FISHERIES RESEARCH BOARD OF CANADA

MANUSCRIPT REPORT SERIES

No. 1219

Distribution and Biomass of intertidal vascular plants on the Squamish Delta

by

P. G. Lim and C. D. Levings

Pacific Environment Institute, West Vancouver, B.C.

April 1973

FISHERIES RESEARCH BOARD OF CANADA

MANUSCRIPT REPORT SERIES

No. 1219

Distribution and Biomass of intertidal vascular plants on the Squamish Delta

by

P. G. Lim and C. D. Levings

Pacific Environment Institute, West Vancouver, B.C.

April 1973

CONTENTS

INTRODUCTION

Study of the plant community is necessary to understand most ecosystems and their component food webs. Data on vascular plants of marsh deltas is of particular interest, since decomposing marsh plants may supply detritus which can be used as food by invertebrates such as amphipods and isopods (Keefe, 1972; Levings, 1973). In some B.C. deltas these invertebrates are consumed by juvenile salmonids (Parker and Kask, 1973; Goodman and Vroom, 1973). The plants also provide a direct food source for water fowl, seed-eating birds, and herbivorous animals.

This report describes a survey of the vascular plants of the Squamish River delta. Vegetation maps, species lists, and biomass data are presented, but due to time limitations only the basic characteristics of the complex tidal marsh vegetation were studied.

DESCRIPTION OF THE STUDY AREA

A. Physical Features of Intertidal Lands and Climatology

Based on Stathers' (MS, 1958 p. 129) classification, most of the vegetation surveyed grew on Type II and/or III lands. Type II land, according to Stathers, is "mostly --- flooded with normal high tides --- practically all flooded with high wind-driven tides", and Type III land is "--- tidal marsh --- flooded with every tide --- generally at or below mean sea level". Figure 1 shows the areas of the Squamish delta which were examined in the present study. The vertical distribution of the vegetation was not thoroughly investigated, but it was observed that vascular plants were not found on the sandy sediments below the mean tide level. The mean tide level, which is about 8.8 ft above chart datum, is often marked by an embankment or wave-cut terrace which sedge rhizomes overhang. In some areas, amphipods were abundant under this rhizome mat (Levings, MS, 1973).

The most recent information on soil types found at the Squamish delta (Anon, MS, 1972 p.25) indicates the vegetation grows on material classified as Fluvial (alluvial) - Glacial Marine, with a slope of less than 5%.

Stathers (MS, 1958, p.24) summarizes the climate of the Squamish area. Summer temperatures (May to September) range between 10°C to 44°C, and most values fall between 30°C and 66°C. Stathers noted the presence of temperature inversions in the area, which trapped smoke from industrial operations. This phenomenon was also observed during the present study.

B. Water Bodies and Oceanographic Features

The seaward portion of the Squamish delta is incised by several channels and many rivulets. The larger channels are present or past river channels, and the smaller rivulets or tidal creeks are part of an irregular, incomplete drainage system. All major water bodies in the inner estuary have been named for the purposes of description (see Fig. 1).

Since 1971, when a dyke was constructed, the flow of the Squamish River has been restricted to the west side of the delta. The dyke construction blocked several "flood channels" which drained into the east arm of the Squamish River. The east arm has become the central basin: water movements in this basin originate primarily through tidal action. Two culverts were installed through the dyke on June 12, 1972. Levings (MS, 1973) reported the following general oceanographic features (May to August 1972) for these major channels in the study area:

	Temperature (range, ^{o}C)	Salinity (range, $^{o}/oo$)
Squamish River	6.2 to 8.9	0.0 to 6.8
Central Basin	5.0 to 16.9	1.0 to 19.6

MATERIALS AND METHODS

A. Vegetation Mapping

Field work on the delta was done at irregular intervals between July 21 and August 11, 1972. Plants were collected and returned to the lab for identification which were made with the aid of standard keys, the U.B.C. Herbarium, and personal communication with U.B.C. botanists, especially J. Pinder-Moss. The plants were preserved in herbarium presses and filed for future reference.

Information on the distribution of species was collected by walking over the delta. Primary paths were paralled to a man-made dyke, a fill region, or a shoreline. Secondary paths followed the banks of rivulets too wide to cross in order to continue the primary path.

A record was kept of the species present in different regions; boundaries were noted and rough maps were sketched to establish the relative size and location of zones. Abundance of species were compared using the Braun-Blanquet method as outlined by Ashby (1969), but these results proved unsatisfactory for this study. Line transects were tried on the east delta by pacing east to west parallel to the fill. Record was kept of any changes in vegetation and pace number, but information from these was not sensitive enough to detect patterns.

Standard aerial photographs (Flight Line BC 5469) and low-level aerial photographs (taken courtesy of C.F.B. Comox) were used to guide field trips, and contrasting regions shown in the photographs were investigated in the field to determine the vegetation present. Arbitrary divisions of the vegetation were decided upon and named according to the most abundant species present. The most abundant species was considered the dominant of a particular division. No attempt was made to quantify the abundance of all species within a division, but presence-or-absence data was recorded.

B. Biomass Data

Total area of the vegetation mapped on the three deltas was calculated from Figures 2, 3 and 4 using a polar planimeter. Percentage cover of each plant community was found by tracing area outlines on millimetre graph paper, and area of coverage was then obtained by multiplying cover by total area.

On two collecting trips in early September 1972, metre square quadrats were collected from the various plant communities. High tides prevented collecting a complete set of samples from each area; time limitations prevented replications.

Each sample consisted of all the aerial plant shoots and surface dead material found within a metre square quadrat. Plants were cut off at ground level with a knife and put in plastic bags.

Samples were stored in a freezer, and after defrosting each bag was wet weighed. Subsamples of each bag were placed into preweighed 500 ml. beakers, dried at 55°C. for 8 hours, and then weighed to determine dry weight. Ash weights were obtained by taking subsamples of dried vegetation and ashing in preweighed aluminum trays at 550°C. for two hours. Percent organic was calculated with the following formula:

$$\frac{\text{dry wgt.-ash wgt.}}{\text{wgt.}} \times 100\% - \%\ \text{organic}$$

$$\text{then, } 100\% - \%\ \text{organic} = \%\ \text{ash.}$$

The standing crop of each community was calculated by first determining the dry weight per square meter of vegetation as follows:

$$\frac{\text{wet wgt. (subsample) - dry wgt. (subsample)}}{\text{wet wgt. (subsample)}} = \%\ \text{moisture}$$

$$100\% - \%\ \text{moisture} = \%\ \text{dry wgt.}$$

$$\frac{\text{wet wgt.}}{M^2} \times \%\ \text{dry wgt.} = \frac{\text{dry wgt.}}{M^2}$$

then multiplying this by the total area of coverage of the community on the delta. Organic weight per unit area was also calculated:

$$\frac{\dfrac{\text{dry wgt. (subsample)}}{\text{wet wgt. (subsample)}}}{\text{wet wgt.}/M^2} \times \%\ \text{organic} = \frac{\text{organic wgt.}}{M^2}$$

RESULTS AND DISCUSSION

A. Distribution of Vegetation

Twenty-four species of plants were identified on the tide flats of the Squamish estuary. Most were species of sedge (*Cyperaceae*), grasses (*Gramineae*), and rushes (*Juncaceae*). These are typical inhabitants of marsh and shore regions of estuaries and inland waters (Reid, 1961). No marine plants (e.g. eelgrass, *Zostera* sp.) were found in the study, and previous studies of shoreline vegetation in the Squamish estuary also showed a scarcity of marine vascular plants (Outram, MS, 1963).

Ten vegetation divisions were decided upon. The species found within each division are listed in Tables 1, 2 and 3, and the distribution of the divisions is shown in Figures 2, 3 and 4. All 10 divisions were found on the east delta, but a division dominated by *Juncus balticus* was absent from the west and central deltas. A division dominated by *Scirpus* was not recorded from the central delta.

Sedges

Members of the sedge family are the dominant plants on the delta. *Carex lyngbyei* is the most widespread, being found in almost all areas. This is a rhizomatous perennial native to boggy and marshy places (Hitchcock, et al, 1969). Throughout summer, the separate thin stalks bear seed heads which are consumed by waterfowl (Caldwell, 1962).

The spike-rush (*Eleocharis palustris*), also a sedge and a rhizomatous perennial, favours regions near the mouth of the Squamish River. Large stands of it occur along the seaward edge of the Central and West deltas. It also occurs on gradually sloping banks of rivulets, such as Castle Creek and Cattermole Creek (Figure 1).

True Grasses

True grasses (*Gramineae*) occupy some large regions of the delta. There are significant strips of true grasses on the west shores of the East and Central deltas. Tufted Hairgrass (*Deschampsia caespitosa*) is commonly found and is the only true grass that has spread in significant quantities into sedge zones. Red Fescue *(Festuca rubra)* is particularly common on all three deltas in upper intertidal regions. Grasses with more limited distributions are Meadow Barley (*Hordeum brachyantherum*), Reed Canary Grass (*Phalaris arundinacea*) and Wheatgrass (*Agropyron repens*).

Stands of true grasses were observed landward of a dyke on the north boundary of the east delta, and north of the fill area on the central delta but were not surveyed in the present study. Paish et al, MS,(1972) report these areas as belonging to a "sedge-rush association" of undetermined species composition.

Flowering Plants

Associated with true grasses are several species of flowering plants: (1) silverweed (*Potentilla pacifica*) is distinquished by silvery lower leaf surfaces. This is a common plant of marsh edges and sand flats and is only occasionally found above high tide (Hitchcock et al, 1969); (2) the marsh pea (*Lathyrus palustris*) is another widespread rhizomatous perennial. It is reported to be found only along the coast, primarily on sandy areas of tide flats. Purple and white sweet pea-like flowers distinquish this species in the summer. Sandy regions seem to be preferred sites for its dense clusters (Hitchcock et al, 1969); (3) an aster (*Aster eatonii*) is found densely clumped in some of the true grass zones. It is a woody-stemmed perennial with creeping rhizomes. The pink-purple, yellow centered flowers bloom profusely in August. Flowering plants present in less significant quantities are the wild lily-of-the-valley (*Maianthemum dilatatum*), *Sidalacea hendersonii*, the perennial sow thistle (*Sonchus arvensis*), and a clover (*Trifolium wormskjoldii*).

Umbelliferae

Several species of the parsley family (*Umbelliferae*) are found scattered on the delta. Water parsnip (*Sium suave*) occurs with *Carex lyngbyei* in large areas. Water hemlock (*Cicuta maculata)*, is most abundant in the sandier zones, especially in the upper intertidal regions. The wild carrot (*Daucus carota*) is associated with the diverse communities dominated by true grasses, silverweed and the marsh-pea.

Arrow Grass

Arrow-grass (*Triglochin maritima*) is found in small, dense patches usually mixed with silverweed. On the West delta, arrow-grass is found associated with the spike-rush. This plant's seeds are eaten by ducks (Caldwell, 1962).

Cat-tails

The Cat-tail (*Typha latifolia*) is only found in small areas of the study area. It is usually found directly in front of the tree-line, except on the East delta where it occurs in small patches in the central region. Cat-tails thrive in fresh-water ponds and marshes, but will also grow in mildly brackish water.

Soft-stem Bulrush

The soft-stem bulrush (*Scirpus validus*) is a conspicuous rhizomatous perennial commonly found in marshes and muddy shores. This species was recorded in small amounts in the areas surveyed during the present study. The soft-stem bulrush seeds are good duck food and its colonies provide nesting sites and protection for marsh birds.

B. Habitats and Effects of Port Development

Port development activities have changed the habitat of the delta vegetation. The most obvious change is outright destruction of habitat by heavy coverage with sand and gravel fill. This is a permanent barrier to vascular plant life as plants cannot recolonize a heavily covered area.

The East delta is the most disturbed region studied. Logging operations, nearby industrial plant effluents, construction activities and sand blow-off contribute to its total disturbance. An immediate threat to the vegetation is the sand blow-off, which could accumulate sand in depths unsuitable for plant life. Another threat is stagnation due to reduced flushing resulting from blocked-off channels.

On the central delta the major fill is near the tree-line. A large area adjacent to the fill has been heavily covered with a silt spill. Young plants, primarily *Carex*, are growing through the mud throughout the region. It does not seem, therefore, that such spills result in permanent destruction of plant life.

The Central delta dyke restricts the flow of fresh water from the Squamish River onto and into the land. This may affect the succession of plants on the delta. If salinities rise significantly, the dominance may shift from sedges to marine eelgrasses.

There are no fill areas on the West delta. Dredging, near the mouth of the river, has been the only development activity to date. Fifteen acres of marshland have been lost. This region now receives the most destructive force of the river currents. Vegetation is lost in large chunks as the banks are eroded away. There has been evidence that these chunks can be transported to different parts of the marshland.

In their new location the chunks may become part of the native vegetation, if conditions permit.

Parts of the East and Central deltas are heavily littered with log debris, and these large landmarks contribute significantly to the structure of the land and surrounding life. Large potholes may form around these irregular forms, resulting in pools. Small evergreens (spruce, fir, hemlock), some alders and other deciduous trees grow on some of the logs and stumps. Some only have moss and lichen growth, which indicates they may be at an early successional stage.

Small dead patches can be found on the East delta, but are virtually absent from the West and Central deltas. Eltringham (1971) observed these 'die-back' regions in *Spartina* stands. The underground buds were dead and the rhizome apices were rotted, yet Eltringham found no evidence that the die-back is caused by pollution or pathogens. The explanation given is the development of unfavourable habitat resulting in poor drainage and water-logging. This could be applicable to the dead patches observed on the East delta because ten major tidal creeks have been blocked by construction.

C. Biomass Estimates

Since vegetation samples were not washed before weighing, weight data in the present study is slightly biased. Silt and dirt clinging to the aerial parts led to error. The magnitude of this error is difficult to determine; however, the average ash content of the plant material is about 2.5 times as high as that reported from sedge meadows in other parts of B.C.:

Mean Ash Content (percent)	Area	Source
25.37	Squamish delta	present study
8.34	Cariboo district	Collins, 1972
9.96	Interior B.C.	McLean et al, 1963
10.10	southern central B.C.	Brink et al, 1963

The error in dry weight and ash-free dry weight values is likely to be less pronounced.

Keefe (1972) has recently reviewed the literature pertaining to marsh production, and her review provides some comparative data on standing crops of sedge meadows in other parts of the world. The biomass of *Carex* communities at Squamish (Table 4) ranged from 573 to 1657 g dry wt/m^2 (average 924), which is above that reported by Pearsall and Gorham (1957 in Keefe, 1972) for *Carex* spp. in England (400 to 630 g dry wt/m^2) but close to that reported by Jervis (1964 in Keefe, 1972) for *Carex stricta* in New Jersey (1340 g dry wt/m^2). Values from a sedge meadow in the spruce-alpine zone near Kamloops, B.C. are much lower (68 to 88 g dry wt/m^2; total clipped data from Table 1 of McLean et al, 1963). Gardner (MS, 1971) studied sedge meadows from lower elevations in the B.C. interior and reported values ranging from 179 to 942 g. dry wt/m^2 (average 505) which are closer to data from the Squamish vegetation.

D. Biomass Difference Between Deltas

Table 4 summarizes the area and standing crop data for plant communities of the three delta regions. The total area of the west delta was estimated to be 94,500 sq.m.; the east delta, 182,925 sq.m. and the central delta 107,325 sq.m.

A single classification analysis of variance with unequal sample sizes was done on the organic weight per m^2 for each delta. The analysis of variance table is shown in Table 2, which shows that the results are not significant at the 5% level. This suggests that there may be no difference in the biomass per m^2 in each area at a given time. Measuring standing crop throughout the growing season would show if each area was equally productive.

A two-way analysis of variance for samples without replication was done on the standing crop of communities with respect to delta and communities. Only those plant communities sampled on all three deltas were used in the calculations. Table 3 show the results, none of which are significant at the 5% level. This test does not give a true representation of the variation between deltas because it is based only on plant communities for which data was available for all three areas. The east delta, because of its larger area, probably accounts for the most plant biomass.

Lack of significant variation between areas with different development by man suggests that at this time disturbance effects are not primarily affecting reproductive-vegetative processes. The most immediate effect is the destruction of area suitable for growth. This reduction in productive area by habitat change may eventually cause a shift in dominance of plants i.e. genetic selection for certain types of plants.

CONCLUSIONS

The delta vegetation has many potential roles in the marsh ecosystem. It can provide food, cover and nesting material for a variety of estuarine organisms. When it dies down it is contributing organic material in the form of detritus to the surrounding waters. Most important of all, vegetation traps the mud, sand and silt which is continuously carried down by the river. This builds up a substratum and maintains its integrity before the annual die-back of plant-life.

Marsh plants are hardy types adapted for living alternately in air and under water. They have evolved structures for optimal anchorage and growth in an unstable substrate, but it is difficult to estimate how adapted they are for coping with disturbances by man.

Sedge meadows are present on other deltas at the heads of B.C. fjords. Meadows briefly surveyed by the second author at Toba, Bute, and Knight Inlets appeared to be of approximately the same species composition as those at Squamish. The problem of man's impact on the structure of these plant communities needs further investigation. Succession after a light sand fill or spill, detritus production, biomass variation, and plant-animal interactions could all be studied. Such information would help establish the importance of higher plants to the delta marsh ecosystem.

ACKNOWLEDGEMENTS

Thanks are due to Dr. V. Brink, Department of Plant Science, University of B.C. and Mr. A. L. van Ryswyk, Canada Department of Agriculture, Kamloops, B.C. for their help in providing comparative information on sedge meadows from other areas of B.C.

LITERATURE CITED

Anon, MS, 1972. Preliminary impact assessments of proposed port development in the Mamquam Channel and rail yard expansion in the Squamish estuary. Dept. of the Environment, Vancouver (published Dec. 1972).

Ashby, M. 1969. Introduction to Plant Ecology, MacMillan & Co. Ltd., London, pp. 192, 204, 205.

Brink, V.C., T.S. Freyman, and F. Harper, MS, 1963. Chemical Analyses of Hay from Native Meadows in South Central British Columbia. Agronomy Circular No. 7, Plant Industry Leaflets, Plant Science, University of B.C.

Caldwell, J.R. 1962. Guide to Saskatchewan Marsh Plants. Ducks Unlimited, Winnipeg.

Collin, J.C., MS, 1972. The Nutritive Value of Several Samples of Slough Hay Produced in the Cariboo District of British Columbia. Unpublished, Canada Dept. Agriculture.

Eltringham, S.K. 1971. Life in Mud and Sand. The English University Press, London, p. 170.

Gardner, J.W., MS, 1971. Quality and growth of several species of Native Sedge. Report for class project in Plant Science 530, University of B.C.

Goodman, D. and P.R. Vroom, MS, 1972. Investigations into fish utilization of the inner estuary of the Squamish River. Fisheries Service (Vancouver) Technical Report No. 1972-12. 52 pp.

Hitchcock, C.L., A. Cronquist, M. Ownby, J.W. Thompson, 1969. Vascular Plants of the Pacific Northwest. University of Washington Press, Seattle, Parts I-V.

Keefe, C.W. 1972. Marsh Production: A Summary of the Literature. Contributions in Marine Science, Vol. 16: 163-181.

Levings, C.D., MS, 1973. Intertidal Benthos of the Squamish Estuary. Fisheries Research Board of Canada, Manuscript Report Series No. 1218.

McLean, A., H.H. Nicolson, and A.L. van Ryswyk, 1963. Growth Productivity and Chemical Composition of a Sub-Alpine Meadow in Interior British Columbia. Journal of Range Management. Vol. 16(5): 235-240.

Outram, D.N., MS, 1963. The extent of Herring Spawning in British Columbia in 1963. Fish. Res. Bd. Canada, Nanaimo Biological Station, Circular No. 70.

Paish, H. et al, MS, 1972. An environmental perspective on a Squamish coal port. H. Paish and Associates, Vancouver, B.C. (published December 1972).

Parker, R. R. and B.A. Kask, MSS, 1972. Progress reports on studies of the ecology of the outer Squamish estuary. Fisheries Research Board of Canada, Manuscript Report Series No. 1192, 1193, 1194, 1195.

Reid, G.K., 1961. Ecology of Inland Waters and Estuaries. Van Nostrand Reinhold Co., New York, pp 225-301.

Stathers, J.K., MS, 1958. A geographical investigation of development potential in the Squamish Valley region, British Columbia. M.A. Thesis, Dept. of Geology and Geography, Univ. of B.C. Vancouver, B.C.

ADDITIONAL REFERENCES

Bourn, W.S. &. C. Coltam, 1950. Some Biological Effects of Ditching Tidewater Marshes. U.S.Fish & Wildlife Serv. Res. Rept. 19: 1-30.

Chapman, V.J., 1964. Coastal Vegetation. The MacMillan Co., New York.

Frankton, C., 1955. Weeds of Canada. Canada Dept. of Agriculture. Publication No. 948, pp. 116-118, 178.

Hitchcock, C.L. Grasses and Grass-like Plants of Montana, Idaho, Washington, Alberta and B.C. University of Washington, Seattle.

Harger, J.R.E., MS, 1971. Damage to Vegetation by Chlorine gas (unpublished manuscript dealing with effects of a chlorine gas spill of forest and shrub plants at Squamish).

Hubbard, W.A. 1969. The Grasses of British Columbia, B.C. Provincial Museum Handbook No. 9.

Kuchler, A.W., 1967. Vegetation Mapping. The Ronald Press Co., New York.

McLaren, K.A., MS, 1972. A Vegetation Study of the Islands and Associated Marshes in the South Arm of the Fraser River, B.C., from the Deas Island Tunnel to Westham Island Foreshore. Fish & Wildlife Branch, B.C. Dept. of Recreation and Conservation, Victoria, B.C. (published in January, 1972).

Patton, D.R. and B.I.Judd, 1970. The Role of Wet Meadows as Wildlife Habitat in the Southwest. Journal of Range Management, Vol. 23(4): 272-275.

Petry, L.C. and M.G. Norman, 1968. A Beachcombers Botany. The Chatham Conservation Foundation Inc. Chatham, Mass.

Schweintz de, L.D., 1824. Monograph of North American Carices.

Teal, J.M. and J.W. Kanwisher, 1970. Total Energy Balance in Salt Marsh Grasses. Ecology, Vol. 52(4): 690-695.

Walker, J.M., MS, 1965. Vegetation changes with falling water levels in the Delta Marsh, Manitoba. Ph.D. Thesis, University of Manitoba, Winnipeg.

T A B L E S

Table 1. Divisions of Vegetation on the East Delta.

1.	*Carex lyngbyei*
2.	*Eleocharis palustris*
3.	*Scirpus validus*
4.	*Typha latifolia*
5.	*Juncus balticus* *Potentilla pacifica* *Triglochin maritima* *Carex lyngbyei* *Eleocharis palustris* *Trifolium wormskjoldii*
6.	*Deschampsia caespitosa* *Carex lyngbyei* *Potentilla pacifica* *Plantago maritima* *Sium suave* *Triglochin maritima* *Juncus balticus* *Eleocharis palustris* *Lathyrus palustris*
7.	*Triglochin maritima* *Potentilla pacifica* *Carex lyngbyei* *Sium suave* *Deschampsia caespitosa* *Plantago maritima*
8.	*Lathyrus palustris* *Potentilla pacifica* *Aster eatonii* *Trifolium wormskjoldii* *Hordeum brachyantherum* *Agropyron repens* *Festuca rubra* *Deschampsia caespitosa* *Phalaris arundinacea* *Juncus balticus* *Plantago maritima* *Sium suave* *Cicuta maculata* *Sonchus arvensis* *Caltha aserifolia*
9.	*Carex lyngbyei* *Sium suave*
10.	*Carex lyngbyei* *Eleocharis palustris* *Triglochin maritima*

Table 2. Divisions of Vegetation on the Central Delta

1.	*Carex lyngbyei*
2.	*Eleocharis palustris*
4.	*Typha latifolia*
6.	*Deschampsia caespitosa* *Carex lyngbyei* *Potentilla pacifica* *Plantago maritima*
7.	*Triglochin maritima* *Potentilla pacifica* *Carex lyngbyei* *Deschampsia caespitosa*
8.	*Lathyrus palustris* *Potentilla pacifica* *Aster eatonii* *Hordeum brachyantherum* *Deschampsia caespitosa* *Festuca rubra* *Sidalcea hendersonii* *Sium suave* *Cicuta maculata* *Daucus carota* *Juncus balticus* *Maianthemum dilatatum* *Habenaria delatata* *Agropyron repens* *Plantago maritima* *Triglochin maritima* *Carex lyngbyei* *Eleocharis palustris*
9.	*Carex lyngbyei* *Sium suave* *Cicuta maculata*
10.	*Carex lyngbyei* *Eleocharis palustris*

Table 3 . Divisions of Vegetation on the West Delta

1.	*Carex lyngbyei*
2.	*Eleocharis palustris*
3.	*Scirpus validus*
4.	*Typha latifolia*
6.	*Deschampsie caespitosa* *Carex lyngbyei* *Potentilla pacifica* *Triglochin maritima* *Sium suave* *Daucus carota* *Juncus balticus*
7.	*Triglochin maritima* *Carex lyngbyei* *Potentilla pacifica* *Eleocharis palustris* *Juncus balticus*
8.	*Lathyrus palustris* *Potentilla pacifica* *Trifolium wormskjoldii* *Sium suave* *Daucus carota* *Cicuta maculata* *Aster eatonii* *Sidalcea hendersonii* *Maianthemum dilatatum* *Plantago maritima* *Carex lyngbyei* *Juncus balticus*
9.	*Carex lyngbyei* *Cicuta maculata* *Sium suave*
10.	*Carex lyngbyei* *Eleocharis palustris* *Triglochin maritima*

Table 4: Area and Biomass Data

Community	% Moisture	% Dry Wgt.	% cover on delta	Area of coverage (sq.m.)	Dry Wgt. (g./m^2)	Organic Wgt. (ash-free) (g./m^2)	Standing Crop (dry wgt.) (g.x10^6)
WEST DELTA							
Carex-Umbelliferae	69.55	30.45	32.1	30334.5	573.98	471.7	17.411
Carex-Eleocharis	66.58	33.42	22.8	21546.0	800.74	606.2	17.253
Lathyrus-Potentilla	66.86	33.14	3.6	3402.0	623.36	474.6	2.121
Carex	65.24	34.76	14.0	13230.0	709.10	526.5	9.381
Typha	49.05	50.95	0.5	472.5	1051.61	980.5	0.497
Scirpus	67.19	32.81	0.2	189.0	383.22	315.1	0.072
Eleochraris	70.17	29.83	13.1	12379.5	148.85	109.3	1.843
Deschampsia	48.95	51.05	12.4	11718.0	810.69	570.2	9.500
Triglochin-Potentilla	69.40	30.60	1.3	1228.5	867.51	303.3	1.066
EAST DELTA							
Juncus	53.05	46.95	0.1	182.9	1098.16	734.6	0.201
Carex-Umbelliferae	56.55	43.45	5.6	10243.8	1162.29	952.2	11.906
Typha	70.63	29.37	0.1	182.9	685.20	594.0	0.125
Scirpus	80.80	19.20	0.1	182.9	416.45	321.3	0.076
Triglochin-Potentilla			0.5	914.6			
Carex	47.07	52.93	73.7	134815.7	1657.24	1263.1	223.422
Eleocharis			1.2	2195.1			
Carex-Eleocharis			0.6	1097.6			
Lathyrus-Potentilla	64.49	35.51	7.7	14085.2	722.98	572.0	10.183
Deschampsia	66.52	33.48	10.4	19024.2	606.32	352.1	11.535

Table 4: Area and Biomass Data (con't)

Community	% Moisture	% Dry Wgt.	% cover on delta	Area of coverage (sq.m.)	Dry Wgt, (g./m^2)	Organic Wgt. (ash-free) (g./m^2)	Standing crop (dry wgt.) (g.x10^6)
CENTRAL DELTA							
Typha	54.98	45.02	1.1	1180.6	532.14	402.8	0.628
Triglochin-Potentilla	58.06	41.94	4.2	4507.7	834.61	586.9	3.762
Lathyrus-Potentilla	47.33	52.67	30.3	32519.5	975.45	707.3	31.721
Carex	55.71	44.29	49.9	53555.2	681.18	463.2	36.481
Carex-Eleocharis			6.4	6868.8			
Eleocharis			1.6	1717.2			
Carex-Umbelliferae	51.61	48.39	0.9	965.9	886.99	763.4	0.857
Deschampsia	59.63	40.37	5.6	6010.2	727.06	514.0	4.370

Table 5: Analysis of Variance Table
for organic wgt. per M^2 of East, West, Central deltas

Source of Variation	df	SS	MS	F
Among Groups (deltas)	2	239451.06	119725.53	1.2869 n.s.
Within Groups	19	1767660.49	93034.76	(0.05)
Total	21			

Table 6: Analysis of Variance Table for standing crop of
communities and deltas

Source of Variation	df	SS	MS	F
Community	4	8967.04	2241.76	1.35 n.s. (.05)
Delta	2	7089.38	3544.69	2.14 n.s. (.05)
Error	8	13259.21	1657.40	

F I G U R E S

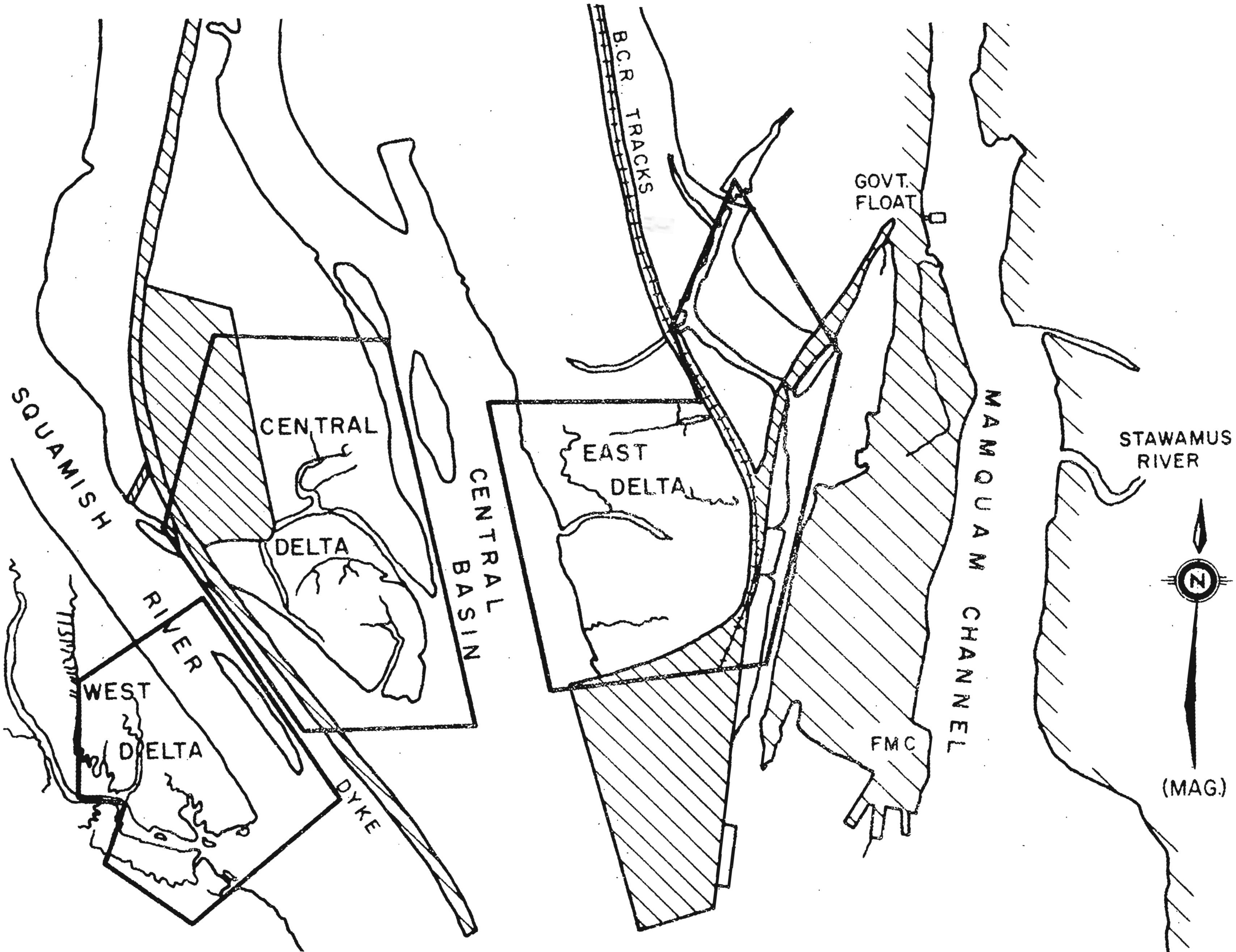

Fig. 1. Areas surveyed for vegetation.

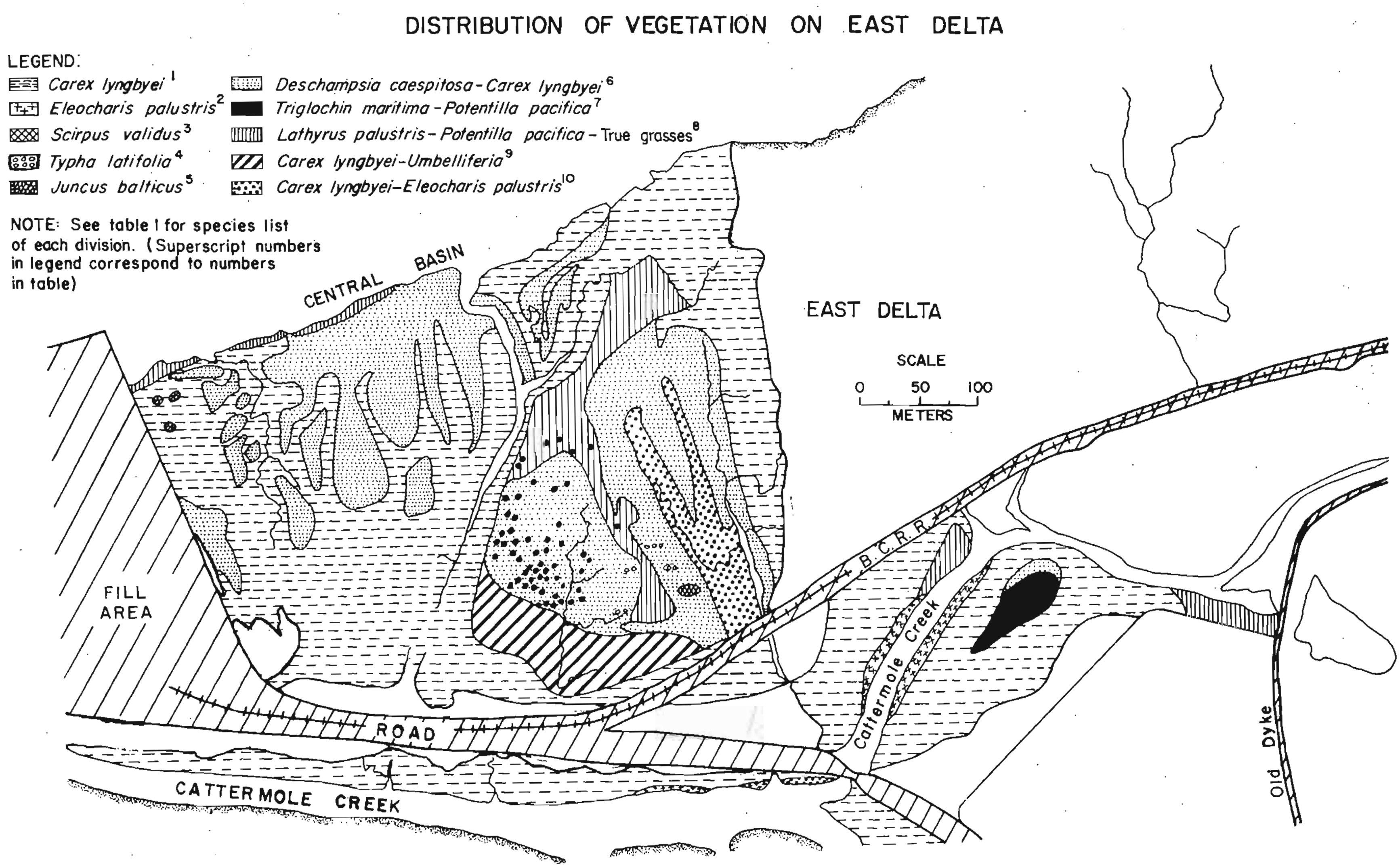

Fig. 2. Distribution of vegetation on the east delta.

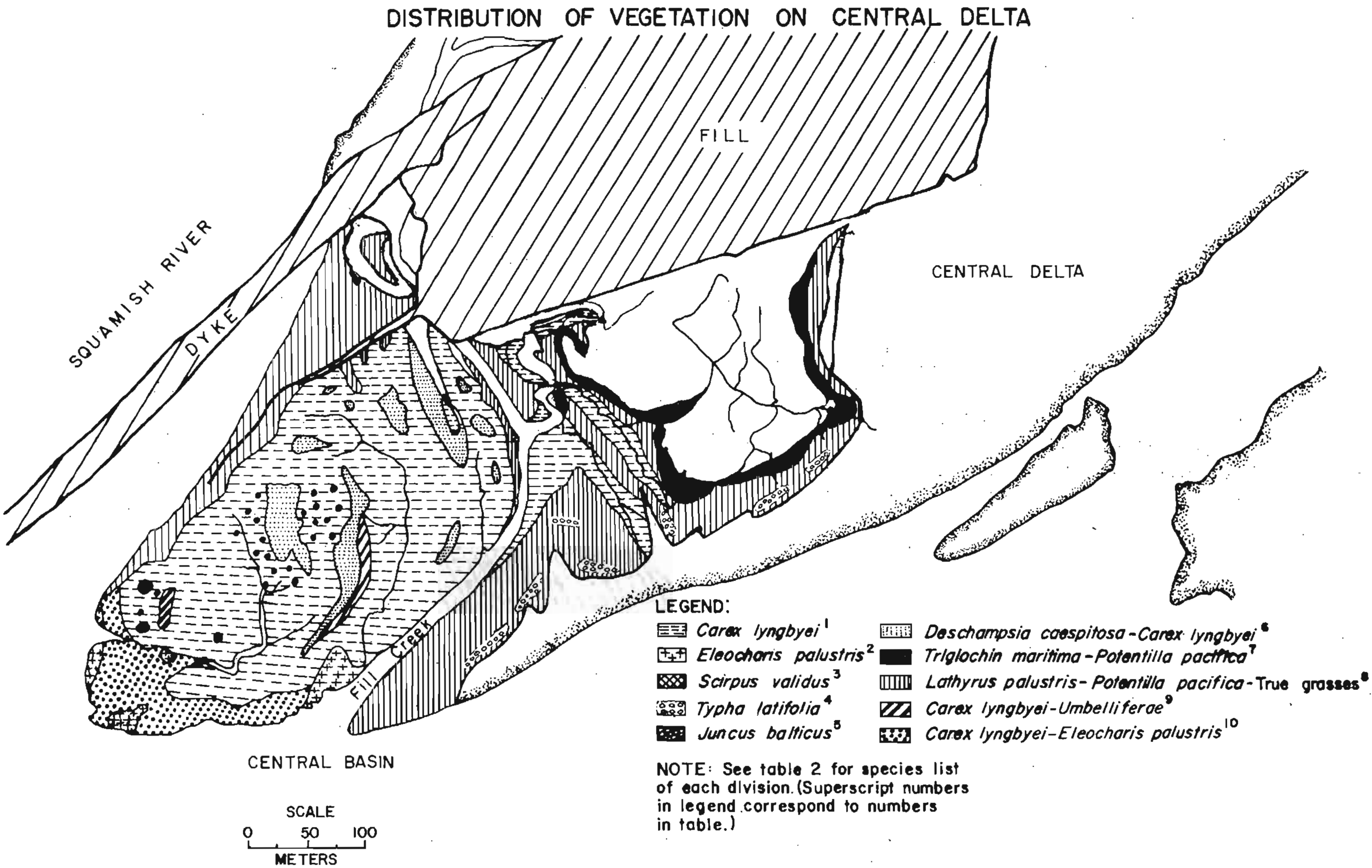

Fig. 3. Distribution of vegetation on the central delta.

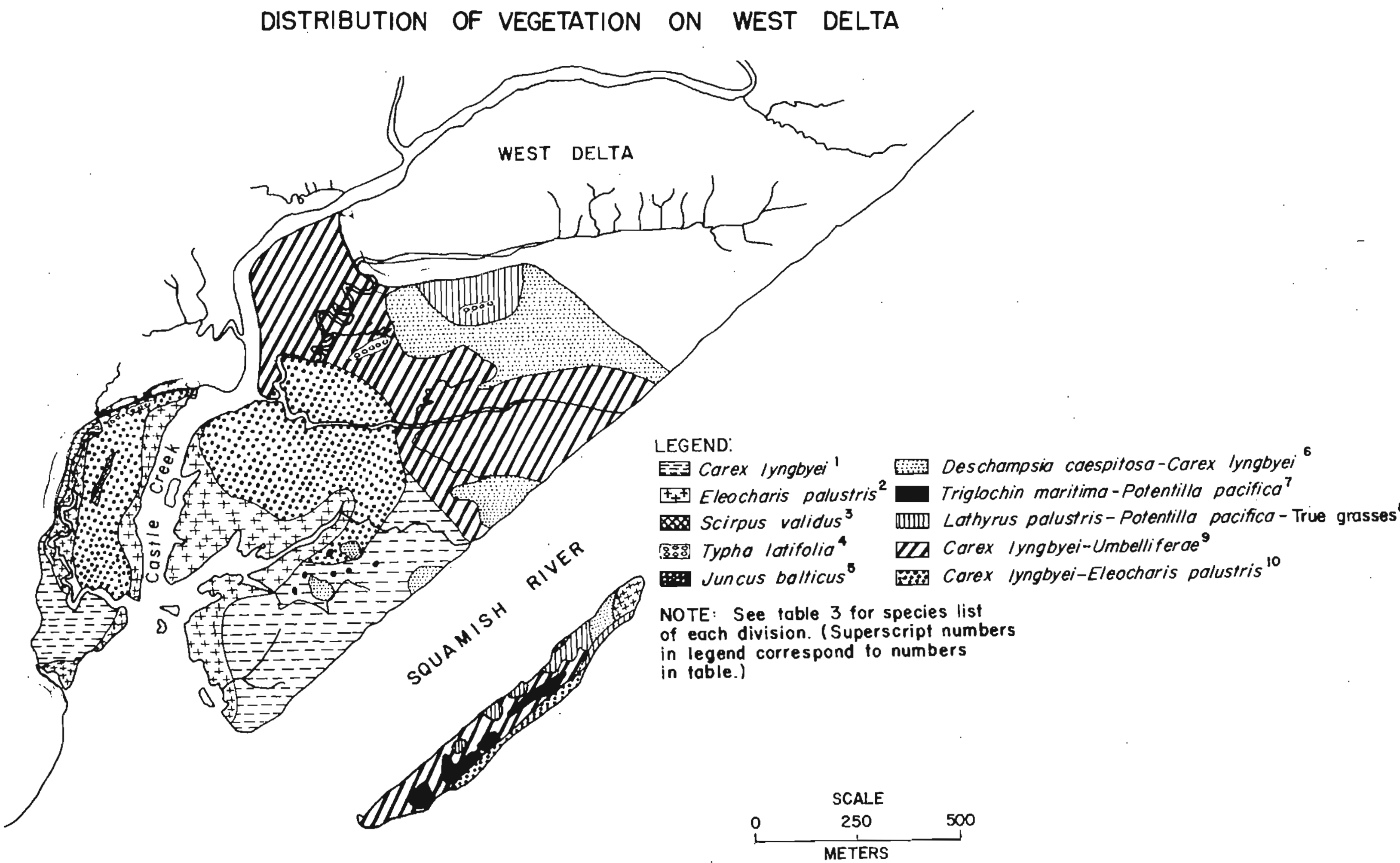

Fig. 4. Distribution of vegetation on the west delta.