RED MANGROVE, *RHIZOPHORA MANGLE*, IN TEXAS: AN EXPERIMENT IN ESTABLISHMENT AND SURVIVAL

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ABSTRACT

Red mangrove, *Rhizophora mangle* L., is an important member of the coastal, littoral fringe vegetation of the more tropical shorelines of the Gulf of Mexico and Caribbean, including southern Florida and Mexico. *Rhizophora* provides shoreline stabilization, habitat for many estuarine and terrestrial fauna, and significant primary productivity to the estuarine food chain. Red mangroves occur northward along both coasts of Florida to approximately the same latitude as Galveston, Texas, but only black mangrove, *Avicennia germinans* (L.) L., occurs along the Texas coast. Studies have indicated that populations of both the black and red mangrove exhibit latitudinal genetic differentiation in their tolerance of chilling temperatures in the Gulf and Caribbean with increasing tolerance in more northerly populations.

Experimental plantings of red mangroves originating from Daytona Beach, Florida, were undertaken on the southern Texas coast near Brownsville to determine if these plants of northern Florida which experience periodic chilling and mild freezing temperatures could survive Texas winter conditions to be used for wetland creation and enhancement efforts on the Texas coast. The results of this study and others indicate that red mangrove can be readily established and may survive most normal Texas winters, but that the frequency and duration of freezing conditions which exceed their tolerance preclude the long-term survival of *Rhizophora* in Texas.

INTRODUCTION

The ecological value of red mangrove (*Rhizophora mangle* L.) and other mangrove species in the littoral fringe communities of coastal waters has been well documented (Davis, 1940; Odum, 1971; Lugo & Snedaker, 1974). Mangroves are also important shoreline stabilizers helping to prevent wave erosion, and in some cases, contributing to the accumulation of peats and sediments to result in land accretion (Davis, 1938, 1940; Scholl, 1964).

Four principal mangrove species occur in the northern Gulf of Mexico, predominantly along the southern Florida and Mexican coasts. However, one species, black mangrove (*Avicennia germinans* (L.)L.), occurs further northward along the Texas, Louisiana, and northern Florida coasts as a result of greater chill tolerance (Sherrod & McMillan, 1985; Markley, et al., 1982). Red mangrove occurs northward

along the Florida coast of the Gulf and Atlantic along with black mangrove to approximately the same latitude as Galveston, Texas, near 29° N lat. (Sherrod, et al., 1986).

Genetic, latitudinal gradients in chill tolerance (2° to 4° C) have been demonstrated in black, red and white (Laguncularia racemosa (L.) Gaertn) mangrove populations in the Gulf and Caribbean with the more northern populations exhibiting greater chill tolerance with increasing latitude of occurrence (Markley, et al., 1982, Sherrod, et al., 1986, McMillan & Sherrod, 1986). As the populations of red mangrove of northern Florida occasionally experience chilling or mild freezing temperatures and have been shown to survive (Lugo & Zucca, 1977), field and laboratory experiments were conducted in Texas using Rhizophora propagules obtained from Daytona Beach, Florida, to determine if these red mangroves could survive Texas winter conditions. The results and conclusions of field plantings of the Florida Rhizophora on the southern Texas coast near Brownsville in 1983 are presented in this paper.

MATERIALS AND METHODS

Approximately 300 unrooted Rhizophora propagules were obtained from Daytona Beach, Florida, in early October of 1982 and were placed in one-gallon buckets with approximately 2-3 cm of potting soil and 5-6 cm of tap water for rooting. Approximately 50 propagules were placed in each bucket. The propagules were kept in an indoor environment at approximately average room temperature (20° - 25°C) with fluorescent lighting on 10-hour daytime cycles. No salts, fertilizers or root stimulants were used during the rooting period. Initiation of root development was noted within two weeks and rooting and leaf initiation were continued in the one-gallon buckets during the winter of 1982.

In mid-February, 1983, approximately 75 rooted propagules were transplanted to the field at a site on South Padre Island along the outer fringe of a Spartina alterniflora and Scirpus maritimus marsh at the outfall point of a sewage treatment plant (Figs. 1 & 2). Plants were transplanted directly from the rooting buckets with no attempt at preconditioning to salinity or the outdoor environment. Sediments at this planting site were generally firm sandy marl. The planting site had a northwestward exposure facing the Laguna Madre. Propagules were planted on approximately 1-meter centers along the outward fringe of the Spartina at an elevation of approximately MLW (mean low water). At time of planting, the sediments and bay water were still cold from the past winter (estimate 10° to 15°C).

In mid-April of 1983, approximately 80 to 90 additional red mangrove propagules were transplanted to another site at the mouth of the Rio Grande River along a tidal ditch in a clearing among a stand of black mangroves (Figs. 1 & 3). As with the previous planting effort, no preconditioning of the plants to salt or the outdoor environment was attempted. Propagules were again planted on approximately 1-meter

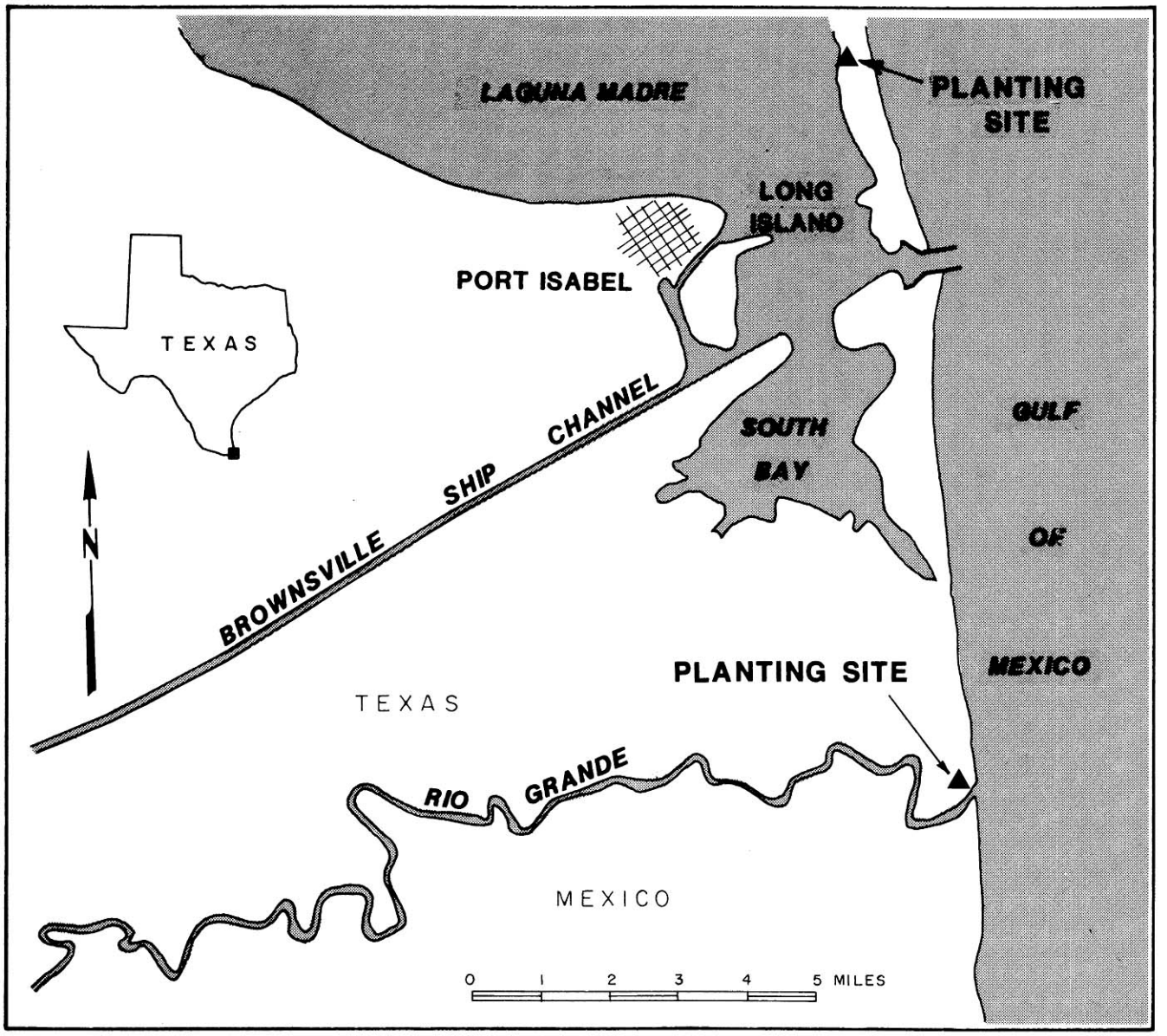

Figure 1. Location of Rhizophora planting sites.

Figure 2. Rhizophora plantings on South Padre Island in February 1983.

Figure 3. Rhizophora plantings at the mouth of the Rio Grande in April 1983.

centers in the soft silty-clay sediments characteristic of this site at an elevation of approximately MLW to MWL (mean water level). The planting area was generally surrounded by black mangroves 1 to 5 meters in height. The sediments and water were relatively warm at this time of year (estimate 20 ° to 25°C).

Remaining propagules were remanded to growth chambers in Austin for chill tolerance testing, the results of which are reported by Sherrod, et al., 1986.

The transplanted propagules were periodically monitored during the remainder of 1983 and into 1984 to determine establishment and survival success.

RESULTS

The plants established at South Padre Island in February, 1983, were inspected in April, June, and August of 1983 for establishment success. Of the 75 seedlings initially planted, 50 survivors were accounted for during the summer. Most surviving plants were producing new leaves. During the summer, the Spartina colonized around and beyond the red mangroves, densely engulfing them by August, 1983.

The seedlings established at the mouth of the Rio Grande River in April, 1983, were inspected only once in June due to the remoteness of the site. Of the original 80-90 seedlings, 60 surviving plants were found in June. Nearly all of those plants exhibited new growth.

The planting sites were not inspected again until January, 1984, following the coldest period of record for the Texas coast during December, 1983. During that 9-day period in December, subfreezing temperatures prevailed with a 54-consecutive hour period below 0°C recorded at Brownsville (ca. 25 km southwest of South Padre Island) on December 24-26 and record lows of -6° to -10°C recorded along the Texas coast (NOAA 1983).

In late January, 1984, the plants were inspected for survival following the record freeze. All plants had brown leaves and drooping stem tips, but many of the seedling bases were still green and roots of several plants removed from the sediment appeared to still be viable.

The plants were again checked in March, 1984, and at that time no remaining green tissue was observed in the stems. All plants were determined lost to the freeze. In addition to the red mangrove mortality, approximately 80 percent of the black mangrove populations along the Texas coast were also lost to the freeze (Sherrod & McMillan, 1985).

DISCUSSION

Although this study was abbreviated by the record freezing conditions of December, 1983, several conclusions can be drawn from these results and other studies. While viable propagules of Rhizophora, presumably of northern Mexico origin, occasionally wash upon Texas beaches, no naturally established plants have been observed (Gunn & Dennis, 1973; McMillan, 1971; Markley, et al., 1982). However, in March, 1983, a group of established red mangroves was discovered at South Padre Island which had apparently been planted several years earlier from an unknown source (Sherrod, et al., 1986). These plants, found along the edge of a dense black mangrove stand, ranged in height from 1.5 to 2.5 meters and were observed to be flowering and producing viable propagules during the summer of 1983. Newly established seedlings, presumed to be progeny of the larger plants, were noted in the immediate vicinity as well as on Long Island (John Hook, personal communication, 1986), across the Laguna Madre from the established parent plants, where the prevailing southeasterly winds may have drifted the propagules.

The successful establishment and initial growth of the northern Florida propagules planted at South Padre Island and at the mouth of the Rio Grande River prior to the devastating freeze of December, 1983, and the discovered presence and fecundity of larger Rhizophora on South Padre Island indicate that red mangroves can be established in Texas and survive normal winter conditions.

However, the long-term survival success of Rhizophora in Texas is questionable due to the frequency, duration, and severity of hard freezing conditions. Tests of chilling tolerance (2° to 4°C) indicate that Rhizophora populations of northern Florida are genetically adapted to withstand lower temperature conditions than populations from southern Florida and the Caribbean to the south (Sherrod, et al., 1986; Markley, et al., 1982). The tolerance limits to freezing conditions in Rhizophora have not been studied, but established populations in northern Florida (Cedar Keys) have been noted to survive short exposures to mild freezing conditions (0° to 5°C) (Lugo & Zucca, 1977). The extreme duration and severity of the December, 1983, freeze in Texas obviously exceeded the low temperature tolerance limits of the northern Florida seedlings as well as the older, previously established plants of unknown origin which had apparently survived one or more previous winters with recorded mild freezing conditions. The natural populations of Rhizophora in northern Florida were also eradicated from their northern distribution limits in that state by severe freezes in 1984 (Steve Beeman, personal communication, 1986).

Due to meteorological and geographic conditions, the potential for more severe and longer duration freezes on the Texas coast may be higher than the northern Florida coastal areas. This, coupled with the extreme distance of a renewing natural seed source of Rhizophora at LaPesca, Tamaulipas, Mexico, 300 km to the south of Brownsville, essentially prevents the long-term survival success of red mangrove in

Texas. Artificial introduction of Rhizophora propagules could result in probable short-term survival, but relatively frequent reintroductions would most certainly be necessary to maintain populations over time following periodic eradications by severe freezes.

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LITERATURE CITED

Davis, J. H. Jr. 1938. Mangroves-makers of land. Nature 31 (Nov): 551-553.

_____. 1940. The ecology and geological role of mangroves in Florida. Carnegie Institute of Washington. Publication 517, Papers of the Tortugas Laboratory 52:303-412.

Gunn, C. R., and J. V. Dennis. 1973. Tropical and temperate stranded seeds and fruits from the Gulf of Mexico. Contributions in Marine Science 17:111-121.

Lugo, A. E., and S. C. Snedaker. 1974. The ecology of mangroves. In: R. F. Johnston, P. W. Frank and C. D. Michener, eds. Annual review of ecology and systematics. Annual Reviews, Inc., Palo Alto, Cal. pp. 39-64.

Lugo, A. E., and C. P. Zucca. 1977. The impact of low temperature stress on mangrove structure and growth. Tropical Ecology. 18:149-161.

Markley, J. L., C. McMillan and G. A. Thompson, Jr. 1982. Latitudinal differentiation in response to chilling temperatures among populations of three mangroves, Avicennia germinans, Laguncularia racemosa, and Rhizophora mangle, from the western tropical Atlantic and Pacific Panama. Canadian Journal of Botany 60:2704-2715.

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

McMillan, C., and C. L. Sherrod. 1986. The chilling tolerance of black mangrove, Avicennia germinans, from the Gulf of Mexico coast of Texas, Louisiana and Florida. Contributions in Marine Science 29:000-000 (in press).

National Oceanic and Atmospheric Administration (NOAA). 1983. Local Climatological Data, Monthly Summary: Galveston, Corpus Christi, and Brownsville, Texas. ISSN 0198-5078, 4977, and 4950.

Odum, W. E. 1971. Pathways of energy flow in a south Florida estuary. Sea Grant Technical Bulletin No. 7. University of Miami, Florida, 158 pp.

Scholl, D. W. 1964. Recent sedimentary record in mangrove swamps and rise in sea level over the southwestern coast of Florida: Part 2. Marine Geology 2:343-364.

Sherrod, C. L., and C. McMillan. 1985. The distributional history and ecology of mangrove vegetation along the northern Gulf of Mexico coastal region. Contributions In Marine Science 28:129-140.

Sherrod, C. L., D. L. Hockaday and C. McMillan. 1986. Survival of red mangrove, Rhizophora mangle, on the Gulf of Mexico coast of Texas. Contributions In Marine Science 29:000-000 (in press).