# VEGETATION STUDIES ON THE DELTA MARSH, DELTA MANITOBA

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ABSTRACT

It is pointed out that there are available no detailed quantitative accounts of the vegetation of fresh water marshes in North America. An opportunity to undertake such a study presented itself at Delta, Manitoba. Brief accounts of the geology, geography, climate and the influence of water fluctuations in Lake Manitoba on the marshes south of the lake are given, and the vegetation met with is described.

In 1955 the water in Lake Manitoba reached an unusually high level, and this resulted in the flooding of approximately twenty one per cent of the emergent marsh. Since 1955, the water has been diminishing, and 1958 saw the recolonization of considerable tracts of dead vegetation and mud, though only a small proportion of the bare areas bore vegetation.

Early in the season a distinct zonation was apparent in sites with a slight gradient. Zone 1 was characterised by Ranunculus sceleratus and later by any or all of the following species: Chenopodium rubrum, Atriplex patula, Scolochloa festucacea, and Rumex maritimus var. fueginus. Zone 2 was usually dominated by Aster brachyactis or Epilobium glandulosum var. adenocaulon, and Zone 3 by Phragmites communis, Cicuta maculata, Typha latifolia, Scirpus validus and a number of minor species. In other sites the vegetation consisted of a mosaic, important species being Ranunculus, Atriplex ,

*Chenopodium*, *Scolochloa* and *Puccinellia nuttalliana*. The expansion of vegetation on progressively drying areas, its variation with edaphic factors and the seasonal change in species composition is considered, together with certain biological aspects of some of the main dominants. The general nature of the study and the need for further investigation, such as soil analysis and autecological studies are emphasized.

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The waterfowl population is affected by fluctuations in the water level in the marsh and the availability of plant food and cover. There is no doubt that vegetation is important to wildlife both in quantity and type (Nelson, 1954) but until more is known of the vegetation at Delta it is impossible to correlate data on waterfowl populations with vegetation. Thus it is of value to record the pattern of vegetation and the changes in it, particularly at this time after the recession of recent high water. (Harris 1957)

In 1958 for the first time in fourteen years, (Hochbaum, 1958) there was no surface water and few nesting duck on the agricultural land in the vicinity of Delta where previously an average of one nest per 16.2 hektares had been reported (Milonski, 1958). Several species, comprising many individuals, moved from the farm land to nest on the open flats of Phragmites stubble exposed by the retreating water. Some knowledge of the seral changes in vegetation on such flats would have obvious use in marsh management, as indicated by Olsen (1959) in his work on the muskrat at Delta. To this end annotated species lists of plants were prepared on primary surveys, and these were expanded throughout the season.

The size of the area made necessary some limitations in the scope of the work, and representative sites were selected for study as it was deemed impossible to cover in detail the whole area.

For the purpose of description these selected sites have been considered as separate units. No attempt has been made to organise them into an integrated whole, since individual site characteristics of topography, soil, drainage, pioneering types of vegetation, etc. seem worthy of mention. An intrinsic part of vegetation is concerned with the species making up the various communities, because the full understanding of vegetation draws on essentially autecological information. Accordingly, a section of this thesis ( Section III) is devoted to presenting some observations on the main dominants.

The work has been organized into four sections which deal in turn with the general description of the area and place it in its broader setting; the description of the marsh communities and their successional relationships; the autecology of various species, and finally, discussion of the observations.

The nomenclature of higher plants follows Scoggan ( 1958) which is based on Gray's Manual of Botany Eighth Edition by Fernald (1950).

## DEFINITIONS

A variety of definitions exists for the word marsh. Needham and Lloyd (1916) use the following phrase to define a marsh " a meadowlike area overgrown with herbaceous aquatic plants such as cat-tails, rushes and sedges." Hancock (1934) described a marsh as " a tract of soft wet land, commonly covered wholly or partly with water." Sears (1934) considers it as " a swamp dominated by grasses and grass-like vegetation." Penfound (1953) describes a marsh as " a grass-sedge-rush community occurring in an area where the soil is saturated or covered with surface water for one or more months of the growing season. It does not normally include submerged, floating or emergent stages of shallow lakes and ponds." Many other partial definitions could be cited e.g. Edelman and Staverer (1958) but terms relating to different kinds of bog, marsh and swamp vegetation have been clarified by Dansereau and Segadas-Vianna (1952) and the latters use of /Tansley (1939) and by the term marsh is followed here. They use the following four headings:

1. Physiography. The drainage pattern does not allow for the accumulation of a great amount of organic material, and the shallow substratum and seepage permit a fairly thorough mixing of organic and mineral sediments. The drainage is gradually improved by the growth of vegetation and the corresponding sedimentation. Areas of open water are generally invaded by floating vegetation, and filling-in is from the bottom upwards.

2. Physical conditions. The water table is well above the surface in the spring and at, or just below it for the rest of the year. When above ground level it is continuous. Adjacent open water is turbid, olive-green or dark green (eutrophic). The substratum is soft and will not resist pressure. It absorbs heavy objects, and has a variable percentage of organic materials with a high mineral content. There is no false bottom.

3. Chemical conditions. There is a small quantity of colloids in suspension. The reaction of the water may be acid or alkaline and the percentage of oxygen saturation is high.

4. Vegetation. There is a physiognomic dominance of rectilinear contours: with graminoid herbs and a flat surface to the soil. Graminoid types of plants dominate the early stages and the vegetal cover is discontinuous. Helophytes, geophytes and hemicryptophytes occur early in the season. Mosses are uncommon and the vegetation eventually becomes thicket-like.

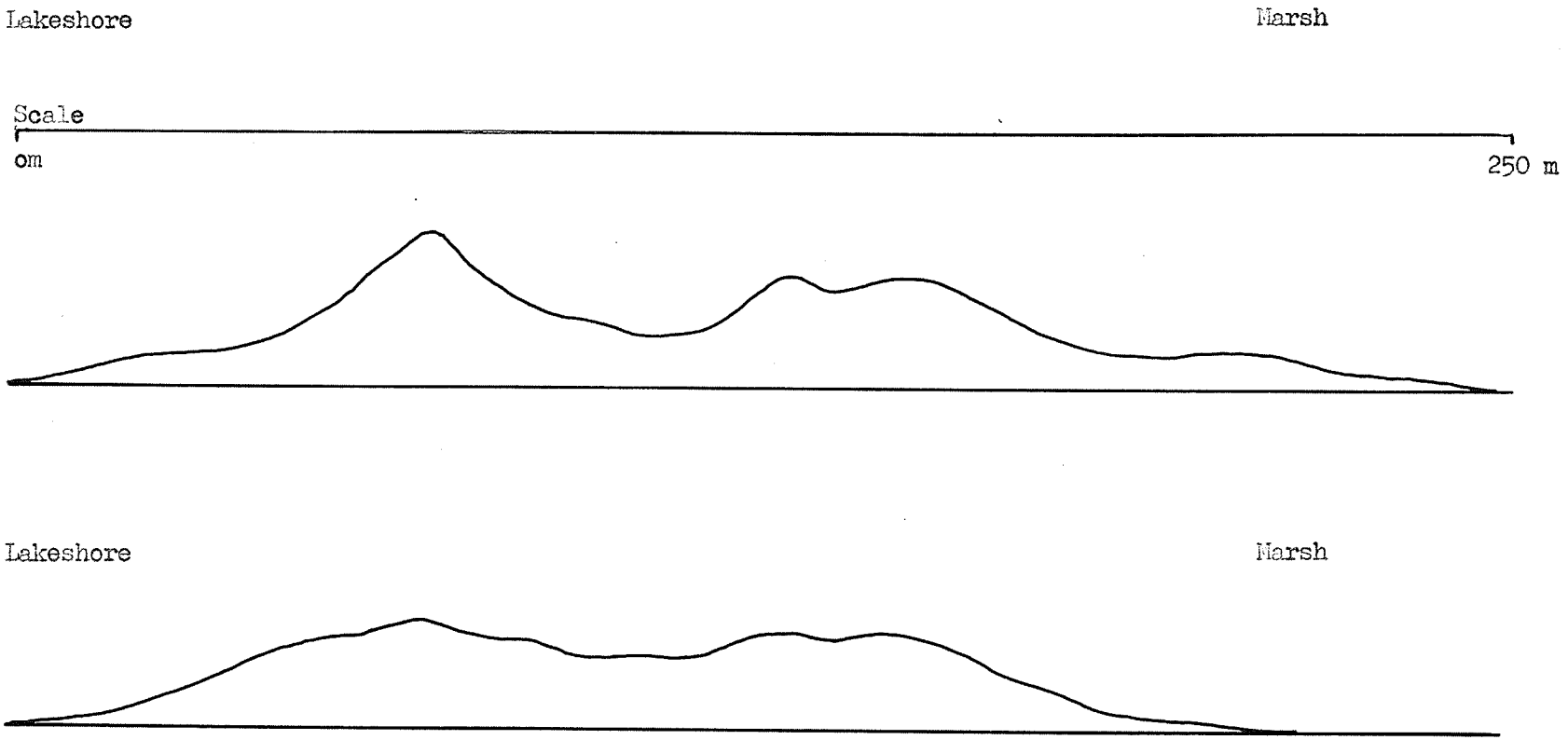
The habitats found in the Delta region cover a variety of types, from aquatic sites with permanent open water 1-2 m. deep, to prairie and scrub. Those in the second category will not be discussed here, but the intermediate stages in the hydrosere such as reedswamp, shallow marsh and wet meadow will be considered under the general heading of marsh vegetation.

## THE SETTING AND GEOGRAPHY OF THE AREA OF STUDY

Lake Manitoba is a large, shallow body of water in the centre of the plains and prairies of southern Manitoba, at an elevation of 248 metres. It is about 180 kilometres long from north to south and 52 kilometres wide at its southern end, with a surface area of about 2,979 hektares. The southern section of the lake is a broad expanse of open water, in contrast with the northern part which is narrower and studded with islands.

The southern shoreline is bounded by a series of low sandy ridges which have been built up by wind and ice (Figure 1) . These, with an average width of 180 metres, have been consolidated in the course of years and now bear a dense growth of trees. Beyond them to the south lies the Delta Marsh covering more than 15,000 hektares, consisting of large and small shallow bays separated by vegetation; and all connected by narrow creeks and channels. (Figure 2).

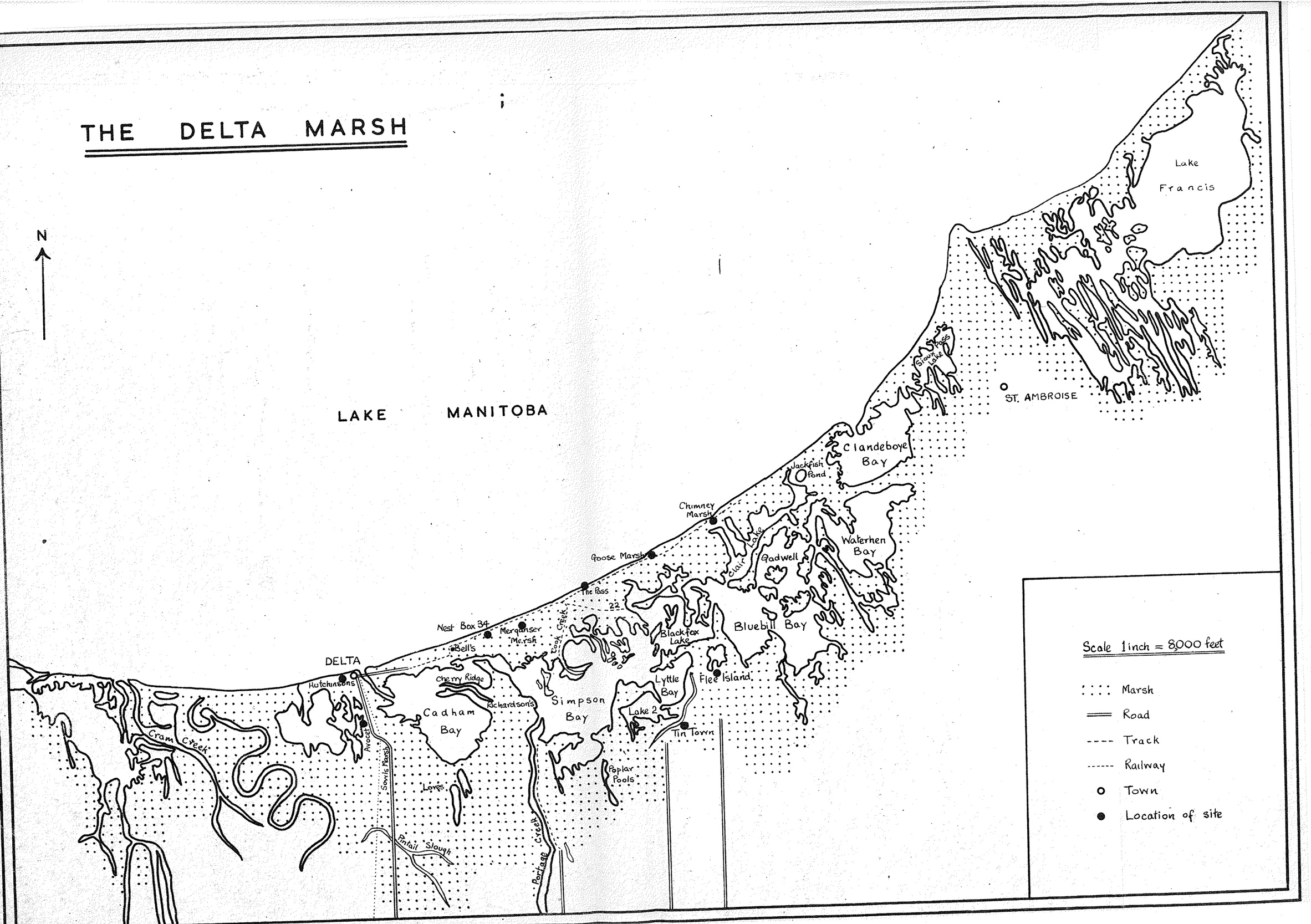
The major contact between marsh and lake is at Clandeboye Bay, where a permanent channel exists. At other placed temporary gaps are torn in the ridge during storms, and these may flood in periods of high water. Thus the water level of the marsh is influenced directly by that of the lake. Information from the Province of Manitoba, Department of Mines and Natural Resources is summarised in Figure 3, and indicates that there has been considerable fluctuation in the Lake level in the last four decades.




Diagrammatic section across the forested ridge a.) near Chimney Marsh, and b.) east of the road to Cook Creek.
Both sections have the vertical scale exagerated five times.

FIGURE I

# THE DELTA MARSH



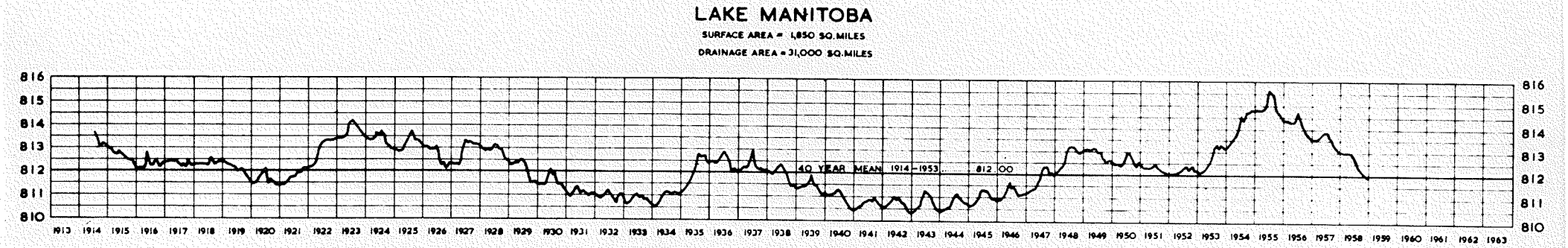



Figure 3. Levels of Lake Manitoba 1914-1958. Data from the Province of Manitoba Department of Mines and Natural Resources, Water Resources Branch.

A new cycle was initiated in 1945, and water levels gradually rose until 1949. They then remained relatively stable until 1952. In 1953 a fairly rapid rise took place which was continued until 1955, when the level of the lake was 105.1 cm. higher than the average. The prevailing north-west winds cause water to collect at the southern end of the lake. Such was the case in 1955 when the lake was higher than at any time in the previous forty years and spring storms resulted in the flooding of twenty one percent of the mergent marsh ( Dillon pers. comm. 1958).

During the high water period, hundreds of acres of Phragmites were reduced to stubble 25 cm. to 150 cm. high. Elsewhere most of the large stands of Typha latifolia, Scirpus acutus and Scirpus paludosus were killed, together with many other emergent marsh species. Thus the general impression of the marsh in 1958 was of open water surrounded by many acres of stubble and bare mud, and a fringe of living Phragmites in higher places.

When the level in the lake falls, water can flow back into it from the marsh. Throughout 1955 the high level was maintained in Lake Manitoba but it has been dropping gradually ever since, reaching the normal or mean in 1958 so that there has been a steady loss of water from the marsh in the intervening years.

In certain areas, generally some distance from the ridge, there are scattered sloughs and ponds which are not in direct contact with the lake. They depend, as do the potholes further inland, upon precipitation and

ground water for their survival (Hochbaum 1944) and in normal summers they retain some water throughout the season. In dry years however, the water in them may disappear completely in the early summer.

## CLIMATE

This region in the centre of Manitoba is characterised by high summer and low winter temperatures, both more extreme than the world average for the latitude. The climate is sub-humid with a summer average of 74.6°F. in July. The annual precipitation is between 25 cm. and 50 cm., eighty percent of it falling as rain between April and October and twenty percent as snow from November to March. These climatic conditions have resulted in a prairie-aspen grove type of vegetation over most of the region south of Lake Manitoba. The area falls within the Hudsonian biotic province of North America. ( Dice 1943) The other major vegetation belts for the province of Manitoba are shown in Figure 4. The average date of the last temperature of 32°F. or less in the spring, is June 1st., and the average date for the first frost in the autumn is September 15th. Thus the frost free period is deemed to be approximately a hundred days and the growing season within the range of one hundred and seventy to one hundred and eighty days. (see Ehrlich, Poyser and Pratt 1957, and the Atlas of Canada 1958).

## GEOLOGY

The following account of the bedrock geology of this region has been taken from the reports of Ehr[illegible] et al. 1957.

Underlying the southern half of Manitoba are rocks of Jurassic and earlier age. There are three main formations:

1. Sundance Formation — glauconitic sandstone, shale, limestone and gypsum.
2. Gypsum Springs Formation—red shale and gypsum.
3. Spearfish Formation— red to brown shales and red argillaceous sandstone.

Devonian limestone and dolostone, and members of the Silurian Interlake group lie to the east.

Recent work by Elson (1957) has helped to fill some of the gaps in present knowledge of the Pleistocene geology of central Canada and in particular in elucidating the history of glacial Lake Agassiz 1 and glacial Lake Agassiz II. The Wisconsin ice sheet covered most of Canada and the neighbouring parts of the United States, and in the course of its retreats northwards and readvances south, the two glacial lakes were formed. The retreat of the Valders ice sheet opened outlets for Lake Agassiz II in the east, through the Black Sturgeon spillway, to Lake Superior. Later a northern outlet opened east of the Sachigo interlobate moraine, when residual ice in the Keewatin District melted into the incipient Hudson Bay and before crustal disturbances caused the gradual emergence of the Hudson Bay Lowlands.

The oldest date obtained for deposits underlying Lake Agassiz is 36,000 years. Prior to the retreat from the Mankaot-Port Huron moraine system most if not all the Lake Agassiz basin, and probably all western Ontario and Manitoba, were covered with ice.

Mankota till is overlain by the clays of Lake Agassiz 1 except where

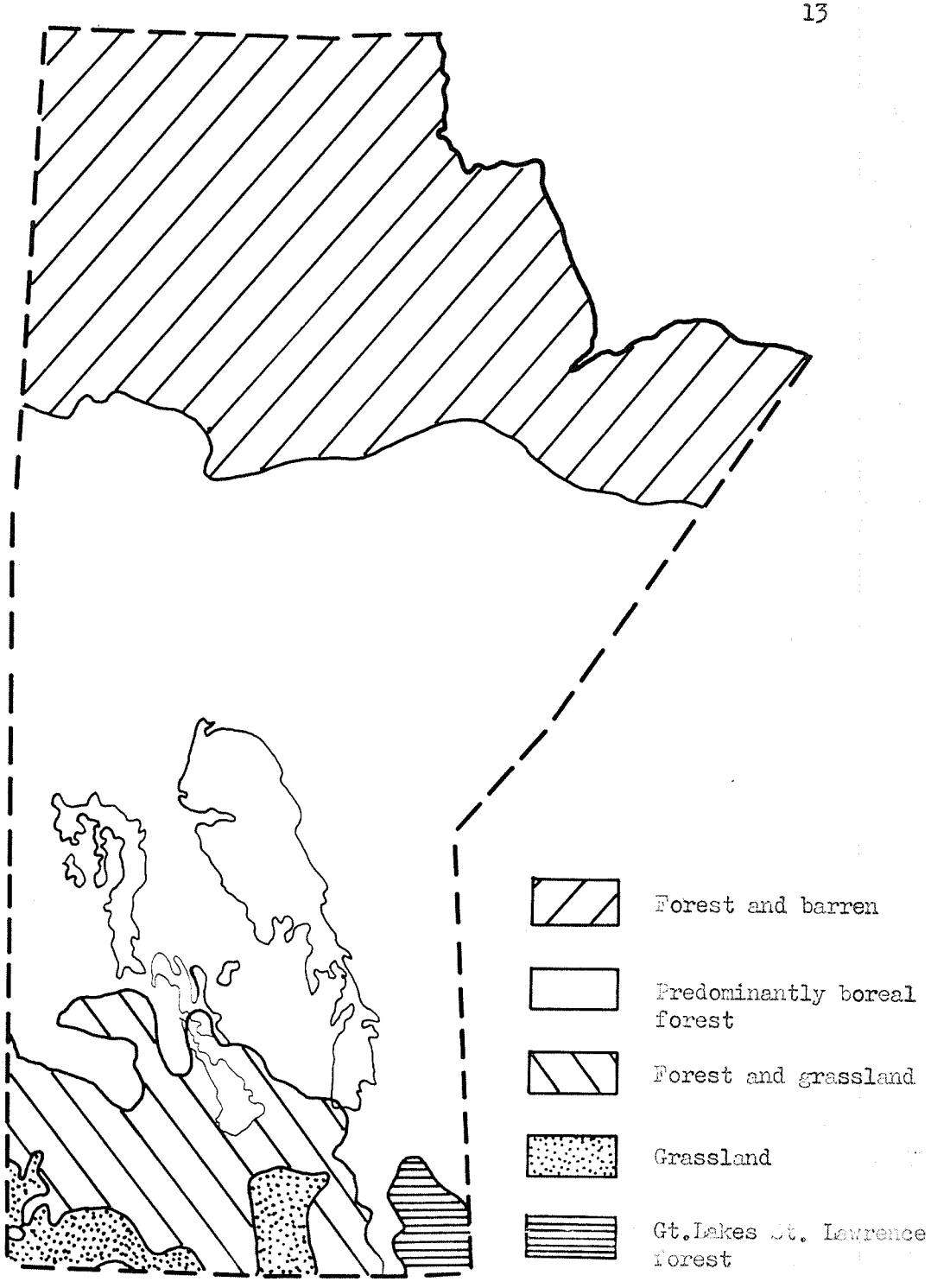



Figure 4. Major vegetation zones in Manitoba.

(Dept. Northern Affairs & Natural Resources 1957)

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# SECTION I

## INTRODUCTION

This study is designed to explore and understand the vegetation of an area of freshwater marsh. From the point of view of basic vegetation study there is an acute need for such an investigation, since inland marsh vegetation has not yet been studied in any detail or described in other than general terms on this continent. There are several fragmentary, usually qualitative descriptions of marsh vegetation, among them Tolstead (1942), Marks (1942), Low (1945), Penfound (1952) and Moss (1953), but none can be described as exhaustive and comprehensive. Löve and Löve (1954) provide a superficial, floristic account of the marsh area studied in the present investigation and Olsen (1959) and Dillon ( pers. comm. 1958) have made sundry observations in the area.

The field work of this study was carried out in the Delta marshes at the southern end of Lake Manitoba. These rank among the finest waterfowl marshes in North America, and attract many thousands of duck on migration, being at the head of the Mississippi Flyway. They also harbour sixteen nesting species of duck.

thin, lenticular deposits of sand and gravel occur. Presumably these deposits were laid down at the base of the ice margin standing in Lake Agassiz, rather than sub-aerially. There is an unconformity between the clays of Lake Agassiz 1 and the silty deposits of Lake Agassiz II. Extensive areas of the lake floor have no lacustrine clay or silt, partly because of removal by wave action during subsidence of the lake, and partly because no major river brought sediments to the basin. Rivers seem to have contributed most of the sediments to Agassiz II whereas glacial contributions were confined to a belt near the ice margin. This retreated across Agassiz I, and both glacier and rivers contributed to its deposits. Rocks underlying areas much further north may have been carried south by the continential ice sheets and contributed to the present day surface deposits as the ice sheets moved in a southerly direction.

The extent of the Pleistocene lakes is shown in Figure 5. As Lake Agassiz II retreated north its path was marked by a series of beaches. Several of these are clearly discernible today, and the present flora shows the influence of vegetation from Ontario in the east, Saskatchewan in the west, and Minnesota and the Dakotas in the south. Remnants of Lake Agassiz still exist in Manitoba, notably in Lakes Winnipeg, Winnipegosis and Manitoba.

The present day surface deposits contain rocks which were carried down from the north with the retreating ice and include tills, generally of unsorted material; glaciofluvial sandy gravels; and lacustrine deposits

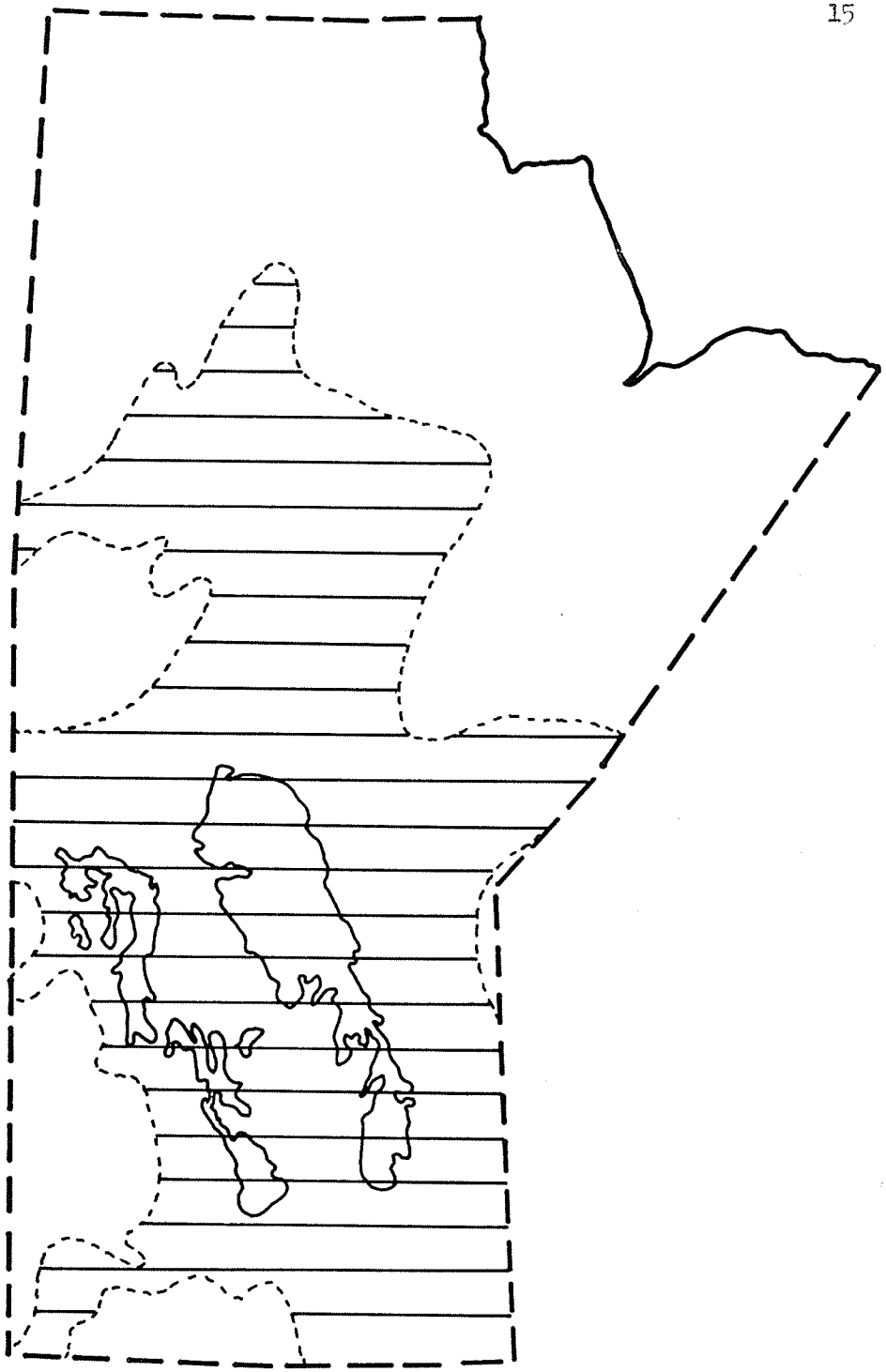


Figure 5. Maximum extent of Lake Agassiz I and Lake Agassiz II in Manitoba cross hatched.
(Geological Association of Canada 1958)
1" = 96.6 kilometres.

of clays, silts and sands, laid down in the glacial lakes. (Figure 6)

## SOILS

The following data on soil has been culled primarily from Ehrlich, Poyser and Pratt 1957. (see Figure 7.) Delta Marsh lies at the north of the area designated as a lowland lacustrine and alluvial plain of medium to fine textured deposits. It is bounded by Interlake and Westlake till plains which lie to the east and west and consist of areas of ground moraine somewhat reworked by shallow waters in the glacial lakes, producing a ridge and hollow pattern in some areas.

The forested ridge which separates the marsh from the lake consists of Agassiz soils and has developed on coarse and very coarse beach and outwash deposits of limestone and granitic rock origin. The surface textures vary from fine sand to fine sandy loam and become coarser with depth. The Agassiz soils are found on ridges with a rounded form. The upper part is excessively drained and the edges are imperfectly to poorly drained. A representative Agassiz soil is a weakly developed Black soil with low organic content, and moisture retaining capacity. In certain areas Black-meadow soils are associated with Black soils along the margins of gravel beaches and merge into the marsh.

The marsh soils are poorly drained and consist of thick muck and peat deposits overlying glacial drift. Flat depressed areas such as the Delta marshes remain very wet due to seepage from the surrounding coarse-textured deposits. The depth of peat overlying the mineral soil

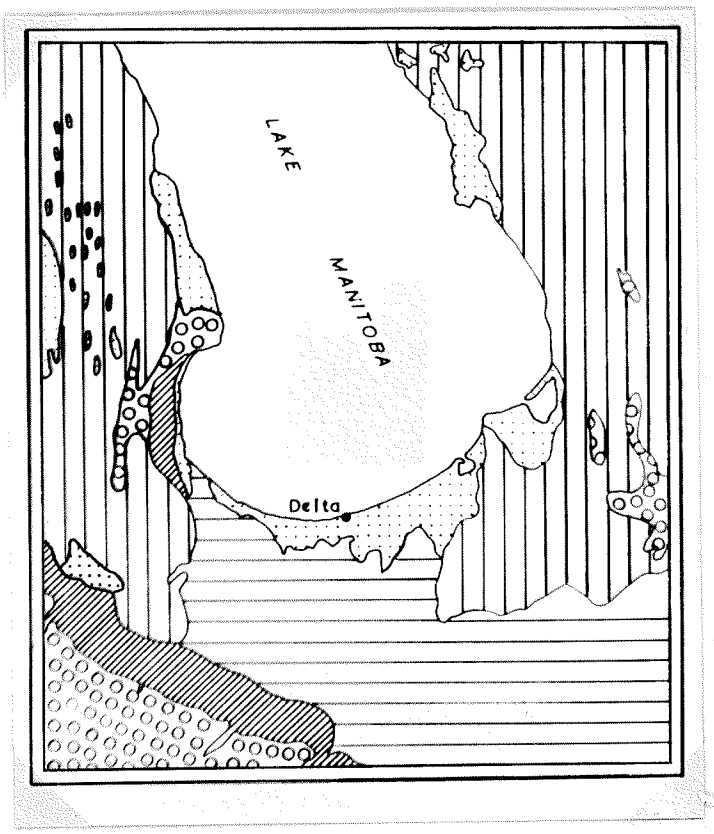



Figure 6. Surface Geology

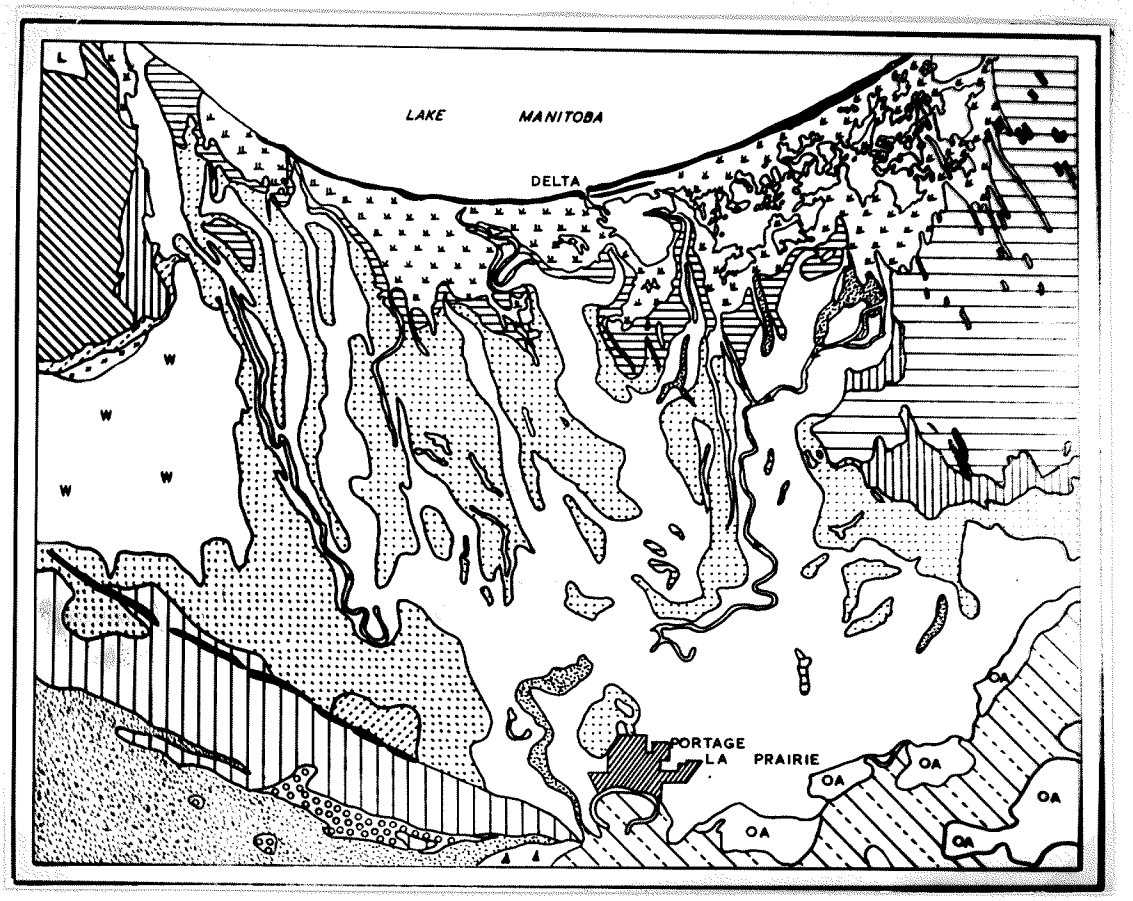
Glacial till or boulder clay modified by wave action.

Muck and peat

Lakebed and flood plain deposits: silty

Lakebed and flora plain deposits, claying

Lakebed and flood plain: sandy




Undifferentiated muck and peat soils, very poorly drained

Westbourne Association , clay

Osborn clay, fine textured

Woodlands complex, fine sandy loam to silty clay loam

Red River clay, fine textured solonetzic

Agassiz Association, sand to fine sandy loam

Isafold Series, rendzina or highly calcareous boulder till

Lakeland Association, fine sandy loam to silty clay

Marquette clay, over medium till

Miniota Association

Burnside Association, silty clay

Almapissi clay substrate

Almapissi loamy sands

Riverdale, fine sandy loam to silty clay

Gladstone Association

Oakville Association, silty clay loam to clay

Figure 7. Soils of the area between Lake Manitoba and Portage la Prairie. (Manitoba Soil Survey 1958).

is variable, but generally thin.

At the southern limits of the marsh, soils of the Red River Association are developed on lacustrine clay sediments in the central basin of Lake Agassiz. The surface texture is of uniform clay, and stones are absent except where the clay covering the till is comparatively thin. The topography is relatively level, in some parts gently sloping with low ridges trending in a north-west, south-east direction.

Interdigitated between the soils of the Red River Association and spreading out from their centre at Portage la Prairie are the soils of the Portage Association developed on a medium to fine grained alluvial fan. The surface textures vary from very fine sandy loam on the levees, to silty clay in the depressions. On some levees within the fan, the soils are coarser in texture. The alluvial sediments are underlain by lacustrine clay except to the east where they border the Isafold Association, and are underlain by till and water-worked till. The thickness of these alluvial deposits on the unconforming substrate varies from 0.6 m. to 1.8 m. The topography is smooth, very gently sloping, sometimes undulating. Generally the soil drainage is good, but where the terrain is nearly level and the clay substrate close to the surface, run-off and internal drainage is impeded. There is abundant organice matter in the soil. It has a moderately high moisture retaining capacity and suffers severely from wind erosion.

The area to the east contrasts markedly with the foregoing. The soils are developed on boulder till predominately of limestone origin,

the parent material having between fifty percent and seventy percent magnesium carbonate and calcium carbonate. Large areas of stony and very stony soils occur. Shallow swales and low ridges characterized the area, the former with poor to very poor drainage, the latter with moderately good drainage, and in these swales there is often a covering of lacustrine sediments over the calcareous till.

SECTION II

# VEGETATION

## Method of description

A preliminary ground survey was made in conjunction with the most recent (1954) aerial photographs of the area. Although these were of considerable value in indicating persistent stands of vegetation and in providing information for further interpretive work, the area has changed so much that it was not possible to map vegetation from existing aerial photographs.

It was decided that the vegetation could best be described quantitatively by devising a more or less uniform method of analysis and description. In each of the sites a species list was compiled including an estimate of cover and abundance using the following modified scale of Braun-Blanquet (1932):-

1 indicates that the species covered less than 5% of the sampling unit. (rare)

2 indicates that the species covered between 5% and 25% of the sampling unit. (occasional)

3 indicates that the species covered between 26% and 50% of the sampling unit. (frequent)

4 indicates that the species covered between 51% and 75% of the sampling unit. (abundant)

5 indicates that the species covered between 76% and 100% of the sampling unit. (dominant)

The size of the sampling unit and number of samples necessary to give a fair picture in any one site was determined by constructing a species area curve, and the area or zones within the community were samples, accordingly. The quadrats were placed in a haphazard, non-systematic manner, here referred to as 'random', but not as defined by Greig-Smith (1957) by using a table of random numbers. The extent of communities, and zones, was determined visually and they were sampled using the foregoing scale of values for assessing abundance and cover together with Braum-Blanquet's (1932) scale for expressing gregariousness or sociability as follows:-

1 growing in one place; singly

2 grouped or tufted

3 in troops, small patches, or cushions

4 in small colonies, in extensive patches, or forming carpets.

5 in great crowds (pure populations).

Hereafter when a figure follows the name of a species it refers to the cover and abundance, e.g. Atriplex patula (3) indicates that A. patula covered between 26% and 50% of the ground in that community. This estimate of cover/abundance was subjective and visual. In an example which uses the data for both cover/abundance and sociability A. patula (3.1) would indicate that while the species in question occupied approximately half the area in the quadrat, it was represented by only one or two individuals growing singly; (3 represents cover/abundance,

and 1 represents sociability). A species with a value of (3.5) would indicate that the species again occupied between 26% - 50% of the sampling area, but the plants occurred in pure populations ( 3 represents cover/abundance and 5 sociability).

Additional information regarding the spatial arrangements of plants was recorded by means of transects and profile diagrams. In these the position and spread of individual plants or groups of plants was noted, thereby giving a more complete impression of the vertical and horizontal distribution of the vegetation and the relationship of the various species to each other. The depth and spread of root systems, the height of vegetation, the time of flowering and the setting of seed, and aggressiveness and duration of the dominants was also recorded.

The sites were revisted on several occasions to observe any changes; as new areas were uncovered by receding water, their pattern of colonisation was recorded, to ascertain the relative consistency of re-colonisation patterns throughout the growing season.

In each site data relating to topography, soils, drainage, exposure and other relevant information was collected.

Water gauges were used to follow changes in the level of water in the system of bays using a water gauge placed at Cook Creek, and the Avocet Marsh area. (Figure 8)

## Site localities

The sites described in this section are arranged in a somewhat arbitrary manner. The first to be considered is the forested ridge and

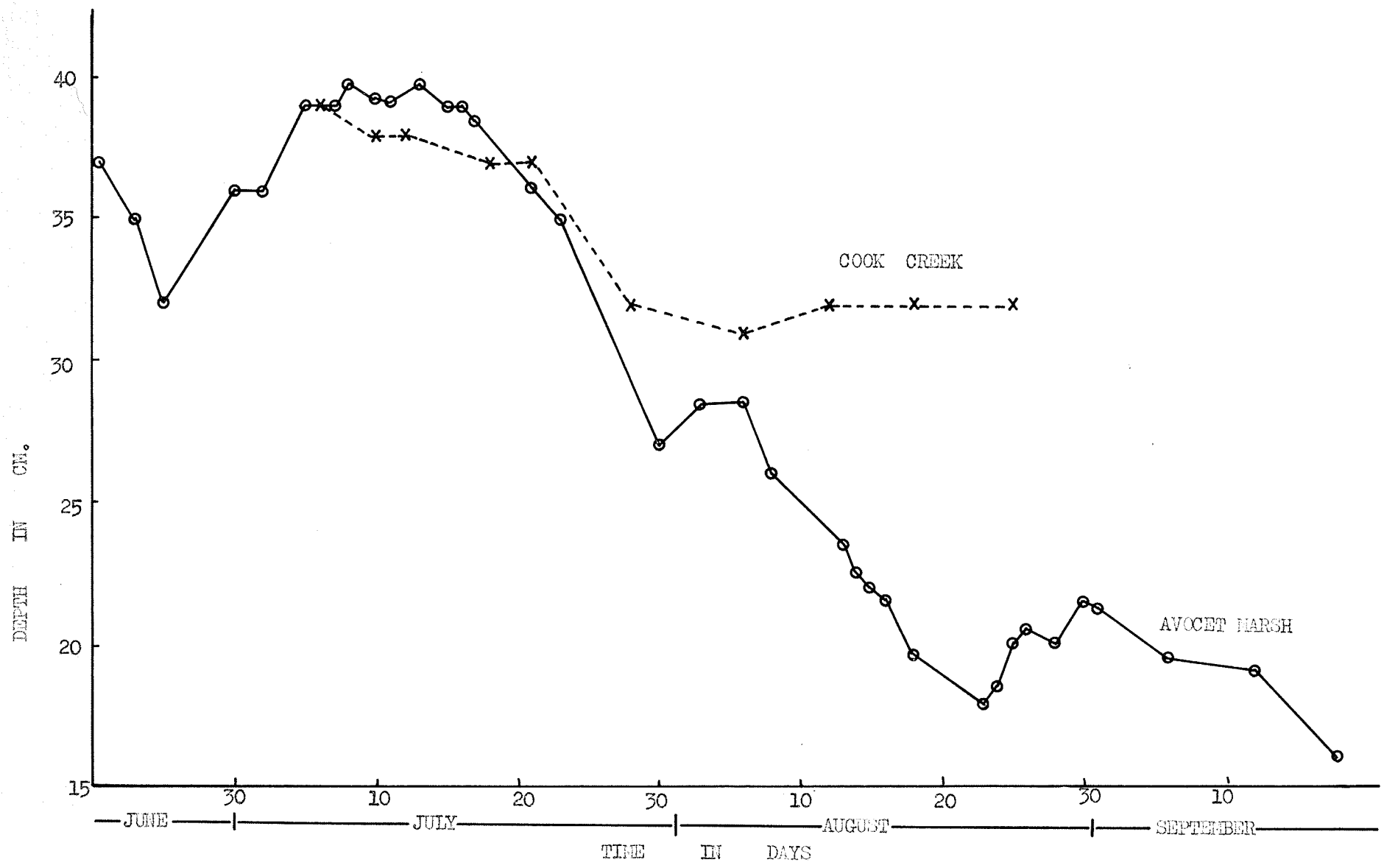



FIGURE 8. Graph showing fluctuations in the level of water at Cook Creek and at Avocet Marsh between June 15th. and September 15th. 1958.

it is followed by descriptions of the sites immediately south of it, i.e., on the north shores of the marsh. Next, some of the areas on both sides of the main road leading south from the village of Delta are discussed, and finally sites on the southern borders of the marsh, working from the west to the east. The location of these sites is given in Figure 2.

1. FORESTED RIDGE

The term 'forested ridge' has been used throughout to describe the old beach line of Lake Agassiz which separates the present day limits of Lake Manitoba from the widespread marshes to the south.

The vegetation of the ridge can be divided into several distinct habitats which will be discussed briefly below.

Lakeshore

Depressions in the forest

i Semi-permanent depressions

ii Shallow and temporary depressions

Sand dunes

Relics of old meadows

General forest

Each of these habitats is represented in more than one place on the ridge, often several kilometres apart. A description combining the various stations in which each community occurs is given here, as local differences are relatively unimportant in a general description of this nature.

Lakeshore. The conditions prevailing in 1955 which caused the innundation of approximately twenty one percent of the marsh have already been described. This flooding lasted for a period longer than the vegetation could survive, and affected not only emergent marsh, but also farmland and the forested ridge, where many trees were killed.

The most severe storms washed sand over the northern edge of the ridge and completely obliterated the ground vegetation. In the spring of 1958 some of the dead trees were erect, many were uprooted and others stood at grotesque angles (Figure 9). In some areas a layer of silty material and plant remains had collected on top of the sand between the trees. Elsewhere layers of silt and plant remains beneath the sand showed that this was not the first occurrence of such conditions. The presence of a fairly high proportion of silt limits drainage appreciably. Consequently the first vegetation to appear on the lakeshore was in these silt accumulations. It was dominated by Eleocharis palustris, and the following species were included:

Mentha arvensis
Solidago canadensis var. villosa
Sonchus arvensis var. glabrescens
Taraxacum officinalis
Cicuta maculata
Juncus torreyi
J. nodosus
Populus deltoides (seedlings)
Carex sp.
Stellaria graminea
Calamagrostis canadensis
Stachys palustris
Amelanchier alnifolia (seedlings)

As the season progressed the number of species increased and the abundance of individuals changed, altering the general picture considerably. Additions included:

Aster praealtus
Echinocystis lobata
Convolvulus sepium
Carex atherodes
Equisetum arvense
Phragmites communis
Fraximus americana
Acer negundo
Salix lucida
Salix amgdaloides
Ranunculus flabellaris
Rubus pubescens
Lycopus americanus
Epilobium glandulosum var. adenocaulon
Erigeron philadelphicus
Polygonum persicaria
Lappula echinata
Eleocharis acicularis
Eleocharis calva
Asclepias incarnata
Axyris amaranthoides
Teucrium occidentale
Agropyron trachycaulon
Draba nemorosa
Lapsana communis
Hordeum jubatum
Rumex maritimus var.fueginus
Artemisia frigida
Puccinellia nuttalliana
Agrostis stolonifera
Rorippa islandica
Chenopodium rubrum
Sium sauve
Melitotus alba
Urtica dioca var.procera
Scutellaria lateriflora
Scutelleria galericulata
Eupatorium maculatum
Eleocharis sp.

At the same time as the foregoing species were appearing high up on the lakeshore, further down the shore surviving patches of Phragmites communis began to show signs of growth, as also did Scirpus validus, S. acutus and the smaller triangular leaved S. americanus.

The elongated stout, hard rhizome of Scirpus americanus seemed able to withstand the constant lapping of waves at the waters edge, and where erosion was slower because the sandy shore was interbedded with bands of silty clay, it grew successfully.

As the season advanced, patches of Phragmites and Scirpus spp. increased in density and consolidated the areas they occupied. Phragmites produced a large number of runners over the sand, so many in

some places that they completely covered the substratum (Figure 10). The majority of the Phragmites did not produce flowers. In seven counts of two hundred shoots in a typical stand, it was estimated that less than two percent had flowered.

In one locality a bed of Typha latifolia had survived and showed early spring growth. A large number of seedlings appeared later and were established by the autumn. (Figure 11).

A soil excavation was examined on the lakeshore in a region of vegetation as just described and showed:

0-30 cm. Sandy loam, light brown with black grains, and finely comminuted shell fragments.

30-55 cm. 25 cm. band of black silty loam with a high proportion of organic material forms the top layer in a mixed horizon containing pockets of dark brown peat packed with plant remains, and black silty loam.

55-100+cm. Silt with occasional silty loam bands.

Water table at depth of 100 cm. pH 6.2 in water and pH 7.2 at surface. (Figure 12).

At the western end of the lakeshore there was a noticeable lack of vegetation except on silty clay bands which had been washed out and formed flat shelves at the water's edge where a few patches of Scirpus americanus, and Eleocharis palustris occurred with occasional Typha latifolia and Ranunculus scleratus. There were extensive areas of

Figure 9.

Lakeshore showing surviving trees and Phragmites communis.

Figure 10.

Phragmites runners on Lake shore.

Figure 11. Typha latifolia seedlings on lakeshore with surviving Typha and trees in background.

dead Phragmites, Scirpus validus and S. americanus with little sign of regrowth.

The delta-like extension into Lake Manitoba at the mouth of Cram Creek was the most westerly station examined. It had been little effected by the floods and supported a fine growth of Phragmites, the only other lakeshore site where Phragmites equalled it in extent and size was near the entrance to Lake Manitoba of Clandeboye Channel 21 kilometres further east. (Figure 13). This channel is kept open by the periodic scouring of wind tides from the lake, and the subsequent return of flood water. The sides of the channel are marked by luxuriant vegetative growths of Typha latifolia 2-3 m. high, in dense stands, broken up by pools of water. (Figure 14). These beds of Typha were more extensive than any others seen in the Delta area, and apparently did not produce flowers in 1958.

Wave action along the lake edge had washed out old beds of Phragmites, whose dead roots extended 15 - 20 m. into the lake. Local residents say the original beds disappeared more than fifty years ago. Evidence of former forest was seen in old tree roots also uncovered by recent storms.

On the lakeshore there were well established clumps of Phragmites and Scirpus validus growing in sand, while on compacted clay bands, in silt-filled depressions along the water's edge, and on washed-out roots of various plants (Figure 15) the following species were recorded: Eleocharis calva, E. acicularis, and E. palustris formed a close turf

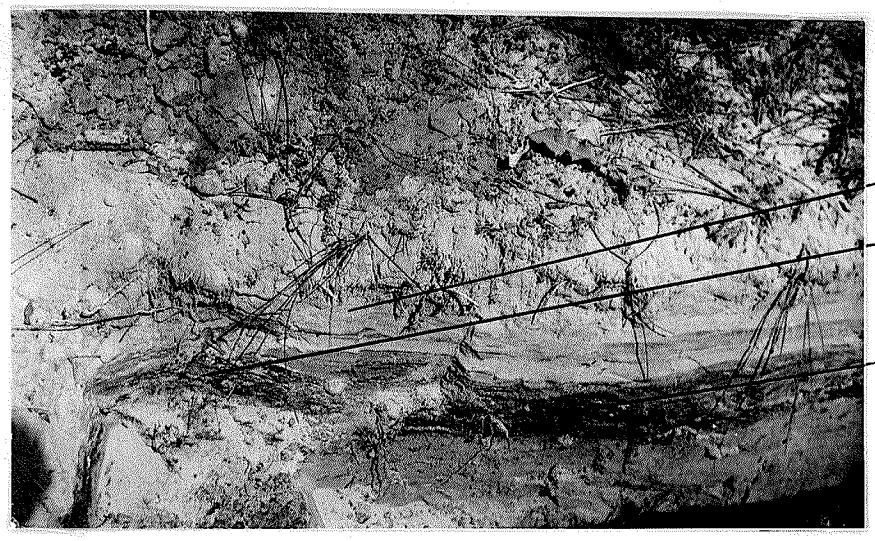



Figure 12. Lakeshore soil excavation

Figure 13. Phragmites near Clandeboye Channel, showing runners radiating out from a well established clump in the foreground, and a dense stand of Phragmites in the background.

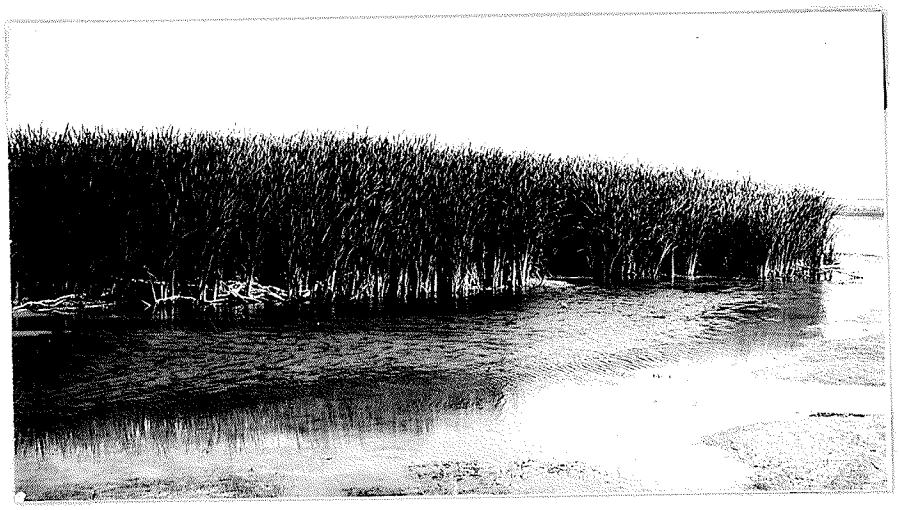


Figure 14. Typha latifolia near Clandeboye Channel

Figure 15. Vegetation on lakeshore, growing on washed out roots and debris.

for short distances—particularly the latter species and with it occasional Sagittaria latifolia. Scirpus americanus was a locally dominant species on the silt and mud accumulations, and Ranunculus sceleratus, R. cymbalaria, Aster brachyactis, Juncus nodosus, J. bufonius, Typha latifolia, Scirpus validus, Phragmites and Epilobium glandulosum var. adenocaulon were recorded less frequently.

In nearly all places where the above species were noted their growth was slow, and in no site did they cover more than a small part of the available substratum except in the case of Eleocharis spp.

Depressions in the forest.

i. Semi-permanent depressions. In many places the forested ridge is composed of two old beach ridges with lows or depressions between them. These depressions are poorly drained and hold water for a considerable time, their semi-aquatic and marsh vegetation contrasts markedly with that of the ridges. Goose Marsh and Chimney Back Marsh are two such examples.

Goose Marsh lies approximately three miles east of Cook Creek. In the spring it was an open 'lagoon' full of water, fringed with trees, and had a few drowned shrubs and trees in the middle. The marsh was bordered with a zone of grasses and sedges. During the summer much of the water dried up and the deep rich organic soil became colonised with a dense and luxuriant growth of vegetation. Bidens cernua, the dominant species, formed a dense carpet approximately 1 m. high,(Figure 16) with occasional patches of Sparganium eurycarpum and Carex retrorsa.

The ground is uneven, almost tussocky and covered with a straggling growth of Calligeron giganteum. Thelypteris palustris, the only fern recorded (Figure 17) occurred where the shrubs or trees added additional shade to that cast by the dense herb layer.

A frequency (F%) cover/abundence (C) and sociability (S) estimate of this area of the marsh gave the figures below:-

| Species | F% | C | S |
|---|---|---|---|
| Bidens cernua | 90 | 3.7 | 4.6 |
| Scolochloa festucacea | 15 | 2.0 | 3.7 |
| Galium trifidum | 35 | 1.4 | 2.1 |
| Epilobium glandulosum var.adenocaulon | 15 | 1.3 | 3.3 |
| Sparganium eurycarpum | 10 | 1.5 | 2.0 |
| Carex retrorsa | 45 | 3.2 | 4.0 |
| Typha latifolia | 30 | 2.3 | 2.8 |
| Phragmites communis | 5 | 1.0 | 1.0 |
| Thelypteris palustris | 5 | 2.0 | 3.0 |
| Impatiens capensis | 10 | 1.5 | 2.0 |
| Cicuta bulbifera | 5 | 2.0 | 3.0 |
| Polygonum punctatum | 15 | 1.3 | 2.0 |

The following species were not recorded in the samples but were occasional in the marsh:-

Ranunculus pennsylvanicus
Sium sauve
Cicuta maculata
Solanum nigrum
Arenaria laterifolia
Potentilla norwegicus
Scutellaria lateriflora
Scirpus fluviatilis
Poa palustris
Carex pseudo-cyperus

On the fringe of the marsh Scolochloa festucacea was locally abundant, Mentha arvensis, Polygonum convolvulus, Urtica dioica var. procera, and Scutellaria galericulata var. epilobiifolia were occasional.

Figure 16. Goose Marsh. Dense growth of vegetation dominated by Bidens cernua with Typha latifolia and lake shore trees in background.

Figure 17. Thelypteris palustris with Scolochloa, Typha latifolia, Mentha arvensis, Carex bebbii and Bidens cernua.

The second example is a depression north of the Chimney Marsh where the water stands for a shorter time than on Goose Marsh. It is an elongated hollow with a sandy ridge on the north, and a slight rising in the ground on the south side. Both these ridges bear trees, predominantly Fraxinus pensylvanica, Ulmus americana and Acer negundo which cast a dense shade over marsh except when the sun is directly overhead. By September, the standing water had dried up though the rich organic soil was still saturated. The area was sampled by throwing twenty five metre squares at 'random'. The results are listed below:-

Central Area

| Species | F% | C | S |
|---|---|---|---|
| Polygonum punctatum | 76 | 3.2 | 4.0 |
| Bidens frondosa | 60 | 1.9 | 2.9 |
| Mentha arvensis var. villosa | 32 | 2.5 | 4.1 |
| Urtica dioica var. procera | 28 | 1.7 | 2.3 |
| Polygonum lapathifolium | 24 | 2.7 | 3.5 |
| Sparganium eurycarpum | 40 | 4.2 | 3.3 |
| Scirpus fluviatilis | 40 | 2.3 | 3.6 |
| Polygonum coccineum | 20 | 2.2 | 3.0 |
| Galium trifidum | 20 | 1.4 | 3.0 |
| Carex retrorsa | 12 | 2.7 | 4.0 |
| Chenopodium rubrum | 12 | 1.0 | 1.3 |
| Sium sauve | 12 | 1.0 | 1.0 |
| Carex atherodes | 8 | 2.5 | 4.0 |
| Scutellaria galericulata | 4 | 1.0 | 1.0 |
| Ranunculus macounii | 4 | 1.0 | 1.0 |
| Bidens cernua | 4 | 2.0 | 4.0 |
| Carex bebbii | 4 | 1.0 | 3.0 |
| Rorippa islandica | 4 | 2.0 | 3.0 |
| Alisma trivale | 4 | 2.0 | 4.0 |

Edge

| Species | F% | C | S |
|---|---|---|---|
| Mentha arvensis var. villosa | 80 | 2.0 | 3.7 |
| Carex retrorsa | 100 | 3.8 | 4.4 |

| Species | F% | C | S |
|---|---|---|---|
| Scutellaria lateriflora | 20 | 1.0 | 3.0 |
| Urtica dioica var. procera | 20 | 1.0 | 3.0 |
| Polygonum punctatum | 20 | 1.0 | 1.0 |
| Galium trifidum | 20 | 1.0 | 3.0 |
| Polygonum coccineum | 40 | 2.5 | 3.5 |
| Ranunculus macounii | 20 | 1.0 | 1.0 |

ii. Temporary depressions Of the shallow depressions, many are slight and enclosed by ridges. The water that accumulates in them, at first from melting snow and ice while the soil is still frozen, and later by flooding or precipitation, is held for varying periods, but generally dries up before the end of the season. The soil is one of these depressions consisted of:-

5 cm. Silty loam with plant remains

8-12 cm. Compact dark brown bands of partly decomposed plant remains, interbedded with narrow silty bands

17 cm. Sandy loam

50 cm. Banded calcareous silty loam. In some of the bands, roots and other plant remains were distinguishable. This silty loam went down below the water table at a depth of 75 cm. (Figure 18)

In early June these depressions held a multitude of seedlings of various species which in many places already formed a hundred percent cover. Recorded were:-

Impatiens capensis
Mentha arvensis var. villosa
Urtica dioica var. procera
Carex atherodes
Typha latifolia
Scolochloa festucacea
Ranunculus pennsylvanicus
Epilobium glandulosum var. adenocaulon
Rorippa islandica
Eleocharis palustris
Juncus balticus var. littoralis
Lycopus americanus


Figure 18. 'Soil' in a depression on ridge.

| | |
|---|---|
| Ranunculus cymbalaria | Agrostis palustris |
| Plantago major | Aster praealtus |
| Cicuta maculata | Thalictrum venulosum |
| Solidago canadensis | Alisma trivale |
| Polygonum coccineum | Hippuris vulgaris |
| Carex pennsylvanica | Scirpus caespitosus |
| Sium sauve | |

As the summer progressed the vegetation grew taller and thicker becoming almost impenetrable. Additions to the foregoing list occurred and some species which flowered early in the year like Ranunculus cymbalaria were completely overshadowed by midsummer when Impatiens, Urtica, Solidago and Aster had increased their size and gave to the now moist depression a very different appearance. Echinocystis lobata and Humulus lupulus added to the tangled vegetation climbing up the dead shrubs and hanging down in festoons.

Depressions which were less than fifty percent shaded and had a rich muck soil, produced a flourishing flora. The following were recorded in one example:-

| | |
|---|---|
| Galium trifidum | 4 |
| Rorippa islandica | 4 |
| Bidens cernua | 4 |
| Epilobium glandulosum var. adenocaulon | 3 |
| Scutellaria galericulata | 3 |
| S. lateriflora | 3 |
| Bidens frondosa | 2 |
| Typha latifolia | 2 |
| Lycopus americanus | 2 |
| Ranunculus sceleratus | 2 |
| Echinocystis lobata | 2 |
| Atriplex patula | 2 |
| Carex atherodes | 2 |
| Teucrium occidentale | 2 |
| Rumex maritimus var. fueginus | 2 |
| Galium aparine | 2 |
| Mentha arvensis var. villosa | 2 |
| Stachys palustris | 2 |

| | |
|---|---|
| Polygonum persicaria | 2 |
| Hordeum jubatum | 2 |
| Potentilla norvegica | 2 |
| Carex retrosa | 2 |
| Glyceria grandis | 2 |
| Hippuris vulgaris | 1 |
| Thalictrum venulosum | 1 |
| Phragmites communis | 1 |
| Poa pratensis | 1 |
| Spiraea alba | 1 |
| Asclepias incarnata | 1 |
| Alisma trivale | 1 |
| Erigeron philadelphicus | 1 |

Sand dunes. Miniature sand-dunes from 0.5 m. to 2 m. high occur near Clandeboye Bay. Lathyrus maritimus grew on the coarse to medium sand with calcareous pebbles and comminuted shells distributed in tidal patches. Agropyron dasystachyum was abundant, and in some areas dominant; it often occurred with clumps of Elymus canadensis. Later in the season along the shore Ambrosia trifida, Xanthium strumarium, Salsola kali, Axyris amaranthoides and Iva xanthifolia became evident though never more than frequent. Spreading rosettes of Astragalus bisculatus growing close to the sand and over half of a meter in diameter, were also found.

In one location where there was an obvious and marked progression of dune into the meadow and forest, (sand had been carried 40 m. into the wood), the following species were recorded:-

| | |
|---|---|
| Bromus purgans | Cirsium arvense |
| Solidago canadensis | Lepidium draba |
| Erigeron canadensis | Erysimum cheiranthoides |
| Mirabilis nyctaginea. | Agrostis stolonifera |

A number of trees along the shore showed signs of the effect of the prevailing northwest winds, which, aided by sand, had produced in them a

markedly asymmetrical growth form.

Meadows. In certain regions particularly at the eastern end of the ridge, in the neighbourhood of Clandeboye Bay there is evidence that meadows existed in the past. These were grazed until 1937, and have since been undisturbed (Figure 19). Generally they have formed on old stabilised sand dunes and ridges jutting out into the marsh.

Grasses were the dominant plants in these meadows, and a few trees and bushes were found. The flora varied with local conditions of aspect, exposure, drainage and soil, showing a marked seasonal change during the summer.

In one station the species list for the early part of the year included:-

| | |
|---|---|
| Juncus balticus var. littoralis | 5 |
| Agrostis palustris | 4 |
| Puccinellia nuttalliana | 4 |
| Poa pratensis | 4 |
| Potentilla anserina | 4 |
| Potentilla norvegica | 4 |
| Sonchus arvensis var. glabrescens | 4 |
| Phragmites communis | 3 |
| Eleocharis palustris | 3 |
| Stachys palustris | 3 |
| Cirsium arvense | 3 |

Later in the season the following were also recorded:-

| | |
|---|---|
| Hordeum jubatum | 3 |
| Erysimum cheiranthoides | 2 |
| Lapsana communis | 2 |
| Lycopus asper | 2 |
| Teucrium occidentale | 2 |
| Cicuta maculata | 2 |
| Draba nemorosa | 2 |

Where the meadow ran down into the marsh, seedlings of Epilobium

Figure 19. Meadow showing coarse grasses and *Artemisia biennis*.

glandulosum var. adenocaulon were abundant, and below them a zone of Ranunculus sceleratus (3), Eleocharis palustris (3) and a few well grown plants of Rumex maritimus var. fueginus and Senecio congestus var. tonsus occurred.

In a similar situation, a slight but fairly extensive ridge at right angles to the road was crowned with Melilotus alba and Agropyron repens. The sides of the ridge bore occasional Carex bebbii, Polygonum coccineum, Chenopodium rubrum, Eleocharis palustris, Juncus balticus var. littoralis, Epilobrum glandulosum var. adenocaulon, Rorippa islandica, and Rumex maritimus var. fueginus. This ridge is confluent with several old meadows in the region of Jackfish Pond. The rather thin patchy turf in the meadow was composed of frequent Agropyron repens, Agropyron trachycaulon, and Sporolobus cryptandrus, with Ambrosia trifida (2), Crepis tectorum (2), Artemisia biennis (2), Arabis divaricarpa (1), Taraxacum officinale (1), Astragalus canadensis (1), Ascelpias speciosa (1), and Potentilla anserina (1), scattered throughout.

In a similar meadow, rounded patches of Ceratodon purpureus occurred together with the grasses, and was almost completely dessicated by August.

Other meadow sites included:

| | |
|---|---|
| Mentha arvensis var. villosa | (3) |
| Elymus canadensis | (2) |
| Elymus virginicus var. hirsutiglumis | (2) |
| Agropyron smithii | (2) |
| Panicum capillare | (2) |
| Muhlenbergia asperifolia | (2) |
| Helictotrichon hookeri | (1) |
| Nepeta cataria | (1) |
| Chenopodium berlandieri | (1) |

General Forest. In the general forest there are several different

habitats depending on a variety of factors such as the aspect, nature of the substratum, drainage, abundance of leaf litter, fallen logs and debris, closeness of canopy, and extent of clearings.

In the high water period referred to earlier many of the trees and shrubs were killed. The only trees surviving in 1958 on low sites in the zone nearest the lake, were Fraxinus pennsylvanica, Salix amygdaloides, and Salix interior. In many instances, however, only one or two branches in a tree 15 - 20 m. high showed signs of life (Figure 9). In higher sites most of the trees were growing normally and the association included Populus tremuloides, Populus deltoides, Populus balsamifera, Celtis occidentalis, Fraxinus pennsylvanica, Acer negundo, Salix nigra, and Alnus rugosa with Corylus americana, Cornus stolonifera, Prunus virginiana and Sambucus pubens as the most frequent shrubs. Beneath them Rubus idaeus, Ribes oxyacanthoides and Symphoricarpos occidentalis occurred sporadically. Where the shade was dense and the soil sandy the undergrowth consisted of a sparse cover of grasses and herbs.

Carex assiniboinensis grew in straggling patches with other shade-loving species like Aralia nudicaulis, Viola rugulosa and Smilacina stellata. Also recorded were:-

Thelypteris palustris
Carex sprengelli
Thalictrum dasycarpum
Thalictrum venulosum
Lactuca pulchellum
Erysimum cheiranthoides
Parthenocissus quinquefolia
Humulus lupulus
Lysimachia terrestris

Less shaded places included in addition, tall straggling plants of

Lappula echinata (3), the leaves almost invariably infected with a fungus of a Botrylus sp. very similar to Botrylus cinerea Pers. Fr. . Also found were:-

| | |
|---|---|
| Arctium lappa | 3 |
| Urtica dioica var. procera | 3 |
| Cirsium arvense | 3 |
| Mirabilis nyctaginea | 2 |
| Polygonum convolvulus | 2 |
| Axyris amaranthoides | 2 |
| Sonchus arvensis var. glabrescens | 2 |

There was seldom a clear line of demarkation between the various forest communities; in many, species were common to a number of habitats and some almost ubiquitous. Sandy areas that were fairly open and protected by a few scattered trees were characterised by the bluish Agropyron smithii, and Sporolobus cryptandrus. Also recorded were Ambrosia trifida, Axyris amaranthoides, Arabis divaricarpa, Oenothera biennis, Artemisia vulgaris, and occasional shrubs, together with Rosa arkansana, Rubus pubescens, and Rubus pumila. Artemisia was particularly obvious in the fall when it was fruiting, and most of the other vegetation had withered.

The felling of trees has influenced the vegetation, and in one cleared area Prunus virginiana, young Populus tremuloides, Acer negundo, and Salix nigra, with Ribes americanum and Rubus idaeus var. strigosus occurred. The ground vegetation consisted mainly of three grasses. Agropyron repens, Poa pratensis, and Sporolobus cryptandrus; with Brassica nigra, Urtica dioica var. procera, Mirabilis nyctaginea, Arabis divaricarpa, and Achillea millefolium.

At the east end of the ridge where it is dry and relatively high

the forest growth was more luxuriant. Where the road runs through in the neighbourhood of Clair Lake there were some well-grown examples of Populus deltoides, Ulmus americana, and Populus tremuloides. Acer negundo, was locally dominant and grew with Salix lucida, Salix amygdaloides, Salix alba, Quercus macrocarpa, Rubus pubescens, Ribes americanus, Prunus virginiana, Cornus stolonifera, Rhamnus alnifolia, and Sambucus pubens. Nettles and other weeds flourished at the sides of the track together with Polygonum achoreum and Polygonum aviculare. Other species recorded at the roadside included Stellaria graminea, Stellaria media, Viola regulosa, Descurainia richardsonii, Setaria viridis, Galium aparine, Smilax herbacea, Humulus lupulus, and Rosa acicularis.

In the clearing at The Pass the herb layer was dominated by Agropyron repens, with Poa pratensis (3), Bromus inermis (3) and Dactylis glomerata (1) in local areas. Polygonum hartwrightii (4) was associated with Axyris amaranthoides (2), Hackelia americana, Aster pansus (1), Aster ericoides, (2) Solidago canadensis (2), Cirsium arvense (1), Erigeron philadelphicus (1), and Epilobium angustifolium (1).

There were many variations in the roadside community, e.g. in one place a zone of Typha latifolia up to 10 m. wide merged into a bed of Carex atherodes 20 m. to 40 m. in width which in turn gave way to Phragmites stubble.

Bryophytes were common on the forested ridge especially on tree trunks and on banks overhung with vegetation, but are not considered relevant to the present study.

## 2. MARSHES IMMEDIATELY SOUTH OF THE RIDGE

General Shoreline. Between the forested ridge and the water there is an area of exposed ground, varying considerably in width, and bearing dead Phragmites and other plants. (Figure 20). As it became colonised the patterns and extent of the vegetation were recorded. Progress in the colonisation of areas which became uncovered as the water level dropped during the season was also noted, and a selection of sites is described in the following pages.

In 1958 the north shore of Cadham Bay was for the most part occupied by dead Phragmites, however, near the road, and on slightly elevated ground a few isolated clumps of Phragmites had survived. Early in the season Senecio congestus became established on Phragmites stubble which had moderate drainage by reason of the uneven surface of the ground, and on drift lines and muskrat houses.(Figure 21) It was flowering by the third week in May. With the Senecio, seedlings of Atriplex patula were abundant and Ranunculus sceleratus was frequent. These two species had germinated in the skin formed from dead Lemna and algae, which covered the Phragmites stubble and the waterlogged soil. Young plants of Typha latifolia, Epilobium glandulosum var. adenocaulon, Stachys palustris, Mentha arvensis var. villosa, Lycopus asper, Scolochloa festucacea and rarely Humulus lupulus were also found.

In some places Atriplex patula formed a complete cover on the drying mud, and was the first plant to appear with Ranunculus sceleratus on water-logged soil in May and early June. Later in the season Chenopodium

Figure 20. *Phragmites* stubble becoming colonised as water level drops.

Figure 21. *Senecio congestus*.

rubrum often filled this niche.

But in general, on drying mud not covered with a thick layer of drift, Ranunculus sceleratus, Epilobium glandulosum and Ranunculus cymbalaria were frequent, and patches of Typha latifolia and Eleocharis palustris occasional. Less commonly recorded species included Scolochloa festucacea, Senecio congestus, Cicuta maculata, Sium sauve, Carex bebbii, and Mentha arvensis. At the beginning of the season this pattern, with minor variations was repeated frequently around the many pools, channels and shore lines on the north side of the marsh. As drying continued a zoned pattern was discernable in the ensuing vegetation. The shore opposite Bell's Lodge was an example. It had a zone of bare, water-logged, soft mud bearing a few scattered seedlings of Ranunculus sceleratus, Rumex maritimus var. fueginus, and Typha latifolia. This merged into a fairly well defined zone of larger specimens of the same species.(Zone 1 ($Z_1$)), together with Chenopodium rubrum (4) and Aster brachyactis (2). The latter became more abundant, and dominated the second zone ($Z_2$) near the surviving Phragmites; with it Chenopodium rubrum (3), Senecio congestus (2), and Hordeum jubatum (2) were recorded.

In depressions among the Phragmites, Epilobium glandulosum var. adenocaulon was dominant, Chenopodium rubrum (3), Atriplex patula (2), Scolochloa festucea (2), Mentha arvensis (1), Stachys palustris (1), and Aster brachyactis (1). By September in many places the shore which had been completely covered by water in June, showed considerable areas of ground in various stages of colonisation. (Figure 22).

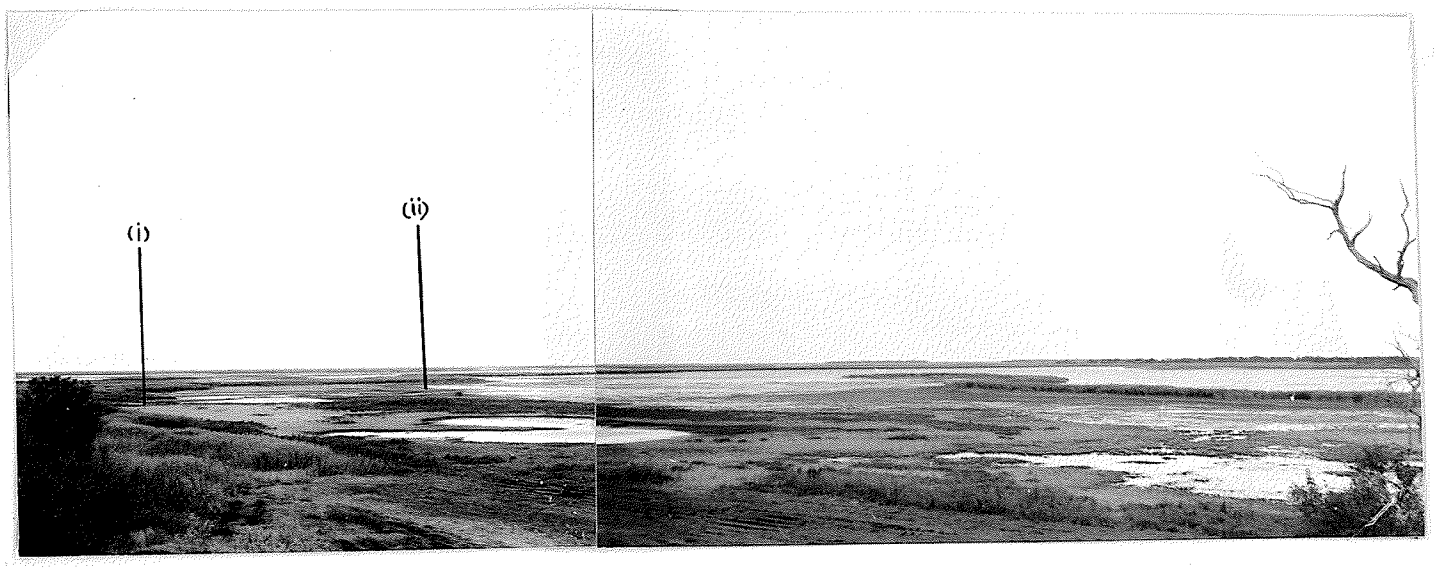



Figure 22. General view of marsh below Bell's Lodge in September. The water had receeded from (i) to (ii) during the summer.

Bell's Marsh. At the beginning of the season on this small marsh was fringed with tall dead reeds which had flowered in 1957. The depression which they surrounded was filled with water above which protruded Phragmites stubble (30 - 60 cm. in height). Between the reeds and the water was mud, covered with Lemna minor, Lemna trisulca, and various green algae. At its outer edge it was colonized by a well-grown but discontinuous band of vegetation, which extended into the Phragmites fringe and was not more than 6 meters in width. The cover and sociability of species follows:

| Species | F% | C | S |
|---|---|---|---|
| Senecio congestus var. tonsus | 60 | 3.0 | 4.2 |
| Ranunculus cymbalaria | 20 | 2.2 | 2.4 |
| Ranunculus sceleratus | 80 | 2.8 | 2.3 |
| Stachys palustris | 10 | 2.0 | 3.1 |
| Scolochloa festucacea | 30 | 1.8 | 1.2 |
| Phragmites communis | 5 | 1.0 | 1.0 |
| Atriplex hastata | 25 | 1.1 | 2.1 |
| Typha latifolia | 5 | 2.0 | 1.0 |
| Eleocharis palustris | 20 | 2.0 | 1.0 |
| Aster brachyactis | 20 | 1.2 | 3.1 |
| Chenopodium rubrum | 10 | 1.5 | 1.0 |

Senecio congestus was one of the pioneer colonisers in this marsh. Together with Ranunculus sceleratus and Rumex maritimus var. fueginus, it flowered and produced fruit in the early summer when most of the other species were becoming established vegetatively. In the majority instances the Senecio congestus and Ranunculus sceleratus then died, leaving bare patches open for recolonisation. In Bell's Marsh the late August pattern showed that in these patches, frequent large plants of Chenopodium rubrum had grown with Aster brachyactis and Atriplex patula replacing Senecio

congestus. Hordeum jubatum, Rumex maritimus var. fueginus, Stachys palustris and Scolochloa festucacea occurred occasionally, and a few areas remained bare.

By this time, a zone of younger vegetation occupied the former zone of bare mud, and occasional Senecio congestus, Typha latifolia, Chenopodium rubrum and Hordeum jubatum grew on the slightly elevated Phragmites roots in the most recently exposed area. The centre was dry but still bare, except for the mat of Lemna minor and green algae on its surface. The lower layers of Lemna were green though the surface layers had dried completely, and the rich organic soil was saturated beneath this cover.

On the other side of the sandy road a similar pattern was observed. However, in some places where the remains of Phragmites from 1957 had been burned in the autumn of the same year, the vegetation which developed on the mud as it became uncovered by the receding water was zoned as follows:

Zone

$Z_0$ completely water-logged, bare mud.

| | | |
|---|---|---|
| $Z_1$ | Ranunculus sceleratus | 4 growing on the water- |
| | Senecio congestus var.tonsus | 3 logged mud, mainly around |
| | Epilobium glandulosum var.adenocaulon | 2 the stands of Phragmites. |
| | Rumex maritimus var. fueginus | 1 |
| $Z_2$ | Cicuta maculata | 1 locally 5 |
| | Atriplex patula | 3 |
| | Phragmites communis | 3 |
| | Eleocharis palustris | 3 |
| | Typha latifolia | 2 |
| | Scolochloa festucacea | 2 |

Carex atherodes was dominant where dry marsh litter and a loamy soil

occurred and was co-dominant in many places with Scolochloa. Salix interior, Amelanchier alnifolia, Rosa acicularis, Humulus lupulus and Aster praealtus grew on the drier ground towards the side of the road.

By early August the zonation, so obvious in June had become obscured by the more vigorous growth of certain species particularly Scholochloa which replaced the earlier colonisers as conditions became suitable for them.(Figure 23)

Nest Box 34. Continuing in an easterly direction, the station Nest Box 34, situated on the south side of the road, was examined because it was the only site where Typha latifolia was the major coloniser. For the main part of the summer this marsh was covered with water containing a dense growth of Lemna minor and some Lemna trisulca. By the end of August a zone of mud had been exposed round the retreating water and vegetation had developed on its outer edge. It could be divided into three zones. The lowest, i.e. nearest the water, consisted of cotyledon stage seedlings which were too small to be identified. The second zone was dominated by Typha, the third, growing partly shaded by trees, had Cicuta maculata as the dominant.

The deep muck soil bearing this vegetation remained thoroughly saturated throughout the summer, and a soil excavation revealed:

| | |
|---|---|
| 0-1 cm. | Lemna and algae |
| 1-20 cm. | undecomposed black organic material with recognisable stems, roots and leaves, etc. |
| 20-33 cm. | fine grey sand |
| 33-40 cm. | brown organic layer with partly decomposed but easily recognisable plant remains. Peaty. |
| 40-45 cm. | fine grey sand |
| 45-53 cm. | brown organic layer with decomposed plant remains. |

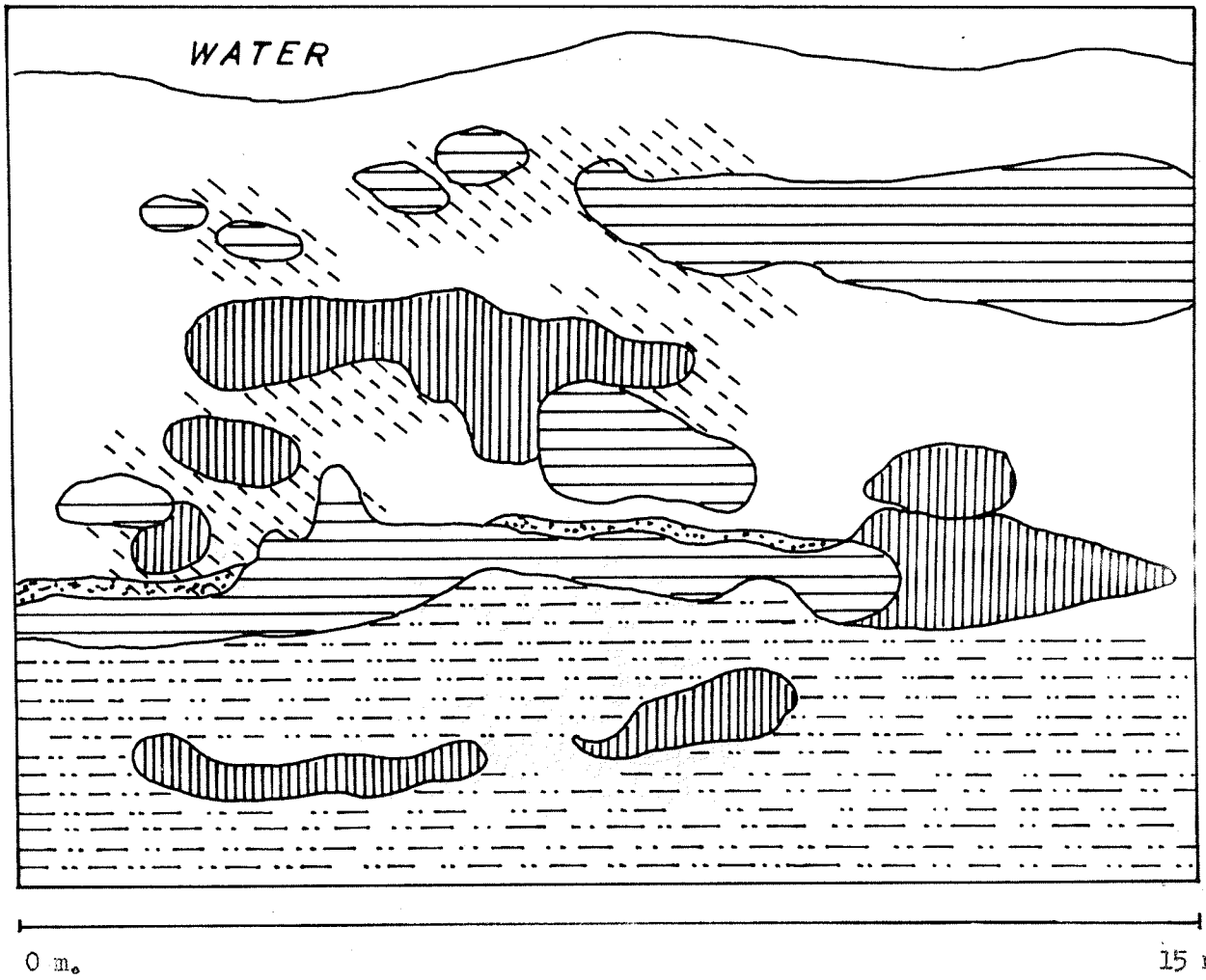



Figure 23. Colonisation on burnt Phragmites opposite Bell's Marsh. (August 7th, 1958).

Phragmites communis

Scolochloa festucacea

Ranunculus sceleratus

Carex atherodes

Phragmites stubble

53 - cm. greyish brown silt and organic layer becoming more silty with depth.

(Water made further examination difficult).

Mergenser Marsh. A little further east than Nest Box 34, lies Merganser Marsh, an extensive area of dead Phragmites, with stands of living Phragmites particularly along the north shore and in scattered areas within the marsh. Most of the water had dried by mid-July, again leaving a thin skin of Lemna and algae on the firm substratum. This soon became colonised with two conspicuous dominants: (Figure 24)

1. Scolochloa festucacea which grew to a height of 75 cm. (Figure 25) and did not flower. It first appeared beneath the Phragmites, and soon extended out forming a zone varying from 2 to 20 m. in width. A uniformly distributed sparse understory of Atriplex patula (25 cm. high) grew beneath the Scholochloa, and flowered successfully.

2. Atriplex patula with an average height of 45-55 cm. and occasional plants 90 - 120 cm. tall occupied nearly all the central region which had formerly been Phragmites. Occasional plants of Chenopodium rubrum were recorded 100-150 cm. in height among the Atriplex patula. (Figure 26)

Cook Creek. The area referred to here lies between the road and Cook Creek (Figure 27), it consists of an expanse of marsh bounded to the north by the forested ridge and to the south by the Creek. It was clear


Figure 24. Merganser Marsh showing forested ridge, Phragmites, Scolochloa festucacea and Atriplex patula.

Figure 25. Scolochloa festucacea with understory of Atriplex patula.

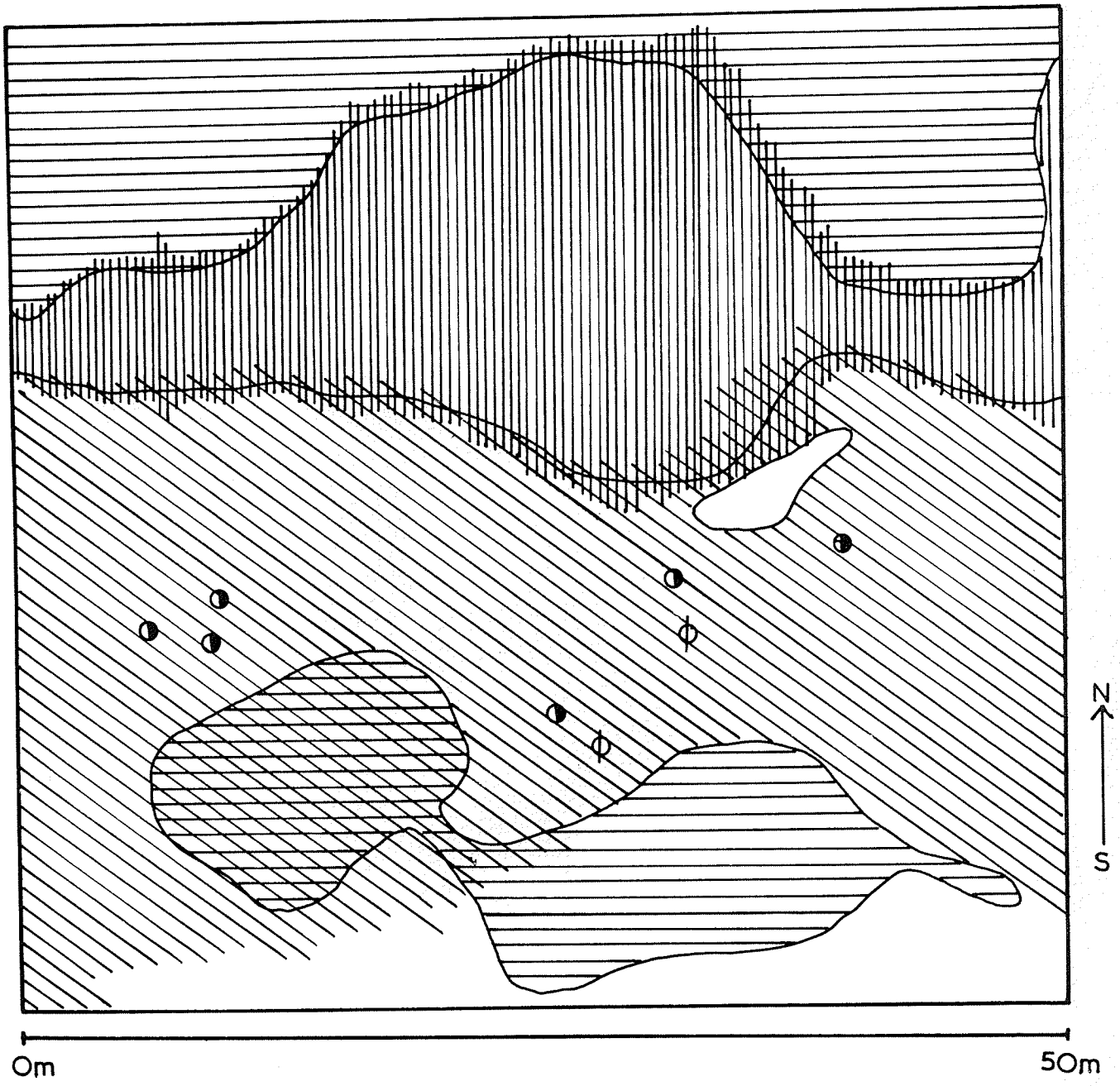



Figure 26. Merganser Marsh, showing the pattern of vegetation (for key see page 202) with a broad zone of Scolochloa festucacea between the central area of Atriplex patula and surviving Phragmites.

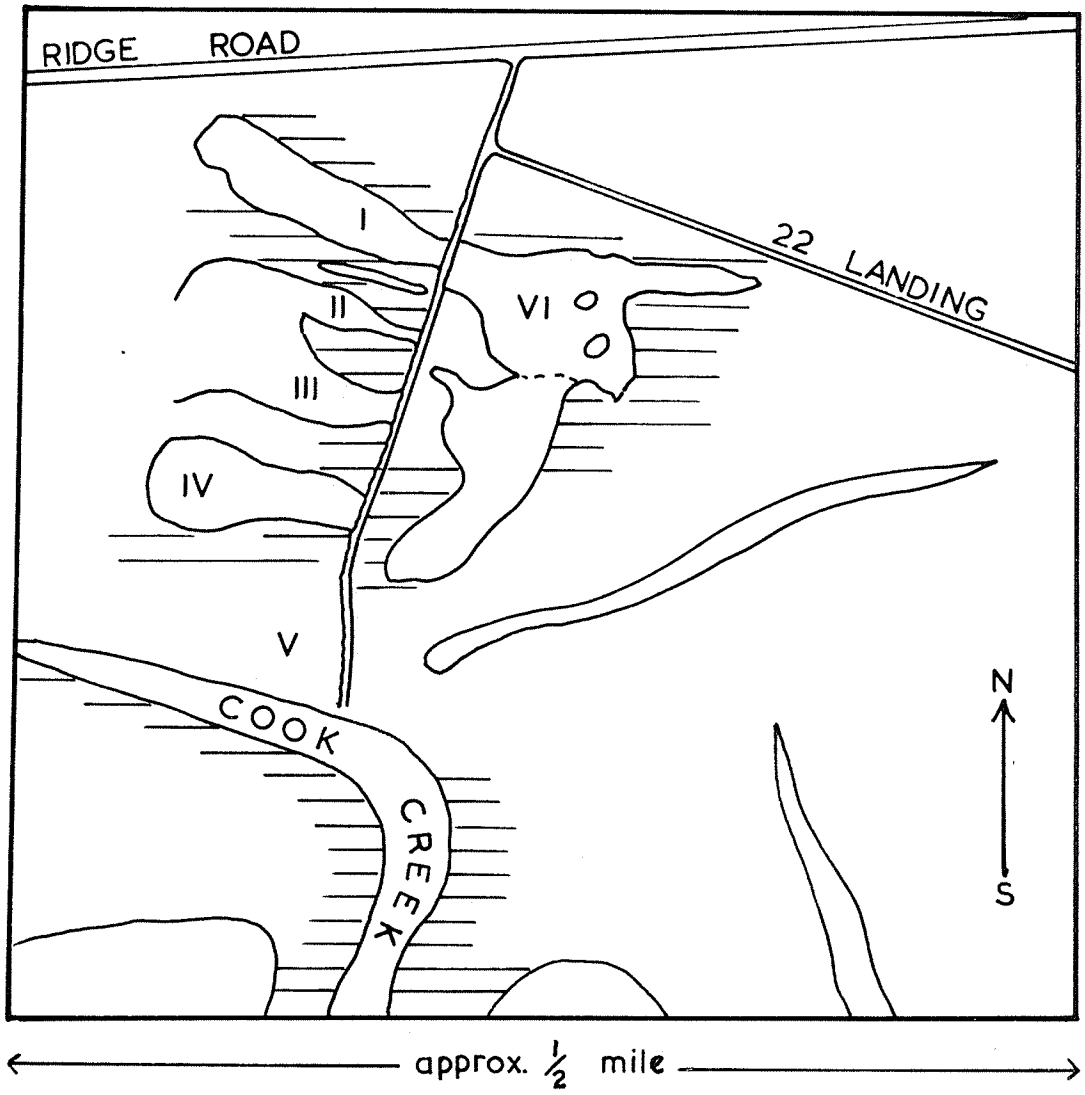



Figure 27. Diagram to show the placing of stations at Cook Creek. Bays numbered I-VI.

that this entire marsh area had been occupied by continuous Phragmites before the high water, but at the time of the study there was a mosaic of persistent living Phragmites on slightly elevated ground, and dead stubble in the depressions. These depressions held standing water at the beginning of the growing season and there was a progressive drying during the summer, from the ridge to the creek. There follows an account of the plant communities which occupied these lower areas as they dried.

At the beginning of the season (late May), dense growths of Cladophora sp., Enteromorpha sp. and Lemna minor were found in the standing water. As the level dropped, mainly by evaporation, these aquatics formed a compact decaying mat which provided the substratum for the first terrestrial invaders. In more or less regular depressions this organic mat formed a ring between the surviving Phragmites and the receding water. In this fringe, abutting on the Phragmites patches, the pioneer species were Atriplex patula and Scolochloa festucacea. At this time the Phragmites started to grow producing horizontal and oblique shoots at the margin, which became runners, (Figure 28) and erect shoots elsewhere. Within a clump where drainage was better, Phragmites consolidated its position by the active formation of rhizomes.

At station I the standing water had disappeared by the end of June. Phragmites spread by runners into the freshly exposed mud, while Atriplex plants, which had become established as large rosettes, dominated the zone. Seedlings of Chenopodium rubrum, Ranunculus sceleratus and Rumex maritimus var. fueginus invaded at this stage. During the rest of the

summer there was further drying out of the mud, accompanied by consolidation and extension of the Atriplex/Scolochloa/Chenopodium/Rumex sward, forming by mid-August a broad (15-25 m.) concentric zone close to the Phragmites (Figure 29.) The following species occurred infrequently in this zone: Ranunculus sceleratus, Hordeum jubatum, Aster brachyactis and Scirpus paludosus. In the Phragmites, Aster praealtus (1), Stachys palustris (1), Cicuta maculata(1) and Spergularia salina (1) were recorded. The Atriplex zone extended into the periphery of the Phragmites where the shoots were not dense. At this station the central wettest areas remained bare with the exception of sporadic Chenopodium rubrum and Aster brachyactis in the mat of decayed aquatic plants. The final, late-summer condition is illustrated in Figure 30, profile Figure 31 and belt transect Figure 32.

Drying out in stations further south than that just described, occurred more slowly, and at the end of August station II had a bare, moist, central area of rotting Phragmites and some living clumps of Phragmites which had produced several runners. On the south side the stubble was dense and 55 cm. high, and several mounds of debris had accumulated amongst the stubble. On them Stachys palustris was locally abundant, growing with Rumex martimus var. fueginus and Aster brachyactis.

In a zone extending 3 m. out from the Phragmites, Atriplex patula grew in two forms, upright and rosette. (See Section III). Chenopodium rubrum and Aster brachyactis occurred occasionally, and associated with these three species were clumps of Hordeum jubatum and scattered plants

Figure 28. Phragmites runners.

Figure 29. Zone of vegetation between Phragmites and bare mud.

of Scolochloa festucacea.

The west end of station II joins station III. Here the ground was firm, moist, and bare except for the centre where it was covered with dead Lemna. There was a zone around it of Atriplex patula (3), Chenopodium rubrum (3), Scolochloa festucacea (2), Aster brachyactis (1) and Scirpus paludosus (1). The vegetation increased in density towards the Phragmites where the Atriplex patula formed a more or less pure understory.

Station IV, lying south of station III, had a central area which was bare except for a few seedlings of Scolochloa festucacea, Chenopodium rubrum and Ranunculus sceleratus. Around this bare area was a broad zone dominated by Atriplex patula (rosette form), with Chenopodium rubrum (3), Rumex maritimus(2), Hordeum jubatum (2) and Aster brachyactis(2). (One patch approximately 36 m. square was pure Atriplex patula of the upright form.)

Station V contained standing water 30-60 cm. deep supporting a flourishing growth of Lemna minor. The stubble was 55 cm. high and occasional Phragmites plants had survived. In these clumps of Phragmites grew Ranunculus sceleratus, Rumex maritimus and seedlings of Aster brachyactis.

Station VI is opposite station I on the east side of the track leading to the creek. The changes here during the summer followed the same pattern as in station I. By late August the vegetation was spreading in towards the centre of the area from the fringing Phragmites. (Figure 33) Station VI is more than 800 m.long and at the eastern end water persisted in two pools — the remnants of a body of water that filled the whole

Figure 30. Station I Cook Creek, showing more or less bare central area and zone of vegetation close to the Phragmites.

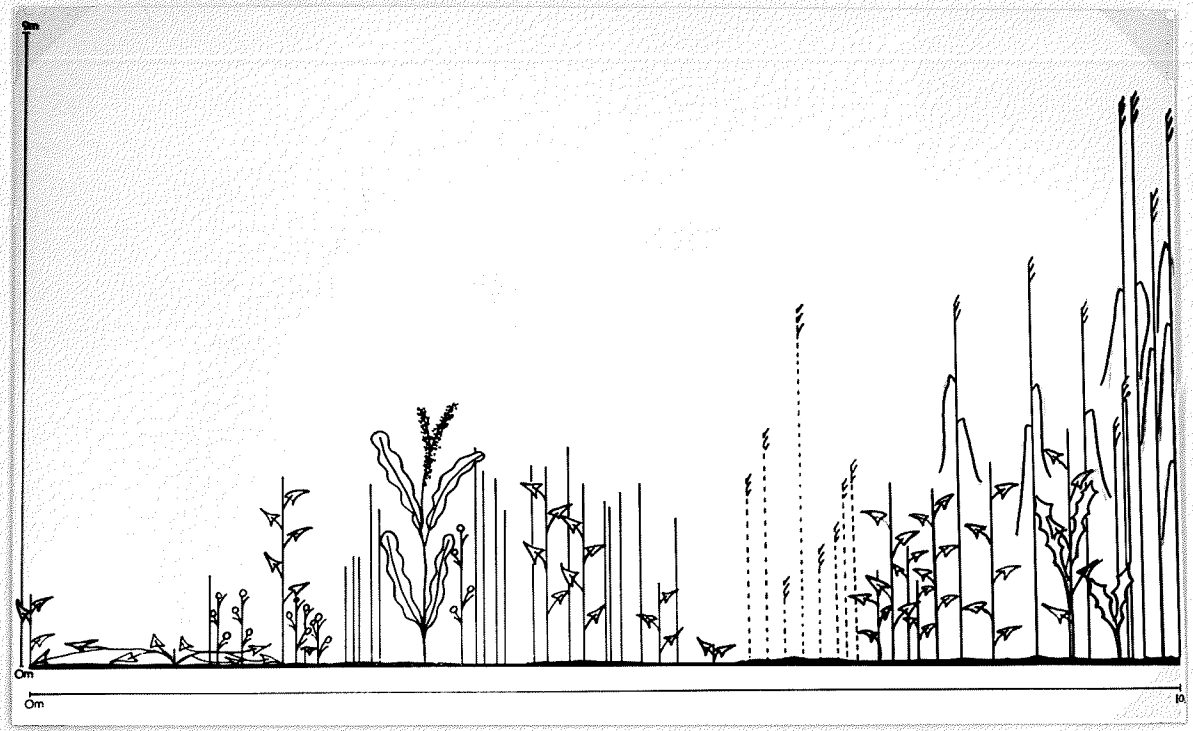



Figure 31. Profile of vegetation. Cook Creek Station I.
(For key see page 202)

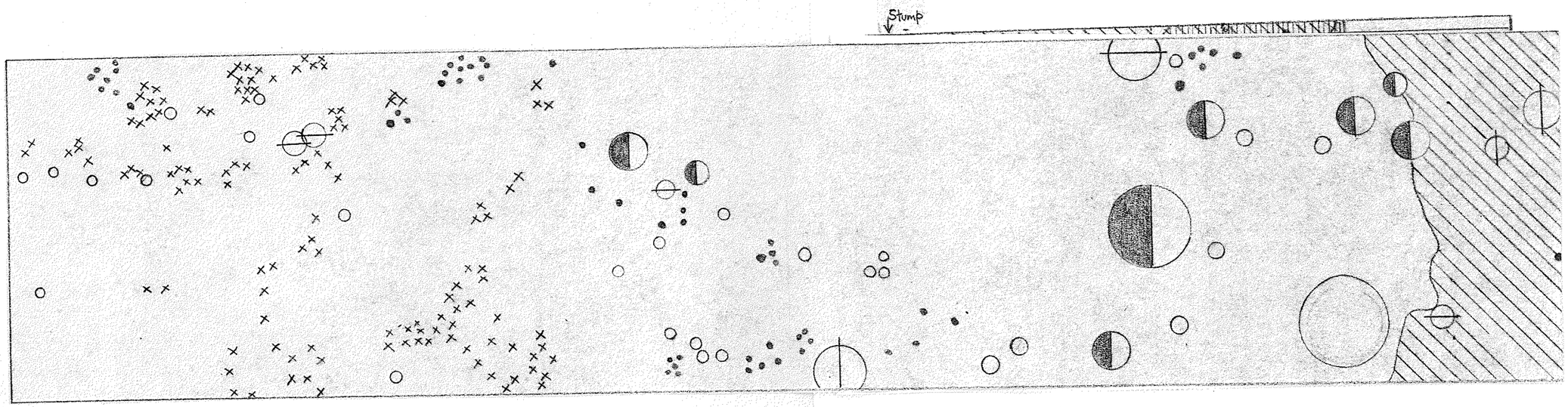



Figure 32. Cook Creek Station I belt transect showing vegetation between the Phragmites stand (R.H.S.) and mud (.L.H.S.) which occurs beyond the Atriplex patula.
(for key see page 202)
Scale 2 inches = 1 metre.

station in early spring. These pools were surrounded by a broad zone of water-logged muck with dense Phragmites stubble, the only vegetation being on small piles of drift where a few plants of Chenopodium rubrum, Rumex maritimus var. fueginus and Atriplex patula had become established (Figure 34). At the western end a transect from the bare centre in either a northerly or southerly direction passed into a zone of small Scolochloa festucacea plants 7-15 cm. tall with young Atriplex patula and Chenopodium rubrum. This merged into a zone of varying width consisting predominantly of Atriplex patula, Chenopodium rubrum and Scolochloa festucacea (Figure 35). As the season progressed many of the Atriplex patula and Chenopodium rubrum plants became large and woody, the majority between 1.3 - 1.5 m. tall with a spread of 1 - 1.8 m. They were shallowly rooted and well spaced, with Scolochloa and the rosette form of Atriplex patula spreading over the ground between them (Figure 36). Puccinellia nuttalliana, Aster brachyactis and Hordeum jubatum were occasionally recorded, particularly near the Phragmites. Together with the aforementioned species they made a dense zone which understoried the Phragmites until the shade from this plant became too dense for subordinate vegetation.

Where sand from the track spilled onto the marsh there were a few fine plants of Spergularia salina, Hordeum jubatum and Rumex maritimus var. fueginus.

The Pass. The area between 22 Landing Road and the Road, stretching east as far as Clair Lake, was inundated with shallow water in the early spring of 1958, much of it remaining thus throughout the season. At The Pass this flood-water lay close to the road where the forest had been cleared

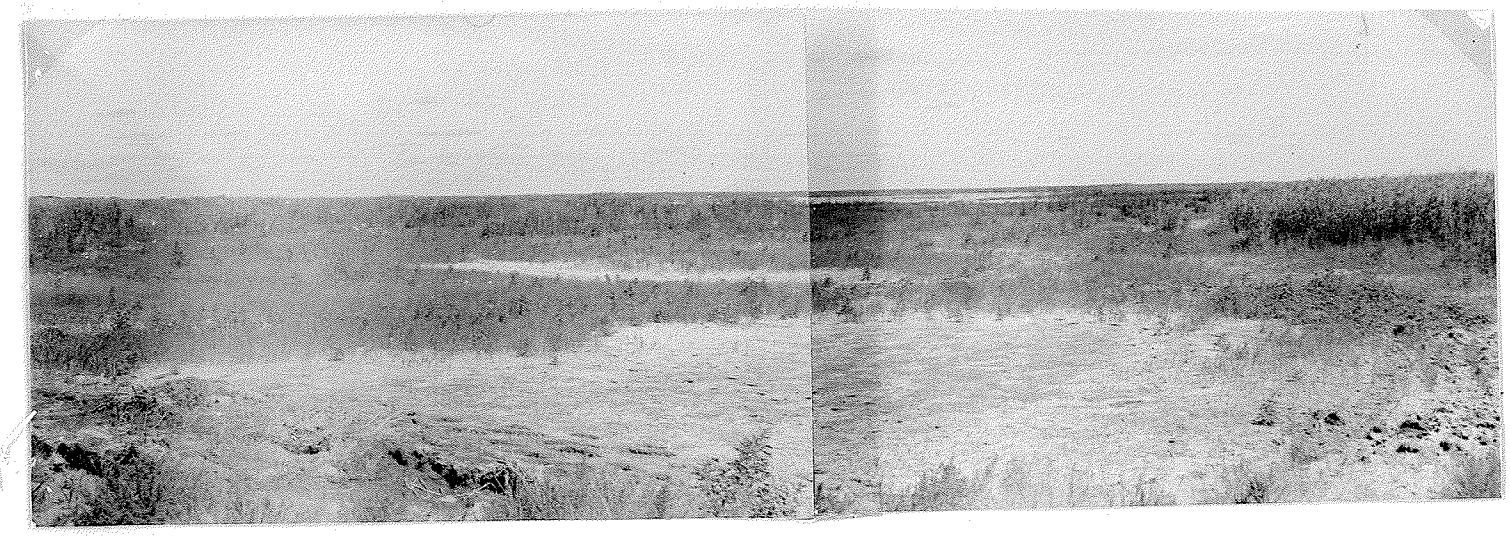


Figure 33. General view of Station VI in late August showing general pattern of vegetation.

Figure 34. Cook Creek Station VI in the distant right-hand side is one of the persistent pools. Central foreground shows a plant of Chenopodium rubrum, among tall Phragmites stubble.

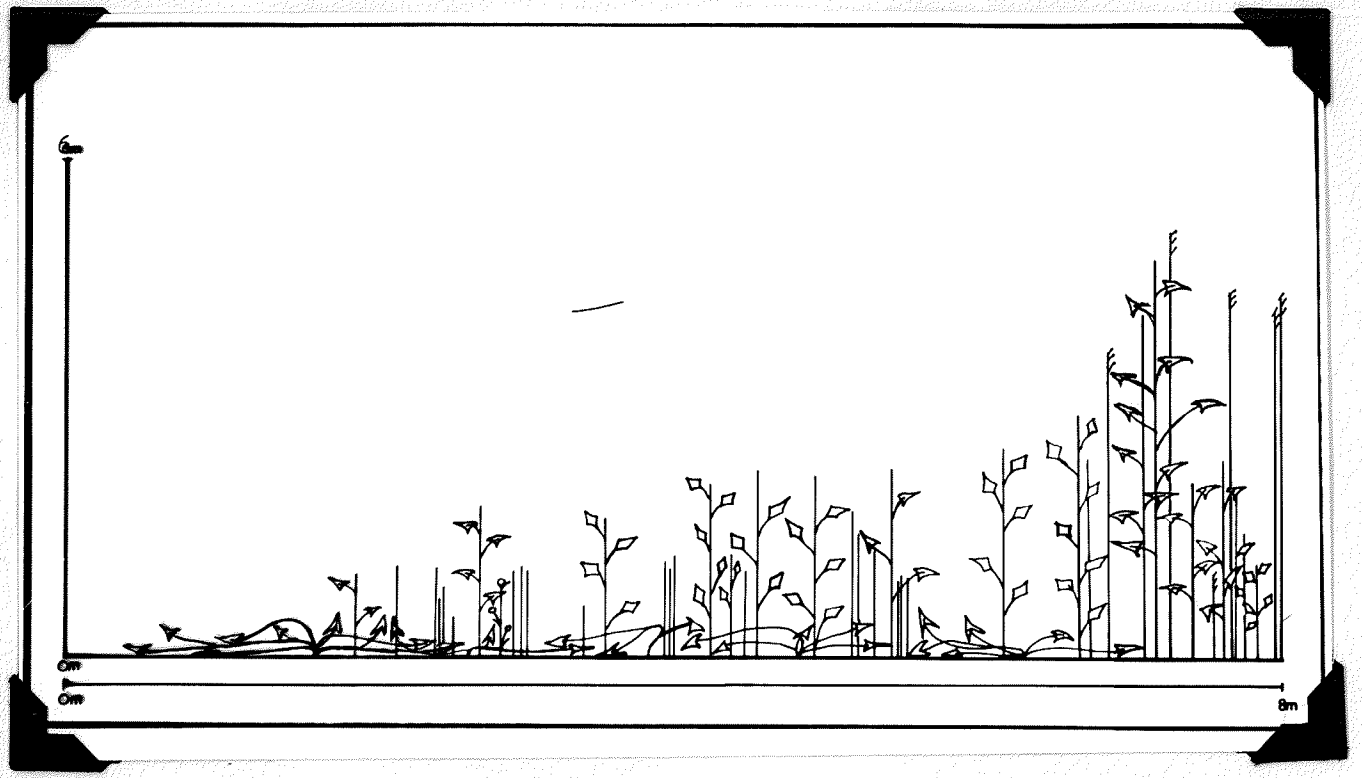



Figure 35. Bay VI. Transect from centre (L.H.S.) to Phragmites fringe.

(For key see page 202 )

~~(Scale 2" = 1 metre)~~

Figure 36. Cook Creek VI. Prominent tall plants of *Chenopodium rubrum* growing with *Scolochloa festucacea* and *Atriplex patula*.

for a short distance to allow for a duck flyway.

There was a condensed sequence of zonation from the water to the road which had a species cover/abundance as follows:-

| | | | |
|---|---|---|---|
| $Z_1$ | Ranunculus sceleratus | (4) | (The Ranunculus |
| | Rumex maritimus var. fueginus | (3) | sceleratus and Rumex |
| | Bidens cernua | (2) | were the only species |
| | Typha latifolia | (2) | in flower) |
| | Epilobium glandulosum var. adenocaulon | (2) | |
| | Chenopodium rubrum | (2) | |
| | Cicuta maculata | (1) | |
| | Setaria virdis | (1) | |
| $Z_2$ | Epilobium glandulosum var. adenocaulon | (5) | General height |
| | Rumex maritimus var. fueginus | (2) | 12 - 35 cm. |
| | Bidens cernua | (2) | |
| | Setaria virdis | (2) | |
| | Ranunculus sceleratus | (2) | |
| | Typha latifolia | (1) | |
| | Polygonum persicaria | (1) | |
| $Z_{21}$ | Epilobium glandulosum var. adenocaulon | (5) | General height |
| | Stachys palustris | (3) | 75 cm. |
| | Polygonum hartwrightii | (2) | |
| | Cicuta maculata | (2) | |
| | Lycopus americanus | (2) | |
| | Scutellaria galericulata | (2) | |
| | Carex pseudo-cyperus | (1) | |
| | Rorippa islandica var. fernaldiana | (1) | |
| | Mentha arvensis var. villosa | (1) | |
| | Carex atherodes | (1) | |
| | Urtica dioica var. procera | (1) | |
| | Galium trifidum | (1) | |
| $Z_3$ | Solidago canadensis | (3) | |
| | Cirsium arvense | (3) | |
| | Sonchus arvensis var. glabrescens | (3) | 'Meadow' vegetation |
| | Polygonum convolvulus | (2) | on sandy, well- |
| | Lycopus americanus | (2) | drained soil bordering |
| | Urtica dioica var. procera | (2) | the road. |
| | Rumex maritimus var. fueginus | (1) | |
| | Eupatorium maculatum | (1) | |
| | Atriplex patula | (1) | |
| | Scolochloa festucacea | (1) | |
| | Impatiens capensis | (1) | |

| | |
|---|---|
| Aster praealtus | (1) |
| Carex bebbii | (1) |
| Carex stipita | (1) |

Chimney Marsh. Chimney Marsh, typical of all the marsh shores east of it, is situated 17.7 km. east of Delta at the original site of Kirchoffer Lodge, marked by an old stone chimney on the south side of the Road. The Road forms the northern boundary of the marsh which extends westwards to a small sandy spit running in a south easterly direction to the first bay of Clair Lake, the southern limit of the marsh.

There is a slight gradient from the Road to the open water (15 cm. in 26 m.). At the beginning of June there was a 2 m. wide band of Lemna minor on the water logged mud between the open water and the first vegetation. The three vegetated zones had a cover/abundance as follows:-

| Zone | Width | Species | | |
|---|---|---|---|---|
| $Z_1$ | 7 m. | Ranunculus sceleratus | (4) | Seedlings sparsely scattered on the drying mud, and more abundant on discontinuous lines of drift.(Figure 37). |
| | | Epilobium glandulosum var. adenocaulon | (2) | |
| | | Chenopodium rubrum | (2) | |
| | | Scolochloa festucacea | (2) | |
| | | Ranunculus cymbalaria | (1) | |
| $Z_2$ | 2 m. | Ranunculus sceleratus | (3) | (Figure 38) |
| | | Epilobium glandulosum | (3) | |
| | | Galium trifidum | (3) | |
| | | Carex bebbii | (1) | |
| | | Potentilla norwegicus | (1) | |
| | | Scolochloa festucacea | (1) | |
| | | Typha latifolia | (1) | |
| $Z_3$ | 4 m. | Typha latifolia | (3) | |
| | | Scolochloa festucacea | (3) | |
| | | Galium trifidum | (3) | |

| Zone | Width | Species (continued) | |
|---|---|---|---|
| | | Epilobium glandulosum | (3) |
| | | Cicuta maculata | (2) |
| | | Rumex maritimus var. fueginus | (2) |
| | | Mentha arvensis | (2) |
| | | Carex bebbii | (1) |

The Ranunculus sceleratus flowered in early June producing abundant viable seed, but it did not perpetuate itself in $Z_2$. Epilobium glandulosum var. adenocaulon had grown in height and width by Mid-July and this may have been a factor in limiting the growth of Ranunculus sceleratus to a few plants. Two age groups of the Epilobium occurred, clearly distinguishable in height, one flowering at least two weeks before the other.

As the water level dropped and fresh areas of mud covered with Lemna dried sufficiently to enable seedlings to become established, Ranunculus sceleratus played a less important part than earlier in the season, and other vegetation changes occurred in the original zones. A belt transect was mapped on August 19th (Figure 39) and a profile drawn (Figure 40) across the zones which had developed parallel with the receeding water. The abundance of species recorded on two occasions in Chimney Marsh is given in Table I.

Towards the end of the growing season zones of vegetation were still evident on Chimney Marsh, but they were partially obscured by Typha which had grown taller as the earlier established species began to die. The sampling figures are given in Table 1; Zone 1, in September, was composed of vary small plants and seedlings.

TABLE I

SAMPLING FIGURES FOR

ZONED VEGETATION ON CHIMNEY MARSH.

| | A Mid July | | | | | | | | | B Mid September | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $Z_1$ | | | $Z_2$ | | | $Z_3$ | | | $Z_1$ | | | $Z_2$ | | | $Z_3$ | | | $Z_4$ | | |
| | F% | C | S | F% | C | S | F% | C | S | F% | C | S | F% | C | S | F% | C | S | F% | C | S |
| Galium trifidum | 80 | 2.4 | 3.2 | | | | | | | 90 | 1.3 | 2.6 | 90 | 2.0 | 3.6 | 10 | 1.0 | 2.0 | 20 | 1.5 | 2.5 |
| Ranunculus scèleratus | 92 | 3.6 | 3.4 | 90 | 3.6 | 4.3 | | | | 80 | 1.2 | 1.9 | 40 | 1.5 | 1.7 | | | | | | |
| Chenopodium rubrum | 40 | 1.8 | 1.1 | 80 | 1.9 | 3.1 | 30 | 1.3 | 3.0 | 30 | 2.7 | 1.0 | 20 | 1.5 | 2.0 | 20 | 1.0 | 1.0 | | | |
| Rumex maritimus var. fueginus | 10 | 1.2 | 1.0 | 50 | 1.4 | 2.2 | 10 | 3.0 | 2.0 | 10 | 1.0 | 1.0 | 20 | 1.5 | 2.5 | 10 | 1.0 | 2.0 | | | |
| Epilobium glandulosum | 21 | 1.6 | 1.2 | 70 | 1.7 | 3.0 | 10 | 1.0 | 2.0 | 60 | 1.0 | 2.0 | 70 | 1.6 | 1.7 | 80 | 2.0 | 3.2 | 20 | 2.5 | 3.5 |
| Mentha arvensis | | | | 60 | 1.7 | 2.5 | 40 | 1.7 | 2.7 | 10 | 1.0 | 1.0 | 40 | 2.2 | 3.5 | 60 | 1.8 | 3.5 | 60 | 2.0 | 3.0 |
| Typha latifolia | 10 | 1.0 | 1.0 | 40 | 1.5 | 3.0 | 50 | 1.4 | 2.6 | 10 | 1.0 | 3.0 | 100 | 2.0 | 3.7 | 35 | 1.3 | 2.1 | 80 | 2.1 | 3.0 |
| Rorippa islandica | | | | 20 | 1.0 | 2.0 | | | | 10 | 1.0 | 2.0 | | | | | | | 10 | 1.0 | 1.0 |
| Carex atherodes | | | | 20 | 1.0 | 2.0 | 40 | 1.7 | 3.0 | 100 | 1.0 | 2.3 | 50 | 1.0 | 1.6 | 50 | 1.3 | 2.3 | 10 | 1.0 | 1.0 |
| Hippuris vulgaris | | | | 20 | 1.0 | 2.5 | | | | | | | | | | 30 | 1.8 | 2.0 | | | |
| Atriplex patula | | | | 10 | 1.0 | 1.0 | 40 | 1.5 | 3.0 | | | | | | | 20 | 1.5 | 2.0 | 10 | 1.0 | 1.0 |
| Lycopus asper | | | | 10 | 1.0 | 3.0 | 40 | 1.5 | 3.5 | | | | | | | 40 | 1.5 | 2.7 | 10 | 1.0 | 3.0 |
| Carex bebbii | | | | 10 | 1.0 | 1.0 | | | | | | | | | | | | | | | |
| Cicuta maculata | | | | 20 | 1.0 | 1.0 | 20 | 2.0 | 2.0 | | | | 20 | 1.0 | 1.0 | 60 | 2.3 | 3.2 | 50 | 2.0 | 2.5 |
| Aster brachyactis | | | | 30 | 2.0 | 3.0 | 20 | 1.5 | 2.0 | | | | 30 | 1.0 | 1.0 | 40 | 1.0 | 1.0 | 60 | 1.0 | 1.0 |
| Stachys palustris | | | | 20 | 1.0 | 2.0 | 80 | 1.7 | 3.4 | 10 | 1.0 | 1.0 | 10 | 1.0 | 1.0 | 60 | 1.1 | 1.3 | 10 | 1.0 | 1.0 |
| Sonchus arvensis var. glabrescens | | | | 10 | 1.0 | 1.0 | 80 | 2.2 | 3.2 | | | | 20 | 1.5 | 1.5 | 40 | 1.5 | 1.7 | 50 | 1.5 | 1.6 |
| Ranunculus cymbalaria | | | | 10 | 3.0 | 4.0 | 40 | 2.7 | 4.2 | | | | | | | | | | | | |
| Urtica dioica var.procera | | | | 10 | 1.0 | 3.0 | | | | 10 | 1.0 | 1.0 | | | | 40 | 1.5 | 2.0 | 40 | 1.0 | 2.3 |
| Scirpus americanus | | | | | | | 60 | 3.1 | 4.5 | | | | | | | | | | | | |
| Scolochloa festucacea | | | | | | | 20 | 1.5 | 3.5 | 100 | 2.5 | 3.5 | 50 | 1.2 | 2.8 | 50 | 2.3 | 3.7 | 90 | 2.8 | 4.0 |
| Cirsium arvense | | | | | | | 90 | 2.0 | 2.8 | | | | 10 | 1.0 | 1.0 | 60 | 1.5 | 1.8 | 30 | 1.3 | 2.3 |
| Eleocharis palustris | | | | | | | 20 | 2.0 | 4.0 | | | | | | | | | | | | |
| Scutellaria galericulata | | | | | | | 10 | 1.0 | 2.0 | | | | 10 | 1.0 | 2.0 | | | | | | |
| Calamagrostis canadensis | | | | | | | 50 | 2.6 | 4.0 | | | | | | | | | | | | |
| Hordeum jubatum | | | | | | | 60 | 1.1 | 2.8 | | | | | | | 10 | 1.0 | 2.0 | | | |
| Phragmites communis | | | | | | | 20 | 1.5 | 2.0 | | | | | | | 50 | 1.0 | 2.5 | | | |
| Solidago canadensis | | | | | | | 5 | 1.0 | 1.0 | | | | | | | | | | | | |
| Melilotus alba | | | | | | | 5 | 1.0 | 1.0 | | | | | | | | | | | | |
| Puccinellia nuttalliana | | | | | | | 30 | 1.3 | 2.7 | | | | | | | | | | | | |
| Bidens cernua | | | | | | | | | | | | | | | | 10 | 1.0 | 1.0 | | | |
| Senecio congestus var.tonsus | | | | | | | | | | 40 | 1.5 | 1.2 | 10 | 1.0 | 1.0 | | | | | | |
| **Polygonum persicaria** | | | | | | | | | | 10 | 1.0 | 2.0 | 10 | 2.0 | 2.0 | | | | | | |
| Polygonum hartwrightii | | | | | | | | | | | | | | | | 10 | 1.0 | 2.0 | | | |
| Eupatorium maculatum | | | | | | | | | | | | | | | | | | | 20 | 1.0 | 1.3 |

Figure 37. Chimney Marsh.

$Z_1$ with Ranunculus sceleratus, Chenopodium rubrum and Scolochloa festucacea.

Figure 38. Chimney Marsh, part of $Z_2$ with Galium trifidum, Epilobium glandulosum var. adenocaulon and Ranunculus sceleratus.

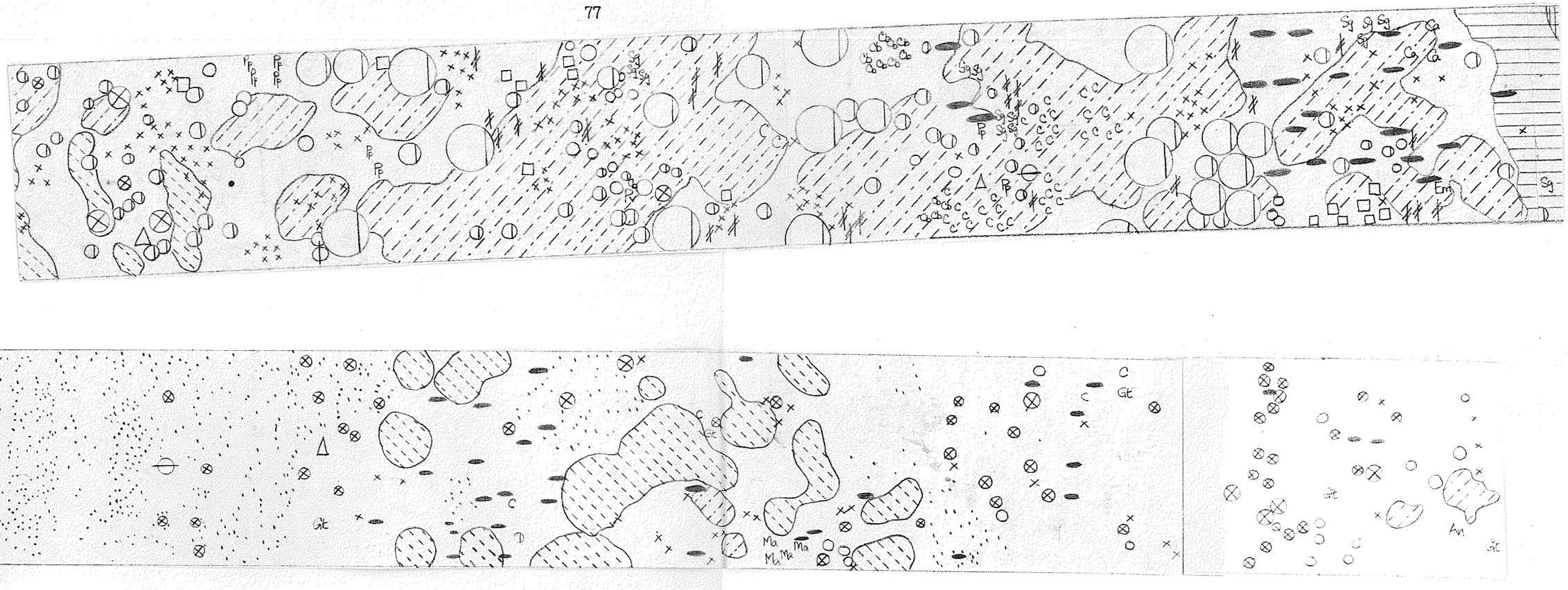


Figure 39. Chimney Marsh transect.

(For key see page 202)

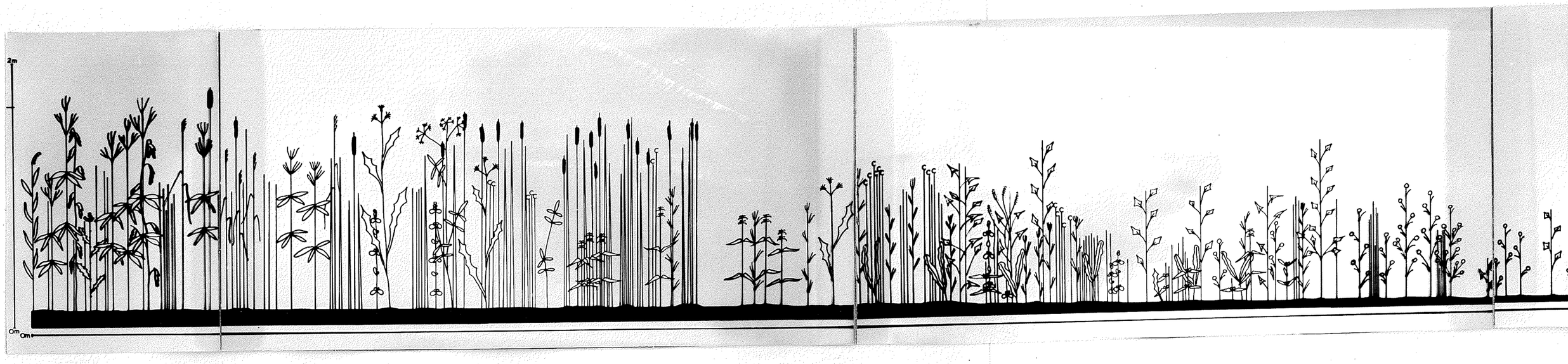



Figure 40. Chimney Marsh profile showing spatial arrangement of plants. (for key see page 202)

The soil was examined in both zone 1 and zone 4. In the former it showed a saturated rich organic muck with narrow silty bands. This extended to a depth greater than 60 cm. and the soft texture and high water table made further examination difficult. At the highest point in zone 4 the soil surface was covered with a thin layer of undecomposed plant remains and below them the soil (Figure 42) consisted of:-

| | |
|---|---|
| 0 - 12.5 cm | Light brown sandy loam with some roots and other plant remains, crumbly. pH 6.9. |
| 12.5 - 25.0 cm. | Blackish brown sandy loam with decomposed organic material. pH 6.8 |
| 25.5 - 28.0 cm. | Light brown sandy loam |
| 28.0 - 32.0 cm. | Blackish brown sandy loam with a high proportion of organic material. |
| 32.0 - 38.0 cm. | Discontinuous brownish black sandy loam. |
| 38.0 - 53.0 cm. | Pale fawn loamy sand. |
| 53.0 - 98.0 cm. | Sandy gravel. |

Water table was 75 cm. from the surface.

The sandy spit which forms the west boundary of Chimney Marsh had zoned vegetation on both sides, an interesting feature being that the zones were not composed of the same species as in the main marsh. (Table II)

The community at the end of the spit had a cover/abundance as follows:-

| Zonation at the end of spit | $Z_1$ | $Z_2$ | $Z_3$ | $Z_4$ |
|---|---|---|---|---|
| Chenopodium rubrum | 4 | 3-4 | | |
| Scolochloa festucacea | 3 | 1 | | |

| Zonation at the end of spit (continued) | $Z_1$ | $Z_2$ | $Z_3$ | $Z_4$ |
|---|---|---|---|---|
| Rumex maritimus var. fueginus | 1 | | | |
| Ranunculus sceleratus | 1 | | | |
| Aster brachyactis | | 4 | | |
| Atriplex patula | 5 locally | | | |
| Phragmites communis | | 2 | 2 | |
| Scirpus validus | | 1 | | |
| Stachys palustris | | 1 | | 2 |
| Sonchus arvensis var. glabrescens | | 1 | 2 | 3 |
| Epilobium glandulosum var. adenocaulon | | | 3 | |
| Carex atherodes | | | 2 | 2 |
| Potentilla norwegicus | | | 1 | |
| Urtica dioica var. procera | | | 1 | 2 |
| Cirsium arvense | | | | 2 |

Hutchinson's Marsh. This small marsh lies immediately south of the Road and a little west of its junction with the main road to Delta. It is bounded on all sides by slightly elevated ridges, those on the north, south and east being more sandy than that on the west.

The central depression was formerly occupied by dense beds of Phragmites, scattered remnants of which still survived at the west end. The depression was filled with water in early June and had a narrow surrounding zone of mud. It was being colonised with vegetation that showed clear zonation.

The following list indicates the general abundance of species in the visually predetermined zones.

| Zone | Width | Species | | |
|---|---|---|---|---|
| $Z_1$ | 3-5 m. | Aster brachyactis | (4) | Young plants. |
| | | Chenopodium rubrum | (2) | Small seedlings |
| | | Ranunculus sceleratus | (1) | 7.5 cm. high |
| | | Atriplex patula | (1) | (Figure 43) |

| Zone | Width | Species | | |
|---|---|---|---|---|
| $Z_2$ | 4-5 m. | Ranunculus sceleratus | (4) | |
| | | Puccinellia nuttalliana | (4) | locally |
| | | Scirpus americanus | (3) | |
| | | Aster brachyactis | (3) | |
| | | Atriplex patula | (3) | |
| | | Chenopodium rubrum | (2) | |
| | | Eleocharis palustris | (2) | |
| | | Ranunculus cymbalaria | (2) | |
| | | Phragmites communis | (1) | |
| | | Sonchus arvensis var. glabrescens | (1) | |
| | | Juncus bufonius | (1) | |
| $Z_3$ | 4-6 m. | Scirpus americanus | (3) | |
| | | Eleocharis palustris | (3) | |
| | | Hordeum jubatum | (3) | |
| | | Ranunculus cymbalaria | (2) | |
| | | Rumex maritimus var. fueginus | (2) | |
| | | Sonchus arvensis | (2) | |
| | | Chenopodium rubrum | (2) | |
| | | Cicuta maculata | (1) | |
| | | Rorippa islandica | (1) | |
| | | Typha latifolia | (1) | |
| | | Phragmites communis | (1) | |

On the ridge, $Z_3$ merged into a fourth zone, most of which was covered by dead vegetation from 1957, when the area was first examined in 1958. However, in bare patches small plants of the following species were recorded: Sonchus arvensis var. glabrescens, Lycopus americanus, Aster sp., Typha latifolia, and first leaf stage grasses which were not identified.

The pattern of vegetation is illustrated in belt transect Figure 44, and the cover/abundance data from the transect parallel with it is given on page 89.


Figure 41. Chimney Marsh in July showing the three main zones of vegetation from R. to L.

$Z_1$ Ranunculus sceleratus

$Z_2$ Epilobium glandulosum var. adenocaulon.

$Z_3$ Typha latifolia and Cicuta maculata

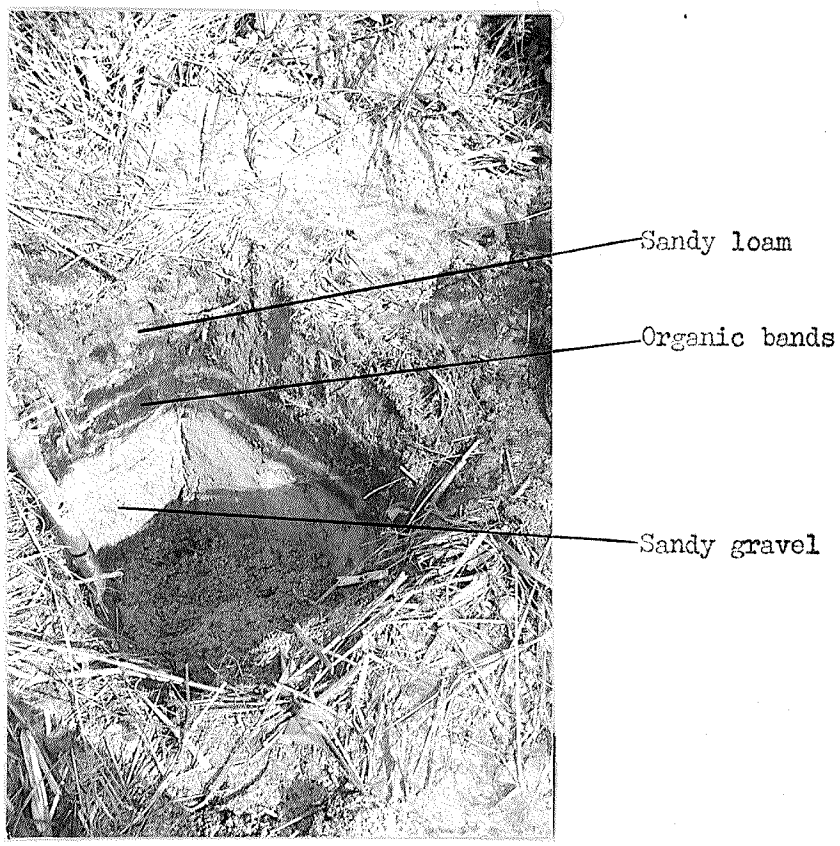



Figure 42. Soil excavation in Zone 4, Chimney Marsh.

Figure 43. Hutchinson's Marsh. Zone $_2$ showing Ranunculus sceleratus, Chenopodium rubrum, Atriplex patula (rosette)

TABLE II

FREQUENCY, COVER/ABUNDANCE AND SOCIABILITY OF VEGETATION

ON EAST SIDE OF SPIT BOUNDING CHIMNEY MARSH

TO THE WEST.

| | $Z_1$ | | | $Z_2$ | | | $Z_3$ | | |
|---|---|---|---|---|---|---|---|---|---|
| Species | F% | C | S | F% | C | S | F% | C | S |
| Scolochloa festucacea | 100 | 2.5 | 4.1 | | | | | | |
| Rumex maritimus var.fueginus | 100 | 1.3 | 2.2 | 100 | 3.9 | 3.8 | 10 | 1.5 | 2.0 |
| Chenopodium rubrum | 60 | 1.5 | 2.5 | | | | 10 | 1.0 | 1.0 |
| Ranunculus sceleratus | 80 | 1.0 | 1.4 | | | | | | |
| Atriplex patula | 10 | 1.0 | 1.0 | | | | 90 | 2.3 | 3.3 |
| Stachys palustris | | | | 30 | 1.3 | 1.7 | | | |
| Epilobium glandulosum var. adenocaulon | | | | | | | 100 | 3.2 | 4.2 |
| Aster brachyactis | | | | | | | 70 | 1.4 | 2.1 |
| Polygonum persicaria | | | | | | | 10 | 2.0 | 2.0 |
| Sonchus arvensis var. glabrescens | | | | | | | 20 | 2.0 | 1.0 |

The ridge continued south between two extensive areas of water fringed with beds of tall dead Phragmites. This Phragmites was producing numerous runners which were rooting at the nodes and growing away from the water towards the centre of the ridge. In one small patch 187 vigorous runners were counted. In the water, there was little sign of growth in existing Phragmites.

The dominant plant on this ridge was Ranunculus cymbalaria forming a pure turf in places, and spreading by runners. Occasionally it was replaced by Scirpus americanus. On the sides of the ridge the following species were recorded: Ranunculus sceleratus (3) and Aster brachyactis (3), well grown clumps of Puccinellia nuttalliana and Agropyron sp., Rumex maritimus var. fueginus (2), and a few scattered tillers of Scolochloa festucacea. Also occasional were Potentilla anserina, Plantago major, Mentha arvensis var. villosa, Urtica dioica var. procera, Glaux maritima and Juncus balticus var. littoralis.

By mid-July the water level in Hutchinson's Marsh had dropped considerably and the zones of vegetation had extended their range. In mid-August most of the area previously occupied by water had become covered with vegetation. Aster brachyactis was then dominant throughout the lower zones (formerly $Z_1$ and $Z_2$) which could be partially divided into two zones by the frequent presence of Eleocharis palustris, Chenopodium rubrum and Atriplex patula in $Z_1$ and the absence of Eleocharis palustris and Chenopodium rubrum in $Z_2$. Less frequent species but common in both zones were Rumex maritimus var. fueginus, Cuscuta campestris (on the Aster) and Hordeum jubatum, while Puccinellia nuttalliana occurred only in $Z_2$.

The pattern in the marsh and on the ridge had changed as can be seen by comparing the two belt transects (Figures 44a and 44b), and the ridge vegetation now included Hordeum jubatum (3), Aster brachyactis (2), Atriplex patula (2), Lycopus asper (2), Sonchus arvensis var. glaberescens (1), Cirsium arvense (1), Typha latifolia (1) and Phragmites communis (1).

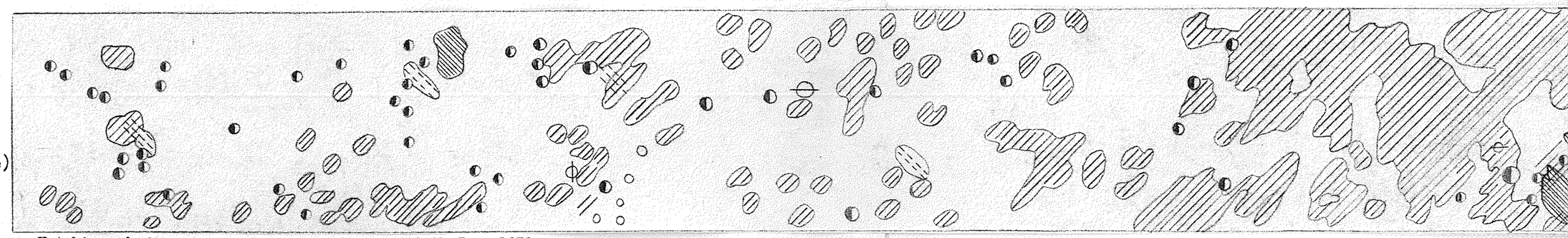
3. MARSHES ACCESSIBLE BY THE DELTA ROAD

Avocet Marsh. On both sides of the main road to the village of Delta there are low-lying, marshy areas. In 1958 some were bare, suggesting that they had been flooded for a long period of time, while others had indications of recent standing water though it was evident from plant remains that a little vegetation grew on them in 1957.

In early June the area called Avocet Marsh (Figure 45) was almost completely inundated with water containing a rich growth of algae, mainly Cladophora sp., much of it in the first stages of decay. A little to the south near the railway line a mosaic of tall dead Spartina pectinatus, Scolochloa festucacea, Scirpus americanus and Carex atherodes covered the ground except in irregular depressions which had recently held water but were dry. Among the Scolochloa, which in contrast with the other remnant plants showed vigorous signs of new growth, there was a pioneer community of Aster brachyactis (3), Eleocharis palustris (2), Sonchus arvensis (2), Atriplex patula (2), Cirsium arvense (2) and Stachys palustris (2). Other depressions were being occupied by seedlings of Atriplex patula, Chenopodium rubrum and Ranunculus sceleratus.

In late June the area of surface water was considerably reduced,

Zone of bare mud 4 m. wide to edge of water. (Scale 2" =1 metre)

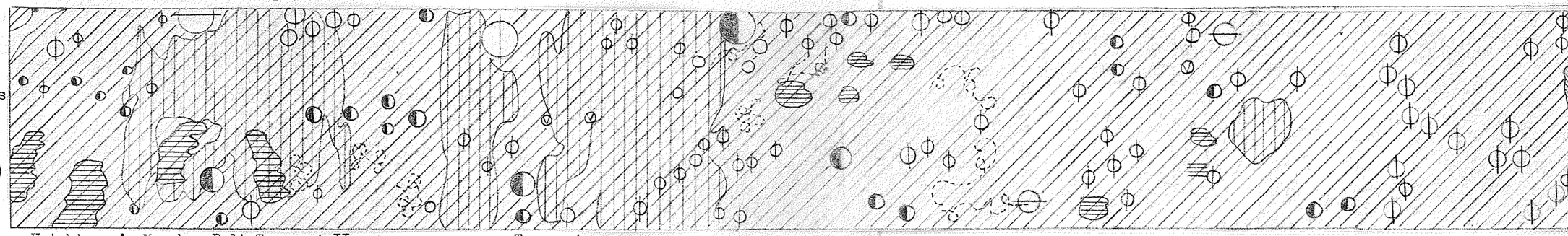


Hutchinson's Marsh. Belt transect I Mapped 27th June, 1958.

Figure 44a

(For Key see page 202)

This pattern of vegetation continues across the marsh where no standing water is present (Scale 2" = 1 metre)



Hutchinson's Marsh. Belt Transect II over same area as Transect I Mapped 20th August 1958.

Figure 44b

(For Key see page 202)

TABLE III.

COVER/ABUNDANCE AND SOCIABILITY FIGURES FROM A BELT

TRANSECT PARALLEL WITH FIGURE 44.

HUTCHINSON'S MARSH

| Species | Metre quadrats; number 1 abuts on the bare mud. | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| Aster brachyactis | 2.4 | 2.4 | 2.4 | 2.4 | | | | | | | | | | | | | | |
| Chenopodium rubrum | 1.3 | 2.3 | 2.3 | 1.2 | 1.2 | 2.3 | 2.3 | 2.3 | 3.4 | | | | | | | | | |
| Atriplex patula | 1.3 | | 2.3 | 1.2 | 2.3 | 2.3 | 2.2 | | 1.2 | | | | | | | | | |
| Puccinellia nuttalliana | | 1.1 | | 1.1 | | 2.3 | 1.2 | 1.3 | 2.3 | 1.1 | | | | | | | | |
| Salicornia rubra | | | 1.1 | 1.2 | | | | | | | | | | | | | | |
| Suaeda depressa | | | | 1.1 | 1.1 | | 2.3 | | 1.3 | | | | | | | | | |
| Ranunculus sceleratus | | | | | 2.4 | 2.3 | 2.4 | 2.4 | 2.3 | | | | | | | | | |
| Ranunculus cymbalaria | | | | | | | | | 1.3 | 2.4 | 2.4 | | | | | | | |
| Scirpus americanus | | | | | | | | | | 1.1 | 1.3 | 1.3 | 1.3 | 4.4 | | | | |
| Eleocharis palustris | | | | | | | | | | 2.4 | 3.3 | 3.4 | 4.5 | 4.4 | | | | |
| Hordeum jubataum | | | | | | | | | | 2.1 | 1.2 | 1.3 | 4.5 | 4.5 | | 2.5 | | 2.4 |
| Sonchus arvensis var.glabrescens | | | | | | | | | | | | | | | | 1.1 | | 2.4 |
| Senecio congestus | | | | | | | | | | | | 1.1 | | 2.3 | | | | |
| Cirsium arvense | | | | | | | | | | | | | | | | | 3.5 | 2.4 |
| Lycopus asper | | | | | | | | | | | | | | | | | 3.5 | 2.4 |
| Potentilla anserina | | | | | | | | | | | | | | | | | | 1.1 |
| Rumex maritimus var. fueginus | 1.1 | | | | | | 1.1 | | | | | | | | 3.3 | 1.2 | | |

and mud covered with decaying algae and Phragmites stubble was exposed in a zone parallel with the dyke.(Figure 46). This mud gradually became colonised, and the area (x) had pure patches of Aster brachyactis in some places and elsewhere scattered individuals. Chenopodium rubrum (Figure 47) followed the same pattern and was particularly dense towards the fringing dead Phragmites. Ranunculus sceleratus grew most abundantly on the banks of the dyke, but its seedlings were well dispersed throughout (x). The number of species increased and this area (Figure 45) was sampled on July 7th with the following results:

| Species | F% | C | S |
|---|---|---|---|
| Chenopodium rubrum | 88 | 2.7 | 3.8 |
| Scolochloa festucacea | 94 | 1.8 | 3.6 |
| Atriplex patula | 16 | 1.4 | 2.1 |
| Ranunculus sceleratus | 30 | 1.4 | 2.7 |
| Aster brachyactis | 34 | 1.7 | 3.2 |
| Rumex maritimus var.fueginus | 14 | 1.6 | 1.7 |

As the water diminished and growth continued, the area of vegetation increased, assuming a mosaic pattern. The composition of the three major units in the mosaic are listed in Table IV. (Figures 48 and 49)

Within this mosaic of vegetation there were many small areas which were still more or less bare, except for seedlings of Scolochloa festucacea, Chenopodium rubrum and Ranunculus sceleratus which had germinated in the algal skin overlying the saturated mud. (Figure 50). The seeds must have been present in the mud and remained dormant until conditions favoured their germination, for these species had not flowered in the area and no living vegetation remnants were found in the mud.

Other species were recorded growing on drift lines and on accumulations of dead vegetation, including occasional plants of Ranunculus


Figure 45. Avocet Marsh July, looking north towards the forested ridge, showing the pioneering vegetation (x) encroaching upon the water covered Phragmites stubble, and deeper open water on L.H.S.

Figure 46. Avocet Marsh. Half-metre quadrat placed on bare Phragmites stubble on June 16.

Figure 47. Avocet Marsh. Same as above on July 7. with dense growth of Chenopodium rubrum.

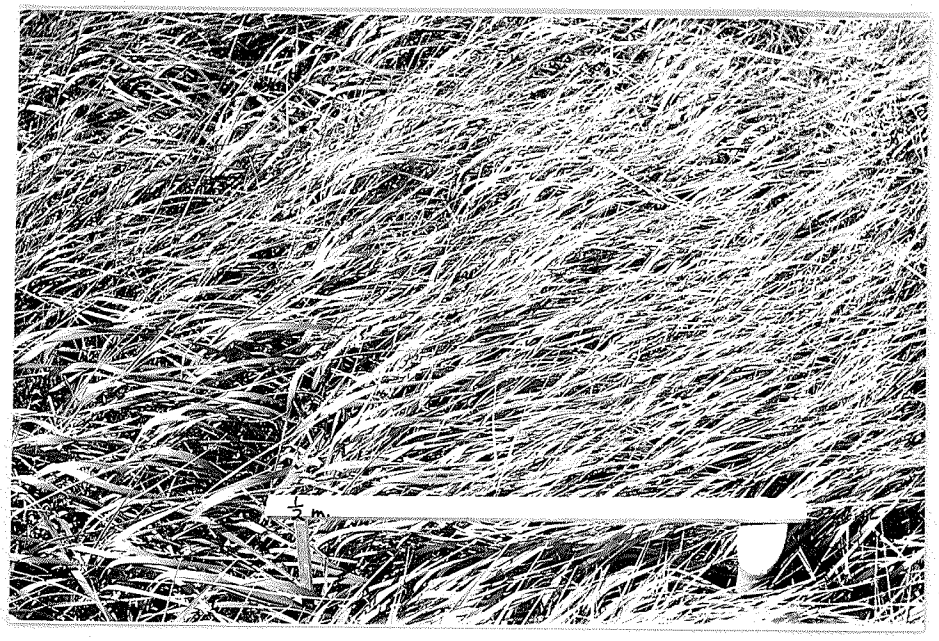



Figure 48. Avocet Marsh. Scolochloa festucacea dominated area. September 4, 1958.


Figure 49. Avocet Marsh. Chenopodium rubrum dominated area. September 4, 1958.

TABLE IV

AVOCET MARSH. COMPOSITION OF THREE UNITS FORMING MOSAIC OF VEGETATION, SEPTEMBER 4TH 1958.

| Species. | Unit with *Scolochloa festucacea* dominant (Figure 48) | | | Unit with *Chenopodium rubrum* dominant (Figure 49) | | | Unit with Mixed composition | | |
|---|---|---|---|---|---|---|---|---|---|
| | F% | C | S | F% | C | S | F% | C | S |
| Scolochloa festucacea | 100 | 3.8 | 4.9 | 100 | 1.9 | 2.1 | 100 | 1.7 | 3.7 |
| Aster brachyactis | 90 | 1.4 | 2.3 | - | - | - | 90 | 2.0 | 2.8 |
| Chenopodium rubrum | 60 | 1.5 | 2.1 | 100 | 4.4 | 4.6 | 70 | 2.5 | 3.4 |
| Atriplex patula | 10 | 1.0 | 2.0 | 20 | 1.0 | 1.0 | 25 | 1.8 | 2.2 |
| Rumex maritimus var. fueginus | 20 | 1.5 | 2.0 | | | | 70 | 1.8 | 2.5 |
| Ranunculus sceleratus | | | | | | | 35 | 1.3 | 1.9 |
| Hordeum jubatum | | | | | | | 10 | 1.5 | 3.0 |
| Scirpus paludosus | | | | | | | 10 | 1.0 | 2.0 |
| Scirpus validus | | | | | | | 5 | 1.0 | 1.0 |
| Scirpus acutus | | | | | | | 5 | 1.0 | 1.0 |

sceleratus, Rumex maritimus, var. fueginus, Aster brachyactis and Scolochloa festucacea, and more rarely Ranunculus cymbalaria.

The area to the south had a dense cover of vegetation in September, and resembled the 'wet-meadow' association described by Weaver (1954). The F%/C/S of the south east portion of Avocet Marsh, immediately north of the Railway Line, on September 11th, 1958 was:-

| Species. | F% | C | S |
|---|---|---|---|
| Aster praealtus | 50 | 3.8 | 2.7 |
| Sonchus arvensis var.glabrescens | 50 | 2.7 | 3.5 |
| Phragmites communis | 30 | 2.3 | 3.5 |
| Spartina pectinatus | 50 | 2.4 | 3.6 |
| Cirsium arvense | 35 | 1.3 | 1.9 |
| Atriplex patula | 35 | 1.3 | 2.3 |
| Hordeum jubatum | 45 | 1.3 | 2.7 |
| Mentha arvensis var. villosa | 10 | 1.0 | 2.0 |
| Melilotus alba | 5 | 1.0 | 2.0 |
| Scolochloa festucacea | 40 | 3.2 | 4.0 |
| Aster brachyactis | 35 | 3.0 | 4.1 |
| Puccinellia nuttalliana | 10 | 1.0 | 2.5 |
| Chenopodium rubrum | 5 | 2.0 | 4.0 |
| Stachys palustris | 10 | 1.0 | 3.0 |
| Suaeda depressa | 5 | 2.0 | 4.0 |
| Scirpus paludosus | 5 | 1.0 | 3.0 |
| Polygonum ramosissimun | 5 | 2.0 | 2.0 |
| Scirpus acutus | 5 | 1.0 | 1.0 |

The marsh on the east side of the main road showed no sign of vegetation until July. The standing flood water was deeper and more persistent, being directly influenced by wind tides from Lake Manitoba via the sluice. The pattern of drying was very like that just described for Avocet Marsh, but later in the season the vegetation showed a pattern of zonation rather than a mosaic, probably because there is a slight gradient from the road to the bay.

The areas close to the surviving Phragmites were the first to become colonised. Ranunculus sceleratus was a frequent pioneer, sometimes

growing clumps but more often as scattered individuals. Scolochloa was also frequent and Aster brachyactis, Rumex maritimus var. fueginus, Chenopodium rubrum and Atriplex patula occurred occasionally. On raised mounds of dead roots and similar debris a few plants of Senecio congestus were growing well.

By September the composition of vegetation which had developed in two zones on the Phragmites stubble is given below:

| Species | Zone 1 | | | Zone 2 | | |
|---|---|---|---|---|---|---|
| | F% | C | S | F% | C | S |
| Scolochloa festucacea | 100 | 2.2 | 3.7 | 100 | 3.6 | 4.4 |
| Chenopodium rubrum | 60 | 1.7 | 2.5 | 40 | 1.5 | 1.7 |
| Aster brachyactis | 90 | 1.6 | 2.6 | 100 | 2.6 | 3.8 |
| Atriplex patula | 10 | 1.0 | 1.0 | 10 | 1.0 | 3.0 |
| Rumex maritimus var.fueginus | 30 | 1.3 | 1.0 | 30 | 1.0 | 1.0 |
| Ranunculus sceleratus | 10 | 1.0 | 1.0 | - | - | - |
| Hordeum jubatum | | | | 10 | 1.0 | 3.0 |
| Suaeda depressa | | | | 10 | 1.0 | 3.0 |

The third zone was contained within the living remnants of Phragmites, and consisted of Phragmites (5), Hordeum jubatum (3), Sonchus arvensis (3), Cicuta maculata (1), and Teucrium occidentale (1).

Sowls' Marsh. Between the old railway line and the road, stretching in a southerly direction for more than a kilometre is a slightly uneven marshy region. The hollows held water for considerably longer than the higher parts and nearly all the area lacked vegetation (Figure 51) until mid-July. By this time it was estimated that seventy percent of the most northern part bore vegetation, and a broad transect was mapped to show the dominants (Figure 52).

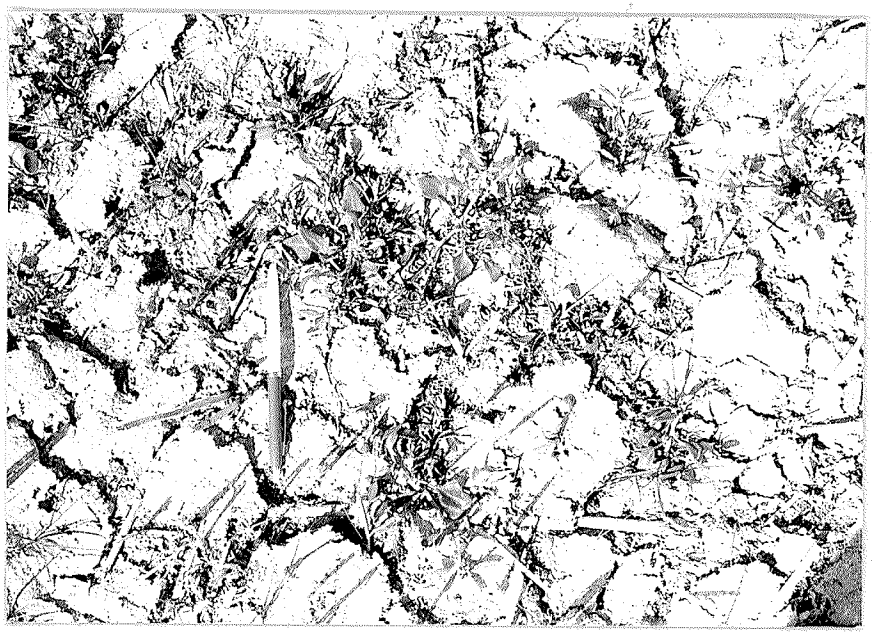


Figure 50. Algal skin and young plants of Chenopodium rubrum, Scolochloa festucacea and Ranunculus sceleratus.

Figure 51. Sowl's Marsh showing lack of vegetation June 1958.

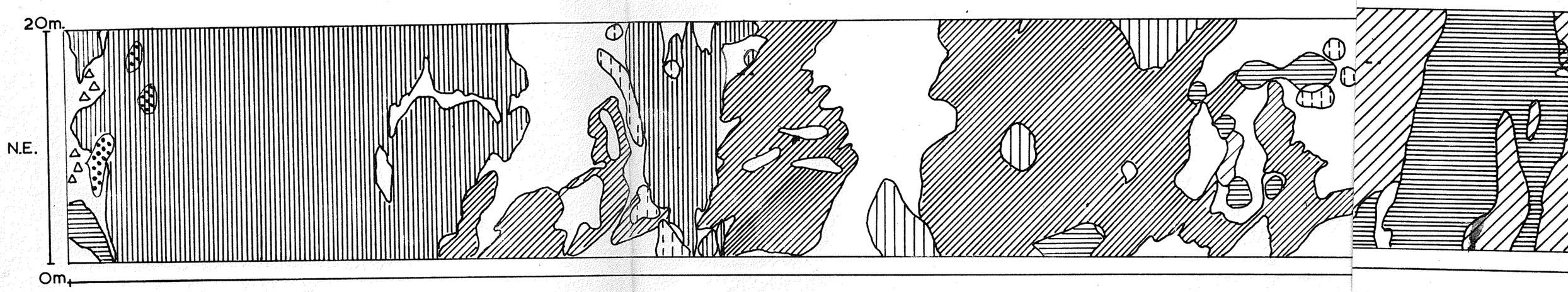



Figure 52. Sowls' Marsh, transect.

(Key page 202).

Most of the area within 800 metres south of this transect remained bare until the end of the season, but isolated patches of Hordeum jubatum and Puccinellia nuttalliana, and a few clumps of Scirpus paludosus appeared. Towards the southern limits a mixed community of Hordeum jubatum and Puccinellia nuttaliana with Atriplex patula, Chenopodium rubrum and Aster brachyactis grew on ground that had been burnt in the latter part of 1957.

As mentioned earlier, most of the land on both sides of the main road to Delta had been inundated with flood water from 1955 (or earlier) until 1957 when much of it bore a dense cover of vegetation. In some places Scirpus validus was dominant, in others Scirpus paludosus, and in a third type, Typha latifolia. In all these areas pools of water had persisted throughout 1957 and some contained water to the end of 1958. However, the majority dried out during the summer and by the autumn many had a peripheral fringe of vegetation.

The meadow dominated by the remains of last year's Scirpus validus had a ground cover in late July (Figure 53) with the following 'wet meadow' composition (F%/C/S from 20 meter squares thrown at random):

| Species | F% | C | S |
|---|---|---|---|
| Aster brachyactis | 100 | 2.4 | 3.6 |
| Atriplex patula | 80 | 2.1 | 3.2 |
| Hordeum jubatum | 20 | 1.5 | 3.0 |
| Suaeda depressa | 20 | 1.0 | 3.0 |
| Scirpus validus | 80 | 1.7 | 3.0 |
| Puccinellia nuttalliana | 10 | 1.0 | 1.0 |
| Chenopodium rubrum | 60 | 1.0 | 1.7 |
| Eleocharis palustris | 10 | 2.0 | 3.0 |
| Rumex maritimus var.fueginus | 10 | 1.0 | 1.0 |
| Ranunculus sceleratus | 10 | 1.0 | 1.0 |

The above is illustrated by the profile Figure 53 (see page 202 for key).

South of Cadham Bay. South of Cadham Bay there is a considerable area of marsh containing two large central persistent lagoons, and other smaller bodies of water. In the past much of the area had been occupied by Phragmites, but in the spring of 1958 some parts were bare, some covered with dead Phragmites or with remnants of other vegetation.

In June the western part of this area was accessible by a track passing Love's Farm, and flooded 'wet meadows' containing Sonchus arvensis var. glabrescens (5), Puccinellia nuttalliana (2), Suaeda depressa (2), Atriplex patula (2), Ranunculus cymbalaria (2), Glaux maritima (2), Salicornia rubra (2), Eleocharis palustris (2), Carex atherodes (2), and some pure patches of Scolochloa festucacea. Below these meadows were many acres of dry black earth which was beginning to crack. It was firm to walk on, and clumps of Puccinellia nuttaliana were growing on it, with a few seedlings of Atriplex patula and Aster brachyactis, generally associated with patches of Phragmites 1-2 metres in diameter. Several runners had been put out, and the general height of Phragmites was 60 cm. It merged into a broad discontinuous band of Scirpus validus which surrounded the whole marsh. In between the patches of Scirpus, the mud was being colonised by Ranunculus sceleratus, Chenopodium rubrum, Aster brachyactis, Hordeum jubatum, and Puccinellia nutalliana.

Almost imperceptible depressions, which were probably more saline than their surroundings, were first covered by an association of Salicornia

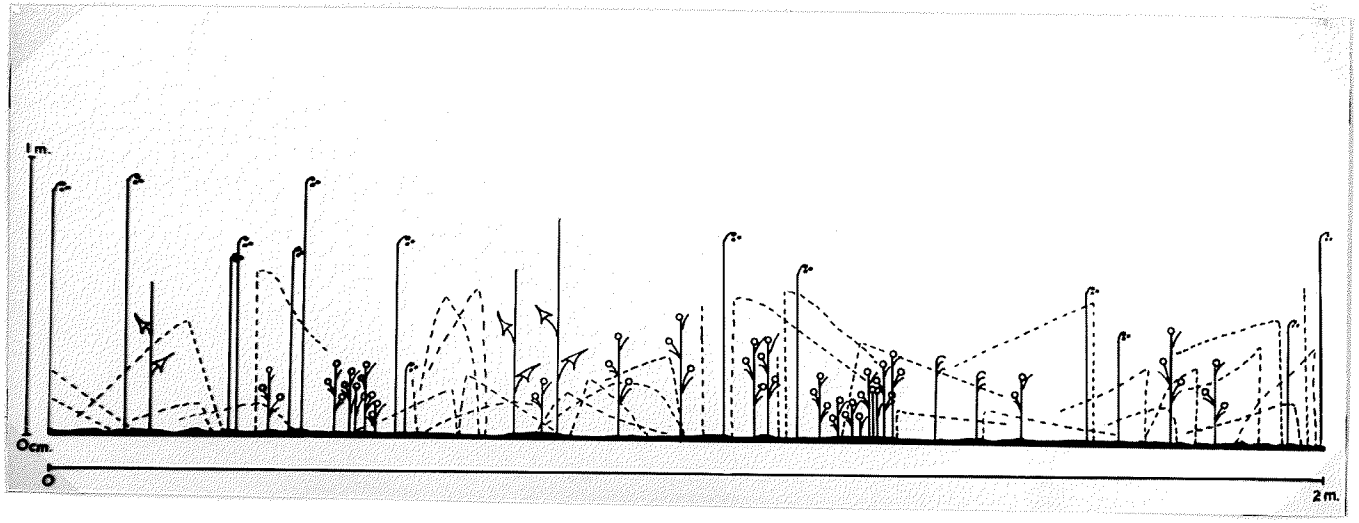



Figure 53. Profile. (Key page 202) showing arrangement of plants along a 2 metre line in the 'wet-meadow' formerly dominated by Scirpus validus, on east side of Delta Road.

rubra, Suaeda depressa, and Puccinellia nuttalliana, growing in an open community, with Glaux maritima, Triglochin maritimum, and rare plants of Chenopodium glaucum var. salinum. Ranunculus cymbalaria colonised the edges of the depressions its runners radiating from the parent plant and causing it to spread rapidly. Aster brachyactis and Chenopodium rubrum were codominant with it.

Pintail Slough. Pintail Slough runs in a northwest to southeast direction crossing the main road, 5.6 km south of Delta village through 'wet meadow' of the type just described. At the beginning of the season the slough was full of water containing a dense growth of filamentous green algae. By the end of July, much of the water had evaporated leaving a layer of Enteromorpha sp. on the exposed mud. This gradually became bleached and dry, and formed an effective blanket over the underlying mud, preventing its rapid drying; with the result that the mud remained moist throughout the summer.

After an initial period of drying the mud was invaded by a dense growth of Aster brachyactis with occasional Chenopodium rubrum and Atriplex patula, which formed a compact zone on the mud along the edge of the slough. The surface 15 cm. of mud was very soft and sloppy, but underneath this the ground was firmer. Relics of Scirpus validus and Phragmites with Carex atherodes formed a zone behind this.

As more mud was exposed by the receding water, it dried and slowly became colonised by plants which gradually spread in from both sides of the slough and eventually met in the centre. Higher up the slough banks a variable zone developed with Scirpus validus, Carex atherodes, Phrag-


Figure 54. Pintail Slough meadow. Showing Phragmites communis in the distance then a broad zone of Hordeum jubatum and Puccinellia nuttalliana with a few Chenopodium rubrum plants. In the foreground Chenopodium rubrum, Scirpus paludosus, Scolochloa festucacea and Hordeum jubatum.

mites communis and Scolochloa festucacea as co-dominants, and frequently associated with the, Rumex maritimus var. fueginus, Aster brachyactis and Scirpus paludosus. This zone merged into the meadow where the vegetation in some places was patchy and sparse and in others formed a fairly close cover (Figure 54). It included the following species in decreasing order of abundance.

Puccinellia nuttalliana
Scirpus paludosus
Aster brachyactis
Hordeum jubatum
Chenopodium rubrum
Suaeda depressa
Chenopodium glaucum var. salinum

Aster fringed the depressions in the meadow which had recently held water but were then dry.

The transect (Figure 55) shows a representative belt across one bank of the slough in September (Figure 56). Some indication of the density of plants in the two newest zones was obtained by counting the number of seedlings in 15 cm. squares taken at random in each zone (Table V).

4. MARSHES FROM PORTAGE CREEK WESTWARDS

In considering areas on the south side of the main series of bays forming the Delta Marshes, certain stations were selected to show the main types of marsh habitat and included areas inundated with water throughout the season, areas which dried out completely and those which dried partially; sloughs, channels, and some of the stages between typical marsh and wet meadow.

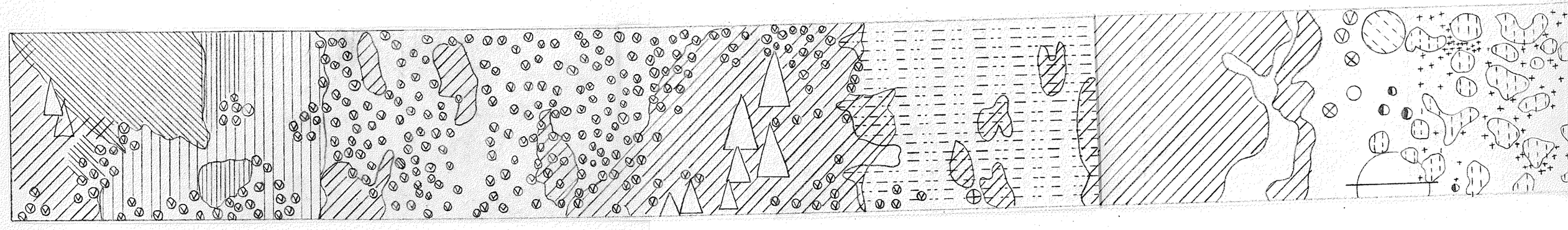


Figure 55. Pintail Slough. Belt transect
(Forekey see page 202)
(Scale 2" = 1 metre)

Figure 56. Pintail Slough in September showing bare central area and zone dominated by Aster brachyactis with Phragmites and Scirpus validus behind.

TABLE V

NUMBER OF PLANTS IN 15 CM. SQUARES IN

A. RECENTLY BARE MUD;

B. ASTER BRACHYACTIS

ZONE.

| | A | | | | | | B. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Most recently bare mud | | | | | | Aster zone | | | | | |
| Chenopodium rubrum | 68 | 105 | 86 | 14 | 19 | 11 | 12 | 6 | 4 | 18 | 18 | |
| Scolochloa festucacea | 47 | 45 | 67 | 21 | 25 | 26 | 2 | 2 | 22 | 2 | 3 | 2 |
| Aster brachyactis | | | 4 | | | | 26 | 7 | 7 | 37 | 48 | 83 |
| Rumex maritimus var.fueginus | | | | 1 | 2 | | | | | | 1 | |
| Ranunculus sceleratus | | | 2 | 1 | | | | | | | | |

Portage Creek. Portage Creek is a broad channel running in a north-south direction and carrying flood water to Simpson Bay from the low-lying areas to the south. The northern part of the channel is permanently filled with water. The southern regions dried out as the general water level dropped during the summer, and here the vegetation followed much the same pattern as seen in Pintail Slough.

Three stations were studied in the neighbourhood of Portage Creek and will be considered in turn:

i. Slough west of the section road.

ii. Creek shoreline.

iii. Marsh south of Simpson Bay.

i. Slough West of the Section Road. This oval-shaped slough was filled with water in early June, but the northern end showed signs of drying. There is a gradual slope from the surrounding meadow and the road down to the marsh, and along this gradient the invading vegetation showed signs of zonation as the level of the water in the slough dropped.

On July 17th a belt transect running across the zones at the north-west end of the slough was mapped. (Figure 57). The zone immediately above the water consisted of patchy but fairly dense Phragmites stubble, overlain with a layer of dried algae and Lemna, bearing a few widely scattered seedlings of Ranunculus sceleratus, Atriplex patula and Rumex maritimus var. fueginus.

The first conspicuous zone of vegetation, about 30 cm. in height (Figure 58), was composed of Ranunculus sceleratus (3), Atriplex patula (3)

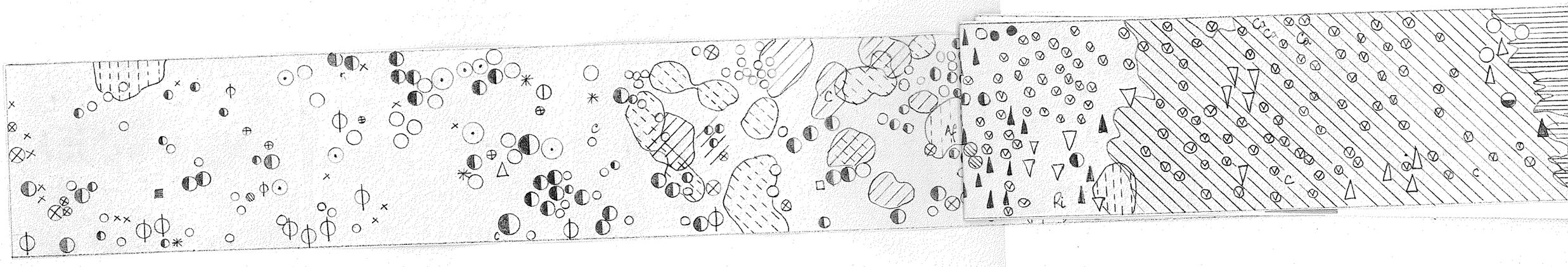



Figure 57. Portage Creek Slough. Belt transect. July 9th. (For key see page 202)
(Scale 2" = 1 metre)

Figure 58a. Ranunculus sceleratus and Rumex maritimus var. fueginus from zone 1, Portage Creek slough.

Figure 58b. Atriplex patula from zone 1, Portage Creek slough.

crowded in clumps, Rumex maritimus(3), Chenopodium rubrum(2), and Scolochloa festucacea (2). The Ranunculus had produced many flowers and the vegetation was flourishing. The zone varied considerably in width depending on the gradient and therefore, the speed with which Senecio congestus was able to colonise the next narrow zone. Hordeum jubatum was frequently present with Senecio and became the dominant in the following zone ($Z_3$).

In both zone 2 and zone 3 Epilobium glandulosum var. adenocaulon, Aster brachyactis, Rumex maritimus var. fueginus and Atriplex patula were frequent and Bidens cernua, Polygonum persicaria, Typha latifolia and Scolochloa festucacea occasionally recorded. In certain places one or both of these zones became obscured by zone 4 which was predominantly composed of Scirpus validus. (Figure 59).

In September when the transect was re-examined it was noted that zone 1 had extended its range to more than three times its original area. The higher zones had become somewhat obscured by the increase in height of their inhabitants. The Senecio congestus had disappeared and the Hordeum jubatum was more or less hidden by the growth of Scolochloa festucacea, Aster brachyactis, Epilobium glandulosum var. adenocaulon, Chenopodium rubrum and Atriplex patula.

ii. Creek Shoreline.

Substratum on the Shore of Portage Creek:

| | |
|---|---|
| 0 - 7.5 cm | Grey sand. |
| 7.5 - 10 cm. | Black stained sand rich in humus with distinct plant remains. |

10 - 18 cm. Dark grey sandy silt smelling of hydrogen sulphide and containing a few roots.

18 - 55 cm. Black silty sand, saturated, merging into dark grey clay with a few large stones.

55- 90 cm. Grey sand and clay.

The water table was 23 cm. from the surface.

The aquatic vegetation in the creek consisted of extensive patches of:

Potamogeton richardsonii (3)
Potamogeton pectinatus (3)
Enteromorpha and other green algae (3)
Myriophyllum exalbescens (2)
Ceratophyllum demersum (2)

Scirpus acutus grew along the shore line in open stands and in many places wave action had washed out the Scirpus americanus var. polyphyllus, which grew some distance in from the water's edge forming a small cliff. Where the Scirpus americanus had died, numerous Aster seedlings were germinating on the exposed roots and rhizomes. Immediately behind the Scirpus, on the meadow side, were patches of seedlings of Atriplex patula, clumps of Puccinellia nuttalliana in flower, occasional young plants of Chenopodium rubrum, Ranunculus sceleratus, Ranunculus cymbalaria and Juncus alpinus var. rariflorus, forming an interrupted zone. Behind this were two zones, the species of which are summarized in Table VI.

Where fresh lines of drift, occurred seedlings of Atriplex patula, Chenopodium rubrum, Chenopodium glaucum var. salinum and Aster brachyactis had germinated. This pattern of vegetation merged into dead Scolochloa festucacea and Spartina pectinata, and thence into wet meadow which

Figure 59. Portage Creek Slough east of the section road. Showing L. to R. *Scirpus validus* ($Z_4$), *Hordeum jubatum* ($Z_3$), *Senecio congestus* ($Z_2$) and zone with *Ranunculus sceleratus*, *Atriplex patula* ($Z_1$) etc., surrounding bare *Phragmites* stubble.

TABLE VI

VEGETATION ALONG THE SHORE OF PORTAGE CREEK.

| Species | $Z_1$ | | | $Z_2$ | | |
|---|---|---|---|---|---|---|
| | F% | C | S | F% | C | S |
| Aster brachyactis | 100 | 2.6 | 3.4 | 40 | 2.0 | 2.2 |
| Puccinellia nuttalliana | 60 | 1.0 | 3.1 | 10 | 1.0 | 1.0 |
| Eleocharis palustris | 30 | 3.0 | 4.7 | 10 | 2.0 | 4.0 |
| Ranunculus cymbalaria | 40 | 1.7 | 3.2 | 40 | 1.7 | 2.5 |
| Atriplex patula | 30 | 1.7 | 3.7 | 30 | 1.3 | 2.7 |
| Chenopodium rubrum | 10 | 1.0 | 3.0 | 20 | 3.0 | 4.5 |
| Scirpus validus | 10 | 1.0 | 1.0 | 20 | 2.5 | 4.0 |
| Glaux maritimus | 10 | 1.0 | 1.0 | 20 | 1.0 | 1.0 |
| Polygonum ramosissimum | 10 | 1.0 | 1.0 | 10 | 1.0 | 1.0 |
| Artemisia canadensis | 30 | 1.0 | 1.5 | 40 | 1.5 | 3.0 |
| Scirpus americanus | 10 | 3.0 | 5.0 | 10 | 2.0 | 4.0 |
| Hordeum jubatum | | | | 30 | 2.0 | 2.7 |
| Sonchus arvensis var. glabrescens | | | | 10 | 1.0 | 2.0 |
| Ranunculus sceleratus | | | | 10 | 2.0 | 3.0 |
| Suaeda depressa | | | | 20 | 1.5 | 2.0 |
| Carex atherodes | | | | 10 | 3.0 | 4.0 |

consisted of the following species, listed in decreasing order of abundance:

Atriplex patula
Scolochloa festucacea
Cirsium arvense
Achillea millefolium
Senecio congestus var. tonsus
Artemesia vulgaris
Stellaria graminea
Astragalus bisulcatus
Glaux maritima
Potentilla anserina
Scirpus americanus
Phragmites communis
Cicuta maculata
Carex atherodes
Carex bebbii
Spartina pectinata
Aster praealtus

Symphoricarpos occidentalis grew on rising ground in the meadow in two large patches with Viola rugulosa beneath it. In the cart tracks across the meadow the following species were found:

Triglochin maritima
Scirpus paludosus
Suaeda depressa
Salicornia rubra
Juncus balticus var. littoralis

At the end of the meadow there was a belt approximately 20 m. wide with Puccinellia nuttalliana, Hordeum jubatum and Eleocharis palustris as co-dominants and occasional Atriplex patula, Suaeda depressa and Scirpus validus. This 'meadow' vegetation (average width 60 m.) was on slightly higher ground than the marsh to the east, and seemed to have been relatively unaffected by standing high water as a layer of undecomposed humus overlay the soil.

To the east of this meadow and lying south of Simpson Bay is a marsh — approximately 1.7 km across. It consisted of an extensive area

of saturated soft mud surrounding a shallow basin of water. At the southern end of there were scattered clumps of Scirpus acutus growing in shallow water rich in decaying algae.

Between 180 and 200 m. from the water was an almost pure zone of Aster brachyactis 70 m. wide. Ranunculus sceleratus was rarely recorded with it. In some places the Aster formed a dense cover, elsewhere the community was more open. The highest part of the zone was invaded by Chenopodium rubrum which became co-dominant with the Aster, and this mixed zone gave way to a belt 20 m. wide composed of Puccinellia nuttalliana, Scirpus validus, Atriplex patula, Aster brachyactis, Suaeda depressa, and Chenopodium rubrum, which merged into the meadow described earlier.

MacDonald's Marsh. At the northwest side of Portage Creek are two elongated persistent pools and a third opening into Cadham Bay immediately south of Cherry Ridge. Their geographical relationship indicates that they were probably one unit in recent years.

Cherry Ridge is a narrow, sandy strip of land with a flourishing growth of Scirpus acutus in the shallow water along the shore. Atriplex patula seedlings were present on little drift lines close to the water, and where there was a more extensive cover of drift, Senecio congestus var. tonsus had produced a dense growth. This zone was 2-3 m. wide and replaced on higher ground by meadow vegetation with abundant Scolchloa festucacea, Scirpus americanus, Carex palustris; frequent Phragmites communis, Glaux maritima, Trifolium repens, Potentilla anserina, Taraxacum officinale, Aster praealtus, Heracleum lanatum, Symphoricarpos

occidentalis, Artemisia absinthium, Urtica dioica, Ranunculus sceleratus, Ranunculus cymbalaria, Mentha arvensis; and rare Plantago major. In some places a shrubby growth of Rosa acicularis and Symphoricarpos occidentalis with Prunus virginiana and Salix nigra crowned the ridge.

The vegetation on the sandy shoreline of the pools differed little from the meadow, with Puccinellia nuttalliana and Hordeum jubatum dominating. The frequency/cover/sociability follows:-

| Species | F% | C | S |
|---|---|---|---|
| Puccinellia nuttalliana | 85 | 1. | 1.8 |
| Spergularia marina | 40 | 1.7 | 2.2 |
| Chenopodium rubrum | 30 | 1.8 | 1.8 |
| Hordeum jubatum | 25 | 1.1 | 1.0 |
| Suaeda depressa | 50 | 1.6 | 1.8 |
| Aster brachyactis | 35 | 1.7 | 1.4 |
| Atriplex patula | 20 | 1.2 | 1.5 |
| Eleocharis acicularis | 5 | 1.0 | 1.0 |
| Polygonum aviculare | 10 | 1.5 | 3.5 |
| Chenopodium glaucum var.salium | 10 | 2.0 | 2.5 |
| Plantago major | 5 | 1.0 | 1.0 |

Poplar Pools. At the south end of Simpson Bay, at its most southern extension, lies an elongated pool with 'wet meadow' on either side. The site lies between Portage Creek marsh and the marsh west of Tin Town.

The 'meadow' was a mosaic of vegetation. One area, previously dominated by Typha latifolia had a dense growth of Atriplex patula beneath the dead Typha. Another had Aster brachyactis and scattered patches of Scolochloa festucacea. Shallow pans were ringed by Atriplex patula and Suaeda depressa, and well-marked channels in which water had earlier accumulated, were bare. In areas where Spartina pectinata was dominant Ranunculus cymbalaria, Ranunculus sceleratus, Triglochin maritima and Glaux

maritima were frequent. On flat stretches of black earth with a surface encrustation of alkali salts Triglochin was frequent in well grown clumps, with Glaux and occasional Puccinellia nuttalliana.

Encircling the south pool in June was a zone of bare mud and short Phragmites stubble 35 - 40 m.wide. This merged into a single zone ($Z_1$) of vegetation with the following composition:-

| Species | $Z_1$ | | |
|---|---|---|---|
| | F% | C | S |
| Ranunculus sceleratus | 100 | 3.9 | 1.2 |
| Scolochloa festucacea | 48 | 1.9 | 1.6 |
| Rumex maritimus var. fueginus | 60 | 1.9 | 2.3 |
| Atriplex patula | 20 | 4.0 | 3.5 |
| Triglochlin maritima | 5 | 1.0 | 2.3 |
| Senecio congestus var.tonsus | 8 | 2.5 | 1.1 |
| Aster brachyactis | 8 | 2.0 | 3.2 |
| Carex bebbii | 5 | 2.0 | 2.1 |

This zone merged into the 'meadow'. Rapid reduction in the area of water resulted in an increase in vegetation, and by mid-June the pattern had expanded from one, to two zones and the composition had changed as follows:-

| | | | |
|---|---|---|---|
| $Z_0$ | Aster brachyactis-small seedlings. | (2) | |
| | Ranunculus sceleratus | (2) | |
| $Z_1$ | Aster brachyactis | (4) | |
| | Ranunculus sceleratus | (3) | |
| 5-20m | Chenopodium rubrum | (2) | |
| wide | Hordeum jubatum | (2) | |
| | Atriplex patula | (2) | |
| | Chenopodium glaucum var.salinum | (1) | |
| | Suaeda depressa | (1) | |
| | Rumex maritimus var. fueginus | (1) | |
| $Z_2$ | Rumex maritimus var.fueginus | (3) | locally |
| | Ranunculus sceleratus | (3) | |
| 2-4 m | Aster brachyactis | (3) | |
| wide | Senecio congestus var.tonsus | (2) | |
| | Puccinellia nuttalliana | (2) | |
| | Atriplex patula | (2) | |

$Z_2$ Continued -

| | |
|---|---|
| Scolochloa festucacea | (2) |
| Eleocharis palustris | (2) |
| Carex atherodes | (1) |
| Carex aurea | (1) |
| Polygonum hartwrightii | (1) |
| Carex sartwellii | (1) |

In some places where the slope to the meadow was more gradual a third zone occurred including three species which shared local dominance Juncus balticus var. littoralis, Hordeum jubatum and Rumex maritimus var. fueginus. Atriplex patula, Ranunculus sceleratus and Sonchus arvensis var. glabrescens were occasional and more rare species in this community were Typha latifolia, Phragmites communis, Senecio congestus and Triglochin maritima.

At this time the former Typha meadow contained:-

| | | |
|---|---|---|
| Eleocharis palustris | (3) | |
| Aster brachyactis | (3) | |
| Sonchus arvensis var. glabrescens | (2) | |
| Solidago canadensis | (2) | |
| Agrostis stolonifera | (2) | |
| Agropyron repens | (2) | |
| Carex aurea | (2) | |
| Juncus balticus var.littoralis | (2) | |
| Cirsium arvense | (2) | |
| Oenothera biennis | (1) | |
| Helianthus annuus | (1) | |
| Astragalus canadensis | (1) | |
| Carex lanuginosa | (1) | |
| Erigeron canadensis | (1) | |
| Hordeum jubatum | (1) | locally abundant |
| Phleum pratense | (1) | |
| Cicuta maculata | (1) | |

The water at the south end of the pool had dried by the end of August, leaving the centre water-logged and bare with a zone consisting of scattered seedlings of Chenopodium rubrum, Scirpus acutus, Aster brachyactis and Scolochloa festucacea round it. This in turn was encircled by a dense

growth of Aster brachyactis with an almost uniform height of 75 cm. In this zone Senecio congestus, Chenopodium rubrum and Scolochloa festucacea were occasionally recorded, together with clumps of Hordeum jubatum and well-grown plants of Rumex maritimus var. fueginus. Towards the back of the Aster zone, Typha, Sonchus and Spartina became common additions, and indicated the beginning of the zone which eventually merged with the 'wet-meadow'.

The north and south parts of Poplar Pools are linked by a narrow, slightly elevated neck of marsh which dried more rapidly than the pools and showed a marked zonation in the vegetation. This followed broadly the zones just described for the south pool but with a predominance of Senecio congestus on the lower limit and Hordeum jubatum on the upper limits of the zone (Figure 60).

By this time ( late August) the water in the north pool had diminished by half and was surrounded by 4-6 m. of bare mud. There followed 5 m. of slightly drier mud covered with decaying algae and debris. Scattered seedlings of Chenopodium rubrum, Typha latifolia, Rumex maritimus var. fueginus, Ranunculus sceleratus, Ranunculus cymbalaria and Scolochloa festucacea were recorded in this zone ($Z_1$)

Zone 2 was 5-10 m. wide and contained well-grown plants of the following species, listed in order of decreasing abundance:-

Aster brachyactis
Atriplex patula
Ranunculus sceleratus
Rumex maritimus var. fueginus
Hordeum jubatum
Scirpus validus
Scirpus paludosus.

Zone 3 was dominated by Phragmites with an understory of Atriplex

Figure 60. Poplar Pools. Zonation at the neck, showing $Z_1$ in the centre of the area, ringed by zones dominated by Senecio congestus and Hordeum jubatum. This merges into 'meadow' in the foreground.

patula, Aster brachyactis and Spartina pectinatus. This merged into a type of 'wet-meadow' with a composition like the Sonchus-meadow, including Sonchus arvensis var. glabrescens (3), Spartina pectinatus (2), Aster pansus (2), Aster praealtus (1), and Cirsium arvense (1). More alkaline areas had scattered clumps of Triglochin maritima, Suaeda depressa, Salicornia rubra and Puccinellia nuttalliana.

Tin Town. The section road leading due north towards Tin Town ends in a group of shooting lodges. From this point a well defined track, carpeted with Salicornia rubra leads to Tin Town. On both sides of the track the 'wet-meadow' consisted of patches of Spartina pectinatus which was locally dominant and grew with frequent Scolochloa festucacea, Sonchus arvensis var. glabrescens and Aster praealtus. Occasional Scirpus validus, Cirsium arvense, Eleocharis palustris, Glaux maritima, Atriplex patula, Suaeda depressa, Carex atherodes and Carex bebbii also occurred.

At the side of the Tin Town Road - former Typha meadow was now dry and colonised by the following species:-

| Species | F% | C | S |
|---|---|---|---|
| Aster brachyactis | 60 | 2.2 | 3.5 |
| Chenopodium rubrum | 20 | 1.0 | 1.0 |
| Rumex maritimus var. fueginus | 15 | 2.0 | 2.7 |
| Atriplex patula | 95 | 2.2 | 3.3 |
| Sonchus arvensis var. glabrescens | 45 | 1.9 | 2.6 |
| Polygonum interior | 40 | 1.4 | 2.2 |
| Beckmannia syzigachne | 10 | 1.5 | 2.0 |
| Hordeum jubatum | 25 | 2.2 | 3.0 |
| Puccinellia nuttalliana | 10 | 1.0 | 2.0 |
| Artemesia absinthium | 5 | 1.0 | 1.0 |
| Suadea depressa | 5 | 2.0 | 3.0 |

| Species (contd) | F% | C | S |
|---|---|---|---|
| Scirpus acutus | 5 | 1.0 | 2.0 |
| Typha latifolia | 5 | 2.0 | 2.0 |
| Rorippa islandica var.fernaldiana | 5 | 1.0 | 1.0 |
| Convolvulus sepium | 5 | 1.0 | 1.0 |
| Carex stipita | 15 | 2.0 | 4.0 |
| Aster praealtus | 20 | 1.2 | 1.7 |

In many areas there were signs that there had been a good growth of Typha in 1957.

Tin Town Creek lies approximately 500 m. from the shore of Lake II and Lyttle Bay, and runs more or less parallel to them. A third of the way along its length it passes the town and continues north for some distance before entering Lyttle Bay. The creek acts as a drainage channel and was filled with water in the spring and early summer. By July it showed signs of drying and from then on the water diminished rapidly, exposing mud on the banks of the creek. This soon became colonised with vegetation showing the following clearly marked zones:-

| | | | | |
|---|---|---|---|---|
| $Z_1$ | 7 m. | Chenopodium rubrum | (2) | small seedlings |
| | | Scolochloa festucacea | (2) | |
| $Z_2$ | 4-6 m. | Aster brachyactis | (2) | |
| | | Atriplex patula | (2) | |
| | | Ranunculus sceleratus | (4) | |
| $Z_3$ | | Phragmites communis | (4) | |

The Phragmites on both sides of the creek merged into the 'wet meadow'. Occasional plants of Rumex maritimus var. fueginus were found in all the zones. (Figure 61)

The pattern of zonation on the drying creek banks was mapped on July 2nd, 1958 and again on September 8th, 1958 to show the expansion of

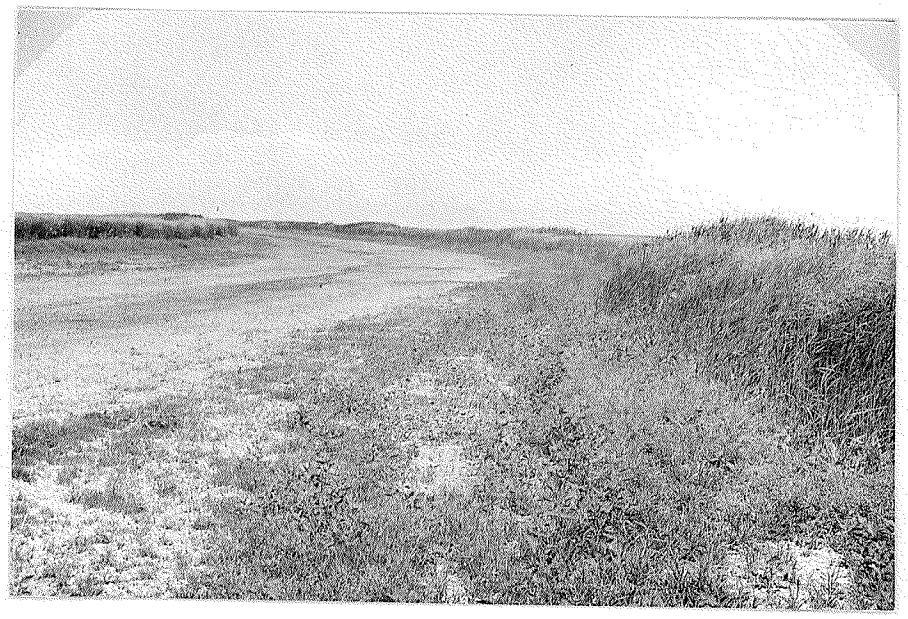


Figure 61. Tin Town Creek. Showing central area of bare mud, an interrupted zone of *Scolochloa* and *Chenopodium rubrum* seedlings followed by a zone of *Ranunculus sceleratus* with taller *Chenopodium rubrum*, occasional *Atriplex patula*, *Aster brachyactis* and *Rumex maritimus* and finally *Phragmites communis* zone.

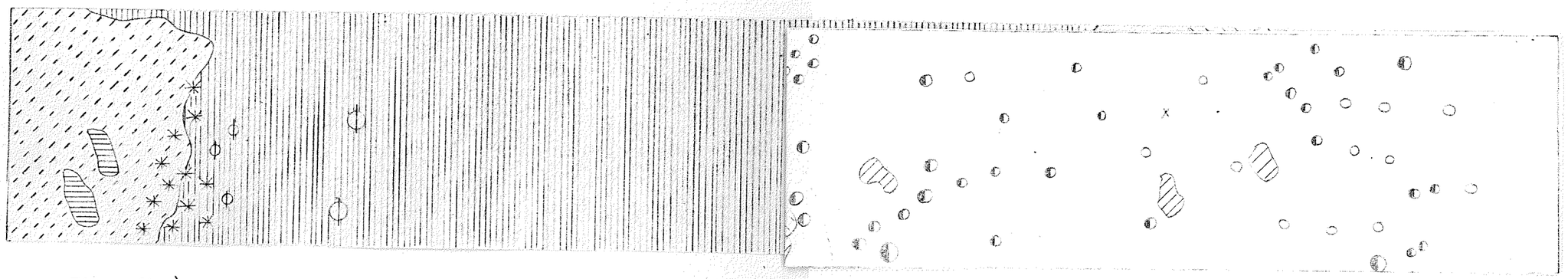


Figure 62 a) Tin Town Creek, 2nd July, 1958.
(Scale 2 inches = 1 metre)

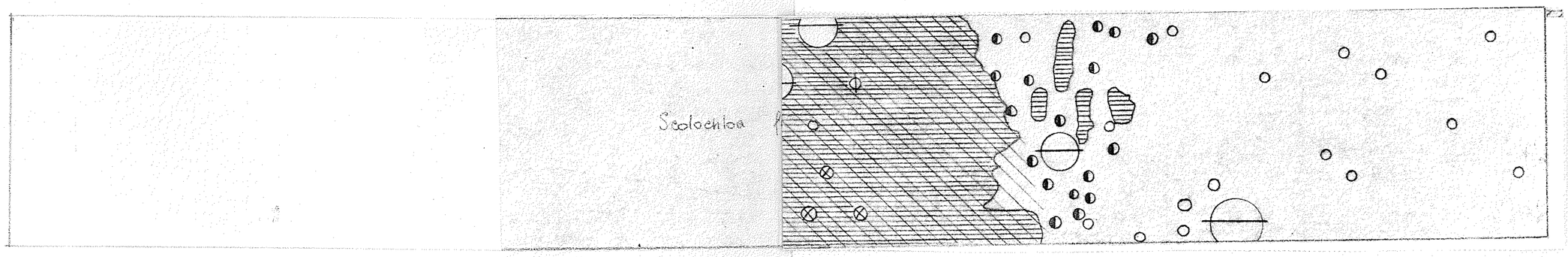



Figure 62 b) South West Bank of Tin Town Creek Mapped 8th August, 1958.
To show the extension of vegetation along the same belt as Figure 62a . The belts are placed in their correct relative positions.
(Scale 2 inches = 1 metre)

the zones and the overall increase in vegetation, as illustrated in belt transects (Figure 62).

As the summer advanced the creek dried out completely in all but a few isolated places, and in many instances the vegetation extended out from the banks to meet in the centre, thus forming a complete carpet across the creek. Where the two sides united Hordeum jubatum and Rumex maritimus var. fueginus were the commonest species and associated with them, Ranunculus sceleratus and Aster brachyactis.

In September the marsh lying between Tin Town and Lake II on the west side of the town had dried out and become irregularly colonised by the species recorded in the following list:-

| Species | F% | C | S |
|---|---|---|---|
| Triglochin maritima | 24 | 2.1 | 1.5 |
| Atriplex patula | 52 | 2.1 | 1.5 |
| Chenopodium rubrum | 56 | 3.0 | 1.5 |
| Aster brachyactis | 100 | 4.3 | 3.0 |
| Ranunculus cymbalaria | 20 | 1.6 | 1.2 |
| Typha latifolia | 28 | 1.1 | 1.0 |
| Hordeum jubatum | 56 | 3.3 | 2.2 |
| Puccinellia nuttalliana | 12 | 1.3 | 1.0 |
| Salicornia rubra | 8 | 1.0 | 1.0 |
| Sonchus arvensis var. glabrescens | 12 | 2.7 | 1.7 |
| Scolochloa festucacea | 44 | 2.0 | 1.1 |
| Artemesia biennis | 20 | 2.5 | 1.0 |
| Rumex maritimus var. fueginus | 40 | 2.5 | 1.9 |
| Carex atherodes | 4 | 2.0 | 1.0 |
| Scirpus validus | 24 | 1.5 | 1.0 |
| Eleocharis palustris | 16 | 1.5 | 1.2 |
| Scirpus paludosus | 8 | 1.5 | 2.5 |
| Ranunculus sceleratus | 20 | 2.4 | 1.4 |
| Senecio congestus var. tonsus | 14 | 1.0 | 1.0 |

This area was bounded on the west by a Typha-dominated ridge which gave way to a depression colonised at the periphery by an interrupted but distinct zone of Aster brachyactis. On the lake side of the depression, Atriplex patula and Senecio congestus grew in clusters among the

sparse Phragmites, and behind the Aster zone (Figure 63). Both these species died out as the Phragmites became denser along the lake shore. Where the Phragmites had been completely eliminated by the high water, the mud at the edge of the lake was colonized by abundant Ranunculus sceleratus, frequent Aster brachyactis and Senecio congestus, and occasional Rumex maritimus var. fueginus and Scirpus paludosus.

Flee Island. The marsh on the northeast side of the town on the shores of Lake II and Lyttle Bay was examined in July. The same area was sampled again in September and it reflected several changes, mainly in the reduction in the amount of Ranunculus sceleratus and the increase in Aster brachyactis. The number of species increased from 8 to 18, and it should be remembered that the whole area had been submerged beneath 45-60 cm. water in June.

| Species. | July | | | September | | |
|---|---|---|---|---|---|---|
| | F% | C | S | F% | C | S |
| Rumex maritimus var.fueginus | 60 | 2.1 | 1.5 | 60 | 2.5 | 3.2 |
| Aster brachyactis | 12 | 2.0 | 2.7 | 100 | 2.7 | 3.7 |
| Scirpus paludosus | | | | 25 | 1.8 | 2.0 |
| Senecio congestus var.tonsus | | | | 20 | 1.2 | 1.0 |
| Chenopodium rubrum | 10 | 1.0 | 3.0 | 45 | 1.6 | 2.1 |
| Ranunculus cymbalaria | 5 | 1.0 | 1.0 | 15 | 1.6 | 2.3 |
| Hordeum jubatum | 20 | 2.3 | 1.8 | 10 | 1.0 | 3.5 |
| Scolochloa festucacea | | | | 55 | 1.5 | 2.6 |
| Puccinellia nuttalliana | | | | 30 | 1.1 | 2.1 |
| Scirpus validus | | | | 15 | 1.3 | 2.3 |
| Typha latifolia | | | | 15 | 1.0 | 2.3 |
| Eleocharis palustris | | | | 15 | 1.0 | 1.0 |
| Ranunculus sceleratus | 100 | 4.5 | 4.2 | 5 | 1.0 | 1.0 |
| Atriplex patula | 20 | 1.8 | 3.2 | 25 | 2.8 | 2.8 |
| Polygonum ramossissimum | | | | 5 | 1.0 | 1.0 |
| Salicornia rubra | | | | 5 | 1.0 | 1.0 |
| Carex atherodes | | | | 5 | 1.0 | 1.0 |
| Suaeda depressa | | | | 5 | 1.0 | 2.0 |

The ground on both sides of the northern end of Tin Town Creek was

Figure 63. Tin Town. Aster brachyactis with scattered plants of Senecio congestus, merging into a zone of Senecio congestus and Phragmites communis at the waters edge.

a flat area resembling a 'flood plain'. The soil was encrusted with alkali salts and on it isolated clumps of Puccinellia nutalliana grew to a height of 15-25 cm. The plants were far from flourishing though a number had flowered. Occasional specimens of Salicornia rubra and Suaeda depressa were recorded and the vegetation changed to the north and east as areas with persistent dead Phragmites and stubble were reached. These surrounded Lyttle Bay and extended between it and Bluebill Bay. The driest ground — on which a few Phragmites plants had survived — had become colonized with two communities of plants as early as the beginning of July. Each could be divided into two zones as shown below:-

| Species | $Z_1$ | | | $Z_2$ | | |
|---|---|---|---|---|---|---|
| | F% | C | S | F% | C | S |
| Aster brachyactis | 92 | 1.8 | 3.0 | 36 | 1.6 | 3.2 |
| Scolochloa festucacea | 56 | 1.0 | 2.0 | 48 | 1.5 | 3.5 |
| Chenopodium rubrum | 28 | 1.0 | 1.4 | 60 | 1.4 | 2.5 |
| Atriplex patula | 12 | 2.7 | 3.7 | 52 | 1.2 | 2.2 |
| Rumex maritimus var.fueginus | 18 | 1.9 | 1.0 | | | |
| Salicornia rubra | | | | 68 | 1.7 | 3.5 |
| Suaeda depressa | | | | 12 | 1.0 | 1.7 |
| Puccinellia nuttalliana | | | | 36 | 1.1 | 2.3 |
| Ranunculus sceleratus | | | | 12 | 2.3 | 2.7 |

Marshy areas west of the Lodge (July 9th) consisted of two zones:-

| Species | $Z_1$ | | | $Z_2$ | | |
|---|---|---|---|---|---|---|
| | F% | C | S | F% | C | S |
| Ranunculus sceleratus | 100 | 4.6 | 5.0 | 20 | 2.0 | 3.0 |
| Rumex maritimus var.fueginus | 20 | 1.5 | 2.0 | | | |
| Hordeum jubatum | 20 | 1.8 | 2.6 | 12 | 2.0 | 1.0 |
| Atriplex patula | 20 | 1.2 | 1.8 | 100 | 3.6 | 4.3 |
| Aster brachyactis | 12 | 1.7 | 3.0 | 24 | 2.1 | 3.5 |
| Chenopodium rubrum | 10 | 1.0 | 1.0 | 5 | 1.0 | 1.0 |
| Puccinellia nuttalliana | | | | 15 | 1.7 | 2.3 |
| Scolochloa festucacea | | | | 12 | 1.7 | 3.0 |

As further situations in this neighbourhood became colonized, species tolerant of a high proportion of alkali salts in the soil predominated. Salicornia rubra was the most abundant plant; Suaeda depressa and Atriplex patula were frequent in persistently moist places, while Puccinellia nuttalliana and Hordeum jubatum were co-dominants on the drier sites.

The area of water continued to diminish and by mid-September an extensive region on the south shores of Lyttle Bay, between it and Bluebill Bay, which had been submerged beneath as much as 1-1.3 m. of water in the early part of the summer, had gradually been exposed (Figure 64). Drying took place in a direction from the surviving remnants of Phragmites, which occurred on slightly higher ground, towards the centre of each depression, and this resulted in a zoned pattern of vegetation even where the gradient was very slight. The figures obtained from sampling one such area are given in Table VII.

The number of plants in sample plots 1 m. square was counted in zones 1 and 2.

| Species | $Z_1$ | | | $Z_2$ | | |
|---|---|---|---|---|---|---|
| Chenopodium rubrum | 60 | 256 | 12 | 1 | 4 | 2 |
| Scolochloa festucacea | 191 | 104 | 81 | 122 | | 2 |
| Atriplex patula | 11 | | 54 | 7 | 4 | 1 |
| Carex atherodes | 1 | | | | | |
| Aster brachyactis | 7 | 1 | 126 | 176 | 118 | 65 |

In one place there was only one zone of vegetation present - a mixed zone - with a composition as shown in the following table. The heights of the plants indicated that more rapid drying of the substratum had probably influenced the establishment of certain species.

TABLE VII.

FLEE ISLAND SAMPLING FIGURES SEPTEMBER 12TH 1958

FROM AREA UNDER WATER IN JUNE.

| Species | Zone 1 | | | Zone 2 | | | Zone 3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | F% | C | S | F% | C | S | F% | C | S |
| Chenopodium rubrum | 100 | 3.2 | 3.7 | 70 | 1.5 | 2.1 | | | |
| Rumex maritimus var.fueginus | 20 | 1.7 | 2.2 | 25 | 1.6 | 2.0 | | | |
| Grass sp. | 80 | 1.4 | 3.0 | | | | | | |
| Senecio congestus var.tonsus | 5 | 1.0 | 1.0 | | | | | | |
| Scolochloa festucacea | 25 | 1.8 | 3.0 | 55 | 1.6 | 2.3 | 30 | 2.0 | 2.7 |
| Ranunculus sceleratus | 15 | 1.3 | 1.3 | | | | | | |
| Aster brachyactis | 35 | 1.0 | 1.4 | 100 | 4.0 | 4.6 | 60 | 2.0 | 2.8 |
| Ranunculus cymbalaria | 20 | 1.2 | 1.8 | | | | | | |
| Sonchus arvensis var.glabrescens | 10 | 1.0 | 1.0 | | | | 70 | 2.6 | 3.1 |
| Atriplex patula | 10 | 1.0 | 1.0 | 35 | 1.6 | 2.1 | 40 | 2.5 | 3.0 |
| Puccinellia nuttalliana | 10 | 2.0 | 3.0 | 45 | 1.2 | 2.5 | 60 | 2.3 | 3.2 |
| Salicornia rubra | 5 | 1.0 | 2.0 | | | | | | |
| Teucrium occidentale | | | | | | | 10 | 1.0 | 1.0 |
| Scirpus acutus | | | | 5 | 2.0 | 3.0 | | | |
| Scirpus paludosus | | | | 5 | 1.0 | 1.0 | | | |
| Phragmites communis | | | | 10 | 2.0 | 3.0 | 40 | 1.0 | 1.7 |
| Hordeum jubatum | | | | 25 | 1.6 | 2.8 | 80 | 1.9 | 3.0 |
| Scirpus validus | | | | 20 | 1.0 | 1.5 | | | |
| Suaeda depressa | | | | | | | 10 | 2.0 | 3.0 |
| Artemisia absinthium | | | | | | | 70 | 1.1 | 1.4 |
| Urtica dioica var.procera | | | | | | | 20 | 1.0 | 3.0 |
| Stachys palustris | | | | | | | 40 | 2.2 | 3.0 |
| Cirsium arvense | | | | | | | 20 | 2.0 | 3.0 |

| Species | F% | C | S |
|---|---|---|---|
| Puccinellia nuttalliana | 20 | 2.0 | 2.5 |
| Aster brachyactis | 60 | 2.3 | 3.3 |
| Artemisia absinthium | 20 | 1.0 | 1.0 |
| Hordeum jubatum | 80 | 1.9 | 3.0 |
| Scolochloa festucacea | 40 | 2.7 | 4.0 |
| Sonchus arvensis var.glabrescens | 20 | 1.5 | 2.5 |
| Atriplex patula | 80 | 1.9 | 3.1 |
| Phragmites communis | 10 | 1.0 | 1.0 |
| Suaeda depressa | 20 | 2.5 | 3.5 |
| Salicornia rubra | 20 | 1.5 | 1.0 |
| Ranunculus cymbalaria | 10 | 2.0 | 3.0 |
| Polygonum interior | 10 | 1.0 | 2.0 |
| Aster praealtus | 10 | 1.0 | 1.0 |

St. Ambroise. The most easterly marshes examined lay north east of the town of St. Ambroise, and at the south end of Moffatt Lake, where there were many sloughs and channels with poor drainage separated by ridges with imperfect to moderately good drainage. The soils belong to the Isafold association and contained large areas of stony and very stony soils. The soil on the ridge between sloughs at Moffat Lake, (Figure 65), consisted of:-

| | |
|---|---|
| | Thin layer of algae on surface. |
| 0 - 7.5 cm. | Dark brown with organic material-mainly roots, and pockets of coarse, angular sand and fine gravel. |
| 7.5 - 22 cm. | Dark brown loam with clay/slatey slabs and gravel pockets. |
| 22 - 57 cm. | Sticky yellow/fawn clay loam with occasional iron-stained orange bands. |
| 57 - 107 cm. | Gravel and coarse sand in clay; grey, wet and sticky; hard to work. |
| 52 cm | Water level. pH 7.1 |

Submerged ridges bore flourishing stands of Phragmites communis and Scirpus acutus (Figure 66) and higher ridges had a varied flora

Figure:64. Flee Island. South shore of Lyttle Bay submerged for the early part of the summer showing colonization by abundant Aster brachyactis with some Scolochloa festucacea, Chenopodium rubrum etc.

Figure 65. Moffatt Lake. Surface layers of soil on one of the ridges between sloughs.

Figure 66. Moffatt Lake. *Scirpus acutus* on a submerged ridge.

(Figure 67).

A typical transect from a ridge to a water-filled depression or slough passed through the one or two zones of vegetation, but there were many minor variations in individual sloughs. 'Meadow vegetation' found on the higher and better drained ground of the ridges included:-

| | |
|---|---|
| Atriplex hastata | (4) |
| Spartina pectinata | (2) |
| Scolochloa featucacea | (2) |
| Hordeum jubatum | (3) |
| Scirpus americanus | (2) |
| Lycopus americanus | (2) |
| Sonchus arvensis var. glabrescens | (1) |
| Glaux maritima | (2) |
| Rumex maritimus var.fueginus | (2) |
| Sium sauve | (2) |
| Ranunculus cymbalaria | (2) |
| Stachys palustris | (1) |
| Potentilla anserina | (2) |
| Beckmannia syzigachne | (2) |
| Mentha arvensis | (1) |
| Scirpus validus | (2) |
| Aster praealtus | (2) |
| Triglochin maritima | (2) |
| Solidago canadensis | (2) |

As soon as the drainage was impaired Phragmites communis, Carex atherodes, Scolochloa festucacea and Scirpus validus increased in abundance and formed a discontinuous zone. On mud that had been exposed by the partial drying up of the sloughs a community developed with the following species:-

| | |
|---|---|
| Aster brachyactis | (3) |
| Ranunculus sceleratus | (3) |
| Rumex maritimus var.fueginus | (2) |
| Chenopodium rubrum | (2) |
| Puccinellia nuttalliana | (2) |
| Hordeum jubatum | (2) |
| Atriplex patula | (2) |
| Calamgrostis canadensis | (2) |
| Epilobium glandulosum var. adenocaulon | (1) |
| Eleocharis palustris | (1) |
| Salicornia rubra | (1) |
| Suaeda depressa | (1) |

Figure 67. Moffat Lake. Part of an emergent ridge with dead stubble and surviving Phragmites communis at the edge of the water. The vegetation in the foreground includes Ranunculus sceleratus, and Rumex maritimus var.fueginus.

| | |
|---|---|
| Rorippa islandica | (1) |
| Senecio congestus var.tonsus | (1) |
| Beckmannia syzigachne | (1) |
| Polygonum amphibium | (1) |
| Glaux maritima | (1) |

Many of the drift lines were colonized exclusively by Ranunculus sceleratus.

The shallow water of the sloughs protected to some extent from wind action by the ridges, had a dense growth of Utricularia vulgaris in the soft silty mud. The mud was covered with an aquatic moss and degenerating green algae. Ceratophyllum demersum and Hippuris vulgaris were also recorded.

A station on the north shore of Sioux Pass Lake was examined and showed three well-marked zones of vegetation surrounding the diminishing water. The frequency of species, their cover and abundance are given in Table VIII.

Zone 1 was dominated by Rumex maritimus var. fueginus a species which did not occur in any other site in such abundance. In Zone 2 dominated by Epibolium glandulosum var. adenocaulon, five other species were encountered but none occurred more than occasionally. Zone 3 on slightly higher ground was well drained and contained a greater variety of species than comparable zones in other sites.

GENERAL AQUATIC VEGETATION

The hydrophytic vegetation of the ponds, sloughs and bays of the Delta Marsh includes the five morphoecological groups suggested by Daubenmire in 1947, namely hydrophytes of the following types:

TABLE VIII

ST. AMBROISE. SIOUX PASS LAKE. AUGUST 13, 1958.

FREQUENCY/COVER/SOCIABILITY SAMPLING FIGURES.

| Species. | $Z_1$ | | | $Z_2$ | | | $Z_3$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | F% | C | S | F% | C | S | F% | C | S |
| Rumex maritimus var. fueginus | 90 | 2.8 | 3.4 | 20 | 1.0 | 1.5 | 5 | 2.0 | 4.0 |
| Ranunculus sceleratus | 75 | 1.8 | 3.0 | | | | | | |
| Typha latifolia | 65 | 1.4 | 3.0 | 20 | 1.0 | 1.0 | 25 | .16 | 2.6 |
| Scolochloa festucacea | 40 | 1.4 | 2.6 | | | | 35 | 2.4 | 3.9 |
| Scirpus validus | 20 | 1.0 | 2.2 | | | | | | |
| Aster brachyactis | 20 | 1.7 | 2.0 | | | | | | |
| Chenopodium rubrum | 20 | 1.0 | 2.0 | 10 | 1.0 | 1.0 | 5 | 1.0 | 1.0 |
| Phragmites communis | 10 | 1.0 | 2.0 | | | | | | |
| Grass sp. | 10 | 1.0 | 2.5 | | | | | | |
| Scirpus paludosus | 10 | 1.5 | 3.3 | | | | | | |
| Eleocharis calva | 10 | 1.5 | 3.0 | | | | | | |
| Eleocharis palustris | 5 | 2.0 | 4.0 | | | | | | |
| Atriplex patula | 10 | 3.0 | 1.0 | 20 | 1.0 | 1.0 | | | |
| Puccinellia nuttalliana | 10 | 1.0 | 1.0 | | | | | | |
| Epilobium glandulosum var.adenocaulon | | | | 100 | 5.0 | 5.0 | | | |
| Teucrium occidentale | | | | 10 | 1.0 | 3.0 | 10 | 1.0 | 1.0 |
| Sonchus arvensis var. glabrescens. | | | | | | | 60 | 2.3 | 3.1 |
| Eupatorium maculatum | | | | | | | 5 | 3.0 | 4.0 |
| Solidago canadensis | | | | | | | 20 | 1.7 | 3.2 |
| Aster praealtus | | | | | | | 65 | 2.0 | 3.3 |
| Polygonum persicaria | | | | | | | 5 | 2.0 | 3.0 |
| Convolvulus sepium | | | | | | | 5 | 1.0 | 3.0 |
| Urtica dioica var. procera | | | | | | | 15 | 1.0 | 1.0 |
| Mentha arvensis var. villosa | | | | | | | 30 | 1.5 | 2.7 |
| Cirsium arvense | | | | | | | 20 | 1.0 | 1.2 |

(continued)

TABLE VIII (CONTD.)

| Species | $Z_1$ | | | $Z_2$ | | | $Z_3$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | F% | C | S | F% | C | S | F% | C | S |
| Axyris amaranthoides | | | | | | | 5 | 1.0 | 1.0 |
| Echinocystis lobata | | | | | | | 10 | 1.5 | 3.5 |
| Salix interior | | | | | | | 10 | 1.5 | 3.5 |
| Lycopus americanus | | | | | | | 5 | 2.0 | 5.0 |
| Artemesia absinthium | | | | | | | 10 | 1.5 | 2.0 |
| Spartina pectinata | | | | | | | 5 | 2.0 | 4.0 |
| Sium sauve | | | | | | | 10 | 2.0 | 3.5 |

1. floating
2. suspended
3. submerged
4. anchored emergent
5. floating-leafed anchored

Lemna minor was the most abundant floating species, especially in enclosed ponds and on the edges of sheltered bays. It was not found where the water was disturbed. In many places its luxuriant growth formed a mat on the top of the water, so thick that only the surface plants were living. In storms quantities of Lemna were washed up along the shores of the marsh, and a few individuals within the mass survived for considerable periods of time. Lemna trisulca, a suspended hyrdophyte, much less common, was recorded only in enclosed bodies of water where it was usually associated with the commoner species. In sites such as Pintail Slough, Enteromorpha sp. was the dominant aquatic, growing with a considerably quantity of filamentous algae.

The association of Ceratophyllum demersum, Myriophyllum exalbescens and Utricularia vulgaris when found in shallow water and not rooted, could be classed as suspended hydrophytes. Ceratophyllum grew in large circular patches, with long radiating branches. It was more plentiful than the other two species, often occurring with Enteromorpha sp. and other green algae of both filamentous and epiphytic forms.

In the sloughs at St.Ambroise and Lakeland, where the water was shallow and well protected from the wind, by ridges or tall stands of Phragmaties; Utricularia vulgaris grew prolifically and produced many spikes of yellow flowers. It was usually associated with green algae, and in water rich in small Cladocera, Amphipods and other forms of aquatic life on which

Utricularia thrives.

Where the water was deeper and liable to greater fluctuations, emergent anchored hydrophytes were found. Large spreading patches of Myriophyllum exalbescens and smaller patches of Myriophyllum verticillatum were frequently encountered in the regions where Potamogeton pectinatus and Potamogeton vaginatus were abundant, covering many square metres of the muddy bottom. Portage Creek, Cadham Bay and Clandeboye Bay are three stations where these species were growing in dense beds almost impenetrable by canoe. They flourished in water from 25 cm. to 1 m. in depth and seemed able to withstand a considerable amount of disturbance by winds which are capable of producing sizable waves in these open bodies of water. Potamogeton richardsonii, a floating-leafed anchored hydrophyte, was less frequent than Potamogeton pectinatus and Potamogeton vaginatus, but nevertheless common throughout the marsh. (Figure 68). It flourished in Portage Creek, and after a storm the fruits from these three Potamogetons sometimes covered the shore in lines with a depth of several centimetres.

In Clandeboye Bay where the water was less turbulent, and in a few other places, Zannichellia palustris thrived. Its elongated straggling patches covered a considerable area, but it was much less widespread than Myriophyllum exalbescens and Ceratophyllum demersum. These anchored hydrophytes grew along the edge of bays and creeks in shallow water and attached to old rhizomes of Phragmites and Scirpus sp.

In ditches such as that running parallel with the main Delta Road, and in other comparable sites that dried up considerably during the summer, a rich growth of Ruppia maritima appeared early in the season, growing in

a dense tangled mass. In many places where Ruppia was recorded the water dried up completely as the summer progressed, but not until it had set seed.

The most obvious emergent on the marsh is Phragmites communis. It grows in a diversity of places, ranging from water more than a metre in depth, to drying marsh and wet meadow where the substratum is scarcely moist in midsummer. Phragmites is further discussed in Section III.

Another frequently-encountered member of the emergent aquatic class is Scirpus acutus. It grows a substratum with a fairly high proportion of sand among the organic material, and sometimes forms sizable islands both close to the main shoreline and far out in the bays. The growth of Scirpus on these islands tends to reduce the constant movement of the water, and to trap debris among the leaves and roots. Over a period of time the substratum is gradually raised and consolidated, by the accumulation of mineral and organic material which is bound together by the rhizomes and roots. Ultimately this may result in the emergence of an island which is uncovered in periods of low water, and then able to support the growth of other marsh plants.(Figure 69).

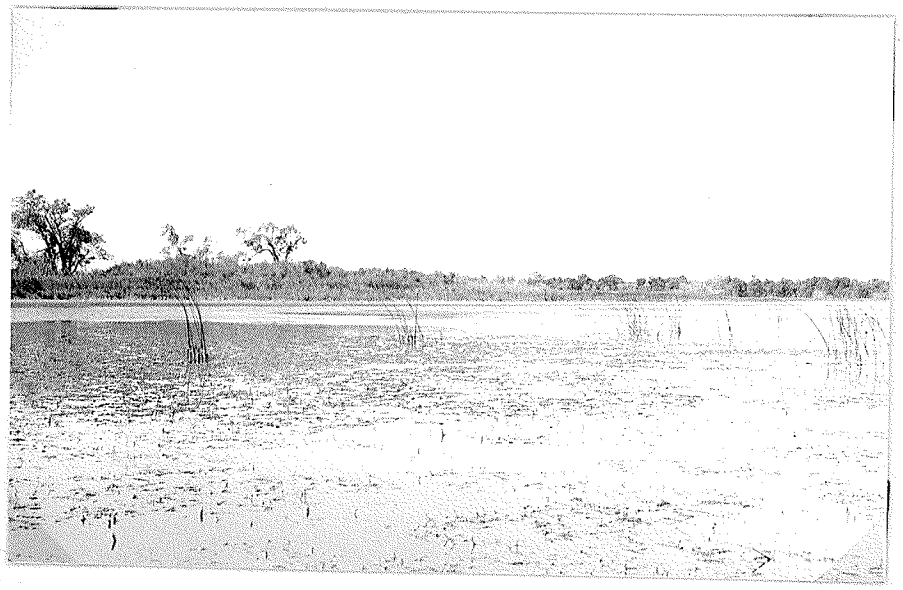


Figure 68. Portage Creek. A few clumps of Scirpus acutus growing in shallow water, with Potamogeton richardisonii and Potamogeton pectinatus.

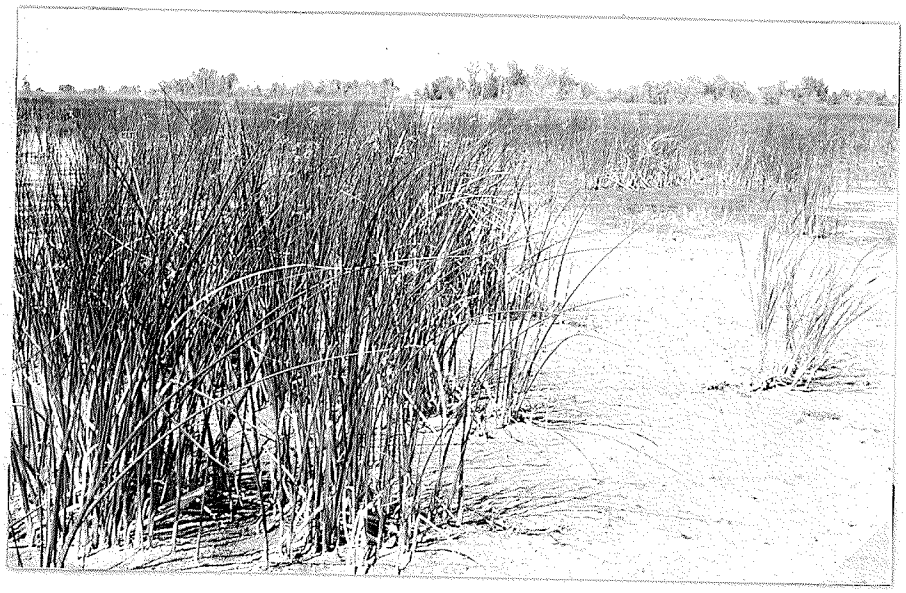


Figure 69. An 'island' of Scirpus acutus exposed during the summer of 1958.

## SECTION III

In this section are presented brief descriptions of certain aspects of the main dominants of the marsh. The observations are of a preliminary nature, serving merely to show some of the features that require further investigation.

### TYPHA LATIFOLIA

Typha was present either as seedlings or as well established plants in the majority of habitats examined. It was seldom abundant and never found in the excessively alkaline sites.

The most luxuriant growth occurred in Clandeboye Bay and on neighbouring shores (Figure 14), where dense stands grew to a height of 4.2 m. in well aeriated shallow water, and its fleshy creeping rhizome consolidated the substratum. It grew with Phragmites and Scirpus acutus in these situations, and can be easily recognised on the aerial photographs by its dark tone, stippled texture and height.

Typha was very variable in leaf width, size of the plants, and in the size of the inflorescence. A series can easily be built up from the extreme broad-leaved form, which has the staminate and pistilate parts of the infloresence convergent; to the narrow leaved form with the two parts of the infloresence well separated. (Löve and Löve 1954).

Seedlings of Typha were occasionally found in the wet mud of Zone 1 as at Chimney Marsh, but it was more frequently encountered in the rather drier second and third zones. (Table IX)

It occurred among the Phragmites ringing many marshy depressions, and at Nest Box 34 was the dominant plant in all the zones. As water retreated towards the centre of this area, many Typha seedlings developed in the saturated substratum. Examination of the young plants showed that they were produced from seeds not from rhizomes. By the end of the season Zones 1 and 3 had plants from 6 cm. to 45 cm. in height growing in a graded series from the water's edge to Zone 4 which consisted of well established Typha (max. ht. 1.8 m.)with a high proportion of the plants in flower. It was associated with abundant Cicuta maculata and frequent Bidens cernua; Chenopodium rubrum, Urtica doica var. procera; and Stachys palustris were occasionally present.

The vegetation at Chimney Marsh was clearly zoned for most of the summer, Zone 1 dominated by Ranunculus sceleratus; Zones 2 and 3 dominated by Epilobium glandulosum and Zone 4 dominated by Typha and Cicuta. By mid-September when the majority of species in these zones were past their prime and many were dying; the vegetation pattern had been changed completely by the relatively late season growth and increase in height of Typha.

PUCCINELLIA NUTTALLIANA

This grass played an important role in many of the better drained sites, sometimes being recorded as the dominant or co-dominant in Zones 1, 2 and 3. For example, as water evaporated from the ditches, along the side of the main road to Delta, three narrow zones of vegetation were conspicuous. Zone 1, nearest the receding water, was almost pure Aster brachyactis; Zone 2 was dominated by Puccinellia and it merged into Zone 3

TABLE IX

SAMPLING FIGURES FOR

TYPHA LATIFOLIA.

| Site and Date of Sampling. | $Z_1$ | | | $Z_2$ | | | $Z_3$ | | | $Z_4$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F% | C | S | F% | C | S | F% | C | S | F% | C | S |
| Jackfish Pond. 15/9 | | | | 50 | 1.8 | 1.6 | 55 | 1.6 | 2.8 | | | |
| Chimney Marsh 9/7 | 10 | 1.0 | 1.0 | 40 | 1.5 | 3.0 | 50 | 1.4 | 2.6 | | | |
| Chimney Marsh 15/9 | 10 | 1.0 | 3.0 | 100 | 2.0 | 3.7 | | | | 80 | 2.1 | 3.0 |
| St. Ambroise 13/8 | | | | 20 | 1.0 | 1.0 | 25 | 1.6 | 2.6 | | | |

on the borders of the meadow which included Atriplex patula, Suaeda maritima, Hordeum jubatum and other species.

In flat, alkaline situations, Puccinellia became established early in the season. On a black silty loam soil, well spaced plants spread out to give 100% cover, as at the Shooting Lodge. Some records of frequency, cover and sociability are given in Table X.

SCOLOCHLOA FESTUCACEA

This grass was found in two types of habitat, as an early colonizer on newly exposed water-logged mud, and in drier situations where it acts as a consolidator rather than as a pioneer (Figure 70). Sites in the latter category are generally covered with water for at least a short period each year. There Scolochloa grew in compact stands, the fleshy rhizome spread through the moderately well drained soil; often associated with Carex atherodes, Spartina pectinata and Phragmites. Further inland Scolochloa was found on ridges between sloughs and in more extensive meadows, where it seldom bore seed, and appeared to be replaced by more aggressive prairie herbs.

It was the second week in July before Scolochloa appeared in any abundance on the bare mud and Phragmites stubble of the marsh. Its seeds germinated well in wet soil and the seedlings developed rapidly growing from 15 cm. in July to 70 cm. a month later. Sometimes it formed a well-defined zone round the retreating water, in other sites its pattern was less regular and it grew thinly scattered or in fairly dense patches. Each shoot produced a single leaf and the growth never covered all the available ground, but in these marshy places it appeared to become more

TABLE X.

SAMPLING FIGURES FOR

PUCCINELLIA NUTTALLIANA.

| Site and Date of Sampling. | $Z_1$ | | | $Z_2$ | | | $Z_3$ | | | $Z_4$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F% | C | S | F% | C | S | F% | C | S | F% | C | S |
| Chimney Marsh 9/7 | - | - | - | - | - | - | 30 | 1.3 | 3.7 | - | - | - |
| Portage Creek 16/7 | - | - | - | - | - | - | 10 | 2.0 | 4.0 | 60 | 1.1 | 2.7 |
| Flee Island 12/9 | 10 | 3.0 | 3.0 | 45 | 1.2 | 2.5 | 60 | 2.3 | 3.2 | - | - | - |
| S.Portage Creek 16/7 | 10 | 1.5 | 1.5 | 30 | 2.0 | 2.7 | - | - | - | - | - | - |
| S.Cadham Bay 30/6 | 16 | 1.2 | 1.8 | 24 | 2.0 | 2.3 | - | - | - | - | - | - |
| Delta Ridge 24/7 | 90 | 2.1 | 3.1 | 15 | 1.4 | 2.4 | - | - | - | - | - | - |
| Unzoned sites: | | | | | | | | | | | | |
| Sowl's Marsh 11/9 | | | | 36 | 2.8 | 3.1 | | | | | | |
| Avocet Marsh 7/7 | | | | 10 | 1.0 | 2.5 | | | | | | |
| Tin Town 12/9 | | | | 30 | 1.1 | 2.1 | | | | | | |

Figure 70. Dense stand of Scolochloa festucacea.

abundant as the season progressed.

As a pioneer, Scolochloa was commonly associated with Atriplex patula, Chenopodium rubrum, Ranunculus sceleratus, Ranunculus cymbalaria, Rumex maritumus var. fueginus, Aster brachyactis and Phragmites. It regenerated from rhizomes which had become established in sparse surviving Phragmites, and here it grew to a height of at least 90 cm. On the higher parts of the marsh (submerged for part of the year) flowering was observed, but only in close, well grown stands.

PHRAGMITES COMMUNIS

In literature, the marshes at Delta have been referred to as Phragmites marshes. Hochbaum (1944) states that "the sea of Phragmites is broken by broad, glinting sheets of water". This may have been true in the past, and probably will be in the future, but between 1955 and 1957 the Delta marshes consisted predominantly of water. It filled the bays, lagoons, and sloughs and considerable areas of surrounding agricultural land. In a few places dead culms appeared above it, and on ridges and other slightly higher sites Phragmites grew more or less normally.

That was at the height of the high water in 1955. In the years immediately following a gradual drop in water level with accompanying drainage and evaporation had exposed hundreds of acres of stubble. These were often fringed with sparse stands of living plants, the fragmentary remains of former extensive beds of Phragmites. By 1958 many sites had only a few isolated individuals which showed signs of growth among the stubble, but there was no evidence of how they had survived, when for acres around them all the Phragmites had been killed during the period of high water.

In June where some of the remaining water in the marsh had retreated and left a margin of drying mud round the fringing Phragmites, underground rhizomes increased in length and tillers were produced (Figure 71). In many plants one or two shoots diverged from the normal vertical position, to grow out at an angle of 45° (Figure 72). These shoots grew more quickly than the erect shoots, and soon bent over to touch the ground (Figure 73) where they continued to grow relatively rapidly over the drying ground, in most cases towards the retreating water. By the third week in June many of the runners had rooted at their nodes, others had produced aerial shoots (Figure 74), and some roots and shoots. It was difficult to determine what factors were influencing the production of runners. In order to try to ascertain whether any erect shoot would become a runner if it diverged sufficiently from the normal position, a dozen erect young shoots were bent over on June 15th, and anchored by means of wooden pegs so that their apices were in contact with the ground. Care was taken to avoid injury and to reproduce the curve made by natural runners. In the same 12 plants, erect shoots were marked. Of the bent-over shoots the ends of 3 had been eaten off 10 days later, 8 of the remainder had not grown along the ground but resumed their vertical growth, and the 12th was tending to grow up. When they were finally measured on the 11th July, their average increase in length was 17.5 cm.

A further 84 shoots were marked, they fell into three groups:

1. normal upright shoots
2. normal runners
3. bent-over shoots

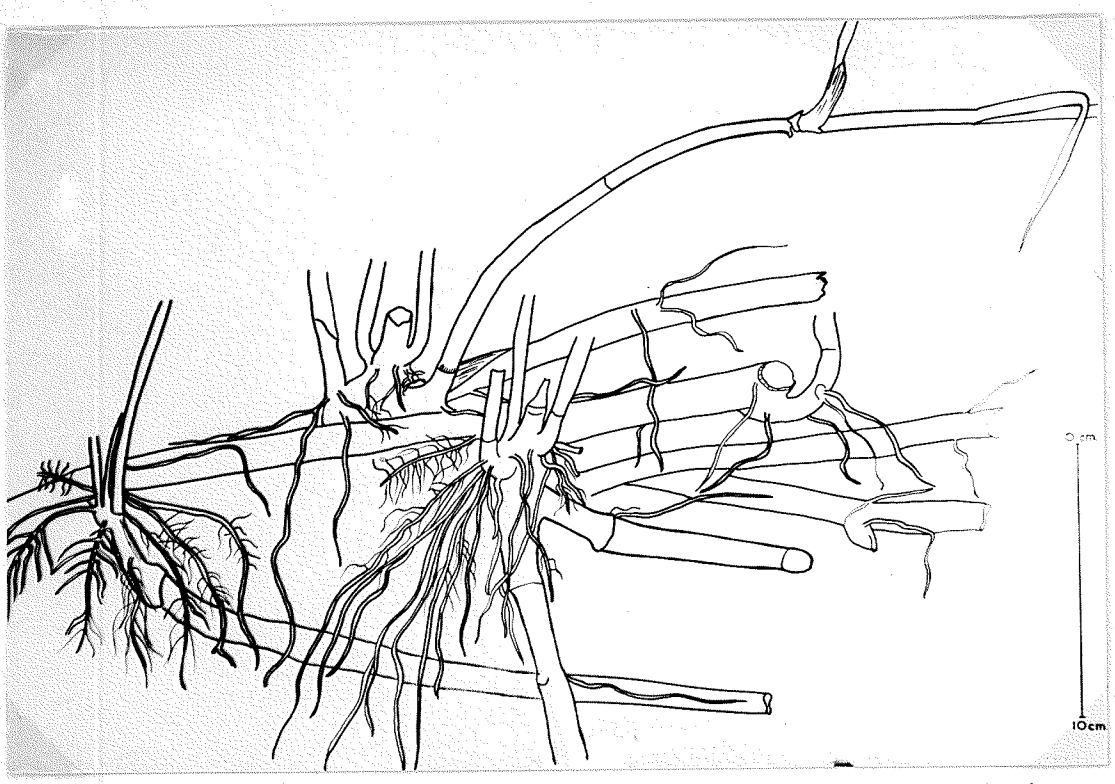



Figure 71. Underground rhizomes and roots of Phragmites communis to show the mode of origin of shoots.

Figure 72. Phragmites communis with a potential runner on the right hand side of the plant.

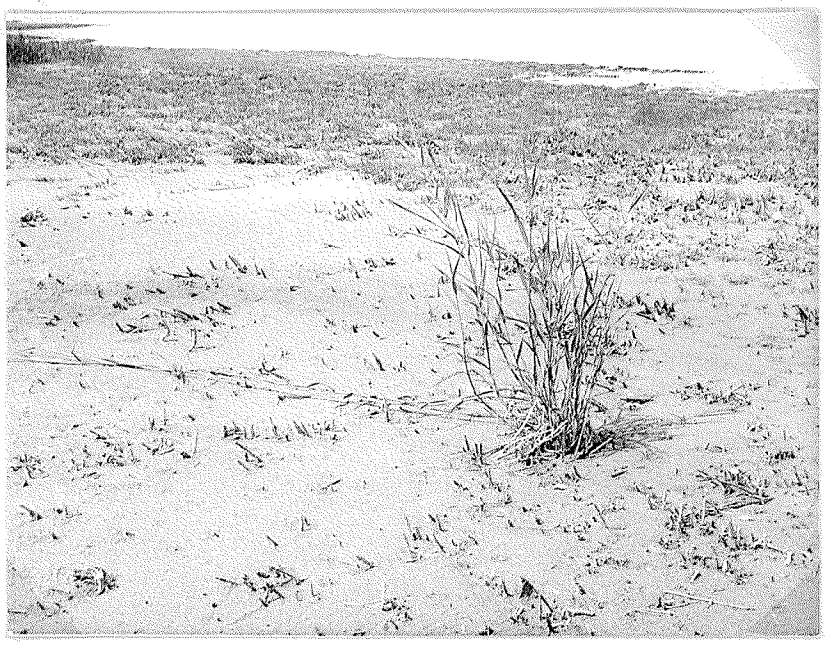


Figure 73. Phragmites runners growing along surface of ground with dead stubble in the background.

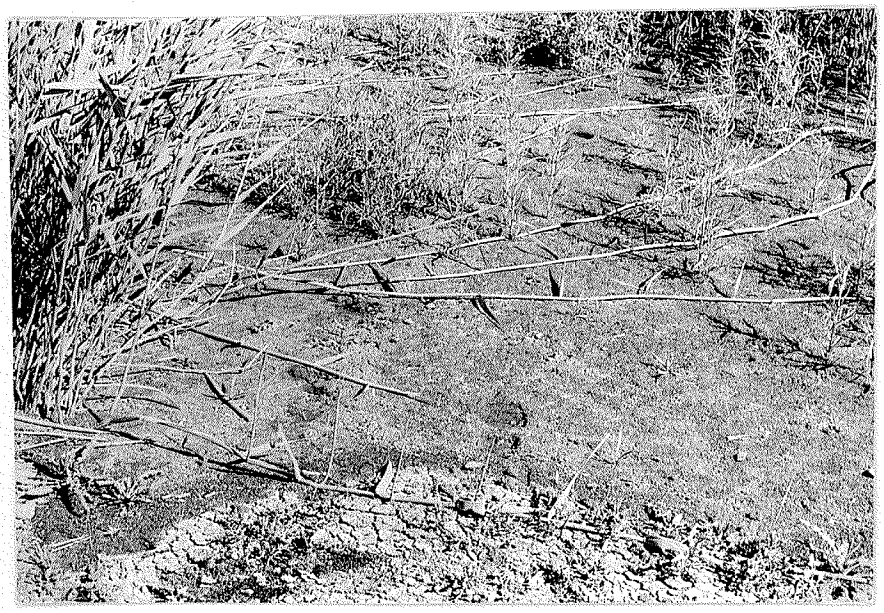


Figure 74. Phragmites runners producing nodal shoots.

Wherever available the 3 types were from the same plant, but it was not possible to measure shoots that were all the same length when the first measurement was taken.

General observations indicated that:

1. the rate of growth in upright shoots was slower than in runners from the same plant and over the same period of time. Upright shoots grew 1.8 cm. and runners 10.8 cm. over the same period of time.
2. that runners continued to grow after growth in upright shoots had ceased.
3. that the seasonal trend in growth in upright shoots and runners was comparable, a peak occurring in both in the third week in July (Figure 75).
4. that the node of a runner had shoot primordia in it from the time that the first leaf was fully unfolded on the runner. These primordia were not found in the macroscopic examination of a number of nodes in erect shoots.
5. the nodal shoots on runners may themselves grow to a height of 60 - 90 cm. in the first season. They do not flower in the first year, and generally remain connected to the parent runner, though capable of completely independant existance.
6. no runners were observed to successfully grow in, or over water; and no runners were produced in dense stands of Phragmites.
7. no bend-over shoots adopted a runner form of growth.

To investigate whether there would be any difference in the rate of

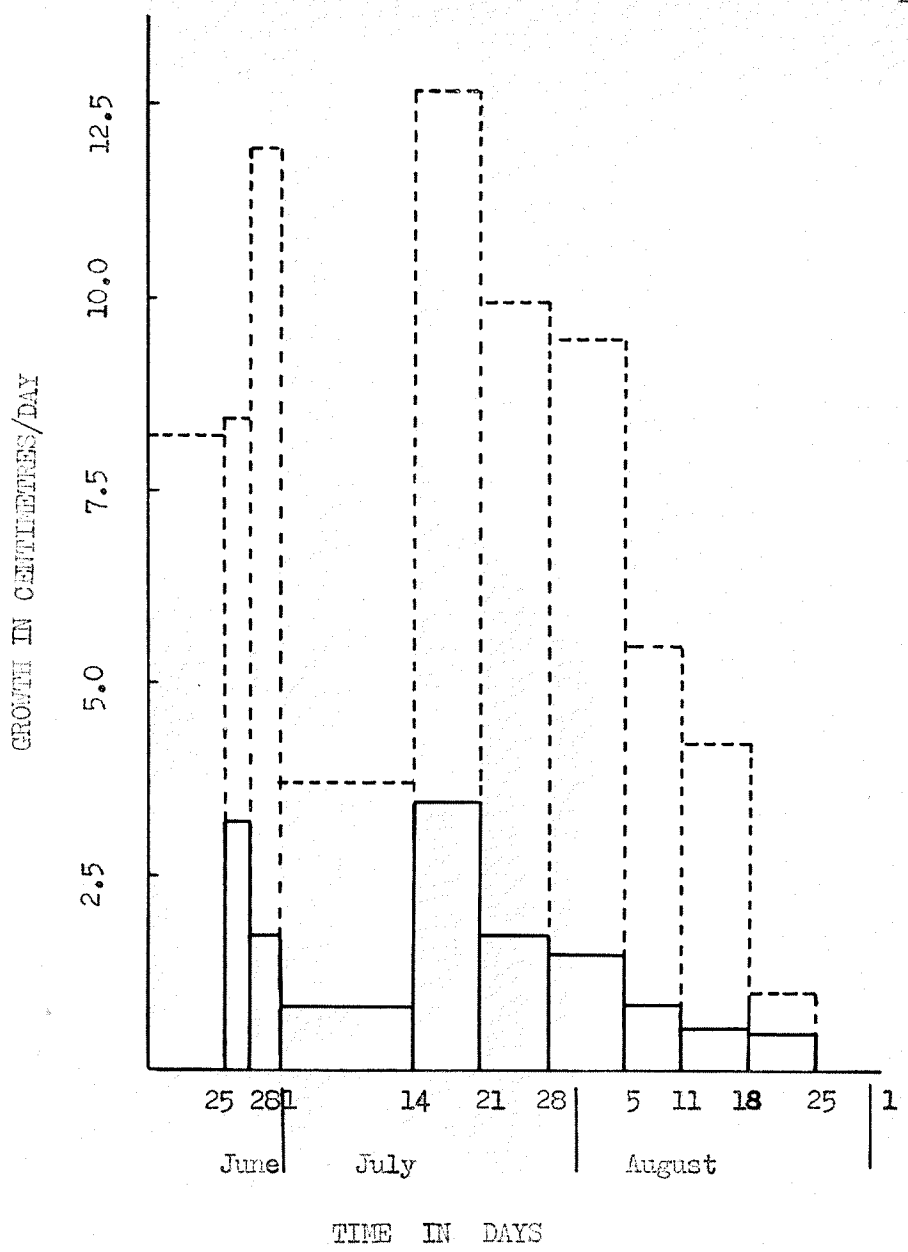



Figure 75. Histogram to show seasonal trends in growth in upright Phragmites shoots and runners.

- - - - - Runners

——— Upright shoots.

development of shoots from runners in wet and in drying situations, two lines were set up across a depression which had drying mud at the edges and 10.5 cm. water over the soft muck in the centre. Young runners were cut up into lengths of about 15.0 cm. each containing a node, some with small shoots and the slight protuberances of potential roots. Others had no indication of shoots or roots. These were planted along a line at intervals of 1 m. and their progress noted.

Older runners were cut up and planted in a row 5m. from the first line. Each node in this case had young shoots and roots well developed. They were planted 2 m. apart.

The height, number of leaves and general condition of the shoots was recorded at the time of planting on June 12th, and subsequently on June 25th and July 21st. The observations for both lines of runners were comparable and for the first line 31 out of 37 nodes had produced shoots 12 days later. On July 21st, 20 of the nodes had developed several shoots seemingly regardless of the wetness of the substrate. Standing water had disappeared in early August.

It was apparent in many sites with surviving clumps of Phragmites that growth was sub-normal. Water had drained off the sites by mid-June, but growth in the isolated clumps was resumed later than in normal stands, in otherwise similar conditions. At the end of the season the leaves were narrower, shoots shorter, flowers rare, and few runners had been produced.

Phragmites fringing areas where the majority of it had been killed

but backed by more or less normal stands, produced numerous runners over the bare mud and, in particular abundance over the sand on the lakeshore (Figure 10). These plants successfully consolidated their position and expanded their range during the summer. Flowers were produced in early August. It has been stated that little viable seed is formed at Delta because of early frosts (Löve and Löve 1954) and no seedlings were observed.

An indication of the productivity of Phragmites growing in from different situations was obtained by selecting stands growing in:-

a) sites which remained water covered or completely water-logged for the whole season (here referred to as 'in water')

b) sites which are water covered for only part of the year (here referred to as normal)

c) sites with isolated stands of Phragmites which showed signs of growth after the high water (here referred to as surviving).

d) sites where the normal growth in 1957 had been cleared by cutting and burning (here referred to as burnt)

In each of these sites at the end of June, July, and August four quadrats each 4 square metres in area were set out, the height of 100 Phragmites shoots selected in a haphazard manner was measured and the number of flowers counted. All the vegetative parts of Phragmites were then cut, approximately 15 cm. above the ground or water surface. They were tied in bundles and dried in the sun for two weeks before being placed in a barn

for a further period of 6 weeks to ensure that they were completely air dry before being weighed on a spring balance. Histograms were plotted to show the length of 100 shoots from each quadrat, at approximately monthly intervals (Appendix I).

Weights of Phragmites from four habitats:-

| Date | Normal | Wet | Surviving | Cut |
|---|---|---|---|---|
| 29th June | 75 oz. | 39 oz. | 59 oz. | 146 oz. |
| 30 July | 194 oz. | 135 oz. | 90 oz. | 207 oz. |
| 28th August | 297 oz. | 340 oz. | 140 oz. | 230 oz. |

Number of flowering shoots from the four habitats:-

| Date | Normal | Wet | Surviving | Cut |
|---|---|---|---|---|
| 29th June | 0 | 0 | 0 | 0 |
| 30th July | 182 | 48 | 49 | 228 |
| 28th August | 217 | 64 | 189 | 258 |

Phragmites grows in a diversity of places which range from aquatic situations with water more than a metre in depth, to sandy sites where the ground is very dry in mid-summer. It occurs where the substratum is soft organic muck, the network of rhizomes and roots produced by the plant stabilize the muck and results in an uneven surface in the terrain. This is particularly noticeable along shorelines and channels where wave action may wash out the muck; (Figure 76) and where the Phragmites grows in clumps (Figure 77) along shorelines. It is also found on many other types of substratum including firm black-earth soil. The two most flourishing stands observed at Delta in 1958 grew in contrasting situations. On dry firm soil near Cram Creek it reached a height of almost 4 metres in a dense close stand; and in the Bluebill/Waterhen/Clandeboye area it grew to a similar height in at least 60 cm. water where deep channels separate

Figure 76. Phragmites on the shoreline showing washed out roots and rhizomes.

Figure 77. Phragmites in characteristic clumps as it grows on the edges of shorelines and bays.

submerged islands clothed with dense Phragmites.

When growing in close dense stands in sites where the water table is below the ground surface for the majority of the summer, no stratum of vegetation was found beneath the Phragmites, but in occasional small clearings straggling plants of Atriplex patula, Chenopodium rubrum, Stachys palustris, Scutellatia galericulata, and Urtica dioica were observed.

In contrast, the edges of stands of Phragmites often support a dense understory of vegetation, again when the substratum is covered with water only part of the season. One of the dominant species in this association was Atriplex patula; also recorded were the following: Aster brachyactis, Stachys palustris, Epilobium glandulosum var. adenocaulon, Urtica dioica, Carex atherodes, Mentha arvensis, Scolochloa festucacea, Ranunculus sceleratus, Ranunculus cymbalaria, Typha latifolia, Sonchus arvensis var. glabrescens, Cicuta maculata, Teucrium occidentale, Rumex maritimus var. fueginus, and Calamagrostis canadensis. Nepeta cateria and Sapponaria vaccaria were both recorded once in this type of situation.

RUMEX MARITIMUS VAR. FUEGINUS

In the majority of drying marsh sites Rumex maritimus var. fueginus was found from the early part of the season until well after the first frosts. It grew on drift lines, muskrat houses, and sites ranging from saturated soft mud to compact dry sand. The thick coarse tap root seldom penetrated more than 10 - 15 cm. but anchored the plant firmly. One or several woody stems were produced and bore many large curled leaves, which, because of their early and rapid growth were a conspicuous feature of the

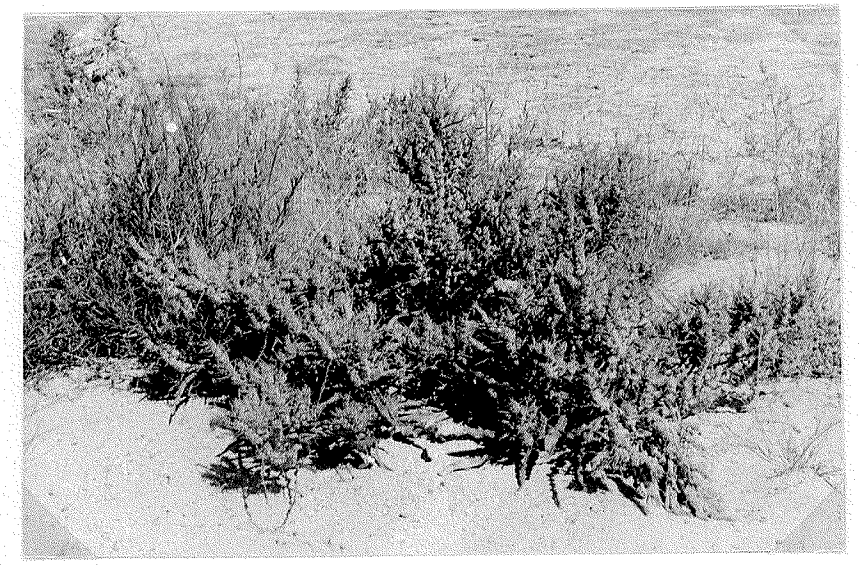


Figure 78. Rumex maritimus var. fueginus showing typical form of growth of well spaced plants.

early flora. Rumex generally occurred as well spaced plants, (Figure 79) the individuals grew rapidly and soon became shrubby. They began to flower in June. The first fruits were formed in early July but flowering continued throughout the season as younger individuals matured.

A few scattered plants occurred on the drying mud zone in most sites, but Rumex was only dominant in the Sioux Pass Lake at St. Ambroise, where it occurred with Typha latifolia. Elsewhere it varied in abundance from single plants to locally dominant. Well-grown individuals reached a height of 90 cm. by the end of the season, and approximately the same width.

CHENOPODIUM RUBRUM

This annual was found in all the wet marshy situations examined, generally occurring as one of the pioneers on the first mud exposed as the level of the water in the marsh dropped. It appeared when the mud was still completely water-logged and very soft, it often grew a few centimetres from the edge of the water, and showed ability to survive short periods of submergence when the water level rose after heavy rains in early July.

It was commonly co-dominant with Atriplex patula, Aster brachyactis and Scolochloa festucacea, either individually or collectively, when forming the first zone of vegetation, and was often associated with Ranunculus sceleratus, Ranunculus cymbalaria, Rumex maritimus var. fueginus and Epilobium glandulosum var. adenocaulon. A selection of stations sampled in June and early July showed Chenopodium recorded with the frequency, cover and sociability in Table XI.

TABLE XI

REPRESENTATIVE SAMPLING FIGURES FOR

CHENOPODIUM RUBRUM

| Locality | Date | $Z_1$ | | | $Z_2$ | | | $Z_3$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | F% | C | S | F% | C | S | F% | C | S |
| Flee Island | 2 July | 28 | 1.0 | 1.4 | 5 | 1.0 | 1.0 | 10 | 1.0 | 1.0 |
| South Cadham Bay | 30 June | 4 | 1.0 | 1.0 | 36 | 1.7 | 2.3 | - | - | - |
| South Portage Creek | 16 July | 10 | 1.0 | 3.0 | 10 | 1.0 | 1.0 | - | - | - |
| Bell's Marsh | 12 June | 10 | 1.5 | - | - | - | - | - | - | - |
| Chimney Marsh | 9 July | - | - | - | 50 | 1.4 | 2.2 | 10 | 2.3 | 2.0 |
| Poplar Pools | 13 June | - | - | - | - | - | - | - | - | - |
| Jackfish Pond | 15 September | 70 | 1.6 | 2.6 | - | - | - | 15 | 1.7 | 2.3 |
| Chimney Marsh | 15 September | 30 | 1.7 | 1.0 | 20 | 1.5 | 2.0 | 20 | 1.0 | 1.0 |
| Flee Island | 12 September | 100 | 3.2 | 3.7 | 70 | 1.5 | 2.1 | - | - | - |
| West Cook Creek | 14 September | 40 | 1.5 | 1.7 | 60 | 1.7 | 2.5 | - | - | - |
| Lead Marsh | 9 September | 60 | 1.5 | 2.5 | - | - | - | 10 | 1.0 | 1.0 |
| Chimney Ridge | 5 September | 80 | 1.6 | 1.9 | 50 | 1.0 | 1.4 | - | - | - |

By September there was a marked increase in the frequency and abundance of this species. At stations where there was no clear zonation of vegetation, Chenopodium rubrum was again one of the first colonizers and was fairly common even early in the year, as the following figures for F/C/S show:-

| Locality | Date | F% | C | S |
|---|---|---|---|---|
| Avocet Marsh | 22 August | 70 | 2.5 | 3.4 |
| Sowl's Marsh | 7 July | 92 | 2.9 | 3.8 |
| E. of Delta Road | 24 July | 60 | 1.0 | 1.7 |
| Tin Town | 30 July | 56 | 1.4 | 3.0 |
| Hutchinsons' Marsh | 5 July | 55 | 1.8 | 3.4 |

It was found on drift lines, Phragmites stubble, washed up Lemna, Muskrat houses, and occasionally in drier habitats, sometimes in dense patches but usually well dispersed. The form of the plant appeared to vary with its density. Crowded individuals assumed a tall (25 - 30 cm.) lean form of growth, with no side branches and with small leaves crowded at the top of the otherwise bare stem. Where there were few plants per unit area, they grew to a height of 140 cm. with low spreading leafy branches giving the plant a broadly triangular shape (Figure 79). Under the latter conditions Chenopodium rubrum overtopped the surrounding vegetation, sometimes by as much as half its own height. When mature the base of the stem was between 1.5 and 3.0 cm. in diameter, coarse and woody. The tap root was short and stocky, reaching a depth of 15 cm. with a spread of 80 cm. (Figure 80) and the ratio of plant height to depth of root system was relatively high. Most of the Chenopodium flowered in late August, and early September.

Even in October, areas of open water continued to diminish and the

Figure 79. Well spaced plants of Chenopodium rubrum showing broadly triangular form of growth. The lower vegetation consists of Scolochloa festucacea, Atriplex patula and a few smaller plants of Chenopodium rubrum.

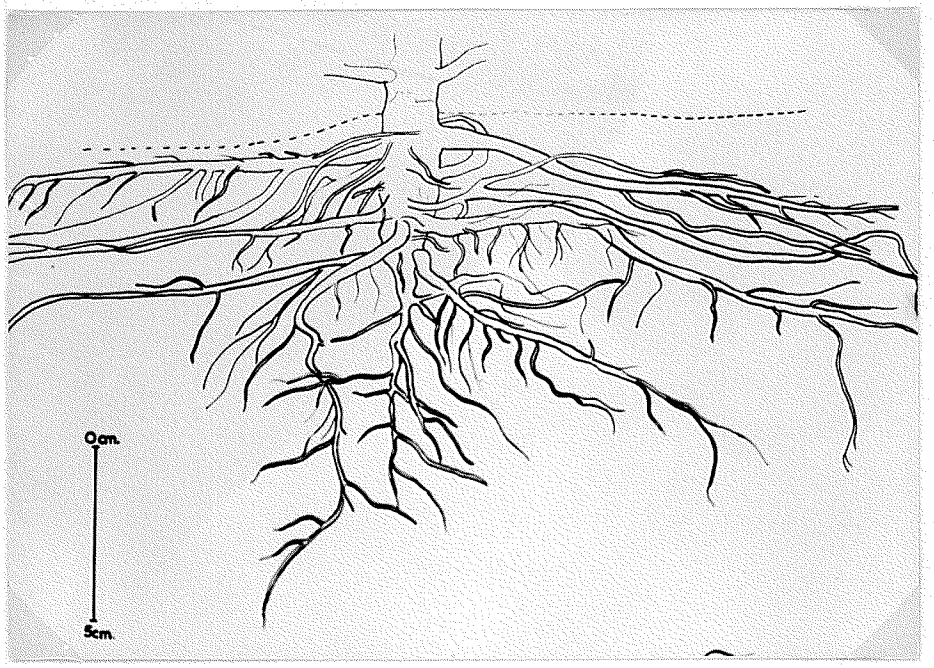



Figure 80. Chenopodium rubrum root system.

exposed mud was colonized almost exclusively by Chenopodium rubrum. An interesting feature of these plants was that though all were less than 15 cm. tall, and most had a rosette habit, they were flowering. Even plants with only two or three leaves had flowers in axillary clusters. This meant that these individuals had developed from seed to flowering in a period of approximately 20 days.

ATRIPLEX PATULA

When vegetative growth began in the spring one of the first plants to appear was Atriplex patula. It grew in many habitats both among the dead Phragmites and on any site with sufficient drainage to permit its establishment, such as drift lines and muskrat houses. It was frequently the dominant plant in drying habitats formerly dominated by Typha, Phragmites or Scirpus sp. where the dead remains of these plants were still standing.

At first the majority of plants grew erect, their slender branches diverging widely, but soon two growth forms were apparent. In some habitats isolated plants adopted a prostrate habit (Figure 81). From the centre of such plants low branches radiated out; they branched and soon a confusion of recumbent leafy stems covered the ground (Figure 82). The ends of these branches frequently grew erect and bore interrupted-spikiform infloresences, towards the end of July, when the first plants began to flower.

In some stations, as at Cook Creek, the majority of Atriplex patula plants adopted this prostrate habit, but erect individuals were found among plants of the prostrate form. A number of these erect plants were examined

Figure 81. Young rosette of Atriplex patula.

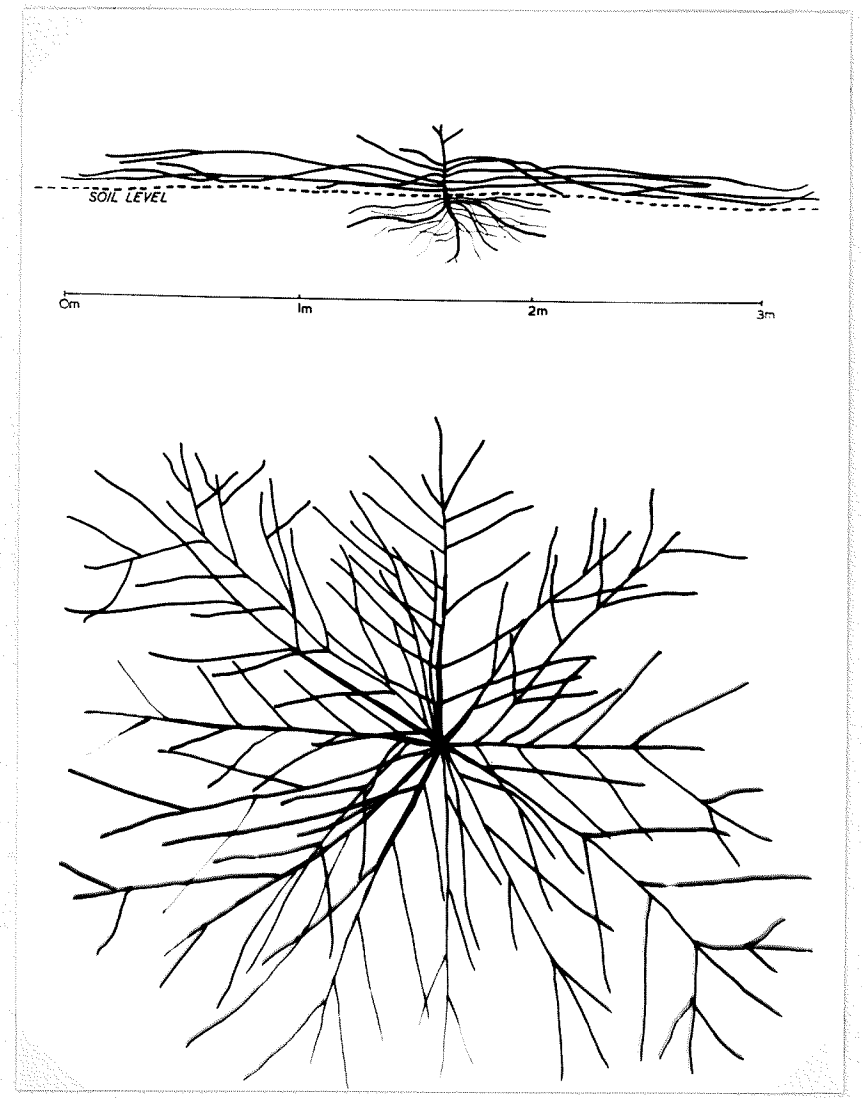



Figure 82. Diagram showing elevation and plan of mature rosette of Atriplex patula

on August 22. The short woody tap root extended into the moist soil to a depth of approximately 15 cm. and bore many lateral roots, the overall width of the root system being 35 cm. (Figure 83). The extensive aerial parts were in marked contrast to the shallow root system. From the tall woody stem (105 - 130 cm. in height) several leafy branches were given off, the lower ones slightly ridged and at right angles to the main axis, the upper at an angle of forty five degrees, their ends tending to grow vertically upwards. The plants were triangular in form, but narrower than Chenopodium rubrum ranging in width from 30 to 45 cm. Each of the original branches itself divided, and the divisions were terminated by an inflorescence. Many of these were flowering in early August, and the fleshy involucral bracts concealed mature seed by mid-September. The leaves were very variable in size and shape. Prominent basal lobes and coarsely toothed margins were present when the leaves were fully grown.

By this time the prostrate forms had a root system very like those of the erect plants (Figure 84), but their aerial parts had a maximum height of 75 cm. The recumbent branches had red ridges along them, and spread out to give the plant a diameter of as much as 250 cm. (Figure 82). The leaves which were generally suffused with red had fewer teeth than in the erect form and large basal lobes were uncommon.

Small erect forms less than 30 cm. high of Atriplex patula grew as an understory to other species in a number of places, e.g. Merganser Marsh beneath Scolochloa, where the Atriplex was about 20 cm. high and though more or less completely shaded by the grass (75 cm. high) it flowered and set fertile seed.

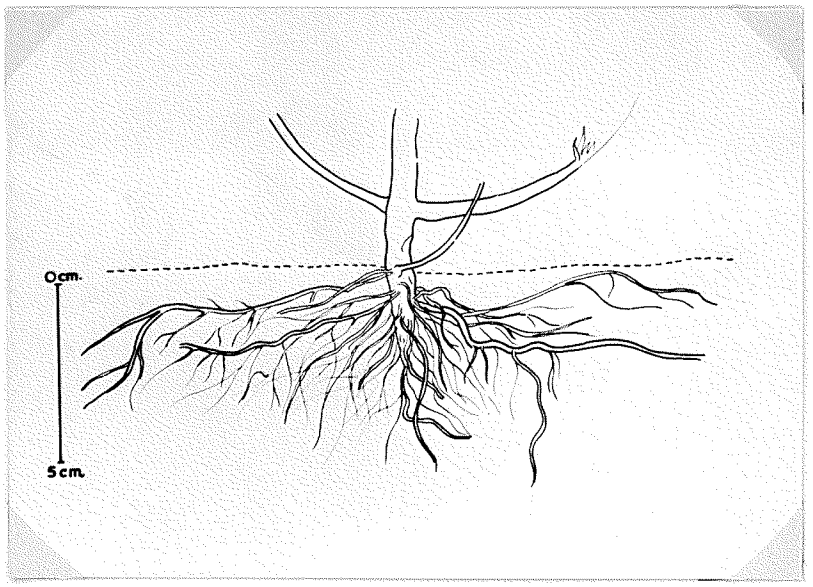



Figure 83. Root system of an erect form of Atriplex patula.

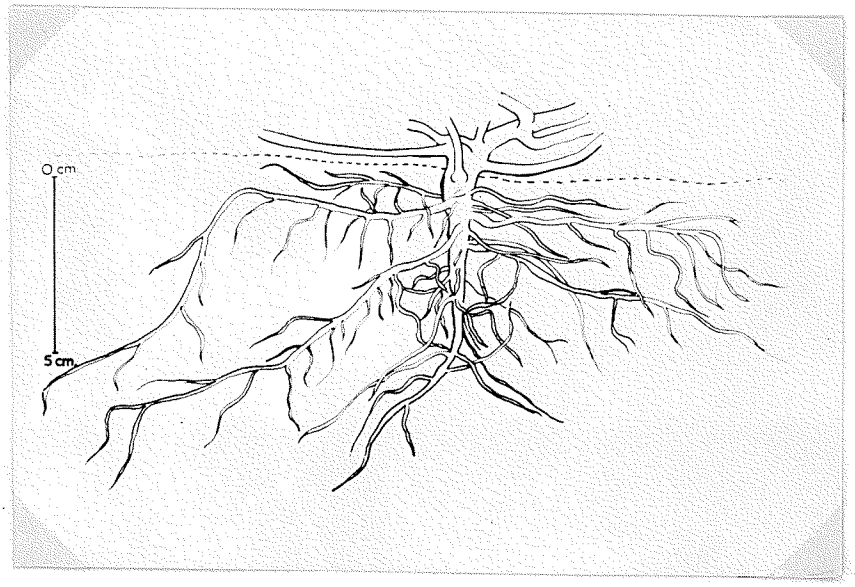



Figure 84. Root system of a prostrate form of Atriplex patula.

Atriplex was commonly associated with Scolochloa, Chenopodium rubrum, Rumex maritimus var. fueginus, Epilobium glandulosum var. adenocaulon, Stachys palustris, Ranunculus sceleratus and Ranunculus cymbalaria, its F/C/S in several sites is given in Table XII.

RANUNCULUS SCELERATUS AND RANUNCULUS CYMBALARIA

Where Phragmites was growing or had recently grown in the marsh the ground was uneven, for areas consolidated by rhizomes and roots were a little higher than their surroundings.

On these raised patches Ranunculus sceleratus became established early in the year, when the ground was covered with shallow water, or bare, and communities open with competition from other species at a minimum. Under these conditions, Ranunculus sceleratus thrived, growing rapidly from a rosette into a spreading succulent plant. The flowers rarely seemed to be perfect, averaging three petals at any time, but they set considerable quantities of seed.

In several places, Ranunculus sceleratus dominated the early association of the following species: Scolochloa festucacea, Aster brachyactis, Rumex maritimus var. fueginus, Atriplex patula, Chenopodium rubrum, Carex atherodes, etc. It became less conspicuous as the season progressed, partly because many of the species with which it was frequently associated, grew more rapidly and over-shadowed the Ranunculus sceleratus. It was never observed to become woody, and individuals did not persist until the end of the growing season. The plants around them generally spread into the space left as Ranunculus withered. It occurred most commonly in the first zone of vegetation, this is shown by the following data:

| Locality | Date | $Z_1$ | | | $Z_2$ | | | $Z_3$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | F% | C | S | F% | C | S | F% | C | S |
| Hutchinson's Marsh | 5 July | 60 | 1.6 | 2.9 | - | - | - | - | - | - |
| Decoy Pool | 9 July | 90 | 3.6 | 4.3 | - | - | - | - | - | - |
| Portage Creek | 16 July | 70 | 1.0 | 1.7 | - | - | - | - | - | - |
| Flee Island | 12 Sept. | 15 | 1.3 | 1.3 | - | - | - | - | - | - |
| Lead Marsh | 9 Sept. | 80 | 1.0 | 1.4 | - | - | - | - | - | - |
| Chimney Marsh | 15 Sept. | 80 | 1.2 | 1.9 | 40 | 1.5 | 1.7 | - | - | - |

At stations where there was no clear zonation but a well developed region of vegetation, the following F/C/S figures were obtained:-

Ranunculus sceleratus

| Locality | Date | F% | C | S |
|---|---|---|---|---|
| Flee Island | 2 July | 100 | 4.6 | 5.0 |
| Avocet Marsh | 7 July | 32 | 1.6 | 3.0 |
| | 22 August | 35 | 1.3 | 1.9 |
| Tin Town | 30 July | 20 | 1.4 | 2.4 |
| Richardsons' | 13 September | 35 | 1.7 | 1.4 |

Ranunculus cymbalaria was found in similar habitats to Ranunculus sceleratus and also on soils with better drainage. In these sites, for example on the ridges at Hutchinson's Marsh and Chimney Marsh, it became locally dominant. When established, it spread rapidly by radiating runners which rooted at their nodes and effected a rapid propagation of the plant. (Figures 86, 87) This habit enabled the plant to persist in a site even after the original plants had died.

In alkaline meadows Ranunculus cymbalaria was an important colonizer, and was found with Suaeda depressa, Salicornia rubra, Puccinellia nuttalliana, Hordeum jubatum, and Atriplex patula. The following data indicate its F/C/S at different stations:-

Figure 85. Ranunculus cymbalaria showing runners radiating out from the plant.

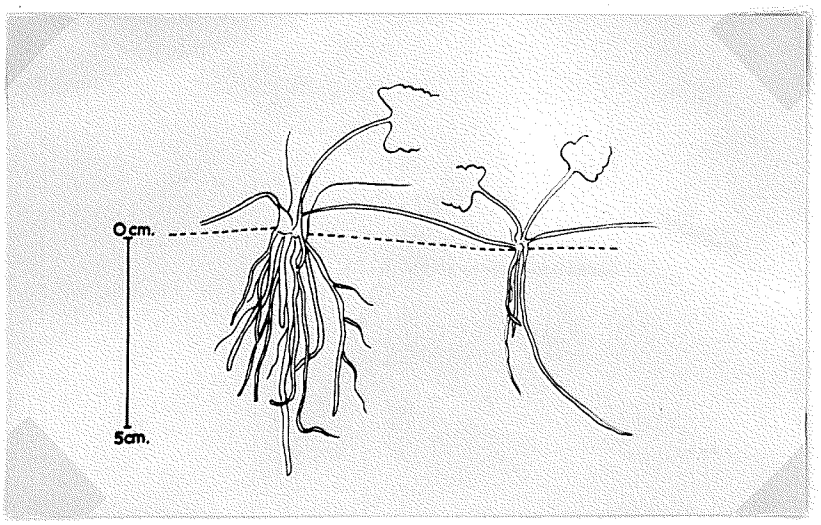



Figure 86. Ranunculus cymbalaria showing root system.

TABLE XII

REPRESENTATIVE SAMPLING FIGURES FOR

ATRIPLEX PATULA.

| Locality | Date | $Z_1$ | | | $Z_2$ | | | $Z_3$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | F% | C | S | F% | C | S | F% | C | S |
| Jackfish pond | 15 September | 95 | 2.9 | 3.4 | 30 | 2.3 | 2.7 | 15 | 1.0 | 2.0 |
| Flee Island | 12 September | 10 | 1.0 | 1.0 | 35 | 1.6 | 2.1 | 40 | 2.5 | 3.0 |
| Shooting Lodge | 2 July | 12 | 2.7 | 3.7 | 100 | 3.6 | 4.3 | 10 | 1.0 | 1.0 |
| Delta Road Ridge | 24 July | 20 | 1.5 | 3.5 | 17 | 1.2 | 2.3 | - | - | - |
| Tin Town | 30 July | 100 | 3.0 | 4.3 | - | - | - | - | - | - |
| | 12 September | - | - | - | 100 | 2.7 | 3.8 | - | - | - |

| Locality | F% | C | S | F% | C | S |
|---|---|---|---|---|---|---|
| Jackfish Pond | 60 | 1.0 | 2.4 | - | - | - |
| Decoy Pool | 10 | 3.0 | 4.0 | 4.0 | 2.7 | 4.2 |
| Flee Island | 20 | 1.2 | 1.8 | - | - | - |
| West Cook Creek | 30 | 1.0 | 1.0 | 30 | 1.0 | 1.0 |
| Lead Marsh | 100 | 1.3 | 2.2 | 100 | 3.8 | 3.8 |

ASTER BRACHYACTIS

Early in the season seedlings of Aster brachyactis germinated in the wet mud which formed drying zones often in close proximity to standing water, on drift lines, and also on hummocks scattered irregularly throughout the marsh where the ground was uneven.

Growth was steady throughout the summer, plants reached a height of between 30 and 45 cm. by September when they flowered prolifically, producing abundant seed. Most of this was scattered during October, much of it being trapped in cracks in the dry surface mud.

Table XIII shows frequency, cover and sociability of Aster brachyactis in a selection of stations.

Where the Aster plants occurred well spaced, the individuals produced many leaves, and side branches along the whole length of the stem, giving the fully grown plant a spreading rounded appearance (Figure 87). The tap root was shallowly rooted e.g. 9 cm. in a plant of 75 cm.(Figure 88b).

In more crowded conditions e.g. where 118 plants of Aster brachyactis occurred in 90 sq.cm. (together with four plants of Chenopodium rubrum and four of Atriplex patula), no branches were formed on the lower part of the stem, and those on the upper portion were short and did not diverge widely from the main axis. The plants were tall and slender.

By the time it was in flower Aster often produced a complete ground

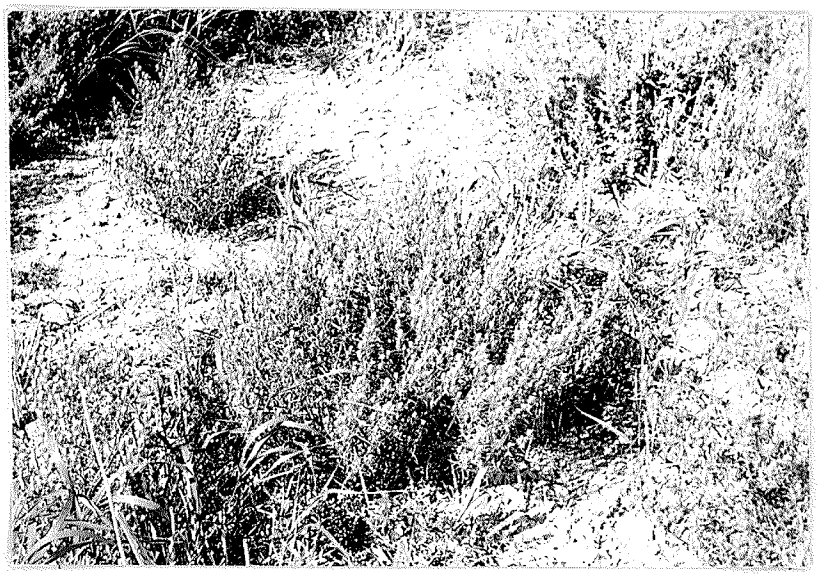


Figure 87. Aster brachyactis single well spaced plants with a rounded form and many side branches.

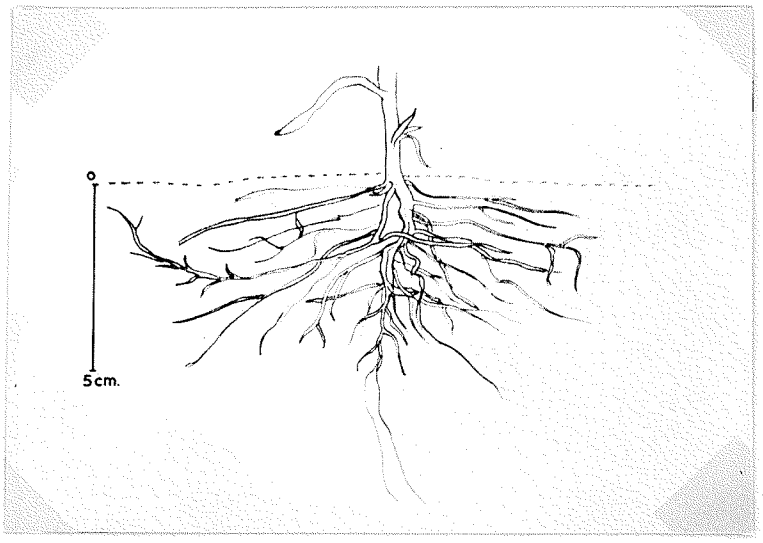



Figure 88. Aster brachyactis showing the relatively shallow root system.

TABLE XIII

REPRESENTATIVE SAMPLING FIGURES FOR

ASTER BRACHYACTIS

| Locality | Date | $Z_1$ | | | $Z_2$ | | | $Z_3$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | F% | C | S | F% | C | S | F% | C | S |
| Jackfish Pond | 15 September | - | - | - | 90 | 2.4 | 3.2 | 15 | 1.5 | 1.3 |
| Decoy Pool | 9 July | - | - | - | 30 | 2.0 | 3.0 | - | - | - |
| Portage Creek | 16 July | 100 | 1.1 | 2.6 | 100 | 4.7 | 4.6 | 75 | 2.6 | 3.0 |
| Flee Island | 12 September | 35 | 1.0 | 1.4 | 100 | 4.0 | 4.6 | 60 | 2.0 | 2.8 |
| Shooting Lodge | 2 July | 92 | 1.8 | 3.0 | 24 | 2.1 | 3.5 | 12 | 1.7 | 3.0 |
| Cook Creek | 2 July | 100 | 2.6 | 3.8 | 90 | 1.6 | 2.6 | - | - | - |
| Portage Creek | 16 July | 100 | 2.6 | 3.4 | 40 | 2.0 | 2.2 | - | - | - |
| Hutchinson's Marsh | 5 July | 75 | 3.1 | 4.0 | - | - | - | - | - | - |
| Tin Town | 30 July | 100 | 3.0 | 4.3 | - | - | - | - | - | - |
| Tin Town | 12 September | 100 | 2.7 | 3.8 | - | - | - | - | - | - |
| Avocet Marsh | 7 July | 28 | 1.7 | 3.1 | - | - | - | - | - | - |
| Avocet Marsh | 22 August | 90 | 2.0 | 2.8 | - | - | - | - | - | - |

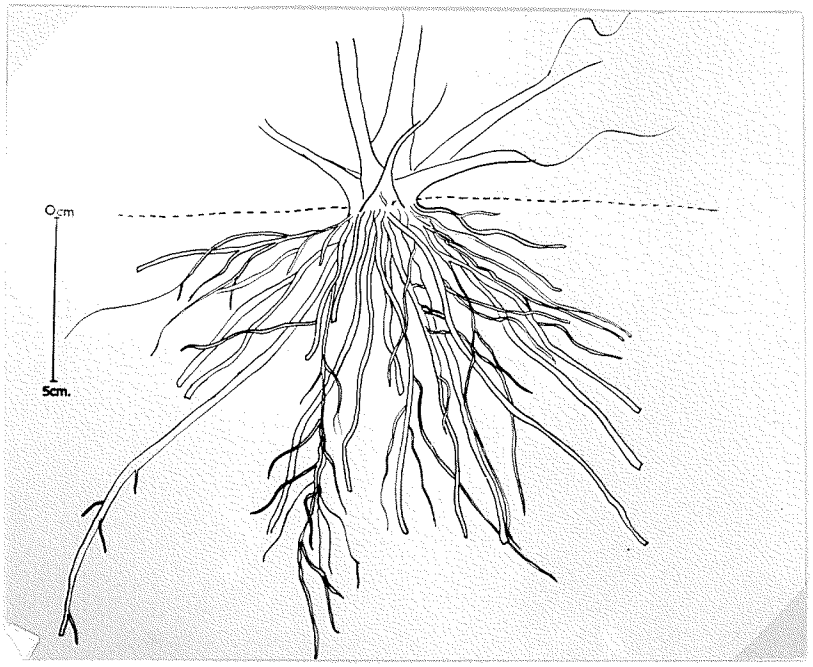



Figure 89. Senecio congestus root system.

Figure 90. Senecio congestus in fruit, with Aster brachyactis growing up around the withering Senecio.

and it was impossible to determine without close examination whether the plants were many and closely packed, or few and well spaced.

SENECIO CONGESTUS VAR. TONSUS

This tall composite with stout hollow stems and large undulate leaves was the first plant to become obvious in the marsh in the spring. It grew in a comparatively small range of habitats, mainly close to the shorelines where dead Phragmites litter, roots and fibrous debris - - some containing a high proportion of comminuted plant remains - - had been washed up. These accumulations were well drained, although generally overlying water, but Senecio showed its ability to flourish in water more than 25 cm. deep.

In the comparatively few localities where it was recorded, Senecio frequently dominated the site, particularly early in the season. It was shallowly rooted; (Figure 89) flowered profusely by early June, and produced abundant seed (Figure 90).

At Bell's Marsh it grew on Phragmites stubble close to surviving Phragmites, and was associated with Ranunculus sceleratus, Scolochloa festucacea, Rumex maritimus var. fueginus, Atriplex patula, and Epilobium glandulosum var. adenocaulon, in order of decreasing relative abundance. In a similar but rather wetter habitat at Tin Town, it was associated with abundant Aster brachyactis, (Figure 90) in another site with Ranunculus sceleratus (3), Scirpus validus (3), Triglochin maritimum (2), Atriplex patula (2), Typha latifolia (2), Rumex maritimus var. fueginus (2), Puccinellia nuttalliana (2), and Aster brachyactis (3). It also occurred as scattered individuals on extensive areas of drying marsh with frequencies of four, five and twenty percent

respectively.

After flowering Senecio slowly withered and was replaced by other species. This was shown clearly at Bell's Marsh where Atriplex patula (3), Chenopodium rubrum (3), and Aster brachyactis (2), invaded the zone of Senecio, together with Stachys palustris (2), Rumex maritimus var fueginus (2), Hordeum jubatum (2), Scolochloa festucacea (2), Typha latifolia (1) and Sonchus arvensis var. glabresecens (1). However, at the end of August, Senacio congestus was again encountered, but this time as a member of the plant communities on the most recently exposed mud, where individual young plants grew in rosettes, 10 - 15 cm. in diameter.

## SECTION IV

## DISCUSSION

In the Delta Marsh the relationship between emergent areas and water levels is effected by both autogenic and allogenic processes.

Autogenic processes involve the slow accumulation of organic and mineral materials on the marsh floor and are accelerated in some places by the presence of various plants.

In the course of years the submerged floor is built up until it supports emergent vegetation. The process of accumulation proceeds at various rates depending on such factors as wave action and density of vegetation, but its tendency is always to produce a less hydric type of habitat. This results in a shift in the hydrach succession.

This shift may be increased or slowed down by fluctuations in water level brought about by the direct influence on the marsh of changes in the level of Lake Manitoba. The lake and marsh are in continuous contact through channels across the forested ridge, and a drop in the lake level will result in loss of water from the marsh, and the exposure of previously submerged shores. With drainage and evaporation the substratum becomes suitable for plants such as Senecio congestus which flourish in water-logged conditions. The soft ground is gradually consolidated and number of species that can grow under these drying conditions increases.

The descriptions in Sections I and II make it clear that the position of the marshes at Delta is not stable. Changes in the environment influence

the vegetation and it is the interaction of factors relating to both vegetation and environment that must be considered in an attempt to understand the ecosystems involved (Tansley, 1935).

During the summer of 1958 there were considerable changes both in the pattern and in the extent of the vegetation. But as only one summer was spent in the field the information drawn on is limited. Nevertheless certain trends emerge, and it is hoped that these will be substantiated by further observations.

The water level in the marsh is one of the prime factors influencing both the physical form of the environment and the vegetation. The shoreline, height of the ridge, length, depth and breadth of channels and other geographical features are governed by the water and the materials it carries. The relationships between these physiographic features and the water table at any one time has great bearing on the vegetation.

The examination of soil excavations shows that the same type of pattern exists in a number of places in the marsh, namely bands of black organic muck interbedded with layers containing a higher proportion of mineral material (mainly sandy loam of a grey-brown colour). It was possible to correlate these alternating bands in several stations, and they appear to show that the marsh has suffered periodic inundation by lake sediments.

The type of conditions that could have produced this effect were illustrated on June 9, when a storm accompanied by northeast winds occurred. On the following morning vegetation growing on the highest reaches of the lake shore was in some areas covered by 10 - 15 cm. of sand and debris, and in other places, the vegetation had been completely obliterated. It is

suggested tentatively that the occurrence of similar storms in the past could have inundated considerable areas of the marsh, resulting in this stratified pattern.

Soil analysis is needed, and an investigation of the layers underlying the present surface substratum throughout the marsh. Various techniques for identifying micro and macro plant inclusions, and mineral material could be employed, and would probably give some indication of the past history of the area.

It seems possible to formulate an hypothesis which allows for the discription of three types of hydrosere (arbitrarily delimited) developing simultaneously at Delta. To a certain extent they overlap, and several features are common to at least two of them. Nevertheless clear examples of the extremes of each type are found. They appear to be governed primarily by the chemical nature and texture of the substratum (Penfound, 1953) and the depth and duration of the water overlying them.

Type I Communities generally on flat expanses, developed on the most saline soils.

Type II Communities generally in sloughs and creeks developed on less saline soils.

Type III Communities generally on shores and bays developed on soils with a nearly neutral reaction.

These three types will be discussed briefly below.

Type I Communities developed on the most saline soils. A number of formerly vegetated sites on the south side of the main body of water in the marsh have recently been laid bare by one of three causes: a) by water standing in them for long enough to kill the earlier vegetation;

b) by severe ice and frost action; c) by the activity of man.

Their bareness allowed several features that might otherwise have been obscured to be revealed, among them a conspicuous encrustation of salts on the soil surface.

Salts accumulate in soils because neither surface nor ground water can drain away. With direct evaporation the salt concentration in the soil water is increased, and in areas with a flat topography the gradual evaporation of water has resulted in the accumulation of salts on the soil surface. As the soil pH is normally in the region of 8.2 the soils would appear to belong to the group of saline soils according to the classification of de Sigmond (1945), though alkaline soils also occur in the area.

In saline soils the principal factor depressing plant growth is the decrease in available water due to the high osmotic pressure of the soil solution. Plants require the presence of considerable oxygen in the substrate for absorption of water and minerals. But many saline and alkali soils are water-logged and have low concentrations of oxygen in the soil air, and this lack of oxygen is believed to limit plant growth (Magistad, 1945).

Examples of Type I were found at Love's, Flee Island and Tin Town. They were characterised by an association of plants tolerant of high concentrations of salt.

The vegetation included Salicornia rubra, Suaeda depressa and Puccinellia nuttalliana as early colonizers. These three species generally occurred in open communites, whether they grew in more or less pure patches of one species, or mingled together. The soil was generally a compact, firm, black silty loam with a white encrustation of salts on the surface.

This pioneer association was joined locally by Glaux maritima, and Triglochin maritima which seemed to thrive where there had been disturbance by man, as in cart tracks. Spreading plants of Chenopodium rubrum var. salinum and of Juncus bufonius sometimes joined the association, and in local patches Juncus balticus var. littoralis produced long lines of plants from its creeping rhizomes.

After varying periods of time this community became invaded by other species which formed an intermediate group, including Eleocharis palustris, Scirpus paludosus, Scirpus americanus, Rumex maritimus var. fueginus, Scolochloa festucacea and Aster brachyactis with some Polygonum ramosissimum. It was in this community that the first shoots of Phragmites were encountered. As the substratum became better drained the size of the plants in this intermediate zone increased and the Phragmites-dominant marsh was reached. With increased density of the Phragmites shoots, the ground vegetation became sparser, and in some places disappeared altogether.

Type II Communities developed on less saline soils. Habitats of this type were distinguished from the foregoing by several features, among them the wider variety of species present, the greater density of vegetation and the wider range in type of substratum. Sites in this category were covered with water in the early part of the year, at least until the sub-soil thawed. Many contained water until the end of the season but in all cases the area occupied by water diminished during the summer, though temporary fluctuations occurred after rain.

As water evaporated, salts were drawn out and formed a thin layer on

the surface of the ground, or on the skin of dead vegetation overlying it. The soil was sometimes a firm, poorly drained, salinised sandy loam. The surface layers dried out during the summer causing cracks up to 25 cm. deep to appear as at Portage Creek. Elsewhere the soils were very poorly drained, muck and peaty deposits, frequently overlying alluvial sands and silts in eroded channels. Such sites were often very stagnant and decomposition gasses accumulated. It is acknowledged that the oxygen concentration must fall below ten or eleven percent in a soil atmosphere before any injurious effect is produced (Romell 1922). This is rare in ordinary soils, but almost invariable in submerged soils of aquatic habitats. As vegetation was sparse (if present at all) in some of the water-covered sites referred to, it can probably be assumed that the available oxygen was below the critical concentration for plant growth. When certain species such as Scirpus validus and Scirpus paludosus were found in these conditions one may ask how their roots developed and grew with a smaller supply of free oxygen for respiration than that needed by plants of other habitats, and whether they do in fact need the same supply and get it, not from their immediate environment but indirectly from the air (Conway, 1940).

During the season, the water level dropped at an irregular rate, periodically uncovering new areas of bare mud. The pioneers which colonized the first mud to be exposed had if necessary, the whole season in which to mature, while those which colonized the last exposed mud had a much shorter growing season.

Thus a gradient existed from tall and mature plants to small young plants only a few centimeters in height. (Brown 1943). In many sites

this gradient could be divided into zones, either on species composition or by species height. Examples are discribed from Flee Island, Pintail Slough and other localities. The most common species were Chenopodium rubrum, Atriplex patula, Scolochloa festucacea, Ranunculus sceleratus, Ranunculus cymbalaria, Rumex maritimus var. fueginus, Aster brachyactis, Eleocharis palustris, Puccinellia nuttalliana, Hordeum jubatum and Carex atherodes.

Type III Communities developed on soils with a nearly neutral reaction. Comparing habitats in this group with acid marshes in the southern United States, according to Penfound (1953) there can be described:-

a. deep marshes (freshwater grass-sedge-rush communities the soil of which is covered by water throughout most or all the growing season).

b. Shallow marshes and wet meadows (grass-sedge-rush communities in which surface water is usually present for only a small part of the growing season).

As already described both deep and shallow marshes are present at Delta. In the former group, submerged aquatic vegetation was normally present - - Potamogetons, Ceratophyllum, and Myriophyllum, the depth in which they grew was largely dependent upon the availability of light, in turn affected by the turbidity of the water. Where the substratum was sufficiently consolidated to support emergent plant growth, beds of Phragmites, Scirpus acutus, and Typha latifolia grew in water sometimes several decimetres deep. On the water's edge, with their roots in completely water-logged soil Senecio congestus, Ranunculus sceleratus, Rumex maritimus var. fueginus, Typha latifolia and other species flourished. This type of habitat was found within the system of the main bays.

Gradual reduction of the water area, ( as in Type II) resulted in the establishment of vegetation, but here the soil was generally a dark, partially consolidated muck, which even at the end of the summer could not be described as firm. Pioneers early in the season included Ranunculus sceleratus, Ranunculus cymbalaria, Galium trifidum, Epilobium glandulosum var. adenocaulon, Carex atherodes, Rumex maritimus var. fueginus, their abundance varying with the site. Towards the end of the growing season Ranunculus sceleratus was less common as a pioneer, its place being taken in part by Typha, Scolochloa festucacea, Chenopodium rubrum and Atriplex patula.

The aggradation of the level of the substratum by organic and inorganic sediments has been one of the causes of the expansion of shallow marshes, and further accumulation of materials has changed them into wet meadows. The net result of this accumulation is the lowering of the water table and increase in oxygen tension in the soil above it. While these changes are in progress more mesic plants are able to become established and reproduce themselves in modified parts of the area, and competition is increased. At Delta the production of a more mesic habitat does not necessarily require the substratum level to be raised; for the periodic lake fluctuations create a similar situation, in which the water table is lowered.

The water level, salt concentrations, soil texture, moisture conditions, debris, seed availability and other factors are important in determining the local distribution of marsh species. Although owing to local variations

in these conditions many sites consist of an intricate pattern of the three types just described, there is a preponderance of Type III in sites immediately south of the forested ridge and no evidence of Type I.

In each area examined, Type I, II or III predominanted but the station name may cover several sites, nevertheless it seems helpful to list the sites studied, in the type group into which they have been tentatively placed:-

| Type I | Type II | Type III |
|---|---|---|
| Tin Town | Portage Creek | Chimney Marsh |
| Flee Island | Tin Town Creek | Jackfish Pond |
| Love's | Pintail Slough | Hutchinson's Marsh |
| Poplar Pools (Meadows) | Avocet Marsh | Nest Box 34 |
| | Flee Island | Bell's Marsh |
| | | Poplar Pools |
| | | Portage Creek (depression) |
| | | General south shore of the marsh. |

Some plants are characteristic of one of the types mentioned for example Salicornia rubra was invariably found in Type I whereas other species such as Atriplex patula were encountered in the full range of types.

During the season there was a change in the pioneers colonizing the mud exposed by the diminishing water. Ranunculus sceleratus appeared early in the year and for a time dominated the fringe of mud, but as successive zones of the substratum were uncovered Scolochloa festucacea and Chenopodium rubrum often replaced Ranunculus as the dominant species. In a similar way the status of Senecio congestus altered during the summer. Its early growth was both rapid and extensive in certain sites, and resulted in the appearance of sizable stands of Senecio before most of the other species had germinated. It flowered and set

seed, which was dispersed, and the plants withered and disappeared from their original stands. Later in the year Senecio was encountered together with other seedlings on the newly exposed mud, but its role was no longer that of an aggressive species. The summer was not long enough for two flowering crops to be produced.

The seasonal aspects of several species are listed in Table XV and though the information is subjective, it indicates whether a particular species had a short period during which seedlings could be found, or whether they occurred throughout the growing season, etc.

Many of the species which played a part in primary colonization were annals, such as Chenopodium rubrum, Atriplex patula, Aster brachyactis, Ranunculus sceleratus and Rumex maritimus var. fueginus. It was found that their root systems were characteristically shallow and occupied a surprisingly small area when compared with their aerial parts. This was also the case with many other plants such as Senecio congestus (annual or biennial), Puccinellia nuttalliana, (biennial or perennial), Ranunculus cymbalaria (annual or perennial).

It appeared that the wetness of the substratum in some measure inhibited the development of deep roots. This was borne out when Atriplex patula growing on the lakeshore was found to have a root that penetrated to a depth of 37 cm. in comparison with Atriplex growing on the marsh (root depth 13 cm). Similarly roots developed at the nodes on the runners of Phragmites on the lake shore, generally penetrated more than 17 cm. into the sand while those in the marsh (of the same age) were never found to exceed 8 cm. in length. The average depth and spread of the roots; and the height of 20 plants growing in muck soils is given in Table XIV.

TABLE XIV.

AVERAGE DEPTH AND SPREAD OF

ROOTS AND HEIGHT FROM 20 PLANTS.

| Species | Root | | Height of aerial parts of plant in cm. |
|---|---|---|---|
| | Depth in cm. | Diameter of spread in cm. | |
| Senecio congestus | 14 | 18 | 90 |
| Chenopodium rubrum | 15 | 75 | 120 |
| Atriplex patula (erect) | 8 | 35 | 120 |
| Atriplex patula (rosette) | 13 | 32 | 40 |
| Aster brachyactis | 12 | 15 | 70 |
| Rumex maritimus var. fueginus | 13 | 30 | 70 |

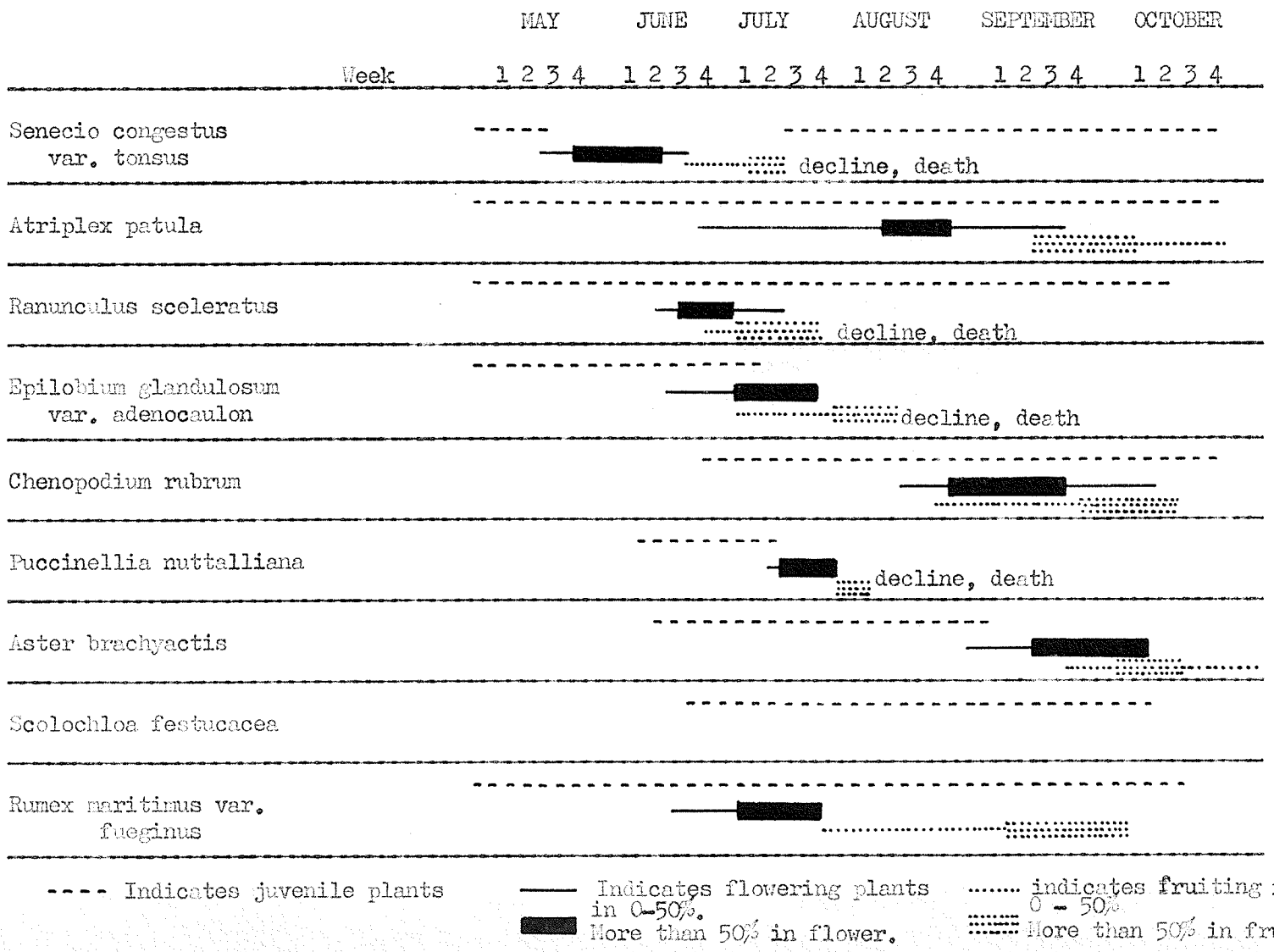
Studies in the relationship between growth, form and habitat, and ecophenic experiments (Clausen, Keck and Hiesey 1940, 1945, 1948) with certain of the dominant species such as Phragmites communis, Chenopodium rubrum, Atriplex patula, and Aster brachyactis would give some indication as to the tolerance of these species, the presence of ecotypes and other useful data.

This work is in the nature of an initial survey and indicates that analysis of the environment is needed. The effects of variations in topography, type of substratum, salinity, moisture and other factors which influence the pattern of vegetation, must be assessed. The effects of prolonged drying and of reflooding on the succession in the marsh will throw some light on the stability of vegetation patterns described here. It is obvious that there are many avenues that must be explored and further work is essential before more than a fragmentary understanding of the Delta Marsh will be obtained.

TABLE XV.

ECOLOGICAL LIFE CYCLE OF SELECTED SPECIES,

ON NEWLY EXPOSED GROUND.



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# APPENDIX.

A. Histograms plotted from the measurements obtained by measuring 100 shoots of *Phragmites communis* growing :

a in normal conditions

b in water

c in surviving stands

d after cutting and burning

In each sample the shoots were selected in a haphazard manner measurements were taken on June 30th, August 1st, and August 29th.

B. Key to transect and profile diagram symbols.

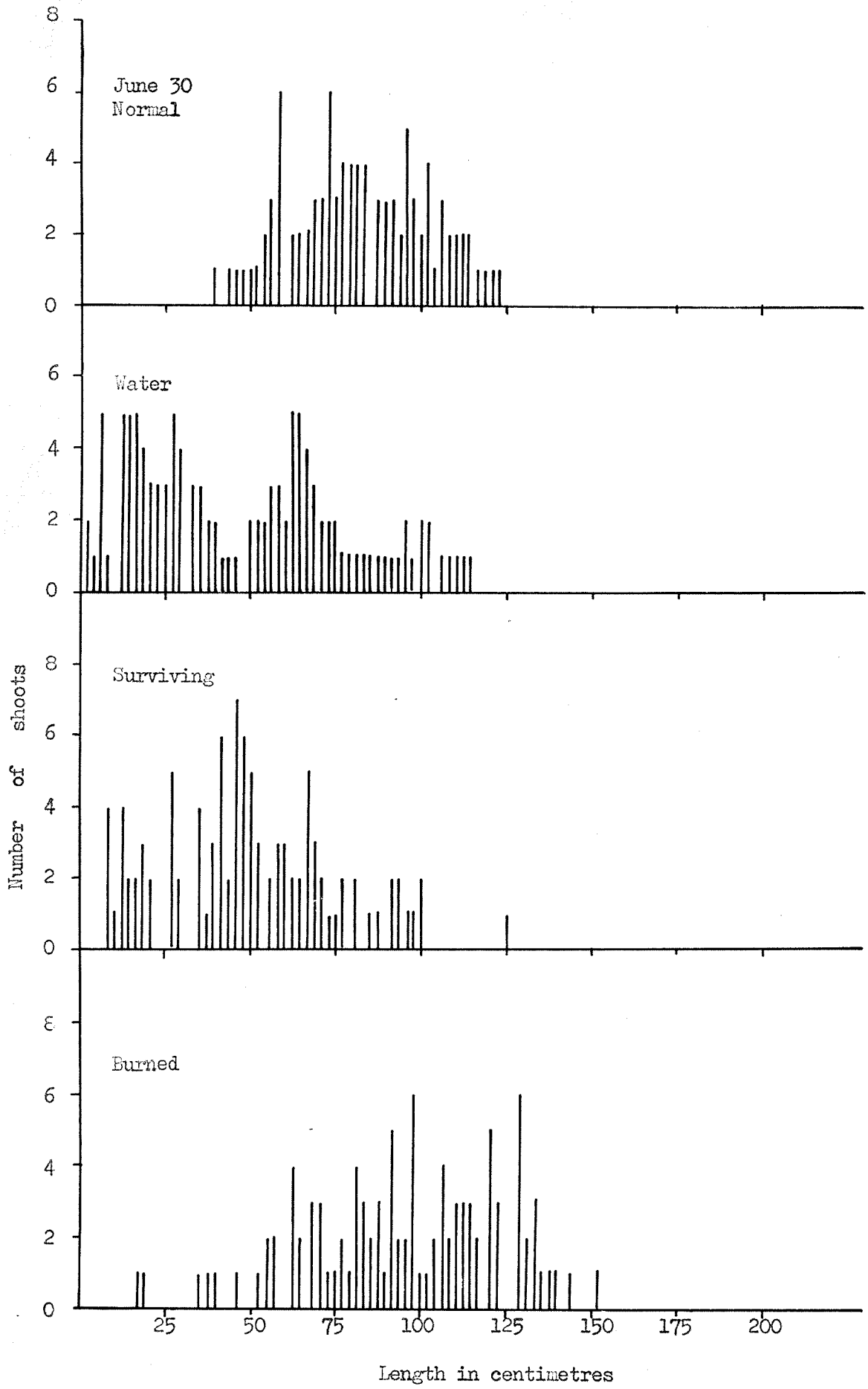

June 30
Normal
Water
Surviving
Burned
Number of shoots
Length in centimetres
0
2
4
6
8
25
50
75
100
125
150
175
200

FIGURE 91

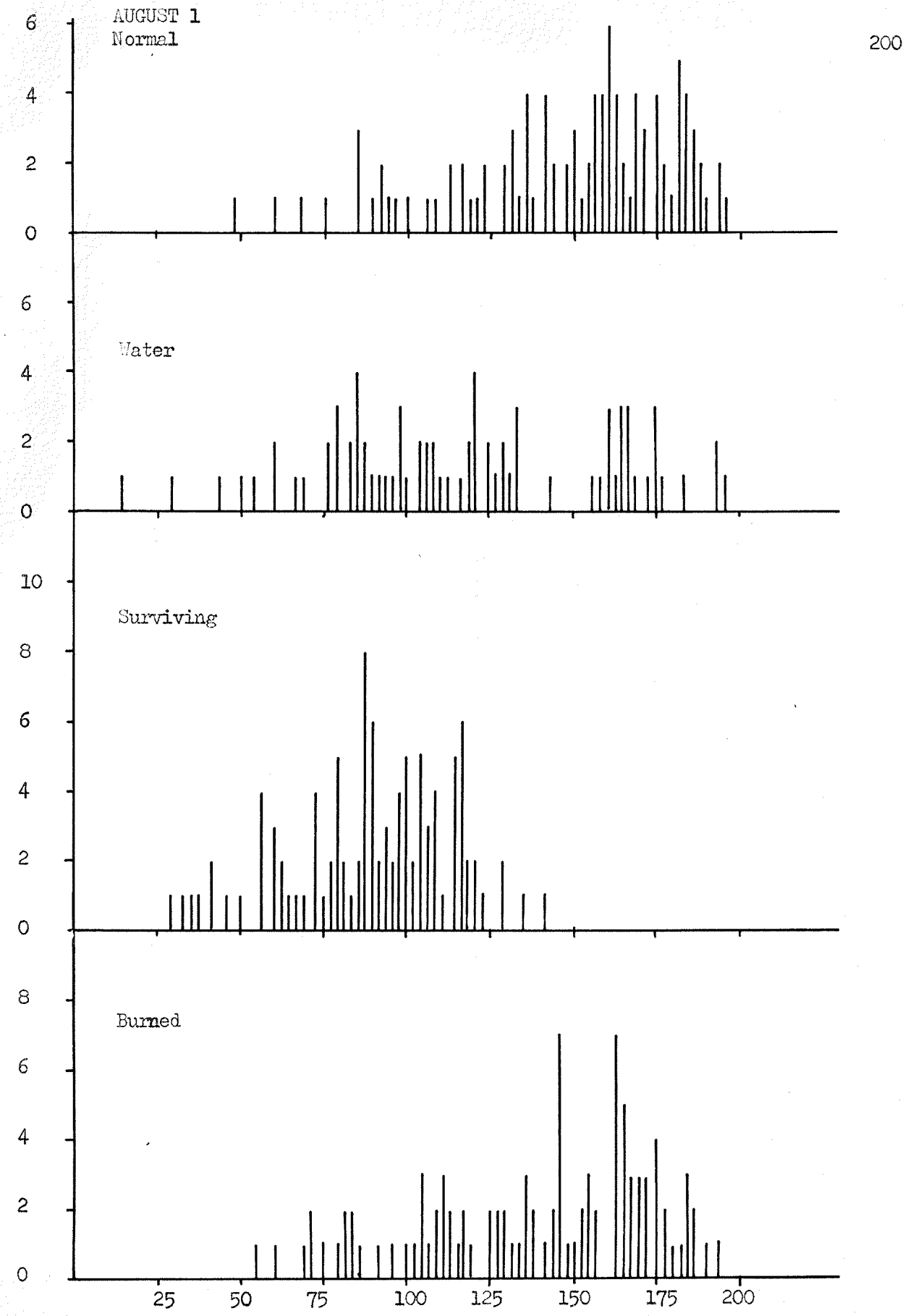
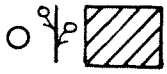
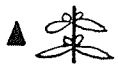
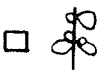
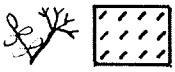

AUGUST 1
Normal
200
Water
Surviving
Burned
25
50
75
100
125
150
175
200
Length in centimetres

FIGURE 92

## B. KEY TO TRANSECT AND PROFILE DIAGRAM SYMBOLS.

| | | | |
|---|---|---|---|
| Acer negundo | An | Galium trifidum | Gt  |
| Artemisia biennis | A | Hordeum jubatum | O  |
| Artemisia frigida | Af | Lactuca pulchella | Lp |
| Aster brachyactis |  | Lemna minor | Lm  |
| Aster praealtus | Ap | Lycopus americanus |  |
| Atriplex patula |  | Mentha arvensis |  |
| Bidens cernua | Bc | Phragmites communis |  |
| Carex atherodes | Ca  | Poa annua | P  |
| Carex bebbii |  | Polygonum hartwrightii | Ph |
| Chenopodium rubrum |  | Polygonum persicaria | Pp  |
| Cicuta maculata |  | Polygonum ramossissimum | Pr  |
| Cirsium arvense |  | Potentilla anserina | Pa |
| Cuscuta megalocarpa |  | Prunus virginiana | Pv |
| Eleocharis palustris |  | Puccinellia nuttalliana |  |
| Epilobium glandulosum var. adenocaulon |  | Ranunculus cymbalaria |  |
| Eupatorium maculatum var. bruneri | Em  | Ranunculus flabellaris | Rf |

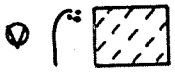
Ranunculus sceleratus 

Rorippa islandica var. fernaldiana Ri

Rumex maritimus var. fueginus 

Scirpus acutus Sa

Scirpus paludosus 

Scirpus validus 

Scolochloa festucacea 

Scutellaria galericulata Sg

Senecio congestus var. tonsus ■

Sium sauve 

Solidago canadensis ▽ 

Sonchus arvensis var. glabrescens △ 

Spartina pectinata Sp

Stachys palustris 

Suaeda depressa ✳

Teucrium occidentale To

Triglochin maritima T

Typha latifolia — 

Urtica dioica var. procera Ud 

Utricularia vulgaris U