PLANT COMPOSITION AND SPECIES RELATIONS-HUNTINGDON MARSH

This thesis is written in the form of a manuscript which has been accepted by the Canadian Journal of Botany for publication in its June 1973 issue. Use of a manuscript as a major part of a thesis is encouraged by the Department of Biology and fully accepted procedure in the Faculty of Graduate Studies and Research.

The appendix includes field data sheets identifying the raw data collected in each sample plot and summarized in the main part of the thesis.

The work involved in this research study has been entirely done by Josephine Pajaczkowski, with directives, advice and corrections offered by the thesis director, Dr. Allan N. Auclair, Associate Professor, Department of Biology, McGill University, and with field assistance and helpful discussion from M. André Bouchard, M.Sc., McGill University.

PLANT COMPOSITION AND SPECIES RELATIONS ON THE HUNTINGDON MARSH, QUEBEC

by

Josephine Pajaczkowski

A thesis presented to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of Master of Science

Department of Biology
McGill University
Montreal, Quebec

August 22, 1973

ABSTRACT

The purpose of this study was to identify significant species relationships and underlying ecological gradients characteristic of the Huntingdon Marsh, Quebec. In 1970, one hundred and seven 1 m^2 samples of plant biomass were obtained from the marsh in conjunction with environmental measurements. These data were later analyzed using principal components analysis.

The marsh complex divided unambiguously into emergent aquatic and sedge meadow communities on the basis of distinct environmental and compositional differences. Equisetum fluviatile, Scirpus fluviatilis, Eleocharis palustris, and Scirpus validus were major species in the emergent aquatic community. Respectively, these species dominated 29, 25, 16, and 14% of 51 quadrats on a dry weight basis. Water depth accounted for almost one-third of the variation in this vegetation. Interaction between submerged and floating forms and competitive exclusion between dominant species explained much of the remaining variation.

On a dry weight basis, Carex aquatilis, C. lacustris, Calamagrostis canadensis, and Typha angustifolia dominated 36, 16, and 11% of the 56 quadrats on the sedge meadow. As a group, Carex spp. dominated 63% of the quadrats. Disturbance related to chance perturbations, water depth, and the incidence of fire accounted for much of the variation in this vegetation.

The organization of emergent and sedge meadow communities was discussed in relation to continuum and community concepts with particular reference to relative changes in discontinuity of species relationships across the environmental gradient.

RESUME

Le but de cette étude était d'identifier les relations significatives entre espèces et les gradients écologiques caractéristiques du Marais Huntingdon, Québec. En 1970, 107 échantillons d'un mètre carré de biomasse végétale ont été prélevés dans le marécage, concurremment avec des mesures de l'environnement. Ces données ont été analysées plus tard à l'aide de l'analyse des composantes principales.

Le complexe marécageux était clairement divisé en communautés aquatiques émergentes et en prés de laîches. Equisetum fluviatile, Scirpus fluviatilis, Eleocharis palustris, Scirpus validus sont les espèces principales de la communanté aquatique émergente. Ces espèces dominaient respectivement 29, 25, 16 et 14% de 51 quadrats, d'après le poids sec. La pronfondeur de l'eau est responsable pour presqu'un tiers de la variation des espèces dans cette communauté. L'interaction entre les formes submergées et flottantes et l'exclusion compétitive entre les espèces dominantes ont expliqué une grande partie du reste de la variance des espèces.

Sur une base de poids sec, Carex aquatilis, C. lacustris, Calamagrostis canadensis et Typha angustifolia dominaient 36, 16, 16 et 11% des 56 quadrats dans les prés de laîches. En tant que groupe, les espèces de Carex ont dominé 63% des quadrats. Le dérangement relié à des perturbations accidentelles, la profondeur de l'eau et l'incidence du feu étaient responsables d'une grande partie de la variation dans cette communauté.

L'organisation des communautés émergentes et des prés de laîches est discutée en rapport avec les concepts du continuum et de la communauté, en tenant compte particulièrement des changements relatifs dans la discontinuité des relations entre espèces en travers du gradient de l'environnement.

(Traduit par le journal)

ACKNOWLEDGEMENTS

I should like to thank Dr. Allan N. Auclair, my thesis director, for his support and help during the course of this study. Mr. André Bouchard, M.Sc. McGill University, for suggesting the possibility and the need of studying a marsh ecosystem, and for his encouragement and assistance in the gathering of field data and in the many fruitful discussions that ensued. Dr. B. Boivin of the National Herbarium, Ottawa, Dr. L. Cinq-Mars, Laval University, Dr. W. Dore, Dept. of Agriculture, Ottawa, Dr. M. Harbert of McGill University, for their invaluable assistance in identifying taxonomically difficult species. Mr. Pierre Bellefleur, M.Sc. McGill, who so graciously helped with the graphs. The Canadian Wildlife Service prepared an initial map of the area. Mr. Gérard Godbout, Division des Sols, Ste.-Anne-de-la Pocatiére, Quebec, for the soil analyses. Les Fréres-du-Sacré-Coeur who so generously permitted use of their premises during the field season.

Appreciation is also expressed for the use of facilities and other assistance provided by the staff of the Department of Biology, McGill University.

I am further indebted to the following for their generous support throughout this study: The Montreal Catholic School Commission (1970), La Congrégation de Notre Dame, Montreal (1971), National Research Council of Canada grants A-6120 and C-135.

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INTRODUCTION

This study of the Huntingdon Marsh in southern Quebec represents one of the few attempts to analyze freshwater marsh vegetation in this region. As part of the largest watershed on the North American continent, there have been surprisingly few studies of the aquatic and wetland vegetation of the St. Lawrence River. This is particularly true of the numerous and often extensive marshes along its 1200-km length. These wetlands serve as an important breeding and staging area for migratory waterfowl and harbour a rich variety of wildlife.

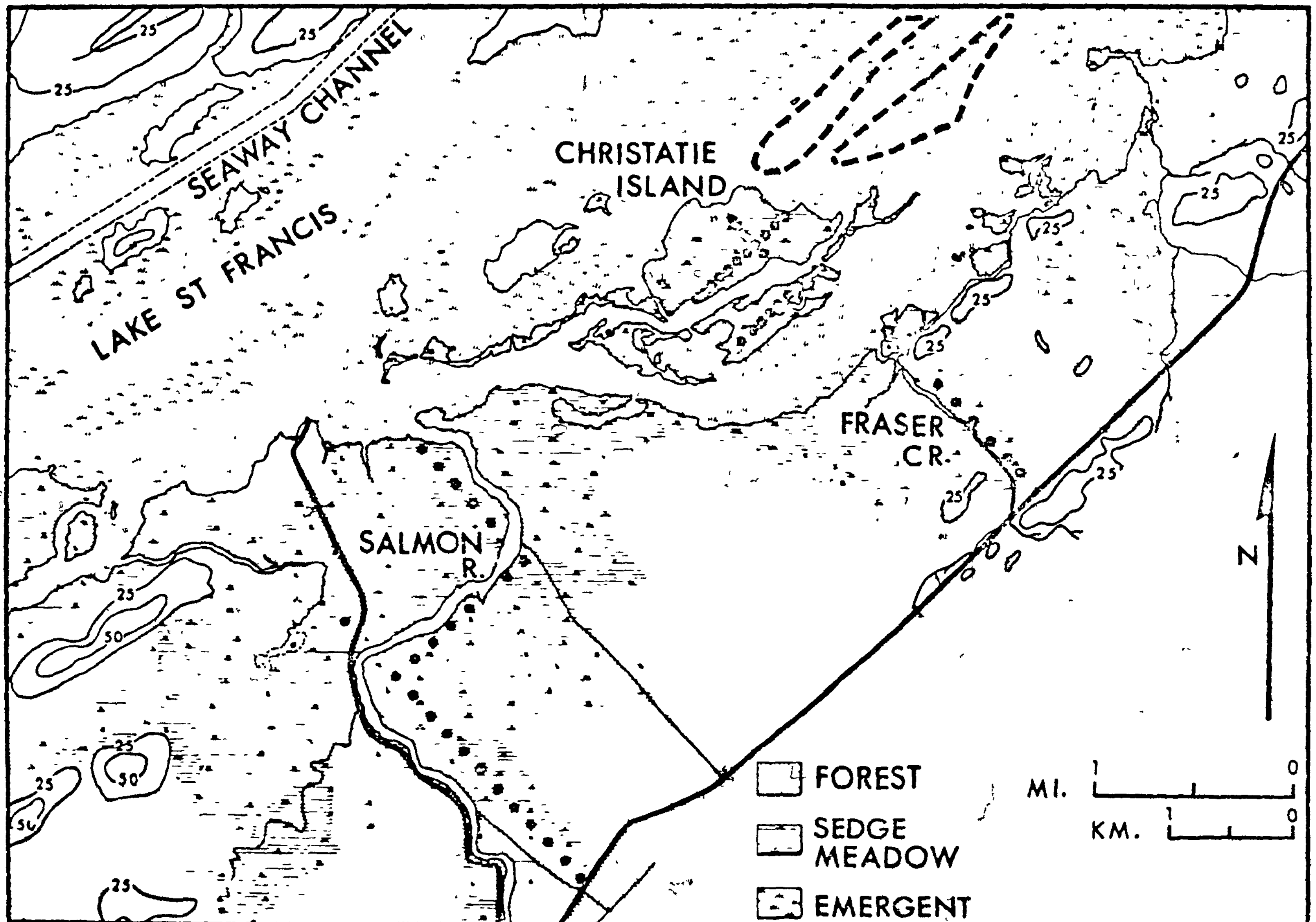
Previous studies on aquatic and wetland communities in this region have been largely floristic and (or) descriptive (Dansereau 1959; Desmarais 1953; Dore and Gillet 1955; Grandtner 1966; Lacoursiére and Grandtner 1971; Lamoureux 1971; Marency-Cartier 1966; Pageau 1959). Quantitative studies on similar communities have been largely confined to midwestern regions of the continent (Jeglum et al. 1971; Natelson 1954; Smeins 1967; Stout 1914; Swindale and Curtis 1957; Walker and Coupland 1968, Walker and Wehrhahn 1971). Most of these studies have dealt analytically with environmental influences. Studies by Curtis (1959), Harris and Marshall (1963), Smeins (1967), Walker and Wehrhahn (1971), and Walker (1966) have repeatedly shown the importance of water depth variation and disturbance on marsh vegetation. Studies by Misra (1938), Moyle (1945), Sculthorpe (1967), Spence (1967), and Swindale and Curtis (1957) are particularly illustrative of the chemical, edaphic, and other environmental influences on the distribution of freshwater macrophytes of north temperate areas.

The purpose of this study is to identify and compare significant species relations and underlying environmental gradients characteristic of emergent aquatic and sedge meadow vegetation. A variety of studies (Beals 1969; ~~Whittaker 1956, 1967, 1970~~) have indicated the tendency of community organization to increase in relative discontinuity from favorable environments with high species diversity to more extreme environments of low species diversity. These comparisons of community relations across large environmental gradients have done much to clarify the long-standing issues of continuum versus community. This study offers a unique opportunity to examine these concepts across differences in dusturbance and environmental rigor.

The Study Area: The Huntingdon Marsh borders Lake St. Francis at the junction of the New York, Ontario, and Quebec borders (Fig. 1), 45°04' N at 74°30' W. Lake St. Francis is an enlargement of the St. Lawrence River, 80 km southwest of Montreal, Quebec. The marsh is a natural vegetation complex about 25 km^2, bordered by deciduous forest and dairy farmland. Despite its accessibility by road and proximity to population centers, the sedge meadow of the mainland area has remained notably free of human disturbance. Use of the emergent area is confined to seasonal hunting of waterfowl from boats secured among strands in shallow water.

Climate: The regional climate of the study area is characterized by abundant rainfall and great seasonality in air temperature. The mean annual temperature is 5.7C. Recorded daily extremes across the year are -42C and 32C. The mean number of frost-free days per year is 120 (May 15-Oct. 1). The number of degree-days above 5.6C is 3500, suggesting a relatively favorable growing season.

Fig. 1. Map of the Huntingdon Marsh, showing general vegetation and topography based on Canadian Hydrographic Services, Ottawa, Map 1413, 1968 edition (contours in feet). Flow of the lake is to the northeast. Points identify the location of quadrats on the sedge meadow. Sample sites in emergent aquatic community are bounded by broken lines east of Christatie Island.


SEAWAY CHANNEL
LAKE ST FRANCIS
CHRISTATIE ISLAND
FRASER CR.
SALMON R.
N
FOREST
SEDGE MEADOW
EMERGENT
MI. 1 0
KM. 1 0
25
50

Precipitation is abundant and does not show marked seasonal variation. Annual mean precipitation is 101 cm including 229 cm of snow. Evaporation exceeds precipitation in June, July, and August with a net moisture deficit of 31.2 cm during these months. Winds prevail from the southwest in summer and from northwest in winter. Wilson (1971) recently summarized the climate of Quebec. Other climatic summaries pertinent to this area include the Atlas of Canada (1957), Fernald and Gagnon (1967), and Villeneuve (1967).

Hydrology: Although Lake St. Francis is a natural enlargement of the St. Lawrence River, it has been impounded by the Beauharnois Dam since 1932. Average discharge at this point is 6500 $m^3.s^{-1}$. Since 1895, several successive structures in the vicinity of the present dam were used for water diversion. Since these diversions were minor (95-285 $m^3.s^{-1}$ or 1.5-4.5% of average discharge) their impact on the Lake St. Francis basin is presumed insignificant. The Beauharnois impoundment, however, has had the following notable effect.

1. The raised water table favored extension of marshland on the lake periphery. This change was sufficient to affect agricultural areas inland from the lake.
2. As a result of enlargement of the river, rate of water flow in Lake St. Francis decelerates. Siltation tends to be pronounced, especially in

shallow water on the southern shores of the lake. This tendency was likely increased by the impoundment.

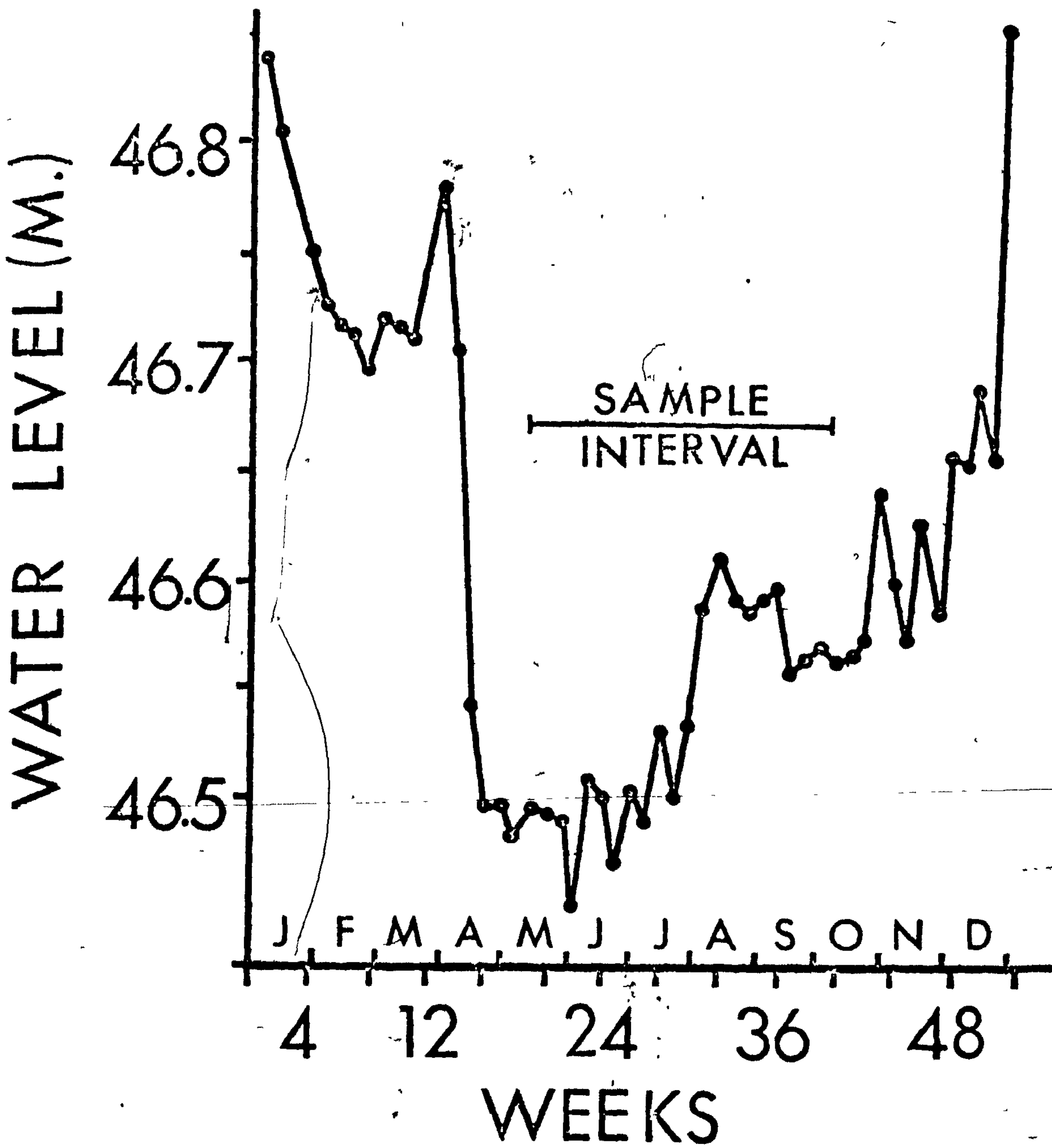
3. The water level was stabilized at 46.6 m. Normal flooding patterns associated with rapid snowmelt in spring and the lowering of the water table throughout the summer no longer occur. It is difficult to overemphasize the significance of this feature. The composition and structure of aquatic and lowland communities are closely associated with the nature and extent of fluctuations in water level (Sculthorpe 1967).

Contrary to natural fluctuation patterns, annual variation is small ($\pm$ 20 cm) and inverse, that is, water level is minimum in the spring and increases across the growing season. Records for Lake St. Francis taken at Summerstown, Ontario (Fig. 2), show an abrupt drop in water level during the first 2 weeks in March and a gradual increase through the last week in December. Management of water level on the lake is associated with flood control and shipping on the St. Lawrence Seaway. The sudden drop in March preceding or coinciding with snowmelt also serves to clear the river of ice. We presume that it is at this time that much of the organic accumulation of dead stems caught or gouged by ice is lost from the emergent aquatic community. Moreover, water level minimum (May 27) coincides with renewed growth activity. The slightly shallower water and influx of relatively warm water from downstream at this time likely accelerate temperature and nutrient change favoring early and rapid growth initiation.

Lake water in the study area (Fig. 1) is relatively clear and only slightly to moderately polluted.

Drainage of sedge meadow on the mainland and land bordering Christatie Island (Fig. 1) is typically poor. Although several streams exist on the mainland portion, relief is insufficient to cause rapid water flow, and shallow

Fig. 2. Weekly mean water level on Lake St. Francis based on St. Lawrence Seaway Authority daily observations at Summerstown, Ontario for 1970. Horizontal line indicates the interval of field sampling.


WATER LEVEL (M.)
46.8
46.7
46.6
46.5
SAMPLE INTERVAL
J F M A M J J A S O N D
4 12 24 36 48
WEEKS

depressions of standing water are common. The water table is at or slightly above the soil surface. Whether it coincides closely with water levels in the lake proper is not known.

Soil: The emergents were sampled downstream from Christatie Island (Fig. 1) in an area typified by shallow (58-126 cm), quiet water. Soils are silt and fine sandy silt on undulating topography intersected by channels 3 - 15m deep. The transition in depth is abrupt and coincides with moving water. Deposition in shallow water is accentuated by the presence of vegetation which in turn promotes succession to vegetation of greater biomass and the eventual formation of organic soils. In the study area, there is little or no organic accumulation except from root mass; the previous year's standing crop is almost totally removed in fall and spring.

Soils in sedge meadow are semidecomposed organic accumulations underlain by clay at 60 cm or more. Mineral concentrations of the organic portion are low. The soil surface is slightly above, to 25 cm below, the water table. Since optimal temperatures for decomposition by microorganisms and photosynthesis by higher plants differ by as much as 15C, organic accumulation is favored in wet soils of cool climates. Important features of these soils are the generally anaerobic, reducing conditions and air-soil temperature lag in the spring, which likely impose limiting stresses on plant growth.

The nutrient contents of the sedge meadow and emergent soils contrast sharply in most macronutrients. The organic soils of sedge meadow are slightly acidic (pH 5.6) and high in organic matter (72.5%), C (42.9%), N (2.0%), and H ions (21.1 meq/100 g). The silt sediments of the aquatic emergent areas are nearly neutral (pH 6.6) but low in these elements (5.5%, 3.2%, 0.2%, 0.1 meq/100 g, respectively). The aquatic sediments have about one-third the concentrations of available K, Na, Ca, Mg (0.5, 0.4, 14.7, 2.1 meq/100 g) compared to soils in sedge meadow (1.6, 1.0, 48.6, 9.6 meq/100 g, respectively). However, the aquatic sediments are high in available phosphorus (P_2O_5, 11.8 mg/100 g) compared with soils in sedge meadow (8.1 mg/100 g). These mean values are based on actual elemental analysis of the top meter of soil in each quadrat and are expressed per unit dry weight.

Vegetation: Communities in the Huntingdon Marsh complex can be unambiguously distinguished as emergent aquatic and sedge meadow. This division is based on the sharp dividing line between open water and terrestrial lowland formed by the autogenic accumulation of peat (Curtis 1959).

The emergent aquatic community consists of strands occupying the crests of shallow underwater ridges in areas of relatively quiet water. Dominants include emergent species of Eleocharis, Equisetum, Phragmites, and Scirpus. Associates of lesser importance include floating species such as Ceratophyllum, Lemna, and Vallisneria, and submerged species including Elodea, Myriophyllum, and Potamogeton. A strong tendency among the emergent dominants to exclude each other results in a mosaic to nearly monospecific communities. This is especially characteristic in our study area.

Sedge meadow is defined as an open community typically on low positions of the regional catena, characterized by excess soil water and in which at least half the dominance is in Carex (Curtis 1959). Toward wetter conditions sedge meadow grades into Typha, Scirpus, or other emergent aquatic groups. Disturbance has generally been considered the major control on variation within this vegetation (Curtis 1959; Walker and Wehrhahn 1971). Other characteristic features are the presence of hummocks and requirement for fire to maintain the prevalence of Carex against invasion by Alnus and Salix shrubs (Zicker 1955; Curtis 1959). In contrast to emergent aquatic communities, sedge meadows are diverse in species and lack the pronounced dominance and segregation of species. Gradients in the vegetation and environment are subdued and generally difficult to discern. Sedge meadow on the Huntingdon Marsh showed all these features. Dominant species included *Carex aquatilis*, *C. lanuginosa*, *Calamagrostis canadensis*, and *Typha angustifolia*.

METHODS

Field Procedures: Initial reconnaisance revealed two distinct communities. Sedge meadow and emergent community types obviously differed in composition and structure. Our field and analytical procedures were therefore kept separate.

Emergent Aquatic Community: This community was sampled using 51 quadrats in a restricted area downstream from Christatie Island (Fig. 1). In this area, the emergent species were particularly prominent. Restricting the samples to this area had two notable effects. (1) The restricted sample could not be used to represent the lake as a whole. We noted during the study, for example, that water depth and exposure to wave action (both greater in more open water) have a strong influence on the composition and structure of the community. (2) The sample represented well-developed (mature) emergent aquatic vegetation typical of shallow, quiet water. In this manner, we limited our study to relatively late successional stages of development.

Sampling in the emergent aquatic vegetation presented us with major operational difficulties in the field. These problems stemmed largely from the mosaic nature of the vegetation which tended to be both strongly patterned and typically present as irregular strands interspersed with open water.

Most aquatic habitats, and particularly those with patchy distributions such as this one, present the ecologist with unique and difficult sampling problems (Greig-Smith 1964; Holme 1965). Systematic sampling using transfers or a grid would have been extremely inefficient and was abandoned early in the study as impractical. The alternative of randomizing the location of sampling points would have been preferable (Finney 1950) but was also considered impractical for the same reasons.

Samples of the emergent aquatic complex were located subjectively to include most of the site and vegetational variation apparent in this community. There was no feasible procedure whereby this subjective judgement could be avoided. It was possible, however, to greatly minimize this influence by the use of a properly chosen set of criteria. Three criteria were applied in the decision to include or reject a particular sample. (1) At least one emergent species had to be present. (2) For each sample the water depth had to differ from previous samples of that vegetation type. In this manner, the study of a water depth gradient was possible. (3) All existing emergent vegetation types were sampled in proportion to their areal extent. This was greatly facilitated by the restricted, contiguous nature of the area sampled.

Although randomized or systematic sampling was not applied, our procedures were carefully formulated to minimize those biases commonly associated with 'preference sampling'. Since our prime objective was to establish species-environment relationships, we felt that sampling across the range of site and vegetation conditions, and hence incorporating as much of the existing variation as possible, was ~~more important than a~~ summary of structural attributes (e.g. species frequency, relative density, relative biomass) of the emergent vegetation as a whole. Most experimental studies using regression seek to measure response for selected intervals and a meaningful range of the independent variable. These conditions are often prejudged on the basis of prior experience and (or) hypotheses generated from other evidence. In this study, having had only cursory knowledge of the vegetation and physical conditions before sampling, we made no assumptions regarding the existing relationships. A possible exception is the importance of water depth variations, which were sufficiently strong to be an obvious correlate with differences in the vegetation.

It is instructive, nevertheless, to examine the outcome of possible bias in species relationships as a result of subjective choice of sample sites. If a preference existed (subconscious or otherwise) for dense stands of Scirpus validus, for example, this bias would have been expressed in the range of densities sampled and this may have provided an important source of omission. As indicated, it was this type of bias that our criteria were designed to avoid. Moreover, unlike in experimental situations where one or two variables are being controlled, the fact that nature is complex and typically multicausal usually limits the influence of subjectivity to one or two out of many relevant variables.

Sedge Meadow Community: Sampling in this community was restricted to sedge meadow proper. Transitional areas between sedge meadow and forest were not considered in this study. In this manner we minimized primary successional influences. Areas of most interest, therefore, tended to be low-lying sections of the marsh adjacent to the river or creeks draining the sedge meadow (Fig. 1).

A factor of practical but secondary importance was accessibility. Since aboveground standing crop was obtained in 1 m^2 quadrats, wet weight of these samples was frequently considerable. Access on foot under such conditions was severely hindered by the presence of hummocks, standing water, and floating mats.

A major consideration of the sampling method was to obtain sufficient variation between samples to expose most of the significant biological relationships. Given this consideration, the following factors favored the use of systematic as opposed to randomized sampling procedure on the sedge meadow. (1) Systematic procedures are more efficient if interest centers on representing of variations within an area (Greig-Smith 1964). (2) The procedure is more accurate than randomized sampling where the pattern of variation is subdued (Finney 1950). (3) The procedure is operationally easier in the field (Greig-Smith 1964). In this study seven linear transects were positioned on sedge meadow (Fig. 1). Samples were located at 200 m intervals on the four mainland transects (30 quadrats) and at 100 m intervals on the three island transects (26 quadrats).

If vegetation summaries are desired, systematic sampling must provide uniform representation over the area (Greig-Smith 1964). In this study, Christatie Island was sampled at twice the intensity as the mainland meadow. This was intended since variation on the islands was considered as important as that on the mainland. The approximately equal number of quadrats in each area reflects this consideration. Since a quantitative summary of sedge meadow attributes was of incidental interest, our procedures do not strictly conform to the criterion for areal uniformity and summary values (e.g. frequency, Table 2) used to represent the entire meadow must be regarded as approximations.

Sampling: At each site in both sedge meadow and emergent aquatic areas plants from 1 m^2 quadrats were harvested at ground level. Live and dead shoots rooted in the quadrats were collected and dried to constant weight at room temperature. Live shoots were subsequently separated by species and weighed. Dead shoots were weighed collectively. Other measurements not dealt with in this paper included species

Table I. Average relative dry weight for quadrats of occurrence, percentage occurrence across 51 quadrats (frequency), and factor loadings (F) on principal components I-V for 14 species in emergent aquatic community.

TABLE I. Average relative dry weight for quadrats of occurrence, percent occurrence across 51 quadrats (frequency) and factor loadings on principal components I-V for 14 species in emergent aquatic community.

No	Species	Relative Dry Weight %	Frequency %	F_1	F_2	F_3	F_4	F_5
1	Alisma triviale	2.38	3.92	0.59	0.53	0.16	-0.02	-0.01
2	Ceratophyllum demersum	3.37	29.41	0.72	-0.42	-0.30	-0.21	0.07
3	Eleocharis palustris	32.64	37.25	0.16	-0.04	0.04	0.92	-0.18
4	Eleodea canadensis	0.79	25.49	0.73	0.50	0.13	-0.03	-0.01
5	Equisetum fluviatile	57.35	45.09	-0.22	-0.19	0.69	-0.21	-0.04
6	Lemna trisulca	1.56	86.27	0.63	-0.52	-0.19	-0.31	0.05
7	Myriophyllum exalbescens	0.80	39.21	0.88	0.16	-0.05	-0.06	0.01
8	Phragmites communis	99.92	13.72	-0.19	0.13	-0.22	0.22	0.89
9	Potamogeton zosteriformis	3.03	31.37	0.74	0.58	0.17	-0.06	-0.01
10	Scirpus fluviatilis	99.86	25.49	-0.29	-0.24	-0.57	-0.31	-0.57
11	Scirpus validus	26.41	58.82	0.59	-0.47	0.28	0.13	-0.08
12	Typha angustifolia	0.00	1.96	-0.06	0.04	-0.07	0.01	0.09
13	Vallisneria americana	4.35	21.56	0.53	-0.50	0.30	0.24	-0.01
14	Algae	1.90	23.52	-0.01	-0.32	0.58	-0.24	-0.04
	Eigenvalues (%)			28.76	14.82	11.39	9.23	8.53

Table II. Average relative dry weight for quadrats of occurrence, percentage occurrence across 56 quadrats (frequency), and factor loadings (F) on principal components I-V for 56 species in the sedge meadow community.

TABLE II. Average relative dry weight for quadrats of occurrence, percent occurrence across 56 quadrats (frequency) and factor loadings on principal components I-V for 56 species in the sedge meadow community.

No	Species	Relative Dry Weight %	Frequency %	F_1	F_2	F_3	F_4	F_5
1	Acorus calamus	8.01	8.92	0.07	-0.02	-0.07	0.21	0.02
2	Anemone canadensis	0.01	1.78	0.53	0.78	-0.06	-0.28	0.01
3	Asclepias syriaca	0.03	1.78	0.56	0.76	-0.16	0.10	-0.07
4	Bidens discoidea	0.19	8.92	-0.73	0.52	-0.28	0.04	-0.22
5	Calamagrostis canadensis	17.95	87.50	0.11	0.23	0.08	0.22	0.44
6	Campanula aparinoides	0.22	42.00	-0.60	0.28	-0.08	-0.04	0.36
7	Campanula rotundifolia	0.39	2.00	-0.15	0.14	0.68	0.17	0.17
8	Carex aquatilis	42.56	36.00	-0.13	-0.16	-0.10	-0.40	-0.13
9	Carex diandra	7.30	25.00	0.01	-0.04	0.10	-0.03	-0.10
10	Carex lacustris	29.56	51.78	0.26	0.17	-0.29	0.57	0.04
11	Carex lanuginosa	13.28	30.35	-0.14	0.14	0.89	0.13	0.22
12	Carex sartwelli	12.71	3.57	-0.02	0.01	0.02	0.04	0.27
13	Carex stricta	9.48	41.07	-0.02	-0.01	-0.01	0.02	0.64
14	Cicuta bulbifera	0.04	25.00	-0.22	0.14	-0.16	0.08	0.14
15	Convolvulus sepium	0.18	5.35	-0.74	0.44	-0.25	-0.03	-0.18
16	Drosera rotundifolia	0.07	3.57	0.33	0.66	0.53	-0.10	-0.15
17	Dryopteris thelypteris	2.30	53.57	-0.70	0.39	0.16	-0.03	0.16
18	Eleocharis compressa	0.17	3.57	0.15	0.13	-0.19	0.74	-0.25
19	Epilobium leptophyllum	0.04	1.78	0.53	0.78	-0.06	-0.28	0.01
20	Equisetum arvense	0.02	1.78	0.55	0.79	-0.09	-0.13	-0.04
21	Equisetum fluviatile	5.76	32.14	-0.18	0.16	0.73	0.19	0.24
22	Equisetum hyemale	2.08	1.78	0.55	0.79	-0.09	-0.13	-0.04
23	Galium aparine	0.12	14.28	-0.78	0.48	-0.25	-0.04	-0.20
24	Galium palustre	0.02	64.28	-0.02	-0.01	-0.09	-0.06	0.61
25	Hypericum virginicum	0.11	32.14	-0.01	-0.10	-0.02	-0.27	-0.10
26	Impatiens carpensis	0.41	32.14	0.01	-0.03	-0.05	0.01	0.01
27	Iris versicolor	3.68	17.85	-0.79	0.48	-0.05	-0.02	-0.19
28	Lathyrus palustris	0.17	7.14	-0.12	0.02	-0.02	-0.05	0.31
29	Liparis loeselii	0.07	3.57	-0.03	0.13	0.78	0.12	-0.19
30	Lycopus europaeus	0.17	10.17	0.56	0.78	-0.10	-0.14	-0.04

TABLE II (cont'd)

No	Species	Relative Dry Weight %	Frequency %	F_1	F_2	F_3	F_4	F_5
31	Lycopus virginicus	0.15	44.64	0.47	0.74	-0.07	-0.28	0.21
32	Lysimachia thysiflora	0.18	75.00	-0.74	0.41	-0.19	0.02	0.03
33	Lythrum salicaria	2.09	25.00	-0.05	0.09	0.11	0.05	0.23
34	Menyanthes trifoliata	7.26	3.57	-0.09	0.04	0.14	0.06	0.19
35	Onoclea sensibilis	0.81	21.42	-0.04	-0.01	-0.09	-0.02	0.22
36	Osmunda regalis	0.34	1.78	-0.05	0.11	0.45	0.06	-0.13
37	Pastinaca sativa	0.04	1.78	0.05	-0.03	-0.05	0.15	0.03
38	Phragmites communis	10.89	5.35	0.02	-0.10	0.01	-0.18	-0.23
39	Polygonum amphibium	0.38	12.50	0.02	-0.11	-0.06	-0.14	-0.02
40	Potentilla palustris	0.86	28.57	-0.002	-0.13	0.10	-0.23	-0.30
41	Rumex orbiculatus	0.31	12.50	0.06	0.01	-0.16	0.27	0.26
42	Sagittaria latifolia	0.48	19.64	-0.42	0.30	0.44	0.14	0.16
43	Sagittaria rigida	0.42	1.78	0.01	-0.04	-0.03	0.04	0.07
44	Salix sp.	0.22	3.57	-0.04	0.14	0.80	0.12	-0.20
45	Scirpus validus	6.55	1.78	0.01	-0.07	-0.03	-0.05	-0.08
46	Scutellaria epilobiifolia	0.38	5.35	-0.10	0.02	-0.08	-0.01	0.21
47	Sparganium eurycarpus	9.77	21.42	0.01	-0.09	-0.06	-0.03	-0.01
48	Spirea alba	1.00	1.78	0.12	0.05	-0.17	0.46	-0.02
49	Trifolium sp.	0.04	1.78	0.16	0.13	-0.21	0.77	-0.24
50	Typha angustifolia	27.50	44.64	0.01	-0.17	-0.07	-0.12	-0.19
51	Typha latifolia	2.69	1.78	-0.78	0.48	-0.25	-0.04	-0.20
52	Utricularia minor	0.04	5.35	0.13	0.09	-0.19	0.67	-0.28
53	Utricularia vulgaris	0.04	32.14	0.01	-0.03	0.37	-0.02	-0.26
54	Viola pallens	0.01	19.64	-0.03	0.02	-0.08	-0.003	0.64
55	Viola cucullata	0.01	1.78	0.01	0.07	0.04	-0.14	0.08
56	Mosses	13.84	69.64	-0.06	-0.27	0.05	-0.36	-0.35
	Eigenvalues (%)			12.15	11.11	8.51	6.02	5.71

phenology density and average height of each species, and water depth. Soil samples were taken at 0- to 20-cm and 20- to 100-cm depths for chemical analysis. Sampling was carried out from May 15 to October 4, 1970.

Taxonomically problematic specimens were sent out for identification. Voucher specimens have been deposited in the McGill Herbarium. Taxonomical nomenclature follows Gray's Manual (Fernald 1950).

Analytical Procedures: The objective of our analysis was to identify the major species-interrelationships on the Huntingdon Marsh without prior knowledge of their relative importance. This knowledge would permit us to focus on those factors which are likely to be of overriding importance in determining the occurrence of species and kinds of vegetation. Since the number of factors affecting plants is very large and the species gradients difficult to discern, it was implicit that the analytical approach would be multivariate and capable of extracting latent structure (Horst 1965) or organization from a dataset showing a high degree of interrelationship among its variables. Requirements of the analytical procedure also included statistical rigour, known mathematical properties and simplicity in extracting species interrelationships.

Principal-Components Analysis: With the large number of variables being considered, the most efficient approach is likely a factor analysis, which has been shown (Goff and Cottam 1967; Goodall 1954; Orloci 1966, 1967) to be applicable to this type of data. In this study, we used principal-components analysis (PCA). This technique differs from factor analysis proper in determining the minimum number of independent dimensions needed to account for most of the variance in the original set of variables (Cooley and Lohnes 1971). Other considerations in our choice of PCA include the following:

1. PCA is especially valuable in generating hypotheses regarding the effect and nature of major controls where complex interrelations exist among a large number of variables. It has proven an effective summary and exploratory technique of greatest value in the initial stages of study (Gittins 1968; Orloci 1966).

2. Recently PCA has been widely applied in ecological studies of a similar nature (Ferrari and Mol 1967; Gittins 1968; Walker and Wehrhahn 1971). As a result of its continued application in ecology, limitations of the technique and its properties in relation to early ordination methods are increasingly known (Austin and Noy-Meir 1971; Goff and Cottam 1967; Noy-Meir and Austin 1970; Orloci 1966; Swan et al. 1971).

3. Since factor loadings express the relationship of each variable with successive components, similar and dissimilar patterns of variability are easily seen. Each component is independent (i.e. uncorrelated with other components), linear, and associated with computed levels of variability. This both provides a means of dealing with a large degree of interdependency among variables and facilitates the construction of spatial models. Unlike in multiple regression procedures in which the choice of variables is dependent on complex criteria, the relationship among variables in PCA are simply retained and at once more easily conceptualized. PCA is regarded as the most objective ordination method in general ecological use (Orloci 1966).

An important consideration in the use of PCA is whether to standardize the original variates (Pielou 1969). If they are standardized, the covariance matrix is replaced by a correlation matrix but the analysis is otherwise unaltered. For reasons discussed later, we used Pearson's product-moment correlation coefficient.

Another question is whether or not to rotate the components. Thurstone (1947) recommends rotation to the simple structure, claiming that it helps elucidate the underlying gradients. In their analysis of heath vegetation, Ivimey-Cook and Proctor (1967) obtained rotated solutions using Kaiser's (1958) varimax criterion that were more readily interpretable than the original components. For these reasons we attempted both unrotated and varimax-rotated solutions of the components in this study. Since the rotated solutions did not facilitate an interpretation of either model, no further use will be made of them in this paper.

Computer facilities at the McGill Computing Center were used for our analysis. The PCA program consisted of IBM System/360 Scientific Subroutine Package (Programmers Manual 360A-CM-03X, Version 3) routines. All computation on floating-point numbers was in double precision.

Correlation Matrix: For each quadrat, the dry weight and other measurements on each species were transferred to IBM cards. The second step computed a species X species correlation matrix for each of the emergent and sedge meadow datasets separately. The emergent set consists of 14 species and 51 quadrats. The sedge meadow set has 56 species and 56 quadrats. The magnitudes used in the correlation coefficient are species dry weights. Since a species X species matrix is used, PCA is of the R-type as opposed to the Q-technique when a stand X stand matrix is used (Orloci 1967).

Analytical Models: Species models for emergent and sedge meadow communities were constructed based on their factor loadings on the first three principal components. Since only plant species were used in the PCA, our knowledge of the species from the field and literature on species behavior was used to interpret major environmental gradients.

Obviously, a complete understanding of species response is dependent on relations to individual environmental factors. To alleviate this difficulty we examined the principal components in relation to water depth and total quadrat biomass. This was accomplished by calculating the species weighted mean depth and biomass across all quadrats of occurrence. For example, mean water depth for Carex stricta in sedge meadow was computed as the product of water depth and the species dry weight. These products were then averaged across the 23 quadrats of occurrence for this species. Water depth and total biomass were chosen to represent important environment and growth parameters, respectively.

RESULTS AND DISCUSSION

Composition

Emergent Aquatic: The emergent community is typified by low diversity of species. Of the 14 species present (Table 1) only six occur as dominants (based on dry weight measurements). These are invariably the emergent growth forms used as a basis for selecting the sample areas. Of these, Equisetum fluviatile (29.4%) and Scirpus fluviatilis (25.0%) were dominant in the greatest number of quadrats. Among the other dominant species (Eleocharis palustris, Scirpus validus, Phragmites communis, Typha angustifolia) only Typha angustifolia is infrequent, occurring in but one quadrat.

As a group the floating and submerged plants, although less in biomass, occur with high frequency. This is especially true of the small duckweed Lemna trisulca (86.3% occurrence), which is widely dispersed by wave action. Other species in this group with greater than 20% occurrence include

Myriophyllum exalbescens, *Potamogeton zosteriformis*, *Ceratophyllum demersum*, *Elodea canadensis*, and *Vallisneria americana*.

The composition of these communities shows a close relationship with other emergent aquatic communities in the north temperate zone (Curtis 1959). The consistent association of these species across the circum-temperature regions is generally acknowledged (Sculthorpe 1967). A further distinction is the high specifity of these species to the emergent aquatic habitat. Of the 34 major community types in Wisconsin (Curtis 1959, p. 633), these species occur in an average of 2.4 types, suggesting narrow specialization to the aquatic environment. By contrast, species in sedge meadow in common with Wisconsin occur in an average of 7.8 community types or 3 times as many.

Sedge Meadow: The diverse complement of species in sedge meadow (56 species) contrasts with the small number of dominants in this community. Only four species were dominant (dry weight basis) in 10% or more of the quadrats (Table 2). *Carex aquatilis* is by far the outstanding species, dominating 35.7% of all quadrats. In total, *Carex* spp. (*C. lacustris* 16.1%, *C. lanuginosa* 5.4%, *C. stricta* 3.6%, *C. diandra* 1.8%) dominated 62.6% of all quadrats. This is the same percentage (63%) noted for sedge meadow in southern Wisconsin (Stout 1914). Other important dominants were *Calamagrostis canadensis* (16.1%) and *Typha angustifolia* (10.7%).

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A large number of other species occur as frequent but minor components of the biomass. Apart from the 4 clearly dominant species, 18 have frequencies of 20% or more. A significant number of these are 'weeds', that is, ecological opportunists showing generalist tendencies and typically occupying a wide range of differing habitats. These species are discussed further in the next section.

Species Relations

The Correlation Matrix: Since species magnitudes (dry weight, $g.m^{-2}$) were used as the basis of the correlation coefficient, the implication of dry weight measurements to represent ecological relations is important. The correlation coefficient is dependent both on mutual presence or absence and colinearities in variation patterns of dry weight. To have a high positive correlation, two species must be present in or absent from the same quadrats and have similar periods of growth across the season (but not necessarily the same growth rates or accumulated biomasses). The use of dry weight correlations as in this study implies more than the capability to survive in the same habitats. It also implies similarity in growth pattern across the entire sampling interval.

The correlation coefficient also affects dominant and less species differently. Since dispersion is used to scale the coefficient, those species whose abundances vary only slightly (usually the less abundant species) will have higher correlations and a greater influence in the factor analysis than if unstandardized values (e.g. covariances) were used (Seal 1964, Pielou 1969). Walker and Wehrhahn (1971) compared principal component solutions on standardized (i.e. correlation) and unstandardized covariance coefficients for wetland vegetation. They noted a tendency for standardized measurements to produce a clumped distribution of factor loadings with one or two loadings far removed from the rest, apparently as a result of minor species whose values were increased by standardization. Excepting this difference, the ecological interpretation was essentially similar for both procedures. The tendency of minor species toward high factor loadings in this study is in part due to standardization (i.e. use of correlation instead of covariance) of the raw data. It should be noted, however, that minor species in either emergent or sedge meadow models do not necessarily have high factor loadings. This can be verified from ~~frequency and~~ relative dry weight data in relation to species factor loadings given in Tables 1 and 2. A decisive advantage of correlation (i.e. standardization of initial data) in principal-components analysis is the low distortion of species relations in vegetation space (Austin and Noy-Meir 1971).

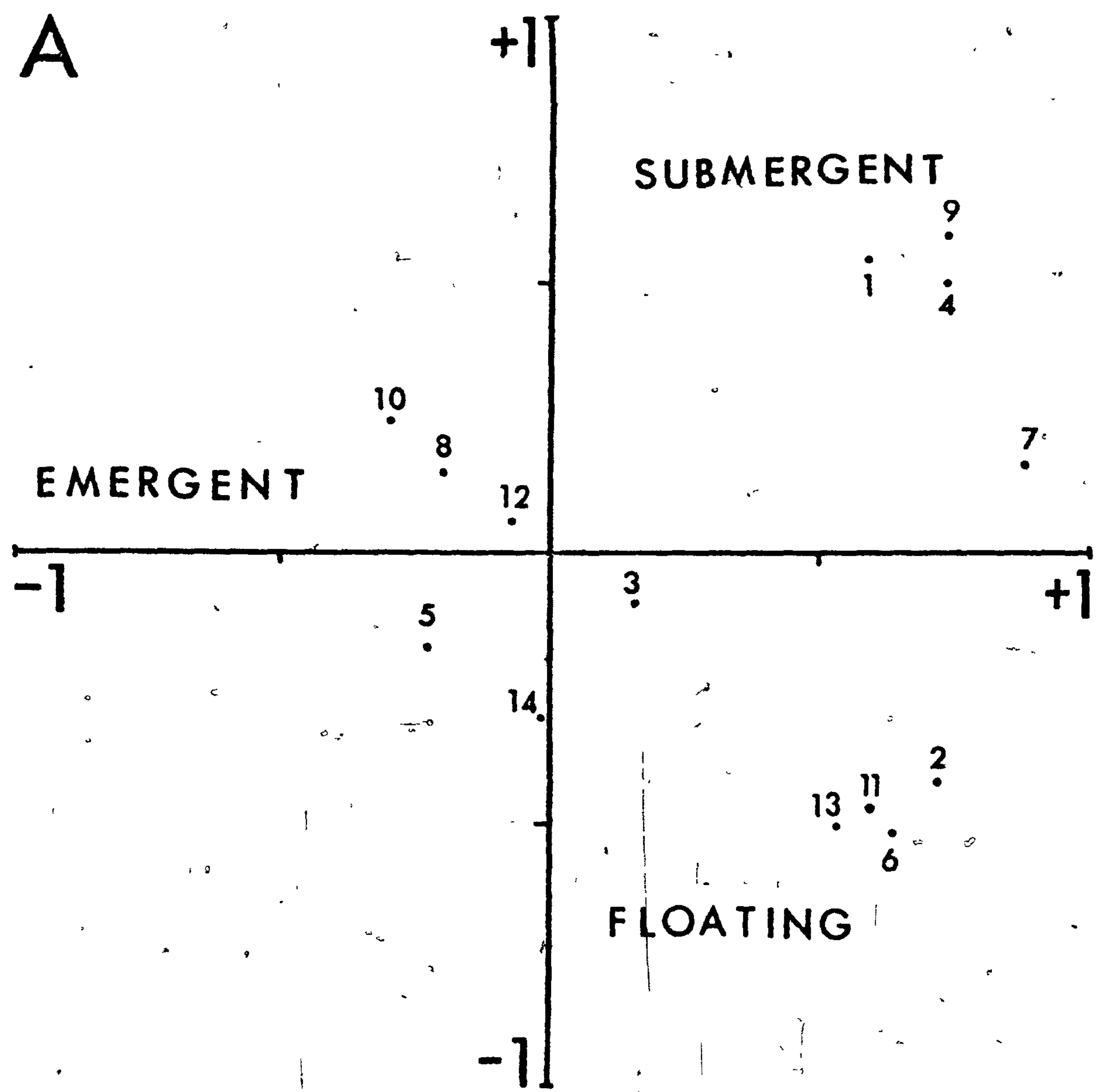
In the emergent community, the floating and submerged species show numerous high positive correlations. Outstanding examples are *Potamogeton zosteriformis* - *Elodea canadensis* (r = .97), *Lemna trisulca* - *Ceratophyllum demersum* (r = .76), and *Alisma triviale* - *Myriophyllum exalbescens* (r = .71). Significant negative correlations occur notably between the emergent species, namely *Scirpus fluviatilis* - *S. validus* (r = -.40) and *S. fluviatilis* - *Esquisetum fluviatile* (r = -.33). *Scirpus fluviatilis* is probably excluding these forms by virtue of strong competitive displacement. Its growth rate is high (6.3 $g.m^{-2}.dy^{-1}$) compared with *Equisetum fluviatile* (4.0 $g.m^{-2}.dy^{-1}$)

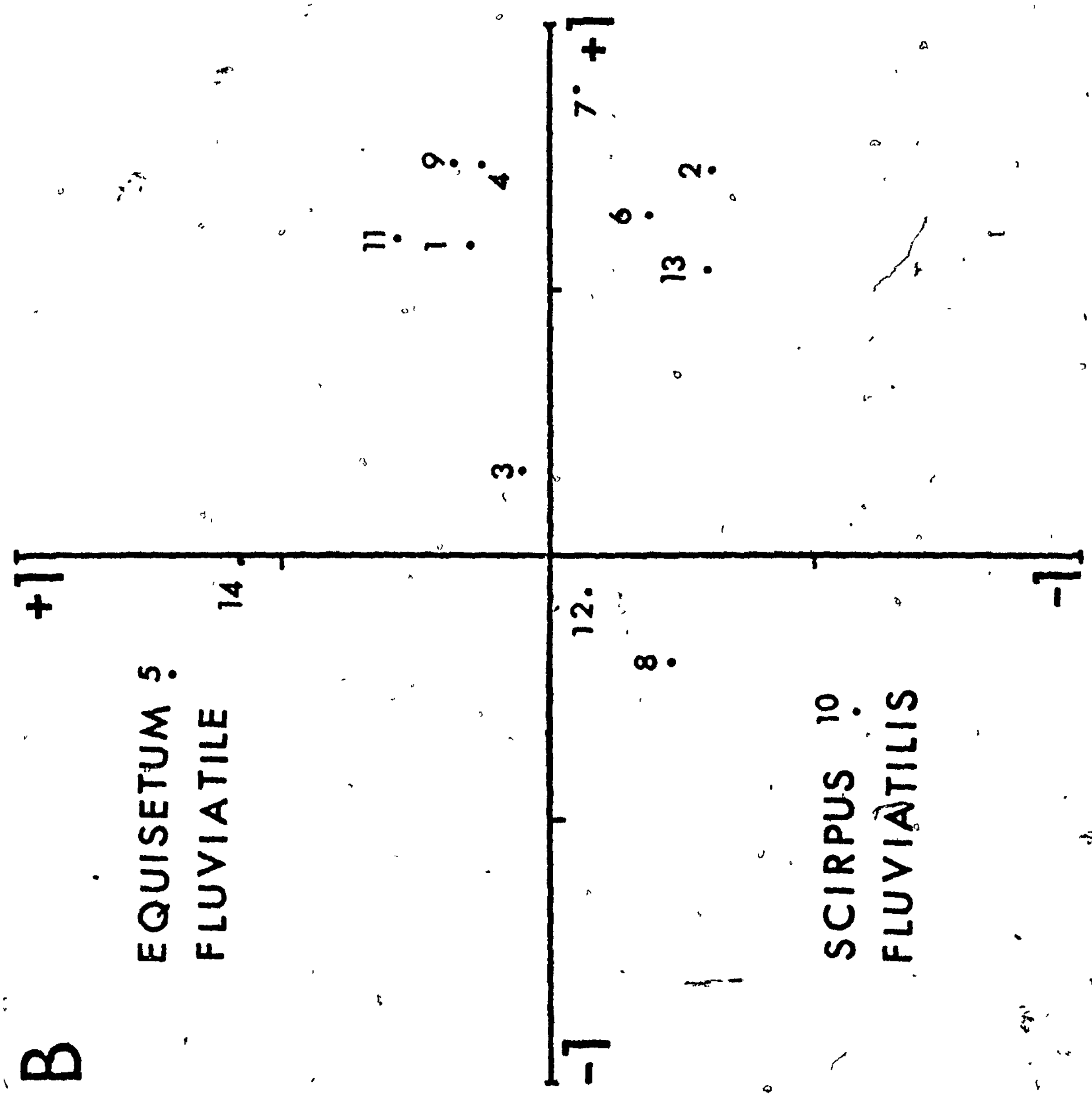
and Scirpus validus (1.4 $g.m^{-2}.dy^{-1}$) In general, emergent species tend to form monospecific communities (as evidenced by their high relative dry weights, Table 1) and show negative correlations among themselves.

In sedge meadow, high negative correlations are numerous. The proportion of these negative correlations (expressed as a percentage of the total number of significant correlations) is high in moss species (81%), Typha angustifolia (77%), Carex aquatilis (74%), C. lacustris (50%), and Calamagrostis canadensis (48%) compared to other species. These forms are all strong dominants in the quadrats they occupy (Table 1) and tend to exclude other species, ultimately resulting in dissociation. This is especially evident with Typha angustifolia, in which large rhizomes and tall leaves serve to preclude other species. The exclusion mechanism in mosses is probably a combination of complete shading of the soil surface and antibiosis (Leibundgut 1952).

The Emergent Aquatic Model: The most significant ecological relations in the emergent community are related to water depth. The first component differentiates the emergent species (low factor loadings) of relatively shallow water from floating and submerged species (Figs. 3A, 5A). Depth varies from an average of 88 cm for Scirpus fluviatilis to 114 cm for Potamogeton and Ceratophyllum. The water depth for Typha angustifolia is unreliable since this species occurs in only one quadrat. The percentage of total variation accounted for on this component is 28.8%. The importance of water depth in the community is widely acknowledged (Swindale and Curtis 1957; Curtis 1959; Sculthorpe 1967, p. 12; Walker and Coupland 1970). However, in other studies, conductivity of the water was the variable most strongly correlated with species differences (Swindale and Curtis 1957;

Fig. 3. Spatial model of the emergent aquatic community on the Huntingdon Marsh, based on principal-components analysis of 14 species: (A) components I and II (vertical axis); (B) components I and III (vertical axis). See Table I for species codes.


A
SUBMERGENT
EMERGENT
FLOATING
+1
-1
+1
-1
1
2
3
4
5
6
7
8
9
10
11
12
13
14


B
EQUISETUM FLUVIATILE
SCIRPUS FLUVIATILIS
+1
-1
+1
-1
1
2
3
4
5
6
7
8
9
10
11
12
13
14

Walker and Wehrhahn 1971). Since our quadrat samples were from the same lake, this factor is unimportant as a source of variability. Other environmental conditions likely associated with increased water depth include light penetration, temperature, and texture and fertility of the substrate. It is to these variables rather than water depth *per se* that species are responding (Sculthorpe 1967). The close relation between water depth and plant productivity of the quadrat (Fig. 5A) suggests that competitive exclusion among species may also be an important consideration on this component.

The second component (14.8% of total variation) is not obviously related to environmental differences but measures interaction between species with differing physiognomy and growth potential. Species with high factor loadings are submergent species (positive pole, Fig. 3A) and at the opposite pole, floating species associated with *Scirpus validus*. *Scirpus validus* forms stands with up to 87 stems/m^2 (average 51.4 stems/m^2. This is insufficient to reduce light intensity to critical levels and thereby exclude other species. These conditions especially favor floating plants such as *Lemna*, *Ceratophyllum* and *Vallisneria*, which become entangled among the stems of *Scirpus*.

The close association between similar life forms is clearly apparent in both floating and submerged groups. Unlike in terrestrial communities in which successive vegetation layers are interdependent, aquatic species of different life forms may coexist but they retain their essential integrity and can generally occur independently elsewhere (Sculthorpe 1967). The reduction of light by the commonly very dense growth of these floating species is sufficient to exclude submerged forms that may have established beneath them. In floating-leaved and free-floating species, optimal exposure to light (i.e. maximum occupation of the surface area) is the critical element of competition (Clayworthy and Harper 1962).

The distinction between Scirpus fluviatilis and Equisetum fluviatile is consistent with our interpretation of this component. As noted earlier, Scirpus fluviatilis, although occupying similar water depth (Fig. 4) is more productive and probably excludes Equisetum by competitive displacement. In strands where patches of these species occurred side by side, Scirpus was sometimes observed to invade the Equisetum community, as evidenced by isolated Scirpus stems in the otherwise pure Equisetum stands. Like Scirpus fluviatilis, Phragmites communis and Typha angustifolia show a strong tendency toward excluding other species. The relative dry weights of these species are about 100% (Table 1), indicating a strong tendency toward monospecific stands. This tendency is much less pronounced in Eleocharis palustris, Equisetum fluviatile, and Scirpus validus, which frequently associate among themselves. Their relative dry weights are correspondingly small (Table 1).

The tendency to form pure closed communities inhibiting colonization by potential competitors is characteristic of most aquatic life-forms. Of the numerous factors responsible, rates of vegetative reproduction and competition between species are the most important (Sculthorpe 1967). In a favorable site, one species may gain an early initiative and increase much faster than any competitor. Such species assert their status early and attain a seasonal or permanent predominance. Spence (1964) noted a tendency toward mutually exclusive distributions among Carex rostrata, Glyceria maxima, Phragmites communis, and Typha latifolia in Scottish marsh communities. Similar tendencies have been observed in Ceratophyllum, Elodea, and *Myriophyllum* (Fosberg 1959, 1960; Stookey *et al.* 1964). Examining competitive displacement between *Phragmites communis* and *Glyceria maxima*, Buttery and Lambert (1965) concluded that the greater productivity of *Phragmites* and its greater tolerance of anaerobic conditions (coinciding with abundant lacunate parenchyma) favored this species. Other important environmental differences besides low oxygen tensions (e.g. soil nutrients) could not be detected. It is not surprising, therefore, that environmental correlates to the second component are not obvious especially since species interactions are of overriding importance.

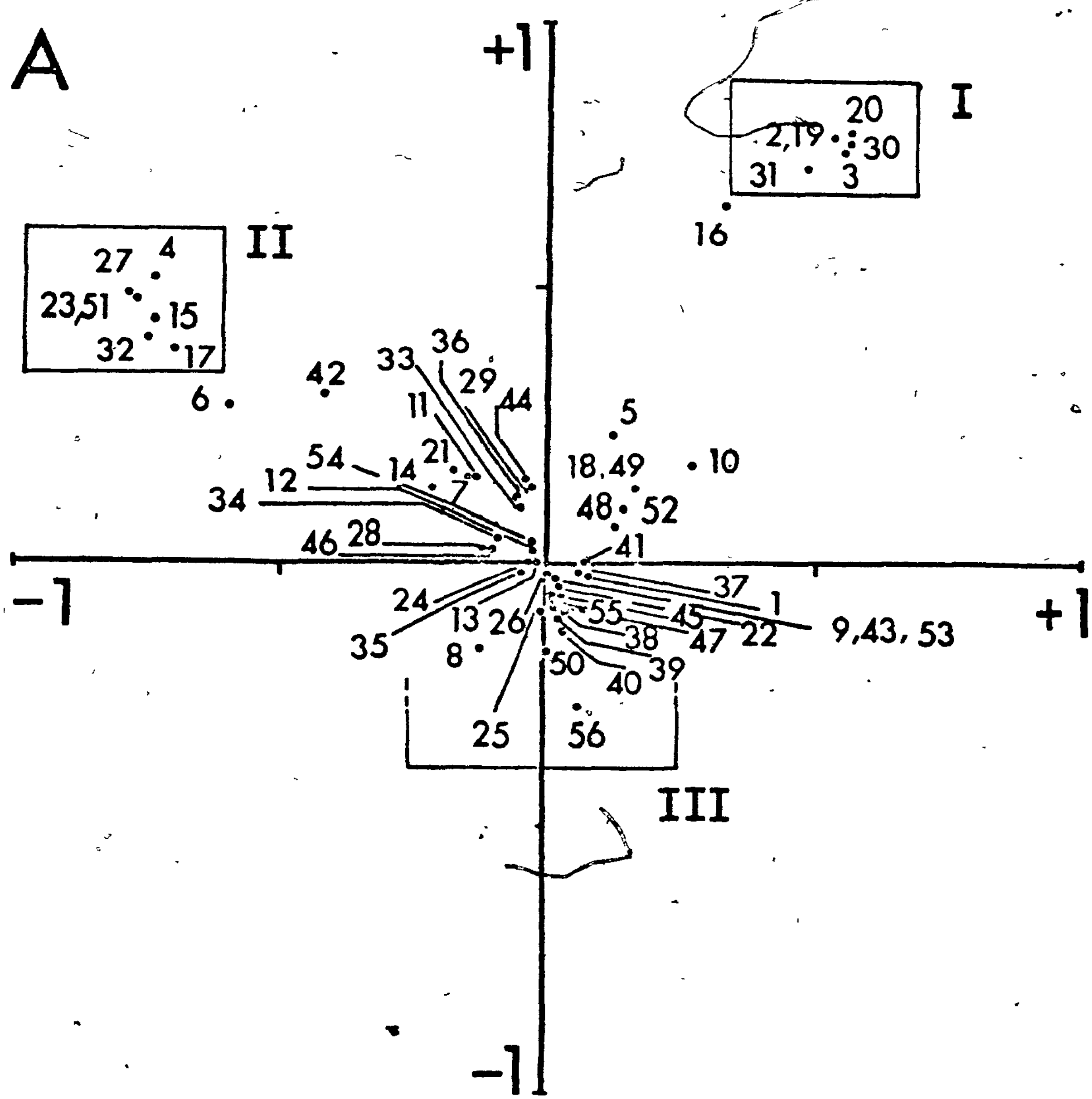
The third component accounted for an additional 11.4% of the total variation in the vegetation (Fig. 3B). Whereas the second component distinguishes the two most prominent emergent forms (*Equisetum fluviatile* and *Scirpus fluviatilis*) and is related to competition and biomass levels. The positive end of this component is typified by comparatively low productivity. Among the dominants, dry weight increases average 4.0, 2.0, and 1.4 $g.m^{-2}.dy^{-1}$ for *Equisetum fluviatile*, *Eleocharis palustris*, and *Scirpus validus* respectively, compared to 11.4, 6.3, and 5.9 $g.m^{-2}.dy^{-1}$ for *Typha angustifolia*, *Scirpus fluviatilis*, and *Phragmites communis*. Among the submerged and floating species, the same distinction is apparent but less pronounced. Whereas the above emergent groups average 2.4 and 6.4 $g.m^{-2}.dy^{-1}$ the submerged and floating species contrast by only 0.07 to 0.09 $g.m^{-2}.dy^{-1}$ at positive and negative ends of the component respectively.

Obviously, the interpretation of the third component lies in differences associated with *Scirpus* and *Equisetum*. Average water depth and soil nutrient contents differ only slightly (with the possible exception of P and Mg) between these species. Structural and productivity differences, however, tend to be large. This is especially true of the productivity per stem (Equisetum fluviatile, 0.02 g per stem per day; Scirpus fluviatilis, 0.05 g per stem per day) and species diversity (5.2 and 2.0 species/m^2, respectively). The strong inverse relationship between species growth rate and species diversity suggests strong competitive exclusion of less vigorous forms by the more productive species. Although chance may play an important role in the initial establishment of Equisetum and Scirpus, we noted a tendency of Equisetum to dominate more exposed locations such as the side of the strand facing the river and away from the island or mainland where wave action is slightly greater.

Any attempt to interpret the first or third components in terms of successional gradients must be considered with skepticism. Autogenic processes such as increased siltation associated with shallow water and dense vegetation are undoubtedly occurring but may easily be outweighted by turbulence in the water and displacement or deposition of sediments by water currents and wave action. These features require a study in themselves and have been described elsewhere (Pageau 1959). Moreover, the impact of artificially increasing the water level 40 years ago is not completely known. Certainly, the present vegetation strong reflects that incident and its origin may be closely associated with it.

The Sedge Meadow Model: The first principal component (12.1% of total variation) is characterized by high factor loadings on 'weed' species (Fig. 4B). Asclepias syriaca, Lycopus europaeus, Equisetum arvense, Anemome canadensis, Epilobium leptophyllum and Lycopus uniflorus (group I, factor loadings 0.57 to 0.48) are typically weedy species of a large variety of disturbed upland habitats. They occupy an average of 15.8 of 36 Wisconsin communities (Curtis 1959) reaching optima in wet communities but also

Fig. 4. Spatial model of the sedge meadow community on the Huntingdon Marsh, based on principal-components analysis of 56 species: (A) components I and II (vertical axis); (B) components I and III (vertical axis). See Table II for species codes.


A
+1
-1
+1
-1
I
2,19
20
30
31
3
16
II
27
4
23,51
15
32
17
6
42
33
36
29
44
11
21
54
14
12
7
34
46
28
5
18,49
10
48
52
41
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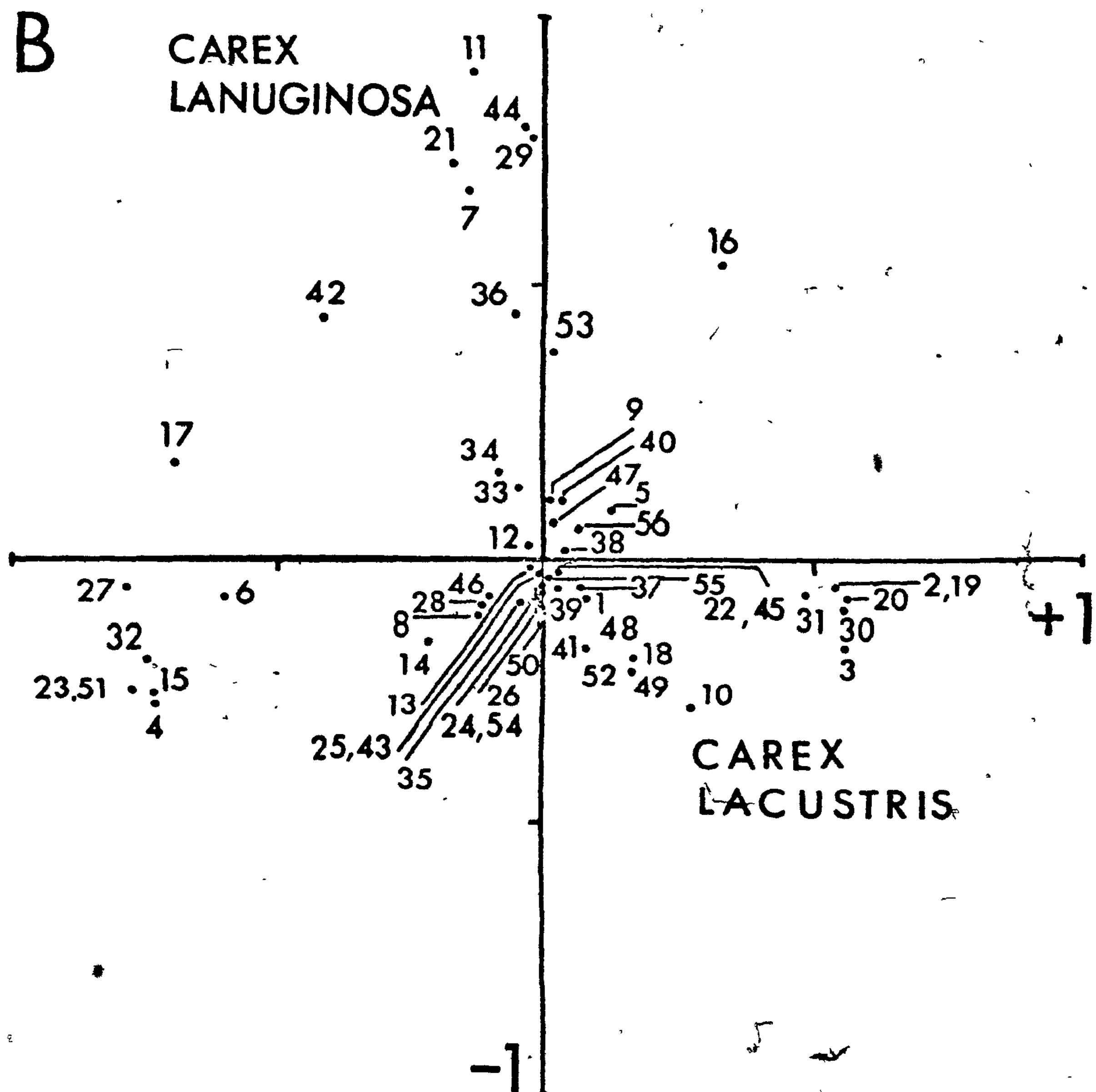
39
40
25
56
III


B
CAREX
LANUGINOSA
CAREX
LACUSTRIS
+1
−1

common in drier well-drained uplands such as roadsides and cropland. Species with high negative factor loadings (-0.79 to -0.70, group II) include Iris versicolor, Galium aparine, Typha latifolia, Dryopteris thelypteris, Lysimachia thyrsiflora, Convolvulus sepium, and Bidens discoidea. These also are typically opportunistic and occur in a wide range of communities. In contrast to species of group I, however, they are specifically lowland or wet habitat forms by preference. In Wisconsin they occupy 9.6 of 36 community types reaching their optima in mesic to wet lowland habitats. Species in the center of the model (factor loadings ± 0.25 on components I and II, group III) are predominantly wet forms specialized toward meadow and other lowland habitats. In Wisconsin they occupy an average of 7.2 of 36 communities (Curtis 1959). Their optima are almost exclusively in lowland community types.

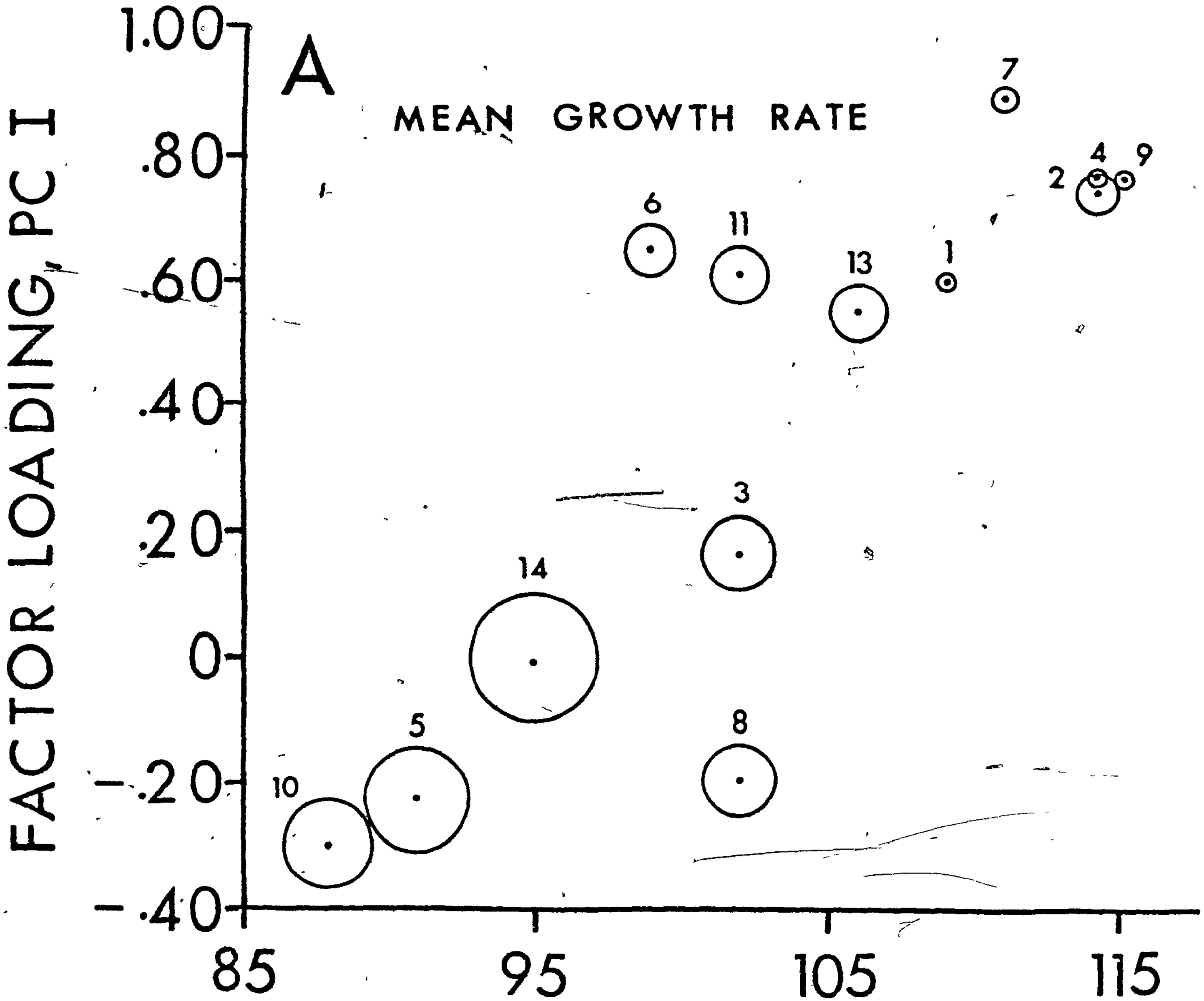
The high factor loadings associated with weed species on component I (groups I and II) illustrate the importance of disturbance as a major environmental factor. This has been noted previously for similar communities (Curtis 1959; Walker and Wehrhahn 1971). Among predominant influences, fire, wind, exposure on hummocks, intense muskrat and bird activity, and the general open nature of the sedge meadow are important features. Muskrat mounds are numerous on the Huntingdon Marsh, and the impact of muskrat on the vegetation is pronounced, especially on Typha (Curtis 1959). Duck and other marsh birds use the island sedge meadows intensively as breeding areas[4] (Whittam 1971). Hummocks occurred in 28 quadrats (50% occurrence) and were well developed in 16 (29%) of the 56 quadrats. Destruction of exposed parts of these hummocks (e.g. by fire or frost) is likely to provide open habitat for opportunistic species.

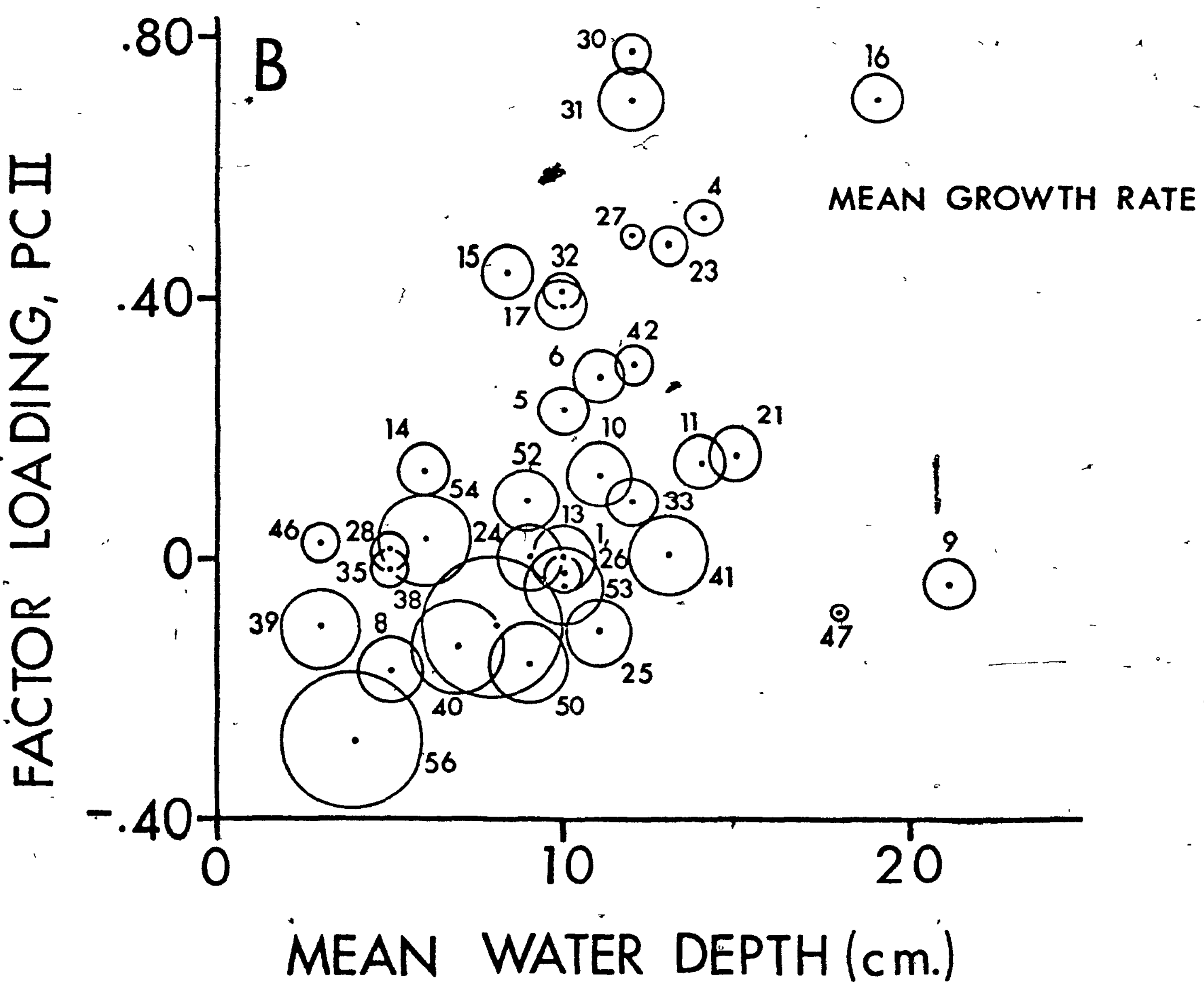
Fire has an especially strong influence on sedge meadow. The Huntingdon marsh is burned (presumably by local residents) almost annually, usually in late fall or spring. Twenty-eight or 50% of all quadrats showed evidence of fire since the last growing season whereas 14 or 25% had been burned previously (probably within 2 or 3 years). These data suggest the great importance of fire on the sedge meadow. Burning is an important distinction between sites on the mainland, Christatie Island, and the remaining islands. Whereas all quadrats on Christatie Island had signs of burning during the current year, no evidence of fire was detected on the two islands between Christatie and the mainland (Fig. 1).

The second component (11.1% of total variation) is a gradient in water depth and plant productivity. Average water depths for species in groups I, II, and III decrease from 12.1 to 11.6 and 10.7 cm respectively. An inverse relationship between plant productivity and water depth is apparent in Fig. 5B.

The third component (8.5% of total variation) is closely related to the incidence of fire. The highest factor loadings are characterized by species associated with current evidence of fire (Fig. 4B). <u>Carex lanuginosa</u>, <u>Salix</u> sp., and <u>Liparis loeselii</u> (factor loadings 0.90 to 0.78) invariably occurred in quadrats that had been burned that year. These are located on Christatie Island and on those parts of the mainland sedge meadow close to the lake or highway. Although a single year's observation on the evidence of fire across a long interval of years, the fact that fire is associated with particular topography lends weight to such an interpretation. Noteworthy is the fact that fire-frequented parts of the sedge meadow are close

Fig. 5. Species factor loadings for (A) emergent aquatic (principal component I) and (B) sedge meadow (principal component II) communities in relation to mean observed water depth. Circle diameters are proportional to mean growth rate (total quadrat dry weight per day) for quadrats of species occurrence. Values range across 10 equal intervals for 3-8 $g.m^{-2}.dy^{-1}$ and 2-12 $g.m^{-2}.dy^{-1}$ in emergent and sedge communities respectively. For species codes see Tables I and II.


A
MEAN GROWTH RATE
FACTOR LOADING, PC I
1.00
.80
.60
.40
.20
0
-.20
-.40
85
95
105
115
7
4
9
2
6
11
13
1
3
14
5
8
10



B
MEAN GROWTH RATE
FACTOR LOADING, PC II
.80
.40
0
-.40
0
10
20
MEAN WATER DEPTH (cm.)
30
31
16
4
27
23
15
32
17
42
6
5
14
52
10
11
21
54
33
46
28
35
24
13
1
26
53
41
9
38
39
8
47
25
40
50
56

to roads or human dwellings and more likely to be burned if fire originates in the vicinity. Carex lacustris, Bidens discoidea, and Convolvulus sepium on the negative end of the third component (factor loadings -0.29 to -0.26) occupy quadrats which showed no evidence or only previous evidence of fire. These species occupied quadrats on topography protected from fire such as areas immediately southeast of the bend in the Salmon River, northeast of Fraser Creek and on the two islands between Christatie Island and mainland (Fig. 1). Significantly these species are infrequent or absent in areas showing current burning.

Average mulch dry weights in Carex lanuginosa and C. lacustris were 167.9 and 849.2 $g.m^{-2}$,further supporting our interpretation of the third component. The strong spearation of these species on the basis of fire incidence is almost certainly related to modifications of the soil surface. In particular, the destruction of dead organic material (mulch) is associated with nutrient mineralization and a pronounced change in albedo. Accumulation of mulch has been associated with greater snow depth, slow snowmelt as a result of high reflectivity and insulation of the soil surface. The dark surface of a burned area is likely to favor early and rapid growth as a result of rapid soil temperature increase in spring and high mineral nutrient levels (Bansal 1971; Curtis and Partch 1948, 1950; Smika 1971; Watt 1971; Weaver and Rowland 1952). On plots with mulch, Weaver and Rowland (1952) observed surface soil temperature to be 12-16C lower and growth was delayed as much as 3 weeks compared to plots where mulch had been removed. By June the biomasses of Andropogon gerardi and Panicum virgatum were less than half that observed on plots with mulch removed. Curtis and Partch (1950) noted that flower production and height growth in Andropogon gerardi were markedly increased on clipped or burned quadrats as a result of early spring growth.

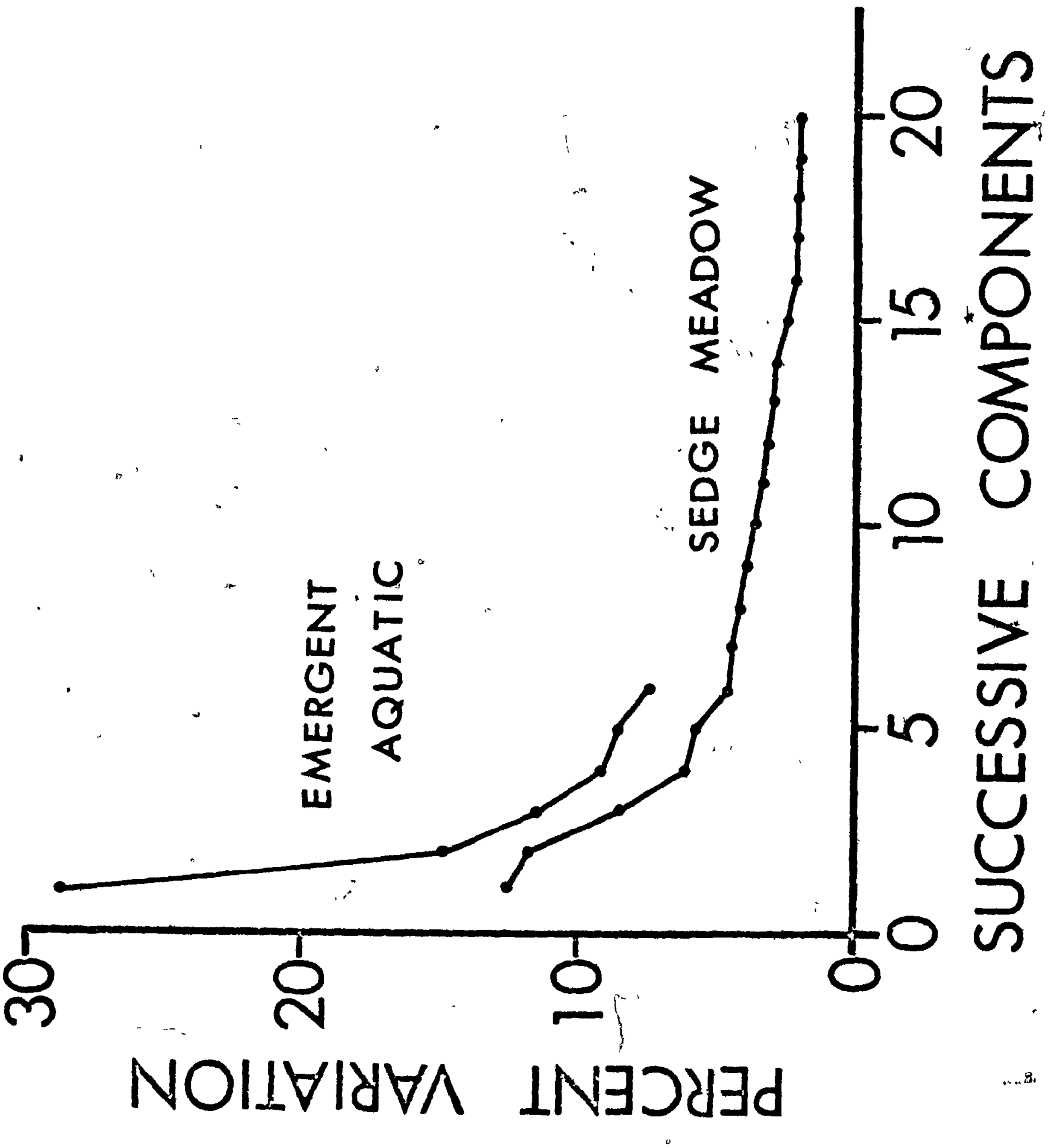
Clear evidence of primary or secondary succession is not apparent in the sedge meadow. The choice of sample areas along the major streams and islands away from upland areas precluded vegetation types that may have been considered successional to shrubs or trees and resulted in areas confined to the strong impact of fire. The strong dependency of sedge meadow on fire as a means of maintenance has been documented elsewhere (Curtis 1959). A small area protected from fire by a highway on the southeast periphery of the mainland sedge meadow showed rapid succession to Acer rubrum, A. saccharinum, Cornus stolonifera, and Salix spp. The presence of meadow species (Carex spp., Typha spp.) in open areas between these shrub and tree species is an indication of the potentially rapid conversion of sedge meadow to forest in the absence of fire.

Organization of Emergent and Meadow Communities:

In this study we have attempted to identify major environmental controls on the vegetation in related but different communities. It has become obvious that some striking ecological differences exist between emergent and sedge meadow communities. An outstanding contrast is the complexity of the sedge meadow. The greater diversity of plant species and the importance of chance peturbations result in complexity that cannot be adequately explained in a few major dimensions of variability (Fig. 6). Whereas the first three principal components explained 55% of the total variability in emergent aquatic community, the first nine components in sedge meadow are required to account for the same level of the total variation.

It would seem axiomatic in plant relations that steep gradients in critical environmental factors impose a strong organization on species (Beals 1969; Whittaker 1956, 1967, 1970). Thus, the comparatively large

Fig. 6. The total variance explained by successive principal components in emergent aquatic and sedge meadow communities on the Huntingdon Marsh. Only significant components are shown.



PERCENT VARIATION
30
20
10
0
0
5
10
15
20
SUCCESSIVE COMPONENTS
EMERGENT AQUATIC
SEDGE MEADOW

differences in water depth within the emergent community are of major significance in accounting for species variations. Large differences in life form and growth potential are also important sources of variation. These large differences are not apparent on the sedge meadow. Variations in water depth and community structure are relatively small and the significance of these features in the organization of this ecosystem is correspondingly reduced.

Whittaker (1967, 1970) has attempted to formulate a general theory on change in niche width and the extent of niche overlap across environmental gradients. For most plant communities, the general pattern is one of continuous intergradation among niche-differentiated but partially competitive species. In more rigorous environments or across steep environmental gradients, there is a tendency toward strong single-species dominance and relative discontinuity (i.e. reduced niche overlap). If the emergent aquatic area can be regarded as the more rigorous environment, typified by steeper gradients than present in sedge meadow, these concepts appear to be valid generalizations. The overlap of species niches in the sedge meadow (as evidenced from similar factor loadings on the principal components of each model) is marked, corresponding with a relatively favorable environment.

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APPENDIX I

SEDGE MEADOW COMMUNITIES

LEGENDS TO APPENDIX I, II

1. STAND	:	Quadrat identification number
2. Observers	:	Persons present at field site A. A. - Dr. Allan Auclair A.B. - Mr. André Bouchard S.H. - Mr. Stuart Hay J.P. - Sr. Josephine Pajaczkowski
3. DATE	:	day, month, and year of quadrat sampling at field site.
4. Locality	:	'Mainland' refers to sedge meadow area of the marsh.
	:	'Emergent' refers to emergent aquatic area identified in Figure 1.
5. COLL. SPECIES	:	Scientific names of plant species present in the sample quadrat.
6. Nb (Column 2)	:	number of stems in sample quadrat
7. DW (Column 3)	:	grams; dry weight tissue in sample quadrat. Total weight of mulch or 'dead material' does not differentiate between species.
8. HT (Column 4)	:	centimeters; average length of shoots above soil surface.
9. Phe (Column 5)	:	phenology code at time of quadrat sample. Abbreviations are listed on following page.
10. Nb (Column 6)	:	percent; number of stems of one species relative to the total number of stems of all species in quadrat.
11. DW (Column 7)	:	percent; dry weight of one species relative to total dry weight of all species in quadrat excepting mulch.
12. WATER DEPTH	:	centimeters; depth of water above soil surface
13. SOIL	:	Standard soil chemical analysis for top 100 cm of soil. Values are for available or exchangeable concentrations. Analyses were provided by the Quebec Soil Testing Laboratory, Ste-Anne de la Pocatiére, Quebec. Description of procedures employed by this laboratory is included on following pages.

APPENDIX LEGEND (cont'd)

Phenology Code

1.	Seed Seedling	Seedling
2.	Veg	Vegetative
3.	Yg	Young, no flower buds
4.	Fl buds	Flower buds
5.	Yg Fl	Young flower, more advanced stage
6.	Fl	Flower, fully developed
7.	Fl/Fr	Flower and fruit stage
8.	Yg Fr	Young fruit stage
9.	Fr	Mature fruit stage
10.	Mt Fr Mat Fr Old Fr	Old fruit stage
11.	Fall Fr Fr Fall Past Fr Fr Open	Past fruiting stage
12.	Fr Sen	Fruit and senescence stage
13.	Sen Start	Senescence for starting
14.	Sen	Senescence
15.	Fall Fr/Sen	Past fruiting and senescence
16.	Spore Cap	Spore capsules on Equisetum
17.	Past Spores	Vegetative - past spore time - Equisetum
18.	Branch	Branching stage of Equisetum
19.	Fem Fl Fem Spikes	Female spikes left on Typha
20.	Fl and Pollen	Male and female flowers on Typha

Soil Procedures

Renseignements sur nos méthodes analytiques utilisées pour les échantillons des sols de Joséphine Pajaczkowski.

- Carbone -

Méthode Walkley et al - méthode au bichromate de sodium. (Combustion humide)

- Azote réduit total -

Méthode du Kjeldahl.-

Références: 1) A.O.A.C. - 1950

2) Chemical Methods of Soil Analyses, Canada Department of Agriculture, Ottawa, 1958.

- pH -

Lecture sur un pH mètre d'un mélange sol-eau dans un rapport 1-1.

- H échangeable -

Méthode avec solution tampon de Woodruff.-

Référence: Graham, E.R. - An Explanation of Theory and Methods of Soil Testing.- Bulletin 734. University of Missouri Agricultural Experiment Station. - July, 1959. - p. 18

Photocopie de la méthode ci-annexée.

- P_2O_5 assimilable -

Méthode de Bray-Arnold

Solution extractive (Bray): 0.1 N HCl et 0.03 N NH_4F
Réactifs: 1) solution de molybdate d'ammonium,
2) solution de l'acide 1-amino-2-naphtol-4-sulfonique

- K, Na, Ca et Mg échangeables -

Extraction par une solution d'acétate d'ammonium normale neutre et détermination par spectrophotomètre de flamme.

- Analyse granulométrique -

Méthode Bouyoucos

- Mn échangeable -

Dosage colorimétrique au photélomètre à filtres Cenco-Sheard-Sanford. - Coloration donnée par le méta-périodate de potassium.

MARSH STUDIES

STAND: 1

OBSERVERS: AA
AB
JP

DATE 15/5/70

LOCALITY: Mainland

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Carex lacustris	183	156	53.9	Fl.		54%	83%			
	Calamagrostis canadensis	151	30	48.0	Veg		45%	16%			
	Rumex orbiculatus	1	2.0	33.0	Veg						
	Lysimachia thyrsiflora	1	0.2	20.0	Yg.						
	DEAD MATERIAL		1091								

ENVIRONMENTAL FEATURES:

WATER DEPTH: 17 cm.

SOIL

MARSH STUDIES

STAND: 2 OBSERVERS: AB JP DATE 28/5/70

LOCALITY: Mainland

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Carex lacustris	97	131.9	89	mat. fr.		29%	57%			
Calamagrostis canadensis	223	98.3	69	Yg.		68%	43%			
Equisetum fluvialite	4	0.6	31	Yg.						
Galium palustre	2	+	18	Yg.						
Lysimachis thyrsiflora	3	0.3	19	Yg.						
Lemna minor	+									
DEAD MATERIAL		783.7								

ENVIRONMENTAL FEATURES:

WATER DEPTH 19 cm.

SOIL

MARSH STUDIES

STAND: 3 OBSERVERS: AB
JP
DATE 28/5/70

LOCALITY: Mainland

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Carex lacustris	18	19.0	78	mat. fr.		4%	12%			
	Calamagrostis canadensis	420	135.1	67	Yg.		91%	88%			
	Impatiens capensis	16	0.1	5	Seedling						
	Lythrum salicaria	2	0.1	13	Yg						
	Galium palustris	1	+	11	Yg						
	Lysimachia thyrsiflora	1	+	16	Yg						
	Galium aparine	2	+	18	Yg						
	DEAD MATERIAL		781.3								

ENVIRONMENTAL FEATURES:

WATER DEPTH 11 cm.

SOIL

MARSH STUDIES

STAND: 4 OBSERVERS: AB JP DATE 28/5/70

LOCALITY: Mainland

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Carex lacustris	99	164.7	93	Mat. Fr.		41%	71%			
	Calamagrostis canadensis	125	53.5	76	Yg.		52%	23%			
	Acorus calamus	9	13.4	71	Yg.		4%	6%			
	Impatiens capensis	2	+	5	Seedling						
	Galium palustre	1	+	9	Yg.						
	Galium aparine	1	+	20	Yg.						
	Lysimachia thyrsiflora	2	0.2	19	Yg.						
	Lemna minor	+									
	DEAD MATERIAL		856.5								

ENVIRONMENTAL FEATURES:

WATER DEPTH 19 cm.

SOIL

MARSH STUDIES

STAND: 5 OBSERVERS: AB JP DATE 28/5/70

LOCALITY: Mainland

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Sparganium eurycarpum	31	37.1	60	Yg		66%	92%			
Calamagrostis canadensis	9	2.0	43	Yg		19%	5%			
Equisetum fluviatile	5	1.3	36	Yg		10%	3%			
Lysimachia thyrsiflora	2	+	16	Yg						
Lemna minor	+									
DEAD MATERIAL		323.8								

ENVIRONMENTAL FEATURES:

WATER DEPTH 20 cm.

SOIL pH: 5.9
% organic matter: 8.7
% Carbon: 5.06
% Nitrogen: 2.27
Available phosphorous: 8.62mg/100g

H ions: 3.0meq/100g
K: 0.42 meq/100g
Na: 0.27 meq/100g
Ca: 11.50 meq/100g
Mg: 3.50 meq/100g

MARSH STUDIES

STAND: 6 OBSERVERS: AB JP DATE 30/5/70

LOCALITY: Mainland

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Calamagrostis canadensis	106	24.9	53	Yg		79%	51%			
	Carex lacustris	27	21.6	71	Mat. Fr.		20%	44%			
	Typha angustifolia	1	2.4	58	Yg						
	DEAD MATERIAL		1073.8								

ENVIRONMENTAL FEATURES:

WATER DEPTH: 7 cm.

SOIL -

MARSH STUDIES

STAND: 7 OBSERVERS: AB JP DATE 30/5/70

LOCALITY: Mainland

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW				
Carex lacustris	105	176.1	91	Mat Fr.		52%	76%				
Calamagrostis canadensis	53	31.8	71	Yg		26%	14%				
Acorus calamus	36	25.3	60	Yg		18%	10%				
Lysimachia thyrsiflora	4	0.5	25	Fl Buds							
Equisetum fluviatile	1	0.1	31	Yg							
Impatiens capensis	1	+	10	Seed-ling							
Galium palustre	1	+	9	Yg							
DEAD MATERIAL		934.5									

ENVIRONMENTAL FEATURES:

WATER DEPTH: 13 cm.

SOIL

MARSH STUDIES

STAND: 8

OBSERVERS: AB JP

DATE 30/5/70

LOCALITY: Mainland

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Calamagrostis canadensis	120	35.0	68	Yg		77%	38%			
Carex lacustris	13	18.0	90	Mat Fr.		8%	20%			
Phragmites communis	7	4.3	56	Yg		4%	5%			
Typha angustifolia	5	33.6	68	Yg		3%	37%			
Impatiens capensis	9	0.1	9	Seedling		-				
Campanula aparinoides	2	+	14	Yg						
DEAD MATERIAL		1203.5								

ENVIRONMENTAL FEATURES:

WATER DEPTH : 20 cm.

SOIL

MARSH STUDIES

STAND: 9 OBSERVERS: AB
JP DATE 30/5/70

LOCALITY: Mainland

COLL.	SPECIES	No	DW	HT	Phe		Nb	DW			
	Calamagrostis canadensis	203	96.0	88	Yg		84%	55%			
	Typha angustifolia	9	67.5	109	Yg		3%	39%			
	Campanula aparinoides	20	1.5	30	Yg						
	Lysimachia thrysyflora	4	0.1	34	Fl. bud						
	Carex lacustris	2	1.5	66	Mat. Fr						
	Lythrum salicaria	4	1.1	19	Yg						
	Impatiens capensis	Very Many	5.4	6	Seed-ling						
	Galium aparine	1	+	8	Yg						
	DEAD MATERIAL		1029.2								

ENVIRONMENTAL FEATURES:

WATER DEPTH: 16 cm.

SOIL

MARSH STUDIES

STAND: 10 OBSERVERS: AB JP DATE 30/5/70

LOCALITY: Mainland

COLL. SPECIES	No	DW	HT	Phe		Nb	DW			
Calamagrostis canadensis	401	218.0	80	Yg		74%	83%			
Carex lacustris	24	39.4	100	Mat Fr		4%	15%			
Lycopus uniflorus	43	2.2	21	Yg						
Campanula aparinoides	33	1.0	29	Yg						
Dryopteris thelypteris	28	1.7	35	Yg						
Typha angustifolia	1	1.7	60	Yg						
Impatiens capensis	7	+	11	Seedling						
Galium palustre	2	+	22	Yg						
Lysimachia thyrsiflora	1	+	41	Yg						
Scutellaria epilobiifolia	1	+	19	Yg						
DEAD MATERIAL		695.3								

ENVIRONMENTAL FEATURES:

WATER DEPTH: 20 cm.

SOIL:

pH: 5.8
% organic matter: 67.7
% Carbon: 41.05
% Nitrogen: 2.52
Available phosphorous: 2.70mg/100g

H ions: 3.15 meq/100g
K: 1.36meq/100g
Na: 1.10meq/100g
Ca: 37.10meq/100g
Mg: 10.32meq/100g

MARSH STUDIES

STAND: 11 OBSERVERS: AB JP DATE 5/6/70

LOCALITY: Mainland

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW				
	Carex lacustris	160	301.4	101	Mat Fr		86%	95%				
	Calamagrostis canadensis	24	16.2	85	Yg		13%	5%				
	Onoclea sensibilis	2	0.3	26	Veg.							
	Impatiens capensis	1	0.1	10	Yg							
	Moss species	+	+									
	DEAD MATERIAL		936.0									

ENVIRONMENTAL FEATURES:

WATER DEPTH: 15 cm.

SOIL:

pH: 5.7
% organic matter: 71.8
% Carbon: 41.61
% Nitrogen: 1.84
Available phosphorous: 2.46 mg/100g

H ions: 2.80 meq/100g
K: 1.48meq/100g
Na: 1.04meq/100g
Ca: 41.20meq/100g
Mg: 11.25meq/100g

MARSH STUDIES

STAND: 12 OBSERVERS: AB JP DATE 17/6/70

LOCALITY: Mainland

COLL.	SPECIES	No	DW	HT	Phe		Nb	DW			
	Carex diandra	642	200.4	69	Mat Fr		90%	80%			
	Carex aquatilis	15	29.6	106	Veg		2%	12%			
	Sparganium eurycarpum	14	14.4	51	Fl		2%	6%			
	Lycopus europeus	12	0.7	17	Veg						
	Campanula aparinoides	9	0.4	25	Veg						
	Cicuta bulbifera	8	+	17	Veg						
	Alisma plantago-aquatica	2	0.2	12	Veg						
	Sagittaria latifolia	6	0.1	20	Veg						
	Typha angustifolia	1	3.0	100	Veg						
	Lysimachia thyrsiflora	1	0.2	18	Veg						
	Impatiens capensis	3	+	7	Veg						
	Galium palustre	2	+	10	Veg						
	Rumex orbiculatus	1	0.3	12	Veg						
	DEAD MATERIAL										

ENVIRONMENTAL FEATURES:

WATER DEPTH

SOIL

see next page...

MARSH STUDIES

STAND: 12, page 2. OBSERVERS: AB
JP
DATE 17/6/70

LOCALITY: Mainland

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Bidens discoidea	1	+	8	Seedling						
Lemna trisulca	Very many	+								
Moss species	+	19.0								
DEAD MATERIAL		392.0								

ENVIRONMENTAL FEATURES:

WATER DEPTH: 25 cm.

SOIL:
pH: 5.9
% organic matter: 77.5
% Carbon: 39.14
% Nitrogen: 2.76
Available phosphorous: 12.86mg/100g

H ions: 21.0 meq/100g
K: 1.51 meq /100g
Na: 1.20 meq /100g
Ca: 43.00 meq/100g
Mg: 12.47 meq/100g

MARSH STUDIES

STAND: 15

OBSERVERS: AA
AB
JP

DATE 6/6/70

LOCALITY: Mainland

COLL.	SPECIES	No	DW	HT	Phe		Nb	DW			
	Carex lacustris	177	240.1	89	Mat. Fr.		97%	99%			
	Lysimachia thyrsiflora	2	0.2	35	Veg						
	Sparganium eurycarpum	1	0.4	31	Veg						
	Campanula aparinoides	1	+	10	Yg						
	Galium palustre	1	+	13	Yg						
	Lemna minor	Few	+	+							
	Moss species	+	100.2								
	DEAD MATERIAL (Mulch)		906.7								

ENVIRONMENTAL FEATURES:

WATER DEPTH 12 cm.

SOIL

pH: 4.07
% organic matter: 41.1
% Carbon: 23.85
% Nitrogen: 1.51
Available phosphorus: 12.45 mg/100g

H ions: 11.8 meq/100g
K: 1.24 meq/100g
Na: 0.89 meq/100g
Ca: 37.70 meq/100g
Mg: 12.72 meq/100g

MARSH STUDIES

STAND: 16 OBSERVERS: AA DATE 6/6/70

AB

LOCALITY: Mainland JP

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Carex aquatilis	293	220.3	75	Fl		84%	84%			
Carex stricta	42	43.5	70	Veg		11%	13%			
Equisetum fluviatile	36	6.1	37	Veg		9%	2%			
Campanula aparinoides	5	0.2	17	Vg						
Calamagrostis canadensis	5	0.2	25	Vg						
Lysimachia thyrsiflora	1	0.1	28	Vg						
Impatiens capensis	1	+	7	Vg						
Lythrum salicaria	1	+	9	Veg						
Cicuta bulbifera	1	+	7	Veg						
Moss species		31.1								
DEAD MATERIAL (Mulch)		408.3								

ENVIRONMENTAL FEATURES:

WATER DEPTH 5 cm.

SOIL

pH: 5.9

% organic matter: 51.8

% Carbon: 30.06

% Nitrogen: 1.51

Available phosphorus: 9.00 mg/100g

H ions: 9.5 meq/100g

K: 1.36 meq/100g

Na: 0.99 meq/100 g

Ca: 41.30 meq/100g

Mg: 13.94 meq/100g

MARSH STUDIES

STAND: 17 OBSERVERS: AA, AB, JP DATE 7/6/70

LOCALITY: Mainland

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Carex aquatilis	145	118.9	59	Veg		65%	61%			
	Equisetum fluviatile	44	14.7	48	Spore cap.		20%	8%			
	Acorus calamus	25	20.3	62	Fl.		11%	10%			
	Galium palustre	1	+	10	Veg						
	Sparganium eurycarpum	7	1.9	32	Yg						
	Campanula aparinoides	1	+	20	Yg						
	Moss species		38.7					20%			
	Lemna minor	Few									
	DEAD MATERIAL (Mulch)		1055.6								

ENVIRONMENTAL FEATURES:

WATER DEPTH 2 cm

SOIL

pH: 6.1
% organic matter: 45.0
% Carbon: 26.12
% Nitrogen: 1.00
Available phosphorus: 20.82 mg/100g

H ions: 7.0 meq/100g
K: 1.26 meq/100g
Na: 0.63 meq/100g
Ca: 36.23 meq/100g
Mg: 10.10 meq/100g

MARSH STUDIES

STAND: 18 OBSERVERS: AA DATE 7/6/70

AB

LOCALITY: Mainland JP

COLL.	SPECIES	No	DW	HT	Phe		Nb	DW			
	Carex aquatilis	92	22.5	93	Mat. Fr.		35%	25%			
	Carex lacustris	64	129.8	100	Mat. Fr.		25%	45%			
	Carex stricta	26	14.7	64	Fr.		10%	5%			
	Sparganium eurycarpum	20	16.9	63	Veg.		8%	6%			
	Calamagrostis canadensis	19	1.2	44	Yg.						
	Campanula aparinoides	18	0.4	22	Veg						
	Dryopteris thelypteris	19	2.2	33	Veg						
	Lysimachia thyrsiflora	4	0.3	35	Veg						
	Lycopus europeus	4	0.3	20	Veg						
	Lythrum salicaria	3	1.6	35	Yg						
	Cicuta bulbifera	1	+	10	Veg						
	Galium palustre	1	+	23	Fl						
	Lemna minor	Many	+	+							
	DEAD MATERIAL										

ENVIRONMENTAL FEATURES:

WATER DEPTH 4 cm

SOIL

pH: 5.5

% organic matter: 75.9

% Carbon: 44.00

% Nitrogen: 1.88

Available phosphorus: 17.43 mg/100g

H ions: 13.0 meq/100g

K: 1.99 meq/100g

Na: 0.85 meq/100g

Ca: 45.65 meq/100g

Mg: 11.10 meq/100g

see next page...

MARSH STUDIES

STAND: 18, page 2. OBSERVERS: AA, AB, JP DATE 7/6/70

LOCALITY:

COLL.	SPECIES	NO	DW	HT	Phe						
Moss species			46.5								
	DEAD MATERIAL (Mulch)		753.0								

ENVIRONMENTAL FEATURES:

WATER DEPTH 4 cm.

SOIL

MARSH STUDIES

STAND: 19 OBSERVERS: AA AB JP DATE 7/6/70

LOCALITY: Mainland

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Carex aquatilis	233	206.6	84	Fl. Fr.		66%	67%			
	Carex lacustris	35	34.5	46	Veg		10%	11%			
	Carex stricta	13	9.3	77	Fl. Fr.		4%	3%			
	Dryopteris Thelypteris	49	5.1	31	Veg						
	Campanula aparinoides	11	+	21	Veg						
	Equisetum fluviatile	6	1.9	30	Veg						
	Lycopus europeus	2	+	17	Vg						
	Cicuta bulbifera	1	+	13	Vg						
	Galium palustre	1	+	13	Fl.						
	Lythrum salicaria	1	0.3	15	Vg						
	Lemna minor	Few	+								
	Moss species		49.4								
	DEAD MATERIAL (Mulch)		715.2								

ENVIRONMENTAL FEATURES:

WATER DEPTH 5 cm

SOIL

pH: 5.8

% organic matter: 68.2

% Carbon: 39.56

% Nitrogen: 1.52

Available phosphorus: 10.86 mg/100g

H ions: 19.5 meq/100g

K: 1.27 meq/100g

Na: 0.85 meq/100g

Ca: 39.06 meq/100g

Mg: 10.37 meq/100g

MARSH STUDIES

STAND: 20 | OBSERVERS: AA, AB, JP | DATE 7/6/70

LOCALITY: Mainland

COLL. SPECIES	No	DW	HT	Phe		Nb	DW				
Carex aquatilis	134	139.6	93	Yg. Fr.		57%	70%				
Carex lacustris	41	44.3	82	Mat. Fr.		17%	22%				
Sparganium eurycarpum	21	11.0	49	Yg.		9%	6%				
Onoclea sensibilis	12	1.6	23	Veg							
Campanula aparinoides	12	0.1	16	Veg							
Lycopus europeus	9	1.1	25	Veg							
Dryopteris thelypteris	4	0.3	19	Veg							
Lythrum Salicaria	1	0.1	17	Yg							
Galium palustre	1	+	17	Fl.							
DEAD MATERIAL (Mulch)		778.6									

ENVIRONMENTAL FEATURES:

WATER DEPTH 7 cm.

SOIL

pH; 5.8
% organic matter: 84.9
% Carbon: 49.73
% Nitrogen: 2.53
Available phosphorus: 6.26 mg/100g

H ions: 21.5 meq/100g
K: 1.81 meq/100g
Na: 1.29 meq/100g
Ca: 48.65 meq/100g
Mg: 13.96 meq/100g

MARSH STUDIES

STAND: 24 OBSERVERS: AB JP DATE 11/6/70

LOCALITY: Island south of Christatie

COLL.	SPECIES	No	DW	HT	Phe		Nb	DW
	Calamagrostis canadensis	130	35.8	60	YG Fl.		47%	22%
	Carex aquatilis	105	87.0	93	Fr		38%	53%
	Carex lacustris	20	33.4	89	YG Fr		7%	20%
	Onoclea sensibilis	9	2.2	22	Veg			
	Convolvulus seoium	9	0.4	49	Veg			
	Lysimachia thyrsiflora	2	0.2	20	Veg			
	Rumex orbiculatus	1	0.6	35	Veg			
	Dryonteris thelvpteris	1	0.2	21	Veg			
	Impatiens caoensis	Many	3.9	13	Seedling			
	DEAD MATERIAL (Mulch)		337.7					

ENVIRONMENTAL FEATURES:

WATER DEPTH 3 cm. below soil

SOIL

pH: 5.3
% organic matter: 40.6
% Carbon: 28.65
% Nitrogen: 1.12
Available phosphorus: 10.88 mg/100g

H ions: 16.7 meq/100g
K: 0.85 meq/100g
Na: 0.56 meq/100g
Ca: 25.17 meq/100g
Mg: 5.00 meq/100g

MARSH STUDIES

STAND: 25 OBSERVERS: AB JP DATE 11/6/70

LOCALITY: Island south of Christatie

COLL.	SPECIES	No	DM	HT	Phe		Nb	DW				
	Calamagrostis canadensis	320	158.1	78	Yg Fl		32%	62%				
	Carex aquatilis	50	51.8	88	Yg Fr		13%	20%				
	Typha angustifolia	11	44.6	111	Yg		3%	17%				
	Campanula aparinoides	6	0.1	37	Veg							
	Lysimachia thyrsiflora	2	0.5	38	Veg							
	Impatiens capensis	2	+	8	Seedling							
	Polygonum amphibium	1	0.5	41	Veg							
	Galium aparine	1	+	17	Veg							
	DEAD MATERIAL (Mulch)		669.6									

ENVIRONMENTAL FEATURES:

WATER DEPTH : 00 cm.

SOIL

pH: 5.8
% organic matter: 43.9
% Carbon: 25.07
% Nitrogen: 1.12
Available phosphorus: 21.60 mg/100g

H ions: 14.0 meq/100g
K: 1.33 meq/100g
Na: 0.58 meq/100g
Ca: 29.30 meq/100g
Mg: 7.44 meq/100g

MARSH STUDIES

STAND: 26 OBSERVERS: AB JP DATE 11/6/70

LOCALITY: Island south of Christatie

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Typha angustifolia	51	351.9	148	Yg		23%	84%			
Carex aquatilis	48	50.1	87	Yg fr.		22%	12%			
Campanula aparinoides	114	4.4	33	Yg		51%				
Potentilla palustris	3	9.5	56	Fl bud						
Phragmites communis	1	2.1	112	Yg						
Calamagrostis canadensis	2	0.6	64	Veg						
Equisetum fluviatile	1	0.2	33	Veg						
Lysimachia thyrsiflora	2	0.2	32	Yg fl						
Galium palustre	1	+	13	Yg						
Cicuta bulbifera	1	+	38	Veg						
Uticularia vulgaris	few	+	+	Fl						
Lemna trisulca	few	+	+	Veg						
DEAD MATERIAL (Mulch)		990.7								

ENVIRONMENTAL FEATURES:

WATER DEPTH : 8 cm.

SOIL

pH:	5.2	H ions:	24.0 meq/100g
% organic matter:	69.6	K:	1.25 meq/100g
% Carbon:	40.12	Na:	0.73 meq/100g
% Nitrogen:	1.54	Ca:	49.30 meq/100g
Available phosphorus:	13.27 mg/100g	Mg:	5.42 meq/100g

MARSH STUDIES

STAND: 27 OBSERVERS: AB JP DATE 11/6/70

LOCALITY: Island south of Christatie

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Carex diandra	54	16.8	55	Fl		29%	3%			
	Phragmites communis	50	155.9	130	Yg		26%	27%			
	Potentilla palustris	26	22.8	30	Yg		14%	4%			
	Campanula aparinoides	36	0.6	17	Veg						
	Carex aquatilis	12	11.6	84	Yg Fr						
	Calamagrostis canadensis	9	1.6	17	Veg						
	Lysimachia thrysiflora	2	0.8	13	Veg						
	Moss species		358.1					63%			
	DEAD MATERIAL (Mulch)		516.4								

ENVIRONMENTAL FEATURES:

WATER DEPTH 6 cm.

SOIL

pH: 5.5
% organic matter: 81.2
% Carbon: 52.10
% Nitrogen: 2.09
Available phosphorus: 8.95 mg/100g

H ions: 21.5 meq/100g
K: 1.76 meq/100g
Na: 1.12 meq/100g
Ca: 52.20 meq/100g
Mg: 8.01 meq/100g

MARSH STUDIES

STAND: 28 OBSERVERS: AB JP DATE 17/6/70

LOCALITY: Mainland

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Carex aquatilis	252	219	91	Fr		56%	71%			
Dryopteris Thelypteris	49	12.8	42	Veg		11%	4%			
Onoclea sensibilis	46	17.2	43	Veg		10%	6%			
Carex diandra	27	7.2	64	Fr		6%	2%			
Sparganium eurycarpum	11	11.8	68	Veg						
Hypericum virginicum	15	1.3	16	Seedling						
Iris versicolor	8	11.0	65	Veg						
Typha angustifolia	8	18.8	83	Veg						
Carex stricta	6	4.9	71	Veg						
Calamagrostis canadensis	5	0.5	76	Veg						
Lythrum salicaria	5	4.3	42	Veg						
Lysimachia thyrsiflora	5	0.7	31	Veg						
Galium Aparine	4	+	15	Veg						
DEAD MATERIAL										

ENVIRONMENTAL FEATURES:

WATER DEPTH

SOIL

see next page...

MARSH STUDIES

STAND: 28, p. 2 OBSERVERS: AB JP DATE 17/6/70

LOCALITY: Mainland

COLL. SPECIES	No	DW	HT	Phe		Nb	DW			
Polygonum amphibium	3	0.7	28	Veg						
Carex lacustris	1	0.5	73	Veg						
Lycopus europeus	1	0.2	31	Veg						
Galium palustre	1	+	20	Veg						
Impatiens capensis	2	+	10	Seedling						
Bidens cernua	1	+	11	Seedling						
DEAD MATERIAL (Mulch)		876.9								

ENVIRONMENTAL FEATURES:

WATER DEPTH 6 cm

SOIL
pH: 5.0
% organic matter: 28.0
% Carbon: 16.22
% Nitrogen: 0.80
Available phosphorus: 6.22 mg/100g

H ions: 15.5 meq/100g
K: 0.58 meq/100g
Na: 0.44 meq/100g
Ca: 17.18 meq/100g
Mg: 3.78 meq/100g

MARSH STUDIES

STAND: 29 OBSERVERS: AB JP DATE 17/6/70

LOCALITY: Mainland

COLL. SPECIES	No	DW	HT	Phe		Nb	DW			
Carex aquatilis	47	37.5	103	Mat Fr		26%	15%			
Lythrum Salicaria	37	12.7	34	Veg		21%	5%			
Typha angustifolia	33	139	128	Yg Fl		18%	54%			
Carex lacustris	20	22.2	79	Veg		11%	9%			
Campanula aparinoides	19	0.4	30	Veg						
Carex lasiocarpa	7	5.4	66	Mat. Fr						
Dryopteris thelypteris	5	0.4	28	Veg						
Sagittaria latifolia	2	1.1	38	Veg						
Rumex orbicularis	2	1.2	44	Veg						
Carex stricta	2	1.7	67	Veg						
Potentilla palustris	3	0.5	25	Veg						
Lysimachia thyrsiflora	1	0.7	25	Veg						
Cicuta bulbifera	1	+	33	Veg						
DEAD MATERIAL -										

ENVIRONMENTAL FEATURES:

WATER DEPTH

SOIL

see next page...

MARSH STUDIES

STAND: 29, p.2

OBSERVERS: AB
JP

DATE 17/6/70

LOCALITY: Mainland

COLL. SPECIES	NO	DW	HT	Phe						
Galium palustre	1	+	11	Fl						
Impatiens capensis	1	+	9	Seed ling						
Utricularia vulgaris	few	+	6	Veg						
Lemna trisulca	few	+		Veg						
Moss		34.9								
DEAD MATERIAL (Mulch)		569.3								

ENVIRONMENTAL FEATURES:

WATER DEPTH 11 cm.

SOIL

pH; 5.7
% organic matter: 89.0
% Carbon: 51.18
% Nitrogen: 2.64
Available phosphorus: 4.12 mg/100g

H ions: 19.0 meq/100g
K: 1.94 meq/100g
Na: 1.44 meq/100g
Ca: 56.80 meq/100g
Mg: 14.81 meq/100g

MARSH STUDIES

STAND 31 OBSERVERS: AB JP DATE 18/6/70

LOCALITY: Christatie Island

COLL.	SPECIES	No	DW	HT	Phe		Nb	DW
	Carex aquatilis	195	146.6	87	Yg Fr		48%	59%
	Carex stricta	27	15.0	83	Yg Fr		7%	6%
	Dryopteris Thelypteris	29	4.5	30	Veg			
	Campanula aparinoides	49	1.0	27	Veg			
	Calamagrostis canadensis	22	2.9	58	Veg			
	Lysimachia thyrsiflora	17	1.8	34	Veg			
	Typha angustifolia	11	22.9	97	Veg			
	Carex lacustris	9	15.6	68	Veg			
	Carex lasiocarpa	9	1.5	63	Veg			
	Carex diandra	6	0.6	47	Yg fr			
	Iris versicolor	6	15.3	53	Fl bud			
	Sparganium eurycarpum	4	4.3	74	Veg			
	Potentilla palustris	1	8.8	88	Fl			
	DEAD MATERIAL							

ENVIRONMENTAL FEATURES:

WATER DEPTH

SOIL

see next page...

MARSH STUDIES

STAND: 31, p.2 OBSERVERS: AB JP DATE 18/6/70

LOCALITY: Christatie Island

COLL. , SPECIES	Nb	DW	HT	Phe		Nb	DW			
Sagittaria latifolia	1	0.3	29	Veg						
Rumex orbicularis	1	+	31	Veg						
Bidens cernua	1	+	9	Veg						
Lycopus uniflorus	1	+	8	Seedling						
Moss		1.7								
DEAD MATERIAL (mulch)		575.2								

ENVIRONMENTAL FEATURES:

WATER DEPTH: 4 cm

SOIL

pH: 5.5
% organic matter: 65.8
% Carbon: 41.41
% Nitrogen: 1.85
Available phosphorus: 9.19 mg/100g

H ions: 21.0 meq/100g
K: 3.98 meq/100g
Na: 0.96 meq/100g
Ca: 44.40 meq/100g
Mg: 6.98 meq/100g

MARSH STUDIES

STAND: 32

OBSERVERS: AB
JP

DATE 18/6/70

LOCALITY: Christatie Island

COLL. SPECIES	No	DW	HT	Phe		Nb	DW			
Carex aquatilis	351	318.4	96	Yg Fr		54%	59%			
Calamagrostis canadensis	97	18.8	50	Fl		15%	3%			
Typha angustifolia	22	48.5	94	Veg		3%	9%			
Carex stricta	36	27.9	90	Yg Fr		6%	5%			
Campanula aparinoides	56	0.9	24	Veg						
Galium palustre	17	0.1	17	Veg						
Hypericum virginicum	16	0.4	18	Veg						
Viola palustris	10	0.1	5	Veg						
Lycopus uniflorus	13	0.5	11	Veg						
Carex diandra	16	1.9	50	Veg						
Dryopteris Thelypteris	4	0.4	27	Veg						
Polygonum amphibium	3	0.4	35	Veg						
Viola pallens	3	+	6	Veg						
Moss		125.5					25%			
DEAD MATERIAL (Mulch)		162.1								

ENVIRONMENTAL FEATURES:

WATER DEPTH 00 cm

SOIL

pH: 5.5

% organic matter: 81.1

% Carbon: 47.05

% Nitrogen: 2.13

Available phosphorus: 7.05 mg/100g

H ions: 24.0 meq/100g

K: 2.07 meq/100g

Na: 3.27 meq/100g

Ca: 56.00 meq/100g

Mg: 8.64 meq/100g

MARSH STUDIES

STAND: 33 OBSERVERS: AB JP DATE 19/6/70

LOCALITY: Christatie Island

COLL.	SPECIES	NO	DW	HT	Phe		Nb	DW			
	Carex aquatilis	187	220.5	105	Yg fr		47%	31%			
	Carex diandra	59	10.5	62	Yg fr		15%	1%			
	Carex lasiocarpa	47	7.4	52	Yg fr						
	Typha angustifolia	38	127.3	122	Fl bud		10%	18%			
	Calamagrostis canadensis	25	2.5	43	Veg						
	Carex stricta	8	7.4	90	Yg fr						
	Potentilla palustris	6	3.3	28	Veg						
	Campanula aparinoides	18	0.3	14	Veg						
	Lycopus uniflorus	7	+	8	Veg						
	Viola pallens	3	+	7	Veg						
	Galium palustre	2	+	6	Veg						
	Utricularia vulgaris	many	1.4	5	Veg						
	Moss		324.8					46%			
	DEAD MATERIAL (Mulch)		490.4								

ENVIRONMENTAL FEATURES:

WATER DEPTH: 2 cm

SOIL
pH: 6.0
% organic matter: 60.4
% Carbon: 35.26
% Nitrogen: 1.51
Available phosphorus: 12.83 mg/100g

H ions: 18.0 meq/100g
K: 1.29 meq/100g
Na: 1.00 meq/100g
Ca: 57.49 meq/100g
Mg: 9.00 meq/100g

MARSH STUDIES

STAND: 34 OBSERVERS: AB
JP
DATE 19/6/70

LOCALITY: Christatie Island

COLL.	SPECIES	No	DW	HT	Phe		Nb	DW			
	Carex aquatilis	345	407.4	112	Fr		72%	86%			
	Calamagrostis canadensis	46	10.6	67	Fl		10%	2%			
	Campanula aparinoides	21	0.1	15	Veg						
	Dryopteris Thelypteris	15	1.8	28	Veg						
	Typha angustifolia	13	33.0	112	Yg fl						
	Polygonum amphibium	13	2.4	26	Veg						
	Carex lacustris	8	16.1	98	Veg						
	Carex stricta	8	3.7	74	Fr						
	Lycopus uniflorus	4	0.1	8	Yg						
	Lysimachia thyrsiflora	4	0.1	18	Yg						
	Lathyrus palustris	2	0.1	11	Veg						
	Cicuta bulbifera	1	+	12	Yg						
	Viola pallens	1	+	5	Yg						
	DEAD MATERIAL										

ENVIRONMENTAL FEATURES:

WATER DEPTH

SOIL

see next page...

MARSH STUDIES

STAND: 34 p. 2   OBSERVERS: AB JP   DATE 19/6/70

LOCALITY:

COLL. SPECIES	Nb	DW	HT	Phc		Nb	DW			
Uticularia vulgaris	few	+	3							
Moss		155.7								
DEAD MATERIAL (Mulch)		148.6								

ENVIRONMENTAL FEATURES:

WATER DEPTH: 2 cm

SOIL

pH: 5.8
% organic matter: 74.1
% Carbon: 42.98
% Nitrogen: 1.60
Available phosphorus: 7.95 mg/100g

H ions: 14.0 meq/100g
K: 1.54 meq/100g
Na: 1.03 meq/100g
Ca: 49.80 meq/100g
Mg: 8.10 meq/100g

MARSH STUDIES

STAND: 35 OBSERVERS: AB JP DATE 19/6/70

LOCALITY: Christatie Island

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW
Carex aquatilis	286	309.2	93	Yg fr		51%	42%
Carex lasiocarpa	274	102.9	84	Fr		40%	17%
Calamagrostis canadensis	91	20	71	Fl		13%	3%
Carex stricta	14	16.9	82	Yg fr			
Campanula aparinoides	9	+	15	Veg			
Hypericum virginicum	6	0.1	16	Veg			
Galium palustre	4	+	12	Veg			
Lysimachia thyrsiflora	1	+	27	Veg			
Lycopus seedling	1	+	15	Seedling			
Moss		155.6					26%
DEAD MATERIAL (Mulch)		285.4					

ENVIRONMENTAL FEATURES:

WATER DEPTH: 2 cm

SOIL

pH: 5.6
% organic matter: 72.8
% Carbon: 37.88
% Nitrogen: 1.82
Available phosphorus: 9.86 mg/100g

H ions: 18.8 meq/100g
K: 4.61 meq/100g
Na: 0.81 meq/100g
Ca: 40.93 meq/100g
Mg: 7.51 meq/100g

MARSH STUDIES

STAND: 36 OBSERVERS: AB JP DATE 19/6/70

LOCALITY: Christatie Island

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Carex aquatilis	240	261.9	91	Fr		37%	52%			
Carex lasiocarpa	168	43.6	71	Fr		26%	9%			
Calamagrostis canadensis	107	20.2	55	Fl		17%	4%			
Dryopteris Thelypteris	70	6.1	26	Veg						
Campanula aparinoides	31	0.4	24	Veg						
Hypericum virginicum	15	0.2	14	Veg						
Typha angustifolia	6	23.2	95	Veg						
Galium palustre	5	+	18	Fl						
Lysimachia thyrsiflora	1	+	15	Veg						
Moss		144.1								
DEAD MATERIAL (Mulch)		223.4								

ENVIRONMENTAL FEATURES:

WATER DEPTH: 00 cm

SOIL

pH: 5.8	H ions: 20.0 meq/100g
% organic matter: 84.3	K: 1.74 meq/100g
% Carbon: 48.86	Na: 1.13 meq/100g
% Nitrogen: 2.21	Ca: 66.80 meq/100g
Available phosphorus: 7.58 mg/100g	Mg: 11.04 meq/100g

MARSH STUDIES

STAND: 37 OBSERVERS: AB JP DATE 19/6/70

LOCALITY: Christatie Island

COLL. SPECIES	No	DW	HT	Phe		Nb	DW			
Carex aquatilis	222	304.7	93	Mat Fr		42%	37%			
Carex diandra	132	15.1	82	Mat Fr		25%				
Calamagrostis canadensis	106	16.2	55	Veg		20%	2%			
Typha angustifolia	16	99.3	154	Fl bud		3%	12%			
Campanula aparinoides	15	0.2	24	Veg						
Lycopus uniflorus	13	+	9	Seedling						
Galium palustre	13	0.3	10	Fl						
Carex stricta	8	3.0	64	Mat Fr						
Carex lacustris	2	3.3	50	Veg						
Potentilla palustris	2	4.5	35	Veg						
Moss		324.8								
DEAD MATERIAL (Mulch)		490.5								

ENVIRONMENTAL FEATURES:

WATER DEPTH: 00 cm

SOIL

pH: 5.6
% organic matter: 86.4
% Carbon: 49.27
% Nitrogen: 1.93
Available phosphorus: 7.46 mg/100g

H ions: 19.0 meq/100g
K: 1.69 meq/100g
Na: 1.14 meq/100g
Ca: 63.47 meq/100g
Mg: 9.16 meq/100g

MARSH STUDIES

STAND: 38 OBSERVERS: AB JP DATE 26/6/70

LOCALITY: Christatie Island

COLL. SPECIES	No	DW	HT	Phe		Nb	DW				
Carex aquatilis	116	211.9	101	Fr		18%	32%				
Carex lasiocarpa	181	55.1	84	Fr		28%	8%				
Calamagrostis canadensis	134	40.8	64	Fl		21%	6%				
Dryopteris thelypteris	63	9.7	30	Veg							
Hypericum virginicum	42	0.9	16	Yg							
Carex diandra	29	5.7	67	Fr							
Typha angustifolia	23	105.9	151	Veg		4%	16%				
Campanula aparinoides	17	0.1	20	Veg							
Lycopus uniflorus	17	+	10	Seedling							
Viola pallens	10	+	6	Yg							
Carex stricta	8	11.3	98	Fr							
Potentilla palustris	6	4.2	36	Veg							
Galium palustre	2	+	8	Veg							
Moss		207.2									
DEAD MATERIAL (Mulch)		313.6									

ENVIRONMENTAL FEATURES:

WATER DEPTH: 00 cm

SOIL

pH: 5.8		H ions: 22.0	meq/100g
% organic matter:	90.4	K: 1.64	meq/100g
% Carbon:	52.44	Na: 1.14	meq/100g
% Nitrogen:	1.96	Ca: 55.60	meq/100g
Available phosphorus:	4.65 mg/100g	Mg: 8.94	meq/100g

MARSH STUDIES

STAND: 39 OBSERVERS: AB JP DATE 26/6/70

LOCALITY: Christatie Island

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Carex aquatilis	356	419.9	92	Fr		68%	74%			
	Calamagrostis canadensis	81	24.5	62	Fl						
	Dryopteris thelypteris	45	6.1	31	Veg						
	Polygonum amphibium	15	7.2	42	Veg						
	Carex stricta	13	3.2	61	Mat Fr						
	Hypericum virginicum	8	0.4	19	Veg						
	Campanula aparinoides	6	0.1	22	Veg						
	Lycopus uniflorus	1	+	22	Seedling						
	Carex lasiocarpa	1	0.3	68	Mat Fr						
	Galium palustre	1	0.1	11	Veg						
	Utricularia vulgaris	few	0.1	4	Veg						
	Moss		108.7								
	DEAD MATERIAL (Mulch)		207.9								

ENVIRONMENTAL FEATURES:

WATER DEPTH 00 cm

SOIL

pH; 5.7
% organic matter: 93.2
% Carbon: 54.08
% Nitrogen: 1.78
Available phosphorus: 5.83 mg/100g

H ions: 18.0 meq/100g
K: 1.65 meq/100g
Na: 1.13 meq/100g
Ca: 52.33 meq/100g
Mg: 8.56 meq/100g

MARSH STUDIES

STAND: 40 OBSERVERS: AB JP DATE 26/6/70

LOCALITY: Christatie Island

COLL.	SPECIES	No	DW	HT	Phe		Nb	DW			
	Carex aquatilis	320	358.4	95	Fr		45%	60%			
	Calamagrostis canadensis	220	78.3	78	Fl		31%	13%			
	Carex lasiocarpa	105	34.0	72	Fr		15%	6%			
	Dryopteris thelypteris	29	2.4	22	Veg						
	Carex diandra	11	2.4	65	Mat Fr						
	Campanula aparinoides	10	+	16	Veg						
	Hypericum virginicum	7	0.2	18	Veg						
	Potentilla palustris	4	1.2	24	Veg						
	Equisetum fluviatile	3	0.4	47	Veg						
	Typha angustifolia	2	9.8	134	Veg						
	Viola pallens	2	+	5	Veg						
	Galium palustre	2	+	8	Veg						
	Moss		110.4								
	DEAD MATERIAL (Mulch)		196.2								

ENVIRONMENTAL FEATURES:

WATER DEPTH: 00 cm

SOIL

pH: 5.6

% organic matter: 87.9

% Carbon: 51.02

% Nitrogen: 2.20

Available phosphorus: 4.95 mg/100g

H ions: 23.0 meq/100g

K: 1.85 meq/100g

Na: 1.19 meq/100g

Ca: 54.25 meq/100g

Mg: 8.65 meq/100g

MARSH STUDIES

STAND: 41 OBSERVERS: AB JP DATE 26/6/60

LOCALITY: Christatie Island

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Carex aquatilis	136	131.2	95	Fr		28%	17%			
	Calamagrostis canadensis	105	77.7	66	Fl		22%	10%			
	Dryopteris thelypteris	60	12.5	29	Veg						
	Campanula aparinoides	43	0.8	32	Veg						
	Typha angustifolia	29	259.6	146	Fl & Pollen		6%	33%			
	Lycopus uniflorus	32	0.3	10	Veg						
	Hypericum virginicum	18	0.5	22	Veg						
	Equisetum fluviatile	12	4.3	74	Veg						
	Lysimachia thyrsiflora	2	0.1	21	Veg						
	Iris versicolor	1	0.3	57	Veg						
	Carex stricta	39	35.4	87	Fr		8%	4%			
	Carex lasiocarpa	1	0.1	75	Fr						
	Viola pallens	1	+	2	Veg						
	DEAD MATERIAL										

ENVIRONMENTAL FEATURES:

WATER DEPTH

SOIL

see next page...

MARSH STUDIES

STAND: 41, p.2 OBSERVERS: AB JP DATE 26/6/70

LOCALITY: Christatie Island

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Galium palustre	1	+	10	Veg						
Onoclea sensibilis	1	+	13	Veg						
Convolvulus sepium	1	+	11	Veg						
Moss		267.0					34%			
DEAD MATERIAL (Mulch)		137.3								

ENVIRONMENTAL FEATURES:

WATER DEPTH: 00 cm

SOIL

pH: 5.5
% organic matter: 78.2
% Carbon: 45.35
% Nitrogen: 1.93
Available phosphorus: 7.35 mg/100g

H ions: 21.3 meq/100g
K: 1.63 meq/100g
Na: 0.88 meq/100g
Ca: 66.93 meq/100g
Mg: 8.36 meq/100g

MARSH STUDIES

STAND: 46 OBSERVERS: AB JP DATE 7/7/70

LOCALITY: Island south of Christatie

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Typha angustifolia	54	547.2	173	Fem. Fl		65%	97%			
Carex aquatilis	18	12.3	88	Veg		22%	2%			
Campanula aparinoides	5	0.1	38	Veg						
Onoclea sensibilis	3	0.1	9	Veg						
Lythrum salicaria	1	1.8	74	Fl bud						
Calamagrostis canadensis	1	0.1	67	Veg						
Galium palustre	1	+	12	Veg						
Lysimachia thyrsiflora	1	1.1	63	Veg						
Cicuta bulbifera	1	+	8	Veg						
Utricularia vulgaris & U. minor	few	+	6	Veg						
Moss	+	+								
DEAD MATERIAL (Mulch)		1032.6								

ENVIRONMENTAL FEATURES: √

WATER DEPTH: 8 cm

SOIL

pH: 5.4
% organic matter: 68.2
% Carbon: 42.17
% Nitrogen: 3.91
Available phosphorus: 14.62 mg/100g

H ions: 16.0 meq/100g
K: 1.69 meq/100g
Na: 0.62 meq/100g
Ca: 52.50 meq/100g
Mg: 7.34 meq/100g

MARSH STUDIES

STAND: 47   OBSERVERS: AB JP   DATE 7/7/70

LOCALITY: Island south of Christatie

COLL. SPECIES	Nb	DW	HT	Phe	Nb	DW			
Typha angustifolia	76	488.4	167	Fl	57%	82%			
Carex aquatilis	24	23.6	82	Fall. Fr	18%	4%			
Scirpus validus	18	39.0	172	Fl	14%	7%			
Campanula aparinoides	12	0.3	34	Veg					
Lysimachia thyrsiflora	3	0.4	40	Veg					
Galium palustre	1	+	10	Veg					
Utricularia vulgaris & U. minor	+	+	9	Fl					
Moss		42.8							
DEAD MATERIAL (Mulch)		1305.6							

ENVIRONMENTAL FEATURES:

WATER DEPTH: 9 cm

SOIL

pH; 5.3
% organic matter: 64.4
% Carbon: 37.38
% Nitrogen: 1.25
Available phosphorus: 23.28 mg/100g

H ions: 18.0 meq/100g
K: 2.19 meq/100g
Na: 0.52 meq/100g
Ca: 80.90 meq/100g
Mg: 7.69 meq/100g

MARSH STUDIES

STAND: 48 OBSERVERS: AB
JP
DATE 12/7/70

LOCALITY: Island south of Christatie

COLL.	SPECIES	No	DW	HT	Phe		Nb	DW			
	Carex aquatilis	142	132.3	110	Fr. Falling		54%	24%			
	Typha angustifolia	42	400.1	171	Fem. Fl		16%	74%			
	Campanula aparinoides	27	0.8	38	Veg						
	Calamagrostis canadensis	20	1.4	46	Fl						
	Lysimachia thyrsiflora	13	1.4	35	Veg						
	Carex lasiocarpa	6	0.9	98	Veg						
	Hypericum virginicum	6	0.4	12	Veg						
	Galium palustre	5	+	12	Veg						
	Dryopteris thelypteris	3	0.3	22	Veg						
	Potentilla palustris	1	0.6	33	Fr						
	Utricularia vulgaris & U. minor	Many	1.0								
	Moss		4.6								
	DEAD MATERIAL (Mulch)		924.7								

ENVIRONMENTAL FEATURES:

WATER DEPTH 9 cm

SOIL
pH: 5.6
% organic matter: 81.5
% Carbon: 47.29
% Nitrogen: 1.96
Available phosphorus: 6.38 mg/100g

H ions: 17.0 meq/100g
K: 1.86 meq/100g
Na: 1.14 meq/100g
Ca: 70.40 meq/100g
Mg: 8.98 meq/100g

MARSH STUDIES

STAND: 49 OBSERVERS: AB JP DATE 12/7/70

LOCALITY: Island south of Christatie

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Carex aquatilis	316	255.1	102	Old Fr		70%	92%			
Calamagrostis canadensis	62	12.8	45	Veg		14%	5%			
Dryopteris thelypteris	26	3.1	23	Veg						
Campanula aparinoides	20	0.5	19	Veg						
Hypericum virginicum	9	0.5	19	Veg						
Lysimachia thyrsiflora	8	0.5	21	Veg						
Lycopus europeus	4	0.2	10	Veg						
Carex stricta	4	4.9	66	Old Fr						
Onoclea sensibilis	1	0.1	13	Veg						
Galium palustre	1	+	27	Fl						
Moss		0.4								
DEAD MATERIAL (Mulch)		884.5								

ENVIRONMENTAL FEATURES:

WATER DEPTH 15 cm

SOIL

pH: 5.7
% organic matter: 74.3
% Carbon: 43.12
% Nitrogen: 2.26
Available phosphorus: 4.87 mg/100g

H ions: 16.0 meq/100g
K: 1.64 meq/100g
Na: 1.24 meq/100g
Ca: 50.80 meq/100g
Mg: 7.82 meq/100g

MARSH STUDIES

STAND: 50 OBSERVERS: AB DATE 12/7/70
JP

LOCALITY: Island south of Christatie

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Dryopteris thelypteris	185	54.8	49	Veg		31%	17%			
Carex aquatilis	174	157.7	88	Fl		29%	48%			
Campanula aparinoides	99	5.6	40	Fl						
Bidens discoidea	30	2.8	42	Veg						
Lysimachia thyrsiflora	27	5.4	46	Fr						
Iris versicolor	18	63.2	74	Yg Fr						
Calamagrostis canadensis	16	2.8	52	Veg						
Convolvulus sepium	14	1.0	49	Veg						
Sagittaria latifolia	8	3.8	55	Veg						
Cicuta bulbifera	5	0.2	32	Veg						
Typha angustifolia	5	20.5	151	Fem Spike						
Impatiens capensis	3	+	27	Veg						
Typha latifolia	1	8.9	123	Veg						
DEAD MATERIAL										

ENVIRONMENTAL FEATURES:

WATER DEPTH

SOIL

see next page...

MARSH STUDIES

STAND: 50, p.2 OBSERVERS: AB, JP DATE 12/7/70

LOCALITY: Island south of Christatie

COLL. SPECIES	No	DW	HT	Phe		Nb	DW			
Galium palustre	1	+	10	Fl						
Galium aparine	Many	2.3	33	Fl						
DEAD MATERIAL (Mulch)		451.4								

ENVIRONMENTAL FEATURES:

WATER DEPTH 14 cm

SOIL

pH: 5.5
% organic matter: 64.7
% Carbon: 37.40
% Nitrogen: 1.79
Available phosphorus: 4.28 mg/100g

H ions: 20.0 meq/100g
K: 1.34 meq/100g
Na: 1.31 meq/100g
Ca: 51.20 meq/100g
Mg: 6.87 meq/100g

MARSH STUDIES

STAND: 51 OBSERVERS: AB JP DATE 17/7/70

LOCALITY: Mainland

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Carex lacustris	110	287	115	Fall. Fr		47%	66%			
	Calamagrostis canadensis	91	268.6	98	Fr		28%	11%			
	Acorus calamus	22	51.7	82	Fr		9%	12%			
	Carex stricta	16	10.3	72	Fall. Fr		7%	2%			
	Lysimachia thyrsiflora	7	0.5	32	Veg						
	Equisetum fluviatile	4	1.7	57	Veg						
	Galium aparine	2	+	23	Fl						
	Lycopus uniflorus	2	+	26	Veg						
	Polygonum amphibium	1	2.0	68	Veg						
	Sparganium eurycarpum	1	1.9	71	Veg						
	Impatiens capensis	1	+	7	Seedling						
	Moss		4.1								
	DEAD MATERIAL (Mulch)		908.1								

ENVIRONMENTAL FEATURES:

WATER DEPTH 9 cm

SOIL

pH; 5.6
% organic matter: 72.1
% Carbon: 41.83
% Nitrogen: 2.03
Available phosphorus: 4.95 mg/100g

H ions: 26.0 meq/100g
K: 1.54 meq/100g
Na: 1.36 meq/100g
Ca: 38.80 meq/100g
Mg: 9.54 meq/100g

MARSH STUDIES

STAND: 52 | OBSERVERS: AB JP | DATE 17/7/70

LOCALITY: Mainland

COLL.	SPECIES	No	DW	HT	Phe		Nb	DW			
	Calamagrostis canadensis	135	90.1	92	Old Fr		45%	22%			
	Carex lacustris	106	291.8	126	Old Fr		35%	71%			
	Onoclea sensibilis	19	4.3	29	Veg						
	Lysimachia thyrsiflora	12	2.1	39	Veg						
	Carex stricta	5	10.5	108	Veg						
	Lycopus uniflorus	5	0.9	30	Veg						
	Equisetum fluviatile	5	3.7	70	Veg						
	Sagittaria latifolia	4	0.2	25	Veg						
	Cicuta bulbifera	4	0.8	33	Veg						
	Scutellaria epilobiifolia	2	1.9	50	Veg						
	Sparganium eurycarpum	1	1.8	102	Veg						
	Eupatorium perfoliatum	1	+	49	Veg						
	Typha angustifolia	1	1.9	69	Veg						
Moss			2.7								
	DEAD MATERIAL (Mulch)		795.2								

ENVIRONMENTAL FEATURES:

WATER DEPTH 1 cm

SOIL

pH:	5.5	H ions:	28.0 meq/100g
% organic matter:	79.3	K:	1.63 meq/100g
% Carbon:	46.01	Na:	0.91 meq/100g
% Nitrogen:	1.37	Ca:	34.70 meq/100g
Available phosphorus:	6.86 mg/100g	Mg:	9.91 meq/100g

MARSH STUDIES

STAND: 53 OBSERVERS: AB JP DATE 17/7/70

LOCALITY: Mainland

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Calamagrostis canadensis	216	206.5	108	Old Fr		41%	41%			
Campanula aparinoides	70	2.2	37	Fl						
Dryopteris thelypteris	66	24.2	52	Veg		13%	5%			
Carex lacustris	45	148.5	135	Old Fr		9%	29%			
Carex aquatilis	42	95.1	104	Old Fr		8%	19%			
Equisetum fluviatile	28	11.8	72	Veg		5%	2%			
Sagittaria latifolia	19	6.1	63	Veg						
Lycopus uniflorus	15	0.4	23	Veg						
Lysimachia thyrsiflora	14	1.5	35	Veg						
Cicuta bulbifera	3	+	33	Veg						
Galium aparine	2	+	19	Yg Fl						
Rumex orbiculatus	2	+	36	Veg						
Acorus calamus	1	1.7	68	Veg						
DEAD MATERIAL										

ENVIRONMENTAL FEATURES:

WATER DEPTH

SOIL

see next page...

MARSH STUDIES

STAND: 53, p.2 OBSERVERS: AB
JP DATE 17/7/70

LOCALITY: Mainland

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Sparganium eurycarpum	1	5.3	98	Veg						
Moss		4.7								
DEAD MATERIAL (Mulch)		487.7								

ENVIRONMENTAL FEATURES:

WATER DEPTH 00 cm

SOIL

pH: 5.6
% organic matter: 82.7
% Carbon: 47.99
% Nitrogen: 2.33
Available phosphorus: 6.82 mg/100g

H ions: 24.0 meq/100g
K: 1.46 meq/100g
Na: 0.94 meq/100g
Ca: 35.30 meq/100g
Mg: 9.88 meq/100g

MARSH STUDIES

STAND: 57 OBSERVERS: AB JP DATE 22/7/70

LOCALITY: Mainland

COLL.	SPECIES	No	DW	HT	Phe	Nb	DW			
	Carex aquatilis	220	330	104	Fall. Fr	35%	71%			
	Carex lasiocarpa	120	31.9	71	Fall. Fr	19%	7%			
	Calamagrostis canadensis	79	50.7	103	Fr	13%	11%			
	Dryopteris thelypteris	79	22.4	40	Senesc.	13%	5%			
	Campanula aparinoides	46	1.9	[illegible]	Veg					
	Lycopus uniflorus	27	0.4	38	Veg					
	Lysimachia thyrsiflora	23	2.6	32	Veg					
	Lathyrus palustris	10	2.6	53	Veg					
	Galium palustre	9	+	20	Fr					
	Scutellaria epilobiifolia	3	3.1	42	Veg					
	Sparganium eurycarpum	1	4.8	110	Fr					
	Eupatorium maculatum	1	+	45	Veg					
	Sagittaria latifolia	2	0.1	58	Veg					
	Moss		14.2							
	DEAD MATERIAL (Mulch)		520.1							

ENVIRONMENTAL FEATURES:

WATER DEPTH 4 cm

SOIL
pH: 5.8
% organic matter: 69.5
% Carbon: 46.22
% Nitrogen: 1.82
Available phosphorus: 9.26 mg/100g

H ions: 24.0 meq/100g
K: 1.51 meq/100g
Na: 1.02 meq/100g
Ca: 39.70 meq/100g
Mg: 10.48 meq/100g

MARSH STUDIES

STAND: 58 OBSERVERS: AB JP DATE 22/7/70

LOCALITY: Mainland

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Carex stricta	360	342.7	99	Fall. Fr		47%	68%			
	Calamagrostis canadensis	104	55.6	83	Fall. Fr		14%	11%			
	Dryopteris thelypteris	84	12.2	31	Senesc.		11%	2%			
	Campanula aparinoides	66	3.5	41	Fl						
7	Lycopus uniflorus	52	3.0	28	Veg						
	Galium palustre	26	0.2	15	Veg						
	Onoclea sensibilis	25	4.3	14	Veg						
	Carex lacustris	18	60.3	109	Fall. Fr		2%	12%			
	Lysimachia thyrsiflora	6	0.7	27	Veg						
	Lathyrus palustris	6	0.5	39	Fl						
	Viola pallens	4	0.1	08	Veg						
	Equisetum fluviatile	2	0.9	87	Veg						
	Rumex orbiculatus	2	0.8	52	Veg						
	DEAD MATERIAL										

ENVIRONMENTAL FEATURES:

WATER DEPTH

SOIL

see next page...

MARSH STUDIES

STAND: 58, p.2 OBSERVERS: AB JP DATE 22/7/70

LOCALITY: Mainland

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW				
Cicuta bulbifera	2	0.1	45	Veg		—					
Polygonum amphibium	1	0.5	49	Veg							
Sagittaria latifolia	1	0.6	58	Veg							
Moss		21.4									
DEAD MATERIAL (Mulch)		146.0									

ENVIRONMENTAL FEATURES:

WATER DEPTH 12 cm

SOIL

pH: 5.6
% organic matter: 94.3
% Carbon: 43.12
% Nitrogen: 2.17
Available phosphorus: 7.77 mg/100g

H ions: 24.7 meq/100g
K: 1.41 meq/100g
Na: 0.85 meq/100g
Ca: 30.53 meq/100g
Mg: 9.22 meq/100g

MARSH STUDIES

STAND: 66 **OBSERVERS:** AB, JP **DATE** 4/8/70

LOCALITY: Nainland

COLL.	SPECIES	No	DW	HT	Phe		No	DW			
	Carex stricta	599	410.1	113	Mt. Fr		64%	55%			
	Calamagrostis canadensis	202	218.2	122	Mt. Fr		22%	29%			
	Equisetum fluviatile	27	12.1	60	Veg						
	Carex lacustris	26	93.7	143	Past Fr						
	Dryopteris thelypteris	41	3.4	36	Veg						
	Lycopus uniflorus	24	1.7	35	Fl Buds						
	Campanula aparinoides	12	1.1	53	Veg						
	Lythrum salicaria	1	1.1	52	Veg						
	Hypericum virginicum	2	0.1	36	Veg						
	Iris versicolor	1	2.1	103	Veg						
	Lysimachia thyrsiflora	1	0.2	35	Veg						
	Galium palustre	1	+	18	Veg						
	Lemna minor	Few									
	Moss		1.9								
	DEAD MATERIAL (Mulch)		178.9								

ENVIRONMENTAL FEATURES:

WATER DEPTH 14 cm

SOIL

pH: 5.7
% organic matter: 62.5
% Carbon: 36.26
% Nitrogen: 1.87
Available phosphorus: 8.81 mg/100g

H ions: 23.0 meq/100g
K: 1.32 meq/100g
Na: 0.82 meq/100g
Ca: 30.40 meq/100g
Mg: 9.03 meq/100g

MARSH STUDIES

STAND: 67 **OBSERVERS:** AB JP **DATE** 4/8/70

LOCALITY: Mainland

COLL.	SPECIES	No	DW	HT	Phe		No	DW			
	Carex lasiocarpa	470	177.7	114	Fall. Fr		28%	29%			
	Carex aquatilis	373	112.9	125	Fall. Fr		22%	19%			
	Calamagrostis canadensis	305	138.3	69	Past Fr		18%	23%			
	Dryopteris thelypteris	189	50.0	52	Veg		11%	8%			
	Carex stricta	147	72.5	110	Fall. Fr		9%	12%			
	Campanula rotundifolia	109	3.6	48	Veg						
	Equisetum fluviatile	54	26.9	95	Veg						
	Lycopus uniflorus	19	0.8	28	Veg						
	Campanula aparinoides	12	1.7	50	Veg						
	Sagittaria latifolia	10	9.2	62	Veg						
	Lythrum salicaria	2	2.8	64	Fl						
	Potentilla palustris	2	1.0	32	Veg						
	Carex lacustris	2	4.5	109	Past Fr						
	DEAD MATERIAL										

ENVIRONMENTAL FEATURES:

WATER DEPTH

SOIL

see next page...

MARSH STUDIES

STAND: 67, page 2 **OBSERVERS:** AB JP **DATE** 4/8/70

LOCALITY: Mainland

COLL. SPECIES	Nb	DW	HT	Phc		Nb	DW				
Lysimachia thyrsiflora	2	0.4	25	Veg							
Lathyrus palustris	1	0.2	67	Veg							
Iris versicolor	1	2.3	78	Veg							
DEAD MATERIAL (Mulch)		52.4									

ENVIRONMENTAL FEATURES:

WATER DEPTH 16 cm

SOIL

pH: 5.7
% organic matter: 50.9
% Carbon: 29.51
% Nitrogen: 1.50
Available phosphorus: 7.51 mg/100g

H ions: 22.38 meq/100g
K: 1.17 meq/100g
Na: 0.54 meq/100g
Ca: 22.89 meq/100g
Mg: 5.93 meq/100g

MARSH STUDIES

STAND: 68 OBSERVERS: AB JP DATE 5/8/70

LOCALITY: Mainland

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Calamagrostis canadensis	577	321.2	92	Fall. Fr		46%	44%			
	Carex Sartwellii	330	148.8	105	Sen.		27%	20%			
	Carex stricta	95	102.9	110	Sen		8%	14%			
	Campanula aparinoides	79	3.6	39	Fl						
	Equisetum fluviatile	62	32.9	92	Past spores						
	Carex aquatilis	55	112.9	117	Sen.		4%	15%			
	Carex lacustris	15	11.7	72	Sen.						
	Iris versicolor	8	0.9	92	Veg						
	Lycopus uniflorus	4	0.5	34	Lat.						
	Lysimachia thrysiflora	4	0.5	30	Veg						
	DEAD MATERIAL (Mulch)		67.3								

ENVIRONMENTAL FEATURES:

WATER DEPTH 4 cm

SOIL

pH: 6.0
% organic matter: 34.2
% Carbon: 19.82
% Nitrogen: 0.96
Available phosphorus: 14.55 mg/100g

H ions: 9.5 meq/100g
K: 0.94 meq/100g
Na: 0.49 meq/100g
Ca: 34.90 meq/100g
Mg: 6.43 meq/100g

MARSH STUDIES

STAND: 69 OBSERVERS: AB JP DATE 5/8/70

LOCALITY: Mainland

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Carex lasiocarpa	490	151.5	96	Sen		32%	35%			
	Calamagrostis canadensis	360	79.6	46	Past Fr		24%	18%			
	Carex Sartwellii	246	22.5	41	Sen		16%				
	Equisetum fluviatile	139	71.9	79	Sen		9%	17%			
	Campanula aparinoides	95	3.8	42	Fl						
	Dryopteris thelypteris	67	6.1	24	Veg						
	Lythrum salicaria	37	16.6	57	Fl						
	Carex diandra	31	8.4	66	Past Fr						
	Menyanthes trifoliata	23	61.3	37	Past Fr						
	Lysimachia thyrsiflora	13	1.1	22	Veg						
	Eleocharis compressa	5	0.4	28	Fr						
	Iris versicolor	3	10.6	64	Veg						
	Cicuta bulbifera	1	+	57	Veg						
	DEAD MATERIAL (Mulch)		177.8								

ENVIROMENTAL FEATURES:

WATER DEPTH 18 cm

SOIL

ph: 5.5
% organic matter: 63.25
% Carbon: 42.49
% Nitrogen: 1.81
Available phosphorus: 5.40 mg/100g

H ions: 24.0 meq/100g
K: 1.15 meq/100g
Na: 0.71 meq/100g
Ca: 29.10 meq/100g
Mg: 8.54 meq/100g

MARSH STUDIES

STAND: 70 OBSERVERS: AB JP DATE 6/8/70

LOCALITY: Mainland

COLL. SPECIES	Nb	DM	HT	Phe		Nb	DM			
Carex lasiocarpa	900	273.8	82	Fall. Fr		62%	56%			
Equisetum fluviatile	232	120	76	Sen		16%	25%			
Calamagrostis canadensis	178	47.4	67	Fall. Fr		12%	10%			
Campanula rotundifolia	70	1.8	23	Veg						
Dryopteris thelypteris	30	1.5	18	Veg						
Lysimachia thyrsiflora	8	0.3	17	Veg						
Drosera rotundifolia	6	o.3	28	Fr						
Iris versicolor	4	6.2	54	Fr						
Gerardia purpurea	3	0.2	35	Fl						
Potentilla palustris	3	3.3	35	Veg						
Lycopus uniflorus	3	+	17	Veg						
Hypericum virginicum	3	+	17	Veg						
Galium palustre	3	+	12	Veg						
DEAD MATERIAL										

ENVIRONMENTAL FEATURES:

WATER DEPTH

SOIL

see next page...

MARSH STUDIES

STAND: 70, page 2 OBSERVERS: AB, JP DATE 6/8/70

LOCALITY: Mainland

COLL.	SPECIES	No	DW	HT	Phe		Nb	DW			
	Liparis loeselii	2	0.5	14	Fr						
	Salix sp.	2	1.2	24	Veg						
	Onoclea sensibilis	2	+	7	Veg						
	Moss		29.4								
	Uticularia vulgaris & U. minor		0.9								
	DEAD MATERIAL (Mulch)		121.7								

ENVIRONMENTAL FEATURES:

WATER DEPTH 19 cm.

SOIL

pH: 5.6
% organic matter: 86.3
% Carbon: 47.44
% Nitrogen: 2.02
Available phosphorus: 4.95 mg/100g

H ions: 32.0 meq/100g
K: 1.37 meq/100g
Na: 0.74 meq/100g
Ca: 33.50 meq/100g
Mg: 9.48 meq/100g

MARSH STUDIES

STAND: 71 **OBSERVERS:** AB JP **DATE** 6/8/70

LOCALITY: Mainland

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Carex lasiocarpa	720	178.1	97	Fall. Fr		53%	55%			
Carex diandra	262	46.4	62	Fall. Fr		19%	14%			
Calamagrostis canadensis	117	24.5	51	Fall. Fr		9%	7%			
Dryopteris thelypteris	97	17.0	24	Veg		7%	5%			
Equisetum fluviatile	61	34.5	69	Sen		4%	11%			
Eleocharis compressa	40	1.0	36	Fr						
Sagittaria latifolia	19	5.4	41	Veg						
Osmunda regalis	9	1.3	16	Fr						
Iris versicolor	7	13.9	56	Veg						
Lysimachia thyrsiflora	6	0.7	17	Veg						
Lycopus uniflorus	5	+	11	Veg						
Potentilla palustris	4	0.5	11	Veg						
Menyanthes trifoliata	4	1.2	20	Fr. Open.						
DEAD MATERIAL										

ENVIRONMENTAL FEATURES:

WATER DEPTH

SOIL

see next page...

MARSH STUDIES

STAND: 71, page 2 OBSERVERS: AB JP DATE 6/8/70

LOCALITY: Mainland

COLL. SPECIES	No	DW	HT	Phe		No	DW			
Campanula aparinoides	3	+	19	Veg						
Salix sp.	2	0.8	17	Veg						
Liparis Loeselii	2	0.2	12	Veg						
Drosera rotundifolia	1	0.3	24	Fr						
Hypericum virginicum	1	0.1	30	Veg						
Utricularia sp.	Few									
Mosses		51.7								
DEAD MATERIAL (Mulch)		104.1								

ENVIRONMENTAL FEATURES:

WATER DEPTH 19 cm

SOIL

pH: 5.6
% organic matter: 86.8
% Carbon: 50.34
% Nitrogen: 2.37
Available phosphorus: 4.25 mg/100g

H ions: 27.3 meq/100g
K: 1.33 meq/100g
Na: 0.91 meq/100g
Ca: 35.07 meq/100g
Mg: 9.80 meq/100g

MARSH STUDIES

STAND: 80 **OBSERVERS:** AB JP **DATE** 18/8/70

LOCALITY: Christatie Island

COLL.	SPECIES	No	DW	HT	Phe		Nb	DW			
	Dryopteris thelypteris	180	24.8	38	Veg		29%	4%			
	Carex aquatilis	166	518.1	107	Sen.		27%	83%			
	Carex stricta	84	50.4	84	Sen.		14%	8%			
	Calamagrostis canadensis	78	23.8	70	Past Fr		13%	4%			
	Lycopus uniflorus	68	3.5	24	Fl						
	Lysimachia thyrsiflora	23	1.4	25	Veg						
	Campanula aparinoides	10	0.2	30	Veg						
	Hypericum virginicum	9	1.7	29	Veg						
	Potentilla palustris	3	1.1	32	Veg						
	Moss		2.0								
	DEAD MATERIAL (Mulch)		111.2		–						

ENVIRONMENTAL FEATURES:

WATER DEPTH 14 cm

SOIL

pH: 5.7
% organic matter: 87.0
% Carbon: 50.47
% Nitrogen: 2.37
Available phosphorus: 3.86 mg/100g

H ions: 25.0 meq/100g
K: 2.45 meq/100g
Na: 1.73 meq/100g
Ca: 74.40 meq/100g
Mg: 12.66 meq/100g

MARSH STUDIES

STAND: 84 OBSERVERS: AB
JP DATE 18/870

LOCALITY: Christatie Island

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Dryopteris thelypteris	190	30.2	34	Veg		34%	7%			
Carex aquatilis	150	340	102	Past Fr.		27%	76%			
Carex lasiocarpa	107	33.8	109	Past Fr		19%	8%			
Calamagrostis canadensis	59	22.0	78	Past Fr		11%	5%			
Hypericum virginicum	27	1.5	24	Fl						
Lycopus uniflorus	17	0.3	13	Veg						
Campanula aparinoides	8	0.2	25	Veg						
Potentilla palustris	2	0.3	34	Veg						
Moss		17.1								
DEAD MATERIAL (Mulch)		177.4								

ENVIRONMENTAL FEATURES:

WATER DEPTH 11 cm

SOIL

pH: 6.0
% organic matter: 85.1
% Carbon: 49.34
% Nitrogen: 2.54
Available phosphorus: 3.26 mg/100g

H ions: 20.0 meq/100g
K: 2.30 meq/100g
Na: 1.80 meq/100g
Ca: 71.00 meq/100g
Mg: 11.67 meq/100g

MARSH STUDIES

STAND: 87 **OBSERVERS:** AB JP **DATE** 25/8/70

LOCALITY: Christatie Island

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Carex aquatilis	213	304.4	81	Sen.		30%	47%			
Carex stricta	137	80.8	88	Sen.		19%	12%			
Carex lasiocarpa	132	45.4	86	Sen.		18%	7%			
Calamagrostis canadensis	70	41.8	83	Sen.		10%	6%			
Dryopteris thelypteris	62	6.3	33	Veg						
Lycopus uniflorus	35	1.3	16	Fl						
Hypericum virginicum	32	1.6	22	Veg						
Campanula aparinoides	18	0.3	26	Veg						
Typha angustifolia	14	103.1	160	Sen			16%			
Galium palustre	4	+	8	Veg						
Viola pallens	2	+	6	Veg						
Potentilla palustris	1	3.3	48	Veg						
Lysimachia thyrsiflora	1	+	6	Veg						
Moss		63.7								
DEAD MATERIAL (Mulch)		304.3								

ENVIRONMENTAL FEATURES:

WATER DEPTH 17 cm

SOIL

pH: 5.8
% organic matter: 83.0
% Carbon: 51.02
% Nitrogen: 1.29
Available phosphorus: 3.97 mg/100g

H ions: 19.0 meq/100g
K: 1.97 meq/100g
Na: 1.52 meq/100g
Ca: 58.00 meq/100g
Mg: 9.71 meq/100g

MARSH STUDIES

STAND: 88 **OBSERVERS:** AB JP **DATE** 25/8/70

LOCALITY: Christatie Island

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Carex aquatilis	123	148.5	111	Sen.		23%	16%			
	Carex lasiocarpa	103	23.7	84	Sen.		20%	3%			
	Lycopus uniflorus	79	7.4	24	Fl						
	Typha angustifolia	49	547.8	191	Sen.		9%	59%			
	Galium trifidum	43	1.6	22	Fr						
	Hypericum virginicum	35	4.2	38	Fr						
	Impatiens capensis	30	11.7	73	Fr						
	Campanula aparinoides	21	0.1	31	Veg						
	Lythrum salicaria	19	158.5	121	Fl. & Fr		3%	12%			
	Lysimachia thyrsiflora	11	2.1	35	Veg						
	Calamagrostis canadensis	6	5.6	46	Veg						
	Viola pallens	3	0.1	16	Veg						
	Epilobium leptophyllum	2	0.4	69	Fr						
	DEAD MATERIAL										

ENVIRONMENTAL FEATURES:

WATER DEPTH

SOIL

see next page...

MARSH STUDIES

STAND: 88, page 2 **OBSERVERS:** AB JP **DATE** 25/8/70

LOCALITY: Christatie Island

COLL. SPECIES	No	DW	HT	Phe			Nb	DW			
Sagittaria latifolia	1	0.8	46	Veg							
Onoclea sensibilis	1	+	10	Sen							
Utricularia sp.	Few										
Moss		28.5									
DEAD MATERIAL (Mulch)		1.7									

ENVIRONMENTAL FEATURES:

WATER DEPTH 12 cm

SOIL

pH: 5.5
% organic matter: 74.5
% Carbon: 42.69
% Nitrogen: 2.00
Available phosphorus: 5.10 mg/100g

H ions: 10.0 meq/100g
K: 1.67 meq/100g
Na: 0.96 meq/100g
Ca: 71.40 meq/100g
Mg: 7.82 meq/100g

MARSH STUDIES

STAND: 101 OBSERVERS: AB, JP DATE 17/9/70

LOCALITY: Mainland

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Calamagrostis canadensis	340	683.3	183	Seh.		87%	85%			
	Carex lacustris	39.	118.5	166	Seh.		10%	14%			
	Impatiens capensis	8	0.9	29	Fl. & Fr.						
	Cicuta bulbifera	1	0.1	97	Fr						
	Galium palustre	1	+	29	Fr						
	Moss		3.2								
	DEAD MATERIAL (Mulch)		432.4								

ENVIRONMENTAL FEATURES:

WATER DEPTH 00 cm

SOIL

pH: 6.1
% organic matter: 37.4
% Carbon: 21.70
% Nitrogen: 1.30
Available phosphorus: 16.94 mg/100g

H ions: 8.8 meq/100g
K: 1.21 meq/100g
Na: 0.84 meq/100g
Ca: 33.65 meq/100g
Mg: 8.98 meq/100g

APPENDIX II

EMERGENT AQUATIC COMMUNITIES

MARSH STUDIES

STAND: 21 **OBSERVERS:** AB, JP **DATE** 10/6/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	No	DW	HT	Phe		Wb	DW			
	Equisetum fluviatile	360	110.1	51	Spore Caps.		97%	60%			
	Scirpus validus	11	66.1	79	Fl.			36%			
	Lemna trisulca		3.7								
	Algae sp.		3.1								
	DEAD MATERIAL (Mulch)		436.1								

ENVIRONMENTAL FEATURES:

WATER DEPTH 81 cm

SOIL

pH: 6.8
% organic matter: 12.5
% Carbon: 7.27
% Nitrogen: 0.39
Available phosphorus: 5.29mg/100g

H ions: 0.0 meq/100g
K: 0.72 meq/100g
Na: 0.60 meq/100g
Ca: 19.90 meq/100g
Mg: 2.16 meq/100g

MARSH STUDIES

STAND: 22 **OBSERVERS:** AB JP **DATE** 10/6/70

LOCALITY: Emergents east of Christatie

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Equisetum fluviatile	360	185.4	54	Veg		83%	96%			
Scirpus validus	71	6.8	73	Fl		16%	4%			
Eleocharis palustris	4	0.7	39	Fl Bud						
Lemna trisulca		0.5								
DEAD MATERIAL (Mulch)		293.3								

ENVIRONMENTAL FEATURES:

WATER DEPTH 58 cm

SOIL

pH: 7.0
% organic matter: 9.8
% Carbon: 5.71
% Nitrogen: 0.21
Available phosphorus: 10.84mg/100g

H ions: 0.0 meq/100g
K: 0.62 meq/100g
Na: 0.42 meq/100g
Ca: 17.90 meq/100g
Mg: 5.68 meq/100g

MARSH STUDIES

STAND: 23 **OBSERVERS:** AB JP **DATE** 11/6/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Sparganium eurycarpum	37	48.2	89	Yg		100%	100%			
	DEAD MATERIAL (Mulch)		24.3								

ENVIRONMENTAL FEATURES:

WATER DEPTH 61 cm

SOIL

pH: 5.5
% organic matter: 6.3
% Carbon: 3.65
% Nitrogen: 0.25
Available phosphorus: 19.95mg/100g

H ions: 2.5 meq/100g
K: 0.29 meq/100g
Na: 0.17 meq/100g
Ca: 8.15 meq/100g
Mg: 2.09 meq/100g

MARSH STUDIES

STAND: 30 **OBSERVERS:** AB JP **DATE** 18/6/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Equisetum fluviatile	124	73.8	67	Veg		59%	29%			
	Scirpus validus	86	129.3	122	Fl		41%	51%			
	Lemna trisulca		51.6								
	DEAD MATERIAL (Mulch)		219.9								

ENVIRONMENTAL FEATURES:

WATER DEPTH 75 cm

SOIL

pH: 7.3
% organic matter: 3.8
% Carbon: 2.23
% Nitrogen: 0.08
Available phosphorus: 16.57mg/100g

H ions: 0.0 meq/100g
K: 0.36 meq/100g
Na: 0.30 meq/100g
Ca: 13.40 meq/100g
Mg: 3.75 meq/100g

MARSH STUDIES

STAND: 42 **OBSERVERS:** AB / JP **DATE** 29/6/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Equisetum fluviatile	425	407.3	105	Spore Caps		93%	84%			
	Eleocharis palustris	17	3.5	105	Fl						
	Scirpus validus	13	40.9	180	Fl		3%	8%			
	Algae sp.		34.0								
	Spirodela polyrhiza		+								
	Lemna trisulca		+								
	DEAD MATERIAL (Mulch)		385.4								

ENVIRONMENTAL FEATURES:

WATER DEPTH 91 cm

SOIL

pH: 6.9
% organic matter: 12.9
% Carbon: 7.49
% Nitrogen: 0.37
Available phosphorus: 6.60mg/100g

H ions: 0.3 meq/100g
K: 0.75 meq/100g
Na: 0.63 meq/100g
Ca: 22.95 meq/100g
Mg: 3.89 meq/100g

MARSH STUDIES

STAND: 43 OBSERVERS: AB JP DATE 6/7/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	No	DW	HT	Phe		Nb	DW			
	Scirnus fluviatilis	65	255	146	Fl Bud		100	100			
	Lemna trisulca		+								
	Lemna minor		+								
	DEAD MATERIAL (Mulch)		196	7							

ENVIRONMENTAL FEATURES:

WATER DEPTH 78 cm

SOIL

pH: 5.8
% organic matter: 2.5
% Carbon: 1.48
% Nitrogen: 0.13
Available phosphorus: 19.18mg/100g

H ions: 2.0 meq/100g
K: 0.24 meq/100g
Na: 0.14 meq/100g
Ca: 6.18 meq/100g
Mg: 2.03 meq/100g

MARSH STUDIES

STAND: 44 **OBSERVERS:** AB JP **DATE** 6/7/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Scirpus validus	72	479.6	217	Fl		100%	83%			
	Lemna trisulca		41.6					7%			
	Valisneria americana		20.0					4%			
	Algae sp.		19.8					[illegible]			
	Ceratophyllum demersum		11.5					2%			
	Elodea canadensis		+								
	DEAD MATERIAL (Mulch)		209.3								

ENVIRONMENTAL FEATURES:

WATER DEPTH 98 cm

SOIL

pH: 5.9
% organic matter: 1.5
% Carbon: 0.89
% Nitrogen: 0.06
Available phosphorus: 12.66mg/100g

H ions: 5.0 meq/100g
K: 0.23 meq/100g
Na: 0.15 meq/100g
Ca: 5.85 meq/100g
Mg: 0.77 meq/100g

MARSH STUDIES

STAND: 45 **OBSERVERS:** AB JP **DATE** 6/7/70

LOCALITY: Emergents east of Christatie

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Phragmites communis	79	412	198	Yg		100%				
Lemna trisulca		+								
Ceratophyllum demersum		+								
Myriophyllum exalbescens		+								
DEAD MATERIAL (Mulch)		332.7								

ENVIRONMENTAL FEATURES:

WATER DEPTH 90 cm

SOIL

pH: 6.5
% organic matter: 2.6
% Carbon: 1.52
% Nitrogen: 0.21
Available phosphorous: 14.29mg/100g

H ions: 0.5 meq/100g
K: 0.25 meq/100g
Na: 0.16 meq/100g
Ca: 8.23 meq/100g
Mg: 1.83 meq/100g

MARSH STUDIES

STAND: 54 OBSERVERS: AB JP DATE 19/7/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Equisetum fluviatile	280	359.1	139	Veg		50%	66%			
	Eleocharis palustris	250	88.3	99	Veg		45%	16%			
	Scirpus validus	26	74.6	215	Fr		5%	14%			
	Algae sp.		21.2					4%			
	Ceratophyllum demersum		+								
	Myriophyllum exalbescens		+								
	Lemna trisulca		+								
	DEAD MATERIAL (Mulch)		120.1								

ENVIRONMENTAL FEATURES:

WATER DEPTH 90 cm

SOIL

pH: None given
% organic matter: 29.2
% Carbon: 16.93
% Nitrogen: 0.73
Available phosphorus: 9.11mg/100g

H ions: None given
K: 0.44 meq/100g
Na: 0.75 meq/100g
Ca: 31.80 meq/100g
Mg: 6.11 meq/100g

MARSH STUDIES

STAND: 55 **OBSERVERS:** AB JP **DATE** 19/7/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Equisetum fluviatile	507,	706.	1 149	Veg		91%	75%			
	Scirpus validus	49	197.	3 206	Fl		9%	21%			
	Algae sp.		33.4					4%			
	Lemna trisulca		1.5								
	Myriophyllum exalbescens		+								
	Lemna minor		+								
	DEAD MATERIAL (Mulch)		125.0								

ENVIRONMENTAL FEATURES:

WATER DEPTH 100 cm

SOIL

pH: 6.7
% organic matter: 4.7
% Carbon: 2.70
% Nitrogen: 0.20
Available phosphorus: 10.22mg/100g

H ions: 0.3 meq/100g
K: 0.60 meq/100g
Na: 0.42 meq/100g
Ca: 17.13 meq/100g
Mg: 1.89 meq/100g

MARSH STUDIES

STAND: 56 **OBSERVERS:** AB, JP **DATE** 20/7/70

LOCALITY: Emergents east of Christatie

COLL. SPECIES	No	DW	HT	Phe		Nb	DW			
Scirpus fluviatilis	93	455.3	186	Fl		100%	99.[illegible]%			
Lemna trisulca		1.2								
DEAD MATERIAL (Mulch)		123.1								

ENVIRONMENTAL FEATURES:

WATER DEPTH 84 cm

SOIL

pH: 6.5
% organic matter: 6.9
% Carbon: 4.01
% Nitrogen 0.31
Available phosphorus: 17.96mg/100g

H ions: 0.8 meq/100g
K: 0.46 meq/100g
Na: 0.39 meq/100g
Ca: 12.13 meq/100g
Mg: 3.71 meq/100g

MARSH STUDIES

STAND: 59 **OBSERVERS:** AB JP **DATE** 23/7/70

LOCALITY: Emergents east of Christatie

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Scirpus validus	79	389.3	245	Fl		100%	92%			
Lemna trisulca		10.1					28			
Ceratophyllum demersum		10.2					23			
Algae sp.		6.3					10			
Potamogeton zosteriformis		2.2					1			
Valisneria americana		1.9								
Myriophyllum exalbescens		1.1								
Elodea canadensis		0.2								
Potamogeton crispus		+								
DEAD MATERIAL (Mulch)		100.0								

ENVIRONMENTAL FEATURES:

WATER DEPTH 104 cm

SOIL

pH: 6.4
% organic matter: 1.8
% Carbon: 1.04
% Nitrogen: 0.18
Available phosphorus: 12.82mg/100g

H ions: 1.0 meq/100g
K: 0.28 meq/100g
Na: 0.20 meq/100g
Ca: 6.60 meq/100g
Mg: 0.50 meq/100g

MARSH STUDIES

STAND: 60 **OBSERVERS:** AB, JP **DATE** 24/7/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Phragmites communis	53	361.3	226	Veg		100%	100%			
	DEAD MATERIAL (Mulch)		202.9								

ENVIRONMENTAL FEATURES:

WATER DEPTH 103 cm

SOIL

pH: 6.8
% organic matter: 4.5
% Carbon: 2.60
% Nitrogen: 0.12
Available phosphorus: 9.26mg/100g

H ions: 0.3 meq/100g
K: 0.61 meq/100g
Na: 0.43 meq/100g
Ca: 17.03 meq/100g
Mg: 1.56 meq/100g

MARSH STUDIES

STAND: 61 **OBSERVERS:** AB JP **DATE** 24/7/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Scirpus fluviatilis	141	644.9	187	Fl		100%	100%			
	Lemna trisulca		+								
	DEAD MATERIAL (Mulch)		65.2								

ENVIRONMENTAL FEATURES:

WATER DEPTH 86 cm

SOIL

pH: 6.8
% organic matter: 5.1
% Carbon: 2.96
% Nitrogen: 0.17
Available phosphorus: 11.89mg/100g

H ions: 0.5 meq/100g
K: 0.55 meq/100g
Na: 0.43 meq/100g
Ca: 15.10 meq/100g
Mg: 2.13 meq/100g

MARSH STUDIES

STAND: 62 **OBSERVERS:** AB JP **DATE** 27/7/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	No	DW	HT	Phe		Nb	DW			
	Scirpus validus	40	191.7	237	Fl		100%	75%			
	Lemna trisulca		30.6					12%			
	Ceratophyllum demersum		14.6					6%			
	Potamogeton zosteriformis		8.8					3%			
	Elodea canadensis		4.1								
	Valisneria americana		1.7								
	Algae sp.		1.7								
	Myriophyllum exalbescens		1.0								
	DEAD MATERIAL (Mulch)		80.5								

ENVIRONMENTAL FEATURES:

WATER DEPTH 106 cm

SOIL

pH: 6.8
% organic matter: 1.0
% Carbon: 0.60
% Nitrogen: 0.18
Available phosphorus: 7.70mg/100g

H ions: 0.5 meq/100g
K: 0.26 meq/100g
Na: 0.22 meq/100g
Ca: 7.00 meq/100g
Mg: 0.61 meq/100g

MARSH STUDIES

STAND: 63 **OBSERVERS:** AB JP **DATE** 27/7/70

LOCALITY: Emergents east of Christatie

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Eleocharis palustris	674	464.6	120	Fl		92%	78%			
Scirpus validus	38	108.7	203	Fr		5%	18%			
Equisetum fluviatile	21	24.6	141	ast Spores		3%	4%			
Potamogeton zosteriformis		0.8								
Myriophyllum exalbescens		+								
Lemna trisulca		+								
DEAD MATERIAL (Mulch)		21.0								

ENVIRONMENTAL FEATURES:

WATER DEPTH 96 cm

SOIL

pH: 6.5
% organic matter: 5.1
% Carbon: 2.95
% Nitrogen: 0.34
Available phosphorus: 1631mg/100g

H ions: 1.3 meq/100g
K: 0.44 meq/100g
Na: 0.31 meq/100g
Ca: 12.68 meq/100g
Mg: 1.97 meq/100g

MARSH STUDIES

STAND: 64 **OBSERVERS:** AB JP **DATE** 3/8/70

LOCALITY: Emergents east of Christatie

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Equisetum fluviatile	358	770.6	136	Branch		87%	91%			
Eleocharis palustris	44	21.1	129	Fl		11%	3%			
Scirpus validus	11	50.9	219	Fr		3%	6%			
Algae sp.		0.8								
DEAD MATERIAL (Mulch)		201.5								

ENVIRONMENTAL FEATURES:

WATER DEPTH 96 cm

SOIL

pH: 6.7
% organic matter: 13.1
% Carbon: 7.57
% Nitrogen: 0.49
Available phosphorus: 7.39mg/100g

H ions: 1.5 meq/100g
K: 7.2 meq/100g
Na: 0.58 meq/100g
Ca: 22.70 meq/100g
Mg: 1.93 meq/100g

MARSH STUDIES

STAND: 65 **OBSERVERS:** AB JP **DATE** 3/8/70

LOCALITY: Emergents east of Christatie

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Equisetum fluviatile	454	772.2	122	Br	nch	92%	83%			
Scirpus validus	39	154.8	221	Fall. Fr		8%	17%			
Algae sp.		3.1								
Lemna trisulca		0.6								
DEAD MATERIAL (Mulch)		54.2								

ENVIRONMENTAL FEATURES:

WATER DEPTH 110 cm

SOIL

pH: 6.8
% organic matter: 6.5
% Carbon: 3.80
% Nitrogen: 0.34
Available phosphorus: 8.49mg/100g

H ions: 0.3 meq/100g
K: 0.78 meq/100g
Na: 0.59 meq/100g
Ca: 20.75 meq/100g
Mg: 2.53 meq/100g

MARSH STUDIES

STAND: 72 **OBSERVERS:** AB JP **DATE** 7/8/70

LOCALITY: Emergents east of Christatie

COLL. SPECIES	ND	DW	HT	Phe		Nb	DW			
Scirpus fluviatilis	07	639	198	Fl		100%	100%			
Lemna trisulca		+								
DEAD MATERIAL (Mulch)		72.2								

ENVIRONMENTAL FEATURES:

WATER DEPTH 88 cm

SOIL

pH: 6.7
% organic matter: 6.4
% Carbon: 3.20
% Nitrogen: 0.25
Available phosphorus: 14.80mg/100g

H ions: 1.0 meq/100g
K: 0.51 meq/100g
Na: 0.42 meq/100g
Ca: 13.65 meq/100g
Mg: 3.79 meq/100g

MARSH STUDIES

STAND: 73 **OBSERVERS:** AB JP **DATE** 7/8/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	Nb	DW	HT	Flo		Nb	DW			
	Phragmites communis	82	670.4	260	Fl Bud		100%	100%			
	Lemna trisulca		*								
	DEAD MATERIAL (Mulch)		163.0								

ENVIRONMENTAL FEATURES:

WATER DEPTH 107 cm

SOIL

pH: 6.5
% organic matter: 4.0
% Carbon: 2.30
% Nitrogen: 0.19
Available phosphorus: 11.35mg/100g

H ions: 1.0 meq/100g
K: 0.46 meq/100g
Na: 0.40 meq/100g
Ca: 12.05 meq/100g
Mg: 1.23 meq/100g

MARSH STUDIES

STAND: 74 **OBSERVERS:** AB, JP **DATE** 7/8/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW
	Typha angustifolia	50	1128.7					
				315	Fem Spikes		100%	100%
	DEAD MATERIAL (Mulch)		374.9					

ENVIRONMENTAL FEATURES:

WATER DEPTH 118 cm

SOIL

pH: 6.7
% organic matter: 3.0
% Carbon: 1.70
% Nitrogen: 0.24
Available phosphorus: 7.57mg/100g

H ions: 0.5 meq/100g
K: 0.46 meq/100g
Na: 0.33 meq/100g
Ca: 11.03 meq/100g
Mg: 1.10 meq/100g

MARSH STUDIES

STAND: 75 **OBSERVERS:** AB JP **DATE** 7/8/70

LOCALITY:

COLL. SPECIES	Nb	DW	RT	Phc		Nb	DW			
Scirpus fluviatilis	116	626.5								
			200	Fr		200	923			
Lemna trisulca		0.2								
DEAD MATERIAL (Mulch)		119.7								

ENVIRONMENTAL FEATURES:

WATER DEPTH 104 cm

SOIL

pH: 6.6
% organic matter: 5.2
% Carbon: 3.01
% Nitrogen: 0.22
Available phosphorus: 13.54 mg/100g

H ions: 1.0 meq/100g
K: 0.64 meq/100g
Na: 0.45 meq/100g
Ca: 16.35 meq/100g
Mg: 4.04 meq/100g

MARSH STUDIES

STAND: 76 **OBSERVERS:** AB, JP **DATE** 10/8/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	Nb	DW	HT	Phe	Nb	DW			
	Eleocharis palustris	720	149.4	146	Fl	94%	73.7			
	Scirpus validus	39	129.5	192	Fall. Fr	55%	21%			
	Equisetum fluviatile	6	9.6	138	Branch.	1%	2%			
	Myriophyllum exalbescens		10.9				2%			
	Valisneria americana		8.5							
	Ceratophyllum demersum		2.6							
	Potamogeton zosteriformis		1.3							
	Lemna trisulca		0.8							
	Elodea canadensis		0.6							
	DEAD MATERIAL (Mulch)		21.6							

ENVIRONMENTAL FEATURES:

WATER DEPTH 103 cm

SOIL

pH: 6.2
% organic matter: 4.9
% Carbon: 2.31
% Nitrogen: 0.29
Available phosphorus: 12.17mg/100g

H ions: 2.5 meq/100g
K: 0.59 meq/100g
Na: 0.42 meq/100g
Ca: 17.08 meq/100g
Mg: 2.16 meq/100g

MARSH STUDIES

STAND: 77 **OBSERVERS:** AB JP **DATE** 10/8/70

LOCALITY: Emergents east of Christatie

COLL. SPECIES	No	DW	HT	Phe		No	DW			
Scirpus validus	40	173.	250	Fr		100	71			
Potamogeton zosteriformis		28.6					12			
Lemna trisulca		20.4								
Ceratophyllum demersum		9.6					4			
Elodea canadensis		6.7					3			
Myriophyllum exalbescens		2.9								
Valisneria americana		1.1								
Lemna minor		+								
DEAD MATERIAL (Mulch)		61.8								

ENVIRONMENTAL FEATURES:

WATER DEPTH 126 cm

SOIL

pH: 6.6
% organic matter: 2.4
% Carbon: 1.39
% Nitrogen: 0.12
Available phosphorus: 12.73 mg/100g

H ions: 0.8 meq/100g
K: 0.39 meq/100g
Na: 0.27 meq/100g
Ca: 10.13 meq/100g
Mg: 1.23 meq/100g

MARSH STUDIES

STAND: 78 **OBSERVERS:** AB JP **DATE** 17/8/70

LOCALITY: Emergents east of Christatie

COLL. SPECIES	No	DW	HT	Phe		Nb	DW			
Equisetum fluviatile	370	976.3	130	Past Spores		97%	99%			
Eleocharis palustris	12	3.3	119	Fl Bud		3%				
Scirpus validus	1	1.7	169	Fall Fr						
Valisneria americana		3.5								
Potamogeton zosteriformis		0.2								
Myriophyllum exalbescens		+								
Lemna trisulca		+								
DEAD MATERIAL (Mulch)		22.0								

ENVIRONMENTAL FEATURES:

WATER DEPTH 91 cm

SOIL

pH: 6.5
% organic matter: 11.0
% Carbon: 6.39
% Nitrogen: 0.27
Available phosphorus: 0.32mg/100g

H ions: 2.0 meq/100g
K: 0.76 meq/100g
Na: 0.62 meq/100g
Ca: 20.45 meq/100g
Mg: 3.06 meq/100g

MARSH STUDIES

STAND: 79 OBSERVERS: AB JP DATE 17/8/70

LOCALITY: Emergents east of Christatie

COLL. SPECIES	ND	DW	HT	Phe		Nb	DW			
Equisetum fluviatile	420	702.8	127	Senesc		95%	96%			
Eleocharis palustris	17	16.8	135	Fl		4%	2%			
Scirpus validus	4	8.7	174	Fr						
Lemna trisulca		0.8								
Myriophyllum exalbescens		0.4								
Ceratophyllum demersum		0.3								
DEAD MATERIAL (Mulch)		9.7								

ENVIRONMENTAL FEATURES:

WATER DEPTH 90 cm

SOIL

pH: 6.6
% organic matter: 3.3
% Carbon: 1.91
% Nitrogen: 0.17
Available phosphorus: 9.79mg/100g

H ions: 0.5 meq/100g
K: 0.57 meq/100g
Na: 0.41 meq/100g
Ca: 16.78 meq/100g
Mg: 1.05 meq/100g

MARSH STUDIES

STAND: 82 OBSERVERS: AB JP DATE 21/8/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Scirpus fluviatilis	122	798.2	217	Fr		100%	100%			
	DEAD MATERIAL (Mulch)		78.1								

ENVIRONMENTAL FEATURES:

WATER DEPTH 92 cm

SOIL

pH: 6.8
% organic matter: 5.6
% Carbon: 3.25
% Nitrogen: 0.27
Available phosphorus: 14.55mg/100g

H ions: 1.3 meq/100g
K: 0.49 meq/100g
Na: 0.35 meq/100g
Ca: 12.25 meq/100g
Mg: 3.84 meq/100g

MARSH STUDIES

STAND: 83 OBSERVERS: AB, JP DATE 21/8/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Scirpus fluviatilis	114	730.3	213	Fr		100%	100%			
	DEAD MATERIAL (Mulch)		56.1								

ENVIRONMENTAL FEATURES:

WATER DEPTH 103 cm

SOIL

pH: 6.4
% organic matter: 5.8
% Carbon: 3.34
% Nitrogen: 0.21
Available phosphorus: 17.65 mg/100g

H ions: 1.5 meq/100g
K: 0.40 meq/100g
Na: 0.33 meq/100g
Ca: 13.10 meq/100g
Mg: 3.40 meq/100g

MARSH STUDIES

STAND: 84 | OBSERVERS: AB JP | DATE 21/8/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	No	DW	HT	Phe		Nb	DW			
	Phragmites communis	101	837.9	257	Fl		100%	100%			
	Lemna trisulca		+								
	DEAD MATERIAL (Mulch)		120.2								

ENVIRONMENTAL FEATURES:

WATER DEPTH 103 cm

SOIL

pH: 7.1
% organic matter: 2.4
% Carbon: 1.38
% Nitrogen: 0.21
Available phosphorus: 9.41mg/100g

H ions: 0.0 meq/100g
K: 0.60 meq/100g
Na: 0.43 meq/100g
Ca: 16.00 meq/100g
Mg: 1.50 meq/100g

MARSH STUDIES

STAND: 85 OBSERVERS: AB JP DATE 24/8/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Eleocharis palustris	1428	1018.3								
				152	Yg fr.		98%	94%			
	Equisetum fluviatile	32	60.2	154	Sen.		2%	6%			
	Scirpus validus	1	3.0	110	Fr.						
	Potamogeton zosteriformis		1.5								
	Myriophyllum exalbescens		1.1								
	Lemna trisulca		+								
	DEAD MATERIAL(Mulch)		0.0								

ENVIRONMENTAL FEATURES:

WATER DEPTH 102 cm.

SOIL

pH: 5.9
% organic matter: 7.1
% Carbon: 4.11
% Nitrogen: 0.31
Available phosphorus: 12.85 mg/100g

H ions: 3.5 meq/100g
K: 0.60 meq/100g
Na: 0.40 meq/100g
Ca: 16.25 meq/100g
Mg: 1.74 meq/100g

MARSH STUDIES

STAND: 86 OBSERVERS: AB JP DATE 24/8/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	ND	DW	HT	Phc		Nb	DW			
	Scirpus validus	34	198.5								
				216	Fr		92%	57%			
	Alisma-plantago-aquatica	3	14.5					4%			
	Potamogeton zosteriformis		65.8					19%			
	Myriophyllum exalbescens		26.0					7%			
	Ceratophyllum demersum		25.0					7%			
	Elodea canadensis		9.5					3%			
	Lemna trisulca		8.4								
	Algae (filamentous) sp.		1.1								
	DEAD MATERIAL (Mulch)		22.3								

ENVIROIMENTAL FEATURES:

WATER DEPTH 111 cm

SOIL

pH: 6.8
% organic matter: 1.5
% Carbon: 0.80
% Nitrogen: 0.21
Available phosphorus: 13.01 mg/100g

H ions: 0.5 meq/100g
K: 0.33 meq/100g
Na: 0.23 meq/100g
Ca: 9.15 meq/100g
Mg: 0.86 meq/100g

MARSH STUDIES

STAND: 89 OBSERVERS: AB JP DATE 31/8/70

LOCALITY: Emergents east of Christatie

COLL. SPECIES	Nb	DW	HT	Phe		Nb	W			
Equisetum fluviatile	280	730	9							
			112	Sen.		96%	93%			
Scirpus validus	13	51.6	236	Sen.		4%	7%			
Lemna trisulca		3.9								
DEAD MATERIAL (Mulch)		0.0								

ENVIRONMENTAL FEATURES:

WATER DEPTH 98 cm

SOIL

pH:	6.5	H ions:	2.8 meq/100g
% organic matter:	10.7	K:	0.72 meq/100g
% Carbon:	6.23	Na:	0.58 meq/100g
% Nitrogen:	0.32	Ca:	20.70 meq/100g
Available phosphorus:	11.57 mg/100g	Mg:	2.88 meq/100g

MARSH STUDIES

STAND: 90 OBSERVERS: AB, JP DATE 31/8/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Equisetum fluviatile	350	898.1								
				124	Sen. Start.		97%	94%			
	Scirpus validus	11	55.4	235	Fr/Sen		3%	6%			
	Lemna trisulca		1.3								
	DEAD MATERIAL (Mulch)		0.0								

ENVIRONMENTAL FEATURES:

WATER DEPTH 97 cm

SOIL

pH:	6.7	H ions:	1.0 meq/100g
% organic matter:	10.6	K:	0.68 meq/100g
% Carbon:	6.14	Na:	0.55 meq/100g
% Nitrogen:	0.34	Ca:	19.05 meq/100g
Available phosphorus:	9.26 mg/100g	Mg:	2.68 meq/100g

MARSH STUDIES

STAND: 93 OBSERVERS: AB JP DATE 3/9/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Scirpus fluviatilis	164	1070	.1							
				226	Mat. Fr.		100%	100%			
	Lemna trisulca		+								
	DEAD MATERIAL (Mulch)		47.1								

ENVIRONMENTAL FEATURES:

WATER DEPTH: 93 cm

SOIL:

pH: 6.6
% organic matter: 5.2
% Carbon: 3.02
% Nitrogen: 0.20
Available phosphorus: 12.98 mg/100g

H ions: 1.0 meq/100g
K: 0.57 meq/100g
Na: 0.45 meq/100g
Ca: 18.55 meq/100g
Mg: 2.24 meq/100g

MARSH STUDIES

STAND: 94 OBSERVERS: AB
JP
DATE 3/9/70

LOCALITY: Emergents east of Christatie

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW				
Scirpus fluviatilis	130	774	124	Fr.		100%	99.9%				
Lemna trisulca		0.1									
Spirodela polyrhiza		+									
DEAD MATERIAL (Mulch)		26.3									

ENVIRONMENTAL FEATURES:

WATER DEPTH: 90 cm

SOIL:

pH: 6.7
% organic matter: 2.3
% Carbon: 1.31
% Nitrogen: 0.52
Available phosphorus: 11.78 mg/100g

H ions: 0.8 meq/100g
K: 0.59 meq/100g
Na: 0.43 meq/100g
Ca: 15.88 meq/100g
Mg: 1.70 meq/100g

MARSH STUDIES

STAND: 95 OBSERVERS: AB
JP DATE 3/9/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	No	DW	HT	Pho		Nb	DW			
	Phragmites communis	72	680.2								
				246	Fr.		100	99	93		
	Algae (filamentous) sp.		2.1								
	Lemna trisulca		0.2								
	Potamogeton zosteriformis		+								
	DEAD MATERIAL (Mulch)		128.4								

ENVIRONMENTAL FEATURES:

WATER DEPTH: 105 cm

SOIL:

pH: 6.5
% organic matter: 6.3
% Carbon: 3.65
% Nitrogen: 0.21
Available phosphorus: 9.66 mg/100g

H ions: 0.5 meq/100g
K: 0.63 meq/100g
Na: 0.50 meq/100g
Ca: 20.45 meq/100g
Mg: 1.07 meq/100g

MARSH STUDIES

STAND: 96 OBSERVERS: AB SH JP DATE 8/9/70

LOCALITY:
Emergents east of Christatie

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW				
	Eleocharis palustris	750	359.1									
				164	Sen		98%	69%				
	Scirpus validus	14	71.6	245	Sen		2%	14%				
	Equisetum fluviatile	2	3.5	139	Sen							
	Potamogeton zosteriformis		59.0					11%				
	Elodea canadensis		11.9					2%				
	Ceratophyllum demersum		9.2									
	Myriophyllum exalbescens		3.7									
	Lemna trisulca		2.6									
	Spirodells polyrhiza		+									
	DEAD MATERIAL(Mulch)		0.7									

ENVIRONMENTAL FEATURES:

WATER DEPTH: 112 cm

SOIL

pH:	6.0	H ions:	2.8 meq/100g
% organic matter:	4.8	K:	0.50 meq/100g
% Carbon:	2.76	Na:	0.30 meq/100g
% Nitrogen:	0.19	Ca:	12.18 meq/100g
Available phosphorus:	12.56 mg/100g	Mg:	1.44 meq/100g

MARSH STUDIES

STAND: 97

OBSERVERS: AB SH JP

DATE 8/9/70

LOCALITY: Emergents east of Christatie

COLL. SPECIES	No	DW	HT	Phe		Nb	DW				
Eleocharis palustris	790	559.1	144	Sen		92%	67%				
Scirpus validus	68	238.4	239	Sen		8%	29%				
Equisetum fluviatile	3	4.0	110	Veg							
Valisneria americana		19.9					2%				
Ceratophyllum demersum		6.2									
Myriophyllum exalbescens		5.6									
Potamogeton zosteriformis		1.4									
Elodea canadensis		0.6									
Lemna trisulca		0.5									
DEAD MATERIAL (Mulch)		1.4									

ENVIRONMENTAL FEATURES:

WATER DEPTH 105 cm

SOIL

pH: 6.0
% organic matter: 5.1
% Carbon: 2.97
% Nitrogen: 0.26
Available phosphorus: 14.55 mg/100g

H ions: 2.3 meq/100g
K: 0.40 meq/100g
Na: 0.33 meq/100g
Ca: 11.93 meq/100g
Mg: 1.61 meq/100g

MARSH STUDIES

STAND 98 OBSERVERS: AB SH JP DATE 8/9/70

LOCALITY: Emergents east of Christatie

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Scirpus validus	70	320.5	233	Seh		100%	45%			
Ceratophyllum demersum		173.9					25%			
Valisneria americana		98.7					14%			
Lemna trisulca		77.2					11%			
Myriophyllum exalbescens		20.3					3%			
Potamogeton zosteriformis		13.5					2%			
Elodea canadensis		3.1								
DEAD MATERIAL (Mulch)		14.0								

ENVIRONMENTAL FEATURES:

WATER DEPTH 119 cm

SOIL

pH: 7.0
% organic matter: 1.8
% Carbon: 1.03
% Nitrogen: 0.15
Available phosphorus: 10.46 mg/100g

H ions: 0.3 meq/100g
K: 0.35 meq/100g
Na: 0.30 meq/100g
Ca: 8.65 meq/100g
Mg: 0.55 meq/100g

MARSH STUDIES

STAND: 99 OBSERVERS: AB JP DATE 13/9/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	ND	DW	HT	Phe	Nb	DW	
	Equisetum fluviatile	350	670.5	133	Sen	32%	84%	
	Eleocharis palustris	67	60.0	123	Sen	16%	8%	
	Scirpus validus	9	65.6	226	Fall. Fr/Sen	2%	8%	
	Myriophyllum exalbescens		+					
	Lemna trisulca		+					
v	Spirodela polyrhiza		+					
	DEAD MATERIAL (Mulch)		1.8					

ENVIRONMENTAL FEATURES:

WATER DEPTH 98 cm

SOIL

pH: 6.9
% organic matter: 1.9
% Carbon: 1.09
% Nitrogen: 0.13
Available phosphorus: 9.15 mg/100g

H ions: 0.0 meq/100g
K: 0.36 meq/100g
Na: 0.30 meq/100g
Ca: 11.15 meq/100g
Mg: 0.84 meq/100g

MARSH STUDIES

STAND: 100 OBSERVERS: AB JP DATE 13/9/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	ND	DW	HT	Phe		Nb	DW			
	Equisetum fluviatile	381	733.6	124	Sen		85%	85%			
	Elocharis palustris	40	36.2	139	Sen		9%	4%			
	Scirpus validus	26	94.6	204	Sen		6%	11%			
	Myriophyllum exalbescens		+								
	Lemna trisulca		+								
	Spirodela polyrhiza		+								
	DEAD MATERIAL (Mulch)		3.1								

ENVIRONMENTAL FEATURES:

WATER DEPTH 89 cm

SOIL

pH: 6.5

% organic matter: 2.0

% Carbon: 1.14

% Nitrogen: 0.24

Available phosphorus: 13.46 mg/100g

H ions: 0.5 meq/100g

K: 0.24 meq/100g

Na: 0.17 meq/100g

Ca: 6.50 meq/100g

Mg: 1.00 meq/100g

MARSH STUDIES

STAND: 102 OBSERVERS: AB JP DATE 18/9/70

LOCALITY:

COLL. SPECIES	Nb	DM	HT	Phe		Nb	DM			
Scirpus fluviatilis	114	780	5							
			210	Fr.		100	100%			
Lemna trisulca		+								
DEAD MATERIAL (Mulch)		31.4								

ENVIRONMENTAL FEATURES:

WATER DEPTH 87 cm

SOIL

pH: 6.8
% organic matter: 4.7
% Carbon: 2.74
% Nitrogen: 0.12
Available phosphorus: 13.03 mg/100g

H ions: 0.3 meq/100g
K: 0.47 meq/100g
Na: 0.39 meq/100g
Ca: 13.38 meq/100g
Mg: 2.47 meq/100g

MARSH STUDIES

STAND: 103 OBSERVERS: AB JP DATE 18/9/70

LOCALITY: Emergents east of Christatie

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Scirpus fluviatilis	105	94	5.7							
			223	Fr		98%	99%			
Equisetum fluvialitle	2	6.8	155	Sen						
DEAD MATERIAL (Mulch)		15.8								

ENVIRONMENTAL FEATURES:

WATER DEPTH 84 cm

SOIL

pH: 6.7

% organic matter: 4.1

% Carbon: 2.34

% Nitrogen: 0.22

Available phosphorus: 9.69 mg/100g

H ions: 0.5 meq/100g

K: 0.53 meq/100g

Na: 0.43 meq/100g

Ca: 14.90 meq/100g

Mg: 1.62 meq/100g

MARSH STUDIES

STAND: 104 OBSERVERS: AB JP DATE 18/9/70

LOCALITY: Emergents east of Christatie

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Phragmites communis	93	870.2								
			294	Mat. Fr		100	100			
Lemna trisulca		+								
Potamogeton zosteriformis		+								
DEAD MATERIAL (Mulch)		117.6								

ENVIRONMENTAL FEATURES:

WATER DEPTH 100cm

SOIL

pH: 7.1
% organic matter: 5.9
% Carbon: 3.43
% Nitrogen: 0.26
Available phosphorus: 11.18 mg/100g

H ions: 0.0 meq/100g
K: 0.54 meq/100g
Na: 0.47 meq/100g
Ca: 18.40 meq/100g
Mg: 2.20 meq/100g

MARSH STUDIES

STAND: 105 OBSERVERS: AB JP DATE 20/9/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	Nb	DW	BT	Phe		Nb	DW			
	Eleocharis palustris	288	372.[illegible]								
				155	Sen		94%	58%			
	Scirpus validus	48	70.[illegible]								
				227	Fall. Fr		6%	27%			
	Valisneria americana		86.[illegible]					14%			
	Ceratophyllum demersum		5.1								
	Myriophyllum exalbescens		1.1								
	Elodea canadensis		0.4								
	Potamogeton zosteriformis		0.3								
	Lemna trisulca		+								
	Spirodella polyrhiza		+								
	DEAD MATERIAL (Mulch)		0.4								

ENVIRONMENTAL FEATURES:

WATER DEPTH 101 cm

SOIL

pH: 6.0
% organic matter: 3.7
% Carbon: 2.16
% Nitrogen: 0.11
Available phosphorus: 14.50 mg/100g

H ions: 0.5 meq/100g
K: 0.42 meq/100g
Na: 0.32 meq/100g
Ca: 11.18 meq/100g
Mg: 1.77 meq/100g

MARSH STUDIES

STAND : 106 OBSERVERS: AB JP DATE 20/9/70

LOCALITY: Emergents east of Christatie

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Eleocharis palustris	1420		161	Sen. Start.		94%	68%			
		683.8								
Scirpus validus	87	364.5								
			217	Fall. Fr.		6%	36%			
Potamogeton zosteriformis		0.1								
Elodea canadensis		+								
Ceratophyllum demersum		+								
Lemna trisulca		+								
DEAD MATERIAL (Mulch)		0.8								

ENVIRONMENTAL FEATURES:

WATER DEPTH 105 cm

SOIL
pH: 6.8
% organic matter: 4.9
% Carbon: 2.86
% Nitrogen: 0.09
Available phosphorus: 13.69 mg/100g

H ions: 0.5 meq/100g
K: 0.51 meq/100g
Na: 0.39 meq/100g
Ca: 15.18 meq/100g
Mg: 2.02 meq/100g

MARSH STUDIES

STAND: 107 OBSERVERS: AB
JP DATE - 27/7/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	Nb	DW	HT	Phc		Nb	DW			
	Equisetum fluviatile	310	643.3								
				129	Sen		75%	88%			
	Eleocharis palustris	90	~~27.8~~	117	Sen		22%	4%			
	Scirpus validus	14	51.1	225	Sen		3%	8%			
	Valisneria americana		1.2								
	Lemna trisulca		0.1								
	Myriophyllum exalbescens		+								
	Potamogeton zosteriformis		+								
	DEAD MATERIAL (Mulch)		0.6								

ENVIRONMENTAL FEATURES:

WATER DEPTH 93 cm

SOIL

pH: not enough soil for test
% organic matter: 2.82
% Carbon: 8.17
% Nitrogen: 0.31
Available phosphorus: 7.26 mg/100g

H ions: not enough soil for test
K: 0.95 meq/100g
Na: 0.80 meq/100g
Ca: 31.00 meq/100g
Mg: 3.49 meq/100g

MARSH STUDIES

STAND: 108   OBSERVERS: AB JP   DATE 27/9/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	No	DW	HT	Phe		Nb	DW			
	Equisetum fluviatile	293	198.7	14?	Sen		77%	82%			
	Eleocharis palustris	65	26.0	12?	Sen		17%	4%			
	Scirpus validus	23	102.4	206	Sen		6%	14%			
	Lemna trisulca		0.7								
	DEAD MATERIAL (mulch)		0.0								

ENVIRONMENTAL FEATURES:

WATER DEPTH 93 cm

SOIL

pH: not enough soil for test
% organic matter: 2.82
% Carbon: 8.13
% Nitrogen: 0.10
Available phosphorus: 7.39 mg/100g

H ions: not enough soil
K: 0.72 meq/100g
Na: 0.70 meq/100g
Ca: 22.95 meq/100g
Mg: 3.26 meq/100g

MARSH STUDIES

STAND: 109 OBSERVERS: AB JP DATE 3/10/70

LOCALITY: Emergents east of Christatie

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Scirpus validus	52	1023.8								
			115	Fr/ Sen		100%	99	9%		
Lemna trisulc?		1.0								
DEAD MATERIAL (Mulch)		22.0								

ENVIRONMENTAL FEATURES:

WATER DEPTH 82 cm

SOIL

pH: 6.6

% organic matter: 5.8

% Carbon: 3.36

% Nitrogen: 0.19

% Available phosphorus: 12.75 mg/100g

H ions: 0.8 meq/100g

K: 0.55 meq/100g

Na: 0.38 meq/100g

Ca: 16.08 meq/100g

Mg: 2.50 meq/100g

MARSH STUDIES

STAND: 110 OBSERVERS: AB, JP DATE 3/10/70

LOCALITY: Emergents east of Christatie

COLL. SPECIES	Nb	DW	HT	Phe		Eh	D'			
Scirpus fluviatilis	110	840	1							
			211	FT/ Sen		100%	99.9%			
Lemna trisulca		3.7								
DEAD MATERIAL (Mulch)		11.6								

ENVIRONMENTAL FEATURES:

WATER DEPTH 78 cm

SOIL

pH: 6.3
% organic matter: 5.9
% Carbon: 3.44
% Nitrogen: 0.19
Available phosphorus: 15.68 mg/100g

H ions: 1.5 meq/100g
K: 0.74 meq/100g
Na: 0.33 meq/100g
Ca: 13.63 meq/100g
Mg: 2.51 meq/100g

MARSH STUDIES

STAND: 111 OBSERVERS: AB, JP DATE 3/10/70

LOCALITY: Emergents east of Christatie

COLL. SPECIES	Nb	DW	HT	Phe		Nb	DW			
Phragmites communjs	81	826	7							
			240	Fr/ Sen		100%	100%			
DEAD MATERIAL (Mulch)		85.3								

ENVIRONMENTAL FEATURES:

WATER DEPTH 103 cm

SOIL

pH: not enough soil for test
% organic matter: 4.7
% Carbon: 2.70
% Nitrogen: 0.13
Available phosphorus: 9.21 mg/100g

H ions: not enough soil
K: 0.36 meq/100g
Na: 0.32 meq/100g
Ca: 9.63 meq/100g
Mg: 1.49 meq/100g

MARSH STUDIES

STAND: 112 OBSERVERS: AB JP DATE 4/10/70

LOCALITY: Emergents east of Christatie

COLL.	SPECIES	Nb	DW	HT	Phe		Nb	DW			
	Eleocharis palustris	790	527.5								
				149	Fr/ Sen		97%	74%			
	Scirpus validus	24	89.8	230	Fr/ Sen		3%	13%			
	Valisneria americana		77.0					11%			
	Ceratophyllum demersum		6.5								
	Alisma plantago-aquatica		4.3								
	Myriophyllum exalbescens		1.8								
	Elodea canadensis		0.9								
	Lemna trisulca		0.1								
	DEAD MATERIAL (Mulch)		2.2								

ENVIRONMENTAL FEATURES:

WATER DEPTH 99 cm

SOIL

pH: 6.5
% organic matter: 2.1
% Carbon: 1.22
% Nitrogen: 0.26
Available phosphorus: 19.50 mg/100g

H ions: 0.0 meq/100g
K: 0.18 meq/100g
Na: 0.16 meq/100g
Ca: 5.05 meq/100g
Mg: 2.27 meq/100g