

Horizon

ENVIRONMENTAL SERVICES, INC.

Horizon Job No. 880017

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FINAL REPORT

PADRE ISLAND NATIONAL SEASHORE
VEGETATIVE HISTORY

Prepared For:

National Park Service
Padre Island National Seashore
9405 S. Padre Island Drive
Corpus Christi, Texas
Contract No. RQ7490-8-0006

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June 1989

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Executive Summary

This study was commissioned by the National Park Service to investigate the historic vegetational characteristics of Padre Island National Seashore to lend perspective to long-term management decisions for the island. Such information is critical in developing policies for protection and enhancement, if necessary, of the natural vegetation of the island.

This study has compiled information on the vegetation of the entire island and surrounding areas where appropriate with emphasis on the period from prior to European Man up to the acquisition of the park lands. Change since the acquisition has been documented scientifically by a number of studies. Because of the dearth of scientific studies on the island prior to its acquisition, this study has concentrated primarily on indirect sources of evidence such as explorer's or traveler's accounts and has, in some cases, been expanded to include accounts of the adjacent islands and the mainland where this information was thought to be relevant.

This study is not the first to attempt a synthesis of the park's vegetative history. Rechenthin and Passey (1973), with the Soil Conservation Service office in Temple, Texas, wrote an excellent early summary devoted largely to this very issue. Several other studies, including Garza (1980), Dahl et al. (1975), have included a brief history of park vegetation as background for their studies. The present study brings together most, if not all, of the previously cited historical references, but adds many new references which have been recently discovered. More important than just adding new references, however, the present study attempts an analysis of the context of these historic sources. In order to accomplish this, and to fully document the research for future investigators, extensive passages have been quoted from critical references. For the

earliest references, pertinent passages have been quoted in the original language, if possible, and new translations have been provided.

The general trend of all historical references to the vegetation of Padre Island has been to identify the area as a grassland or prairie with shifting sand dunes and rare arboreal vegetation. Dozens of primary sources have been collected tracing this general vegetation pattern back perhaps as far as 1553.

Excluding Davilla Padilla's secondary account of the first documented landing on Padre Island in 1554 which provides little detail of the island's vegetation, the earliest direct observations of the Padre coast are those of the Spanish naval expeditions of the 1680's searching for the reported French colony along the Texas coast. Made with the typical precision of trained naval observers, and documented with dates and latitude readings, these sources are fairly explicit in documenting the coastline. Although they neither list species nor vegetation communities, they clearly indicate the dune-center, grassland nature of the coastal islands and the apparent lack of arboreal species.

The diary of Chevalier Grenier, shipwrecked on the Texas coast in 1745, provides one of the best early descriptions of the general barrier island environment. He clearly indicates the foredunes, 50 paces from the shore, backed by a prairie grassland mixed with salty lakes. He also notes the lack of arboreal vegetation, specifically pointing out the absence of low, shrubby vegetation. His description, however, is apparently of St. Joseph's Island which does not today have any significant arboreal vegetation and, not surprisingly, did not in the historic past. Although he does not note the appearance of trees until much farther south (well beyond the Rio Grande), he does

not specifically note their absence again. In any case, the lack of further reference suggests they were not a significant component, if at all, of the vegetation on Padre Island.

Ortiz Parilla's report of the nature of the island in 1766 is one of the most important of early descriptions. The description of the island very clearly establishes the typical grassland habitat present, specifically noting only three hillocks of trees, two of laurels and one of willows.

Domingo de la Fuente's survey of the Padre Balli land grant in 1828 is important because it is the first terrestrial survey of the island which notes the changes from south to north. This survey was conducted some 20 years after the introduction of cattle ranching on the south end of the island by the Ballis. The extent and quality of the pastures increases northward and he does not mention trees until reaching the last 20 miles or so of the island.

The list of arboreal species provided by de la Fuente is more extensive than any prior to that given by William Lloyd in 1891. Whether this indicates the training and experience of a cadastral surveyor, noting trees as landmarks in the environment, or an actual increase in arboreal species cannot be determined. In any case, no other reports from the island support such an increase. The other early and mid-nineteenth century reports tend to describe the island as an impoverished environment, marked by grasses and shifting dunes.

Correspondence reporting on a topographic survey of the island conducted in the late 1870's by R. E. Halter of the U.S. Coast and Geodetic Survey provides relatively few clues to the vegetation given the length of his stay, but a few of his notations are important. In one place, he describes the mainland as having mixed grasses and sand dunes with occasional scrub oaks

and a few larger oaks, while noting only the shifting sand dunes on the island. He refers over and over to the sand on the island and the problems it causes him. In one key quote, he notes that his benchmarks are located on the second range of hills which are covered with grass and seem to be permanent, contrasting this to the moving sand of the middle of the island and on the laguna shore. His field maps mark both vegetation and open sand areas. Along most of the island, these areas are about equal, with slightly more sand along some stretches. The detail with which these areas are mapped suggest that they are relatively accurate observations. Thus, we are left with the fairly strong suggestion that unvegetated dune fields were present and perhaps common as early as the late 1870's. In addition, there is the clear notation that bare, shifting dunes existed along the Laguna Madre shore at this time.

The end of the nineteenth century marked the first scientific studies of the region. Although the quantity and quality of descriptions increases on into the twentieth century, there are any number of suggestions that the vegetation of the area had already sustained great damage, in large part to heavy cattlegrazing, but also to natural influences such as hurricanes and drought. Many early researchers, such as Tharp (1929) and Price and Gunter (1943) clearly recognized this. Despite the clear evidence of disturbance, there are some interesting factors at work here, since brush vegetation typical of cattle ranching does not seem to have taken hold on the island.

The advent of aerial photography brought a new dimension to studies of change on the island. Using photography and old maps, the advance and retreat of the shore and vegetation lines could be tracked with great accuracy. The enormous, barren dune fields of the 1940's and 50's, accentuated by the mix of drought and overgrazing, is clearly documented.

The historical record of the last 400 years on the island is sketchy at best. During periods there are fairly good, if general, accounts of the vegetation. At other times, the only available documents are maddeningly vague or seemingly more impressionistic than realistic. However, the general vegetation trend stands out quite clearly. Padre Island has been primarily a grassland since the arrival of Europeans in the area and probably since it rose from the sea several thousand years ago. Arborescent vegetation has been noted infrequently, but most notably by the 1828 Balli land grant survey and by William Lloyd in 1891.

The first unquestionable mention of oaks on Padre Island was by Lloyd, who was told by an island resident at that time that they were a recent introduction to the island. Mentions of laurels in earlier sources, including the Balli survey and the Ortiz Parilla reconnaissance in 1766, could be misidentifications of live oak, but laurel is also common on the mainland and occurs on the northern part of the island.

If, as Tharp (1926) has argued, oaks followed the disturbance caused by ranching on the coastal plain, then the oaks on Padre Island may be an indication of that disturbance rather than, as some have thought, the survivors of the pre-ranching era. In this light, it is interesting to note comments by Lynch (1989) that he had heard the concentration of oaks at the north end of the island, near Packery Channel, were attributable to the packeries that had been located there, and the cattle which were butchered in that area. Since the packeries were there prior to the turn of the century, this would at least correlate well in time with the comments by Lloyd noted above. On the other hand, Warren has argued that the oaks are in decline because of the demise of the passenger pigeon which was a main source of disseminating their seeds. The idea of demise, at least with respect to the immediate present, seems viable because of the

apparent greater presence of oaks documented on the island previously, through pictures and descriptions of the stump forest (Rawalt, n.d.). There are several existing pictures which verify the existence of this forest which was reportedly in the Bird Island Basin area.

Overall it is very difficult to form a clear picture of the history of oaks on the island. Whether the oaks were there prior to ranching or not, there is little evidence to suggest that they were ever a major component of the island's vegetative community. During the nineteenth century, however, they may have extended their range across the island. If, however, their initial presence was due to ranching, they seem to have begun to vanish long before the cessation of ranching on the island, perhaps during the drought of the 1950's, but probably as early as the 1930's. Perhaps the combination of the extinction of the passenger pigeon and the dredging of the Intracoastal Canal Waterway (which ceased cattle drives across the Laguna Madre), or perhaps natural phenomena such as fires, drought and hurricanes, ultimately caused the apparent decline.

From this study, it would appear that the vegetational characteristics of the island have been altered from time to time in the past by various influences including hurricanes, droughts, fires (mostly man-caused), and various other activities of man. Some of these alterations have been subtle or localized while others have been dramatic and widespread. However, even though some of the alterations from the pre-acquisition past are still evident today (predominantly hurricane damage and the presence of introduced species), the overall vegetative character of the island appears very similar today to the accounts provided by the earliest European explorers.

Low barrier islands, such as those of the Texas coast, are dynamic landforms which are continuously in a state of surficial

change in response to numerous environmental processes. Since its supposed initial formation some 5,000 years ago, the natural state of change of Padre Island has been compounded to varying degrees by the activities of man, most notably during the past 200 years. While certain of these influences can be singled out, it is difficult, if not impossible, to say what the exact character of the island would now be without the previous influences of man. The effects of several actions (natural or man-induced) often produce synergistic results beyond or different from those of the simple combination. Additionally, the natural processes of barrier island development and evolution are frequently so intertwined, that modification of one process often results in an unpredictable effect on other processes.

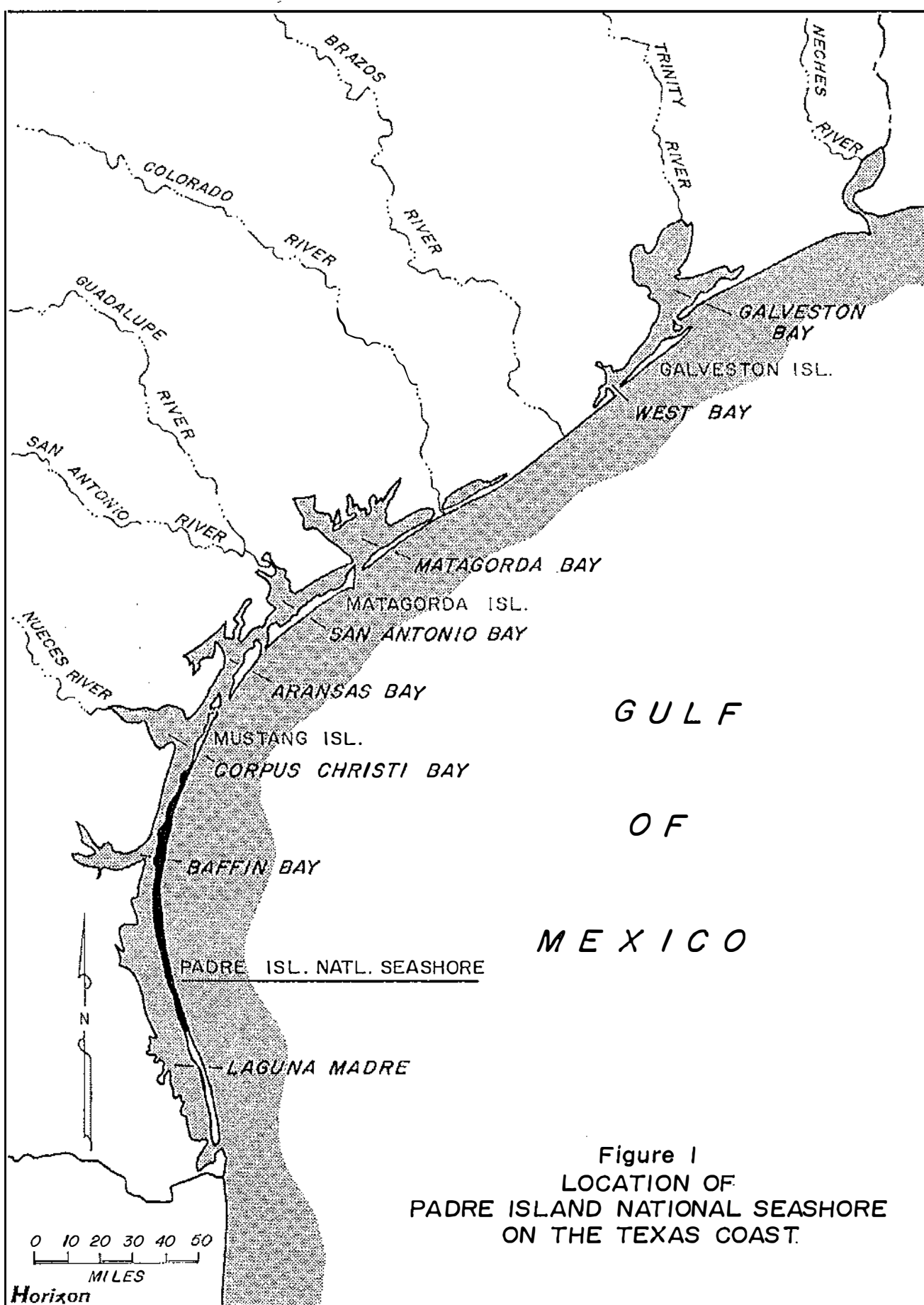
In general, the recommendations put forth here, based on the conclusions of our historical research, are that management of the island should be largely passive by simply allowing natural processes to take their course.

1.0 INTRODUCTION

Stretching 120 miles along the lower Texas coast, Padre Island is one of the largest and most unique barrier islands on the North American coastline (Figure 1). Its miles of white powdery beaches, active sand dunes, grasslands and marshes form a fragile, yet resilient, habitat which has survived millennia of natural forces such as hurricanes and droughts and centuries of human activity, including ranching and intentional burning. The Padre Island National Seashore now provides a degree of protection from further degradation for a significant segment of the island.

Padre Island is a relatively recent geological phenomenon, gradually emerging from the sea off of the Texas coast during the middle Holocene period, 4,000 to 5,000 years ago. From the earliest period, seeds and spores brought across the broad, yet generally shallow, Laguna Madre by wind, water, birds, animals and the aboriginal human inhabitants of the coastal regions would have begun to establish themselves. In the harsh environmental conditions present on the island, with shifting, coarse sandy soils, brackish wetlands, daily winds and frequent storms, only certain hardy species could be expected to survive.

The species present on the island today are indicative of this restricted environment. Whether these species represent those historically present on the island is not totally certain. The impact of man on the vegetation of the island has been dramatic throughout much of the island's recent history. While development in recent years has drastically altered selected portions of the island, the long term impact of ranching, an important activity on the island since the early 1800's, has been much more significant, having had a more drastic impact on the vegetation over a much larger area.



The fine sandy sediment of the island supports a coastal grassland or prairie environment which was severely degraded prior to acquisition of the park. Natural environmental perturbations such as hurricanes, droughts, fire, flooding, and high salinity were accentuated by human impact, including overgrazing, burning, military activities, resort development, and oil and gas exploration, in reducing large areas of the island to little more than blowing sand. Since the central portion of the island was taken over by the National Park Service, the park area vegetation has significantly recovered.

The concern for long term management of the park area vegetation, however, has led to the present study, which was commissioned by the National Park Service to characterize the predominant vegetational characteristics of the island through time. Such information is critical in developing policies for protection and enhancement, if necessary, of the natural vegetation of the island.

This study has compiled information on the vegetation of the entire island and surrounding areas where appropriate with emphasis on the period from before European Mans' influence up to the acquisition of the park lands. Change since the acquisition has been documented scientifically by a number of studies. Because of the dearth of scientific studies on the island prior to its acquisition, this study has concentrated primarily on indirect sources of evidence such as explorer's and traveler's accounts and has, in some cases, been expanded to include accounts of the adjacent islands and the mainland where this information was thought relevant.

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1.1 FORMATION OF THE ISLAND

Padre Island is a typical, transgressive, microtidal barrier island which is thought to have formed during the middle Holocene. As Weise and White (1980:13) illustrate, the island probably first rose from the sea as a series of discontinuous segments, initially bare sand patches covered periodically by tidal fluctuations. Sediments migrating northward with the prevailing longshore currents from the Rio Grande delta have filled in these gaps stretching this narrow barrier island along more than a hundred miles of coastline northward from the mouth of the Rio Grande.

Islands forming in microtidal areas are formed by the dominance of wave action processes over tidal action (Hayes, 1979). Such islands are, like Padre, typified by long, narrow shapes with few inlets, frequent washover fans and flood tidal fans rather than ebb tidal fans.

Among the original studies of Padre Island was the study by Fisk (1959) which identified the geological areas of sedimenta-

tion. Other studies addressing the geology of the area have been those by Price (1955) and Hayes (1965; 1967). Weise and White (1980) have summarized much of the geological history of the island in their park service study.

Weise and White (1980) recognize a series of environments on the island and in the Laguna Madre which have distinct sedimentary and vegetation characteristics. At the front of the island is the beach, the source of sand for construction of the dunes. Behind the beach is the fore island dune ridge which offers protection to the center of the island from winds and high seas. Also near the gulf side of the island can be found both active and stabilized blowout dunes, as well as storm-generated washover fans, runways and wind-deflation flats. In the center of the island is the vegetated barrier flat, mixed with various ephemeral fresh- to brackish-water ponds and marshes. Closer to the Laguna shore are back-island sandflats, dune fields, as well as numerous ponds and marshes (Weise and White, 1980:47-57). In the Laguna Madre, these environments include the wind-tidal flat, lagoon sand and shell berms, lagoon-margin sand, the grassflat, and serpulid reefs.

One of the most important notions in understanding the island is that it is a dynamic system. As noted by Weise and White (1980), barrier islands can be stable, building, or eroding. At any one time, various parts of Padre Island are responding differently to different environmental pressures. Thus, the north end of the island has been relatively stable over the last half century, while the south end is eroding rapidly (Weise and White 1980). To some degree, this change may be the result of human activity. Overgrazing is recognized as a chief reason for the destabilization of dunes and migration of the Laguna shore northward over the last 50 years or more (Price and Gunter 1943; Baccus and Horton 1979). Natural events such as

hurricanes have also had dramatic effects (Price and Gunter 1943; Bailey 1933).

To what degree the modern vegetation reflects that of the historic and prehistoric past has been much discussed and is a primary question addressed in this report. While the effects of natural forces and human activities have, through time, altered landforms and vegetation on large parts of the island, the general physical and vegetative character of the island as a whole may have changed little. The historical character of the island's vegetation is explored in the following section.

2.0 HISTORICAL VEGETATION

It was not until the late nineteenth century that anything approaching a scientific description of the vegetation of Padre Island was undertaken. Relatively unbiased, quantitative scientific studies were not completed until the eve of the creation of the National Seashore. Despite the lack of scientific precision in the early period, there are some excellent general descriptions of the vegetation and wildlife of the island contained in early journals and traveler's accounts. What is lost in accuracy and quantitative form is more than made up for by the 300-year perspective. Even more important than the length of the historic perspective on the vegetation is the presence of some accounts which detail the vegetation prior to extensive disturbances by European settlement and ranching activities.

This section is divided by historic periods which reflect the extent of human influence on the region. In the first period, the era of exploration, there was no known European settlement on the island. All of the accounts are from casual visitors, shipwreck survivors or military observers. The accounts during this period are generally sketchy, but often made by trained observers whose prime intention was the documentation of the area.

In the mid-eighteenth century, Josè de Escandòn began the settlement of the Tamaulipas area, then known as the province of Nuevo Santander. Settlement began along the Rio Grande and then crept northward. The earliest settlement had little effect on Padre Island, but by the early nineteenth century, Padre Island was a cattle ranch and probably had a few permanent inhabitants. Thus began the second major period in the island's history. Throughout the first two-thirds of the nineteenth century, settlement and use of the island was sporadic but generally continuous and casual visitors of all types were frequent. There

are numerous references to the island during this period but relatively few precise descriptions, perhaps fewer than in the previous era. And though settlement was very limited, and the extent of ranching has not been determined (but seems to have been less intense than in the latter part of the eighteenth century), there may have been some influence on vegetation by settlement during this period.

Towards the end of the nineteenth century, ranching on the island began in earnest with the efforts of Mifflin Kenedy and Patrick Dunn. The ranching period is the third and last major historic era. The apparent increase in cattle ranching on the island during the years after the Civil War had an impact which is still difficult to judge, but which lasted essentially until the island became part of the National Park system. Unfortunately, it is not until this latter period that scientific studies of the island and the surrounding region began to be undertaken. Thus, the earliest accurate descriptions are likely to have been biased by the influences of ranching on the vegetation.

2.1 THE EXPLORATION PERIOD

Little data is available on the vegetation of the island prior to the arrival of the first Europeans in the area. Seeds from Croton punctatus collected from site 41KL60 during a 1974 archaeological reconnaissance of the Padre Island National Seashore area were described as possible archaeological remains (Scurlock et al., 1974:63). This species, whose seeds are relatively durable, is common on the island today. Artifacts recovered from this site suggest that it was occupied during the latter part of the Late Prehistoric period, dated between about A.D. 1200 and A.D. 1700 in South Texas.

Almost nothing in the ethnohistoric accounts of Indians frequenting the coastal islands suggests specific plant species or communities. There is also little to suggest the degree of impact that the Indian populations may have had on the Padre Island environment. While there is documented evidence of local mainland groups using fire as a hunting tool, for example, there are no references to its use on the island (Herman Smith, personal communication, 1989). There is, however, some evidence that the island Indian populations may have simply used drives much like the nineteenth and twentieth century ranchers used to herd cattle.

What can be said is that the Indians were present on the island. Every historic account written before the early nineteenth century refers to having observed Indians or their campsites. The aboriginal population probably never had permanent settlements on the island because of the seasonal variation in resources and because of natural hazards such as hurricanes. However, they did frequent the island during part of the year. What impact this may have had is uncertain, but the evidence is far from clear that Padre Island can be considered untouched prior to European colonization of the area. In fact, since Padre Island is only thought to have risen from the sea within the last 5,000 years, and the Texas coast has been inhabited for at least twice that long, it may be naive to think that the island has ever been uninfluenced by humans for any extended period.

2.1.1 The Early Explorers - 1519 to 1554

While the earliest European visits to the Texas coast began during the early sixteenth century, the documentation of such visits is scarce. What little documentation that does exist is often vague and provides little clue to the vegetation. Interviews with a long-time island resident by Robert Whistler of

the National Park Service suggested that Cortez had stopped at Padre Island on his way to Mexico. If this is true, there is little evidence, either physically or in the historical sources, of such a visit.

The first European to have visited the island may have been in the employ of one of Cortez' chief rivals, Francisco Garay, then governor of Jamaica. In 1519, ships under the command of Alonso Alvarez de Pineda sailed along the Texas coast, stopping for forty days to keel their ships at a large river, thirty leagues north of the Panuco. The location of this river has been a controversial issue for many years. A number of historians (Weddle, 1985; McDonald and Arnold, 1978) feel that this river, which Alvarez named the Rio de las Palmas, is the modern Rio Soto de la Marina along the Tamaulipas coast. Other historians (Salinas, 1986; Hoyo, 1972) have argued that it was the Rio Grande. The controversy has yet to be satisfactorily resolved and the discovery near Port Isabel of an inscribed clay tablet attributed to Alvarez de Pineda has done little to resolve the matter. Although the tablet's authenticity has not been fully tested, Weddle (1985) points out the obvious fact that the orthography of the tablet (illustrated in Border Kingdom Press, 1975:5) is clearly not that of the sixteenth century.

In any case, Alvarez de Pineda, wherever he may have landed, offered little in the way of description of the vegetation of the barrier islands. Cruising upriver, however, he noted a forest extending for several miles along the banks. If this were the Rio Grande, this may well have been the palm forest, remnants of which still exist along the river below Brownsville. On the other hand, mangrove forests exist along the lower Rio Soto de la Marina.

Cabeza de Vaca was certainly the first European to have spent anytime in Texas. His landing point and his route across

Texas have been argued and discussed for many years (Smith, 1871; Hallenbeck, 1940; Bishop, 1933; Davenport, 1923-4). It is generally thought, however, that he landed at Galveston, or one of the adjacent barrier islands. Travelling down the coast, he may have reached St. Joseph Island, and later, during his stay with the Charrucos, he appears to have travelled widely in the interior of East Texas (Weddle, 1985:196-198).

Eventually, he travelled southwest to the prickly pear fields along the Nueces River. It is not clear if, during his travels, he ever visited Padre Island. If he did, he left no description of the islands along the lower coast. While on the coast and the coastal plain, he noted extensive nut (pecan?) trees along what must have been the Guadalupe, the extensive prickly pear fields of South Texas, as well as miscellaneous fruit and bean producing trees which may include Texas ebony and/or mesquite. All of these are, to some degree, still present in their respective areas.

The first documented landing on Padre Island came when three ships from the 1554 Spanish fleet returning to Spain were wrecked about midway along the island (Arnold and Weddle, 1978). Figure 2 shows the location of the shipwreck. A few of the survivors were able to sail back to Panuco or Veracruz, but the greatest number, possibly as many as 250, were stranded on the beach. In an attempt to walk southward to Panuco, with little food or water and fewer weapons, they were eventually killed by Indians along the way. The single survivor, Fray Marcos de Mena, who had been left for dead by his companions, finally made his way to Panuco where he eventually told his tale.

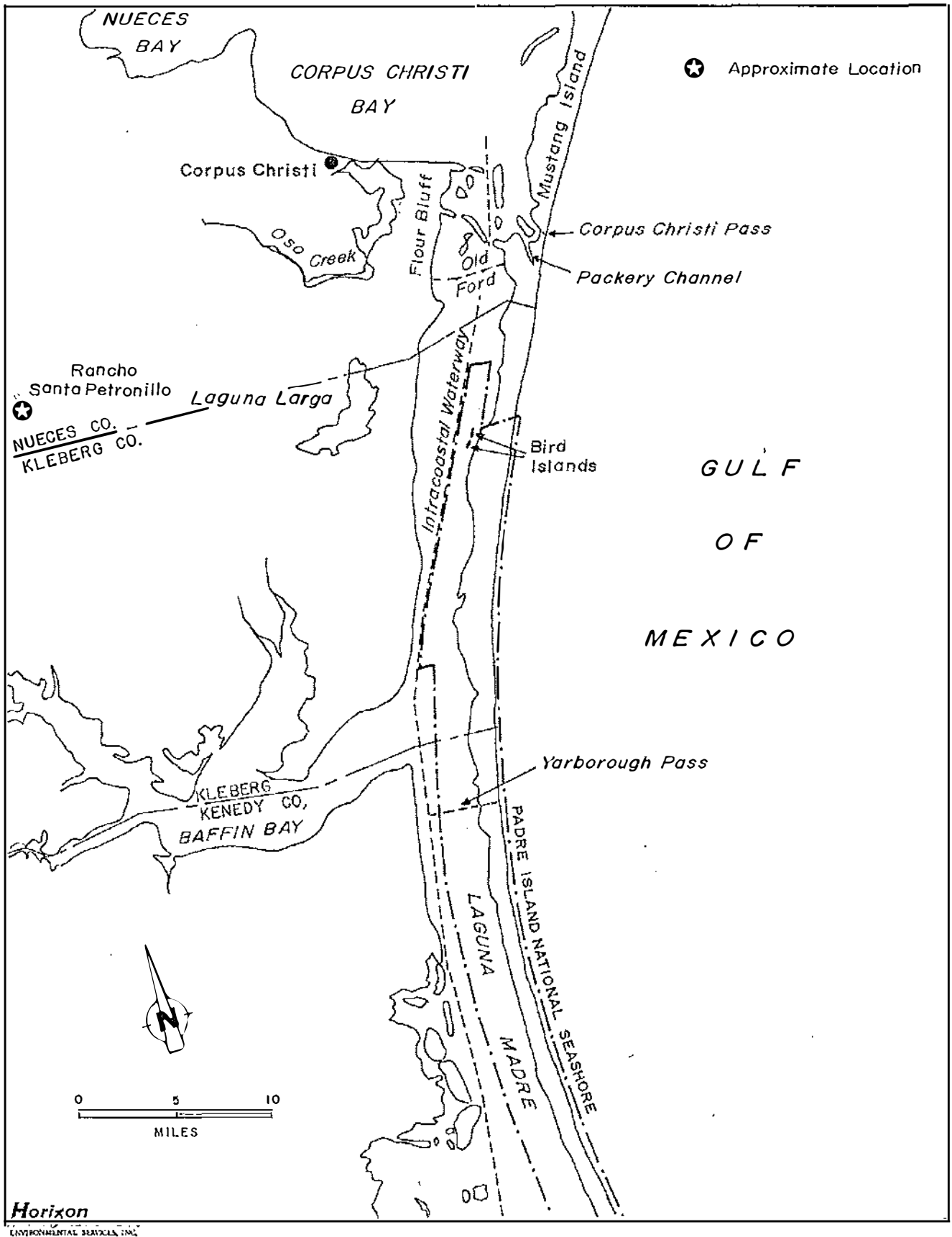


Figure 2a
HISTORIC SITES IN AND AROUND THE
PADRE ISLAND NATIONAL SEASHORE AREA

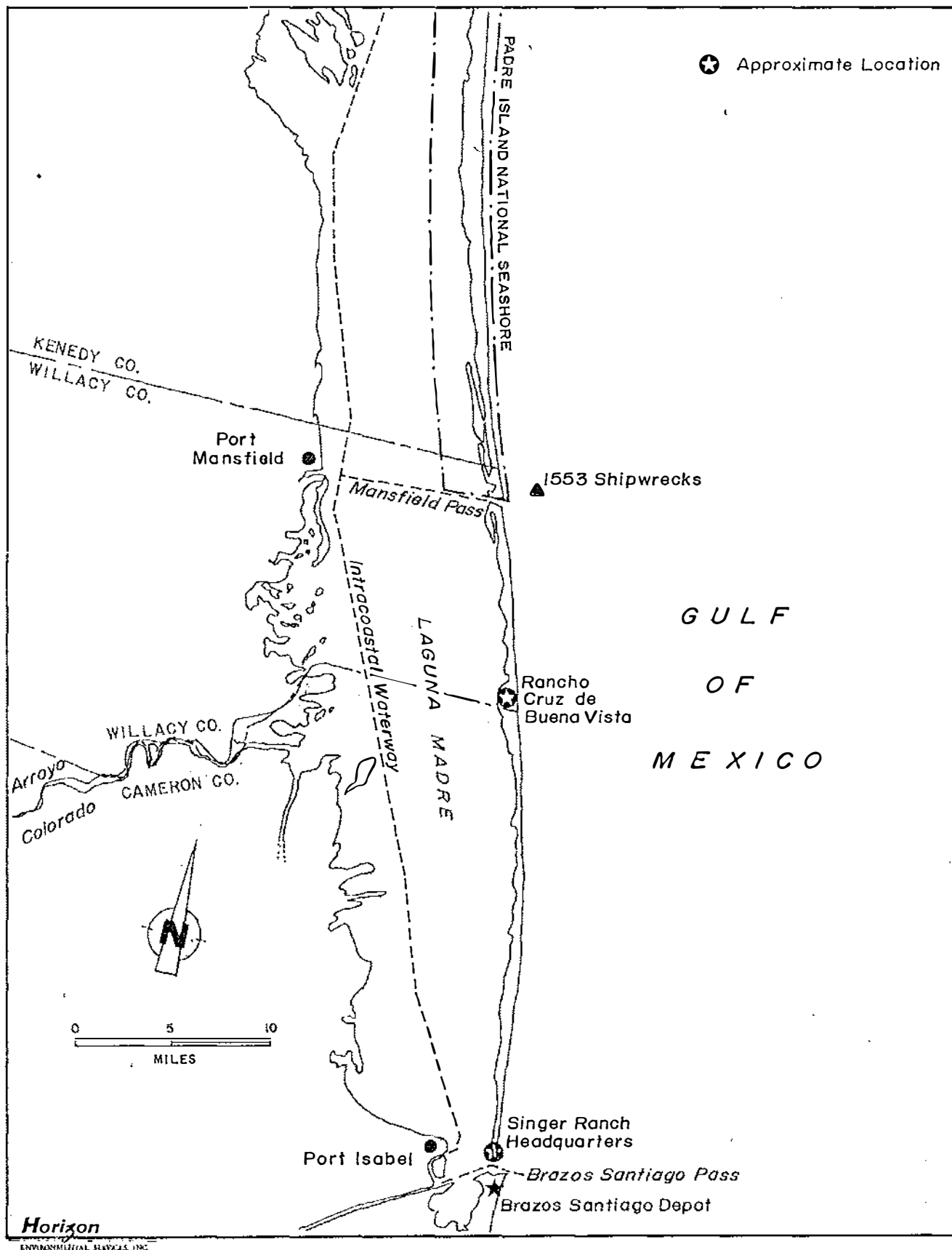


Figure 2b
 HISTORIC SITES IN AND AROUND THE
 PADRE ISLAND NATIONAL SEASHORE AREA

His story is related in Fray Agustin Davila Padilla's history of the province of Santiago Mexico, originally published soon after Marcos de Mena's trek. English translations are available in Mahan's (1967) history of Padre Island and in McDonald and Arnold's (1978) historical sourcebook for the Padre Island shipwrecks. As history, the story is fascinating, but as ethnography or scientific observation, it suffers from being retold by Davila. There is really no description of the island and nothing about the natural vegetation. Only in their extreme deprivation is there any hint of how desolate the landscape might have been. From the very first few days after the shipwreck, when the survivors were camped near the wreck point, they were confronted with the lack of available resources. Although food from the ship's stores had washed ashore, the survivors had not had a cooked meal in days when a group of Indians appeared.

"En los feys que alli eftuuieron, no auian vifto Indios; pero vierolos a los fiete dias que llegaro a ellos hafta cien Indios, con fu diuifa de guerra, arco y flechas; aunque traian mueftras de paz, trayendo los arcos rendidos, y mucha comida en las manos. Llegaronfe a los Espanoles, y ofrecieronles grade cantidad de buen pefcado, y lumbré que traian para que fe guifaffe. No auian tenido fuego los Espanoles hafta entonces, ni con que facrle; y deuan de auer eftado a la mira los Indios, y porque vieron la falta fe le traian." (Mahan 1967)

In the six (days) that they were there, they had not seen Indians; but they saw arriving on the seventh up to one hundred Indians, with war equipment, bow and arrows; although they carried signs of peace, carrying the bows down, and much food in their hands. They arrived at the Spaniards, and offered them a great quantity of good fish, and they brought fire

(?) in order to cook. The Spaniards had not had fire until then, nor anything to make it with; and they should have been under scrutiny by the Indians, and because they (the Indians) saw this lack, they brought it. (translation by author)

The translation of lumbre or fire in this sense is uncertain - it could literally mean a light, that is a means by which to light their cooking fires, since the Spaniards, stranded on the beach without their strike-a-lights and with no naturally occurring stone, may have been at a loss to start a fire. Or it could mean in a more figurative sense, material with which to start a fire, that is, wood. The Indians, ranging the length of the island and the mainland, would probably have carried a supply with them. Despite the logic of this, and Mahan's (1967) assumption of the meaning "firewood" in his translation, there is no reason to expect that there would be no wood available after the sinking of several large wooden vessels, from which they salvaged some stores, presumably including food in wooden crates. Additionally, as many of the historic reports have suggested, driftwood probably occurred in some quantities on the beach then as it does now.

The poverty of their landscape is evident on the march south, reflected in the only mention of vegetation while still on Padre Island. For most of their march south, they were beset by hunger and thirst, suggesting very little edible plant material.

"Todos estos dias no comieron fino yeruas y marifco: ninguno beuio gota de agua, porque no la auia: y el regalo de los mas afligidos era coger el rocio de la manana, facandole con las lenguas de las yeruas adonde eftaua guardado." (Mahan 1967)

All these days they ate nothing but grasses and shellfish: no one drank a drop of water, because there was none: and the gift to the most afflicted was to gather the morning dew, sucking it from the grasses where it was stored. (Translation by author)

Although the description suggests the paucity or even complete absence of arboreal vegetation, the ambiguity of the Spanish word yerba (yeruas) in this context provides no clue to the actual plants eaten. Possible translations could include herbs, grasses, grass (i.e., a single species), or any combination of low-lying vegetative cover.

The importance of Fray Marcos de Mena's descriptions, however filtered in Davilla Padilla's history, cannot be understated. It is simply the first unquestioned description of Padre Island. While the tone of Davila Padilla's narrative may account for the lack of physical description, the poverty of description may also partly reflect the poverty of the landscape, as noted above. The lack of resources available on the island is evident in the description.

While it is possible to infer from the history that the southern half island did not have extensive arborescent vegetation at that time, it is impossible, given the indirect references and the secondary nature of Davilla Padilla's text, to extend the inferences further, distinguishing between areas that are predominantly grassland and areas that are predominantly bare sand or establishing the complete absence of arborescent vegetation. It is reasonable to imagine, however, that the area of their trek, from Mansfield Pass to the southern tip of the island, was not too different than today.

2.1.2 The Search for LaSalle's Colony - 1686 to 1692

In 1682, the French explorer Robert Cavelier Sieur de La Salle put into action his plan for finding the mouth of the Mississippi River or Rio del Espiritu Santo as it was then known. With four ships, he set sail from La Rochelle, France, on July 24, 1684. After numerous difficulties and delays in the voyage, the ships ultimately landed on the Texas coast, having sailed past the mouth of the Mississippi. In February of 1685, LaSalle and his colonists finally went ashore at Matagorda Bay, having already lost one of their ships to Spanish privateers. Within a short time, two of the three vessels had run aground and the third, under the command of the French navy captain, Sieur de Beaujeu, had returned to France. Thus began the tragic story of La Salle's Fort St. Louis colony. While it appears certain that at least some in La Salle's party may have travelled as far south as the Laguna Madre, there are no detailed descriptions of these travels.

When a deserter from LaSalle's expedition, captured in an ill-fated buccaneer raid on Tampico, reported that the French had colonized the Texas coast, the Spanish began a series of searches for the rumored colony, both by sea and by land. While it was not until 1689 that Alonso De Leon and his troops were to encounter the ruins of Fort St. Louis on Garcitas Creek south of Victoria, the numerous previous expeditions by land and sea had provided valuable explorations of Texas and the Gulf coast (Weddle, 1985).

One of the earliest voyages was that of the captains Martin de Rivas and Pedro de Iriarte who sailed from Veracruz in two piraguas on Christmas morning of 1686 (Weddle, 1988:134). A journal kept by the pilot, Juan Enriquez Barroto (Weddle, 1988) describes the voyage in great detail.

"Wednesday the 12th [of March]. [off the Tamaulipas coast just south of the Rio Grande - lat. 24° 55']... Here the river branch [the Laguna Madre] runs about two leagues from the coast, which is made up solely of somewhat high, humped dunes with no timber whatsoever in all that could be discerned." (Weddle, 1988:163)

"Friday the 14th. [off the Texas coast near the mouth of the Rio Grande - lat. 26° 45']... The large, long, barren dunes that I have mentioned extend this far, and there are some knolls among them at intervals." (Weddle, 1988:164)

"Saturday the 15th. [along the coast of Padre Island - lat. 26° 56']... Here end the dunes that I say are like those of Veracruz, and again the knolls follow with tall grass. On the whole shore there are no high ones, nor any with trees." (Weddle, 1988:164-65)

"Monday the 7th [of April]. [near Sand Point at the entrance to Lavaca Bay]... We went another 5 leagues, beating to windward until near a small island with some low woods, and I have seen no other place anywhere on the shore that is so flat and marshy in the extreme. ... Past 3:30 in the afternoon, having seen some Indians gather among the mottes on the mainland, a little to leeward of the small island that I have mentioned, the ensigns went to them in the canoes and reached the Indians, who then made them signs that they should lay down their arms. ... [describing an encounter with Indians either on the island or the mainland near the entrance to Matagorda Bay] To his shouting many

others came out who had concealed themselves in very tall grass and commenced shooting arrows at the captain and the rest, defenseless but for the two Indians, who fought to defend them until our Ensign Miguel Barroa came with his people and arms. After a few musket shots all of them fled across the savannah and our people came back aboard. One Indian was seen to fall among the grass and two were wounded by our Indians arrows." (Weddle, 1988:174)

"Friday the 11th. [near the mouthes of the San Bernard and Brazos Rivers]... All this coast is as I have said, very flat, smooth, with neither dunes nor woods." (Weddle, 1988:175)

Farther still down the coast, near Galveston, the pilot observed woods and groves of trees (Weddle, 1988:177). With the exception of the low-lying trees mentioned on the small island near the entrance to Matagorda Bay, the pilot is generally very explicit about the lack of trees. Describing the high dunes at the north end of Padre Island, he makes no mention whatsoever of trees (Weddle, 1988:166).

When no word came of the Rivas and Iriarte expedition for many months and the Spanish paranoia had increased because of new reports of the French colony, a second expedition was sent. Two more ships, under the command of Captains Don Andres del Pez and Luis Gomez Raposo, sailed from Veracruz on Monday the 30th of June, 1687 (Pez, 1944:114). The following excerpts are from the diary of Andres del Pez.

"Viernes 11 de Julio ...toda la tierra, por aqui por este paraje, pardea la arena y por la parte de adentro de la costa, es todo anegadizo, no se ve

tierra en forma, sino alagunas, con algunas matas de manglar..." (Pez, 1944:119)

Friday 11 July [north of 25° 23' lat., south of the mouth of the Rio Grande] ...in all the land here in this landscape the sand is drab-colored and on the inner part of the coast, everything is subject to flooding, not being dry land as such, but lakes, with some thickets of mangrove... (translation by author)

"Sábado 12 del dicho ...Y desde los 25° y 50', corre la costa al Norte y es la tierra rasa con la mar, en partes, y hay médanos..." (Pez, 1944:120)

Saturday 12 of said month [sailing northward from near the mouth of the Rio Grande] ...And from 25° y 50', the coast runs north and the land is level with the sea, in parts, and there are dunes... (translation by author)

"Domingo 13 de julio ...este día observé el sol, que fué la altura 27° y 15'; es costa de médanos de arena y por la parte de adentro de dicha costa, es anegadero de algunas lagunas; ...y a las cinco de la tarde, llegamos a un paraje, que hacía quebrada la costa en dos partes; distan uno de otro, un cuarto de legua, y se vía la laguna y anegadizo que estaba a la parte de adentro, que llegaba cerca de dichos quebrados que hace la costa; y la tierra que estaba de por medio, donde hacía quebrado, la costa era tan rasa, que en habiendo flujo de mar, pasa por encima el agua de la mar y entra en la laguna o sale de la laguna, por encima a la mar, cuando hubiere lluvias..." (Pez, 1944:120)

Sunday the 13th of July [arriving at Corpus Christi pass] ...this day I observed the sun, which was at a height of 27° and $15'$; the coast consists of sand dunes and in the interior part of said coast, it is subject to flooding by some lakes; ...and at 5 in the afternoon, we arrived at a place, where the coastline was broken in two places; one was a quarter-league (1 kilometer) from the other, and you could see the lake and low lying lands that were on the interior part, which came very close to the broken areas in the coastline; and the land that was within, where the breaks were, the coastline was so low, that during high tide, the sea water passes through and enters the laguna or leaves the laguna, when there are rains... (translation by author)

"Lunes 14 del dicho ...Corriendo la costa al Nornordeste, mas arrimado a la cuarta del Norte, en los 27° y $52'$, esta un medano que altea mas que todos los que hay en toda la costa; es abierto por encima de la hierba y del prosigue la costa, cosa de dos leguas y remata haciendo morro y del prosigue, playa rasa con la mar, de arena y algunos mogotillos..." (Pez, 1944:121)

Monday the 14th of said month [July - near the north end of Mustang Island] ...Running along the coast to the north northeast, but approaching a north bearing, at 27° and $52'$, there is a dune which is higher than all those that are found on the whole coast; it is open above the grass and from this the coast continues, about two leagues, and stops, making a mound, and from this continues a beach level with the sea, of sand and some hummocks... (translation by author)

"Martes 15 del dicho ...tiene por señas: de la parte del Sur, un tiro de mosquete, empieza a correr la costa de mèdanos pequeños hasta la barra y del quebrado que hace dicha barra, para el Nordeste, va prosiguiendo la costa de mèdanos bajos cubiertos de hierba." (Pez, 1944:121)

Tuesday the 15th of said month [near the entrance to Aransas Bay] ...it has more specifically: from the southern part, one musket shot, it begins to run the coast of small dunes up to the bar and from the entrance that the said bar makes, to the northeast, it follows the coast of small dunes covered with grass. (translation by author)

"Jueves 17 de julio. Este día, luego que amaneciò, fuè la lancha en tierra a ver el dicho río, hallaron poca mar en la barra y le hallaron 6 palmos de agua, entraron dentro y tenía bastante agua la parte de adentro, y corria la vuelta del Norueste y la tierra de adentro, era muy rasa, sin arboleda... tambièn se vio un palo empezado a aserrar y en partes hacheado, que allí vieron las astillas, no de mucho tiempo." (Pez, 1944:122)

Thursday the 17th of July. [at the mouth of Espiritu Santo bay] This day, as soon as it dawned, the launch went to land to see the said river, they found little water on the bar and they found 6 hands of water, they entered within and the interior part had enough water, and it turned to the northwest and the land inside was very flat, without any woods [speaking of an Indian camp found at this location] ...also seen was a pole which had begun to be sawn

and in places chopped, since there one could see the wood shavings, from not very long previously.
(translation by author)

On the 23 of July, they observed several stands of pine near San Luis Pass, at the west end of Galveston Island (Pez, 1944:124). This is the first mention of trees of any type in the journal and Pez plainly states:

"...no hay dende Tampico...otras piezas de pinar, sino estas..." (Pez, 1944:124)

...there have not been since Tampico...other stands of pine but these... (translation by author)

Neither the Barroto nor the Pez diary provide any new information on the specific vegetation of Padre Island in the late seventeenth century. Both of these diaries, written within a year and a half of one another, do strongly suggest, however, the lack of notable arboreal vegetation on the island. Barroto first notes trees on a small island near the entrance to Lavaca bay, while Pez does not mention trees until reaching the west end of Galveston Island.

This observed lack of arboreal vegetation is relatively clear, but should be taken in the context of its observers and of their position. Because of difficult near-shore currents along the barrier island beaches, the ships were forced to maintain some distance from the shore so as not to run aground in the surf. Thus, they were viewing the island from some distance without sophisticated telescopic viewers. The piraguas they were sailing were shallow-draft vessels, however, and the diaries indicate in places that observers were stationed on the topmasts. Secondly, the trees that do occur on Padre Island today are characteristically low, barely distinguishable from the tall

grass in most places. And, finally, the existing trees generally, if not universally, occur on the back side of the island, distant from the gaze of coastwise observers, and perhaps partially blocked from ocean view by high foredunes.

This is not to argue that trees were present and not observed at this time, only that it is possible that they were missed. On the other hand, the ships' primary mission was the observation of the coast for evidence of the French intrusions and one has to assume that they were watching the island closely, probably continuously, from the lookout on the mast. Their accounts can be taken as accurate descriptions of their observations, insofar as they had no salient biases in their reporting. These were the observations of literate and educated military men part of whose job was the accurate description of the coast. Although their observations are made from afar, with respect to their daily logs and position descriptions, their information provides a geographic precision which is not duplicated until the cadastral survey conducted nearly two hundred years later.

From all of this it is possible to conclude that the island was not heavily wooded at the time of their voyages. In fact, the data could even be taken to indicate the near absence of trees on the island in the late 1600's. While none of the descriptions cataloged in this report suggest that the island was ever heavily wooded, a few descriptions do indicate arboreal growth of varying degrees. Whether this is observer error or bias or actual fact is difficult to ascertain. The hypothetical absence of trees in the early periods could reflect their utilization as firewood or for tools by the Indian inhabitants, or could, potentially, reflect dryer conditions and possibly lower sea level associated with the Little Ice Age of the sixteenth through nineteenth centuries. On the other hand, trees may have become more common with settlement and cattle ranching, similar to invasion of brushy species documented on

the Rio Grande plain. With respect to the latter, it should be noted that very few of the typical 'brush country' species, with the exception of mesquite (Prosopis glandulosa), Acacia, and prickly pear (Opuntia sp.), are found on the island, now or in the past.

2.1.3 Early Eighteenth Century French Explorations

After the Spanish forces, under the command of Alonso de Leon, finally found the remains of LaSalle's fort at Bay St. Louis, Spanish visits to the lower Texas coast slowed considerably. While the colonization of inland Texas proceeded apace, with settlements at San Juan Bautista along the Rio Grande in 1700 and at San Antonio de Bexar by 1735, the coast was virtually ignored. There exists only a single account of the lower coast during this period, that of the French ship's captain Jean Beranger. Beranger sailed from Louisiana in June of 1720, reaching as far south as Aransas Pass. He made notes on vegetation and aboriginal populations observed along the way. While he did not reach as far south as Padre Island, he did land at either Harbor (or Mud) Island or Live Oak Point, about which he said

"It is completely covered with small oaks the height of a man that are full of acorns. Our men started gathering some, and a few savages who had followed us helped them; they gathered about six casks full."
(Carroll, 1983:23)

The description of such oaks clearly indicates that oaks similar to the ones present on Padre Island were present in nearby areas, perhaps only a short distance northeast, as early as 1714. Note that Enriquez Barroto, in his 1686 journal, had mentioned a wooded island in this vicinity (Weddle, 1988). It is also of interest that, according to Robert Whistler (personal communica-

tion, 1989) and Eric Warren (n.d.), the small oaks of the region are even today prolific producers of acorns.

Also describing the island where they were moored to complete ship's repairs, Beranger noted

"There is, also, a large amount of agave, as also of a root on the seashore that resembles horsehair; the savages make lines out of it that they fasten to the ends of their darts to secure them lest the fish carry them away when they are stuck. They [the savages] are not ungrateful to us, for they were giving to us lavishly. They also make other small ropes from mulberry-tree bark, which is very strong. (Carroll, 1983:22-23)

Carroll (1983) identifies the seashore root as whip coral (Agardhiella tenera), noting that it is quite common in the area. Sea whip (Leptogorgia setacea) and sea fan (Leptogorgia virgulata), soft coral species found on the Texas Gulf coast (Fotheringham 1980:16-17, 25-26), are both possible candidates for this 'root', but both have a hard skeleton which becomes brittle upon drying. The dark-colored axial rod, however, may be strong enough for use as a bow line. Another possibility might be the parasitic, terrestrial vine, dodder (Cuscuta sp.) which is as fine as horsehair but more flexible than the sea whip. Carroll also notes that agave does not grow readily on the off-shore islands. Although agave is certainly not common on the islands, it should be noted that several species of Yucca are common on the mainland and that Spanish dagger (Yucca treculeana) has been reported from several dunes on central Padre Island during this century and in previous times. Two prominent dunes, Big Dagger Hill and Little Dagger Hill, still bear this name. Yucca is probably more common on the lower coast, where Beranger apparently did not sail. In general, Beranger's observations

seem quite accurate, despite having been written some time after the voyage. Only the mention of agave seems out of place, as much for the supposed quantity as its presence. Perhaps he may have sailed farther south than commonly asserted. Finally, although Beranger mentions mulberry, which is common along the Texas coastal plain, but not generally present on the barrier islands, he only refers to the bark, which may actually have been procured from the mainland.

Beranger did not mention Padre Island and probably did not sail that far south. His observation regarding oaks is important, however, in that it emphasizes the continuity of oak growth north of Padre Island. If it were the same island that Barroto had noticed, it might strongly argue that oaks were very limited in their extent in the late seventeenth and early eighteenth centuries.

Twenty-five years after Beranger made his voyage, a French ship under the command of Chevalier Grenier was shipwrecked on the coast of Texas, returning from a trading voyage to Vera Cruz (Grenier, 1745). After running their ship on a sand bar on the 10th of May, 1745, they salvaged what they could from their ship and set up a camp on the island they had landed on. After a few days of exploration, they began a southward march on the 24th of May and for two months they marched south until returning to Vera Cruz where they were rescued and sent back to New Orleans. The journal of this voyage has never been fully analyzed and thus it is somewhat difficult to place the various descriptions of the coast in a precise geographic context, but it is almost certain that they traversed much or all of Padre Island and that the descriptions given here are of Padre or adjacent islands.

Throughout the journal, there are numerous references to the island (l'Islette) and its sand dunes (dunes de sable) backed by a lagoon (lagon) and the area is described more than

once as a prairie (prairie). In the following quote, recorded during the initial salvage operation, Grenier notes the lack of even shrubby vegetation and suggests the general lack of arboreal species by emphasizing the quantities of wood thrown up on the beach, as if without this driftwood there would be no fire.

"Ceux du canot Laisserent donc Perdre la grande voile qui S'ensabla; Elle nous aurait etez d'une grande utilite puisque nous en aurions fait une tente qui nous auraient pris a l'abry des injures du Tems puisqu'il n'y avait pas un arbrisseaux Sur l'Islette ou nous Estons; nous nous Serious(??) mis par la En Etat d'y Resister. Nous ne manquious point de Bois que la Mer avait Jette a la coste. Nous nous en servious(??) pour faire cuire le Pain, que nous faisons avec la farine que la Mer nous avait Restitue" (Grenier, 1745:51).

Those in the canoe lost the big sail that came ashore; it would have been of great use to us since we could have made a tent where we could have sheltered those injured by the since there was not a shrub on the small island where we are; we could?? make good use of it (the tent) in the business of survival. We do not lack for wood which the sea has thrown up on the coast. We use it to bake bread, which we make with the flour which the sea has spared us (Translation by author).

The following entry, dated the 24th of May, 1745, was made shortly after beginning their southward journey. The notation concerning the change in orientation of the island - where the course of the island turns from east-west to north-south - seems to indicate a location somewhere in the coastal bend region of Texas, probably between Matagorda and upper Padre Island. The

excellent description of the landscape makes it one of the more important entries in the journal.

"A l'E. de la Pointe la Coste Courait N. et S. Quand nous l'Eumes doublez Elle courait E. et O. - C'est une Terre Basse sans arbres ny meme un arbrisseaux, la [sic] Mer Bris-ent une Demye lieue au large de la Coste - Nous marchames Jusques vers le Midy sur un Rivage de Sable fin, dur Et Uny. A cinquante pas de la Mer il y a des dunes de Sable Mouvant qui Separent le Rilvage d'une Prairie entre coupee de Lagons Sallez ou il y a le plus Beau paturage du Monde, il y a beaucoup de Chevreuils et des lapins ou Lievres de l'Espece de ceux qui sont autour de la Nouvelle Orleans" (Grenier, 1745:59).

To the east of the point the coast ran north and south. When we turned it ran east and west. - This is a low land without trees nor even any shrubby trees, the sea destroys a half league along the length of the coast - we march due south over a fine, hard and smooth beach. At fifty paces from the sea there are shifting sand dunes that separate the beach from a prairie interspersed with salty lakes where there is the best pasturage in the world, there are many deer and rabbits or hares of a species which is found around New Orleans (Translation by author).

Despite the brevity of Grenier's descriptions, they are the first clear descriptions of the general habitat of the islands. He emphasizes not only the lack of trees but of shrubs or small shrubby trees (arbrisseaux) as well. The description is the first mention of specific foredunes, some fifty paces from the waterline, as well as the first description of prairie mixed with salty lakes. Of great interest is his comment on the

quality of the pasture. This suggests much more than sparse grass.

While there are no clear indications of where Grenier was when he made the above comments, there are some hints. On the 27th of May, three days after the above description, the party crossed a small pass (lagon) which they were able to swim, but had to build a raft for their provisions (Grenier, 1745:61). On the 28th, they came to a larger pass where they were able to obtain canoes from Indians who were fishing there (Grenier, 1745:62). On the 6th of June, the coastline curved south-southeast and the party came to a river where the mouth contained a number of islands, each about a quarter league (one km) apart (Grenier, 1745:70). On the 20th of June, the 27th day of their southward march, Grenier (1745:74-5) and his party observed wooded mountains in the distance while crossing a coastal pass. On the 26th, the troop rested all day by a lake filled with oysters. After a four day sojourn in an Indian village at the end of June, the party reached another lake or crossing on the 3rd of July (Grenier, 1745:95) and, finally, on the 5th of July, the little group of shipwrecked sailors reached Tampico (Grenier, 1745:98-100).

Extrapolating backwards from their arrival at Tampico, it is possible to suggest that the point where they observed the mountains from the coast was probably at or just south of the Soto de la Marina area, the same area where Evia (1968:179) mentions the Sierra de Tamaulipas some 40 years later. This would probably make the river reached on the 6th (which actually took several days to cross) the Brazos Santiago Pass or the mouth of the Rio Grande. Prior to the dredging of the Brownsville Ship Channel, Brazos Santiago Pass contained several islands, most notably Clark Island and Brazos Island. In either case, it took 10 to 12 days to traverse 150-mile segments of coastline, an average of 15 or so miles a day. Extending this

backward further still, the nine days between the 28th of May and the 6th of June would have been more than sufficient to cross the 113 miles of Padre Island. At the northern end of this journey, the pass which was difficult to cross could have been Corpus Christi pass, reportedly much larger during the historic period (Lloyd [1891] reports it was a mile across in 1891). The first small pass may well have been Aransas Pass or Cedar Bayou, separating Matagorda Island from St. Josephs Island. In establishing bounds for the actual locations, it seems likely that the description could not have been further east than Matagorda Island nor further south than the north end of Padre Island, given the number and size of rivers and passes crossed and the distance traversed to Tampico.

2.1.4 Diego Ortiz Parilla's 1766 Reconnaissance

By the mid-1700's, the Spanish had become trading partners with the French and no longer felt the threat of French settlements on the Texas shoreline. When reports arrived of English settlements on the coast, however, the Spanish Viceroy, the Marquès de Cruillas became worried and sent instructions to Josè de Escandon, the founder of the Nuevo Santander colony which at that time included the Texas coast, to conduct an investigation. Escandòn interviewed a number of persons familiar with the area and immediately wrote the Viceroy with a description of the coast (Escandòn, 1766). In a letter to the Viceroy on the 2nd of May 1766, he asserts that there is no island worth mentioning between the Rio Grande and the Rio de las Nueces, describing Padre Island as a "Potrero grande". Describing the islands which extend north from the mouth of the Nueces, Escandòn describes series of sandbanks which are Mustang and St. Joseph Islands, noting:

"que su ancho es por unas partes, como de un quarto de legua, y en la mayor como de una; q^e es muy baxo,

todo de arena, que aunque tiene algunos Médanos de ella, son bajitos, y que sobre lo más alto hai basureros, que deza el Mar, quando la inunda, como subzedie por Junio de el año pasado de 765 [sic] que se ahogaron tres Indios, q^e havian entrando [sic] a pescar, y que por ese rezelo solo van en cortas temporadas por el berano, siendo su continua habitaz.ⁿ en la tierra firme; asientta no tienen arbol ninguno, ni animales, a excepcion de algunos, Benados, por que, en la referida inundazian no quedo ninguno: que el agua que se bebe es de unas lagunitas, que se llenan quando lleueb [sic], de las que algunas tienen tule y que por la parte de el Mar a lo que prezibe la vista, todo es mui baxo y de fuerte rebentazon..." (Escandòn, 1766)

that its width is in some parts about a quarter of a league, and in the widest about one (league); that it is very low, all of sand, that although it has some sand dunes, they are very low, and that on top of the highest there are trash deposits left there by the sea when it covers them as happened June of last year, 1765, when three Indians were drowned, having gone there to fish, and that because of this they only go for short times during the summer, their permanent habitation being on the mainland; this place has not a single tree, nor animals, with the exception of some deer, because after the above mentioned inundation none remained: that the drinking water is from some small lakes that fill when it rains, some of which have reeds, and along the coast side which can be seen, everything is very low and with a strong surf... (translation by author)

At almost the same time as his initial response, Escandòn sent a detachment of soldiers from Camargo under the command of Josè de la Garza Falcòn. Castañeda (1939:216) asserts that the soldiers arrived at Santa Petronilla Ranch, on Oso Creek southwest of present Corpus Christi, in June of 1766 and, with the help of Indian guides, proceeded across to Padre Island, then known as Isla Blanca or Isla de los Malaguitas, the latter name after the Malaguitas Indians who reportedly lived there. Castañeda also asserts that a second reconnaissance was conducted of the island in September of 1766, under the command of Colonel Diego Ortiz Parilla. According to Salinas (1986:131-133), a small detachment of soldiers under his command crossed to Padre Island and travelled southward as far as Baffin Bay. Kilgore (1975) notes that because of a hurricane, described by both Ortiz Parilla and Escandòn, the soldiers could not have made the reconnaissance at this time but were simply relating the results of the earlier reconnaissance. However, the documents seem to clearly indicate, contradicting both Castañeda and Kilgore, that there was only a reconnaissance conducted in September by Garza Falcòn and the soldiers who supposedly were there three months earlier. If they had gone across earlier, there is no surviving record or journal, and their testimony, reported by Ortiz Parilla (1767) clearly states that they were on the island between the 13th and 22nd of September, 1766 (Fernàndez et al., 1766). In any case, this is the earliest description of the island itself which actually mentions individual species. The following is excerpted from their report.

"Al cuarto, experimentamos que dicha isla no tiene en toda ella màs palizada propia que la de dos motitas muy cortas de laurel y otra de sauces, pero en su playa del oriente tiene, de la que el mar arroja de todas especies, y entre ellas algunos masteleros, bergas, motones y otras correspondientes

a la arboladura de bajeles de todos tamaños.
(Fernández et al., 1766:3)

In the fourth, we find that said island does not have anywhere a more proper palisade than that of two very short hillocks of laurel and another of willows, although on its eastern shore, where the sea throws up all kinds of things, it does have foremasts, yardarms, pulley blocks and other things which are from the rigging of vessels of all sizes. (Translation by author)

As noted previously, this is the first mention by name of individual species actually observed on the island. In particular, this is the first mention of trees of any type. Neither willows nor laurels are particularly large trees, nor does the author specify their size. One can only speculate that they were tall enough to stand out above the grass.

This passage is interesting, not only in the identification of laurels and willows as present on the island, but in the specificity with which they are described. There are, the writer notes, only two hillocks (dunes?) of laurel and one of willow. This quite clearly limits the extent of arboreal species. It is unfortunate, however, that we do not know, where the authors may have crossed the Laguna, and how far north along the island he may have ranged. Crossing just a few miles south of the northern tip of Padre Island today would limit observations to little more than a very few dunes of laurel (probably in this case, oak) and willow. In any case, it seems clear that there was hardly a greater quantity of arboreal vegetation present on the island in 1766 than today. If the crossing was made below Santa Petronilla, near the modern causeway, and the detachment carefully examined the north end of the island, it seems there

may have actually been much less arboreal vegetation than there is today.

"En el sexto capitulo, experimentamos que los pastos que tiene dicha isla solo son el de zacate colorado y el espinoso, que uno y otro no lo comen los caballos sino obligados de la necesidad." (Fernàndez et al., 1766:3)

In the sixth chapter, we find that the pastures that said island has are only those of red grass and the spiny variety, that neither one or the other are eaten by the horses unless they are obligated by necessity. (Translation by author)

Again, the potential identification of species is the first reference of its kind. Although red grass and spiny grass do not necessarily equate with biological species, the red grass may be seacoast bluestem (Schizachrium scoparium var. littoralis), which turns a purplish red in the fall. This grass is presently common, though not dominant, and is not particularly inedible to horses. Additionally, the identification of this grass species by its color is interesting in the light of Kilgore's (1975) comments on the actual author of the island's description. Unless one postulates early cold weather, it is unlikely that the bluestem would have turned color by Ortiz Parilla's supposed visit in September, much less a visit in June. Since seacoast bluestem usually needs some cold weather to begin its color change, another possibility is Eragrostis sp. which has red seeds maturing somewhat earlier. This latter grass is far from dominant, however, and also unlikely to have been an obvious red color during the early summer visit of de la Garza Falcòn. Another definite possibility is that seacoast bluestem was a well-known species to the Spaniards and identified as such by them in any season.

The spiny grass, incorrectly identified by Sheire (1971:70-72) as "three spined stickleback" (a fresh water fish species), is more probably gulf cordgrass (Spartina spartinae) or marshhay cordgrass (S. patens). Both species are unpalatable to horses (and cattle). Marshhay cordgrass is today, and has been throughout the recent past (personal communication, James Lynch, 1989), one of the dominant grasses of the island.

James Lynch, last foreman of the Dunn Ranch, noted that cordgrass (which he calls saltgrass) was burned to make it palatable. Before burning, it was reportedly sharp and injurious to the cattle. He notes

"There are some times of the year that saltgrass gets a sharp point on it. Have you noticed that? It gets a sharp point on it. You walk through it and it'll stick your legs? You've noticed that. On cows, it sticks them. Of course the bellies -- the skin (there) is the thinnest, tenderest part of their skin -- it'd stick to their belly and it makes a little (bruise). If you skin the animal you get a little bruise, blood-stained spots all under the belly and that's (what) they get that during that time, when they get sharp pointed. -- I don't know whether it's the time of year or the age -- but one or the other. It gets a real sharp point and... that's when it sticks the cattle. If you skin 'em you can see... where it penetrated that skin and made little blue marks." (Lynch, 1989)

Although the identifications of grass species observed in 1766 are highly tenuous, this is the most accurate description available for any herbaceous species on the island prior to the twentieth century.

In overall perspective, it seems that the general character of the vegetation is not too different than that reported by the naval observers. On the whole, the Ortiz Parilla report seems to indicate a community that is definitely lacking in arboreal species. This does not necessarily contradict later reports which seem to indicate more arboreal growth, but it does emphasize the question of whether the nineteenth century might have seen a brief florescence of arboreal species. Again, this leaves unanswered the question of whether such a florescence is simply a matter of observer bias or whether it was a real phenomenon, paralleled by arboreal extensions in other parts of south Texas.

2.1.5 Josè de Evia's Reconnaissance

By the latter part of the eighteenth century, Spain had finally become convinced of their dominion over the Seno Mexicano, the upper Tamaulipas and lower Texas coastal area. In 1785, Josè de Evia was ordered to survey the coast from New Orleans to the Bay of Saint Bernard by the new Viceroy, the Conde de Galvez. Sailing southward, Evia kept a detailed diary and notes on his voyage. It was on this trip that he discovered Galveston Bay, which he named after the Viceroy. Charged to map the coast and make a detailed record of the land and vegetation, this is an excellent description of the coast (Evia, 1968).

A year later, Evia conducted a reconnaissance of the coast northward from Vera Cruz to the Bay of Saint Bernard. In general, he has less to say about the landforms and vegetation of this southern area, particularly as he sailed farther north from Vera Cruz, perhaps because they are not particularly striking. Unlike his earlier voyage, during practically this entire trip he was accompanied by various troops of foot soldiers who marched

along the strand. One troop, from the Rio Grande settlements, accompanied him along the Padre Island coast.

Kilgore (1975) has published a map, on which Padre, Matagorda, and St. Joseph's Islands are combined into one, named 'San Josef', extending north from the Rio Grande to Pass Cavallo. This map was actually published 10 years before Evia's voyage by an English mapmaker, Sir Thomas Jeffries (Martin and Martin, 1984:102-103). Copies of Evia's field maps are included in the volume edited by Holmes (Evia, 1968). These maps clearly show the separate islands and do not exaggerate the width of the islands size as was done in the earlier compilation.

Describing the vegetation at the southern end of his first voyage, noting Galveston and San Luis Island, he states:

"Toda la tierra de este Puerto (Galveston) es anegadiza, y sin arboleda hasta dentro del Lago.... La Isla de San Luis es muy rasa y la mayor parte anegadiza: no tiene arboleda, y la parte del Sur es toda playa de arena blanca muy fina... toda la peninsula desde el Rio Savina, hasta San Bernardo abunda de venados y osos" (Evia, 1968:130-1)

All of the land on this port is low-lying, and without trees except within the bay.... The Island of Saint Luis is very flat and for the most part, subject to flooding: it does not have trees, and the southern part is all very fine, white sandy beach... the entire mainland from the Sabine River, to the San Bernard, abounds in deer and bear (translation by author)

In a later description of the interior of San Bernard Bay, as Lavaca Bay was then known, he adds:

"Esta se extiende 6 leguas al N. como especie de lago, en cuya distancia la tierra es anegadiza y muy baxa, sin arboleda mas que de mirtos; pero en lo interior se presenta algo mas alta, con mucha arboleda de robles y algunos pinos" (Evia, 1968:137)

This extends 6 leagues to the north like some kind of lake, in which distance the land is subject to flooding and very low, without any trees other than myrtles; but in the interior, the land is somewhat higher, with many oaks and some pines (translation by author)

As noted above, Evia's description of the southern coast is somewhat impoverished. Describing the fauna of the entire south coast, he notes:

"Toda esta costa abunda de Benaos Cabras y liebres y pocas aves por la falta de agua dulce, pero en la Peninsula abundan de toda especie" (Evia, 1968:187)

This entire coast abounds in deer, goats and hares and few birds because of the lack of fresh water, but on the mainland all kinds of animals abound (translation by author).

His description of the vegetation in this area is even less specific. Speaking of the coastline north of the Rio Grande, he adds that:

"...la tierra es tan baja, y sin Arboleda para poderse ocultar los Indios Brabos" (Evia, 1968:187)

...the land is so low, and without trees to hide wild Indians (translation by author).

Although Evia mentions little about vegetation in general, his descriptions from the northern leg of the voyage suggests that he would have noted more had it been there. If they were to be found, any records or journals left by the foot soldiers who accompanied him north from the Rio Grande, sent from Camargo and Reynosa (Evia, 1968:159), would be of great value.

Evia's journal does not add much to the previous narratives in describing the vegetation of the island, but it does seem to emphasize the general paucity of arboreal species noted in all the reports from this period. It is the last report available from the pre-settlement and ranching period, and is important in corroborating earlier reports.

Although the data are sparse and subject to the vagaries of observer bias, it does seem that the vegetation of the seventeenth and eighteenth centuries on the island was characterized by a general lack of arboreal species.

2.2 THE ERA OF SETTLEMENT

2.2.1 De la Fuente's 1828 Survey

The best early description of the island's vegetation comes from the survey report which followed the second claim of Padre Nicholas Balli and his nephew Juan Josè Balli to the island under Mexican law. The survey, undertaken between the 14th and 20th of February, 1828, was conducted by the Alcalde of Matamoros with a surveyor, Domingo de la Fuente. The following descriptions are separated by day and locale, moving northwards from the Brazos de Santiago channel to Corpus Christi bay. Although there are translations available in the court brief filed in the

Supreme Court of Texas (State of Texas vs. Alberto Balli, n.d.), the following Spanish sections have been taken from the copy in the archives of the General Land Office in Austin and new translations made.

14 February 1828 - Brazos de Santiago to El Jardin

"...hasta llegar al paxaje nombrado el Jardin. Tombando el rumbo de Sur a Norte haciendo Vista de ojos en Cuia Distancia no se encontro otra cosa q^e Mèdanos de Arena, algunas Bahias saladas, muy pocos pastos y malos... (General Land Office Records, 1828)

...until arriving at the place named The Garden. Taking the route from south to north making the inspection in which distance nothing was encountered but sand dunes, some salty bays, very few, poor pastures... (translation by author)

15 February 1828 - El Jardín to rancho of Santa Cruz de Buena Vista

"...siguiendo el mismo rumbo hta llegar al Rancho de Santa Cruz de Buena Vista y en este Distancia no se encontrò otra cosa que Mèdanos y Bahías con muy poco pasto, a excepciòn de un Llano que està al llegar de dho con algùn pasto xazonable, vastante Ganado Bacuno y Caballado perteneciente a los Ynteresados..." (General Land Office Records, 1828)

...following the same route until arriving at the Rancho de Santa Cruz de Buena Vista and in this distance nothing was encountered but dunes and bays with very little pasture, with the exception of a flat located just before arriving at said rancho

which has some fair-sized pasture, considerable cattle and horses belonging to the interested parties... (translation by author)

16 February 1828 - Santa Cruz de Buena Vista to Los Sauces de San Jose

"...siguiendo el mismo rumbo hasta llegar al paxaje nombrado los Sauces de San José en Cuia Distancia no se encontró otra cosa que muchos Médanos de Arena, surtidos de algunos pastos xazonables, algunas Bahías, una Alverca de Agua Dulce y algunas bienes de los Ynteresados..." (General Land Office Records, 1828)

...following the same route until arriving at the place called The Willows of San José in which distance nothing was found other than many sand dunes, with some fair-sized pastures, some bays, a fresh water pool and some stock of the interested parties... (translation by author)

17 February 1828 - holiday

18 February 1828 - Los Sauces de San José to San Vincente

"...Saliendo del paxaje los Sauces de San José siguiendo el mismo rumbo de Sur a Norte hasta Llegar al paxaje de San Vincente en Cuia Distancia no se encontró otra cosa q^e muchos Médanos de Arena con muchos pastos, algunas Bahías y una Alverca de Agua Dulce..." (General Land Office Records, 1828)

...Leaving The Willows of St. Joseph following the same route from south to north until arriving at the

place of St. Vincent in which distance nothing was found other than many sand dunes with many pastures, some bays and a fresh water pool... (translation by author)

19 February 1828 - San Vincente to Carnestolendas

"...del mismo paxaje de San Vincente sitado arriba siguiendo el mismo rumbo de sur a norte hasta Llegar al paxaje de Carnes Tolendas en Cuia Distancia no se encontrò otra cosa que muchos Mèdanos de Arena muy empastados algunas Bahias que atrabiesan de Oriente ha Poniente y algunos bienes de Caballada de los Ynteressados..." (General Land Office Records, 1828)

...from the same place of St. Vincent noted above following the same route from south to north until arriving at the place of Carnestolendas in which distance nothing was found other than many, very grassy sand dunes, some bays which cross from east to west and some horse stock of the interested parties... (translation by author)

20 February 1828 - Carnestolendas to the Brazo de Corpus Christi

"...Dho paxaje de Carnes Tolendas siguiendo el mismo rumbo de Sur a Norte hta llegar al Barro de Corpus Christi en donde terminan las tierras mencionadas en Cuia Distancia se encontrò alguna Caballada Mesteña de los mismos denunciados. Tierra de muchos mèdanos altos bien bestidos y Pastos Planes xazonables mas Lomas de Arena empastadas y Arboles gruesos q^e Llanan palo de muelas, bastante Sauseda, mucho Laurel, Encinales cortos, vastante Yerva Anis, muchas

Alvercas de Agua Dulce con mucho Tule q^e se reconose sean Durables..." (General Land Office Records, 1828)

...said place of Carnestolendas following the same route from south to north finally arriving at the Bar of Corpus Christi where the above-mentioned lands end in which distance was found some wild horses belonging to the named parties. A land of many high, well-covered dunes, and large, flat pastures with grassy sand hills and thick trees that are called "palo de muelas", considerable willow groves, much laurel, short oaks, considerable anise herb, many fresh water pools, with abundant reed, that are known to be permanent... (translation by author)

On the same day, on a small corner of the end of the island.

"...se encontraron buenos pastos, unas Lomas de Arena altas con muchos sauses en sus laderas y bajos..." (General Land Office Records, 1828)

...are found good pastures, some high sand hills with many willows on their sides and flats... (translation by author)

The descriptions given in this legal document refer over and over again to the use of the island for pasture, noting that the lands are not as good a pasture as on the mainland and that the land has very little use. Clearly there is some amount of pasture grass available across the entire island. To what degree any amount of bias introduced here can be detected is not known. Also to be noted in the descriptions are the increased appearance of grass from south to north, with the final notation of trees occurring at the extreme northern end, by Corpus Christi Bay.

The descriptions in this survey hint that the grass cover on the southern and central portions of the island may have been more extensive than it is today. Whether it was grazing pressure (note that more stock are noted in this southern area by de la Fuente), or natural phenomena such as droughts or hurricanes (see discussion below for effects of the 1887 and 1933 hurricanes; see also Bailey [1933] and Baccus and Horton [1979]), which significantly denuded this area cannot be stated with certainty at this time. Further up the island, the grass cover has noticeably recovered since grazing was ended. The differences between north and south probably reflect slightly higher rainfall in the north area which has lessened the effects of grazing pressure, but could also reflect other factors such as longevity of grazing (both Balli and Singer were ranching primarily on the southern half more than 50 years before the northern half became part of the Kenedy and then the Dunn Ranch) or the cumulative effects of hurricanes over the last 150 years.

Freshwater ponds surrounded with "reeds" increase in prevalence on the north end of the island. Reeds are most probably cattails (Typha sp.), although switchgrass (Panicum virgatum) or various sedges or rushes (Eleocharis, Juncus, Scirpus spp.) are also possible candidates. It is not likely that the reeds were common reed (Phragmites sp.) as its natural occurrence in south Texas is primarily in riverine or lacustrine environments on the mainland. The Phragmites occurring on the island today by the ranger station was probably introduced from the mainland.

The "thick trees that are called palo de muelas" are still a mystery. No sensible reference to this name has yet been found. The only arboreal species known by this name is the Coutarea pterosperma, a small flowering tree of the deserts of northwestern Mexico (Martinez 1937:359), an unlikely native of the

island. The native toothache tree (Zanthoxylum clava-herculis) is sometimes called palo mulato in Spanish.

Also of curiosity is the "anise herb". Anise (Pimpinella anisum), a member of the carrot family (Umbelliferae), is a non-native plant commonly used as a food flavoring, particularly in alcoholic beverages. If properly identified by de la Fuente, this could represent the first recorded introductions on the island.

The importance of this document cannot be understated for the understanding of the historic vegetation of Padre Island. For the first time, there are very specific references to location which can be tied to a map of the island. Therefore, not only do we have a picture of the vegetation of the island, but a very clear picture of how the vegetation changes from south to north with the rainfall gradient.

The character of the survey, however, almost completely contradicts the earlier reports in emphasis on arboreal species. Willows are noted much further down the island and in greater quantity. If one takes the 1766 Ortiz Parilla report as accurate, there was some increase in these species during the intervening half century or more.

2.2.2 The Mid-Nineteenth Century

The French botanist Jean Louis Berlandier came to Texas in 1826, first serving as botanist on the Mexican Boundary Commission, later settling in Matamoros until his death in 1851 (Muller, 1980). According to his journal, he visited the island of Brazos Santiago and may well have journeyed on the southern end of Padre Island. He made specimen collections in the area of Matamoros, on the Nueces River and at Aransas Bay but no botanical collections are listed from Padre Island or adjacent

areas. His only descriptions of vegetation in the area are from the mainland areas (Berlandier, 1980:440-441;544). Describing the vegetation near Boca Chica, he states:

"Arborescent vegetation is almost excluded from these localities: some scarce shrubs are found only on the edges of the Rio Bravo, while some thickets, scattered on the plain, are a little more abundant on a small height known as the Mesa del Gavilan." (Berlandier, 1980:440)

Describing the banks of the Rio Bravo near Boca Chica and the road from there to Matamoros, Berlandier adds:

"On that road one encounters fewer ranchos and esteros [lakes] than on the opposite bank of the Rio Bravo, but, in exchange, the countryside is prettier. Forests are rare. The mezquite (sic) is very sparse, and all the ground is covered with prairies and thickets. Before arriving at Matamoros, however, one travels for quite a long time through a small forest situated on the banks of the river. Among the trees one encounters several cabins of the field hands who go to sow grain there." (Berlandier, 1980:441)

Padre Balli himself died within a year of filing the deed on the Padre Island ranch. His nephew apparently continued to operate the ranch for several years, but by 1846, when American troops landed on the island in preparation for the coming war with Mexico, it had apparently been abandoned for several years. At the time, according to Samuel Reid, the island was "uninhabited save by one old man, who follows the business of wrecker, and lives not far from Port Isabel." Reid was a member of Ben McCulloch's Texas Ranger Company marching to join the main American army forces near Brownsville. Arriving at Corpus

Christi on the 13th of May, 1846, they travelled twenty miles south along the coastline to a point where they forded the Laguna Madre to Padre Island to begin their march south to Port Isabel. Reid notes that the Laguna was about five miles wide where they crossed. Reid's description of the island is brief but interesting.

"The island is one hundred and twenty-five miles long, and averages only a mile in width, containing no sign of vegetation, save a species of sour wiry grass, which our horses would only eat when compelled by hunger. There is not a single tree throughout its whole extent. On all sides is to be seen sand hillocks and sand wastes; and, taken altogether, it is one of the most gloomy and desolate looking places which it has ever been our bad fortune to visit. It seemed to us to be a long slice from the western coast of the desert of Sahara, detached by some convulsion of nature, and floated over and anchored on the eastern shore of Mexico." (Reid, 1847:39)

Reid's description brings up several interesting points. Was the entire island as bleak as he reports, or did he cross well south of the somewhat more verdant north end of the island? Examination of the route across utilized by various eighteenth and nineteenth century travellers (Ortiz Parilla, 1767; Noakes, 1865; Halter, 1875-1882) suggests that the ford is and has always been just south of where the existing causeway is today. This route is inked on a 1867 map of Padre Island and the Laguna Madre drawn by Felix Blucher, a nineteenth century Nueces County surveyor (Blucher, 1867). Although this route actually crosses slightly below the greatest extent of arboreal vegetation which is located in the Packery Channel area, there is no reason to expect that the entire island from the crossing to the south tip would have been barren sand dunes. Clearly, in 1828, less than

twenty years prior to Reid's journey, the Balli survey party noted frequent pastures and some arboreal vegetation extending south from the north end of the island. And in the late 1870's, less than 25 years after Reid's journey, the draft coastal survey map shows grassy areas covering as much as half of the island.

Examination of the language utilized in his description suggests that his description is more metaphorical than scientifically accurate. Freeman (1972) has pointed out the influence of artistic traditions in historical narratives and the romantic allusions in Reid's descriptions are quite obvious. According to Freeman, deserts and cataclysmic phenomena, clear themes in Reid's brief description, were a favorite theme of early nineteenth century naturalists.

Several limited descriptions of the island were made during the Mexican War period, none of which were encountered for this publication. These include a reconnaissance down the Laguna by Lt. George Meade (1913) of the Army Engineers, another reconnaissance of the island by Blake (1846), and a description of the island by Taylor's scouts who searched for a route for the army moving south (Hardee 1846).

The Mexican War diary of Ethan Allen Hitchcock gives a brief description of the mainland along the southern edge of the Laguna Madre. Although less obvious in its romantic tone than the description given by Reid, there are some echoes of this common nineteenth century literary style. Marching from Corpus Christi to Matamoros, Hitchcock wrote the following description from the army camp on the Laguna Madre near the Arroyo Colorado.

"On the 23rd (of March, 1846) we marched some 12 or 14 miles in four columns abreast at deploying intervals, and, as most of the march was through prairie, the army presented a fine appearance. We

made a good deal of easting and came in sight of the coast of the Laguna Madre and Padre Island.

We encamped at night in one of the sweetest spots of partially timbered country that I ever saw in my life. The wood was principally muskeet (mesquite), a species of locust and very beautiful, the leaves fresh and green. There was an immense quantity of flowering acacia and the country was literally covered with flowers, while the woods were resonant with the song of birds. (Hitchcock, 1909:211-212)

After the Mexican War, John Singer, brother of the Singer sewing machine inventor, was shipwrecked on Padre Island in 1847 and decided to stay, reportedly building a home for himself and his family near the southern end of the island where he operated a ranch. A Yankee sympathizer, he left during the Civil War. Unfortunately, no journals or letters have survived from this crucial period which might describe the vegetation of this period. Only one legend of dubious origin provides any hints at the vegetation. Before leaving, he reportedly buried his savings, some \$80,000 dollars in silver bars, silver and gold coins, table silver and jewelry, between two scrub oaks (Mahan, 1963). Singer is supposed to have returned in 1869 but found the scrub oaks gone and never recovered the treasure. Were the story true, it may indicate the presence of scrub oaks toward the southern end of the island where Singer is supposed to have lived.

During the Civil War, there was some activity on Mustang, and possibly, Padre Islands by both armies. The Union Army captured Port Isabel early in the war and used it as a supply base for the blockade of southern Gulf ports. In 1863, the Union Army captured Port Aransas and a garrison was stationed there for more than a year. The commander, Major William G. Thompson,

wrote frequent letters home to his wife Jane in Iowa. There is almost no mention of Padre Island and only the briefest description of the environment of Mustang Island. Only one very brief note, from a letter dated December 3, 1863, mentions vegetation on Mustang Island.

"I frequently take a horse & ride over the Island. It is about 25 miles long and 5 miles wide. Plenty of Cattle, Deer and Hogs on it, but very wild. I can not see any difference between the Deer & Cattle in wildness. They both have to be hunted & shot just the same. There is no Timber on the Island but plenty of good grass and water. How our Hogs and Cattle come to be on the Island is more than I know as no one lives on it." (Thompson, 1863)

Arriving at Port Isabel less than a month earlier, Thompson, in a letter dated 11 November 1863, gives a similarly brief description of the south end of the island and the adjacent mainland.

"The Island itself is small and worthless being only sand and a perfect waste. I am informed also that the main land back of us from 70 miles into Texas is barren & sandy & used only for Mexican Ranches & occasionally Pampas or Prairies are to be found with good grass." (Thompson, 1863)

A diary written by Thomas John Noakes (1865) who lived north of Corpus Christi on the Nueces River describes a week long trip to Padre in July of 1865. Although it does not provide a detailed description of the vegetation, there is some excellent information here. Noakes, who had a farm on Agua Dulce Creek, was well-educated, literate and observant. His diary provides a wealth of important observations on the period and the area. The

following sections are excerpted from his diary between July 9th and nineteenth and include all relevant botanical observations.

On the 9th of July, Noakes and his four companions rode as far as the Laguna Madre shore near the crossing where they camped. The Laguna crossing, probably somewhere near the modern Flour Bluff causeway, was six miles across. Early in the morning on the 10th of July, the group crossed the Laguna, Noakes noting that the water was unusually high. Once on the other side, he says that

"...we took our breakfast in the sandhill near some willows which were full of Heron nests and most of the nests occupied by young birds. We saw a pair of Sandhill Cranes flying round, the first I have ever seen here in summer." (Noakes 1865, 3:247)

The little group rode on down the island, spending one night at a hut called Curry's Ranch (note: Curry apparently still lived on the island in 1891 when William Lloyd interview him concerning oaks - see below), where one of the party shot a hog. The next day they rode on down the beach, noting what appears to be considerable debris from ships washed up on the shore. On Wednesday the 12th, they met a local named Murdock (the Murdock of Murdock's Pass?) and another man in a light wagon with a yoke of steers. Later that day, at what Noakes estimates as seventy-five miles down the island, they reached the boat which they had intended to free up (for salvage?). Noakes offers a description.

"...The Island here was nothing but loose white sand, with a very little very coarse grass which the horse would not eat so we saddled (sic) up Hooper to drive the horses to the nearest place where they might feed and attend to them..." (Noakes 1865, 3:249)

There are no further descriptions of the vegetation, but it is interesting to note that, on the return trip, Noakes and Hooper (the other two took the boat) were unable to find a hog or any cattle which they could kill for meat. Finally, starved, they were able to find Murdock and purchase some of a hog he had just killed. This indicates, on the one hand, that hogs (javelina or feral domestic hogs?) were present on the island, although there may have been little else which would make a meal. On the other hand, at least the north end of the island seems not to have been ranched at the time and there were apparently few, if any, wild cattle around.

Little is available in the way of detailed vegetation descriptions during the latter part of the nineteenth century, but a few tantalizing quotes are found. In their discussion of changes in the Laguna Madre, Price and Gunter (1943:144) relate this note.

"An item related to the late sanding-up of large parts of the lagoon is the thinning of vegetation on Padre Island. In a statement to the senior author a retired foreman of the Laureles Headquarters of the King Ranch, confirmed by John Kenedy of the Kenedy Ranch, said that Mifflin Kenedy, founder of the ranch, found Padre Island when first seen by him, "as green as a garden." Pat Dunn, former owner and ranchman of Padre Island, recently deceased, said that this verdure disappeared sometime after 1870, along with the numerous cotton-tail rabbits and spotted skunks which formerly inhabited it. ... The "suddenness" of the disappearance of the skunks and rabbits, as reported by Dunn, may have been only the layman's somewhat sudden realization of the effects of a more gradual change, or their departure may have been hastened by the effects of a severe drought.

That the vegetative denudation was not quite so sudden is indicated by the fact that men living today, whose age is about fifty years, can remember when Padre Island was 'green'." (Price and Gunter 1943:144)

2.2.3 R. E. Halter's Topographic Survey

Between 1875 and 1882, R. E. Halter of the U. S. Coast and Geodetic Survey intermittently conducted surveys on the island, setting markers and making surveys (Sheire, 1971:41). Halter left no complete report of the condition of the island, but in his correspondence to the superintendent of the U.S. Coast Survey, C. P. Patterson, he makes numerous brief references to the nature of the island and adjacent mainland at that time. As Sheire points out, Halter's correspondence suggests that the island was desolate and all but deserted at this time. In one of Halter's first letters to Patterson, dated 14 December 1875, he states that:

"The country is nearly uninhabited and the waters are almost unknown & unfrequented... Padre I^d I found to be a long narrow I^d varying in width from one to two miles and partly covered with sand hills or dunes about ten and fifteen feet high, the general character of the island and hills is the same as most of the islands on the immediate coast of the Capes. The main land or west side of Laguna Madre I found to be an uninhabited prairie about five feet above the water of the bay - as a general thing level & flat but in places undulating the whole devoid of all vegetation except grass and sometimes tracts of low scraggy bushes about eighteen inches high similar to scrub oak - one place about eight miles from Flour Bluff there are similar ones have grown to be about

ten feet high this tract is represented on enclosed sketch. With these exceptions the country is nearly destitute of trees or bushes" (Halter, 1875)

Halter frequently notes the sandy nature of the country and the presence of dunes. To him, sand is a continual problem. At one point he cannot find a suitable place for his tent because the tent won't stand up in the sand and all of the grassy areas are wet. In this passage, dated 16 January 1876, he expresses his concern for the stability of his survey datum points, suggesting that at least some of the sand dunes are not stabilized during this period.

"It will be impossible to secure the points on the outer islands permanently as the hills move with the wind, but they can probably be secured plenty long enough to execute the topography & hydrography" (Halter, 1876)

A few years later, in a letter dated 31 August 1878, Halter has become slightly better acquainted with the area and distinguishes between moving and stabilized dunes. He states that

"The stations on Padre Id are on the second range of hills and are not likely to be disturbed. The hills seem to be permanent and are mostly covered with grass. The bare moving hills I avoid, they are mostly near the Laguna shore and in the middle of the Island." (Halter, 1878)

Halter's field maps of the island clearly designate areas of sand versus vegetated areas. Along much of the island, these seem about evenly mixed with the bare sand generally located in the center of the island. In a few places, bare sand is indicated across the entire width of the island. In at least

one place, a short stretch of island appears to be completely stabilized, with no dune areas shown. A careful analysis of the field maps could be utilized to estimate approximate percentages of sandy versus stabilized areas in the late 1870's and early 1880's.

Halter's correspondence only infrequently mentions animals, and usually in the context of their being pests of some sort. In this passage, from a letter dated 9 May 1876, he points out some of the more unusual of the islands inhabitants.

"Rattlesnakes were very plenty and so hard to see in the grass that we were often very near to them, one was between my feet before I saw it. A wolf about the size of a dog, here called "coyote" are very numerous. They are not dangerous and very annoying, one night they carried off the shoe of one of the men and another night actually cut two of the tent ropes so neatly as could have been done with a knife."
(Halter, 1876)

Halter continues to be plagued by rattlesnakes, with several dogs and a horse bitten by them. During one day in May of 1878, he killed seven. In a letter dated 30 April 1878, he talks about his camp partway down the island.

"What we have plenty of is sand, rattlesnakes & coyotes. I lost a valuable water dog a short time since by a rattlesnake bite. And some of my men have had narrow escapes from them." (Halter, 1878)

In another passage, dated 1 April, Halter is justifying his spending \$30 for a rifle, alluding to the increasing presence of wild species farther south on the island.

"I use it for protection against coyotes, wolves and panthers which become more plenty as we go down the island." (Halter, 1878)

Throughout his stay, Halter continues to describe the island and the adjacent mainland as desolate and almost uninhabited. On 6 December 1876, he wrote that his camp was on the north end of the island "which is a very desolate place." (Halter, 1876) He goes on to mention several apparent inhabitants in various letters, including a Dinn (Dunn?) whose house is near the north end of the island. Later, from a camp near the middle of the island, he writes

"This is a very wild, lonesome, & desolate place. There is no one living within forty miles of me that I know of." (Halther, 1876)

Halter's survey notes, although providing only sparse references, are nonetheless an important commentary on the nature of Padre Island during this period. Several potential biases must be remembered in reading his correspondences. In the first place, he does not seem to want to be there, and except at the very last, is very eager to get away from the island and head back east during the summers. In one case, he writes that he is headed to New Orleans to pass the summer because it is so much cheaper there than in Corpus Christi. Also, many of the comments in his letters are directed toward explaining his expenditures, justifying ever-increasing expenses and enumerating reasons for delays in his work. Given this emphasis, it would be a great surprise to hear him speak of the islands as green and lush, as Kenedy did (see above). It is interesting to note that Halter only arrived after 1870 when Dunn had claimed that the islands had lost their verdure (Price and Gunter, 1943:144).

Although there is some variety in the accounts from the hundred years between the maritime explorations of Josè de Evia and the founding of the Dunn Ranch, the general trend seems to indicate that Padre Island and the adjacent mainland were mixed grassland and open dune areas with scattered small oaks and other small shrubby trees. Only one report, the Padre Balli survey, seems to indicate any greater degree of arboreal vegetation. In comparison to the topographic survey of Halter, who spent years on the island, this two-week survey noted a seeming abundance of vegetation. This may well be because a description of the quality of the land and its pastures was inherent in the Spanish and Mexican grant process, or because land surveyors commonly use vegetation in their work while topographic surveyors do not. With regard to the latter, it is interesting to note that Blucher's diary of his survey on the mainland side of the Laguna Madre, at Los Laureles Ranch, lists a number of arboreal species, including several Palo Blancos, Tulares, numerous Encinales (oaks) and Encino motts, several Hackberries, a mott of Borrachos(?), Mesquite motts, and an Ebony mott among others (Blucher, 1871). Blucher's mention of these species, although from the mainland, may indicate that the species mentioned during the 1828 survey are more an indication of the observational training of the cadastral surveyor as opposed to the casual diarist.

On the other side of the coin, however, are descriptions such as Reid's (1847), Noakes' (1865) and Halter's which seem to indicate the lack of arboreal species and the general harshness of the environment. Could there have been one or more periods during which arboreal vegetation was more common on the island. The limited description available will not allow an easy answer to this question. Certainly there is some reason to expect that prior to the introduction of grazing by Padre Balli there may have been a somewhat denser vegetation. Unfortunately, the Balli

grant records indicate that he had already been grazing cattle there for 20 or more years prior to the survey.

2.3 THE RANCHING ERA

2.3.1 The Late Nineteenth Century

With some brief interludes after the Texas Revolution and during the Civil War, ranching seems to have continued on the island throughout the nineteenth century. In Halter's letters to Superintendent Patterson, there are brief mentions of cattle ranching on the island. Most of these reports suggest the scarcity of cattle, rather than their frequency, however. In a letter to his supervisor dated 30 April 1877, Halter notes that cattle are being driven off the island, suggesting that ranching is an ongoing process and the cattle he reports are not wild animals.

"I am now forty five miles from Corpus Christi and have the Lagoon between it and camp... Nearly all the cattle are being driven off the island and all the families have gone so the place is very desolate." (Halter, 1877)

In the summer of the following year, there are still cattle on the island as Halter, in a letter dated 31 August 1878, mentions that

"Mr. Wentz who lives near the south end has left his house and is now driving his cattle up the island to a place of safety until after September or the gale." (Halter, 1878)

It is clear from Halter's correspondence that the island was being used for ranching during the 1870's although to what

extent is difficult to ascertain. Smylie (1972) has noted that the efforts of the King Ranch to utilize the island occurred during this period, coming to an end by 1886. And in the 1870's, Patrick Dunn began his ranching efforts on the island, obtaining the lease from the former owner in 1879 and eventually purchasing most of the island (Smylie, 1972).

In any case, by the 1880's, ranching on the island seems to have taken off, reaching a higher level than before and the corresponding effect on the vegetation is thought to have been greater. With the ranching era came a notable increase in the accounts of the island and its vegetation, particularly scientific accounts. To what degree the vegetation may have already been markedly altered before these studies is not known.

It is during the ranching era that we begin to get increasingly better reports on other factors affecting the vegetation of the island such as hurricanes and droughts. Halter finished his topographic survey of the island in 1882, just five years before a devastating hurricane which struck the middle section of Padre Island. A 1933 report by the Texas Highway Department, surveying for a proposed island road, described the condition of this section 46 years later.

[Referring to the middle section of the island, between miles 66.2 and 106.7] "The storm of September 1887, struck the Gulf coast with great intensity between the limits of this section, and all the sand dunes adjacent to the beach area were flattened down and moved on an average of 0.4 of a mile from the beach. ... There is very little vegetation on this 40.5 miles of this island" (Bailey, 1933).

Although other hurricanes are documented as having struck the island prior to this (for instance, the hurricane which destroyed the settlement at the mouth of the Rio Grande), there is little or no description of effects on the vegetation. Although the 1933 assessment of the hurricane damage must to some degree be based on hearsay evidence, the certainty with which it is presented is notable. Particularly important is the 1933 notation that below this devastated mid-section there is a light vegetative cover (Bailey, 1933).

One of the earliest scientific descriptions of the vegetation of the coastal plain was undertaken by Valery Havard who studied the area in the early 1880's. Although he does not specifically mention the island, the importance of his work merits the following extensive quote from his description of the mainland.

"The vicinity of the sea does not appear to have any favorable influences on either the nature or vigor of the vegetation. From the mouth of the Rio Grande to Corpus Christi the coast is low, mostly bare, and unattractive. The trees or arborescent shrubs seen at the above town are Mezquit, mostly shrubby, extending to the very edge of the bay, Huisache and Retama, both of large size and much cultivated, Ebony (Acacia flexicaulis), Black Willow, Hackberry, Texas Persimmon. These trees, or some of them, with the addition of the Green Ash, the Water Elm (Ulmus crassifolia), Anaqua (Ehretia elliptica), and Nacahuite (Cordia Boissieri) are seen in thin fringes on many of the drains, arroyos and creeks opening into the sea.

Of Grasses, the most common are Bermuda Grass (Cynodon Dactylon), Aristida purpurea, Bouteloua

Texana, Eragrostis reptans, and Eleusine Aegyptica
[sic]." (Havard, 1885:485)

In addition to the above description, Havard also notes motts of lives oaks extending southward from Corpus Christi. He states that:

"Clumps or "motts" of Live Oak occur farther south on the sandy plains between the Olmos, the Rio Grande, and the coast; the trees are small and not of much account." (Havard, 1885:484)

The first actual description of the vegetation of the island itself which approaches scientific accuracy is that written by William Lloyd, who reportedly travelled the entire length of Padre Island (and probably Mustang Island) in November of 1891. Although Berlandier in the first half of the nineteenth century had provided excellent descriptions of some of the surrounding areas of south Texas and Mexico, he never scientifically described nor made collections at Padre Island. Lloyd's description, which was published in an abbreviated form by Bailey in 1905 (Bailey, 1905:24-25), is singularly important as the first published description of the island which intentionally lists vegetation types and certainly the first to list scientific names for plants on the island. In the following unedited version, taken from the Smithsonian Archives, Lloyd states:

"It is surrounded by a net-work of smaller islands, with Mustang Island separated from it by a channel a mile wide. The drift or wrack & floating timbers on the Gulf side are rapidly imbedded in the restless sand and form a nucleus for the sand dunes which stretch along the beach & form the back-bone of the island. Beyond them are smaller mounds with some little vegetation, and at their feet lie fields of

sandy grass broken by numerous salt water lakes where the sea has washed in from time to time; and after rainy weather fresh water readily collects tho' it quickly becomes brackish and tho' not undrinkable it is undesirable for various reasons.

A lighthouse at each end; - a quarantine station at the north point & a place call the Settlement where Mr. Dunn the lessee of the Island sometimes lives (It is used for a cattle ranch.) There is also an old hut in ruins about 15 miles n. of Pt Isabel & a deserted ranch (owners murdered last April) about 10 miles from North end - in both of which places we camped. There are no other inhabitants. ... Deer & Coyotes have been seen, by several informants both in Corpus & Pt. Isabel, swimming or wading to & from the Island from the mainland - which is identical in its sandy characteristics & dunes with Padre Is. Snakes are scarce but of at least three species including the ubiquitous rattlesnake which bit a Mexican during my stay.

The island has no arborescent growth worth noticing with the exception of a shin-oak (Quercus ____? [sic]), which extends from the north end of the island for about a mile, continuing on sandy hills on the lagoon side for 5 or 6 miles further. It is nearly all 6 in. to 18 in. high but there are trees, perhaps a different species, 6 to 8 feet high. The quarantine officer Mr. Curry assures me it was scarcely to be seen 5 years ago. (He has lived 30 years on the island & when not attending to his duties he rummages in the wrack) If this mat spreads it will exercise a great influence on the island both in giving stability to the sand and giving cover

to the Fauna.) As this species is always loaded with acorns - even now it is the favorite wintering ground of birds such as Wood Ibis, Whooping and Sand-hill Crane. Wild celery abounds also in the Lagoon & attracts ducks of a number of species in myriads.

A few willow, presumably Salix nigra, grow at the settlement and at one point north of it - & and also were observed a few patches of button-bush (Cephalanthus occidentalis). Also occur a few stunted "huisache", (Acacia farnesiana). These all are on the north and centre of the island - south of which grow salt grass & various waxy and creeping plants. What are known as the salt cranberry - grow abundantly round the quarantine station near where I also noted some Phlox Roemerii? [sic] still in bloom.

A peculiar and striking plant grows in abundance on many of the dunes. It is of the nettle family but unfortunately had finished blooming - and its root half in & half out of the ground like an immense sweet potato. This root is one of the great medicinal herbs of the Mexicans who call it "Yerba de mala mujer". Trompillo (Solanum elaeagnifolium) whose yellow berries are used for curdling milk is also common & also Jatropha macrohoya & also the wild sagebrush whose seeds cover the ground in places.

At the north end is also the common crab-grass (Cenchrus triboloides) and patches of cockle-burr - and a wild grape Vitis ____? [sic] that may be a promising growth later on.

Strange to say, neither hackberry, mesquite, & Mexican persimmon, tho' abundant with low Ebony on

the adjacent mainland have not succeeded in obtaining a footing anywhere & but two stragging [sic] prickly pear (Opuntia engelmanni) were the sole representatives of the cactus family & tho' Although palmetto and banana stumps washed ashore were in great numbers, none were seen growing." (Lloyd, 1891)

In contrast to other writers of the period, Lloyd clearly mentions oak trees, including shin oak and a taller species, extending down as far as six to seven miles south of the north end of the island. What Bailey (1905) omitted, however, was the comment by the quarantine officer that these oaks were rare five years earlier. Lloyd's mention of willow is not unusual; many of the early reports have noted it. His report is the first mention of huisache, however, and is important in clearly noting the absence of species otherwise common on the mainland such as hackberry, mesquite and Mexican persimmon. All of this should be placed in the context of his prefatory statement, however, that the island has "no arborescent growth worth noting."

Several other scientific studies were conducted in Corpus Christi Bay region in the late nineteenth century, but most were concerned with the mainland or other islands. Heller (1895) spent eight weeks in the Corpus Christi area in 1894 but does not specifically note having visited the island. He spent some time at Flour Bluff, where he may have made some collections (overall he collected 248 specimens in the Corpus Christi area). He describes the Flour Bluff area in the following quote:

"Between the Oso and the Lagoon de Madre is a strip of slightly elevated sandy land, about three miles wide, called Flower Bluff, the principal growth of which is the live oak, reduced to a scrubby bush, from three to eight feet high." (Heller, 1895:5)

Among the wildlife studies conducted in the area at this time were studies by Chapman (1891) on birds in the Corpus Christi area and by Allen (1894) on mammals from the Aransas County area. Allen does mention museum specimens from Padre Island, but does not give further information.

2.3.2 The Early Twentieth Century

Despite the increase in activity on the island with the ranching of Pat Dunn, there is very little hard data on the vegetation of the island after Lloyd's commentary. Very little was published on the island during this period and much of the available data is based on interviews and private correspondence.

In a series of letters to Robert Whistler, chief naturalist of the Padre Island National Seashore, Eric Warren, a friend of the Dunns who had visited the island as early as the 1920's, recalled the vegetation on the island during the early twentieth century.

"Various writers had reported that the island had never had trees but I had seen many areas of dense brush when I first came here in about 1918 with Mr. Pat Dunn, his cow hands and guests. There was a lot of mesquite, willow, sweet bay and oak. Each seemed to keep its own company except the sweet bay which mixed with the oaks and cactus with the mesquite. Willow was usually around the little fresh water lakes mixed with jaboncillo and salt cedar" (Warren, n.d.)

[Speaking of the area near Yarbrough Pass] "That area, as I remember, was once a cactus, mesquite and rough grass [Sacahuiste?] area." (Warren, 1976)

Describing the Dunn ranch house, Warren adds:

"There was such a grape vine growing on the props to the old outdoor toilet to the old Dunn ranch house at the park. Burton [Dunn, son of Pat Dunn] said he would tear it away but for the fact that the wasps built their nests in that vine rather than inside the toilet.

There were many wild flowers here in the yard, fenced to keep out the cattle, bachelor buttons, verbinas, sage, [illegible word], clover, thistles, several kinds of sun flowers and a big fig tree which bore big purple fruit.

He had a little hand scythe with which he cut these "weeds" away from the house for snake and fire protection but he grumbled that the more he cut them the faster they grew." (Warren n.d.)

Various articles have been written about ranching on Padre Island (Harris 1965, Luckie 1966), but most tend to be personal portraits of Dunn himself or emphasize the unusual or difficult nature of ranching on a barrier island. Few of these articles mentions vegetation and none address the question of the effects of cattle on the vegetation. Jim Lynch, whose father was foreman of the Dunn Ranch from the 1930's onward and who himself was foreman of the ranch in the 1960's, describes cattle grazing in general in this segment from a taped interview.

"Well, I don't know how to put acres per cow because... that'd be hard to say how much land is in grazing land, that may be in this island. A lot of it is salt flats that can't be grazed, but there was

2,500 mother cows on this island and there was 500 on Mustang Island. We also had Mustang (leased). It's a funny thing. When the cattle get used to an area, you'd see the same cows in the same area, maybe five miles one way or another. You'd see them in that area. You'd never see them go way down below or way up above, you'd see them mostly in their areas. They divide themselves out on these different locations. The most grass, the most cattle stayed up here. There's some exceptions, of course. There's always one that'd wander off here and there, but, in most cases, when you would see one and recognize one... they were in the same... general areas that they always ranged in. The bulls would move around some. We always run about a bull to 25 cows, so I don't remember exactly what the count is anymore." (Lynch, 1989)

Lynch felt that cattle were not only not harmful to the vegetation, but were beneficial in keeping the grass from overrunning the island. Despite this, it is clear that overgrazing was a factor in creating and maintaining the extensive dune fields of the island. In his letters to Robert Whistler, Eric Warren describes having observed some of the effects of cattle on the vegetation.

"After Pete Lynch went to work for them [in the mid-1930's] it was here that the loading and shipping pens were built and nothing grew there any more. I saw a picture somewhere of the fence after the trough causeway was built and its road went by the pen. It was completely bare on one side and knee high in grass just past where the cattle could reach through the wires. Later there were tiny bare dunes as the

sand in the holding pens began to blow toward Packery where the new marinas are now.

Down where the road is now, was a thick patch of sand burrgrass. He said it probably got started from a sand bur from some one's sock when they got off the boat. That was the boat landing also. Cattle wouldn't bother them as long as there was plenty to eat but would paw them to knock off the stickers and eat the grass down to the roots. Their roots are very long and do not pull up, even in sand."
(Warren, n.d.)

Also from the early twentieth century comes the first reports of intentional efforts to alter the vegetation. In this passage, Warren notes Dunn's habit of adding debris to the foredunes to help stabilize them. This echoes Lloyd's 1891 observation of foredunes forming behind the debris washed up on the beach.

"As old Pat Dunn hunted for things to hold the sand dunes, I always intended to ask him if he had tried gourds. He did like vines of all kinds, especially the kind which the cattle wouldn't eat."
(Warren, 1976)

Very few formal studies of vegetation were conducted on Padre island during the early part of the twentieth century. One article on an ornithologist's visit to Bird Island gives some interesting, if indirect insight into the vegetation of that small island in the late 1920's. The author notes that the south end of the island had "...no vegetation of any kind - just the bare sand and shell" and that in the center of the island "...there grew a sort of beach grass and a succulent weed"

(Carroll, 1927:197-198). More important perhaps is the observation of cactus on the northern end of the island.

"We were now approaching the northern end of the island where grew the prickly pear cactus, spreading in clumps over a considerable area. Some of these cacti reached a height of four or five feet and many of the clusters would measure fifteen or twenty feet in diameter." (Carroll, 1927:200)

Tharp (1926), one of the earliest writers to look at Texas in a broad ecological perspective may have visited Padre Island and made collections there in the 1920's, but this has not been determined. He does provide a general description of the vegetation of the coastal prairie west of the Brazos River and of the beach vegetation in this area, which probably represent the general vegetation of the barrier islands at this time. He does not specifically mention Padre Island, however. His comments on the woody invaders of the coastal prairie are some of the earliest on the effects of grazing on coastal grasslands. In particular, he notes live oaks as a prairie invader species, although, their presence had been noted as early as 1844 by Lindheimer (Tharp, 1926:72).

The previously mentioned Texas Highway Department report on the feasibility of a highway down the length of Padre Island has a few incidental references to the vegetation. For the purposes of this study, a series of mile posts were established, beginning with 0 at Corpus Christi and ending with 131.1 at the south end of the island. The end of the Don Patricio Causeway and the beginning of Padre Island is at mile 18.55. As noted above, the highway department survey indicated the scarcity of vegetation on the island between miles 66.2 and 106.7, a supposed result of the 1887 hurricane which struck this area. Concerning the areas

north and south of this devastated mid-section, the report states:

(In the Big Shell area) "the beach slopes up on a average of 1 to 30 feet to the base of high dunes, which have the most dense vegetation of any dunes adjacent to the beach." (Bailey, 1933)

[Referring to the southernmost section of the island, south of mile 106.7] "There is a light growth of vegetation on the dunes in most cases." (Bailey, 1933)

In general, no specific vegetation types are mentioned within the text with the exception of a reference to "three Spanish daggers on hill" at mile 56.40. Several popular maps of the island show a Dagger Hill or Little and Big Dagger Hills. Such a name probably indicates the relative scarcity of this species on the island. It is not reported at present within the park area and is not otherwise described in the literature.

One of the more interesting aspects of this report is that it was in the process of completion during the major hurricane of September, 1933. The effects of this hurricane were so devastating that the idea of a State Highway down Padre Island was abandoned. Although this report indicates the magnitude of some of the topographic and hydrologic changes following the hurricane, it unfortunately does not indicate specific changes in vegetation on the island in their discussion of the post-hurricane aerial reconnaissance.

Morton and Pieper (1975; 1977a; 1977b) have discussed the effects of the 1933 hurricane on various parts of the island. Concerning the extreme southern portion, from Mansfield Channel to the mouth of the Rio Grande, they state:

"The effects of the September 1933 hurricane on vegetation of southern Padre Island and Brazos Island were still visible on the 1937 photomosaics. The eroded dunes were separated by broad, smooth, washover channels; only isolated remnants of vegetated foredunes remained. Except for the remnants, the southern half of Padre Island was virtually denuded.

Vegetation on Brazos Island was also restricted to erosional remnants of the foredunes and scattered coppice mounds seaward of the foredune remnants." (Morton and Pieper, 1975:24)

One of the most important early vegetation studies in the South Texas area was that of Clover (1937) who summarized the vegetation of the entire Rio Grande Valley. Although his work did not touch on the northern end of the island, he did describe Clark Island near Brazos Santiago and the coastal climax associations from the mainland in this area.

The 1930's are seen as a period of extensive geomorphic change on the island. The hurricane noted above has been cited as having a devastating effect on the vegetation. Two other events of the 1930's may have had equal, although less well-documented, impact on the vegetation of the island. The first of these was the drought of the summers of 1933 and 1934 (according to Eric Warren, however, Lowry [1959] lists 1937-1939 as the only major drought in the region between 1918 and 1954) and the second was a large fire reported by Eric Warren to have occurred during 1934.

Fire was frequently used by Dunn's cowboys to burn the dense pastures of Sacahuiste grass which as it grows becomes hard

and inedible to the cattle and kills off the lower, less hardier species. According to Jim Lynch, last foreman of the Dunn Ranch and son of the former foreman, Pete Lynch, burning was used frequently as a tool to control grass growth.

Eric Warren remembered a major fire in 1934 which burned a significant proportion of the northern part of the island. His explanation of the cause is speculative.

"Evidently the brush and grass had burned off in 1934 during the Dust Bowl days. It may have started as the cow hands burned the thorns off of cactus for the cows to eat or it could have been from lightning, or a careless camper or a cigarette. Anyway, it had burned off clean." (Warren, n.d.)

Burning was used on the island, at least during the twentieth century, to control the cordgrass which became inedible to the cattle as it grew mature. Jim Lynch, whose father was foreman of the Dunn Ranch from the thirties and who himself was foreman of the ranch during the 1960's, described the use of controlled fires on the island. While he also remembered burning thorns off of prickly pear on the mainland, he did not remember ever having burned cactus on the island to feed cattle. In fact, he remembered the lack of prickly pear on the island and was surprised to find that it now exists on the island (but see above for a description of cactus on Bird Island in the 1920's). In the following interview segment, Lynch describes his recollections of controlled burning on the island.

"In the past there was natural barriers through here for fire lanes (i.e., dune fields). They use to be all along and you might find 4,000 or 5,000 acres, 1,000 acres in a spot that we would burn off and it had a natural barrier around it to stop the fire.

We'd come to one of those that was being taken over by this old salt grass, why then we'd just stick a match to it. We would maybe skip quite a ways so the cattle wouldn't have to travel back and forth to find grass. We would burn a spot here, maybe skip 4 or 5 miles, burn another spot, and do the same all up and down the island to get all the old thick grass out and then that's in the flats. It doesn't grow that much on the hills but in the flats it gets bad. That's the only thing. The better grasses are covered up by that and from the sunlight and everything else, I'm sure. For some reason or other, it just takes over. Well (it takes over) over a period of years, yes -- maybe over a period of 5 years or something. It would get matted up again. It's according to the rain conditions and whether it grows back or not and how fast it'd grow back and if it'd get bad, we'd burn again. That's control burning you understand. We did that in the winter months -- February -- January and February when it was dry, when it was causing the most problems, when the wind wasn't blowing so bad. The grass was dry, the weather and the sand. You don't burn in the summertime. We never burn in the summertime because then you would have sand-blow, but we wanted the grass to come back green before the spring and even that old salt grass would come back and they would graze on it some when it's tender. The first year, maybe two or three (it's edible by the cattle). It will keep growing young shoots at the bottom. It would go for a year or three. They wouldn't have any certain time they would burn a certain place. They'd look at it by sight and it needed burning, burn it. Well it gets about so-so (describing how high the salt grass grows) but it gets a lot of dead

leaves and limbs. I guess you'd call it leaves or stems would fall down and get around the bottom and get matted. You may have a lot of green leaves sticking out the top but you got a lot of dead leaves in the bottom. That's when we would burn it. Well, now, they will eat that when it's young but the other grasses no. That was the only problem we ever had with grasses - the salt grass. And everybody does that. King Ranch does it right across the road, across the Laguna. Welder Ranch does it up here on the river. Anywhere that you find salt grass you will find the same thing. That's nothing new. People been doing that ever since I can remember. The other grasses... never did need burning off or anything -- just the salt grass. That's the only (burning) that we did." (Lynch, 1989)

It should be noted as well that the fabled drought of the 1930's, which was disastrous in West Texas and the Panhandle, was relatively mild along the coast (Riggio et al., 1987). It was shorter and less intense than droughts of the 1950's and 1960's. Jim Lynch made some important observations concerning drought on the island from the rancher's perspective.

"Drought in the whole history of the Island that I know anything about and I'm starting -- I remember well in 1936. I've never known them to feed an animal. ... I think a whole lot of the Island as far as running cattle on it with no more care than it had. ...we didn't feed cattle over here in the whole history of the Island; but I can tell you there's some times that they were poor and they were in pretty bad shape in some of those dry spells and the sand was -- man, it was bare in a lot of places. I would say the cows ate it all (the grass) -- ate it

down to the ground. Course they might have pulled some of the roots up -- but... there was no feeding. The sand was dry right on top, but there's always moisture down in the dune, always moisture. But it would be deeper than the roots, of course. Yes, droughts has an effect on the Island, but it didn't have as much effect that they had to feed. Well, '51, '52, '53, somewhere right along in there. That was a dry time. Other than that, ...off and on a dry spell for a little while -- but I mean (not) to last any length of time." (Lynch, 1989)

The drought of the early 50's which Lynch mentions is the worst in Texas history (Riggio et al., 1987:1). On the upper part of Padre Island, it lasted for ten years, from 1947 through 1957, peaking in 1956. After a few years of relatively abundant precipitation, drought struck again, from early 1962 through 1964. Shorter in duration and somewhat less intense, this later drought was still the second worst of the period from 1931 to 1985 on the lower coast (Riggio et al., 1987).

While Lynch's observations suggest that the drought may have been less severe on the island than on the mainland, the impact is clear. Parts of the island were denuded by hungry cattle and dune activity increased. This is important to remember when assessing the starting point for vegetation studies in the park. While grazing was a major factor in devegetating the island, the effects of grazing were amplified when the park was created shortly after the worst drought in Texas history.

2.3.3 The Mid-Twentieth Century

The earliest aerial photographs of Padre Island, taken in 1937, mark the beginning of a new dimension in large-scale, quantitative analysis of vegetation change. Through a series of

studies published in the mid- and late-1970's by the Bureau of Economic Geology at the University of Texas (Morton and Pieper, 1975; 1977a; 1977b; White et al., 1978), a fifty-year sequence of changes in vegetation lines and vegetative cover, based on aerial photograph interpretations, was undertaken.

According to White et al. (1978), on North Padre Island from 1938 to 1974 vegetation expanded greatly, reducing erosional forms from 19 to 5 percent of the landscape. Vegetated dune and barrier flats spread from 12 to 30 percent of the area, and subaqueous grassflats increased from less than 1 to 16 percent of the area.

White et. al (1978) state that this trend may be a return to the reported greener conditions of the 1800's. They report that vegetation cover in the area is recorded as depleted during the droughts of 1880-1890 and 1895-1905, probably combined with overgrazing, and large areas of Padre Island were barren sand until 1941. North Padre had active dune field covering 18 percent of its area in 1938.

The appendices of Morton and Pieper's (1975; 1975a; 1975b) works also detail vegetation line changes along the island, though the authors caution that inferring vegetation trends from this can be invalid as the location of the vegetation line is primarily storm dependant.

Baccus and Horton (1979:51-2) summarize the work of Hunter and Dickinson (1970) who examined the condition of the north end of Padre Island through time by study of the early Bird Island quadrangle map and comparing it to a time series of photographs. The area was first surveyed sometime between 1860 and 1882, when one fourth of the center of the island was bare sand and the remainder vegetated dunes, without a back-island dune field. Subsequently most of the bare sand blew toward the lagoon,

forming the dune field and leaving a deflation plane that revegetated as a hummocky barrier flat in the central part of the island, and stopped the migration of sands to the back-island dune field.

Hunter and Dickinson (1970) found that, between 1945 and 1967, the island had advanced an average of 213 meters into the Laguna Madre. They note that this was expected to continue until the dunes were stabilized by vegetation or depleted. In a recent, unpublished study of the same area, Jennifer Prouty of Corpus Christi State University has found that the Laguna shoreline in the Bird Island area is now retreating, indicating that the sand source has been depleted (Prouty and Prouty, 1989).

In other recent studies tracking vegetation change in the area, Sherrod (1980) and Sherrod and McMillan (1981) follow the historical information on the distribution of the Black Mangrove (Avicennia germinans) on the Texas Coast, noting three relatively protected refugia areas from which populations tend to advance and retreat in response to variations in environmental conditions.

In a commentary on the wildlife dynamics of the mid-twentieth century, Lynch makes the following general comments.

"(There were) rabbits. I saw two deer on this island at one time and that was after we moved from here. We came over here looking for those bulls that time and I saw two great big bucks and so when I got back I called Joe Stiles and asked them if they was working cattle over here at the Laureles and he told me yes. So my guess was that when they were working cattle, the cattle and the cowboys and what have you and all the noise ran those deer into the Laguna and

they crossed over here on the Island. That would be my guess. But they didn't stay long. We never did see them again. We had a few ground squirrels and, yeah, there was gophers.. I don't remember anything else, and at one time, no rattlesnakes. Now they tell me there's rattlesnakes over here now. This was during Beulah when it rained so much and the eye of the storm was coming off the Laguna right over here and coming this way. And if you remember, just on this side of the paved road right at the entrance up there on that side there's a low place that comes all the way up, almost up to the road, and there was trash all in that area there. Well, when we come up here to build this fence, right after Beulah, I had Charlie Smithwick with me. We was walking in this deep grass over there and I said "there's one thing you never have to worry about over here on the Island." I said "I've been coming over here all my life and I've never seen a rattlesnake." All those years, I had never (seen one) and I had never seen one of the boys say anything about rattlesnakes. Nothing had ever been said about a rattlesnake all the time I been coming to this island. And Charlie and I were walking along with a tape and as we were walking along side by side -- and Charlie is a big man -- we were walking side by side and looking at our map and what have you, surveying and, just a glance, something struck across in front of him and he jumped straight up. I got out of the way, but I guess I pushed him back in. I don't know what happened, but anyway... he was the one -- and that snake -- and it hadn't been ten minutes since I'd told him don't worry about rattlesnakes over here. There's not any on this Island and because that's something that you do worry about when you're in

grass that deep. So I came back and I talked to Jack and I said Jack, "Tell me about rattlesnakes. When did we start getting rattlesnakes over here?" And he said "When all that trash came over here from Mainland, they bound to have come over here on that trash, because," he said, "right away after that storm, we started maneuvering around here, there was snakes on this Island. And it was during Beulah that started. But we had never seen one before. No other snakes of any kind. Coyotes, they's quite a few coyotes. I guess they still have those."
(Lynch, 1989)

The comments regarding snakes are quite interesting, taken in the context of nineteenth century comments by Halter on the abundance of rattlesnakes. Lynch was foreman of the Dunn Ranch and had ridden and driven the length of the island many times in his years there. Is it possible that the rattlesnake population on the island was kept down by cattle grazing and controlled burning?

2.4 HISTORICAL SUMMARY

The general trend of all historical references to the vegetation of Padre Island has been to identify the area as a grassland or prairie with shifting sand dunes and rare arboreal vegetation. Dozens of primary sources have been collected tracing this general vegetation pattern back perhaps as far as 1553.

Excluding Davilla Padilla's secondary account, the earliest direct observations of the Padre coast are those of the Spanish naval expeditions of the 1680's searching for the reported French colony along the Texas coast. Made with the typical precision of trained naval observers, and documented with dates and latitude

readings, these sources are fairly explicit in documenting the coastline. Although they neither list species nor vegetation communities, they clearly indicate the lack of arboreal species and the dune-center, grassland nature of the coastal islands.

The diary of Chevalier Grenier, shipwrecked on the Texas coast in 1745, provides one of the best early descriptions of the general barrier island environment. He clearly indicates the foredunes, 50 paces from the shore, backed by a prairie grassland mixed with salty lakes. He also notes the lack of arboreal vegetation, specifically pointing out the absence of low, shrubby vegetation. His description, however, is apparently of St. Joseph's Island which does not today have any significant arboreal vegetation and, not surprisingly, did not in the historic past. Although he does not note the appearance of trees until much farther south (well beyond the Rio Grande), he does not specifically note their absence again. In any case, the lack of further reference suggests they were not a significant component of the vegetation on Padre Island.

Ortiz Parilla's report of the nature of the island in 1766 is one of the most important of early descriptions. The description of the island very clearly establishes the typical grassland habitat present, specifically noting only three hillocks of trees, two of laurels and one of willows.

De La Fuente's survey of the Padre Balli land grant in 1828 is important because it is the first terrestrial survey of the island which notes the changes from south to north. The number and quality of the pastures increases northward and they do not mention trees until reaching the last 20 miles or so of the island.

The list of arboreal species provided by de la Fuente is more extensive than any prior to that given by Lloyd in 1891.

Whether this indicates the training and experience of a cadastral surveyor, noting trees as landmarks in the environment, or an actual increase in arboreal species cannot be determined. In any case, no other reports from the island support such an increase. The other early and mid-nineteenth century reports tend to describe the island as an impoverished environment, marked by grasses and shifting dunes.

Halter's correspondence reporting on the topographic survey of the island in the late 1870's provides relatively few clues to the vegetation given the length of his stay, but a few of his notations are important. In one place, he describes the mainland as having mixed grasses and sand dunes with occasional scrub oaks and a few larger oaks, while noting only the shifting sand dunes on the island. He refers over and over to the sand on the island and the problems it causes him. In one key quote, he notes that his benchmarks are located on the second range of hills which are covered with grass and seem to be permanent, contrasting this to the moving sand of the middle of the island and on the laguna shore. His field maps mark both vegetation and open sand areas. Along most of the island, these areas are about equal, with slightly more sand along some stretches. The detail with which these areas are mapped suggest that they are relatively accurate observations. Thus, we are left with the fairly strong suggestion that unvegetated dune fields were present and perhaps common as early as the late 1870's. In addition, there is the clear notation that bare, shifting dunes existed along the Laguna Madre shore at this time.

The end of the nineteenth century marked the first scientific studies of the region as well as increased ranching activities. Although the number and quality of descriptions increases on into the twentieth century, there are any number of suggestions that the vegetation of the area had already sustained great damage. Many early researchers, such as Tharp (1929) and

Price and Gunter (1943) clearly recognized this. Despite the clear evidence of disturbance, there are some interesting factors at work here, since brush vegetation typical of cattle ranching does not seem to have taken hold on the island.

The advent of aerial photography brought a new dimension to studies of change on the island. Using photography and old maps, the advance and retreat of the shore and vegetation lines could be tracked with great accuracy. The enormous, barren dune fields of the 1940's and 50's, accentuated by the mix of drought and overgrazing, can be clearly documented.

The historical record of the last 400 years on the island is sketchy at best. During periods there are fairly good, if general, accounts of the vegetation. At other times, the only available documents are maddeningly vague or seemingly more impressionistic than realistic. The general vegetation trend stands out quite clearly, however. Padre Island has been primarily a grassland since the arrival of Europeans in the area and probably since it rose from the sea several thousand years ago. Arborescent vegetation has been noted infrequently, but most notably by the 1828 Balli land grant survey and by William Lloyd in 1891.

The first unquestionable mention of oaks on Padre Island was by Lloyd, who was told by Curry that they were a recent introduction to the island. Mentions of laurels in earlier sources, including the Balli survey and the Ortiz Parilla reconnaissance in 1766, could be misidentifications of live oak, but laurel is also common on the mainland and occurs on the northern part of the island.

If, as Tharp (1926) has argued, oaks followed the disturbance caused by ranching on the coastal plain, then the oaks on Padre Island may be an indication of that disturbance rather

than, as some have thought, the survivors of pre-ranching era. In this light, it is interesting to note comments by Lynch (1989) that he had heard that the concentration of oaks at the north end of the island, near Packery Channel, were attributable to the packeries that had been located there, and the cattle which were butchered in that area. Since the packeries were there prior to the turn of the century, this would at least correlate well in time with the comments by Lloyd and Curry noted above. On the other hand, Warren has argued that the oaks are in decline because of the demise of the passenger pigeon which was a main source of disseminating their seeds. The idea of demise, at least with respect to the immediate present, seems viable because of the apparent greater presence of oaks documented on the island previously, through pictures and descriptions of the stump forest (Rawalt, n.d.). There are several existing pictures which verify the existence of this forest which was reportedly in the Bird Island Basin area.

Overall it is very difficult to form a clear picture of the history of oaks on the island. Whether the oaks were there prior to ranching or not, there is little evidence to suggest that they were ever a major component of the island's vegetative community. During the nineteenth century, they may have extended their range across the island. If, however, their initial presence was due to ranching, they seem to have begun to vanish long before the cessation of ranching on the island, perhaps during the drought of the 1950's, but probably as early as the 1930's. Perhaps the combination of the extinction of the passenger pigeon and the cutting of the Intracoastal Waterway (which ceased cattle drives across the Laguna Madre), or perhaps natural phenomena such as fires, drought and hurricanes, ultimately caused the apparent decline.

3.0 MODERN VEGETATION STUDIES

3.1 HISTORICAL VEGETATION STUDIES

Prior to 1900 the southern coast of Texas was relatively inaccessible. The railroad from Kingsville to Brownsville was not complete until 1904, and it was 1941 before a highway was available. Consequently rigorous botanical study of the area before 1900 was extremely limited (Johnston, 1955). Between 1829 and 1892 several notable pioneer botanists including Berlandier, Poselger, Thurber, Schott, Palmer, Buckley, and Neally, made collections along the coast. Unfortunately, in almost all cases their collections in the area consist of only a relatively small number of sheets, as part of a collection that concentrated on more inland areas. While of great historical interest they are an insufficient document from which to gain information about the plant communities of the area, and none of the sheets are from Padre Island (Johnston, 1955; and Jones, n.d.)

The first known collection on Padre Island consists of two sheets collected by A. A. Heller in 1894, during an eight week collecting trip in the Corpus Christi area. He subsequently commented that botanists knew practically nothing of the area between Corpus Christi and Brownsville (Johnston, 1955). Vernon Bailey collected in the area in 1900, and J. K. Small reviewed his collections in compiling his Flora of the Southeastern United States. Small stated in 1927 that coastal southern Texas remained almost a virgin botanical field. Eventually, the Don Patricio causeway to Padre Island was built (1927), exploration in the area increased, and material for study became available (Jones, n.d.).

3.2 FLORISTIC AND PHYTOGEOGRAPHIC STUDIES

The earliest detailed floristic description of a Texas barrier island appears to be the account of Clark Island, at Brazos Santiago Pass, given by Clover (1937) in his study of the vegetation of South Texas. He describes the vegetation as about one third coastal prairie and upland vegetation, and gives a "complete" list of the flora.

The first floristic treatment of the Coastal Bend region plants appears to have been Gould and Box's Grasses of the Texas Coastal Bend (1959, 1965), which lists Sporobolus tharpii, Padre Island dropseed, as a probable Texas endemic. A more general checklist concentrating on the Coastal Bend region followed in 1961 (Jones, Rowell, and Johnston, 1961) when Flowering Plants of the Texas Coastal Bend Counties was published, followed in 1975 by a regional flora (Jones, 1975).

Individual islands began to receive attention as well. Fleetwood (1963) compiled a checklist of the plants of the Laguna Atascosa National Wildlife Refuge. Jones (1966) produced Checklist of Padre and Mustang Island Plants which recorded 327 species. Gillespie (1976) compiled an annotated checklist for Mustang Island, with 178 species. Jones (n.d.) later updated his original checklist for Padre and Mustang Island, including 400 species, subspecies and varieties.

South Padre Island was investigated by Lonard, Judd, and Sides (1978) who produced a checklist with 207 species. They compared their findings with those of Gillespie for Mustang Island and found considerable floristic differences. While 93 species, 96 genera, and 36 families were common to both islands, Mustang Island had 53 exclusive genera and South Padre Island had 55 exclusive genera. Based on this work, keys to the terrestrial

flora of South Padre Island were produced by Lonard, Judd, and Wade (1978) and by Lonard and Judd (1981).

Specimens collected from these floristic studies by the authors are deposited in herbaria at the University of Texas, Southern Methodist University, The Welder Wildlife Foundation, Corpus Christi Museum, and Pan American University.

Identification of unique, rare, threatened or endangered species present on Padre Island is not well documented. Jones attempted to delineate some of these species in a letter dated February 1975 to the National Park Service, Padre Island National Seashore. He included a list entitled "Plants that should not be taken by collectors" (Jones, 1975). Shew et. al. (1981) include a list of rare and endangered plants native to Laguna Madre taken from Gustavson et. al. (1978) and USFWS (1979). Endemics are mentioned by Gould and Box (1965) and Lonard and Judd (1980).

Phytogeographic affinities of the flora of South Padre Island was examined by Lonard and Judd (1980). They surmised that 44 percent of the species present on the island are also present on the mainland, three of which have probably traveled to the mainland from the island. Tropical floral affinities were found for 28 percent of the species. Two species are probably island endemics (Flaveria brownii and Sporobolus tharpii). Weedy species of disturbed sites that are believed to be introduced by man's activities comprise 54.2 percent of the flora.

Gunn and Dennis (1973) found the beaches of Padre Island to be "rich in tropical disseminules", finding representatives from 28 tropical families arriving on gulf beaches, most in viable condition.

In addition to the studies of terrestrial flora conducted within the park area over the years, a number of floristic

studies have concentrated on estuarine flora as well. Figure 3 shows the locations of some of these studies. One of the earliest investigations of the species of seagrass in the Laguna Madre is that of Simmons (1957) who collected Halodule, Syringodium, and Ruppia.

Later, investigators began to monitor the species composition and distribution in the lagoon, and produce distribution maps, because of the Laguna Madre's importance to hunters and fishermen. There are several records of transects and distribution maps of seagrasses in the Laguna Madre including Singleton (1964), and McMahan (1965, 1967). McMahan (1969) discussed changes in the distribution and abundance of seagrasses in the lagoon. Merkord (1978) conducted the most rigorous of these studies to date, producing detailed distribution maps, comparing his distributions to those of earlier workers, and relating these changes to disturbance by man and attendant changes in salinity.

Baca, Sorenson, and Cox (1979) compiled a systematic checklist of the seaweeds of South Texas. Baca and Cox (1977) describe collections of benthic marine algae from South Padre Island.

3.3 VEGETATIVE COMMUNITY CHARACTERIZATIONS

The earliest quantitative ecological study, using analytical quadrants to survey vegetation and describing communities correlated with geological, soil, and climatic data is that of Tharp (1926, 1939). He was known to be an enthusiastic collector on Mustang and Padre Islands. Jones (n.d.), in discussing collectors of the Island floras, states that Tharp:

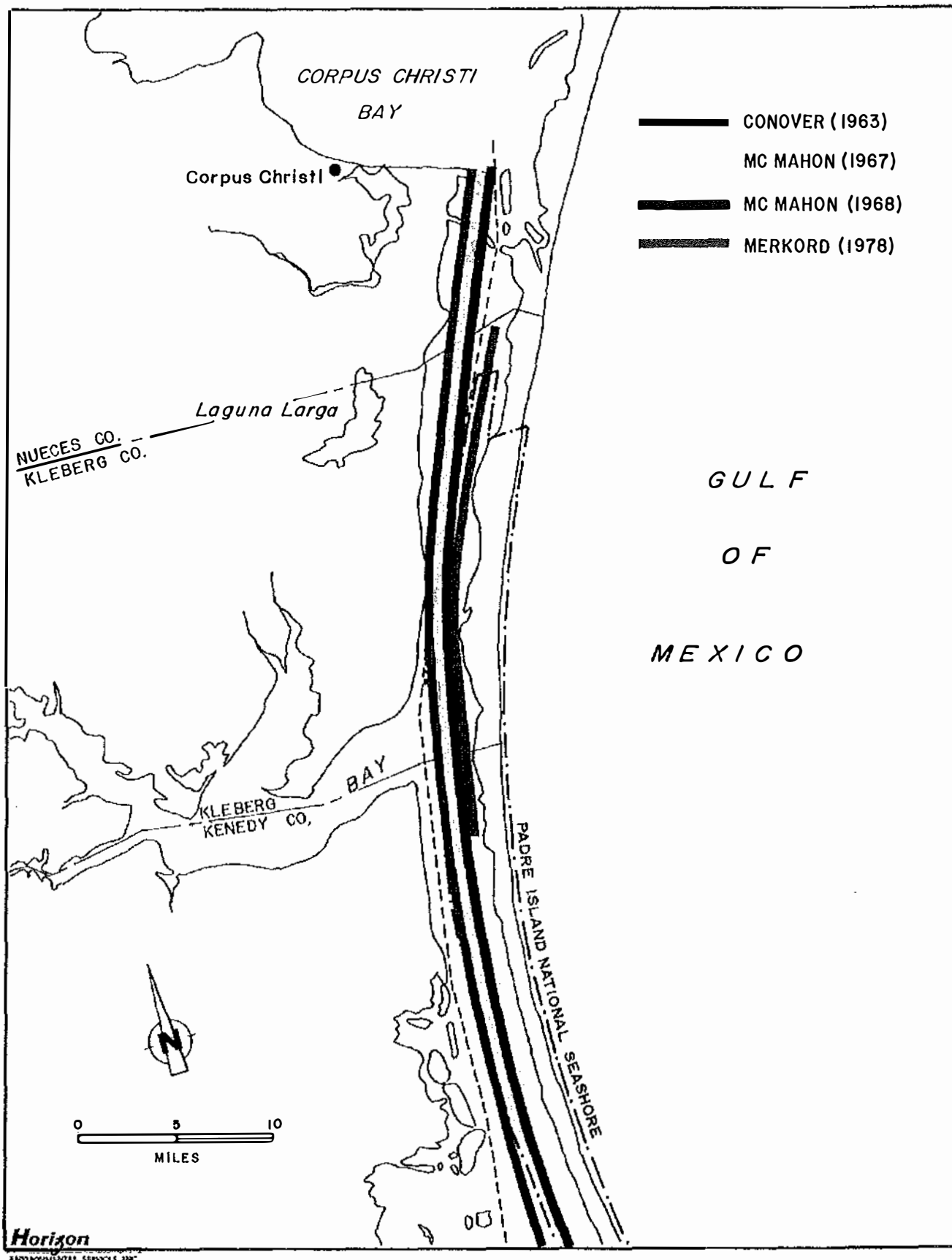


Figure 3a
LOCATION OF LAGUNA MADRE ESTUARINE STUDIES
AT PADRE ISLAND NATIONAL SEASHORE

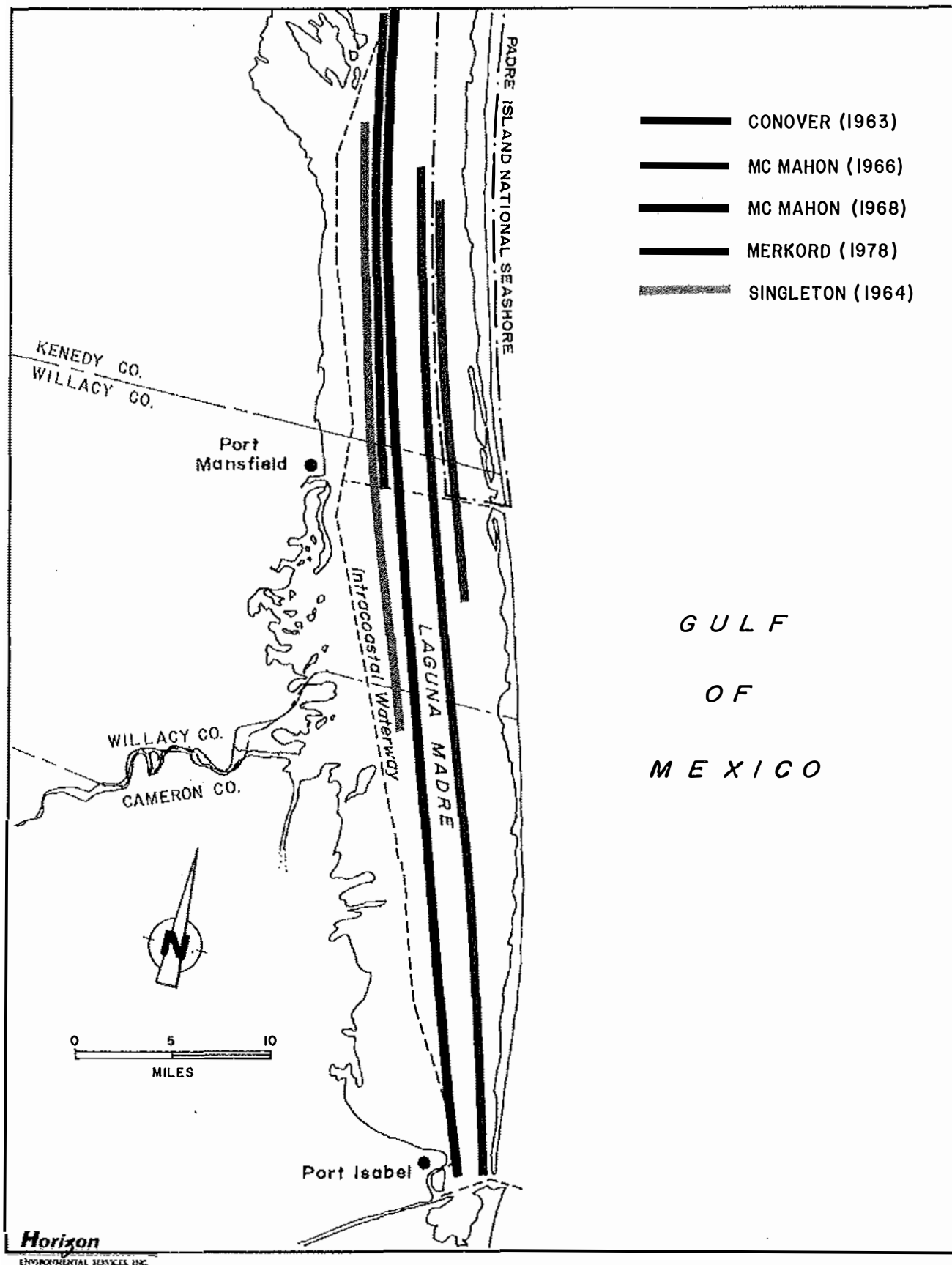


Figure 3b
LOCATION OF LAGUNA MADRE ESTUARINE STUDIES
AT PADRE ISLAND NATIONAL SEASHORE

"...probably gave more attention to Padre and Mustang over a longer period of time than anyone else..."

Tharp classifies the coastal area including the barrier islands as Coastal Prairie, which he describes as a mosaic of grassland and marshes on alluvial soil/sand, with a moisture gradient ranging from 50 inches in the northeast to 30 inches as you move southwest. Vegetation dominants are Panicum, Paspalum, Aristida, Bulbilis, Eragrostis, and Andropogon. Sporobolus replaces Bulbilis as one moves eastward. His discussions of the distribution of the community and its successional sequence is noteworthy:

"...it is generally conceded that active and relatively rapid invasion of prairie by woody plants is now going on. Testimony... is to be had for the asking of any of the older inhabitants of the area and seems to be backed by field studies.. ..the original open prairie has been transformed into dense chaparral composed principally of Acacia, Colubrina, Zizyphus, Eysenhardtia, Aloysia, Prosopis, and Celtis pallida. Led in its invasion by Acacia... Other woody invaders of coastal prairie regions lying northeast of the present limit of chaparral constitute...inhabitants of transitions between coastal prairie and climax associations to the north. The more important are as follows:

Quercus virginiana, principally in the form of a shrub, occupies rather large areas. That its occupation of this territory is largely recent appears doubtful, however, for Lindheimer... speaks of having noted its presence as early as 1844. To what extent it is now actively spreading has not been

ascertained, but with intensive pasturing and elimination of prairie fires, mottes of it are unquestionably proceeding to attain the dignity of trees. As was suggested... liveoak, scattered or in mottes, constitutes the normal woody inhabitant of the transition zones between coastal prairie and oak forest as far east as the eastern edge of that association." (Tharp, 1926:71-72).

Johnston (1955) also conducted quantitative ecological studies along the eolian plain and associated coastal features of southern Texas, classifying communities that correlate with soil characteristics. He maps Padre Island in his eolian sand and sandy loam region, and characterizes this vegetation as Loose Sand Prairie, which he describes as a fire climax dominated by Andropogon littoralis, containing up to 40 other perennials and annuals, exhibiting little bare ground, and attaining a height of 3 feet in undisturbed stands. The association is not disturbed by salt spray. On higher ground it may grade into liveoak scrub, and on lower ground with Spartina. Johnston discusses oaks as climax formations on loose sand as well, but distinguishes:

"Upland climax formations in the study area are brush and liveoak scrub. Liveoak scrub is topo-edaphic climax on loose sand upland...In the past, evidently because of the repeated burning which favored the existence of dense prairie, the climax formations were not nearly as extensive as they are now...horses and cattle depleted the fire climax to the extent it could no longer support extensive fires. In the absence of fires, live oak and brush have been, ... spreading at the expense of...prairie."

and:

"live oak scrub is confined to loose sandy soil and occupies only the higher terrain not too greatly subject to salt spray. It is considered an edaphic climax."

Rechenthin and Passey (1973) conducted an inventory of the vegetation of Padre Island National Seashore during 1966 and 1967, recognizing five vegetation types and four bare land types:

"Coastal Dunes. This is described as the fore-dune ridge area by many other investigators. Dominant species are Bluestem, Sea Oats, and Gulfdune Paspalum. They divided this vegetation type into three subtypes. Subtype 1a designated dunes with less than 35% bare surface. It typically had a reduced per cent cover of the dominant species and an increase in forbs such as Primrose (Oenothera drummondii), Beach tea, Riddells groundsel (Senecio spartioides), and Camphorweed (Heterotheca pilosa). Subtype 1b had 35%-75% of the ground surface bare. Grasses were reduced to clumps of Sea Oats, with an increase in forbs as listed above. Subtype 1c had greater than 75% of the ground surface bare and was composed of widely scattered clumps of the plants found in subtype 1b, along with some Sesuvium (Sesuvium sp.).

Low Coastal Sands. These are nearly flat areas with a hummocky surface near sea level, that are composed of deep sands, located behind the fore-dune ridge. Vegetation dominants include Bluestem, and Gulfdune Paspalum. Under grazing pressure several weedy species (unspecified) will increase.

Salt Marsh. Found in areas of poorly drained shallow depressions and vegetated with plants tolerant to both salt and fresh water. Vegetation was found to be very variable but included Cordgrass, numerous sedges, Seashore Saltgrass, and Seashore Dropseed (Sporobolus virginicus).

Salty Sands. This is an area of saline flat interspersed with and behind the back-island dunefield. They may be intermittently inundated with saltwater and suffer active wind erosion. Vegetation includes scattered plants of sedges, rushes, Sesuvium, Salt Heliotrope, Shoregrass, Salicornia, and Seashore dropseed.

Shoregrass Flats. These are low-lying salt flats along the Laguna Madre, which are frequently inundated with salt water. Vegetation is almost a monoculture of Shoregrass, with some succulents.

Bare Land Types. These include Salt Flats, Active Dunes, Beach, and Spoil Banks."

Higginbotham (1972) attempted to sample within the vegetation types recognized by Rechenthin and Passey, comparing areal extent of the habitat types. He constructed permanent transects, but unfortunately was unable to adequately sample the area and make meaningful comparisons. Drawe et al. (1981) later successfully measured the relative occurrence of the six habitat types delimited by Rechenthin and Passey (1973), using the transects set out on the island in 1972. These transects and a number of the other vegetation study transects which could be located, are shown on Plate 1.

Judd, Lonard, and Sides (1977) analyzed three transects across the vegetation of South Padre Island, and correlated the vegetation profile with measurements of dune topography. They recognized six terrestrial-topographic zones. Two of these zones, the Foreshore and Washovers, were unvegetated. The vegetated area, the backshore, is a topographic zone which consists of the area from the berm crest seaward to the base of the primary dune ridge. Its vegetation dominants are sea oats and Sesuvium.

Primary Dunes This zone contains the first leeward dune ridge from the waterline, and is composed of dunes 0 - 9.8m high. The dominant plants in this community are morning glory, and Sesuvium in addition to the backshore species mentioned above.

Secondary Dunes and Vegetated Flats. This area is composed of the zone of relatively flat or low elevation dunes west of the primary dune ridge and its accompanying flat grassland. It is dominated by bluestem, with marsh vegetation in the low spots.

Tidal Flats. These are the tidal flats on the Laguna Madre side which are flooded at high tides or during heavy rains. They are largely barren but contain some Sesuvium.

White et al. (1978) conducted an environmental survey of Mustang and North Padre Island, examining areas both in terms of geological land resource capability and biotype. They combined the two concepts, studying landforms and vegetation using aerial photographs and field studies. They divided the area into land and water resource Units, producing a more detailed description of geomorphology and vegetation at the association level,

including aquatic vegetation. They recognized 14 units and three subunits. The following were mapped on Padre Island:

Beaches, Coppice Mounds, and Wind Shadow Dunes. This unit includes the forebeach, berm, backbeach, and partly vegetated eolian dunes along the Gulf. It has vegetation between the back beach and the foredune ridge. Dominant species are goatfoot morning glory (Ipomoea pes-caprae), bitter panicum (Panicum amarum), seaots, beach tea, and sea purslane.

Vegetated Fore-Island and Back-Island Dunes. Composed of the nearly continuous dune ridge of well vegetated dunes and interlying swales. Dominant species include a variety of grasses and flowering plants tolerant of salt spray, including seaots, bitter panicum, goatfoot morning glory, gulfdune paspalum, and beach tea.

Vegetated Barrier Flat. This unit consists of the hummocky, grass covered areas behind the fore-island dunes, and includes ephemeral fresh water ponds and marshes and small patches of salt water marsh. Vegetation is dominated by grasses including gulfdune paspalum, a variety of Panicum species, as well as bluestem. Forbs include silverleaf sunflower (Helianthus argophyllus) and indian blanket (Gaillardia pulchella).

Grassflats. These are shallow subaqueous flats containing moderate to dense growth of marine grasses. The most common grass is shoalgrass, but there is also turtlegrass (Thalassia testudinum) in deeper areas.

Subaerial Spoils and Made Land. This unit is composed of dredging spoils or lands filled, graded, or altered for development and industrial purposes. Vegetation varies considerably depending on the location, configuration and age of the area.

Subaqueous Spoil. As above, but in a subaqueous environment. These units usually support the same vegetation as bay margin sand and shoals, that is, local patches of seagrasses.

Navigation Channels and Permanent Surface Water Bodies. This includes canals and channels, as well as permanent natural water bodies. Marine grasses frequently become established in shallow areas.

Weise and White (1980) expanded on the approach of White et. al. (1978) in their inventory of the environments of the Padre Island National Seashore. They classify their environments into three systems (Barrier, Lagoon, and Man made/modified units). They recognized 18 separate units, many of which are unvegetated. They apparently did not use field studies of the vegetation to identify the vegetation in their environments at the community level. In many units the vegetation is not discussed in any detail. Nevertheless, their excellent delineation of the physical/geological units was long awaited. Many of their environmental units have correspondence to previous community types, other units suggested the existence of distinct communities, and the publication immediately became the standard framework for discussion and research on the vegetation of Padre Island. Their terminology has been widely adopted, often with respect to vegetation, hence its inclusion here. The vegetated environments in their study include: The Sandflat and/or coppice dune field, The fore-island dune ridge, The vegetated barrier flat, Stabilized blowout dunes, Ephemeral fresh-to-brackish-water

ponds and marshes, Grassflats, Spoils, and Land modified by human activity.

Perhaps the most detailed community analysis is that of Baccus and Horton (1979). They realized the value of Weise and White's work, but recognized that there were significant vegetation units within their environments. Obtaining the results of Weise and White's analysis even before publication, they started with the base map units as "geotypes", did intensive sampling within the base units, analyzed the plant relationships using cluster and discriminant analyses, and identified 37 vegetation types or "biotypes" on Padre Island National Seashore. They used these biotypes as baseline data for experiments and studies of the effects of disturbances of various types. A discussion of the 37 biotypes is beyond the scope of this report. One unfortunate aspect of the Baccus and Horton report is that the 37 biotypes are unnamed (they are numbered) which may inhibit the use of the biotypes for reference by other investigators.

Barbour et al. (1987) sampled the vegetation of the entire Northern Gulf of Mexico using 63 strip transects, including two on South Padre Island. Cluster analysis and ordination of samples revealed three broad vegetation types (Southern Florida assemblage, Florida panhandle to the Mississippi assemblage, and Louisiana to Texas assemblage). An attempt to correlate vegetation differences to varying environmental factors with limited success. They noted a distinct zonation pattern of vegetation associations with distance from the leading edge of vegetation.

While these studies represent community analyses conducted from 1967 to 1981, comparisons between studies must be approached cautiously. Differences in techniques and scale used to map and describe associations make comparisons difficult, particularly in interpreting differences between communities or trying to infer

changes in community structure over time. Examining common elements in the different community studies, especially those using an approach that combines an evaluation of geology, topography and vegetation does allow some generalizations to be made.

For example, plant communities on Padre Island tend to be one-layered, and fall into zones parallel to the shoreline that follow changes in topographic features. Vegetation associations are undoubtedly responding to changes in inundation, elevation, and exposure.

On a broad scale, common features in these community studies serve as field validation of the integrity of the associations delimited. It is notable that all the community type schemes include a flat bluestem or bluestem and cordgrass grassland type, the primary dune ridge type, and a beach landform. In addition four of the five schemes include marshes, and three of the five recognize shoregrass flats.

Finally, a number of recent studies have examined the community dynamics of estuarine flora. In the earliest of these studies conducted within the National Seashore area, Conover (1963) sampled along transects in the Laguna Madre for a rigorous study on the distribution, seasonal periodicity and reproductive periodicity of benthic plants with observations on environmental factors that might be governing periodicity. He published transect locations and a species list.

McMahan (1966) continued his studies on seagrasses, investigating seasonality and standing crop. He found that shoalgrass exhibited a strong seasonal abundance pattern, while manateegrass did not. McMahan (1968) examined biomass and salinity tolerances of Halodule (shoalgrass) and Syringodium (manateegrass) from 6 point sample sources in the lagoon.

In one of the more recent estuarine community studies, Shew et al. (1981) divide the Laguna Madre into three basic habitats: aquatic or lagoon, wind tidal flat, and emergent wetland. Seagrasses are the dominant flora of the aquatic habitat. Wind tidal flats are vegetated with algal mats and floating algae. The emergent wetlands are dominated by holophytic succulents in the lower areas and by shoregrass in the upper elevation areas. The authors discuss and summarize work done on the vegetation of the Laguna. Most of those works pertaining to the park are addressed here, but several other studies have been conducted in the general area of Padre Island National Seashore including Armstrong and Gordon (1979); Brown, Brewton, McGowen, Evans, Fisher, and Groat (1976); Circe (1979); Diener (1975); Hedgpeth (1967); Hellier (1962); Humm and Hildebrand (1962); Johnston (1984); Pulich (1980); and Taylor (1954).

4.0 VEGETATION DYNAMICS AND FACTORS INFLUENCING CHANGE

Padre Island is a fragile ecological system which has seen considerable change throughout its 5000-year history. It is impossible to be certain, but it was probably colonized very early by hardy plants. Certainly those plants that survive today are primarily hardy species and/or rapid colonizers.

Two things are quite obvious from the historical survey: 1) that while specifics may have changed from time to time, the general character of the vegetation has changed little in the last 400 years, and, 2) that the drastic influences of hurricanes, fire, drought and human intervention have frequently caused fluctuations or variations in the general community present in any one place at any one time.

One of the more significant factors influencing vegetation change has been human activities. With the exception of some early observations about the impact of grazing, however, scientists did not begin rigorous long term investigations of the effect of perturbation on the vegetation of Padre Island until after the establishment of the Padre Island National Seashore. Thus, the baseline for a 'natural ecosystem' has been lacking throughout the studies.

A number of studies have sought to elucidate the principal factors involved in geomorphic and vegetational change on the island. Many of these studies have focused on the management of park resources. Most of the studies have emphasized the negative effects of past human utilization of the island and not a few have stressed the potential damage from continued utilization, even for recreation. In trying to bridge the gap between the park's use and foreseen continued degradation of the environment, some of the studies have recommended aggressive, active resource

management such as extensive revegetation or drastic reduction in visitor access.

4.1 GRAZING

Tharp (1926) and Johnston (1955) sampled quantitatively in undisturbed and grazed areas of their coastal plain vegetation types. They discussed the role of overgrazing in the invasion of prairie lands by woody species, particularly Quercus virginiana in the Northeastern part of the coastal prairie, as reviewed earlier. They believed that grazing reduced the coverage of native grasses and impeded the ability of the grassland to carry the usual sporadic wildfires which deterred the survival of woody seedlings.

Rechenthin and Passey (1973) relate a historical account of intense grazing on Padre Island, and attribute the low coverage of grass species and abundance of weedy species on the Island to its detrimental effects, accentuated by drought and spring burning.

The trend of solid historical evidence tends to suggest that grazing has had a damaging effect on the vegetation of the island. The recovery of the northern part of the island after grazing was stopped has been dramatic and illustrates not only the harsh effects of grazing, but the potential ability of the island to recover from such effects.

The most serious question which remains regards the southern end of the island, where recovery has been slow or absent altogether. It is possible that grazing pressures in such an already fragile environment have pushed the island's ability to recover beyond some threshold. From a geological perspective, the answer is no. Given sufficient time, natural forces will continue to operate and the island will recover. Whether this

recovery will be in line with National Park Service goals or timetables cannot be foreseen.

4.2 MOWING

Kattner (1973) and Drawe and Kattner (1975, 1978) are conducting a long term study examining the impact of mowing and burning. Permanent research transects were established in 1972. summer and winter mown plots were monitored in an area identified as Rechenthin and Passey's (1973) low coastal sand vegetation type. After two seasons of treatment they found that mowing was damaging to the vegetation, initially leaving scattered bare spots from scalping on the uneven terrain. Summer mowing reduced the percent of live grass culms significantly. Percent composition of species of grasses and forbs was unaffected, but the standing crop and litter components of the vegetation was increased over the level in control plots, an undesirable result in range management. Mowing was considered inferior to controlled burning for management of grassland standing crop and litter levels.

4.3 FIRE

Fire is known to be an important component of grassland ecosystems, playing an important role in nutrient cycling, succession, and the inhibition of woody species. Baccus and Horton (1979) discuss the probable role of fire in Padre Island ecosystems. They consider that on Padre Island fire would naturally be cyclic, and would be expected to result in long term changes only if it were so severe that the community could not regenerate quickly, allowing erosional forces of water or wind to cause topographic changes.

In an attempt to better understand the dynamics of fire and the plant communities of Padre Island, Baccus and Horton

(1979), Drawe and Kattner (1975), and Kattner (1973) undertook fire studies on the Island. Drawe and Kattner (1975, 1978) and Kattner (1973) conducted winter and summer burns in the low coastal sands vegetation type (Rechenthin and Passey, 1973). They found no change in species diversity, and that a winter burn increased productivity in the stand.

In 1978 Baccus and Horton (1979) initiated a long term study of fire ecology, reburning plots in the vegetated barrier flats (Weise and White, 1980) that had burned in 1973, and also plots in an area without previous known fire history. They monitored effects on ground and aerial litter, soil organic matter, exchangeable cations, nitrogen, phosphorous, species diversity, abundance, richness, and evenness. Species richness initially decreased following the burn, but recovered within 6 months. Interestingly, species composition changed significantly, and monitoring of the various species for effects of burning was to continue. Productivity did increase on burned plots, as did soil organic matter. They state that while their initial results are preliminary, it did appear that fire was an effective tool for controlling litter levels, especially aerial litter.

While the role of fire in maintaining grasslands is well known, and its role as a park management tool is potentially important, there is some question as to the historic occurrences of fire on the island. Certainly there is extensive historic documentation on the use of fire during the ranching period. While the evidence is far from clear regarding the Indian use of fires on the island, the natural environment may be less susceptible to fire than mainland areas and less dependent upon them.

4.4 VEHICLE AND PEDESTRIAN TRAFFIC

In an attempt to understand and document the impact on the barrier islands of man's increasing use of them for recreational purposes, McAtee (1975) and McAtee and Draw (1980; 1981) set up transects in 4 areas along the barrier island beach and dune area that were subject to various levels of use. Transects were set up in an area with no (or little) visitation, in an area with predominately pedestrian visitation, in an area that had sustained both vehicular and pedestrian traffic for many years, and an area opened to both vehicular and pedestrian traffic for only a short time. They monitored both elevation and cross sectional profile of the transect area and quantitative aspects of the vegetation during the fall of 1973 and spring of 1974.

The results were a sobering testimonial to the fragility of the beach and foredune zone. In all cases traffic decreased top and root production, percent cover, and diversity of the vegetation. In addition, as activity levels increased beach elevation decreased, and the microclimate changed to a more compacted, saline soil with wider temperature fluctuations, and a windier environment carrying more airborne salt and sand. These conditions make natural revegetation difficult and could permit destabilization of the area and severe erosional and storm damage.

The following year the study was continued by Behrens, Carangelo, and Finkelstein (1976) who used the same three transects inside the Padre Island National Seashore and added another at Shell Beach. They monitored elevations and cross sectional profiles but made only qualitative observations on the vegetation. Their findings supported the previous study, though they thought pedestrian usage less threatening.

Baccus, Horton, and Carangelo (1977) and Baccus and Horton (1979) continued the study on the same transects, again making quantitative vegetation measurements. Their results support those of McAtee and Drawe (1980; 1981). McAtee (1975) made a number of suggestions for management practices to reduce the impact of recreational uses, which were supported by the subsequent investigators. These include moving traffic off the beach area onto a road behind the dune line, spreading pedestrian use areas out to reduce concentrations at any one area, boardwalks for pedestrian access through the dune to protect the vegetation, and moving as many recreational activities as reasonable to the Laguna side of the island to protect the foredune area.

Drawe (1988) is studying the succession following the use of off-road vehicles in an oil company seismic survey in the summer of 1988. He has located transects in each of the vegetation types impacted including low coastal sands, Shoregrass flats, Salty sands, Marsh, and Lateral Dunes (Rechenthin and Passey, 1973). His preliminary report contains data from only one sampling session, from which he noted decreased coverage, increased litter, and lower species diversity.

The overwhelming evidence shows that even small amounts of vehicular, and even pedestrian, traffic can be harmful to vegetation. Although restrictions on traffic are certainly in order, it is difficult to fairly evaluate the long term differences between recreational damage, and the extensive damage suffered by catastrophic natural forces such as hurricanes.

4.5 REVEGETATION

From 1969 to 1974 a cooperative research program involving many researchers and institutions was carried out on the reconstruction and revegetation of foredunes, overwash channels,

and barren dunes (Dahl et al., 1974, 1975; Dahl and Goen, 1977; Woodward et al., 1970, 1971; Otteni et al., 1972; and Baker, 1972). They succeeded in economically building and revegetating a foredune ridge on Padre Island National Seashore. Their publications detail their techniques, preferred species, planting densities, colonization rate, sand trapping rates, and costs for implementation. It would appear their work shows great promise for the prospects of repair of breached foredune areas. In addition this artificial dune face held up well to the storm forces of Hurricane Allen (Dahl et al., 1983).

4.6 HURRICANES

Hurricanes have been previously mentioned as a factor in vegetation change. The Texas Highway Department report on the feasibility of a coastal road from Corpus Christi to Matamoros (Bailey 1933) clearly indicates the magnitude of recent as well as past hurricane events and the potential long term effects.

Despite the importance of hurricanes as a force in altering natural vegetation, relatively few studies have been conducted. Judd and Sides (1983) studied the effect of hurricane Allen on the near shore vegetation in an area of South Padre Island just below the Mansfield Channel area. They found that damage was greatest in the foredune area. These low, leading dunes were completely leveled, only 11 percent of the vegetative cover remained, and the number of species dropped from eight to three. In contrast, plants of the taller primary dune ridge retained about the same number of species and percent cover, although low growing species were reduced relative to the numbers of grasses.

Judd and Sides' (1983) study and the study of Dahl et. al. (1983) discussed above are an insufficient record to allow generalization. However, their results tend to give some support to the observations and ideas of others that well vegetated

dunefields have the potential to withstand hurricane damage well, and may blunt the impact of storms further inland. These studies should serve to stimulate additional work.

Baccus and Horton (1979) give an excellent review of the forces involved in hurricanes, their erosional characteristics, the role of vegetation in mitigating erosion and flooding, and the vulnerability of Padre Island National Seashore due to the degradation of critical beach and foredune areas that help dissipate these tremendous erosional forces.

Weise and White (1980) briefly discuss the effects of hurricanes on Padre Island. More detailed information on hurricanes that have struck Padre Island, their storm surges and the amount of shoreline erosion and washovers associated with them can be found in Morton and Pieper (1975, 1977a, 1977b). Their appendices list Hurricanes affecting the Texas Coast from 1854-1973. Notable among them are a 1919 hurricane that inundated North Padre with an 11.5 foot storm surge, and the 1933 hurricane that severely eroded the dunes of Central Padre, and eroded nearly all the dunes on South Padre Island with a 15 foot storm surge. In 1961 Carla eroded 60 to 150 feet of foredunes on Padre Island, and in 1967 Beulah again hit South Padre eroding 50 - 350 feet of dunes. These major erosional episodes have undoubtedly resulted in vegetation changes on the island for many years.

4.7 DROUGHT

One of the primary factors influencing vegetation growth is rainfall. Droughts have undoubtedly played a role throughout history in shaping the vegetative character of the island. Although the existing island vegetation is relatively resistant to short-term drought, there seems little doubt that prolonged

dry periods would eventually denude portions of the island and reactivate dune fields.

There are no quantitative vegetation studies tracking the impact of drought on Padre Island vegetation. There are, however, several references to the impact of droughts in the literature. Rechenthin and Passey (1973) state:

"Drought intensified the effects of close grazing by reducing the growth of the desirable plants. The area has been subjected to periodic droughts, the most recent enduring for almost seven years, 1950-1957."

Baccus and Horton (1979) also mention drought in connection with the erosion history on Padre Island:

"Drouths in the 1880's and a drouth from 1896 to 1903 advanced the destabilization of the island sand (Lowry, 1959; Price and Gunter, 1943). Hurricane surges impacted this portion of the coast in 1912, 1913, 1916, and 1919 (Hayes, 1967). Overgrazing probably initiated the destabilization, and the drouths and hurricane surges advanced and compounded the process."

White et.al. (1978) discuss drought as well:

"Some of the earliest depletion of the vegetational cover recorded began during the droughts from 1880 to 1890 and 1895 to 1905; the denudation of vegetation apparently resulted from a combination of both drought and overgrazing. Price and Gunter (1943) suggested that after the drought periods, increased grazing enhanced evaporation and runoff by thinning

the vegetation cover, and discouraged the return of vegetation."

In the short term, drought is a lot less damaging than a single major hurricane. Prolonged droughts, however, may have even greater long term effects, especially when combined with other factors. The drought of the 1950's was the worst of the century and does appear to have caused serious damage to the vegetation of the island, particularly when combined with cattle grazing.

5.0 MANAGEMENT RECOMMENDATIONS

5.1 GENERAL CONSIDERATIONS

The intent of this study has been to attempt to determine what may have been the natural character of the island prior to the influences of European man and what management practices are appropriate to restore and/or maintain the island in that original condition.

From this study, it would appear that the vegetational characteristics of the island have been altered from time to time in the past by various influences including hurricanes, droughts, fires (mostly man-caused), and the various other activities of man. Some of these alterations have been subtle or localized while others have been dramatic and widespread. However, even though some of the alterations from the pre-acquisition past are still evident today (predominantly hurricane damage and the presence of introduced species), the overall vegetative character of the island appears very similar today to the accounts provided by the earliest European explorers.

Low barrier islands, such as those of the Texas coast, are dynamic landforms which are continuously in a state of surficial change in response to numerous environmental processes. Since its supposed initial formation some 5,000 years ago, the natural state of change of Padre Island has been compounded to varying degrees by the activities of man, most notably during the past 200 years. While certain of these influences can be singled out, it is difficult, if not impossible, to say what the exact character of the island would be now without the previous influences of man, as the effects of several actions (natural or man-induced) often produce synergistic results beyond or different from those of the simple combination. Additionally, the natural processes of barrier island development and evolution

are frequently so intertwined, that modification of one process often results in an unpredictable effect on other processes.

Several questions should be answered concerning active management of the Seashore.

1. Should prairie management techniques (i.e., prescribed burning, mowing, discing, etc.) be utilized on the island to maintain the natural cordgrass/bluestem prairie?
2. Should attempts be made to foster the redevelopment of oak motts on the island?
3. Should attempts be made to correct or mitigate the effects of natural processes (i.e., hurricanes, natural fires, drought)?
4. Should attempts be made to correct the still-evident effects of man's previous activities (i.e., introduced species)?
5. To what intensity can man utilize the island for recreation without causing undue harm or alteration?

In general, the recommendations put forth here, based on the conclusions of our historical research, are that management of the island should largely be passive, simply allowing natural processes to take their course.

5.2 PRAIRIE MANAGEMENT

Many prairies are disturbance climax communities, or more precisely, they are pre-climax communities maintained in a constant, revolving evolutionary state by periodic disturbances.

Wild fires from dry lightning storms or tillage by the hooves of large ungulate (i.e., bison) herds were characteristically the natural disturbance factors which maintained the native prairies of the mid-western United States. Indians, in using fire as a hunting technique also contributed to the ecology of inland prairies. However, historical evidence indicates that large natural ungulate herds never existed on the barrier islands and there is no clear evidence that the Indians intentionally burned the islands. Since most lightning storms on the coast are usually accompanied by heavy rains, wildfire is also not a significant factor in island ecology. The predominant natural disturbance factor which may effect barrier island prairies is simply the surficial dynamics of the island (i.e., constantly shifting sands resulting in accretion and erosion). Therefore, the classical prairie management techniques used on inland prairies are not recommended in an island environment, particularly since burning, mowing, or discing may result in undesirable changes in the natural sand balance (i.e., erosion and deposition).

5.3 OAK MOTTS

It might appear from the accounts prior to the early nineteenth century that arborescent or even woody forms of vegetation were scarce on the island. Willows seem to be the only woody species observed with any regularity.

Oaks seem to have fluctuated in distribution and abundance during the 19th and present century due to various natural and man-induced causes. Some as yet unanswered questions still exist relative to oaks on the island which may necessitate additional studies to determine appropriate management recommendations:

1. Is the formation and maintenance of oak motts related to any particular soil characteristics?

2. Are existing motts growing, shrinking or remaining the same in size?
3. Why are some oaks currently in a state of decline?
4. Are any new motts naturally beginning from acorn dissemination and germination?
5. What effect on acorn dissemination and germination was brought about by the large nesting birds (herons, cranes, etc.) observed to extensively utilize these motts during the 19th century?

At present time, until some of these questions can be answered, no active management of oak motts is recommended. Some limited experimental plantings may be of interest, however, answers to some of the questions above, particularly related to soil associations, would lend more practicality to experimental plantings.

5.4 NATURAL PROCESSES

Hurricanes have the potential to drastically alter the entire face, and even the position of the island. Hurricane-induced blowouts and washovers are natural processes which may vary considerably with the magnitude and location of any given storm.

Even though foredune rebuilding and revegetation has previously been successful (Section 4.5), attempting to bolster the foredune complex to better withstand a hurricane, or attempting to artificially rebuild dunes following a storm, is sometimes expensive and may not truly be cost-effective. Common sense would dictate that hurricanes have occurred throughout the

island's life and, in most cases, although slow at times, natural rebuilding processes have followed adequately. There is even some recent evidence that artificial foredune stabilization coupled with reduced sand availability overall may be interrupting the natural progress of sand to the bayside of the island and bay shorelines appear to be eroding in places due to wave and current action in the Laguna Madre (Section 2.3.3).

Once again, our recommendation is to generally let natural processes take their course. Padre Island National Seashore presents a unique opportunity for people to observe the natural processes of the coastal barrier environment, even if those processes are occasionally devastating, as in a hurricane. In some certain circumstances, however, dune repair or bolstering may be appropriate to protect certain natural or man-made features of the island, or in areas where visitor traffic has un-naturally destabilized the dunes.

5.5 INTRODUCED SPECIES

For the most part, it would appear that introduced species have not had a significant effect on the overall botanical character of the island. With the exception of bermudagrass and sandburs, most introduced species seem to be rather benign, clinging to feeble existences in isolated locations. Such examples are Phragmites, predominantly at the Ranger Station, and salt cedar, at the old Dunn Ranch.

It is impractical to attempt to eradicate such ubiquitous species as bermudagrass or sandbur, particularly since their reintroduction is almost certainly assured. Eradication of the other restricted species could be accomplished fairly easily with mechanical or chemical means. However, some of the occurrences present some unusual research opportunities. It is puzzling why such normally aggressive species such as salt cedar

and Phragmites are apparently held in check at just a few locations.

Our recommendation for introduced species is to leave them to fend for themselves. If any one species should begin to show noxious characteristics, then localized mechanical or chemical control would be appropriate. The ecological and physiological situations of the more benign species might deserve additional research.

5.6 HUMAN UTILIZATION

One of the original purposes of the establishment of Padre Island National Seashore was to preserve a segment of coastal barrier for the recreational enjoyment of the public. Under that context, the central issue is how much public usage can occur and still maintain the resource for the enjoyment of future generations.

Although fairly restricted, many current public activities are still contributing to the degradation of the island environments. Vehicular and pedestrian traffic along the beach is the predominant public usage. Despite clear signs and occasional patrols, traffic often encroaches into the dunes bringing destabilization. Heavy vehicular traffic on the beach has been shown to adversely affect the sand transport dynamics necessary for island maintenance. We tend to agree with the recommendations of McAtee (1975) for restriction of vehicular traffic to a mid-island roadway and restriction of beach activities to pedestrians only. This aspect has many advantages besides beach and foredune stabilization, such as, allowing better observation of the back-island environments by the general public, and beach safety. However, a roadway is quite expensive to build and maintain, as demonstrated by the Texas Highway Departments' 1933

decision to abandon the idea of an island roadway following the devastating effects of a hurricane that year.

We feel that the most important and cost-effective management job that can be undertaken on the Seashore is beefed-up public education as to the natural forces at work, and increased enforcement of traffic restrictions on dunes and back-island areas.

Observation of the island and its processes is an invaluable experience to many people. Additional controlled interpretive trails such as the Grassland Trail north of Bird Island Basin would be orderly manners by which the public could enjoy the island without undue degradation.

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ACKNOWLEDGMENTS

The Principal Investigators for this study were C. Lee Sherrod and David O. Brown of Horizon Environmental Services, Inc.

This study could not have been undertaken without the assistance of a great number of people. In particular, the authors wish to thank the personnel at Padre Island National Seashore, notably Bob Whistler and Jennifer Bjork, who have been most helpful throughout. A number of historians donated their time and research materials to aid in the study, including Dan Kilgore, Robert S. Weddle, and Martha Freeman. The staff of the Corpus Christi State University library, particularly Margaret McKinnon, were most helpful, as were the staff at La Retama Public Library. Several archaeologists contributed ideas and information, including J. Barto Arnold and Herman Smith. Thanks also to Jennifer Prouty who shared information from her ongoing study of historical changes along the Laguna shoreline of the island. Special thanks are extended to Jerilyn Smith and Kathryn Kennedy who aided in research and preparation of this document. Thanks also to Michael Horvath, Richard Day, Larry Perez and Mary Fischer of Horizon who also helped in the research and production of this volume.

APPENDIX 1: ANNOTATED BIBLIOGRAPHY

ANNOTATED BIBLIOGRAPHY OF LITERATURE ON
VEGETATION OF PADRE ISLAND NATIONAL SEASHORE
WITH SPECIAL REFERENCE TO OCCURRENCE OF OAKS AND OAK MOTTES

Compiled by:

Jerilyn Jewett-Smith, David O. Brown, and Kathryn Kennedy

Anonymous. 1964. Padre Island National Seashore, Master Plan, Chapter II - Draft, July, 1964.

p. 20 "Only a few trees, live oak (Quercus virginiana) are found and these are in a few isolated clumps on the back side of the island." Box 29.

Anonymous. 1974. File on Dunn Ranch line shacks - dated October 1974.

Includes several pictures of the Novillo and Green Hill line shacks, no oaks in pictures. Box 29.

Anonymous. 1976. Carrying capacity study - Padre Island National Seashore; a study of beach elevation and vegetation interrelationships on Padre Island, Texas, 1975-1976.

Apparently the initial proposal and notes of E.W. Behrens. Does not include final report, study locations, or species list. Box 84a.

Anonymous. n.d. Checklist of Padre and Mustang Island plants: Monocotyledoneae and Dicotyledoneae.

Anonymous checklist of plants. Probably the work of F. Jones based on collection numbers cited. Mentioned Q. virginiana with Nos. 6463, 6765, 6802. Box 85.

Anonymous. n.d. Effect of vehicular and pedestrian traffic on back shore vegetation and dune development - final report for contract CX 700040146.

Vegetation of fore dunes primarily. No oak motte areas sampled. Box 84.

Anonymous. n.d. Padre Island National Seashore, Vegetation Summary and Listing. Probably attributable to Fred Jones.

Anonymous checklist of plants and ecological descriptions of PINS. Mentions Q. virginiana and Q. fusiformis.

Anonymous. n.d. Untitled manuscript. (Bob Whistler feels that this manuscript is probably from Eric Warren). Included in the envelope of Dunn family pictures, Box 29.

Page 22..."He went on to tell me that hogs, wild animals and scavenger birds cleaned up what was left but he said there were still thousands [of passenger pigeons] which roosted in the trees (Yes there were trees on the islands at that time) ...there were not enough trees as they broke down the branches so most of them spent the night on the dunes or in the grass, down beside the lakes [marshes?]...."

Page 26..."Their riders would cut dead grass and light brush and pile it on the cactus to get it on fire (so cattle can eat it). This may have been how the 1933 fires got started..."

"...starving cattle had moved in on the head of the island [N. Padre?]. They were eating everything even to sunflowers and oak leaves."

Baca, B. J. and E. R. Cox. 1977. Observations on several benthic marine algae from South Padre Island, Texas. S. W. Nat. 21(4): 459-462.

A description of four marine algae found at various locations on South Padre Island with a discussion of their local distribution. Apparently no collections were made in the Park.

Baca, B. J., L. O. Sorensen, and E. R. Cox. 1979. Systematic List of the seaweeds of South Texas. Contr. Mar. Sci. v.22:179-192.

A checklist of the species of seaweeds in South Texas. Includes collections by the authors in the Park.

Baccus, J. T. and J. K. Horton. 1979. An ecological and sedimentary study of Padre Island National Seashore. Department of Biology, Southwest Texas State University. Prepared for the Office of Natural Resources, Southwest Region, National Park Service, Santa Fe, New Mexico. Contract No. CX 702970059.

A compilation of several studies conducted in 1977 and 1978 including sedimentology, fire ecology, and community types. Includes sampling of vegetation transects in National Seashore area including various land use areas. Similar to but somewhat broader study than Baccus et al. 1977. Good discussion of island origins and sedimentology. One of the most comprehensive treatments of factors influencing vegetation change. No trees in sampled areas. No oak motte areas sampled. Shelf copy.

Baccus, J. T., J. K. Horton, and P. D. Carangelo. 1977. A study of beach and dunes floral and faunal interrelations as

influenced by recreational and user impact on Padre Island National Seashore. Department of Biology, Southwest Texas State University. Prepared for the Office of Natural Resources, Southwest Region, National Park Service, Santa Fe, New Mexico. Contract No. CX 702960168

Sampling of beach and dune transects for flora and fauna in National Seashore area during 1976 and 1977. Comparison of various land use areas. No trees in transect areas. Studies on beaches and dunes next to the beach. No Quercus species identified on the species lists for the 4 sites between shell beach and PINS headquarters. Box 84/84a.

Bailey, V. 1905. Biological Survey of Texas. North American Fauna 25:7-217.

Historical reference with quotes from William Lloyd, 1891. He described "Shin-oak" and "Wild Celery".

"The island has no arborescent growth worth noticing, with the exception of a shin-oak, which extends from the north end for about a mile and continues on sandy hills on the lagoon side for 5 or 6 miles farther. This is usually 6 inches to 18 inches high, but there are trees, perhaps a different species, 6 to 8 feet high. As this oak is always loaded with acorns, even now it is the favorite wintering ground of birds such as wood ibis, whooping and sand-hill cranes ..."

Bailey, T. W. 1933. Padre Island: Texas Highway Dept. Rept., Sept. 11, 1933. Corpus Christi District Office.

Description of a survey of the island conducted in conjunction with a planned coastal road from Corpus Christi to Matamoros. The road plan was abandoned after the 1933 hurricane and the report contains some references to the effects of hurricanes on vegetation including one incredible statement that a 40-mile segment of the island had not yet recovered from a hurricane which had struck in the 1800's.

Baker, R. L. 1972. Use of fertilizer to increase vigor of sea oats and bitter panicum. Unpublished M.S. thesis, Texas Technological University. Lubbock.

A study examining the results of adding fertilizer to species used in revegetation and restoration work.- Box 85.

Barbour, M. G., D. M. Rejmanek, A. F. Johnson, and B. M. Pavlik. 1987. Beach vegetation and plant distribution patterns along the Northern Gulf of Mexico. Phytocoenologia 15: 201-233.

A broad classification of the beach vegetation types along the Gulf, based on 63 transects including one within the park boundary. No Quercus mentioned. Box 83.

Behrens, E. W. 1976. A study of beach elevation and vegetation interrelationships on Padre Island, Texas. Contract CX700040146. Proposals.

The proposal and notes for his study on pedestrian and vehicular traffic impacts. No vegetation lists. Box 84a.

Behrens, E. W., P. D. Carangelo, and H. S. Finkelstein. 1976. Effects of vehicular and pedestrian traffic on backshore vegetation and beach development. Final report prepared for Office of Natural Science, Southwest Region, National Park Service.

A continuation of the study initiated by McAtee (1975) using three of the original McAtee study locations inside the park boundary and adding a fourth at shell beach. Includes only qualitative vegetation observations. Box 84.

Behrens, E. W., R. L. Watson, P. D. Carangelo, W. H. Sohl, and H. S. Finkelstein. 1975. Effect of vehicular and pedestrian traffic on back shore vegetation and dune development. Beach impact study, Padre Island National Seashore. Contract #CX700040146.

Primarily addresses the effects of traffic on beach and foredune, a geological study, continuing the work begun by McAtee (1975), and using three of the same sample locations. Fore dune only, no Quercus mentioned. Box 84.

Blake, J. E. 1846. Report on the route toward Matamoros by Padre Island. National Archives Record Group No. 77. Records of the Chief of Engineers, Letters Received, Topographical Bureau. 10 March 1846, Corpus Christi Texas, Feb 1846.

Brown, L. F., J. H. McGowen, T. J. Evans, C. G. Groat, and W. L. Fisher. 1977. Environmental Geologic Atlas of the Texas Coastal Zone -- Kingsville Area. Bureau of Economic Geology, University of Texas at Austin.

Campbell, T. N. 1964. Appraisal of the archaeological resources of Padre Island, Texas. Report submitted to the National Park Service by The University of Texas, Purchase Order No. RO 33-472.

Original archaeological survey of the National Seashore area. No finds relate to vegetation but reports several sites with bone, including bison at one site (41KL12).

Carr, J. T., Jr. 1966. Texas droughts - causes, classification, and prediction. Texas Water Development Board, Report 30.

_____. 1967. Hurricanes affecting the Texas Gulf Coast. Texas Water Development Board, Report 49.

Does not mention effects on vegetation directly but provides meteorological description of hurricanes and notes their historic occurrence beginning with 1818 storm which struck Galveston. Notes major hurricanes along Padre Island coastline in 1844, 1880, 1916, 1919 and 1933.

Castañeda, Carlos E. 1939. Our Catholic Heritage in Texas. 1519-1936. The Mission Era: The Passing of the Missions. 1762-1782. Vol. 4. Austin: Von Boeckmann-Jones.

Excellent and detailed history of early Texas; brief accounts of Ortiz Parilla expedition.

Carroll, William M. 1983. Beranger's Discovery of Aransas Pass. A translation of Jean Beranger's French Manuscript. Frank Wagner, ed. Occasional Papers. Vol. 8. Corpus Christi: Friends of the Corpus Christi Museum.

Beranger's account of his voyage from Louisiana to Aransas Pass in 1720. Did not come as far south as Padre Island, but overlapped a considerable portion of the Andres de Pez and Enriquez Barroto voyages in the late 1600's. Contains some description of vegetation and Indian groups encountered. Not a journal, however; probably written after the voyage.

Clover, E. U. 1937. Vegetational survey of the lower Rio Grande Valley, Texas. Madrono, Vol. 4:41-72.

Does not mention Padre Island, but provides an early description of another barrier island to the south, Clark Island.

Conover, J. T. 1963. The ecology, seasonal periodicity, and distribution of benthic plants in some Texas lagoons. Bot. Marina 7:4-41.

Includes study of the benthic plants in the Laguna Madre. Sampling involved collecting on transects that did run within park boundaries.

Dahl, B. E., and J. P. Goen. 1977. Monitoring Foredunes on Padre Island, Texas. MR-77-8. U.S. Army Corps of Engineers; Coastal engineering Research Center, Fort Belvoir, Va. July 1977.

An interim report monitoring the conditions of restoration foredunes built from 1969 to 1973 on north Padre Island beaches, within the park. Box 9.

Dahl, B. E., B. A. Fall, A. Lohse, and S. G. Appan. 1974. Stabilization and reconstruction of Texas coastal foredunes with vegetation. Gulf Universities Research Consortium. GURC Report 139.

Same report as Dahl, Fall, Lohse and Appan 1975. Box 9

_____. 1975. Construction and stabilization of coastal foredunes with vegetation: Padre Island, Tx. MP 9-75, US Army Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, Va.

Mentioned in Dahl, et al., 1981, page 46, as being "sampled by Dahl et al., 1975" Oak motte NW of PINS ranger station, =lone oaks. Good vegetational history of island. Literature search good. page 32 "woody vegetation primarily of live oak. Sizable mottes (dense groves surrounded by grassland) exist on the north end of the island and several small mottes occur farther south. (Derek Hambly, PAIS naturalist, personal communication, 1970). Stumps of this motte are occasionally uncovered during hurricanes. Box 9.

Dahl, B. E., P. C. Cotter, D. B. Wester, and D. D. Drbal. 1981. Posthurricane Survey of Experimental Dunes on Padre Island, Texas. Texas Technological University. Lubbock. Contract study.

Dune impact study on dune systems on Padre Island N.S. after Hurricane Allen. Monitor effectiveness of experimental foredune plantings to provide coastal protection from major hurricane (Allen). Quercus not sampled in transects. Box 84a. Box 9.

_____. 1983. Posthurricane survey of experimental dunes on Padre Island, Texas. MR-83-8. U. S. Army Corps of Engineers; Coastal Engineering Research Center, Fort Belvoir, Va.

Same report as above.

Drawe, L. 1988. Evaluation of vehicular impacts from geophysical seismic survey on plant survival and regrowth on Padre Island National Seashore. Preliminary report. Contract RFQ-7490-8-0005.

Discussion of the profile of first few months of regrowth in areas of the park that have sustained heavy equipment damage. An ongoing study. Box 84a.

Drawe, D. L. and K. R. Kattner. 1975. Burning and mowing influence vegetation on Padre Island Texas. (Publication = Drawe & Kattner 1978. Effect of burning and mowing on vegetation of Padre Island. The Southwestern Naturalist 23(2):273-278)

Appears to be identical to Kattner, 1973. Box 85.

Drawe, D. L., K. L. Kattner, W. H. McFarland, and D. D. Neher. 1981. Vegetation and soil properties of five habitat types on north Padre Island. Tx. Jnl. Sci. 33(2,3,4):145-157.

An analysis of the percentage of different habitat types present in a 455 ha study site constructed in 1972.

Drawe, D. L. and J. McAtee. 1973. Effects of human activity on the ecology of the sand dunes of Padre Island National Seashore and adjacent areas. Proposal, Texas A&I University. Kingsville.

Initial proposal for McAtee (1975) work.

Enriquez Barroto, J. 1988. The Enriquez Barroto Diary. Translated and annotated by Robert S. Weddle. In La Salle, the Mississippi, and the Gulf: Three Primary Documents. College Station: Texas A&M University Press.

Diary of the 1686 voyage along the Padre Island coastline. Very brief mention of landscape and vegetation.

Escandon, Joseph de. 1766a. Letter to the Viceroy, Marquès de Cruillas. 2 May 1766. Archivo General de Mexico. Provincias Internas. Vol. 110:237-241. Dunn Transcripts: Barker Texas History Center. Austin.

Very brief and somewhat inaccurate description of the islands off the Texas coast in 1766, just prior to the Ortiz Parilla investigation.

Everett, J. K. 1970. Novillo Line Camp, PINS - Historic structures report, working draft. U.S. National Park Service, SW Cultural Resources Center, Santa Fe, New Mexico.

"... Patrick Dunn relied upon the island itself for the various materials used to build his line camps. The SE prevailing winds and the Gulf Stream continually deposited an odd assortment of materials, mostly wood,

on the shore and it was merely a matter of gathering them up; letting them dry and then incorporating them into the structural components that either needed to be built or required repair."

Evia, José de. 1968. José de Evia y sus Reconocimientos del Golfo de Mexico. 1783-1796. Jack D. L. Holmes, ed. Colecciones Chimalistac de Libros y Documentos Acerca de la Nueva España. 26. Madrid: Ediciones Jose Porrua Turanzas.

Diary and notes on a voyage along the Texas coast in 1785 and 1786. Contains brief notes on the vegetation.

Fernández, Eugenio, Joseph Antonio de la Garza Falcón, and Mateo Martínez. 1766. Testimony of trip to Padre Island in Ortiz Parilla 1767. Archivo General de Indios. Audiencia de Guadalajara. Vol. 100:1-6. Dunn Transcripts: Barker Texas History Center. Austin.

The testimony of the leaders of the detachment that visited Padre Island in September of 1766. Part of the 1767 Ortiz Parilla report.

Fisk, H. N. 1959. Padre Island and the Laguna Madre Flats Coastal South Texas. Second Coastal Geography Conference. Coastal Studies Institute, Louisiana State University.

Discussion of the origins and history of Padre Island and the Laguna Madre. Almost no discussion of vegetation but classic reference on island origins and description of active geomorphic processes.

Fleetwood, R. J. 1963. Plants of Laguna Atascosa National Wildlife Refuge. Laguna Atascosa National Wildlife Refuge, Bureau of Sport Fisheries and Wildlife. Harlingen, Texas.

No oaks mentioned.

Garza, R. 1980. An island in geographic transition: a study of the changing land use patterns of Padre Island, Texas. Unpublished Ph.D. Thesis, University of Colorado. Boulder.

States that before man's intrusion, natural vegetation consisted of a dense cover of tall prairie grasses, primarily seacoast bluestem and seaoats. Thesis references Dahl, et al., 1975. Box 85.

Gillespie, T. S. 1976. The flowering plants of Mustang Island, Texas, an annotated checklist. Tx. Jnl. Sci. 27 (1): 131-148.

A checklist for Mustang Island, with a short discussion of the environments encountered. Useful and interesting for comparisons. Shelf copy.

Godfrey, P. J., S. P. Leatherman, and P. A. Buckley. 1978. Impact of off-road vehicles on coastal ecosystems. Proceedings of the symposium on technical, environmental, socioeconomic and regulatory aspects of coastal zone planning and management. San Francisco, California, March 14-16, 1978.

Primarily regards Cape Cod National Seashore and the vegetational impacts of ORV's.

Gould, F. W. 1962. Texas Plants, a checklist and ecological summary. Texas A&M University, Agricultural Experiment Station. College Station

In describing flora of the coastal bend "...The climax vegetation of the Gulf Prairie is largely grassland (tall grass prairie) or post oak savannah. However, much of the area has been invaded by trees and brush such as mesquite (Prosopis glandulosa), oaks (Quercus spp.) and several acacias." Box 86.

_____. and T. W. Box. 1959. Grasses of the Texas Coastal Bend. Wilder Wildlife Foundation Contribution 34, Series C. 85pp. mimeo.

_____. 1965. Grasses of the Texas Coastal Bend. Texas A&M University Press, College Station. 189pp.

Grenier, Chevalier. 1745. Relation en forme de journal du voyage que Moy Che.^r Grenier vient de faire a Vera Cruz dans le Batteau "le Superbe" de la Martinique, que je commanday, Arme de 10 canon, Dix-huit Pierriers, de 110 hommes d'Equipage, y compris un Officer, un sergent, et six soldats des troupes detachees de la Marine en garrison dans cette Colonie, a la Louisianne. French National Archives. Archives de la Marine. B4, 57: Folio 323. Barker Texas History Center Archives.

Important untranslated document which describes a march down the islands to Tampico by shipwrecked French sailors in 1745.

Gunn, C. R. and J. V. Dennis. 1973. Tropical and temperate stranded seeds and fruits from the Gulf of Mexico. *Contri. Mar. Sci.* 17:111-121.

Reviews the phytogeography of species with seeds that have washed up on gulf beaches, including Padre Island. The great majority are tropical and arrived in viable condition.

Havard, Dr. V. 1885. Report on the Flora of Western and Southern Texas. *Proceedings of United States National Museum*. p. 449-485. T581.9764, H298r, Barker.

Description of the flora of southern Texas along the Rio Grande between 1880 and 1883. No specific mention of Padre Island or coastal islands but mention of the vegetation along the coast from Brownsville to Corpus Christi.

Higginbotham, I. 1971. An analysis of the vegetation of Padre Island National Seashore. Partial fulfillment of course GNA5AS, Texas A&I University.

A study attempting to analyze the percentage of various vegetation types present in a sample area of Padre Island. Box 85.

_____. 1972. An analysis of the vegetation of the Padre Island National Seashore. Class report, Texas A&I University. Kingsville.

Ran transects of a sand dune site, low coastal sand site and a salt marsh site, July 1972. No Quercus mentioned. Box 85.

Hill, L. W. 1926. Jose de Escandon and the founding of Nuevo Santander. Ohio State University Press, Columbus.

Does not talk about vegetation of coast, only mountains.

Hitchcock, Ethan Allen. 1909. Fifty Years in Camp and Field: Diary of Major-General Ethan Allen Hitchcock, U.S.A. W. A. Croffut, ed. New York: G. P. Putnam and Sons.

Contains some brief references to the vegetation of the mainland between Corpus Christi and Matamoros in 1846.

Hoyo, Eugenio del. 1972. Historia del Nuevo Reino de Leon (1577-1723). Publicaciones del Instituto Tecnologico y de Estudios Superiores de Monterrey, Serie: Historia 13. Monterrey, Nuevo Leon, Mexico.

History of Nuevo Leon with an argument relative to the landing place of Francisco Garay's expeditions.

Hummel, G. A. 1982. Interdune areas of the back-island dune field, North Padre Island, Texas. Unpublished M.A. Thesis. The University of Texas. Austin.

Jameson, J. F. 1907. Original narratives of early American history. Spanish explorers in the Southern United States 1528-1543. Reproduced under the auspices of the American Historical Association.

No information about the PINS area vegetation.

Johnston, J. B., compiler. 1984. Texas Barrier Islands Region ecological characterization atlas: biological resources narrative. U.S. Fish Wildl. Serv. FWS/OBS-8216. Minerals Management Service Rep. 84-0005. 12pp.

A bibliography with a section related to seagrass beds. Box 8a.

Johnston, M. C. 1955. Vegetation of the eolian plain and associated coastal features of southern Texas. Unpublished Ph.D. dissertation, University of Texas.

A quantitative, ecological approach to identifying the communities and associations in coastal southern Texas. Field work included sampling on Padre Island. Map shows Padre Island in the loose sand prairie community type. Discussed succession, and its relationship to live oak scrub community types.

Jones, F. 1966. Checklist of Padre and Mustang Island Plants.

_____. 1975. Flora of the Texas Coastal Bend. Welder Wildlife Foundation, Sinton, Texas.

_____. 1975. Threatened vegetation (flora) on Padre Island, a workup by Fred Jones to detail this resource.

A letter to Padre Island staff delineating vulnerable vegetation in the park. Methods used to arrive at the list are unstated. No locations or inventory. States that Quercus should not be taken by collectors in the PINS. Box 83.

_____. C. M. Rowell, Jr., and M. C. Johnston. 1961. Flowering plants and ferns of the Texas coastal bend counties.

Describes Quercus virginiana - "Evergreen tree, sometimes forming dense, "scrubby" thickets. Loose-sandy soils near coast; sandy and calcareous ground inland; also along streams. Blooms spring.

Judd, F. W., R. I. Lonard, and S. L. Sides. 1977. The vegetation of South Padre Island, Texas in relation to topography. The Southwestern Naturalist 22:31-48.

An analysis of the relationship between topography and vegetation. Identifies some characteristic communities. Done below the PINS, from Port Mansfield south. No Quercus mentioned. Box 85.

_____. and S.L. Sides. 1983. The effect of hurricane Allen on the near-shore vegetation of South Padre Island. S.W.Nat. 28(3):365-369.

A comparison of vegetation conditions from Judd, Lonard, and Sides (1977) and conditions after the hurricane. Show reduction in diversity and percent cover and loss of landform in the foredunes, less impact in the primary dune ridge zone.

Kattner, K. R. 1973. Secondary successional vegetation on Padre Island National Seashore. M.S. Thesis, Texas A&I University. Kingsville.

Details the vegetational changes due to burning and mowing dune vegetation. Brief discussion of oaks and oak motts, with the surprising statement that "Historically there was an extensive forest of live oak (Quercus virginiana Mill.) on the island." No oak mott areas sampled in study. Box 85.

Kilgore, D. E. 1975. Nueces County, Texas 1750-1800: A Bicentennial Memoir. Friends of the Corpus Christi Museum. Occasional Papers. No. 1. Corpus Christi, Texas.

Excellent brief history of Nueces County with some critical discussion of the 1767 Ortiz Parilla report.

_____. 1983. Texas Cattle Origins. The Cattleman.

Brief account of the origins of feral cattle in South Texas. Does not specifically mention Padre Island.

Kingsolver and Sanderson. 1969. A selected bibliography of insect-vascular plant associational studies. USDA #AN5-33-115. Entomology Research Division. Agricultural Research Service, USDA.

Bibliography of plant-animal associations. Box 86.

Leonard, S. W. 1980. Plant Succession (?) on New Coastal Land. In: W.F. Tanner, editor. Shorelines, Past and Present. Proc., Fifth Symposium on Coastal Sedimentology. Geology Department, Florida State University. Tallahassee.

Discussion of differences in vegetation on barrier islands from South Carolina to Alabama. Does not mention Padre Island or Texas.

Lloyd, William. 1891. Padre Island. Notes on file in the Smithsonian Institution Archives. Record Unit 7176. Box 94. F19. Washington, D.C.

An excellent description of the vegetation of the island in 1891; contains some material edited out of the version in Bailey (1905).

- Lonard, R. I. and F. W. Judd. 1980. Phytogeography of South Padre Island, Texas. Department of Biology, Pan American University. Edinburg. The Southwestern Naturalist-25(3):313-322.

Discusses the phytogeographic affinities of the flora of South Padre Island. Nearly one third have tropical affinities. Less than half occur on the adjacent mainland. Two species appear endemic.

- _____. 1981. The terrestrial flora of South Padre Island, Texas. Texas Memorial Museum miscellaneous papers No. 6. University of Texas at Austin. 74pp.

A field guide with keys to the vegetation. Little discussion is included about the habitat or floristics of the area.

- Lonard, R. I., F. W. Judd and S. L. Sides. 1978. Annotated checklist of the flowering plants of South Padre Island, Texas. S.W. Nat. 23(3):497-510.

A checklist of the plants of South Padre with a comparison to the floristics of Mustang Island based on the checklist of Gillespie (1976).

- Lonard, R. I., F. W. Judd, and J. R. Wade. 1978. The terrestrial flora of South Padre Island, Texas. Pan American University. Edinburg.

Key to the terrestrial flora of south Padre Island, including typical vegetation of dunes, salt flats and marshes. Minimal discussion of ecological relationships and short bibliography. Few tree species noted (Prosopis glandulosa, Acacia smallii, Tamarix aphylla), but no oaks mentioned. Box 86.

- Lowry, R. L., Jr. 1959. A study of droughts in Texas. Texas Board of Water Engineers, Bulletin 5914.

- Lynch, J. 1976. Transcriptions of taped conversations between Jim Lynch and Bob Whistler, PINS naturalist. Mr. Lynch was the last foreman of the Dunn Ranch on Padre Island.

April 14, 1976. "...The cowboys and Jim would pick out areas on the island in February and burn 5,000 acres at a time in controlled burn, skip 4 or 5 miles and then burn another spot."

- _____. 1989. Transcriptions of taped interview with James Lynch, last foreman of the Dunn Ranch on Padre Island, by David O. Brown and Bob Whistler.

Contains essentially same material as 1976 tapes but with greater emphasis on vegetation.

Lynn, W. M. 1975. Texas coastal bibliography. Austin: Texas Historical Commission, General Land Office Coastal Management Program, Inter-Agency Contract No. IAC-74-75-1540.

Good bibliography of archaeological and historical studies along coast prior to 1975. Archaeological references in south coastal area superceded by more recent bibliography in Mercado-Allinger et al. 198_, but detailed historic bibliography remains unsurpassed.

McAtee, J. W. 1975. Human impact on the vegetation and microclimate on the beach and fore dunes of Padre Island National Seashore. Unpublished M.A. Thesis. Texas A&I University. Kingsville.

A study examining the effects of different types and levels of recreational pressure on the beach and foredune vegetation. Most sampling was within the park. No Quercus mentioned in species lists. Box 84.

McAtee, J. W. and D. L. Drawe. 1980. Human impact on beach and foredune vegetation of North Padre Island, Texas. Environmental Management 4:527-538.

A study of the effects of pedestrian and vehicle traffic on beach and foredune vegetation measuring top and root growth, and percent cover. Significant degradation was found.

_____. 1981. Human impact on beach and foredune microclimate on North Padre Island, Texas. Environmental Management 5:121-134.

Contains information on microclimate on barrier island especially with reference to atmospheric salinity, and physical-chemical parameters. The impact with pedestrian and vehicular traffic is noted, and its probable effects on plant growth. No Quercus mentioned. Box 84.

McDonald, David and J. Barto Arnold. 1978. Documentary Sources for the Wreck of the New Spain Fleet of 1554. Texas Antiquities Committee Publication No. 8. Austin.

Contains a transcription and translation of the Davilla Padilla history of Marcos de Mena's flight down the island after the 1553 shipwreck. Translation is somewhat better than that contained in Mahan 1967.

McMahan, C.A. 1965. Ecology of the principal waterfowl foods of the lower Laguna Madre. Job Completion Report no. 17. Texas Parks and Wildlife Department. Austin, Texas.

Includes transects and vegetation cover measurements for seagrasses in the Laguna Madre, but does not include samples in the park.

- _____. 1966. Ecology of principal waterfowl foods in lower Laguna Madre. Job Completion Report No. 17. Texas Parks and Wildlife Department, Austin, Texas.

An annual update of the above study.

- _____. 1967. Ecology of principal waterfowl foods of Laguna Madre. Job Completion Report No. 17. Texas Parks and Wildlife Department, Austin, Texas.

A report on waterfowl food sources for the whole Laguna Madre, including many transects that were done at least partially within park boundaries. Includes abundance of seagrasses.

- _____. 1968. Biomass and salinity tolerance of shoalgrass and manatee grass in lower Laguna Madre, Texas. J. Wild. Manag. 32(3):501-506.

An examination of biomass production and seasonality of the seagrasses of the Laguna Madre. Does not include collections within the park.

- McMahan, C. A. 1969. The food habits of ducks wintering on Laguna Madre, Texas. Unpublished M.S. Thesis. New Mexico State University. Las Cruces, New Mexico.

Contains a vegetation type map of the seagrasses of the upper Laguna Madre, and discusses the value of the various species for duck forage or nursery areas for fauna that are important for waterfowl diets. Shelf copy.

- Mahan, William. 1963.

Contains an account of the Singer treasure which mentions burial near small oaks in the 1850s.

- _____. 1967. Padre Island: Treasure Kingdom of the World. Waco: Texian Press.

Contains a facsimile version and a translation of the Davilla Padilla account of the 1553 shipwreck survivors trek to Tampico.

- Masch, F. D., R. J. Brandes, W. A. White, F. R. Hill. 1969. A Study of Hurricane Tides at the Padre Island Development Site, Padre Island, Texas.

Detailed discussion of hurricane tides and their potential effect. No specific discussion of vegetation.

Merkord, G. W. 1978. The distribution and abundance of seagrasses in Laguna Madre of Texas. Unpublished Master's Thesis. Texas A & I University.

A detailed study of the distribution and abundance of seagrasses. Vegetation maps are included. Changes in abundance and possible causes are discussed. Sampling included numerous transects in the Laguna which included areas within park boundaries.

Morton, R. A. and M. J. Pieper. 1975. Shoreline Changes on Brazos Island and South Padre Island (Mansfield Channel to Mouth of the Rio Grande): An Analysis of Historical Changes of the Texas Gulf Shoreline. Bureau of Economic Geology, The University of Texas at Austin, Geological Circular 75-2.

Historic changes in shoreline, including vegetation line, from aerial photos and historic maps with probable causes.

_____. 1977a. Shoreline Changes on Mustang Island and North Padre Island (Aransas Pass to Yarbrough Channel): An Analysis of Historical Changes of the Texas Gulf Shoreline. Bureau of Economic Geology, The University of Texas at Austin, Geological Circular 77-1.

Historic changes in shoreline, including vegetation line, from aerial photos and historic maps with probable causes.

_____. 1977b. Shoreline Changes on Central Padre Island (Yarbrough Pass to Mansfield Channel): An Analysis of Historical Changes of the Texas Gulf Shoreline. Bureau of Economic Geology, The University of Texas at Austin, Geological Circular 77-2.

Historic changes in shoreline, including vegetation line, from aerial photos and historic maps with probable causes.

Muller, C. H. 1980. Introduction. In Journey to Mexico During the Years 1826 to 1834. By Jean Louis Berlandier. Austin: The Texas State Historical Association in cooperation with the Center for Studies in Texas History, University of Texas at Austin.

Discussion of Berlandier's travels and the history of his botanical collections.

Noakes, T. J. n.d. Diary. 1858-1867. Manuscript in the La Retama Public Library, Corpus Christi, Texas.

Details a week-long trip to Padre Island in 1865 which has very brief mention of landscape, flora and fauna.

Odum, H. T. and R. F. Wilson. 1962. Further studies on recreation and Metabolism of Texas Bays, 1958-1960. Institute of Marine Science, The University of Texas, Port Aransas, Texas. Contr. Mar. Sci. 8:23-55.

A study of photosynthesis and respiratory consumption rates and the average for several Texas bays. Includes a good discussion of estuary dynamics and the importance of light, temperature and turbidity. Includes samples taken within the grassflats of the Laguna Madre and has several sample locations within park boundaries.

Ortiz Parilla, D. 1767. Autos y Diligencias Fechas Por El Coronel D. Diego Ortiz Parilla, Sobre las Circunstancias de la Isla de Los Malaguillas, Que Communmente Han Llamado Isla Blanca. Archivo General de la Nacion, Historia 396 (Barker Texas History Collection, 2Q188, Vol 397: 1-42)

Transcription of original document contained in Barker Archives, University of Texas at Austin. Earliest known terrestrial description of the island, including flora. Mentions oaks and willows.

Otteni, L. C., B. E. Dahl and R. L. Baker. 1973. The use of grasses for dune stabilization along the Gulf Coast with initial emphasis on the Texas Coast. Year end report for contract No DACW 72-6-0013-x-01. Gulf Universities Research Consortium GURC report no. 120.

One of several reports by the Dahl et. al. group monitoring the progress of the experimental dunes revegetation project. Study was done within the park. Box 84a.

Otteni, L. C. 1973. Dune stabilization study - grass plantings South Beach. Contract study.

Use of grasses for dune stabilization along the Gulf Coast - Contains notes, newspaper clippings. Oak mottes (Quercus) not mentioned. Box 84a.

Otteni, L. C., B. E. Dahl, R. L. Baker, and A. Lohse. 1972. The use of grasses for dune stabilization along the Gulf Coast with initial emphasis on the Texas Coast. Gulf Universities Research Consortium. Report 120. 1972 annual report.

Same as Woodard, et al., 1971.

- Pez, A. del. 1944. Diario del descubrimiento que hizo el Capitan Don Andres del Pez. In Collecccion de Diarios y Relaciones para la Historia de los Viajes y Descubrimientos. IV. Madrid: Instituto Historico de Marina.

Original Spanish diary of the 1687 expedition along the Padre Island coast. Very limited description of landform and flora.

- Price, W. A. and G. Gunter. 1943. Certain recent geological and biological changes in south Texas, with consideration of probable causes. Tex. Acad. Sci. Proc. and Trans., 26:138--156.

Discussion of historic changes in vegetation and hydrology of South Texas in light of climate change. Mentions Kennedy's assessment of Padre Island in the late 1800's as "green as a garden".

- Prouty, J. S. and D. B. Prouty. 1989. Final report. Quantification of sediment erosion/deposition in the Bird Island Basin Visitor Use Area of Padre Island National Seashore. Coastal Research Associates, Corpus Christi.

- Rawalt, L. Personal interviews conducted by Bob Whistler, PINS naturalist, transcribed from tapes.

The following are excerpts from these transcriptions which may describe oak motte areas.

"... Great Horn Owls nested in oak forest clumps..."

"...150 acres of stumps where sand dunes moved across left build up of dunes. Indian tooth ache tree- that's what Louis called it, was among three kinds on the island. Live oak, etc. Louis says during dry spells dunes moved across them or the stands of trees. Strong S.E. winds each day caused this movement... Loma Alta Motel present location was indeed as I had heard before, the tallest spot on the island. There were bay trees, oak trees, and shin oaks..."

From Aug. 25 interview "... Tree rings took samples to University of Arizona. Dr. Price and Louis through oil company contract to study the perimeter and extent of trees. Followed their contour line. cored trees to tell southern boundary of oak trees... In 1940, oak trees were affected by drought blew all around this area and afterwards saw the tree stumps 150-acre stump forest north part of island and ran down some 3 miles south..."

Rechenthin, C. A. and H. Passey. 1973. The vegetation of Padre Island National Seashore. Unpublished report by Soil Conservation Service, Temple, Texas.

Brief vegetational history back to 1500's. No oak mottes mentioned, Primarily grasses mentioned, some trees, including huisache. Box 85.

Reese, P. 1938. The history of Padre Island. Unpublished M.A. thesis. Texas College of Arts & Industries. Kingsville.

Reid, S. C., Jr. 1847. The Scouting Expeditions of McCulloch's Texas Rangers; or, the Summer and Fall Campaign of the Army of the United States in Mexico-1846; Including Skirmishes with the Mexicans, and an Accurate Detail of the Storming of Monterrey; also, the Daring Scouts at Buena Vista; Together with Anecdotes, Incidents, Descriptions of Country, and Sketches of the Lives of the Celebrated Partisan Chiefs, Hays, McCulloch and Walker. Philadelphia: G. B. Zieber and Co.

Brief description of the island by Reid who rode the length of the island with McCulloch's Rangers in 1846. Metaphorical comparison of Padre to Sahara desert.

Riggio, R. F., G. W. Bomar, and T. J. Larkin. 1987. Texas drought: its recent history (1931-1985). Texas Water Commission, LP 87-04.

Does not mention Padre Island or vegetation specifically but provides some insight into factors affecting recent historic vegetation change. The two worst mid-twentieth century droughts in the central and southern Texas coast region occurred in the late 1940's through 1957 and between 1961 and 1965, immediately prior to and during the Padre Island National Seashore's creation.

Salinas, M. 1986. Historic Indian Populations of the Rio Grande Delta and Vicinity: An Approach to Definition of Basic Ethnic Units. Unpublished M.A. Thesis, Department of Anthropology, University of Texas at Austin.

Excellent source on historic Indian cultures in the area, with discussion of material culture which includes some plant usage. Good bibliography.

Scurlock, D., W. M. Lynn and R. T. Ray. 1974. An Assessment of the Archeological Resources of Padre Island National Seashore, Texas. Austin: Texas Historical Commission, Office of the State Archeologist, Special Report No. 11.

Archaeological survey for the National Seashore. Very brief discussion of past vegetation. Contains list of

faunal and floral remains from several archaeological sites. Excellent bibliography.

Shew, D. M., R. H. Baumann, T. H. Fritts, and L. S. Dunn. 1981. Texas Barrier Islands Region ecological characterization: environmental synthesis papers. U.S. Fish and Wildlife Service, Biological Services Program, Washington, D.C. FWS/OBS-81/32. 413pp.

An excellent bibliography and discussion of the constituents and dynamics of the barrier island ecosystem. Cites many interesting studies, some of which may include a few samples from within park boundaries. Box 8a.

Sheire, J. W. 1971. Historic resource study, Padre Island National Seashore, office of history and historic architecture, Eastern Service Center, Washington D.C., U.S. Department of the Interior, National Park Service.

Most detailed study of the history of the island with several references to historic vegetation and good sources. Contains translation of Ortiz Parilla's "Autos y Diligencias" which contains some unfortunate translation errors.

Sherrod, C. L. 1980. Present and past distribution of black mangrove (Avicennia germinans (L.) L.) on the Texas Gulf Coast. Master's thesis. The University of Texas.

A study tracing past and present distributions of Black Mangrove, showing scattered populations along the spoil islands of the Padre Island area. While there are no plot locations a good deal of the study involved the park.

Sherrod, C. L. and C. McMillan. 1981. Black Mangrove, Avicennia Germinans in Texas: past and present distribution. Contr. Mar. Sci. 24:115-131.

A brief presentation of Sherrod (1980).

Simmons, E. G. 1957. An ecological survey of the upper Laguna Madre of Texas. Publ. Inst. Mar. Sci. Univ. Tex. 4(2):156-200.

A broad overview of environmental parameters and their effects on flora and fauna. Most interesting section on salinity and flora. Has several collection points within park boundaries.

Singleton, J. R. 1964. Ecology of the principal waterfowl food plants of the lower Laguna Madre. Job completion report 17. Texas Parks and Wildlife Department, Austin, Texas.

One of a series of studies with transects in the Laguna Madre monitoring the distribution and abundance of seagrasses. Follows the same format for studies as the above cited papers by McMahon but involves the first attempts at coming up with methods. Includes samples within park boundaries.

Smylie, Vernon. 1972. The Secrets of Padre Island. Corpus Christi: Texas News Syndicate Press.

General account of the history of Padre Island with very little reference to vegetation and few documented sources.

State of Texas, et als. vs. Alberto Balli et als. n.d. Brief and Argument for Defendants in Error. Case No. 27265-8187 in the Supreme Court of Texas. Dallas: E. Duncan & Co., Brief Printers.

Contains translation of the 1828 survey notes for the Padre Balli grant, describing vegetation of island at selected stations during survey. Earliest detailed description of vegetation, including distribution across island. Trees mentioned at north end of island.

Tharp, B. C. 1926. Structure of Texas vegetation east of the 98th meridian. Univ. of Tx. Bull. 2606.

A quantitative ecological approach to identifying communities and their successional stages for eastern Texas. Field work was done in 1922, 23, and 24. Tharp was known to have collected enthusiastically on Padre Island but it is not clear if his collections relate to this work. He identified a Coastal Plains community type and his vegetation map includes the barrier islands of the Texas coast within it.

Traylor, J. B., J. E. Leif, R. Q. Zepeda, D. F. Dutra, S. Cheney, and M. C. McKown. A comparison of biotic and abiotic factors of selected communities of the Texas Gulf Coast.

A paper done in fulfillment of a marine ecology class requirements. The study examined several aquatic environments including North Bird Island, and details the species found.

Watson, R. L. 1968. Origin of shell beaches. Unpublished M.S. Thesis, Department of Geology, University of Texas at Austin. (study done on Padre island, 1968).

No vegetation mentioned. Lists of fauna composition of shells forming shell beaches.

Warren, E. Personal letters to Robert Whistler and various resources.

From August 1980 Letter - "... It has been a long struggle to overcome the drought and fires of 1933-34 and the coldest winter I can remember. Moving sand dunes and the loss of seed stock, root and wildlife which was once there."

1977 letter - fences used to keep cattle "... out of the holding pens and the house yard and oak brush."

From the West Side of Padre "... I had seen many areas of dense brush when I first came here in about 1918 with Mr. Pat Dunn, his cowhands and guests. There was a lot of mesquite, willow, sweet bay and oak ... evidently the brush and grass had burned off in 1933 during the dust-bowl days."

"I would like to see tree mottes and areas of brush on the island again. They supply places for birds to nest and day time hiding places for the nocturnal animals ... old field notes in the Spanish and Mexican land grants mention palos blancos or white trunked trees, the name they apply to hackberry."

Oct. 8, 1977 letter to Bob Whistler - "... Pat Dunn didn't like them [sweet bay bushes] for they grow in thickets and grass didn't grow among them. Burning off sweet bay may have caused some of the grass fires which plagued the island."

March 7, 1978 letter to Bob Whistler - "... Sweet bay... Pat Dunn hated them and even cut them to make brush fences and for the little fire wood they provided."

July 11, 1978 letter to Bob Whistler - Mr. Warren suggests that islands in the lagoon "... which have samples of what grew down there including bunch grass and thorny bushes, protected from the fire."

September 29, 1976 letter to Bob Whistler - "... since the passenger pigeons are no more and can not be depended upon for future re-seeding and the fertilization of the island ..."

Conversation between Warren and Whistler, Sept. 27, 1976 - "large oak motte at Loma Alta motel, called 'Big Hill'... people able to weather out hurricanes at that place."

April 30, 1976, letter to Bob Whistler - "... the soap trees [jaboncilla] were once found on the Padre Island

along with stands of oak and sweet bay in mottes and strips."

Letter to Barney Farley from Eric Warren - "Derek Hambly at Flour Bluff asked me if I remember seeing oak and mesquite forest on Padre Island years ago. He says there are stumps all over the island, but very few trees anywhere, but at the head of the island. I vaguely remember a fire down there but have no memory of when it was."

Weddle, R. S. 1985. Spanish Sea: The Gulf of Mexico in North American Discovery, 1500-1685. College Station: Texas A&M University Press.

Well-written and carefully researched discussion of Spanish exploration along the Gulf Coast. Good source of references. No direct mention of Padre Island vegetation.

Weddle, R. S., ed. 1988. La Salle, the Mississippi, and the Gulf: Three Primary Documents. College Station: Texas A&M University Press.

Contains Enriquez Barroto journal, plus commentary on Spanish voyages in search of LaSalle.

Weise, B. R. and W. A. White. 1978. Map: Geology and Natural Environments of Padre Island National Seashore, Texas. Bureau of Economic Geology, University of Texas at Austin.

An excellent overview of the geological environments of the Padre Island National Seashore and some of the common species found in them. Done using aerial reconnaissance techniques and presenting material in fine detail. An excellent description of the dynamic processes involved in development of the environments as well. While not a vegetative community study in the strict sense, many of the associations identified are consistent with the work of botanists in the area, and the terminology of this publication is quickly becoming the standard for reference to the landforms and their plant communities.

White, W. A. and W. E. Galloway. 1977. Guide to modern barrier environments of Mustang and North Padre Islands and Jackson (Eocene) barrier/lagoon facies of the south Texas uranium district. Research Note 7. Bureau of Economic Geology, University of Texas at Austin.

White, W. A., R. A. Morton, R. S. Kerr, W. D. Kuenzi, and W. B. Brogden. 1978. Land and Water Resources, Historical Changes, and Dune Criticality: Mustang and North Padre

Islands, Texas. Bureau of Economic Geology, The University of Texas at Austin, Report of Investigations, No. 92.

Historic changes in shoreline, including vegetation line, from aerial photos and historic maps with probable causes. Includes an excellent description of the physical and vegetation environments included as well, and used field validation studies to establish the plant associations discussed, for an excellent overview of the area.

Whitehouse, E. 1962. Common fall flowers of the coastal bend of Texas. Bob and Bessie Welder Wildlife Foundation, Sinton, Texas.

A layman's guide, with some historical habitat discussion included, and some discussion of the present day environments where the plants are found.
No oaks mentioned. Box 86.

Woodward, D. W., B. E. Dahl, R. L. Baker, and D. E. Feray. 1970. The use of grasses for dune stabilization along the gulf coast with initial emphasis on the Texas coast. Gulf Universities Research Corporation. Annual report of 1969.

Primarily a reference on dune grasses and their use in stabilization. Much the same information as the Dahl and Otteni papers annotated above. Oaks not mentioned.
Box 9.

Woodward, D. W., L. C. Otteni, B. E. Dahl, R. L. Baker, and T. W. Bilhorn. 1971. The use of grasses for dune stabilization along the gulf coast with initial emphasis on the Texas coast. Gulf Universities Research Consortium Report 114.

Same info as Dahl, 1981B and nearly identical to Woodward et. al. (1970) above. Box 9 and Box 84a

Writers' Round Table. 1950. From Padre Island: The long Texas coastal stretch that curves through the Gulf of Mexico from Corpus Christi to Port Isabel. San Antonio: Naylor Company.

No Quercus mentioned.

APPENDIX 2: MAP NOTES

Two maps of the vegetation studies within the boundaries of the Padre Island National Seashore are included. One, a longshore map of the entire National Seashore boundaries shows as precisely as possible the locations of studies within the park boundaries, with the exception of transect studies within the waters of the Laguna Madre. The extent of these transect studies is represented on the second map, showing the waters of the Laguna Madre. Completeness and accuracy of study locations on both maps has been impeded by the apparent loss of information, and by imprecise location information in the final reports and/or publications.

Baccus and Horton (1979) state that their data file and original map of 1000+ sample locations for their vegetation analysis and classification have been archived with the National Park Service. However, this information could not be located. We spoke with the principal investigator, John T. Baccus and learned that he cannot yet locate another copy of the map. Therefore, we were unable to include these study points on the map.

Similarly, we were unable to locate the map showing the transect down the island done by Rechenthin and Passey (1967). We have contacted the Soil Conservation Service in Temple, and their cartography division, and the map could not be located. Both of these investigators have since retired. We were unable to represent this study as well.

The map of the extent of transect studies in the Laguna Madre is representative of the northward and southward extensions of various transect studies by various investigators. While many of the original reports and publications have sketches of the transects, few maps have longitude and latitude markings or a scale. It was, therefore, impossible to place the transect lines with any accuracy.