

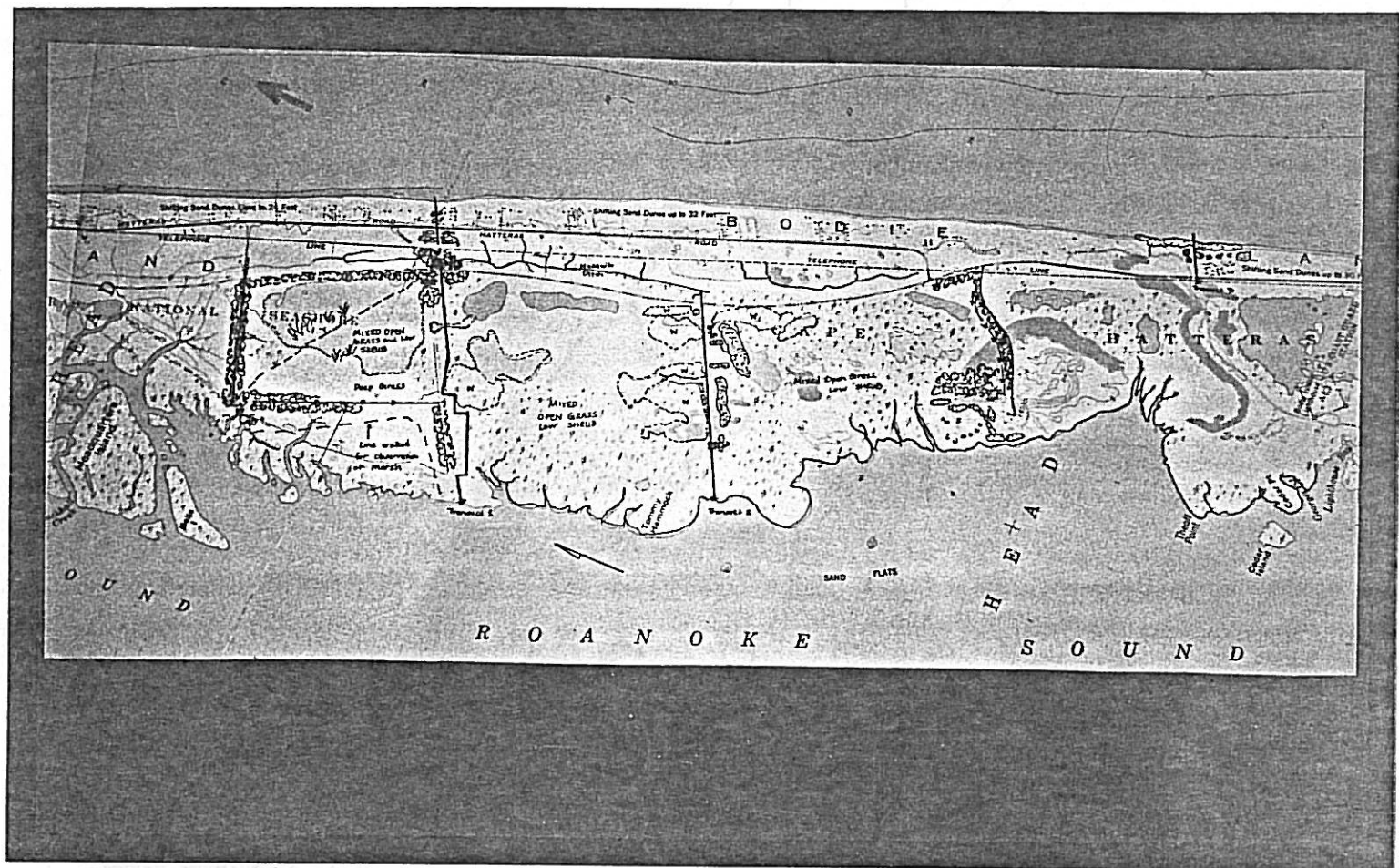
STMA 9821

A STUDY OF THE SHRUB AND VEGETATION PATTERNS ON
BODIE ISLAND, NORTH CAROLINA FROM 1932
to 1982

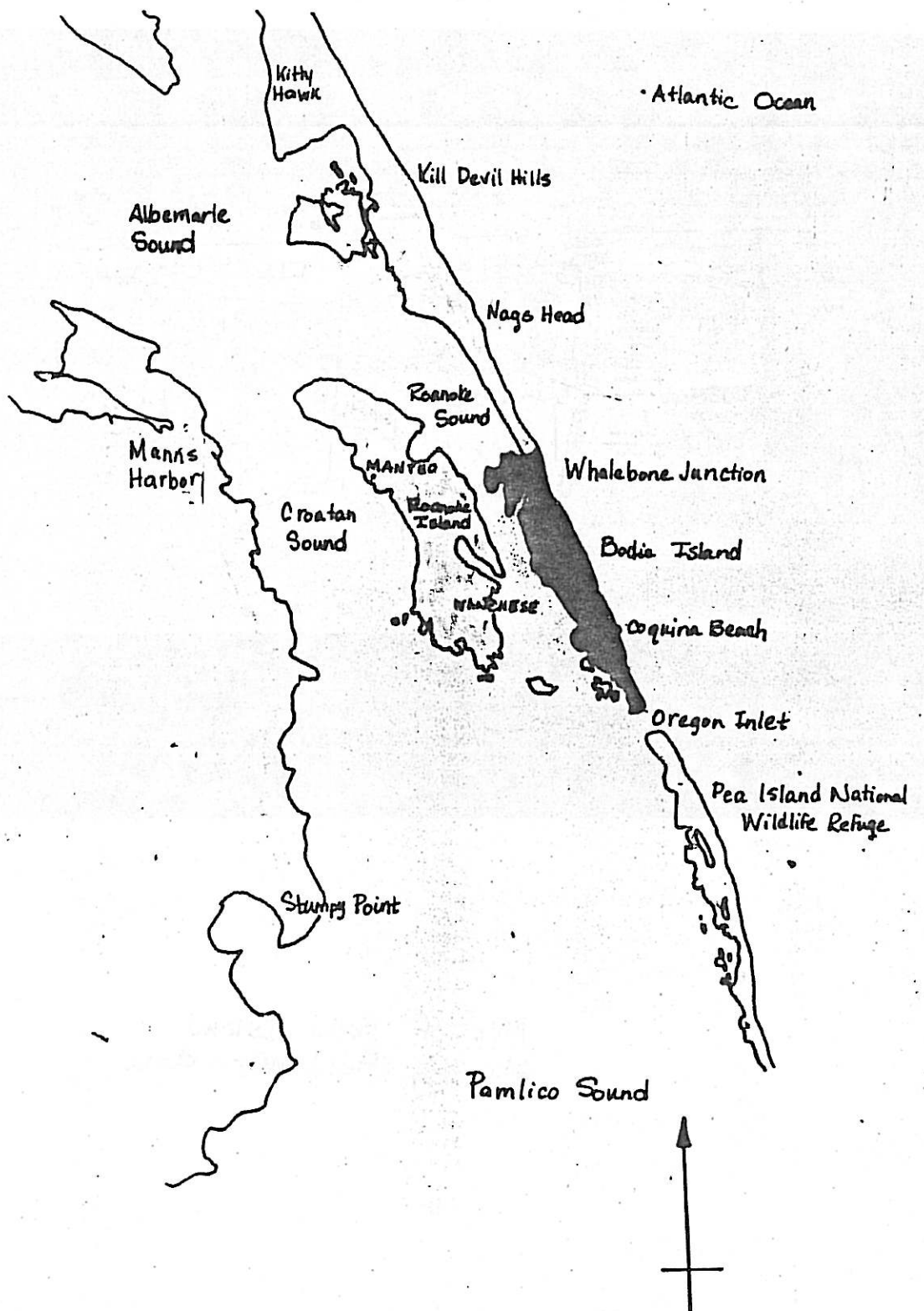
MARY T. STROH

3 MAY, 1982

Coastal Processes, Dolan



Map of Bodie Island
showing field work done



Introduction

Historical Sketch

Aerial photography, testimony from residents, and literature show that prior to 1936 the Outer Banks of North Carolina, particularly around Bodie Island, were largely flat, subject to wind and storm overwash effects from sound and shore, lacking in vegetative cover and affected by freely drifting sand. Aerial photographs show a very wide, flat expanse of beach and large overwash fans in the Pamlico and Roanoke sounds. In 1936 a North Carolina Beach Erosion Control Project, federally funded and carried out mainly by the North Carolina W.P.A. and C.C.C., began. The National Park Service took over the project in May of 1936. The Assistant Director of the National Park Service in 1937, H.E. Weatherwax, explained the project:

"We must not only correct the devastation which had been going on for more than a century (storms, grazing, etc.), but during the progress of the work must adopt measures for the protection of the coastal community against tidal inundation by both sound and sea."

(Weatherwax, p. 12, 1937.)

In January of 1937 artificial dunes were built with brush and slat fences for a length of 250 km. along the barrier islands and approximately 30 to 76 meters back from the water's edge to allow sand accretion by wind. This was followed by the planting of native trees, shrubs, and vast amounts of grasses. The Stratton report of 1940 notes that some 2,552,359 seedlings and shrubs were set out along the length of the dune system with extensive work done from Wright Memorial to Nagshead. By 1941 the stabilization program enabled a hard surfaced road to be built. From 1950 to 1970 a maintenance program continued and involved keeping and improving the road, holding the dune line intact by spot replantings and rebuilding after storm damage, and mosquito

control by use of mosquito ditches (Dave Austin, N.P.S., interview). The cost over this period averaged \$20 million (Odum, 1982). In 1982 the Park Service decided to end dune maintenance on Bodie Island park-owned property and anticipated a westward migration of dunes and island. The cost of holding the dune line and the possibility that such maintenance contributed to erosion of the beach were cited as possible reasons for the decision (Dave Austin, interview).

Bodie Island

Bodie Island, located past Nagshead on the Outer Banks of North Carolina, was called the 'flats' in the 1930's for its flat, sandy, vegetationless expanses (resident, interview, 1982). North-Easters, heavy storms, caused flooding across the island from ocean shore to Roanoke Sound. North-Westers, storms from the opposite direction caused flooding from the sound to the shore and often returned the island to its initial pre-storm width (resident, interview, 1982). The intersection at Whalebone Junction marks the beginning of National Park property on the main road, Highway 12; a service road with private property runs parallel to the main road but closer to the beach. The private section contains residences on the shore side of the service road. The entire island underwent extensive work to maintain dunes, stabilize the roads and control mosquitoes. Mosquito control involved the use of very deep channels or ditches located in the area between Highway 12 and the service road; these channels drain into Roanoke Sound near Whalebone Junction. Roadwork on Highway 12 led to extensive dredging in the marsh to build up the roadbed elevation. Deepest marsh open water is now found in the areas dredged (Dave Austin, interview, 1982). Dikes to impound fresh water may be seen in aerial photography of the 1930's. The dikes were improved and expanded

in the 1930 to 1960 period as evidenced by changes in the aerial photography. These dikes are now among the highest and driest portions of the marsh. Marsh extends from the main Highway 12 to Roanoke Sound. Today vegetation on the dikes and in between the service road and Highway 12 is significantly denser and taller than elsewhere on the island.

Objectives

The project involved three main objectives:

1.) Sample the shrub vegetation along baselines on Bodie Island to determine diversity of species, occurrence of species, and number of individuals present in 1982.

a.) Diversity = number of species present

b.) Occurrence = significant observations as to where shrubs occur

c.) Number of individuals = Total number per baseline and total number per species

2.) Analyze the aerial photography of the 1930's through 1970s (latest date available for study) to determine approximate trends of vegetation and to show significant changes over the fifty year period of 1932 to 1982 that resulted from W.P.A. and CCC and N.P.S. initial stabilization program and additional work including dike and mosquito control.

a.) Map areas

b.) Show trends

3.) Estimate the trends including gross factors for them and the positive or negative effects of them.

Design

The fieldwork involved establishing three baselines along Bodie Island. Transects spaced every 50 meters along each baseline and a mean width of 12 meters, 6 meters perpendicular to each side of the baseline per transect, were used. Shrubs were identified, photographed, and counted at each transect. It was anticipated that the shrubs would occupy areas of Bodie Island behind the artificial dunes, along the dikes and in the marsh that shrubs did not occupy prior to 1936. Analysis of aerial photographs occurred in facilities at Charlottesville. The photographic prints were projected and mapped out along the same area covered in the field in 1982. Microscopy allowed bare land to be distinguished from covered land; however, shrubs could not be distinguished. The mapping allowed the trends of change to be seen and documented.

Methods

Fieldwork

Three baselines were established on Bodie Island and each baseline was transected every 50 meters by perpendicular transects averaging 6 meters per side and 12 meters total width. Baseline location was determined by ease of location on aerial photography coverage, for example dikes were easy to spot; location in National Park property, line 1 included some private property; accessibility, areas of open water could not be traversed; and significance of change, areas unvegetated in the 1930s were likeliest candidates for lines. Baseline 1: 2.5 miles south of Whalebone Junction at USGS survey marker #Y168. Line starts at Roanoke Sound and follows roughly a bearing of 60 degrees East from sound to shore. It runs

parallel to the old dike in the marsh, across Highway 12 and through the area between the roads, across the service road and to the top of the last dune before the beach. It has a total of 47 transects and a total length of 2.32 km.

Baseline 2: 1.2 miles north of entrance to Bodie Island Maintenance Station at road pull off. Line starts at Roanoke Sound, follows roughly 60 degrees East from sound to Highway 12 and across the road to the impassible mosquito ditch. It has a total of 37 transects and a total length of 1.76 km.

Baseline 3: 30 meters south of Coquina beach entrance opposite the lighthouse road. Line starts at U.S.D.I. marker and runs 60 degrees East from the marker to the top of the last dune. It has a total of 5 transects and a total length of 200 meters.

The selection of the three baselines to show vegetation characteristic of Bodie Island, ^{ie.,} methodology, was verified by frequency of occurrence parameters.

$$\text{Frequency}_{\text{Baseline}} = \frac{\# \text{ transects shrubs occur on}}{\text{total} \# \text{ transects}} \times 100$$

$$F_{B1} \text{ sound to mosquito ditch} = 66\%$$

$$F_{B2} = 76\%$$

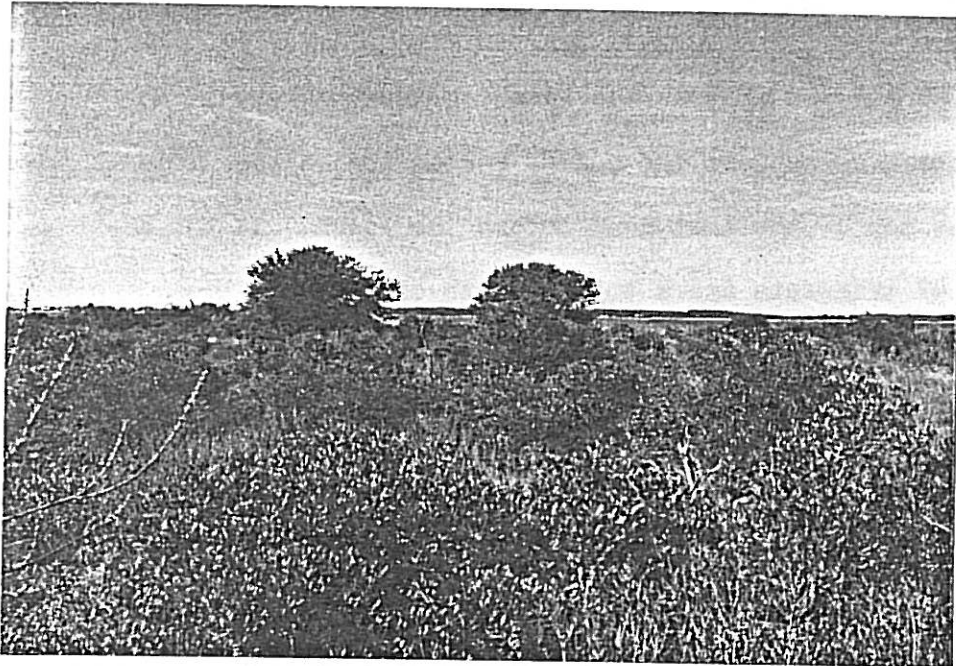
13.2% difference

$$F_{B1} \text{ service road to top of dune} = 33\%$$

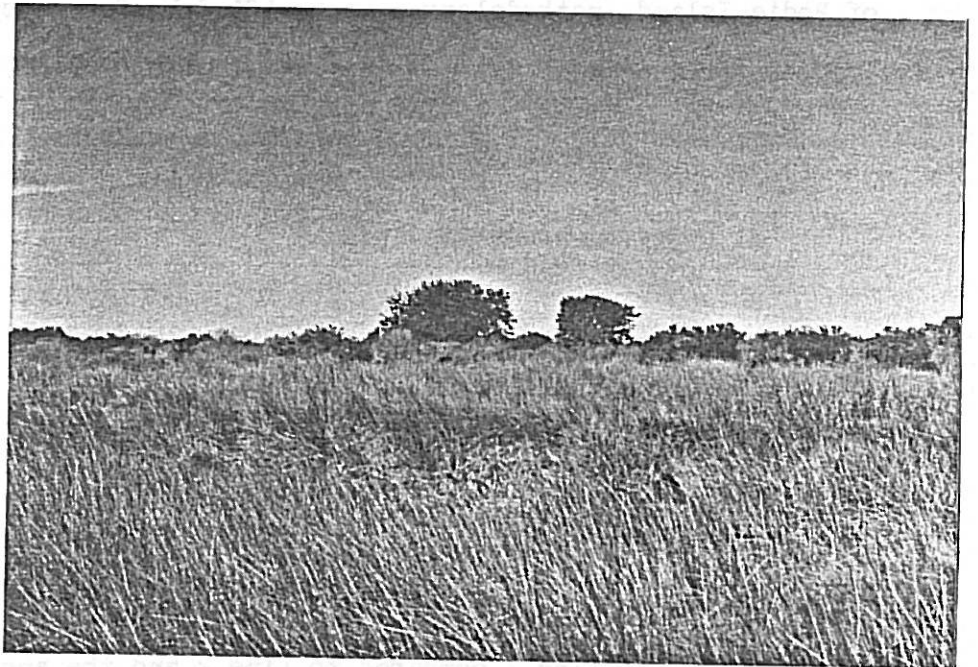
$$F_{B3} = 40\%$$

17.5% difference

These differences may be accounted for by the amount of open water that interfered with Line 1 compared to Line 2 and the amount of residential disturbance of the shrub community behind the dune at Line 1 when compared to Line 3.



View of lagoon from dike
on first baseline.



Typical Marsh View open grass
and Tree-shrub cluster.

At each transect along the baseline all shrubs that fell on the tape pulled perpendicular to the baseline were counted. Only shrubs were included in the count. A vegetation count per species was done per transect. The length per transect varied with the denseness of the vegetation. For very dense areas the length pulled was 5 meters per side, 10m total; for less dense areas length pulled was 10m per side, 20m total; and for open areas 20m per side, 40m total. Species that fell on the baseline were identified but not included in the vegetation count. Additionally an index of dominance test was performed per species per transect and per species across island to determine which specie dominated per environment. Dominance was determined with $C = (n_i/N)^2$ where n_i = # individuals per species and N = # individuals total.

Aerial Photography

Aerial photographs in the form of prints were available for February 21, 1933, April 28, 1945, March 13, 1962, and August 12, 1976. No prints of the study area were available for 1950. Each photo available was mapped and areas of apparent vegetation were mapped in red. Shrub and tree cannot be distinguished from grass cover until the infra-red photography of 1976. The maps were overlaid to show the changes over the fifty year period along baselines 1 and 3. The vegetation trend for baselines 1 and 3 was graphed.

Results

Shrub Vegetation

Diversity: 8 shrub species were identified in the three baselines

and in the area around the island water towers. These included:

Baccharis halimifolia

Ilex cassine

Ilex vomitoria

Iva frutescens

Myrica cerifera

Myrica pensylvanica

Persea borbonia

Zanthoxylum clava-herculis

The dominants included the Baccharis h., Iva f., and the Myrica p. and c..

Baseline 1 was dominated by the Baccharis h.; baseline 2 was dominated by Iva f.; and baseline 3 was dominated by the Myrica c. and p..

Occurrence: Three distinct environmental delineations were evident. They included open marsh and dike, mosquito control between the roads, and back of the barrier dune communities. The marsh and dike community is found from Roanoke Sound to Highway 12. Initial fieldwork in this area involved randomly crossing by foot from the main road to the sound to determine the pertinent features of the marsh and to establish the reliability of the baseline and transect method to yield accurate vegetation counts. This initial assessment showed that large expanses of grass; grass and shrub intermingled; fluctuating ponds; and clumps or clusters of shrub vegetation were the norm. Vegetation counts along the transects of the three baselines confirmed the observations. The largest shrub clusters occurred along the man-made dikes (almost in a solid line), near the road, and in elevated and scattered groves. Average heights of the shrubs ranged from 1.0 to 2.0 meters. Baccharis h., Iva f., and both Myrica c. and p. were the primary species of shrub present. It is likely that Myrica cerifera and Myrica pensylvanica occurred next to each other and intermingled with each other with M. pensylvanica occupying ground a few centimeters above M. cerifa.

Iva frutescens was found most often nearest the sound side of the marsh and in open grass expanses. Baccharis halimifolia stood at pond edges and usually on the lowest marsh elevations alone or on the highest elevations with other shrubs around it.

The mosquito control between the roads community is located from Highway 12 at the road edge and continues to the service or beach road. Its main characteristics included dense and tangled growth, then a slight rise and a few meter wide strip of open grass to shrubs and trees right on the banks of the mosquito ditches, and then dense and tangled growth again. Baccharis h. and Myrica p. and c. were the primary shrubs. The height of these shrubs was a large increase over the marsh and dike shrubs with the average height in the mosquito control community equal to 3.5 to 4.0 meters. The entire community was at a higher elevation than the marsh community and seemed to represent a totally created system that was the result of manipulations by man.

The behind the dunes community is found from the service road to the toe of the last dune before the beach or from the part of Highway 12 along the beach to the toe of the last dune before the beach. The elevation is higher than the marsh and vegetation is dense for the first fifty meters. The average height of vegetation in this community was 1.5 meters. Primary shrubs were Baccharis h. and Myrica p. and c.. After the first fifty meters the vegetation opened up and shrubs occurred in small clusters. No shrubs were found past the first line of low scattered dunes on the baseline; however, small clusters were seen at the toe of the dune north and south of the baseline.

Vegetation Count:

Figure 3 shows a chart of the number of individuals for each transect on all three baselines and the total number of individuals (shrubs) per line.

Aerial Photography:

The overlaid map shows the changes that occurred on baselines 1 and 3 from 1932 to 1982. The major changes are an increase in vegetative cover, a decrease in overwash fans into Roanoke Sound, and an apparent decrease in beach width and area covered by sand. The 1932 map shows open water along the dike at baseline 1. Vegetation is very sparse and open sand extends almost to the open water impounded by the dike. Large overwash fans may be seen in Roanoke Sound and the island is subject to shifting inlets. 1945 shows an increase in vegetative cover and a decrease in the open water next to the dike at baseline 1. The area of open sand does not extend as far as it did in the 1932 photograph. Large overwash fans into Roanoke Sound are not evident although some overwash is still present at close proximity to the edge of the island. The 1962 coverage again shows an increase in vegetation and the area covered by open sand now extends to just slightly past the service road; this represents a decrease by almost one - half of the area of open sand evident in 1932. No overwash is evident in Roanoke sound. 1976 infra-red photography shows that vegetation is now present from the edge of Bodie Island at Roanoke Sound to just behind the artificial dune line. Open sand does not extend to the service road which indicates a decrease from 1962. Again no overwash may be seen in Roanoke Sound.

Trends:

Three major trends indicated by the aerial photography include; an increase in vegetative cover; a fixation for the island overall with a decrease in sand cover and an end of overwash into Roanoke Sound; and a decrease in beach width. Both positive and negetative aspects may be seen in these trends. The ability to build a road on Bodie Island increased

the island's capacity to be used for recreational use and therefore an influx of capital into the area took place. The stabilization of the island decreased the constant opening of new inlets. This meant that the road benefitted by the protection afforded it. Conversely, deleterious factors resulted also including apparent increased storm vulnerability (Dolan, Godfrey, N.P.S.) and apparent increased erosion of the entire island. The cost of continuing maintenance also represented a negative aspect.

Conclusions

The study of vegetation changes on Bodie Island from 1932 to 1982 shows that vegetative cover increased significantly over the period considered. The results of 1982 reveals that shrub vegetation occurs from the shore of Roanoke Sound to just behind the dunes built by man at the shore of the Atlantic Ocean. Shrub occurrence is greatly influenced by elevation. Three environments indicate the general nature of shrub occurrence. They are: marsh and dike environment, with clumps and lines of shrubs and great expanses of open grass, and average height of shrubs equal to 1.0 to 2.0 meters; mosquito control area between Highway 12 and the service road environment, with dense, tangled growth and average height of shrubs equal to 3.5 to 4.0 meters; and behind the artificial dune environment, with heavy shrub growth for approximately 50 meters and then scattered clusters of shrub up to the toe of the dune closest to open beach, and with average height equal to 1.5 meters. Interviews and literature point out that these results overall may be more negative than positive. The major problem arises from a growing conviction that the changes are contributing to erosion of the

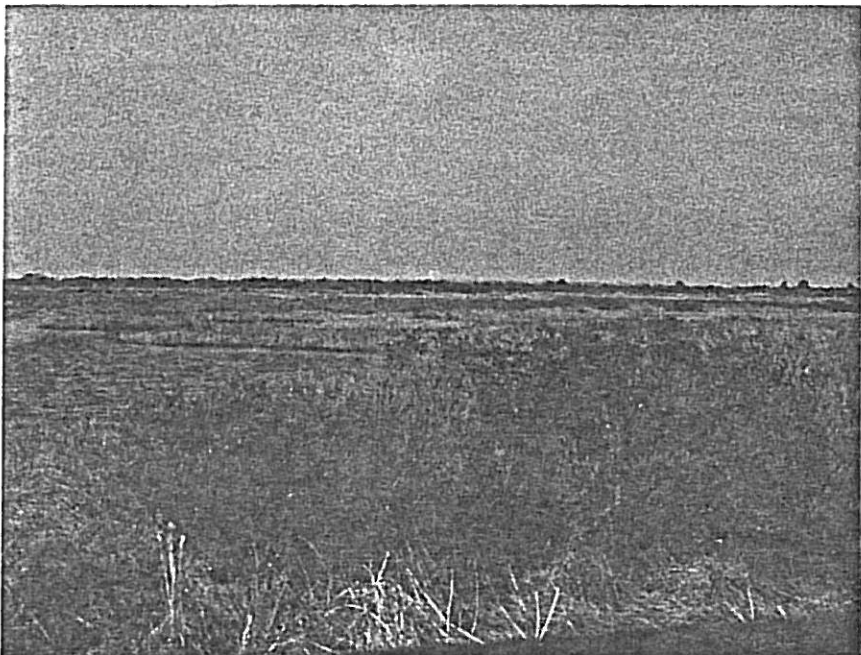
barrier. This led the National Park Service to make a decision in 1982 to end artificial dune maintenance on park property on Bodie Island. Cost and the problem of erosion were the major factors for the decision. The belief held about the end of maintenance is that the natural system will migrate and retreat in a westward direction.

Many problems affected the study both in the field and in looking at the aerial photography. Time limitations and winter botany created difficulty in the field. The influence of tidal cycles and the presence of the impassible mosquito ditch between the roads caused many complications in establishing baselines. The tidal cycle caused areas that appeared to be dry grass one day to become uncrossable ponds the next and thus caused the baseline to veer off its overall heading. Density could not be extrapolated too accurately from the measurements taken in the field. More measurements were needed. A vegetation count had to be resorted to. Incomplete coverage in the aerial photography of the study area complicated that part of the study. A major problem was that the existing coverage was done at different scales, at different altitudes, and at different angles so that some coverage did not show the whole width of the island. The black and white coverage also did not allow shrub vegetation to be detected. Vegetated from unvegetated land was all that could be determined. Finally, because of the last complication, density of shrub vegetation could not accurately be quantified. This changed the nature of the presentation of the study from a quantitative to a qualitative approach.

The significant results of the study indicate that further work in the study would be beneficial. Density in the field could be quantified by use of quadrats or by radial transects. A careful topographic mapping



Dune stand on Sound side of Bodie Island.



View from highway 12
into Marsh showing open
water 1 mile in from sound.

of the study area would show precise elevations of where the shrubs occur and where they do not occur. This could be related back to the effects of water influx during the tidal cycle on shrubs and to the effects of salinity both water and wind borne on the shrubs. Instrumental analysis of the aerial photography would allow changes and vegetation cover to be quantified. Measurements of island width, sand cover width, beach width and inlet and overwash shift would most likely prove significant.

trans. #	# shrubs	trans. #	# shrubs
1	8	1	0
2	0	2	2
3	10	3	6
4	11	4	9
5	0	5	16
6	2	6	23
7	0	7	12
8	7	8	11
9	0	9	15
10	0	10	6
11	23	11	9
12	18	12	8
13	7	13	1
14	2	14	2
15	4	15	0
16	0	16	4
17	0	17	6
18	17	18	4
19	0	19	14
20	36	20	13
21	4	21	5
22	0	22	2
23	0	23	0
24	0	24	0
25	0	25	1
26	3	26	1
27	25	27	0
28	11	28	1
29	17	29	7
30	0	30	2
31	18	31	10
32	13	32	0
33	28	33	0
34	14	34	9
35	25	35	4
36	22	36	0
37	30	37	0
38	26	38	0
39	14	39	0
40	5	40	0
41	31	41	0
42	18	42	0
43	0	43	0
44	27	44	0
45	0	45	0
46	0	46	0
47	0	47	0

1

2

trans. #	# shrubs
1	0
2	24
3	8
4	0
5	0

3

Trans. #	1	2	3
total # shrubs	488	205	32

Total # shrubs / baseline

Figure 3. Vegetation Count

Vegetation: #shrubs/transect (Not to scale)

HHH3

Example
of transects

Located at USPI M.P.1
Coquina Beach Highway 12
Road to shore
5 transects
200m

Located 1.2 miles N of entrance to Bodie Island
Maintenance Station

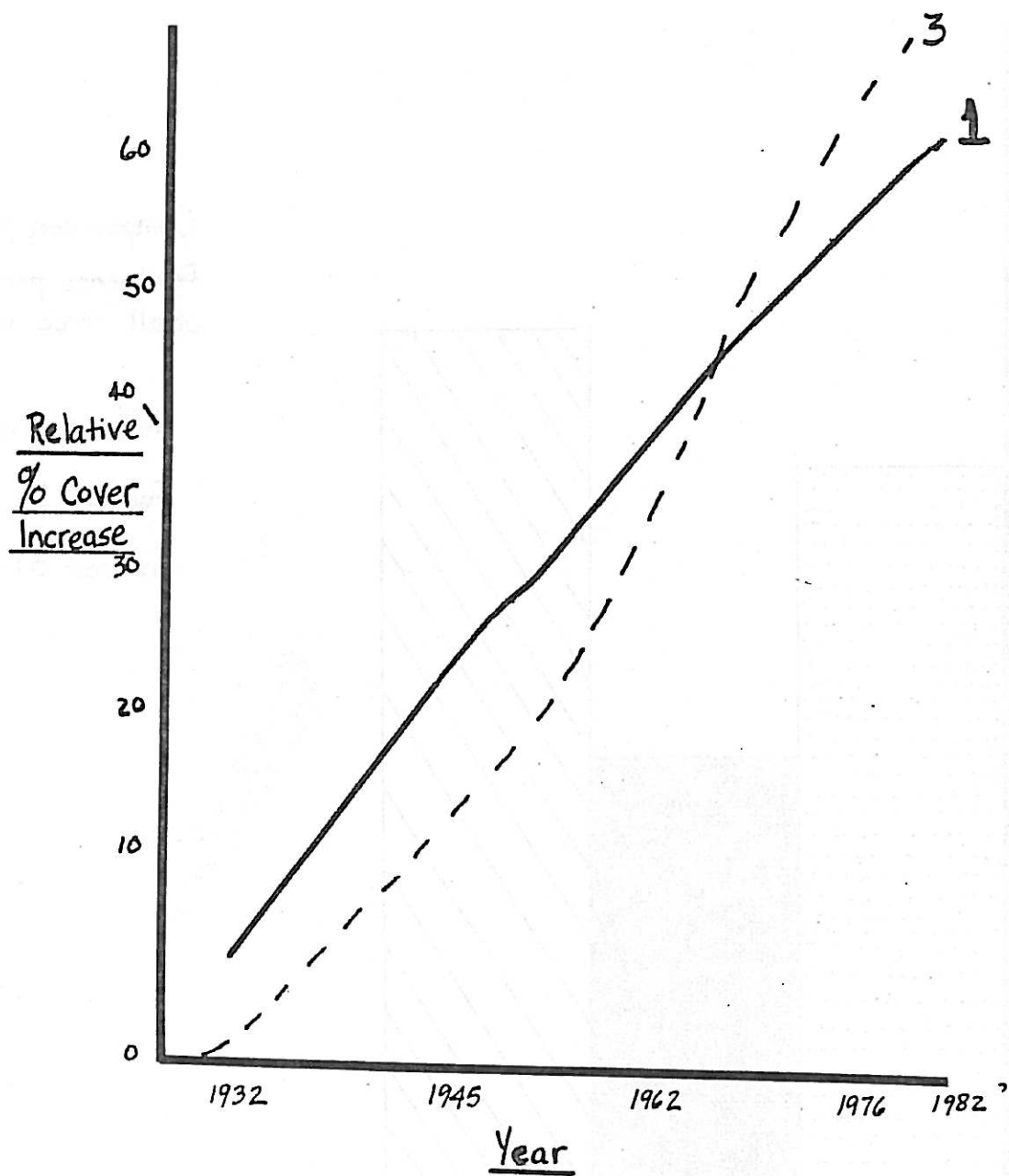
Sound to Mosquito Ditch
37 transects
1.76 km

2

1' inferred

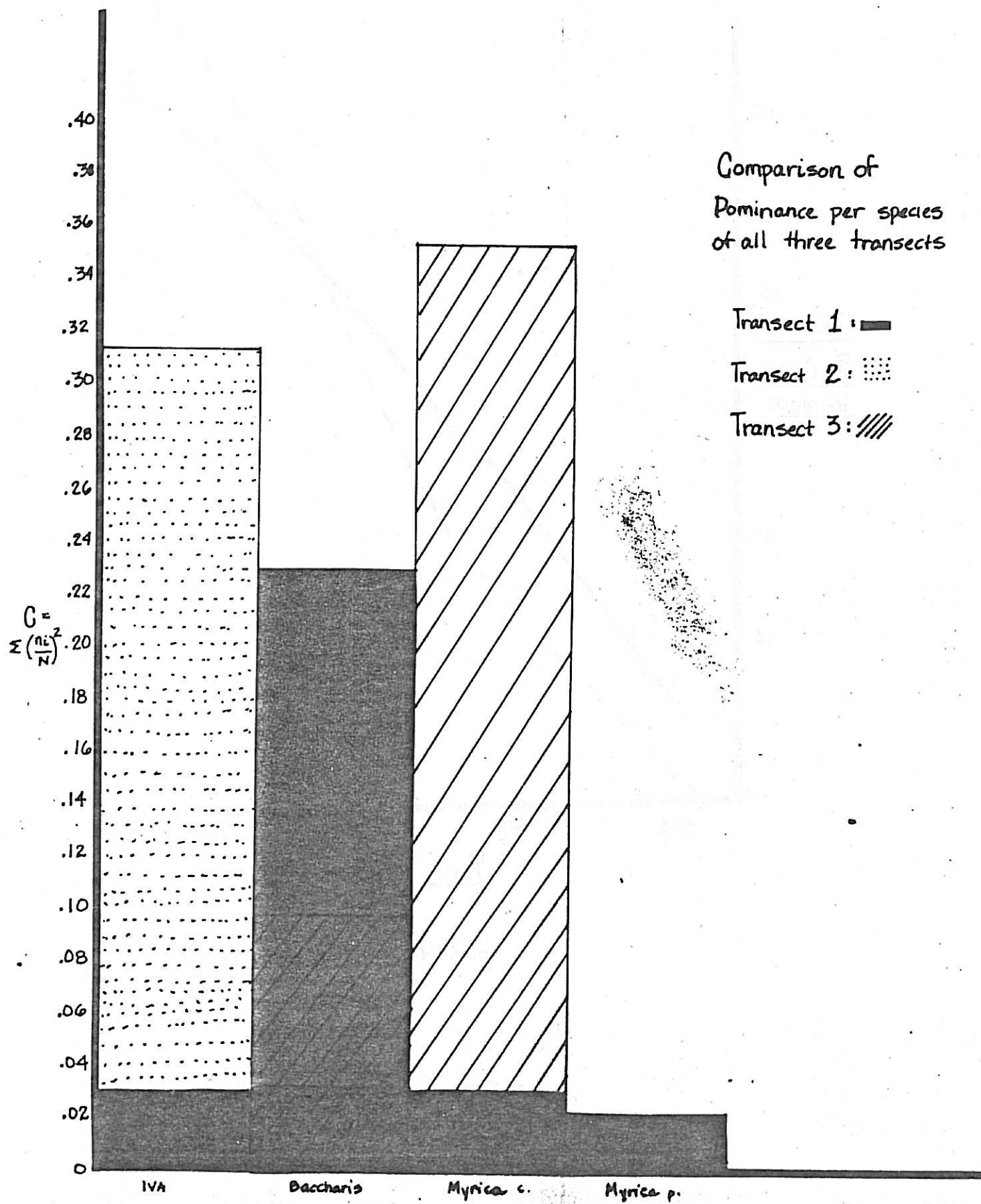
Located 2.5 miles S Whalebone
Junction USGS Survey Marker Y168
Sound to Shore
47 transects
2.32 km

1



GRAPH: VEGETATION TREND
(for Baselines 1 + 3)

- Estimated from Aerial Photographs -



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ENVIRONMENTS Found



Behind the dune Dominant: Myrica
Average height: 1.5 m



Between the Roads Dominant: Myrica
Average height: 3.5-4.0 m

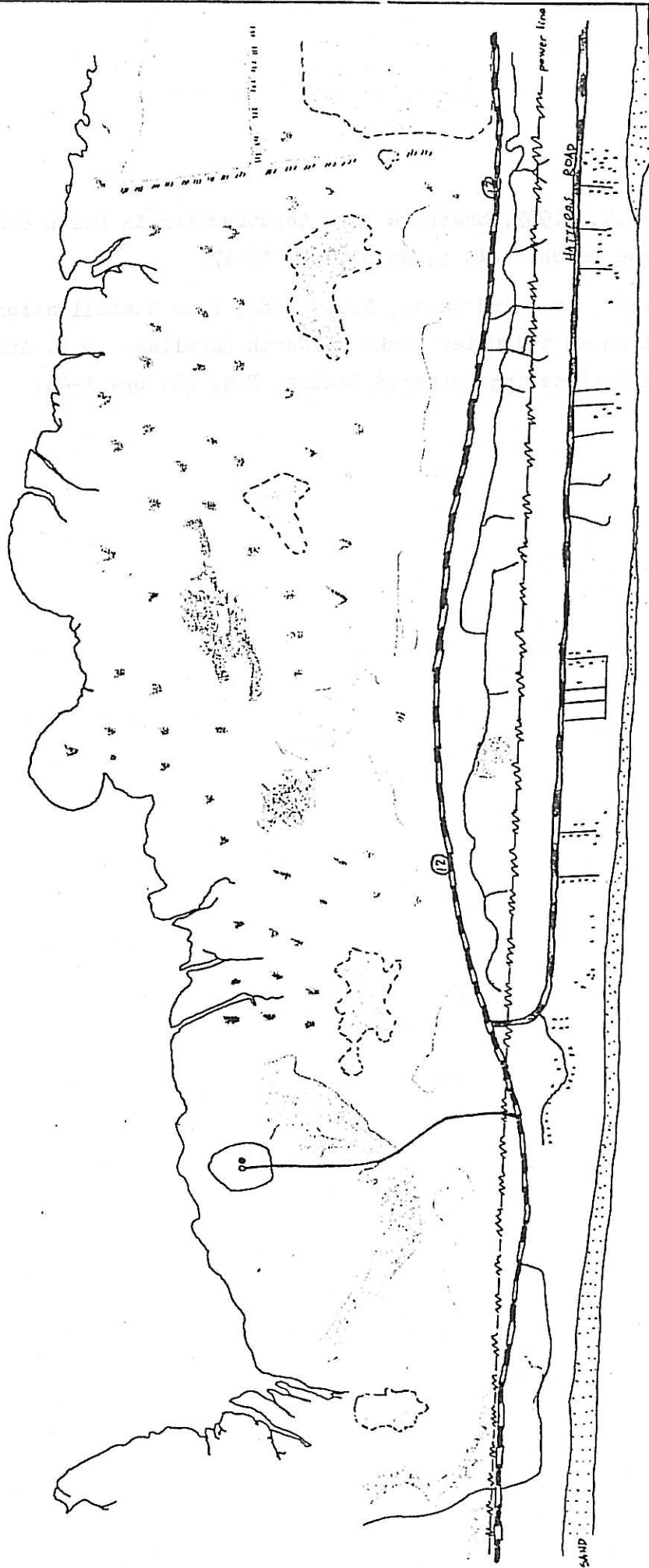


Marsh and Dike Dominant: Baccharis
Average Height: 1.0-2.0 m

Weatherwax, H.E., 1937, Seashore Park Construction in North Carolina;
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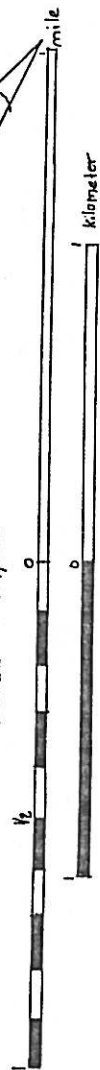
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Roanoke Sound



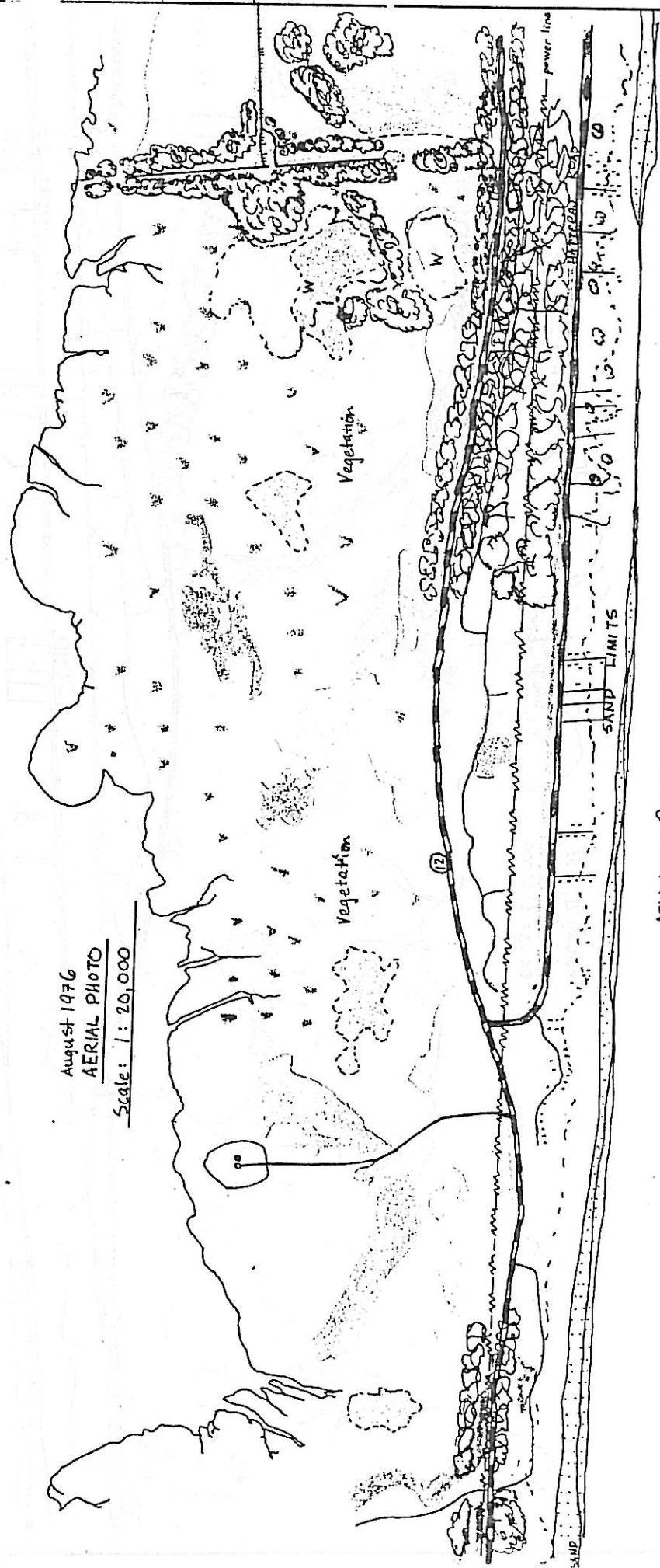
ATLANTIC OCEAN

SCALE 1:24,000

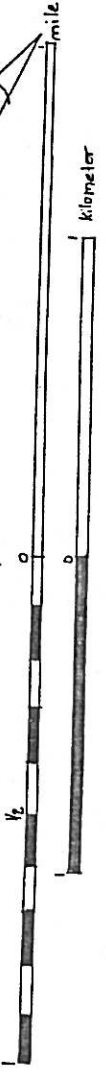


ROANOKE SOUND

August 1976
AERIAL PHOTO
Scale: 1:20,000

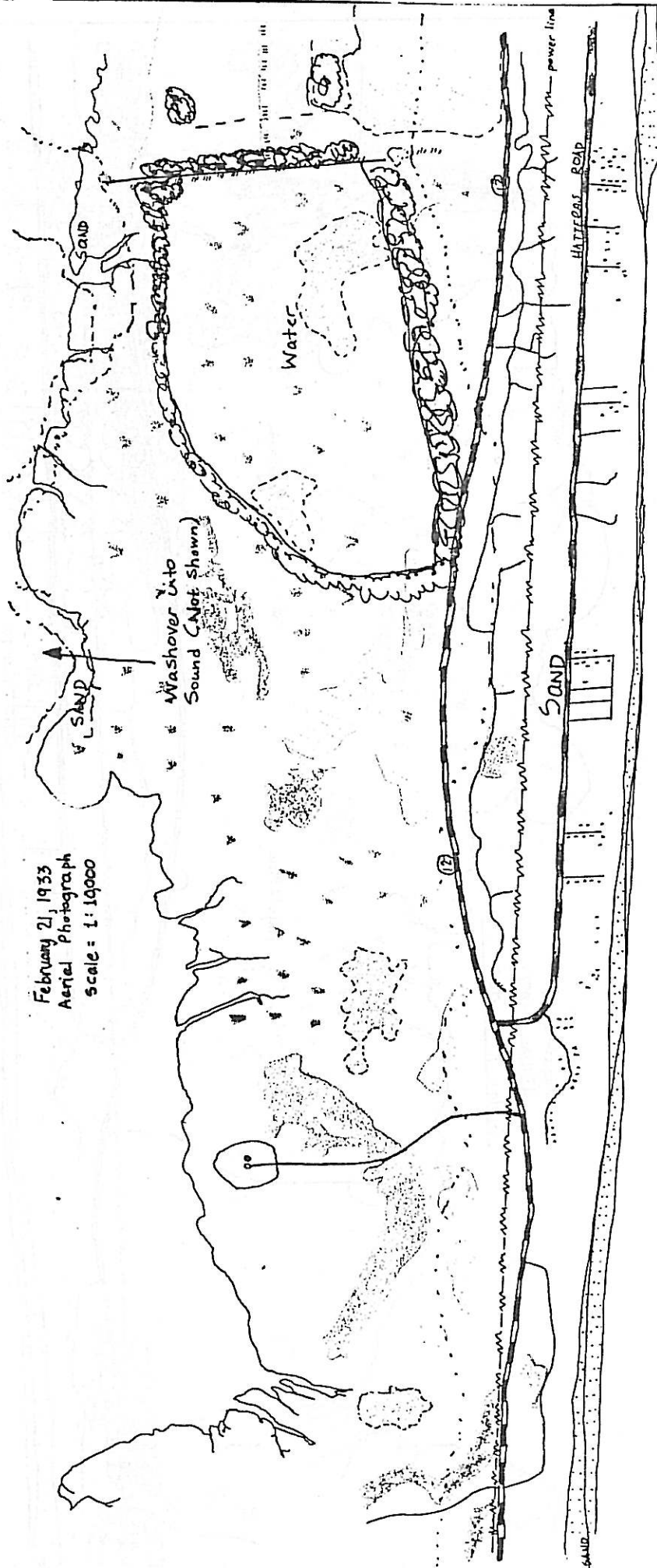


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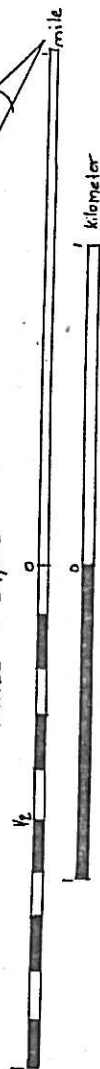
ROANOKE SOUND

February 21, 1953
Aerial Photograph
Scale = 1:10,000



ATLANTIC OCEAN

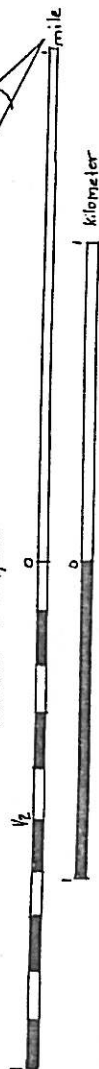
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Base map from Topographic Map

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Basemap from Topographic Map

