

# OCCASIONAL PAPERS



*Museum of Texas Tech University*

*Number 209*

*9 July 2001*

## A COMPARISON OF THE FLORA OF NORTHERN PADRE ISLAND TO THAT OF MATAGORDA ISLAND, MUSTANG ISLAND AND SOUTHERN PADRE ISLAND, TEXAS

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The Texas Coast is bordered by a series of barrier islands floristically similar to other barrier islands of the Gulf and Atlantic Coasts except that upland sites on Texas barrier islands often grade into extensive grassland areas (Judd et al., 1977; Duncan and Duncan, 1987; Britton and Morton, 1989). Texas barrier islands were formed by deposition of sand during the Pleistocene and, as sea levels fluctuated, island physiography changed (McAlister and McAlister, 1993). Annual temperatures increase and annual precipitation decreases from north to south down the Texas coast (McAlister and McAlister, 1993). Typical habitats found on Texas barrier islands include coppice dunes, foredunes, barrier flats, and tidal flats (Nelson et al., 2000).

Padre Island National Seashore (PINS) encompasses most of northern Padre Island (Figure 1) and has recently been examined for floristic composition (Negrete et al., 1999). Matagorda Island represents the northernmost barrier island (Figure 1) in this investigation and has been previously examined for floral composition (McAlister and McAlister, 1993).

Corpus Christi Pass once separated northern Padre Island from Mustang Island but this pass is now filled and the two islands are joined (Weise and White, 1980). Nonetheless, the flora of Mustang Island is considered separately from that of northern Padre Island (Gillespie, 1976; Jones, 1982). Southern Padre Island is considered separately from northern Padre Island in floristic analyses (Judd et al., 1977; Lonard et al., 1978; Lonard and Judd, 1980) and is physically separated from northern Padre Island by the Mansfield Ship Channel (Figure 1).

The purpose of this investigation is to compare the most recent floristic inventory of PINS (Negrete et al., 1999) to three other barrier island systems along the southeastern Texas coast. Northern Padre Island is compared to other Texas barrier islands in terms of community similarity, percentage of shared and unique taxa, endangered and threatened species, as well as endemism and richness in relation to island areas. In addition, an inter-island checklist of known flora of some major barrier islands of Texas is provided to aid conservation managers.

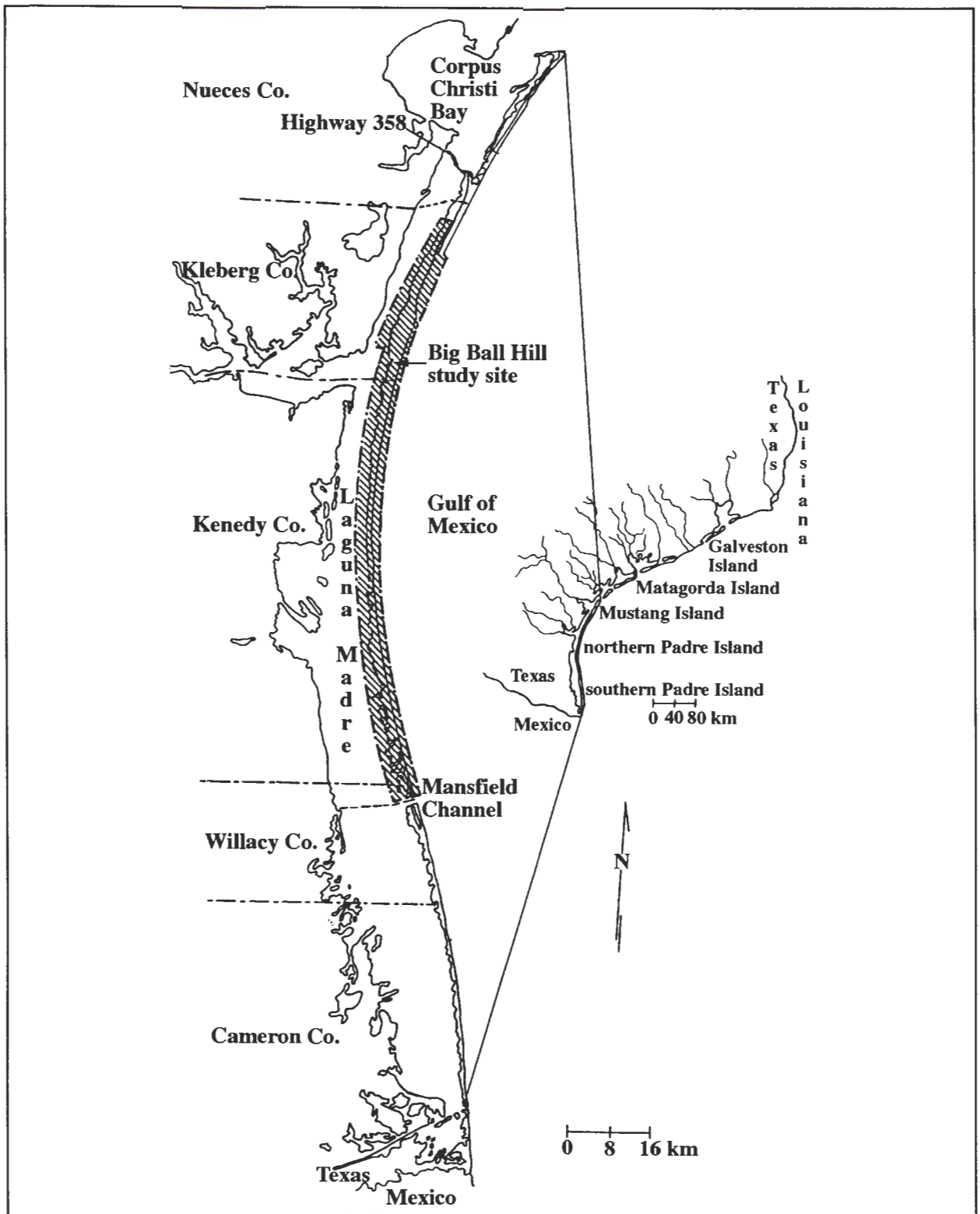


Figure 1. Map of the barrier islands of Texas (hatched lines indicate the boundaries of Padre Island National Seashore). Inset shows the southernmost islands along the Texas coast (modified from Weise & White 1980).

## METHODS AND MATERIALS

Data from Matagorda Island (McAlister and McAlister, 1993), Mustang Island (Gillespie, 1976; Jones, 1982), northern Padre Island (Negrete et al., 1999), and southern Padre Island (Lonard et al., 1978; Lonard and Judd, 1980) were compiled and used in floristic comparisons. Nomenclature of native or naturalized plants was standardized using Jones et al. (1997). Numbers of species, genera, and families from each barrier island were used to calculate richness, percentages of common families, and coefficients of community (Lonard et al., 1978; Brower et al., 1990).

Coefficients of community (CC) were calculated by  $CC = 2c/s_1 + s_2$ , where  $s_1$  and  $s_2$  are the number of species in the island communities 1 and 2, respectively, and  $c$  is the number of species common to both island communities (Lonard et al., 1978).

Putative endemism was determined using data from Correll and Johnston (1970), Amos (1991), Lonard and Judd (1980), Britton and Morton (1989), and Carr and Diamond (1995). Island area was taken from published sources (McAlister and McAlister, 1993) or was determined using polygon measurements on 1:100,000 scale maps in Terrain Navigator, Edition 1.0 (Anonymous, 1998). Z-values were calculated using the equation  $S = CA^z$ , where  $S$  is the number of species on the island,  $A$  is island area, and  $C$  and  $Z$  are constants. The exponent  $Z$  determines the slope of the curve and is referred to as a  $Z$  value (MacArthur and Wilson, 1967). Coefficients of determination ( $r^2$ ) were calculated between richness and endemism compared to island areas.

## RESULTS

All barrier islands shared 32 families, 78 genera, and 84 species (Table 1). A number of taxa were limited to each of the four barrier islands. Northern Padre Island had 10 families 54 genera, and 172 species limited to the island (Table 2). Matagorda Island had 11 families, 38 genera and 68 species that are limited, whereas Mustang Island had no families, ten genera, and 18 species (Table 2). Southern Padre Island had two families, 11 genera, and 34 species that are limited to the island (Table 2). Thirty-one species that are endemic to Texas are found on these barrier islands (Table 1) and two species may be endemic to Gulf barrier islands (Lonard and Judd, 1980; Britton and Morton, 1989). Matagorda Island has 13, Mustang Island has 11, northern Padre Island has 24, and southern Padre Island has five species endemic to the state (Table 1). The richest flora was found on northern Padre Island, whereas Mustang Island has the fewest taxa (Table 2). Thirteen families comprised greater than two-thirds of species found on these islands (Table

3). Families Asteraceae, Fabaceae, and Poaceae comprised greater than 40% of species on the islands (Table 3). Asteraceae comprised the greatest proportion of species on Matagorda Island, Fabaceae on Mustang Island, and Poaceae on northern and southern Padre islands (Table 3). Coefficients of community for species, genera, and families indicated northern Padre Island and Matagorda Island were most similar (Table 4). Mustang Island was most similar to Matagorda Island in terms of species and generic composition, but was more similar to northern Padre Island in terms of family composition (Table 4). However, it had the lowest coefficient of community for species compared to northern Padre Island (Table 4). Southern Padre Island had the lowest coefficients of community for genera and families in inter-island comparisons (Table 4). The  $Z$  value for species richness was 0.453 and for endemism was 0.654 (Table 5). Species richness and endemism were correlated with island area (Table 5).

Table 1. Presence (+) or absence (-) of taxa in the floras of Matagorda Island, Mustang Island, northern Padre Island, and southern Padre Island. Texas endemic species are in boldfaced italics. Common names, when available, are given in parentheses and follow Correll and Johnston (1970).

Taxon/common name	Matagorda	Mustang n.	Padre s.	Padre	Matagorda	Mustang n.	Padre s.	Padre	Taxon/common name
<b>Liliopsida</b> (monocots)									<b>Cyperaceae</b> (cont.)
<b>Agavaceae</b> (agave)	+	+	+	+	+	+	+	+	<i>Fimbristylis caroliniana</i>
<i>Yucca</i> (beargrass)	+	-	+	-	+	-	+	-	<i>F. castanea</i>
<i>Y. stricta</i>	-	-	+	-	-	-	+	+	<i>Furieta</i> (umbrella-grass)
<b><i>Y. tenuistyla</i></b>	+	-	-	-	-	-	+	-	<i>F. scirpoides</i>
<i>Y. ireuleana</i> (Spanish dagger)	+	-	+	-	-	-	+	+	<i>F. simplex</i>
<b>Alismataceae</b> (water plantain)	+	+	+	+	+	+	+	+	<i>Lipocarpus micrantha</i>
<i>Echinodorus</i> (burhead)	+	+	+	+	+	+	+	+	<i>Rhynchospora colorata</i>
<i>E. beteroi</i>	+	+	+	+	+	+	+	+	(white-topped umbrella grass)
<b>Commelinaceae</b> (spiderwort)	+	+	+	+	+	+	+	+	<i>Schoenoplectus</i> (bulrush)
<i>Commelina erecta</i> (hierba de pollo)	+	+	+	+	+	+	+	+	<i>S. erectus</i>
<i>Tradescantia</i> (spiderwort)	+	+	+	+	+	+	+	+	<i>S. pungens</i> (sword-grass)
<i>T. hirsutiflora</i>	+	+	+	+	+	+	+	+	<i>S. saximontanus</i>
<b><i>T. humilis</i></b>	-	+	+	+	-	-	+	+	<b>Hydrocharitaceae</b> (frog's bit)
<b><i>T. subcaulis</i></b>	+	-	+	-	-	-	+	+	<i>Halophila engelmannii</i>
<b>Cymodoceaceae</b> (manatee-grass)	-	+	+	+	-	-	+	+	<i>Thalassia testudinum</i> (palmas del mar)
<i>Cymodocea filiformis</i> (manatee-grass)	-	-	+	-	-	-	+	+	<b>Iridaceae</b> (iris)
<i>Halodule beaudettei</i>	-	-	+	-	-	-	+	+	<i>Allophia drummondii</i>
<b>Cyperaceae</b> (sedge)	+	+	+	+	+	+	+	+	<b>Herbertia lahue</b>
<i>Cladium mariscus</i> (saw grass)	+	-	+	-	+	-	+	+	<i>Sisyrinchium</i> (blue-eyed grass)
<i>Cyperus</i> (flatsedge)	+	+	+	+	+	+	+	+	<i>S. biflorus</i>
<i>C. croceus</i>	-	+	+	+	+	+	+	+	<i>S. rosulatum</i>
<i>C. echinatus</i>	-	+	+	+	+	+	+	+	<i>S. sagittiferum</i>
<i>C. elegans</i>	-	-	+	-	+	-	+	+	<b>Juncaceae</b> (rush)
<i>C. exculentus</i> (yellow nut-grass)	+	-	+	+	+	-	+	+	<i>Juncus</i> (rush)
<i>C. haspan</i>	+	+	+	+	+	+	+	+	<i>J. acuminatus</i>
<i>C. polystachyos</i>	-	+	+	+	+	+	+	+	<i>J. brachycarpus</i>
<i>C. psuedothyrsiflorus</i>	-	+	+	+	+	+	+	+	<i>J. bufonius</i> (toad-rush)
<i>C. retroflexus</i>	-	+	+	+	+	+	+	+	<i>J. interior</i>
<i>C. retrorsus</i>	+	+	+	+	+	+	+	+	<i>J. marginatus</i>
<i>C. rotundus</i> (nut-grass)	-	-	+	+	+	+	+	+	<i>J. megacephalus</i>
<i>C. squarrosus</i>	+	+	+	+	+	+	+	+	<i>J. roemerianus</i>
<i>C. surinamensis</i>	+	+	+	+	+	+	+	+	<i>J. scirpoides</i>
<i>Eleocharis</i> (spikerush)	+	+	+	+	+	+	+	+	<i>J. validus</i>
<i>E. albidia</i>	+	+	+	+	+	+	+	+	<b>Liliaceae</b> (Lily)
<i>E. atropurpurea</i>	+	+	+	+	+	+	+	+	<i>Allium canadense</i> (onion)
<i>E. cellulosa</i>	+	+	+	+	+	+	+	+	<i>Cooperia drummondii</i> (cebolleta)
<i>E. flavescens</i>	-	+	+	+	+	+	+	+	<i>Nothoscordum bivalve</i> (crow-poison)
<i>E. geniculata</i>	-	+	+	+	+	+	+	+	<b>Najadaceae</b> (water-nymph)
<i>E. inerstincta</i>	-	+	+	+	+	+	+	+	<i>Najas guadalupensis</i>
<i>E. minima</i>	-	+	+	+	+	+	+	+	(common water-nymph)
<i>E. montevidensis</i>	+	+	+	+	+	+	+	+	<b>Orchidaceae</b> (orchid)
<i>E. obtusa</i>	-	+	+	+	+	+	+	+	<i>Spiranthes vernalis</i> (Spring ladies' tresses)
<i>E. parvula</i>	-	-	+	+	+	+	+	+	<b>Poaceae</b> (grass)

Table 1. cont.

Taxon/common name	Matagorda	Mustang n.	Padre s.	Padre	Taxon/common name	Matagorda	Mustang n.	Padre s.	Padre
<b>Poaceae (cont.)</b>					<b>Poaceae (cont.)</b>				
<i>Andropogon</i> (bluestem)	+	+	+	+	<i>Eragrostis</i> (lovegrass)	+	+	+	+
<i>A. gerardii</i> (big bluestem)	-	-	-	-	<i>E. barrelieri</i>	-	-	-	-
<i>A. glomeratus</i> (bushy beardgrass)	+	+	+	+	<i>E. capillaris</i> (lacegrass)	-	-	-	-
<i>A. tenarius</i> (splitbeard bluestem)	-	-	-	-	<i>E. curtipedicellata</i> (gummy lovegrass)	-	-	-	-
<i>A. virginicus</i> (broomsedge)	+	+	+	+	<i>E. intermedia</i>	-	-	-	-
<i>Aristida</i> (three-awn grass)	+	+	+	+	<i>E. lugens</i>	-	-	-	-
<i>A. longispica</i>	+	+	+	+	<i>E. pectinacea</i>	-	-	-	-
<i>A. oligantha</i> (prairie three-awn)	-	-	-	-	<i>E. secundiflora</i> (red lovegrass)	+	+	+	+
<i>A. purpurea</i> (purple three-awn)	-	-	-	-	<i>E. sessilispica</i>	-	-	-	-
<i>Arundo donax</i> (giant reed)	-	-	-	-	<i>E. silveana</i>	-	-	-	-
<i>Avena fatua</i> (oats)	-	-	-	-	<i>E. spectabilis</i>	-	-	-	-
<i>Bothriochloa</i> (beardgrass)	+	+	+	+	<i>Eriochloa punctata</i> (cupgrass)	+	+	+	+
<i>B. barbinodis</i>	+	+	+	+	<i>Eustachys petraea</i>	-	-	-	-
<i>B. ischaemum</i>	+	+	+	+	<i>Hordeum pusillum</i> (little barley)	+	+	+	+
<i>B. laguroides</i>	+	+	+	+	<i>Leersia hexandra</i>	-	-	-	-
<i>Bromus</i> (chess)	+	+	+	+	<i>Leptochloa</i> (sprangletop)	-	-	-	-
<i>B. catharticus</i> (rescue grass)	+	+	+	+	<i>L. dubia</i> (green sprangletop)	-	-	-	-
<i>B. texensis</i>	+	+	+	+	<i>L. fascicularis</i>	-	-	-	-
<i>Cenchrus echinatus</i> (cadillo)	+	+	+	+	<i>L. mucronata</i> (red sprangletop)	-	-	-	-
<i>C. spinifex</i> (grassbur)	+	+	+	+	<i>L. nealleyi</i>	-	-	-	-
<i>Chloris</i> (fingergrass)	+	+	+	+	<i>Limnodea arkansana</i>	+	+	+	+
<i>C. andropodonooides</i>	-	-	-	-	<i>Lolium perenne</i> (ryegrass)	-	-	-	-
<i>C. canterai</i>	-	-	-	-	<i>Monanthochloa littoralis</i>	+	+	+	+
<i>C. cucullata</i> (hooded fingergrass)	+	+	+	+	<i>Muhlenbergia capillaris</i> (Guld muhly)	+	+	+	+
<i>C. gayana</i> (Rhodes grass)	-	-	-	-	<i>Nassella leucotricha</i> (Texas speargrass)	-	-	-	-
<i>C. verticillata</i> (windmill fingergrass)	-	-	-	-	<i>Panicum</i> (panic grass)	+	+	+	+
<i>C. X subdolihostachya</i>	+	+	+	+	<i>P. aciculare</i>	+	+	+	+
<i>Cynodon dactylon</i> (Bermuda grass)	+	+	+	+	<i>P. acuminatum</i>	+	+	+	+
<i>Dactyloctenium aegyptium</i> (crowfoot)	-	-	-	-	<i>P. amarum</i> (beach panic)	+	+	+	+
<i>Dichanthium annulatum</i>	+	+	+	+	<i>P. capillarioides</i>	-	-	-	-
<i>D. aristatum</i>	-	-	-	-	<i>P. hallii</i>	-	-	-	-
<i>Digitaria</i> (crabgrass)	+	+	+	+	<i>P. hians</i>	+	+	+	+
<i>D. arenicola</i> (fall witchgrass)	-	-	-	-	<i>P. maximum</i> (Guinea grass)	-	-	-	-
<i>D. bicornis</i> (Tropical crabgrass)	+	+	+	+	<b>P. nodatum</b>	-	-	-	-
<i>D. ciliaris</i> (Southern crabgrass)	+	+	+	+	<i>P. oligosanthes</i>	+	+	+	+
<i>D. cognata</i> (fall witchgrass)	+	+	+	+	<i>P. portoricensis</i>	-	-	-	-
<i>D. sanguinalis</i> (Northern crabgrass)	-	-	-	-	<i>P. sphaerocarpon</i>	-	-	-	-
<i>D. texana</i>	+	+	+	+	<i>P. virgatum</i> (switchgrass)	-	-	-	-
<i>Distichlis spicata</i> (saltgrass)	+	+	+	+	<i>Parapholis incurva</i> (sicklegrass)	-	-	-	-
<i>Echinochloa colona</i> (Jungle rice)	-	-	-	-	<i>Paspalidium geminatum</i>	+	+	+	+
<i>E. crus-galli</i> (barnyard grass)	-	-	-	-	<i>Paspalum</i> (paspalum)	+	+	+	+
<i>E. crus-pavonis</i>	-	-	-	-	<i>P. monostachyum</i>	+	+	+	+
<i>E. walteri</i>	-	-	-	-	<i>P. notatum</i> (Bahia grass)	+	+	+	+
<i>Eleusine indica</i> (goosegrass)	-	-	-	-	<i>P. plicatulum</i> (brownsseed paspalum)	+	+	+	+

Table 1. cont.

Taxon/common name	Matagorda	Mustang	n. Padre	s. Padre	Taxon/common name	Matagorda	Mustang	n. Padre	s. Padre
<b>Poaceae (cont.)</b>					<b>Poaceae (cont.)</b>				
<i>P. setaceum</i>	+	+	+	+	<i>Vulpia octoflora</i> (six-weeks fescue)	+	-	+	-
<i>P. vaginatum</i>	+	-	+	+	<b>Potamogetonaceae</b> (pondweed)	+	-	-	-
<i>Pennisetum ciliare</i> (buffelgrass)	-	+	+	-	<i>Potamogeton pectinatus</i>	+	-	-	-
<i>P. glaucum</i> (yellow foxtail)	+	-	+	-	(sago pondweed)	+	-	+	+
<i>Phalaris canariensis</i> (canary grass)	-	-	-	-	<b>Ruppiaceae</b> (ditch-grass)	+	-	+	+
<i>Phragmites australis</i> (common reed)	+	-	+	-	<i>Ruppia maritima</i> (widgeon-grass)	+	-	+	+
<i>Poa annua</i> (bluegrass)	-	+	-	-	<b>Typhaceae</b> (cat-tail)	+	-	+	+
<i>Polypogon monspeliensis</i>	-	-	+	+	<i>Typha</i> (cat-tail)	+	-	+	+
(rabbitfoot grass)	-	-	+	+	<i>T. domingensis</i> (tule)	+	-	+	+
<i>Schedonnardus paniculatus</i>	-	-	+	-	<i>T. latifolia</i> (common cat-tail)	-	-	+	-
(tumblegrass)	-	-	+	-	<b>Xyridaceae</b> (yellow-eyed grass)	-	-	+	-
<i>Schizachyrium scoparium</i>	+	+	+	+	<i>Xyris jupicai</i>	-	-	+	-
(seacoast bluestem)	+	+	+	+	<b>Zannichelliaceae</b> (horned pondweed)	+	-	-	-
<i>Setaria leucopila</i>	-	-	+	+	<i>Zannichellia palustris</i>	+	-	-	-
<i>S. macrostachya</i>	+	-	+	-	(common poolmat)	+	+	+	+
<i>S. parviflora</i>	+	-	+	-	<b>Magnoliopsida</b> (dicots)	-	+	+	-
<i>S. verticillata</i>	-	-	-	+	<b>Acanthaceae</b> (acanthus)	-	+	+	-
<i>Sorghastrum nutans</i> (Indian grass)	-	-	+	-	<i>Carlownrightia parviflora</i>	-	-	-	-
<i>Sorghum halepense</i> (Johnson grass)	+	+	+	+	<i>Ruellia corzoii</i>	-	-	+	+
<i>Spartina</i> (cordgrass)	+	+	+	+	<b>Aizoaceae</b> (carpet-weed)	+	+	+	+
<i>S. alterniflora</i> (smooth cordgrass)	+	+	+	+	<i>Mollugo verticillata</i> (carpet-weed)	+	+	+	+
<i>S. patens</i> (saltmeadow cordgrass)	+	+	+	+	<i>Sesuvium</i> (sea purslane)	+	+	+	+
<i>S. spartinae</i> (Sacahuista)	+	+	+	+	<i>S. maritimum</i>	-	-	+	+
<i>Sphenopholis obtusata</i>	+	+	+	+	<i>S. portulacastrum</i> (cenicilla)	+	+	+	+
(prairie wedgescale)	+	-	+	-	<b>S. trianthemoides</b>	-	-	+	-
<i>Sporobolus</i> (dropseed)	+	+	+	+	<i>S. verucosum</i>	+	-	+	+
<i>S. airoides</i> (alkali sacaton)	-	-	+	-	<i>Trianthema portulacastrum</i>	-	-	+	-
<i>S. cryptandrus</i> (sand dropseed)	+	-	+	-	<b>Amaranthaceae</b> (amaranth)	+	+	+	+
<i>S. indicus</i> (smutgrass)	+	-	+	+	<i>Amaranthus</i> (pigweed)	+	+	+	+
<i>S. pyramidalis</i>	+	-	+	+	<i>A. arenicola</i> (sandhills amaranth)	-	-	+	-
<i>S. tharpitii</i> (coastal sacaton)	+	+	+	+	<i>A. blitum</i>	-	-	+	-
<i>S. virginicus</i> (coastal dropseed)	+	+	+	+	<i>A. greggii</i>	+	-	+	+
<i>Stenotaphrum secundatum</i>	-	-	-	+	<i>A. palmeri</i>	-	-	+	-
(St. Augustine grass)	-	+	-	+	<i>A. polygonooides</i> (tropical amaranth)	-	-	+	-
<i>Trachypogon spicatus</i> (crinkle-awn)	+	-	+	-	<i>Blutaparon vermiculare</i> (silverhead)	+	+	+	+
<i>Trichoneura elegans</i> (silveus-grass)	-	-	+	+	<i>Celosia nitida</i> (albahaca)	-	-	+	-
<b>Tridens congestus</b>	-	-	+	+	<i>Froelichia</i> (snake-cotton)	+	-	+	-
<i>Triplasis purpurea</i> (purple sandgrass)	-	-	+	+	<i>F. drummondii</i>	-	-	+	-
<i>Uniola paniculata</i> (sea oats)	+	+	+	+	<i>F. floridana</i>	-	-	+	-
<i>Urochloa ciliatissima</i>	-	-	+	+	<i>F. gracilis</i>	+	-	+	-
<i>U. reptans</i>	-	-	+	+	<i>Tidestromia lanuginosa</i>	+	-	+	-
<i>U. texana</i> (Texas millet)	-	-	+	+	(espana vaqueros)	+	+	+	+
<b>Vaseyochloa multinervis</b>	-	-	+	+	<b>Anacardiaceae</b> (sumac)	-	-	-	-
(Texas grass)	-	-	+	+	<i>Schinus terebinthifolius</i> (pepper-tree)	-	-	+	+
	-	-	+	+	<b>Apiaceae</b> (parsley)	+	+	+	+
	-	-	+	+	<i>Cenella asiatica</i>	+	+	+	+



Table 1. cont.

Taxon/common name	Matagorda	Mustang	n. Padre	s. Padre	Taxon/common name	Matagorda	Mustang	n. Padre	s. Padre
<b>Apiaceae (cont.)</b>					<b>Asteraceae (cont.)</b>				
<i>Ciclospermum leptophyllum</i> (celery)	-	+	-	+	<i>C. nuecensis</i>	-	-	-	+
<i>Daucus pusillus</i> (carrot)	-	+	-	-	<i>C. tinctoria</i>	+	+	+	-
<i>Hydrocotyle</i> (water-pennywort)	+	+	+	+	<i>Croptilon</i> (scratch-daisy)	+	+	+	+
<i>H. bonariensis</i> (sombrenillo)	+	+	+	+	<i>C. divaricatum</i>	+	-	+	+
<i>H. umbellata</i> (ombigo de Venus)	+	+	+	+	<i>C. rigidifolium</i>	-	-	+	+
<i>Limnocaradum pumilum</i>	+	-	-	-	<i>Dyssodia</i> (dogweed)	-	-	+	+
<b>Apocynaceae</b> (dogbane)	+	-	-	+	<i>D. pentachaeta</i> (parralena)	-	-	+	+
<i>Carissa macrocarpa</i>	-	-	-	+	<i>D. tenuiloba</i>	-	-	+	+
<i>Nerium oleander</i> (common oleander)	+	-	-	+	<i>Eclipta prostrata</i> (yerbe de tago)	-	-	+	+
<b>Aquifoliaceae</b> (holly)	+	-	-	+	<i>Erigeron procumbens</i> (fleabane)	+	+	+	+
<i>Ilex vomitoria</i> (yaupon)	+	-	-	-	<i>Eupatorium compositifolium</i>	+	+	+	+
<b>Asclepiadaceae</b> (milkweed)	+	+	+	+	(yankee weed)	+	-	+	-
<i>Asclepias</i> (milkweed)	+	+	+	+	<i>Euthamia gymnospermoides</i>	+	+	+	-
<i>A. emoryi</i>	-	-	+	+	<i>E. leptoccephala</i>	+	+	+	-
<i>A. oenotheroides</i> (hierba de zizotes)	+	+	+	+	<i>Evax verna</i> (rabbit-tobacco)	-	+	+	+
<i>A. viridiflora</i>	-	-	+	+	<i>Flaveria brownii</i>	+	+	+	+
<i>Cynanchum angustifolium</i>	+	-	+	+	<i>Fleischmannia incanata</i> (boneset)	+	-	-	+
<i>C. barbigerum</i>	+	-	+	+	<i>Floerestina tripteris</i>	-	-	+	+
<i>Sarcostemma cynanchoides</i>	+	+	+	+	<i>Gaillardia pulchella</i> (Indian blanket)	+	+	+	+
<b>Asteraceae</b> (sunflower)	+	+	+	+	<i>Gamochaeta</i> (cudweed)	+	-	+	+
<i>Ambrosia</i> (ragweed)	+	+	+	+	<i>G. falcata</i>	-	-	+	-
<i>A. artemisiifolia</i> (short ragweed)	-	-	+	+	<i>G. pensilvanica</i>	+	-	+	+
<i>A. psilostachya</i> (western ragweed)	-	-	+	+	<i>Helenium amarum</i> (bitterweed)	+	-	+	+
<i>Amphiclytris dracunculoides</i>	+	+	+	+	<i>Helianthus</i> (sunflower)	+	+	+	+
(broomweed)	+	+	+	+	<i>H. annuus</i> (common sunflower)	+	+	+	+
<i>Aphanosiphus skirrhobasis</i> (lazy daisy)	+	+	+	+	<i>H. argophyllus</i> (silvertleaf sunflower)	+	+	+	+
<i>Baccharis</i> (groundsel-tree)	+	+	+	+	<i>H. debilis</i>	+	-	+	-
<i>B. halimifolia</i> (sea-myrtle)	+	+	+	+	<b>H. praecox</b>	-	-	+	-
<i>B. neglecta</i> (Roosevelt weed)	-	-	+	+	<i>Heterotheca subaxillaris</i>	+	+	+	+
<i>B. salicina</i>	-	-	+	+	(camphor weed)	+	+	+	+
<i>Borrchia frutescens</i> (sea ox-eye daisy)	+	+	+	+	<i>Iva</i> (sump-weed)	+	+	+	+
<i>Centaurea americana</i> (basket-flower)	-	-	+	+	<i>I. annua</i> (marsh-elder)	-	-	+	-
<i>Chaetopappa asteroides</i>	+	-	-	-	<i>I. frutescens</i>	+	-	-	-
<i>Chloracantha spinosa</i>	+	-	-	-	<i>I. imbricata</i>	-	-	+	-
(Mexican devil-weed)	+	-	-	-	<i>I. texensis</i>	+	+	+	+
<i>Chromolaena odorata</i> (crucita)	+	-	-	-	<i>Krigia occidentalis</i> (dwarf dandelion)	-	-	+	-
<i>Chrysopsis pilosa</i> (golden aster)	+	+	+	+	<i>Liatris elegans</i> (gay feather)	-	-	+	-
<i>Cirsium</i> (thistle)	+	+	+	+	<i>Machaeranthera phyllocephala</i>	+	+	+	+
<i>C. horridulum</i>	+	+	+	+	(camphor daisy)	+	+	+	+
<i>C. texanum</i>	-	-	+	+	<b>Palafoxia hookeriana</b>	+	+	+	+
<i>Clappia suaeidifolia</i>	-	-	+	+	<i>P. rosea</i>	-	-	+	-
<i>Conoclinium betonicifolium</i> (boneset)	+	+	+	+	<i>P. texana</i>	+	+	+	+
<i>Conyza canadensis</i> (horse-weed)	-	-	+	+	<i>Parthenium hysterophorus</i>	+	+	+	+
<i>C. ramosissima</i>	-	-	+	+	(false ragweed)	-	-	+	-
<i>Coreopsis</i> (tick-seed)	+	-	+	+	<i>Pluchea purpurascens</i> (canela)	+	+	+	+

Table 1. cont.

Taxon/common name	Matagorda	Mustang	n. Padre	s. Padre	Taxon/common name	Matagorda	Mustang	n. Padre	s. Padre
<i>Pyrrhopappus</i> (false dandelion)	+	-	-	+	(water-cress)	-	-	+	-
<b>Asteraceae</b> (cont.)					<b>Buddlejaceae</b> (butterfly-bush)	+	+	+	+
<i>P. carolinianus</i>	+	-	-	-	<i>Polypremum procumbens</i>	+	+	+	+
<i>P. pauciflorus</i>	-	-	-	+	<b>Cactaceae</b> (cactus)	+	+	+	+
<i>Ratibida</i> (Mexican hat)	+	+	+	+	<i>Opuntia</i> (prickly pear)	+	+	+	+
<i>R. columnifera</i>	+	-	-	+	<i>O. engelmannii</i>	+	+	+	+
<i>R. peduncularis</i>	+	+	+	+	<i>O. humifusa</i> (eastern prickly pear)	-	-	+	-
<i>Rudbeckia hirta</i> (brown-eyed Susan)	+	+	+	-	<i>O. leptocaulis</i>	+	-	-	-
<b>Senecio</b> <i>ridgellii</i>	+	+	+	-	(desert Christmas cactus)	+	-	+	+
<i>Solidago</i> (goldenrod)	+	-	+	+	<i>O. macrorhiza</i> (plains prickly pear)	+	+	+	+
<i>S. odora</i> (sweet goldenrod)	-	-	+	-	<i>O. stricta</i>	+	+	+	-
<i>S. sempervirens</i> (seaside goldenrod)	+	+	+	+	<b>Campanulaceae</b> (bluebell)	-	+	+	-
<i>Sonchus</i> (sow thistle)	+	+	+	+	<i>Triodanis</i> (Venus' looking-glass)	-	+	+	-
<i>S. asper</i> (achicoria dulce)	-	-	+	+	<i>T. holzingeri</i>	-	+	+	-
<i>S. oleraceus</i>	+	+	+	-	<i>T. perfoliata</i>	-	-	+	-
<i>Symphytotrichum</i> ( <i>aster</i> )	+	-	+	+	<b>Capparidaceae</b> (caper)	+	+	+	-
<i>S. divaricatum</i> (hierba del marrano)	+	-	+	+	<i>Polanisia</i> (clammy-weed)	+	+	+	-
<i>S. tenuifolium</i>	-	-	-	-	<i>P. dodecandra</i>	+	+	+	-
<b>Tetragonotheca repanda</b> (nerve-ray)	-	+	+	-	<i>P. erosa</i>	-	-	+	-
<i>Thelesperma</i> (green-thread)	+	+	+	-	<b>Caryophyllaceae</b> (pink)	-	+	+	-
<i>T. filifolium</i>	+	+	+	-	<i>Silene antirrhina</i> (sleepy catchfly)	-	+	+	-
<i>T. nuccense</i>	-	-	+	-	<i>Spergularia</i> (sand-spurrey)	-	-	+	-
<i>Verbesina encelioides</i> (cowpen daisy)	-	-	+	+	<i>S. echinosperma</i>	-	-	+	-
<i>Xanthium strumarium</i> (abrojo)	+	+	+	-	<i>S. marina</i> (salt-marsh sand-spurrey)	-	-	+	-
<b>Avicenniaceae</b> (black mangrove)	+	-	+	+	<i>Stellaria prostrata</i> (llovizna)	-	+	+	-
<i>Avicennia germinans</i> (black-mangrove)	+	-	+	+	<b>Chenopodiaceae</b> (goosefoot)	+	+	+	+
<b>Bataceae</b> (saltwort)	+	+	+	+	<i>Atriplex</i> (saltbush)	+	+	+	+
<i>Batis maritima</i> (vidrillos)	+	+	+	+	<i>A. matamorensis</i> (quelite cenizo)	+	+	+	+
<b>Boraginaceae</b> (borage)	+	+	+	+	<i>A. pentandra</i>	+	+	+	+
<i>Heliotropium</i> (turnsole)	+	+	+	+	<i>A. semibaccata</i> (Australian saltbush)	-	+	+	-
<i>H. convolvulaceum</i>	-	+	+	-	<i>A. texana</i>	-	-	+	-
<i>H. curassavicum</i> (seaside heliotrope)	-	+	+	+	<b>Chenopodium</b> (goosefoot)	+	+	+	+
<b>H. racemosum</b>	-	+	+	-	<i>C. album</i> (pigweed)	-	-	+	-
<b>Brassicaceae</b> (mustard)	+	+	+	+	<i>C. ambrosioides</i> (Mexican tea)	+	+	+	-
<i>Cakile</i> (sea rocket)	+	+	+	+	<i>C. berlandieri</i> (pitseed goosefoot)	+	+	+	-
<i>C. geniculata</i>	-	-	+	+	<i>C. incanum</i>	-	+	+	-
<i>C. lanceolata</i>	+	+	+	+	<i>Salicornia</i> (glasswort)	+	+	+	+
<i>Lepidium</i> (pepperwort)	+	+	+	+	<i>S. bigelovii</i>	+	+	+	+
<i>L. austrinum</i>	-	-	-	+	<i>S. virginica</i>	+	+	+	+
<b>L. lasiocarpum</b>	-	-	+	-	<i>Suaeda</i> (sea blite)	+	+	+	+
<i>L. virginicum</i> (lentejilla)	+	+	+	+	<i>S. conferta</i>	+	+	+	+
<i>Lesquerella</i> (bladderpod)	-	+	+	+	<i>S. linearis</i>	+	+	+	+
<b>L. grandiflora</b>	-	+	+	-	<i>S. moquinii</i>	-	-	+	+
<i>L. lasiocarpa</i>	-	+	+	-	<i>S. tampicensis</i>	-	-	+	+
<i>Rorippa nasturtium-aquaticum</i>	-	-	-	+	<b>Cistaceae</b> (rockrose)	-	-	+	-



Table 1. cont.

Taxon/common name	Matagorda	Mustang n. Padre	s. Padre	Taxon/common name	Matagorda	Mustang n. Padre	s. Padre
<b>Cistaceae (cont.)</b>				<b>Euphorbiaceae (cont.)</b>			
<i>Helianthemum georgianum</i> (rockrose)	-	-	+	<i>C. coryi</i>	-	+	-
<i>Lechea mucronata</i> (pin-weed)	-	-	+	<i>C. glandulosus</i>	+	+	-
<b>Clusiaceae</b> (St. John's-wort)	-	-	+	<i>C. monanthogynus</i> (prairie-tea)	-	+	-
<i>Hypericum</i> (St. John's-wort)	+	+	+	<i>C. parksii</i>	-	+	-
<i>H. gentianoides</i> (orange grass)	-	-	+	<i>C. punctatus</i> (beach-tea)	+	+	+
<i>H. hypericoides</i> (St. Andrew's cross)	-	-	+	<i>C. texensis</i> (Texas croton)	+	-	-
<i>H. pauciflorum</i>	+	+	+	<i>Euphorbia</i> (spurge)	+	+	+
<b>Convolvulaceae</b> (morning glory)	+	+	+	<i>E. bombensis</i>	+	+	+
<i>Cressa truxillensis</i>	+	-	-	<i>E. cordifolia</i>	-	+	+
<i>Dichondra carolinensis</i> (pony-foot)	+	-	-	<i>E. corollata</i>	-	+	+
<i>Ipomoea</i> (morning glory)	+	+	+	<i>E. cyathophora</i>	-	-	+
<i>I. cordatorriloba</i>	-	+	+	<i>E. heterophylla</i> (Catalina)	-	-	+
<i>I. imperati</i> (beach morning glory)	+	+	+	<i>E. hypericifolia</i>	-	+	+
<i>I. pes-caprae</i> (railroad vine)	+	+	+	<i>E. innocua</i>	-	+	-
<i>I. sagittata</i>	+	+	+	<i>E. maculata</i>	+	+	-
<i>Merremia dissecta</i> (Alamo vine)	-	+	-	<i>E. serpens</i> (hierba de la golondrina)	-	+	-
<i>Stylisma villosa</i>	+	-	-	<i>Phyllanthus</i> (leaf-flower)	+	+	-
<b>Cucurbitaceae</b> (gourd)	-	-	+	<i>P. abnormis</i>	+	+	-
<i>Citrullus lanatus</i> (watermelon)	-	-	+	<i>P. polygonoides</i>	+	+	-
<i>Cucumis melo</i> (muskmelon)	-	-	+	<i>P. pudens</i>	-	+	-
<i>Cucurbita foetidissima</i> (buffalo gourd)	-	-	+	<i>Ricinus communis</i> (castor-bean)	-	+	-
<i>C. texana</i> (Texas gourd)	+	+	+	<i>Sapium sebiferum</i> (Chinese tallow tree)	+	-	-
<i>Ibervillea lindheimeri</i> (globe-berry)	+	-	-	<i>Stillingia sylvatica</i> (Queen's delight)	-	+	-
<i>Melothria pendulana</i> (meloncito)	-	-	+	<b>Fabaceae</b> (legume)	+	+	+
<b>Cuscutaceae</b> (dodder)	-	-	+	<i>Acacia minuarta</i>	+	+	+
<i>Cuscuta</i> (dodder)	+	+	+	<i>A. schaffneri</i> (huisachillo)	+	-	-
<i>C. cuspidata</i>	+	-	-	<i>Aeschynomene viscidata</i>	-	+	-
<i>C. indecora</i> (pretty dodder)	+	-	-	(sticky joint vetch)	-	+	-
<i>C. pentagona</i>	-	-	+	<i>Amorpha bushii</i>	+	-	-
<b>Droseraceae</b> (sundew)	-	-	+	<i>Astragalus</i> (loco weed)	-	+	+
<i>Drosera brevifolia</i>	-	-	+	<i>A. brazoensis</i>	-	+	-
<b>Ebenaceae</b> (persimmon)	-	-	+	<i>A. leptocarpus</i>	-	+	-
<i>Diospyros texana</i>	+	-	-	<i>A. nuttallianus</i>	-	+	+
(common persimmon)	+	-	-	<i>Baptisia bracteata</i> (Plains wild indigo)	+	+	+
<b>Elaeagnaceae</b> (Russian olive)	+	-	-	<i>Canavalia</i> (jackbean)	-	+	+
<i>Elaeagnus angustifolia</i>	+	-	-	<i>C. rosea</i>	-	+	+
<b>Elatinaceae</b> (waterwort)	-	-	+	<i>Centrosema</i> (butterfly pea)	+	+	-
<i>Elatine triandra</i>	-	-	+	<i>C. virginianum</i>	+	+	-
<b>Euphorbiaceae</b> (spurge)	+	+	+	<i>Chamaecrista fasciculata</i> (partridge pea)	+	+	+
<i>Acalypha</i> (three-seeded mercury)	-	-	+	<i>Cliothia</i> (pigeon-wings)	-	+	-
<i>A. radicans</i>	-	-	+	<i>C. mariana</i>	-	+	-
<i>Chnidroscolus texanus</i> (bull nettle)	-	-	+	<i>Crotalaria</i> (rattlepod)	-	+	+
<i>Croton argyranthemus</i> (silver croton)	-	-	+	<i>C. incana</i> (chipilin)	-	+	+
<i>C. capitatus</i> (wooly croton)	+	+	+	<i>C. sagittalis</i>	-	+	-

Table 1. cont.

Taxon/common name	Matagorda	Mustang	n. Padre	s. Padre	Taxon/common name	Matagorda	Mustang	n. Padre	s. Padre
<b>Fabaceae (cont.)</b>					<b>Fabaceae (cont.)</b>				
<i>Dalea emarginata</i>	+	+	+	+	<i>S. helvula</i> (Amberique bean)	-	+	+	-
<i>D. lanata</i> (wooly dalea)	-	-	+	+	<i>S. leiosterma</i> (sick-seed bean)	+	-	+	-
<i>D. obovata</i> (pussyfoot)	-	-	+	-	<i>Sylosanthus</i> (pencil-flower)	+	+	+	-
<i>D. pogonathera</i> (bearded dalea)	-	-	+	-	<i>S. viscosa</i>	+	+	+	-
<i>Desmanthus brevipes</i>	+	-	+	-	<i>Vicia</i> (vetch)	+	+	+	-
<i>D. virgatus</i>	-	-	+	+	<i>V. ludoviciana</i> (deer pea vetch)	+	+	+	-
<i>Erythrina</i> (coral bean)	+	+	+	-	<i>Vigna luteola</i>	-	-	+	+
<i>E. herbacea</i>	+	+	+	-	<i>Zornia bracteata</i> (vipertina)	+	+	+	-
<i>Galactia</i> (milkpea)	+	+	+	-	<b>Fagaceae</b> (beech)	+	+	+	-
<i>G. canescens</i> (hoary milkpea)	+	+	+	-	<i>Quercus</i> (oak)	+	-	+	-
<i>G. marginalis</i>	-	-	+	-	<i>Q. minima</i>	-	-	+	-
<i>Glottidium vesicaria</i> (bladder pod)	+	-	+	-	<i>Q. virginiana</i> (live oak)	+	-	+	-
<i>Indigofera miniata</i> (scarlet pea)	+	+	+	+	<b>Fumariaceae</b> (fumitory)	-	+	+	-
<i>I. suffruticosa</i> (indigo)	+	+	+	-	<i>Corydalis</i> (scrambled eggs)	-	+	+	-
<i>Leucaena</i> (lead-tree)	-	+	+	+	<b>C. micrantha</b>	-	+	+	-
<i>L. leucocephala</i> (popinac)	-	+	+	+	<b>Gentianaceae</b> (gentian)	+	+	+	+
<i>L. pulverulenta</i> (tepeguaje)	-	-	+	+	<i>Eustoma</i> (catchfly-gentian)	+	+	+	+
<i>Medicago</i> (bur-clover)	-	+	+	+	<i>E. exaltatum</i>	+	+	+	+
<i>M. lupulina</i> (black medic)	+	+	+	-	<i>Sabatia</i> (rose-gentian)	+	+	+	+
<i>M. minima</i> (small bur-clover)	-	+	+	-	<i>S. arenicola</i>	+	+	+	+
<i>M. polymorpha</i>	+	-	+	+	<i>S. campestris</i>	-	+	+	-
<i>Melilotus</i> (sweet clover)	+	+	+	+	<b>Goodeniaceae</b> (goodenia)	-	+	+	-
<i>M. albus</i> (white sweet clover)	-	-	+	+	<i>Scaevola plumieri</i>	-	+	+	-
<i>M. indicus</i> (sour clover)	-	-	+	+	<b>Hydrophyllaceae</b> (waterleaf)	-	+	+	-
<i>Mimosa</i> (catclaw)	+	+	+	+	<i>Nama hispidum</i>	-	-	+	-
<i>M. latidens</i>	+	-	+	+	<i>Phacelia hirsuta</i>	-	+	+	-
<i>M. strigillosa</i> (powderpuff)	+	+	+	+	<i>P. patuliflora</i>	-	+	+	-
<i>Neptunia lutea</i> (yellow-puff)	-	-	+	-	<b>Lamiaceae</b> (mint)	+	+	+	-
<i>N. pubescens</i>	+	+	+	-	<i>Brazoria scutellarioides</i> (prairie brazoria)	-	+	+	-
<i>Parkinsonia aculeata</i> (retama)	+	+	+	-	<i>Lamium amplexicaule</i> (henbit)	-	+	+	-
<i>Pediemelum rhombifolium</i>	+	+	+	+	<i>Monarda</i> (horsemint)	+	+	+	-
<i>Prosopis</i> (mesquite)	+	+	+	+	<i>M. citriodora</i> (lemon beebalm)	-	+	+	-
<i>P. glandulosa</i> (honey mesquite)	+	+	+	+	<i>M. punctata</i> (spotted beebalm)	-	+	+	-
<i>P. reptans</i> (tomillo)	-	-	+	+	<i>Scutellaria</i> (skulleap)	+	-	+	-
<i>Rhynchosia</i> (snoutbean)	+	+	+	+	<i>S. drummondii</i>	-	-	+	-
<i>R. americana</i>	+	+	+	+	<i>S. muriculata</i>	+	+	+	-
<i>R. minima</i>	-	+	+	+	<i>Teucrium</i> (germander)	+	+	+	-
<i>R. reniformis</i> (dollar-leaf)	-	+	+	+	<i>T. cubense</i>	+	+	+	-
<i>R. senna</i>	-	-	+	+	<b>Lauraceae</b> (laurel)	-	+	+	-
<i>Senna occidentalis</i> (coffee senna)	+	+	+	-	<i>Persea borbonia</i> (red bay)	-	-	+	-
<i>Sesbania drummondii</i> (rattlebush)	+	+	+	-	<b>Lentibulariaceae</b> (bladderwort)	-	-	+	-
<i>S. exaltata</i> (bequilla)	+	+	+	+	<i>Utricularia</i>	-	-	+	-
<i>Sophora tomentosa</i> (yellow sophora)	-	+	+	+	<i>U. subulata</i>	-	+	+	-
<i>Strophostyles</i> (fuzzy bean)	+	+	+	-	<b>Linaceae</b> (flax)	+	+	+	+

Table 1. cont.

Taxon/common name	Matagorda	Mustang	n. Padre	s. Padre	Taxon/common name	Matagorda	Mustang	n. Padre	s. Padre
<b>Linaceae (cont.)</b>					<b>Onagraceae (evening primrose)</b>	+	+	+	+
<i>Linum</i> (flax)	+	+	+	+	<i>Calyophus bertandieri</i>	-	-	+	+
<i>L. alatum</i>	+	+	+	+	<i>C. serrulatus</i> (yellow evening primrose)	+	+	+	+
<i>L. aristatum</i>	-	-	-	-	<i>Gaura drummondii</i>	-	+	-	-
<i>L. imbricatum</i> (tufted flax)	-	-	-	-	<i>G. longiflora</i>	-	-	+	-
<i>L. rigidum</i>	+	+	+	+	<i>G. parviflora</i> (lizard-tail)	+	+	+	+
<b>Loasaceae (stick-leaf)</b>					<i>Ludwigia</i> (seedbox)	+	+	+	+
<i>Mentzelia oligosperma</i> (stick-leaf)	+	+	+	+	<i>L. glandulosa</i> (cylindric-fruited ludwigia)	+	+	+	+
<b>Lythraceae (loosestrife)</b>					<i>Oenothera</i> (evening primrose)	+	+	+	+
<i>Ammannia latifolia</i>	-	-	-	-	<i>O. drummondii</i> (beach evening primrose)	+	+	+	+
<i>Lythrum</i> (loosestrife)	+	+	+	+	<i>O. engelmannii</i>	-	-	+	+
<i>L. alatum</i>	+	+	+	+	<i>O. grandis</i>	-	-	+	+
<i>L. californicum</i> (hierba del cáncer)	+	+	+	+	<i>O. kumthiana</i>	+	+	-	-
<i>Rotala ramosior</i> (tooth-cup)	-	-	-	-	<i>O. laciniata</i> (cut-leaved evening primrose)	+	+	+	+
<b>Malvaceae (mallow)</b>					<i>O. speciosa</i> (showy primrose)	+	+	+	+
<i>Abutilon</i> (Indian-mallow)	+	+	+	+	<b>Orobanchaceae (broomrape)</b>	-	-	+	+
<i>A. abutiloides</i>	+	+	+	+	<i>Orobancha</i> (broomrape)	-	-	+	+
<i>A. fruticosum</i> (pelotazo)	+	+	+	+	<i>O. ludoviciana</i>	-	-	+	+
<i>Callirhoe</i> (poppy-mallow)	-	-	-	-	<b>Oxalidaceae (wood-sorrel)</b>	+	+	+	+
<i>C. involucrata</i>	-	-	-	-	<i>Oxalis</i> (wood-sorrel)	+	+	+	+
<i>Hibiscus laevis</i> (scarlet rose-mallow)	+	+	+	+	<i>O. dillenii</i>	-	-	+	+
<i>Kosteletzkya</i> (salt marsh-mallow)	+	+	+	+	<b>O. drummondii</b>	+	+	+	+
<i>K. virginica</i>	+	+	+	+	<b>Papaveraceae (poppy)</b>	+	+	+	+
<i>Malva</i> (cheese-weed)	-	-	-	-	<i>Argemone</i> (prickly poppy)	+	+	+	+
<i>M. parviflora</i>	-	-	-	-	<i>A. albiflora</i> (white prickly poppy)	+	+	+	+
<i>Malvastrum americanum</i> (malva loca)	+	+	+	+	<i>A. sanguinea</i> (red poppy)	-	-	+	+
<i>M. coromandelianum</i>	-	-	-	-	<b>Passifloraceae (passion-flower)</b>	+	+	-	-
<i>Malvastrum drummondii</i>	+	+	+	+	<i>Passiflora foetida</i> (corona de Christo)	+	+	+	+
(Drummond wax-mallow)	+	+	+	+	<b>Phytolaccaceae (pokeweed)</b>	-	-	+	+
<i>Sida ciliaris</i> (bracted sida)	+	+	+	+	<i>Phytolacca americana</i> (pokeweed)	+	+	+	+
<i>S. cordifolia</i>	-	-	-	-	<i>Rivina humilis</i> (pigeon-berry)	+	+	-	-
<i>S. lindheimeri</i>	+	+	+	+	<b>Plantaginaceae (plantain)</b>	+	+	+	+
<i>Sphaeralcea</i> (globe mallow)	+	+	+	+	<i>Plantago</i> (plantain)	+	+	+	+
<i>S. lindheimeri</i>	+	+	+	+	<i>P. heterophylla</i>	-	-	+	+
<b>Meliaceae (mahogany)</b>					<b>P. hookeriana</b> (tallow weed)	+	+	+	+
<i>Melia azedarach</i> (Chinaberry-tree)	+	+	+	+	<i>P. rhodosperma</i> (red-seeded plantain)	+	+	-	-
<b>Moraceae (mulberry)</b>					<i>P. virginica</i> (pal-seeded plantain)	+	+	+	+
<i>Maclura pomifera</i> (osage orange)	+	+	+	+	<b>Plumbaginaceae (plumbago)</b>	+	+	+	+
<b>Myricaceae (wax-myrtle)</b>					<i>Limonium</i> (sea-lavender)	+	+	+	+
<i>Morella cerifera</i> (candle-berry)	-	-	-	-	<i>L. carolinianum</i>	+	+	+	+
<b>Nyctaginaceae (four-o'clock)</b>					<i>Plumbago scandens</i> (pitillo)	-	+	+	+
<i>Boerhavia coccinea</i> (scarlet spiderling)	+	+	+	+	<b>Polemoniaceae (phlox)</b>	+	+	+	+
<i>Bougainvillea glabra</i> (bougainvillea)	-	-	-	-	<i>Gilia incisa</i>	+	+	-	-
<i>Mirabilis albidia</i> (white four-o'clock)	+	+	+	+	<i>Phlox</i> (phlox)	-	-	+	+
<b>Oleaceae (olive)</b>					<i>P. drummondii</i>	-	-	+	+
<i>Forestiera angustifolia</i> (desert olive)	+	+	+	+	<i>P. glabriflora</i> (grande phlox)	-	-	+	+

Table 1. cont.

Taxon/common name	Matagorda	Mustang n. Padre	s. Padre	Taxon/common name	Matagorda	Mustang n. Padre	s. Padre
<b>Polygalaceae</b> (milkwort)	+	-	+	<b>Rubiaceae</b> (cont.)	-	-	+
<i>Polygala</i> (milkwort)	+	-	+	<i>Oldenlandia boscii</i>	-	-	+
<i>P. alba</i>	-	-	+	<i>O. uniflora</i>	-	-	+
<i>P. incarnata</i>	-	-	+	<i>Richardia brasiliensis</i>	+	+	+
<i>P. verticillata</i>	+	-	+	<b>Rutaceae</b> (citrus)	+	-	-
<b>Polygonaceae</b> (knotweed)	+	+	+	<i>Amyris texana</i> (chapotillo)	+	-	-
<i>Eriogonum</i> (wild buckwheat)	+	+	+	<i>Zanthoxylum clava-herculis</i>	+	-	+
<i>E. longifolium</i>	-	-	+	(toothache tree)	-	-	-
<i>E. multiflorum</i>	+	+	+	<i>Z. fagara</i> (colima)	+	-	-
<i>Polygonella</i> (jointweeds)	-	-	+	<i>Z. hirsutum</i> (tickle-tongue)	+	+	+
<i>P. polygama</i> (October-flower)	-	-	+	<b>Salicaceae</b> (willow)	+	+	+
<i>Polygonum punctatum</i> (water smartweed)	+	-	-	<i>Populus deltoides</i> (eastern cottonwood)	+	+	-
<i>Rumex</i> (dock)	+	-	+	<i>Salix nigra</i> (black willow)	-	-	-
<i>R. chrysocarpus</i> (amamastla)	+	-	+	<b>Sapotaceae</b> (sapodilla)	+	-	-
<b>Portulacaceae</b> (purslane)	+	+	+	<i>Sideroxylon celastrium</i> (la coma)	+	-	-
<i>Portulaca</i> (purslane)	+	+	+	<b>Saxifragaceae</b> (saxifrage)	-	-	+
<i>P. oleracea</i> (verdolaga)	+	+	+	<i>Lepuropetalon spathulatum</i>	-	-	+
<i>P. pilosa</i> (chisme)	+	+	+	<b>Scrophulariaceae</b> (figwort)	-	+	+
<i>P. umbraticola</i>	-	+	+	<i>Agalinis fasciculata</i>	+	-	+
<i>Talinum</i> (flame-flower)	-	+	+	<i>A. heterophylla</i> (prairie agalinus)	-	-	+
<i>T. parviflorum</i>	-	+	+	<i>A. maritima</i> (seaside gerardia)	-	-	+
<b>Primulaceae</b> (primrose)	+	+	+	<i>A. strictifolia</i>	-	-	+
<i>Anagallis</i> (pimpernal)	-	+	+	<i>Bacopa</i> (water-hyssop)	+	+	+
<i>A. arvensis</i> (scarlet pimpernal)	-	-	+	<i>B. caroliniana</i> (blue hyssop)	-	-	+
<i>A. minima</i> (chaffweed)	-	-	+	<i>B. monnieri</i>	+	+	+
<i>Samolus</i> (water-pimpernal)	+	+	+	<i>B. rotundifolia</i> (disc-water-hyssop)	-	-	+
<i>S. ebracteatus</i>	+	+	+	<i>Buchnera</i> (bluehearts)	-	-	+
<b>Ranunculaceae</b> (crowfoot)	-	-	+	<i>B. americana</i>	-	-	+
<i>Clematis drummondii</i> (old man's beard)	-	-	+	<i>Castilleja</i> (Indian paintbrush)	-	+	+
<b>Rhamnaceae</b> (buckthorn)	+	+	-	<i>C. indivisa</i> (Texas paintbrush)	-	+	+
<i>Condalia hookeri</i> (brasil)	+	-	-	<i>Lindernia</i> (false pimpemel)	-	-	-
<i>Zizyphus obtusifolia</i> (lotebush)	+	-	+	<i>L. dubia</i>	-	-	+
<b>Rosaceae</b> (rose)	+	-	-	<i>Maurandya antirrhiniflora</i>	-	-	-
<i>Prunus caroliniana</i> (laurel cherry)	+	-	-	(snapdragon vine)	+	+	-
<i>Rosa bracteata</i> (Macartney rose)	+	-	-	<i>Nuttallanthus texanus</i> (Texas toad-flax)	+	+	-
<i>Rubus riograndis</i> (southern dewberry)	+	-	-	<i>Stemodia lanata</i> (wooly stemodia)	+	+	+
<b>Rubiaceae</b> (madder)	+	+	+	<b>Solanaceae</b> (potato)	+	+	+
<i>Cephalanthus occidentalis</i>	-	-	-	<i>Capsicum annuum</i> (bird pepper)	-	-	+
(common buttonbush)	-	-	+	<i>Lycium</i> (wolfberry)	+	+	+
<i>Diodia</i> (buttonweed)	+	-	+	<i>L. bertlandieri</i>	+	-	-
<i>D. teres</i> (poor Joe)	+	-	+	<i>L. carolinianum</i> (Carolina wolfberry)	+	+	+
<i>D. virginiana</i>	+	-	+	<i>Margaranthus solanaceus</i>	-	-	+
<i>Hedyotis</i> (bluets)	+	-	+	(netted globe-berry)	-	-	+
<i>H. nigricans</i>	+	-	+	<i>Nicotiana</i> (tobacco)	-	-	+
<i>Houstonia subviscosa</i>	-	-	+	<i>N. glauca</i> (tree tobacco)	-	-	+

DISCUSSION

Although one should be cautious when comparing floras compiled by different researchers with different study durations, sampling regimes, and biases inherent to taxonomy (Lonard et al. 1978), much useful information may be gained from such comparisons. Comparative studies of species composition allow examination of unique components of the flora, endemism, and richness. Community coefficients provide a quantitative means to compare similarity of taxa among barrier islands. In addition, common elements of barrier island flora can be discerned and biogeographic hypotheses proposed.

Floral endemism of each barrier island

*Flaveria brownii* and *Sporobolus tharpaii* were thought to occur only on Padre Island and on barrier islands off the coast of Tamaulipas (Lonard and Judd, 1980; Britton and Morton, 1989). *Flaveria brownii* is

frequent on brackish, low grounds (Jones, 1982) and is often found in barrier flats on northern Padre Island in the fall (Nelson et al., 1999). However, it has been observed on all four barrier islands included in this investigation (Asteraceae, Table 1) and thus occurs further north than originally reported. *Sporobolus tharpaii* is morphologically similar to the widespread species *S. wrightii* (Lonard and Judd, 1980) and needs to be examined taxonomically. Herein, *S. tharpaii* (Poaceae, Table 1) is reported from Matagorda Island, northern Padre Island, and southern Padre Island. It is usually found on sand and calcareous shell soils (Gould and Box, 1965).

Although few endemic plants occur on the western barrier islands of the Gulf of Mexico, a number of possible Texas state endemic species occur on the barrier islands included in this investigation (Table 1). The greatest numbers of species endemic to the state

Table 1. cont.

Taxon/common name	Matagorda	Mustang	n. Padre	s. Padre
<b>Solanaceae (cont.)</b>				
<i>N. repanda</i> (wild tobacco)	-	+	+	+
<i>Physalis</i> (ground cherry)	+	+	+	+
<i>P. cinerascens</i>	+	-	+	-
<i>P. pubescens</i> (downy ground cherry)	+	+	+	+
<i>Solanum</i> (nightshade)	+	+	+	+
<i>S. americanum</i> (American nightshade)	+	+	+	+
<i>S. elaeagnifolium</i> (silver-leaf nightshade)	-	-	+	-
<i>S. rostratum</i> (buffalo bur)	+	+	+	+
<i>S. triquetrum</i> (Texas nightshade)	+	+	+	+
<b>Tamaricaceae (tamarisk)</b>				
<i>Tamarix</i> (salt cedar)	+	+	+	+
<i>T. aphylla</i>	-	-	+	+
<i>T. canariensis</i>	-	-	+	+
<i>T. chinensis</i>	+	+	+	+
<i>T. gallica</i> (tamarisco)	+	+	+	+
<i>T. ramosissima</i>	-	-	+	+
<b>Ulmaceae (elm)</b>				
<i>Celtis pallida</i> (granjeno)	+	+	+	+
<b>Urticaceae (nettle)</b>				
<i>Parietaria</i> (pellitory)	+	+	+	+
<i>P. floridana</i>	+	+	+	+
<i>P. pensylvanica</i> (hammerwort)	-	-	+	+
<i>Urtica</i> (nettle)	+	+	+	+
<i>U. chamaedryoides</i> (ortiguilla)	+	+	+	+
<b>Verbenaceae (vervain)</b>				
<i>Glandularia bipinnatifida</i>	+	+	+	+
(small-flowered vervain)	-	-	+	-
<i>G. quadrangulata</i> (beaked vervain)	+	+	+	+
<i>Lantana</i> (lantana)	+	+	+	+
<i>L. camara</i> (Indian lantana)	-	-	+	+
<i>L. urticoides</i> (Texas lantana)	+	+	+	+
<i>Phyla</i> (frog-fruit)	+	+	+	+
<i>P. lanceolata</i> (northern frog-fruit)	-	-	+	+
<i>P. nodiflora</i> (common frog-fruit)	+	+	+	+
<i>Verbena halei</i> (Texas vervain)	+	+	+	+
<b>Vitaceae (grape)</b>				
<i>Cissus</i> (possum grape)	+	+	+	+
<i>C. incisa</i> (marine-ivy)	+	+	+	+
<b>Zygophyllaceae (caltrop)</b>				
<i>Kallstroemia hirsutissima</i> (carpetweed)	-	-	+	+
<i>Tribulus terrestris</i> (goat head)	-	+	+	+



Table 2. Number of plant species, genera, and families reported from Matagorda Island, Mustang Island, northern Padre Island, and southern Padre Island. Numbers of each taxon limited to particular islands are given in parentheses.

	Species	Genera	Families
Matagorda	299 (68)	217 (38)	72 (11)
Mustang	183 (18)	157 (10)	51 (0)
northern Padre	456 (172)	259 (54)	77 (10)
southern Padre	216 (34)	160 (11)	48 (2)

Table 3. Percentages of species of the most common families based on the total number of species present on each island.

Family	Matagorda	Mustang	n. Padre	s. Padre
Amaranthaceae	1.3%	2.2%	2.0%	1.9%
Asteraceae	14.0%	13.1%	12.5%	13.0%
Chenopodiaceae	2.7%	2.7%	2.4%	3.2%
Convolvulaceae	2.0%	2.2%	1.0%	1.0%
Cyperaceae	4.3%	2.7%	6.4%	5.6%
Euphorbiaceae	2.7%	5.5%	4.2%	3.2%
Fabaceae	9.7%	14.2%	9.4%	11.6%
Juncaceae	2.0%	0.0%	1.8%	0.0%
Malvaceae	3.0%	2.7%	1.5%	1.0%
Onagraceae	2.7%	2.2%	2.0%	2.8%
Poaceae	16.4%	13.7%	20.8%	25.5%
Scrophulariaceae	2.0%	2.7%	2.9%	3.2%
Solanaceae	2.0%	1.6%	1.3%	2.3%
Others	35.2%	34.5%	31.8%	25.7%

(24) are found on northern Padre Island (Table 5). All endemic species present on northern Padre Island will be discussed in this section.

*Tradescantia humilis* (Commelinaceae, Table 1) is locally abundant in sandy soils in shady areas (Jones, 1982), and also has been observed on Mustang and northern Padre islands. Four grasses (Poaceae, Table 1) endemic to the state are found on northern Padre Island. *Digitaria texana* is known only from sandy areas of the middle and lower Gulf Coast (Gould and Box, 1965; Hatch et al., 1999) and has been observed on northern and southern Padre islands as well as Matagorda Island. *Panicum nodatum* is occasionally found in sandy soils of the middle and lower Gulf Coast, whereas *Tridens congestus* is scattered in poorly drained, clay soils and saline, marshy grasslands bor-

Table 4. Coefficients of Community for species, genera, and families for pairwise comparisons of floral community similarity between Matagorda Island, Mustang Island, northern Padre Island and southern Padre Island.

Species:	Matagorda	Mustang	n. Padre	s. Padre
Matagorda	----	53.1%	56.1%	50.5%
Mustang	----	----	47.6%	49.1%
north Padre	----	----	----	50.0%
Genera:	Matagorda	Mustang	n. Padre	s. Padre
Matagorda	----	66.3%	70.6%	61.5%
Mustang	----	----	65.9%	61.8%
north Padre	----	----	----	65.9%
Families:	Matagorda	Mustang	n. Padre	s. Padre
Matagorda	----	71.5%	79.2%	66.7%
Mustang	----	----	78.1%	70.7%
north Padre	----	----	----	70.4%

Table 5. Relationship between species richness and island size as well as number of endemics and island size.

Island	Area (km <sup>2</sup> )	Species Richness	No. of Endemics
Matagorda	146.35	299	13
Mustang	64.84	183	11
northern Padre	272.20	456	24
southern Padre	56.03	216	5
	z-valu	0.453	0.654
	r <sup>2</sup> (vs. area)	0.833	0.697

dering the Gulf (Gould and Box, 1965; Hatch et al., 1999). Both have only been observed on northern Padre Island (Negrete et al., 1999). *Vaseyochloa multinervosa* is locally abundant on sandy sites of the lower and middle Gulf Coast (Hatch, 1999) and has been observed on both northern and southern Padre islands.

The Aizoaceae, Boraginaceae, Brassicaceae, Capparadaceae, Fumariaceae, Oxalidaceae, and Plantaginaceae each contain a single endemic found on northern Padre Island (Table 1). *Sesuvium trianthemoides* was thought to be fairly frequent in brackish swales, marshes, and depressions along the coast (Jones, 1982). However most of these occurrences were based upon misidentified specimens and the only known, extant population (personal commu-



nication with B. Carr of the Nature Conservancy) has been observed on northern Padre Island (Negrete et al., 1999). *Heliotropium racemosum* is rather frequent on deep sands (Jones, 1982) and occurs on Mustang and northern Padre Islands. *Lepidium lasiocarpum* is widely scattered on deep sands along the coast (Jones, 1982). *Polanisia erosa* occurs in deep sands from Aransas National Wildlife Refuge to Baffin Bay (Jones, 1982). Both species have only been observed on northern Padre Island. *Corydalis micrantha* var. *texensis* is frequently found on various soils in prairies, openings, fields, and disturbed areas (Jones, 1982) and is found on Mustang and northern Padre islands. *Oxalis drummondii* is common in pastures, woods, stream edges, and disturbed areas (Jones, 1982). *Plantago hookeriana* is frequent in sandy soils of prairies, openings, and waste places (Jones, 1982). Both occur on all the barrier islands in this investigation except southern Padre Island. However, they have been reported from the mainland adjacent to southern Padre Island (Richardson, 1995).

Six species of Asteraceae occur on northern Padre Island and are endemic to Texas (Table 1). *Helianthus praecox* ssp. *runyonii* is frequently found on coastal sands (Jones, 1982) and occurs only on northern Padre Island. Two species of *Palafoxia* are endemic to the state and primarily occur near the coast (Jones, 1982). *Palafoxia hookeriana* has been observed on northern Padre and Matagorda islands whereas *P. rosea* var. *rosea* is known only from northern Padre Island. *Senecio riddellii* is frequent on deep coastal sands (Jones, 1982) and has been observed on northern Padre and Matagorda islands. *Tetragonotheca repanda* occupies habitats similar to *S. riddellii* (Jones, 1982), but is known from Mustang and northern Padre islands. *Thelesperma nuecense* is frequent on deep coastal sands (Jones, 1982) and has been observed only on northern Padre Island.

Three species of Euphorbiaceae are found on northern Padre Island and are endemic to Texas (Table 1). *Croton coryi* is localized on the foredunes of northern Padre Island (Jones, 1982) while *C. parksii* is localized on deep sands in prairies and openings along the coast and farther inland (Jones, 1982), and is found on both Mustang and northern Padre islands. *Euphor-*

*bia innocua* is frequent on deep sands in openings, prairies, and on dunes (Jones, 1982) of Mustang and northern Padre islands.

Two species of Fabaceae are endemic to the state and found on northern Padre Island. *Dalea obovata* is frequent on coastal sands and occasionally occurs inland (Jones, 1982). It only has been observed on northern Padre Island. *Galactia canescens* has been observed on Matagorda, Mustang, and northern Padre islands and has been reported from counties adjacent to southern Padre Island (Richardson, 1995). It is frequent in sandy areas near the coast and island dunes (Jones, 1982).

Matagorda Island has 13 species that are endemic to Texas (Table 1). Eight of these have been previously discussed. The remaining five species are found only on Matagorda Island. *Yucca tenuistyla* occurs south of the Edwards Plateau to the south-central coast of Texas (Correll and Johnston, 1970). *Tradescantia subacaulis* occurs locally on looser sands in openings and prairies (Jones, 1982). *Herbertia lahue* is frequently found on sand or clay soils in prairies and openings (Jones, 1982). *Bromus texensis* occurs infrequently (Jones, 1982) and often grows in the protection of shrubs in sandy loam soils found in the middle and upper portions of the Texas coast (Hatch, 1999). *Cucurbita texana* is rare (Correll and Johnston, 1970) and usually occurs along rivers and bayshores (Jones, 1982).

Mustang Island has 11 species endemic to the state, and southern Padre Island has five (Table 1). In both cases, all but one of these species has been discussed previously. *Lesquerella grandiflora* (Brassicaceae, Table 1) has been observed only on Mustang Island. It is occasionally found in southern and central Texas in sandy soils of prairies and openings (Correll and Johnston, 1970; Jones, 1982). *Coreopsis nuecensis* (Asteraceae, Table 1) is rather common on sandy loam in prairies (Jones, 1982) and has been observed only on southern Padre Island. It has not been reported from the adjacent mainland (Richardson, 1995) and was rare in disturbed sites near roads on the island (Lonard et al., 1978).

Taxa limited to each barrier island

A number of taxa are limited to each of the four barrier islands. More taxa are limited to northern Padre Island than to the other three barrier islands. Nine of the ten families limited to northern Padre Island are associated with aquatic habitats. Two of these families are comprised of submerged, marine aquatic species. *Cymodocea filiformis* and *Halodule beaudettei* (Cymodoceaceae, Table 1) are frequent to common in Laguna Madre and bay waters (Jones, 1982) but have not been reported from the other barrier islands. *Halophila engelmannii* and *Thalassia testudinum* (Hydrocharitaceae, Table 1) are found in most bays along the Texas coast (Jones, 1982).

Seven additional families, each represented by a single species, are associated with freshwater habitats. *Drosera brevifolia* (Droseraceae, Table 1) is carnivorous and occurs occasionally on moist sands on northern Padre Island and in similar habitats scattered along the adjacent mainland (Jones, 1982). *Elatine triandra* (Elatinaceae, Table 1) occurs frequently along the coast on damp or low grounds in shallow water or mud (Jones, 1982). *Utricularia subulata* (Lentibulariaceae, Table 1) is carnivorous with subterranean branches and underground bladders or traps (Correll and Johnston, 1970). It is locally abundant in moist sands of swales along the coast (Jones, 1982). *Morella cerifera* (Myricaceae, Table 1) is frequent on coastal sands (Jones, 1982) and often occurs along streams, lakes, in boggy grasslands, and wet woodlands (Correll and Johnston, 1970). *Lepuropetalon spathulatum* (Saxifragaceae, Table 1) is localized on damp sandy or clayey soils (Jones, 1982). *Najas guadalupensis* (Najadaceae, Table 1) is frequent in ponds, marshes, lakes, and ditches (Jones, 1982). *Xyris jupicai* (Xyridaceae, Table 1) occurs in moist sandy soils or depressions on northern Padre Island (Jones, 1982). The large number of unique, aquatic families on northern Padre Island can be accounted for by numerous marshes that occur throughout the barrier flats along its length (Nelson et al., 1999).

Only two species (in family Cistaceae, Table 1) limited to northern Padre Island do not occur in aquatic habitats. *Helianthemum georgianum* is frequent in sandy oak woods along the coast and *Lechea*

*mucronata* is frequent on sandy soils in prairies and openings (Jones, 1982).

Most species limited to northern Padre Island occur in sandy soils, are widely scattered and have small population sizes, and many are ruderal, as reported for the flora of southern Padre Island (Lonard et al., 1978). However, about 30% of species limited to northern Padre Island are associated with aquatic habitats. Two unique grass species, *Sorghastrum nutans* and *Andropogon gerardii* indicate that habitats are recovering from grazing that occurred there from 1850 to 1971. *Sorghastrum nutans* is found only in well managed areas and both *S. nutans* and *A. gerardii* are part of the coastal prairie climax ecosystem (Hatch, 1999). These species often occur with *Schizachrium scoparium* var. *littoralis*, which dominates the barrier flat habitat on most of northern Padre Island (Nelson et al., 1999).

Matagorda Island has the second largest number of limited taxa (Table 1). Two of these families (Potamogetonaceae and Zannichelliaceae, Table 1) are freshwater aquatics and are each represented by a single species. *Potamogeton pectinatus* and *Zannichellia palustris* are rare along the middle Texas coast (Jones, 1982). The remainder of the families limited to Matagorda Island are part of a well developed shell ridge community that occurs on the bay-side margin of Matagorda Island that is high enough in elevation to support thick, woody cover (McAlister and McAlister, 1993). Seven families are each represented by a single woody species. *Ilex vomitoria* (Aquifoliaceae, Table 1) is common in sandy oak woods (Jones, 1982). *Diospyros texana* (Ebenaceae, Table 1) is common on various soils in mottes, brushy pastures, and woods (Jones, 1982). *Elaeagnus angustifolia* (Elaeagnaceae, Table 1) likely escaped from cultivation on the island. *Maclura pomifera* (Moraceae) is relatively rare along the middle Texas coast, whereas *Forestiera angustifolia* (Oleaceae, Table 1) is common on various soils in pastures and woods (Jones, 1982). *Sideroxylon celastrinum* (Sapotaceae, Table 1) occurs in sandy and clayey loams sometimes containing shell, mostly in brushy thickets along ravines and bluffs near the coast (Jones, 1982). *Celtis pallida* (Ulmaceae, Table 1) is common on various soils in brushy pastures and is scattered in prairie habitats

(Jones, 1982). Two additional families, the Rhamnaceae and Rosaceae (Table 1), are comprised of five woody species limited to Matagorda Island. *Condalia hookeri* and *Ziziphus obtusifolia* are common on various soils in brushy pastures and *C. hookeri* is occasionally found along streams and in woods (Jones, 1982). *Prunus caroliniana*, a popular ornamental in the eastern one-third of Texas, occurs in and on the edge of forests, lowland areas, fields, and thickets of eastern Texas (Correll and Johnston, 1970). *Rosa bracteata* is native to China and is associated with stream lowlands, swales, and along ditches (Jones, 1982). It is often planted as a living fence and readily escapes from cultivation (Correll and Johnston, 1970). *Rubrus riograndis* is almost ubiquitous as a weedy plant occurring in various soil types (Correll and Johnston, 1970) and is common along streams and occasional along ravines and in coastal woods (Jones, 1982).

Of the taxa limited to Matagorda Island, many are associated with sandy soils, occur in small populations, and are ruderal. There are fewer aquatic habitats (about 24%) than on northern Padre Island (about 30%) and thus fewer species are limited to these habitats. However, the chief difference is the woody understory species. This category contains about 38% of the species limited to Matagorda Island. Of the four barrier islands, Matagorda Island contains the largest woody element in its flora.

On southern Padre Island, the two families limited to the island each contain a single species. *Schinus terebinthifolius* (Anacardiaceae, Table 1) is an introduced ornamental (Correll and Johnston, 1970). *Clematis drummondii* (Ranunculaceae, Table 1) is common on sandy and clayey loam or caliche in pastures and woods (Jones, 1982).

Most of the genera and species limited to southern Padre Island prefer sandy soils, are widely scattered with small population sizes, and are ruderal, as was reported for the flora of southern Padre Island when compared to Mustang Island (Lonard et al., 1978). There is less of an aquatic element (estimated at about 18% of limited taxa) than on either northern Padre Island or Matagorda Island. About 15% of the limited genera and species likely escaped from cultivation and became naturalized on the island.

Taxa limited to Mustang Island follow a pattern similar to southern Padre Island (Lonard et al., 1978) with many sand-loving ruderals that are widely scattered, have small population sizes, and are escaped from cultivation. Mustang Island has the fewest species associated with aquatic habitats (estimated at about 11%).

#### Species richness, endemism, and island biogeography

The richest flora is found on northern Padre Island, whereas Mustang Island contains the fewest taxa (Table 2). Much of the floral diversity found on the islands is due to the presence of ruderal weedy species and the patchy occurrence of other invading species. In addition, most of the genera limited to southern Padre Island or Mustang Island are represented by a single species (Lonard et al., 1978). On Matagorda, Mustang, and southern Padre islands, 47-50% of the families are represented by a single species, whereas only 30% of the families found on northern Padre Island are comprised of a single species. All the genera limited to Mustang and southern Padre islands are represented by a single species, 97.4% of the genera limited to Matagorda Island are represented by a single species, and 92.6% of the genera limited to northern Padre Island are represented by a single species.

Species richness and endemism on Texas barrier islands are correlated with island area ( $r^2$  values in Table 5). Results of our study generally agree with island biogeography models proposed by MacArthur and Wilson (1967). Larger islands usually support more species than smaller ones and, when plotted on a double log scale, the number of species increases linearly with island size according to the equation  $S = CA^Z$ . The exponent  $Z$  determines the slope of the curve and is referred to as a  $Z$  value (Table 5). Whenever considering a variety of taxa on many different island systems,  $Z$  values have been found to range from 0.24 to 0.33 (MacArthur and Wilson, 1967). When species richness and endemism was plotted against island area in this investigation, the islands had  $Z$  values of 0.453 and 0.654, respectively (Table 5). MacArthur and Wilson (1967) attribute larger values to topographic diversity, proximity to the mainland, and rates of immigration and extinction. There is little topographic diversity on the islands with the exception of greater

numbers of wetland habitats on northern Padre Island. High rates of immigration could occur on islands close to the mainland and, for the islands in this investigation, distance from the mainland is often less than 2.0 km. Because there is little difference in distance from the mainland among the four islands, this factor would not greatly influence species richness or endemism. Extinctions on the islands would likely be caused by anthropogenic disturbances, tropical storms, hurricanes, or droughts. Island biogeography theory predicts that extinctions should be greatest on smaller islands. With similar topography and rates of immigration among the islands, extinction likely has the greatest influence on the *Z* values.

Greater extinction rates on smaller islands (southern Padre and Mustang islands) could result in higher than normal *Z* values. It should be noted that human development on the smaller islands is greater than on Matagorda and northern Padre islands, which also could contribute to extinctions on the smaller islands. High *Z* values may also occur when studying only a few islands (MacArthur and Wilson, 1967). As the Texas barrier island floras are analyzed in detail, this initial *Z* value may decrease with larger sample sizes.

Island colonization from the mainland is common but mainland floras are more diverse. Lonard and Judd (1980) found that 44% of species on southern Padre Island also occurred on the adjacent mainland at Laguna Atascosa National Wildlife Refuge. Lonard and Judd (1980) estimated that about twice as many species occurred on Laguna Atascosa National Wildlife Refuge and McAlister and McAlister (1993) estimated that Aransas National Wildlife Refuge, adjacent to Matagorda Island, supports about three times as many species as the island. If one combines the floras of northern Padre and Mustang islands, there are 485 species on the island complex compared to 1411 species reported by Jones (1982) for an area covering a large portion of the adjacent mainland. In all cases, the island floras are depauperate in comparison to the adjacent mainland floras.

#### Community Coefficients

The coefficients of similarity (Table 4) indicate that the northern islands are more similar to each other than to southern Padre Island. This is likely due to the

north-south temperature and rainfall gradient along the islands. Southern Padre Island has the driest and warmest climate of the four barrier islands examined in this investigation. The subtropical climate of southern Padre Island is apparent in its flora, with 28% of its native species having tropical affinities (Lonard et al., 1980). Patterns could also be influenced by the amount of floristic information available for each island.

Differences in community similarity between islands are largely influenced by species that occur on two or three of the islands. Of the 136 species shared between pairs of islands (Table 1), 41.2% are shared between Matagorda and northern Padre islands, 27.9% between northern and southern Padre islands, 16.2% between northern Padre and Mustang islands, 5.8% between Matagorda and southern Padre islands, and less than 5% for other combinations of islands. Matagorda and northern Padre islands share 56 species, 23 of which probably do not occur on southern Padre Island based on known distributions. *Fimbristylis caroliniana* (Cyperaceae), *Sisyrinchium sagittiferum* (Iridaceae), *Juncus bufonis*, *J. megacephalus*, *J. roemerianus*, *J. validus* (Juncaceae), *Cynanchum angustifolium* (Asclepidaceae), *Helianthus debilis*, *Palafoxia hookeriana* (Asteraceae), *Opuntia stricta* (Cactaceae), *Ipomoea sagittata* (Convolvulaceae), *Glottidium vesicaria*, *Strophostyles leiosperma* (Fabaceae), *Mentzelia oligosperma* (Loasaceae), *Gaura longiflora*, *Ludwigia glandulosa* (Onagraceae), *Polygala verticillata* (Polygalaceae), *Zanthoxylum clava-herculis*, *Z. hirsutum* (Rutaceae), *Agalinus fasciculata* (Scrophulariaceae), and *Parietaria floridana* (Urticaceae) (Table 1) are not known from Cameron, Hidalgo, or Willacy counties (Richardson, 1995) of the adjacent mainland. *Panicum acuminatum*, and *Sphenopholis obtusata* (Poaceae, Table 1) are not known to occur along the southernmost Texas coast (Hatch, 1999). Mustang and northern Padre islands share 24 species, eight of which would not likely occur on southern Padre Island based on known distributions. *Tradescantia humilis* (Commelinaceae), *Froelichia floridana* (Amaranthaceae), *Iva imbricata* (Asteraceae), *Heliotropium convolvulaceum*, *H. racemosum* (Boraginaceae), *Euphorbia innocua* (Euphorbiaceae), *Plantago virginica* (Plantaginaceae), and *Phlox glabriflora* are not known from Cameron, Hidalgo, or Willacy counties (Richardson, 1995) of the mainland. Matagorda and Mustang islands share

six species that could occur on northern and southern Padre Islands.

Northern Padre, Matagorda, and Mustang islands each share species with southern Padre Island. Northern and southern Padre islands share 38 species. These species also could occur on Matagorda and Mustang islands. Matagorda and southern Padre islands share eight species, whereas Mustang and southern Padre islands share four species. In both cases, these species could also occur on northern Padre Island.

Eighty-two species are shared by three islands (Table 1) and are referred to as triplets. The largest numbers of triplets (47.6%) exclude Mustang Island. Based on known distributions, all these species could occur on Mustang Island but do not. This may be due to its small area or relative lack of floristic sampling compared to the other islands. Southern Padre Island is excluded 41.5% of the time from the triplet category (Table 1) and 11 of these species probably do not occur on southern Padre Island based on known mainland distributions (Richardson, 1995; Hatch, 1999). Excluded species include *Cyperus surinamensis* (Cyperaceae), *Panicum aciculare* (Poaceae), *Centella asiatica*, *Hydrocotyl umbellata* (Apiaceae), *Cirsium horridulum*, *Helianthus argophyllus*, *Thelesperma filifolium* (Asteraceae), *Euphorbia maculata* (Euphorbiaceae), *Stylosanthes viscosa* (Fabaceae), *Kosteletzkya virginiana* (Malvaceae), *Oxalis dillenii* (Oxalidaceae), and *Tamarix gallica* (Tamaricaceae) (Table 1). Matagorda Island is excluded from the triplet category in 9.8% of the cases whereas Northern Padre Island is excluded 1.2% of the time. The exclusion of these islands does not appear to be due to distribution, as all the species in this category could potentially occur on all four islands. A number of species in the triplet category are regarded as common, frequent, or abundant (Jones, 1982; Hatch, 1999) and, though not reported, could occur on islands that are excluded and would comprise part of the common flora of the islands.

#### Common flora of the islands

Thirteen families comprise greater than two-thirds of the species found on the four barrier islands (Table 3). Of the 84 common (occurring on all four

islands) species (Table 1), only one, *Flaveria brownii*, is endemic and none of the common flora is considered endangered or threatened by the Texas Organization for Endangered Species.

Most of the common flora is native, but 4.8% is introduced. *Cynodon dactylon* (Poaceae) is native to Eurasia and found throughout Texas but is abundant in coastal areas (Correll and Johnston, 1970) in low moist sites (Jones, 1982). It is also tolerant of saline soils (Jones, 1982) which has undoubtedly aided its establishment on the barrier islands. *Sonchus oleraceus* is an European introduction found throughout the state (Correll and Johnston, 1970) and is frequent on various soils in fields, waste places, prairies, and openings (Jones, 1982). *Melilotus indicus* (Fabaceae) is native to Eurasia and is common in waste places and along roads (Jones, 1982). *Richardia brasiliensis* is native to South America and occurs on dunes, in coastal prairies and sandy scrub oak areas as well as roadsides and waste places (Correll and Johnston, 1970).

Most of the flora common to the barrier islands is herbaceous to sub-shrubby, with only 3.6% of the species being shrubs or trees. This lack of woody vegetation is unique to Texas barrier islands and was noted for southern Padre Island (Judd et al, 1977). The pronounced lack of woody vegetation is not characteristic of barrier islands further south along the Mexican coastline (Britton and Morton, 1989). The small component of the common woody flora includes: *Opuntia engelmannii* (Cactaceae), *Acacia minuatea*, *Prosopis glandulosa* (Fabaceae), and *Lycium carolinianum* (Solanaceae, Table 1).

All Texas barrier islands are considered part of the Gulf Prairies and Marshes biome (Correll and Johnston, 1970) and much of the islands' common flora is comprised of grasses (Poaceae) and other marsh plants. Grasses comprise 17% of the common flora whereas plants that occur in marshy habitats comprise 24% of the common flora. Plants that comprise the common flora of marshy habitats on the barrier islands include: *Cyperus retrorsus*, *Eleocharis montevidensis*, *Rhynchospora colorata*, *Schoenoplectus pungens* (Cyperaceae), *Andropogon glomeratus*, *Monanthochloe littoralis*, *Spartina patens*, *S. spartinae*, *Sporobolus virginicus* (Poaceae), *Hydrocotyle*

*bonariensis* (Apiaceae), *Borrchia frutescens*, *Conoclinium betonicifolium*, *Flaveria brownii*, *Pluchea purpurascens* (Asteraceae), *Batis maritima* (Bataceae), *Salicornia bigelovii* (Chenopodiaceae), *Sesbania exaltata* (Fabaceae), *Limonium carolinianum* (Plumbaginaceae), *Samolus ebracteatus* (Primulaceae), and *Bacopa monnieri* (Scrophulariaceae).

Common flora also occur in coppice dune, foredune, barrier flat, tidal flat, and disturbed habitats as identified by Nelson et al. (1999) in the Big Ball Hill region of northern Padre Island (Figure 1). Previous researchers also designated habitat types for the islands (Judd et al, 1977; Lonard et al, 1978; Lonard and Judd, 1981; Jones, 1982). These designations will provide some information on the types and diversity of habitats where the common flora is found.

The fewest members of the common flora are found in coppice dune habitats and include *Sporobolus virginicus*, *Uniola paniculata* (Poaceae), *Sesuvium portulacastrum* (Aizoaceae), *Tidestromia lanuginosa* (Amaranthaceae), *Heterotheca subaxillaris* (Asteraceae), *Cakile lanceolata* (Brassicaceae), *Ipomoea imperati*, *I. pescaprae* (Convolvulaceae), and *Croton punctatus* (Euphorbiaceae).

Foredune and tidal flat habitats share an almost equal number of common floral species (16 and 14 respectively). Common flora that occur in the foredune habitat include: *Paspalum monostachyum*, *P. setaceum*, *Sporobolus virginicus*, *Uniola paniculata* (Poaceae), *Sesuvium portulacastrum* (Aizoaceae), *Tidestromia lanuginosa* (Amaranthaceae), *Asclepias oenotheroides* (Asclepidaceae), *Heterotheca subaxillaris* (Asteraceae), *Polypremum procumbens* (Buddlejaceae), *Opuntia engelmannii* (Cactaceae), *Ipomoea imperati*, *I. pescaprae* (Convolvulaceae), *Croton punctatus* (Euphorbiaceae), *Chamaecrista fasciculata*, *Indigofera miniata* (Fabaceae), and *Oenothera drummondii* (Onagraceae) (Table 1). Species of the common flora that occur in the tidal flat include: *Schoenoplectus pungens* (Cyperaceae), *Monanthochloe littoralis*, *Spartina patens*, *Sporobolus virginicus* (Poaceae), *Blutaparon vermiculare* (Amaranthaceae), *Borrchia frutescens*, *Iva texensis*, *Machaeranthera phyllocephala* (Asteraceae), *Batis maritima* (Bataceae), *Heliotropium*

*curassavicum* (Boraginaceae), *Salicornia bigelovii*, *Suaeda linearis* (Chenopodiaceae), *Limonium carolinianum* (Plumbaginaceae), and *Lycium carolinianum* (Solanaceae).

Greatest numbers of the common flora are found in the barrier flat or disturbed sites on the islands. Species that are known to occur in barrier flat habitats of all four islands include: *Commelina erecta* (Commelinaceae), *Eleocharis montevidensis*, *Rhynchospora colorata*, *Schoenoplectus pungens* (Cyperaceae), *Sisyrinchium bifforme* (Iridaceae), *Andropogon glomeratus*, *Eragrostis secundiflora*, *Paspalum monostachyum*, *P. setaceum*, *Schizachyrium scoparium*, *Spartina patens*, *S. spartinae*, *Sporobolus virginicus*, *Uniola paniculata* (Poaceae), *Blutaparon vermiculare* (Amaranthaceae), *Hydrocotyl bonariensis* (Apiaceae), *Asclepias oenotheroides* (Asclepidaceae), *Ambrosia psilostachya*, *Aphanostephus skirrobasis*, *Borrchia frutescens*, *Conoclinium betonicifolium*, *Erigeron procumbens*, *Flaveria brownii*, *Gaillardia pulchella*, *Heterotheca subaxillaris*, *Machaeranthera phyllocephala*, *Palafoxia texana*, *Ratibida peduncularis* (Asteraceae), *Polypremum procumbens* (Buddlejaceae), *Opuntia engelmannii* (Cactaceae), *Euphorbia bombensis* (Euphorbiaceae), *Acacia minuata*, *Chamaecrista fasciculata*, *Dalea emarginata*, *Indigofera miniata*, *Mimosa strigillosa*, *Prosopis glandulosa*, *Rhynchosia americana*, *Sesbania exaltata* (Fabaceae), *Sabatia arenicola* (Gentianaceae), *Linum alatum* (Linaceae), *Oenothera drummondii* (Onagraceae), *Samolus ebracteatus* (Primulaceae), *Bacopa monnieri*, *Stemodia lanata* (Scrophulariaceae), *Physalis cinerascens* (Solanaceae), and *Phyla nodiflora* (Verbenaceae).

Common species known to occur in disturbed habitats of barrier islands include: *Cyperus retrorsus* (Cyperaceae), *Cooperia drummondii* (Liliaceae), *Bothriochloa laguroides*, *Cenchrus spinifex*, *Chloris cucullata*, *Cynodon dactylon*, *Eragrostis secundiflora* (Poaceae), *Tidestromia lanuginosa* (Amaranthaceae), *Hydrocotyle bonariensis* (Apiaceae), *Asclepias oenotheroides* (Asclepidaceae), *Ambrosia psilostachya*, *Aphanostephus skirrobasis*, *Erigeron procumbens*, *Gaillardia pulchella*, *Heterotheca subaxillaris*, *Iva texensis*, *Palafoxia texana*, *Ratibida peduncularis*, *Sonchus*



*oleraceus*, *Verbesina encelioides* (Asteraceae), *Heliotropium curassavicum* (Boraginaceae), *Cakile lanceolata*, *Lepidium virginicum* (Brassicaceae), *Polypremum procumbens* (Buddlejaceae), *Atriplex pentandra* (Chenopodiaceae), *Croton capitatus* (Euphorbiaceae), *Acacia minута*, *Dalea emarginata*, *Indigofera miniata*, *Melilotus indicus*, *Mimosa strigillosa*, *Pediomelum rhombifolium*, *Prosopis glandulosa*, *Rhynchosia americana*, *Sesbania exaltata* (Fabaceae), *Boerhavia coccinea* (Nyctaginaceae), *Oenothera drummondii*, *O. laciniata*, *O. speciosa* (Onagraceae), *Argemone albiflora* (Papaveraceae), *Portulaca pilosa* (Portulacaceae), *Richardia brasiliensis* (Rubiaceae), *Lycium carolinianum*, *Physalis cinerascens* (Solanaceae), *Phyla nodiflora*, *Verbena halei* (Verbenaceae), and *Cissus incisa* (Vitaceae) (Table 1). Many species that comprise the flora of southern Padre Island are weedy and grow in waste places (Lonard et al., 1978). This is true for many of the species included in the common flora of the barrier islands.

#### Endangered and threatened species

Three species that occur on the barrier islands are listed by the Texas Organization for Endangered Species (TOES). *Sesuvium trianthemoides* (Aizoaceae) is designated TOES, category III (Jones et al., 1997). This designation indicates *S. trianthemoides* is in danger of becoming extinct in Texas and lacks legal protection. *Helianthus praecox* (Asteraceae) and *Cucurbita texana* are designated TOES, category V (Jones et al., 1997). This designation indicates these two species lack legal protection and are on a watch list for plants with low population numbers or restricted ranges. In the Coastal Bend region of Texas, *S. trianthemoides* is rare (personal communication with B. Carr of the Nature Conservancy). It is possibly only known from the barrier flat of Padre Island National Seashore (Negrete et al., 1999). *Helianthus praecox* ssp. *runyonii* is frequent on coastal sands (Jones, 1982) and occurs on Padre Island National Seashore (Negrete et al., 1999). *Cucurbita texana* occurs along rivers and bays on the mainland (Correll and Johnston, 1979; Jones, 1982) but is also known from Matagorda Island (McAlister and McAlister, 1993).

#### Concluding remarks

In this investigation, we compare the flora of northern Padre Island to that of Matagorda Island, Mustang Island and southern Padre Island, Texas. Families with the greatest representation on all four islands are the Asteraceae, Fabaceae, and Poaceae. These three families constitute greater than 40% of the species found on the barrier islands. Thirty-two families, 78 genera, and 84 species are common to all four islands. Only one species occurring as a part of the common flora is endemic, none are endangered or threatened, most are native herbs, and about 40% are grasses or marsh-dwelling plants.

The richest flora is on northern Padre Island with 456 species followed by Matagorda Island (299), southern Padre Island (216), and Mustang Island (183). In all cases, the island floras are not as rich as the mainland floras but share affinities with the nearest mainland. Northern Padre Island has the greatest number of genera and species limited to the island. Of these limited taxa, northern Padre Island has the most wetland species, Matagorda Island has the most woody species, and all four islands have many limited species associated with sandy soils, occurring in small populations, and ruderal.

*Flaveria brownii* and *Sporobolus tharpii* are endemic to Texas and Tamaulipas barrier islands. Thirty-one species are endemic to Texas and found on the barrier islands included in this investigation. Three species are especially rare and of interest to conservation managers. *Sesuvium trianthemoides* is listed by TOES as in danger of extinction. *Helianthus praecox* ssp. *runyonii* and *Cucurbita texana* lack legal protection and are on a watch list for plants with low population numbers or restricted ranges.

Coefficients of community indicate that the flora of northern Padre Island is most similar to that of Matagorda Island and these differences may be caused by climatic changes that occur as one moves from north to south along the Texas coast. In addition, anthropogenic and natural disturbances likely influence extinction rates on the smaller islands resulting in higher than normal Z values for species richness and endemism as compared to island area.

## ACKNOWLEDGMENTS

The authors thank Paul Eubank and Darrell Echols at PINS, R. Nelson and M. Goetze and students at TSU for field assistance. In addition, unpublished research reports on file at PINS provided invaluable information. Of these, we especially acknowledge re-

ports by J. T. Baccus, J. K. Horton, and P. D. Carangelo, F. B. Jones, as well as C. A. Rechethin and H. Passey. The authors appreciated support from Organized Faculty Research at TSU.

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It was through the efforts of Horn Professor J Knox Jones, as director of Academic Publications, that Texas Tech University initiated several publications series including the Occasional Papers of the Museum. This and future editions in the series are a memorial to his dedication to excellence in academic publications. Professor Jones enjoyed editing scientific publications and served the scientific community as an editor for the Journal of Mammalogy, Evolution, The Texas Journal of Science, Occasional Papers of the Museum, and Special Publications of the Museum. It is with special fondness that we remember Dr. J Knox Jones.

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**ISSN 0149-175X**

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