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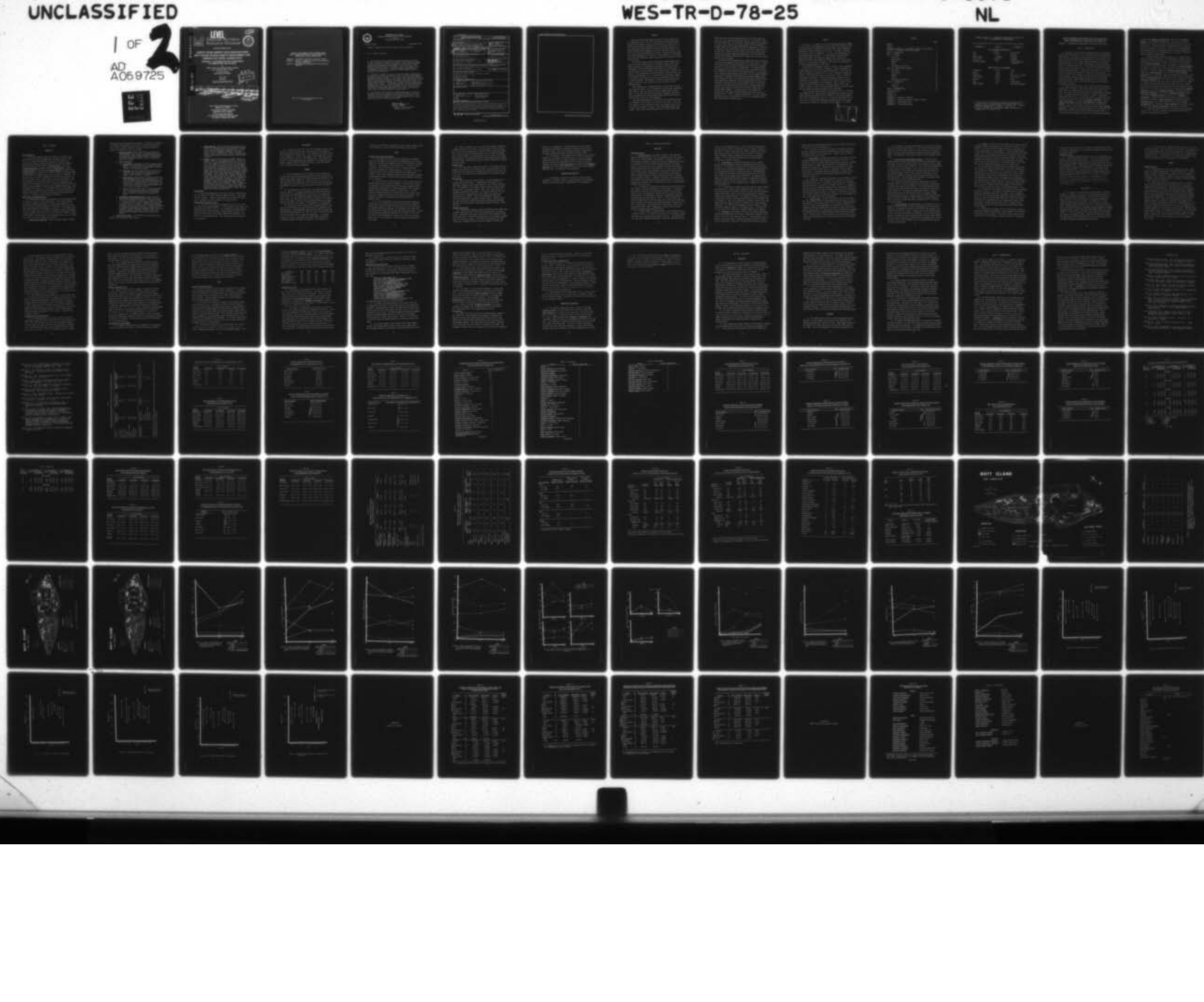

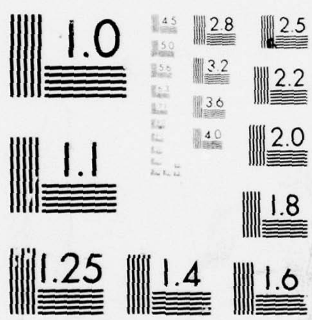

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DREDGED MATERIAL RESEARCH PROGRAM

TECHNICAL REPORT D-78-25

HABITAT DEVELOPMENT FIELD INVESTIGATIO
NOTT ISLAND UPLAND HABITAT DEVELOPMENT
CONNECTICUT RIVER, CONNECTICUT

APPENDIX C: POSTPROPAGATION MONITORING OF VEGETATION AND WILDLIFE

by

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New London, Conn. 06320

August 1978

Final Report

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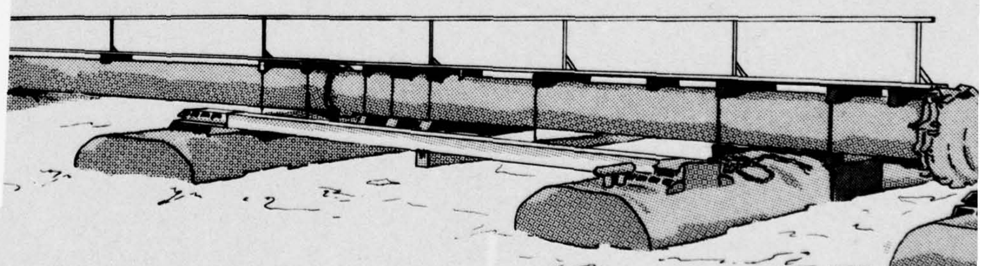

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Monitored by Environmental Laboratory
U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Miss. 39180

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

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS
P. O. BOX 631
VICKSBURG, MISSISSIPPI 39180

IN REPLY REFER TO: WESEV

30 September 1978

SUBJECT: Transmittal of Technical Report D-78-25, Appendix C

TO: All Report Recipients

1. The technical report transmitted herewith represents the results of one of a series of research efforts (work units) undertaken as part of Task 4B (Terrestrial Habitat Development) of the Corps of Engineers' Dredged Material Research Program (DMRP). Task 4B was part of the Habitat Development Project of the DMRP and had as its objective the development and application of habitat management methodologies on upland disposal areas for the purposes of planned habitat creation, reclamation, and mitigation.

2. This report presents the results of Work Unit 4B04F, postpropagation monitoring of vegetation and wildlife at the Nott Island Upland Habitat Development Site in Connecticut. It is one of three contractor-prepared appendices published relative to the Waterways Experiment Station Technical Report D-78-25, entitled "Habitat Development Field Investigations, Nott Island Upland Habitat Development Site, Connecticut River, Connecticut; Summary Report" (4B04G). The appendices provide technical background and supporting data and may or may not represent discrete research products. Appendices that are largely data tabulations or that clearly have only site-specific relevance were published as microfiche; those with more general application were published as printed reports.

3. The purpose of this study was to document vegetation and wildlife response to habitat development activities at Nott Island. Data from this report are best interpreted in the context of the series of six work units that were conducted at Nott Island (4B04A-F) and are synthesized in that site's summary report (4B04G).

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

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Waste disposal sites
Wildlife habitat

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

A 3.2-ha diked dredged material disposal site was constructed in 1975 on Nott Island in the Connecticut River, 11 km upriver from Long Island Sound. It was filled with sandy dredged material, top-dressed with finer sediments, and experimentally treated and planted with legumes and grasses. Monitoring of the planted vegetation and wildlife response to the vegetation during the 1977 growing season is reported.

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SUMMARY

The Nott Island dredged material disposal site was divided into two experimental areas. The first consisted of 96 experimental plots located in the southwest corner of the disposal site. Each plot was rototilled, fertilized, treated with one of four lime levels (0, 4, 6, and 8 tons/acre), and planted with one of six species (tall fescue, timothy, orchard grass, ryegrass, red clover, and white clover). One set of plots was left unplanted as a control. There were 3 replicates. The second experimental area consisted of the remainder of the disposal site, which was fertilized, limed, and planted with a mixture of clover and tall fescue.

In both areas, plant success was measured through biomass taken at the end of the growing season, stem density, percent cover, plant height, phenology, seed production, and degree of natural invasion. The majority of these measurements indicated that the grasses were more successful than the clovers or the unplanted plots. However, the results of these measurements, and especially of those taken only once during the growing season (i.e., seed production and biomass), appear to be masked by differences in life cycles and/or maturation rates of the species planted. Measurements of natural invasion indicated the greatest invasion on plots planted with the two clovers and the unplanted plots.

Lime treatments had a significant effect on practically all measures of plant success. In all cases where a statistically significant main effect of lime was found, the 0 lime treatment had the lowest value. It was also true that the lower and intermediate lime treatments consistently had a significantly greater effect upon plant success than any of the other lime treatments.

Four small mammal grids of 44 traps each were established around the periphery of the disposal site and one in its center. Each grid was trapped for seven consecutive days in two sessions either in June or early July and again in August. Three small mammal species were caught: meadow voles, meadow jumping mice, and short-tailed shrews.

Meadow voles were the most abundant species on all grids except the north one in the first session and the east one in the second. Their densities ranged from 7 to 56 mice/ha. Meadow jumping mice outnumbered the voles on the two grids just mentioned and were the second most abundant species on the island with densities ranging up to 73 mice/ha. As expected, short-tailed shrews were scarce and were caught only on the east grid. Meadow voles were caught on the center grid in both sessions, while meadow jumping mice apparently had not invaded this area until the second trapping session in August when they were caught there in very low numbers.

The island's bird populations were censused using both a breeding bird survey and combined transect-observation station counts. A total of 23 species were recorded as breeding on the island with an average density for the entire island of 356 pairs/km^2. The highest density of breeding birds was found in the marsh with an estimated 400 pairs/km^2, compared to 340 pairs/km^2 on the upland portions. As in previous years, the most abundant nesting species were the red-winged blackbird, song sparrow, long-billed marsh wren, yellow warbler, common yellowthroat, and gray catbird. The transect and observation-station counts also revealed that goldfinches and mourning doves were at least as abundant as these six species in total numbers present on the island. In general, both density and species diversity increased along the transects and observation stations from late May through July, and then declined in August. A diurnal survey of the disposal site revealed that song sparrows and mourning doves used the area to the greatest extent. A pair of killdeer nested there. The only waterfowl attempting to nest on the island in 1977 was the Canada goose, whose nest was destroyed by unknown causes.

PREFACE

This report is a summary of the work accomplished during the summer of 1977 as part of the Dredged Material Research Program (DMRP) Task 4B, "Terrestrial Habitat Development," Work Unit 4B04F, "Post-Propagation Monitoring of Flora and Fauna at Nott Island." The DMRP is sponsored by the Office, Chief of Engineers, U. S. Army, and is monitored by the Environmental Laboratory (EL), U. S. Army Engineer Waterways Experiment Station (WES). The study was conducted under Contract No. DACW33-77-C-0076 between Connecticut College, New London, Connecticut, and the U. S. Army Corps of Engineers. The contract was administered by the New England Division of the Corps.

The principal investigators were Drs. William J. Barry, Department of Zoology, and R. Scott Warren and William A. Niering, Department of Botany, Connecticut College, New London, Connecticut. Field work was under the immediate supervision of Ms. Joan L. Tabachnick, Connecticut College. The breeding bird study was done by Mr. Allen C. Carroll of East Haddam, Connecticut. All of these individuals assisted in the preparation of this report. The authors would also like to thank the able team of undergraduate field assistants: Nels E. Barrett, Lynn D. Clements, Kathleen Carleton, Ross M. Delaney, James A. Murch, and Susan H. Tweedie. Finally, Ms. Nancy Stebbins deserves a special thanks for her careful typing and preparation of the manuscript.

This study was conducted under the supervision of Ms. L. Jean Hunt, Site Manager of Nott Island, Habitat Development Project (HDP), EL, and under the general supervision of Dr. Hanley K. Smith, Project Manager, HDP, and Dr. John Harrison, Chief, EL. Director of WES during the conduct of this study and the preparation and publication of this report was COL John L. Cannon, CE. Technical Director was Mr. F. R. Brown.

CONTENTS

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

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

Multiply	By	To Obtain
U. S. Customary to Metric (SI)		
acres	4046.873	square metres
acres	0.405	hectares
pounds (mass)	0.4535924	kilograms
tons (short)	907.1847	kilograms
Fahrenheit degrees	5/9	Celsius degrees or kelvins*
Metric (SI) to U. S. Customary		
centimetres	0.394	inches
metres	3.281	feet
kilometres	0.6214	miles (U. S. Statute)
square metres	10.764	square feet
hectares	2.471	acres
grams	0.002	pounds (mass)
Celsius degrees	9/5	Fahrenheit degrees**

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

** To obtain Fahrenheit (F) temperature readings from Celsius (C) readings, use: $F = (9/5)(C + 32)$.

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

APPENDIX C: POSTPROPAGATION MONITORING OF VEGETATION AND WILDLIFE

PART I: INTRODUCTION

1. One aspect of the Habitat Development Project of the Dredged Material Research Program is use of field sites to test habitat development concepts. Nott Island, a 31-ha island located in the Connecticut River 11 km north of Long Island Sound (Figure 1), was selected as an upland field site in 1974. Sandy sediments dredged from an adjacent shoal were placed in a 3.2-ha diked impoundment on the north-central part of the island in early 1975. Finer grained dredged material from another channel was placed on top of the sand in late 1975 and allowed to drain until August 1976. At that time the majority of the site was limed, fertilized, and seeded with a legume and a grass species. In the south portion of the disposal site, 96 small plots were established for an agronomic experiment using six plant species and four lime application levels. Establishment and growth of the plantings was monitored until fall 1977, as was wildlife response to the habitat development activities.

2. Much of the vegetation of Nott Island provides an indication of man's past activities. From colonial times until as recently as the early 1950's, the island was used for agricultural purposes. Since 1936, it has been used on nine occasions as a dredged material disposal site. The upland portion of the island is a mosaic of shrublands, grasslands, and bare sand. The northern portion is dominated by mostly old field species such as red cedar (*Juniperus virginiana*), bayberry (*Myrica pensylvanica*), and sumac (*Rhus copallina*, *R. glabra*, and *R. typhina*). The lower elevations of both the northern end and the southern margins of the island are dominated by false indigo (*Amorpha fruticosa*), a common shrub found on alluvial soil in Connecticut. Much of the central portion of the island and extensive areas along its eastern shore are old disposal sites that are now grasslands dominated

by beach grass (Ammophila breviligulata) and panic grass (Panicum virgatum). The habitat development site is located in the central portion of the island, an area that was largely panic grass on an old disposal site. An estuarine marsh of approximately 9.7 ha comprises the southern portion of the island. Warren et al. (1978) identified fourteen major vegetation associations for the island including four types of shrubland, four of grassland, and six of marsh. A total of 253 plant species was identified.

3. Warren and Niering (1978) and Warren et al. (1978) reported baseline conditions of wildlife. The small mammal populations of Nott Island have been observed since 1974. One species, the white-footed mouse (Peromyscus leucopus), has not been trapped on the island since the most recent disposal activities. The Norway rat (Rattus norvegicus) was apparently present only in 1975 during the height of the disposal operations. At present, meadow voles (Microtus pennsylvanicus), meadow jumping mice (Zapus hudsonius), and short-tailed shrews (Blarina brevicauda) are the three most common small mammal species on the island. Muskrats (Ondatra zibethicus) inhabit the marsh, and white-tailed deer (Odocoileus virginiana) and their tracks are seen periodically. Breeding bird surveys have been conducted on Nott Island since 1975. The number of breeding species has been relatively constant each year; however, the density of breeding birds has declined. The most abundant breeding species in all three years have been the red-winged blackbird (Agelaius phoeniceus), song sparrow (Melospiza melodia), long-billed marsh wren (Cistothorus palustris), yellow warbler (Dendroica petechia), common yellowthroat (Geothlypis trichas), and gray catbird (Dumetella carolinensis). Among the game species recorded as breeding on the island are the bobwhite (Colinus virginianus) and American woodcock (Philohela minor) on the upland portions, and the mallard (Anas platyrhynchos) and Canada goose (Branta canadensis) on the marsh portion. The common crow (Corvus brachyrhnchos) also nests on the island.

4. This report provides results of monitoring during the growing season of 1977. Botanical parameters were measured and wildlife observations continued from the baseline.

PART II: METHODS

Vegetation

Site preparation

5. The 96 experimental plots were located in a portion of the disposal area that was most homogeneous in sediment texture. Each 1.0- by 1.5-m plot was rototilled, fertilized, and subjected to experimental liming and seeding according to the design in Figure 2. Species planted were white clover (Trifolium repens), red clover (Trifolium pratense), perennial ryegrass (Lolium perenne), timothy (Phleum pratense), orchard grass (Dactylis glomerata), and tall fescue (Festuca elatior var. Kentucky 31). Lathco flatpea (no scientific name) was included in the original design, but seeds were not available. One row was left as a control, unplanted but limed and fertilized as if it had been planted. Table 1 gives details of plot specifications. With the exception of the small plots and a buffer area around them, the disposal site was worked with a blade to level the sand dike and mix the sandy and finer sediments to produce a more homogeneous substrate. Lime was applied at the rate of 4 to 8 tons/acre, with the larger quantities placed where the sediments were less sandy. Fertilizer (10-20-10) was applied at 500 lb/acre. The site was harrowed and seeded with white clover at 2.5 lb/acre and tall fescue at 14 lb/acre.

Monitoring of experimental plots

6. Nondestructive sampling was performed at three intervals during the summer: 14 June, 11 July, and 8 August. Every month, quadrats were located randomly to measure the various plant parameters. The size and number of quadrats sampled were determined by the growth form and random subsamples of stem density of each plot. In the high-density plots (up to 1600 stems per $0.25m^2$), two $0.0625m^2$ quadrats were sampled. In the intermediate density plots (up to 400 stems per $0.25m^2$), a single $0.25m^2$ quadrat was taken, while in the low-density plots (up to 150 stems per $0.25m^2$), two $0.25m^2$ quadrats were utilized.

7. Nondestructive sampling. Within each sample quadrat, natural

invasion and plant performance were measured. In addition, the effects of a number of environmental factors were recorded, including plant vigor, physical damage, symptoms of disease or mineral deficiency, evidence of competition, and use by animals.

a. Natural invasion. Within each quadrat, the number of invading plants (those species not seeded) was counted and the percent cover visually estimated (Phillips 1959). When individual plants became difficult to distinguish, the number of stems was counted. Date of invasion was noted when possible.

b. Plant performance.

(1) Stem density. The number of stems of planted species present in a quadrat was used as a measure of plant density. It was difficult to distinguish individual plants, so all stems were counted.

(2) Phenology. For each planted species, the percent of stems flowering or fruiting was calculated as the number of stems flowering or fruiting per total number of stems present in a quadrat.

(3) Plant height. Twenty plants of planted species were selected randomly within each experimental plot. Each plant was labeled and its height was measured as the linear distance from soil surface to the apex of the longest leaf or the highest point in each clump. The results were calculated as the average maximum height per species by treatment and month.

(4) Cover. Percent foliage cover was visually estimated for each planted species within each experimental plot. This measure provided data on the average percent cover for each species by treatment and month.

c. Miscellaneous environmental effects. Plant vigor was subjectively evaluated within each quadrat using one of the following descriptive indices: 1 = dead; 2 = dying; 3 = chlorotic, burned, or showing other symptoms of stress; 4 = stable; and 5 = new growth. Damage to the plants by physical forces (i.e., wind or sand transport), symptoms of disease or mineral deficiency (i.e., chlorosis), evidence of competition, and signs of herbivory were also noted. Categories used were anthropic (evidence of man's activity), chlorotic (yellowed), droughty (wilted or dried out), grazed (eaten by animals), and utilized (other use by animals).

8. Destructive sampling. Seed production and biomass were each measured once during the growing season.

a. Seed production. All fruiting stems of planted species present per experimental plot were harvested and weighed after the July nondestructive sampling period. The collected stems were subsampled randomly and all seeds removed by hand, collected, and weighed. Estimates of seeds per stem were multiplied by percent flowering stems to give average weight of seeds per plot by species and treatment.

b. Biomass. At the end of August, a $0.0625 m^2$ quadrat was sampled randomly in each experimental plot. Within each quadrat, all of the aboveground material was cut at the root crown, bagged, dried for 24 hr at 60°C followed by 4 to 8 hr at 83°C to a constant weight, and then weighed. During any delay between collection and drying, samples were refrigerated to minimize any weight loss due to plant respiration. All belowground material (to 15 cm) in each sample quadrat was dug up and the soil removed by carefully shaking and washing. Each sample was then bagged, dried, and weighed. Total biomass was calculated from the combined data of the two procedures. Plants collected for biomass measurements were not separated into invading and planted species during this procedure. First, since it was impossible to separate the belowground samples (root biomass) by species, the aboveground samples were not separated in order to be consistent. Second, biomass was not considered a measure of the success of a planted species, but rather a measure of productivity within the area planted with a particular species. Hence, all plant growth was considered collectively.

Data analysis

9. The Student-Newman Keuls test (Steel and Torrie 1960:110) was used for analysis of variance among the means of each of 3 replicates for each treatment. Figures in data tables are all means of 3 replicates. Appendix A´ gives all analysis of variance tables.

Monitoring of remainder of site

10. The site was divided into 168 quadrats 15 m on a side, and 19 of these were selected randomly. A $2\text{-}m^2$ permanent nested quadrat was established within each of the 19. All nondestructive (plant survival, natural invasion, plant performance, and environmental effects) and destructive (seed density and biomass) sampling was conducted as outlined for the experimental plots. Data are presented as the means of all 19 quadrats.

Microclimate

11. At the end of June 1977, the five microclimate stations established in 1976 were relocated and a sixth station was established in the dredged material disposal area. One thermometer was placed in each of five communities: cattail, beach grass, false indigo, panic grass, and tree-thicket, as well as in the disposal area. Each station consisted of a single maximum-minimum thermometer 30 cm above the ground surface, shaded on three sides and above with its open side facing north. Readings were taken midmorning.

Mammals

12. Five rectangular grids of 44 traps each were established on the island with one grid paralleling each of the four sides of the disposal area (North, South, East, and West grids) and one grid in the center (Central grid) (Figure 3). Traps were set in a 4 by 11 configuration with 15 m between each trap. The area covered by each grid was assumed to include 7.5 m on all sides for an area of 0.99 ha per grid.

13. One Sherman live trap was set at each station and baited with dry oatmeal. All traps were checked twice daily for seven consecutive days from approximately 8:30 to 11:30 a.m. and again from 1:00 to 3:00 p.m. All animals were marked using a toe clip and ear punch system. The North and South grids were trapped on 9-15 June and again on 3-9 August. The East, West, and Central grids were trapped on 7-13 July and on 13-19 August. See Appendix B′ for nomenclature.

14. The percent cover by species of all vegetation within a 1-m radius (3.14 m^2) radius from each trap station was recorded on standardized forms. This information along with that from the vegetation map of Nott Island (Warren et al. 1978) was used to classify each trap location according to major vegetation communities. A chi-square analysis was used to test whether each small mammal species was distributed randomly throughout all habitats. The proportion of

captures in each habitat was compared with what would be expected based on the frequency of traps located in each habitat (Batzli 1974).

Birds

Transect and station observations

15. Four transects (A-D) of varying lengths were established around the periphery of the disposal site, approximately 30 m from its edge, with two additional transects (E and F) located within its center (Figure 4). The lengths of each transect were: A, 273 m; B, 256 m; C, 195 m; D, 183 m; E, 100 m; and F, 100 m. Sixteen 10-minute observation stations were located along the six transects. The three stations on each of the two center transects were equidistantly located. Those on the peripheral transects were established to provide a representative sample of habitats while affording maximum visibility for the observer.

16. Each survey was conducted within 3 hr after sunrise while the observer walked slowly along each transect. All birds seen or heard or considered to be actually using the island were recorded and their perpendicular distances from the transect estimated. When a singing bird was heard, an attempt was made to actually see it. At each 10-minute observation station, all birds seen or heard within a 60-m radius were recorded and their activities noted when possible. This procedure is similar to the sample count method described by Anderson (1972).

17. As it was impossible to cover all the transects during any one morning, the starting point was alternated between a peripheral transect and a central transect with only one half of the total transect distance walked each morning. This procedure also assured that all areas were not covered at the same time during each survey. A total of 12 surveys were conducted during each of the months of June, July, and August, with approximately six surveys in the first half of each month and six in the second half. Three surveys were also conducted in late May.

18. Every two surveys (i.e., two consecutive mornings) represented a complete census of all transects. For each complete census, density per species on each transect was calculated using the King method (Hayne 1949). Density at each observation station was calculated by assuming that the area censused was circumscribed by a circle with a 60-m radius. Species diversity was calculated using the Shannon-Weaver Index (Shannon and Weaver 1949). Equitability indices were also determined as explained by Sheldon (1969).

Diurnal survey

19. Once each month a diurnal bird survey of the disposal area was conducted from sunrise to 2 hr before sunset. All bird activity on the disposal site was recorded for a 10-minute observation period every hour on the hour. The observer was on high ground off the northwest corner of the site.

Nest searches

20. Once during both July and August, a search was made of the disposal area for bird nests. A "human chain" consisting of five individuals walking at arm's length apart was used to sweep the entire area. The remainder of the island's upland portion was also searched, although not in a systematic fashion. When a nest was located, the following information was recorded: bird species, habitat, nest site, principal plant or supporting structure, height above ground, and whether active or inactive. Nests containing eggs or young were revisited periodically to determine nesting success. Nesting success data were recorded on standard North American Nest-Record Cards made available by the Laboratory of Ornithology, Cornell University, Ithaca, New York.

Breeding bird survey

21. Breeding and transient birds were observed on Nott Island from mid-March through the end of June with three additional trips made in August. Observations were made by canoe and on foot, primarily during the morning hours. During the breeding period, the locations of singing males were plotted on maps of the island; birds singing in the same locale over a minimum of three trips were presumed to indicate the

presence of a breeding pair. This information was in some cases confirmed by observations of breeding or nesting activity and the presence of nests. This is the standard procedure as published in the Audubon Field Notes (1950) and discussed by Hall (1964).

22. For purposes of data analysis and discussion, the island was divided into two tracts as in previous years. Tract A included all upland areas, shoreline, two small wetland areas, and the dredged material disposal area (approximately 23.5 ha total); and Tract B comprised the cattail (*Typha angustifolia*) and common reed (*Phragmites australis*) marsh in the south-central portion of the island (approximately 8.5 ha). See Appendix B′ for nomenclature.

Amphibians and Reptiles

23. No systematic search of the island was made for either amphibians or reptiles. However, several species were noted coincidentally to other activities. See Appendix B′ for nomenclature.

PART III: RESULTS AND DISCUSSION

Vegetation

Experimental plots

24. Natural invasion. The means for percent cover and stem density of invading species within the experimental plots are shown in Tables 2 and 3, respectively. The analysis of variance for both of these measures indicated a significant difference among planted species (see Appendix A′ for this and all subsequent analysis of variance tables). The percent cover of the grasses and clovers were significantly different from each other (Table 4). (In this and all subsequent similar tables, any two means not joined by the same vertical line are significantly different at the 0.05 level.) Stem counts showed a similar pattern dividing the grasses and clovers, although not as distinctly (Table 5). Timothy, tall fescue, and orchard grass were significantly different from white and red clover, but tall fescue, orchard grass, ryegrass, and the unplanted plots were not significantly different from each other.

25. The analysis of variance for percent cover indicated that the main effect of time was significant at the 0.001 level. In contrast, the analysis of variance for stem density indicated no significant effect of time. The analysis of variance for both percent cover and stem density of invading species indicated a significant interaction between species and time (Figures 5 and 6). Percent foliage cover increased significantly in red and white clover, decreased in the plots where no species were planted, and remained relatively constant for the rest of the species. The stem densities in red clover, white clover, and unplanted plots showed a significant increase, while the stem density of ryegrass significantly decreased.

26. The mean number of invading species on all experimental plots is shown in Table 6. The analysis of variance for this measure revealed that there was a significant main effect of species. The Newman-Keuls test indicated a significant difference between the unplanted plots and

clovers, and the grasses (Table 7). The interaction between species and time was also found to be significant and is graphed in Figure 7. The number of species invading the two clovers, ryegrass, and orchard grass decreased from June to July, while the number of invaders of timothy remained slightly constant and of tall fescue increased slightly. A list of species invading the entire dredged material disposal site is shown in Table 8.

27. Stem density. The mean stem densities for all planted species and lime treatments within the experimental plots are shown in Table 9. The analysis of variance for stem density indicated that the main effect of species was significant, as was expected because of the different growth forms of the species planted. The Newman-Keuls test revealed no significant difference among the means for red and white clover and the unplanted plots (Table 10). No significant difference was found between fescue and ryegrass although both were significantly different from all other species. A significant difference between the mean for no lime treatment and the treatment of 4 tons/acre was found (Table 11).

28. One significant interaction was found for stem density between species and time. Figure 8 shows a dramatic increase in density (of more than 400 stems) for ryegrass from June to July, while other species remained relatively constant. There was no significant interaction between lime treatment and time. The analysis of variance also revealed a significant three-way interaction between species, lime treatment, and time (Figure 9). White clover appeared to decrease in density over time (Figure 9f) while ryegrass showed an increase for two lime treatments (Figure 9d). The other species remained relatively constant or showed no obvious changes or trends over the growing season. The reason for the July high for tall fescue at 4 tons/acre (Figure 9a) is unknown.

29. Phenology. The analysis of variance for percent flowering or fruiting stems indicated that there was a significant difference in the percent of flowering stems among the species. The Newman-Keuls test for multiple comparisons showed a significant difference between ryegrass and all other species (Table 12). No significant difference was found

between the percent stem flowering of white and red clover, tall fescue, orchard grass, and the unplanted plots.

30. The analysis of variance for percent flowering stems shows a small but significant interaction between species and lime (Figure 10) and between species and time (Figure 11). Timothy shows an increase of 20 percent from June to July.

31. Plant height. The mean plant heights for all species and lime treatments within the experimental plots are shown in Table 13. The analysis of variance for plant height indicated that there was a significant difference in height among the species. The Newman-Keuls test indicated that there was a significant difference between the clovers and all other species (Table 14), as a consequence of their normal growth forms. A significant difference among lime treatments was also found; the plots in which no lime was added showed the least plant production (Table 15).

32. As expected, significant differences in plant height were found over time (Figure 12). This interaction was expected due to natural differential growth rates. Decreases in plant height over the growing season could be due to a number of biological factors (i.e., grazing) or possibly to various sampling techniques (i.e., those plants sampled for plant height may have had their flowering stalks removed for threshing, therefore decreasing the height of the plant). The analysis of variance also revealed a small but significant interaction of lime treatment and time. This finding has yet to be explained.

33. Percent cover. The means for percent cover for all species and lime treatments within the experimental plots are shown in Table 16. The analysis of variance for percent cover revealed a significant main effect of species; the Newman-Keuls test indicated that there was a significant difference between the two species of clover and all other planted species (Table 17), and between tall fescue/timothy and ryegrass. The unplanted plots were significantly different from all the planted plots. The main effect of lime treatment was also significant, with a difference found between the no lime and the two lowest lime treatments (Table 18).

34. As expected, a significant difference in percent cover between species and time was found (Figure 13). All species increased in percent cover over time (including the plots in which no species were planted) except the clovers, which decreased or remained constant throughout the season. No significant interaction was found for lime treatment versus time.

35. Plant vigor and environmental effects. Within each plot sampled during the study, plant vigor and selected environmental effects were noted. The most noticeable effect was the decrease in plant vigor of planted species over time (Table 19). This decrease may be attributed to one or more of the following: (a) the life cycle of each species (by August, most of these species have completed seed production and are becoming dormant); (b) the lack of rain in August 1977; and (c) the effect of sampling techniques (especially the handling of clover during labeling). The only stable plots throughout the growing season were those plots in which nothing was planted.

36. Evidence of selective grazing by small mammals or geese indicated that tall fescue, ryegrass, and orchard grass were grazed to a greater extent than any other species. The plant height data indicated that these same grasses were shorter than timothy, which was not grazed (Figure 12). New growth was especially evident in ryegrass where grazing occurred, which may account for its dynamic increase through the growing season. Although evidence of wind abrasion was not noted consistently through the summer, those plots located along the edge of the grid collected more sand (accumulations up to 5 cm) than the interior plots.

37. Seed production. The mean weights of seed production for all species and lime treatments within the experimental plots are shown in Table 20. The analysis of variance of seed production revealed a significant main effect of species. However, much of this difference may be due to the time and techniques of sampling. Not all species produce seeds at the same time within a growing season; therefore, many species may have already lost most of their seeds by the sampling time. Neither the main effect of lime treatment nor the interaction between species and lime was significant.

38. Biomass. The means for shoot biomass of all species and lime treatments within the experimental plots are shown in Table 21. The analysis of variance for shoot biomass indicated no significant difference among species or lime treatments. The shoot biomass measure for each plot included all the aboveground plant parts within a 0.25-m^2 quadrat; planted and invading species were not separated. This same procedure was followed for root or belowground biomass. Therefore, the biomass means by species represent all the vegetation within those plots, not just the productivity of the planted species. These facts must be kept in mind when examining any of the biomass data.

39. No significant interaction was found between species and lime treatment in regard to shoot biomass. The lack of significance for this measure is most likely due to a large error term. Factors contributing to this large error term include the location of plots (the planting of species was not randomized) and the presence of invading species commonly found in the legume plots and included in the biomass measure. Another obvious factor is the differing times of maturity of the various planted species. Biomass was collected only once, at the end of August, thus biasing against timothy and tall fescue which had reached the peak of their growing season in July.

40. The means for root biomass of all species and lime treatments are shown in Table 22. The analysis of variance for root biomass revealed a significant main effect of species. The root biomass of tall fescue and orchard grass was significantly greater than the root biomass of the two clovers planted (Table 23). Values for ryegrass and timothy were intermediate, and not significantly different from the extremes. Neither the main effect of lime treatment nor the interaction of species and lime treatment was significantly related to root biomass.

41. The analysis of variance for total plant biomass showed no significant difference among species, lime treatments, or interaction of species and lime treatment. The means for total biomass of each species and each lime treatment are given in Table 24. The analysis

of variance for shoot to root ratio revealed no significant main effect of species or lime treatment. The interaction between these two effects was also nonsignificant.

Remainder of site

42. The dredged material disposal area can be characterized as a mixture of planted and invading species. It was only in isolated areas that tall fescue formed a mat as dense as in the experimental plots. White clover, the other planted species, did poorly as was the case in the experimental plots. All measures of plant performance (except stem height) appear to support these observations. It is interesting to note that although cover in some areas was extremely sparse, stem height in these plots appeared unaffected. As might be expected with the sparse growth of planted species, the stem density of invading species was moderately high, compared to the experimental plots (Table 25). Some invading species such as timothy grew in dense patches, which suggests some contamination of the seeds sown across the disposal area.

Microclimate

43. The data for the microclimate stations appear in Figures 14 through 19. (Figures 15, 16, and 17 are each missing one data point due to uncontrollable circumstances.) The 1977 data were similar to data collected in 1976; the station with the greatest temperature range was located in the beach grass. The stations set in false indigo and panic grass had ranges quite close to that of the beach grass. Maximum temperatures of stations set in false indigo and panic grass were within 2 deg of the beach grass station maximum, and minimum temperatures were at most 8 deg warmer than found for the beach grass station. In 1976, the stations set in beach grass and false indigo were similar in temperature range. However, the temperature range in the panic grass in 1976 was more similar to that in the cattail (i.e., the range was smaller and temperatures were cooler).

44. As in 1976, the most temperature-stable site was in the tree-thicket (Figure 18). This site and the cattail were the two coolest sites with lows averaging around 47°F and highs around 90°F. Unfortunately, the thermometer in the dredged material disposal site was broken midway through the study. One might expect that temperature extremes in this area would resemble those of the station set in beach grass.

Mammals

Species abundance

45. Representatives of three small mammal species were caught: meadow vole, meadow jumping mouse, and short-tailed shrew. The total number of captures and recaptures by species, grids, and trapping session is shown in Table 26. Population sizes were estimated using the Schnabel method (Schnabel 1938) and are shown with density figures by grids and sessions in Table 27.

46. Meadow voles were the most abundant species on all grids except the South during the first trapping session, when meadow jumping mice were more abundant. The density of voles varied from 7.1/ha on the Central grid to 56.3/ha on the North grid. During the second trapping session, meadow voles were again the most abundant species on all grids except on the East, where the number of jumping mice increased dramatically. The densities of meadow voles declined slightly on the North, South, East, and West grids from the first trapping session to the second. In contrast, their density on the Central grid more than doubled between the two trapping periods. The densities of meadow voles found in this study are low compared with the range reported for this species in the literature. Hamilton (1937) reported densities for the northeastern United States of 37.1 to 98.8/ha during "lows" of their 3- to 4-yr cycle and 148.2 to 568.1/ha during "highs." Krebs et al. (1973) reported that their numbers on a grassland habitat in Indiana varied seasonally from 1/ha in January to 150/ha in May.

47. Meadow jumping mice were the second most abundant species on the island. Their numbers reached the highest density on the North grid (34.9/ha) during the first trapping session, and on the East grid (72.7/ha) during the second. The number of mice caught on the North grid declined sharply from 61 in the first session to 1 in the second. The reason for this is unknown. Their high density on the East grid during the August session is also surprising compared with densities reported for this species in the literature. Quimby (1951) reported monthly averages varying from 7.4 to 14.4 mice/ha on one site in Minnesota and a density of 48.3 mice/ha on another site. Densities of 0.5 to 12.4 mice/ha were reported by Blair (1940a) for this species in southern Michigan. Although the small number of recaptures in the present study may have inflated the density estimate on the East grid, the data showed that only 2 of the 14 mice captured in the first session were recaptured in the second. This suggests that the population had in fact increased on that grid. No jumping mice were caught on the Central grid during the first trapping session. In the second session, four mice were caught but with no recaptures.

48. Short-tailed shrews were caught only on the East grid with four individuals captured in the first trapping session and two in the second. Their population density on that grid during the second trapping period was estimated to be only 3.0 shrews/ha. Densities for short-tailed shrews are typically small with Blair (1940b) reporting a maximum density of 5.4 and 2.0 shrews/ha for two successive summers in a field in southern Michigan. Wetzel (1958) reported average densities ranging from 2.5 to 17.3/ha on a strip-mine sere in eastern Illinois.

Comparison of 1977 and 1976 data

49. The trapping results for the first session of 1977 were surprisingly consistent with those obtained in 1976 (see Warren et al. 1978). As in 1976, meadow voles were the most abundant species on all grids except the South, where they were outnumbered by jumping mice. Both species were almost equally abundant on the East grid, as was the case in 1976. In 1977, the highest densities of jumping

mice in the first trapping session were found on the North and South grids, where their densities were similar (34.9 and 32.3 mice/ha, respectively). In 1976, this species obtained its highest density on the South grid with a density of 44.8 mice/ha.

50. As the trapping procedure followed was different for each year (one trapping session and larger grids in 1976), any comparison of the 1977 second session's trapping results with those of 1976 is tenuous at best. The potential impact of two trappings must also be considered. Nonetheless, the dramatic fluctuation in the densities of meadow jumping mice would have gone unnoticed without the two separate trapping sessions. This fluctuation is especially interesting when compared with the relatively small changes in density of meadow voles (except on the Central grid as discussed earlier). The phenomenon noticed in the present study with meadow jumping mice deserves further examination.

Habitat utilization, 1977

51. Tables 28 and 29 provide a summary of captures by habitats for all five grids during the first and second trapping sessions, respectively. Results of chi-square analysis for the first session revealed that meadow voles were not randomly distributed between the two major habitats of shrubland and grassland ($X^2 = 7.27$, df = 1, $p < 0.01$). Significantly fewer meadow voles were captured in the grassland than expected, while more than expected were captured in the shrubland areas. In comparison, jumping mice were randomly distributed in both major habitat types ($X^2 = 3.31$, df = 1, $p < 0.10$). During the second trapping session, both species were randomly distributed in the two habitats ($X^2 = 0.03$, df = 1, $p < 0.90$ for meadow voles; $X^2 = 0.35$, df = 1, $p < 0.75$ for jumping mice). The greater amount of cover in the shrubland habitat during early summer may account for the apparent preference by voles for this habitat. Too few short-tailed shrews were captured for a chi-square analysis.

Observations on other mammals

52. Four mammal species besides those sampled by the trapping are known to be present on the island: the white-tailed deer, muskrat,

raccoon (*Procyon lotor*), and eastern mole (*Scalopus aquaticus*). As in previous years, deer were noticed on the island on several occasions with two being the most seen at any one time (size differences in June suggested that it may have been an adult female and a yearling). Evidence of browsing was apparent throughout the upland portion of the island. A tuft of fur found on the disposal site and tracks along the eastern shore indicated that raccoons visited the island. Muskrat houses were common in the marsh. The eastern mole was never seen but its tunnels were noticed in the loose sand of the unvegetated area south of the disposal site. No evidence was found for the presence of either white-footed mice or Norway rats on the island.

Birds

Transect and station counts

53. Density, diversity, and equitability measures for all transects and observation stations are given by month in Appendix C´. Transects A-D, on the periphery of the disposal area, had a higher average density (45.5 birds/ha) than did Transects E and F within the disposal area (26.9 birds/ha). This was expected because of the greater amount of cover along the peripheral transects.

54. Both density and diversity increased on all transects except D from late May to July. The density of birds recorded on Transect D, east of the disposal area, declined from late June to August because of a decrease in the observed number of yellow warblers and common yellowthroats. These two species had been especially abundant along Transect D during the late May and June surveys. Their subsequent scarcity may have been a consequence of their increased secrecy and reluctance to flush during the peak nesting period of midsummer. The decline in bird density on all transects from July to August was due to the normal dispersal of yearlings as well as early migration.

55. The five most common species observed during walks along the transects and at the observation stations were, in order: yellow warbler (*Dendroicha petechia*), song sparrow (*Melospiza melodia*), common

yellowthroat (Geothlypis trichas), mourning dove (Zenaida macroura), and American goldfinch (Carduelis tristis). The relatively high number of mourning doves was due to their abundance on Transects E and F in the disposal area. Red-winged blackbirds (Agelaius phoeniceus), which were abundant in the breeding bird survey, were not in the top five because of the relative scarcity of their preferred marsh habitats along the transects. The average monthly densities of the most common species along all the transects are shown in the following tabulation:

Species	May	June	July	August	Mean
Yellow warbler	8.3	8.5	4.7	1.0	5.6
Song sparrow	2.9	5.6	9.0	4.5	5.5
Common yellowthroat	9.2	6.2	3.7	1.3	5.1
Mourning dove	0.0	1.7	4.8	9.3	3.9
American goldfinch	1.8	4.5	3.7	1.9	3.0
Gray catbird	1.5	2.8	4.4	2.2	2.7
Red-winged blackbird	0.6	2.5	4.6	2.3	2.5

Breeding bird survey

56. The breeding bird population of Nott Island consisted of 114 nesting pairs belonging to 23 species. The density of breeding birds over the entire island was 356 pairs/km^2. The most abundant nesting species were the red-winged blackbird, song sparrow, long-billed marsh wren (Cistothorus palustris), yellow warbler, common yellowthroat, and gray catbird (Dumetella carolinensis). The territories of all breeding pairs were mapped. A limited number of copies of the map are available upon request.

57. The number of breeding pairs and densities by species for Tracts A and B (upland and marsh) are summarized in Table 30. A total of 80 pairs comprising 19 species bred on Tract A for a density of 340 pairs/km^2. The three most abundant species were the song sparrow (68.1 pairs/km^2) which preferred all upland areas with good cover; the yellow warbler (55.3 pairs/km^2) which was found throughout the upland shrub-thicket areas; and the common yellowthroat (46.8 pairs/km^2) which was most often seen on the marsh and shrub edges. On Tract B there were 34 nesting pairs of six species for a total density of 400 pairs/km^2. Red-winged blackbirds and long-billed marsh wrens

were the two most abundant species with densities of 176.5 and 152.9 pairs/km^2, respectively.

58. A species list of all birds seen on and around Nott Island from mid-March to August 1977 but not recorded as breeding is shown in Appendix D´.

Comparison with previous years

59. The total number of species observed in 1977, including breeding and visiting birds, was 70. The combined species list for all three years is now 85. The following 15 species were seen in previous years but not observed in 1977 (date in parentheses is year last seen):

common loon, Gavia immer (1976)
semipalmated plover, Charadrius semipalmatus (1976)
American woodcock, Philohela minor (1976)
great egret, Casmerodius albus (1975)
American bittern, Botaurus lentiginosus (1975)
American green-winged teal, Anas crecca (1975)
common goldeneye, Bucephala clangula (1975)
laughing gull, Larus atricilla (1975)
rock dove, Columba livia (1975)
yellow-billed cuckoo, Coccyzus americanus (1975)
chimney swift, Chaetura pelagica (1975)
downy woodpecker, Picoides pubescens (1975)
American robin, Turdus migratorius (1975)
northern oriole, Icterus galbula (1975)
northern waterthrush, Seiurus noveboracensis (1976)

The American woodcock bred on the island in 1976.

60. The number of breeding species on Nott Island in 1977 was 23 compared with 18 species in 1976 and 23 species in 1975 (Table 31). The number of breeding pairs, however, has apparently decreased rather steadily over the three census years, from 142 in 1975 to 122 in 1976, and finally to 114 in 1977. The species showing the greatest apparent decline in breeding numbers from 1975 to 1977 was the red-winged blackbird, down to 23 pairs from 31 pairs. However, it is difficult to accurately judge the larger population of red-wings nesting in the marsh.

61. The relative numbers of the island's most common breeding species have remained almost constant over the three census years. The red-winged blackbird, song sparrow, long-billed marsh wren, yellow

warbler, and yellowthroat have, in that order, been the five most common breeding species. However, the total number of breeding pairs of these five species has declined from 90 in 1975 to 76 in 1977. (The 92 pairs recorded for 1976 was high because of the high red-winged blackbird population.) The greatest fluctuation in breeding population among Nott Island's common species was that of the gray catbird, which went from 10 pairs in 1975 to 3 in 1976 and back up to 7 in 1977.

62. Three breeding species were observed on Nott Island in 1977 that were not found in previous censuses: the great horned owl (Bubo virginianus), which fledged three young from a nest north of the disposal area; alder flycatcher (Empidonax alnorum); and purple finch (Carpodacus purpureus). The presence of the purple finch is interesting in that house finches, which have occurred on the island during all three census years, were presumed to have displaced the purple finches on the island. The house finch is a relatively recent introduction into the Northeast.

63. In contrast to the two previous censuses, no evidence was found for the successful breeding of any waterfowl on the island in 1977. A pair of Canada geese (Branta canadensis) nested in common reed at the north end of the marsh in early May, but the eggs were destroyed by a predator or human disturbance. Mallards (Anas platyrhynchos) have nested in the grasslands near the disposal area and in the marsh in past years, but none were observed in 1977.

64. A pair of killdeer (Charadrius vociferus) was observed nesting on the disposal site and apparently are the first birds to do so since deposition of the dredged material in 1975.

Nest searches

65. Eight nests were located on the island during the summer of 1977 (Table 32). The denseness of the vegetation surrounding the disposal area made nest searching difficult and all nests in those habitats were usually located coincidental to other activities (i.e., small mammal trapping). The human chain used to search the disposal area was effective, but only one nest, a killdeer's, was found. The sparseness of ground cover on the disposal area in early June apparently

made it an attractive habitat to killdeer. Similarly, two killdeer nests were found on the unvegetated area south of the disposal site during early July.

Diurnal surveys of the disposal site

66. Total bird usage of the disposal area increased from late May until August. This was due to the large increase in the two most abundant species, song sparrows and mourning doves. Both species are seed-eaters, and their numbers drastically increased once the cultivated fescue had set seed in July. Three savannah sparrows (*Passerculus sandwichensis*) were seen in late May among the invading plants located near the north edge of the disposal area. This species was not sighted on any of the three succeeding surveys. Numerous swallows were observed catching insects over the disposal area. Their peak numbers occurred in both May and July and corresponded to their migratory movements. During June an occasional gray catbird was observed alighting on the taller invading plants along the edges of the disposal area. The reason for their presence could not be determined.

67. Canada geese visited the experimental plots in June at which time they grazed heavily on the orchard grass. The immature timothy was only moderately grazed. Geese were not observed on the area during the July and August surveys.

Amphibians and Reptiles

68. Two amphibian species were seen: a Fowler's toad (*Bufo woodhousei fowleri*) on the disposal site in July and a green frog (*Rana clamitans*) in a low area on the east side of the island during both July and August. Evidence was found of three reptile species. On 3 June, a common snapping turtle (*Chelydra s. serpentina*) nest containing 32 eggs was found in the unvegetated area north of the large marsh. On the same day a snapping turtle was spotted in this area and was probably also laying eggs. A check of the nest in mid-August disclosed that none of the eggs had hatched. A dead, newly hatched snapping turtle was discovered on the Central mammal grid on 18 August.

69. A skin from a northern black racer (Coluber c. constrictor) was found on the East mammal grid during August. This species was also sighted on several occasions on this grid during the summer of 1976 and probably represents a significant predator of small mammals on the island. Two northern water snakes (Natrix s. sipedon) were seen 25 May in beach grass on the north shoreline.

PART IV: CONCLUSIONS

Vegetation

70. In all measurements of plant success, the grasses appeared to be more successful than either the legumes or the unplanted plots. The fact that no Rhizobium was added to the seed and that none appeared to be present in the soil, as indicated by a lack of any observed nodulation, may account for the poor success of legumes.

71. The various measurements of plant success included: above- and belowground biomass, stem density, percent foliage cover, plant height, phenology, mean weight of seed production, and natural invasion. Those plots planted with orchard grass appeared to have the greatest shoot biomass, the greatest root biomass, and, therefore, the greatest total biomass. Although these plots had a biomass greater than any other species, there was never any statistically significant difference between any of the various grasses. The consistently high readings for orchard grass plots may reflect the differing maturation rates between species rather than a consistently greater biomass throughout the growing season. The clovers in some cases were significantly different from the grasses in biomass measurements. However, since the techniques for sampling biomass included any invaders found within the $0.25m^2$ quadrat, and since the clovers had the greatest number of invaders, their biomass measurements were increased by this technique and the differences between the grasses and legumes decreased.

72. Tall fescue consistently had the greatest stem density and the greatest percent foliage cover, although these measurements were not always significantly greater than for the other grass species. Also, as might be expected, all of the grasses planted had significantly greater stem densities and cover than both the legumes and the unplanted plots.

73. Both phenology and the mean weight of seed production indicated that seed production was the greatest for timothy and ryegrass in late July. These results do not necessarily indicate that timothy and

ryegrass had the greatest number of stems flowering and the greatest seed production over the growing season. For example, tall fescue flowered earlier than either of these two species and therefore dispersed many seeds before threshing in July. The inherent differences between species are probably the overriding factor in these measurements.

74. Percent cover and stem density of invading species indicated the greatest invasion occurred within the clover and the unplanted plots and the least within those plots planted to grasses. This also holds true for the number of different taxa invading these plots. The most abundant invader was Panicum dichotomiflorum with timothy and orchard grass as important associate invaders. (The importance of these associated species may be biased by seed impurities and the techniques used for planting.) It is interesting to note that the means for all parameters measuring invasion within the two clover plots were consistently greater than in the unplanted plots.

75. In most of the plant success measurements (i.e., percent cover, stem density, and plant height), differences in lime treatment had a significant effect. In all cases where a main effect for lime was found, the 0 lime treatment had the lowest value. It was also true that the lower and intermediate lime treatments consistently had a significantly greater effect than any of the other lime treatments.

76. From these data, it can be concluded that the grasses have had more success on this site than the other plot types. However, the clovers and the unplanted plots have greater diversity due to the increase in invaders. It can also be concluded that generally, the lowest levels of added lime have the greatest effect upon plant growth.

Wildlife

77. The results of the surveys of both small mammals and birds indicated that some changes have occurred on the island since the disposal operations were initiated in 1975. Small mammal trapping in the summer of 1977 again failed to locate any white-footed mice on the island. The local disappearance of this species appears to be

coincidental with the dredging operation and may have been a direct result of it, or may have been the result of a natural cycling. As relatively little is known on the ecology of this species in regards to its co-existence with other small mammals on islands, it is impossible to determine the reasons for its lack of success after the dredging operation. It can be assumed, however, that a future recolonization of the island will take place considering the island's close proximity to the mainland. The apparent absence of another species, the Norway rat, might be considered fortuitous as their presence was apparently dependent upon human activity on the island. Rats have probably invaded and gone extinct on the island on several occasions since colonial times.

78. No major changes in the population densities of meadow voles, meadow jumping mice, and short-tailed shrews have been noticed in three years of trapping. The disposal activities have had little effect upon all three species. The invasion of the newly vegetated disposal site by both meadow voles and meadow jumping mice indicated that both species will readily colonize these disturbed sites once replanted. It will be interesting to note whether the short-tailed shrew also invades this relatively xeric area.

79. It is difficult to determine whether the disposal operation has had any effect on the one large mammal species on the island, the white-tailed deer. Observations in the summer of 1977 revealed that the species is still present in very low numbers as reported as early as 1975. The continual human activity on the island during the summer months might be expected to have had some effect on this species. It is unknown whether the few deer on this island are in fact truly resident or simply swim back and forth to the mainland periodically. The heavy browsing on such "starvation foods" as the red cedar suggests, however, that a year-round population exists.

80. The number of breeding bird species on the island has remained relatively constant in the three survey years, although the total density of breeding pairs has declined. It is impossible to determine what have been the causes for this decline. The impact of continual human activity during the nesting season deserves some study.

PART V: RECOMMENDATIONS

81. With one complete year of data, it is possible to make some general recommendations concerning the revegetation of the disposal site. It is generally believed that it is best to seed and lime in early spring and then lime again in the fall. Those plants to be seeded should be carefully selected considering both the site conditions and each plant's particular growth form and life cycle. Other factors to be considered may be related best to red clover, one of the planted species. Red clover is an acid tolerant species and should therefore be selected as a possible seeding species (Elliot and Edward 1953). However, red clover is also known to be unusually susceptible to disease, and may burn itself out within two years (Chenrette _et al_. 1960). The uninoculated red clover was planted in a relatively sterile substrate of dredged material. Because no nodulation was found, it appears that there was insufficient _Rhizobium_ within the disposal area for the clovers to grow. Red clover, therefore, should be inoculated immediately before planting, for the greatest plant success.

82. When making general observations of the disposal area, any comparison of the experimental plots and the remainder of the site should be made very cautiously. The comparison is difficult due primarily to differences in site conditions and sizes of experimental areas. Now that more knowledge of the disposal area is available (i.e., acidity, salinity, temperature, moisture conditions, nutrient content, etc.), a better selection of species may be made. As stability is usually related to diversity, one ought to select two or more species whose peak growing periods occur at different times throughout the summer. If _Rhizobium_ could be successfully introduced into the substrate, the ideal combination of plantings would be that of a legume as a nitrogen fixer and an acid tolerant, xerophytic grass. From the data collected on Nott Island during the summer of 1977, one would recommend planting two grasses (a species that develops early in the season such as tall fescue, and one that develops late in

the season such as orchard grass) mixed with a legume (such as red clover or bird's foot trefoil). Bird's foot trefoil is a longer-lasting and more disease-tolerant species than red clover and probably should be tested on the site (Templeton et al. 1967). This combination of plantings would yield a continuously high biomass throughout the season and add species diversity.

83. The wildlife surveys on Nott Island should continue at least for another one to two years. It will be very interesting to see at what rate the three small mammal species colonize the disposal site. There is also a chance (although a very small one) that future trappings may reveal the time necessary for white-footed mice to recolonize the island. Future trappings may also reveal whether there are noticeable population fluctuations occurring in any of the species inhabiting the island. A knowledge of such fluctuations would be essential for a thorough understanding of the population dynamics of the wildlife on the island.

84. The bird species on Nott Island comprise a conspicuous portion of the island's total fauna. Both the breeding bird surveys and the transect counts should be continued in order to determine any successional changes in the avifauna density or diversity on both the disposal area and the island in general. Long-term effects of the disposal activities can be assessed only if the censuses are continued. Special emphasis should be placed on monitoring the use of the island by all waterfowl species, especially the target species, Canada goose. The populations of all upland game birds, such as American woodcock and bobwhite, also should be watched. Strong, reliable data on these species will be helpful in making future decisions about the island in regard to its use for recreational purposes. All future plantings of the disposal site or similar ones should also take into consideration not only the upland game species but also the variety of song birds inhabiting the island. Some idea of the attractiveness or suitability of the various plant species could be obtained from the literature.

LITERATURE CITED

American Ornithologists' Union. 1957. Checklist of North American birds. 5th ed. AOU, Port City Press, Baltimore. 691 pp.

American Ornithologists' Union. 1973. Thirty-second supplement to the American Ornithologists' Union checklist of North American birds. The Auk 90: 411-419.

American Ornithologists' Union. 1976. Thirty-second supplement to the American Ornithologists' Union checklist of North American birds. The Auk 93: 875-879.

Anderson, S. H. 1972. Seasonal variations in forest birds of western Oregon. Northwest Sci. 46(3): 194-206.

Audubon Field Notes. 1950. Instructions for making bird population studies: Breeding bird census. Aud. Field Notes 4: 185-187.

Batzli, G. O. 1974. Influence of habitat structure on a population of voles. Bull. S. Calif. Acad. Sci. 73: 83-85.

Blair, W. F. 1940a. Home ranges and populations of the jumping mouse. Amer. Midl. Nat. 23: 244-250.

Blair, W. F. 1940b. Notes on home ranges and populations of the short-tailed shrew. Ecology 21: 284-288.

Chenrette, S. E., L. P. Folicins, F. M. Gunther, and J. R. Greenshields. 1960. Evaluation of bird's foot trefoil I. Compatibility of bird's foot trefoil with other legumes and grasses. Can. J. Plant. Sci. 40: 259-267.

Conant, R. 1975. A field guide to reptiles and amphibians of eastern and central North America. 2nd ed. Houghton Mifflin Co., Boston. 429 pp.

Elliot and Edward. 1952. Diseases, insects, and other factors in relation to red clover failures in West Virginia. W. Vir. Agr. Exp. Sta. Bull. 3517.

Hall, G. A. 1964. Breeding bird censuses -- why and how. Aud. Field Notes 18: 413-416.

Hamilton, W. J. 1937. The biology of microtine cycles. J. Agric. Res. 54: 779-790.

Hayne, D. W. 1949. An examination of the strip census method for estimating animal population. J. Wildl. Manage. 13: 145-147.

Jones, J. K., Jr., D. C. Carter, and H. H. Genoways. 1975. Revised checklist of North American mammals north of Mexico. Occas. Pap. No. 28, The Museum, Texas Tech. Univ. 14 pp.

Krebs, C. J., M. S. Gaines, B. L. Keller, J. H. Meyers, and R. H. Tamarin. 1973. Population cycles in small rodents. Science 179: 35-41.

Phillips, E. A. 1959. Methods of vegetation study. Holt, Rinehart, and Winston, Inc., NY. 107 pp.

Quimby, D. C. 1951. The life history and ecology of the jumping mouse, Zapus hudsonius. Ecol. Monogr. 21: 61-65.

Schnabel, Z. E. 1938. The estimation of the total fish population of a lake. Amer. Math. Monthly. 43: 348-352.

Shannon, C. E. and W. Weaver. 1949. The mathematical theory of communication. Univ. Illinois Press. 125 pp.

Sheldon, A. L. 1969. Equitability indices: dependence on the species count. Ecol. 50: 466-467.

Steel, R. G. D. and J. H. Torrie. 1960. Principles and procedures of statistics. McGraw-Hill, NY. 481 pp.

Templeton, W. C., C. F. Buck, and D. W. Wattenburger. 1967. An evaluation of bird's foot trefoil in pasture improvement. Agron. J. 59: 385-386.

Warren, R. S. and W. A. Niering. 1978. Habitat development field investigations, Nott Island upland habitat development site, Connecticut River, Connecticut, Appendix A: preliminary terrestrial ecological survey. TR D-78-25, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Warren, R. S., W. A. Niering, W. J. Barry, and A. C. Carroll. 1978. Habitat development field investigations, Nott Island upland habitat development site, Connecticut River, Connecticut, Appendix B: survey of terrestrial ecology and preliminary botanical monitoring. TR D-78-25, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Wetzel, R. M. 1958. Mammalian succession on midwestern floodplains. Ecology 39: 262-271.

Table 1

Plant Seeding and Lime Application Specifications for Experimental Plots

Species	Seeding Rate (lbs/ac)	Actual Application per Plot (lbs)	Percentage Germination*	
			Minimum	Maximum
No species	NA	NA	NA	NA
White clover	2.5	.05	85	90
Red clover	5.0	.10	88	90
Flatpea**				
Perennial ryegrass	14.0	.28	85	90
Timothy	8.0	.16	84	88
Orchard grass	8.0	.16	80	88
Tall fescue	14.0	.28	84	88

Lime Designation	Liming Levels	Tons/acre	Actual Application per Plot (lbs)
0	No lime	0	0
1	Low level	4	5.2
2	Intermediate level	6	7.5
3	High level	8	10.4

* Germination rates are company standards, determined by actual germination under laboratory conditions.

** Flatpea seeds were not available.

Table 2

Mean Percent Cover of Invading Species in the Experimental Plots

Planted Species	Lime Treatment 0 tons/acre	4 tons/acre	6 tons/acre	8 tons/acre
No species	24.5	26.4	30.6	33.0
White clover	22.9	30.2	37.7	45.6
Red clover	21.3	22.2	38.4	52.2
Tall fescue	4.7	1.0	0.3	1.6
Ryegrass	15.2	4.3	18.6	13.9
Timothy	0.4	0.1	0.4	0.0
Orchard grass	3.0	7.1	0.9	6.7

Table 3

Mean Stem Density of Invading Species in the Experimental Plots (stems/0.25 m^2)

Planted Species	Lime Treatment 0 tons/acre	4 tons/acre	6 tons/acre	8 tons/acre
No species	28.3 ± 7.7	42.4 ± 11.8	45.0 ± 8.1	33.0 ± 9.2
White clover	37.0 ± 10.3	56.7 ± 11.2	54.2 ± 10.2	70.1 ± 17.9
Red clover	47.2 ± 6.7	50.4 ± 9.7	72.4 ± 18.1	83.6 ± 15.2
Tall fescue	22.2 ± 5.8	6.4 ± 2.6	5.6 ± 2.6	12.3 ± 7.8
Ryegrass	87.9 ± 26.4	32.4 ± 12.6	34.7 ± 17.1	33.7 ± 17.2
Timothy	2.6 ± 2.0	0.4 ± 0.3	0.4 ± 0.3	0.4 ± 0.3
Orchard grass	15.2 ± 7.2	25.1 ± 7.0	2.0 ± 1.2	30.4 ± 8.3

Table 4

Multiple Comparisons of Mean Percent Cover of Invading Species in the Experimental Plots

Planted Species	Mean Percent Cover
White clover	34.09
Red clover	33.54
No species	28.68
Ryegrass	13.00
Orchard grass	4.41
Tall fescue	1.90
Timothy	0.24

Table 5

Multiple Comparisons of Mean Stem Density of Invading Species in the Experimental Plots (stems/0.25 m^2)

Planted Species	Mean ± Standard Error
Red clover	63.42 ± 6.82
White clover	54.50 ± 6.44
Ryegrass	47.19 ± 9.76
No species	37.19 ± 4.63
Orchard grass	18.19 ± 3.61
Tall fescue	11.64 ± 3.73
Timothy	0.97 ± 0.51

Table 6

Mean Number of Invading Species in the Experimental Plots

Planted Species	Lime Treatment			
	0 tons/acre	4 tons/acre	6 tons/acre	8 tons/acre
No species	2.0 ± 0.3	2.9 ± 0.6	3.3 ± 0.2	3.0 ± 0.6
White clover	2.8 ± 0.7	4.4 ± 0.4	3.7 ± 0.8	2.7 ± 0.6
Red clover	1.7 ± 0.2	3.6 ± 0.4	4.1 ± 0.4	3.3 ± 0.4
Tall fescue	2.3 ± 0.3	0.9 ± 0.2	0.4 ± 0.2	0.8 ± 0.3
Ryegrass	2.0 ± 0.5	1.5 ± 0.3	1.4 ± 0.4	1.3 ± 0.3
Timothy	0.3 ± 0.2	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1
Orchard grass	1.7 ± 0.4	1.0 ± 0.3	0.6 ± 0.2	2.1 ± 0.3

Table 7

Multiple Comparisons of Mean Number of Invading Species in the Experimental Plots (species/0.25 m^2)

Planted Species	Mean Number Invading Species ± Standard Error
White clover	3.39 ± 0.32
Red clover	3,17 ± 0.23
No species	2.81 ± 0.24
Ryegrass	1.58 ± 0.19
Orchard grass	1.33 ± 0.18
Tall fescue	1.11 ± 0.17
Timothy	0.25 ± 0.07

Table 8

Invading Species for Entire Dredged Material Disposal Site, With Stem Densities in August 1978

Species	Density (number/m^2)*
Panicum dichotomiflorum	115.4
Phleum pratense (timothy)	26.7
Dactylis glomerata (orchard grass)	17.2
Triplasis purpurpea (sand-grass)	8.4
Festuca sp. (fescue)	4.3
Echinochloa Walteri	2.7
Solidago rugosa (goldenrod)	1.2
Polygonum punctatum (water smartweed)	0.8
Phragmites australis (common reed)	0.7
Chenopodium sp. (pigweed)	0.6
Carex sp.	0.3
Elymus sp. (rye)	0.3
Bromus sp. (brome grass)	0.2
Plantago sp. (plantain)	0.2
Ailanthus altissima (tree-of-heaven)	0.1
Phytolacca americana (pokeweed)	0.1
Achillea Millefolium (common yarrow)	*
Agropyron repens (quack grass)	*
Agrostis alba (red top)	*
Agrostis scabra (hairgrass)	*
Ammophila breviligulata (beachgrass)	*
Amorpha fruticosa (false indigo, indigo bush)	*
Anthemis arvensis (dogfennel, chamomile)	*
Asparagus officinalis (asparagus)	*
Celastrus orbiculatus (oriental bittersweet)	*
Cirsium sp. (thistle)	*
Convolvulus sepium (morning glory)	*

*Asterisk indicates less than 0.1 individual/m^2.

(Continued)

Table 8 (Continued)

Species	Density (number/m^2)
Cyperus sp.	*
Cyperus dentatus (umbrella-sedge)	*
Digitaria sanguinalis (crab grass)	*
Echinochloa pungens	*
Eragrostis megastachya (stink-grass)	*
Eragrostis pilosa (love-grass)	*
Erigeron canadensis (daisy fleabane)	*
Galium sp. (bedstraw)	*
Juniperus sp. (cedar)	*
Krigia virginica (dwarf dandelion)	*
Lepedium virginicum (poor man's pepper)	*
Linaria canadensis (old-field toadflax)	*
Linaria vulgaris (butter-and-eggs)	*
Lolium perenne (English rye grass)	*
Lonicera sp.	*
Mentha sp. (mint)	*
Mollugo verticillata (carpetweed)	*
Oenothera sp. (primrose)	*
Oxalis sp. (wood sorrel)	*
Panicum capillare (old witch grass)	*
Panicum clandestinum	*
Panicum virgatum (switch grass)	*
Polygonum cespitosum	*
Polygonum scandens (climbing false buckwheat)	*
Potentilla norvegica (rough cinquefoil)	*
Prunus sp. (wild cherry)	*
Rhus sp. (sumac)	*
Rorippa islandica (yellow cress)	*
Rosa sp. (rose)	*
Rumex Acetosella (sheep sorrel)	*
Rumex crispus (sour dock)	*
Sambucus canadensis (common elder)	*

(Continued)

Table 8 (Concluded)

Species	Density (number/m^2)
Silene nutans (campion)	*
Solanum sp. (nightshade)	*
Spartina pectinata (freshwater cord-grass)	*
Stellaria media (common chickweed)	*
Strophostyles helvola (wild bean)	*
Taraxacum sp. (dandelion)	*
Teucrium canadense (wood stage)	*
Trifolium arvense (rabbit-foot clover)	*
Trifolium pratense (red clover)	*
Trifolium repens (white clover)	*
Verbascum Thapsus (common mullein)	*
Verbena hastata (blue vervain)	*

Table 9

Mean Stem Density of Planted Species in the Experimental Plots (stems/0.25 m^2)

Planted Species	Lime Treatment			
	0 tons/acre	4 tons/acre	6 tons/acre	8 tons/acre
No species	28.3 ± 7.9	42.4 ± 11.8	45.0 ± 8.1	33.0 ± 9.2
White clover	30.7 ± 13.8	177.4 ± 47.1	34.0 ± 13.8	96.9 ± 49.6
Red clover	0.9 ± 0.5	49.7 ± 29.2	49.7 ± 29.2	32.8 ± 19.5
Tall fescue	505.1 ± 54.1	911.1 ± 119.0	724.2 ± 107.9	651.3 ± 56.1
Ryegrass	610.7 ± 90.4	589.0 ± 80.5	510.7 ± 116.3	483.3 ± 121.4
Timothy	253.1 ± 38.3	524.7 ± 57.4	542.9 ± 45.9	532.2 ± 51.3
Orchard grass	296.0 ± 30.5	405.8 ± 78.3	424.8 ± 37.0	281.8 ± 19.2

Table 10

Multiple Comparisons of Mean Stem Density of Planted Species in the Experimental Plots (stems/0.25 m^2)

Planted Species	Mean ± Standard Error
Tall fescue	697.94 ± 49.33
Ryegrass	548.42 ± 50.32
Timothy	463.22 ± 31.06
Orchard grass	352.08 ± 24.89
White clover	84.75 ± 19.76
No species	37.19 ± 4.63
Red clover	34.75 ± 11.44

Table 11

Multiple Comparisons of Mean Stem Density of Planted Species in the Experimental Plots by Lime Treatment (stems/0.25 m^2)

Lime Treatment	Mean ± Standard Error
4 tons/acre	385.73 ± 44.97
6 tons/acre	333.03 ± 40.95
8 tons/acre	302.48 ± 36.63
0 tons/acre	246.40 ± 32.79

Table 12

Multiple Comparisons of Mean Percent of Stems of Planted Species in the Experimental Plots Flowering or Fruiting

Planted Species	Mean ± Standard Error
Ryegrass	42.65 ± 5.19
Timothy	19.27 ± 3.37
White clover	11.96 ± 4.59
Tall fescue	4.35 ± 1.27
Orchard grass	3.70 ± 1.47
No species	2.92 ± 1.77
Red clover	0.00 ± 0.00

Table 13

Mean Plant Height of Planted Species
in the Experimental Plots (height, cm)

Planted Species	Lime Treatment			
	0 tons/acre	4 tons/acre	6 tons/acre	8 tons/acre
No species	25.5 ± 3.2	34.2 ± 5.1	33.2 ± 3.3	31.9 ± 3.7
White clover	3.7 ± 1.2	5.1 ± 0.8	5.2 ± 1.9	6.0 ± 1.3
Red clover	0.7 ± 0.6	4.5 ± 1.0	6.9 ± 1.5	4.9 ± 1.6
Tall fescue	25.7 ± 1.7	40.3 ± 1.9	36.4 ± 3.1	41.0 ± 3.5
Ryegrass	39.0 ± 4.9	38.7 ± 4.4	36.9 ± 6.2	37.3 ± 6.4
Timothy	41.6 ± 6.8	59.8 ± 4.9	43.3 ± 2.8	44.7 ± 3.8
Orchard grass	34.8 ± 2.9	41.9 ± 3.4	51.1 ± 2.2	40.6 ± 3.1

Table 14

Multiple Comparisons of Mean Plant Heights of Planted Species
in the Experimental Plots (height, cm)

Planted Species	Mean ± Standard Error (cm)
Timothy	47.36 ± 2.61
Orchard grass	42.10 ± 1.71
Ryegrass	37.95 ± 2.66
Tall fescue	35.87 ± 1.64
No species	31.20 ± 1.95
White clover	5.03 ± 0.66
Red clover	4.28 ± 0.71

Table 15

Multiple Comparisons of Mean Plant Heights of Planted Species in the Experimental Plots by Lime Treatment (height, cm)

Lime Treatment	Mean ± Standard Error
4 tons/acre	32.06 ± 2.70
6 tons/acre	30.45 ± 2.40
8 tons/acre	29.49 ± 2.39
0 tons/acre	24.45 ± 2.32

Table 16

Mean Percent Cover of Planted Species in the Experimental Plots

Planted Species	Lime Treatment			
	0 tons/acre	4 tons/acre	6 tons/acre	8 tons/acre
No species	24.7	26.4	30.6	33.0
White clover	6.2	18.5	10.3	14.0
Red clover	0.1	4.5	9.0	4.3
Tall fescue	65.2	93.3	85.6	81.5
Ryegrass	57.5	59.9	64.5	63.1
Timothy	55.0	84.3	78.6	84.7
Orchard grass	69.1	70.1	82.9	62.5

Table 17

Multiple Comparisons of Mean Percent Cover of Planted Species in the Experimental Plots

Planted Species	Mean ± Standard Error
Tall fescue	80.91
Timothy	75.66
Orchard grass	71.16
Ryegrass	61.23
No species	28.68
White clover	12.25
Red clover	4.50

Table 18

Multiple Comparisons of Mean Percent Cover of Planted Species in the Experimental Plots by Lime Treatment

Lime Treatment	Mean ± Standard Error
6 tons/acre	51.64
4 tons/acre	51.01
8 tons/acre	49.01
0 tons/acre	39.42

Table 19

Plant Vigor and Environmental Effects on the Experimental Plots

Lime Treatment (tons/acre)	Replicate 1 Effect*	Replicate 1 Intensity** June	July	Aug.	Replicate 2 Effect	Replicate 2 Intensity June	July	Aug.	Replicate 3 Effect	Replicate 3 Intensity June	July	Aug.
No Species												
0	U	4.0	4.0	4.0	--	3.0	4.0	4.0	--	4.0	2.5	3.5
4	C	4.0	3.5	3.0	D	4.0	4.0	4.0	--	3.0	4.0	4.0
6	--	4.0	4.0	3.5	C	3.5	4.0	4.0	--	4.0	4.0	4.0
8	C	3.0	3.5	3.0	U	3.0	4.0	4.0	D	4.0	4.0	4.0
White Clover												
0	D	4.0	3.0	1.0	--	1.0	1.0	1.0	--	4.0	3.0	1.0
4	A	4.0	2.0	1.5	--	3.5	3.0	1.5	--	4.0	3.5	1.5
6	--	4.0	3.0	2.5	--	3.5	3.0	1.0	--	4.0	2.5	1.0
8	--	4.0	3.0	3.0	--	4.0	2.5	3.0	--	4.0	3.0	1.0
Red Clover												
0	--	1.0	1.0	1.0	--	1.0	1.0	1.0	--	1.0	1.0	1.0
4	CU	3.5	1.5	1.5	A	4.0	3.0	1.5	--	3.0	1.0	1.0
6	A	4.0	4.0	1.0	--	4.0	2.0	1.0	A	2.0	4.0	1.0
8	AD	4.0	4.0	1.5	G	4.0	3.0	1.0	AC	2.0	4.0	1.0
Ryegrass												
0	GW	4.0	2.0	2.0	CDGU	4.0	2.5	3.0	CDG	4.0	2.5	1.5
4	G	4.0	4.0	3.5	CG	4.0	3.5	1.5	CG	4.0	3.0	1.5
6	GU	4.5	4.0	2.5	CG	4.0	2.5	2.5	G	4.0	3.0	3.0
8	CGU	4.0	2.5	1.5	CG	4.0	2.5	1.5	GU	4.0	3.0	1.5
Timothy												
0	C	3.5	3.0	1.0	--	4.0	1.5	2.0	C	4.0	2.5	1.0
4	CDU	4.0	1.5	3.0	CU	4.5	2.5	2.5	DU	4.0	2.0	2.5
6	CU	4.0	2.5	1.5	--	4.5	2.0	1.0	GDGU	4.0	2.5	1.0
8	--	4.0	1.5	1.5	CDGU	4.0	3.0	2.5	G	4.0	2.5	2.5

* 1 = dead
2 = dying
3 = stressed
4 = stable
5 = new growth

** A = anthropic influences
C = chlorotic
D = droughty
G = grazed
U = used
W = wind

(Continued)

Table 19 (Concluded)

Lime Treatment (tons/acre)	Replicate 1 Effect	Replicate 1 Intensity June	July	Aug.	Replicate 2 Effect	Replicate 2 Intensity June	July	Aug.	Replicate 3 Effect	Replicate 3 Intensity June	July	Aug.
Orchard Grass												
0	--	4.0	4.0	3.5	--	4.0	3.0	2.5	--	4.0	4.0	4.0
4	CG	2.5	4.0	3.5	CDG	4.0	4.0	3.0	CDGU	4.0	3.0	2.0
6	CGU	4.0	2.5	3.5	GU	4.0	3.0	3.0	G	4.0	2.5	2.5
8	--	3.5	4.0	4.0	GU	4.0	4.0	3.5	GU	4.0	4.0	3.5
Tall Fescue												
0	DUW	4.0	3.0	2.0	G	4.0	2.0	2.5	G	4.0	1.5	2.5
4	CG	4.0	2.0	2.5	CGU	4.0	3.0	2.5	AG	4.0	3.5	2.5
6	CDG	4.0	1.5	2.5	CDG	4.0	3.0	2.5	CDG	4.0	2.5	2.5
8	GU	4.0	1.5	2.5	CDGU	4.0	3.0	2.5	GU	4.0	1.5	2.0

Table 20

Mean Weight of Seed of Planted Species Produced in the Experimental Plots (g/plot)

Planted Species	Lime Treatment			
	0 tons/acre	4 tons/acre	6 tons/acre	8 tons/acre
No species	---	---	---	---
White clover	1.5 ± 1.5	3.7 ± 1.4	4.7 ± 2.6	0.9 ± 0.9
Red clover	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Tall fescue	1.2 ± 0.5	10.7 ± 3.3	6.8 ± 2.3	16.6 ± 4.1
Ryegrass	34.6 ± 17.5	47.8 ± 15.9	27.6 ± 15.1	40.5 ± 22.6
Timothy	20.0 ± 12.0	44.2 ± 6.5	26.6 ± 4.2	43.8 ± 2.3
Orchard grass	1.5 ± 0.6	2.4 ± 1.6	2.7 ± 0.6	4.8 ± 1.39

Table 21

Mean Shoot Biomass of Planted and Invading Species in the Experimental Plots ($g/0.25m^2$)

Planted Species	Lime Treatment			
	0 tons/acre	4 tons/acre	6 tons/acre	8 tons/acre
No species	3.6 ± 1.0	145.2 ± 114.1	25.3 ± 1.1	22.4 ± 12.8
White clover	13.0 ± 8.4	25.7 ± 16.3	100.2 ± 56.7	60.7 ± 32.9
Red clover	30.1 ± 15.2	13.4 ± 7.4	92.9 ± 28.4	44.4 ± 10.2
Tall fescue	52.7 ± 10.9	78.9 ± 7.2	58.5 ± 9.8	64.5 ± 10.7
Ryegrass	55.3 ± 5.3	36.0 ± 5.6	60.4 ± 1.4	66.9 ± 5.8
Timothy	37.4 ± 15.8	54.5 ± 12.0	47.0 ± 1.6	72.0 ± 10.2
Orchard grass	60.8 ± 5.0	98.5 ± 25.8	87.5 ± 10.3	71.7 ± 15.2

Table 22

Mean Root Biomass of Planted and Invading Species in the Experimental Plots ($g/0.25m^2$)

Planted Species	Lime Treatment			
	0 tons/acre	4 tons/acre	6 tons/acre	8 tons/acre
No species	0.6 ± 0.3	28.2 ± 24.5	6.4 ± 1.8	10.2 ± 4.0
White clover	3.4 ± 1.8	8.4 ± 4.5	11.2 ± 5.6	13.4 ± 6.2
Red clover	7.2 ± 3.3	4.5 ± 3.2	15.2 ± 11.8	9.2 ± 1.1
Tall fescue	18.7 ± 2.9	29.6 ± 1.7	26.1 ± 3.7	29.5 ± 3.6
Ryegrass	11.7 ± 4.1	16.1 ± 9.6	18.9 ± 12.8	24.3 ± 13.2
Timothy	11.8 ± 2.4	14.6 ± 3.3	17.0 ± 1.7	27.1 ± 3.5
Orchard grass	23.7 ± 6.0	28.6 ± 14.6	31.4 ± 6.0	30.5 ± 6.0

Table 23

Multiple Comparisons of Mean Root Biomass of Planted and Invading Species in the Experimental Plots ($g/0.25m^2$)

Planted Species	Mean ± Standard Error
Orchard grass	28.55 ± 3.92
Tall fescue	25.98 ± 1.87
Ryegrass	17.73 ± 2.94
Timothy	17.64 ± 2.29
No species	10.96 ± 6.18
White clover	9.10 ± 2.35
Red clover	9.01 ± 2.97

Table 24

Mean Total Biomass of Planted and Invading Species in the Experimental Plots (g/0.25m^2)

Planted Species	Lime Treatment			
	0 tons/acre	4 tons/acre	6 tons/acre	8 tons/acre
No species	4.2 ± 1.0	173.4 ± 138.6	31.8 ± 2.7	31.0 ± 17.5
White clover	16.4 ± 10.3	34.1 ± 20.7	111.5 ± 60.6	74.1 ± 39.1
Red clover	37.3 ± 17.5	18.5 ± 10.1	108.2 ± 90.2	53.6 ± 10.9
Tall fescue	71.4 ± 10.9	101.8 ± 4.0	84.6 ± 13.2	94.1 ± 14.3
Ryegrass	67.0 ± 7.4	52.1 ± 10.3	79.3 ± 8.5	91.1 ± 11.4
Timothy	49.2 ± 20.6	69.1 ± 15.2	66.0 ± 0.1	99.0 ± 11.9
Orchard grass	84.5 ± 4.9	127.1 ± 40.4	119.0 ± 4.4	104.8 ± 19.8

Table 25

Plant Performance in $0.25m^2$ Quadrats

Dredged Material Disposal Area

Parameter	June	July	August	Means
Percent cover of natural invaders	13.68%	20.37%	17.45%	18.10%
Density of natural invaders	66.47 ± 28.81	48.69 ± 13.94	43.79 ± 11.65	52.98 ± 8.13
Number of species of natural invaders	2.32 ± 0.37	2.26 ± 0.41	1.05 ± 0.25	2.19 ± 0.17
Stem density, Fescue and clover	294.0 ± 50.49	393.0 ± 58.84	370.58 ± 63.10	352.91 ± 33.23
Stem height (cm)				
Fescue	30.89 ± 4.30	26.27 ± 2.46	22.85 ± 2.00	26.67 ± 1.56
Clover	3.60 ± 0.83	3.08 ± 0.87	0.41 ± 0.23	2.36 ± 0.38
Percent cover, Fescue and clover	39.14%	49.13%	53.13%	46.15%
Biomass/$0.25m^2$				
Shoot	---*	---	---	39.95g ± 6.02
Root	---	---	---	8.76g ± 1.25
Total	---	---	---	48.71g ± 7.02
Shoot/root ratio	---	---	---	5.25g ± 0.58

* Indicates no data collected

Table 26

Summary of Small Mammal Captures on Each of Five Grids During Two Trapping Sessions

Grid Date	Meadow Vole Number Individuals	Meadow Vole Number Recaptures	Meadow Vole Total	Meadow Jumping Mouse Number Individuals	Meadow Jumping Mouse Number Recaptures	Meadow Jumping Mouse Total	Short-tailed Shrew Number Individuals	Short-tailed Shrew Number Recaptures	Short-tailed Shrew Total	Combined Total Caught
North										
June 9-15	58	45	103	30	31	61	0	0	0	164
August 3-9	50	72	122	1	0	1	0	0	0	123
South										
June 9-15	14	11	25	8	1	9	0	0	0	34
August 3-9	5	3	8	8	0	8	0	0	0	16
East										
July 7-13	30	64	94	14	6	20	4	0	4	118
August 13-19	19	43	62	13	1	14	2	1	3	79
West										
July 7-13	47	89	136	4	0	4	0	0	0	140
August 13-19	39	77	116	3	0	3	0	0	0	119
Central										
July 7-13	10	13	23	0	0	0	0	0	0	23
August 13-19	15	12	27	4	0	4	0	0	0	31
Totals (all grids)										
1st Session			381			94			4	479
2nd Session			335			30			3	368

Table 27

Population Densities of Small Mammal Captures on Each of Five Grids During Two Trapping Sessions

Grid and Dates	Meadow Vole Density (No./ha)	Meadow Jumping Mouse Density (No./ha)	Short-tailed Shrew Density (No./ha)
North			
9-15 June	56.3	34.9	--*
3-9 August	45.2	--	--
South			
9-15 June	14.9	32.3	--
3-9 August	7.4	--	--
East			
7-13 July	24.0	21.0	--
13-19 August	19.4	72.7	3.0
West			
7-13 July	41.9	--	--
13-19 August	21.4	--	--
Central			
7-13 July	7.1	--	--
13-19 August	17.8	--	--

* Insufficient data for density estimate.

Table 28

Summary of Small Mammal Captures By Habitat on All Five Grids During the First Trapping Session

		No. of Captures*			
		Meadow Vole		Meadow Jumping Mouse	
Habitat	No. Trap Nights	No. Captures	Catch/ Trap Night	No. Captures	Catch/ Trap Night
Shrubland					
False indigo	784	158	.20	20	.02
Bayberry	126	27	.21	6	.05
Mixed shrub	308	66	.21	21	.07
Tree thicket	98	4	.04	19	.20
Subtotal	1316 (43)**	255(67)	.19	66(70)	.05
Grassland					
Beach grass	266	48	.18	4	.02
Panic grass	252	15	.06	12	.05
Grass-shrub	28	6	.21	0	.00
Common reed	112	23	.21	5	.04
Subtotal	658(21)	92(24)	.14	21(22)	.03
Other					
Unvegetated	392	0	.00	0	.00
Disposal site	616	23	.04	0	.00
Disturbed vegetation	98	11	.11	7	.07
Subtotal	1106(36)	34(9)	.03	7(7)	.01
Total	3080	381	.12	94	.03

*Four short-tailed shrews were trapped in the false indigo.

**Numbers in parentheses are percentages of traps and captures per habitat.

Table 29

Summary of Small Mammal Captures By

Habitat on All Five Grids During the Second Trapping Session

		No. of Captures*			
		Meadow Vole		Meadow Jumping Mouse	
Habitat	No. Trap Nights	No. Cap- tures	Catch/ Trap Night	No. Cap- tures	Catch/ Trap Night
Shrubland					
False indigo	784	108	.14	10	.01
Bayberry	126	18	.14	3	.02
Mixed shrub	308	71	.23	1	.00
Tree thicket	98	3	.03	0	.00
Subtotal	1316(43)**	200(60)	.15	14(47)	.01
Grassland					
Beach grass	266	48	.18	1	.00
Panic grass	252	26	.10	5	.0[illegible]
Grass-shrub	28	7	.25	1	.04
Common reed	112	17	.15	2	.02
Subtotal	658(21)	98(29)	.15	9(30)	.01
Other					
Unvegetated	392	0	.00	2	.01
Disposal site	616	27	.04	4	.01
Disturbed vegetation	98	10	.10	1	.01
Subtotal	1106(36)	37(11)	.03	7(23)	.01
Total	3080	335	.11	30	.01

* Three short-tailed shrews were trapped in the false indigo.

** Numbers in parentheses are percentages of traps and captures per habitat.

Table 30

Number and Densities of Breeding Bird Pairs on the Upland (Tract A) and Marsh (Tract B) Habitats in 1977

Species	Tract A (23.5ha)		Tract B (8.5ha)	
	No. Pairs	No./km^2	No. Pairs	No./km^2
Canada goose	--	--	1	11.8
Bobwhite	2	8.5	--	--
Virginia rail	--	--	1	11.8
Killdeer	3	12.8	--	--
Spotted sandpiper	1	4.3	--	--
Mourning dove	3	12.8	--	--
Great horned owl	1	4.3	--	--
Common flicker	1	4.3	--	--
Willow flycatcher	3	12.8	1	11.8
Alder flycatcher	1	4.3	--	--
Black-capped chickadee	1	4.3	--	--
Long-billed marsh wren	--	--	13	152.9
Gray catbird	7	29.8	--	--
Starling	3	12.8	--	--
Yellow warbler	13	55.3	--	--
Yellowthroat	11	46.8	--	--
Red-winged blackbird	8	34.0	15	176.5
Cardinal	1	4.3	--	--
Purple finch	1	4.3	--	--
House finch	2	8.5	--	--
Goldfinch	2	8.5	--	--
Swamp sparrow	--	--	3	35.3
Song sparrow	16	68.1	--	--
Totals	80	340.8	34	400.1

Table 31

Summary of Three Years of Breeding Bird Censuses on Nott Island from 1975 to 1977*

Year	Tract	No. Species	No. Pairs	No./km^2
1975	A	17	90	383
	B	8	55	647
	A&B	23	142	455
1976	A	16	78	331
	B	4	44	518
	A&B	18	122	391
1977	A	19	80	340
	B	6	34	400
	A&B	23	114	356

*Data for 1975 and 1976 from Warren and Niering (1978) and Warren et al. 1978, respectively.

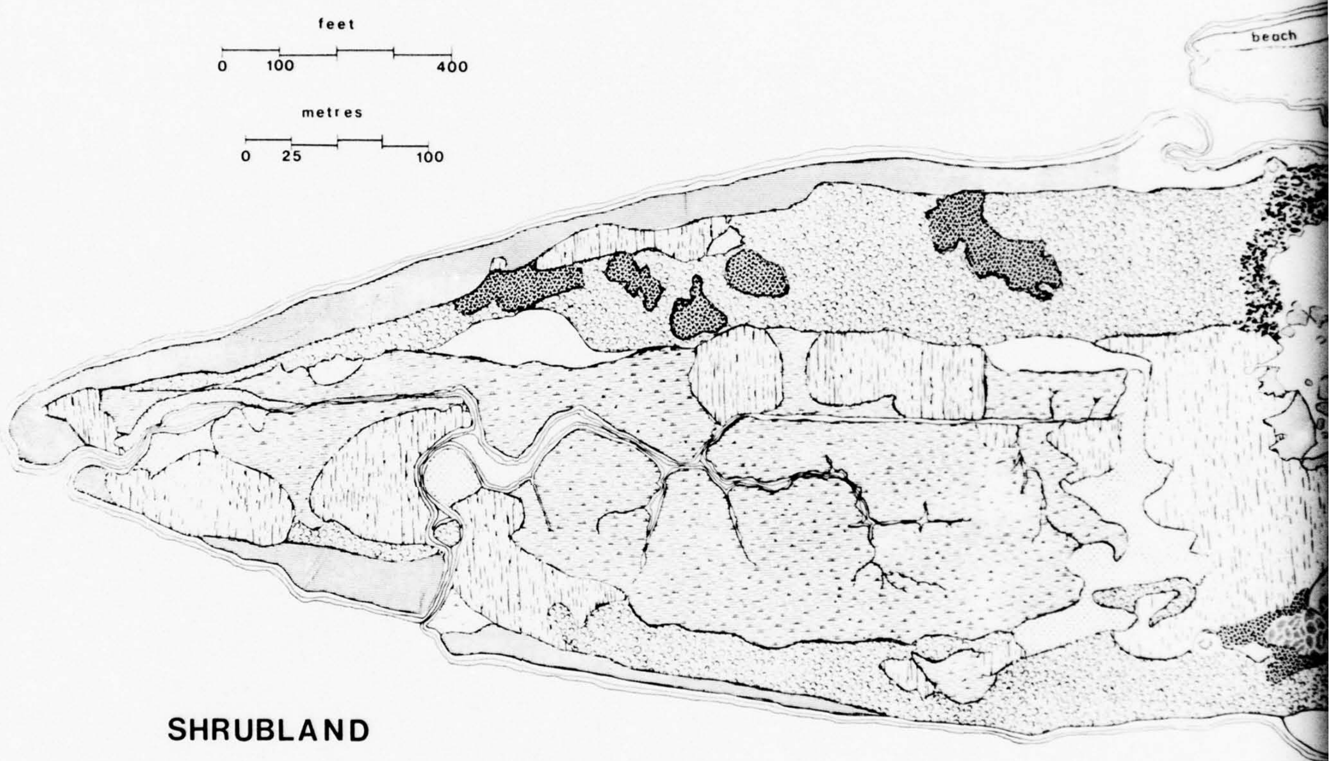
Table 32

Bird Nests Found on Nott Island in 1977, by Species and Habitat, with Nest Success

Species	Habitat	Date Found	Percent Nest Success (Fledged)
Canada goose	Common reed	14 May	0
Great horned owl	Cedar tree	10 May	75
Killdeer	Disposal site	3 June	100
Killdeer	Unvegetated area	1 July	100
Killdeer	Unvegetated area	5 July	unknown
Yellow warbler	Panic grass-mixed grass	6 May	unknown
Yellow warbler	Tree-thicket	15 July	unknown
Yellow warbler	Tree-thicket	15 July	unknown

NOTT ISLAND

LYME, CONNECTICUT



SHRUBLAND

AMORPHA FRUTICOSA

MYRICA PENSYLVANICA

MIXED SHRUB

TREE - THICKET

u UNVEGETATED AREA

DISTURBED VEGETATION

GRASSLAND

AMMOPHILA BREVILIGULATA

PHRAGMITES AUSTRALIS

PANICUM VIRGATUM - MIXED GRAMINOID

GRAMINOID - SHRUB

August 1976

Figure 1. Dia

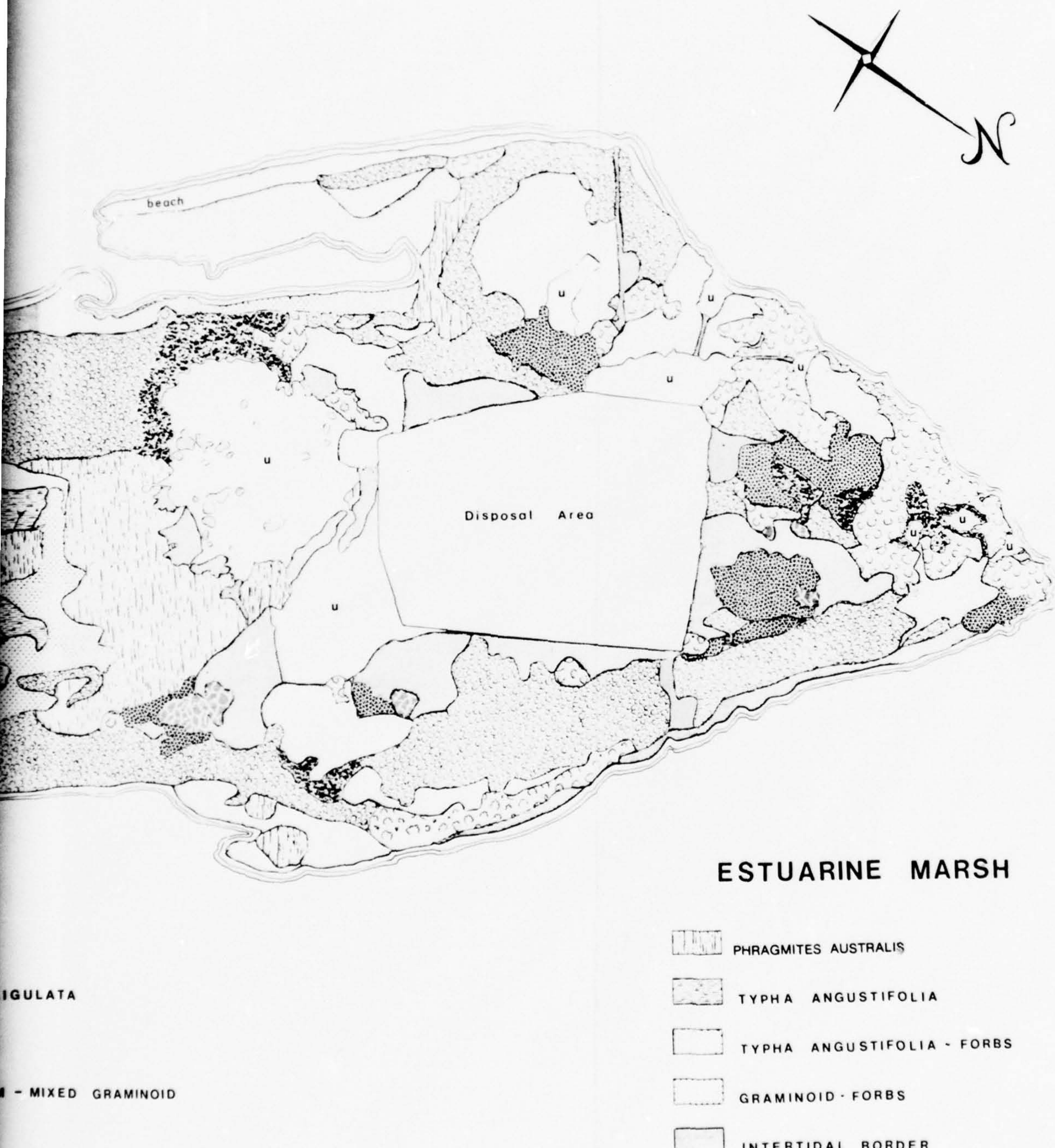


Figure 1. Diagram of Nott Island

Connecticut College Department of Botany

Species	Replicate 1				Replicate 2				Replicate 3			
No species	1	0	3	2	3	2	1	0	0	3	2	1
White clover	2	3	0	1	1	3	2	0	2	0	1	3
Red clover	1	2	3	0	1	0	2	3	2	0	1	3
Flatpea (not planted)	1	2	0	3	2	0	3	1	2	1	3	0
Perennial ryegrass	1	2	3	0	2	3	0	1	1	2	0	3
Timothy	2	3	0	1	3	2	0	1	0	1	3	2
Orchard grass	3	1	0	2	2	0	1	3	2	1	0	3
Tall fescue	0	2	1	3	3	1	2	0	2	3	0	1

Figure 2. *Planting Plan for the Experimental Plots Established within the Disposal Area.* Each plot is 1.0 × 1.5 m with 0.5 m between contiguous plots. Lime treatments are indicated by numbers within each plot: 0 = no lime, 1 = 4 tons/acre, 2 = 6 tons/acre, 3 = 8 tons/acre

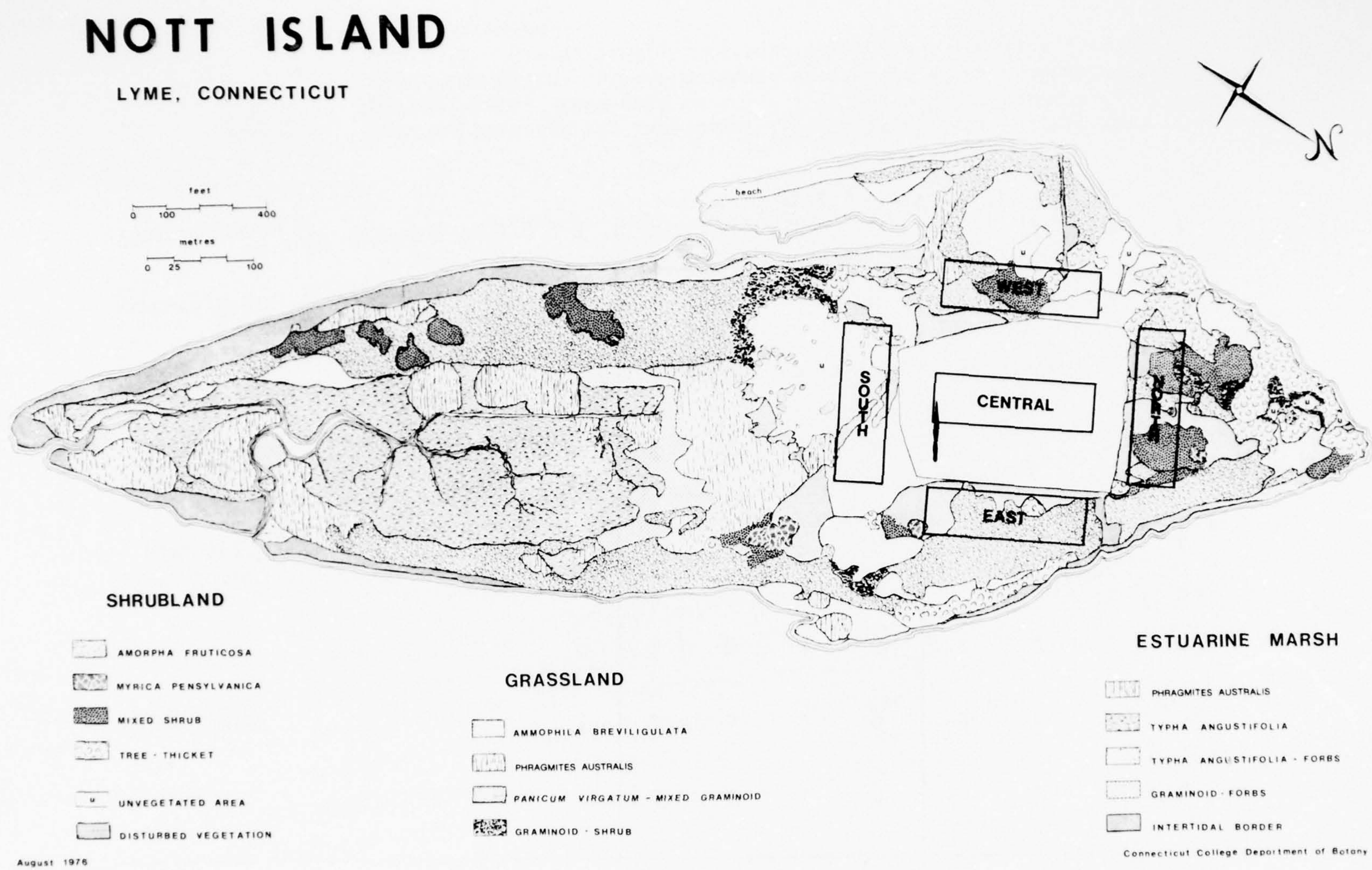


Figure 3. Small Mammal Trapping Grids

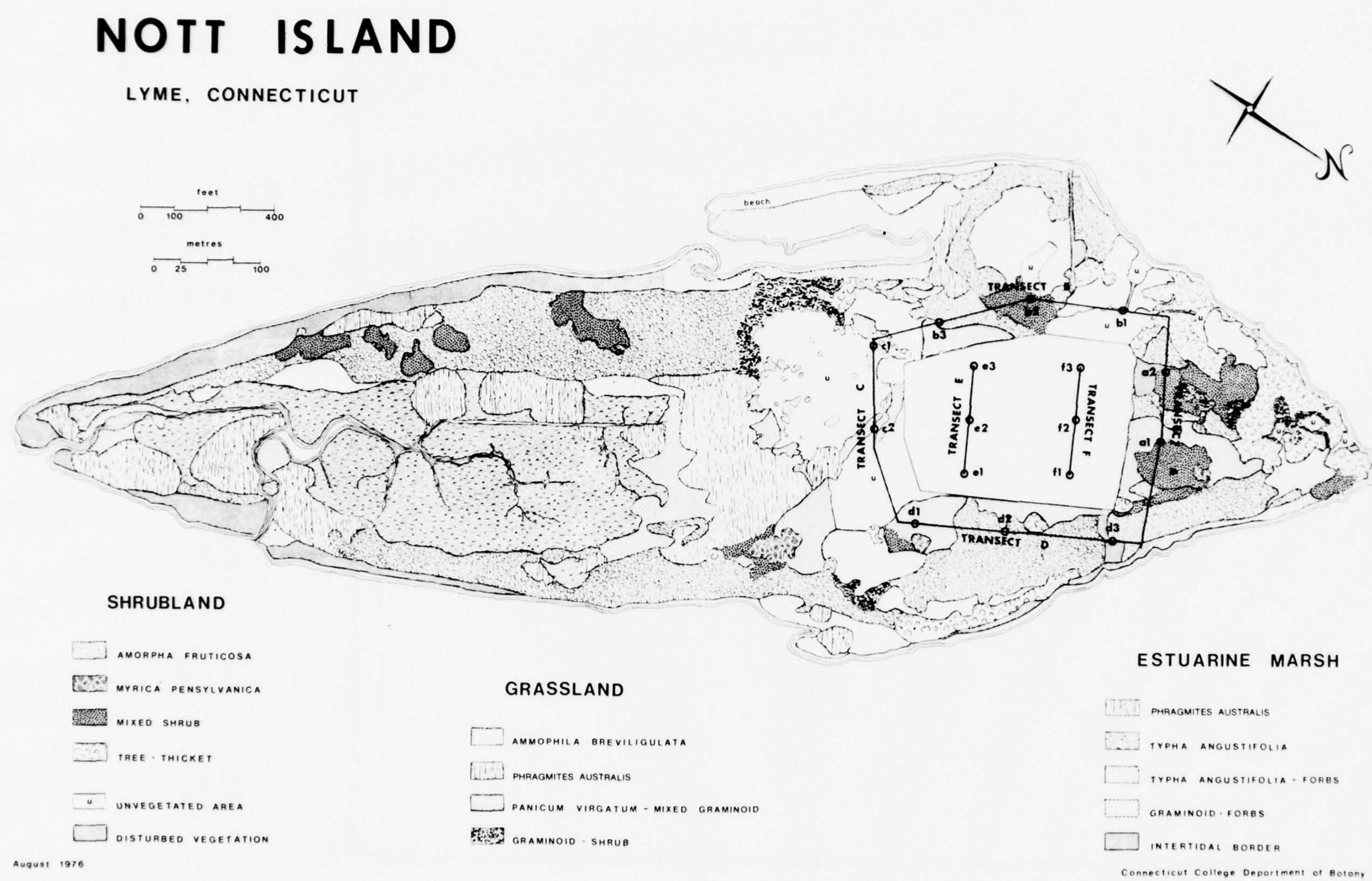


Figure 4. Bird Survey Transects (—) and Observation Stations (·)

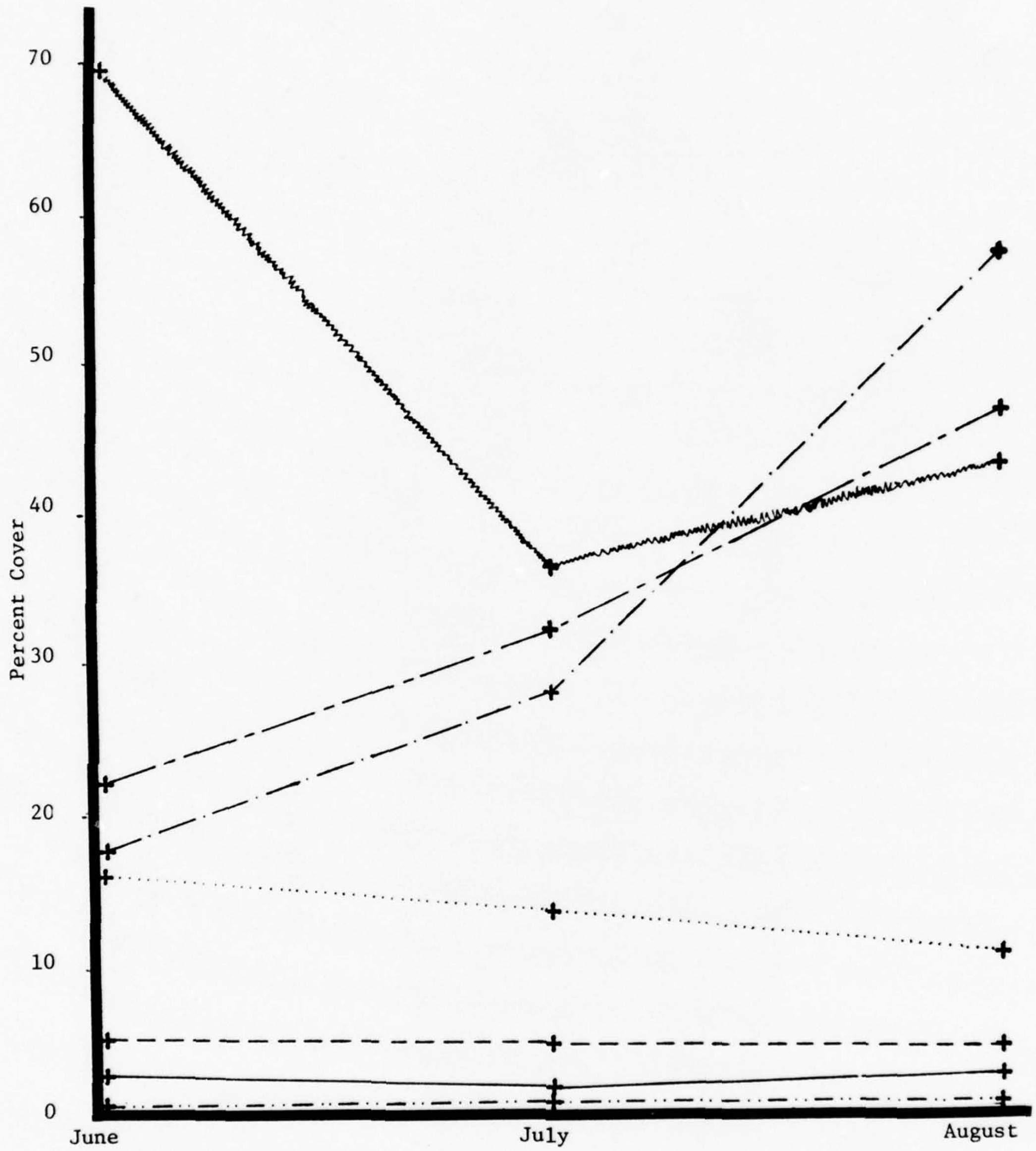


Figure 5. Change in Percent Cover of Invading Species for the Significant Interaction of Species and Time in the Experimental Plots

LEGEND

tall fescue

orchard grass

timothy

ryegrass

red clover

white clover

unplanted

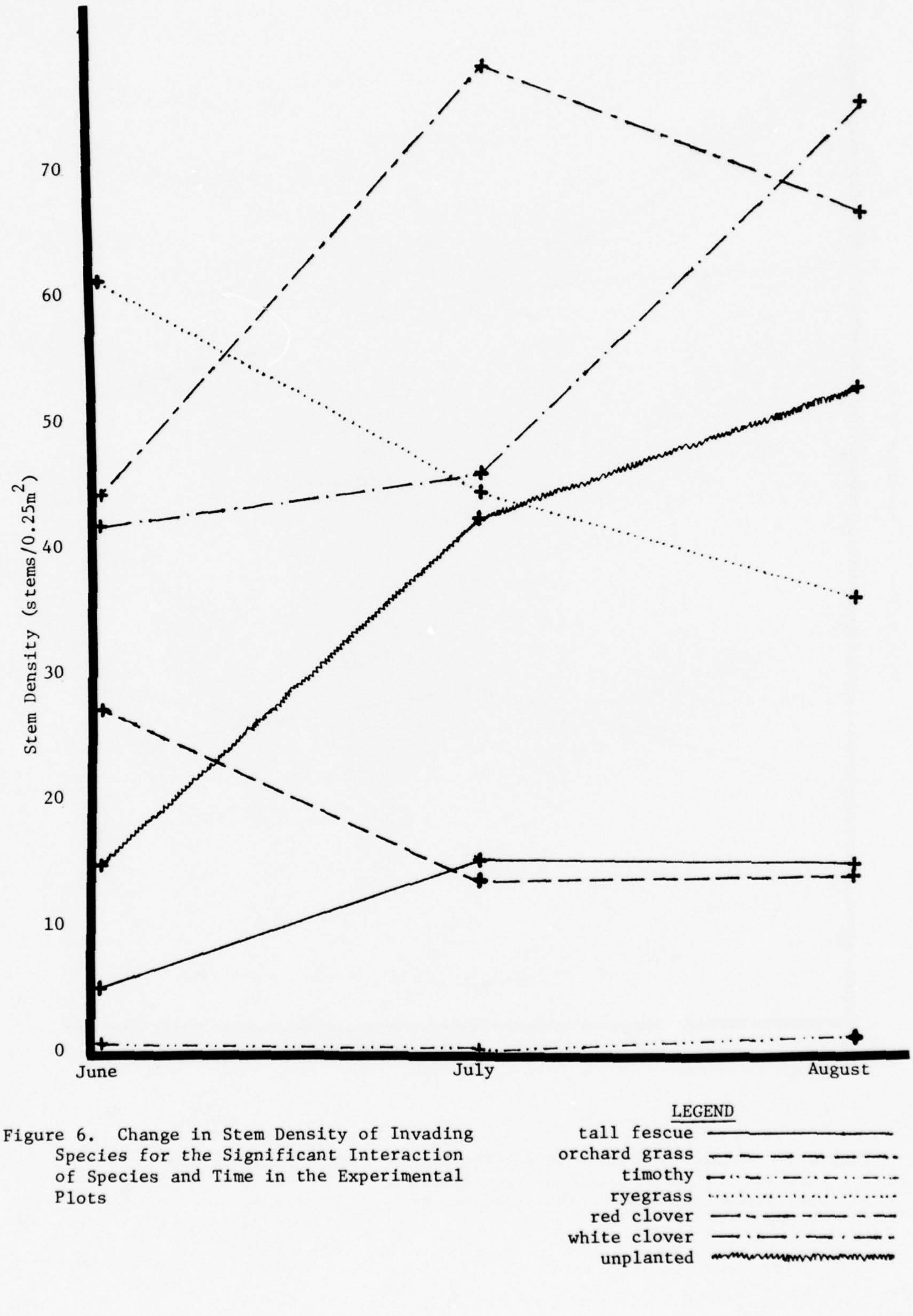


Figure 6. Change in Stem Density of Invading Species for the Significant Interaction of Species and Time in the Experimental Plots

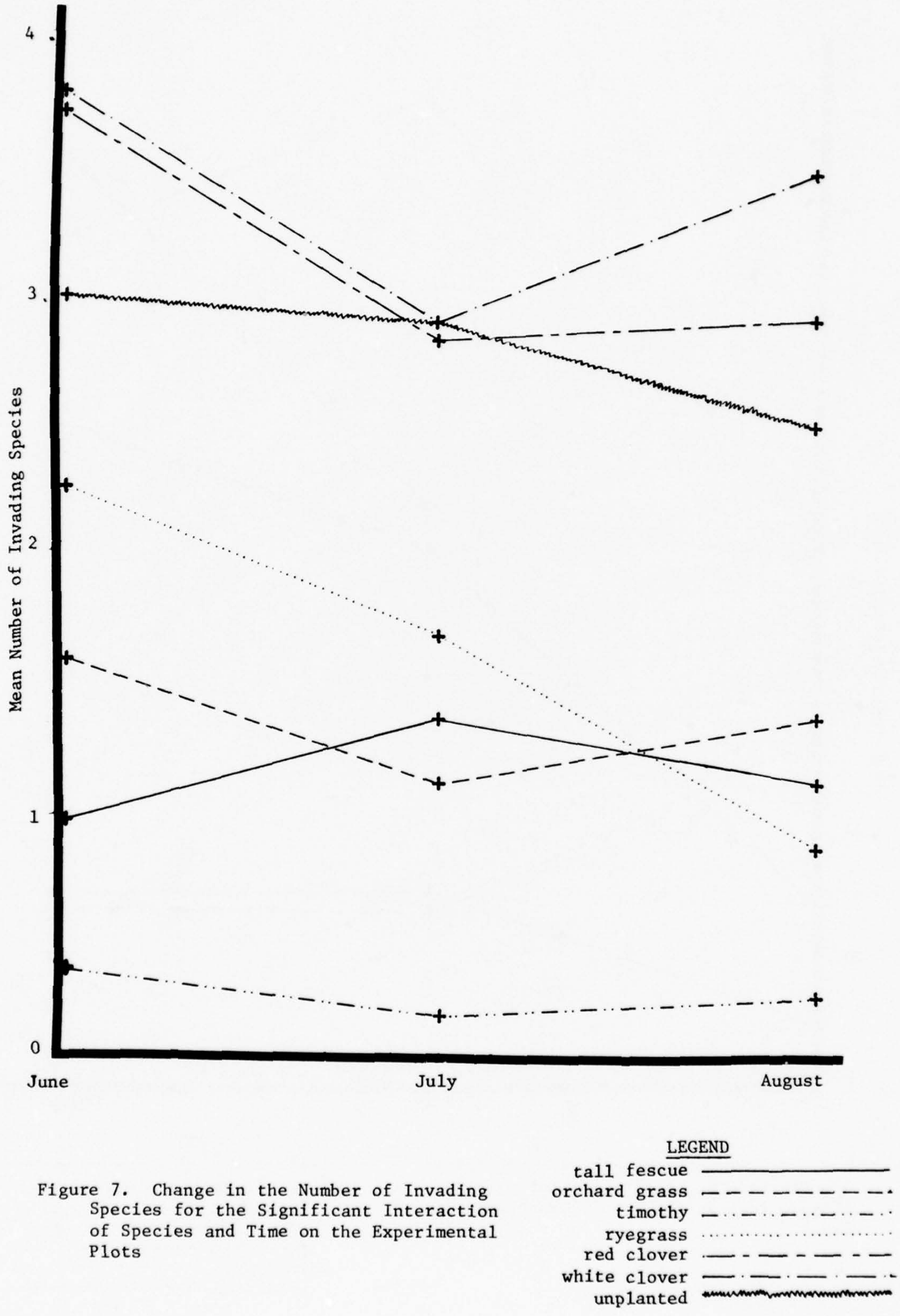


Figure 7. Change in the Number of Invading Species for the Significant Interaction of Species and Time on the Experimental Plots

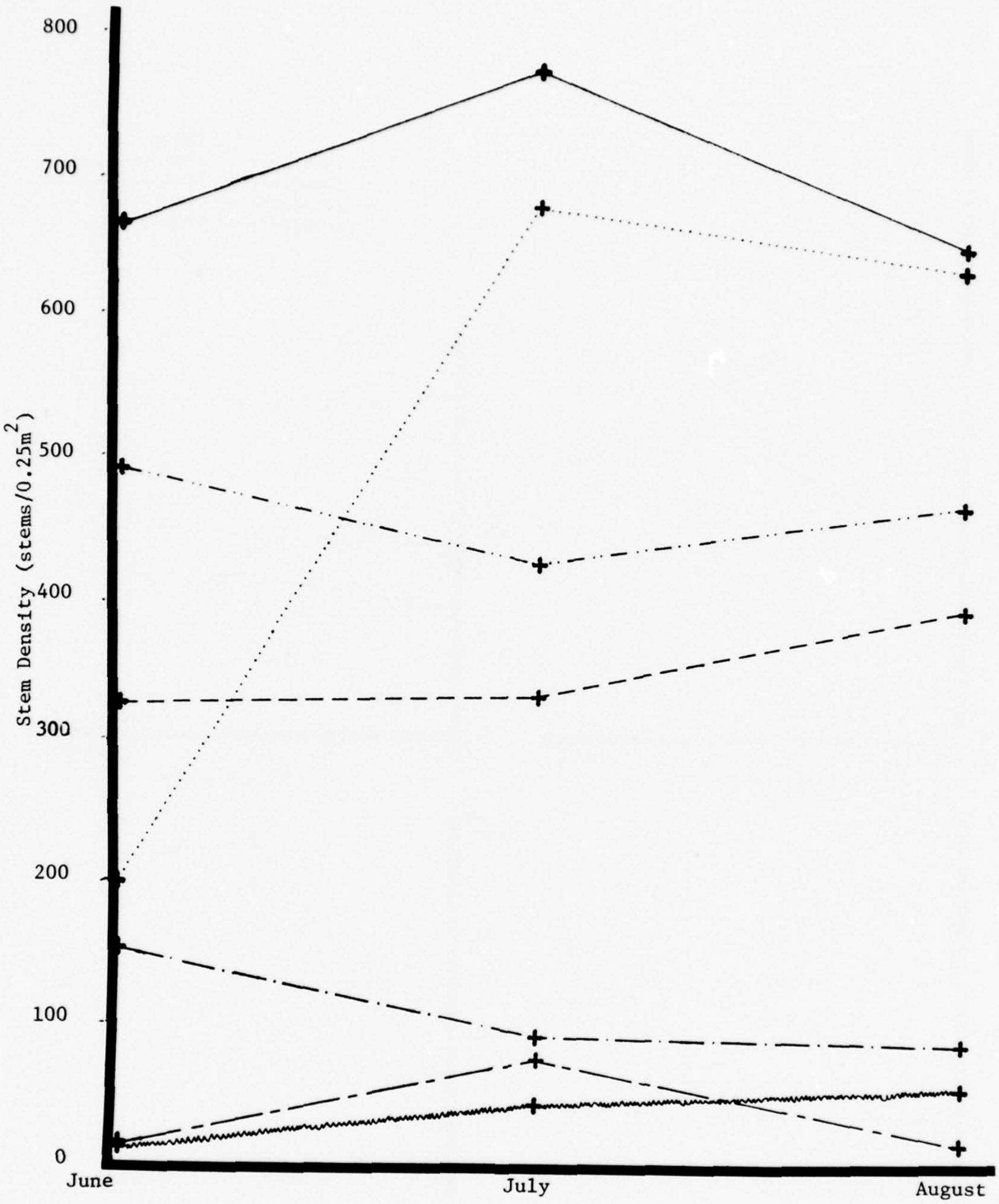
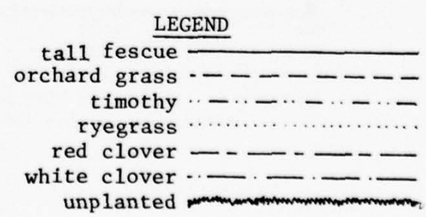


Figure 8. Change in Stem Density of Planted Species for the Significant Interaction of Species and Time on the Experimental Plots



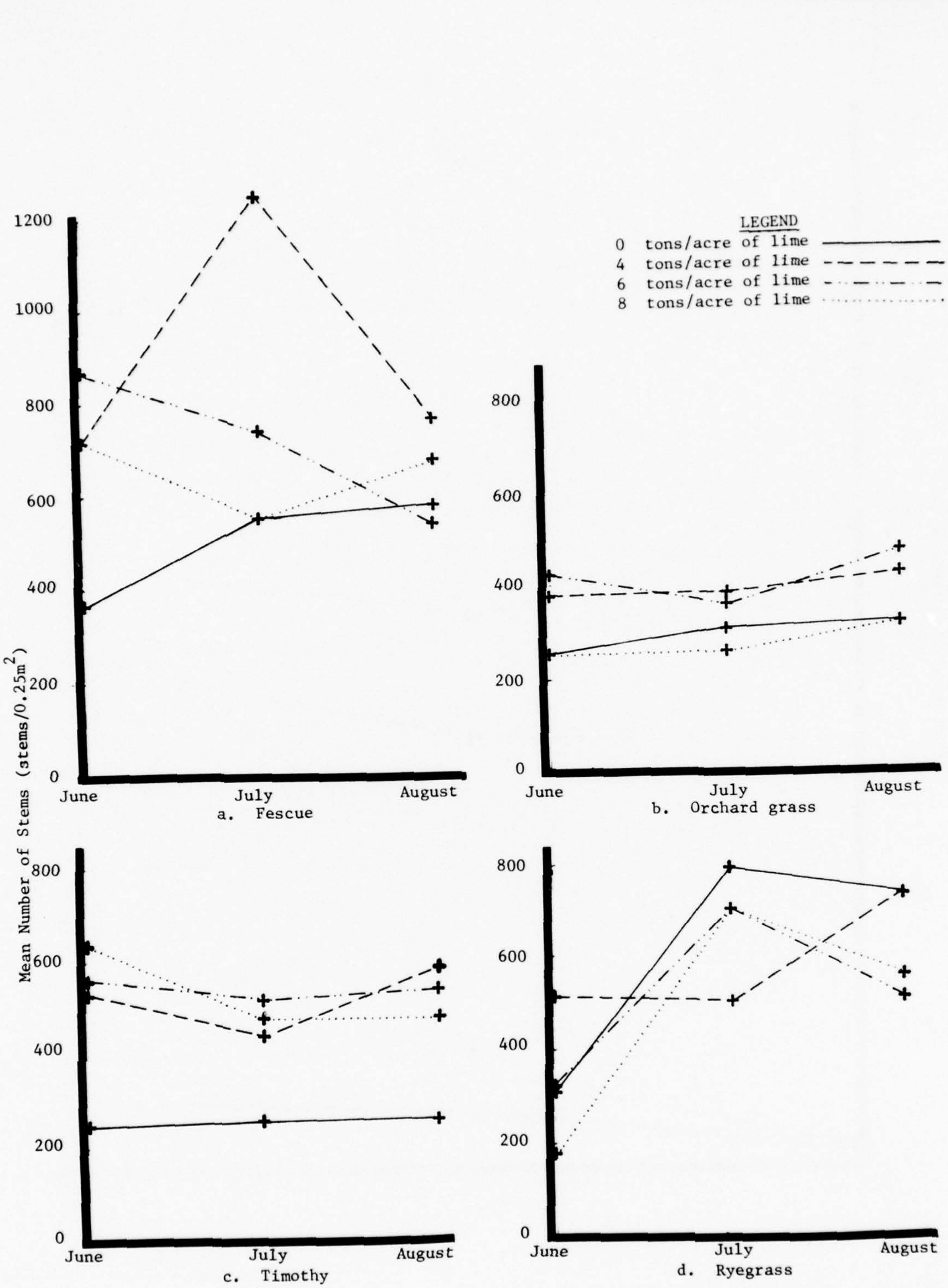
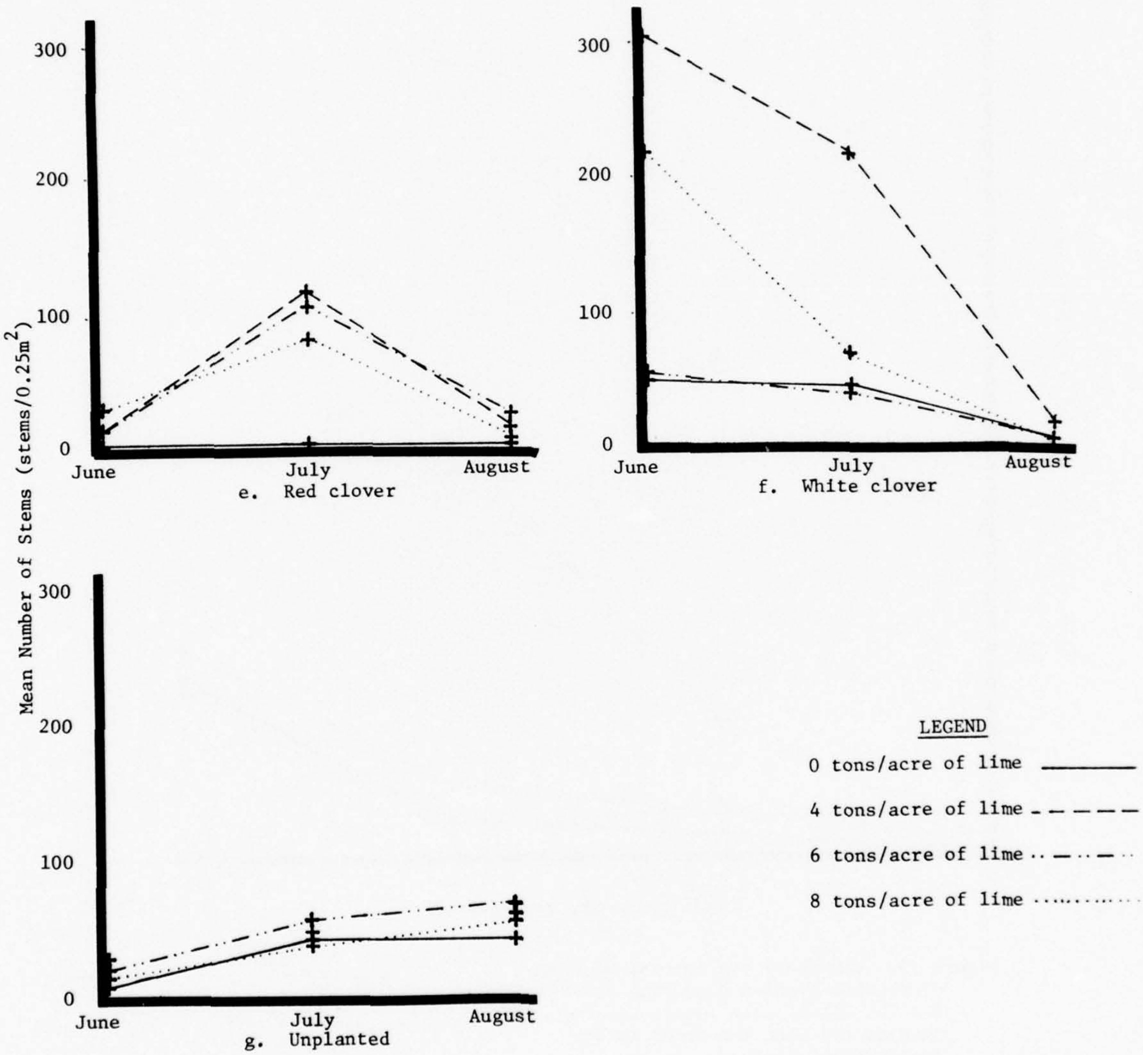


Figure 9. Change in Stem Density of Planted Species for the Significant Interaction of Species, Lime Treatment, and Time in the Experimental Plots (Continued)

Figure 9 (Concluded)



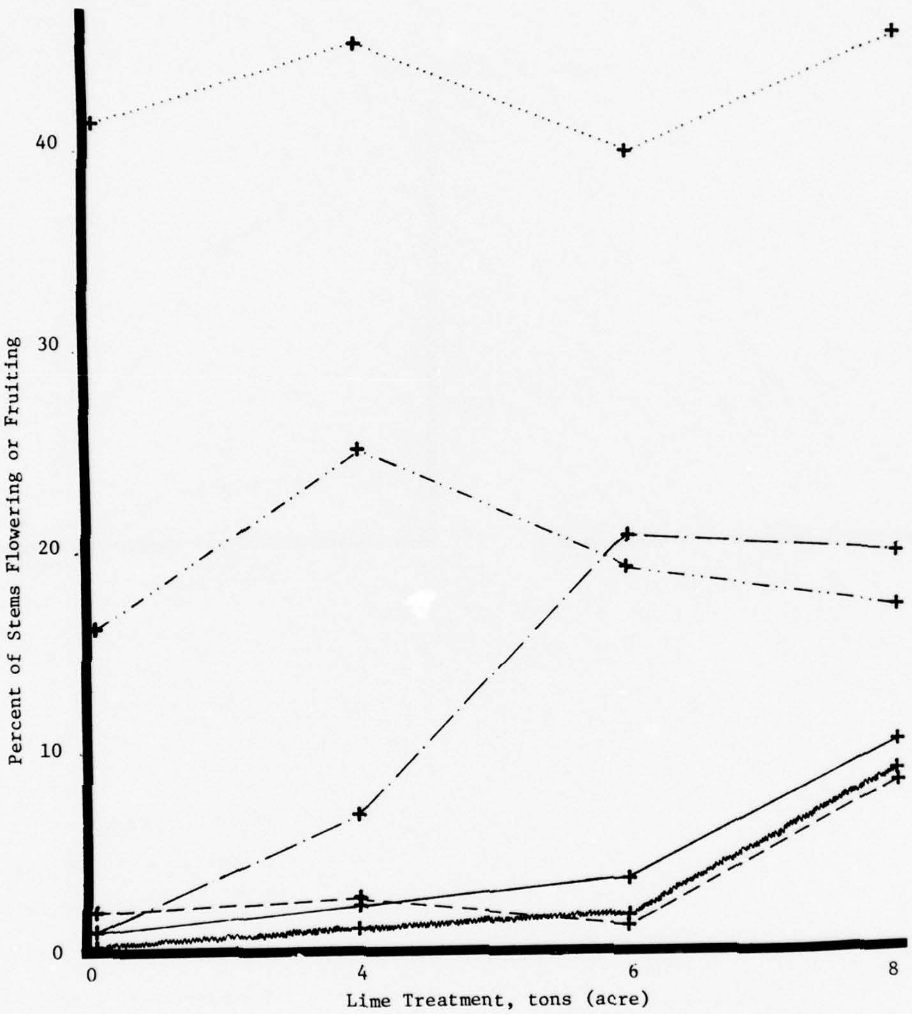


Figure 10. Change in the Percent of Stems of Planted Species Flowering or Fruiting for the Significant Interaction of Species and Lime Treatment in the Experimental Plots

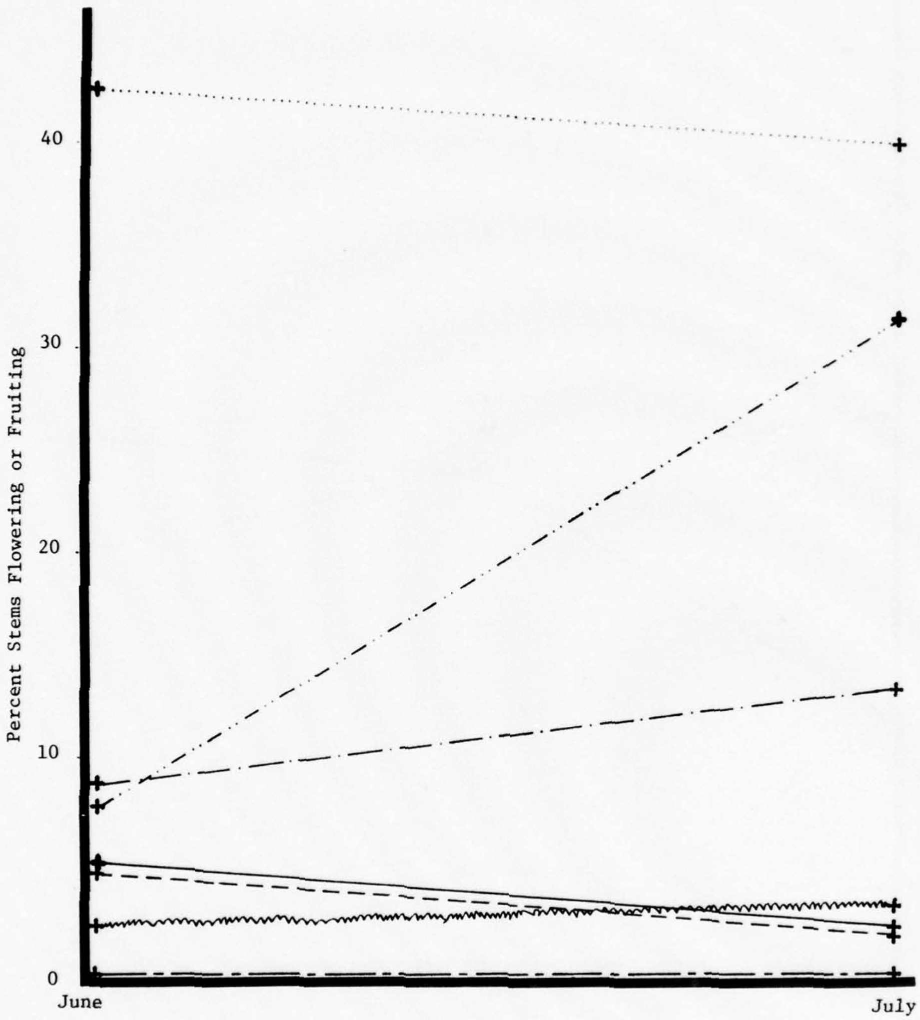


Figure 11. Change in Percent of Stems of Planted Species Flowering or Fruiting for the Significant Interaction of Species and Time in the Experimental Plots

LEGEND

tall fescue
orchard grass
timothy
ryegrass
red clover
white clover
unplanted

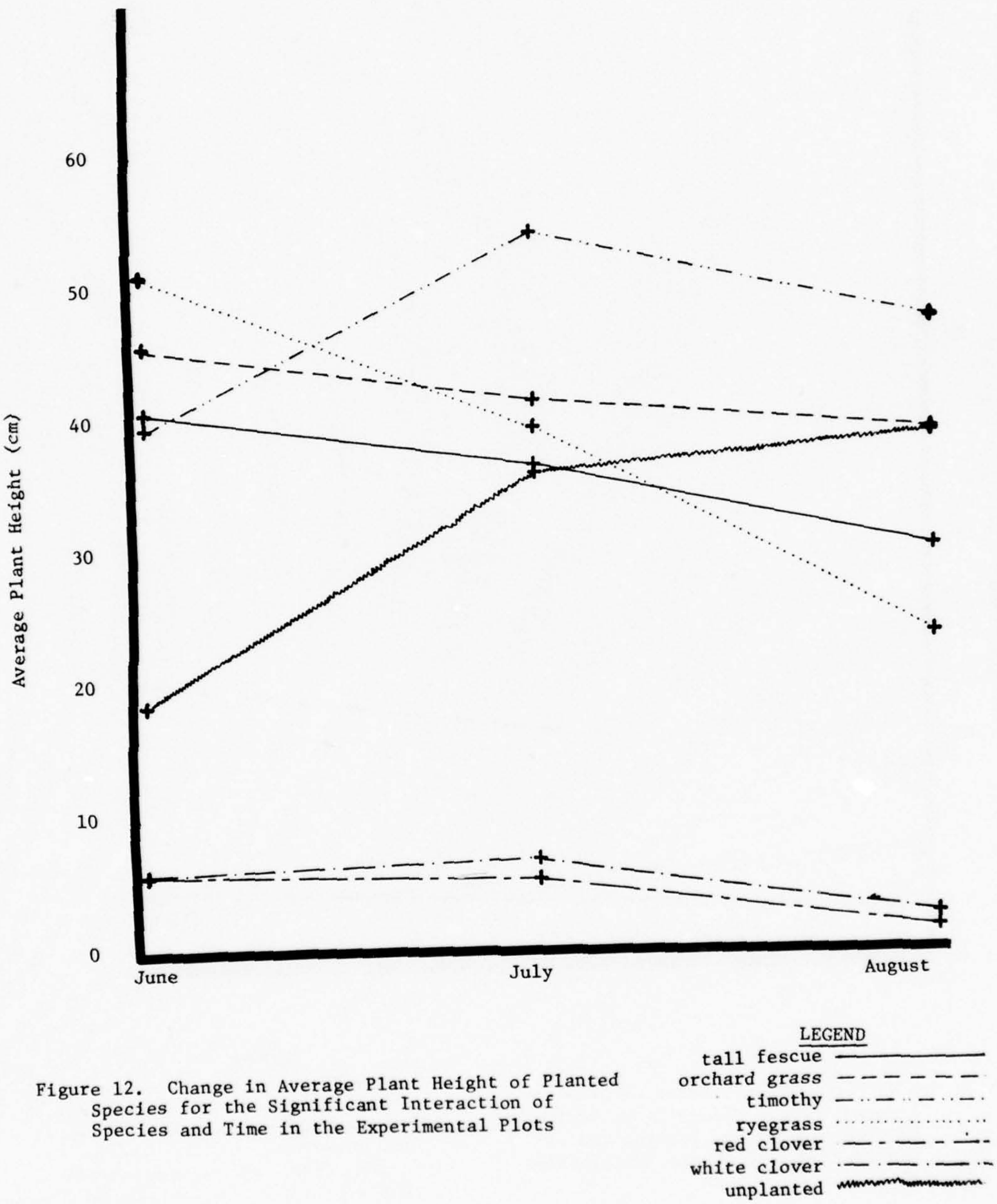


Figure 12. Change in Average Plant Height of Planted Species for the Significant Interaction of Species and Time in the Experimental Plots

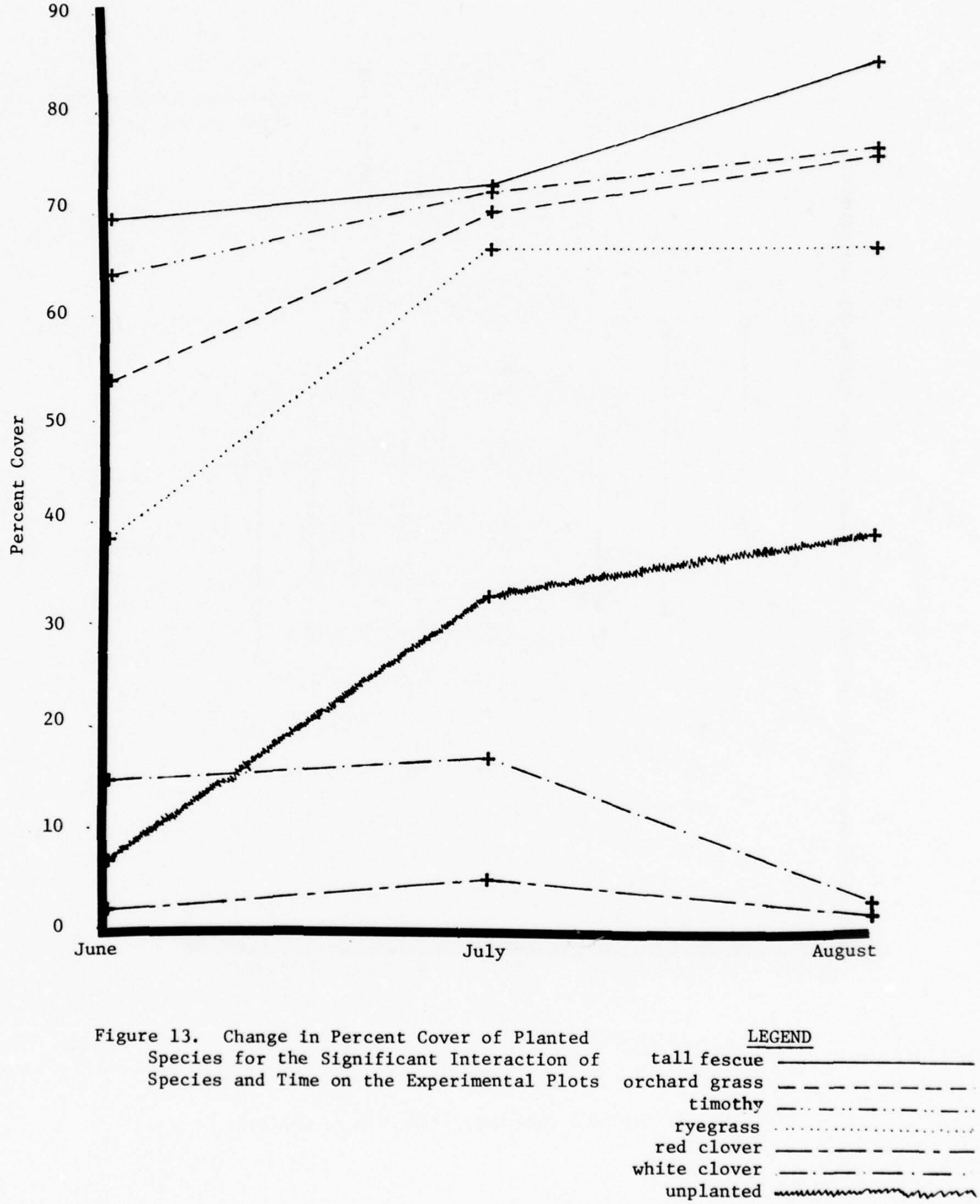


Figure 13. Change in Percent Cover of Planted Species for the Significant Interaction of Species and Time on the Experimental Plots

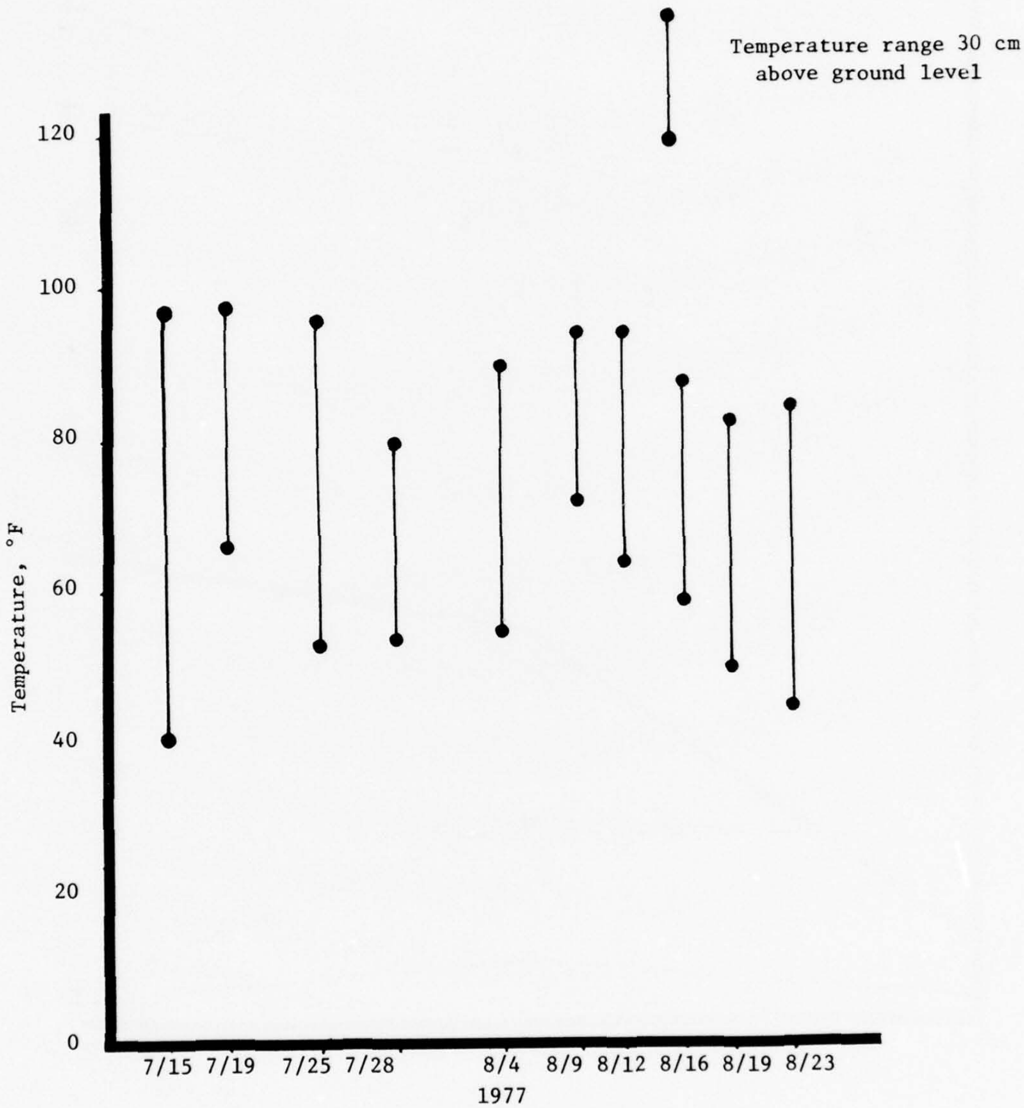


Figure 14. Microclimate Data from Site 1, Cattail

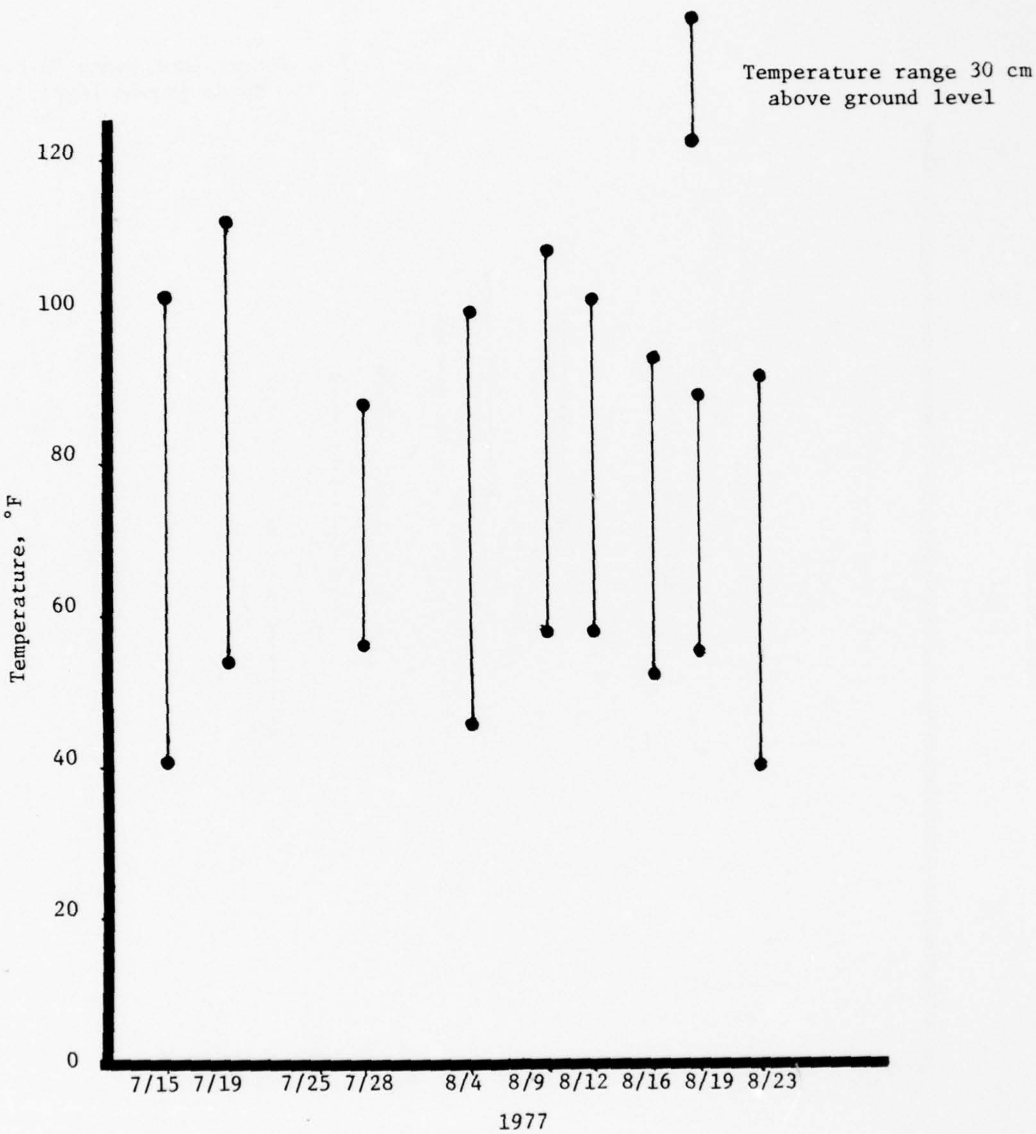


Figure 15. Microclimate Data from Site 2, Beach Grass

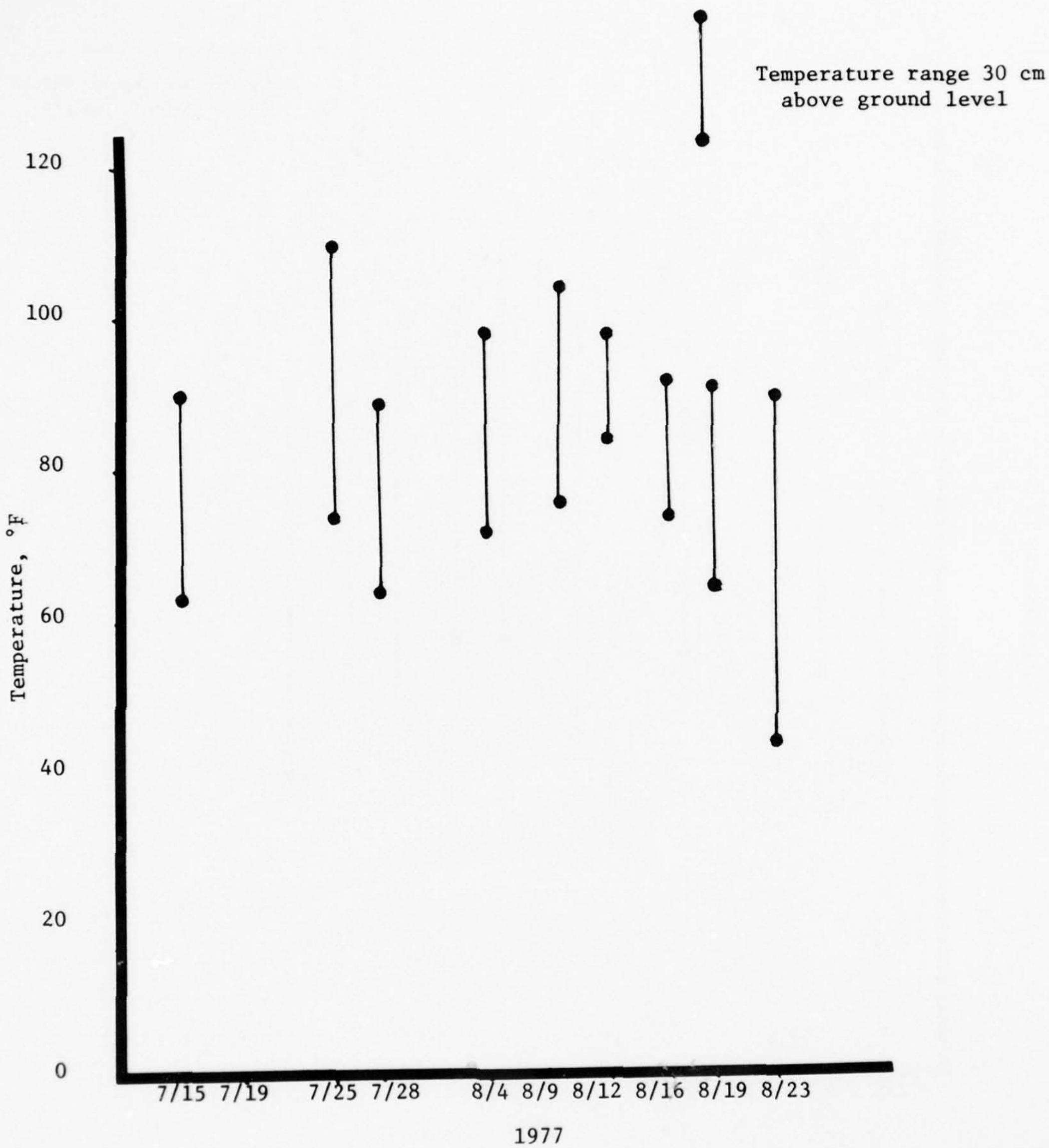


Figure 16. Microclimate Data from Site 3, False Indigo

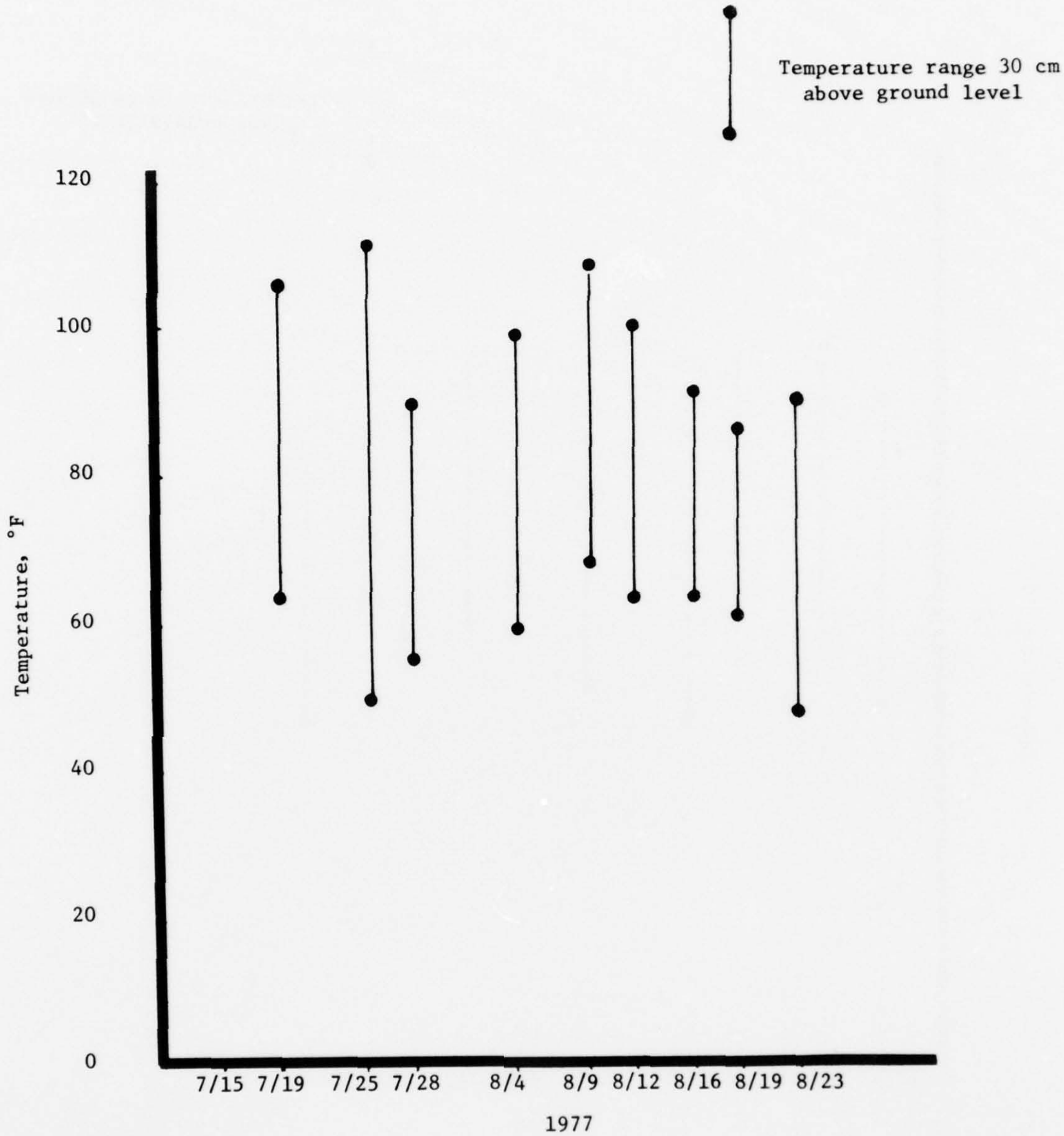


Figure 17. Microclimate Data from Site 4, Panic Grass

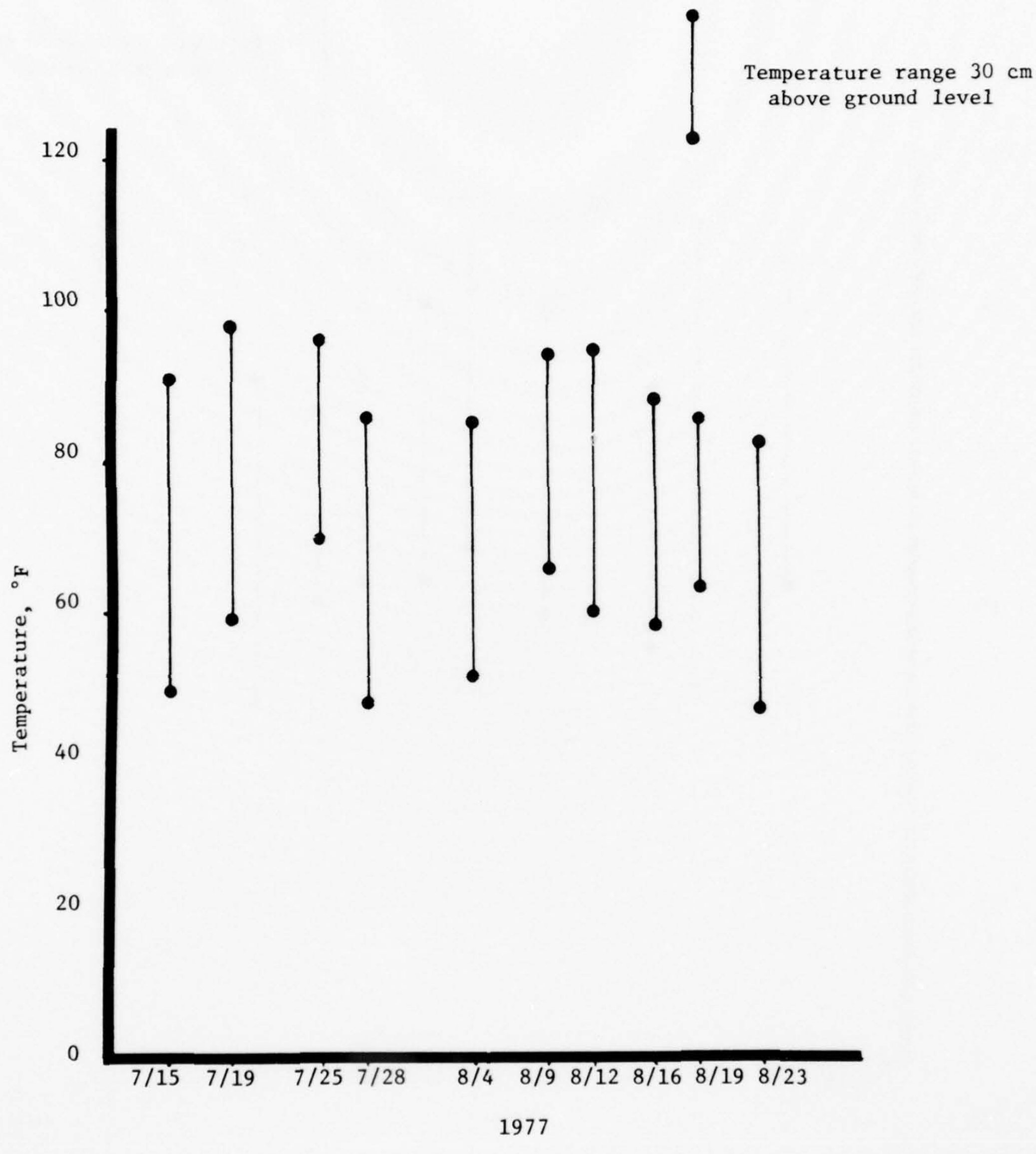


Figure 18. Microclimate Data from Site 5, Tree-thicket

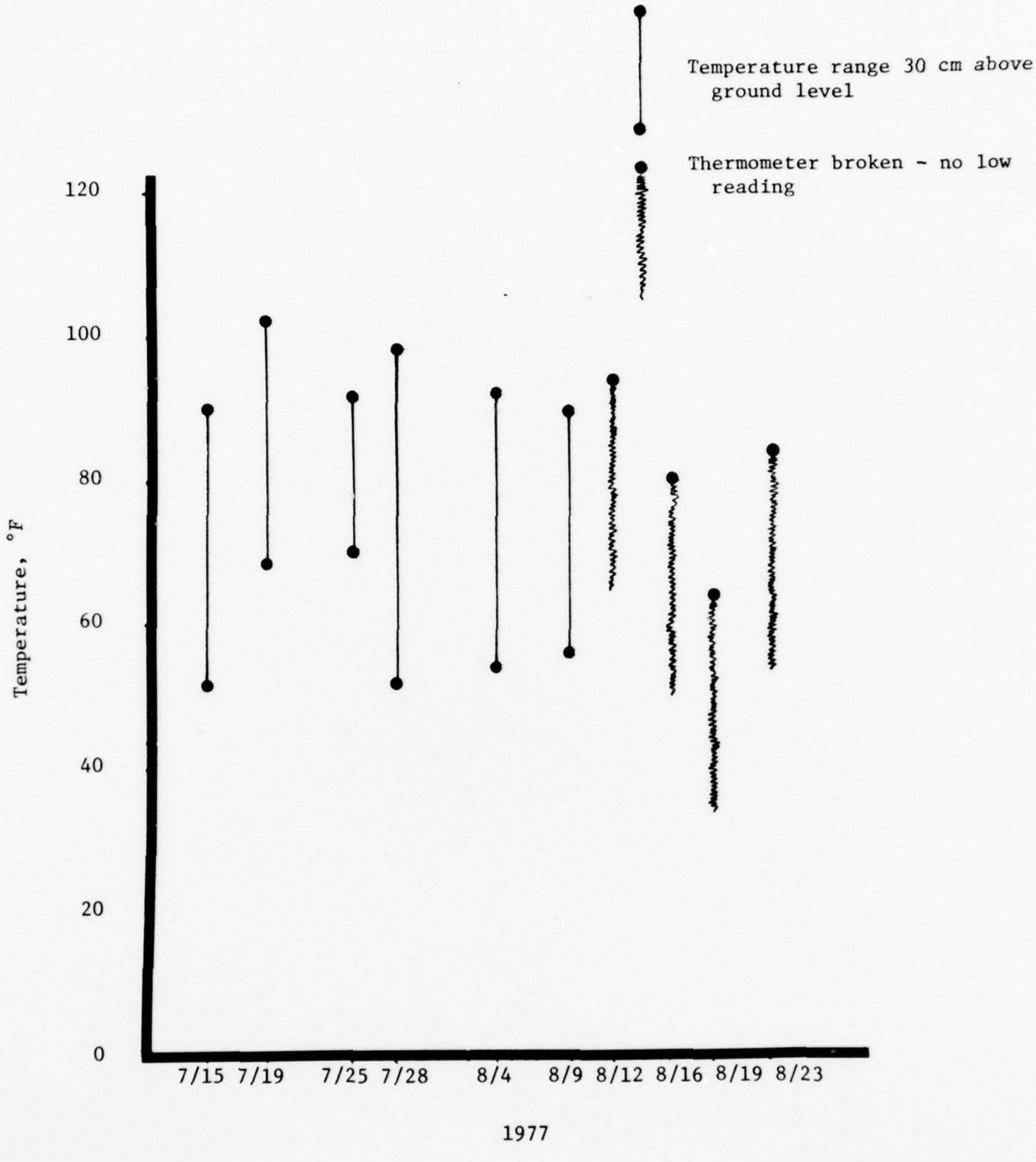


Figure 19. Microclimate Data from Site 6, Dredged Material Disposal Site

Appendix A´

Analyses of Variance

Table A'1

Analysis of Variance for Stem Density, Percent Cover, and Number of Species for the Invading Plants Within the Experimental Plots

	Source	DF	Sum of Squares	Mean Square	F Ratio	Significance[1]
Stem Density	Species	6	151321.0	25220.2	12.1111	***
	Lime	3	3561.99	1187.33	0.570176	
	Species/Lime	18	35423.5	1967.97	0.945054	
	Error	56	116614.0	2082.39		
	Time	2	628.079	314.0139	0.683480	
	Species/Time	12	21004.3	1750.36	3.80951	***
	Lime/Time	6	4445.91	740.986	1.61269	
	Species/Lime/Time	36	23722.8	658.967	1.43417	
	Error	112	51460.8	459.471		
Percent Cover	Species	6	50164.7	8360.71	17.8666	***
	Lime	3	2623.28	874.428	1.86860	
	Species/Lime	18	7146.37	397.020	0.848413	
	Error	56	26205.5	467.956		
	Time	2	3195.59	1597.79	25.1905	***
	Species/Time	12	11013.7	917.812	14.4700	***
	Lime/Time	6	225.663	37.6105	0.59296	
	Species/Lime/Time	36	1199.154	33.3205	0.52532	
	Error	112	7103.98	63.4284		
Number of Species	Species	6	302.083	50.3473	16.7826	***
	Lime	3	2.11121	0.703737	0.234582	
	Species/Lime	18	89.4718	4.97065	1.65690	
	Error	56	167.997	2.99996		
	Time	1	10.7254	5.36371	7.90406	***
	Species/Time	6	18.2747	1.52289	2.24458	**
	Lime/Time	3	6.06813	1.01135	1.49062	
	Species/Lime/Time	18	29.5970	0.822140	1.21174	
	Error	56	75.9892	0.678475		

[1] ** = significant at the .01 level, *** = significant at the .001 level

Table A´2

Analysis of Variance for Stem Density and Percent Cover Within the Experimental Plots

	Source	DF	Sum of Squares	Mean Square	F Ratio	Significance[1]
Stem Density	Species	6	15594600.0	2599100.0	50.7003	***
	Lime	3	641263.0	213754.0	4.16968	**
	Species/Lime	18	1050610.0	58367.5	1.13856	
	Error	56	2870780.0	51264.0		
	Time	2	149418.0	74709.2	4.30759	*
	Species/Time	12	1105620.0	92135.3	5.41101	***
	Lime/Time	6	91104.3	15184.0	0.891744	
	Species/Lime/ Time	36	1118730.0	31076.0	1.82506	**
	Error	112	1907060.0	17027.0		
Percent Cover	Species	6	219697.0	36616.2	67.4965	***
	Lime	3	6100.61	2033.53	3.74851	**
	Species/Lime	18	7361.37	408.1964	0.753865	
	Error	56	30379.5	542.491		
	Time	2	12684.9	6342.48	50.7888	***
	Species/Time	12	13268.6	1105.72	8.85431	***
	Lime/Time	6	1350.09	225.016	1.80187	
	Species/Lime/ Time	36	5081.16	141.143	1.13023	
	Error	112	1398.65	124.879		

[1] * = significant at the .05 level; ** = significant at the .01 level; *** = significant at the .001 level

Table A´3

Analysis of Variance for Plant Height, Mean Weight of Seed Production, and Percent Stems Flowering or Fruiting Within the Experimental Plots

	Source	DF	Sum of Squares	Mean Square	F Ratio	Significance[1]
Plant Height	Species	6	65753.3	10958.8	71.1415	***
	Lime	3	2036.95	678.986	4.40775	**
	Species/Lime	18	3091.88	171.771	1.11508	
	Error	56	8626.43	154.043		
	Time	2	1160.72	580.361	13.3781	***
	Species/Time	12	8725.43	727.119	16.7611	*
	Lime/Time	6	633.658	105.609	2.43446	*
	Species/Lime/ Time	36	1368.47	38.0131	0.876259	
	Error	112	4858.68	43.3811		
Mean Weight of Seed Production	Species	6	19127.488	3187.914	19.115	***
	Lime	3	853.677	284.559	1.706	
	Species/Lime	18	1584.451	88.025	0.527	
	Error	56	9338.986	166.767		
Phenology	Species	6	32298.9	5383.15	19.4026	***
	Lime	3	1037.21	3457.37	1.24614	
	Species/Lime	18	1839.42	102.190	0.368326	
	Error	56	15536.8	277.444		
	Time	1	232.916	232.916	1.35075	
	Species/Time	6	2721.10	453.518	2.63009	*
	Lime/Time	3	1167.95	387.317	2.25777	
	Species/Lime/ Time	18	4384.65	243.591	1.41266	
	Error	56	9656.30	172.434		

[1] * = significant at the .05 level; ** = significant at the .01 level; *** = significant at the .001 level

Table A´4

Analysis of Variance for the Factors of Shoot Biomass, Root Biomass, Total Biomass, and Shoot to Root Ratio in the Experimental Plots

	Source	DF	Sum of Squares	Mean Square	F Ratio	Significance[1]
Shoot Biomass	Species	6	9909.388	1651.564	0.584	
	Lime	3	12751.564	4250.521	1.505	
	Species/Lime	18	56468.023	3137.112	1.110	
	Error	56	158141.531	2823.955		
Root Biomass	Species	6	4533.088	755.514	4.900	***
	Lime	3	1067.065	355.688	2.306	
	Species/Lime	18	1569.674	87.204	0.565	
	Error	56	8633.998	154.178		
Total Biomass	Species	6	26645.300	4440.883	1.101	
	Lime	3	19841.293	6613.763	1.640	
	Species/Lime	18	73732.750	4096.263	1.015	
	Error	56	225827.281	4032.629		
Shoot to Root Ratio	Species	6	67.971	11.328	1.681	
	Lime	3	21.580	7.193	1.067	
	Species/Lime	18	98.240	5.457	0.810	
	Error	56	377.327	6.737		

[1] *** = significant to the .001 level.

Appendix B´

Common and Scientific Names of Animals

Table B´1

Common and Scientific Names of Animals Mentioned in the Report*

Mammals

Blarina brevicauda	Short-tailed shrew
Microtus pennsylvanicus	Meadow vole
Odocoileus virginiana	White-tailed deer
Ondatra zibethicus	Muskrat
Peromyscus leucopus	White-footed mouse
Procyon lotor	Raccoon
Rattus norvegicus	Norway rat
Scalopus aquaticus	Eastern mole
Zapus hudsonius	Meadow jumping mouse

Birds

Agelaius phoeniceus	Red-winged blackbird
Anas crecca	American green-winged teal
Anas platyrhynchos	Mallard
Botaurus lentiginosus	American bittern
Branta canadensis	Canada goose
Bubo virginianus	Great horned owl
Bucephala clangula	Common goldeneye
Charadrius semipalmatus	Semipalmated plover
Carduelis tristis	American goldfinch
Carpodacus purpureus	Purple finch
Casmerodius albus	Great egret
Chaetura pelagica	Chimney swift
Charadrius vociferus	Killdeer
Cistothorus palustris	Long-billed marsh wren
Coccyzus americanus	Yellow-billed cuckoo

* Nomenclature follows Jones et al. (1975), AOU checklist (1957, 1973, 1976), and Conant (1975) for mammals, birds, and amphibians and reptiles, respectively.

(Continued)

Table B'1 (Concluded)

Colinus virginianus	Bobwhite
Columba livia	Rock dove
Corvus brachyrhynchos	Common crow
Dendroica petechia	Yellow warbler
Dumetella carolinensis	Gray catbird
Empidonax alnorum	Alder flycatcher
Gavia immer	Common loon
Geothlypis trichas	Common yellowthroat
Icterus galbula	Northern oriole
Larus atricilla	Laughing gull
Melospiza melodia	Song sparrow
Passerculus sandwichensis	Savannah sparrow
Philohela minor	American woodcock
Picoides pubescens	Downy woodpecker
Seiurus noveboracensis	Northern waterthrush
Turdus migratorius	American robin
Zenaida macroura	Mourning dove
Amphibians	
Bufo woodhousei fowleri	Fowler's toad
Rana clamitans melanota	Green frog
Reptiles	
Chelydra serpentina serpentina	Common snapping turtle
Coluber constrictor constrictor	Northern black racer
Natrix sipedon sipedon	Northern water snake

Appendix C´

Bird Transect Data

Table C'1

Mean Densities of Bird Species Along

Each Transect in May 1977 (Birds/ha)

Species	Transect					
	A	B	C	D	E	F
Mute swan	7.32					
Mallard						
Black duck						
Marsh hawk						
Osprey						
American kestrel						
Bobwhite						
Killdeer		0.98				
Spotted sandpiper						
Mourning dove						
Great horned owl						
Chimney swift						
Ruby-throated hummingbird						
Belted kingfisher						
Common flicker						
Downy woodpecker						
Eastern kingbird						
Willow flycatcher	0.61					
Alder flycatcher						
Eastern wood pewee						
Tree swallow						
Bank swallow		2.60				
Rough-winged swallow						
Barn swallow						
Blue jay						
Common crow						
Black-capped chickadee						

(Continued)

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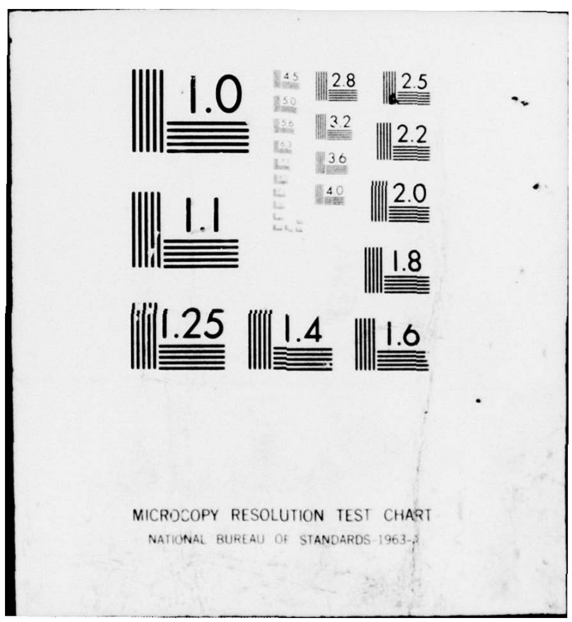
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Table C'1 (Concluded)

Species	Transect					
	A	B	C	D	E	F
Long-billed marsh wren						
Mockingbird						
Gray catbird	2.97	1.95		0.91		
Brown thrasher						
American robin						
Wood thrush						
Loggerhead shrike						
Starling						
White-eyed vireo						
Yellow warbler	15.00	4.79	7.85	5.36		
Common yellowthroat	29.20	7.32	0.64			
Red-winged blackbird		1.30	0.43	0.68		
Northern oriole						
Common grackle						
Cardinal						
Purple finch	2.36					
House finch	1.83	1.30				
American goldfinch	1.37		3.21	2.73		
Savannah sparrow						
Song sparrow	4.72	4.88	1.92			
Total	65.38	25.12	14.05	9.68		

Table C'2

Mean Densities of Bird Species Along Each Transect in June 1977 (Birds/ha)

Species	Transect A	B	C	D	E	F
Mute swan	1.22					
Canada goose						
Mallard		0.03	0.09			0.55
Black duck						
Marsh hawk						
Osprey						
American kestrel						
Bobwhite	0.42	0.27	0.19	1.14	0.48	0.63
Killdeer		0.28	1.71		3.33	2.60
Spotted sandpiper		1.04	0.29			
Mourning dove		0.42	8.68	0.46	0.33	
Great horned owl						
Chimney swift			0.21			
Ruby-throated hummingbird						
Belted kingfisher						
Common flicker	6.11		0.86			
Downy woodpecker						
Eastern kingbird		9.77	0.86			
Willow flycatcher	0.61	1.25		0.83	0.20	0.35
Alder flycatcher				0.12		
Eastern wood pewee						
Tree swallow			0.64			
Bank swallow		3.26				1.11
Rough-winged swallow						
Barn swallow		0.62	0.29	4.55		0.42
Blue jay						
Common crow	0.78		0.28	0.46	0.22	0.14

(Continued)

Table C'2 (Concluded)

Species	Transect					
	A	B	C	D	E	F
Black-capped chickadee	0.58	0.22	0.51	0.12		0.05
Long-billed marsh wren						
Mockingbird						
Gray catbird	2.22	7.07	1.11	5.35	0.68	0.53
Brown thrasher						
American robin						
Wood thrush						
Loggerhead shrike						
Starling	1.16	0.43		2.44		
White-eyed vireo	3.05					
Yellow warbler	11.89	11.59	6.08	18.47	1.62	1.40
Common yellowthroat	12.89	5.74	7.52	10.67		0.56
Red-winged blackbird		2.47	3.04	2.64	4.85	1.74
Northern oriole		0.16				
Common grackle						
Cardinal	0.50	0.36	1.55			0.65
Purple finch			0.35			
House finch	5.13	3.82				
American goldfinch	8.33	3.81	0.57	5.03	8.33	1.11
Savannah sparrow			0.21			
Song sparrow	13.60	5.55	7.47	4.33	1.59	1.16
Total	68.49	58.16	42.51	56.61	21.64	13.00

Table C'3

Mean Densities of Bird Species Along Each Transect in July 1977 (Birds/ha)

Species	Transect A	B	C	D	E	F
Mute swan						0.62
Canada goose						
Mallard		0.43				
Black duck						
Marsh hawk						
Osprey		0.07				0.44
American kestrel		0.11	0.11			
Bobwhite	0.08	0.11	0.07	0.09		
Killdeer	0.15		2.40	0.43		0.14
Spotted sandpiper						
Mourning dove	0.67	1.47	2.87	0.11	10.17	13.48
Great horned owl						
Chimney swift		3.26				
Ruby-throated hummingbird						
Belted kingfisher						
Common flicker	3.05			0.15		0.24
Downy woodpecker		1.49				
Eastern kingbird	3.05					
Willow flycatcher		0.43	0.74			
Alder flycatcher	0.21			0.23		
Eastern wood pewee						
Tree swallow	5.76	7.06	5.00	1.82	3.35	8.76
Bank swallow		1.97				6.11
Rough-winged swallow	0.44	1.63	0.43	0.25	0.42	3.33
Barn swallow	3.05	4.38	0.34	0.45	4.16	5.60
Blue jay						
Common crow	0.44	0.18	5.09	0.44	0.47	

(Continued)

Table C'3 (Concluded)

Species	Transect					
	A	B	C	D	E	F
Black-capped chickadee	0.08	0.11		0.48		
Long-billed marsh wren		0.42	0.09			
Mockingbird	0.53					
Gray catbird	12.32	7.48	3.45	1.95	0.87	0.59
Brown thrasher						
American robin	0.15					
Wood thrush						
Loggerhead shrike						
Starling	2.22	0.52	4.53	0.62		3.70
White-eyed vireo						
Yellow warbler	8.02	9.24	2.08	6.35	1.99	0.39
Common yellowthroat	6.68	6.75	1.47	6.30	0.55	0.71
Red-winged blackbird	2.95	6.59	11.27	4.73	0.68	1.06
Northern oriole						
Common grackle			0.21	0.30		
Cardinal		0.09	0.24			
Purple finch	1.26					
House finch	0.21	3.26				
American goldfinch	6.51	4.45	7.10	3.47		0.55
Savannah sparrow						
Song sparrow	6.42	15.34	13.72	9.23	6.47	2.92
Total	64.25	76.84	61.21	37.40	29.13	48.64

Table C'4

Mean Densities of Bird Species Along Each Transect in August 1977 (Birds/ha)

Species	Transect					
	A	B	C	D	E	F
Mute swan						
Canada goose	0.86	0.15	2.99	1.52		
Mallard	0.33	0.55		0.58		
Black duck						
Marsh hawk	0.26	0.12				
Osprey						0.08
American kestrel						
Bobwhite		1.30				
Killdeer		0.37				
Spotted sandpiper						
Mourning dove	6.01	7.25	15.65	0.97	2.02	23.94
Great horned owl						
Chimney swift						
Ruby-throated hummingbird						
Belted kingfisher						
Common flicker	0.69			1.21		
Downy woodpecker						0.12
Eastern kingbird						
Willow flycatcher	0.08					
Alder flycatcher						
Eastern wood pewee						
Tree swallow	5.02	15.00	9.36	2.97		9.07
Bank swallow			1.43			
Rough-winged swallow	0.23	0.58	2.85	0.43	0.19	
Barn swallow	0.55	0.37	0.71	0.91	0.68	
Blue jay				0.09		
Common crow	0.66	1.24	0.57	0.90	0.12	1.83
Black-capped chickadee	0.80	0.36	0.17	0.20		0.81

(Continued)

Table C'4 (Concluded)

Species	Transect A	B	C	D	E	F
Long-billed marsh wren						
Mockingbird		0.09	0.29			
Gray catbird	2.49	5.24	1.07	2.91	0.14	1.20
Brown thrasher						
American robin						
Wood thrush						
Loggerhead shrike			0.11			
Starling	1.06		4.37	5.52	1.10	
White-eyed vireo						
Yellow warbler	1.82	1.81	0.33	1.82	0.14	0.30
Common yellowthroat	1.33	2.70	0.11	3.67		0.21
Red-winged blackbird	1.42	5.89	1.40	2.73		2.22
Northern oriole						
Common grackle						
Cardinal						
Purple finch						
House finch		0.08				
American goldfinch	3.15	2.38	2.01	2.28	0.71	0.56
Savannah sparrow						
Song sparrow	6.28	7.07	6.04	3.72	1.13	3.00
Total	33.04	52.55	49.46	32.43	6.23	43.34

Table C´5

Density, Diversity, and Equitability Measures for All Birds Counted on the Transects and at the Observation Stations in May 1977

Location	No. of Species	Total Density*	Species Diversity ($\bar{H}$)	$\bar{H}$ Max.	Equitability
Transect A	9	65.20	1.78	2.20	0.81
Station a1	12	10.88	2.11	2.48	0.85
Station a2	13	11.46	2.04	2.56	0.80
Transect B	8	25.12	1.98	2.08	0.95
Station b1	11	8.52	2.05	2.40	0.85
Station b2	14	12.93	2.24	2.64	0.85
Station b3	13	13.24	2.33	2.56	0.91
Transect C	5	14.05	1.36	1.61	0.85
Station c1	13	12.06	2.37	2.56	0.93
Station c2	11	3.22	1.67	1.79	0.93
Transect D	4	9.68	1.03	1.39	0.75
Station d1	11	16.48	2.19	2.40	0.91
Station d2	14	14.99	2.07	2.64	0.78
Station d3	13	12.04	2.20	2.56	0.86
Transect E	--**	--	--	--	--
Station e1	6	1.75	1.56	1.61	0.97
Station e2	7	2.06	0.96	1.10	0.87
Station e3	8	2.55	1.21	1.39	0.87
Transect F	--	--	--	--	--
Station f1	3	0.87	1.10	1.10	1.00
Station f2	3	2.95	1.06	1.10	0.96
Station f3	10	2.92	2.02	2.08	0.97

* Birds/ha.

** Indicates no species seen while walking the transect.

Table C'6

Density, Diversity, and Equitability Measures for All Birds Counted on the Transects and at the Observation Stations During June 1977

Location	No. of Species	Total Density*	Species Diversity ($\bar{H}$)	$\bar{H}$ Max.	Equitability
Transect A	15	68.49	2.07	2.71	0.76
Station a1	13	11.20	1.94	2.56	0.76
Station a2	13	14.29	2.27	2.56	0.89
Transect B	20	57.16	2.17	3.00	0.72
Station b1	9	8.40	1.91	2.20	0.87
Station b2	12	9.00	2.13	2.48	0.86
Station b3	13	9.89	2.11	2.56	0.82
Transect C	21	42.51	2.37	3.05	0.78
Station c1	11	6.47	2.02	2.40	0.84
Station c2	11	6.46	2.10	2.40	0.88
Transect D	14	56.61	2.05	2.64	0.78
Station d1	18	10.15	2.58	2.89	0.89
Station d2	13	12.06	1.99	2.56	0.78
Station d3	12	15.33	2.11	2.48	0.85
Transect E	10	21.64	2.01	2.30	0.87
Station e1	13	5.47	2.28	2.56	0.89
Station e2	13	3.98	2.31	2.56	0.90
Station e3	15	7.35	2.58	2.71	0.95
Transect F	15	13.0	2.37	2.71	0.88
Station f1	13	7.0	2.00	2.56	0.78
Station f2	13	4.28	2.26	2.56	0.88
Station f3	11	3.68	2.05	2.40	0.85

* Birds/ha.

Table C'7

Density, Diversity, and Equitability Measures for All Birds Counted on the Transects and at the Observation Stations During July 1977

Location	No. of Species	Total Density*	Species Diversity ($\overline{H}$)	$\overline{H}$ Max.	Equitability
Transect A	22	64.25	2.38	3.09	0.76
Station a1	20	29.05	2.53	2.00	0.84
Station a2	15	15.77	2.22	2.71	0.82
Transect B	24	76.84	2.39	2.18	0.75
Station b1	15	17.36	2.16	2.71	0.80
Station b2	20	14.31	2.46	3.00	0.82
Station b3	13	12.82	2.18	2.56	0.85
Transect C	19	61.21	2.33	2.94	0.79
Station c1	17	11.05	2.51	2.83	0.89
Station c2	17	10.01	2.43	2.83	0.86
Transect D	18	37.40	2.41	2.89	0.83
Station d1	18	15.45	2.51	2.89	0.87
Station d2	20	24.48	2.10	3.00	0.70
Station d3	18	17.67	2.43	2.89	0.84
Transect E	10	29.13	1.87	2.30	0.81
Station e1	16	16.21	2.37	2.77	0.86
Station e2	14	8.38	2.35	2.64	0.89
Station e3	12	16.08	2.29	2.48	0.92
Transect F	16	48.14	2.48	2.77	0.90
Station f1	12	11.05	2.14	2.48	0.86
Station f2	14	8.54	2.46	2.64	0.93
Station f3	16	17.24	2.21	2.77	0.80

* Birds/ha.

Table C'8

Density, Diversity, and Equitability Measures for All Birds Counted on the Transects and at the Observation Stations During August 1977

Location	No. of Species	Total Density*	Species Diversity ($\bar{H}$)	$\bar{H}$ Max.	Equitability
Transect A	18	33.04	2.54	2.89	0.88
Station a1	17	23.58	2.57	2.83	0.91
Station a2	15	12.68	2.01	2.71	0.74
Transect B	19	52.55	1.99	2.94	0.68
Station b1	17	19.30	2.47	2.83	0.87
Station b2	14	10.46	2.05	2.64	0.78
Station b3	12	18.56	1.96	2.48	0.79
Transect C	17	49.46	2.24	2.83	0.79
Station c1	18	31.67	1.89	2.89	0.65
Station c2	12	29.20	1.58	2.48	0.64
Transect D	17	32.43	2.58	2.83	0.91
Station d1	12	10.91	2.12	2.48	0.85
Station d2	16	14.00	2.48	2.77	0.90
Station d3	15	21.82	2.31	2.71	0.85
Transect E	9	6.23	1.99	2.20	0.91
Station e1	18	18.71	2.02	2.89	0.70
Station e2	10	16.06	1.61	2.30	0.70
Station e3	15	31.95	1.80	2.71	0.66
Transect F	12	43.34	1.93	2.48	0.78
Station f1	16	27.99	1.99	2.77	0.72
Station f2	11	14.74	1.85	2.40	0.77
Station f3	14	24.31	2.15	2.64	0.81

* Birds/ha.

Appendix D´

Visitor Bird Species

Table D'1

List of "Visitor" Bird Species Seen on and Around Nott Island From Mid-March to August 1977

Pied-billed grebe
Double-crested cormorant
Green heron
Great blue heron
Little blue heron
Black-crowned night heron
Snowy egret
Least bittern
Mute swan
Mallard
Black duck
Redhead
Bufflehead
Common merganser
Osprey
Marsh hawk
American kestrel
Merlin
Red-tailed hawk
Turkey vulture
Ring-necked pheasant
Black-billed plover
Spotted sandpiper
Least sandpiper
Semipalmated sandpiper
Greater yellowlegs
Lesser yellowlegs
Herring gull
Great black-backed gull
Ring-billed gull
Common tern
Least tern
Belted kingfisher
Ruby-throated hummingbird
Eastern kingbird
Tree swallow
Barn swallow
Bank swallow
Blue jay
Common crow
Mockingbird
Wood thrush
Cedar waxwing
Loggerhead shrike
Common grackle
White-eyed vireo
Indigo bunting
Rufous-sided towhee

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.

Barry, William J

Habitat development field investigations, Nott Island upland habitat development site, Connecticut River, Connecticut; Appendix C: Postpropagation monitoring of vegetation and wildlife / by William J. Barry ... [et al.], Connecticut College, New London, Conn. Vicksburg, Miss. : U. S. Waterways Experiment Station ; Springfield, Va. : available from National Technical Information Service, 1978.

ii, 34, [67] p. : ill. ; 27 cm. (Technical report - U. S. Army Engineer Waterways Experiment Station ; D-78-25, Appendix C)

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Literature cited: p. 33-34.

1. Disposal areas. 2. Dredged material disposal. 3. Fauna. 4. Flora. 5. Habitat development. 6. Nott Island, Conn. 7. Waste disposal sites. 8. Wildlife habitat. 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 C.

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