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COMPARISONS OF RESIDENT BIRDS OF THE PASEO DEL INDIO NATURE TRAIL TO OTHER PUBLIC LANDS IN SOUTH TEXAS

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More avian species occur in Texas than any other state of the United States (Tveten, 1993). The South Texas region contains highly diverse avian faunas (Holt et al., 2000). The region is located in the central flyway of migratory species but also serves as a transition zone between southern, eastern, and western birds (Sibley, 2000). Ecotourism has been encouraged along the lower Texas coast and establishment of the Great Texas Coastal Birding Trail by the Texas Parks and Wildlife Department and Texas Department of Transportation supports that industry. The South Texas portion of the trail extends along State Highway 77 from Riviera in the north to Brownsville in the south. Many birders take advantage of the trail in order to view some of the bird life of Texas. In addition, many grassland birds, waterfowl, shorebirds, and raptors over-winter in the southern portion of Texas, thus making this region critical to conservation efforts (Igl and Ballard, 1999). Although not as well known as the area along the Texas coast, there is great potential for ecotourism and bird conservation along the Rio Grande and western areas of South Texas.

This study compared the resident birds of the Paseo del Indio Nature Trail along the Rio Grande and Laredo Community College campus with three other established public land tracts in southern Texas (Figure 1). We attempted to detect avian transition zones within the region by calculation and comparison of

community coefficients for all localities. In addition, the resident species data matrix (Table 1) enabled us to determine whether particular localities supported characteristics of insular biogeography.

Limited avian research has been conducted in the Laredo area. Butcher (1868) compiled a list of birds of Laredo that is notable for the absence of many introduced species. Woodin et al. (2000) utilized point counts to census breeding birds from several locations within and outside of the city of Laredo. The Laredo International Birding Association was established on 6 June 2000, and the association conducted its first Christmas Bird Count (CBC) on 6 January 2001 as part of the nationwide 101st CBC. Therefore, organizations dedicated to study of the area's avian fauna also are relatively new.

Similar to the Paseo del Indio Nature Trail, Falcon State Park and Santa Ana National Wildlife Refuge also are near the Rio Grande. The remaining site (Chaparral Wildlife Management Area) is found north of Laredo and away from the Rio Grande in Dimmit and LaSalle counties (Fig. 1). The Santa Ana National Wildlife Refuge is included at the southern extreme of the coastal birding trail.

Preservation of the habitat within these parcels could prove to be vital to wildlife conservation efforts

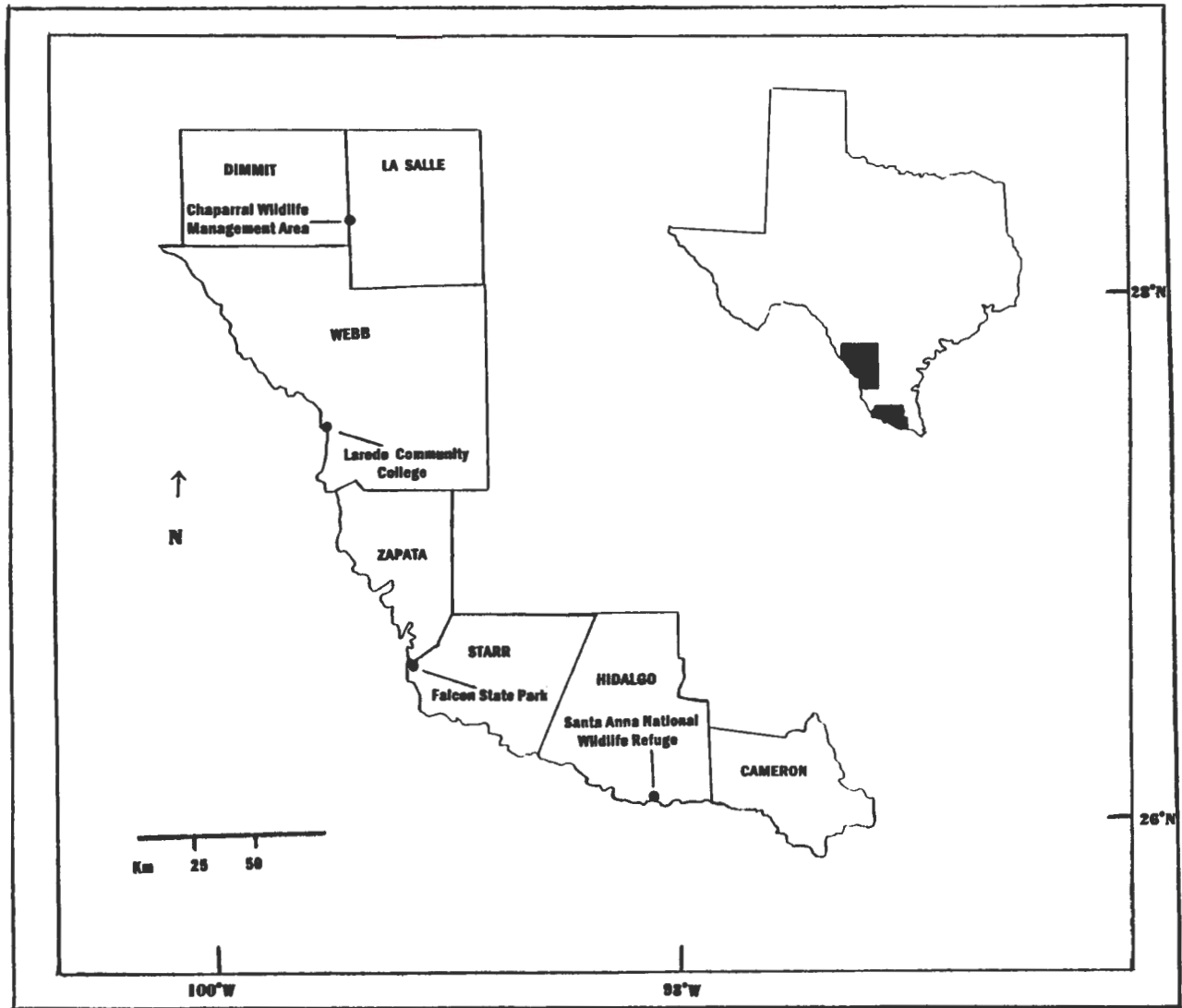


Figure 1. Map of the four study localities. Inset shows the location of the counties within Texas.

in South Texas. The city of Laredo was ranked ninth nationwide in percentage growth (44.9) during the 1990-2000 United States census (U. S. Census Bureau, 2001), indicating rapid growth and expansion within the city and surrounding area. Preservation of

even small tracts of land within the city and along the Rio Grande provides critical nesting habitat for many avian species, and these tracts serve as corridors for dispersal within the region.

MATERIALS AND METHODS

Observation and identification of birds on the Paseo del Indio Nature Trail (PI) and Laredo Community College campus were undertaken from 1995 to 2001. Occurrence data from Chaparral Wildlife Man-

agement Area (CP), Falcon State Park (FSP), and Santa Ana National Wildlife Refuge (SWR) were obtained from checklists from those entities.

Table 1. Resident birds of the four study localities. SWR = Santa Ana National Wildlife Refuge, FSP = Falcon State Park, PI = Paseo del Indio Nature Trail, CP = Chaparral Wildlife Management Area. X = Present and O = Absent.

Bird Species	SWR	FSP	PI	CP	Bird Species	SWR	FSP	PI	CP
Least Grebe	X	X	X	O	Gulf-billed Tern	X	O	O	O
Pied-Billed Grebe	X	X	X	O	Forster's Tern	X	O	O	O
American White Pelican	X	O	O	O	Least Tern	X	O	X	O
Neotropical Cormorant	X	X	X	O	Black Skimmer	X	O	O	O
Double-Crested Cormorant	X	O	O	O	Rock Dove	X	X	X	O
Anhinga	X	O	O	O	Red-billed Pigeon	X	X	O	O
Least Bittern	X	O	O	O	White-winged Dove	X	X	X	X
Great Blue Heron	X	X	X	X	Mouring Dove	X	X	X	X
Great Egret	X	X	X	O	Inca Dove	X	X	X	X
Snowy Egret	X	X	X	O	Common Ground Dove	X	X	X	X
Little Blue Heron	X	O	O	O	White-tipped Dove	X	X	X	O
Tricolored Heron	X	X	O	O	Budgerigar	O	O	X	O
Reddish Egret	X	O	O	O	Green Parakeet	O	O	X	O
Cattle Egret	X	O	X	O	Red-crowned Parrot	X	O	X	O
Green Heron	X	X	O	O	Yellow-billed Cuckoo	X	O	O	O
Yellow-crowned Night Heron	X	O	O	O	Greater Roadrunner	X	X	X	X
White-faced Ibis	X	O	O	O	Barn Owl	X	X	X	X
Roseate Spoonbill	X	O	O	O	Eastern Screech Owl	X	X	O	X
Black Vulture	X	X	X	X	Great Horned Owl	X	X	X	X
Turkey Vulture	X	X	X	X	Ferruginous Pygmy-Owl	O	X	O	O
Black-bellied Whistling Duck	X	X	X	O	Burrowing Owl	O	O	O	X
Fulvous Whistling Duck	X	O	O	O	Barred Owl	O	O	O	X
Mottled Duck	X	X	O	O	Pauraque	X	X	O	X
Blue-Winged Teal	X	O	O	X	Common Poorwill	O	X	O	X
Masked Duck	X	O	O	O	Buf-bellied Hummingbird	X	X	O	O
Ruddy Duck	X	O	O	O	Ruby-throated Hummingbird	X	O	O	O
Osprey	X	X	O	O	Black-Chinned Hummingbird	X	O	O	O
Hook-billed Kite	X	X	O	O	Rufous Hummingbird	X	O	O	O
White-tailed Kite	X	X	X	X	Ringed Kingfisher	X	X	X	O
Gray Hawk	X	X	O	O	Green Kingfisher	X	X	X	O
Common Black-Hawk	O	X	O	O	Golden-fronted Woodpecker	X	X	X	X
Harris' Hawk	X	X	X	X	Yellow-bellied Sapsucker	O	X	O	O
Red-shouldered Hawk	X	O	O	O	Ladder-backed Woodpecker	X	X	X	X
Swainson's Hawk	O	X	O	O	Northern Beardless-Tyrannulet	X	O	O	O
White-tailed Hawk	X	O	X	O	Eastern Phoebe	O	O	O	X
Zone-tailed Hawk	O	X	O	O	Vermillion Flycatcher	X	O	O	X
Red-tailed Hawk	O	O	X	X	Brown-crested Flycatcher	X	O	O	O
Crested Caracara	O	X	X	O	Great Kiskadee	X	X	X	O
American Kestrel	O	X	X	X	Couch's Kingbird	X	X	O	O
Plain Chachalaca	X	X	O	O	Scissor-tailed Flycatcher	X	O	O	O
Turkey (Rio Grande) Wild	O	O	O	X	Rose-throated Flycatcher	X	O	O	O
Scaled Quail	O	X	O	X	Loggerhead Shrike	O	O	O	X
Northern Bobwhite	X	X	O	X	White-eyed Vireo	X	X	O	O
King Rail	X	O	O	O	Green Jay	X	X	X	X
Sora	X	O	O	O	Brown Jay	O	X	O	O
Common Moorhen	X	X	X	O	Tamaulipas Crow	X	O	O	O
American Coot	X	X	X	O	Chihuahuan Raven	O	X	X	X
Killdeer	X	X	X	X	Horned Lark	X	O	O	O
Black-necked Stilt	X	O	O	O	Purple Martin	X	O	O	O
Northern Jacana	X	O	O	O	Northern Rough-winged				
Greater Yellowlegs	X	O	O	O	Swallow	O	X	O	O
Lesser Yellowlegs	X	O	O	O	Cave Swallow	O	X	X	O
Solitary Sandpiper	X	O	O	O	Tufted Titmouse	X	X	X	X
Spotted Sandpiper	X	O	O	O	Verdin	X	X	X	X
Least Sandpiper	X	O	O	O	Cactus Wren	X	X	X	X
Stilt Sandpiper	X	O	O	O	Rock Wren	O	X	O	O
Short-billed Dowitcher	X	O	O	O	Carolina Wren	X	O	O	O
Long-billed Dowitcher	X	O	O	O	Bewick's Wren	X	X	X	X
Laughing Gull	X	O	O	O	Ciay-colored Robin	X	O	O	O

Table 1 cont.

Bird Species	SWR	FSP	PI	CP	Bird Species	SWR	FSP	PI	CP
Northern Mockingbird	X	X	X	X	Cassin's Sparrow	X	X	X	X
Long-billed Thrasher	X	X	X	X	Lark Sparrow	X	X	X	X
Curve-billed Thrasher	X	X	X	X	Black-throated Sparrow	O	X	X	X
European Starling	X	X	X	X	Northern Cardinal	X	X	X	X
Cedar Waxwing	X	O	O	O	Pyrrhuloxia	X	X	X	X
Northern Parula	X	O	O	O	Painted Bunting	O	X	O	O
Tropical Parula	X	O	O	O	Red-winged Blackbird	X	X	X	X
Yellow Warbler	X	O	O	O	Great-tailed Grackle	X	X	X	X
Blackburnian Warbler	X	O	O	O	Bronzed Cowbird	X	X	O	O
Black-and-white Warbler	X	O	O	O	Brown-headed Cowbird	X	X	O	X
Prothonotary Warbler	X	O	O	O	Altamira Oriole	X	X	O	X
Louisiana Waterthrush	X	O	O	O	Audubon's Oriole	X	X	O	X
Common Yellowthroat	X	O	O	O	Bullock's Oriole	X	O	O	O
Yellow-breasted Chat	X	O	O	O	House Finch	O	O	O	X
Olive Sparrow	X	X	X	X	Black-tailed Gnatcatcher	O	X	O	X

A table of resident birds was compiled from our observational data and the available checklists (Table 1). Resident birds were defined as those species that had been observed or recorded from all seasons at each locality. Vagrant species and accidentals were not considered. Because our data were based upon occurrence, not population numbers, resident species were deemed most appropriate for our analyses. Resident birds must utilize area resources for survival and nesting throughout the year regardless of population numbers. Thus, higher numbers of resident species within a locality should indicate a more diverse and stable community (Brower et al., 1990). In addition, the analysis of resident species allowed inclusion of many species of shorebirds and waterfowl that might otherwise be omitted by conducting a terrestrial bird comparison. We hypothesized that the presence of permanent sources of water would contribute to more

diverse avian communities at some localities. The completed table contained 148 species.

The tabular information was utilized to calculate Sørensen community coefficients for a 4 x 4 pairwise comparison matrix (Table 2). The Sørensen community coefficient is calculated as $CCs = 2c / s_1 + s_2$, where c = species common to both communities and s_1 and s_2 are total number of species found within each community (Brower et al., 1990).

Additionally, the resident species matrix was utilized to test species-area relationships of the four habitats. The logarithms of species number and area (in acre units) were obtained for each locality and subjected to linear regression using the *Slope* function of *Microsoft Excel* (Jacobson, 1997).

Table 2. Sørensen community coefficient matrix of resident birds from the three study localities. SWR = Santa Ana National Wildlife Refuge, FSP = Falcon State Park, PI = Paseo del Indio Nature Trail, CP = Chaparral Wildlife Management Area.

	SWR	FSP	PI	CP
SWR	0	0.6280	0.5494	0.4444
FSP		0	0.7194	0.6423
PI			0	0.6428
CP				0

HABITAT DESCRIPTIONS

All four locations lie within the South Texas Plains ecoregion as defined by Taylor et al. (1999). As such, each location enjoys an extended growing season with high summer temperatures and mild winters. Average annual rainfall varies from 17 inches in the Laredo area to 28 inches at the Santa Ana Wildlife Refuge (Rappole and Blacklock, 1985). Topography varies from gently rolling plains to nearly level areas, and soils differ greatly across the region (Taylor et al., 1999). Adjacent to the Rio Grande, most soils are formed of fine sands, silts, and mixed clays.

Vegetation along the Paseo del Indio Nature Trail and Laredo Community College Campus consists of dense, woody vegetation extending in a narrow band along the Rio Grande with upland areas of grassland, thorny shrubs, and mesquite thickets. Riparian areas are dominated by *Arundo*, hackberry, spiny hackberry, and black willow and contain a dense ground cover of buffelgrass. Abandoned gravel pits along the Rio Grande provide a still-water habitat for various avian species. Mesquite trees, javalina bush, and Tamarisk trees also are found along the trail in upland areas. Grass cover (primarily buffelgrass) is less dense in upland areas. The college campus adjacent to the nature trail contains Arizona ash, live oak, Mexican olive, mulberry, palm trees, and pecan trees. The Rio Grande provides a permanent source of water. The entire area has been disturbed by natural and human activities.

The Chaparral Wildlife Management Area to the north of Laredo (Fig. 1) is a typical example of the thorny, brush communities of South Texas. Domi-

nant woody vegetation includes mesquite, blackbrush, whitebrush, and guayacan. Cacti are numerous on the site and include prickly pear and tasajillo. Prickly pear is often found in large clusters in these brushland habitats. Native grasses have been reduced by competition with introduced grasses and native forbs, but hairy grama, lovegrass, hooded windmill grass, crabgrass, and panic grass are found within the wildlife management area (Ruthven, 2001). Permanent water sources are more limited within the Chaparral Wildlife Management Area than on the other three localities.

Falcon State Park has been described as a thorn woodland. Butterwick and Strong (1976) classified the vegetation into three association groups. Hydrophilic species such as black willow and buttonbush are found along the banks of the Rio Grande. Sedges, bullrush, and *Arundo* are present, and Bermuda grass and lovegrasses often carpet the more extensive river terraces (Butterwick and Strong, 1976). A flood plain area supports mesquite trees, spiny hackberry, huisache, and *Acacia* trees, and upland, mesa areas support thorny, mostly small-leaved shrubs.

The Santa Ana National Wildlife Refuge is the largest remaining tract of native thorn woodland in the lower Rio Grande Valley (Vora, 1990). The subtropical climate at this locality supports a diverse assemblage of plant life. Plant communities on the refuge follow former river channels and flooding patterns. Boundaries between the old river channels and upland areas create a large amount of edge habitat between communities.

RESULTS

Based upon community coefficient analysis, Falcon State Park and the Paseo del Indio Nature Trail exhibit the highest affinity of resident species with a calculated value of 0.7194 (Table 2). Next in rank is the Paseo del Indio Nature Trail and Chaparral Wildlife management area at 0.6428. Falcon State Park and Chaparral Wildlife Management Area rank third (0.6423). A linear distribution pattern of resident birds is indicated by these results.

Santa Ana National Wildlife Refuge demonstrated a definite linear distribution pattern (Table 2). The refuge shared its highest affinity to Falcon State Park (0.6280), and an intermediate value with the Paseo del Indio Nature Trail (0.5494). Santa Ana National Wildlife Refuge was least similar to Chaparral Wildlife Management Area as indicated by a value of 0.4444.

Thirty species were residents of all four localities (great blue heron, black vulture, turkey vulture, white-tailed hawk, Harris' hawk, killdeer, white-winged dove, mourning dove, Inca dove, common ground dove, greater roadrunner, barn owl, great horned owl, ladder-backed woodpecker, green jay, tufted titmouse, verdin, cactus wren, Bewick's wren, Northern mockingbird, long-billed thrasher, curved-billed thrasher, European starling, olive sparrow, Cassin's sparrow, lark sparrow, northern cardinal, pyrrhuloxia, red-winged blackbird, and great-tailed grackle) (Table 1), whereas 23 species were shared between three localities (least grebe, pied-billed grebe, neotropical cormorant, great egret, snowy egret, black-bellied whistling duck, American kestrel, northern bobwhite, common moorhen, American coot, rock dove, white-tipped dove, ringed kingfisher, green kingfisher, eastern screech owl, parakee, golden-fronted woodpecker, great kiskadee, Chihuahuan raven, black-throated sparrow, brown-headed cowbird, altamira oriole, and Audubon's oriole). Santa Ana National Wildlife Refuge and Falcon State Park shared 15 species pairs (tricolored heron, green heron, mottled duck, osprey, hook-billed kite, gray hawk, plain chachalaca, red-billed pigeon, white-tipped dove, buff-bellied hummingbird, ringed kingfisher, green kingfisher, Couch's kingbird, white-eyed vireo, and bronzed cowbird), whereas Santa Ana National Wildlife Refuge and Paseo del Indio Nature Trail shared only four species (cattle egret, white-tailed hawk, least tern, and red-crowned parrot). Finally, SWR and CP shared only two exclusive species (blue-winged teal and vermilion flycatcher).

Falcon State Park and Chaparral Wildlife Management Area shared three exclusive species (scaled quail, common poorwill, and black-tailed gnatcatcher), whereas only two unique species were shared between

FSP and PI (crested caracara and Northern mockingbird) and PI and CP (red-tailed hawk and northern mockingbird).

Fifty-three species were found to reside throughout the entire year only on the Santa Ana National Wildlife Refuge. This group of exclusive residents included many species of wading birds, waterfowl, and shorebirds (Table 1). The other three localities had a much lower total of unique residents. Falcon State Park had nine unique resident species (common blackhawk, Swainson's hawk, zone-tailed hawk, yellow-bellied sapsucker, brown jay, northern rough-winged swallow, cave swallow, rock wren, and painted bunting), whereas Chaparral Wildlife Management Area provided residence to seven exclusive species (burrowing owl, barred owl, belted kingfisher, eastern phoebe, loggerhead shrike, house finch, and wild turkey). PI had only two species that were exclusive residents (budgerigar and green parakeet).

Compilation of data for the log species/log area analysis of resident birds resulted in a matrix containing 125 resident species for SWR, 82 residents for FSP, 57 residents at PI, and 55 species at CP. Total area of the SAR was 2088 ac., and area of FSP was 573 ac. The Laredo Community College campus (location of PI) was 200 ac., and the total acreage of CP was 15,200 ac. Logarithm of species number regressed against logarithm of area for all localities yielded a value of 0.008. Regression analysis of only SWR, FSP, and PI resulted in a value of 0.335. The value for all localities is much lower than that predicted for mainland studies (0.12-0.17), whereas the value for the three southernmost localities is within the predicted range of 0.24-0.34 for habitat islands (Begon and Mortimer, 1986).

DISCUSSION

Gehlbach (1988) divided the Texas borderlands into three biotic provinces after conducting a principal component analysis of breeding birds along the Texas-Mexican borderlands. The Santa Ana National Wildlife Refuge fell into his southernmost province, which included Cameron, Hidalgo, and Willacy counties of the Rio Grande Delta, whereas Falcon State Park, Paseo del Indio, and Chaparral Wildlife Management Area were

located within the central biotic province. Gehlbach's northernmost province began along the Pecos River drainages.

The presence of numerous drainages, deltas, and a subtropical climate helped to make the southernmost region distinct from the central and northern biotic provinces (Gehlbach, 1988). Gehlbach also found the

central province to be distinct but more like the northernmost province. This indicated that a shift in avian species occurred across the central province.

The results of our study are in good agreement with the work of Gehlbach (1988). Our community coefficient analyses also group the localities in a south-to-north fashion, with SWR exhibiting a definite south to north cline when compared to the other localities. Santa Ana National Wildlife Refuge contains the highest number of resident species among the localities (125 species); many of these residents are associated with water habitats. The lower community coefficients obtained when comparing SWR to the other three localities also indicate that its resident avian community is distinct.

Falcon State Park, Paseo del Indio, and Chaparral Wildlife Management Area also pair together in a south to north fashion. Our analysis indicates the presence of shifting biotic zones for birds in this portion of South Texas. This result for resident species also corresponds well with Gehlbach's research regarding his central avian biotic province. However, because PI is the central community of the aforementioned three localities, our results indicate that perhaps the biotic shift occurs closer to the Laredo area than indicated by Gehlbach (1988).

Results of the species/area analysis indicate that area effects are important deterministic factors in the avian faunas of the three southern localities. These three localities contain resident bird communities within areas acting as habitat islands. This is especially true of PI; a remnant tract of land located within the city of Laredo. However, a regression value much lower than expected was obtained when comparing all four localities. This low value may have been obtained because the locality with the largest area (CP) also contains a relatively low number of resident species (55 species).

Other factors besides area effects must play greater deterministic roles at CP. One contributing factor may be avian source areas for this tract of land. Sibley (2000) indicated that SAWR, FSP, and PI contain avian species from eastern, western, and southern (Mexican) source areas, but CP is located northeast of the southern source area. Muscovy ducks, red-shouldered and white-tailed hawks, plain

chachalacas, buff-bellied hummingbirds, white-collared seedeaters, and hooded orioles have not been recorded from CP. Absence of these southern species likely contributes to a transition zone in the area of CP.

Additionally, CP lacked 10 species of resident birds found at the other three localities (least grebe, pie-billed grebe, neotropical cormorant, great egret, snowy egret, black-bellied whistling duck, common moorhen, American coot, rock dove, and great kiskadee). As nine of these species require permanent sources of water, the more xeric habitats at CP exclude them as permanent residents. This indicates the importance of water as a contributing factor to avian community diversity within South Texas, and supports our earlier hypothesis. In addition, CP is the most distant locality from the Texas coast. This distance factor may exclude some avian species from CP and separate it from the other three study localities.

Based upon data available at the time, Gehlbach (1988) predicted that human impact upon borderland habitats would likely be greatest in the Rio Grande Valley, Corpus Christi, and El Paso areas. However, recent census data (U. S. Census Bureau, 2001) indicated that Laredo had undergone a greater increase in human population than the previously mentioned areas. The human population of Laredo increased by 44.9 % between 1990 and 2000, whereas Corpus Christi increased 8.8 %, El Paso increased 14.9 %, and the Brownsville- Harlingen-San Benito area increased by 28.9 %. A need of heightened conservation efforts in the Laredo area, as-well-as other coastal and borderland localities, is needed because of these population increases.

Conversely, growth of the human population may favor increased ecotourism in the region. For instance, there were 130,000 visitors to Santa Ana National Wildlife Refuge in year 2000 (Robyn Koch, Pers. Comm.). Falcon State Park recorded 165,000 visitors during the same period (Eileen Gomez, Pers. Comm.). The Lamar Bruni Vergara Environmental Science Center and Paseo del Indio Nature Trail received 13,751 visitors (Tom Miller, Pers. Comm.), and Chaparral Wildlife Management Area received 3050 visitors in year 2000 (David Synatzske, Pers. Comm.). Although hunting and fishing activities are not allowed at Santa Ana National Wildlife Refuge and on the Laredo Community College campus, these activities account for some

of the visitors to Falcon State Park and the Chaparral Wildlife Management Area. Informing tourists, other visitors, and area residents of the great diversity of South Texas avian faunas could play a vital role in future conservation efforts if these trends in population growth continue.

Despite the relatively small area encompassed by the Paseo del Indio Nature Trail and Laredo Community College campus, a fairly diverse fauna of resident birds is present. In fact, a total of 197 species (including the 57 resident species compared within this work) have thus far been recorded from PI and the immediate vicinity. Of 32 species of birds that Wauer and Elwonger (1998) termed Texas specialists, 20 species (least grebe, muscovy duck, white-tailed hawk, red-billed pigeon, white-tipped dove, red-crowned parrot, green parakeet, pauraque, buff-bellied humming-

bird, ringed kingfisher, green kingfisher, golden-fronted woodpecker, great kiskadee, Couch's kingbird, green jay, clay-colored robin, long-billed thrasher, olive sparrow, white-collared seedeater, and Audubon's oriole) have been recorded from PI.

Many of the 197 total species are seasonal migrants. Suitable habitats for these migrant birds are essential in conservation efforts (Igl and Ballard, 1999). Peterjohn and Sauer (1999) analyzed North American Breeding Bird Survey data from 1966 to 1996 and found trends indicating a decline in grassland birds across most of the United States. Some of the most notable population declines were found in the dickcissel, grasshopper sparrow, and eastern meadowlark. All of these species have been observed and identified at PI. Preservation of suitable habitat in South Texas may aid in conservation of these declining species.

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PUBLICATIONS OF THE MUSEUM OF TEXAS TECH UNIVERSITY

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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