NASA CR-
147585

FINAL REPORT

TO

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MISSISSIPPI TEST FACILITY

Contract Number-
NAS -9- 14501

(NASA-CR-147585) EFFECTS OF ENVIRONMENTAL CHANGES ON MARSH VEGETATION WITH SPECIAL REFERENCE TO SALINITY Final Report, 1 Feb. 1975 - 31 Jan. 1976 (Tulane Univ.) 112 p HC $5.50 CSCL 08J G3/42

N76-22616

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Alfred E. Smalley
Leonard B. Thien

TULANE UNIVERSITY
New Orleans, Louisiana 70118

February 1, 1976

INTRODUCTION

The following is the final report on the NASA grant "Effects of Environmental Changes on Marsh Vegetation with Special Reference to Salinity." The period of study began on February 1, 1975 and was terminated January 31, 1976.

LITERATURE REVIEW OF MARSHES

The word "marsh" connotes low wet land, often treeless that is periodically inundated and characterized by a variety of grasses, sedges, rushes, etc. Despite the general appearance of marshes, ecologists recognize many different types of marsh communities, i.e., salt marsh, cattail marsh, freshwater marsh, etc.

The following literature review is concerned primarily with brackish and salt marshes located along the eastern coast of North America and the Gulf Coast. The review concentrates upon the vegetation of the marshes particularly in regard to distribution, composition, succession and productivity although other aspects are also reviewed. Special efforts were made to include major works concerned with the Louisiana and Mississippi coastal marshes.

Distribution

Within brackish and salt marshes the phanerogamic vegetation is composed primarily of grasses, rushes and succulent dicotyledons. Such genera as *Spartina*, *Distichlis*, *Juncus*, and *Salicornia* are encountered repeatedly in widely separated areas (Adams, 1963; Chapman, 1960). Monospecific communities of *Spartina* sp., *Juncus roemerianus* and of *Distichlis* sp. frequently dominate large areas depending upon environmental factors.

The salt marshes begin as grassy arctic marshes in the far north beginning in the northern reaches of Ellesmere Island within the Arctic circle, on Baffin Island, along the northern shore of Quebec on Hudson Bay and along the upper reaches of Labrador, followed by marshes tucked in coves and bays along the glaciated coast of the Canadian Maritimes and New England coasts. The salt marshes cover significant areas along the central coast of Nova Scotia. Extensive marshes lie behind the barrier beaches of the mid-Atlantic coast. At the southern limit of the salt marshes in Florida, mangrove trees replace the march (Teal and Teal, 1969). Salt marshes are found in their greatest abundance from Albermarle Sound on the coast of North Carolina south to the northern coast of Florida and in Louisiana (Teal and Teal, 1969; Martin, Hotchkiss, Uhler and Bourn, 1953; Thorne, 1954; Linton, 1968; Uphof, 1941).

In the South Atlantic and Gulf states there are approximately 5,600,000 acres (22,662 square kilometers) and of this area 3,381,500 acres (13,683 square kilometers) are located in Louisiana (Penfound and Hathaway, 1938; Griffitts, 1928). Louisiana has nearly twelve times as much salt marsh as New Jersey and almost half the total salt marsh area of the Atlantic and Gulf Coasts (Penfound and Hathaway, 1938). Cibula (1972) states that southeastern Louisiana alone possesses 1,750,000 acres (7,123 square kilometers) of fresh water marsh and about 2,500,000 acres (10,117 square kilometers) of salt marsh. The salt marsh vegetation on the northern portion of the Gulf of Mexico extends in a discontinuous arc from Galveston, Texas to just south of St. Petersburg, Florida (Eleuterius, 1973). In addition to the vast quantities of salt marsh in Louisiana there are approximately 315,000 acres (1,277 square kilometers) in Texas, 26,500 acres (109 sq. km.) in Mississippi, 34,000 acres (138 sq. km.) in Alabama and 680,000 acres (2,873 sq. km.) in Florida (Thorne, 1954; Griffitts, 1928).

Vegetation

The early work on marshes in the United States was done on the Atlantic Coast, especially the northern part of Kearney (1900, 1901), Harshberger (1900, 1909), Johnson and York (1915), Taylor (1939), Conrad (1935), Rudolphs (1926), and Chapman (1940a, 1940b). The southern portion was studied by Wells (1928), Davis (1943), Jackson (1952), Bourdeau and Adams (1956), Bourn and Cottom (1950), Kerwin (1966), Reed (1947), Hinde (1954), McCormick, Grant and Patrick (1970) and Kerwin and Pedigo (1971).

In a paper on the vegetation of Wequetequock-Pawcatuck tidal marsh in Connecticut, Miller and Egler (1950) list botanical literature by state for the Atlantic Coast of North America. Although incomplete, the list is useful. Uphof's (1941) world review of the halophyte problem includes a bibliography of 363 titles.

In the tidal marshes of the north *Spartina alterniflora* borders the bay, ditches and estuaries. *Panicum virgatum* and its associates border the uplands. Large colonies of *Juncus* sp. are found with stretches of *Spartina patens* and beds of *Distichlis* sp. distributed about. Forbs such as *Plantago* sp. and *Limonium* sp. are scattered

(Miller and Egler, 1950). Thus a typical cross-section of vegetation from bay to upland would be as follows: Spartina alterniflora-lower border, Spartina patens-lower slope, Juncus sp.-upper slope, Panicum virgatum-upper border, Iva sp. and other shrubs-upland shrub border, and Quercus sp. and other forest trees-upland forest. The transition between S. alterniflora and S. patens is marked by the normal high tide zone. Exceptional high tide zone marks the border between Panicum virgatum and the shrub border (Miller and Egler, 1950). A list of plants for the Wequetequock-Pawcatuck Tidal Marsh are presented with frequencies by Miller and Egler (1950). In unit areas along transects on the high marsh at the western end of Barnstable Marsh, the angiosperm communities were dominant in the following proportions (Blum, 1968).

Monospecific Dominance	
Spartina patens	39.6%
Spartina alterniflora	32.2%
Distichlis spicata	12.0%
Juncus gerardi	1.1%
Heterospecific Dominance	
Spartina alterniflora	10.0%
Spartina patens - Distichlis spicata	1.6%
S. alterniflora - D. spicata	0.6%

In the Great Marshes, Barnstable, Mass., Redfield (1972) traces the development of a typical New England marsh and maintains it takes from 500-1,000 years or more for high marsh to develop. Nixon and Oviatt (1973) discuss the vegetation and other factors of Bissel Cove on Rhode Island and give lists of plants as well as animals with their interaction.

Succession

In the northern marshes (New England) the general succession sequence is as follows (Chapman, 1940a): primary colonist - *Spartina alterniflora* - (*Spartinetum alterniflora*) - *Spartina patens* - *Juncetum gerardi* - freshwater. Most workers would consider that the *Spartina patens* community should be subdivided into a *Spartina* community and a *Distichlis spicata* community (Chapman, 1940a; Flowers, 1973).

On Saugus Marsh (near Boston) Chapman (1940a, 1940b) recognized the following consocies:

	Depth
Spartinetum alterniflora glabrae	2.5 m
Spartinetum patentis	1.5
Spartineto-Distichlidetum	.4
Juncetum-Gerardii	.4
Spartinetum pectinatae	.4
Scirpetum with Phragmites	-

Chapman (1960) presents a series of diagrams of plant succession at various locations in northern marshes. The *Spartinetum alterniflora glabrae* is a "sedge association" (Conrad, 1935; Ganong, 1903) and is recognized from Nova Scotia through the northern shores of the Gulf of Mexico. The next shoreward community is either the Spartinetum patentis, the Distichlidetum spicatae or Salicornietum ambiguae (Conrad, 1935). Rather than use the above association names it is perhaps best to simply list species for each successional zone. It should be noted that Spartina alterniflora is the first species to appear starting with bare mud in saline areas on the coast (Chapman, 1960).

Southern marshes

Species associations in the North Carolina salt marshes are given by Adams (1963).

Low Marsh

Spartina alterniflora
S. alterniflora-S. perennis, Limonium carolinianum
Juncus roemerianus

High Marsh

Aster tenuifolius, Distichlis spicata,
Fimbristylis castanea, Borrichia frutescens
and Spartina patens.

The primary colonist is Spartina alterniflora. It may contain Salicornia perennis or Limonium carolinianum and these plants reach their best development at about mean sea-level. At higher levels Juncus roemerianus is the dominant.

South Atlantic Coast

Successional Series for the south Atlantic Coast is as follows:

Spartina alterniflora - *Spartina* sp. - *Salicornia* sp. - Juncus sp. - *Fimbristylis* sp. - *Baccharis* sp. - *Kosteletzkya* sp. Various diagrams showing succession are given by Wells (1928). Arranged according to depth the species are associated in the following manner (Chapman, 1960).

Deeper Water:

Spartina sp. and *Salicornia* sp.

Middle Zone: (shallow water)

Distichlis spicata
Borrechia f~utescens
Juncus sp.
Lythrum lineare
Scirpus olneyi

Inner Zone:

Baccharis - *Kosteletzkya*

The salt marshes of Florida are slightly different in that there is a transition to mangrove swamp. In the northern portion of the state, the successional relationships are similar to those from Virginia and the Carolinas. In the southwest, the salt marsh commonly develops behind the mangrove swamp or enclaves with the mangrove (Chapman, 1960). The community succeeding the mangrove is often dominated by *Batis maritima* and at higher levels is associated with *Salicornia ambigua.* A *Distichlis* sp. - *Spartina patens* community occurs at still higher levels followed by a *Juncus roemerianus* - *Spartina cynosuroides* - *Spartina bakeri* community (Chapman, 1960). Jackson (1952) analysed the covital vegetation within the St. Marks National Wildlife Refuge in Wakulla County, Florida. He lists the vegetation of various zones (A - D) in order of abundance.

Zone A (only the edge of this zone is inundated)

Fimbristylis castanea
Spartina patens
Spartina spartinae
Limonium carolinianum
Juncus roemerianus
Salicornia ambigua
Distichlis spicata
Batis maritima
Seutera nitida

Zone B - S ("salt-zone")

Salicornia ambigua

Zone C

Distichlis spicata
Spartina cynosuroides
Salicornia ambigua
Batis maritima
Borrichia frutescens
Juncus roemerianus
Limonium carolinianum

Zone D

Juncus roemerianus
Limonium carolinianum
Batis maritima

Louisiana & Mississippi

Eleuterius (1973) notes that very little work has been done on the marshes associated with the Gulf of Mexico until recent years. The cornerstone work on the Louisiana marshes (Gulf Coast marshes in general) was by Penfound and Hathaway (1938). Seven transects were laid out in the marshes south of New Orleans from fresh to salt water involving eleven distinct community types. The paper gives extensive lists of plants found within these various communities.

The marshes on the coastline of the northern Gulf of Mexico vary considerably. West of the Mississippi River to the 98th meridian in Texas, Spartina spartinae and Sporobolus virginicus are the dominant species (Tharp, 1926). A vegetational map of the marshes of Louisiana by Chabreck et al. (1968) shows little saline marsh west of the 91st meridian but large expanses of brackish marsh are evident. The works of Day (1959), Pullen (1960, 1962), Childress (1960) should be consulted for lists of plants and maps of marshes along the Texas coast. Hoese (1967) also maintains that there is little or no salt marsh west of Vermilion Bay, Louisiana and that little Spartina alterniflora marsh is present in Mississippi with the Apalachicola Bay marshes poorly defined.

In Mississippi, Juncus roemerianus is the dominant plant species in the marshes (Eleuterius, 1973). Line transect data revealed that this species composed 57.8% of the marsh population in April, 42.1% in June and 43.7% in August. The marsh was not as diverse in species in April (25 species) as it was in June (43 species) and August (40 species). J. roemerianus composed 45.3% of the total plant population for the entire growing season (Eleuterius, 1973).

The twelve most abundant plant species in the marshes of Mississippi are as follows: J. roemerianus 42%, Spartina patens 8%, Spartina alterniflora 7%, Spartina cynosuroides 6.5%, Cladium jamaicense 3%, Scirpus validus 2.5%, Distichlis spicata 2%, Osmunda regalis 1.5%, Fimbristylis spadicea 2%, Phragmites communis 1.5%, and Boltonia asteroides 1% (Eleuterius, 1973).

In Mississippi the primary difference between the brackish and saline marshes is the reduction in the abundance of Spartina alterniflora and an increase in brackish and fresh water plant species (Eleuterius, 1973).

In the saline marshes two species predominate: Juncus roemerianus and Spartina alterniflora. Brackish water species, such as Spartina cynosuroides, Spartina patens and Scirpus olneyi are found intermixed with J. roemerianus. S. alterniflora always occurs in pure stands (Eleuterius, 1973).

Distichlis spicata, "salt grass" and several succulent plants as Salicornia bigelovii, Suaeda linearis and Batis maritima grow in the "salt flats" area. J. roemerianus is always associated with these plants (Eleuterius, 1973).

Scirpus olneyi, S. robustus and Spartina patens occur as zones near the periphery of the marsh.

In the intermediate marsh (overlap between brackish and freshwater) the upper limit of Juncus roemerianus is reached. Phragmites communis becomes very common in this area (Eleuterius, 1973).

Louisiana

The Gulf Coast marshes of Louisiana range in elevation from minus 6.096 dm. (2 feet) to 6.096 dm. above sea level (excluding chenieres and natural levees). Most of the marshes in Louisiana are on land created by the Mississippi River through thousands of years. The Mississippi River has inhabited seven courses in the past 7,200 years (Juneau, 1975). About 2,800 years ago the river shifted eastward to occupy the St. Bernard course in southeastern Louisiana. While occupying the St. Bernard course, the Mississippi River developed a vast delta extending from the general vicinity of Barataria Bay out into the Gulf beyond the present position of the Chandeleur Island group (National Shoreline Study, 1971). Then about 1,200 years ago, the Mississippi River again shifted to the west. Today the Breton and Chandeleur Island groups represent a late stage in deltaic distribution resulting from subsidence behind the old shoreline (National Shoreline Study, 1971). The present delta began building about 400 years ago (Russell, 1936; Coleman, 1966).

In Louisiana, O'Neil (1949) classifies the marsh into Delta marsh, Sub-delta marsh and Prairie marsh. The Delta marshes consist of approximately 300,000 acres (1192 sq. km.) centered around the Mississippi River into the Gulf of Mexico (present day outlet).

The Sub-delta marshes consist of approximately 2,940,000 acres (11,895 sq. km.) which start at Baptiste Collette and Grand Pass, Plaquemines Parish on the southeast, and continue in a meandering line from Cow Island to the east of Cheniere au Tigre in Vermilion Parish on the west. The Sub-delta marshes are the ancient deltas of the Mississippi River (O'Neil, 1949).

The prairie marshes are located in Vermilion and Cameron Parishes and consist of approximately 760,000 acres (2,670 sq. km.) according to O'Neil (1949).

Other papers dealing with the vegetation of the Gulf marshes are by Curl (1959), Kurz and Wagoner (1957) on the Florida marshes. The Mississippi and Louisiana marshes have been described by Lloyd and Tracy (1901), Lowe (1921), Penfound and O'Neil (1934), Penfound and Hathaway (1938), Penfound (1952), Viosca (1928) and Mohr (1901), Lemaire (1961), Eggler (1961), Eichhorn, and Duice (1969).

In recent years there has been a flourish of activity in analysing the vegetation of the marshes of Louisiana and Mississippi with works by Chabreck (1970), Uhler and Hotchkiss (1968), Gabriel and de la Cruz (1974), Shiflet (1963), Linton (1968), Palmisano (1970), Juneau (1975) and Woodhouse, Seneca and Broome (1974). A vegetation map of the Louisiana coastal marshes showing saline, fresh, brackish and intermediate vegetation has been constructed by Chabreck, Joanen and Palmisano (1968). Also a phytogeographic and ecologic relationships of the flora of Breton Island has been written by Gould and Ewan (1975). For notes on Louisiana in general with keys to biting flies consult Tidwell (1973).

Succession

Few studies of succession have been made in the Gulf coast area. However, Chapman (1960) maintains that the general succession within the marshes is not materially different from that of the New England marshes except at the higher levels, or where, in Florida and Texas, there is a transition to the mangrove area (also Louisiana). Chapman (1960) gives a few diagrams of succession in the Gulf area.

Penfound and O'Neil (1934) give a successional sequence on Cat Island as follows (for brackish water): Spartina Conspecies - Distichlis Conspecies - Juncus Conspecies.

On Grand Isle, Louisiana, Walker (1939) gives a sequence as follows: *Spartina alterniflora* - *Distichlis* and *Avicennia* - *Baccharis* - *Iva* association.

Factors Affecting Zonation and Distribution in Marshes

In an excellent paper Adams (1963) discusses factors influencing plant zonation. Chapman (1940a, 1940b) thought inundation was the important factor while Miller and Eggler (1950) considered the present day distribution of plants due to past environmental changes that could not be interpreted today. Johnson and York (1915) believed salt marsh species to be distributed according to submergence-to-emergence ratios. Reed (1947) working in North Carolina considered that inundation, salinity and poor drainage were important factors at lower levels of the marsh whereas competition with other angiosperms on the upper periphery was the main factor.

Adams (1963) studied the effects of elevation, soil texture and salinity on the distribution of *Spartina patens*, *Juncus roemerianus*, and the tall, medium and short growth forms of *Spartina alterniflora*.

A micro-relief gradient was found to be significant in delimiting the lower boundary of Spartina patens. Soil texture was similar for J. roemerianus and S. alterniflora. Salinity of the soil at low tide increased landward to a value more than twice as high in the short growth form of S. alterniflora and Salicornia perennis and then decreased to a low level in the S. patens zone. Adams (1963) concludes that tide level elevation influences are the primary factors controlling the distribution of salt marsh species. Most salt marsh species exhibit reduced growth and fertility with increasing salinity-salt concentrations of about 7% NaCl (twice sea strength) prohibit establishment and survival of all species.

Apparently S. alterniflora is restricted to the low marsh because of its moderate salinity and high iron requirements (Adams, 1963). If grown in low iron or fresh water it becomes chloritic whereas Distichlis spicata and Spartina patens (competitors) do not display this quality. Thus Distichlis spicata and S. alterniflora are salt obligates and S. patens a faculative halophyte (Adams, 1963).

Babcock (1967) in a study of wiregrass (Spartina patens) and saltmarsh grass (Distichlis spicata) in Louisiana investigated the effects of salinity and water depth. It was found that both species grew best in salinity of 0.50 - 2.50%. At salinities lower than this both species were greatly reduced in number and replaced by Scirpus olneyi. It was thought that water level was a very important limiting factor. As water depths exceeded .3048 m (1 foot), the densities of wiregrass and saltmarsh grass decreased with young sprouts more sensitive to flooding than older shoots.

Chapman (1960) maintains that germination of many salt marsh species is dependent on a reduction in the soil surface salinity. Germination tests with seeds of S. alterniflora indicate decreased germination rates with increasing salinity (Mooring, Cooper, and Seneca, 1971). The height forms of S. alterniflora apparently represent different ecotypes that result from exposure to environments differing in salinity (Mooring et al., 1971), (Woodhouse, Seneca, and Broome, 1974), (Shea, Warren, and Niering, 1975). For an excellent description of Spartina species see Mobberly (1956). This taxonomic treatment also provides keys to species as well as distribution maps for each species.

In Louisiana, Penfound and Hathaway (1938) emphasize that the transition from one community to another is conditioned by a change in elevation of as little as 7.62 cm since four communities may occur on a slope having a fall of less than 3.048 dm. Penfound and Hathaway (1938) maintain that water level and salinity of the soil water are the most important habitat factors influencing the plants in the Louisiana marshes. In the probable order of salt tolerance the major marsh dominants in Louisiana are (Penfound and Hathaway, 1938):

	%Salt Tolerance
Mariscus (Caldium) jamaicensis	0-0.2
Scirpus californicus	0-1.13

Typha latifolia	0-1.13
Scirpus olneyi	0.55-1.68
Typha angustifolia	0-1.68
Spartina patens	0.12-3.91
Juncus roemerianus	0.12-4.43
Spartina alterniflora	0.55-4.97
Distichlis spicata	0.45-4.97
Avicennia nitida	3.68-4.97

Isohaline map of Louisiana coastal marshes see Chabreck and Palmisano (1968). A map of isohalines for the Breton Sound area (specifically the Mississippi River Gulf Outlet Canal area) is presented by Rounsefell (1964). The vegetation map of Chabreck, Joanen and Palmisano (1968) list the following common plants for the marshes of Louisiana:

Saline

- *S. alterniflora*
- *Salicornia* sp.
- *Juncus roemerianus*
- *Batis maritima*
- *Avicennia nitida*
- *Distichlis spicata*

Brackish

- *S. patens*
- *Scirpus olneyi*

Intermediate

- *Vigna repens*

Scirpus californicus

Cladium jamaicense

Fresh

Panicum hemitomon

Alternanthera philoxeroides

Hurricanes

Hurricane damage to any area is largely dependent on the physical features of that area. Usually hurricanes produce an increase in the amount of open areas, effect translocation of vegetation inland, cause deposits of vegetational debris along levees, reduce the density of dominant plant species, plus raise the salinity, particularly of fresh water marshes.

The effect of hurricane Audrey on Marsh Island, Louisiana, was studied by Harris and Chadreck (1958). Marsh Island, a saltmeadow-cordgrass (*Spartina patens*) and Olney's three square (*Scirpus olneyi*) marsh, became flooded with about 2.5 m of water. The normal tide water at Marsh Island is brackish because fresh water from the Atchafalaya Basin bathes the island shores. Salinities of soil water measured during 1955 and 1956 ranged from 7 to 29 per cent sea-water, while measurements taken after the hurricane were 8 to 20 per cent of sea water. If salinity of the water is altered by the hurricane, it quickly returns to its normal range.

A change in the dominant vegetation of the brackish marsh on Marsh Island was noticed after the hurricane. In 1956 *Spartina patens* comprised 99% of the brackish marsh and Scirpus olneyi 1%. In 1958 S. patens comprised 90.6 and S. olneyi 9.4% (Harris and Chabreck, 1958).

Chamberlain (1959) studied the influence of hurricane Audrey on the Rockefeller Wildlife Refuge, Louisiana, an area about 45 km west of Marsh Island. The tidal surge was at least 2.5 m in this area.

Natural beaches, formed of sand and shells in equilibrium with the tide and wave action, separates the Gulf of Mexico from the salt-water marsh. These beaches, characterized by a relatively low profile, underwent a geomorphic change due first to the rising tide water and wave action, then to the recession of the tidal surge. Storm waves broke over the submerged crest causing mass transport of and spreading of shell-sand material. This resulted in the rear margin of the beach being moved approximately 100 m. The main change in the beach habitat was in the distribution of the endemic flora. There was a general increase in soil salinity, but in the salt marsh and brackish zone this increase has very little effect. In the fresh water zone, however, the increase was disastrous. Where dense stands of Cladium jamaicense was dominant the intrusion fo salt water was severe. Pre-hurricane growth of this species in the Sweet Lake region was such that travel through this area was almost impossible. After the hurricane the field resembled a wet prairie. C. jamaicense has been in a steady decline in the southwest area of Louisiana largely due to salt-water intrusion and impeded marsh drainage.

Two large masses of clay were deposited over the beach by the hurricane's tidal surge and these "mud arcs" have become permanent features of the shoreline. Four weeks after the hurricane the mud was very fluid, six months later the mud surface dried, becoming cracked. Fourteen months after the formation of the mud arcs a study was made to determine the type and density of the vegetation. The vegetation-encroachment, on the peripherial of the mud arc, is a typical salt marsh with Spartina alterniflora, Distichlis spicata, Borrichia frutescens and Batis maritima. It was estimated that it would take approximately two years for the arcs to become completely covered with vegetation.

Chabreck and Palmisano (1973) studied the effect of hurricane Camille on the marshes of the Mississippi River delta. Immediately following the hurricane the salinity in the marsh along the natural levee increased from .92 ppt to 3.61 ppt. But one year after the hurricane the salinity was raised from .10 ppt to .26 ppt but receded to .11 ppt within one year. Alternanthera philoxeroides seemed to be the species affected by the increase in salinity. This species was absent in the ponds and lakes after the hurricane and had not reappeared one year later.

In general in the salt marsh and brackish zones recovery after a hurricane can be complete after one or two uninterrupted growing seasons.

Productivity

Estuaries in general and salt marshes in particular are unusally productive places (Teal and Teal, 1969). None of the common agriculture, except possibly rice and sugarcane production, comes close to producing as much potential animal food as do the salt marshes. The agricultural crops which approach this high figure are fertilized and maintained by man at great expense (Teal and Teal, 1969). There are many reasons to account for the productivity of marshes (particularly salt marshes). Only a small percentage (less than 10%) of the organic material produced by the marsh plants is actually grazed by marsh herbivores (de la Cruz, 1973; Keefe, 1972). The bulk of the plant materials dies (annually for most species) and falls to the surface of the mud where it may decompose (Teal and Teal, 1969). Protein enrichment due to bacteria occurs shortly thereafter.

Another reason for the richness of marshes (salt) is that there is a continuous mixing of nutrients (and water) in the marshes. These nutrients are turned over at a relatively high rate in some cases. Pomeroy, Johannes, Odum, and Roffman (1969) found that the sediment in the well-established coastal Spartina alterniflora marsh contained enough phosphorous for 500 years growth without replenishment. Their studies indicate that Spartina obtains its phosphorous from the soil. The phosphorous in the water provides phosphorous for the sediment for it is absorbed on the surface of the sediment, then combined into the crystal lattice of the clay. From this combination with the clay, it can still be released as free phosphate available for biological uptake. Thus, the large supply of phosphorous in the sediment assures a continuing source of phosphorous for phytoplankton and mud algae, as well as Spartina.

The high concentration of organic matter in the soil leads to the formation of colloids. The colloids absorb ions necessary for plant growth (Albrecht, 1941; Gorham, 1953). The decomposition of organic matter produces large quantities of carbon dioxide, increasing the acidity of the water and thereby increasing the solubility of iron and manganese (Keefe, 1972). These ions may occur at concentrations that would normally be considered toxic (Robinson, 1930), but marsh plants have adapted to high concentrations. Spartina has an unusually high demand for iron and despite the high concentrations in marsh soil still appears chlorotic in some areas (Teal and Teal, 1969).

The tides not only remove detritus from marshes but also add nutrients (Aurand, 1968). In addition, flowing water is more important than standing water (Schelske and Odum, 1961). Particles rich in nutrients are trapped on the marsh obstructions provided by the plants (Gorham and Pearsall, 1956; Blum, 1969; Ranwell, 1964a), thus increasing the size of the marsh laterally and vertically, while producing soil rich in nutrients for the plants. Soil nutrients decrease in concentration away from the sea (Ranwell, 1964b).

Nutrient levels in the water over freshwater marshes are often high. Buttery, Williams, and Lambert (1965) reported values of 0.17-0.30 mg PO_4-P liter $^{-1}$, 0.81-1.18 mg NO_3-N liter $^{-1}$ and 2.88-1.08 mg

NH_3-N liter $^{-1}$ in the water over a Phragmites communis-Glyceria maxima streamside marsh. Phosphorous in the soil water decreased from 100.9-509 mg liter $^{-1}$ at the channel to 9.5-9.3 mg liter $^{-1}$ at the landward side of the marsh.

Another reason for the high productivity of marshes (salt) may be the vertical orientation of the leaves. This orientation reduces intenss heating (Palmer, 1941), exposes the maximum leaf surface to sunlight over the day, and minimizes mutual shading (Jervis, 1964).

de la Cruz (1974) analyzed nine species of marsh plants in the Gulf Coast of Mississippi to determine their productivity (monotypic stands). Three 1 square meter plots were harvested monthly from each of the nine plots. Annual net productivity of the above ground material was estimated from the monthly increases during the season. Caloric values of the plant material were also recorded along with ash-free weight. The values are as follows:

Species	Annual Net Primary Productivity	
	Dry g/m^2	Kcal/m^2
Sagittaria lancifolia	600	2468
Phragmites communis	2330	9841
Scirpus robustus	1056	4576
Juncus roemerianus	1697	7558
Spartina cynosuroides	2190	9347
Spartina patens	1922	8464
Distichlis spicata	1484	6020
Spartina alterniflora short	1089	4028
Spartina alterniflora long	1964	8088

The production value of 1697 g/m^2 yr $^{-1}$ for Juncus roemerianus is higher than previously reported in the literature (Williams and Murdoch, 1972; Heald, 1969; Stround and Cooper, 1968; Waits, 1967).

The net primary productivity of S. alterniflora short form is higher than previously reported; the tall form productivity is comparable to the values reported for Georgia and Louisiana (de la Cruz, 1973; Keefe, 1972). The values for the other species are comparatively higher than the production values observed for similar and related species from other estuaries. de la Cruz (1974) found the tidal marshes to be generally more productive than the marshes found in the Atlantic Seaboard. Dirby (1971) suggested that the greater productivity in the Gulf marshes may be partly due to the longer growing season.

Keefe (1972) in a major review article gives a summary of biomass and production values for marsh plants. The list of over sixty items covers plants growing in salt, brackish and freshwater growing throughout the Atlantic and Gulf Coasts.

de la Cruz (1973) also provides a list on estimates of annual Net Primary Production shown in Table A.

In the salt marsh, the water flooding the marsh is the source of the nutrients, but there is a net loss of produced material to the estuary, providing food for consumers (Odum and de la Cruz, 1963; Reimold, 1965; Reimold and Daiber, 1970). In addition there is evidence that salt marshes serve as spawning and nursery grounds for the young of a number of economically important marine species (see Hitchcock, 1972 for a review).

TABLE A. Values from de la Cruz, 1973

Marsh Community	Annual Net Production g/m^2	Geographic Location	Reference
Mixed vegetation	992-1108	St. Louis Bay Estuary, Ms.	de la Cruz & Gabriel (Present Research)
Mixed vegetation	1246	Patuxent Estuary, Md.	Johnson (1970)
Spartina alterniflora	2883	Sapelo Is., Ga.	Odum & Fanning (1973)
Spartina alterniflora	1150	Barataria Bay Estuary, La.	Kirby (1971)
Spartina alterniflora	1207	Patuxent Estuary, Md.	Johnson (1970)
Spartina alterniflora	650	Beaufort, N.C.	Williams & Murdoch (1969)
Spartina alterniflora	1158	Sapelo Is., Ga.	Teal (1964)
Spartina alterniflora	2000	Sapelo Is., Ga.	Schelske & Odum (1961)
Spartina alterniflora	445	Canary Creek Estuary, Del.	Morgan (1961)
Spartina alterniflora	985	Sapelo Is., Ga.	Smalley (1959)
Juncus roemerianus	2000	Ocean Springs, Ms.	Eleuterius (Pers. comm.)
Juncus roemerianus	754	Cape Lookout, N.C.	Williams & Murdoch (1972)
Juncus roemerianus	849	Everglades, Fla.	Heald (1969)
Juncus roemerianus	796	Cape Fear River, N.C.	Stroud & Cooper (1968)
Juncus roemerianus	560	Cape Fear River, N.C.	Foster (1968)
Juncus roemerianus	895	Bodie Is., N.C.	Waits (1967)
Spartina cynosuroides	1028	Altamaha River Estuary, Ga.	Odum & Fanning (1973)
Spartina patens	1296	Bodie Is., N.C.	Waits (1967)
Spartina patens	993	Long Is., N.Y.	Harper (1918)

Decomposition

Table B gives a summary of decomposition rates for various marsh plants. The data represents the fate of plant materials being produced and dying on the marsh. Decomposition rates are expressed as per cent loss of material. The removal of material from the surface of the marsh by water makes the plant material available to the detritus-based consumers (de la Cruz, 1973; de la Cruz and Gabriel, 1974).

Energy Flow

Organisms maintain themselves and reproduce by utilizing energy from the environment. This movement of energy from organism to organism is called energy flow (McNaughton and Wolf, 1973). Analysis of energy flow in ecosystems is a tedious undertaking that takes years of effort.

A summary of energy flow in a Georgia salt marsh has been worked out by Teal (1962). A summary of his findings is given below:

Input as light	6000,000 kcal/m^2/yr
Loss in photosynthesis	563,620 or 93.9%
Gross production	36,380 or 6.1% of light
Producer respiration	28,175 or 77% of gross prod.
Net production	8,205 kcal/m^2/yr
Bacterial respiration	3.890 or 47% of net prod.
Primary consumer respiration	596 or 7% of net prod.
Secondary consumer respiration	48 or 0.6% of net prod.
Total energy dissipation by consumers	4,534 or 55% of net prod.
Export	3,671 or 45% of net prod.

TABLE B. Decomposition rates of various plant species expressed as % loss of material after one year. From de la Cruz, 1973.

Species	Decomposition Rate (%/yr)	Locality	Methods	Reference
Juncus roemerianus	40	Bay St. Louis, Ms.	Nylon net bags, 5.0 mm mesh	de la Cruz and Gabriel (1973)
Juncus roemerianus	46	N. of Cape Lookout, N.C.	Dissappearance rate, tidal removal	Williams and Murdoch (1972)
Juncus roemerianus	36	Everglades, Fla.	Nylon net bags, 1.5 mm mesh	Heald (1969)
Juncus roemerianus	47	Bodie Is., N.C.	Nylon net bags, 1.0 mm mesh	Waits (1967)
Juncus roemerianus	35	Sapelo Is., Ga.	Nylon net bags, 2.5 mm mesh	de la Cruz (1965)
Juncus squarrosus	27	Lancashire, England	Nylon net bags, 10 mm mesh	Latter and Cragg (1967)
Scirpus americanus	60	Bay St. Louis, Ms.	Nylon net bags, 5.0 mm mesh	de la Cruz and Gabriel (Present Research)
Distichlis spicata	38	Bay St. Louis, Ms.	Nylon net bags, 5.0 mm mesh	de la Cruz and Gabriel (Present Research)
Distichlis spicata	53	Sapelo Is., Ga.	Nylon net bags, 2.5 mm mesh	de la Cruz (1965)
Salicornia sp.	94	Sapelo Is., Ga.	Nylon net bags, 2.5 mm mesh	de la Cruz
Sawgrass leaves	45	Everglades, Fla.	Nylon net bags, 2.5 mm mesh	Heald (1969)
Red mangrove leaves	60	Everglades, Fla.	Nylon net bags, 2.5 mm mesh	Heald (1969)
White mangrove leaves	38	Everglades, Fla.	Nylon net bags, 2.5 mm mesh	Heald (1969)

In the marsh analyzed Spartina accounts for approximately three-forths of the primary production, while algae on the mud accounts for the rest. The model shows that only 1.5% of the sunlight is transformed into energy available to consumers. In other marshes, even less incident radiation is converted to organic matter. In a Spartina alterniflora - Juncus roemerianus marsh in North Carolina Stroud and Cooper (1969) found that only 0.2% of the incident light was converted to net primary production. Bray (1962) found 0.6% of the incident light was utilized in a Typha angustifolia - latifolia hybrid marsh in Minnesota.

In Teal's study (1962), 45% of net production was exported to the surrounding waters. This export would be available to the estuarine consumers. This is quite high compared to similar ecosystems. Nixon and Oviatt (1973) estimated 10 to 30% was exported in a salt marsh in Rhode Island (also gives energy flow diagrams).

Energy flow studies for the Gulf Coast similar to Teal's (1962) and Nixon and Oviatt (1973) for New England area have not been conducted.

SITES

The study areas are located in southeastern Louisiana along Bayou Terre Aux Boeufs and adjoining bays. See the attached map for location of the following study sites.

Site No.	Name	Location			
1	Petain Lagoon	89	42	29	45
2	Bayou Gaudet	89	42	29	44
3	Bottle Lagoon	89	39	29	42
4	Dead Duck Pass	89	37	29	41
5	Drum Bay	89	34	29	39

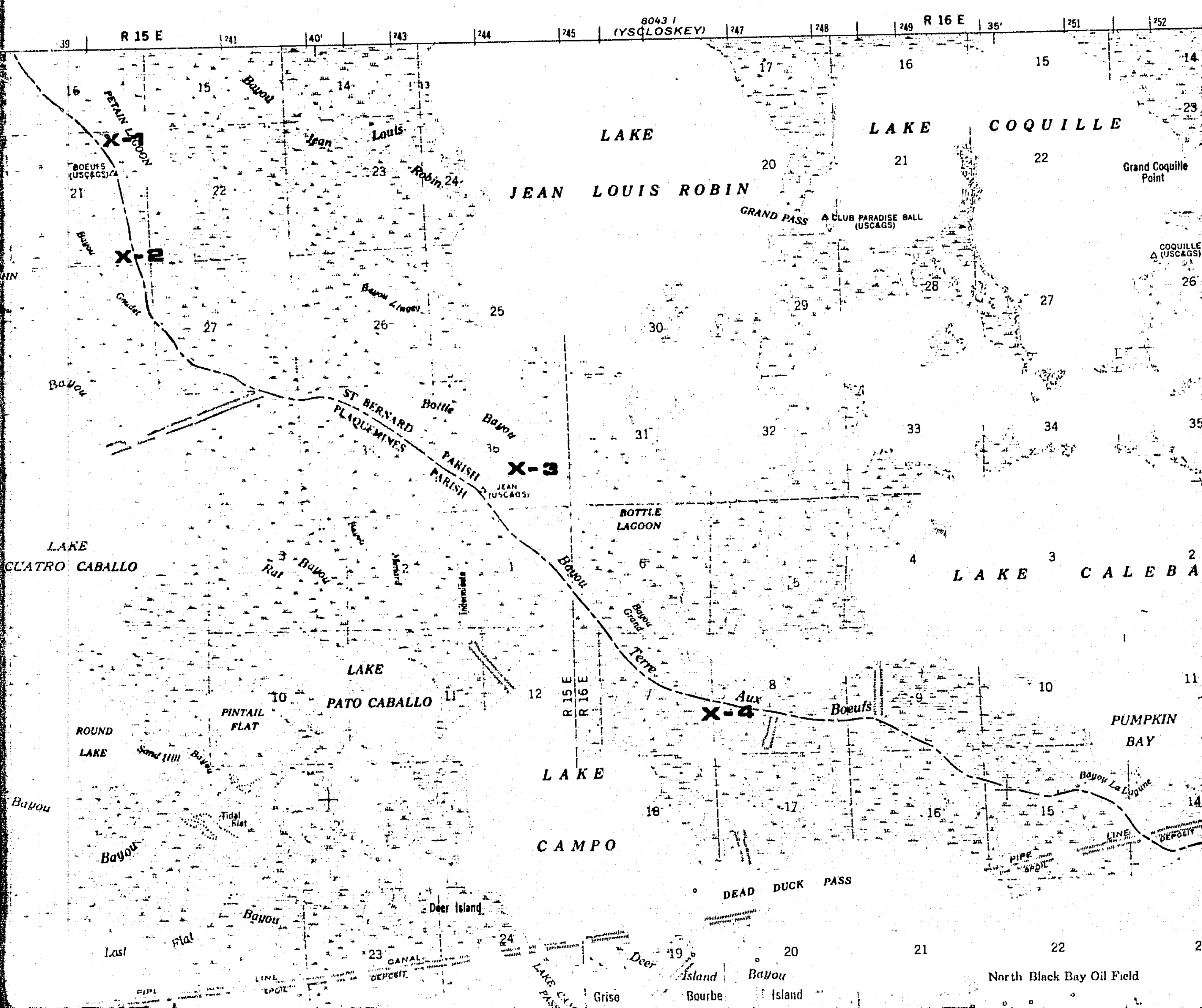
Petain Lagoon (1) is a mixed stand of vegetation with species of Spartina alterniflora, Spartina patens, and Spartina cynosuroides with areas of Distichlis spicata and Juncus roemerianus.

Bayou Gaudet (2) consists of an unburned area of Spartina patens and a burned area of Distichlis spicata with very sharp lines between the two species. The margin of this area has many species of halophytes.

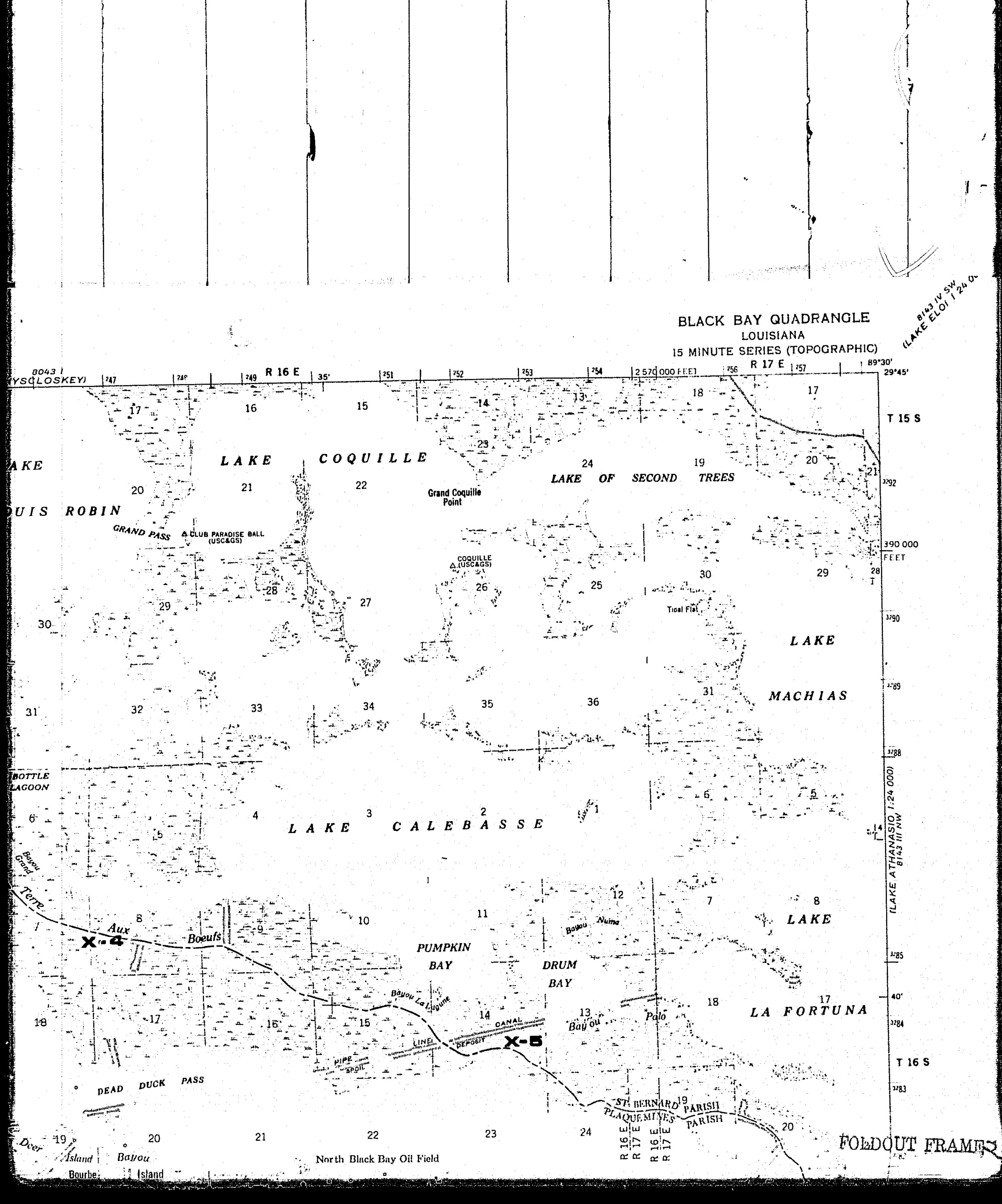
Bottle Lagoon (3) is intermediate in the gradient of study plots. Plants within the site include Spartina alterniflora, Spartina patens, Distichlis spicata, and Juncus roemerianus with additional minor species.

Dead Duck Pass (4) study area is composed primarily of Juncus roemerianus with populations of Spartina alterniflora and Distichlis spicata scattered about the site.

Drum Bay (5) is composed almost entirely of Spartina alterniflora with succulent halophytes on the margins including mangrove (Avicennia sp.).


R 15 E
R 16 E
8043 I (YSCLOSKEY)
LAKE JEAN LOUIS ROBIN
LAKE COQUILLE
Grand Coquille Point
COQUILLE (USC&GS)
GRAND PASS
CLUB PARADISE BALL (USC&GS)
PETAIN LAGOON
BOEUFS (USC&GS)
X-1
X-2
X-3
X-4
Bayou Jean Louis Robin
Bayou Gaudet
Bayou Lingee
Bottle Bayou
ST BERNARD PARISH
PLAQUEMINES PARISH
JEAN (USC&GS)
BOTTLE LAGOON
LAKE CUATRO CABALLO
Rat Bayou
LAKE PATO CABALLO
LAKE CALEBA
Bayou Terre Aux Boeufs
PINTAIL FLAT
ROUND LAKE
Sand Hill Bayou
Tidal Flat
LAKE CAMPO
PUMPKIN BAY
Bayou La Lugune
PIPE LINE
SPOIL DEPOSIT
DEAD DUCK PASS
Deer Island
Last Flat Bayou
CANAL DEPOSIT
LAKE CAMPO PASS
Deer Island Bayou Grise
Bourbe
Island
North Black Bay Oil Field

OUT FRAME /



FOLDOUT FRAME 2

The study area for this report is located in the Sub-delta marsh area of Louisiana (St. Bernard). These marshes are delta formations that have been inactive for possibly 200-500 years in the eastern areas. Their geographic position places them a considerable distance from the Tremendous amounts of fresh water poured into the Gulf of Mexico by the Mississippi River. The mineral deposits are generally of marine origin and saline in nature (O'Neil, 1949). Most of the Sub-delta area is subject to daily tide action. Continual subsidence of the Sub-delta marshes is evident almost anywhere, i.e., the abandoned sea-rims of the Chandeleur Islands. The Breton and Chandeleur Islands have retreated westward at about 13.7 ft/yr (ca. 65 m) between 1812 and 1954. Between 1807 and 1939, the land has been reduced from 721 square miles (1,867 sq. km.) to about 617 square miles (1,598 sq. km.) due to retreat of shoreline (National Shoreline Study, 1971) and enlargement of ponds, bays within the marshlands (O'Neil, 1949). Further evidence are the drowned marshes of Breton Sound (O'Neil, 1949), plus the ghost cypress swamps that flank practically all the bayous near their midway areas, the trees having been destroyed by the intrusion of salt water. Dead live oaks (Quercus virginiana) are present on the crests of natural levees and the vegetation replacing the oaks are the brackish low-ridge species primarily.

Spartina cynosuroides, Baccharis halimifolia and Iva frutescens (O'Neil, 1949).

In the Bayou Terre Aux Boeuf area (location of study plot) the islands are dominated by mangrove, Avicennia nitida. The first substantial marsh in this area is a crest of matted roots and mineral soils 12-15 inches (3.48 dc.) in depth. Under this is an organic peat about 6 m in depth (O'Neil, 1949). About midway on Bayou Terre Aux Boeuf until the direct influence of the present-day river's natural levee Scirpus olneyi dominates. This species has been cultivated for years by annual burning making it easier to hunt animals and travel (O'Neil, 1949). This practice has been used for over 100 years in the area.

The area in general has been greatly disturbed. Hunters and trappers sometimes cut small ditches or drag their piroques over certain spots. Tidal action would in a period of years cut a canal 6 to 10 m wide and 2-4 m deep. The natural bayou levees and lake shores are built of organic material. The entire area is shredded with bayous and dotted with lakes and ponds (O'Neil, 1949).

The marsh in the study area contains Spartina alterniflora, Spartina patens, Spartina cynosuroides, Distichlis spicata, Sporobolus sp. and Fimbrystylis sp. (primary species). The marshes of Louisiana are very complex in regard to zonation unlike many of the Atlantic Coast marshes, particularly those found in the New England area. In the Gulf, Spartina alterniflora reaches its lower limit at mean sea level. In the brackish marshes the dominant community is a Spartina patens - Distichlis spicata - Juncus roemerianus complex, but as the *Spartina* is less tolerant of salt than the other two species it disappears in the more saline areas. The free soil water in the marshes is more saline than the water in neighboring lagoons and it is thought that the high salinity of the soil water must be maintained by surface evaporation and transpiration (Chapman, 1960).

METHODS

Within each site a 200 meter square study area was delimited and the vegetation analyzed within the square. Two procedures were used to gather vegetation data from these areas. The first method, clipped quadrat (Cox, 1972), was used at all sites. At each site a number of quarter square meter quadrats were clipped. The samples were separated and counted per species. The following measurements were then determined:

$$\text{density} = \frac{\text{number of individuals}}{\text{area sampled}}$$

$$\text{relative density} = \frac{\text{density for a species}}{\text{total density for all species}} \times 100$$

$$\text{frequency} = \frac{\text{number of plots in which species occurs}}{\text{total number of plots sampled}}$$

$$\text{relative frequency} = \frac{\text{frequency value for a species}}{\text{total of frequency values for all species}} \times 100$$

importance value = relative density + relative frequency
(per species)

At those sites in which the vegetation was not dominated by one species, another procedure was also employed. The line transect or line intercept (Canfield, 1941) technique was used with modifications to facilitate its application in the salt marsh. In this study the line consisted of a 4 meter wooden pole subdivided into 1 meter intervals. This pole was run at ground level and the number of individuals per species per interval was recorded. With these values and the average stem diameter values for each species as measured from the clipped samples, the following measurements were then determined:

$$\text{frequency} = \frac{\text{intervals in which species occurs}}{\text{total number of transect intervals}}$$

$$\text{relative frequency} = \frac{\text{frequency value for a species}}{\text{total of frequency values for all species}} \times 100$$

$$\text{density} = \frac{\text{number of stems per species}}{\text{average stem diameter}} \times \left(\frac{10^3}{\text{number of intervals}}\right)$$

$$\text{relative density} = \frac{\text{density value for a species}}{\text{total density for all species}} \times 100$$

$$\text{dominance} = \frac{\text{number of stems per species (average stem diameter)}}{\text{total transect length}}$$

$$\text{relative dominance} = \frac{\text{dominance value for a species}}{\text{total dominance for all species}} \times 100$$

importance value = relative frequency + relative density + relative (per species) dominance

The importance values are seen to be on two scales, 200 for the clipped quadrat method and 300 for the line transect method.

For this study's work in the field the two methods were used in the following manner. At a mixed site a random point of entry along the shoreline was chosen. Once past the shoreline vegetation a quadrat sample was taken. From that point a series of 4 lines was run moving inland. From there 20 paces were traversed and then another quadrat sample was taken. This procedure was followed until the sample area had been crossed. The final sample taken was always a clipped quadrat. (See diagram 1 for example.)

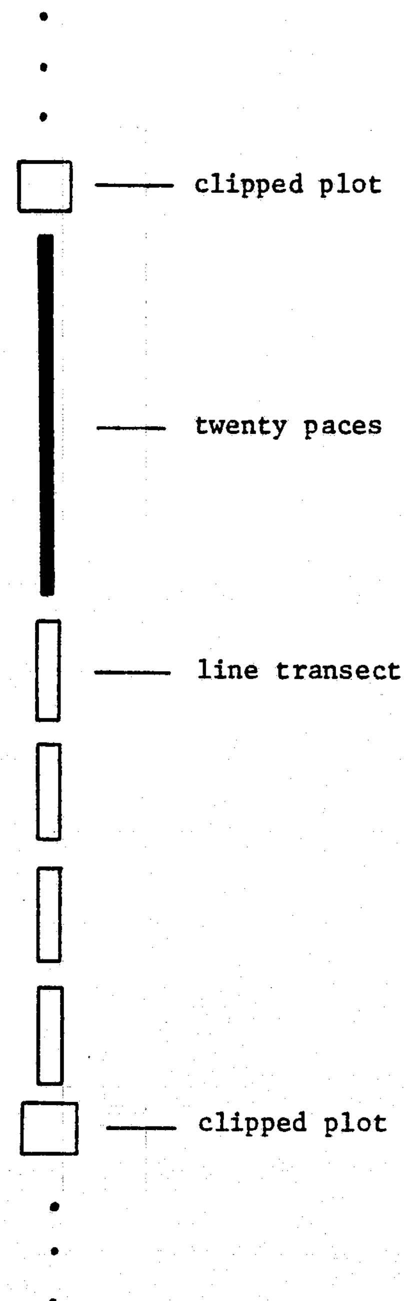


Diagram 1. Sampling method in the field.

The use of these two methods permitted a more detailed analysis of a community's vegetation. Also possible was the corraboration of two unrelated methods for the discernment of any changes noted in the community's structure over time. It is to these ends that these methods were applied.

Salinity measurements were taken concurrently with the vegetation sampling. Both water and soil water were measured when possible. The salinity was measured using a YSI SCT meter.

RESULTS

The following twenty-five tables gives density, relative density, relative frequency, relative dominance and importance values for each site for the period of study.

The following list gives tables for specific study sites:

Table	1-6	Petain Lagoon
Table	7-12	Bayou Gaudet
Table	13-18	Bottle Lagoon
Table	19-24	Dead Duck Pass
Table	25	Drum Bay

Salinity values for the various sites are given in Table 26.

In addition, Figure 1 and 2 give density values per week of the year for Bayou Gaudet and Drum Bay respectively.

Figure 3 and 4 give the importance values via clipped and line transect methods for Petain Lagoon. Figure 5 and 6 give the same information for Bottle Lagoon as do Figure 7 and 8 for Dead Duck Pass.

Table 1 Petain Lagoon

Density — stems/m^2

Date	4/9	4/30	5/26	6/24	7/16	8/11	9/3	9/26	10/15	11/5	11/26
Aster tenuifolius	3	—	—	5	—	6	6	1	5	—	—
Borrichia frutescens	—	—	—	—	—	8	6	13	—	—	1
Distichlis spicata	864	599	689	733	73	471	530	390	619	499	376
Juncus roemerianus	—	—	211	—	—	—	—	—	—	—	—
Salicornia virginica	—	8	1	—	—	—	29	1	—	—	—
Scirpus robustus	13	—	31	25	2	8	6	—	2	4	—
Spartina alterniflora	—	51	—	—	100	—	—	—	—	—	—
S. cynosuroides	27	44	46	33	18	36	18	21	15	15	4
S. patens	513	193	126	254	552	197	401	219	150	191	369
						(1)					(2)

Also present:
(1) *Baccharis halimifolia*
(2) *Fimbristylis castanea*

Table 2 Petain Lagoon

Relative Density

Date	4/9	4/30	4/30	5/26	5/26	6/24	6/24	7/16	7/16	8/11	8/11	9/3	9/3	9/26
Method	C	C	LT	C	LT	C	LT	C	LT	C	LT	C	LT	C
Aster tenuifolius	.4	-	.4	-	-	.4	.9	-	-	.8	.5	.6	.7	.1
Borrichia frutescens	-	-	-	-	-	-	.2	-	-	1.1	.2	.6	.6	2.0
Distichlis spicata	60.8	67.0	63.4	62.4	88.1	69.8	79.0	9.8	48.9	64.8	77.1	53.3	73.4	60.5
Fimbristylis castanea	-	-	-	-	-	-	.3	-	-	-	-	-	.4	-
Juncus roemerianus	-	-	-	19.1	2.9	-	-	-	-	-	-	-	-	-
Salicornia virginica	-	.8	.7	-	-	-	-	-	-	-	1.5	2.9	.4	.1
Scirpus robustus	.9	-	5.8	2.8	1.4	2.4	2.0	.3	1.0	1.1	.9	.6	.7	-
Spartina alterniflora	-	5.7	-	-	-	-	-	13.4	3.4	-	-	-	-	-
Spartina cynosuroides	1.9	4.9	26.1	4.3	3.5	3.1	.5	2.4	.4	4.9	1.4	1.8	1.2	3.3
Spartina patens	36.0	21.6	3.6	11.4	4.1	24.2	17.1	74.1	46.3	27.1	18.1	40.2	22.6	34.0

Table 2 Petain Lagoon

Relative Density

6/24	7/16	7/16	8/11	8/11	9/3	9/3	9/26	9/26	10/15	10/15	11/5	11/5	11/26	11/26
LT	C	LT	C	LT	C	LT	C	LT	C	LT	C	LT	C	LT
.9	-	-	.8	.5	.6	.7	.1	.5	6.0	.6	-	.6	-	-
.2	-	-	1.1	.2	.6	.6	2.0	1.3	-	-	-	-	.1	.1
79.0	9.8	48.9	64.8	77.1	53.3	73.4	60.5	68.0	78.2	61.9	70.4	52.9	47.9	81.2
.3	-	-	-	-	-	.4	-	-	-	3.7	-	5.2	4.5	-
-	-	-	-	-	-	-	-	-	-	1.0	-	-	-	-
-	-	-	-	1.5	2.9	.4	.1	1.0	-	.4	-	-	-	.3
2.0	.3	1.0	1.1	.9	.6	.7	-	.7	3.0	.3	.5	.3	-	-
-	13.4	3.4	-	-	-	-	-	-	-	-	-	-	-	-
.5	2.4	.4	4.9	1.4	1.8	1.2	3.3	.6	1.9	.9	2.1	.8	.5	.2
17.1	74.1	46.3	27.1	18.1	40.2	22.6	34.0	27.9	19.0	31.2	27.0	40.2	47.0	18.2

Table 3 Petain Lagoon

Relative Frequency

Date	4/9	4/30	4/30	5/26	5/26	6/24	6/24	7/16	7/16	8/11	8/11	9/3	9/3	9/
Method	C	C	LT	C	LT	C	LT	C	LT	C	LT	C	LT	C
Aster tenuifolius	16.7	-	1.7	-	-	6.3	4.2	-	-	11.8	3.1	9.5	4.7	5
Borrichia frutescens	-	-	-	-	-	-	2.1	-	-	5.9	3.1	9.5	5.4	11
Distichlis spicata	27.8	26.6	42.1	26.7	46.9	25.0	43.1	29.4	34.6	23.5	38.5	23.8	35.6	27
Fimbristylis castanea	-	-	-	-	-	-	1.2	-	-	-	-	-	.8	-
Juncus roemerianus	-	-	-	6.7	3.1	-	-	-	-	-	-	-	-	-
Salicornia virginica	-	6.9	3.4	6.7	-	-	-	-	-	-	3.7	4.8	1.8	5
Scirpus robustus	16.7	-	18.0	26.7	18.8	25.0	20.8	11.8	9.8	11.8	12.8	14.3	8.9	-
Spartina alterniflora	-	26.6	-	-	-	-	-	23.5	20.3	-	-	-	-	-
Spartina cynosuroides	11.1	13.3	30.5	13.3	20.0	25.0	8.4	5.9	3.3	17.7	17.1	14.3	14.9	22
Spartina patens	27.8	26.6	4.3	20.0	11.2	18.8	20.2	29.4	32.0	23.5	21.4	23.8	27.9	27

FOLDOUT FRAME 1

Table 3 Petain Lagoon

Relative Frequency

4	6/24 LT	7/16 C	7/16 LT	8/11 C	8/11 LT	9/3 C	9/3 LT	9/26 C	9/26 LT	10/15 C	10/15 LT	11/5 C	11/5 LT	11/26 C	11/26 LT
3	4.2	-	-	11.8	3.1	9.5	4.7	5.5	2.1	10.1	3.8	-	3.5	-	-
	2.1	-	-	5.9	3.1	9.5	5.4	11.1	7.9	-	-	-	-	9.1	2.3
0	43.1	29.4	34.6	23.5	38.5	23.8	35.6	27.8	40.4	27.8	45.0	33.3	41.7	36.3	68.2
	1.2	-	-	-	-	-	.8	-	-	-	2.3	-	2.8	9.1	-
	-	-	-	-	-	-	-	-	-	-	1.5	-	-	-	-
	-	-	-	-	3.7	4.8	1.8	5.5	2.6	-	.8	-	-	-	1.1
0	20.8	11.8	9.8	11.8	12.8	14.3	8.9	-	6.6	5.5	3.1	6.7	3.5	-	-
	-	23.5	20.3	-	-	-	-	-	-	-	-	-	-	-	-
0	8.4	5.9	3.3	17.7	17.1	14.3	14.9	22.2	10.6	27.8	12.2	26.7	12.5	18.2	3.4
8	20.2	29.4	32.0	23.5	21.4	23.8	27.9	27.8	29.8	27.8	31.3	33.3	36.0	27.3	25.0

Table 4 Petain Lagoon

Relative Dominance

Date	4/30	5/26	6/24	7/16	8/11	9/3	9/26	10/15	11/5	11/26
Aster tenuifolius	.2	—	.7	—	.4	.7	.5	.7	.5	—
Borrichia frutescens	—	—	.4	—	1.4	1.8	6.3	—	—	.7
Distichlis spicata	51.8	70.3	72.7	31.0	67.2	61.0	51.1	57.9	53.3	81.4
Fimbristylis castanea	—	—	—	—	—	.4	—	1.9	2.4	—
Juncus roemerianus	—	4.1	—	—	—	—	—	2.0	—	—
Salicornia virginica	1.2	—	—	—	1.3	.4	.8	.3	—	.3
Scirpus robustus	10.5	5.3	8.5	3.4	3.8	2.4	2.1	1.0	1.6	—
Spartina alterniflora	—	—	—	30.0	—	—	—	—	—	—
S. cynosuroides	31.2	18.8	3.4	3.2	13.1	10.7	6.3	9.9	9.0	2.4
S. patens	5.1	1.5	14.3	32.4	12.7	22.6	32.9	26.3	33.2	15.2

Table 5 Petain Lagoon

Importance Values – Clipped

Date	4/9	4/30	5/26	6/24	7/16	8/11	9/3	9/26	10/15	11/5	11/26
Aster tenuifolius	17.1	—	—	10.3	—	12.6	10.1	3.1	16.1	—	—
Borrichia frutescens	—	—	—	—	—	7.0	10.1	13.1	—	—	9.2
Distichlis spicata	88.6	93.6	89.1	94.8	39.2	88.3	77.1	88.3	106.0	103.4	84.2
Fimbristylis castanea	—	—	—	—	—	—	—	—	—	—	13.6
Juncus roemerianus	—	—	25.8	—	—	—	—	—	—	—	—
Salicornia virginica	—	7.7	6.7	—	—	—	7.7	5.6	—	—	—
Scirpus robustus	17.6	—	29.5	27.4	12.1	12.9	14.9	—	8.0	7.2	—
Spartina alterniflora	—	32.3	—	—	36.9	—	—	—	—	—	—
S. cynosuroides	13.0	18.2	17.6	28.1	8.3	22.6	16.1	22.5	29.7	28.8	18.7
S. patens	63.8	58.2	31.4	42.9	103.5	50.6	64.0	61.8	46.8	60.3	74.3

Table 6 Petain Lagoon

Importance Values – Line Transect

Date	4/30	5/26	6/24	7/16	8/11	9/3	9/26	10/15	11/5	11/26
Aster tenuifolius	2.3	—	5.8	—	4.0	6.1	3.1	5.1	4.6	—
Borrichia frutescens	—	—	2.7	—	4.7	7.8	15.5	—	—	3.1
Distichlis spicata	157.3	205.3	194.8	114.5	182.8	170.0	159.5	164.8	147.9	230.8
Fimbristylis castanea	—	—	1.5	—	—	1.6	—	7.9	10.4	—
Juncus roemerianus	—	10.1	—	—	—	—	—	4.5	—	—
Salicornia virginica	5.3	—	—	—	6.5	2.6	4.8	1.5	—	1.7
Scirpus robustus	34.3	25.5	31.3	14.2	17.5	12.0	9.4	4.4	5.4	—
Spartina alterniflora	—	—	—	53.7	—	—	—	—	—	—
S. cynosuroides	87.8	42.3	12.3	6.9	31.6	16.9	17.5	22.8	22.3	6.0
S. patens	13.0	16.8	51.6	110.7	52.2	73.1	90.6	88.8	109.4	58.2

Table 7 Bayou Gaudet

Density - Stems/m^2

Date	4/14	5/13	6/13	7/1	7/30	9/3	9/26	10/15	11/5	11/26	1/15
Distichlis spicata	44	258	48	21	20	21	21	32	16	19	-
Spartina patens	1511	1280	1980	1610	1495	1775	1308	1193	1340	1228	1438

Table 8 Bayou Gaudet

Relative Density

Date	4/14	4/16	5/13	5/13	5/26	6/13	6/13	7/1	7/30	9/3	9/26	10/15	11/5	11/26	1/15
Method	C	LT	C	LT	LT	C	LT	C	C	C	C	C	C	C	C
Distichlis spicata	2.9	-	16.7	23.6	.6	2.5	10.6	1.2	1.3	1.1	1.5	2.5	1.1	1.6	-
Spartina patens	97.1	100	83.3	76.4	99.4 *	97.5	89.4 *	98.8	98.7	98.9	98.5	97.5	98.9	98.4	100

Also present:
*Scirpus olneyi

Table 9 Bayou Gaudet

Relative Frequency

Date	4/14	4/16	5/13	5/13	5/26	6/13	6/13	7/1	7/30	9/3	9/26	10/15	11/5	11/26	1/15
Method	C	LT	C	LT	LT	C	LT	C	C	C	C	C	C	C	C
Distichlis spicta	42.9	-	50.0	45.5	9.9	50.0	24.5	25.0	40.0	50.0	39.8	40.0	40.0	25.0	-
Spartina patens	57.1	100	50.0	54.5	88.4	50.0	73.4	75.0	60.0	50.0	60.2	60.0	60.0	75.0	100

Table 10 Bayou Gaudet

Relative Dominance

Date	4/16	5/13	5/20	6/13
Distichlis spicta	-	32.0	1.1	11.3
Spartina patens	100	68.0	98.5	85.9

Table 11 Bayou Gaudet

Importance Values - Clipped

Date	4/14	5/13	6/13	7/1	7/30	9/3	9/26	10/15	11/5	11/26	1/15
Distichlis spicata	45.8	66.7	52.5	26.2	41.3	51.1	41.3	42.5	41.1	26.6	-
Spartina patens	154.2	133.3	147.5	173.8	158.7	148.9	158.7	157.5	158.9	173.4	200

Table 12 Bayou Gaudet

Importance Values - Line Transect

Date	4/16	5/13	5/26	6/13
Distichlis spicata	-	101.1	11.6	46.4
Spartina patens	300	198.9	286.3	248.7

Table 13 Bottle Lagoon

Density – stems/m^2

Date	6/10	6/27	7/22	8/11	9/10	10/3	10/23	11/12	12/2
Aster tenuifolius	13	15	14	8	1	4	7	6	—
Borrichia frutescens	5	—	—	—	—	2	—	—	—
Distichlis spicata	694	605	525	404	807	498	135	441	402
Juncus roemerianus	79	30	59	159	92	162	202	146	170
Salicornia virginica	18	—	2	—	6	55	—	19	—
Scirpus robustus	5	7	14	3	—	—	—	—	—
Spartina alterniflora	87	115	138	155	83	100	151	113	54
S. patens	118	290	107	76	134	182	98	340	231
			(1)	(2)				(3)	

Also present:
(1) *Agalinis maritima*
(2) *Eleocharis* sp.
(3) *Lythrum lineare*

Table 14 Bottle Lagoon

Relative Density

Date	6/10	6/10	6/27	6/27	7/22	7/22	8/11	8/11	9/10	9/10	10/3	10/
Method	C	LT	C	LT	C	LT	C	LT	C	LT	C	LT
Aster tenuifolius	1.2	.5	1.4	.7	1.6	1.1	1.0	.6	-	.1	1.0	.
Borrichia frutescens	.5	.4	-	1.0	-	.2	-	-	-	-	.3	-
Distichlis spicata	68.1	78.4	56.9	60.0	61.0	74.4	50.2	48.6	72.0	63.2	49.8	61.
Juncus roemerianus	7.8	9.1	2.8	7.3	6.8	7.3	19.8	20.6	8.2	14.2	16.2	9.
Salicornia virginica	1.8	1.1	-	.3	.2	2.2	-	-	.4	.1	5.5	-
Scirpus robustus	.5	.2	.8	.2	1.6	.4	.4	.6	-	.1	-	-
Spartina alterniflora	8.5	4.7	10.8	4.2	16.2	6.6	19.2	14.7	7.4	6.5	10.0	7.
Spartina patens	11.6	5.6	27.3	27.1	12.4	7.8	9.4	14.9	12.0	15.9	18.2	20.

Table 14 Bottle Lagoon

Relative Density

7/22	7/22	8/11	8/11	9/10	9/10	10/3	10/3	10/23	10/23	11/12	11/12	12/2	12/2
C	LT	C	LT	C	LT	C	LT	C	LT	C	LT	C	LT
1.6	1.1	1.0	.6	-	.1	1.0	.5	1.1	-	.6	1.6	-	.5
-	.2	-	-	-	-	.3	-	-	-	-	.1	-	.5
61.0	74.4	50.2	48.6	72.0	63.2	49.8	61.3	22.8	50.0	41.4	55.1	46.9	52.2
6.8	7.3	19.8	20.6	8.2	14.2	16.2	9.6	34.1	15.1	13.7	15.0	19.8	14.2
.2	2.2	-	-	.4	.1	5.5	-	-	1.8	1.8	1.1	-	-
1.6	.4	.4	.6	-	.1	-	-	-	.5	-	-	-	-
16.2	6.6	19.2	14.7	7.4	6.5	10.0	7.7	25.5	19.5	10.6	15.1	6.3	12.0
12.4	7.8	9.4	14.9	12.0	15.9	18.2	20.9	16.5	13.1	31.9	9.3	27.0	20.6

Table 15 Bottle Lagoon

Relative Frequency

Date	6/10	6/10	6/27	6/27	7/22	7/22	8/11	8/11	9/10	9/10	10/3	10/3
Method	C	LT	C	LT	C	LT	C	LT	C	LT	C	LT
Aster tenuifolius	8.3	1.9	10.0	3.4	10.0	2.2	6.6	2.1	5.9	1.0	10.5	2.2
Borrichia frutescens	4.3	1.9	-	-	-	.8	-	-	-	-	5.3	-
Distichlis spicata	25.0	40.6	30.0	36.5	25.0	38.4	26.7	25.0	29.4	36.8	26.3	34.5
Juncus roemerianus	4.3	8.5	5.1	6.9	5.0	8.4	13.4	11.4	5.9	9.4	5.3	8.8
Salicornia virginica	8.3	2.2	-	1.7	5.0	3.9	-	-	11.8	2.0	5.3	-
Scirpus robustus	8.3	1.9	10.0	2.2	10.0	2.2	6.6	2.1	-	1.0	-	-
Spartina alterniflora	20.8	32.1	24.9	29.7	25.0	32.4	26.7	43.5	23.5	34.1	21.0	37.7
Spartina patens	20.8	10.9	20.0	19.6	15.0	11.7	20.0	14.3	23.5	14.7	26.3	16.8

FOLDOUT FRAME /

Table 15 Bottle Lagoon

<u>Relative Frequency</u>

22	7/22	8/11	8/11	9/10	9/10	10/3	10/3	10/23	10/23	11/12	11/12	12/2	12/2
C	LT	C	LT	C	LT	C	LT	C	LT	C	LT	C	LT
.0	2.2	6.6	2.1	5.9	1.0	10.5	2.2	6.3	-	5.6	4.6	-	1.0
-	.8	-	-	-	-	5.3	-	-	-	-	.9	-	1.0
.0	38.4	26.7	25.0	29.4	36.8	26.3	34.5	31.2	29.6	27.8	32.8	33.3	37.8
.0	8.4	13.4	11.4	5.9	9.4	5.3	8.8	6.3	8.7	5.6	9.9	11.1	7.6
.0	3.9	-	-	11.8	2.0	5.3	-	-	.8	11.1	1.5	-	-
.0	2.2	6.6	2.1	-	1.0	-	-	-	.8	-	-	-	-
.0	32.4	26.7	43.5	23.5	34.1	21.0	37.7	31.2	50.5	22.2	39.6	22.3	37.0
.0	11.7	20.0	14.3	23.5	14.7	26.3	16.8	25.0	9.6	27.8	8.4	33.3	15.1

Table 16 Bottle Lagoon

Relative Dominance

Date	6/10	6/27	7/22	8/11	9/10	10/3	10/23	11/12	12/2
Aster tenuifolius	.3	1.2	.5	.2	.2	.6	—	1.0	.4
Borrichia frutescens	.4	.1	—	—	—	—	—	.3	1.5
Distichlis spicata	49.4	39.8	36.5	15.8	33.6	29.6	13.7	19.7	21.1
Juncus roemerianus	11.7	9.9	6.1	11.6	11.8	7.2	6.6	12.9	13.7
Salicornia virginica	.8	.4	1.1	—	.3	—	.5	.2	—
Scirpus robustus	.5	.6	.7	.8	.3	—	.2	—	—
Spartina alterniflora	33.9	31.6	52.6	67.5	47.0	52.5	75.4	62.1	55.8
S. patens	3.1	16.4	2.7	4.0	6.8	10.1	3.6	3.0	7.5

Table 17 Bottle Lagoon

Importance Values — Clipped

Date	6/10	6/27	7/22	8/11	9/10	10/3	10/23	11/12	12/2
Aster tenuifolius	9.5	11.4	11.6	7.6	5.9	11.5	7.4	6.2	—
Borrichia frutescens	4.8	—	—	—	—	5.6	—	—	—
Distichlis spicata	93.1	86.9	86.0	76.9	101.4	76.1	54.0	69.2	80.2
Juncus roemerianus	12.1	7.9	11.8	33.2	14.1	21.5	40.4	19.3	30.9
Salicornia virginica	10.1	—	5.2	—	12.2	10.8	—	12.9	—
Scirpus robustus	8.8	10.8	11.6	7.0	—	—	—	—	—
Spartina alterniflora	29.3	35.7	41.2	45.9	30.9	31.0	56.7	32.8	28.6
S. patens	32.4	47.3	27.4	29.4	35.5	44.5	41.5	59.7	60.3

Table 18 Bottle Lagoon

Importance Values — Line Transect

Date	6/10	6/27	7/22	8/11	9/10	10/3	10/23	11/12	12/2
Aster tenuifolius	2.7	5.3	3.8	2.9	1.3	3.3	—	7.0	1.9
Borrichia frutescens	2.7	.2	1.0	—	—	—	—	1.3	3.0
Distichlis spicata	168.4	136.3	149.5	89.4	133.6	125.4	93.3	107.6	111.1
Juncus roemerianus	29.3	24.1	21.8	43.6	34.8	25.6	30.4	37.8	35.5
Salicornia virginica	4.1	2.4	7.2	—	2.4	—	3.1	2.8	—
Scirpus robustus	2.6	3.0	3.3	3.5	1.4	—	1.5	—	—
Spartina alterniflora	70.7	65.5	91.6	125.7	87.6	97.9	145.4	116.8	104.8
S. patens	19.6	63.1	22.2	33.2	37.4	47.8	26.3	20.7	43.2

Table 19 Dead Duck Pass

Density — stems/m^2

Date	3/27	4/23	5/21	6/16	7/9	7/29	8/27	9/8	10/3	10/23	11/12	12/2	2/5
Aster tenuifolius	—	13	10	6	—	14	1	26	2	3	—	4	1
Borrichia frutescens	—	—	2	—	13	—	—	4	4	3	—	—	—
Distichlis spicata	61	34	84	81	15	245	16	33	12	8	22	23	13
Juncus roemerianus	472	423	878	673	663	485	722	475	511	261	350	586	486
Spartina alterniflora	286	113	46	90	110	97	84	68	134	157	160	82	130
S. patens	6	13	16	78	35	—	88	182	8	—	1	—	1
			(1)	(2)	(2)				(1)(3)	(3)	(1)		

Also present:
(1) *Salicornia virginica*
(2) *Eleocharis sp.*
(3) *Batis maritima*

Table 20 Dead Duck Pass

Relative Density

Date	3/27	4/16	4/23	4/23	5/21	5/21	6/16	6/16	7/9	7/9	7/29	7/29
Method	C	LT	C	LT	C	LT	C	LT	C	LT	C	LT
Aster tenuifolius	-	1.1	2.2	1.7	.9	.2	.7	.4	-	1.1	1.8	1.3
Borrichia frutescens	-	2.6	-	.5	.2	.7	-	-	1.6	.2	-	-
Distichlis spicata	7.4	25.4	5.7	4.5	8.1	6.6	8.7	4.3	1.8	6.3	29.1	20.5
Juncus roemerianus	57.2	63.0	71.0	59.4	84.8	83.3	72.5	74.1	79.3	78.2	57.6	64.5
Spartina alterniflora	34.6	7.9	18.9	12.3	4.4	8.5	9.7	10.0	13.1	10.4	11.5	11.9
Spartina patens	.8	-	2.2	21.6	1.5	.3	8.7	11.2	4.2	3.8	-	1.8

8/27	8/27	9/8	10/3	10/3	10/23	10/23	11/12	11/12	12/2	12/2	2/5	2/5
C	LT	C	C	LT	C	LT	C	LT	C	LT	C	LT
-	-	3.3	.3	-	.7	1.1	-	.6	.5	-	.2	-
-	.8	.5	.5	-	.7	-	-	-	-	-	-	.7
1.7	5.0	4.2	1.8	1.3	1.8	7.6	4.1	2.6	3.3	1.3	2.1	2.0
79.4	70.0	60.3	75.8	75.1	60.2	73.7	65.7	62.9	84.4	78.6	76.9	65.9
9.2	14.2	8.6	19.9	16.5	36.2	12.8	30.0	21.9	11.8	17.5	20.6	30.7
9.7	10.2	23.1	1.2	3.7	-	4.8	.2	10.5	-	2.6	.2	.7

Table 21 Dead Duck Pass

Relative Frequency

Date	3/27	4/16	4/23	4/23	5/21	5/21	6/16	6/16	7/9	7/9	7/29	7/29
Method	C	LT	C	LT	C	LT	C	LT	C	LT	C	LT
Aster tenuifolius	-	3.4	8.3	3.9	7.1	1.1	15.0	1.2	-	2.1	14.3	4.0
Borrichia frutescens	-	13.4	-	5.2	7.1	6.7	-	-	10.0	1.1	-	-
Distichlis spicata	30.0	20.0	25.0	9.5	28.6	13.2	20.0	7.7	20.0	7.5	28.6	16.8
Juncus roemerianus	23.3	33.2	16.7	25.6	21.5	39.2	20.0	39.4	20.0	38.3	21.3	34.9
Spartina alterniflora	33.3	30.0	33.3	34.2	21.5	35.3	25.0	45.1	40.0	46.8	35.8	43.0
Spartina patens	10.0	-	16.7	21.6	7.1	3.2	20.0	4.4	10.0	2.1	-	1.3

Table 21 (cont.)

8/27 C	8/27 LT	9/8 C	10/3 C	10/3 LT	10/23 C	10/23 LT	11/12 C	11/12 LT	12/2 C	12/2 LT	2/5 C	2/5 LT
9.3	-	6.7	7.7	-	8.3	1.3	-	1.3	8.3	-	7.1	-
-	1.4	6.7	7.7	-	8.3	-	-	-	-	-	-	2.3
9.1	4.7	26.6	15.4	1.0	25.0	7.0	20.0	2.5	25.0	2.5	28.6	2.3
27.3	43.5	20.0	23.1	38.8	16.7	38.8	20.0	35.0	25.0	35.9	28.6	37.2
27.3	45.7	20.0	30.7	55.8	33.4	49.4	50.0	54.9	41.7	59.0	28.6	57.0
27.3	4.7	20.0	7.7	2.2	-	3.5	10.0	5.0	-	2.5	7.1	1.2

Table 22 Dead Duck Pass

Relative Dominance

Date	4/16	4/23	5/21	6/16	7/9	7/29	8/27	10/3	10/23	11/12	12/2	2/5
Aster tenuifolius	.7	.7	.1	.1	.6	.4	—	—	.3	.1	—	—
Borrichia frutescens	7.3	1.2	1.8	—	.3	—	.3	—	—	—	—	.4
Distichlis spicata	12.8	2.4	3.1	1.5	2.2	6.6	1.2	.4	2.4	.7	.2	.4
Juncus roemerianus	55.3	52.4	70.3	52.1	55.6	40.5	58.5	47.7	52.4	36.2	37.2	48.4
Spartina alterniflora	24.9	36.2	23.6	39.3	40.1	52.2	38.1	50.2	43.7	60.6	62.2	50.7
S. patens	—	7.1	.9	3.5	1.2	.4	1.9	.8	1.2	2.0	.4	.1

Table 23 Dead Duck Pass

Importance Values — Clipped

Date	3/27	4/23	5/21	6/16	7/9	7/29	8/27	9/8	10/3	10/23	11/12	12/2	2/5
Aster tenuifolius	—	10.5	8.0	15.7	—	16.1	9.3	10.0	8.0	9.0	—	8.8	7.3
Borrichia frutescens	—	—	7.3	—	11.6	—	—	7.2	8.2	9.0	—	—	—
Distichlis spicata	37.4	30.0	36.7	28.7	21.8	57.7	10.8	30.8	17.2	26.8	24.1	28.3	30.7
Juncus roemerianus	80.5	87.7	106.3	92.5	99.3	78.9	106.7	80.3	98.9	76.9	85.7	109.4	105.5
Spartina alterniflora	67.9	52.2	25.9	34.7	53.1	47.3	36.5	28.6	50.6	69.6	80.0	53.5	49.2
S. patens	10.8	18.9	8.6	28.7	14.2	—	37.0	43.1	8.9	—	10.2	—	7.3

Table 24 Dead Duck Pass

Importance Values — Line Transect

Date	4/16	4/23	5/21	6/16	7/9	7/29	8/27	10/3	10/23	11/12	12/2	2/5
Aster tenuifolius	5.2	6.3	1.3	1.7	3.8	5.6	—	—	2.7	2.0	—	—
Borrichia frutescens	23.3	6.9	8.8	—	1.6	—	2.5	—	—	—	—	3.4
Distichlis spicata	58.2	16.4	22.9	13.5	16.0	43.9	10.9	2.7	17.0	5.8	4.0	6.7
Juncus roemerianus	151.5	137.4	192.8	165.6	172.1	139.9	172.0	161.6	164.9	134.1	151.7	151.5
Spartina alterniflora	62.8	82.7	67.4	94.4	97.3	107.1	98.0	122.5	105.9	137.4	138.7	138.4
S. patens	—	50.3	4.4	19.1	7.1	3.4	16.8	6.7	9.5	17.5	5.5	2.0

Table 25 Drum Bay

Density — stems/m^2

Date	3/25	4/16	5/15	6/19	7/10	7/30	8/28	9/17	10/8	10/29	11/19	12/2	12/10	12/15	1/5
Spartina alterniflora	473	440	442	438	441	437	469	470	494	(653) 592	423	621	520	267	525
	(1)(2)							(1)		(2)	(a)				

Also present:

(1) Distichlis spicata

(2) Avicennia nitida seedlings

(a) This sample is not consistent with others due to inexperienced sorter.

Figure 1. Density of *Spartina patens* in stems/m^2 at Bayou Gaudet site versus week of the year 1975.

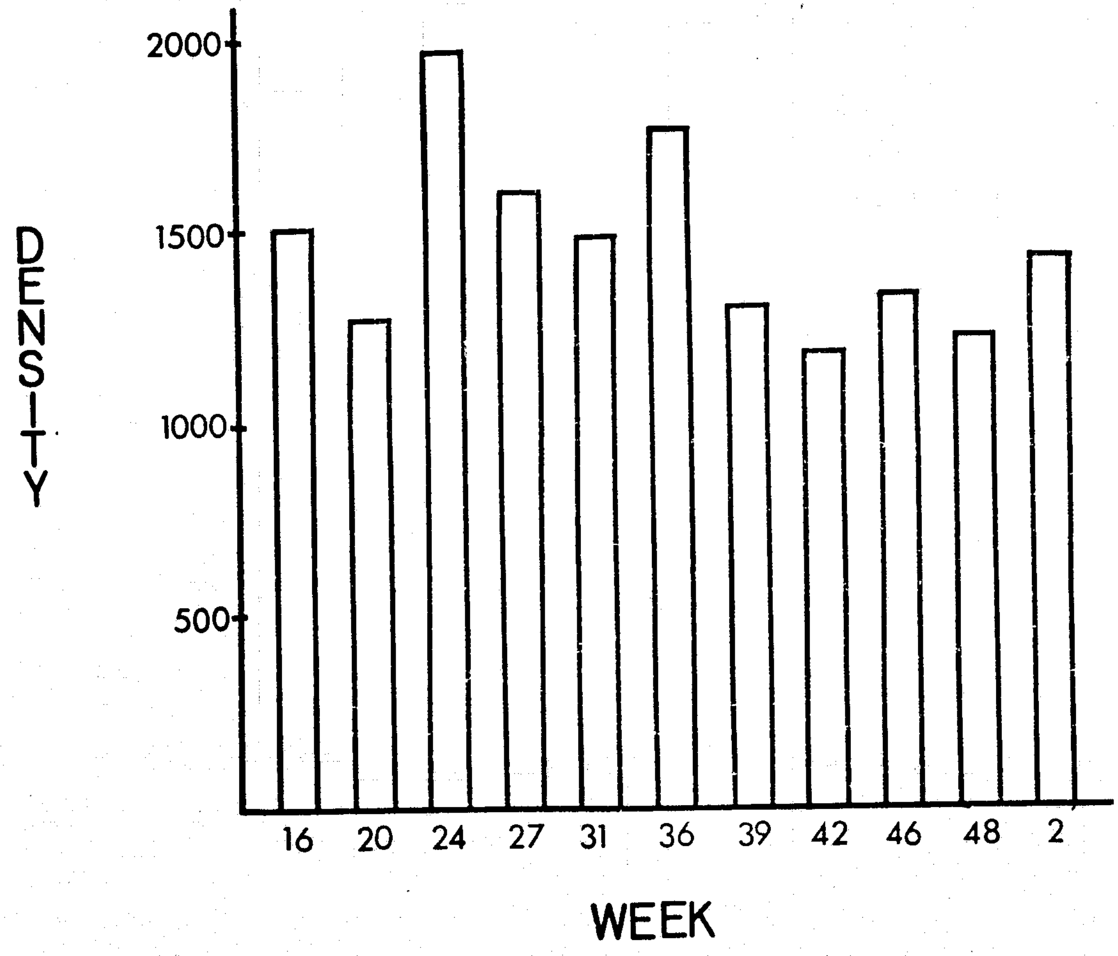
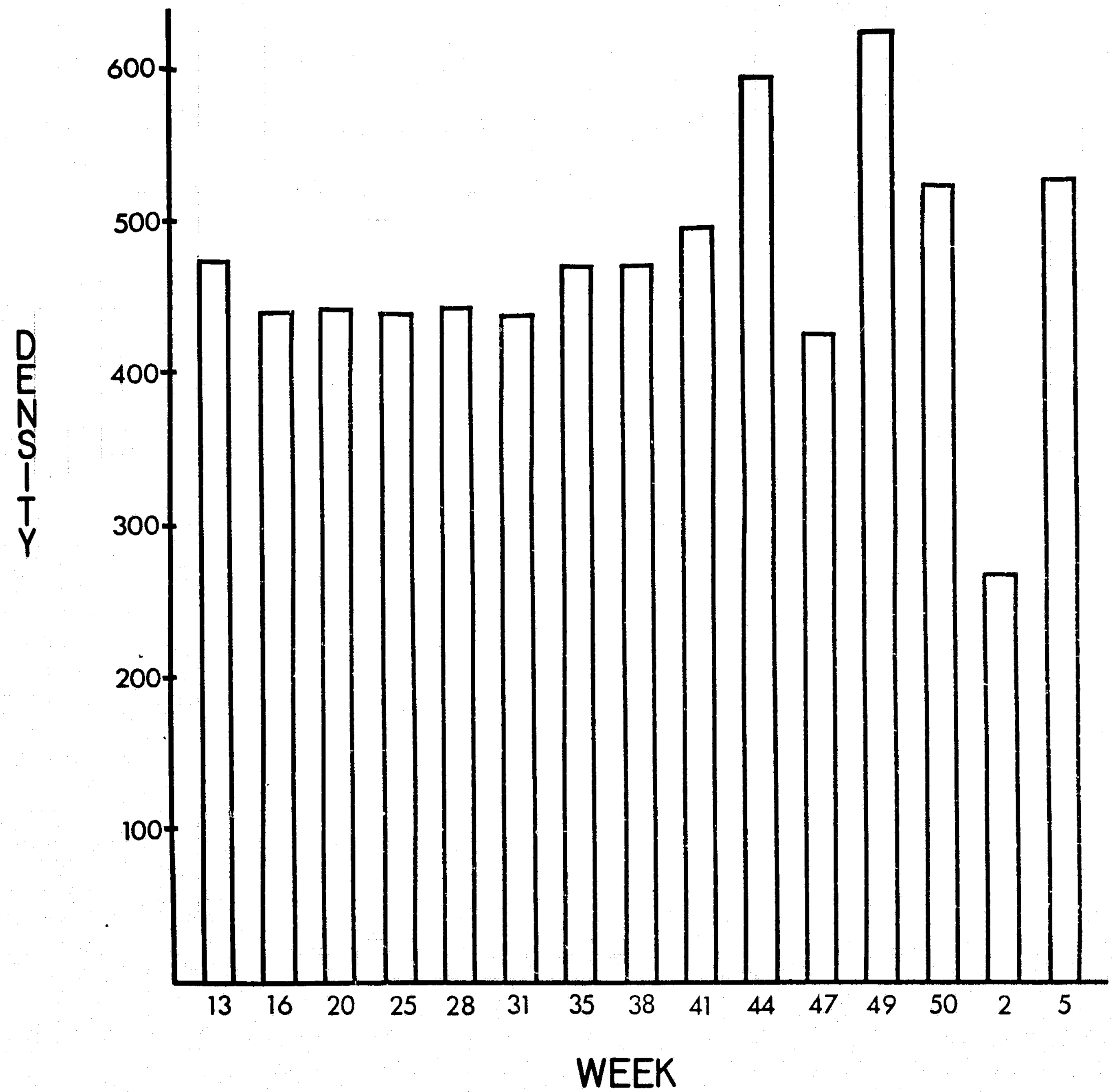

2000
1500
1000
500
DENSITY
16
20
24
27
31
36
39
42
46
48
2
WEEK

Figure 2. Density of *Spartina alterniflora* in stems/m^2 at Drum Bay site versus week of the years 1975 and early 1976.



DENSITY
600
500
400
300
200
100
13
16
20
25
28
31
35
38
41
44
47
49
50
2
5
WEEK

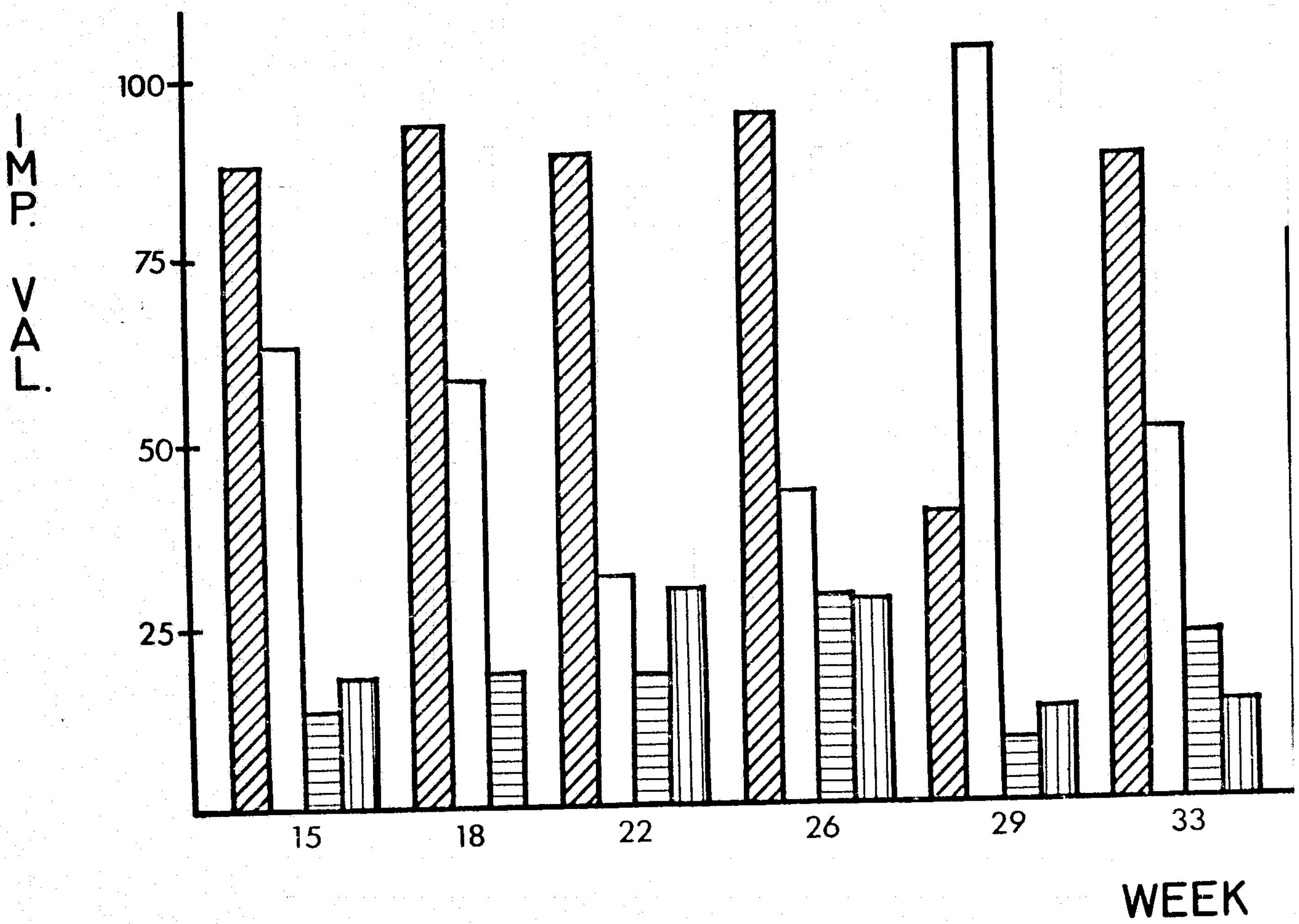
Figure 3. Clipped importance values from Petain Lagoon site versus week of the year 1975.

Distichlis spicata (diagonal hatching)

Scirpus robustus (vertical hatching)

Spartina cynosuroides (horizontal hatching)

Spartina patens (open)


IMP. VAL.
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22
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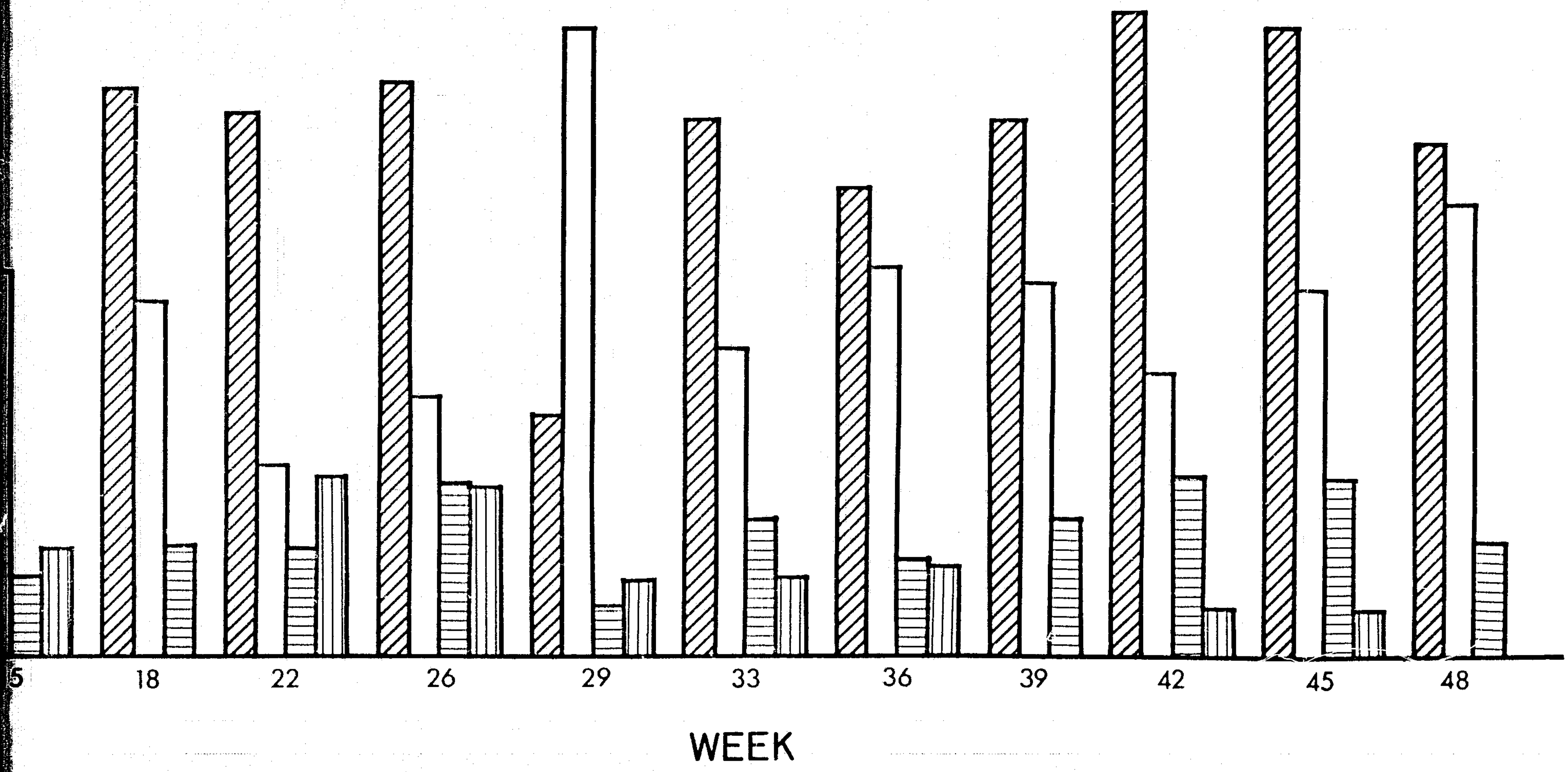
29
33
WEEK


5
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45
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WEEK

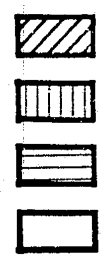
Figure 4. Line transect importance values from Petain Lagoon site versus week of the year 1975.

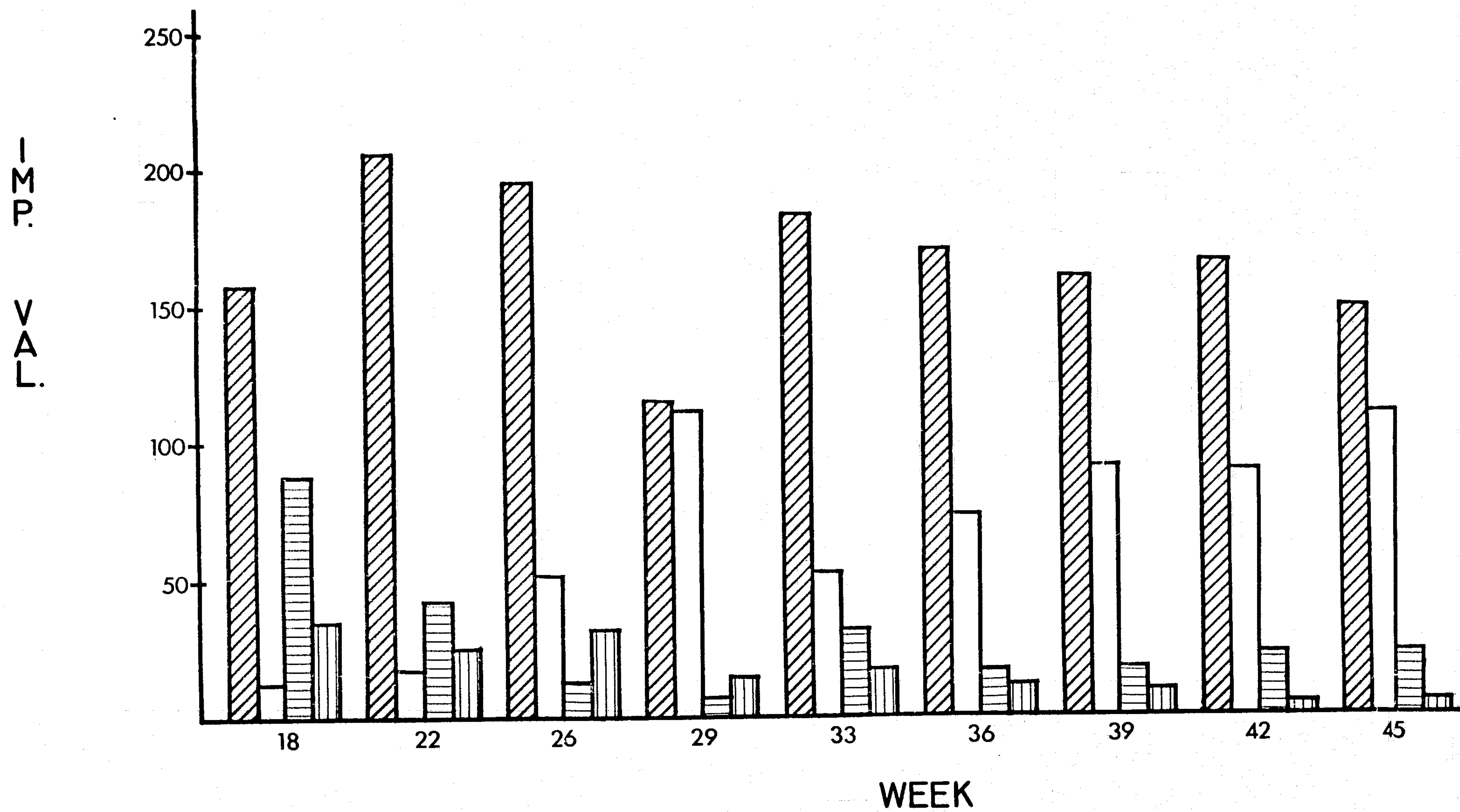
Distichlis spicata

Scirpus robustus

Spartina cynosuroides

Spartina patens





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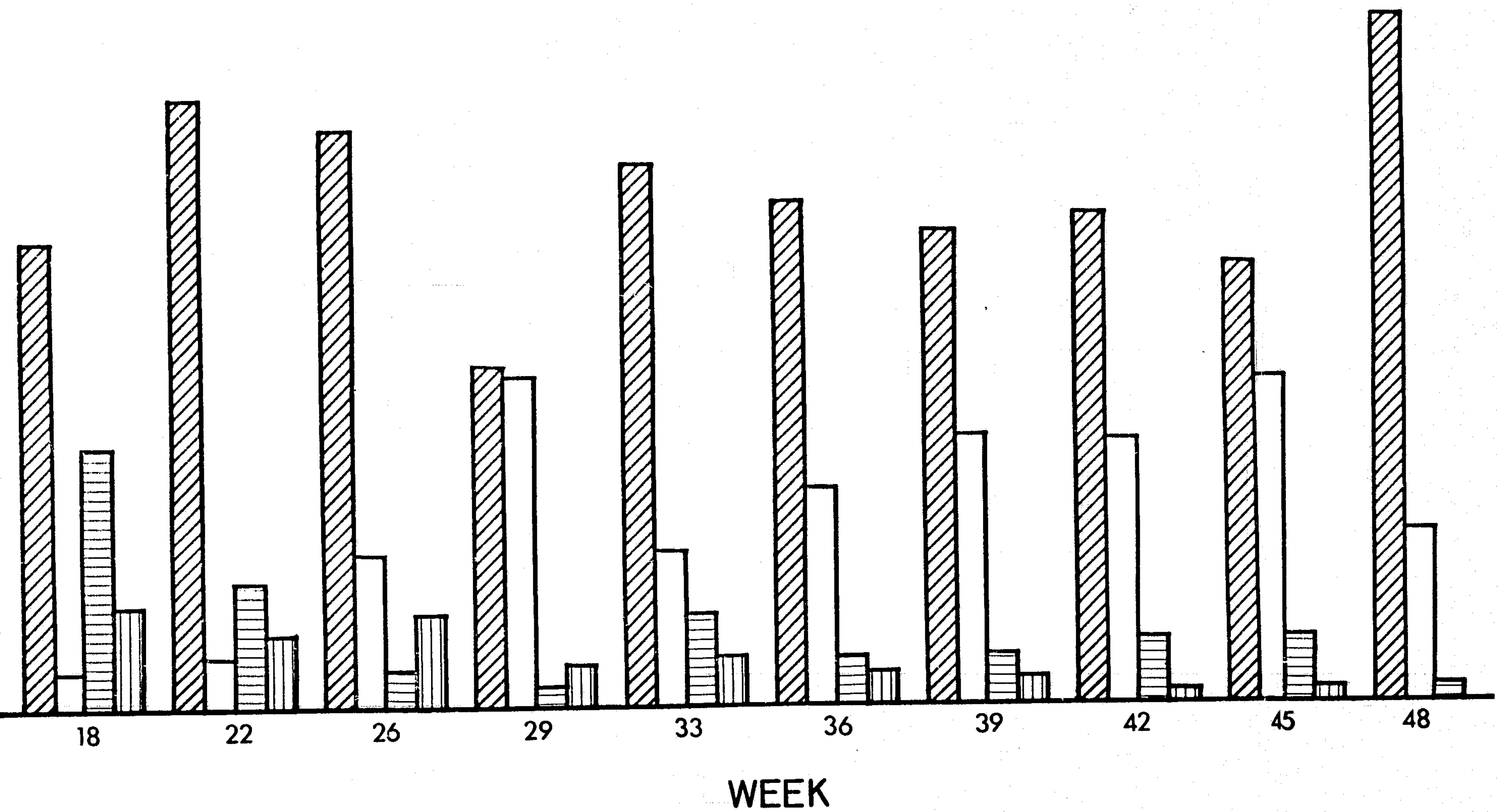
WEEK



18
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39
42
45
48
WEEK

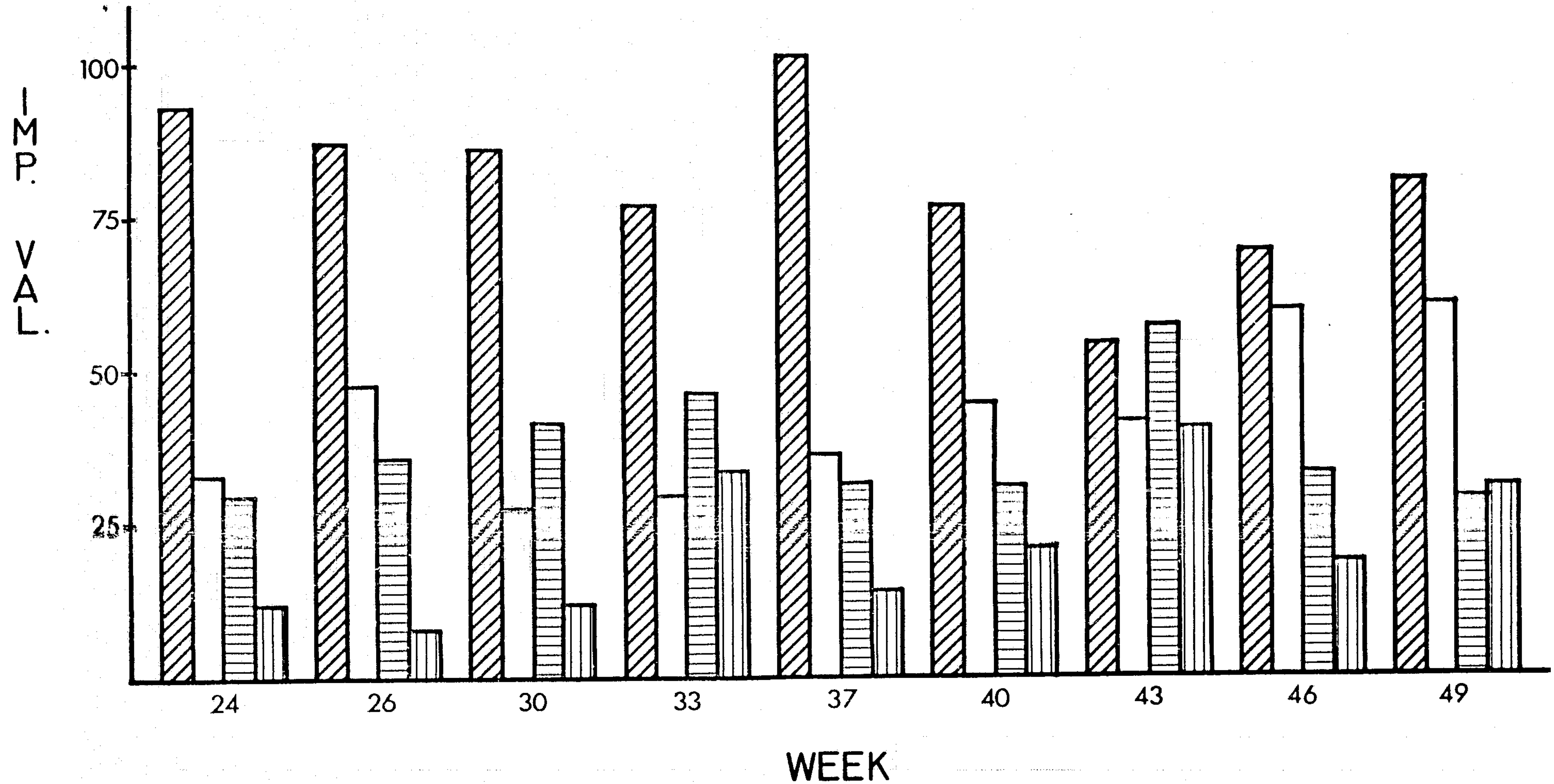
Figure 5. Clipped importance values from Bottle Lagoon versus week of the year 1975.

Distichlis spicata

Juncus roemerianus

Spartina alterniflora

Spartina patens



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WEEK

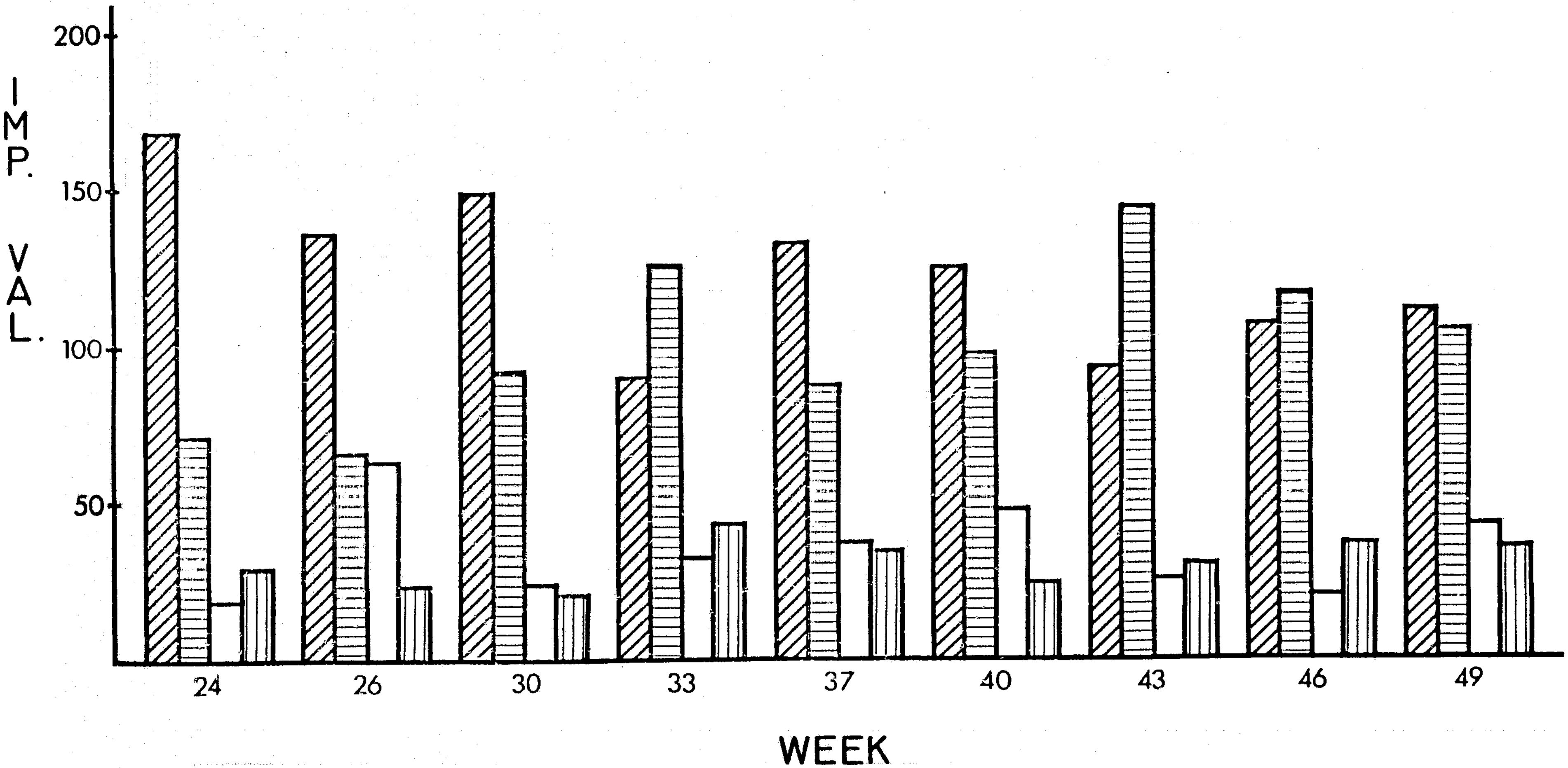
Figure 6. Line transect importance values from Bottle Lagoon versus week of the year 1975.

Distichlis spicata

Juncus roemerianus

Spartina alterniflora

Spartina patens



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WEEK

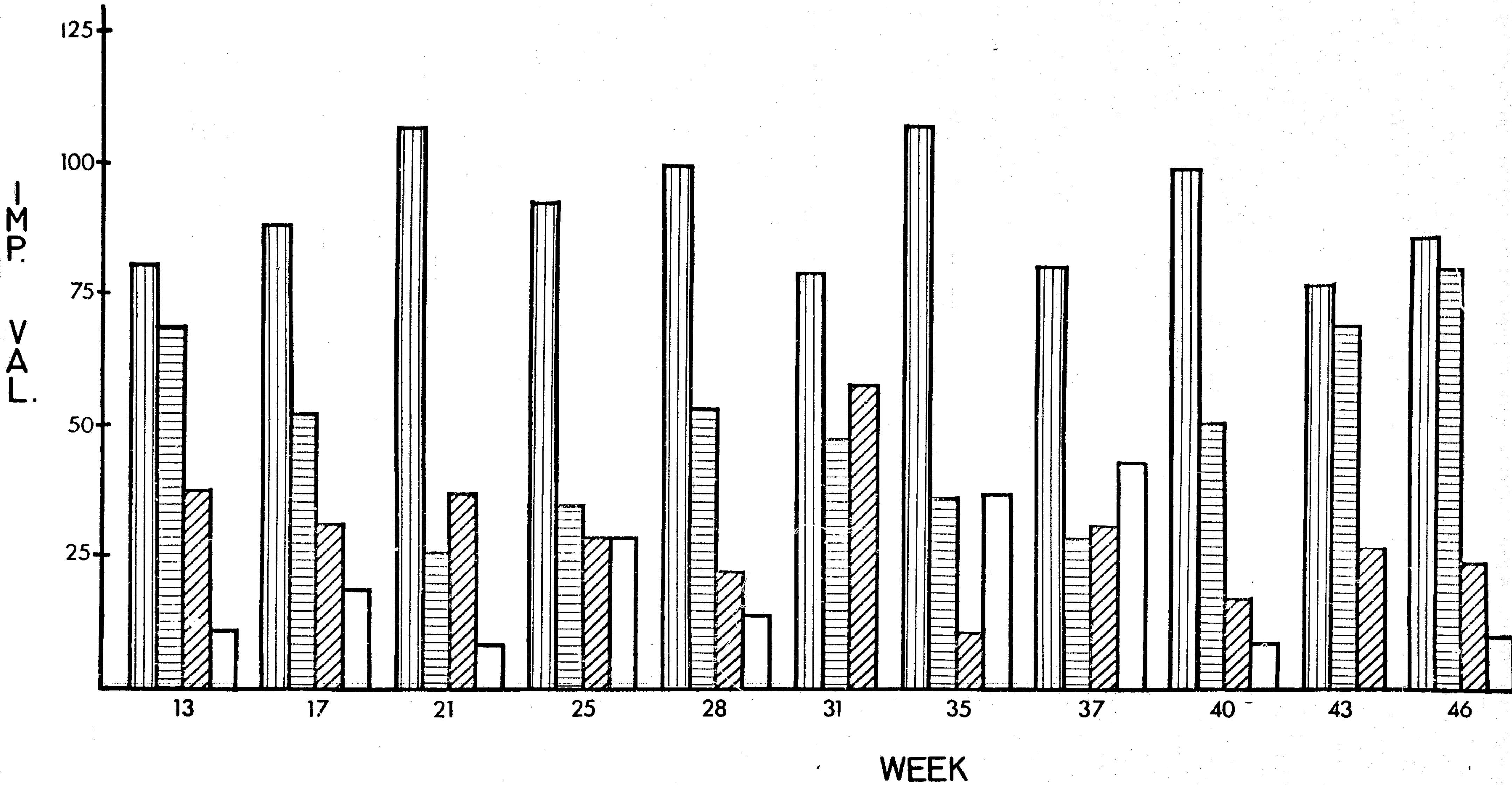
Figure 7. Clipped importance values from Dead Duck Pass versus week of the years 1975 and early 1976.

Distichlis spicata

Juncus roemerianus

Spartina alterniflora

Spartina patens



125
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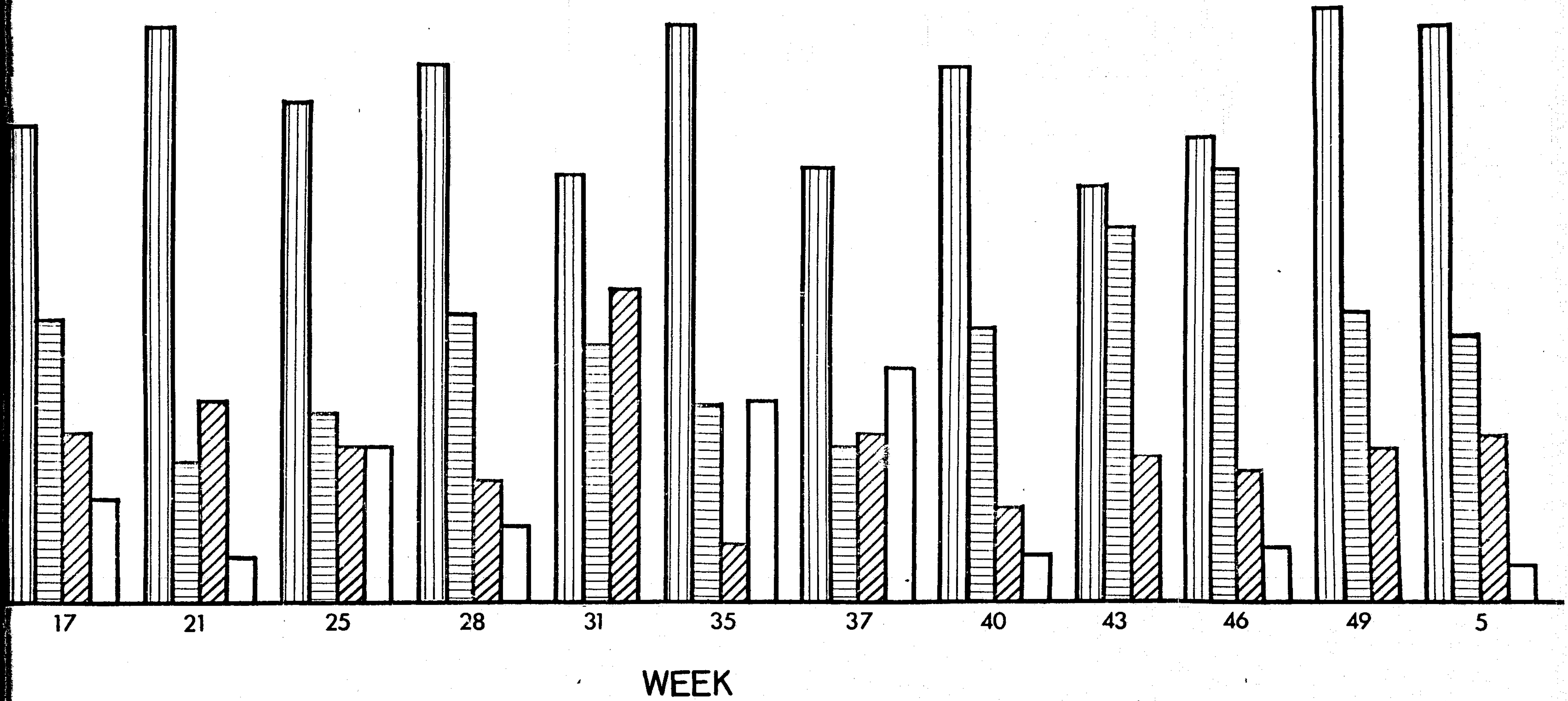
WEEK



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49
5
WEEK

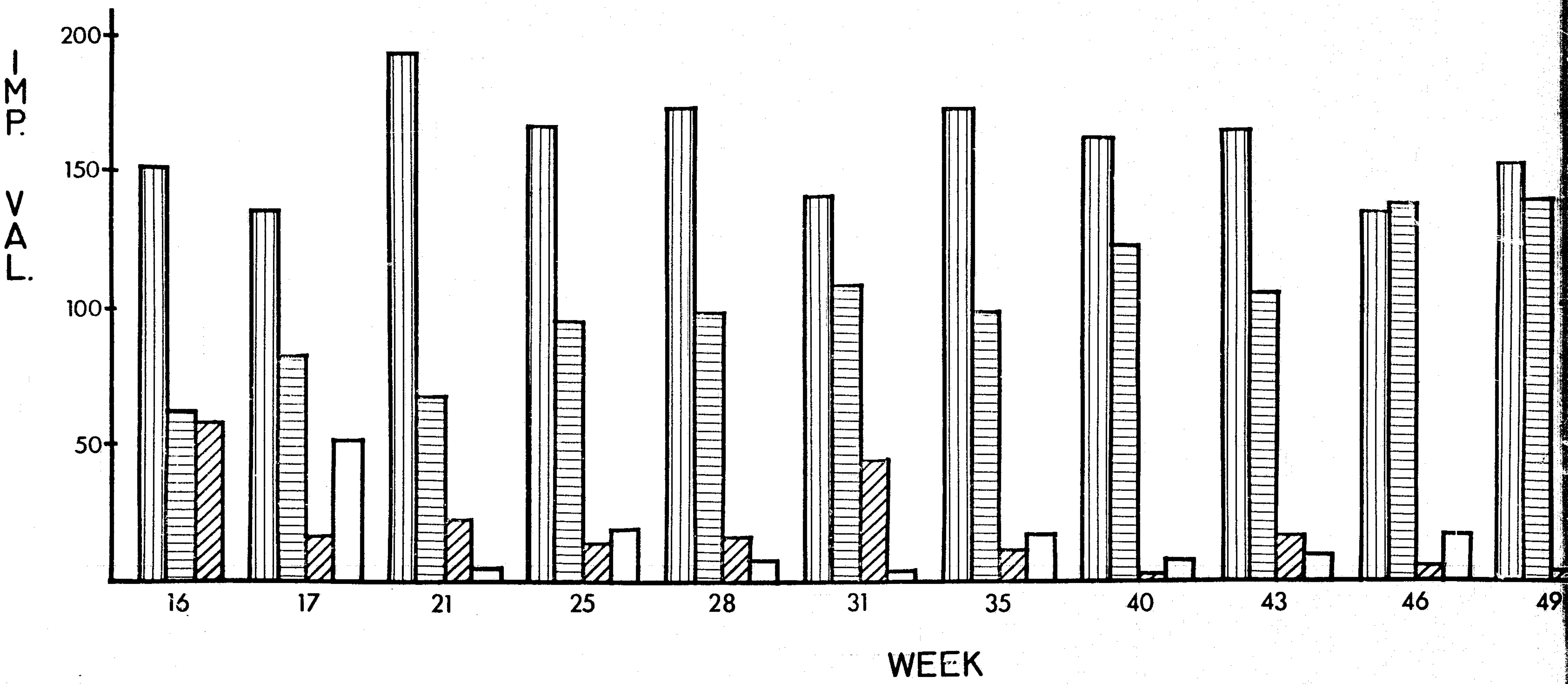
Figure 8. Line transect importance values from Dead Duck Pass versus week of the years 1975 and early 1976.

Distichlis spicata

Juncus roemerianus

Spartina alterniflora

Spartina patens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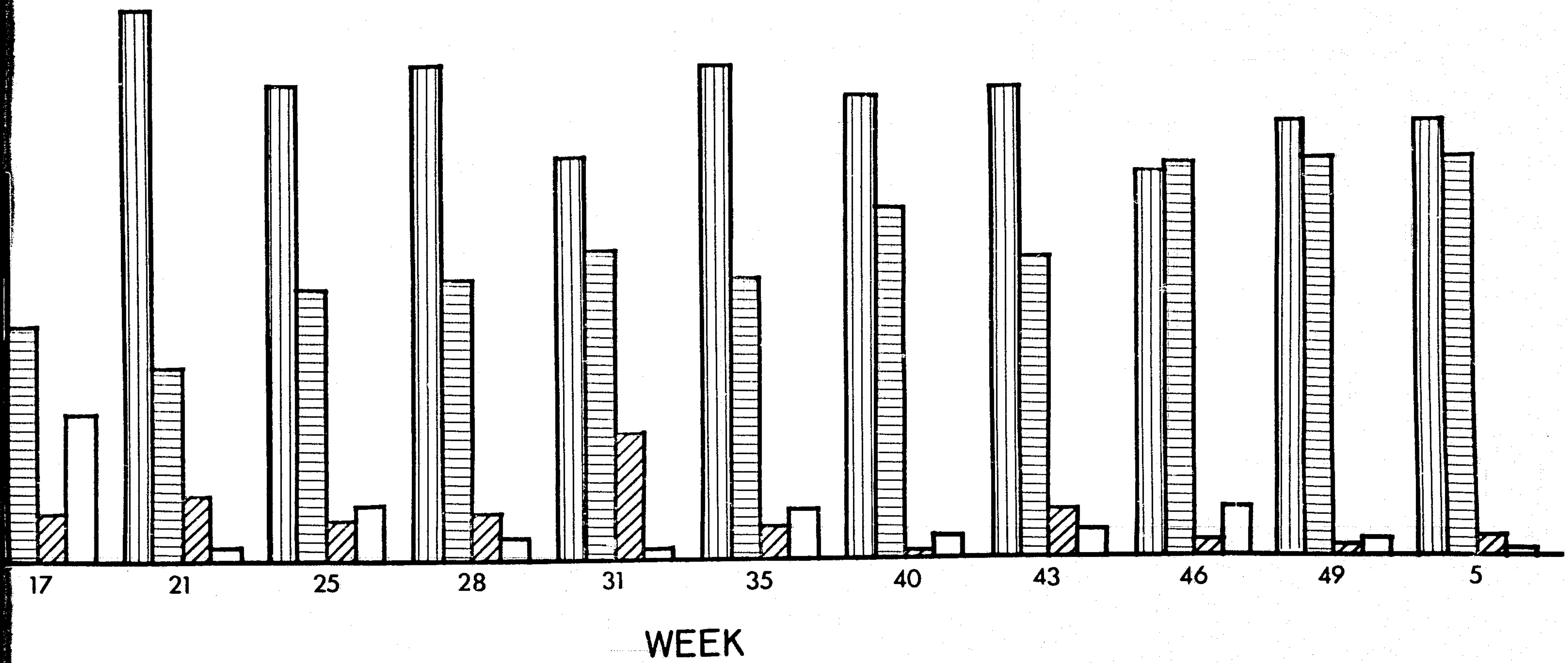

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WEEK

DISCUSSION

Introduction

This study involved an analysis of marsh vegetation over a one year period to determine seasonal variation in the species composition and it s relationship to salinity. Two methods of sampling the vegetation were utilized, the clipped method and the line transect. This was done to more adequately survey the vegetation and the make a comparison of methods as applied to marsh vegetation. In addition, salinity regimes were established and vegetation surveyed in each regime.

Salinity

From the values obtained as presented in Table 26 salinity regimes can be established based on peak soil salinities (PSS). Petain Lagoon and Bayou Gaudet exhibit PSS of 10 ppt or less, Bottle Lagoon between 10 and 20 ppt, Dead Duck Pass between 15 and 25 ppt and Drum Bay above 20 ppt with regular flooding.

In correlating salinity with vegetation, Spartina patens occurs as the dominant species or in pure stands when the PSS is 10 ppt or less. The vegetation of Petain Lagoon is in a successional sequence toward pure S. patens. This vegetation is also found in areas with a PSS of 10 ppt or less.

In those areas such as Bottle Lagoon in which the PSS is between 10 and 20 ppt, Distichlis spicata is the dominant species throughout

Table 26 Salinity - ‰

Petain Lagoon

Date	4/9	5/26	6/24	8/11	9/13	9/26	10/15	11/5	10/26
Water type	soil	surface	surface	surface	surface	soil	surface	surface	surface
Salinity	9.0	3.5	2.0	7.0	5.0	7.5	4.0	4.0	0.1

Bayou Gaudet

Date	4/14	4/16	5/13	5/21	6/13	7/1	9/3	9/26	10/15	11/5
Water type	surface	soil	surface	soil	soil	surface	surface	surface	surface	surface
Salinity	6.0	8.5	5.0	9.0	8.5	5.0	5.5	5.0	4.0	5.0

Bottle Lagoon

Date	6/10	6/27	7/1	7/22	8/11	9/10	10/3	10/23	11/12
Water type	surface	soil	soil	soil	surface	surface	surface	surface	surface
Salinity	3.75	7.0	14.0	19.0	8.75	5.0	5.5	3.5	3.0

Dead Duck Pass

Date	4/16	4/23	5/21	6/16	7/9	7/29	8/27	10/3	10/23	11/12
Water type	soil	soil	soil	surface	soil	surface	surface	surface	soil	surface
Salinity	10.0	8.5	19.0	5.0	23.5	7.25	5.5	5.0	6.5	3.5

Drum Bay

Date	3/25	4/16	5/15	6/19	7/10	7/30	8/28	9/17	10/8	10/29
Water type	surface	surface	surface	surface	mixed	mixed	surface	surface	soil	soil
Salinity	8.0	6.0	5.0	3.0	15.0	17.0	7.5	6.5	9.0	7.5

the year. Spartina alterniflora shares sub-dominance with S. patens. Juncus roemerianus is also present but only as a minor constituent.

When the PSS is between 15 and 25 ppt as in Dead Duck Pass, Juncus roemerianus is the dominant species. Spartina patens is then relegated to a very minor role. Spartina alterniflora is quite important as the chief species found growing between the clumps of Juncus roemerianus. Distichlis spicata plays only a minor role in the composition of this community.

In those areas with the highest PSS and regular flooding, such as Drum Bay, an almost pure community of Spartina alterniflora is found.

Seasonality

Figures 9-14 show the seasonal variation in species composition over time for the mixed sites.

Figures 9 and 10 indicate that Distichlis spicata maintains dominance throughout the year in Petain Lagoon. A slight increase in the importance of Spartina patens is exhibited in the months of November and December. Correspondingly, a decrease in Distichlis spicata and Spartina cynosuroides is seen.

Figures 11 and 12 indicate a period of high importance for Distichlis spicata in early spring with a decline to a low in early winter. This change at Bottle Lagoon is similar to the change at Petain Lagoon. Correspondingly there is an increase from early spring toward winter in the importance of both Spartina alterniflora and Spartina patens.

Figures 13 and 14 for Dead Duck Pass show that Juncus roemerianus remains relatively constant in its importance throughout the year. Only Spartina alterniflora seems to display any change in its importance during the year, with a slight increase at the time of its flowering. Spartina patens and Distichlis spicata show an inconspicuous level of importance at all times.

Conclusions

From the work completed it appears that spring to early summer (weeks 18-34 of the year; April - mid-July) is the best period of time to categorize the communities. It is during this time of the year that the communities appear most stable in regard to species composition. This allows a strong correlation to be drawn between the salinity of the region (PSS) and the dominant species of the community. As such, this would seem to be the best period in which to sample the marsh via air or land for differences in vegetation and salinity.

A slight discrepancy in the sampling methods was noticed. Apparently the line transect method underestimates the smaller stemmed species such as Spartina patens. This is probably due to the difficulty of discerning individual plants. In conclusion, both methods are valid and when used together provide a good measure of marsh vegetation composition.

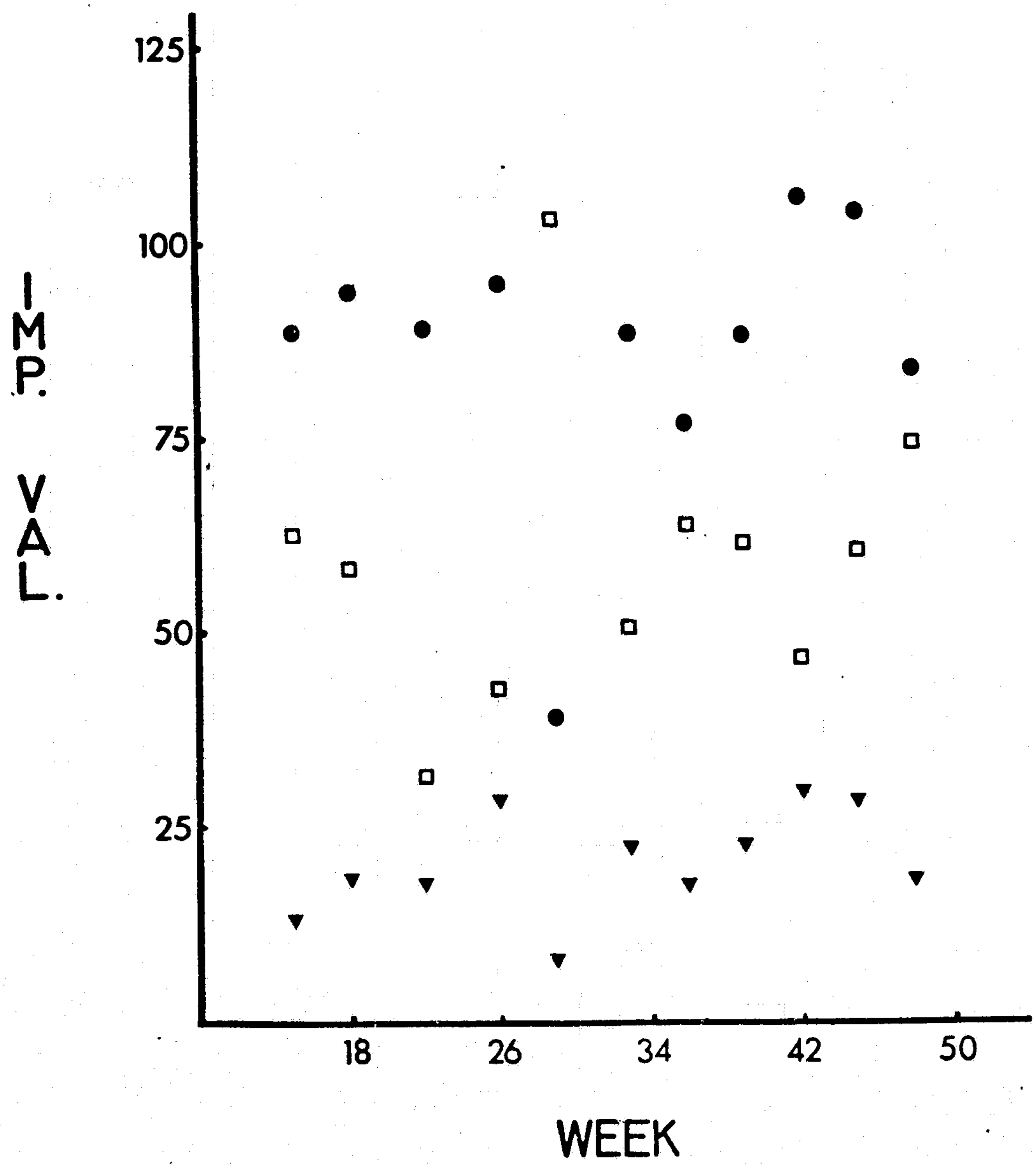

Figure 9. Clipped importance values from Petain Lagoon plotted against weeks of the year 1975.

● *Distichlis spicata*

▼ *Spartina cynosuroides*

□ *Spartina patens*

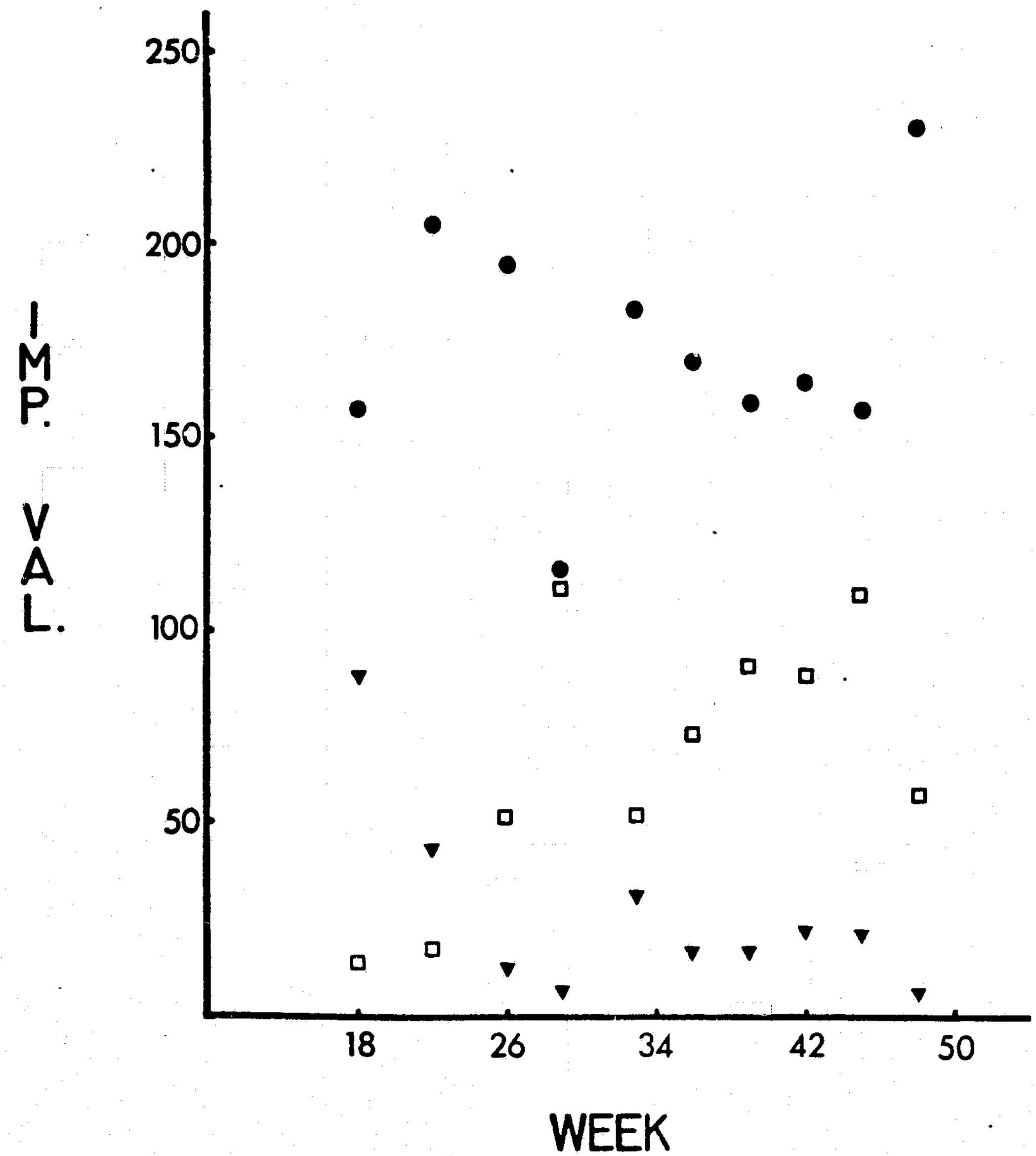

Figure 10. Line transect importance values from Petain Lagoon plotted against weeks of the year 1975.

- ● *Distichlis spicata*
- ▼ *Spartina cynosuroides*
- □ *Spartina patens*

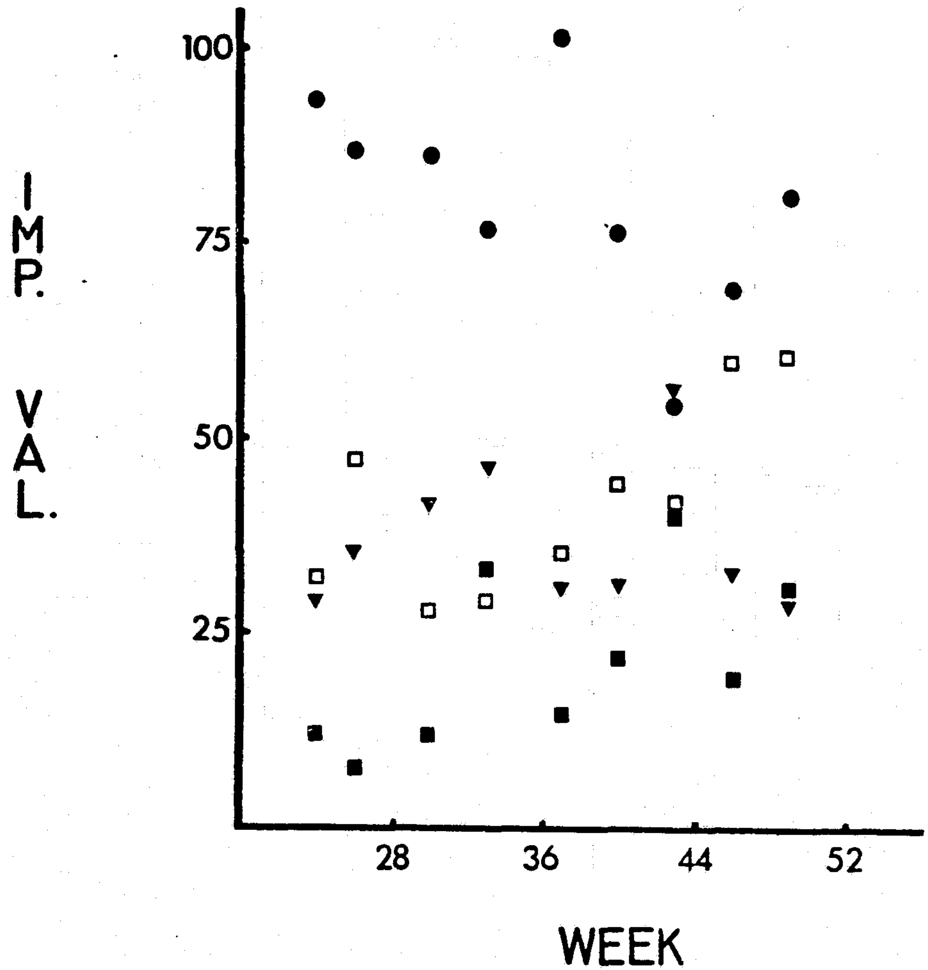

Figure 11. Clipped importance values from Bottle Lagoon plotted against weeks of the year 1975.

● *Distichlis spicata*
■ *Juncus roemerianus*
▼ *Spartina alterniflora*
□ *Spartina patens*

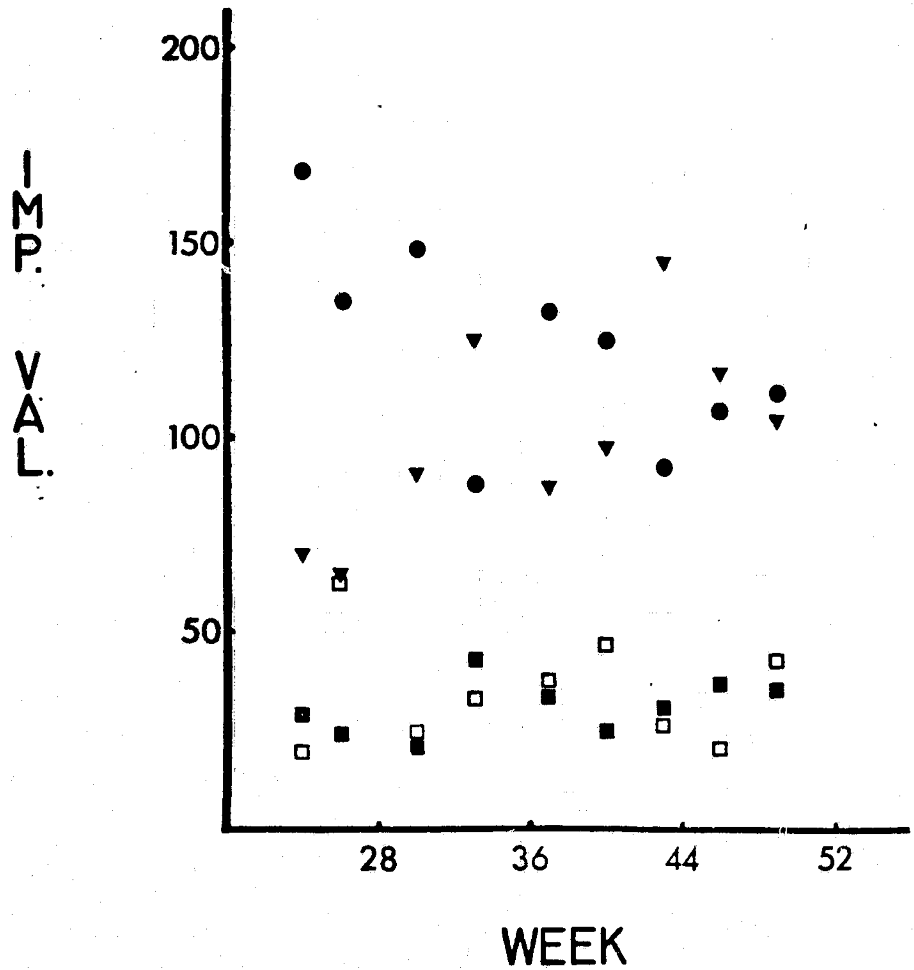

Figure 12. Line transect importance values from Bottle Lagoon plotted against weeks of the year 1975.

- ● *Distichlis spicata*
- ■ *Juncus roemerianus*
- ▼ *Spartina alterniflora*
- □ *Spartina patens*

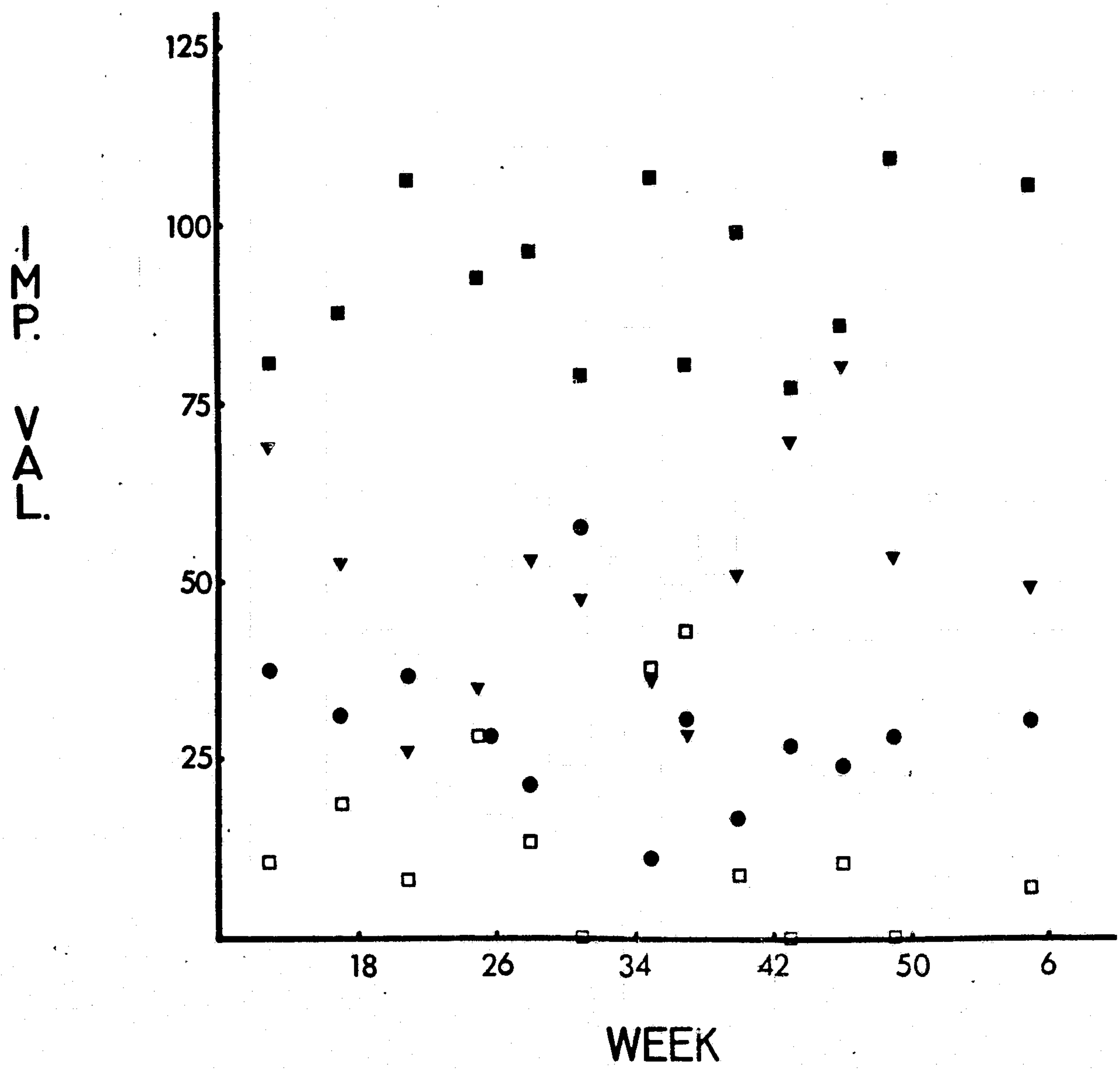

Figure 13. Clipped importance values from Dead Duck Pass plotted against weeks of the years 1975 and early 1976.

● Distichlis spicata
■ Juncus roemerianus
▼ Spartina alterniflora
□ Spartina patens

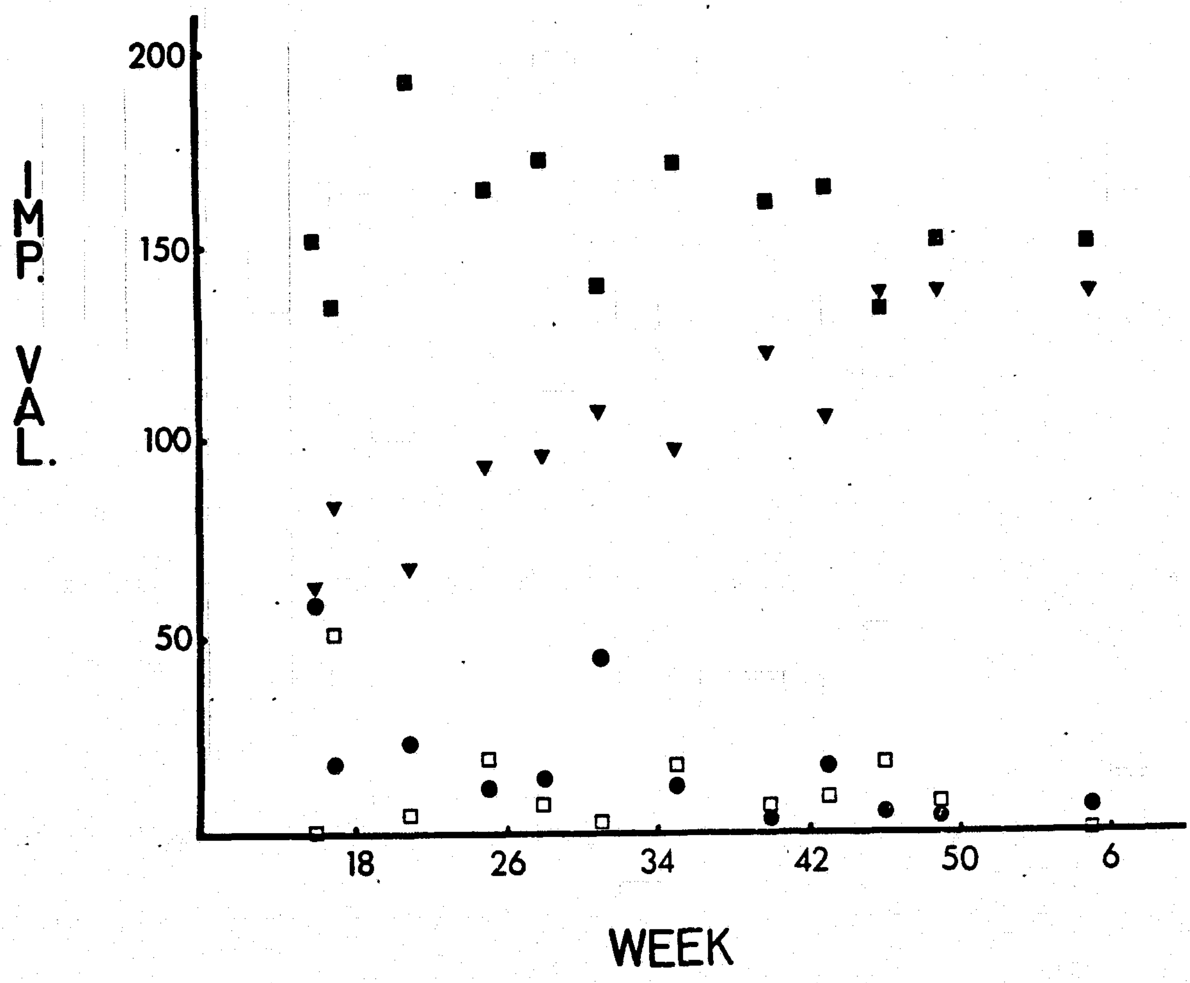

Figure 14. Line transect importance values from Dead Duck Pass plotted against weeks of the years 1975 and early 1976.

● *Distichlis spicata*

■ *Juncus roemerianus*

▼ *Spartina alterniflora*

□ *Spartina patens*

C-2

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