2/ Proceedings of

FIRST ANNUAL CONFERENCE ON
ORATION OF COASTAL VEGETATION
IN FLORIDA

Cover Photo: Over 200 acres of mangroves on the east side of Tampa Bay, Florida, that were cleared prior to planned development. The area has since been ordered restored by the Jacksonville District, U. S. Army Corps of Engineers.

Photo Courtesy of Morris of Selbypic,
Tampa, Florida

PROCEEDINGS OF THE FIRST ANNUAL CONFERENCE ON RESTORATION OF COASTAL VEGETATION IN FLORIDA

May 4, 1974
Hillsborough Community College
Tampa, Florida

Sponsored by
The Florida Audubon Society

Co-Chairmen

Robin Lewis
Department of Biology
Hillsborough Community College

Jim Thomas
King Helie Planning Group
Orlando, Florida

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INTRODUCTION

This conference was organized as an effort to bring together those persons in Florida who had an interest in coastal vegetation and were working with the problem of its restoration in Florida.

Since no such conference had been held before we felt it would be helpful to invite several noted researchers from other states to discuss their research with us. We were indeed fortunate to have as our keynote speakers Dr. Edgar W. Garbisch, Jr., of Environmental Concern Inc., St. Michaels, Maryland, and Dr. W. W. Woodhouse, Jr., from the North Carlolina State University at Raleigh. We would like to take this opportunity to thank them for coming to Florida assist us in our efforts.

We are also grateful to the Florida Audubon Society for sponsoring this meeting and to Ms. Susan Bird of the Tampa Audubon Society for her help in organizing the meeting.

Another conference is planned for May, 1975, and those wishing to be added to our mailing list to receive notice of the time and place of the meeting should contact one of the co-chairmen.

Robin Lewis

Jim Thomas

CONFERENCE ON RESTORATION OF COASTAL VEGETATION IN FLORIDA

AGENDA

9:00 Introduction

9:15 Edgar W. Garbisch, Jr., Environmental Concern Inc., St. Michaels, Maryland
"Salt Marsh Creation on Dredge Material and Natural Shores"

10:00 W. W. Woodhouse, Jr., North Carolina State University at Raleigh
"Stabilizing Coastal Dunes"

10:30 Jim Thomas, Green Earth Landscaping Co., and Otto Bundy, Horticultural Systems, Inc.
"Replanting Sea Oats in Florida"

11:00 W. W. Woodhouse, Jr., North Carolina State University at Raleigh
"Propagation of Spartina alterniflora for Stabilization and Salt Marsh Development"

11:20 Clifford Willis and Jedfrey Carlton, Florida Department of Natural Resources
"Florida Department of Natural Resources Efforts in Coastal Vegetation Restoration and Marine Habitat Construction"

11:35 Thomas Savage, Florida Department of Natural Resources
"Survey and Management of Florida's Coastal Vegetation"

11:45 Preston Howard, Michael Baker, Jr., Inc.
"The Use of Vegetation in the Design of Regulations Pertaining to Coastal Development of the Big Cypress Critical Area"

12:05 Lunch

1:30 Joseph Bell and Dave Klassen, Milo Smith and Associates
"Dunedin Bay Shoreline Stabilization and Beautification"

1:50 Anitra Thorhaug, Gary Beardsley, and Raymond Hixon, University of Miami
"Large Scale Transplanting of Thalassia"

2:05 Reginald G. Rodgers, Environmental Protection Agency, Gulf Breeze
"Seagrass Revegetation in Escambia Bay, Florida"

2:15 Cherie Down, Broward County Health Department
"Aerial Photographic Methods of Studying Submerged Vegetation, a One Area Study"

2:25 Howard Teas, University of Miami
"Mangrove Planting in South Florida"

2:40 Break

3:00 James Haeger, Florida Entomology Laboratory
"Sixteen Years of Growing Mangroves and Transplanting Other Desireable Plants of the Coastal Sand Dunes"

3:15 Violet Stewart, Conservation Consultants, Inc.
"Seeds and Seas"

3:35 Ernest Estevez, University of South Florida
"The Role of Wood-Boring Organisms in Mangrove Restoration"

3:50 Tom Detweiler, East Stroudsburg State College, Pennsylvania
"A Preliminary Report on Natural Revegetation Rates in Disturbed Mangrove Communities"

4:05 Robin Lewis, Hillsborough Community College, and Frank Dunstan, National Audubon Society
"Possible Use of Spoil Material to Replace Lost Coastal Vegetation in Florida"

4:20 Julie Morris and Jono Miller, New College
"Colonization of Spoil Islands"

4:35 Gregory Smith, Vero Beach High School
"Planting Mangroves on Spoil Islands in the Indian River"

4:50 John Morrill, New College
"The Submerged and Shoreline Vegetation of Three Canal Systems, Seista Key, Florida, Preliminary Observations and Recommendations"

Salt Marsh Creation on Dredge Material and Natural Shores

Edgar W. Garbisch, Jr.

Biotic techniques for shore stabilization include fresh, brackish, and saltwater marsh establishment either on existing shores or on fill material deposited and graded to appropriate elevations alongshore. This talk presents a synopsis of such techniques currently under exploration.

Objectives of the various projects underway include the identification of methods for and limitations to vegetation establishment of thirteen species of emergent marsh plants within the tidal zone on various natural and artificial substrates in areas subject to different wave stress, water salinities, and tidal amplitudes. The effects of vegetative establishment on substrate stabilization and sediment accretion are being examined at each project site. Estuarine invertebrate recovery and successionsal characteristics in vegetated and unvegetated artificial tidal flats are being determined.

Salient conclusions derived from this research are: (1) substrate characteristics do not appear to limit vegetative establishment; (2) periodic fertilization may be essential for vegetative establishment on some substrates and in areas subject to high degrees of physical stress; (3) mammal and waterfowl utilization of virgin artificial marsh areas for feeding may be extensive for specific plant species and may lead to the permanent removal of plants not flowering the first season; (4) artificial intertidal areas appear to achieve benthic invertebrate populations comparable to those in undisturbed control areas within one year; (5) physical stress appears to limit both the age of plant material incorporated and the elevations at which vegetation artificially incorporated can become established within the tidal zone; (6) vegetative establishment has been most successful with *S. alterniflora*, *S. patens*, *S. cynosuroides*, *D. spicata*, *P. communis*, *P. virgatum*, and *A. breviligulata* seedlings in salt and brackish water areas and with *S. americanus* and *S. alterniflora* seedlings in fresh water areas.

STABILIZING COASTAL DUNES

W. W. Woodhouse, Jr.

Dunes are natural features of sandy seashores outside the Tropics, functioning as flexible barriers to storm tides and waves, and as sand reservoirs nourishing the beach during storm attack. They are not effective against permanent erosion and beach recession. Where lacking, their absence can usually be attributed to man's activities or to recent beach recession.

Dunes may be built mechanically or by trapping blowing sand (sand fences and vegetation). The latter is preferable where sufficient blowing sand is available and time permits. Accumulation rates of 2-5 yds^3/ front ft/yr for fence-vegetation combinations are not uncommon, and the dune is stabilized as it grows.

Foredune plants must have special adaptations which limit the number available. From our research the past 15 years in North Carolina, plus observations along much of the Atlantic and Gulf coasts we find perennial grasses to be the primary stabilizers. At present there are only four of these available in the Southeast--sea oats and running beachgrass or bitter panicum (*Panicum amarum*) from the Virginia Capes to Mexico; American beachgrass from South Carolina to New England; saltmeadow cordgrass on low moist sites throughout. There are many others of value but these form the front line.

Panicum amarum is "new," having been largely grazed out years ago, and being slow to reinvade. It is the most palatable to cattle of the dune grasses and apparently reproduces but rarely by seeds. It is easy to propagate vegetatively, a rapid stabilizer, and is becoming available commercially. There is a profusion of types and evaluation of these is needed.

Dune grasses normally have to be transplanted into beach and fore-dune areas, by hand or with tractor-drawn transplanters. Mixed species plantings are more dependable than single species, less vulnerable to disease and insect epidemics. A mixed planting 30-50 feet wide, hills spaced 1.5-2.0 feet, on centers, will usually trap all sand moving across it by midsummer of the first growing season. Wide spacings are not effective, initially, and are a frequent cause of failure.

Preferred planting season is December through March. Most dune species respond to fertilizer, largely N and P; particularly in the absence of fresh sand.

Dunes are very susceptible to damage from foot and vehicular traffic. In public use areas, provision should be made to limit such effects as well as allowance for periodic repairs.

ABSTRACT

"PLANTING OF SEA OATS"

JIM THOMAS

KING HELIE PLANNING GROUP, INC.

P.O. BOX 115

ORLANDO, FLORIDA

The massive destruction of dune systems along the entire southeastern coast by wind and water erosion, overuse by man and construction, has brought about the need for research in the best method for replacing and stabilizing these dunes. The protective function of the dune to upland development has now been well established as has the need for stabilizing the loose sands composing the dunes from wind erosion. Of the various methods attempted, stabilization by using vegetation appears to be among the most promising. Considerable research has been conducted along these lines, some of which is summarized here along with personal experience in establishing a practical and economical method for use of native dune plants on primary dunes, natural or man-made, for the purpose of stabilizing against wind erosion.

Any plant able to live on the seaward side of the primary dune must be able to withstand severe environmental conditions: high soil temperatures, semi-arid soils, some saline build-up in soils, low nutrient levels, shifting sands, high winds, and considerable salt spray. Of these conditions, the salt spray from the ocean is probably one of the major controlling factors in determining which plants can survive on the front of the dunes. A number of plants have adapted to these severe conditions and are able to thrive in numbers sufficient to stabilize the shifting dunes, by holding the sands with fibrous root systems and by catching and holding blowing sands, thereby causing the dunes to "grow."

The most common and effective dune plant along the Florida coast is the sea oats (*Uniola paniculata L.*), dominant on the primary dunes

THROUGHOUT MOST OF ITS RANGE, FROM SOUTHERN VIRGINIA ALONG THE ATLANTIC AND GULF COASTS TO MEXICO. THIS PLANT IS ABLE TO SURVIVE EXTREMES OF WIND-BLOWN SALT, EVAPORATION AND BURIAL BY SHIFTING SANDS. ITS LEAVES, BECAUSE OF THEIR SHAPE AND HEAVY LAYERS OF WAX-LIKE CUTIN, MAKE THE PLANT RESISTANT TO SALT DAMAGE.

EARLIER EXPERIMENTS, CONDUCTED PRIMARILY ALONG THE ATLANTIC COAST OF NORTH CAROLINA AND VIRGINIA, ATTEMPTED TO SHOW PRACTICAL WAYS OF USING DUNE PLANTS SUCH AS EUROPEAN BEACHGRASS (AMMOPHILA ARENARIA), AMERICAN BEACHGRASS (AMMOPHILA BREVILIGULATA), SALTMEADOW CORDGRASS (SPARTINA PATENS), BITTER PANICUM (PANICUM AMARUM), AND SEA OATS (UNIOLA PANICULATA). OF THESE, ONLY THE BITTER PANICUM AND SEA OATS SEEM SUITABLE FOR USE ALONG THE FLORIDA COAST.

A STUDY OF THE DOMINANT VEGETATION ON THE DUNES OF THE FLORIDA COAST SHOWS THAT SEA OATS DOMINATE THE DUNE VEGETATION. SMALLER PLANTS SUCH AS HYDROCOTYLE SPECIES MAY BE FOUND WITH SEVERAL OTHER SMALL HERBS SOMETIMES INTERSPERSED AMONG THE SEA OATS. ALMOST ALL STABILIZING AND SAND TRAPPING, HOWEVER, ARE ACCOMPLISHED BY THE SEA OATS.

IN REVIEWING AVAILABLE RESEARCH AND WORKING WITH OTHERS INTERESTED IN DUNE RESTORATION, TECHNIQUES FOR ESTABLISHING COLONIES OF SEA OATS ON NEW OR DAMAGED DUNES HAVE BEEN ATTEMPTED AT SEVERAL POINTS ALONG THE SOUTHEASTERN COAST AND THE COAST OF TEXAS.

OF THE MANY APPROACHES TRIED, THE MOST SUCCESSFUL AND PRACTICAL SEEMS TO BE THAT DEVELOPED PRIMARILY BY MR. OTTO BUNDY AND OTHER

REPRESENTATIVES OF GULF STATES PAPER CORPORATION, TUSCALOOSA, ALABAMA. THIS TECHNIQUE ESSENTIALLY INVOLVES THE USE OF A WOVEN PAPER FABRIC PINNED TO OPEN SAND BY USE OF WIRE STAPLES AND ANCHORED BY SAND AROUND THE PERIPHERY WITH SEA OAT SEEDLINGS PLANTED IN HOLES THROUGH THE FABRIC. THE FABRIC, HELD IN PLACE UNTIL IT DETERIORATES, SOLVES THE PROBLEM OF WIND EROSION AND SAND MOVEMENT BEFORE THE SEEDLINGS BECOME ESTABLISHED.

THE GREATEST PROBLEM STILL SHOWN BY THIS TECHNIQUE IS AVAILABILITY OF PLANTS. MOST ATTEMPT AT MASS PRODUCTION OF NURSERY STOCK HAVE NOT BEEN VERY PRODUCTIVE BECAUSE OF THE MANY VARIABLES REGULATING VIABILITY AND GERMINATION. ATTEMPTS AT SEEDING ALONG DUNE LINES HAVE BEEN LARGELY UNSUCCESSFUL. RECENT STUDIES BY MR. BUNDY AND OTHERS HAVE SHOWN THAT SEA OATS CAN AND ARE BEING PRODUCED IN NURSERIES, THOUGH ARE STILL NOT ALWAYS AVAILABLE EXCEPT FOR MATERIAL THAT IS CONTRACT GROWN. THE MAJOR PRODUCER OF THESE PLANTS AT THE PRESENT TIME IS HORTICULTURAL SYSTEMS, INC., BRADENTON, FLORIDA.

RESEARCH ALSO SHOWS GENERALLY THAT MOST DUNE PLANTS RESPOND READILY TO FERTILIZER PROGRAMS, WITH SEA OATS RESPONDING PRIMARILY TO N AND P. THE FERTILIZER PROGRAMS DEVELOPED FOR PLANTED SEA OATS SHOULD INCLUDE PELLETIZED FORMS OF FERTILIZER AND, BECAUSE THESE PLANTS ARE WARM WEATHER GRASSES, SHOULD INCLUDE HEAVIEST APPLICATIONS LATE IN SPRING AND THROUGHOUT THE SUMMER. OPTIMUM PLANTING TIME FOR NEW SEEDLINGS IS APPARENTLY DECEMBER THROUGH MARCH. IDEAL PLANTING DEPTHS FOR SEEDLINGS SEEMS TO BE 5 TO 8 INCHES DEEP.

IN AREAS SUBJECT TO CONTINUAL HIGH WINDS, THE USE OF A STABILIZING FABRIC BECOMES EXTREMELY IMPORTANT. BECAUSE THE WINDS ARE GENERALLY LANDWARD FROM THE SEA, THE FABRIC AND PLANTINGS SHOULD BE PARALLEL TO THE BEACH.

A TECHNIQUE THAT HAS ALSO BEEN SHOWN TO BE SUCCESSFUL IS THE USE OF SNOW FENCING IN HIGH-WIND AREAS TO TRAP AND HOLD SAND WHILE SEA OATS BECOME ESTABLISHED BEHIND THESE FENCES.

SUCCESS IN ESTABLISHING COLONIES OF SEA OATS SUFFICIENT TO STABILIZE DUNES OF SOME SIZE HAS BEEN RECORDED IN SEVERAL AREAS, ONE OF THE MOST SUCCESSFUL AT PADRE ISLAND, TEXAS. CURRENT PROJECTS IN FLORIDA BY MR. BUNDY AND OTHERS INCLUDE SUCCESSFUL PLOTS AT AMELIA ISLAND, HUTCHINSON ISLAND (OCEAN VILLAGE PROJECT, ST. LUCIE COUNTY), FORT WALTON BEACH AND MIAMI.

BIBLIOGRAPHY

OTTENI, LEE C., B. E. DAHL, R. L. BAKER, AND ALAN LOHSE. THE USE OF GRASSES FOR DUNE STABILIZATION ALONG THE GULF COAST WITH INITIAL EMPHASIS ON THE TEXAS COAST. 1972 YEAR-END REPORT TO DEPARTMENT OF THE ARMY CORPS OF ENGINEERS, COASTAL ENGINEERING RESEARCH CENTER, WASHINGTON, D. C.

WOODHOUSE, W. W., JR., E. D. SENECA, AND A. W. COOPER, 1968. USE OF SEA OATS FOR DUNE STABILIZATION IN THE SOUTHEAST. SHORE AND BEACH, 36 (2) : 15-21.

WOODHOUSE, W. W., JR. AND R. E. HANES, 1967. DUNE STABILIZATION WITH VEGETATION ON THE OUTER BANKS OF NORTH CAROLINA. U. S. ARMY CORPS OF ENGINEERS, COASTAL ENGINEERING RESEARCH CENTER TECH. MEM. NO. 22, 43 P.

PROPAGATION OF *SPARTINA ALTERNIFLORA* FOR STABILIZATION AND SALT MARSH DEVELOPMENT

W. W. Woodhouse, Jr.

This study was initiated in 1969 and involved development of techniques for the propagation of smooth cordgrass on dredge spoil and eroding shorelines. Both seeding and transplanting methods have been successful. Transplants are more vigorous than seedlings and are better able to survive on exposed sites and lower elevations. Plants can be dug from natural stands or nursery areas may be established on freshly deposited sandy material in the intertidal zone by seeding or transplanting and utilized the following growing season. Plants produced in this manner provide a source of easy to obtain, vigorous stock. Transplanting is usually done with single stems spaced 3 ft apart. April and May are the best months for transplanting in North Carolina, but it can be done year round. Plants may also be produced from seed under greenhouse conditions.

Seeding is an economical and effective method of establishing this grass. It is less tolerant of rigorous conditions that transplants and is usually effective only in about the upper half of the tide range. Seed are collected at maturity and stored in sea water at 2-3^{o} C. Seeding is done in April or early May in North Carolina by incorporating 50-100 viable seed/m^2 to a depth of 1-3 cm. Seedlings grow rapidly, and under favorable conditions usually produce a better first-year cover than transplants.

Development of transplanted or seeded areas is rapid. After two growing seasons little or no difference exists in appearance and primary productivity between these and long-established natural marshes. The time required for a new marsh to achieve a fully functional biological role is unknown.

The productivity of some natural stands of salt marsh has been found to be limited by the supply of N or of N and P. Nitrogen and P fertilizers enhanced the growth of transplants and seedlings of *S. alterniflora* on sandy sites. These findings suggest that salt marshes may be important in the recycling of nutrients that may otherwise occur as pollutants in the estuary.

"FLORIDA DEPARTMENT OF NATURAL RESOURCES EFFORTS IN COASTAL VEGETATION RESTORATION AND MARINE HABITAT CONSTRUCTION"

Clifford Willis
Director
Division of Marine Resources
Florida Department of Natural Resources
Larson Building
Tallahassee, Florida 32304

Jedfrey Carlton
Marine Biologist
Florida Department of Natural Resources
Marine Research Laboratory
100 - 8th Avenue, S.E.
St. Petersburg, Florida 33701

The Department of Natural Resources has completed or has in progress several projects relating to re-establishment of coastal plant communities and construction of marine habitats. Currently underway is the compilation of a guide to restoration of marine habitats, including salt marsh, mangrove, and seagrasses, as well as artificial reef construction and creation of new oyster beds and their maintenance. This publication should give interested officials and laymen a guide to previously published studies on habitat restoration, and a list of sources of supplies which could be utilized in these projects.

Recently Savage (1972) published on experiments designed to assess the feasibility of utilizing mangroves as natural shoreline stabilizers. His results indicated the black mangrove, Avicennia germinans, might be put to use foe shoreline stabilization due to its cold hardiness, adaptability to damaged substrates (ie., fills, causeways), and to early production of pneumatophores. Also discussed were rooting techniques for seedlings, transplanting oy young naturally occurring seedlings, and pruning of adult specimens. Biologists at the Marine Laboratory are extending Savage's work, experimentally transplanting 150 specimens of Florida mangroves, these between 1.0 and 1.5 meters in height. Fifty plants of each mangrove species found in Florida have been utilized, results indicating a 98% success ratio.

Seagrass transplant experiments have been carried out by Bureau biologists in various sites around Tampa and Boca Ciega Bays. Past seagrass transplant experiments have placed much emphasis on devices used for anchoring the plants to the substrate. However, the main concern should be on the substrate into which the seagrasses are to be transplanted. Thalassia needs an anaerobic environment, whereas Halodule (= Diplanthera) requires an aerobic substrate; Syringodium can thrive in either a reduced or oxidized sediment. If the substrate is unfavorable for specific seagrasses, the initial substrate has to be transplanted with the seagrass clumps. Clumps should be utilized, placed close together, thus roots and rhizomes will exist in a suitable environment from the start and will be able to gradually stabilize surrounding areas. Transplants should be taken from nearby grass beds or from nursery stock obtained from seed.

During 1973, staff members of the Marine Laboratory conducted a floristic survey of coastal vascular plants at seventeen sites around Florida. Sites ranged from Fort Clinch State Park (Fernandina Beach) to the Gulf Islands National Seashore - Fort Pickens (Pensacola Beach). Mangrove, salt marsh and dune community structures were investigated. Data indicates a varied community structure exists in the state, with low indices of similarity values reported for trans-state stations.

An initial transplanting of smooth cord grass, Spartina alterniflora, was also attempted by state biologists during summer of 1973. Plants experienced an almost complete die-back in the winter, but seem to be producing vigorous new shoots from the rhizomes which survived.

SURVEY AND MANAGEMENT OF FLORIDA'S COASTAL VEGETATION

Thomas Savage

No Abstract Submitted

THE USE OF VEGETATION IN THE DESIGN OF REGULATIONS PERTAINING TO COASTAL DEVELOPMENT OF THE BIG CYPRESS CRITICAL AREA

-by-

PRESTON O. HOWARD
Project Planner
Michael Baker, Jr., Inc.
Tampa, Florida

--formerly--
Land Planner
Division of State Planning
Tallahassee, Florida

Abstract

As a result of the passage of the "Big Cypress Conservation Act of 1973," the Florida Division of State Planning was directed to recommend definitive boundaries and land development regulations for approximately 1300 square miles of southwest Florida. The intent of the legislature seemed clear in that specific resources of state or regional concern requiring protection were identified as, "...the Federal Big Cypress National Fresh Water Reserve, Florida, together with such contiguous land and water areas as are ecologically linked with the Everglades National Park, certain of the estaurine fisheries of south Florida, or the fresh water aquifer of south Florida."

Vital to the protection of the estaurine fisheries of this portion of Florida were the maintenance of both the natural coastal vegetative cover and the seasonal hydro-period. Like so many dominos in a row, Man's canalization and other alteration of surface water flows as an early adjunct of settlement caused a substantial decrease in the natural, coastal bio-mass which, together with the altered surface water regime, caused a noticeable loss in resident marine life, including several species of commercial fish and shellfish that are dependent upon these areas as juvenile nurseries.

In attempting to address this problem, while still permitting reasonable use of privately owned land, the Florida Division of State Planning developed regulations which addressed such diverse topics as: 1) Site alteration and maintenance of natural vegetation, 2) Construction of new drainage facilities, and 3) Building of new homesites and other structures. Through regulations such as these, and others more directly pertinant to inland portions of the Big Cypress Area, the Division of State Planning was able to provide what the Governor and Cabinet felt was reasonable protection sufficient to safeguard the above-mentioned resources while still providing for reasonable use of privately-owned land.

This presentation will briefly discuss certain aspects of these regulations as they relate either to the maintenance of existing or to restoration of adversely impacted coastal vegetation.

Dunedin Bay Shoreline Stabilization and Beautification

Joseph Bell and Dave Klassen

No Abstract Submitted.

LARGE SCALE TRANSPLANTATION OF _THALASSIA_ IN SOUTH FLORIDA

IN PRESS IN CONFERENCE ON RESTORATION OF COASTAL VEGETATION IN FLORIDA

by

Thorhaug, A., G. Beardsley and R. Hixon
Department of Microbiology and
Department of Biology and Living Resources

University of Miami
Miami, Florida

The history of transplanting totally submerged grasses has been far less successful than reforestation of tidal marshes. Specifically, the marine grass _Thalassia testudinum_ Konig has been transplanted by sprig on a small scale by several investigators in Florida; these include Phillips, 1960; Strawn, 1961; Jones, 1968; Kelly, Fuss, and Hall 1971. The most detailed description of transplantation is by Kelly, Fuss, and Hall who utilize locations of planting, various anchoring techniques, and various combinations of hormones. Their mortality reported in one area was more than 80% during the first six months. Due to the fact that _Thalassia_ grows chiefly from an apical meristem of the rhizomes we feel that planting by sprig is time consuming and will have limited value. Only rarely does a plant without the apical meristem produce a new short shoot and thus grow laterally. The alternative is planting by seed which was untested until our attempt.

Fruit were collected manually by divers employing SCUBA gear. They were dehisced by mechanical shock of fresh water and immediately cleaned and separated from fruit pod. The seedlings were rapidly transported to the area of planting under aeration and running seawater. Various concentrations and soak time of NAA (Napthalene Acetic Acid) were applied. Seedlings were kept agitated in seawater until planted. Two 150 meter transects were laid out on either side of a 9 hectare area previously denuded of _Thalassia_ and macro-algae by thermal effluents, but now permanently closed to any effluents. This was at Turkey Point, Biscayne Bay, Florida. These transects ran through 3 major zones of regrowth: Halodule wrightii, green siphonaceous algae, and bare peat. Planting included anchoring a portion of the plant with plastic anchors and planting another portion without any anchors. Planting also was done via SCUBA gear. Frequency of planting was at 0.5, 0.25 and 0.1 meters in a pattern repeated every 50 meters.

Growth of blade and root were vigorous. Approximately 15,000 seedlings were planted in the field. Mean growth of blade after 8 months was 16.5 cm ±4.5. Approximately 80% of the plants germinated and remained in position. Of the 20% escaping from position approximately 10% were found in the immediate area of transplanting. Blade turnover began to occur after three weeks and new blades appeared every 14 to 21 days. Rhizomes were present in 89% of the plants after 8 months. 50% of these had second short shoots. 18% had 4 short shoots. The mean number of roots per seed was 8.6±2.6. All plants developed roots.

We wish to acknowledge the support of Sea Grant (NOAA) and Atomic Energy Commission.

LITERATURE CITED

JONES, J. 1968. Primary productivity of the tropical marine turtle grass Thalassia testudinum. Ph.D Dissertation, Univ. Miami, Coral Gables, Florida. 196 pp.

KELLY, J.A.
C.M. FUSS,
J.R. HALL 1971. The transplanting and survival of turtle grass, Thalassia testudinum, in Boca Ciega Bay, Florida. Fish.

Bull. 69 (2): 273-280.

PHILLIPS, R.C. 1960. Observation on ecology and distribution of the Florida seagrasses. SAL. State BD. CONSER., Mar. LAB. PROF. PAP. SER. 2: 1-72.

STRAWN, K. 1961. Factors influencing the zonation of submerged monocotyledons at Cedar Key, Florida. J. WILDL. MANAGE. 25: 178-189.

SEAGRASS REVEGETATION IN ESCAMBIA BAY, FLORIDA

Reginald G. Rogers
EPA, Escambia Bay Recovery Study
Sabine Island, Gulf Breeze, Florida

There is no question that seagrass beds increase diversity in a bay system and that removal of beds will affect the overall well being of an estuary. Historically, submerged vegetation once existed in much of the nearshore portion of Escambia Bay. While no documentation exists of species and their distribution, long-time residents have related where beds existed and their areal extent. This information gives no idea of the species present at that time, but for purposes of revegetation these same areas should be used rather than areas that historically have never had vegetation. Attempts are being made to locate aerial photographs taken in the past. Today we can find only one small bed of grass in the bay.

The main objective of this study is to re-introduce seagrasses into Escambia Bay. Although past species are not recorded, there are at present certain species in adjacent bays which most likely were also present in Escambia Bay.

We plan to transplant four species from adjacent waters into Escambia Bay. Location and species to be transplanted are as follows:

Vallisneria americana	from Blackwater Bay
Ruppia maritima	from East Bay
Halodule wrightii	from East Bay
Thalassia testudinum	from Santa Rosa Sound

Figure 1 shows the relationship of the bays in the Pensacola Bay System. Transplants will be made into eight locations in Escambia Bay. At each location 5 plantings will be made at depths of 1 to 3 feet on 6 inch depth intervals. Four replica plants per each depth interval is planned, therefore, 20 plants of a given species will be utilized at each location. This effort is considered minimal and with increased manpower the locations and plantings will increase. Plantings may be attempted by tying sprigs to metal anchor rods, however, we hope to develop a method of obtaining plugs and putting them into individual degradeable bags.

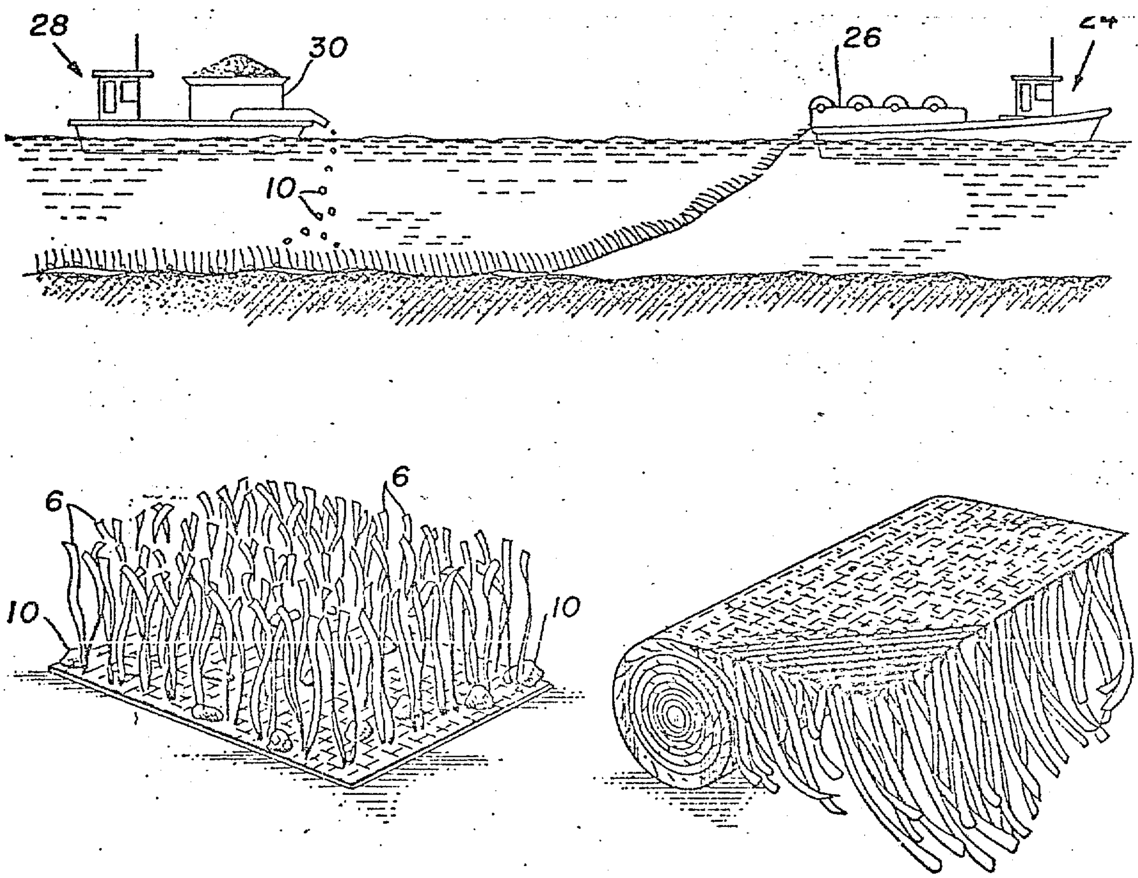
Physical and chemical parameters have been determined on sediments at 258 stations, extensive sampling of benthic fauna has been done at 60 stations, and water quality determined throughout the system. Heavy metals were analyzed at 57 stations in the system. This data will aid in evaluating the results of revegetation.

ADJUNCT STUDY

The main objective of the Environmental Protection Agency, Escambia Bay Recovery Study (EBRS) is to look at ways to accelerate recovery of the bay. Automatically, it is assumed natural recovery is progressing after industrial, agricultural and domestic wastes are reduced in the bay. The addition of artificial seaweed is designed as a temporary measure to increase diversity and enhance sport fishing until a full bay recovery has developed.

Plans are to place the artificial seaweed mats in three locations, each with different salinity regimes. A mat consists of a perforated plastic sheet or of course mesh fabric to which is attached buoyant plastics fronds (Figure 2). The fronds will measure 3 inches wide and 3 feet high. The inventor of this scheme states that wider fronds, consequently increased cover, attract larger fish. Mats will be placed in water depths ranging from 5 - 9 feet. At each of the three locations, a 45 inch by 32 foot mat will be used as well as a cluster of eight 45 x 48 inch mats. A comparison will be made of the strip and cluster configuration for attraction of fish and invertebrates.

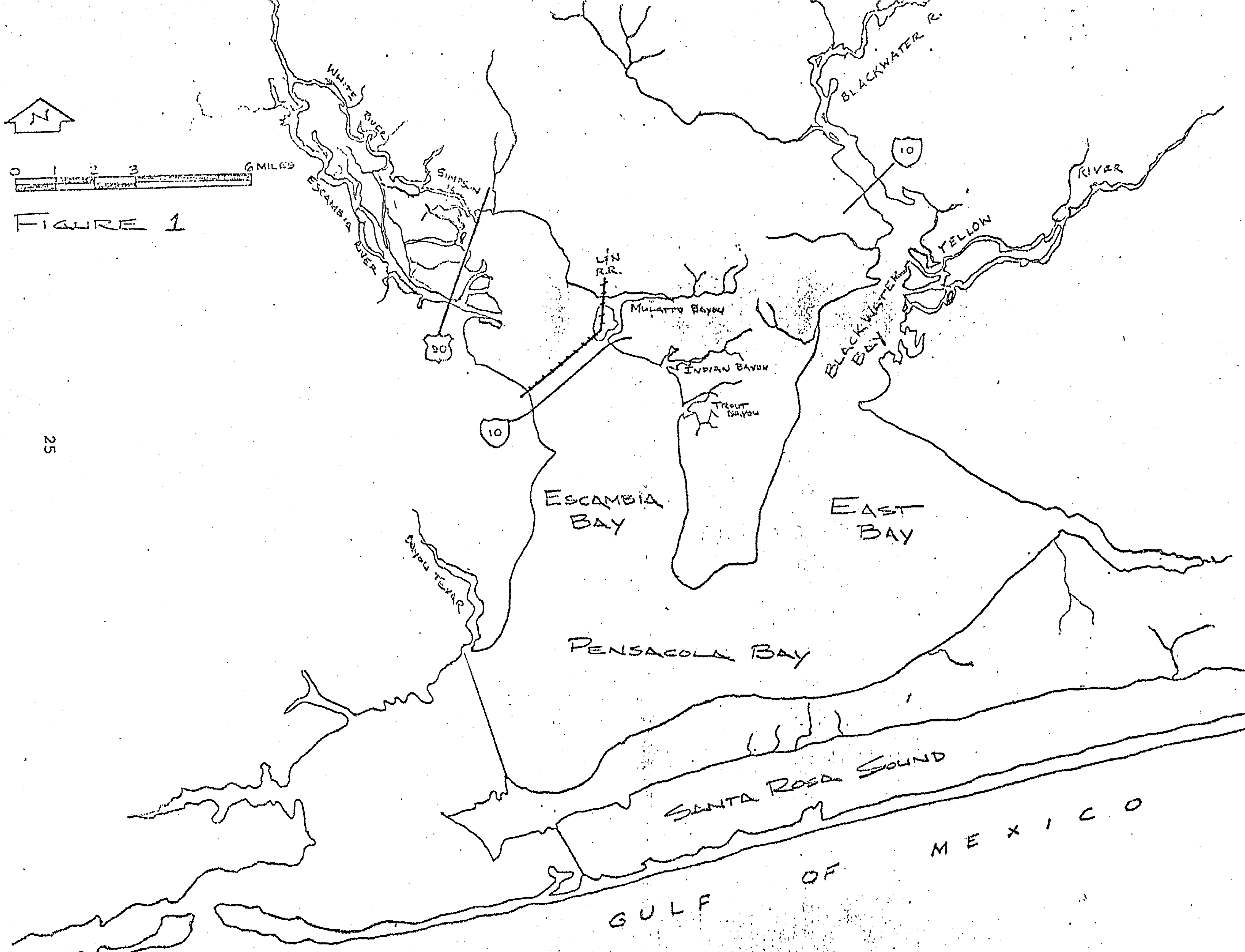
Figure 2



INVENTOR
JAMES E. BROMLEY

BY Stanley M. Tanter

ATTORNEY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TROUT BAYOU
BLACKWATER BAY
90
10
ESCAMBIA BAY
EAST BAY
BAYOU TEXAR
PENSACOLA BAY
SANTA ROSA SOUND
GULF OF MEXICO

FIGURE 1

Aerial Photographic Methods of Studying Submerged Vegetation, a One Area Study

Cherie Down

No Abstact Submitted.

MANGROVE PLANTING IN SOUTH FLORIDA

by Howard Teas, University of Miami

The planting of mangroves is known from the literature. In 1917, Bowman mentioned the planting of red mangroves among ballast stones along the causeways for the "Overseas Railway" as an aid in holding soil (1). Watson, in 1928, referred to mangrove planting as a silvicultural practice (2). In 1940, Davis referred to having planted several thousand red mangrove seedlings at Long Key in the Dry Tortugas (3).

We have hand planted mangroves, in several cases all three Florida species (Rhizophora mangle, Laguncularia racemosa and Avicennia germinans), in a variety of locations in South Florida. These include sites on the North Fork of the St. Lucie River, Elliott Key, North and South Biscayne Bay, Everglades National Park and Port Charlotte. Experimental plantings in the Miami area tested the effects of substrate, fertilizer and ten light levels. We have also transplanted several hundred small (4-8' high) mature plants of all three species for nutrient cycling, herbicide sensitivity and other experiments. In other experiments, we have also transplanted black and white mangroves up to 17 feet tall and 5 inch trunk diameter. Success has varied with method and location. Red mangroves are expecially susceptible to wave energy in exposed sites.

Aerial plantings of Rhizophora were carried out at Sandy Key (and in defoliated areas in the Saigon River Basin in South Vietnam). It was demonstrated that mangrove propagules can be planted at remote sites from a helicopter. The use of slow release fertilizer improved growth in Vietnam experiments.

(1) Bowman, H. H. M. The ecology and physiology of the red mangrove. Proc. Amer. Philos. Soc. 56: 589-672 (1917).

(2) Watson, J. C. Mangrove forest of the Malay peninsula. Malayan Forest Records, No. 6, 1-275 (1928).

(3) Davis, J. H. The ecology and geological role of mangroves in Florida. Carnegie Inst. Wash. Publ. 32: 305-412 (1940).

SIXTEEN YEARS OF GROWING MANGROVES AND TRANSPLANTING OTHER DESIRABLE PLANTS OF THE COASTAL SAND DUNES OF FLORIDA'S LOWER ATLANTIC EAST COAST.

James S. Haeger[1] and William L. Bidlingmayer[1]

In 1968 plantings of natural seedlings of black mangrove, *Avicennia germinans* and white mangroves, *Laguncularia racemosa* were planted at the edge of newly constructed marl and sand dikes on the upper salt marsh east of the Florida Medical Entomology Laboratory. Others volunteered along ditches, reservoirs and canals where the seed floated to the banks at high tide. None of these were subject to wave action, therefore they had a good chance to become established.

The slides we are showing today of *Avicennia* depicts the size that can be attained in 16 years, 8-10" in diameter are average at tree base. At ten years of age the major branch (4½" in diameter) of one tree was cut and the rings counted, surprisingly enough there were 22-24 rings, showing that 2 annual rings per year were formed.

Both black and white mangroves can be grown on beaches or fills away from the water line and almost no pneumatophores will show above the soil. During the past two years we grew black mangrove from seed. Some of these were grown in 6" pots and planted in our salt marsh at FMEL and others were further grown in 18" cylinders and were planted as shown in this slide, during April 1974, on the Beach dunes in association with *Uniola* and *Coccolobis*. Red mangrove can also be found growing inland away from salt water if quantities of muck and other organic mulching is naturally present, or compost could be provided if planted. Sea grasses and sea weed provide all the nutrients needed, under shoreline conditions. Nitrogen is the limiting factor to good growth of all the mangroves under

[1]Biologists, Florida Medical Entomology Laboratory
P. O. Box 520, Vero Beach, Florida 32960

natural or artificial conditions. Black and red mangroves (only 2'-4' tall) growing on calcarious tidal flats on the Florida Keys are between 75-100 years old (or more) presumably because of low detritus, nitrogen and high saline content and the latter is probably not as important as shown by the scrub red mangroves growing many miles inland in Everglades National Park in fresh calcarious soil with low nitrogen.

Plants That Hold Beach Dunes and Drifting Sand in Florida.

Grasses: Paspalum vaginatum*, Spartina patens, Sporobolus virginicus, Uniola paniculata and Paspalum distichum

Herbes or low shrubs: Iva imbricata*, Scaevola plumieri, Tournefortia graphalodes, Agave sisalana, Chrysobalanus icaco (var.) icaco, Licania michauxii, Serenoa repens*, Śesuvium portulacastrum and Yucca aloifolia*

Trees: Coccoloba uvifera*, Conocarpus erecta* and black mangrove, Avicennia germinans*

Vines: Helianthus debilis*, Ipomea pes-caprae and Canavalia maritima, Ernodea littoralis var. litteralis

Back Dune Vegetation that Tolerates Salt Spray

Shrubs: Randia aculeata*, Myrsine guianensis*, Croton punctatus, Bumelia tenax*, Eugenia dicrana*, Lycium carolinianum*

Trees: Quercus virginiana*, Pisonia discolor*, Bumelia tenax*, Persea borbonia var. humilis, Bursera simaruba*, Conocarpus erecta* and Sable palmetto*.

In conclusion, I might stress that there are other salt tolerant plants besides these on the east and south east coast of Florida, but these are the major ones besides the mangroves.

*Plants that have been transplanted or grown from seed successfully.

Seeds and Seas

Violet Stewart

No Abstract Submitted.

The Rôle of Wood-Boring Organisms in Mangrove Restoration

Ernest D. Estevez
Department of Biology,
The University of South Florida, Tampa, Fl. 33620

Attempts at mangrove planting or restoration in Florida must take into consideration the variety, distribution and activity of wood-boring organisms. Formulation of particular restoration strategies requires prior knowledge of the intensity and seasonality of dispersal, the proximity and mode of infestation of the wood-borers discussed below.

The scolytid beetle *Poecilips rhizophorae* (Hopkins), reported from Miami and Longboat Key, Florida, was known to infest rooted seedlings of *Rhizophora mangle*, the red mangrove (Woodruff, 1970). Reported here is destructive activity of the beetle in propagules still attached to the parent mangrove.

The marine bivalve family of "shipworms" (Teredinidae) is represented in Florida waters by 15 species of *Teredo* and 6 species of *Bankia*. Shipworms burrow for protection and nourishment, and are difficult to detect during casual inspection of woods due to the small size of entrance holes formed during larval penetrance. However, shipworm burrows may be identified by their characteristic, calcareous linings (Turner, 1966). Relative to the abundance of other wood-borers, few shipworms are found in the intertidal mangrove habitat of west Florida. The rarity of shipworms may be due to natural chemical resistance of mangrove tissue (Davis, 1940), or the typical subtidal pattern of settlement of shipworm larvae. Another bivalve capable of destroying mangrove wood is the pholadid *Martesia striata* Linne, which produces wide but shallow excavations. *Martesia* should not be confused with *Modiolus*, represented by two mussel species in Florida mangroves.

Wood-boring crustaceans found in Florida belong to the isopod genera *Limnoria* and *Sphaeroma*. Little is known of the distribution of *Limnoria* in

Florida mangroves. Limnorids utilize their wood substratum for food. Only one of the four species of Florida Sphaeroma is a true wood-borer, but this species burrows only to secure protective habitat. On the basis of an examination of types deposited with the Smithsonian Institution, it is clear that the proper identity of the wood-borer in Florida is Sphaeroma terebrans Bate, and that S. destructor Richardson is correctly placed into synonomy with S. terebrans. Two orthostenohaline species of Sphaeroma frequently mistaken for the wood-borer are S. walkeri Stebbing and S. quadridentatum Say. These species may be distinguished from S. terebrans on the basis of dorsal sculpturing: S. walkeri displays extreme tuberculation, while S. quadridentatum (sensu strictum) is entirely smooth.

A form of Sphaeroma new to the fauna of Florida is reported. The new species is sexually dimorphic and chromatically polymorphic, and is the only abundant congener sympatric with S. terebrans in Florida mangroves. It is not a known wood-borer, and may be found from inner estuaries out to the higher salinity regime of the Gulf of Mexico, wheras S. terebrans penetrates far into the fresh waters of inland rivers.

Davis, J.H. 1940. Papers from Tortugas Laboratory, 32: 305-412, plus plates.

Turner, R.D. 1966. A Survey and Illustrated Catalogue of the Teredinidae. Harvard.

Woodruff, R.E. 1070. Entomology Circular No. 98, Florida Department of Agriculure and Consumer Services. 2 pp.

A Preliminary Report on Natural Revegetation Rates in Disturbed Mangrove Communities

Tom Detweiler

Research is presently in progress at three sites on Tampa Bay to determine the natural revegetation rates in distrubed mangrove communities. The three sites are:

1. An undisturbed site as a control
2. A recently disturbed site where natural revegetation will be followed from the start
3. A site disturbed three years ago and having undergone natural revegetation since

Preliminary observations indicate white mangroves (Laguncularia) predominate and appear as the pioneer species in disturbed mangrove communities on Tampa Bay. Black mangroves (Avicennia) appear to revegetate at a somewhat slower rate. Red mangroves (Rhizophora) are the least common of revegetating species.

POSSIBLE USE OF SPOIL MATERIAL TO REPLACE LOST COASTAL VEGETATION IN FLORIDA

Robin Lewis and Frank Dunstan

Nationwide it has been estimated that about 300,000,000 cu yd (230,700,000 cu m) of maintenance dredge material and 80,000,000 cu yd (61,500,000 cu m) of new dredge material are generated each year at a cost exceeding $150,000,000 (Boyd et al, 1972).

The disposal of this material has, in the past, been accomplished in one of two major ways: open water disposal, with its resultant turbidity problems and destruction of benthic organisms, and disposal on coastal marshes. The latter, in conjunction with landfill operations, has resulted in the loss of 23,521 acres (9,519 ha) of shallow bottoms and marshes along the Gulf Coast of Florida alone (McNulty et al, 1972).

Past deepening and maintenance of the Tampa Bay Harbor channels has resulted in the creation of approximately 170 acres (72 ha) of emergent spoil. The oldest of these spoil islands, Bird Island, presently supports a large nesting population of 12 species of birds numbering up to 20,000 pairs. The island has been designated as a National Audubon Wildlife Sanctuary for 20 years.

A proposed harbor deepening project is expected to generate 75,000,000 cu yd (55,276,000 cu m) of spoil material, all of which is presently planned for open water disposal within the bay. The U. S. Fish and Wildlife Service has suggested that some of this spoil could be placed in such a manner as to allow rapid creation of beneficial coastal vegetation habitat similar to that of Bird Island.

A joint investigation of the possible beneficial use of spoil material in Tampa Bay is presently in progress under the sponsorship of the Tampa Port Authority. Save Our Bay, Inc., and the National Audubon Society are examining 14 man-made spoil islands and 3 natural islands to determine the feasibility of additional spoil island creation to replace lost rookery habitat in the Tampa Bay area.

The investigations will include large scale replanting of mangroves on spoil islands and damaged coastal areas. Initial observations indicate that it may also be desirable to use Spartina to stabilize spoil, much as has been done in North Carolina (Woodhouse, Seneca, and Broome, 1972).

It also appears that the most beneficial use of existing and proposed spoil islands would include the establishment and maintenance of a variety of habitats for different species of birds such as mangroves for the Brown Pelican, Paspalum for the Laughing Gull, and bare sand for the Caspian Tern.

Literature Cited

Boyd, M. B., R. T. Saucier, J. W. Keeley, R. L. Montgomery, R. D. Brown, D. B. Mathis, and C. J. Guice. 1972. Disposal of dredge spoil. Technical Report H-72. Office, Chief of Engineers, U. S. Army. 121 p.

McNulty, J. K., W. N. Lindall, and J. E. Sykes. 1972. Cooperative Gulf of Mexico estuarine inventory and study, Florida: Phase 1, area description. NOAA Technical Report NMFS Circ-368. 126 p.

Woodhouse, W. W., E. D. Seneca, and S. W. Broome. 1972. Marsh building with dredge spoil in North Carolina. Bull. N. C. Agic. Expt. Station No. 445. 28 p.

COLONIZATION OF SPOIL ISLANDS

Julie Morris and Jono Miller

Julie Morris
1351 3rd St.
Sarasota, FL 33577

Jono Miller
#542 - Box 1958
Sarasota, FL 33578

Spoil islands are artificially created as the result of piling spoil from dredging operations higher than sea level. The spoil islands created by the dredging of the intracoastal waterway on the west coast of Florida are modified by a number of forces, including human use, water currents, winds, and the arrival and colonization by various organisms in both upland and submerged areas. Our study focuses on upland vegetation and defines general associations and trends on a number of spoil islands in Sarasota Bay, Roberts Bay, and Charlotte Harbor. The study raised a number of yet unanswered questions regarding the entire process of the creation and management of spoil islands.

Planting Mangroves on Spoil Islands in the Indian River

Gregory Smith

No Abstract Submitted.

John B. Morrill, Division of Natural Sciences
New College - Sarasota, Florida 33578

The submerged and shoreline vegetation of three canal systems, Siesta Key, Florida - preliminary observations and recommendations.

In 1972 three man made canal-waterway systems were studied with respect to the distribution of marine grasses, water circulation and water quality parameters. Two canal systems had vegetated shorelines and one sea walled shorelines. The overall "water quality" of each system was unique. The distribution of marine grasses was related to recruitment, depth and width of hermo, tidal current velocities (Conover, 1967. Bot. Mar. 11, 1-9) and presence of shoreline vegetation.

Recommendations for shoreline and waterway management include - 1) canal design for optimal tidal flushing, 2) pruning of vegetated shorelines, 3) removal of aquatic plants and debris that enter the canal systems from the open bays and 4) aeration of the bottom waters in dead end canals.

*Kenneth C. Alvarez
Divsision of State Parks
P.O. Box 398
Osprey, FL 33559

Library
Archbold Biological Station
Rt. 2 Box 180
Lake Placid, FL 33852

*Gail Baker
Seminole Jr. College
Sanford, FL 32771

*Richard Bantz
Corkscrew Swamp Sanctuary
Rt. 2 Box 1875
Naples, FL 33940

Brian Barnett
Fla. Game and Freshwater
Fish Comm.
P.O. Box 1840
Vero Bch, FL 32960

*Gary L. Beardsley
Univ. of Miami
10 Rickenbacker Causeway
Miami, FL

*Joe Bell
Milo Smith and Assoc.
215 Madison St.
Tampa, FL 33602

Brian Bedford
The Nature Conservancy
1800 N. Kent St., Suite 800
Arlington, VA 22209

J. D. Benefield, Jr.
Sea-Island Properties, Inc.
Sea-Island, GA 31561

*Scott Benyon
Internal Improvement Trust Fund
2432 N.E. 7th St., Apt. 1
Ocala, FL 32670

*William L. Bidlingmayer
Fla. Medical Entomology Lab
P.O. Box 520
Vero Bch, FL

*Susan Bird
Tampa Audubon Society
1617 E. Hanna
Tampa, FL 33610

Derek Burch
Dept. of Biology
Univ. of South Fla.
Tampa, FL 33620

*Allen Burdett
Fla. Dept. of Nat. Res.
525 Mirror Lake Dr.
St. Petersburg, FL 33701

*Otto Bundy
Horticultural Systems
P.O. Box 3
Bradenton, FL

*Brian Bussen
Arthur Strock and Assoc.
829 S.E. 9th St.
Deerfield Bch, FL 33441

*Bill Byle
Biological Consultant
Rt. 4 Box 463
Ft. Myers, FL 33905

*Jedfrey Carlton
Fla. Dept. of Nat. Res.
100 8th Ave., S.E.
St. Petersburg, FL 33701

Roberta Carney
Georgia Office of Planning and Budget
270 Washington St., S.W.
Atlanta, GA 30334

*Joseph D. Carroll, Jr.
Bureau of Sports Fisheries and Wildlife
P.O. Box 2676
Vero Bch, FL 32960

*Sally Casper
Save Our Bay, Inc.
5307 Cleveland St.
Tampa, FL

George Christy
1138 East Osceola
Stuart, FL 33494

* Attended Conference

*Marvin Collins
3650 Rins Lane, Apt 118
Jacksonville, FL 32207

*Marc A. Cormier
Fla. Dept. of Pollution Control
3319 Maguire Ave.
Orlando, FL

Charles L. Coultas
Fla. A and M University
Tallahassee, FL 32307

*Dennis F. Creamer
Bureau of Sport Fisheries and Wildlife
P.O. Box 2676
Vero Bch.,Fl 32960

Jerry Cutlip
Corkscrew Swamp Sanctuary
Box 1875 Rt. 2 Sanctuary Rd.
Naples, FL 33940

Lillian Dean
Georgia Dept. of Nat. Res.
270 Washington St., N.W.
Atlanta, Ga.

*Scott Derek
210 Miramar St.
Ft. Myers, FL 33931

*John F. Dequine
Southern Fish Culturists, Inc.
P.O. Box 251
Leesburg, FL 32748

*Cherie Down
Brevard County Health Dept.
1744 S. Cedar St.
Rockledge, Fl 32922

Cathie Duncan
Vista Harbor, 10-G
2800 Indian River Blvd.
Vero Bch., FL 32960

Mike Durak
Phillips, Wine and Phillips, Inc.
595 N. Nova Rd.
Ormond Bch., FL 32074

*Frank Dunstan
National Audubon Society
Rt. 1 Box 205-U
Ruskin, FL

*Tom Detweiler
East Stroudsburg State College
Rt. 1 Box 205-U
Ruskin, FL

*Ernest Estevez
Dept. of Biology
Univ. of S. Fla.
Tampa, FL 33620

Jack Fell
University of Miami
10 Rickenbacker Causeway
Miami, FL

*Robin H. Fields
Merritt Island National Wildlife Refuge
P.O. Box 6504
Titusville, FL 32780

*Carole Goetz
U. S. Geological Survey
500 Zack St.
Tampa, FL 33602

*Carl R. Goodwin
U. S. Geological Survey
500 Zack St.
Tampa, FL 33602

*Stanley Graves
M.G.E., Inc.
3000 N.E. 30th Pl.
Ft. Lauderdale, FL 33306

Ozzie Gray
Dept. of Natural and Economic Res.
P.O. Box 27687
Raleigh, N.C. 27611

*Edgar W. Garbisch, Jr.
Environmental Concern, Inc.
P.O. Box P
St. Michaels, MD 21663

*James S. Haeger
Fla. State Board of Health
P.O. Box 520
Vero Bch., FL

John L. Gallagher
Univ. of Georgia
Marine Institute
Sapelo Island, GA 31327

*Warren W. Hagenbuck
Bureau of Sport Fisheries and Wildlife
P.O. Box 2676
Vero Bch., FL 32960

*Jim Hannan
Fla. Institute of Technology
720 Indian River Dr.
Jensen Beach, FL 33457

Jay L. Harmic
Deltona Corp.
Marco Applied Ecology Station
Marco Island, FL 33937

J. F. Havel
S. C. Water Resources Comm.
700 Know Abbott Dr.
Drawer 164
Cayce, S.C. 29033

Robert J. Heald
Tropical Bio-Industries Development Co.
8966 S. E. 87 Ct.
Miami, FL 33156

E. T. Heinen
Environmental Protection Agency
Suite 101 - 3203 Lawton Rd.
Orlando, FL 32803

Vernon J. Henry
Skidaway Institute of Oceanography
P.O. Box 13687
Savannah, GA 31406

*Raymond F. Hixon
Univ, of Miami
10 Rickenbacker Causeway
Miami, FL 33149

Marcus L. Horton
Bureau of Sports Fisheries and Wildlife
P.O. Box 2676
Vero Bch., FL 32960

*Preston O. Howard
Michael Baker Jr., Inc.
Suite 713, Barnett Bank Building
Tampa, Fl 33602

*W. Bruce Johnson
Coastal Coordinating Council
309 Office Plaza Dr.
Tallahassee, FL 32301

*Adrien A. Jump
1705 Beddingfield Dr.
Tampa, FL 33603

Herbert W. Kale
Pelican Island Audubon Society
P.O. Box 1833
Vero Bch., FL 32960

Carl R. Keeler
Manatee Jr. College
Bradenton, FL 33507

*Reese H. Kessler
Fla. Dept. of Nat. Res.
P.O. Box 2569
Titusville, FL

Marilyn C. Kimball
Post, Buckley, Schuh, and Jernigan, Inc.
7500 N.W. 52nd St.
Miami, FL 33166

*Dave Klassen
Milo Smith and Assoc, Inc.
215 Madison St.
Tampa, FL 33602

Kathy Laduca
Dept. of Biology
University of South Fla.
Tampa, FL 33620

Jim Lee
Phillips, Wine and Phillips, Inc.
595 N. Nova Rd.
Ormond Bch., FL 32074

*M.E. Lehman
Univ. of FLa.
213 Black Hall
Gainesville, FL

*Roy R. "Robin" Lewis III
Dept. of Biology
Hillsborough Community College
P.O. Box 22127
Tampa, FL 33622

Jeffrey L. Lincer
Mote Marine Lab
9501 Blind Pass Rd.
Sarasota, FL 33581

John R. Lindell
Bureau of Sport Fisheries and
Wildlife
P.O. Box 2676
Vero Bch., FL 32960

Aeriel Lugo
Dept. of Nat. Res.
Box 5887
Puerta de Tierra
Puerto Rico 00906

*Joseph R. Lynch
M.G.E., Inc.
3000 N.E. 30th Pl.
Ft. Lauderdale, FL 33606

*Patrick B. Lyons
17 Sailfish Rd.
Vero Bch, FL 32960

John Martin
Hillsborough County Environmental
Protection Agency
906 Jackson St.
Tampa, FL 33602

*Valentine Maynard
Univ. of S. Fla.
Marine Science Dept.
830 1st. St. S.
St. Petersburg, FL 33701

*Michael D. McKenzie
S.C. Wildlife and Marine Res. Dept.
P.O. Box 12559
Charleston, S.C. 29412

John L. McQuigg
Florida Audubon Society
P.O. Box 1408
Stuart, FL 33494

*James M. Madden
2004 142nd Ave.
Tampa, FL 33612

*Jack Merriam
Dept. of Biology
Univ. of S. Fla.
Tampa, FL 33620

Ted Mew
National Parks Service
Manteo, N.C. 27954

*Jono Miller
Division of Natural Science
New College
Sarasota, FL 33578

*John B. Morrill
Division of Natural Science
New College
Sarasota, FL 33578

*Julie Morris
Division of Natural Science
New College
Sarasota, FL 33578

Mrs. Clarence Naas
289 Tropical Shore Way
Ft. Myers Bch., FL 33931

Frank P. Nelson
S.C. Water Resources Comm.
700 Knox Abbott Dr.
Cayce, S.C. 29033

Maurice W. Provost
Fla. Medical Entomology Lab
P.O. Box 520
Vero Bch., FL 32960

Richard T. Paul
National Audubon Society
115 Indian Mound Trail
Tavenier, FL 33070

*Frank Phillips
Fla. Dept. of Pollution Control
2562 Executive Center Cir.
Tallahassee, FL 32301

Terry Pulver
Fla. Dept. of Nat. Res.
100 8th Ave., S.E.

Carl C. Radder
St. Petersburg Audubon Society
5863 Bayou Grande Blvd., N.E.
St. Petersburg, FL 33703

*P. W. Ramee
Thomas and Hutton Eng. Co.
P.O. Box 8042
Savannah, GA 31402

Andrew E. Rehm
William F. Clapp Lab
397 Washington St.
Duxbury, Mass. 02332

Richard E. Roberts
Div. of Parks and Recreation
P.O. Box 1246
Hobe Sound, FL 33455

*Reginald G. Rodgers
Environmental Protection Agency
Sabine Island
Gulf Breeze, FL 32561

Steve Rose
Environmental Design Group
4306 Silver Star Rd.
Orlando, FL 32808

Bill Rosenberg
Henderson-Rosenberg and Assoc.
P.O. Box 430680
Miami, FL 33143

Jack Rudloe
Gulf Specimen Co.
P.O. Box 237
Panacea, FL 32346

Jack Salmela
Brevard Mosquito Control
P.O. Box 728
Titusville, FL 32780

*Thomas Savage
Fla. Dept. of Nat. Res.
301 Pennington Building
Tallahassee, FL 32304

Allan M. Schrader
Tampa Port Authority
P.O. Box 2192
Tampa, FL 33601

Ralph W. Schreiber
Dept. of Biology
Univ. of S. Fla.
Tampa, FL 33620

*David Scott
Internal Improvement Trust Fund
4706 N.W. 28th St.
Gainesville, FL 32605

*Donald P. Self
Studio 10 Design Group
10 S. Fort Harrison Ave.
Clearwater, FL 33516

*Maurice Sell
Univ. of Fla.
39 N.W. 39th Ave.
Gainesville, FL 32601

*Warren Silver
Dept. of Biology
Univ. of South Fla.
Tampa, FL 33620

Harold Sims
Natural Science Dept.
St. Pete Jr. College
2465 Drew St.
Clearwater, FL 33515

*Gregory Smith
Vero Beach Jr. High Ecology Club
P.O. Box 292
Vero Bch., FL 32960

Richard Stalter
Dept. of Biology
St. Johns University
Jamaica, N.Y. 11439

*Robert J. Standish
Bureau of Sport Fisheries and Wildlife
PO. Box 2676
Vero Bch., FL 32960

Mike Stearman
Phiiips, Wine and Phillips, Inc.
595 N. Nova Rd.
Ormond Bch., FL 32074

J. A. Stevenson
Div. of Parks and Recreation
Larson Building
Tallahassee, FL

*Roger P. Stewart
Rt. 1 Box 236
Plant City, FL 33566

*Violet N. Stewart
Conservation Consultants, Inc.
TECO Big Bend Marine Lab
P.O. Box 111
Tampa, FL 33601

*Carolyn D. Stiles
Dept. of Marine Science
Univ. of S. Fla.
830 1st St., S.
St. Petersburg, FL

*Michael Stuart
Florida Audubon Society
2727 Kilgore Place
Sarasota, FL 33580

Paul W. Sykes, Jr.
U. S. Fish and Game Service
P.O. Box 2077
Delray Bch.,FL 33444

Thomas S. Talley
U. S. Fish and Wildlife Service
P.O. Box 4277
Panama City, FL

*Howard Teas
Univ. of Miami
P.O. Box 8389

W. J. Tiffany
Environmental Studies
New College
P.O. Box 1898
Sarasota, FL 33578

*Anitra Thorhaug
Univ. of Miami
10 Rickenbacker Causeway
Miami, FL 33149

*Suzanne Todd
2503 Irene St., Apt. 4
Lutz, FL 33549

Richard S. Tomasello
Gee and Jenson Consulting Eng, Inc.
2019 Okeechobee Blvd.
West Palm Bch., FL 33401

*Sarita Van Vleck
Sanibel-Baptiva Conservation Foundation
Captiva, FL 33924

*Jack Van Breedveld
Fla. Dept. of Nat. Res.
100 8th Ave., S.E.
St. Petersburg, FL 33701

*Timothy Varney
Michael Baker, Jr., Inc.
Suite 713, Barnett Bank Building
Tampa, FL 33602

Gerald M. Ward
Gee and Jenson, Eng.
P.O. Box 10441
Riveria Bch., FL 33404

Gerald Walsh
U. S. Environmental Protection Agency
Sabine Island
Gulf Breeze, FL 32561

*John Wester
Internal Improvement Trust Fund
P.O. Box 263
White Springs, FL 32096

*Richard G. Wilkins
Hillsborough County Environmental Protection Commission
906 Jackson St.
Tampa, FL 33602

*Dick Williams
Internal Improvement Trust Fund
732 Valley Forge Rd.
West Palm Bch, FL 33405

Herbert L. Windom
Skidaway Institute of Oceanography
Box 13687
Savannah, GA 31406

*Clifford A. Willis
Fla. Dept. of Nat. Res.
Larson Building
Tallahassee, FL

*W. W. Woodhouse, Jr.
N. C. State University at Raleigh
Box 5907
Raleigh, N.C. 27607

Bernard J. Yokel
Univ. of Miami
Rookery Bay Marine Station
Rt. 1, Box 684
Naples, FL 33620

*David A. Zuberer
Dept. of Biology
Univ. of S. Fla.
Tampa, FL 33620

A PARTIAL BIBLIOGRAPHY

OF PAPERS ON COASTAL PLANT VEGETATION

Jedfrey M. Carlton
Department of Natural Resources
Marine Research Laboratory
100 - 8th Avenue, S.E.
St. Petersburg, Florida 33701

I. GENERAL REFERENCES

Bernstein, L. 1964. Salt tolerance of plants. U.S. Dept. of Agriculture Bull. 283.

Bernstein, L. and H. E. Hayward. 1958. Physiology of salt tolerance. Ann. Rev. Plant Physiol. 9: 25-46.

Bush, C. S. and J. F. Morton. n.d. Native trees and shrubs for Florida landscaping. Fla. Dept. of Agriculture, Tallahassee.

Chapman, V. J. 1960. Salt marshes and salt deserts of the world. Leonard Hill Books, Ltd., London. 392 pp.

Harper, R. M. 1927. Natural resources of southern Florida. Eighteenth Ann. Rept., Fla. Geol. Survey, Tallahassee, pp. 26-206.

Hitchcock, A. S. 1935. Manual of the grasses of the United States. U.S. Dept. of Agriculture, Miscl. Pub. No. 200. 1,040 pp.

Long, R. W. and O. Lakela. 1971. A flora of tropical Florida. Univ. of Miami Press, Coral Gables. 962 pp.

Menninger, E. A. 1964. Seaside plants of the world. Hearthside Press, New York. 303 pp.

McNulty, J. K., W. N. Lindall and J. E. Sykes. 1972. Cooperative Gulf of Mexico estuarine inventory and study, Florida. Phase I - area description. U.S. Dept. of Commerce, NOAA Tech. Rept. NMFS Circ-368. 126 pp.

Oosting, H. J. 1954. Ecological processes and vegetation of the maritime strand in the southeastern United States. Botanical Review 20(4): 226-262.

Radford, A. E., H. F. Ahles and C. R. Bell. 1968. Manual of the vascular flora of the Carolinas. Univ. of North Carolina Press, Chapel Hill. 942 pp.

Reasoner, E. S. 1952. Salt tolerant plants in south Florida. Proceedings of the Fla. State Horticulture Soc., Vol. 65.

Shore and Beach. Semi-annual journal of the American Shore and Beach Preservation Society, 10 Rickenbacker Causeway, Miami, Florida.

Small, J. K. 1933. Manual of the southeastern flora. Univ. of North Carolina Press, Chapel Hill. 1,554 pp.

Teal, J. and M. Teal. 1969. Life and death of the salt marsh. Ballantine Books, New York. 274 pp. (paper)

Thorne, R. F. 1954. Flowering plants of the waters and shores of the Gulf of Mexico, pp. 193-202, in, The Gulf of Mexico, its origins, waters and marine life. U. S. Fish and Wildl. Serv., Fisheries Bull. 89.

Uphof, J. C. 1941. Halophytes. Botanical Review 1: 1-58.

Waisel, Y. 1972. Biology of halophytes. Academic Press, New York. 395 pp.

Wells, B. W. and I. V. Shunk. 1938. Salt spray: an important factor in coastal ecology. Bull. Torrey Bot. Club 65: 485-492.

II. SAND DUNE/STRAND VEGETATION

Blake, C. T. and W. W. Woodhouse, Jr. 1972. Vegetative dune stabilization in North Carolina. Agronomy Information Leaflet, N. C. Agric. Extention Service, Beach and Dune Stabilization Series No. 1. 2 pp.

Boyce, S. G. 1954. The salt spray community. Ecol. Monogr. 24: 29-67.

Davis, J. H. 1957. Dune formation and stabilization by vegetation and plantings. U.S. Army Corps of Engineers, Beach Erosion Control Board, Tech. Memorandum No. 101. 59 pp.

Gage, B. O. 1970. Experimental dunes of the Texas coast. U.S. Army Corps of Engineers, Coastal Engineering Research Center, Miscl. Paper No. 1-70. 30 pp.

Gibbs, R. F. and E. Nash. 1961. Beach and sand dune erosion control. Trans. Amer. Agricult. Engineering 1961: 122-127.

Graetz, K. E. 1973. Seacoast plants of the Carolinas - for conservation and beautification. Office of Sea Grant, Univ. of North Carolina, Raleigh, Sea Grant Publ. No. UNC-SG-73-06. 206 pp.

Hawk, V. B. and W. C. Sharp. 1967. Sand dune stabilization along the north Atlantic coast. J. Soil Water Conserv. 22(4): 143-146.

Kurz, H. 1940. The reaction of magnolia, scrub live-oak, slash pine, palmetto and other plants to dune activity on the western Florida coast. Proceedings of the Florida Academy of Sciences 1939: 195-203.

Kurz, H. 1942. Florida dunes and scrub - vegetation and geology. Fla. Geol. Survey Bull. No. 23. 154 pp.

Oosting, H. J. 1945. Tolerance to salt spray of plants of coastal dunes. Ecology 26: 85-89.

Oosting, H. J. and W. D. Billings. 1942. Factors affecting vegetational zonation on coastal dunes. Ecology 23: 131-142.

Ranwell, D. S. 1972. Ecology of salt marshes and sand dunes. Chapman and Hall, Ltd., London. 258 pp.

Savage, R. P. and W. W. Woodhouse, Jr. 1968. Creation and stabilization of coastal barrier dunes. U.S. Army Corps of Engineers, Coastal Engineering Research Center, Reprint No. 3-69. Reprinted from Proceedings of the Eleventh Conference on Coastal Engineering, London, England, September, 1968. pp. 672-700.

Schory, E. A., Sr. 1970. Salt tolerant, cold hardy, drought resistant trees and shrubs for north and central Florida. Fla. Div. of Forestry, Tallahassee. 10 pp.

Seneca, E. D. 1972a. Germination and seedling response of Atlantic and Gulf coast populations of Uniola paniculata. Am. J. Bot. 59(3): 290-296.

Seneca, E. D. 1972b. Seedling response to temperature and salinity in four dune grasses from the Outer Banks of North Carolina. Ecology 53(3): 465-471.

Stalter, R. 1970. Factors affecting vegetational zonation on coastal dunes, Georgetown County, South Carolina. A.S.B. Bull. 17: 102. (Abstr.)

Wagner, R. H. 1964. The ecology of Uniola paniculata L. in the dune-strand habitat of North Carolina. Ecol. Monogr. 34(1): 79-96.

Westra, R. N. and W. E. Loomis. 1966. Seed dormancy in Uniola paniculata. Am. J. Bot. 53(4): 407-411.

Woodhouse, W. W., Jr., and R. E. Hanes. 1967. Dune stabilization with vegetation on the Outer Banks of North Carolina. U.S. Army Corps of Engineers, Coastal Engineering Research Center, Tech. Memo. No. 22. 45 pp.

Woodhouse, W. W., Jr., E. D. Seneca and A. W. Cooper. 1968. Use of sea oats for dune stabilization in the southeast. Shore and Beach 36(2): 41-48.

Zak, J. M. and E. Bredakis. 1963. Dune stabilization at Provincetown, Mass. Shore and Beach 31(2): 19-24.

III. SALT MARSHES

Adams, D. A. 1963. Factors affecting vascular plant zonation in North Carolina salt marshes. Ecology 44: 445-456.

Broome, S. W., W. W. Woodhouse, Jr., and E. D. Seneca. 1973. An investigation of propogation and the mineral nutrition of *Spartina alterniflora*. Univ. of North Carolina, Sea Grant Publ. No. UNC-SG-73-14. 121 pp.

Coultas, C. L. 1969-1970. Some saline marsh soils in north Florida. I. Proc. Soil Crop Soc. Fla. 29: 111-123. II. Proc. Soil Crop Soc. Fla. 30: 275-282.

Hinde, H. P. 1954. The vertical distribution of salt marsh phanerograms in relation to tide levels. Ecol. Monogr. 24(2): 209-225.

Jackson, C. R. 1954. Some topographic and edaphic factors affecting plant distribution in a tidal marsh. Q. J. Fla. Acad. Sci. 15(3): 137-146.

Keefe, C. W. 1972. Marsh production: A summary of the literature. Contrib. Mar. Sci., Univ. of Texas 16: 163-181.

Kurz, H. and K. Wagner. 1957. Tidal marshes of the Gulf and Atlantic coasts of northern Florida and Charleston, South Carolina. Fla. State Univ. Studies No. 24. 168 pp.

Lytle, T. F., J. S. Lytle and P. L. Parker. 1973. A geochemical study of a salt marsh environment. Gulf Research Reports 4(2): 214-232.

Mobberley, D. G. 1956. Taxonomy and distribution of the genus Spartina. Iowa State College Journal of Science 30(4): 471-574.

Penfound, W. T. 1952. Southern swamps and marshes. Botanical Review 18: 413-446.

Penfound, W. T. and E. S. Hathaway. 1938. Plant communities in the marshlands of southeastern Louisiana. Ecol. Monogr. 8: 1-56.

Reed, J. F. 1947. The relation of the Spartinetum glabrae near Beaufort, North Carolina, to certain edaphic factors. Amer. Midl. Naturl. 38: 605-614.

Stalter, R. 1970. The zonation of vegetation in southeastern salt marshes. A.S.B. Bull. 17: 65. (Abstr.)

Stalter, R. 1973a. Factors influencing the distribution of vegetation of the Cooper River estuary. Rhodora 38(1): 18-24.

Stalter, R. 1973b. Seed viability in two Atlantic coast populations of Spartina alterniflora. Rhodora 38(1): 110-113.

Stalter, R. 1973c. Transplantation of salt marsh vegetation II, Georgetown County, South Carolina. Castanea 38: 132-139.

Stalter, R. and W. T. Batson. 1969. Transplantation of salt marsh vegetation I, Georgetown, South Carolina. Ecology 50: 1087-1089.

Stalter, R. and W. T. Batson. 1973. Seed viability in salt marsh taxa, Georgetown County, South Carolina. Rhodora 38(1): 109-110.

Wherry, E. T. 1920. Plant distribution around salt marshes in relation to soil acidity. Ecology 1: 42-54.

Woodhouse, W. W., Jr., E. D. Seneca and S. W. Broome. 1972. Marsh building with dredge spoil in North Carolina. Bull. N. C. Agric. Expt. Station No. 445. 28 pp.

Yarlett, L. L. and J. R. Moore. 1963. Management of Gulf coast salt marshes. J. Soil Water Conserv. 18(4): 166-167.

IV. SEAGRASSES

Humm, H. J. 1956. Seagrasses of the northern Gulf of Mexico. Bull. Mar. Sci., Gulf and Caribb. 11(3): 305-308.

Moore, D. R. 1963. Distribution of the sea grass *Thalassia* in the United States. Bull Mar. Sci., Gulf and Caribb. 13(2): 329-342.

Phillips, R. C. 1960. Observations on the ecology and distribution of the Florida seagrasses. Fla. State Bd. Conserv. Mar. Lab. Prof. Pap. Ser. No. 2. 72 pp.

Phillips, R. C. 1962. Distribution of seagrasses in Tampa Bay, Florida. Fla. State Bd. Conserv. Mar. Lab. Spec. Sci. Rept. No. 6. 12 pp.

Strawn, K. 1961. Factors influencing the zonation of submerged monocotyledons at Cedar Key, Florida. J. Wildl. Managm. 25(2): 178-189.

V. MANGROVES

Bowman, H. H. M. 1917. Ecology and physiology of the red mangrove. Amer. Phil. Soc. Proc. 56(7): 589-672.

Breteler, F. J. 1969. The Atlantic species of *Rhizophora*. Acta. Bot. Neerl. 18(3): 434-441.

Brown, J. M. A., H. A. Outred and C. F. Hill. 1969. Respiratory metabolism in mangrove seedlings. Plant Physiol. 44(2): 287-294.

Chapman, V. J. 1962a. Respiratory studies of mangrove seedlings. I. Materials and some preliminary experiments. Bull. Mar. Sci., Gulf and Caribb. 12(1): 137-167.

Chapman, V. J. 1962b. Respiratory studies of mangrove seedlings. II. Respiration in air. Bull. Mar. Sci., Gulf and Caribb. 12(2): 245-263.

Davis, J. H. 1940. The ecology and geologic role of mangroves in Florida. Carnegie Inst., Washington, Pap. Tortugas Laboratory 32(16): 303-412.

Gill, A. M. and P. B. Tomlinson. 1969. Studies on the growth of red mangrove (Rhizophora mangle L.). I. Habit and general morphology. Biotropica 1(1): 1-9.

Gill, A. M. and P. B. Tomlinson. 1971a. Studies on the growth of red mangrove (Rhizophora mangle L.). II. Growth and differentiation of aerial roots. Biotropica 3(2): 109-124.

Gill, A. M. and P. B. Tomlinson. 1971b. Studies on the growth of red mangrove (Rhizophora mangle L.). III. Phenology of the shoot. Biotropica 3(2): 109-124.

Graham, S. A. 1964. The genera of Rhizophoraceae and Combretaceae in the southeastern United States. J. Arnold Arbor. 45(3): 285-301.

Humm, H. J. 1973. "Mangroves," pp. 3D(1)-3D(6), in, A summary of knowledge of the eastern Gulf of Mexico, 1973. Am. Petrol. Inst Rept., prep. by State Univ. System, Inst. of Oceanogr., St Petersburg (SUSIO).

Moldenke, H. N. 1960. Materials toward a monograph of the genus Avicennia. I. Phytologia 7(3): 123-168. II. Phytologia 7(4): 179-232. III. Phytologia 7(5): 259-292.

McMillan, C. 1971. Environmental factors affecting seedling establishment of the black mangrove on the central Texas coast. Ecology 52(5): 927-930.

Savage, T. 1972a. Florida mangroves: a review. Fla. Dept. Nat. Res., Mar. Res. Lab. Leafl. Ser., Vol. VII, Part 2 (Vascular Plants), No. 1. 15 pp.

Savage, T. 1972b. Florida mangroves as shoreline stabilizers. Fla. Dept. Nat. Res., Mar. Res. Lab., Prof. Pap. Ser. No. 19. 46 pp.

Scholander, P. F. 1968. How mangroves desalinate seawater. Physiol. Plant. 21: 251-261.

Scholander, P. F., von Dam, L. and S. I. Scholander. 1955. Gas exchange in mangroves. Am. J. Bot. 42: 92-98.

Scholander, P. F., H. T. Hammel, E. Hemmingsen and W. Garey. 1962. Salt balance in mangroves. Plant Physiol. 37: 722-729.

Stern, W. L. and G. K. Voigt. 1959. Effect of salt concentration on growth of red mangrove in culture. Bot. Gaz. 121: 36-39.

Teas, H. J. and F. Montgomery. 1968. Ecology of red mangrove seedling establishment. A.S.B. Bull. 15(2): 56-57. (Abstr.)

Walsh, G. E., G. H. Barrett, R. Cook and T. A. Hollister. 1973. Effects of herbicides on seedlings of the red mangrove, Rhizophora mangle L. BioScience 23(6): 361-364.