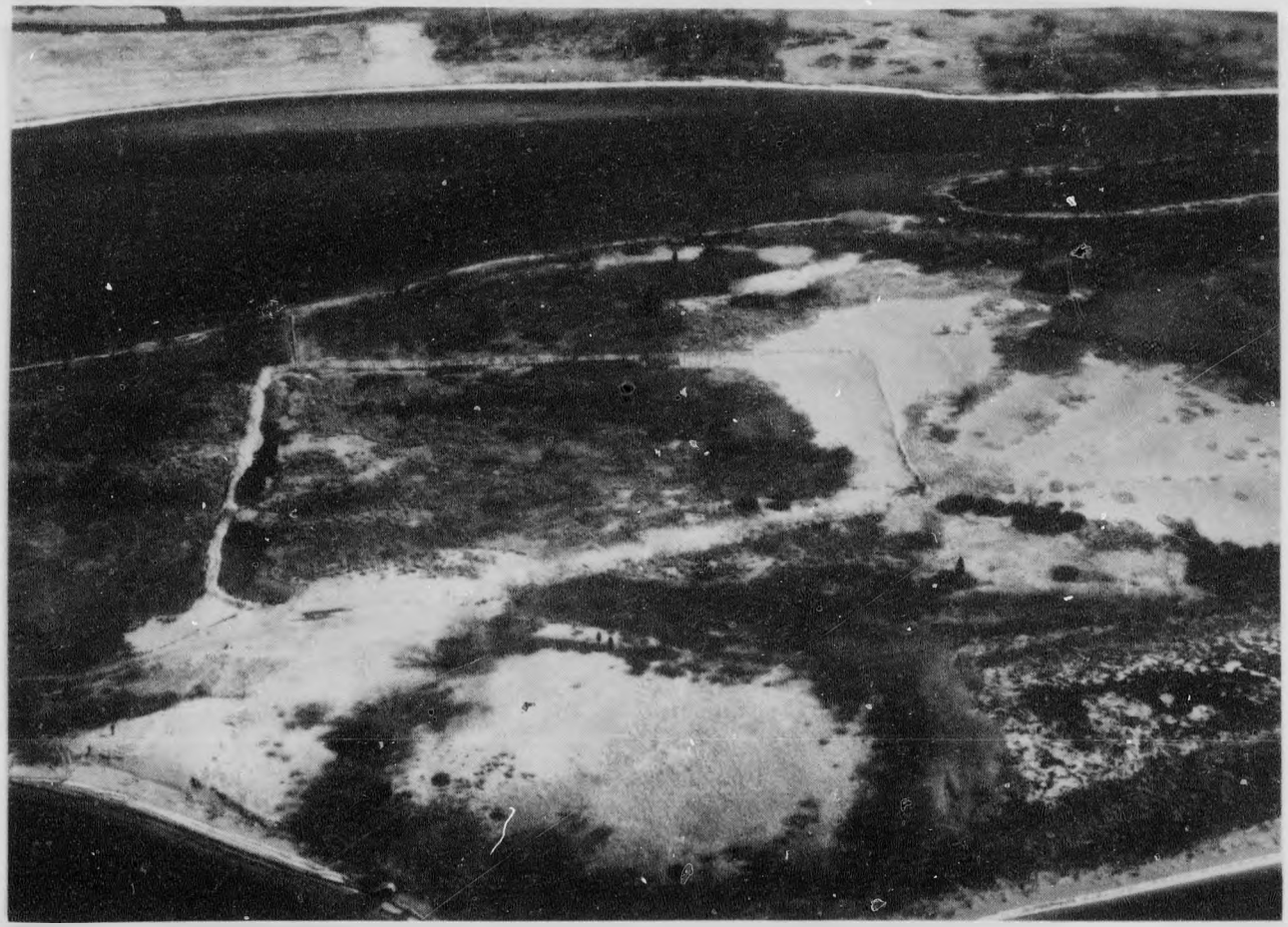


Figure 1. Oblique aerial view of Nott island after dike construction but before disposal operations

Figure 2. Ground view during initial stages of filling

September 1974 and again in March 1975, after the dike had been constructed but before the actual dredging operation had begun.

5. After disposal operations and during the spring and summer of 1975, a preliminary flora and vegetation map of the island was prepared. A breeding bird census was also taken and a year-round study of bird use of the island was initiated. From June to August 1975, the disposal site and other upland areas were intensively trapped for small mammals. The results of these initial studies have been presented in a previous report (Warren and Niering 1978).

Objectives

6. The primary purpose of this study was to develop a biotic description of Nott Island prior to the actual reclamation of the disposal site. This description would provide a baseline against which to monitor changes associated with the habitat development work. Field work, done in the summer of 1976, included census or sampling of vegetation, floristics, small mammals, and breeding birds, and observations of larger mammals and visiting birds. A small-scale microclimate study was also conducted in different vegetation types in order to compare temperature extremes and ranges.

7. A second objective was to establish and monitor experimental plots planted within the disposal area. This study sought to assess the success of establishment of different species of grass and legumes seeded under different levels of added lime.

PART II: DESCRIPTION OF VEGETATION PATTERNS ANIMAL POPULATIONS, AND MICROCLIMATES

Vegetation

Methodology

8. The vegetation map prepared by the authors in 1975 (Warren and Niering 1978) and aerial photographs at 1:1200 taken by the New England Division in late summer of 1975 provided the basis of information for the 1976 vegetation study. Preparation of the 1976 vegetation map involved three major steps. First, the 1976 map and aerial photos were used to pick out distinct units of vegetation. Second, these units were identified and quantified by ground truth reconnaissance and quadrat sampling. Third, the detail (Figure 3) given by the individual units was considered impractical for most applications so units were pooled into 14 vegetation associations and mapped.

9. For the quadrat sampling, a minimum of five circular 5-m diameter quadrats was located within each unit of vegetation determined from the aerial photos and 1975 map. A total of 974 quadrats was sampled for this study. Within each quadrat, species were identified and grouped by trees, shrubs and vines, and herbs. Additional information recorded for each quadrat included: coded estimated percent cover for each species; heights of trees, shrubs, and herb strata; soil texture and moisture; and disturbance and animal activity. Note was made of any species in flower and a specimen was taken for the flora collections.

10. In addition to the field work conducted from mid-June to mid-August for the 1976 mapping and quantification of vegetation, collection trips were made biweekly to Nott Island throughout the early spring to obtain specimens of flowering plants. The inventories of plant species observed on Nott Island during 1975 and 1976 were combined into a master list (Appendix A').

Results

11. The 14 major vegetation associations are mapped in Figure 4 and summarized on Table 1. The associations consist of eight upland types

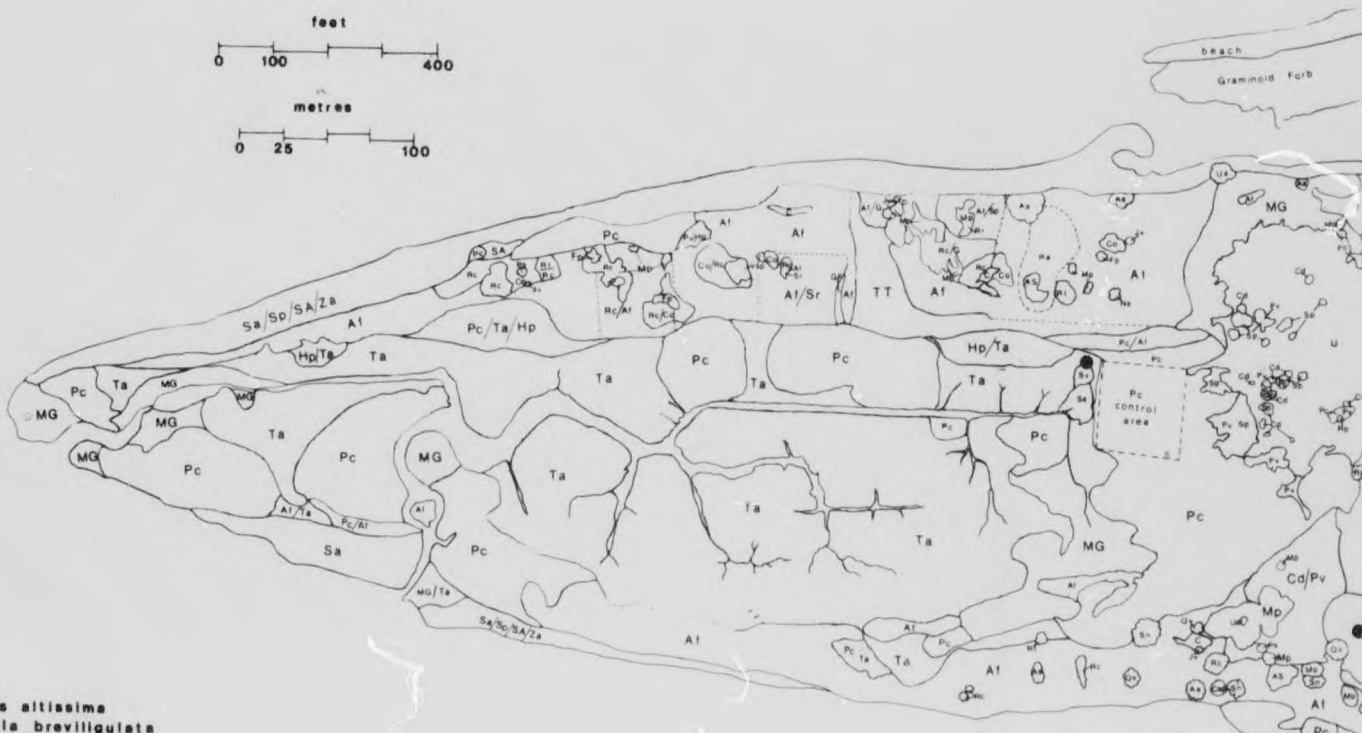
NOTT ISLAND

LYME, CONNECTICUT

Scale 1:1200

feet
0 100 400

metres
0 25 100

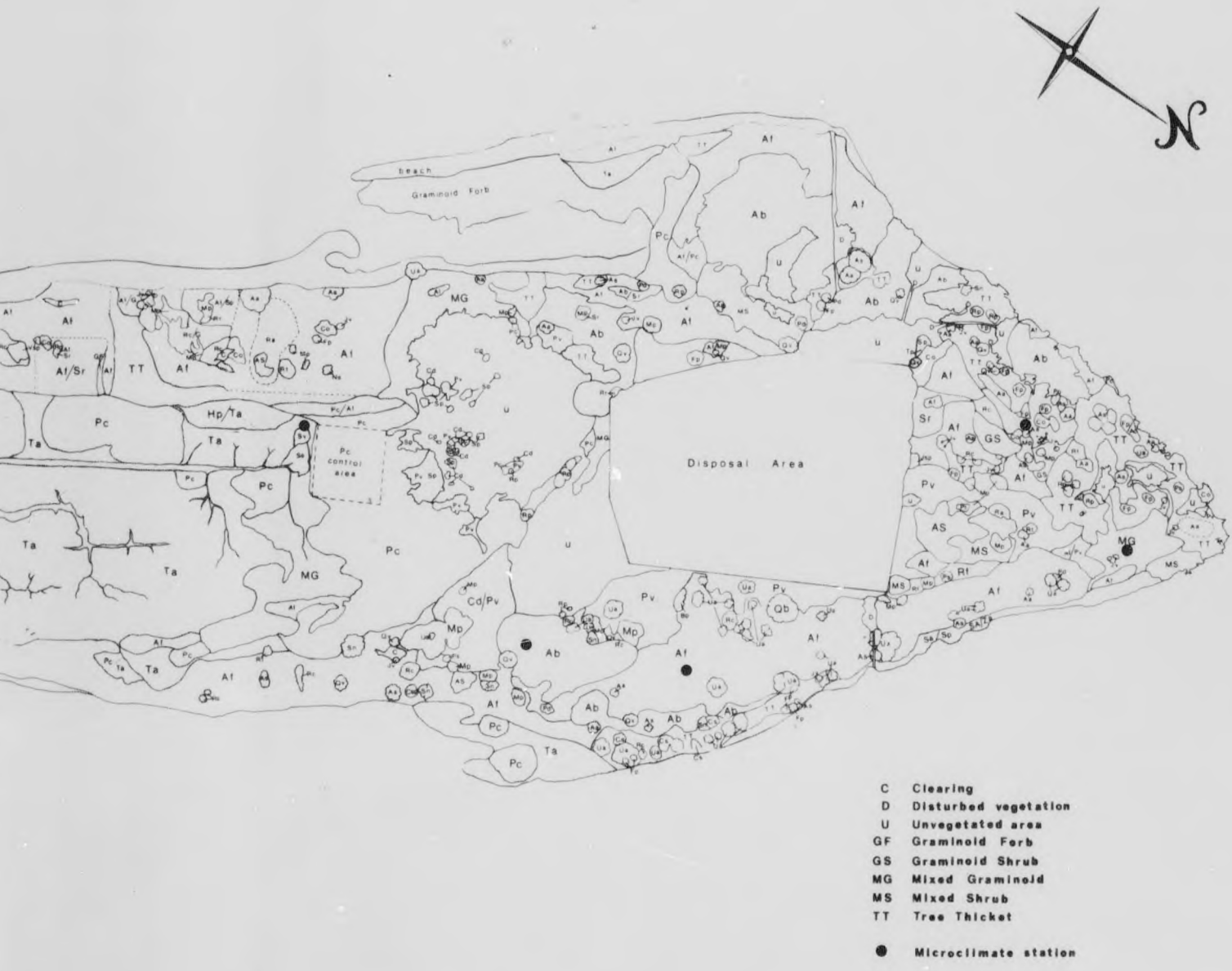


As Allanthus altissima
Ab Ammophila breviligulata
Af Amorpha fruticosa
As Acer saccharum
AS Alnus serrulata
Cd Cyperus dentatus
Co Celastrus orbiculatus
Cs Catalpa speciosa
Csp Crataegus sp.
Fp Fraxinus pennsylvanica
FP Fraxinus pennsylvanica var. subintegerrima
Hp Hibiscus palustris
Jsp Juncus sp.
Jv Juniperus virginiana
Mp Myrica pensylvanica
Pc Phragmites communis*
Pd Populus deltoides
Ps Prunus serotina
Pt Populus tremuloides
Pv Panicum virgatum
Qb Quercus bicolor
Qv Quercus velutina

Ra Rubus alleganiensis
Rc Rhus copallina
Rf Rubus flagellaris
Rp Robinia pseudo-acacia
Rt Rhus typhina
Sa Scirpus americanus
SA Spartina alterniflora
Sn Salix nigra
Sp Spartina pectinata
Sr Solidago rugosa
Sv Scirpus validus
Ta Typha angustifolia
Ua Ulmus americana
Vsp Vitis sp.
Za Zizania aquatica

* Current taxonomic use is now Phragmites australis.

Figure 3. Detailed vegetation map of Nott Is



strails.

re 3. Detailed vegetation map of Nott Island

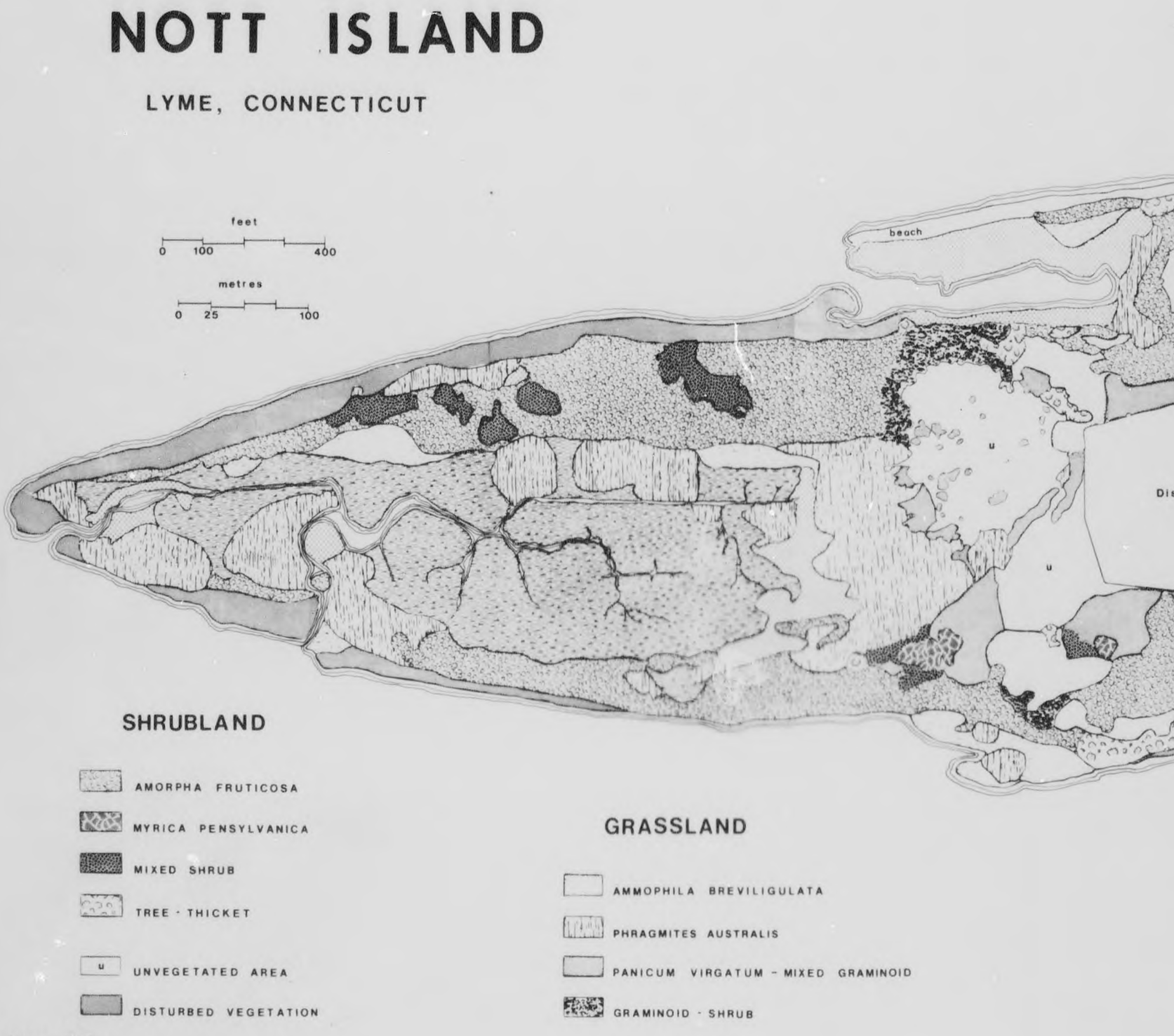


Figure 4. Generalized vegetation map of Nott Island

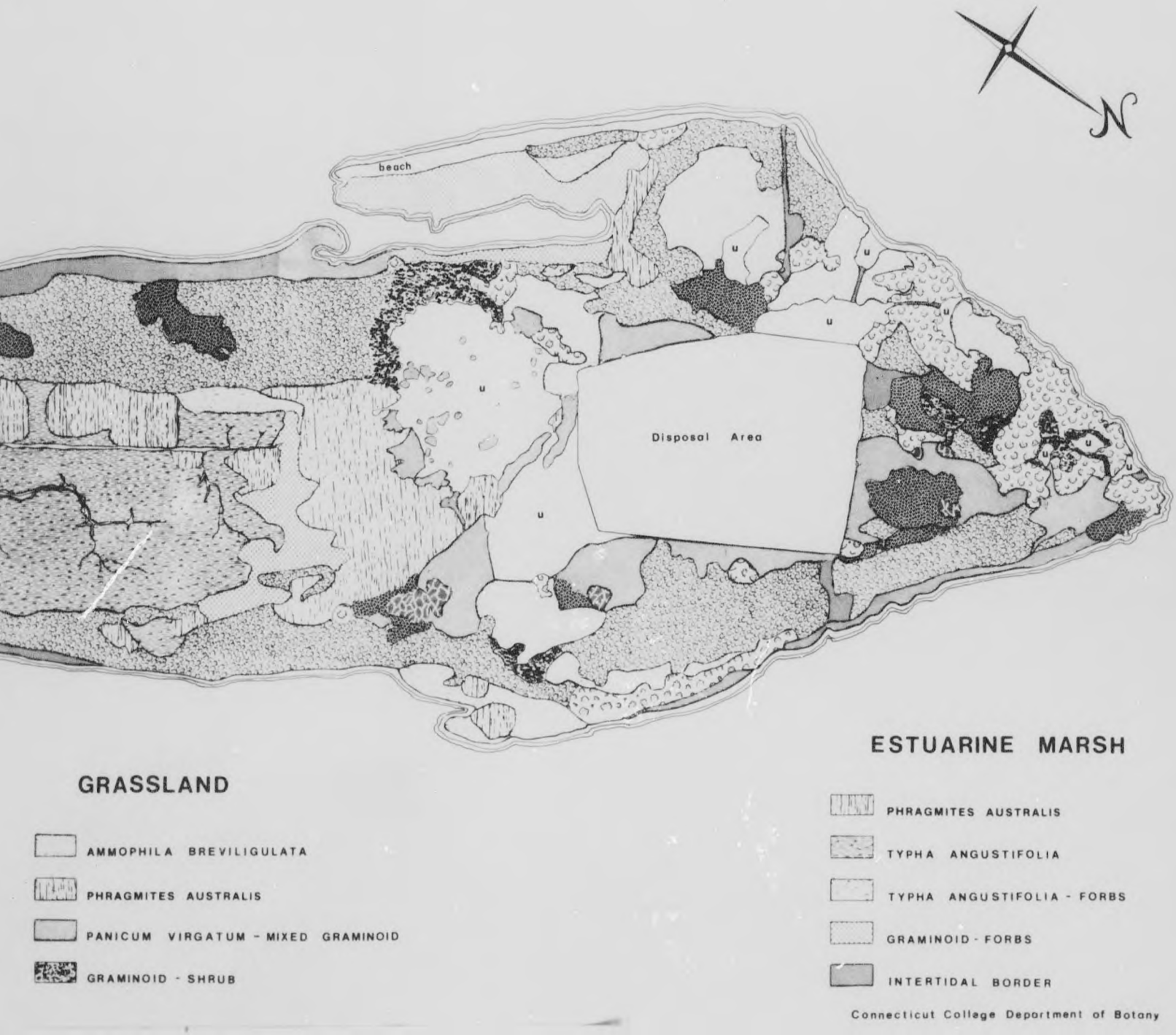


Figure 4. Generalized vegetation map of Nott Island

Table 1

Area and Percent Contribution of Major Vegetation Associations of Nott Island

Vegetation Association	Total Area, ha	Percent of Total Area	Number of Quadrats
Shrublands	9.6	30.1	520
Amorpha fruticosa	6.5	20.4	299
Mixed shrub	1.4	4.4	96
Myrica pensylvanica	0.2	0.6	10
Tree-thicket	1.5	4.7	115
Grasslands	5.1	16.0	198
Ammophila breviligulata	1.8	5.6	
Panicum virgatum-Mixed graminoid	1.7	5.3	
Graminoid - Shrub	0.6	2.0	
Phragmites australis	1.0	3.1	
Estuarine wetlands	11.9	37.3	224
Typha angustifolia	4.4	13.8	69
Phragmites australis	3.3	10.3	65
Typha - Forb	0.8	2.5	13
Graminoid - Forb	1.5	4.7	43
Intertidal Border	1.9	6.0	34
Disturbed vegetation	0.1	0.3	32
Disposal Site	3.1	9.7	0
Unvegetated Areas	2.1	6.6	0
Total	31.9	100.0	974

of shrublands and grasslands and five types of estuarine wetlands. The fourteenth association is defined as disturbed vegetation. In all, 253 species of plants were recorded on Nott Island. A description and analysis of each of the fourteen associations is given in the following sections. A map of soil types is given in Figure 5.

Shrubland Associations

Amorpha fruticosa

12. The *Amorpha fruticosa* (false indigo) shrubland consists of three subtypes (*Amorpha/Solidago*, *Amorpha* wet phase, and *Amorpha*/Graminoid) and is the most extensive association on Nott Island, covering about 6.5 ha or 20 percent of the island's total area (Table 1). *Amorpha* shrubland occurs as an irregular 25- to 100-m-wide border above the intertidal zone along most of the eastern and western shores of the island (Figure 4). The association is characterized by thickets of dense indigo, 2 to 3 m tall, with the canopy providing 75 to 100 percent cover. The subtypes are distinguished by differences in the herbaceous layer, which in turn is largely a reflection of edaphic conditions. The *Amorpha* shrublands appear to represent the typical riparian vegetation on alluvial soils deposited on riverine islands such as Nott Island. Table 2 summarizes the quadrat for the three *Amorpha* subtypes and the following paragraphs describe each subtype.

13. *Amorpha/Solidago*. This is most extensive *Amorpha* subtype, covering most of the northern end of the island and a lobe extending to the southwest. The herbaceous cover is characterized by rough-edged goldenrod (*Solidago rugosa*), which was reported in 83 percent of the 191 quadrats sampled. Where it occurs, rough-edged goldenrod generally provides 25 to 50 percent of the herbaceous cover. Other herbs, which occurred in 20 percent or more of the 191 quadrats sampled, are common wintercress (*Barbarea vulgaris*), climbing false buckwheat (*Polygonum scandens*), wood-sage (*Teucrium canadense*), climbing hempweed (*Mikania scandens*), and pokeweed (*Phytolacca americana*). A variety of shrubs and vines also occur, particularly in the marginal areas, and include

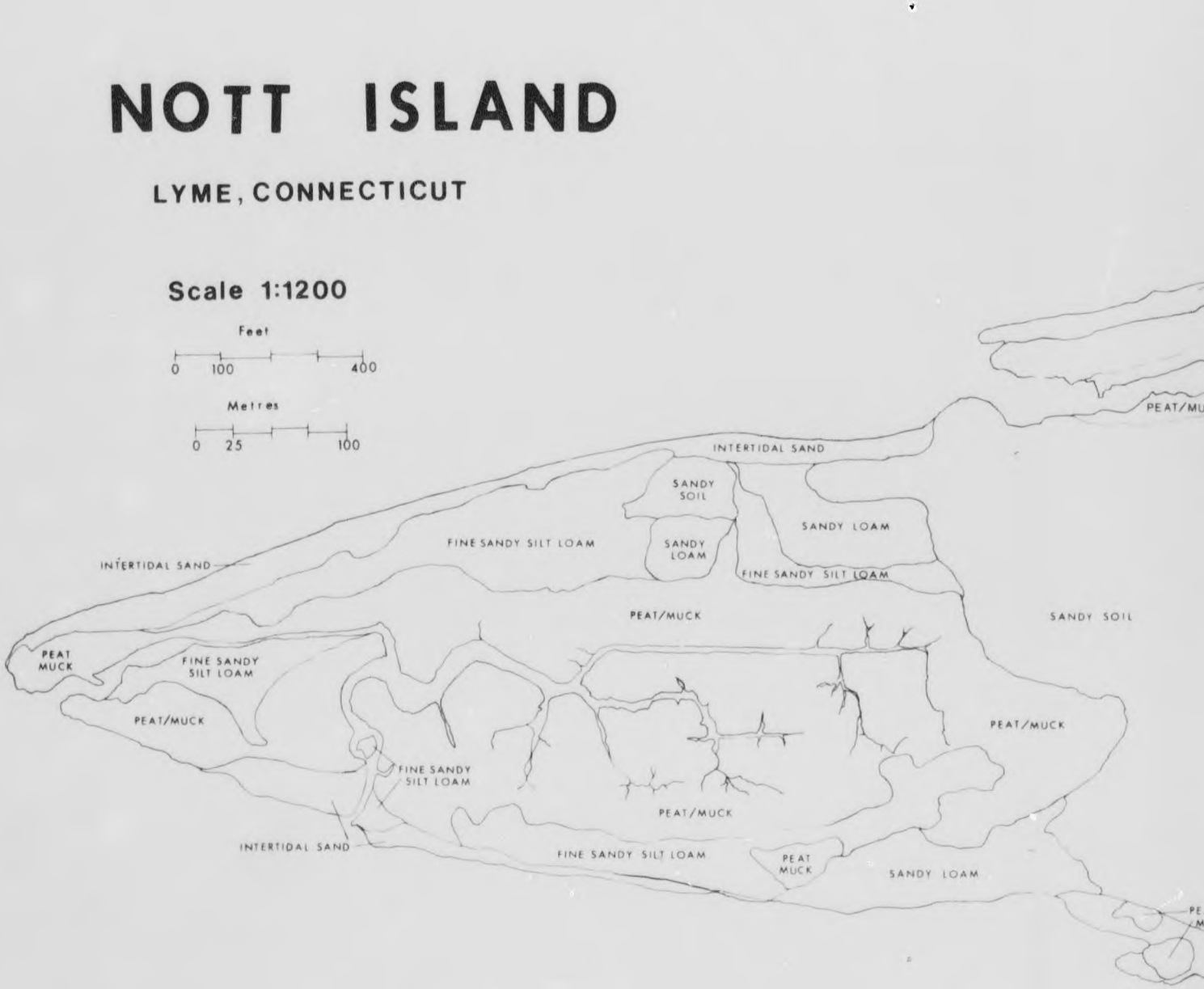


Figure 5. Soils map of Nott Island

Figure 5. Soils map of Nott Island

Table 2

Summary of Quadrat Data for the Three Subtypes of Amorpha fruticosa Shrubland*

Life Form and Species		Subtype and Number of Quadrats Sampled: Amorpha/Solidago, 191 Quadrats — Occurrence in Quadrats: Number in Which Present	Amorpha/Solidago, 191 Quadrats — Occurrence in Quadrats: Percent of Total Sampled Frequency	Amorpha/Solidago, 191 Quadrats — Mean Coded** Cover, Density: For Quadrats in Which Present	Amorpha/Solidago, 191 Quadrats — Mean Coded** Cover, Density: Total Sample	Amorpha/Weed Phase, 72 Quadrats — Occurrence in Quadrats: Number in Which Present	Amorpha/Weed Phase, 72 Quadrats — Occurrence in Quadrats: Percent of Total Sampled, Frequency	Amorpha/Weed Phase, 72 Quadrats — Mean Coded** Cover, Density: For Quadrats in Which Present	Amorpha/Weed Phase, 72 Quadrats — Mean Coded** Cover, Density: Total Sample	Amorpha/Graminoid, 36 Quadrats — Occurrence in Quadrats: Number in Which Present	Amorpha/Graminoid, 36 Quadrats — Occurrence in Quadrats: Percent of Total Sampled, Frequency	Amorpha/Graminoid, 36 Quadrats — Mean Coded** Cover, Density: For Quadrats in Which Present	Amorpha/Graminoid, 36 Quadrats — Mean Coded** Cover, Density: Total Sample
Trees		57	30	4.4	1.3	11	15	3.7	0.6	4	11	2.8	0.3
Ailanthus altissima	Tree of heaven	17	9	3.9	0.4	2	3	5.0	0.1	0	0	0	0
Ulmus americana	American elm	11	6	3.9	0.2	1	1	3.0	0.1	0	0	0	0
Fraxinus pensylvanica	Red ash	3	2	2.3	< 0.1	0	0	0	0	0	0	0	0
Juniperus virginiana	Red cedar	6	3	1.0	< 0.1	0	0	0	0	4	11	2.3	0.3
Shrubs and Vines		191	100	5.7	5.7	70	97	5.4	5.2	36	100	5.4	5.4
Amorpha fruticosa	False indigo	175	92	4.8	4.4	69	96	4.4	4.2	33	92	4.2	3.9
Parthenocissus quinquefolia	Virginia creeper	77	40	2.0	0.8	9	13	1.8	0.2	5	14	1.8	0.3
Celastrus obiculatus	Oriental bittersweet	73	38	3.4	1.5	17	24	2.9	0.2	16	14	2.1	2.9
Myrica pensylvanica	Bayberry	62	32	3.6	1.1	4	6	3.0	0.2	22	61	3.1	1.9
Rhus radicans	Poison ivy	43	23	2.5	0.6	8	11	2.4	0.3	11	31	3.7	1.1
Rhus copallina	Shining sumac	42	22	3.2	0.7	4	6	3.0	0.2	16	44	3.3	1.5
Herbs		175	92	4.8	4.4	71	99	5.4	5.4	36	100	5.2	5.2
Solidago rugosa	Rough-edged goldenrod	159	83	4.0	3.4	14	19	2.6	0.5	25	69	3.0	2.1
Barbarea vulgaris	Common wintercress	97	51	2.2	1.1	29	40	2.0	0.8	6	17	0.2	0.3
Polygonum scandens	Climbing false buckwheat	97	51	1.9	0.9	21	29	1.6	0.5	20	55	1.4	0.8
Teucrium canadense	Wood-sage	63	33	3.3	1.1	36	50	3.0	1.5	15	42	2.3	0.9
Mikania scandens	Climbing hempweed	51	27	2.3	0.6	21	29	1.6	0.5	3	8	1.7	0.1
Phytolacca americana	Pokeweed	40	21	2.1	0.4	7	10	1.6	0.2	0	0	0	0
Carex sp.	Sedge	16	8	2.5	0.2	27	38	3.0	1.1	4	17	5.0	0.6
Cirsium vulgare	Common thistle	22	12	1.6	0.2	0	0	0	0	10	28	1.9	0.5
Panicum virgatum	Switchgrass	0	0	0	0	0	0	0	0	9	25	3.9	1.0
Polygonum sagittatum	Arrow-leaved tearthumb	9	5	2.0	0.1	18	25	1.8	0.4	0	0	0	0
Spartina pectinata	Freshwater cordgrass	7	4	2.0	0.1	7	10	2.4	0.2	6	17	2.2	0.4
Juncus effusus	Soft rush	0	0	0	0	0	0	0	0	6	17	3.0	0.5
Impatiens capensis	Touch-me-knot	0	0	0	0	32	44	1.6	0.7	0	0	0	0
Pilea pumila	Clearweed	8	4	2.1	0.1	18	25	3.0	0.7	0	0	0	0
Hibiscus palustris	Marsh mallow	0	0	0	0	22	31	2.9	0.3	0	0	0	0
Polygonum punctatum	Water smartweed	28	15	1.6	0.2	24	33	2.5	0.8	2	6	3.0	0.2

* Only the more frequently occurring species are included.

** For coded percent cover, the following classes were used:

< 1% Cover	= Class 1
1-5%	= 2
5-25%	= 3
25-50%	= 4
50-75%	= 5
75-100%	= 6

Virginia creeper (*Parthenocissus quinquefolia*), oriental bittersweet (*Celastrus orbiculatus*), bayberry (*Myrica pensylvanica*), poison ivy (*Rhus radicans*), and shining sumac (*Rhus copallina*). The most common scattered trees within the subtype are the tree of heaven (*Ailanthus altissima*), American elm (*Ulmus americana*), and red cedar (*Juniperus virginiana*). Soils are variable but are predominantly sand or sandy loam covered with a layer of organic material.

14. *Amorpha* wet phase. Most of the eastern and western margins of the estuarine marsh are *Amorpha* wet phase, the second most extensive *Amorpha* subtype. The *Amorpha* wet phase is also found locally within areas of the *Amorpha/Solidago* subtypes. Shrub density is lower here than in the other two *Amorpha* subtypes: only oriental bittersweet was recorded. The herbaceous layer is lush and extremely diverse. Woodsage occurred in half of the quadrats studied and made up 25 percent of the cover in those quadrats. Other herbaceous species that occurred in nearly 30 percent or more of the quadrats are: touch-me-not (*Impatiens capensis*), common wintercress, sedge (*Carex sp.*), water smartweed (*Polygonum punctuatum*), marsh mallow (*Hibiscus palustria*), climbing hempweed, and climbing false buckwheat. Trees were reported in only 15 percent of the quadrats and were represented by only two species: tree of heaven and American elm. Wet phase *Amorpha* occurs most typically on dark, heavy wet, alluvial soil. To a lesser extent it is also found on wet sandy areas just above the intertidal zone.

15. *Amorpha*/Graminoid. The most limited of the *Amorpha* subtypes, the *Amorpha*/Graminoid is restricted to the northern end of the island where it has invaded red cedar associated clearings. These areas are usually fairly xeric. Several species occur within the shrub stratum. Besides indigo, bayberry, shining sumac, oriental bittersweet, and poison ivy were reported in 30 percent or more of the quadrats sampled. With the exception of oriental bittersweet those species made up nearly 25 percent of the cover in the quadrats in which they occurred. The herbaceous layer reflects the soil moisture conditions of the various sites. Rough-edged goldenrod and climbing false buckwheat were the most common species. In xeric areas, grasses such as switchgrass (*Panicum*

virgatum) and freshwater cordgrass (*Spartina pectinata*) are frequently encountered. At the more mesic sites, sedges became common. Trees were found in only 11 percent of the quadrats and red cedar was in all of these. Soils were typically dry and sandy. In the wetter areas soils were sandy but not of alluvial origin.

Mixed shrub

16. There are a variety of small, vegetationally distinct mixed shrubland areas that occur throughout Nott Island. Most are located north of the disposal area or along the southwestern upland arm. Four distinct subtypes are recognized within the mixed shrub association: shining sumac, dewberry (*Rubus flagellaris*), common alder (*Alnus serrulata*), and shrub-thicket. These four subtypes are described in the following paragraphs. Data for the mixed shrub association is given in Table 3 but is not broken out by subtypes. Trees were reported in less than half of the quadrats and contributed to about one percent of the cover. Herb species made up nearly 25 percent of the cover and occurred in 97 percent of the quadrats (Table 3).

17. Shining sumac. Areas dominated by shining sumac are most extensive on the southwestern upland arm within an *Amorpha* matrix. Scattered areas are also found north of the disposal site. In the shining sumac subtype, the shining sumac canopy is about 3 to 6 m high and makes up more than 50 percent of the cover. The only important shrub is indigo and only in the southern areas. Rough-edged goldenrod, about 1.5 m tall, is the dominant herb in the more mesic areas while a variety of graminoids are the most common herbs in the more xeric situations. Soil types are variable: to the south they tend to be sandy silt or sandy loam with a distinct layer of organic content and so are well drained.

18. Dewberry. There are two conspicuous dewberry areas on Nott Island. One is on the northeastern side of the disposal area between the alder wetland (described below) and dense *Amorpha* shrubland. The other site is southeast of the disposal area, and is more open, bordered along only on one side by *Amorpha*. Dewberry is found trailing along the ground, 5 to 25 cm high and, in these areas, contributes about 25 percent of the cover. Short indigo (1.5 m) is scattered within both

Table 3

Summary of Quadrat Data for the Mixed Shrub and Tree-Thicket Shrublands*

Life Form and Species		Association and Number of Quadrats Sampled: Mixed Shrub, 96 Quadrats — Occurrence in Quadrats: Number in Which Present	Occurrence in Quadrats: Percent of Total Sampled, Frequency	Mean Coded Cover, Density**: For Quadrats in Which Present	Mean Coded Cover, Density**: For Total Sampled	Tree-Thicket, 115 Quadrats — Occurrence in Quadrats: Number in Which Present	Occurrence in Quadrats: Percent of Total Sampled, Frequency	Mean Coded Cover, Density**: For Quadrats in Which Present	Mean Coded Cover, Density**: For Total Sampled
Trees		41	43	4.3	1.8	101	88	5.2	4.6
Ailanthus altissima	Tree of heaven	13	14	3.6	0.4	42	37	4.7	1.7
Juniperus virginiana	Red cedar	11	11	3.5	0.4	22	19	4.2	0.8
Quercus velutina	Black oak	6	6	3.7	0.2	7	6	3.1	0.2
Robinia pseudo-acacia	Black locust	0	0	0	0	12	10	4.4	0.5
Ulmus americana	American elm	0	0	0	0	14	12	4.2	0.5
Fraxinus pensylvanica	Red ash	0	0	0	0	9	8	4.9	0.3
Salix spp.	Willow	0	0	0	0	9	8	4.5	0.2
Prunus serotina	Wild black cherry	4	4	4.0	0.2	9	8	4.3	0.3
Shrubs and Vines		96	100	5.8	5.8	115	100	5.8	5.8
Amorpha fruticosa	False indigo	84	88	3.7	3.2	81	70	3.6	2.5
Celastrus orbiculatus	Oriental bittersweet	60	63	3.5	2.2	99	86	4.1	3.5
Rhus copallina	Shining sumac	46	48	3.7	1.8	13	11	2.5	0.3
Myrica pensylvanica	Bayberry	34	35	3.1	1.1	30	26	3.5	0.9
Rhus radicans	Poison ivy	32	33	2.7	0.9	55	48	3.3	1.6
Parthenocissus quinquefolia	Virginia creeper	30	31	2.1	0.7	75	65	2.4	1.6
Rubus flagellaris	Dewberry	13	14	4.8	0.7	24	21	2.9	0.6
Alnus serrulata	Common alder	6	6	4.8	0.2	0	0	0	0
Herbs		93	97	3.8	3.7	96	83	3.5	2.9
Solidago rugosa	Rough-edged goldenrod	66	69	3.5	2.4	57	50	2.7	1.4
Polygonum scandens	Climbing false buckwheat	34	35	2.0	0.7	25	22	2.6	0.6
Carex spp.	Sedge	20	21	3.1	0.6	12	10	2.4	0.2
Panicum virgatum	Switchgrass	20	21	2.0	0.4	25	22	2.3	0.5
Spartina pectinata	Freshwater cordgrass	12	13	1.1	0.2	0	0	0	0
Panicum clandestinum	Panic grass	29	30	2.2	0.7	26	23	2.3	0.5
Solanum Dulcamara	Nightshade	1	1	2.0	< 0.1	22	19	1.8	0.3

* Only the more frequently occurring species are included.

** For coded percent cover, the following classes were used:

< 1% Cover	=	Class 1
1-5%	=	2
5-25%	=	3
25-50%	=	4
50-75%	=	5
75-100%	=	6

dewberry areas. Rough-edged goldenrod and xeric graminoids also occur. Soils tend to be dry and quite sandy.

19. Common alder. There is a dense thicket of alder north of the disposal area and just east of the center of the island. Multi-stemmed, 4- to 6-m tall alders make up 100 percent of the cover except along the margins of the stand. Here, indigo and bayberry are important shrub associates. Total herbaceous cover is 40 to 60 percent in the margins and decreases toward the center of the thicket. Sedges and grasses are the most common herbs but no one species is clearly dominant. The water table is at or near the surface and soils are wet or moist sandy loam covered by 5 cm of organic matter.

20. Shrub-thicket. Areas of shrub-thicket occur within the *Amorpha* association of the southwestern arm and in shrubland mosaic north of the disposal site. The dominant species in the shrub-thicket subtype areas varies but the commonly found shrubs include oriental bittersweet, indigo, shining sumac, poison ivy, and bayberry. Trees occur in about 40 percent of the quadrats in this subtype with tree of heaven and red cedar being the most common. The herbaceous layer is dominated by rough-edged goldenrod and panic grass (*Panicum clandestinum*). Soils are extremely variable and cannot be generalized.

Myrica pensylvanica

21. There are six large, pure clones of bayberry (1 to 2 m in height) on Nott Island and these are designated as a separate vegetation unit. They occur at the borders of the grasslands and the mixed shrub association. There are virtually no associated species within the dense centers of these areas and they exhibit a remarkable ability to withstand tree invasion. Vegetation along the margins of the bayberry area is highly variable, relfecting the surrounding vegetation associations.

Tree-thicket

22. The tree-thicket association is extensive along the northwestern shore of Nott Island also occurs along an area of shore due east of the disposal area (Figure 4). Quadrat data for the tree-thicket areas is given in Table 3. Vegetationally these areas are characterized by well-established trees, most of which are typically floodplain species.

These include American elm, ash (*Fraxinus sp.*), and willow (*Salix sp.*). Other typically floodplain species of trees that were observed in the areas but were not included in the quadrat samples are cottonwood (*Populus deltoides*), black gum (*Nyassa sylvatica*), and silver maple (*Acer saccharinum*). The most frequently occurring tree was tree of heaven, which was reported in 37 percent of the quadrats (Table 3). Other commonly encountered tree species are red cedar, black cherry (*Prunus serotina*), and black locust (*Robinia Pseudo-Acacia*). The black cherry is indicative of the old field/postagricultural nature of the island.

23. Although there is considerable diversity in the shrub stratum, false indigo and three woody vines (oriental bittersweet, virginia creeper, and poison ivy) occur most frequently. The herbaceous cover is greatly reduced because vines occupy much of the herb stratum. Rough-edged goldenrod is most common and occurred in half of the quadrats (Table 3). Switchgrass and panic grass also occur commonly, but in clumps and so do not contribute much to overall cover.

Grassland Associations

Ammophila breviligulata

24. Areas of this grassland occupy what appear to be sandy dredged material from previous disposal operations and occur only on the northern half of Nott Island (Figure 4). Although the density of its cover varies, the beach grass (*Ammophila breviligulata*) is nearly pure; other herbs are found only along the margins and are characteristic of the adjoining vegetation association. Lichens (*Cladonia sp.*) are fairly common. Shrubs are scattered, usually in depressions, and often appear stunted. The most common shrubs are shining sumac, poison ivy, and bayberry. Trees rarely occur and only along the margins. Quadrat data are given in Table 4.

Panicum virgatum - mixed graminoid

25. Areas of this grassland occur around the disposal site, primarily on the eastern half of Nott Island (Figure 4). Soils are dry and sandy with little organic content and probably result from

Table 4

Summary of Quadrat Data for All Four Grassland Associations Combined*

Life Form and Species		Occurrence in 198 Quadrats: Number in Which Present	Occurrence in 198 Quadrats: Percent of Total Sampled, Frequency	Mean Coded Cover, Density**: For Quadrats in Which Present	Mean Coded Cover, Density**: For Total Sample
Trees		25	13	3.6	0.4
Ailanthus altissima	Tree of heaven	12	6	3.5	0.2
Juniperus virginiana	Red cedar	5	3	2.4	0.1
Ulmus americana	American elm	4	2	3.5	0.1
Quercus velutina	Black oak	3	2	2.7	
Shrubs					
Amorpha fruticosa	False indigo	87	44	2.9	1.3
Celastrus orbiculatus	Oriental bittersweet	47	24	2.9	0.7
Rhus copallina	Shining sumac	45	23	2.7	0.6
Myrica pensylvanica	Bayberry	38	19	2.8	0.5
Rosa spp.	Rose, blackberry	24	12	2.5	0.3
Rhus radicans	Poison ivy	23	12	2.3	0.3
Rhus typhina	Staghorn sumac	22	11	2.2	0.2
Herbs		198	100	5.8	5.8
Panicum virgatum	Switchgrass	104	52	3.2	1.7
Ammophila breviligulata	Beachgrass	69	35	4.8	1.7
Panicum clandestinum	Panic grass	70	35	3.7	1.3
Spartina pectinata	Freshwater cordgrass	61	31	2.6	0.8
Solidago rugosa	Rough-edged goldenrod	85	43	2.8	1.2
Oenothera parvifolia	Evening primrose	34	17	1.6	0.3
Carex spp.	Sedge	26	13	3.5	0.5
Leptoloma cognitum	Fall witch-grass	26	13	3.1	0.4
Verbascum Thapsis	Common mullein	21	11	1.7	0.2
Cyperus dentatus	Umbrella-sedge	21	11	3.5	0.1
Phragmites australis	Common reed	18	9	3.5	0.3
Agropyron repens	Witch-grass	18	9	2.1	0.2
Achillia Millefolium	Common yarrow	17	9	1.9	0.2

* Only the more frequently occurring species are included.

** For coded percent cover, the following classes were used:

< 1%	Cover =	Class 1
1-5%	=	2
5-25%	=	3
25-50%	=	4
50-75%	=	5
75-100%	=	6

old dredged material. Switchgrass, the dominant species, grows to 1 to 1½ m high. Other common herbaceous species include panic grass, umbrella sedge, freshwater cordgrass, rough-edged goldenrod, and clumps of reedgrass (*Phragmites australis*) and beach grass. Shrubs are not important in this grassland. Dewberry is sometimes found as a ground cover between tussocks of switchgrass. Poison ivy and shining sumac occur as widely scattered individuals and small clumps, and indigo is found along the margins. Trees rarely occur, but there are a few scattered American elm, tree of heaven, and black oak (*Quercus velutina*).

Graminoid - shrub

26. The largest area of this grassland lies southwest of the disposal site and forms a transition zone 20 to 50 m wide between unvegetated sand and the *Amorpha fruticosa* shrubland association (Figure 4). Smaller patches are found southeast and north of the disposal site. In most of the areas shrub cover appears to be increasing over grass cover. The shrub stratum is typically discontinuous, covering about 50 percent of the areas while grasses cover about 80 percent. Floristically, this association is quite variable with some species occurring in only a few locations. The most widespread grasses are switchgrass and freshwater cordgrass with panic grass, beach grass, and witch grass as important associates. The dominant herb is rough-edged goldenrod, although evening primrose (*Oenothera parvifolia*) and sedge are also frequently encountered. The shrub layer is characterized by shining sumac, poison ivy, and indigo. Other, less frequently occurring shrubs are bayberry and oriental bittersweet. Trees, red cedar and tree of heaven, are few and scattered.

Phragmites australis

27. Reedgrass appears on Nott Island in two different associations, grassland (dry phase) and estuarine wetland (wet phase), but the two are not differentiated on the vegetation map (Figure 4). The dry phase occurs on relatively dry upland sites along the upper border of the wet phase in a belt about 25 to 50 m wide, and is less extensive than the wet phase. It also occurs in a narrow 2- to 40-m belt along the upland edge of the head of the western inlet. The dry phase reedgrass generally

forms a monoculture, 2 to 3 m in height, but at its northernmost extension into the dry, sandy, unvegetated central area of the island, it becomes increasingly stunted and is less than a meter high in places. Where the dry phase borders the *Amorpha fruticosa* shrubland, additional species are associated with the reedgrass, including rough-edged goldenrod.

Estuarine Wetland Associations

Typha angustifolia

28. The *Typha angustifolia* association covers 4.4 ha, or nearly 14 percent of Nott Island (Table 1). It is the most extensive wetland association and the second most extensive of the vegetation types on Nott Island. This association occurs in the tidally flooded expanse between the southwest and southeast arms of the *Amorpha fruticosa* shrubland (Figure 4). There, stands of narrow-leaved cattail (*Typha angustifolia*) are relatively pure, provide nearly 100 percent coverage, and are 2.0 to 2.5 m high in the interior of the marsh and 1.5 m high along creek banks. Within the marsh the monoculture is broken only by occasional clumps of marsh mallow. Along creek banks a variety of aquatics occur in association with narrow-leaved cattail including water hemp (*Acnida cannabina*), arrow arum (*Peltandra virginica*), and stinkweed (*Pluchea purpurascens*). Additional wetland herbs are limited to forage areas surrounding muskrat houses. Where the *Typha* wetland association borders the *Phragmites* wetland association, the reedgrass appears to be invading the cattails. Quadrat data are given in Table 5.

Phragmites australis

29. Extensive areas of the wet phase association of reedgrass occur at the southern end of Nott Island and as a border along the northern head of the central marsh. Additional areas are scattered within the *Typha angustifolia* association and other tidally influenced sites on the southern two-thirds of the island. Most of these islands appear to be spreading into the surrounding wetland types. In its wet phase, reedgrass occurs in very dense stands, reaching heights of 4.5 m in the central sections and up to 3 m along tidal creeks and ditches. Associated

Table 5

Summary of Quadrat Data for Estuarine Wetland Associations*

Life Form and Species		Occurrence in Quadrats: Number in Which Present	Occurrence in Quadrats: Percent of Total Sampled, Frequency	Mean Coded Cover, Density**: For Quadrats in Which Present	Mean Coded Cover, Density**: For Total Sampled
a. Typhus angustifolia, 69 Quadrats					
Shrubs		9	13	2.0	0.3
Amorpha fruticosa	False indigo	9	13	2.0	0.3
Herbs		69	100	6.0	6.0
Typha angustifolia	Narrow-leaved cattail	69	100	5.5	5.5
Mikinia scandens	Climbing hempweed	36	52	1.5	0.8
Polygonum punctatum	Water-smartweed	36	52	1.7	0.5
Hibiscus palustris	Marsh mallow	32	46	3.1	1.4
Peltandra virginica	Arrow arum	28	41	2.7	1.1
Pluchea purpurascens	Stinkweed	22	32	1.7	0.6
Scirpus americanus	Three-square	18	26	3.4	0.9
Galium spp.	Bedstraw	15	21	1.9	0.4
Ptilimnium capillaceum	Mock bishop's weed	14	20	1.9	0.4
Eleocharis spp.	Spike-rush	13	19	3.4	0.6
Phragmites australis	Common reed	13	19	1.7	0.3
Impatiens capensis	Touch-me-not	14	20	1.4	0.3
Lophotocarpus spongiosus	Hooded arrowhead	7	10	1.5	0.1
Spartina pectinata	Freshwater cordgrass	1	1	1.0	<0.1
Cicuta bulbifera	Water-hemlock	3	4	1.0	<0.1
Lycopus americanus	Bugleweed	5	7	1.8	0.1
b. Phragmites australis, 65 Quadrats					
Shrubs		20	31	3.2	1.0
Amorpha fruticosa	False indigo	20	31	3.2	1.0
Herbs		65	100	5.8	5.8
Typha angustifolia	Narrow-leaved cattail	17	26	2.5	0.6
Mikania scandens	Climbing hempweed	37	57	1.8	1.0
Polygonum punctatum	Water-smartweed	20	31	1.7	0.5
Hibiscus palustris	Marsh mallow	20	31	2.7	0.8
Peltandra virginica	Arrow arum	28	43	2.0	0.9
Pluchea purpurascens	Stinkweed	5	7	1.6	0.1
Scirpus americanus	Three-square	5	7	3.0	0.2
Galium spp.	Bedstraw	13	20	1.7	0.3
Ptilimnium capillaceum	Mock bishop's weed	11	17	1.5	0.2
Eleocharis spp.	Spike-rush	9	14	3.1	0.4
Phragmites australis	Common reed	65	100	5.8	5.8
Impatiens capensis	Touch-me-not	25	38	2.4	0.9
Acnida cannabina	Water-hemp	3	5	1.0	<0.1
Lythrum Salicaria	Spiked loosestrife	15	23	1.8	0.4
Lycopus americanus	Bugleweed	3	5	1.7	0.1
Panicum virgatum	Switchgrass	7	10	3.3	0.4

(Continued)

* Only the more frequently occurring species are included.

** For coded percent cover, the following classes were used:

< 1%	Cover =	Class 1
1-5%	=	2
5-25%	=	3
25-50%	=	4
50-75%	=	5
75-100%	=	6

Table 5 (Continued)

Life Form and Species		Occurrence in Quadrats: Number in which Present	Occurrence in Quadrats: Percent of Total Sampled Frequency	Mean Coded Cover, Density: For Quadrats in Which Present	Mean Coded Cover, Density: For Total Sampled
	c. Typha-Forb, 13 Quadrats				
Shrubs		3	23	2.7	0.6
Amorpha fruticosa	False indigo	3	23	2.7	0.6
Herbs		13	100	5.8	5.8
Typha angustifolia	Narrow-leaved cattail	10	77	4.1	3.2
Mikania scandens	Climbing hempweed	9	69	1.7	1.2
Polygonum punctatum	Water-smartweed	9	69	2.1	1.5
Hibiscus palustris	Marsh mallow	4	31	3.5	1.1
Peltandra virginica	Arrow arum	6	46	2.3	1.1
Pluchea purpurascens	Stinkweed	9	69	1.4	1.0
Scirpus americanus	Three-square	8	62	3.1	1.9
Galium spp.	Bedstraw	3	23	2.7	0.6
Ptilimnium capillaceum	Mock bishop's weed	2	15	1.0	0.2
Eleocharis spp.	Spike-rush	8	62	4.2	2.6
Phragmites australis	Common reed	4	31	1.8	0.5
Impatiens capensis	Touch-me-not	5	38	1.4	0.5
Lophotocarpus spongiosus	Hooded arrowhead	3	23	1.3	0.3
Spartina pectinata	Freshwater cordgrass	2	15	2.0	0.3
Scirpus validus	Great bulrush	1	8	3.0	0.2
Zizania aquatica	Wild rice	1	8	5.0	0.4
Cicuta bulbifera	Water-hemlock	2	15	4.0	0.6
Acnida cannabina	Water-hemp	3	23	1.0	0.1
Juncus acuminatus	Rush	3	23	2.3	0.5
Lythrum Salicaria	Spiked loosestrife	9	69	2.3	1.6
Lycopus americanus	Bugleweed	3	23	1.0	0.2
	d. Graminoid-Forb				
Shrubs		4	9	1.3	0.1
Amorpha fruticosa	False indigo	4	9	1.3	0.1
Herbs		43	100	5.9	5.9
Typha angustifolia	Narrow-leaved cattail	19	44	2.9	1.3
Mikania scandens	Climbing hempweed	14	33	1.4	0.5
Polygonum punctatum	Water-smartweed	20	47	2.2	1.0
Hibiscus palustris	Marsh mallow	12	28	2.7	0.7
Peltandra virginica	Arrow arum	7	16	2.1	0.3
Pluchea purpurascens	Stinkweed	29	67	2.4	1.6
Scirpus americanus	Three-square	34	79	3.5	2.8
Galium spp.	Bedstraw	14	33	2.4	0.8
Ptilimnium capillaceum	Mock bishop's weed	17	40	2.6	1.0
Eleocharis spp.	Spike-rush	33	77	3.6	2.7
Phragmites australis	Common reed	11	26	2.4	0.6
Lophotocarpus spongiosus	Hooded arrowhead	31	72	2.5	0.9
Spartina pectinata	Freshwater cordgrass	20	47	2.9	1.3
Scirpus validus	Great bulrush	15	35	3.3	1.1
Zizania aquatica	Wild rice	10	23	2.7	0.6
Cicuta bulbifera	Water-hemlock	9	21	1.3	0.3
Acnida cannabina	Water-hemp	9	21	1.1	0.2
Juncus acuminatus	Rush	8	19	3.1	0.6
Lythrum Salicaria	Spiked loosestrife	7	16	1.6	0.3

(Continued)

Table 5 (Concluded)

Life Form and Species		Occurrence in Quadrats: Number in Which Present	Occurrence in Quadrats: Percent of Total Sampled Frequency	Mean Coded Cover, Density: For Quadrats in Which Present	Mean Coded Cover, Density: For Total Sampled
	d. Graminoid-Forb (continued)				
Lycopus americanus	Bugleweed	2	5	1.0	<0.1
Panicum virgatum	Switchgrass	3	7	5.6	0.4
Scirpus robustus	Bulrush	2	5	1.0	0.5
	e. Intertidal Border				
Shrubs		2	6	1.5	0.1
Amorpha fruticosa	False indigo	2	6	1.5	0.1
Herbs		33	97	5.6	5.4
Typha angustifolia	Narrow-leaved cattail	5	15	2.8	0.4
Mikania scandens	Climbing hempweed	5	15	1.2	0.2
Polygonum punctatum	Water-smartweed	7	21	1.7	0.4
Peltandra virginica	Arrow arum	10	29	1.2	0.4
Pluchea purpurascens	Stinkweed	23	68	2.1	1.4
Scirpus americanus	Three-square	32	94	4.1	3.9
Eleocharis spp.	Spike-rush	15	44	3.0	1.3
Phragmites australis	Common reed	15	44	2.9	1.3
Lophotocarpus spongiosus	Hooded arrowhead	12	35	1.5	0.8
Spartina pectinata	Freshwater cordgrass	23	68	3.5	2.4
Scirpus validus	Great bulrush	5	15	2.8	0.4
Zizania aquatica	Wild rice	8	24	3.4	0.8
Acnida cannabina	Water hemp	8	24	1.1	0.3
Lythrum Salicaria	Spiked loosestrife	7	21	1.6	0.3
Spartina alterniflora	Saltwater cordgrass	2	6	2.5	0.1
Panicum virgatum	Switchgrass	12	35	2.5	0.9
Scirpus robustus	Bulrush	6	18	1.3	0.3

herbaceous species rarely occur, but are generally within 2 to 3 m of the edge of the reedgrass stands. These species include marsh mallow, touch-me-not, arrow arum, water smartweed, and narrow-leaved cattail. At the higher and more isolated areas of the larger reedgrass stands, climbing hempweed and indigo occur with up to 50 percent cover. These are probably relic areas because reedgrass appears to invading the bordering *Amorpha fruticosa* shrubland as well as other adjacent wetland associations. Quadrat data are given in Table 5.

Typha - Forb

30. There are four cattail dominated areas of wetland on Nott Island in which a variety of forbs and grasses make a substantial contribution to the vegetation. These areas are recognized as a distinct association. The most common species occurring with cattail in this association are bulrush (*Scirpus americanus*), spikerush (*Elocharis sp.*), water smartweed, stinkweed, and arrow arum (Table 5). Spiked loosestrife (*Lythrum salicaria*), an introduced species, and climbing hempweed are found on higher, often sandier sites. Isolated clumps of marsh mallow also occur.

31. Two areas of *Typha*-Forb lie along the island's eastern shore and a third in the inlet formed by the sand spit beach on the western side of the island. The fourth area, at the northwestern corner of the central *Typha augustifolia* wetland, may represent older muskrat forage areas that are sufficiently open to favor a greater diversity of aquatic plants than can be found in dense stands of cattail.

Graminoid - Forb

32. These low wetlands are widely scattered through Nott Island's tidal marshes. They are found in protected areas behind the mouth of the two southern tidal creeks and in an irregular band at the head of the central marsh where it separates *Typha augustifolia* wetland from *Phragmites australis* wetland (Figure 4). Another extensive area occurs along protected shores of the embayment formed by the western sand spit beach. The soils in the graminoid - forb association are typically very wet muck; in the embayment area, varying amounts of sand are also present. Floristically, this association is extremely diverse but only bulrush,

spikerush, hooded arrowhead (*Lophotocarpus spongiosus*), and stinkweed occurred in more than 50 percent of the sampled quadrats (Table 5). Other plants that are commonly found or that dominate in places include freshwater cordgrass, water smartweed, narrow-leaved cattail, mock bishop's weed (*Ptilimnium capillaceum*), soft-stemmed bulrush (*Scirpus validus*), wild rice (*Zizania aquatica*), and rushes (*Juncus acuminatus*).

Intertidal border

33. The southern half of the western and eastern shores and areas along the northeastern shore support a distinct association on a sandy, alluvial substrate (Figure 4). Approximately half of the total cover is contributed by bulrush, which occurred in 94 percent of the quadrats sampled. Freshwater cordgrass is also widespread and provided about 35 percent of the cover in the quadrats in which it occurred (Table 5). Saltwater cordgrass (*Spartina alterniflora*) and wild rice are common at the southern end of the island and combine to give about 20 percent of the total cover within the intertidal border there. Commonly associated forbs are water hemp and stinkweed. Common graminoids are panic grass and reedgrass.

Disturbed Vegetation Association

34. There are four strips of land radiating from the northwestern and northeastern sides of the disposal area that were subjected to heavy equipment traffic during the disposal operation. This disturbance opened the sites, and several species became established. Most common of these invaders are sedges, pigweed (*Chenopodium sp.*), and evening primrose. Rough-edged goldenrod and panic grass are also common. The balance of the floristic composition of the disturbed areas reflects the vegetation established before disposal and cannot be generalized.

Small Mammals

Methodology

35. The areas bordering the disposal site were divided into five

trapping grids: Northeast, Northwest, East, West, and South (Figure 6). The boundaries of the Northeast, Northwest, and West grids all extended to the shore of the island. The boundaries of both the East and South grids were arbitrarily decided upon considering both the time and number of traps available.

36. Each grid was laid out in 15-m squares by a team of three individuals using a 30-m tape and hand compass. Trap stations were established on the intersections of the squares. The grid areas and number of traps per grid were:

Grid	Area, ha	Number of Traps
Northeast	2.16	95
Northwest	1.58	67
East	2.02	93
West	2.55	120
South	2.07	101
	10.38	476

37. One Sherman live trap was set at each station and baited with dry oatmeal. All traps were checked twice daily from approximately 8:30 - 11:00 am and again from 1:00 - 3:00 pm for seven consecutive days. Grids were run sequentially from 1 June to 2 August. All traps were inspected periodically to check bait and working mechanisms.

38. For each animal caught, species, weight, sex, and reproductive condition were recorded. Each animal was marked using the toe clip system described by Davis (1956). Since this system allows a maximum of 160 animals to be marked without repeating numbers, an ear clipping system was used in addition.

39. In order to determine mammal species distribution by habitat, the percent cover by species of all vegetation within a 1-m radius of each trap station was recorded. This information along with that from the 1976 vegetation map of Nott Island were used to classify each trap location according to the 14 major vegetation associations shown on the 1976 map. A chi-square analysis was applied to test whether each small mammal species was randomly distributed throughout all habitats (i.e.

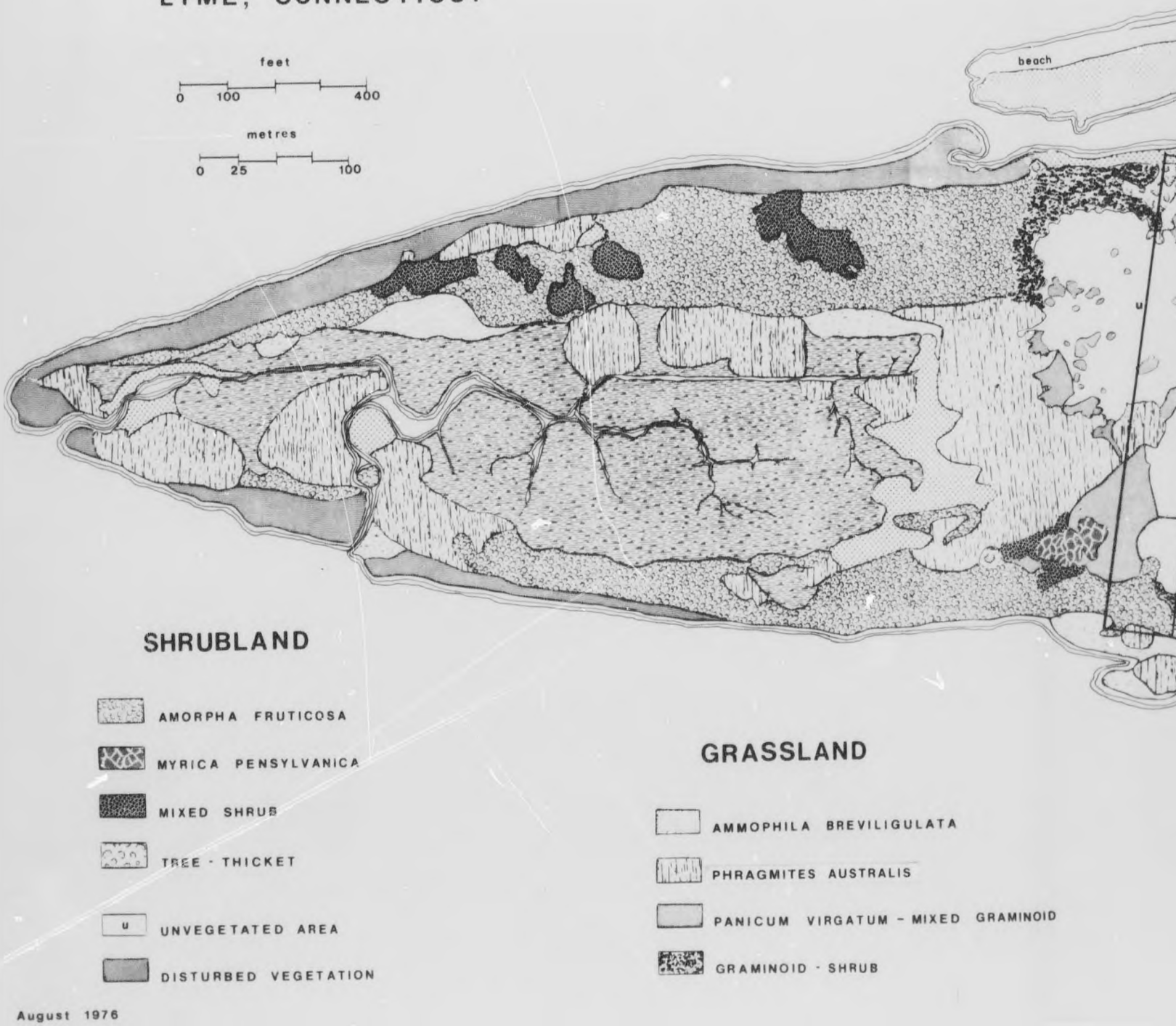


Figure 6. Locations of small mammal sampling

GRASSLAND

AMMOPHILA BREVILIGULATA

PHRAGMITES AUSTRALIS

PANICUM VIRGATUM - MIXED GRAMINOID

GRAMINOID - SHRUB

ESTUARINE MARSH

PHRAGMITES AUSTRALIS

TYPHA ANGUSTIFOLIA

TYPHA ANGUSTIFOLIA - FORBS

GRAMINOID - FORBS

INTERTIDAL BORDER

Connecticut College Department of Botany

6. Locations of small mammal sampling grids

showed no habitat preference).

Results

40. Species abundance. Three small mammal species were caught: meadow vole (*Microtus pennsylvanicus*), meadow jumping mouse (*Zapus hudsonius*), and short-tailed shrew (*Blarina brevicauda*)* The actual number of captures and recaptures for each species is given in Table 6. Population sizes were estimated by the Schnabel technique (Schnabel 1938) and are given with density figures and species ratios by grids in Table 7.

41. The meadow vole was the most abundant species on all grids except the South. Their average density varied from 12.9 to 66.1 per ha with the highest population in the Northwest grid. Studies of meadow vole populations in the northeastern United States show that densities vary seasonally and fluctuate cyclically, apparently on a 4-yr cycle (Hamilton 1937 and Krebs et al. 1973). Assessment of meadow vole populations on Nott Island must, therefore, take into account their variable nature.

42. Meadow jumping mice were caught in greatest numbers on the West grid (Table 6), but the population estimate indicated that their greatest density (44.8/ha) was on the South grid (Table 7). The lowest density for this species occurred on the Northwest grid (5.1/ha). It was noteworthy that the greatest density of meadow jumping mice was in the grid containing the lowest density of meadow voles, and similarly, the lowest density of jumping mice occurred where meadow voles were most abundant. It was not known if this situation was due to interspecific interactions, differences in habitat, or to some other factor. Reports in the literature for average densities of meadow jumping mice indicate that their numbers vary seasonally and annually (Blair 1940a, Quimby 1951). The densities determined for meadow jumping mice on Nott Island were consistent with those reported in the literature.

43. Few short-tailed shrews were caught: the most, 6, were caught in the West grid and none were caught in the Northeast grid (Table 6).

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* Nomenclature follows that of Jones et al. (1975).

Table 6

Summary, by Grids, of Total Number of Captures and Recaptures of Small Mammals, Nott Island, 1976

Grid	Meadow vole			Meadow jumping mouse			Short-tailed shrew			Total Captured and Recaptured
	Number Captured	Number Recaptured	Total	Number Captured	Number Recaptured	Total	Number Captured	Number Recaptured	Total	
heast	56	49	105	28	68	96	0	0	0	201
hwest	84	68	152	8	7	15	3	0	3	170
	47	116	163	27	17	44	3	0	3	210
	73	108	181	38	67	105	6	3	9	295
h	31	77	108	24	3	27	2	0	2	137
l, all grids			709			287			17	1013

: see text for number of traps and dates.

Table 7

Summary, by Grids, of Population Estimates, Densities, and Percent Composition for the Three Small Mammal Species, 1976

d	Area	Meadow vole		Meadow jumping mouse		Short-tailed shrew		Percent Composition by each species		
		Population Estimate	Density No./ha	Population Estimate	Density No./ha	Population Estimate	Density No./ha	Vole	Mouse	Shrew
theast	2.16	46.6	21.6	27.6	12.8	0*	-	62.8	37.2	0
thwest	1.58	104.5	66.1	8.0	5.1	3*	-	92.9	7.1	0
t	2.02	39.2	19.4	38.6	19.1	3*	-	50.4	49.6	0
t	2.55	65.2	25.6	37.7	14.8	76.67	2.6	59.5	34.4	6.1
th	2.07	26.8	12.9	92.7	44.8	2*	-	22.4	77.6	0
n Densities			29.1		19.3		2.6			

nber actually caught when too few were trapped for a reliable p pulation estimate.

There were enough recaptures to estimate the population density in the West grid at 2.6/ha. This appears to be consistent with densities reported for short-tailed shrews (Blair 1940c, Wetzel 1958).

44. Sex composition. Behavioral differences between the sexes are known to interact with age and breeding condition to influence the trappability of small mammals (Smith et al. 1975). Hence the sex composition observed on Nott Island must take into account that all trapping was done during the summer months.

45. The sex composition for the population of captured meadow voles was 62 percent male and 38 percent female, or a male:female ratio of 1.6. For comparison, other male:female ratios of meadow voles reported in the literature are 1.3 (Blair 1940b), 2.3 (Townsend 1935), 0.7 and 2.3 in an old field situation (Getz 1960), and 0.7 and 1.5 in a marsh (Getz 1960).

46. For jumping mice, the sex composition of captures on Nott Island was 56 percent male and 44 percent female, for a male:female ratio of 1.3. In comparison, Blair (1940a) reports a ratio of 1.1 and Townsend (1935) a ratio of 1.6.

47. The sex ratio for short-tailed shrews on Nott Island was 0.7 (40 percent male and 60 percent female). However, most studies in the literature report a preponderance of males for this species (Dapson 1968). The disagreement may in part be due to the relatively small numbers of shrews caught in this study and possible error in sexing the animals.

48. Habitat use. Table 8 summarizes the number of small mammal captures and recaptures as to the habitat (vegetation association) in which they occurred. The results of chi-square analyses indicated that both the meadow vole and the meadow jumping mouse were evenly distributed in the three major habitats of shrubland, grassland, and wetland (i.e., the porportion of captures in each of the three major habitats agreed with what would be expected based on the frequency of traps: for voles $\chi^2 = .75$, df = 2, $P < .750$; for mice $\chi^2 = 2.46$, df = 2, $P < .500$). In contrast, short-tailed shrews were not evenly distributed in the three major habitats and were found at a higher percentage than expected in the wetland habitat ($\chi^2 = 79.58$, df = 2, $P < .005$). Lack

Table 8

Summary, by Habitat of Total Captures of Small Mammals, Nott Island, 1976

Habitat	Number of Trap Nights	Meadow vole		Meadow jumping mouse		Short-tailed shrew	
		Number Captures	Catch/ Trap Night	Number Captures	Catch/ Trap Night	Number Captures	Catch/ Trap Night
Shrublands							
Amorpha fruticosa	1400	194	0.14	102	0.07	3	< 0.01
Mixed shrub	392	42	0.11	16	0.04	0	0
Myrica pensylvanica	154	10	0.06	17	0.11	0	0
Tree - thicket	728	106	0.15	12	0.02	3	< 0.01
Subtotal	2674(40.1)	352(49.6)	0.13	147(51.2)	0.05	6(35.3)	< 0.01
Grasslands							
Ammophila breviligulata	1190	145	0.12	54	0.05	1	< 0.01
Panicum virgatum - Mixed Graminoid	924	115	0.12	69	0.07	0	0
Graminoid - Shrub	168	33	0.20	5	0.03	2	0.01
Phragmites australis	0	0	0	0	0	0	0
Subtotal	2282(34.2)	293(41.3)	0.13	128(44.6)	0.06	3(17.6)	< 0.01
Estuarine wetlands							
Typha angustifolia	0	0	0	0	0	0	0
Phragmites australis	168	25	0.15	5	0.03	7	0.04
Typha - Forb	14	2	0.14	0	0	0	0
Graminoid - Forb	0	0	0	0	0	0	0
Intertidal border	0	0	0	0	0	0	0
Subtotal	182(2.7)	27 (3.8)	0.15	5(1.7)	0.03	7(41.2)	0.04
Disturbed vegetation	140 (2.1)	25 (3.5)	0.18	5(1.7)	0.04	0	0
Disposal Site	532 (8.0)	11 (1.6)	0.02	0	0	0	0
Unvegetated Areas	854 (12.8)	1 (0.1)	<0.01	2(0.7)	<0.01	1	<0.01
Total	6664	709	0.11	287	0.04	17(5.9)	<0.01

Note: Numbers in parentheses are percentages of trap nights and of number of catches per habitat

of adequate vegetative cover led to low numbers of captures in the disposal site and in unvegetated areas. The major exception to this was meadow voles caught in the disposal site near clumps of beach grass and reedgrass.

49. The occurrence of meadow voles in all three habitat types on Nott Island is consistent with reports in the literature that it is found in a variety of situations: moist grasslands (Hall and Kelson 1959), mixed trees and grass (Buckner 1957, Stickel and Warbach 1960), and mature woodlands on islands (Dice 1925, Manville 1951, Werner 1956, and Webb 1965) and on the mainland (Soper 1946, Connor 1960).

50. Habitat use by meadow jumping mice on Nott Island is consistent with reports in the literature. Quimby (1951), Getz (1961), and Whitaker (1963) have found jumping mice in marsh, grass areas, and open upland forests. On Nott Island it was interesting to note that the greatest density of jumping mice was in the South grid in the area closest to the large marsh.

51. Short-tailed shrews indicated a preference for wetland habitat on Nott Island. According to the literature, shrews are normally found in moist situations (Pruitt 1953 and 1959) but avoid standing water (Getz 1961). The relative scarcity of shrews in Nott Island grasslands is at least partially explained by the lower moisture and higher temperatures in those areas.

Comparison with previous studies

52. Data from previous small mammal studies in 1974 and 1975 on Nott Island are given in Table 9. In the three years of study, three species (meadow voles, meadow jumping mice, and short-tailed shrews) have been continually present. The white-footed mouse (*Peromyscus leucopus*) was present in two years and the Norway rat (*Rattus norvegicus*) was trapped in one year. The white-footed mouse, which inhabits shrublands and forests and which was present in 1974 and in March 1975, may have been eliminated from the island by some aspect of the disposal operation of February to April 1975, or may have undergone natural extinction. Whether the disposal altered the white-footed mouse habitat or perhaps buried a small population is not known. The north end of the

Table 9

Comparison of Trapping Results for all Periods

Trapping Period	Number of Trap Nights	Meadow vole		Meadow jumping mouse		White-footed mouse		Short-tailed shrew		Norway rat	
		Number Captures	Catch/ Trap Nights	Number Captures	Catch/ Trap Nights	Number Captures	Catch/ Trap Nights	Number Captures	Catch/ Trap Nights	Number Captures	Catch/ Trap Nights
22 September 1974	235(2.6)	73(7.7)	0.31	14(3.7)	0.06	2(66.6)	0.09	1(5.3)	0.04	0	0
12 March 1975	52(0.6)	2(0.2)	0.04	0*	0	1(33.3)	0.02	0	0	0	0
23 April 1975	61(0.7)	4(0.4)	0.07	0*	0	0	0	1(5.3)	0.02	0	0
June - 14 August 1975	1938(21.7)	163(17.1)	0.08	78(20.6)	0.04	0	0	0	0	4(100.0)	0.02
une - 2 August 1976	6664(74.5)	709(74.6)	0.11	287(75.7)	0.04	0	0	17(89.5)	<0.01	0	0
Total or Average	8950	951	0.11	379	0.04	3	<0.01	19	<0.01	4	<0.01

Note: Numbers in parentheses are percent of trap nights and percent of number of catches per period.

* Meadow jumping mice would be expected to be hibernating during this period and none were caught.

island would still appear to be suitable habitat for this species, yet none were trapped. The possible significance of any interspecific interactions that were related to the disappearance of white-footed mice is unknown.

53. Norway rats were present in the summer of 1975, but were apparently absent in 1974 and 1976. Rats probably invaded the island on boats, pipes, and other equipment associated with the disposal operations. In 1975, they were trapped mainly along the southern shores. Their ability to scavenge washed up material may have permitted their survival that summer. However, the absence of suitable food and shelter during the winter of 1975-76 may have eliminated them.

Observations of Other Mammals

54. Direct observation on conclusive signs of other mammal species not already mentioned in this report indicate that at least three other species inhabit Nott Island: white-tailed deer (*Odocoileus virginianus*), muskrat (*Ondatra zibethicus*), and eastern mole (*Scalopus aquaticus*). Apparently about three deer reside on Nott Island during the summer and move back and forth between the island and the eastern shore during the winter. Ground reconnaissance and aerial photographs reveal several muskrat houses throughout the marsh, mainly in the cattail areas. Numerous underground runways, evidenced by raised areas in the sand, were seen near the south end of the disposal site and are believed to have been made by moles.

Birds

Methodology

55. From late February through June 1976, a record of birds visiting and breeding on Nott Island was made. Observations were made on foot and by canoe and primarily during morning hours. Visiting birds included those seen in flight over the island and in the cove and river areas adjacent to the island. During the breeding period, males singing

in the same locale over a period of time were presumed to indicate a breeding pair. This information was confirmed by further observation and location of active nests.

56. To relate bird breeding to general habitat, birds were recorded as being in the upland area (any shrubland or grassland association) or in the central wetland area (the *Typha angustifolia, Phragmites australis, and Typha*-Forb associations). Densities of breeding pairs within upland and the central wetland areas were calculated.

Results

57. A total of 51 species was observed in 1976; this includes 33 species of visitors (Table 10) and 18 species of breeding pairs (Table 11). In 1975, the species count totalled 60 of which 23 were breeding. For both years combined, 70 species were recorded of which 26 were breeding.

58. Common visitors during 1976 included black duck (*Anus rubripes*), semipalmated sandpiper (*Calidris pusillus*), snowy egret (*Egretta thula*), little blue heron (*Florida caerulea*), herrring gull (*Larus argent tus*), great black-backed gull (*Larus marinus*), osprey (*Pandion haliaetus*), and double-crested cormorant (*Phalacrocorax auritus*) (Table 10). The most commonly seen species, the herring gull, was particularly abundant on the sandspit on the west side of the island.

59. Of the 29 species of birds that nested on Nott Island in 1975 and 1976, 15 species nested both years (Table 11). Of these, only the song sparrow (*Melospiza melodia*) nested in both upland and marsh areas in both years. The red-winged blackbird (*Agelaius phoeniceus*) nested in the marsh both years but in the upland only in 1976. Two species nested only in the marsh area but in both years: the long-billed marsh wren (*Cistothorus palustris*) and swamp sparrow (*Melospiza georgiana*). By comparison, eight species had nests in upland areas both years: common flicker (*Colaptes auratus*), bobwhite (*Colinus virginianus*), yellow warbler (*Dendroica petechia*), gray catbird (*Dumetella carolinensis*), willow flycatcher (*Empidonox trailli*), American goldfinch (*Carduelis tristis*), starling (*Sturnus vulgaris*), and mourning dove (*Zenaida macroura*).

Table 10

Bird Species Observed Visiting Nott Island,
February - June 1976

Scientific Name	Common Name	Remarks
Anas rubripes	Black duck	Common
Butorides striatus	Green heron	Uncommon
Calidris pusillus	Semipalmated sandpiper	Common
Cathartes aura	Turkey vulture	Occasional
Carpodacus purpureus	Purple finch	Rare
Charadrius semipalmatus	Semipalmated plover	Uncommon
Circus cyaneus	Marsh hawk	Occasional
Cygnus olor	Mute swan	Occasional
Egretta thula	Snowy egret	Common
Erolia minutilla	Least sandpiper	Uncommon
Falco sparverius	American kestrel	Seen once
Florida caerulea	Little blue heron	Fairly common
Gavia immer	Common loon	Seen once
Hirundo rustica	Barn swallow	Occasional
Iridoprocne bicolor	Tree swallow	Occasional
Ixobrychus exilis	Least bittern	Seen once in marsh
Larus argentatus	Herring gull	Abundunt
Larus marinus	Great black-backed gull	Common to abundant
Megaceryle alcyon	Belted kingfisher	Rare
Mergus merganser	Common merganser	Occasional
Nyticorax nycticorax	Black-crowned night heron	Occasional immatures in marsh
Pandion haliaetus	Osprey	Common
Phalacrocorax auritus	Double-crested cormorant	Common
Phasianus colchicus	Ring-necked pheasant	Rare

(Continued)

Table 10 (Concluded)

Scientific Name	Common Name	Remarks
Pluvialis squatarola	Black-bellied plover	Rare
Quiscalus quiscula	Common grackle	Occasional
Riparia riparia	Bank swallow	Rare
Seiurus noveboracensis	Northern waterthrush	Seen once
Sterna albifrons	Least tern	Uncommon
Sterna hirundo	Common tern	Uncommon
Tringa flavipes	Lesser yellowlegs	Rare
Tringa melanoleucus	Greater yellowlegs	Uncommon
Tyrannus tyrannus	Eastern kingbird	Two seen

Table 11

Number of Breeding Bird Pairs and Densities in Central Marsh and Upland Areas on Nott Island, 1975 and 1976

(Central Marsh = 8.5 ha, Upland Areas = 20.0 ha)

	Central Marsh Area				Upland Areas				Total (Central Marsh and Upland Areas)			
	1975		1976		1975		1976		1975		1976	
Scientific And Common Name	Number of Breeding Pairs	Density/ ha	Number of Breeding Pairs	Density/ ha	Number of Breeding Pairs	Density/ ha	Number of Breeding Pairs	Density/ ha	Number of Breeding Pairs	Density/ ha	Number of Breeding Pairs	Density/ ha
Actitis macularia Spotted sandpiper	Not observed	--	Not observed	--	3	0.15	Not observed	--	3	0.11	Not observed	--
Agelaius phoeniceus Red-winged blackbird	25	2.94	23	2.71	Not observed	--	8	0.40	25	0.88	31	1.09
Anas platyrhynchos Mallard	2	0.24	Not observed	--	Not observed	--	3	0.15	2	0.07	3	0.11
Branta canadensis Canada goose	3	0.35	Not observed	--	Not observed	--	Not observed	--	3	0.11	Not observed	--
Cardinalis cardinalis Cardinal	Not observed	--	Not observed	--	2	0.10	Not observed	--	2	0.07	Not observed	--
Carduelis tristis American goldfinch	Not observed	--	Not observed	--	5	0.25	1	0.05	5	0.18	1	0.04
Carpodacus mexicanus House finch	Not observed	--	Not observed	--	3	0.15	2	0.10	3	0.11	2	0.07
Charadrius vociferus Killdeer	Not observed	--	Not observed	--	Not observed	--	2	0.10	Not observed	--	2	0.07
Cistothorus palustris Long-billed marsh wren	15	1.76	16	1.88	Not observed	--	Not observed	--	15	0.53	16	0.56
Colaptes auratus Common flicker	Not observed	--	Not observed	--	2	0.10	1	0.05	2	0.07	1	0.04
Colinus virginianus Bobwhite	Not observed	--	Not observed	--	6	0.30	3	0.15	6	0.21	3	0.11
Corvus brachyrhynchos Common crow	Not observed	--	Not observed	--	Not observed	--	1	0.05	Not observed	--	1	0.04
Cyanocitta cristata Blue jay	Not observed	--	Not observed	--	1	0.05	Not observed	--	1	0.04	Not observed	--
Dendroica petechia Yellow warbler	Not observed	--	Not observed	--	17	0.85	15	0.75	17	0.60	15	0.53
Dumetella carolinensis Gray catbird	Not observed	--	Not observed	--	10	0.50	3	0.15	10	0.35	3	0.11
Empidonax traillii Willow flycatcher	Not observed	--	Not observed	--	5	0.25	3	0.15	5	0.18	3	0.11
Geothlypis trichas Common yellow-throat	2	0.24	Not observed	--	12	0.60	11	0.55	14	0.49	11	0.40
Melospiza georgiana Swamp sparrow	1	0.12	3	--	Not observed	--	Not observed	--	1	0.04	3	0.11
Melospiza melodia Song sparrow	6	0.71	2	--	13	0.65	19	0.95	19	0.67	21	0.74
Mimus polyglottos Mockingbird	Not observed	--	Not observed	--	2	0.10	Not observed	--	2	0.07	Not observed	--

(Continued)

Table 11 (Concluded)

Scientific and Common Name	Central Marsh Area				Upland Areas				Total (Central Marsh and Upland Areas)			
	1975		1976		1975		1976		1975		1976	
	Number of Breeding Pairs	Density/ ha	Number of Breeding Pairs	Density/ ha	Number of Breeding Pairs	Density/ ha	Number of Breeding Pairs	Density/ ha	Number of Breeding Pairs	Density/ ha	Number of Breeding Pairs	Density/ ha
Parus atricapillus Black-capped chickadee	not observed	--	not observed	--	1	0.05	not observed	--	1	0.04	not observed	--
Philohela minor American woodcock	not observed	--	not observed	--	not observed	--	1	0.05	not observed	--	1	0.04
Rallus limicola Virginia rail	1	0.12	not observed	--	not observed	--	not observed	--	1	0.04	not observed	--
Sturnus vulgaris Starling	not observed	--	not observed	--	3	0.15	2	0.10	3	0.11	2	0.07
Tyrannus tyrannus Eastern kingbird	not observed	--	not observed	--	2	0.10	not observed	--	2	0.07	not observed	--
Zenaida macroura Mourning dove	not observed	--	not observed	--	3	0.15	2	0.10	3	0.11	2	0.07
TOTAL	55	6.47	44	5.18	90	4.50	77	3.85	145	5.09	121	4.25

60. Eight species nested in 1975 but not in 1976: Canada goose (*Branta canadensis*), Virginia rail (*Rallus limicola*), spotted sandpiper (*Actitis macularia*), blue jay (*Cyanocitta cristata*), mockingbird (*Mimus polyglottus*), black-capped chickadee (*Parus atricapillus*), cardinal (*Cardinalis cardinalis*), and eastern kingbird (*Tyannus tyrannus*).

61. Three species of breeding birds were observed in 1976 but not in 1975: killdeer (*Charadrius vociferus*), American woodcock (*Philohela minor*), and common crow (*Corvus brachyrhynchos*).

62. The number of breeding pairs, as well as the number of breeding species, declined from 1975 to 1976. In 1975, 145 pairs were observed, and in 1976 there were 121 pairs (Table 11). In both years, nearly twice as many pairs nested in upland areas as compared to the number in the central marsh. However, the density of pairs was greater in the central marsh (6.47 and 5.18) than in the upland (4.50 and 3.85)(Table 11).

63. There was no breeding activity on either the new or the old disposal areas. Bird activity there was mostly roosting and some feeding by gulls, crows, and swallows. The areas of greatest diversity of breeding birds were also those with the greatest vegetational diversity and maximum cover. While greatest densities of breeding pairs occurred in marsh areas, only the swamp sparrow showed a preference for reedgrass.

Microclimates

Method

64. Five temperature stations were established on 30 June 1976 and read at least twice weekly until they were removed on 19 August 1976. The locations of the stations are given on Figure 3. One was located in wetland, three in the shrublands, and one in the grasslands (Figure 7). Each station consisted of a pair of minimum-maximum thermometers, one at ground level and one 30 cm above the soil surface. Both thermometers were supported on a single stake, shaded on three sides and above, with the open side facing north.

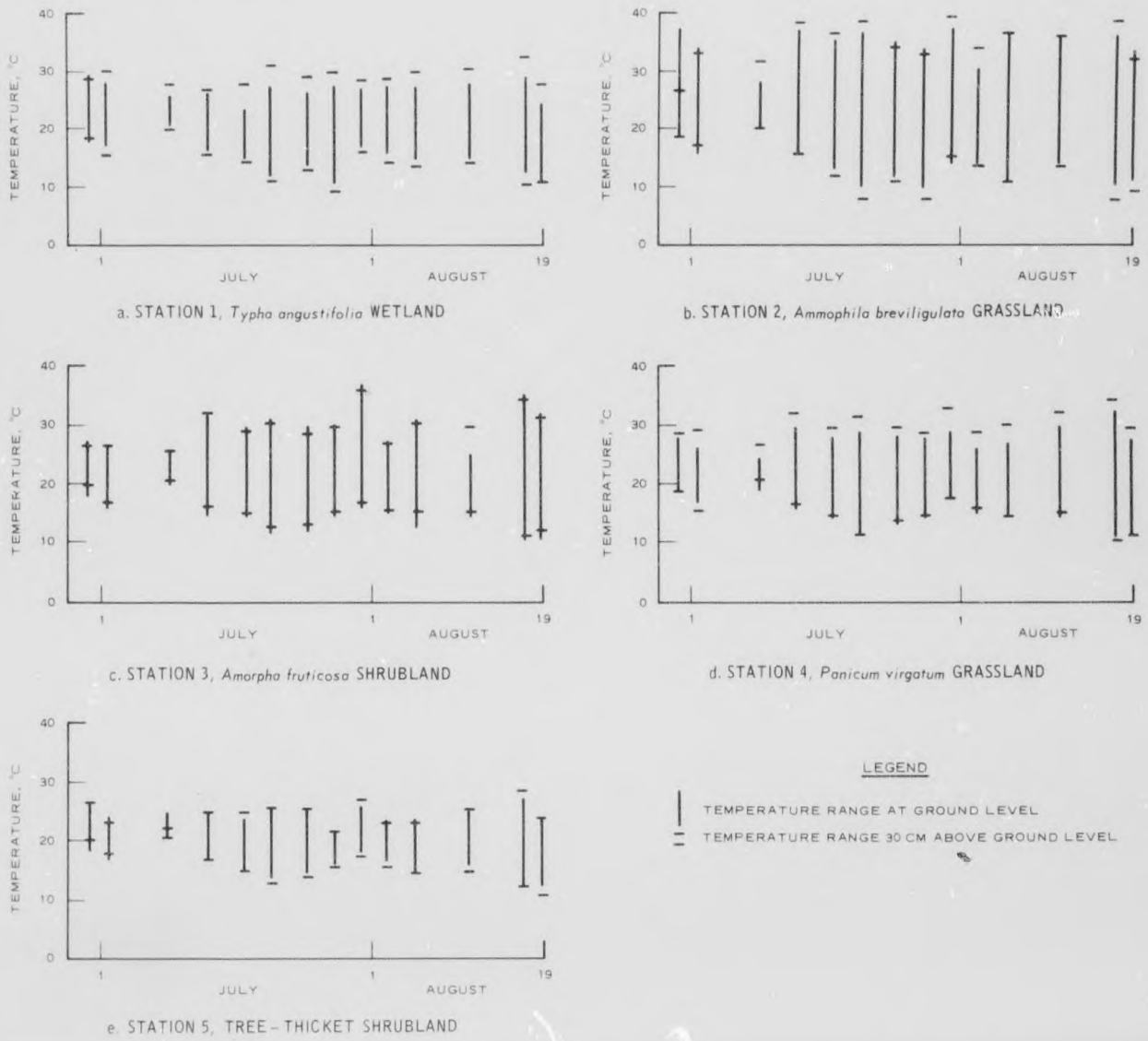

Figure 7. Temperature ranges at microclimate stations

with the open side facing north.

Results

65. Graphs of temperature ranges for each station during the study period are given in Figure 7. The station showing the greatest temperature extremes was Number 2 in the *Ammophila breviligulata* grassland. There, both minimum and maximum values for surface and 30-cm readings had the largest minimum - maximum ranges throughout the sampling period; the temperature at the 30-cm height consistently tended to be 5 to 18 degrees greater than at ground level.

66. The most temperature-stable station was Number 5 in the Tree-Thicket shrubland. Maximum temperature were 10 to 35 degrees lower than in the *Ammophila breviligulata*) (Station 2) grassland and minimums were 10 to 25 degrees higher. There was also much less difference between the surface and 30-cm readings. All these differences were predictable from microclimate literature. The *Amorpha fruticosa* shrubland (Station 3) showed a range of temperatures at both ground level and 30-cm that was second only to the *Ammophila breviligulata* (Station 2) grassland. Because of the rather dense shrub canopy at Station 3, the results were not quite as expected. Temperature extremes at the *Typha angustifolia* (Station 1) wetland and at the *Panicum virgatum* - mixed graminoid (Station 4) grassland were approximately the same, with the wetland station slightly cooler.

PART III: ESTABLISHMENT OF EXPERIMENTAL PLOTS

Experimental Design

67. An area in the southwest corner of the disposal site was selected for establishment of the experimental plots. This area had a relatively uniform layer of fine organic material (from the recreational channel) over sandy dredged material (from the main channel). The depths of the finer-textured deposits appeared to increase somewhat on both north-to-south and east-to-west gradients. The area was thoroughly rototilled by the Wildlife Division of the Connecticut Department of Environmental Protection (DEP) during mid-August 1976, and planted in the third week.

68. Three replicates of 32 plots, for a total of 96, were laid out (Figure 8). Each plot measured 1.5 by 1.0 m and 0.5-m spacing was left between contiguous plots. Four species of grasses, tall fescue (*Festuca elatior*), orchard grass (*Dactylis glomerata*), timothy (*Phleum pratense*), and perennial ryegrass (*Lolium perenne*); and two legumes, red clover, (*Trifolium pratens*), and white clover (*Trifolium repens*) were planted. Two rows were left unplanted. Four different lime treatments were applied to each species: control, and 3.6, 5.4, and 7.2 metric tons per 0.4 ha.

Initial Observations

69. The site was visited on 1 October 1976, and estimates were made of percent vegetation cover and plant height within each plot. Notes on plant appearance and other observations were made. Cover and height estimates are given in Table 12. Even after this short growing period, the estimates for these species clearly showed the positive effects of lime but did not indicate any clear trend in terms of optimum levels. Overall, plant growth was least vigorous in the Replicate 3, the southernmost replicate where the finer-textured deposits were the deepest.

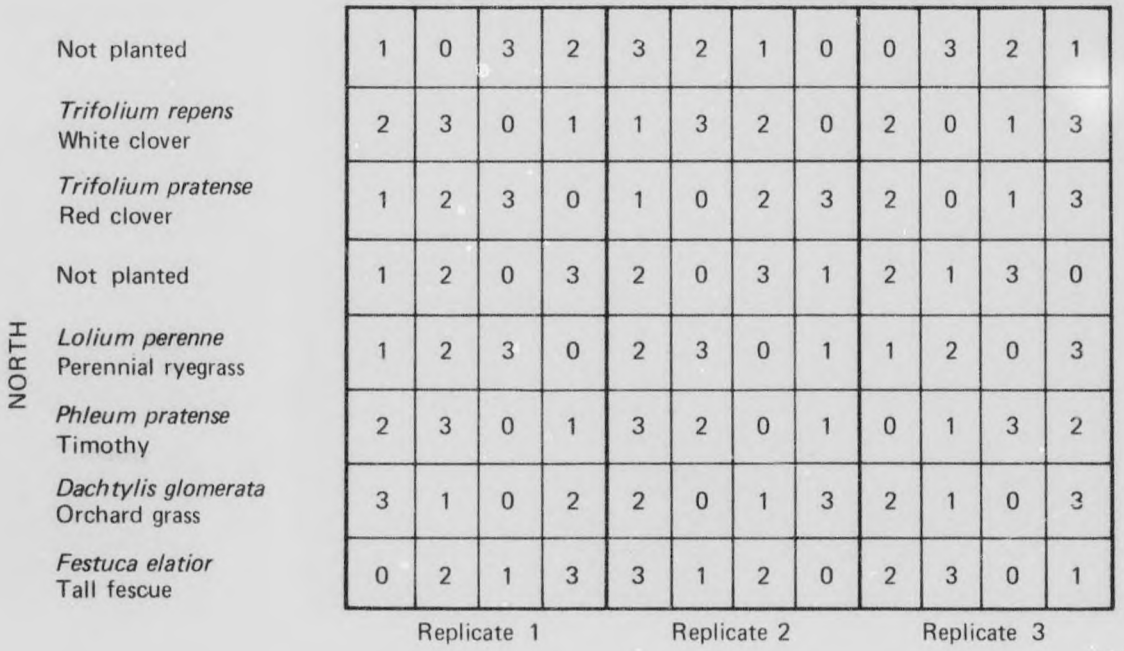

Figure 8. Planting plan for the experimental plots established within the disposal area. Each plot is 1.5 x 1.0 m with 0.5 m between contiguous plots. Lime treatments are indicated by numbers within each plot as follows: 0, no lime; 1, 3.6 metric tons/0.4 ha; 2, 5.4 metric tons/0.5 ha; and 3, 7.2 metric tons/0,4 ha

Table 12

Seedling Development in the Experimental Plots about Four Weeks after Planting*

Species	Replicate No.	Estimate of Growth within Lime Treatment**							
		Percent Cover				Height, cm			
		Lime 0	Lime 1	Lime 2	Lime 3	Lime 0	Lime 1	Lime 2	Lime 3
Trifolium repens									
White clover	1	2	25	25	35	1.5	3.0	7.5	5.0
	2	2	15	28	30	1.5	3.5	6.0	4.5
	3	12	13	10	12	2.5	2.0	3.0	2.0
	Mean	5.3	17.7	21	25.7	1.8	2.8	5.5	3.8
Trifolium pretense									
Red clover	1	3	10	12	20	3.0	5.0	7.5	7.0
	2	5	15	35	22	3.5	3.5	8.0	9.0
	3	3	15	15	11	1.0	4.5	4.5	3.5
	Mean	3.7	13.3	20.7	17.7	2.5	4.3	6.7	6.5
Lolium perenne									
Perennial ryegrass	1	25	28	45	45	14.0	12.0	20.0	16.0
	2	12	45	33	35	10.0	18.0	15.0	18.0
	3	5	50	35	45	7.0	23.0	17.0	16.0
	Mean	4.0	41.0	37.6	41.7	10.3	17.7	17.3	16.7
Phleum pratense									
Timothy	1	2	8	20	25	5.0	8.0	7.0	10.0
	2	2	20	35	45	5.0	9.0	11.0	12.0
	3	1	7	10	30	5.0	7.0	7.0	8.0
	Mean	1.7	11.7	21.7	33.3	5.0	8.0	8.3	10.0
Dachtylis glomerata									
Orchard grass	1	5	23	55	18	8.0	13.0	25.0	13.0
	2	5	42	45	28	13.0	18.0	22.0	17.0
	3	3	40	33	20	8.0	17.0	18.0	15.0
	Mean	4.3	35.0	44.3	22.0	9.7	16.0	21.7	15.0
Festuca elatior									
Tall fescue	1	8	35	35	30	8.0	13.0	15.0	18.0
	2	15	55	32	35	14.0	20.0	20.0	18.0
	3	3	35	60	35	6.0	20.0	18.0	18.0
	Mean	8.7	41.7	42.3	33.3	9.3	17.7	17.7	18.0

*Seeds were planted third week of August 1976. Estimates on this table were made 1 October 1976.

** Lime 0 = No lime
Lime 1 = 3.6 metric tons/0.4 ha
Lime 2 = 5.4 metric tons/0.4 ha
Lime 3 = 7.2 metric tons/0.4 ha

70. Deer and geese were common on the site in October, as witnessed by tracks and droppings, and may have grazed the plantings. The clovers and orchard grass in particular appeared to have been grazed.

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APPENDIX A': NOTT ISLAND FLORA BY FAMILIES*

Family	Scientific Name	Common Name
Equisetaceae Horsetail family	*Equisetum arvense*	Horsetail
Polypodiaceae Fern Family	*Dryopteris Thelypteris*	Marsh fern
	Onoclea sensibilis	Sensitive fern
Taxaceae Yew family	*Taxus cuspidata*	Japanese yew
Pinaceae Pine family	*Juniperus virginiana*	Red cedar
	Pinus sp.	Pine
Typhaceae	*Typha angustifolia*	Narrow-leaved cattail
Sparganiaceae Bur-reed family	*Sparganium eurycarpum*	Bur-reed
Zosteraceae Pondweed family	*Potamogeton sp.*	Pondweed
Alismataceae Water-plantain family	*Alisma subcordatum*	Water-plantain
	Lophotocarpus spongiosus	Hooded arrowhead
Gramineae Grass family	*Agropyron repens*	Witch-grass
	Agrostis alba	Red top
	Agrostis hyemalis	Ticklegrass
	Agrostis scabra	Hairgrass
	Agrostis tenuis	Rhode Island bent
	Ammophila breviligulata	Beachgrass
	Anthoxanthum odoratum	Sweet vernal grass
	Cenchrus tribuloides	Sand-spur
	Digitaria sanguinalis	Crab-grass
	Echinochloa crusgalli	Barnyard-grass
	Echinochloa pungens **	
	Echinochloa Walteri **	
	Elymus virginicus	Wild rye
	Eragrostis megastachya **	Stink-grass
	Eragrostis pilosa **	Love-grass
	Festuca octoflora	
	Festuca ovina	Sheep's-fescue
	Festuca rubra	Fescue
	Leersia oryzoides	Rice cutgrass
	Leptoloma cognatum	Fall witch-grass
	Panicum capillare	Old-witch grass

*Nomenclature based primarily on Gray's Manual of Botany, 8th edition (Fernald 1950).

**Tentative identification for these species and for the genera *Agrostis*, *Poa*, *Carex*, *Cyperus*, and *Juncus* except *Juncus effusus*.

Family	Scientific Name	Common Name
Gramineae (Continued)	*Panicum clandestinum*	Panic grass
	Panicum dichotomiflorum	Panic grass
	*Panicum latifolium***	Panic grass
	*Panicum lanuginosum***	Panic grass
	*Panicum meridicnale***	Panic grass
	*Panicum philadelphicum***	Panic grass
	Panicum virgatum	Switchgrass
	Phragmites australis	Reedgrass
	Poa compressa	Canada bluegrass
	Poa nemoralis	Foin a vaches
	Poa palustris	Fowl-meadow grass
	Poa trivalis	Rough-stalked meadow-grass
	Spartina alterniflora	Salt-water cordgrass
	Spartina cynosuroides	Salt reedgrass
	Spartina pectinata	Fresh-water cordgrass
	Triplasis purpurea	Sand-grass
	Zizania aquatica	Wild rice
Cyperaceae Sedge family	*Bulbostylis capillaris*	Sedge
	Carex annectens	Sedge
	Carex hormathodes	Sedge
	Carex lanuginosa	Sedge
	Carex lurida	Sedge
	Carex retrorsa	Sedge
	Carex rostrata	Sedge
	Carex scabrata	Sedge
	Carex stipata	Sedge
	Carex vulpinoidea	Sedge
	Cyperus dentatus	Umbrella-sedge
	Cyperus erythrorhizos	Sedge
	Cyperus esculentus	Yellow nut-grass
	Cyperus filiculmis	Sedge
	Cyperus odoratus	Sedge
	Cyperus strigosus	Sedge
	Eleocharis spp.	Spike rush
	Scirpus americanus	Three-square
	Scirpus atrovirens	Bulrush
	Scirpus cyperinus	Wool grass
	Scirpus fluviatilis	River-bulrush
	Scirpus robustus	Bulrush
	Scirpus validus	Great bulrush
Araceae Arum family	*Arisaema Dracontium*	Green dragon
	Peltandra virginica	Arrow arum
Commelinaceae Spiderwort family	*Commelina communis*	Dayflower

Family	Scientific Name	Common Name
Pontederiaceae Pickerelweed family	*Pontederia cordata*	Pickerelweed
Juncaceae Rush family	*Juncus acuminatus*	Rush
	Juncus dichotomous	Rush
	Juncus Dudleyi	Rush
	Juncus effusus	Soft rush
	Juncus secundus	Rush
	Juncus tenuis	Rush
Liliaceae Lily family	*Allium sp.*	Wild onion
	Asparagus officinalis	Garden asparagus
	Lilium canadense	Wild yellow lily
	Smilax glauca	Sawbrier
	Smilax herbacea	Carrion flower
Iridaceae Iris family	*Iris Pseudacorus*	Yellow iris
	Iris versicolor	Blue flag
	Sisyrinchium angustifolium	Blue-eyed grass
Salicaceae Willow family	*Populus deltoides*	Cottonwood
	Populus tremuloides	Quaking aspen
	Salix fragilis	Crack willow
	Salix nigra	Black willow
Myricaceae Wax-myrtle family	*Myrica pensylvanica*	Bayberry
Corylaceae Hazel family	*Alnus serrulata*	Common alder
	Betula populifolia	White birch
Fagaceae Beech family	*Quercus bicolor*	Swamp white oak
	Quercus velutina	Black oak
Ulmaceae Elm family	*Celtis occidentalis*	Hackberry
	Ulmus americana	American elm
Urticaceae Nettle family	*Boehmeria cylindrica*	Bog-hemp
	Parietaria pensylvanica	Pellitory
	Pilea punila	Clearweed
	Urtica dioica	Stinging nettle
Polygonaceae Buckwheat family	*Polygonum arifolium*	Halberd-leaved tearthumb
	Polygonum cuspidatum	Japanese knotweed
	Polygonum lapathifolium	Smartweed
	Polygonum punctatum	Water smartweed
	Polygonum sagittatum	Arrow-leaved thumbweed
	Polygonum scandens	Climbing false buckwheat
	Rumex Acetosella	Sheep sorrel
	Rumex orbiculatus	Water dock

Family	Scientific Name	Common Name
Chenopodiaceae Goosefoot family	*Chenopodium ambrosioides*	Mexican-tea
	Chenopodium sp.	Pigweed
Amaranthaceae Amaranth family	*Acnida cannabina*	Water-hemp
Phytolaccaceae Pokeweed family	*Phytolacca americana*	Poke
Aizoaceae fleshy, succulent plants	*Mollugo verticillata*	Carpetweed
Caryophyllaceae Pink family	*Arenaria lateriflora*	Grove sandwort
	Saponaria officinalis	Soapwort
	Stellaria media	Common chickweed
Ranunculaceae Crowfoot family	*Ranunculus acris*	Common buttercup
	Thalictrum polygamum	Tall meadow-rue
Berberidaceae Barberry family	*Berberis Thunbergii*	Japanese barberry
	Berberis vulgaris	Common barberry
Lauraceae Laurel family	*Sassafras albidum*	White sassafras
Cruciferae Mustard family	*Barbarea vulgaris*	Common wintercress
	Cakile edentula	Sea-rocket
	Cardamine sp.	Bitter cress
	Lepidium virginicum	Poor man's pepper
	Raphanus Raphanistrum	Wild radish
	Rorippa islandica	Yellow cress
	Rorippa sylvestris	Creeping yellow cress
Saxifragaceae Saxifrage family	*Penthorum sedoides*	Ditch-stonecrop
Platanaceae Plane-tree family	*Platanus occidentalis*	Sycamore
Rosaceae Rose family	*Crataegus sp.*	Hawthorn
	Geum laciniatum	Avens
	Potentilla anserina	Silverweed
	Potentilla canadensis	Cinequefoil
	Potentilla norvegica	Rough cinquefoil
	Prunus serotina	Wild black cherry
	Pyrus malus	Apple
	Rose multiflora	Multiflora rose
	Rosa allegheniensis	Blackberry

Family	Scientific Name	Common Name
Rosaceae (Continued)	*Rubus flagellaris*	Dewberry
	Spiraea latifolia	Meadow-sweet
	Spireaea tomentosa	Hardhack
Leguminosae Pulse family	*Amorpha fruticosa*	False indigo
	Desmodium sp.	Tick-trefoil
	Lespedeza sp.	Bush-clover
	Robinia Pseudo-Acacia	Black locust
	Strophostyles helvola	Wild bean
	Wisteria sinensis	Chinese wisteria
Linaceae Flax family	*Linum sp.*	Flax
Oxalidaceae Wood-sorrel family	*Oxalis europaea*	Wood-sorrel
Geraniaceae Geranium family	*Geranium maculatum*	Wild geranium
Simaroubaceae Quassia family	*Ailanthus altissima*	Tree-of-heaven
Euphorbiaceae Spurge family	*Euphorbia Cyparissias*	Cypress spurge
	Euphorbia polygonifolia	Spurge
Anacardiaceae Cashew family	*Rhus copallina*	Shining or Winged sumac
	Rhus glabra	Smooth sumac
	Rhus radicans	Poison ivy
	Rhus typhina	Staghorn sumac
Aquifoliaceae Holly family	*Ilex verticillata*	Winterberry
Celastraceae Staff-tree family	*Celastrus orbiculatus*	Oriental bittersweet
	Euonymus europaeus	European spindle-tree
Aceraceae Maple family	*Acer saccharinum*	Silver maple
Balsaminaceae Touch-me-not family	*Impatiens capensis*	Touch-me-not
Rhamnaceae Buckthorn family	*Rhamnus cathartica*	Common buckthorn
Vitaceae Vine family	*Parthenocissus quinquefolia*	Virginia creeper

Family	Scientific Name	Common Name
Vitaceae (continued)	*Vitis Labrusca*	Fox grape
	Vitis sp.	Grape
Malvaceae Mallow family	*Hibiscus palustris*	Marsh mallow
Guttiferae St. John's wort family	*Hypericum gentianoides*	Orange-grass
	Hypericum mutilum	St. John's-wort
	Hypericum punctatum	St. John's-wort
Lythraceae Loosestrife family	*Lythrum Salicaria*	Spiked loosestrife
Nyssaceae Sour gum family	*Nyssa sylvatica*	Black gum
Onagraceae Evening primrose family	*Circaea quadrisulcata*	Enchanter's nightshade
	Epilobium hirsutum	Willow-herb
	Oenothera parvifolia	Evening primrose
Umbelliferae Parsley family	*Cicuta bulbifera*	Water-hemlock
	Heracleum maximum	Cow-parsnip
	Ptilimnium capillaceum	Mock bishop's weed
	Sium suave	Water parsnip
Cornaceae Dogwood family	*Cornus Amomum*	Silky dogwood
Ericaceae Heath family	*Vaccinium corymbosum*	Highbush blueberry
Primulaceae Primrose family	*Lysimachia ciliata*	Loosestrife
	Samolus parviflorus	Water pimpernel
Oleaceae Olive family	*Fraxinus pensylvanica*	Red ash
Loganiaceae Logania family	*Ligustrum sp.*	Privet
Apocynaceae Dogbane family	*Apocynum cannabinum*	Indian hemp
Asclepiadaceae Milkweed family	*Asclepias incarnata*	Swamp milkweed
	Asclepias syriaca	Milkweed
Convolvulaceae Convolvulus family	*Convolvulus sepium*	Morning glory
	Cuscuta sp.	Dodder
Boraginaceae Borage family	*Myosotis laxa*	Scorpion-grass

Family	Scientific Name	Common Name
Verbenaceae Vervain family	*Verbena hastata*	Blue vervain
Labiatae Mint family	*Lycopus americanus*	Bugleweed
	Mentha arvensis	Mint
	Mentha sp.	Mint
	Scutellaria epilobiifolia	Common scullcap
	Scutellaria lateriflora	Mad-dog skullcap
	Stachys tenuifolia	Hedge nettle
	Teucrium canadense	Wood-sage
Solanaceae Nightshade family	*Solanum Dulcamara*	Nightshade
	Solanum nigrum	Common nightshade
Scrophulariaceae Figwort family	*Gratiola neglecta*	Hedge-hyssop
	Linaria canadensis	Old-field toadflax
	Linaria vulgaris	Butter-and-eggs
	Lindernia anagallidea	False pimpernel
	Lindernia dubia	False pimpernel
	Mimulus ringens	Monkey-flower
	Scrophularia lancelata	Figwort
	Verbascum Thapsus	Common mullein
Bignoniaceae Bignonia family	*Catalpa speciosa*	Catawba tree
Plantaginaceae Plantain family	*Plantago major*	Common plantain
	Plantago sp.	Plantain
Rubiaceae Madder family	*Cephalanthus occidentalis*	Buttonbush
	Galium Aparine	Cleavers
	Galium sp.	Bedstraw
	Houstonia caerulea	Bluets
Caprifoliaceae Honeysuckle family	*Lonicera japonica*	Japanese honeysuckle
	Sambucus canadensis	Common elder
	Viburnum recognitum	Arrowwood
Cucurbitaceae Gourd family	*Echinocystis lobata*	Wild cucumber
Campanulaceae Bluebell family	*Campanula aparinoides*	Marsh bellflower
Compositae Composite family	*Achillea Millefolium*	Common yarrow
	Ambrosia artemisiifolia	Common ragweed
	Ambrosia trifida	Great ragweed

Family	Scientific Name	Common Name
Compositae (Continued)	*Baccharis halimifolia*	Groundsel-tree
	Bidens sp.	Bur-marigold
	Cirsium vulgare	Common thistle
	Erechtites hieracifolia	Fireweed
	Erigeron canadensis	Horse-weed
	Eupatorium maculatum	Joe-pye-weed
	Eupatorium perfoliatum	Boneset
	Galinsoga ciliata	Blake
	Gnaphalium obtusifolium	Everlasting
	Gnaphalium uliginosum	Low cudweed
	Gnaphalium sp.	
	Hieracium pratense	King devil
	Krigia virginica	Dwarf dandelion
	Lactuca canadensis	Lettuce
	Mikania scandens	Climbing hempweed
	Pluchea purpurascens	Stinkweed
	Rudbeckia serotina	Black-eyed susan
	Solidago graminifolia	Grass-leaved goldenrod
	Solidago rugosa	Rough-edged goldenrod
	Solidago sempervirens	Seaside goldenrod
	Tanacetum vulgare	Common tansy
	Taraxacum officinale	Dandelion
	Xanthium sp.	Cocklebur

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

Warren, R Scott
Habitat development field investigations, Nott Island upland habitat development site, Connecticut River, Connecticut; Appendix B: Survey of terrestrial ecology and preliminary botanical monitoring / by Scott R. Warren ... [et al.], Connecticut College, New London, Conn. Vicksburg, Miss. : U. S. Waterways Experiment Station ; Springfield, Va. : available from National Technical Information Service, 1978.
60, 8 p. : ill. ; 27 cm. (Technical report - U. S. Army Engineer Waterways Experiment Station ; D-78-25, Appendix B)
Prepared for Office, Chief of Engineers, U. S. Army, Washington, D. C., under Contract No. DACW33-76-C-0017 (DMRP Work Unit No. 4B04E)
References: p. 59-60.
1. Biota. 2. Dredged material. 3. Dredged material disposal. 4. Field investigations. 5. Habitat development. 6. Habitats. 7. Nott Island, Conn. 8. Terrestrial habitats. 9. Vegetation establishment. 10. Waste disposal sites. I. Connecticut College. II. United States. Army. Corps of Engineers. III. Series: United States. Waterways Experiment Station, Vicksburg, Miss. Technical report ; D-78-25, Appendix B.
TA7.W34 no.D-78-25 Appendix B