VEGETATION OF THE BRUCKER MARSH
AND THE BARN ISLAND NATURAL AREA,
STONINGTON, CONNECTICUT

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by
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ABSTRACT

The two study areas, the Brucker Marsh and the Barn Island Natural Area, are located in the Barn Island Game Management Area owned by the State of Connecticut. The Brucker, an unimpounded natural valley marsh, displays a series of different vegetation types and generally decreasing salinities from bay to upland. The tidal marsh along the bay front is replaced by a brackish cattail marsh which is then replaced by a shrubby fresh-water swamp. The hurricane of 1938 destroyed an open red maple forest originally found where the cattails are now dominant. This storm also killed many of the large maples once found in the Shrubby Swamp itself.

In the tidal marsh a *Spartina alterniflora* Low Marsh Community (20 parts per thousand) nearest to the bay is replaced by a very saline (25 p/T) Flooded Panic, giving way to a *Spartina patens* High Marsh Community (5 p/T). In the High Marsh, marsh elder (*Iva oraria*) forms a belt along the mosquito ditches. A switch grass (*Panicum virgatum*) belt borders the upland. On areas bared by erosion (the Eroded Edge), various forbs and spike grass (*Distichlis spicata*) are predominant. Black grass (*Juncus Gerardi*) is rare in the tidal marsh. Salinities of the cattail marsh and the Shrubby Swamp are 1.5 p/T and 0 p/T, respectively.

Studies of the past documented coastal submergence and the encroachment of the tidal marsh over the fresh-water sediments. This is resulting in a gradual shift of all vegetation belts landward. Each vegetation type within itself appears to be relatively stable.

Productivity studies in the Brucker tidal marsh show that *Spartina patens* yields the greatest biomass per area at 660 gm./m². *Spartina alterniflora* averages 480 gm./m², and the lowest production is found in the forb-covered Eroded Edge at 200 gm./m². The probable average figure for the total marsh is about 500 gm./m², which is one-half ton of dry material per acre.

The Brucker Marsh is unique for studying the effects of coastal submergence and various storms on a salt marsh to fresh-water swamp vegetation gradient and has the added benefit of being State-owned, but does not yet have the protection of being a natural area.
The Barn Island Natural Area includes a tidal marsh and three upland islands. The former is somewhat similar to that of the Brucker; the marsh vegetation types include *Spartina alterniflora* Low Marsh, *Spartina patens* High Marsh, and the Forb Panne. This is one of the few places in the Barn Island marshes where the patens community still retains some importance; within the High Marsh is found a *Juncus* Phase, lacking in the Brucker.

The upland islands, formerly cleared for agriculture but since abandoned, are mainly covered by shrubby thickets. On Barn Island a relatively stable shrub community dominated by bayberry (*Myrica pensylvanica*) covers the greater part of the area. A small open-grown oak woodland is reproducing rather ineffectually and may eventually be replaced by the vigorous shrub clones. A few limited Herbaceous Openings covered with goldenrods (*Solidago* sp.) and broom sedge (*Andropogon scoparius*) are slowly being invaded by dwarf sumac (*Rhus copallina*) and bayberry. Around the edge of the island occur belts of *Iva*, goldenrods, and sweet pepper-bush (*Clethra alnifolia*); these are largely discontinuous. On Barn Island salt spray, severe storms, and shrub competition are among factors limiting the presence of other species.

The tidal marsh vegetation exhibits an exceptional spectrum of the varied vegetation types described by Miller and Egler (1950) for this region. On Barn Island the clonal bayberry development is unique in its extensiveness and stability. The Barn Island Natural Area offers unusual opportunities for continued ecological research.
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INTRODUCTION

The Brucker Marsh and the Barn Island Natural Area are two separate but neighboring portions of the Wequetequeck-Pawcatuck Tidal Marshes (Miller and Ezler, 1930), commonly referred to as the Barn Island Game Management Area or as the Barn Island Marshes. Located in the southeastern corner of Connecticut along the Rhode Island border, between Wequetequeck Cove and the Pawcatuck River, the Barn Island Marshes are immediately landward of Little Narragansett Bay off Long Island Sound. They are protected from the open ocean by Napatree Point, a sand spit which extends northwest from Watch Hill, Rhode Island, leaving only a narrow channel for the flow of the tides (Fig. 1).

The Marshes are owned by the State of Connecticut and managed by the State Board of Fisheries and Game as a shooting area, primarily for wildfowl. To this end, the four westernmost valley marshes have been impounded, the Brucker remaining the only unimpounded, State-owned valley marsh. The adjacent Davis Marsh is unimpounded but is privately owned and is mowed each year (Fig. 2). The Brucker Marsh may be classified as an estuarine valley marsh and remains in a nearly natural state. The total length is about three-quarters of a mile, the lower portions consisting of tidal marsh which is abruptly replaced by brackish cattail marsh; and this is ultimately replaced by fresh-water shrubby swamp in the upper portions (Figs. 3, 4).
The Natural Area, composed of a tidal marsh and three small upland islands (Fig. 5), is located south of the Brucker to which it is connected by an intervening section of tidal marsh. The upland islands are covered mostly by a shrubby type of vegetation. The Brucker and the Natural Area, although separated by a short distance, may actually be considered to be contiguous, as the intervening tidal marsh is similar in composition to the marshes of both areas.

The purpose of this study is to document the vegetational pattern and the dynamics of the Brucker Marsh and the Barn Island Natural Area. The Brucker is unique in this part of the State in that it represents a striking sequence of community types from bay to upland and from salt to fresh water that occurs over an unusually short distance. It is probably one of the finest examples of this sequence in this part of the country and offers the added benefit of being owned by the State of Connecticut which can protect it from industrial exploitation or ecologically unsound management practices. Being the last unimpounded and relatively undisturbed valley marsh in the Barn Island Marshes, the Brucker is a useful control to be used in evaluating management practices in the impoundments. And as the upper portions of the marsh are covered with fresh-water swamp, continued periodic study of the vegetation will enable us more fully to understand the phenomenon of coastal submergence with its attendant landward and upward shift of vegetation belts to encroach upon the
upland. Unfortunately, if impoundment of the Krucker occurs as
planned within the next one or two years (James Bishop, personal
 correspondence), this would not only destroy its research value as a
control area but destroy the permanent transects established as a
result of this study.

The Barn Island Natural Area peninsula was set aside as a natural
area by the State Board of Fisheries and Game in 1965 for a trial
period of three years, its continuation to be dependent on a program
of scientific research. It is hoped that this study will fulfill at
least part of this requirement for its retention as an unmanaged
retreat from man's busy hands. The three upland islands of the
Natural Area may be used for studies of the effects of salt spray
and severe storms on these natural biotic communities along the coast
and the recovery of these communities after severe storms. The
Natural Area Marsh is ideally suited for an experiment involving
blocking off and filling in the mosquito ditches to determine the
natural pattern of tidal marsh vegetation. At present, the only known
unditched portion of tidal marsh is a small area adjacent to Manascope
Island in the Thames River which is owned by the Connecticut Arboretum;
no unditched coastal marshes are known in this area.

An attempt will be made to correlate the vegetational pattern
with certain of the environmental factors, but these must be reviewed
with caution because of the complexity and interactions of these
factors with one another.
The climate of the Barn Island Marshes is similar to that of southeastern New England, being moderated somewhat by the proximity of the ocean. Average monthly precipitation (taken over the period 1931-60 at Groton, about five miles to the west) for the months from January to December is 4.87, 4.05, 4.88, 4.19, 3.72, 3.21, 3.67, 4.59, 3.76, 3.54, 4.80, and 4.34 inches per month. The average yearly total is 49.82 inches. Monthly mean temperatures (taken at New London, about ten miles to the west, over the period 1931-60) are 31.3, 31.3, 38.3, 47.7, 57.8, 66.6, 72.4, 71.2, 65.1, 55.1, 44.9, and 33.7 degrees Fahrenheit. These data are from Brumbaugh (1965) and do not include the last five years, in which we have had a severe drought.

Hurricanes and other severe storms have a profound effect on coastal vegetation. These coastal storms will frequently hit the coast with winds as high as 100 miles per hour and flood the marshes and upland with sea water. The 1938 hurricane is credited with destroying the red maple swamp at the head of the Brucker Marsh (John Davis, voice). More recent hurricanes and severe storms occurred in 1944 (hurricane), 1950 (two windstorms), 1954 (two hurricanes), 1955 (two hurricanes), and 1960 (hurricane) (Brumbaugh, 1965). Thus it is seen that coastal vegetation is constantly in danger of severe alteration but on an irregular basis, depending on the severity of the storm and the condition of the tides at time of impact (a storm coupled with a high tide will cause much more extensive flooding than a low tide); the vegetation must be in a constant state of adjustment and recovery.
Fig. 1. - OVERLAY.
Fig. 1. Aerial photograph of the Barn Island Marshes, showing the location of the study areas on the OVERLAY. Scale of the photo is: 1 inch = 1667 feet. Major geographical features are indicated on OVERLAY; State of Connecticut owns most of the upland surrounding the marshes which appear smooth versus the rough-appearing forest. Straight lines emanating from creeks are mosquito ditches. Photo taken September 1963.
Fig. 2. Map of the Barn Island Marshes showing locations of the Brucker Marsh and Barn Island Natural Area in relation to the other finger-like impoundments and valley-marshes. The Brucker and Davis valley-marshes are the last ones remaining un-impounded, but it is planned to soon impound the Brucker; the Davis is still in private ownership. The map shows the manner in which the marshes are largely protected from the open ocean, as Napatree Point crosses in front of them, but out of the picture to the left side. The Pawcatuck river is effective in lowering the salinity of the bay as it supplies a constant influx of fresh water.
Fig. 3a. A cross-section of the Lower Brucker Marsh, showing generalized sequence of vegetation types from the estuary to the upland ridge on either side, looking to the northeast (up from the bay.) The forb phase of the eroded edge is generally present on both sides, while the Distichlis phase is normally limited to the south side. Patens occurs in the alterniflora community (about 35% coverage). Bed of the estuary is on sand, while the banks are of peat. Vertical scale is very much exaggerated, but width of the whole sequence will often be less than 100 meters.
Diagrammatic representation of Miller and Egler's Bay-to-Upland Sequence, showing major vegetational units. This was the generalized sequence which they found for the Barn Island Marshes, and is similar to the sequence found in this paper, except that the relative importance of several of the belts has changed, at least for the Brucker Marsh. Vertical scale is much exaggerated; from Miller and Egler, 1950.

Fig. 3. Diagram of the vegetational sequence from bay to shrubby swamp in the Brucker Valley Marsh. Extensiveness of Low Marsh community is seen, along with the relatively minor role of Patens High Marsh and completely lacking "Juncus Slope". Flooded Panne is boundary between Low and High Marshes, while Perpendicular Stream is boundary between Tidal Marsh and brackish Cattail Marsh. Cattail to fresh-water shrubby environment is gradual. Underlying sediments are mostly level sandy peat bluff at the bay front is cut straight down to the sandy bottom of the bay. Encroachment of salt marsh onto fresh-water marsh and swamp is seen by peat profile which is generalized for these purposes. Vertical is much exaggerated.
Fig. 4. The Brucker Marsh, with major features and transects located. Numbers with photo stations are figure numbers. Inset shows detailed view of area around Stone Bridge, which was the base of most measurements and observations. Scale: 1 inch = 660 feet.
Fig. 5. The Barn Island Natural Area peninsula, showing locations of transects and major geographical features. Tidal marsh is stippled. Bare areas around Barn and Sassafras Islands which are not covered by marsh are usually composed of bare rocks and sand, showing erosional tendencies. Scale: 1 inch = 660 feet. Numbers on peat surface indicate depth of peat to underlying sediments and former upland ridge.
HISTORY OF THE STUDY AREAS

The original formation of the Barn Island Marshes is a moot point, for this happening would have occurred well before the coming of the white man in this hemisphere and, therefore, well before the time of recorded history in this area. Formation may even have been before the advent of the Indian, who probably first appeared in New England over 3000 years ago (Day, 1953).

At the moment, there are two theories to which I would give credence: the first is that put forth by Miller and Egler (1950) following the ideas of Knight (1934). This theory is based on the phenomenon of coastal submergence or a rise in sea level; which of the two is actually occurring is academic, as the effect is the same in both cases. The first step in marsh formation would be the development of a sandbar extending between two headlands, forming a pool or lagoon inland of it. The lagoon becomes filled with silt as submergence continues, until the water depth is shallow enough to support a community of salt water cord grass (Spartina alterniflora) which is hereafter referred to as "alterniflora." The grass builds up the level of the substrate until salt meadow cord grass (Spartina patens), which is hereafter referred to as "patens," grows upon the drier portions. Meanwhile, the bar is moving landward and submergence is continuing, causing the salt marsh to overlie fresh-water swamp or even upland species, if submergence has progressed that far. This inland and
self-elevation migration continues with submergence until the bar is directly over fresh-water peat or upland. And, finally, the bar is removed by wave action, leaving the marsh front itself exposed to erosion. Miller and Egler believe the Barn Island Marshes to be in this final stage. It would appear that the marsh will eventually be eroded away if it cannot migrate inland faster than it is removed at its exposed front.

The second theory is that expressed by Redfield (1965) which holds that an extensive sand flat is developed in a sheltered region. This sand flat will receive a certain amount of silt from runoff from the surrounding upland until the substrate is suitable for the growth of alterniflora, this in turn raising the level until the conditions are right for patens and spike grass (Distichlis spicata). These two species, but mostly the former, will then continue to raise the level of the marsh coincident with the rise in sea level and will migrate toward and over any adjacent fresh-water swamp and upland that it may chance to encounter. Hence, the peat will overlie sand at its seaward extremity and be continuous toward the upland over sand at a fairly constant depth until it begins to overlie the fresh-water species. This theory of Redfield's is the position taken by this author as to the formation of the Brucker Marsh in particular, with the strong suggestion that this is the phenomenon responsible for the formation of the entire Barn Island Marshes, as will be discussed later. The projecting upland islands on the Natural Area are in the process of
being overrun by the rising marsh; this, of course, unless the marsh is removed by erosion, in which case the islands will eventually be covered by the waters of the bay.

It is my contention that the entire marsh complex at one time extended much further out into Little Narragansett Bay than it does at this time, perhaps even flanking the Pescatuck River to such an extent that there would have been no bay, only a channel for the passage of the water.

From the time of marsh formation until the occupancy of New England by Indians, the conditions occurring with respect to the vegetation of the marsh are not known. Probably the marshes were swept by naturally occurring fires every few years or less frequently, depending on conditions of drought. With the advent of the Indians about 3000 years ago, the burning became more frequent and possibly even occurred in a certain rhythm as the Indians started fires to drive the game into their waiting traps. The marshes might have been burned as often as the vegetation would replace itself; but more likely, the burning was at longer intervals. When salt marsh burns, there is little danger of starting a fire which will smoulder its way through an entire area since the peat is characteristically soaked and frequently holds standing water. But even if the marsh fires were not started on purpose by the Indians, they did frequently set fires on the upland to control brush, to clear land for agriculture, and for
hunting (Day, 1953), so these fires could easily have spread to the
marsh during dry seasons. The frequency and effect of the fires on
the marsh is unknown.

With the coming of the white man, the vegetation of New England
became protected to some extent from fires as laws were passed to
limit all but local and private burning; but fires still occurred.
At the same time, these early farmers recognized the value of the
marsh hay, composed mainly of patens and Distichlis, as feed, bed-
ding, and mulch. This led to extensive mowing of the drier marshes
during the low tides in the fall harvest season. As with the Indian
fires, the effects of this early cutting cannot be ascertained without
controlled experiments along the same lines as the original conditions.
Today, the only marsh in the Barn Island area which is regularly cut
is the upper portion of the Davis Marsh (Fig. 2) by John L. Davis.
The author's observations of this area in comparison with the unmowed
area in the Brueker Marsh, along with the testimony of Mr. Davis,
indicates that no denuding occurs in mowed areas of the tidal marsh
itself. It also would appear that mowing has no great effect on the
species composition and that it may actually help to improve the pro-
ductivity of the marsh hay. Cutting of the upland border, however,
is another story and will be discussed later.

The Barn Island Marshes and the surrounding upland originally
belonged to several farms which have been in family hands for hundreds
of years in some cases. The farmers cut the marsh hay for fodder or sometimes let their cattle and sheep graze the marsh until it was found that the salt content of the grasses gave the milk a taste objectionable to those accustomed to milk from cows grazed on sweet grass. The uplands were cut for firewood and saw-timber or were cleared for agriculture.

The Brucker Marsh and the Barn Island Natural Area were no different from the other portions of the marshes in this respect. The Brucker Marsh and the other marshes were moved by their respective farmers until about 1940, except the Davis Marsh which is moved to this day (Davis, voice). The apparent reason for the cessation of moving was the altering of the tides by the hurricane of 1938 which swept across Napatree Point, removing all the summer residences and causing a break in the narrow spit at about its midpoint. This opening lets the tides ebb and flow with much increased vigor, making the harvesting of marsh hay much more difficult except in the parts of the marshes well removed from the bay (C. Henry Stewart, conversation).

Even after the cessation of moving on the Brucker, this marsh as well as the Natural Area Marsh and Islands were grazed by Mr. Brucker's sheep up until perhaps 1950. The hurricane also killed most of the large maple trees which occupied the fresh-water swamps at the heads in of the Brucker and Davis Marshes by inundation by salt water (Davis, voice).
Before the period of Brucker's sheep grazing, the Natural Area Islands were under cultivation by members of the Burdick family which had owned the area from the early 1700's. The Burdicks originally had a house and barn on the largest of the three islands (now called "Barn Island") until one was destroyed by fire and the other was severely damaged by the 1938 hurricane and later burned by vandals. Mr. Stewart reports that even before cultivation by the Burdicks, the island was denuded of its trees by a strong hurricane in the early 1800's, which was probably the 1815 hurricane (Brubach, 1965). The Burdicks may have made use of this natural clearing or may have cut down the regrowth; either way, the large island was put to cultivation in the 1800's. The trees on the smaller two islands would have also been removed, and it is believed that they were used for pasture.

Mr. Davis also reports that cultivation of the Natural Area ceased around 1919. His son, John Davis, Jr., reported that he could not expect to find any very old trees due to the habit of cutting them for firewood or saw-timber. Even after the Burdicks had ceased to farm the Natural Area, it was still being exploited by Brucker's sheep as mentioned above; they probably helped to keep the islands in an open aspect.

The State of Connecticut began to acquire parcels of land in and around Barn Island Marshes with the intention of managing them as a shooting area in the early 1940's. The ditching program was initiated in the 1930's with the purpose of controlling the reproduction of
marsh mosquitos. The early ditching was carried out by the Federal Government; maintenance of the original ditches and construction of new ditches has been under the auspices of the Mosquito Control Board, a division of the Connecticut State Health Department. Their work in the last few years has been mostly limited to maintenance of the old ditches, with only a few new ones being cut.

When the State Board of Fisheries and Game first began to develop the marshes in the 1940's, they called in Dr. W. G. Bourne, L. G. Nechama, and W. Taylor for their opinions. They advised that the best program for an increase in "biological values" would be to flood as much of the area as possible. Dr. R. P. Hunter suggested that dikes be created across each of the fingers of the marsh at a level slightly below the level of the highest spring tides, both to control mosquitos and to increase waterfowl populations (C. T. Martin, 1966).

As previously mentioned, four impoundments have now been constructed in the four westernmost fingers; and it has been planned to dike the Brucker Marsh (Martin, 1964; Bishop, personal correspondence). At the time of this writing, the Brucker has not yet been impounded; and it is hoped that this will never occur.

So these are the marshes as they are found today, the two study areas being inviolate except for the occasional forays of hunters after grouse, woodcock, pheasant, ducks, and geese and the occasional hunter equipped with bow and arrow tracking deer much in the way of his
Indian forbears who stalked the marsh and uplands several hundreds of years ago.
THE BRUCKER MARSH

The Brucker is a valley marsh extending from the bay to the upland and passing through a sequence of community types as the distance from the bay increases (Fig. 3). The three major types found are (1) the tidal marsh, (2) the brackish cattail marsh, and (3) the shrubby fresh-water swamp. These three communities are bisected by a tidal creek or estuary which runs out of the swamp and down the bank of the marsh until it reaches the bay. The waters leaving the swamp are fresh in character; but the closer to the bay, the greater becomes the percentage of salt found in the estuary due to the inrushing high tides which also cause the fresh water to back up slightly in the estuary. The estuary is an important feature of the Brucker, for it appears that much of the circulation of surface and ground waters is due to its presence and the multitude of mosquito ditches which branch from either side. As all the straight lines on the aerial photo (Fig. 1) are mosquito ditches, the great number of these may be appreciated. Direct flooding of the marsh was noted to be rare, occurring only during some of the highest spring tides. The presence of surface water on the tidal marsh seems to be due partly to ground seepage (Nichols, 1920) and partly to flooding from the estuary and ditches.

For convenience of discussion, I have divided the tidal marsh into the Lower Marsh and the Upper Marsh (Fig. 4). The Lower Marsh
lies below the Stone Bridge, while the Upper Marsh is above the Bridge. To either side of the Lower Marsh are located drainage or wildlife pools, both of which are actually located at the tips of the two upland ridges. Both the Upper and Lower Marshes are tidal marsh, but at the Perpendicular Stream one encounters the Cattail Marsh. This stream is a part of the estuary but runs at right angles from the main flow and is presumably man-made. The beginning of the Shrubby Swamp is located by the presence of heavy shrub cover.

Brucker Methods

The vegetation of the Brucker Marsh was investigated by means of transects laid out over the marsh surface and through the swamp (Fig. 4). Some of the apparent environmental factors were measured, either in the field or in the laboratory, depending on their nature. Additional observations were made wherever pertinent, and some productivity figures were obtained for the various tidal-marsh communities.

In the Upper Marsh a permanent transect, designated Transect-I, was laid out for a distance of 550 meters from the Stone Bridge to the Shrubby Swamp following the line-intercept technique (Phillips, 1959). This transect consists of 22 sections, each section being 25 meters long and marked by wooden stakes; brass pipes are inserted at every
fifth section as permanent markers. After laying out a meter tape, the amount of leaf cover of each species intercepted by the tape was measured for each section. The data from this transect are found in the Appendix. The location of the first pipe, marking the beginning of Section-I, is as follows:

From the Game Warden's cottage (at the end of Stewart Lane), proceed in a northwesterly direction along the wide path through the upland scrub until one walks out onto the tidal marsh and encounters the Stone Bridge. At the Stone Bridge, locate the tip of the highest boulder and measure 7.3 meters from the tip along a direction of 90 degrees (due East). This is the location of the stake marking the beginning of Section-I. Transect-I runs up into the swamp along a heading of 70° (20° N). This heading will run one directly up the center of the marsh into the swamp. Figure 6 is a picture of the view from T-I, S-1, looking up the transect.

A second permanent transect, designated T-V, crosses at right angles to T-I at a point 35 meters from the pipe at S-1. This is a shorter transect, having only a total of four 25-meter sections, three on the north side (designated "B") and one on the south side (designated "A"), as the marsh is quite narrow at this point. Its location is marked by reference to T-I and wooden stakes. The procedure of measuring and recording the vegetation here is identical to that of T-I.
Fig. 6. View of the Upper Marsh of the Brucker Valley Marsh, looking northeast from the Stone Bridge. First stake in the foreground is the beginning of Section-1 of Transect-I, the stakes of which can be seen extending toward the distant swamp. The stunted alterniflora community dominates the foreground and much of the marsh beyond. The dark green line across the marsh in distance is the Iva Belt along the ditches. The gray line is the shrubs of the swamp which have already lost their leaves; taller ones are Acer rubrum which occurs along edges of swamp; most are actually behind the shrubs. Estuary is on the left. October 1966.
The remaining two transects (T-VI and T-VII) in the Upper Marsh are strip transects, with each strip being marked off into 10x1 meter sections. Species composition was determined by estimates of the percent coverage of each species within each section. These transects were not permanently located or marked, but the approximate locations may be seen in Figure 4; T-VI crosses the Upper Marsh at a point near Section-9 of Transect-I; T-VII crosses the marsh between T-I, S-15, and S-16. Sections on the south side of the estuary are designated "A."

In the Lower Marsh all strip transects were used. Transect-II is a bayward extension of T-I, consisting of six 50x1 meter sections. It runs from the Stone Bridge in an approximate southwesterly direction until it reaches the edge of the bay on the southern side of the estuary. Of necessity, it follows a curving path in order to escape running through the estuary. A brass pipe was placed at the end of Section-6 near the bay front to be used as an erosion marker.

Transect-III and Transect-IV are composed of 10x1 meter sections and run across the Brucker in an approximately northwest-southeast direction. The portion of each transect located on the southern side of the estuary has been designated by "AF". T-III is located approximately between the two drainage pools in the Lower Marsh; T-IV is also in the Lower Marsh but runs across the marsh at a point about midway between the Stone Bridge and the two drainage pools.
Transect-VIII is located in the Lower Marsh, running from the bay to the Stone Bridge along the north side of the estuary (parallel-
ing T-II). Each section here is 25x2 meters. The greater length of this transect is accounted for by the extension of the marsh out into the bay beyond where the marsh extends on the south side of the estuary.

Among the environmental factors, water depths, salinities, and underlying peat deposits were investigated. The depth of the water which covers a great deal of the marsh peat was measured at each stake of T-I and at a point midway between each stake (every 12.5 meters). This was also done at each section of T-II. Measurement was accomplished by merely inserting a millimeter rule into the water until it rested on the surface of the peat. Often it was necessary to push through a layer of dead grass which is found among the stems of several species. If no standing water was present on the surface, a note was made as to the condition of the peat, i.e., if it was "damp," "wet," or "very wet." It was never dry. These data were taken over a period during the spring and summer of 1965 and may be seen in Figure 7.

While measuring the water depth, samples of the surface water were taken at most markers along T-I and T-II, except where there was no surface water present. The water samples were taken to the Noank Marine Research Laboratory of the University of Connecticut where the salinity was determined with an electrical-resistance type of salinometer. Readings were in parts per thousand, and notes were taken as
to the condition of the tide at sampling for correlation between flooding, water depth, salinity, and evaporation. The averages may be seen in Figure 7.

Peat depth and peat samples were obtained by means of the Davis peat sampler at frequent intervals along T-I and T-II. This instrument allows an undisturbed sample to be obtained from any predetermined depth; and by extending the sampler downward until it strikes the firm underlying sediments, the depth may be determined. The peat samples were then removed to the laboratory for microscopic examination to determine if they were of salt- or fresh-water origin (Fig. 7).

To determine the rate of erosion, four brass pipes were driven into the peat at the foot of the Brucker in the Lower Marsh, three on the northern side of the estuary and one on the southern side (at the end of Transect-II). The approximate location of these may be seen in Figure 4, and the distances to the bayward edge of the peat mass from the stakes are as follows: Erosion Stake #1 -- 2.4 meters at a heading of 270 degrees to the edge of the bay; Erosion Stake #2 -- 10 meters at 180 degrees. Erosion Stakes #3 and #4 are both 10 meters from the edge of the peat, which is at a heading of 255 degrees in both cases. The stakes were placed August 10, 1965.

To measure the rate of deposition, a thin layer of sand was spread upon the peat across the estuary from T-I, S-I. In several years, the peat sampler may be used to determine the depth of peat
TRANSECT - I: THE BRUCKER MARSH

Fig. 7. Transect-I in the Upper Brucker Marsh, running from stone bridge to shrubby swamp. Length of bars indicates percent cover contributed by each species, using line-intercept technique, in each 25-meter section. An "x" in a section indicates cover of less than 10% for that species (Limonium, Salicornia, Aster were each present in almost every section - 1-15 - but were always less than 10%, so were left out for clarity.) Tidal marsh extends from S-1 to 15; Cattail marsh from 16-19; Shrubby swamp from 20-22 and beyond. Salinity, Water depth are represented as solid and broken lines, respectively, on over-leaf, and are drawn to indicate the section in which they occurred.
which has built up on the layer of sand. The sand was put in place in November, 1965. Erosion or a severe storm may wash the sand off before there is enough deposition on top of it to be stabilized, but it is hoped that this method will prove satisfactory as it has for Redfield (1965).

Nomenclature follows Gleason (1952). No attempt was made to locate all species, but the more important species of all vegetation types have been collected and identified.

All results from the above works may be found in their original forms in the Appendix.
Fig. 8. View up T-I from S-16 at Perpendicular Stream which is in foreground. Across Stream is belt of tidal marsh grasses, then goldenrod belt (not visible), then cattail belt containing red maple snags. Shrubby Swamp begins shortly after tall snag in center of picture. Edges of upland forest are to either side. High tide, November 1964.
Fig. 9. The Shubby Swamp, taken from the top of a windthrow near Transect-I, S-20, and looking southwest toward the bay. Cattails are seen in depressions in foreground. Shrubs including Vaccinium, Rhododendron, and Rosa palustris are most common on the hummocks. Scattered snags of red maple are evident in the background.

November 1964.
Vegetation of the Brucker Marsh

Since the Brucker Marsh extends as a valley marsh from Little Narragansett Bay into the surrounding upland, one can recognize a series of vegetation types from the bay front inland up the marsh. An extensive tidal marsh along the bay extends about two-thirds of the way up the valley where it is eventually replaced by a small brackish cattail marsh that is ultimately replaced by an extensive shrubby fresh-water swamp (Figs. 3, 6). Since a road with a small stone bridge divides the tidal marsh, a Lower and an Upper Marsh are recognized for study purposes. Although separated geographically by the road, it is to be emphasized that these two areas are, in fact, a continuum in floristic composition.

Compared to the smooth grassland appearance of the tidal marsh, the brackish marsh is roughened by the coarse character of the dominant cattails which are interspersed with a few shrubs and rotting, ghost-like snags of red maple (Acer rubrum) (Fig. 8). The cattails mark an abrupt ecotone between the tidal marsh and the swamp.

The shrubby fresh-water swamp is a tangle of shrubs and occasional low trees located on hummocks which are separated by shallow pools dominated by cattails (Fig. 9). The footing here is treacherous, and a false step may put one in water up to his knee.
Although little detailed research was done on the Brucker Marsh, a review of Miller and Egler's tidal marsh studies (1950) in the contiguous marshes west of the Brucker appears pertinent. They recognized four major belts occurring from bay to upland: (1) The *Spartina alterniflora Lower Border* occurs as a narrow belt along the seaward edge of the marsh peat, being composed predominantly of that species growing up to one meter in height. It forms a fringe along the canals, ditches, or other sources of freely moving salt water. (2) The *Spartina patens Lower Slope* occurs in regions more inland than the Lower Border, not along the ditches or canals but on slightly elevated peat to allow drainage after each tide which inundates it. The aspect is that of a fairly extensive field of relatively pure patens. (3) The *Juncus gerardi*¹ Upper Slope occurs still more inland than the patens Lower Slope and at a slightly higher level, possessing complete surface drainage. It would appear as an almost pure, extensive belt near the upland and would probably not be flooded as often as the patens Lower Slope. (4) The *Panicum virgatum*² Upper Border is described as a narrow belt of tall grasses, the soil level of which is considerably

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¹ black grass
² switchgrass
above the general marsh level, meaning that it would only be flooded by the very highest of spring tides.

Since there are slight topographical irregularities in the bay to upland slope, this idealized pattern is interrupted by what Miller and Eger recognize as the "Panne Sequence," a panne being defined as a shallow, undrained depression supporting a characteristic vegetation. (1) The "Forb Panne" is the shallowest of the recognized types, being covered mostly with plantsin (*Plantago maritima*), gerardia (*Gerardia maritima*), sea-lavender (*Limonium carolinianum*), and Distichlis. In slightly lower depressions, the forbs are replaced by (2) the "Stunted Alterniflora Community," dominated by essentially pure alterniflora in a stunted form. At even lower levels is (3) the "Salt Panne" in which a crust of dried salt and algae is to be found but no vascular plants. In some depressions, one can recognize various belts in the panne sequence occurring outward from the center of the depression in concentric rings; others may be covered by either forbs or stunted alterniflora, depending on the relative depression.

Although Miller and Eger carried out most of their observations in the marsh south of Headquarters (Fig. 2), several of their communities and panne types may be found in the Brucker Marsh; and others occur in modified form. I have modified their sequence and borrowed from the work of Redfield (1965), Adams (1963), and others in recognizing two major site types in the Brucker: the High Marsh and the Low Marsh
Communities. The Alterni flora Low Marsh community includes the Alterni flora Belt and an extensive Stunted Alterni flora Phase which only locally exhibits the typical stunted panne aspect. The patens High Marsh community includes primarily patens and its major associates and the Iva Belt.

The Alterni flora Low Marsh Community

The Low Marsh, dominated by alterni flora, covers more than 50% of the tidal marsh. Two phases may be recognized: (1) a taller belt occurring along the edges of the estuary and mosquito ditches, and (2) a stunted community covering extensive areas back from and between the ditches.

The Alterni flora Belt. This phase is that recognized by Miller and Egler as the "Alterni flora Lower Border" and occurs along the banks of the estuary and the mosquito ditches often as a continuous belt but occasionally is intermittent and rarely is absent. It is composed of an almost pure stand of alterni flora rarely reaching a maximum height of one meter. The maximum width of this belt is one meter except in places where the edge of the estuary is lower than normal, causing the belt to attain a width of several meters. The more luxuriant growth of the alterni flora along the banks appears to be correlated with the regular flooding with sea water from the tides, offering rapid removal
of wastes and frequent turnover of nutrients, as will be discussed later. Although conspicuous along many of the banks, this belt is quite insignificant in terms of total coverage, occupying less than one per cent of the Brucker tidal marsh.

The Stunted Alterniflora Phase. This is the most extensive vegetation type on the marsh, covering over 80% of the Lower Marsh (Transects II, III, IV, and VIII, Figs. 10, 11) and about 50% of the Upper Marsh (Transects I, V, and VI, Figs. 7, 12). The stunted alterniflora community is represented in the transect data wherever alterniflora represents over 50% coverage. It may easily be recognized in the field by the lower growth habit of the grass, which is usually less than ½ meter in height. Although occasionally extending to the edges of the ditches, it more typically covers the areas more removed from the taller Alterniflora Belt and over the extensive stretches between the ditches. Compared to the dark green color of the taller grass along the ditches, the stunted alterniflora is typically yellowish-green in appearance.

Although dominated by alterniflora (55% coverage of the community), patens is an important associate (35%), with some Distichlis and such forbs as Limonium, glasswort (Salicornia europaea and S. Bigelovii), and aster (Aster tenuifolius) occurring interspersed or in localized colonies. The alterniflora and patens are usually interspersed but with
In each section of I-II over a period of several months, and finally since the section where it was taken
is shorter than I-III because of the curvature of the bay front. Plots in one of these sections means that the species covered less than 1% of the sections total cover. I-II
is 25-meters. Note that in I-III, while being impacted a total of 10% impacted of the entire 100% in
section is recorded by the striped bass method. Each section of I-II is so meters long. Each of I-III
section is 0.5 meters long. No sections of I-II is visible. Percent cover of each species in each
25-meter section.

After

S. patterns

S. attenuatae

PH 10.6

The Bay

The Stone Bridge

0% 50% 70%
Fig. 11. Transects III and IV, running across the Lower Brucker Marsh, with the estuary as a reference point. All sections are 10-meters long; length of bars indicates percent cover contributed by each species in each section and was obtained by the strip-transect technique. Coverage of less than 10% is indicated by "x". Narrowness of the Lower Marsh is indicated by shortness of transects which reach to the edges of the Panicum Belt. Sections closest to the estuary are typically of the Alterniflora Low Marsh Community, while those further away show the Eroded Edge forb vegetation and a small portion of the Panicum Belt.
Fig. 12. Transects V, VI, VII running across the Upper Brucker Marsh, with the estuary as a reference point. T-V is a permanent transect, done by line-intercept along 25-meter sections. The right-hand section runs into a stone wall as the marsh is narrow here. T-VI and VII are strip transects. Length of bars indicates percent cover contributed by each species. Sections to right of estuary are on the south side. T-VI and VII are each composed of 10-meter sections; VI shows transition from Panicum Belt to Low Marsh, passing through Eroded Edge; VII shows High Marsh composition. T-V shows Panicum Belt.
the coarse quality of the former overshadowing the finer aspect of the latter. The alterniflora frequently occurs in a pure stand. Locally one encounters slight depressions sparsely covered with extremely stunted alterniflora similar to the stunted pannes recognized by Miller and Egler. Aspects of this phase can also be seen around the edges of the extensive Flooded Pannes in the Upper Marsh, which will be discussed later.

The widespread occurrence of alterniflora and its dominance in the community is due to a complex of factors including frequent flooding, moderate salinities, nutrient availability, and a permanently wet or flooded peat surface; these are all tied up with the lowness of the substrate under the alterniflora cover, as it is easily flooded. It will be noted that the stunted alterniflora community occurs in the portions of the Brucker Marsh closest to the bay; it does not seem able to occur at any great distance from a salt-water supply or source of supply (e.g., the bay and the estuary). Adams (1963) has found that alterniflora has definite iron requirements; low iron seems to place the species under physiological stress and cause chlorosis. The availability of iron seems to be tied up with circulation of the surface waters which cover the marsh peat; when circulation is curtailed, the amount of available iron is curtailed. Several workers (Conard, 1924; Hinde, 1954; Johnson and York, 1915; Martin, 1959; Taylor, 1939) have noted that
alterniflora is associated with lengthy immersion times and/or regular (twice-a-day) flooding, along with the presence of salinity. This may involve the iron requirement or may induce other unknown factors.

Occasionally, an exceptionally high tide will overflow the banks (levees) of the ditches and the estuary and flood the inland stunted alterniflora areas; but this water is largely stagnated due to the natural levees formed by the ditching process (in which the excavated peat is piled up alongside the ditches), and overturn will not be as frequent as along the banks. This stagnation is probably an important factor in maintaining or expanding the stunted alterniflora community, as no other species is as well adapted to living under these conditions; even though the alterniflora may be living under conditions far from ideal.

The salinity of Little Narragansett Bay just off the Lower Marsh is about 13 parts per thousand since the sea water (normally about 30 parts per thousand) is diluted by fresh water flowing into the bay from the Pawcatuck River. Therefore, the marsh could not be flooded with a salinity greater than 13 p/T (except, of course, in the case of a hurricane which would carry in ocean water); and any increase over this moderate salinity would have to come through surface evaporation. The salinity data show that the surface water of the Lower Marsh never gets much above 13 p/T (Fig. 10) but that as the distance from the bay
increases, the salinity increases to a maximum of about 20 p/T at the upper limit of alterniflora. This must be due to the isolation of these waters from the "washing" effect of the tides, which would "dilute" these waters with less salty water. It will be noted (Fig. 7) that the continuous coverage of alterniflora ceases where the salinity of the Upper Marsh reaches its maximum at T-1, S-11.

The presence of patens associated with the stunted alterniflora is of interest. Several workers have found that patens is inhibited by continued submergence or excessive salinities, including Adams (1969), Taylor (1939), and Johnson (1915). Since all of the Lower Marsh and the portion of the Upper Marsh covered by the Stunted Alterniflora Community are typically inundated by at least several centimeters of saline water, it would appear that frequent flooding and/or constant surface water may account for the subdominance of patens. Frequent flooding and the subsequent saline standing water appear to enable alterniflora to compete more successfully in this region than any other species, even though it is stunted. Or perhaps the present patens is a relief of a previously more extensive community.

Miller and Sigler related that the lower portion of the Brucker Marsh was being moved during their period of study in 1947-9. Presently dominated by alterniflora which is of little value as hay, it would now
be difficult to mow because of the ever-present surface water and soft peat surface, unless this mowing was restricted to the extensive Panicum belt. This suggests that the Lower Marsh, prior to the late 1940's, may have been covered with a greater percentage of patens, a species typically mowed. John Davis, Sr. (voice) has reported that Mr. Brucker ceased mowing his marsh around 1930; a reason for this may have been the transition of the then-cuttable Lower Marsh (dominated by patens?) into the undesirable alterniflora community.

What factors might have triggered this change?

Ditching of the marshes was completed in the early 1930's. It is entirely possible that the levees caused by piling the excavated peat alongside the ditches served to convert the former patens slope with its "complete drainage after each tide that covers it" (Miller and Egler, 1950) into a penne-like relief which retained some of the water after each flooding. The patens which is found today in the stunted alterniflora Low Marsh may well be a relief of this previous "patens Lower Slope Community." If this hypothesis is true, alterniflora may continue to increase with a concomitant decrease in patens, unless an equilibrium has already been reached between the two grasses.

Another contributing factor, or possibly an alternative hypothesis, is that when the 1938 hurricane breached the sandy spit of Napatree Point, the greater surge of tides which resulted from the second
opening into Little Narragansett Bay became more active in inundating the tidal marshes, effectively raising the mean high tide level. The tide range as measured at the Stone Bridge now averages about three feet; its range before 1938 is not known. A raising of the mean high tide would foster an inland and upward migration of all vegetation types if they were to retain their normal relation to tide levels. Yet another factor favoring this trend is the slow but continuous submergence of the coastline, which will be treated at a later time.

The Flooded Panne

As one moves up the tidal marsh, the stunted alterniflora community is replaced by an extensive Flooded Panne, a variation of the Salt Panne which occurs in the Upper Marsh. It has been named the Flooded Panne as it is normally filled with 7 centimeters of salty water (Fig. 13). This extensive panne extends almost continually from the upland across the marsh for about 100 meters until it reaches the estuary, from which it is separated by a barely discernible levee. Its length along T-1 is about 50 meters, occurring to either side of the marker at T-1, S-11. The depression occupies about 5% of the total marsh surface.

The Flooded Panne marks the inland limit of the alterniflora Low Marsh Community, seeming to act as a trap to the tidal waters when
they happen to flood this far inland over the marsh surface; beyond the panne (T-1, S-12) occurs the patens High Marsh with a sudden drop in salinity and low surface-water levels.

Over 50% of the panne's area is open water supporting a floating algal mat which appears to be composed primarily of blue-green algae which has been tentatively identified as *Lynsbya sp.* The remainder of the area supports approximately equal amounts of alterniflora and Distichlis.

The water of the Flooded Panne was sampled periodically for about two months and was found to remain at a fairly constant salinity of 25 parts per thousand, the highest found in the Brucker Marsh and 10 p/T greater than the bay water. The estuary only occasionally floods this area with saline water due to its great distance from the bay. Additional water is derived from rainfall or seepage of groundwaters from the Shrubby Swamp. The great increases in salinity appear to be due to the accelerated evaporation of the shallow waters. In support of this, it was noted during the drought of the summer of 1965 that the panne dried up completely and remained in this condition for about a week. After the next rainfall, the water returned to its normal 7 cm depth; but the water was fresher in character, being less than 15 p/T; it was only after several weeks of evaporation and light rainfall that the salinity returned to the average figure of 25 p/T.
This type of panne may be developed from a slight depression which holds standing water; this seems to be happening at one location, at T-I, S-I (Fig. 14).

Fig. 13. The Flooded Panne, looking southeast from edge of estuary. Stake marking T-I, S-I can be seen in water on left side of picture. Extremely stunted alterniflora is in foreground, is remnant from the previous year's growth, appears to be dying out and becoming extension of the Flooded Panne. Taller luxuriant grass is Distichlis. Panne extends almost continuously to stone wall in background, November 1964.
Fig. 14. Looking up the Brucker Marsh, standing on the highest rock of the Stone Bridge. Stake at right marks beginning of T-1, S-1. The two dark spots in foreground are very wet and the alterniflora has been packed down. The area around the spots is drier. Patens and Distichlis are in immediate foreground. Eroded edge and Panicum B lie are seen on right extending up the edge of the marsh. Meandering estuary is seen extending up the marsh on the left. November 1964.
The Patens High Marsh Community

Some 600 meters from the bay front and just beyond the Flooded Panics, one can recognize the High Marsh, dominated by a mosaic of yellow-greens (patens), light greens (Distichlis), and dark browns (the fruiting capsules of Juncus). Representing about 10% of the tidal marsh, this low grassy cover, including Juncus, is dissected by ditches which are often edged by marsh elder (*Iva operia*), a one-meter-high shrub (Fig. 15).

Although dominated by patens (contributing about 50% of the cover), Distichlis is an important associate (30%); and Juncus occurs in limited colonies. The patens is often in pure stands but quite frequently will occur in conjunction with Distichlis, a species which occasionally occurs in stands. The Juncus never occurs alone here but is usually associated with Distichlis and sometimes patens, with the percentage of Juncus to the other species being about 50-50. On the Headquarters Marsh to the west, Miller and Egler found Juncus occurring as an almost pure belt between the patens and Panicum communities at the higher marsh levels. Whether it was ever this well developed in the Brucker is not known. However, assuming it was present, its disappearance may be related to the ditching or increased flooding after the 1938 hurricane, as mentioned in conjunction with the alterniflora community. The effects of such changes on the Juncus may have been slow but continuous in
Fig. 15. The Iva Belt as it occurs along the edges of a ditch in the Upper Marsh of the Brucker, looking north. Coverage of Iva is seen to increase as it approaches the estuary which is on left. Stunted alterniflora is in left foreground, surrounded by the lighter grasses of pennis and Distichlis. Far side of ditch is pennis High Marsh, November 1964.
modifying the Juncus community. Within the past few years Egler and Niering (voce) have found the Juncus Belt to be replaced by arrowgrass (Triglochin maritima) on parts of the Headquarters Marsh. They feel that the impact of man's trampling as he walks along the upper edge of the marsh may be important in contributing to the decrease of Juncus.

Among the various factors influencing the vegetational pattern of the High Marsh are the low water depths and decreasing salinities on the marsh surface (Fig. 7). Salinity of the surface water here averages a low four or five parts per thousand compared to the figure of 15-20 p/T which is usually found in the Low Marsh, and the peat surface is usually only damp instead of being flooded. These low quantities are, in turn, thought to be due to the great distance from the available supplies of salt water, the proximity of the fresh-water stream which emerges from the swamp, and perhaps a slight elevation of the peat surface. Salty water is not often able to traverse the great distance up the estuary; so the main influx would appear to be from the swamp, meaning that it would be essentially fresh. And the apparent level of the peat, combined with the distance from the bay, means that the substrate will only be damp rather than flooded.

The combination of lower salinities and lower water level, along with better drainage, appears to be among the factors favoring patens and its associates over alterniflora. It is not known if the High
Marsh is really higher than the Low Marsh (this would require accurate surveying techniques), but the combination of factors certainly makes it appear that way.

Iva Belt. Along the ditches within the High Marsh, Iva forms a narrow belt usually less than one meter in width (Figs. 6, 15). Coverage along portions of the ditches may be as great as 90%, but in other places its occurrence will be only intermittent or completely lacking. Scattered small seedlings may be found extending a few meters into the areas between some of the ditches, but the permanent establishment of these seedlings was not apparent during the course of this study. The presence of Iva seems to depend on a slight elevation of the substrate above the general marsh level. This higher elevation is present along the ditches due to the levees.

Iva is also found in the Lower Marsh as a pure stand around the raised banks of the drainage pool located to the north of the estuary. Its presence here may be explained by the elevation of the banks; and it was also noted that this bank was denuded during the fall of 1964 by bulldozing operations, leaving bare soil ready for the invasion of Iva. It is suggested that the invasion of Iva along the ditches may have followed the same pattern as the invasion of the denuded banks, as the ditching process includes effective denudation of the ditch edges with the placement of peat upon them. With the lack of marsh grass competition, Iva seems to invade readily, while it does not do so in grassy plots. This needs further study and experimentation.
The Panicum Belt

Panicum forms the upper edge of the tidal marsh along both sides of almost the entire Lower Marsh and the bayward half of the Upper Marsh, occurring as a belt of grasses about one meter high and from one meter at the narrowest to over ten meters at the widest (Fig. 16). The appearance of the belt is more like that of an old field than of a tidal marsh, with scattered shrubs, small trees, and upland herbs occurring quite frequently. Miller and Egler, working in the Brucker, found over 100 species in their "Panicum Upper Border," the greater proportion being upland rather than marsh species. The Panicum Belt is elevated above the general marsh level on a low (about 50 cm.) plateau-like formation of peat.

Panicum, averaging 50% coverage and locally reaching 100% cover, is easily the dominant here. The more important associates are high-blueberry (Vaccinium corymbosum), bayberry (Myrica pensylvanica), swamp rose (Rosa palustris), and goldenrod (Solidago spp.). Typical tidal marsh species previously mentioned are rare.

Both its location and composition place the Panicum Belt as a transition zone between the tidal marsh and the surrounding upland but with greater similarities to the upland. Its higher surface level prevents it from being flooded by high tides as is characteristic of the tidal marsh, and this is suggested by the presence of the upland species which are normally sensitive to salt water. The only time at which this
Fig. 16. View up the Brucker Marsh northeast above the Stone Bridge and to south of estuary, showing the Eroded Edge and the Panicum Belt of tall grasses. Short grass in center of bare Eroded Edge is Distichlis; slope may be seen. Alterni-flora community extends up marsh to left. November 1964.
Fig. 17. Looking southeast while standing in alterniflora community below Stone Bridge on south side of estuary. View shows the Eroded Edge in bare winter aspect, but the completely bare zone here is bare all year. Panicum Belt in background, tide- and ice-flattened Distichlis and alterniflora in foreground. Tuftsocks are mostly devoid of vegetation but may have very sparse Triglochin occasionally. This area was even more bare in December, 1965; picture taken November 1964.
belt could be flooded is during severe storms, as not even the highest spring tides were seen to inundate it.

Portions of the Panicum Belt appear to be undergoing slow erosion of its lower edge by the grinding action of the winter ice sheet as a small bluff is formed at the edge of the grasses. In other locations, the bluff will not be apparent; and scattered tussocks of depauperate Panicum will occur scattered on a gradual slope which has been largely denuded (Fig. 17). The rate of denudation is not known.

Vegetation of the Eroded Edge

The Eroded Edge, constituting less than 5% of the Tidal Marsh, is a belt of relatively bare peat which occurs between the limits of the stunted alterniflora and within portions of the Panicum Belt where severe erosion has occurred, as previously mentioned. It is found only where both the stunted alterniflora phase and the Panicum Belt occur, i.e., mostly along the edges of the Lower Marsh and along the more bayward portions of the Upper Marsh. This conspicuously bared area of the Eroded Edge slopes gently down from the upland with its innermost portions grading into a slight pannes-like depression. Forbs tend to dominate the sloping peat, whereas Distichlis is predominant in the depressions. On the basis of this pattern, both a Forb and a Distichlis Phase are recognized (Fig. 17).
The Forb Phase. This is dominated by Plantago and Triglochin, with some Salicornia (app.), Limonium, and Distichlis. These pioneer species form a sparse cover which ranges locally from 10-50%, while other portions are completely bare (Fig. 16). Very little dead matter is found between the stems of the plants, indicating that erosion here is an important factor and that no deposition is occurring.

The Distichlis Phase. This phase is usually only encountered in the Lower Marsh, adjacent to the stunted alterniflora in the slightly lower depressions of the Eroded Edge. The Distichlis is essentially pure but shorter than normal, being less than 15 centimeters high. Cover is sparse, being less than 50%; but rarely, it may exceed this figure. The presence of the Distichlis is seen on Transect-III, Section-1.

An analog of the Eroded Edge is the "Mowed Forb Community" of Miller and Egler. This is described as once having been a portion of the "Panicum Border" which was destroyed through continued mowing and sheet erosion. The forbs, including especially Triglochin, act as pioneer species colonizing the denuded peat surface. They also noted an invasion of Distichlis into the bare area and raised the question of this species replacing the lost Panicum. But my observation of the area during the winter of 1964-65 lead me to believe that any advances made by a colonizing species over the warm months are quickly eroded...
by the winter ice sheet as it grinds over the surface at its outer edges. The still-extensive bare areas bear this out.

A new invader of the Eroded Edge was noted during the summer of 1963. Adjacent to the drainage pool on the south side of the Lower Marsh is an expanding colony of reed (Phragmites communis). Several of these plants were noted sending runners out into the exposed peat. Whether these plants will be able to withstand the ravages of the winter ice sheet is not known but will have to be determined years hence, if the colony is not removed by the State Board of Fisheries and Game as is planned (James Bishop, personal correspondence).

The Cattail Marsh

Beginning at the Perpendicular Stream (T-I, S-16) 400 meters from the Stone Bridge, one encounters an ecotonal brackish wetland typified by cattails. Although extending completely across the marsh, it is limited to less than 100 meters in depth as it grades into the more extensive shrubby fresh-water swamp (Fig. 8). On crossing the Perpendicular Stream, one encounters first a 10-15 meter wide belt of tidal marsh grasses (alterniflora, patens, and Distichlis) and then a 5-meter belt of seaside goldenrod (Solidago sempervirens) which grades into pure cattails. Within each of these two belts, the presence of the respective
species is relatively continuous although they do grade into one another somewhat along the borders of the belts. Cattails are infrequent along the stream to the upper limit of the grass belt but become more frequent and then dominant at the limit of the goldenrod belt. Woody species are not present in the two belts.

As one enters the cattails (*Typha latifolia* and *T. angustifolia*), their coverage reaches 80-90%, with the former far exceeding the latter in importance. Woody species are rare except where the cattails grade into the woody swamp. However, a few high-blueberry bushes are conspicuously scattered in the upper portions of the cattails.

Throughout the cattails one finds old tree stumps and snags (up to 20 inches in diameter), presumably of red maple which were killed by the 1938 hurricane. According to Davis (voces), this area was formerly covered by a red maple swamp; and based on the hummocky nature of the substrate and the number of snags present, this information appears sound. Scattered smaller snags appear down to within about 15 meters of the Perpendicular Stream. Today, the nearest living maple sprouts arising from a tree not completely killed by the hurricane are about 75 meters from the stream near the limit of the Cattail Marsh. Direct evidence of swamp shrubs was not found with the snags near the Perpendicular Stream; however, one might assume that shrubs typical of those found today in the adjacent swamp were originally associated with the maples.
Changes in salinity also occur as one moves from the patans High Marsh below the Perpendicular Stream across this brackish cattail marsh into the fresh-water swamp. The salinity in the High Marsh near the stream is about 5 parts per thousand; just above the stream it is 2.2 p/T; in the pure cattails it is 1.1 p/T; and where the swamp shrubs begin to increase in importance, the salinity drops to zero. As the salinity decreases from that found on the tidal marsh, the cattails and goldenrods can compete more successfully than other species in this only slightly saline environment.

Future trends in the Cattail Marsh suggest a relative equilibrium. Although formerly a woody swamp, there is no evidence of swamp shrubs and trees invading at this time. The effects of the hurricane in modifying the area will be discussed in conjunction with the Shrubby Swamp.

The Shrubby Swamp

Proceeding up the marsh (to about T-1, S-19), one sees the cattails replaced by an extensive fresh-water swamp which extends about 300 meters farther up the valley until it abuts on the surrounding upland forest. Transect data were taken for only the first 100 meters of the swamp as it was noted to be fairly homogenous in species composition beyond this point: (Fig. 7).
The general aspect is that of semi-open shrub thicket arising from hummocks elevated above the level of the fresh-water pools (Fig. 9). Prior to the 1938 hurricane, the area was covered with scattered large red maples (John Davis, voice). Snags up to 24 inches in diameter still persist, and those which are still living (about one-half) give rise to sprouts which range from 2 to 6 meters in height. Taller red maples may be found on the borders of the swamp.

The shrubby vegetation, ranging from 2 to 4 meters in height, is dominated by high-blueberry, low red maple sprouts, and swamp rose, although several other species are present but with limited coverage. Poison ivy (Rhus radicans), bayberry, swamp asters (Rhododendron viscosum), and sweet peppertush (Clethra alnifolia) are the more important of these.

The most common herbs in order of importance are sedge (Carex sp.), cattail, goldenrod, and cinnamon fern (Osmunda cinnamomea). The sedges typically cover the hummocks, whereas the cattails are predominant in the surrounding pools; but the cattails tend to disappear almost completely some 100 meters beyond the end of the transect. It was noted with interest that skunk cabbage (Symplocarpus foetidus), a common swamp herb in this region, was absent from the Shrubby Swamp.

Among the factors involved in interpreting the dynamics of this swamp community are salinity, catastrophe, and coastal submergence.
The salinity of the ground waters is normally at zero, i.e., the water is fresh, which favors certain of the typical swamp shrubs, herbs, and red maple. But when a severe storm hits the coast and washes ocean waters (at 35 parts per thousand) up and over the marsh in conjunction with extremely high winds, the salinity will be indefinitely raised to an unknown degree and the wind will uproot or break off larger trees, as occurred during the 1938 storm. Several large windthrows up to 24 inches DBH have been noted, all thrown toward the head of the swamp and away from hurricane winds.

The 1938 hurricane is an example of the ferocity of this extremely severe type of storm (which seems to occur at least once every 100 years -- although there is an average of one hurricane every ten years -- Brumbaugh, 1965), as it washed all the summer homes off Napatree Point and deposited their timbers on the marsh, in the swamp, and on the upland which surrounds the entire Barn Island Marshes Area. This hurricane had enough force (winds over 100 mph) to topple taller trees or shrubs and seriously whip all others in the swamp, either killing or causing severe breakage. It is easily seen in the swamp today that all large red maples were effectively eliminated and that many of the smaller maples were partially killed, but the effect on the shrubs is not known. It must be assumed that many were killed by the prolonged inundation with sea water and the residual salts, but the extent of this is not known.
The cyclic catastrophes are of major importance in modifying or maintaining the vegetation of this swamp, depending on their frequency and violence and whether the vegetation has had time to become re-established from the preceding storm. A hypothetical sequence of vegetation types following a major storm might be as follows: first, an "open period" in which cattails and other species which have some salt tolerance would dominate until the excess salt could be washed or leached out of the soil; then an "open scrub" of the more resistant shrubs; then a maple swamp forest which would be removed by the next violent storm. The sequence might only involve the last two steps if the shrubs involved were resistant enough to persist after inundation. But the time between storms must be quite long if red maple is to resume dominance, as it was noted that no seedlings of red maple are present in the swamp at this time. The present stage exemplified in the swamp is the open scrub with a small amount of red maple.

Another factor operating is the phenomenon of coastal submergence which tends to be "pushing" the several belts of the Brucker Marsh farther and farther back toward the upland and the head of the valley, through elevation and migration of the belts. It becomes difficult to separate the effects of severe storms and coastal submergence, since the latter is slowly tending to increase the salinity up the valley marsh. More will be said about this in the section on "Peat and Coastal Submergence."
Productivity of the Brackish Tidal Marsh

It has been well documented that tidal marshes are among the most productive land areas in the world, if not the most productive natural areas (Odum, 1961). Therefore, it was of interest to determine the productivity of the dominant marsh grasses and forbs of the several communities in the Brackish Marsh and compare these figures with those of other workers. All clipping and harvesting was done during September, 1965, when the plants had reached their maximum development. Due to the uniformity of the vegetation, it was felt that rapid approximations of the productivity could be obtained with relatively few plots. The data (Fig. 18) bear this out, even though only 4 to 6 square meters were clipped for each species.

In the alterniflora Low Marsh it was found that, regardless of the size of the alterniflora, the productivity was about equal for any given area. In the Alterniflora Belt the grasses were taller but less dense, while in the stunted alterniflora community the individuals were smaller but of greater density; the biomass per square meter was almost identical in both cases, as the dry weight for the former averaged 467 grams per square meter and that for the latter averaged 470 grams. For this reason, the productivity of alterniflora seems independent of its mode of growth, except in severely stunted areas or pannes where both
the density and size are reduced. When patens is mixed with alterniflora, as frequently happens in the Low Marsh, the total productivity is raised, as stands containing both species averaged 640 grams versus the usual 470 grams for pure alterniflora. The average productivity of the alterniflora Low Marsh community is about 325 gm/m² when the percentages of alterniflora and patens present are taken into account.

Graal (1962), working in a Georgia tidal marsh, described alterniflora as being either "tall" (growing along levees) or "short" (growing on "fields" between the levees), which sounds similar to the situation in the Brucker Low Marsh. He recorded the following net productivity for each type in the appropriate season:

<table>
<thead>
<tr>
<th>Type</th>
<th>Fall</th>
<th>Season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short</td>
<td>900 gm/m²</td>
<td>Winter</td>
</tr>
<tr>
<td>Tall</td>
<td>1800 gm/m²</td>
<td>Winter</td>
</tr>
<tr>
<td>705</td>
<td>3225</td>
<td>Spring</td>
</tr>
<tr>
<td>600</td>
<td>1350</td>
<td>Summer</td>
</tr>
<tr>
<td>300</td>
<td>750</td>
<td>Autumn</td>
</tr>
</tbody>
</table>

The first thing noticed is that he clipped four times a year, while my study only clipped once (and in the late summer). I believe that the Brucker could be harvested twice a year but would assume that the second crop might be less productive; and this might have serious consequences on the standing vegetation, since our growing season is much shorter than that in Georgia.
<table>
<thead>
<tr>
<th>SPECIES/COMMUNITY</th>
<th>AVERAGE GRAMS OF DRY MATTER PER EACH METRE SQUARE PLOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stunted alterniflora</td>
<td>645 490 475 470</td>
</tr>
<tr>
<td>Taller alterniflora (Salt)</td>
<td>600 665 70</td>
</tr>
<tr>
<td>Pure patens</td>
<td>635 645 345 310</td>
</tr>
<tr>
<td>Patens and alterniflora</td>
<td>335 390 420 490</td>
</tr>
<tr>
<td>Distichlis (almost 50%)</td>
<td>380 470 255 160</td>
</tr>
<tr>
<td>Distichlis</td>
<td>420 310</td>
</tr>
<tr>
<td>Pure Panicum (with upland species)</td>
<td>260 225</td>
</tr>
<tr>
<td>Mixed Panicum (with Erodent species)</td>
<td>180 160</td>
</tr>
</tbody>
</table>
The tall growth is noted to be much more productive per square meter than the short by a factor of two or three; productivity of my alterniflora belt was about the same as that of the stunted alterniflora. His summer short growth figure is only about 100 grams (one-fifth) higher than mine, but the tall growth is about three times as great. Truly, the climate and growing conditions of Georgia are superior to those of the Brucker Tidal Marsh.

Daiber (1959) examined a Delaware tidal marsh with a group of graduate students and found the previous year's (he did his work in the spring on the dead grasses) productivity to average 55 grams per square foot, taken as a marsh average, but presumably dominated by alterniflora. This is about 525 grams per square meter, a figure which is identical to my average tidal marsh productivity. When one remembers that some of his productivity was lost through decomposition and predation during the winter, it is apparent that the Delaware marshes must also be more productive than those found in Connecticut.

The data from both of these studies may be higher for one very good reason: These areas are known for their extensive stands of tall, luxurious alterniflora, as are marshes near Boston, while luxurious alterniflora is nearly absent in the Brucker Marsh. The reason(s) for this are not known.
In the patens High Marsh, pure stands of patens, Distichlis, and Juncus, respectively, averaged 660, 350, and 400 grams of dry matter per square meter. By combining the above figures and taking into account the per cent coverage of each of these three species in the community, an average figure of about 500 grams per square meter is attained by the High Marsh Community.

In the Panicum Belt, samples were taken in both the denser pure Panicum phase and the more open phase where scattered shrubs and other species occur with a coverage of about 50%. The pure Panicum plots averaged 460 grams, whereas the mixed plots averaged 275 grams. Thus it is seen that the more dense-appearing mixed plots are actually of lesser productivity than the pure plots, but it must be explained that no mixed plots were selected which contained shrubs of more than one meter in height.

Samples taken in the Forb Phase of the Eroded Edge were particularly interesting. Although appearing relatively bare and low in vegetation cover, the average weight of dry material (not including the completely bare areas) was 200 grams per square meter, almost half of that found in the stunted alterniflora and one-third of the densest stands of patens in the High Marsh. The Distichlis phase of the Eroded Edge was not measured due to its limited occurrence, but an estimate of the average productivity of the Eroded Edge (including bare areas) would be
in the neighborhood of 150-200 grams per square meter, since the
Distichlis may balance off the Bare Areas.

On the Brucker, the most productive communities in terms of biomass
of above-ground vegetation are the Low Marsh (325 grams) and the High
Marsh (500 grams). The Low Marsh is slightly more productive, but
the amount is not significant. Among pure stands of the several grasses,
patens is the most productive, as one might expect when its dense cover
is noted.

The productivity of an acre of either the Low Marsh or the High
Marsh is approximately one-half ton (1000 pounds) per acre, a truly
impressive figure. Odum (1961) has ranked estuarine tidal marshes with
deltas, coral reefs, and intensive agriculture (sugar cane) as being the
most productive areas in the world, in terms of gross primary productivity
(dry weight of organic matter fixed annually). This goes beyond mere
productivity of the surface vegetation and includes all biotic systems.
He ranks estuarine marshes as producing in the ten thousands of pounds
per acre per year.

The productivity work done as a part of this study has only
scratched the surface of the many possibilities for work here, and a
complete dissertation could be written about this one aspect alone,
incorporating all biotic systems.
Peat Studies and Coastal Submergence

From peat studies on the Brucker Marsh it was found that the salt marsh is advancing inland over the fresh-water peat, a phenomenon well documented in areas along the New England coastline (Redfield, 1905; Egler, 1956). Data from peat samples taken along Transects I and II are presented in Figure 12. It was found that fresh peat, recognized by the presence of woody stems and fibers as well as a grayish-brown color, extended as a wedge for about 100 meters down to Section-12 of Transect-I under the salt-marsh peat. Conversely, the salt peat overlies the fresh peat for about 100 meters up to a point just across the Perpendicular Stream (the upper border of the tidal marsh). Salt peat is characterized by the absence of woody particles and presence of grass fragments, as well as being a dark brown or black color.

With continued coastal submergence at the present rate of between 4 and 10 inches per 100 years, the salt marsh will continue to encroach upon the Cattail Marsh which will, in turn, encroach upon the Shubby Swamp. Since the sides of the tidal marsh abut directly upon the upland, some encroachment will also occur here. This inward and upward migration of the several belts is, of course, dependent on continued submergence of the coast, for if submergence were to cease or emergence to begin, the depositing grasses would soon build themselves above the
Fig. 19. Peat Diagram of the peat profile as found along Transect-I, showing the encroachment of the salt peat onto the fresh peat. This is a phenomenon of coastal submergence; the marsh grasses raise themselves concomitantly with the rise in mean sea-level, and will inundate anything which stands in their path, in this case, the fresh-water swamp which also moves landward. Salt peat is characterized by a grayish-brown color and the presence of undecomposed grass fragments; fresh peat is usually dark brown or black in color and will contain small pieces of woody material. Other workers have found whole trees immersed in salt peat! Vertical scale above is very much exaggerated as each section is 25 meters long, while peat depth to underlying sediments (usually sand) is 30 inches (0.73 meters). Diagonal line separating the two types of peat is an approximation, but indicative of the situation.
effective level of the tides and cause a concomitant shift in belts
toward the bay. For example, the Low Marsh would probably be replaced
by the present High Marsh. The present High Marsh would probably be
invaded by shrubs, including a large percentage of Iva. Bourne and
Cotman (1950) found that with effective ditching operations in the
coastal marshes of New Jersey, the surface dried out and was invaded
by shrubs; this would appear to be the probable fate of the Barn Island
Marshes if submergence ceased. It is likely that the Low Marsh
would extend out into the bay as the bottom has been observed to be
mostly sand with little silt, but this would need further investigation.

The inland migration and elevation of the several belts is ultima-
tely dependent upon the rate of deposition of the peat from organic
matter and accumulating silt deposits. This rate of uplift of the peat
surface has not yet been determined, but an accurate measure of the rate
will tell us much about the speed of the migration as well as the rate
of submergence in this area.
Fig. 20. The Wooden Bridge over the Boat Canal into the Natural Area, looking west. Iva has sparse growth on far side of canal which has been raised by deposition of peat excavated from digging canal. Behind Iva is seen mostly patens High Marsh. Tide is coming in, will usually reach bottom of first step of bridge when high. November 1965.
Fig. 21. View from the Wooden Bridge looking southwest toward Barn Island with the Natural Area Marsh in foreground. Projecting upland boulders are to left. Green streaks across the marsh are taller alterniflora belts; yellow-green areas between are stunted alterniflora. Author is standing in a fragment of Forb Flats. Barn Island from here appears to be mostly trees, actually is not. September 1965.
THE BARN ISLAND NATURAL AREA

The Barn Island Natural Area is an extension of the lower portion of the Davis Marsh and consists of a peninsula jutting out into Little Narragansett Bay (Figs. 1, 5).

The Natural Area consists of a 50-acre tract, about equally distributed between a salt marsh and three upland islands. The marsh forms a connection between the islands and the Davis Marsh, although its continuous character was ended in 1955 when a 12-foot-wide boat canal was dug across the neck. This canal now delimits the Natural Area from the remaining portions of the Barn Island Marshes. Entrance to the Natural Area is by a wooden footbridge over the boat canal (Fig. 20), which offers a good view of the area (Fig. 21).

Natural Area Methods

The vegetation of the Barn Island Natural Area was studied by means of two transects. Although not as precisely located as on the Brucker, they should be invaluable reference points for future comparative studies.

The first transect, referred to as the Marsh Transect, runs across the Natural Area marsh from the Wooden Bridge (over the Boat Canal) toward the center of Barn Island, but ends at the edge of the
island. This is a strip transect composed of 30 10x1-meter sections, in each of which the per cent coverage of each species was recorded (Fig. 22). The location of the Marsh Transect is as follows:

From the Game Warden's cottage, head in a southwesterly direction by walking through the upland fields until you pass through the shrub border of the marsh. Continue in a southwesterly direction, walking to the right side of a large parallel ditch. If it is a clear day, the Wooden Bridge will be seen, with Barn Island in the background. Continue in the same direction until the bridge is reached; at the far side of the bridge is a brass pipe which marks the beginning of Section-1. The transect runs toward Barn Island along a heading of 255 degrees (25.135° S) for 300 meters, but no stakes are placed to mark the individual sections; each 10x1-meter section was marked off with steel arrows which were removed after the data were recorded. Another brass pipe will be found at the end of Section-30, placed in front of the largest rock in the stone wall.

Vegetation found along the transect consists for the most part of grasses and forbs; but at the end of the transect, a belt of goldenrod and Iva will appear on the edge of Barn Island.

Since Barn Island is covered mainly by shrubs with a few trees and herbaceous openings occurring occasionally, a line-intercept type of transect was used, divided into several strata. Each stratum was measured from the beginning of each 25-meter section, but only for that length which is designated below:
Barn Island

The natural area wedge transect. Each section is 10 meters long; entire transect is 300 meters.

The boat canal.

Saltmarsh Sedges

Ceratnum

JUNCUS TRIGLOCHIUM

Paspalum

Limonium

S. altissimorum

S. patens

THE BOAT CANAL
A. Trees (15'-high) recorded over the entire section.
B. Understory (10'-15') recorded over the entire section.
C. High shrubs (6'-10') recorded over the first 10 meters in each section.
D. Low shrubs (1'-6') recorded over the first five meters of each section.
E. Herbs, recorded over the first meter of each section.

The length of tape covered by each species in each section was recorded, if it occurred within the limits set above. The recorded length of any given stratum was increased where it appeared interesting or of importance to do so. All strata except (A) were measured by the nearest 1/2 meter; (A) was measured to the nearest decimeter. Heights and diameters at breast height were recorded in (A) and (B), and the heights of shrubs were noted in most cases.

The location of the Island Transect may be found from the following:

The brass pipe at Section 30 of the Marsh Transect must be first located; from this pipe, sight along a heading of 310 degrees (W 40° N) for a distance of 5 meters. At this point a large rock will be encountered, which will have a drill mark. This mark locates the beginning of the first section of the Island Transect. To follow the transect, place a meter tape at the drill mark and follow a heading of 265 degrees (W 5° S). At the end of the fourth section (100 meters from the beginning), follow a new heading of 240 degrees (W 30° S). This heading is followed until the end of the transect is reached at the southeastern tip of the island. At about
190 meters from the beginning of the transect, a stone wall will be encountered on which is located another drill mark. About five meters north of this drill mark, another stone wall runs parallel with the transect until it stops in the middle of an old field. From here a black oak (*Quercus velutina*) may be sighted on as a marker. Once beyond the oak, the next and last marker is the largest rock on the beach. The last section ends at the rock.

Trying to follow the Island Transect is quite rigorous; and due to the dense shrubby nature of the vegetation, it was not possible to maintain an exactly straight line or make precise measurements. The transect is an approximation, but is valid enough to enable future comparisons to be made.

In order to determine the ages of some representative trees on Barn Island, cores of wild cherry (*Prunus serotina*), black oak, and sassafras (*Sassafras albidum*) were taken at breast height with an increment borer. The approximate ages are to be found in the Appendix along with the DBH and height of each tree.

Depths of pest to the underlying sediments were determined by probing with the Davis pest sampler until firm substrate was struck. These depths appear in Figure 5, recorded in feet.

Many, but certainly not all, of the species present were collected; and nomenclature is according to Gleason (1952). The above work was done during the summer and fall of 1965.
Vegetation of the Barn Island Natural Area

The Natural Area Tidal Marsh

On the tidal marsh one can recognize three major vegetation types (Fig. 5). As on the Brucker Marsh, the Alterniflora Low Marsh Community is most conspicuous and widespread. However, in the center of the Low Marsh is located an extensive Forb Panne essentially similar to that described by Miller and Egler. On the higher portions of the marsh, as in the Brucker, occurs the Patens High Marsh Community, but here it includes a Juncus Phase which was not found in the Brucker.

The entire Natural Area Marsh is subject to periodic inundation by the higher spring tides, but most of the area is protected from wave action and prevailing winds by dint of being located leeward of the islands. The entire marsh is intersected by the complex of mosquito ditches which may or may not be an important factor in regulating the surface water level and, thereby, regulating the segregation of communities. When standing on the Wooden Bridge which crosses the Boat Canal and looking in a southeasterly direction toward Barn Island (Fig. 21), one may see the ditches running across the marsh from right to left, as they are outlined by tall dark green alterniflora (the Alterniflora Belt). The ditches do not extend all the way across the marsh but end just before they reach the area of the protruding
boulders on the left. The three communities may be seen from this van-
tage point by their distinctive colors and textures: the Alterniflora
Low Marsh Community is usually a yellowish green with dark green along
the ditches and is rough-textured; the Forb Panne appears as a dark,
almost bare area from this distance; the High Marsh is most frequently
a straw color and looks fine-textured but in the summer is a medium
green.

The Alterniflora Low Marsh Community

The Low Marsh is the first community encountered when entering the
Natural Area by way of the Wooden Bridge. It extends for approximately
120 meters (about halfway) toward Barn Island (Fig. 22) and almost con-
tinuously from one side of the marsh to the other, for a width of about
200 meters. After being interrupted by the Forb Panne, it recurs as
one approaches Barn Island along the transect line; it is also present
throughout the marsh along most ditches. The neck of marsh joining the
Natural Area to the Mainland is primarily Alterniflora Low Marsh.

As in the Brucker, one finds two phases of the Low Marsh, but these
are not as well defined here. The Alterniflora Belt is an almost pure
stand of tall grass along most ditches which occasionally will
extend out into the areas between the ditches. The Stunted
Alterniflora Phase is a mixture of shorter marsh species which occurs over the inland regions.

The Alterniflora Belt. Although found primarily as a narrow belt along the ditches as in the Brucker, it sometimes spreads out for as such as 10 meters to either side of the ditches if the peat surface is low enough to allow the passage of water at high tide. The height of the grass along the ditches in this case will frequently be over one meter and will grade off as one moves into the area between the ditches but will not become small enough to be called stunted. Even where the alterniflora does become stunted between the ditches, the decline of size will be very gradual, distinctly different from the Brucker which shows abrupt size changes.

Frequent overturn of water seems to be an important factor here, although an almost constant submersion of the roots may also be important; the peat is very soft under the tall alterniflora, probably due to constant wetness. The Alterniflora Belt along other ditches will not be as extensive or as tall as that found in the first 6 to 8 sections of the transect.

The Stunted Alterniflora Phase. The occurrence of this phase is similar to that found in the Brucker, being found in the areas slightly removed from the ditches. The growth habit in its locations (mostly along the first and last 10 sections of the Marsh Transect) is lower
than that of the Belt, as the height is usually not greater than 20-30 centimeters. The plants take on a yellowish color (Fig. 21) which Adams (1963) has ascribed to chlorosis from lack of available iron. As in the Brucker, patens is the most abundant associate, occasionally occurring in equal amounts with alterniflora; but its total coverage in the Low Marsh is less than 10%. The presence of other species is severely limited.

The generally greater dominance and larger size of the individuals of alterniflora in the Natural Area, be they members of either the Belt or the Stunted Phase, appears to be tied up with the more frequent flooding of this area from the surrounding bay waters and its attendant washing qualities which insure adequate supplies of iron and the elimination of excessive salinities. The exposure of the Natural Area Marsh to tidal influences constitutes an ideal site for a tidal marsh, rather than the seclusion and unavailability of a valley marsh which is more subject to dependence on an estuary and ditches as the source of salt water. Flooding and drainage of the Natural Area was noted to be quite rapid.

The stunted alterniflora community of the Natural Area seems to be almost identical to that of Miller and Egler in that very few other species attain any noticeable coverage with the exception of local colonies of patens, and the Belt is very similar to their Lower Border in that, indeed, the coverage along ditches and edges is almost complete.
The Forb Panne

Forb panne of various sizes occur in tidal marsh, small ones occurring scattered, while an extensive panne covers the central portion of the Transect (Fig. 22) from Sections 12 to 18. This one panne covers about 15-20% of the marsh; others are insignificant in coverage. Although sparsely covered, the forbs add a distinctive color to the generally bare aspect of the underlying peat in these areas (Fig. 21). The peat here has a soft and springy feeling somewhat like that of a quaking bog since there is not the dense mat of grass roots to bind it tightly. These Forb Panes are essentially identical to those described by Miller and Egler; Plantago is most often the dominant species (Fig. 22) with Distichlis next in coverage, but Triglochin is more important here than in the areas which they studied. Limonium occurs quite frequently, but its coverage is not as great as would at first appear from a distance for each plant is usually quite small and thin and does not affect much cover around it.

The Forb Panne occurs at a higher level than the Low Marsh Community and will only occasionally be covered by water. This is in keeping with Miller and Egler's "Panne Sequence." They will drain rapidly, generally not holding standing water for any length of time, although the surface is perpetually damp. Distichlis may be migrating into the panes as
patches of it were noted occurring sporadically with coverage up to 50%, but the success or longevity of this is not yet known.

The Patosa High Marsh Community

Occurring at a level slightly above that of the Fort Panne is the High Marsh, characterized by the patosa community and the Juncus Phase. The Transect did not include this community, but it was visually observed to consist for the most part of patosa (over 90%) with several stands of Juncus occurring locally for a total of 5% and Aster, Limonium, Distichlis, and Salicornia scattered throughout but not amounting to over 5% of the total. The High Marsh occurs on both the north and south areas of the Natural Area Marsh, as well as in the region of the protruding upland boulders (Fig. 5), covering a total of 35% of the Marsh.

The High Marsh is flooded only rarely, and it was noticed that drainage is almost immediate after flooding due to the system of mosquito ditches which do not have levees along the banks. As these ditches open to the leeward side of the marsh, they will not admit or force the bay water into the marsh as happens in the Brucker Marsh where the estuary opens to the force of the incoming tides.
Similar to Miller and Egler's "Patens Lower Slope," this community appears to be one of the few places left in the Barn Island Marshes where the coverage of this type is at all extensive; it is almost completely eliminated from the Brucker, and few extensive stands were noted in other portions of the Barn Island Marshes.

Juncus Phase. Closely associated with the patens High Marsh community occur a few colonies of Juncus, occupying slightly raised portions of the High Marsh. These essentially pure stands (90%) did not occur in the Brucker but occupy about 5% of the High Marsh in the Natural Area. The phase is essentially similar to the "Juncus Upper Slope" described by Miller and Egler as occurring at the higher marsh levels.

The Juncus phase of the High Marsh appears to be slowly disappearing, perhaps due to an inability to keep up with the advancing tide levels; its most immediate replacement will be patens as the sequence of belts shifts itself upward with coastal submersion.

The patens High Marsh seems to be relatively stable at this time, but with continued submersion and a possible inability of the patens to deposit faster than submersion, the patens High Marsh may be replaced by the Perb Pannes or the Alterniflora Low Marsh Community.
The Natural Area Islands

Of the three islands in the Barn Island Natural Area, only Barn Island itself (covering about 20 acres) was studied in detail. On the two smaller islands, Middle Island and Sassafras Island (together occupying about five acres), observations were limited to a single reconnaissance. All are relatively flat and do not rise over 15 feet above mean sea level. As mentioned earlier, Barn Island was originally cleared for agricultural use but abandoned about 1910 (John Davis, voce). Presently it is covered by a shrubby thicket with trees scattered or in groves, most often near the edge of the island. The original open fields have been covered by shrubs except for a few small herbaceous openings in the interior (Fig. 23). Except for the almost complete absence of openings, the vegetational pattern of the adjacent islands is similar to that found on Barn Island.

On the basis of a thorough reconnaissance and a line intercept transect run across Barn Island, several vegetation types were recognized. These included an extensive Shrubland in which occur Herbaceous Openings, an Oak Woodland, and a series of vegetation belts around the periphery of the island. The general aspects of these will be described in addition to the dynamics of the vegetation.

The soils, typical of the region, are well drained upland sandy loam classified as a Gloucester fine sandy loam (Morgan, 1939).
Fig. 23. The three main vegetation types of Barn Island: Herbaceous Opening in foreground is dominated by Solidago here; Andropagon is present but not seen. Shrubland is dominated by Myrica clones ringing the openings. Beyond is black oak, an outlier of the Oak Woodland; open-grown habit of trees is seen. November 1963.
The Shrubland

Covering approximately three-quarters of the island and virtually all of the interior, this community represents the dominant vegetation type on Barn Island. The shrubs form an often-impenetrable dense cover, ranging in height from one to three meters, and consisting largely of interlocking clones which may be as large as 20 meters in diameter.

Bayberry, a clone former, is the single most important shrub, forming many of the large clones mentioned above and occasionally being of such density as to exclude all other woody or herbaceous species. Within some of the larger clones, the ground is bare except for leaf litter, the live bayberry stems, and rare bayberry seedlings which may reach the height of 10 to 15 centimeters. Other smaller and lower-growing bayberry clones are more open and here one frequently encounters a tangle of rose (Rosa rugosa), dwarf sumac (Rhus opulifolia), smooth sumac (R. glabra), and, rarely, greenbrier (Smilax glauca). Scattered clumps of highblueberry may be found throughout the interior and occasionally along the edge, but its total coverage is less than 10%. A single extensive clone of dogwood (Cornus racemosa) reaching a height of four meters occurs as a pure stand and comprises about 10% of the total shrub cover. The ground under the dogwood is quite bare except for a species of sedge. A single tall clone of lilac (Syringa vulgaris) about 5x5 meters in size occurs near the former site of the farmhouse (Fig. 5). Presumably
planted by the inhabitants, it appears vigorous but does not seem to be expanding. Other scattered associates, though rare, include shadbush (Amelanchier sp.), arrow-wood (Viburnum dentatum), and poison ivy occurring on stone walls. The interior portions of the smaller islands are largely covered by dwarf sumac and upright raspberry (Rubus sp.); the presence of bayberry is largely lacking except along the edges.

Occasional trees, representing about 10-15% of the shrubland, occur scattered throughout the shrub thicket, the most important being wild cherry (Prunus serotina), black oak (Quercus velutina), and sassafras (Sassafras albidum) (Fig. 23). These first two species appear to be open grown, i.e., they are relatively short with wide, spreading branches. They probably were established at the same time as the shrubs and now rise above them. But very few (only one or two) seedlings of these two species were found, either along the transect or elsewhere; so it seems that the presence of trees within the shrub community will be quite limited in the future with the death of the present trees. Sassafras, on the other hand, is a root-suckering species which may increase its coverage and density through vegetative reproduction. It generally occurs along the edges of the island which are not covered by other tree species or by heavy shrub cover and may be slowly encroaching upon other shrubs by shading them out. At present, it is limited to the southeastern edge of the island where it is protected from the prevailing winds.
Red cedar (*Juniperus virginiana*) and gray birch (*Betula populifolia*) are very rare on Barn Island; there is only one known birch and three or four cedars. Both these species and aspen (*Populus spp.*) are typical associates in old field development in this region, and it is interesting to note their absence on this site.

One of the most striking features of this Shrubland, compared to other shrubby areas away from the coast in this region, is the extremely luxuriant clonal development of bayberry and dogwood. The clonal growth habit is a favorable adaptation to continue the spread of an individual species without constantly subjecting it to the critical seedling stage when the effects of salt-laden winds can be especially severe (Wells and Shunk, 1938; Martin, 1950; Boyce, 1954). Over the years, the effects of salt spray in addition to shrub competition have played a role in limiting further tree development.

The relative absence of tree or shrub seedlings is notable especially within the dense shrub cover (although small seedlings of bayberry were found, the presence of larger individuals was completely lacking). The few scattered trees will obviously shade out the shrubs in the immediate vicinity; but the Shrubland appears relatively stable over most of the area, with no apparent trend toward development of a forest.

Old-field succession in the classical sense is lacking. Egler (1954) has put forth a concept which would account for this stability
of the Shrubland, termed "Initial Floristic Composition." This concept holds that actual invasion and success of a species in a new location is rather limited and that we often do not see an orderly progression from herbs to shrubs to trees, each in pure stands with the first eliminating itself and paving the way for the next. What actually happens is that the trees and shrubs become established at about the same time (when a field is allowed to go fallow) because propagules of each are in the soil or enter the site at abandonment. The shrubs and trees often get started about the same time that the site becomes open and grow up together. I feel this is what has happened in the shrub community.

The concept applied to the orderly progression from herbs to shrubs to trees has been named "Relay Floristics," since each species acts like a member in a relay team, passing the baton to the next man and letting him take over completely. This process may also occur following old-field abandonment, but it does not seem to be important on Barn Island.

**Low Shrub Phase.** Occurring over the southwestern end of Barn Island where it is exposed to the prevailing winds and salt spray is the Low Shrub Phase, occupying about 20% of the Shrubland and so called because the shrubby vegetation is characteristically lower than 1½ meters. Along the edge of the shore it is less than one meter in height but gradually increases as one moves inland, until it blends into the taller shrub phase (Fig. 24). The composition is similar to that of
the taller shrub community; but the presence of the large pure clones is eliminated, giving a much more mixed aspect of interspersed bayberry, greenbrier, dwarf sumac, and an occasional high-blueberry which stands above the other shrubs (2 meters). The Low Shrub Phase is relatively open, offering opportunities for the establishment of a few grasses and herbs, mostly *Spartina anglica* and goldenrod (*Solidago graminifolia*), which are able to withstand the effects of coastal winds. Maintenance of this community seems to be due to the prevailing winds and the attendant salt spray, as the vegetation shows some wind-training effects. Reproduction here was noted to be of only the vegetative type; no seedlings were seen.

One must also ask himself how these species originated on Barn Island, since it is separated from the nearest mainland by about half a mile. If the islands were connected to the mainland at some time by an upland ridge (a good possibility), then original vegetation would be no problem. But if the island was completely cleared for agriculture (the extent of clearing is not known), then a recent migration must have occurred. It is noted with interest that the major species on Barn Island have propagules which are frequently disseminated by birds; the prevailing winds tend to blow propagules from the islands to the mainland.
The Shrubland is of unusual interest. Here on Barn Island one finds some of the most extensive and luxuriantly developed clones of bayberry and dogwood in southeastern Connecticut. These native species best adapted to our coastal conditions bear further study in order to obtain data for comparison with continued coastal subsidence and frequent hurricanes. These species might become of great importance along our coastline.

Oak Woodland

Covering about 10% of Barn Island, this early forest extends as a discontinuous belt along the northeast ern edge of the island. The island transect runs through a partially wooded area, but the best developed areas are found to either side. In such areas a partly open woodland is characterized by black oak (over 50%) along with scattered sassafras, white oak (*Quercus alba*), and gray birch. Several of the oaks appear to be decadent and one or two are already dead; most are less than 20 meters high and are up to 25 inches (62 cm) in diameter at breast height; all show open-grown characteristics of low and spreading branches, indicating that they were probably established before abandonment of agriculture. On the basis of increment borings, the oldest trees counted were about 75 years old at breast height. These portions
Fig. 24. The low shrub phase of the shrub community, from the southwestern tip of Barn Island looking northeast. The waist-high complex of Solidago graminifolia-Khus copallina-Myrica-Smilax glauca is in foreground and grades into taller Myrica with scattered trees in the background. November 1965.
of the trees would have been about 20 years old at abandonment, assuming it was in 1910. Oak reproduction in the stands is limited as only a few saplings were noted.

White oak and gray birch are rare (less than 5% of the woodland), and only one or two individuals of each were found. Sassafras seems to be assuming an importance second only to black oak although most of the trees are fairly small at this time, being less than 15 meters in height. Reproduction of sassafras is present, although it is vegetative. With its root-suckering ability, it seems to be expanding its coverage as it is well adapted to this severe coastal environment; and sassafras is forming an understory under the black oaks. Since oaks do not seem to be reproducing in sufficient quantities to replace the mature trees, it might be assumed that sassafras may ultimately dominate the woodland, barring the entrance of the aggressive clone-forming shrubs.

The height of the woodland, although not great by typical inland standards, is enough to place this community in more danger of being destroyed by coastal storms than any other community on the island. The occurrence of woodland is probably a cyclic phenomenon for this reason, as it would be relegated to resurging after each severe storm which could flatten all the trees if it were powerful enough. The ability to resurge from stump sprouts or root suckers is probably of paramount
importance here where frequent killing of the critical seedling stage might occur. It is evident that the future of the woodland is uncertain, and future studies here could prove very interesting.

Herbaceous Openings

These small openings are the last remnants of the formerly open fields which have not yet been covered by the shrubs or trees. On the aerial photo (Fig. 1) the Openings may be seen as light spots in the interior surrounded by the darker Shrubland. Openings account for about 5% of the island.

Entering an opening, one encounters either broomsedge (*Andropozon scoparius*), goldenrod (usually *Solidago graminifolia*), or a mixture of the two (Fig. 25). Where the transect crossed the openings, these species were about equally important, forming an almost continuous cover. Other associates are conspicuous by their absence. Among the few found were St. John's-wort (*Hypericum perforatum*) and red sorrel (*Rumex Acetosella*), but these were of very minor coverage. A woody species, creeping raspberry (*Rubus sp.*) forms an occasional ground cover between the tussocks of broomsedge. Lichens frequently cover bare soil in the openings.

Shrubby invasion of the openings is occurring at an unknown rate. The first invader of the openings is dwarf sumac (*a species capable of*
Fig. 25. Aspect of the interior of Barn Island. Solidago graminifolia in foreground; Andropogon is present but not seen. Opening is surrounded by Myrica clones. Juniperus (left center) and Prunus are isolated trees in the shrub community, both rare on islands. September 1965.
very rapid and widespread invasion through the utilization of root suckers), although the cover of these low (one meter) clones is quite thin. Following the sumac, bayberry invades more slowly but will eventually move in under the pioneer's sparse cover and then increase in height until it often eliminates the sumac and the last remnants of the openings. Rose (R. rugosa) frequently associates with bayberry during the first stages. Tree invasion was not seen in the openings.

The future of the openings lies toward gradual encroachment of the neighboring clones, a trend which apparently has been going on for some time, since most of the formerly open fields are now covered by the shrub clones we see today.

The Island Edge

Between the tidal marsh and the upland types previously discussed occurs a discontinuous series of belts, which may, but often do not, encircle Barn Island.

Along the windward (southwestern) edge, the vegetation is sparse, consisting mainly of grasses on peat such as slough grass (Spartina pectinata) and Panicum along with scattered forbs. These are probably remnants of a previous tidal marsh which totally enclosed Barn Island and the smaller islands and extended well out into Little Narragansett Bay. It is along the leeward edge of Barn Island where tidal marsh
and upland meet that the most apparent belting occurs.

When walking up toward the island from the marsh, one first crosses an Iva Belt which is usually less than 5 meters wide. It occurs here on peat, but this peat is shallow and directly over rocks, indicating either erosion or recent formation and suggesting the pioneering ability of Iva. The Iva Belt is not continuous around the leeward edge of Barn Island but extends across the tidal marsh to the Middle Island, which also has an Iva Belt. The coverage of Iva is over 50%.

The Iva is replaced by a goldenrod belt (mostly S. sempervirens and S. graminifolia) which is usually less than 3 meters wide. This belt is nearly continuous, extending almost completely around Barn Island, and also occurs within the Iva Belt which sweeps across the tidal marsh to the Middle Island.

The third major belt of the Island Edge is composed of sweet pepperbush (Clethra alnifolia), a belt up to 3 meters wide on the leeward edges of all three islands and grading immediately into the upland. Replacing pepperbush in a depression along the northeastern edge of Barn Island occur a few scattered cattails, their only occurrence in the Natural Area.

Other species may be seen along portions of the edge of Barn Island as is gama-grass (Eriocoma dactyloides) along part of the southeastern
edge, but the presence of these accessory species is, for the most part, localized.

Each of these belts seems to be located by its position on the upward slope of the island. It would be assumed that as coastal submergence continues, the belts would move upward and inland onto the islands.

Future Trends

Since abandonment in the early 1900's, a relatively heavy shrub cover has become established over the former farmland of Barn Island and the two smaller islands. The shrubs appear to have displaced the early open fields which were left after cultivation or pasturing, and it is suggested that they will continue to expand their range until all herbaceous openings have been eliminated. Future of the Oak Woodland is uncertain due to its lack of visible reproduction and the frequent occurrence of hurricanes. But it would appear at this time that the Woodland will not reassume dominance. The extensive shrub community appears relatively stable and represents an especially interesting mosaic of shrub clones worthy of continued study in respect to their stability.
With continuation of coastal submergence, the island is expected to be eventually inundated by the tidal marsh, since it appears that the present Natural Area marsh is located on a former ridge which once connected the islands to the mainland. The projecting boulders seen today in the marsh are evidence of this prior situation.
LITERATURE CITED


APPENDIX

Species Present in the Study Areas

The following is a list of all those species found and identified following Gleason (1952) in the two study areas. The location in which the species is found most often is as follows:

1. Brucker Marsh:
   a. tidal marsh
   b. Panicum Set
   c. cattail marsh
   d. Shrubby Swamp

2. Natural Area:
   a. tidal marsh
   f. upland islands.

This list is not meant to be complete but includes the more important and apparent species.

Grasses, Rushes, and Sedges

Agropyron repens (L.) Beauv. -- quack grass (d)
Agrostis stolonifera L. -- creeping bent (b), (d)
Andropogon scoparius Michx. -- broom sedge, little bluestem (f)
Carex sp. L. -- sedge (d), (f)
Distichlis spicata (L.) Green. -- spike grass, salt grass (a), (e)
Eleocharis rostellata Torr. -- spike rush (b), (d)
Elymus virginicus L. -- wild rye (b), (d)
Festuca rubra L. -- red fescue (b)
Juncus Gerardi Loisel. -- black grass (a), (e)
Panicum virgatum L. -- switch grass, panic grass (b), (f)
Phragmites communis Trin. -- reed (in its own clone on upland ridge in Brucker, around south drainage pool)
Scirpus americanus Pers. -- bulrush (b), (e)
Spartina alterniflora Loisel. = salt water cord grass (a), (e)
Spartina patens (Ait.) Muhl. = salt hay cord grass (a), (e)
Spartina pectinata Link. = slough grass (f)
Tripsacum dactyloides (L.) L. = grass-grass, sesame grass (f)
Typha angustifolia L. = cattail (c), (f)
Typha latifolia L. = cattail (c), (f)

Other Herbs and Fern

Aster tenuifolius L. = aster (a), (e)
Atriplex patula L. = spearscale (a), (e), (f)
Gerardia maritima Raf. = gerardia (a), (e)
Hypericum perforatum L. = St. John’s-wort (f)
Lilium superbum L. = Turk’s cap lily (c)
Limonium carolinianum (Vahl.) Britt. = sea-lavender (a), (e)
Csmunda cinnamomea L. = cinnamon fern (c), (d)
Plantago pusilla Nutt. = plantain (a), (e)
Polygonum Convolvulus L. = black bindweed (c), (d)
Potentilla Anserina L. = silver-weed (a), (b)
Rumex Acetosella L. = red sorrel (f)
Salicornia Bigelovii Torr. = glasswort, samphire (a), (e)
Salicornia europaea L. = glasswort, samphire (a), (e)
Solidago graminifolia (L.) Salisb. = goldenrod (f)
Solidago rugosa Mill. = goldenrod (f)
Solidago sempervirens L. = seaside goldenrod (a), (b), (c), (d), (e), (f)
Suaeda maritima (L.) Dum. = sea blite (e), (f)
Triglochin maritima L. = arrow grass (a), (e)

Shrubs

Amelanchier sp. = shadbush (d), (f)
Baptisia tinctoria (L.) R.Br. = wild indigo (f)
Celastrus scandens L. = bittersweet (d)
Clethra alnifolia L. = sweet pepper-bush (d), (f)
Cornus racemosa L. = dogwood (f)
Corylus cornuta Marsh. = beaked hazel (f)
Ilex verticillata (L.) Gray = black alder, winter berry (d)
Iva frutescens L. = marsh elder (a), (e), (e), (f)
Lindera benzoin (f) Blume == spicebush (d)
Lonicera sp. == honeysuckle (d), (f)
Lyonia ligustrina (L.) DC. == maleberry (d)
Myrica pensylvanica Loisel. == bayberry (b), (c), (d), (f)
Parthenocissus quinquefolia (L.) Planch. == Virginia creeper (f)
Rhamnus catharticus L. == European buckthorn (f)
Rhododendron viscosum (L.) Torr. == swamp azalea, swamp honeysuckle (d)
Rhus copallina L. == dwarf sumac (f)
Rhus glabra L. == smooth sumac (f)
Rhus typhina L. == staghorn sumac (f)
Rhus radicans L. == poison ivy (b), (c), (d), (f)
Rhus vernix L. == poison sumac (c)
Rosa carolina L. == swamp rose (f)
Rosa palustris Marsh. == swamp rose (c), (d)
Rosa rugosa Thumb. == rose (f)
Sambucus canadensis L. == common elder (f)
Syringa vulgaris L. == common lilac (f)
Vaccinium corymbosum L. == high-blueberry (d), (f)
Viburnum dentatum L. == arrowwood (d), (f)
Vitex labrusca L. == fox grape (f)

Trees

Acer rubrum L. == red maple (d)
Betula populifolia Marsh. == gray birch (f)
Juniperus virginiana L. == red cedar (b), (d), (f)
Nyssa sylvatica Marsh. == black gum (d), (f)
Prunus serotina Ehrh. == wild cherry (f)
Quercus alba L. == white oak (f)
Quercus velutina Lam. == black oak (f)
Sassafras albidum (Nutt.) Nees. == sassafras (f)
## Transect - I

**Brooker Marsh - October, 1964**

Line Intercept-Type of Transect Running From Stone Bridge up the Marsh into the Shrubby Swamp. Occurrence of each species is recorded along length of tape in each 25 meter section.

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<td>Distichlis - 2240-2500.</td>
<td>260 CM</td>
</tr>
<tr>
<td></td>
<td>Bare Peat - 50-70, 1300-1330.</td>
<td>50 CM</td>
</tr>
<tr>
<td>S-7</td>
<td>S. PAT. - 80-200, 810-1140, 1950-2140, 2210-2240, 2330-2480.</td>
<td>820 CM</td>
</tr>
<tr>
<td></td>
<td>S. ALT. - 80-210, 730-2050, 2320-2340, 2460-2500.</td>
<td>1510 CM</td>
</tr>
<tr>
<td></td>
<td>Dist. - 0-80, 210-760, 2290-2310, 2380-2460.</td>
<td>730 CM</td>
</tr>
<tr>
<td></td>
<td>Iva - 1240-2250.</td>
<td>10 CM</td>
</tr>
<tr>
<td></td>
<td>Aster - 335, 520-540, 2290.</td>
<td>30 CM</td>
</tr>
<tr>
<td></td>
<td>Juncus - 520-920.</td>
<td>400 CM</td>
</tr>
<tr>
<td>S-8</td>
<td>S. PAT. - 810-1400, 2150-2200, 2250-2300.</td>
<td>690 CM</td>
</tr>
<tr>
<td></td>
<td>S. ALT. - 0-2030, 2220-2230, 2370-2500.</td>
<td>2170 CM</td>
</tr>
<tr>
<td></td>
<td>Limon. - 85-95, 130-140.</td>
<td>20 CM</td>
</tr>
<tr>
<td></td>
<td>Dist. - 2010-2410.</td>
<td>400 CM</td>
</tr>
<tr>
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<td>Juncus - 2100-2250.</td>
<td>150 CM</td>
</tr>
<tr>
<td></td>
<td>Aster - 2370.</td>
<td>5 CM</td>
</tr>
<tr>
<td>S-9</td>
<td>S. PAT. - 280-440, 2190-2320, 2410-2500.</td>
<td>380 CM</td>
</tr>
<tr>
<td></td>
<td>S. ALT. - 0-280, 330-2100, 2230-2280, 2470-2500.</td>
<td>2130 CM</td>
</tr>
<tr>
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<td>Dist. - 30-100, 250-350, 2050-2110, 2420-2470.</td>
<td>250 CM</td>
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<tr>
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<td>Iva - 2320-2330.</td>
<td>10 CM</td>
</tr>
<tr>
<td></td>
<td>Aster - 2410-2420.</td>
<td>10 CM</td>
</tr>
<tr>
<td>Transect</td>
<td>Pat.</td>
<td>Alt.</td>
</tr>
<tr>
<td>-----------</td>
<td>--------</td>
<td>----------</td>
</tr>
<tr>
<td>S-10</td>
<td>0-160</td>
<td>0-1640, 1820-1900</td>
</tr>
<tr>
<td>S-11</td>
<td>310-460, 500-610, 2390-2500</td>
<td>440-1705, 1940-2500</td>
</tr>
<tr>
<td></td>
<td>1250-1560</td>
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</tr>
<tr>
<td>S-12</td>
<td>0-90, 1390-2270</td>
<td>0-10, 90-140, 170-190, 210-320, 2200-2270, 2350-2500</td>
</tr>
<tr>
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<td></td>
<td>0-290, 560-600, 640-1380, 1690-1710, 2140-2270, 2390-2410</td>
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<tr>
<td>S-13</td>
<td>500-720, 790-830, 1170-1260, 1640-2500</td>
<td>0-500, 820-830, 1190-2120</td>
</tr>
<tr>
<td></td>
<td>720-800, 910-1040</td>
<td>Aster - 830-840</td>
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<tr>
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<td></td>
<td>Salic. - 890-920</td>
</tr>
<tr>
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<td>Transect - I [cont.]</td>
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<tr>
<td><strong>S-14</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. Par. - 0-430.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dist. - 430-1660, 1690-2500.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salic. - 910-920, 980.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Juncus - 1070-1540, 1850-2500.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iva - 1390-1400, 1470-1520, 1560-1650, 1700-1840.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solidago - 1690-1740.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>S-15</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. Par. - 220-2280, 2310-2500.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dist. - 0-260, 2110-2500.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solid. - 2430-2450, 2490-2500.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iva - 2460-2500, 2280-2350.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Juncus - 0-270, 1350-1400, 2050-2370.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elymus - 2450-2500.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>S-16</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. Par. - 0-80, 210-450, 550-1400.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. Alt. - 60-70, 210-720, 990-1500, 2040-2200, 2300-2500.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dist. - 0-20, 480-1800.</td>
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</tr>
<tr>
<td>Typha - 1500-1870, 1870-2500.</td>
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<td></td>
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<tr>
<td>Elymus - 1800-1900.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polygonum - 2020-2040, 2240-2300.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Transect I [Cont'd]

#### S-17
- **Typha**: 0 - 2500.
- **Iva**: 2450 - 2470, 370 - 380.
- **Solid**: 100 - 100, 730 - 780, 830 - 890, 930 - 970, 1540 - 1570.
- **Polyg**: 100 - 130, 1310 - 1330.
- **Elymus**: 810 - 840, 1180 - 1190, 2040 - 2160.
- **Festuca**: 920 - 950, 1940 - 2030, 2200 - 2290, 2430 - 2480.

#### S-18
- **Rhus Radicans**: 410 - 430, 520 - 530, 690, 900 - 1360.
- **Elymus**: 350 - 360.
- **Myrica**: 2040 - 2090.
- **S. Pat**: 1980 - 2290.
- **Osmunda Cinnamomea**: 2370 - 2410.

#### S-19
- **Typha**: 0 - 820, 900 - 2130, 2240 - 2500.
- **S. Pat**: 40 - 100, 260 - 290, 820 - 1100.
- **Cinnamomea**: 70 - 100, 1320 - 1800, 1930 - 2000.
- **Solid**: 280 - 340, 390 - 420, 870 - 920, 2300 - 2310.
- **Festuca**: 530 - 560.
- **Polyg**: 750 - 820, 1040 - 1060.
- **Elymus**: 1150 - 1700, 1800 - 1920, 2160 - 2480.
<table>
<thead>
<tr>
<th>Transect - I  [cont]</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-20</td>
</tr>
<tr>
<td>Typha - 0-600, 1700-1740.</td>
</tr>
<tr>
<td>Carex - 200-1400, 1440-2500.</td>
</tr>
<tr>
<td>Vaccinium - 600-940, 1800-2080, 2260-2500.</td>
</tr>
<tr>
<td>Solid. - 610-650, 2380-2420.</td>
</tr>
<tr>
<td>Panicum - 1320-1360, 1900-1960.</td>
</tr>
<tr>
<td>Myrica - 2260-2400.</td>
</tr>
<tr>
<td>Acer Rubrum - 1940-1150</td>
</tr>
<tr>
<td>S-21</td>
</tr>
<tr>
<td>Rhododendron - 0-100, 550-600, 640-690, 980-1100, 1150-1260, 1580-1620, 2350-2500.</td>
</tr>
<tr>
<td>Elymus - 100-200.</td>
</tr>
<tr>
<td>Acer Rub. - 30-110, 600-630, 1600-1730.</td>
</tr>
<tr>
<td>Vaccinium - 160-390, 1730-1930, 2350-2500.</td>
</tr>
<tr>
<td>Carex - 0-2500.</td>
</tr>
<tr>
<td>Cornus Fasciculata - 1500-1560, 2120-2160, 2230-2340.</td>
</tr>
<tr>
<td>Typha - 540-650, 970-1150, 2050-2080.</td>
</tr>
<tr>
<td>Lindera Benzoin - 950-980.</td>
</tr>
<tr>
<td>Rhus Vernix - 1010-1070.</td>
</tr>
</tbody>
</table>
TRANSECT - I  [cont.]

S-22

**RHODODENDRON** - 0 - 200, 1950 - 2100.

**VACCINIUM** - 400 - 970, 1320 - 1480, 1750 - 1930, 2100 - 2500.

**ACER RUB.** - 400 - 640, 1480 - 1600, 2100 - 2300.

**CARC.** - 0 - 2500.

**VIBURNUM DENTATUM** - 190 - 260, 2450 - 2500.

**Typha** - 300 - 350, 740 - 800, 950 - 1500.

**SOLID.** - 870 - 900.

**CINNAMONEA** - 1850 - 2000, 2300 - 2450.

**ROSA** - 2050 - 2100.
TRANSECT - II
BRUCKER MARSH MAY 3, 1965

This transect begins at the stone bridge and runs to the bay in 2 x 50 meter sections along the north side of the estuary. The percent cover of each species in each section is recorded as the transect winds down the marsh approximately paralleling the estuary.

SECTION - #1
SPARTINA PATENS - 5070
SPARTINA ALTERNIFLORA - 5070
ASTER - 41

S-2
S. PAT. - 4570
S. ALT. - 4570
ASTER - 1070

S-3
S. PAT. - 1070
S. ALT. - 8070

S-4
S. PAT. - 1070
S. ALT. 9070
SALICORNIA - 1070
ASTER - 41

S-5
S. PAT. - 4070
S. ALT. - 4070
ASTER - 1070
SALICORNIA - 2070
LIMONIUM - 570

S-6
S. PAT. - 7070
S. ALT. - 2070
ASTER - 570
LIMON - 1070
TRANSECT - III-a

BRUCKER MARSH     AUGUST 15, 1965

TRANSECT CROSSES FOOT OF LOWER MARSH BETWEEN THE TWO DRAINAGE POOLS. PERCENT COVER IS RECORDED IN EACH 10 X 1 METER SECTION. TRANSECT III-a RUNS FROM THE PANICUM BELT ON THE SOUTH SIDE OF THE ESTUARY TO THE ESTUARY BANK.

SECTION #1

SPIRACEA - 5%
PANICUM VIRGATUM - 65%
ELYMUS - 20%
SPARTINA ALTERNIFLORA - ≤1
IVA - ≤1

S-2
PANICUM - 30%
ELYMUS - 15%
SPIRACEA - ≤1
IVA - 5%
TRIGLOCHIN - 30%
PLANTAGO - 5%
GRAEBIA - ≤1
SALICORNIA - 2%
ASTER - ≤1
S. PAT. - 5%

S-3
S. PAT. - 10%
IVA - ≤1
DISTICHILIS - 30%
LIMONIUM - 5%
PLANT. - 8%
TRIGLOCH - 30%
SUNCHUS - 3%
ASTER - ≤1

S-4
GRAEBIA - 2%
ASTER - 5%
S. ALT. - 40%
TRIGLOCH - ≤1
S. PAT. - 45%
TRANSECT - III a

S-5
S. ALT. - 36%
S. PAT. - 60%
ASTER - 4%

TRANSECT - III b

BROCKER MARSH AUGUST 17, 1965

IT IS ESSENTIALLY SIMILAR TO III a BUT RUNS FROM THE NORTHERN POOL TO THE ESTUARY; IT IS ON THE NORTHERN SIDE OF THE ESTUARY.

SECTION - #1
S. ALT. - 80%
S. PAT. - 20%
ASTER - <1
LIMON. - <1

S-2
S. PAT. - 80%
ASTER - 49%
S. ALT. - 10%
DIST. - 7%
TRANSECT - IV a.

BRUCE MARSH   AUGUST 15, 1965


SECTION - #1

PANICUM VIRGATUM - 50%  
VACCINIUM - 25%  
ASTER - <1  
ROSA PALustrIS - 3%  
MYRICA - 5%  
A-TRIPLEX - <1

S-2

BARE AREA - 50%  
TRIGLOCHIN - 47%  
PLANTAGO - <1  
SALICORNIA - 15%  
DISTICHlis - 25%  
LIMONiUM - <1

S-3

LIMON. - 15%  
DIST. - 40%  
TRIGLOCH. - 5%  
PLANT. - 20%  
SALIC. - <1  
SPARTINA ALTERNIFLORA - 40%  
SPARTINA PATENS - <1

S-4

S. PAT. - 35%  
S. ALT. - 65%  
SALIC. - <1

S-5

S. ALT. - 99%

S-6

S. ALT. - 65%  
LIMON. - 30%  
ASTER - 6%  
PLANT. - 20%  
SALIC. - 2%  
S. PAT. - 8%  
TRIGLOCH. - <1
TRANSECT - IV b

BRUCER MARSH  AUGUST 17, 1965

IV b is similar to IV a, but it begins in the Panicum Belt to the north of the estuary and runs to the estuary.

SECTION - #1
Panicum - 80%
Solidago - 10%
Atriplex - 5%
Spiraea - 8%
Myrica - 5%

S-2
Panicum - 55%
Atriplex - 5%
Solidago - 10%
Rhizus coppalina - 3%
Juncus - 17%
Salicornia - 21
Aster - 2%
Limonium - 21
Triglochin - 2%

S-3
Juncus - 30%
Triglochin - 30%
Plant - 10%
Limon - 8%
Salic - 4%
Spartina Patens - 5%
Gerardia - 4%
Aster - 5%
Bare Area - 15%

S-4
Bare Area - 25%
Distichlis - 5%
Salic - 5%
Limon - 8%
Triglochin - 20%
Plant - 5%
Juncus - 5%
S. Pat. - 10%
Spartina Alterniflora - 10%
Aster - 10%

S-5
S. Alt. - 95%
S. Pat. - 17%
Dist. - 17%
<table>
<thead>
<tr>
<th>Transect</th>
<th>S-6</th>
<th>S-7</th>
<th>S-8</th>
</tr>
</thead>
<tbody>
<tr>
<td>S.Alt.</td>
<td>95.9%</td>
<td>99.7%</td>
<td>55.9%</td>
</tr>
<tr>
<td>Salicornia</td>
<td>17.0%</td>
<td>40.9%</td>
<td>5.9%</td>
</tr>
<tr>
<td>Distichlis</td>
<td>31.0%</td>
<td>40.9%</td>
<td>5.9%</td>
</tr>
</tbody>
</table>
TRANSECT - Va and Vb

Brucker Marsh May 3, 1965

This is a permanent transect running across the upper marsh, perpendicular to T-1 at S-5 (85 m. from first stake at Stone Bridge). Amount of each species was recorded along length of tape as measurement was by line-intercept method. Each section is 25 m. long. T-Va begins at T-I and runs south toward the Panicum belt. T-Vb also begins at T-I, but runs north crossing the estuary and runs to the opposite Panicum belt.

[Va]
Section #1
Spartina alterniflora - 0-580 cm. 580 cm
Spartina patens - 220-980 cm. 760 cm
Triglochin - 1030-1990 cm. 960 cm
Limonium - 1620-1640 cm. 20 cm
Solidago - 2000-2010 cm. 10 cm
Panicum - 2010-2500 cm. 490 cm
Rosa palustris - 2350-2500 cm. 150 cm

[Vb]
Section #1
S. alt. - 0-1100 cm, 1250-1320, 1620-2500 cm. 2050 cm
S. pat. - 440-1100, 1250-1640, 2460-2480 cm. 1100 cm
Estuary - 1100-1250 cm. 150 cm
S-2
S. alt. - 0-310, 310 cm
S. pat. - 120-160, 280-1930, 1690 cm
Triglochin - 1860-2500 cm. 640 cm
Distichlis - 300-1980 cm. 1680 cm
Aster - 1100-1180 cm. 80 cm
Limonium - 1860-1900, 1980-2020 cm. 80 cm
TRANSECT - V  [CON'T]

[S-3]

BARE AREA - 0-480.
TRIGLOCHIN - 0-4150, 680-700, 1110-1200, 1540-1700, 2300-2340.
LIMONIUM - 450-500, 940-1000, 1280-1370, 1690-1730.
PANICUM - 1890-2170, 2350-2500.
ASTER - 830-870.
SALICORNIA - 1570-1600.
TRANSECT - III
BRUCKER HARSH    AUGUST 19, 1965

THIS TRANSECT CROSSES THE UPPER MARSH 200 METERS FROM THE STONE BRIDGE (AT T-1, S-9). THE PERCENT COVERAGE OF EACH SPECIES IS RECORDED IN EACH 10 X 1 METER SECTION. T-IV A BEGINS AT THE STONE WALL ALONG THE SOUTH SIDE OF THE MARSH AND RUNS ACROSS TO THE ESTUARY.

SECTION - #1
DISTICHILIS - 60%  
TRIGLOCHIN - 30%  
ASTER - 8%  
Spartina Patens - 15%  
IVA - 3%  
SOLIDAGO - 2%  
SALICORNIA - 35%  
Atriplex - 21%  
S-2  
Spartina Alterniflora - 60%  
ASTER - 5%  
DIST. - 10%  
TRIGLOCHIN - 15%  
S. PAT. - 30%  
S-3  
DIST. - 75%  
ASTER - 30%  
JUNCUS - 10%  
S. ALT. - 10%  
S-4  
BARE - 30%  
SALIC. - 1%  
ASTER - 25%  
JUNCUS - 10%  
S-5  
S. ALT. - 35%  
DIST. - 30%  
JUNCUS - 15%  
ASTER - 5%  
S. PAT. - 20%  
SALIC. - 1%  
S-6  
S. ALT. - 99%  
S-7  
S. ALT. - 85%  
SALIC. - 15%  
S-8  
S. ALT. - 60%  
DIST. - 20%  
JUNCUS - 8%  
SALIC. - 15%  
S-9  
S. ALT. - 65%  
DIST. - 15%  
S. PAT. - 15%  
JUNCUS - 8%  
SALIC. - 25%  
ASTER - 3%  
S-10  
S. PAT. - 3%  
JUNCUS - <1  
DIST. - <1
TRANSECT - VI b
BRUCKER MARSH  AUGUST 19, 1965

T-IX D runs from the Panicum border along the north side of the marsh to the estuary. Other details are identical to VI-a.

<table>
<thead>
<tr>
<th>SECTION</th>
<th>#1</th>
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<tbody>
<tr>
<td>PANICUM</td>
<td>20%</td>
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<tr>
<td>ROSA PALUSTRIS</td>
<td>57%</td>
<td></td>
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<tr>
<td>MYRTICA</td>
<td>49%</td>
<td></td>
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<tr>
<td>SOLIDAGO</td>
<td>3%</td>
<td></td>
</tr>
<tr>
<td>TRIGLOCHIN</td>
<td>25%</td>
<td></td>
</tr>
<tr>
<td>JUNCUS</td>
<td>35%</td>
<td></td>
</tr>
<tr>
<td>LIMONIUM</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>DISTICHILIS</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>ASTER</td>
<td>&lt;1</td>
<td></td>
</tr>
</tbody>
</table>

| S-2 | JUNCUS | 30% |  |
|     | TRIGLOCHIN | 15% |  |
|     | DIST | 60% |  |
|     | ASTER | <1 |  |
|     | LIMON | <1 |  |
|     | SOLID | 5% |  |

| S-3 | BAKE | 15% |  |
|     | DIST | 35% |  |
|     | TRIGLOCHIN | 45% |  |
|     | LIMON | <1 |  |
|     | JUNCUS | 3% |  |
|     | S. PAT | 3% |  |

| S-4 | DIST | 70% |  |
|     | LIMON | <1 |  |
|     | JUNCUS | 3% |  |
|     | TRIGLOCHIN | 2% |  |
|     | SALIC | 2% |  |
|     | ASTER | 4% |  |
|     | S. PAT | 8% |  |

| S-5 | DIST | 40% |  |
|     | JUNCUS | 40% |  |
|     | ASTER | 3% |  |
|     | S. PAT | 20% |  |

| S-6 | S. ALT | 15% |  |
|     | S. PAT | 40% |  |
|     | JUNCUS | 20% |  |
|     | DIST | 30% |  |

| S-7 | DIST | 18% |  |
|     | S. ALT | 40% |  |
|     | BAKE | 30% |  |
|     | SALIC | 3% |  |

| S-8 | S. ALT | 80% |  |
|     | S. PAT | 10% |  |
|     | SALIC | 5% |  |

| S-9 | S. ALT | 70% |  |
|     | S. PAT | 30% |  |

| S-10 | S. ALT | 40% |  |
|      | S. PAT | 30% |  |
|      | JUNCUS | 25% |  |
|      | LIMON | 3% |  |
|      | ASTER | 5% |  |
TRANSECT - III
BRUCKER MARSH AUGUST 20, 1965

This transect runs across the upper marsh from the stone wall along the south edge of the estuary. It is located between sections 15 and 16 of transect I and is approximately perpendicular to it. Each section is 1 x 10 meters and the percent cover for each species in each section has been recorded.

SECTION - #1
SOLANDAGO - 37%
DISTICHLOUS - 20%
SPARTINA PATENS - 75%
SERRPUS - 5%

S-2
S. PAT. - 9970
DIST. - 41

S-3
S. PAT. - 95%
DIST. - 57%

S-4
S. PAT. - 95%
DIST. - 47%
ASTER - 41

S-5
S. PAT. - 95%
JUNCUS - 37%
DIST. - 27%

S-6
S. PAT. - 99%


S-7
S. PAT. - 99%
DIST. - 1070

S-8
S. PAT. - 20%
JUNCUS - 45%
DIST. - 35%

S-9
JUNCUS - 41%
SALICORNIA - 28%
DIST. - 40%
S. PAT. - 30%

S-10
S. PAT. - 40%
SALIC. - 41
ASTER - 41
IVA - 21
DIST. - 35%
JUNCUS - 30%

S-11
S. PAT. - 10%
DIST. - 10%
JUNCUS - 35%
IVA - 10%
SPARTINA ALTERNIFLORA - 41
**TRANSECT — VIII**

**BRUCKER MARSH — AUGUST 13, 1965**

**TRANSECT ALONG NORTH SIDE OF ESTUARY**

STARTING FROM BAY TO STONE BRIDGE; USING 25 X 1 METER QUADRATS; RECORDING PERCENT COVER FOR EACH SPECIES IN EACH QUADRAT.

<table>
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<tr>
<th>#1</th>
<th>S. PATENS</th>
<th>70%</th>
<th>S. ALTERNIFLORA</th>
<th>25%</th>
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<tr>
<td></td>
<td>ASTER</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>PLANT.</td>
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<td>TRIGLOCH.</td>
<td>8%</td>
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<tr>
<td></td>
<td>S. ALT.</td>
<td>45%</td>
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<td>TRIGLOCH.</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PLANT.</td>
<td>3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LIMON.</td>
<td>2%</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>SALIC.</td>
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| #10  | S. PAT.    | 25%  | S. ALT.         | 80%  |


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<th>Transect - VIII [cont']</th>
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<tr>
<td>#13. S. ALT. - 95%</td>
</tr>
<tr>
<td>S. PAT. - 5%</td>
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<tr>
<td>#14. S. ALT. - 65%</td>
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<td>#15. Dist. - 2%</td>
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<td>SALIC. - 2%</td>
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<tr>
<td>LIMON. - &lt; 1</td>
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<tr>
<td>S. ALT. - 60%</td>
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<td>S. PAT. - 35%</td>
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<td>#16. S. PAT. - 50%</td>
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Natural Area Tidal Marsh Transect
September 7, 1965

Strip transect running from wooden bridge to edge of Bear Island using cover estimates in 10 x 1 meter sections.

Section - 1

*Spartina alterniflora* 80%
*Aster*
*Limonium*
*Liriope*

4 - 2
S. alt. 3
Aster 3
Liriope 3

5 - 3
S. alt. 80
*Spartina patens* 20

6 - 4
S. alt. 80
S. patens 20

S. alt. 95
S. patens 5
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<tr>
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<th>Percent</th>
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<tr>
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<tr>
<td>3 - 14</td>
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<tr>
<td>5 - 19</td>
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BARN ISLAND TRANSECT
October 1965

A line intercept running the length of Barn Island from northeast to southwest measured on five strata as follows: A. Overstory (15' for 25 m.), B. Understory (10 - 15' for 25 m.), C. High Shrub (6 - 10' for 10 m.), D. Low Shrub (1 - 6' for 5 m.), and E. Herb Layer (for 1 m.). Each section is twenty-five meters long, with each stratum being recorded over the length mentioned above, unless otherwise noted.

#1 A. Betula Populifolia - 5m. (35'-13" DBH)
   Quercus Alba - 10m. (35')
   C. Clethra Alnifolia - 2m.
   Smilax Rotundifolia - 1m.
   E. Solidago Rugosa - 1m.

#2 A. Bet. Populifolia - 2m.
   B. Rhododendron Viscosum - 5m.
   Sassafras Albidum - 5m.
   C. Sassafras Albidum - 3m.
   Rhus Copallina - 2m.
   D. Rhus Copallina - 2m.
   Sassafras Albidum - 2m.
   E. Rubus spp. - 0.7m.
   Solidago Graminifolia - 0.4m.

(last 10 m. of section is pure Myrica - 5')
#3

C. **Myrica Pensylvanica** - 7m.

Vaccinium corymbosum - 4m.

D. **Rosa Rugosa** - 3m.

Myrica pensylv. - 3m.

Rhus copallina - 1m.

E. **Myrica pensylv.** - 0.5m.

#4

B. **Vaccinium corymbosum** - 2.5m.

C. **Rhus copallina** - 7m.

Myrica pensylv. - 3m.

D. **Rosa rugosa** - 3m.

Myrica pensylv. - 1m.

Rhus copallina - 2m.

E. Rhus copallina - 0.25m

Myrica pensylv. - 0.25m.

Rosa rugosa - 0.25m.

(Crosses Solidago graminifolia field)

#5

D. **Rhus copallina** - 7m

Myrica pensylv. - 19m.

Rosa rugosa - 12m.

E. **Myrica pensylv.** - 8m

Rosa rugosa - 3m

Andropogon scoparius 6m.

Hypericum perforatum 2.1m.
#6. D. Myrica - 9m.  
Rosa rug. - 4m.  
E. Sol. gram - 16m.  
Andropogon - 5m.  
Rubus - 2m.

#7. D. Myrica - 6m.  
Smilax rot. - 5m.  
Rosa rug. - 3m.  
E. Solid. rug. - .2m  
Myrica - .5m

#8. B. Amelanchier sp. - 2m. (12' High).  
Prunus serotina - 7m. (14' High; 5 stems - 2"-3" DBH).  
Viburnum dentatum - 4m (11' High).  
C. Myrica - 3m.  
Rhus glabra - 2m.  
Rubus sp. - 2m (5' High)  
D. Rosa rug. - 3m.  
Myrica - 2m.  
Rhododendron visc. - 1m.

Crosses stone wall at 14m; perpendicular stone wall meets a few meters to north.
#9. C. Prunus serot. - 6 m. 3 stems - all 1.5" DBH.
Rhus glabra - 1 m.
Myrica - 7 m.
Rubus sp. - 1 m.
D. Rosa rug. - 4 m. (D-Layer measured over full 25 meters).
Viburn. dent. - 2 m.
Lonicera - 1 m.
Myrica - 13 m.
Rubus - 1 m.
Parthenocissus - 3 m.
Rhus copallina - 1 m.
E. Rosa rug. - 0.1 m.
Myrica - 0.3 m.
Sol. rug. - 0.5 m.

#10. C. Viburn. dent. - 3 m.
Myrica - 3 m.
D. Myrica - 14 m.
Rosa rug - 9 m.
Sol. rug - 1 m.
Sol. gramm. - 3 m.
E. Rubus - 0.8 m.
Myrica - 0.2 m.
#11. B. Cornus racemosa - 3 m. (12'High; 5 stems).
C. Myrica - 1 m.
D. Sol. gram - 2 m.
   Myrica - 3 m.
   Rosa rug. - 2 m.
E. Myrica - 0.1 m.
   Rosa - 0.1 m.

#12. D. Sol. gram. - 2 m.
   Rhus cop. - 2 m.
   Myrica - 1 m.
   Sol. rug. - 1 m.
E. Rubus - 0.1 m.
   Carex sp. 0.2 m.
   Myrica 0.3 m.

#13. C. Cornus race. - 7 m.
   Tripsacum dactyloides - 3 m.
   Rhus glabra - 2 m.
E. Cornus, race - 0.2 m.
   Sol. gram. - 0.2 m.
   Sol. rug. - 0.1 m.
   Rhus glabra - 0.1 m.

#14. C. Myrica - 7 m.
   Rosa rug. - 3 m.
   Rhus glabra - 1 m.
#15.  A. Quercus velut. - 8 m. (20' high; 3 stems - 5", 5", 9")
   B. Cornus race. - 12 m. (10' high; 1/2" - 3/4" DBH)
   Prunus serot. - 3 m. (12' high; 3" DBH)
   D. Rosa rug. - 3 m.
      Rhus glabra - 2 m.
      Myrica - 1 m.
      Vitis labrusca - 2 m.
   E. Myrica - 0.4 m.
      Rosa rug. - 0.2 m.
      Sol. gram. - 0.1 m.

#16.  C. Cornus race. - 2 m. (Passes by 5 - Vacc. cory. clones, to north of t-e cot.)
   D. Cornus race - 2 m.
      Myrica - 1.0 m.
      Rhus glabra - 1.0 m.
   E. Myrica - 0.2 m.
      Rosa rug - 0.5 m.

#17.  D. Smilax rot. - 2 m.
   Rhus glabra - 2 m.
   Myrica - 3 m.
   Rosa rug. - 1 m.
   E. Sol. gram. - 0.5 m.
   Myrica - 0.1 m.
   Smilax rot. - 0.2 m.
18. Was split into 3-5 meter sections with only the D+E layers present; ends on small sandy beach. E is 5 m long, also.

a). D. Myrica - 2 m.
    Smilax rot. - 2 m.
    Rhus cop. - 1 m.
    Rosa rug. - 1 m.
    E. Myrica - 0.4 m.
    Sol. gram. 0.5 m.

b). D. Myrica - 3 m.
    Smilax rot - 2 m.
    E. Sol. gram. - 0.1 m.

c). D. Smilax rot. -1 m.
    Myrica - 1 m.
    Iva frut. - 1 m.
    E. Sol. gram. 3 m.
    Panicum virgat. - 0.5 m.
    Sol. semper virens - 1 m.
    Smilax rot. - 0.5 m.
    Spartina patens - 0.1 m
    Limonium - 0.2 m.
    Juncus gerardi - 0.2 m.
    Salicornia - 0.1 m.