

BIRD DIVERSITY IN THE PETENS OF YUCATAN STATE, MEXICO

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Resumen. – **Diversidad de aves de los petenes de Yucatán, México.** – La avifauna presente en los petenes de la costa norte del estado de Yucatán no se había estudiado de manera previa. El trabajo se desarrolló de Septiembre 2005 a Octubre de 2006 y las aves se identificaron de manera visual y auditiva mediante la técnica de conteos en puntos con radio fijo. Se verificaron 104 especies y fueron las residentes las mejor representadas. Estas aves corresponden al 19% de las especies de aves reportadas para la Península de Yucatán y al 54% de las aves con distribución en ambientes terrestres de la Reserva El Palmar. Dentro del área cubierta con los puntos de conteo se registraron 70 especies. De acuerdo con las densidades registradas y frecuencias de observación consideramos que las aves que mejor representaron a los petenes y pastizales inundables de la costa noroeste de Yucatán son *Todirostrum cinereum*, *Geothlypis poliocephala*, *Melanerpes aurifrons*, *Cyanocorax yncas* y *Mimus gilvus*. Tres especies migratorias estuvieron presentes durante siete u ocho meses en el área de estudio: *Dendroica petechia*, *Geothlypis trichas* y *Seiurus motacilla*. Las mayores riquezas de especies y abundancias se registraron durante los meses de Febrero, Marzo y Abril. La mayor diversidad se registró en Abril 2006. Diferencias de resultados de este trabajo con trabajos realizados en Campeche pudieron deberse al esfuerzo de muestreo y técnicas de observación empleadas, la estructura de la vegetación de los petenes estudiados y la ubicación geográfica de los petenes con respecto a la costa. Aún y cuando muchas de las aves de este trabajo ya se habían registrado haciendo uso de petenes, se anexan 22 especies más a la lista de aves presentes en los petenes de la Península de Yucatán.

Abstract. – The avifauna of the petens on the northwestern coast of the Yucatan state, Mexico, has not been previously studied. A study was done of this avifauna based on records generated between September 2005 and October 2006, using visual and auditory identification and the point count method with a fixed radius. A total of 104 species was identified, primarily resident ones. This species list accounts for 19% of the bird species reported for the Yucatan Peninsula and 54% of those distributed in land habitats of the El Palmar State Reserve. Within the point count area, a total of 70 species was recorded. According with the density and frequency data, we consider five species as representative of the petens and flooded grasslands of the northwestern coast of Yucatan state: *Todirostrum cinereum*, *Geothlypis poliocephala*, *Melanerpes aurifrons*, *Cyanocorax yncas*, and *Mimus gilvus*. Three migratory species were present in the study area during 7 or 8 months: *Dendroica petechia*, *Geothlypis trichas*, and *Seiurus motacilla*. The highest species richness and abundance were recorded in February, March, and April. The highest diversity was recorded in April 2006. Discrepancies between these data and those reported from nearby the Campeche state may be due to differences in sampling effort, observation techniques, vegetation structure of the studied petens, and geographic location of the petens relative to the coast. Although most of the recorded species have been previously reported for the petens of the Yucatan Peninsula, 22 are new records. *Accepted 15 October 2007.*

Key words: Birds, petens, diversity, Yucatan, Mexico.

INTRODUCTION

In the Mayan language, “peten” generally means “island” (Solís-Alcalá 1949, De Landa 1978), but is used botanically to refer to specific vegetal associations characteristic of the Yucatan Peninsula, Cuba and south Florida (Olmsted & Duran 1988). Barrera (1982) defines petens as “islands of vegetation” consisting of different floral associations distributed in concentric circles outward from a water upwelling in its center: reedbeds or mangrove remains at the periphery with forest, or a forest/mangrove mixture, towards the center.

Rico-Gray (1982) classified petens into two types. Type I is characterized by an almost total dominance of red mangrove (*Rizophora mangle*), with the physiognomic characteristics of well-developed mangrove, and is located closer to the coast. Saline influence is strong, which minimizes the effect of the freshwater upwelling and generally keeps them inconspicuous. Type II petens are characterized by a freshwater upwelling or sinkhole (cenote) in their center, deep soils with high decomposing organic matter content and a clear separation between the peten and mangrove vegetation caused by vast zones of flooded grasslands (*Cladium jamaicense* and *Typha domingensis*). The principal vegetation in this type of peten consists of species characteristic of tropical forests (*Manilkara zapota*, *Ficus* sp. and *Sabal* sp.) and mangrove (*R. mangle* and *Laguncularia racemosa*).

A number of vegetation characterization studies have recognized petens as an important floristic unit (Barrera 1982, Rico-Gray 1982, López-Portillo *et al.* 1989, Durán 1995, Mas *et al.* 2000). However, very few studies have addressed the fauna within this unit. One of the principal reasons for this lack of studies is the difficulty of accessing petens (particularly during rainy seasons). They are usually surrounded by marshy or flooded

areas, and are not frequented by humans, and thus lack established routes.

Recent research on peten fauna includes that of Montiel *et al.* (2006), who analyzed the bat assemblage in petens in Campeche state, and Cimé *et al.* (2006), who analyzed bats and rodents in the Ría Celestún Biosphere Reserve. Studies focusing on peten bird fauna include Rico-Gray *et al.* (1988), who observed 60 species in northwest Campeche, and Correa & De Alba (1998), who reported 191 species recorded by netting and observation posts; the species list from the latter study is included in full in Mas *et al.* (2000). More recently, Rojas-Soto & Bocanegra (2002) reported *Lophodytes cucullatus* as a new record for northwest Campeche based on observations in petens.

As is clear from the above studies, bird fauna research that incorporates petens as characteristic vegetal associations on the Yucatan Peninsula have been limited to the west coast of Campeche state. Although the wetlands portion of the northwest coast of Yucatan state also forms part of the same ecological entity (Correa & De Alba 1998), no previous research has been done there. Previous studies also present results as species lists without any estimation of abundance. In response, the present study objective was to analyze the bird community in petens in the wetland areas of the northwest coast of Yucatan state in terms of richness and abundance, and determine the importance of petens in maintaining bird diversity in the El Palmar State Reserve and the region overall.

METHODS

The study area is in the wetlands zone of the northwest coast of Yucatan state, Mexico, within the El Palmar State Reserve (EPSR) (Fig. 1). The reserve is considered important for the conservation of the bird fauna in Mexico due to its role in maintaining species

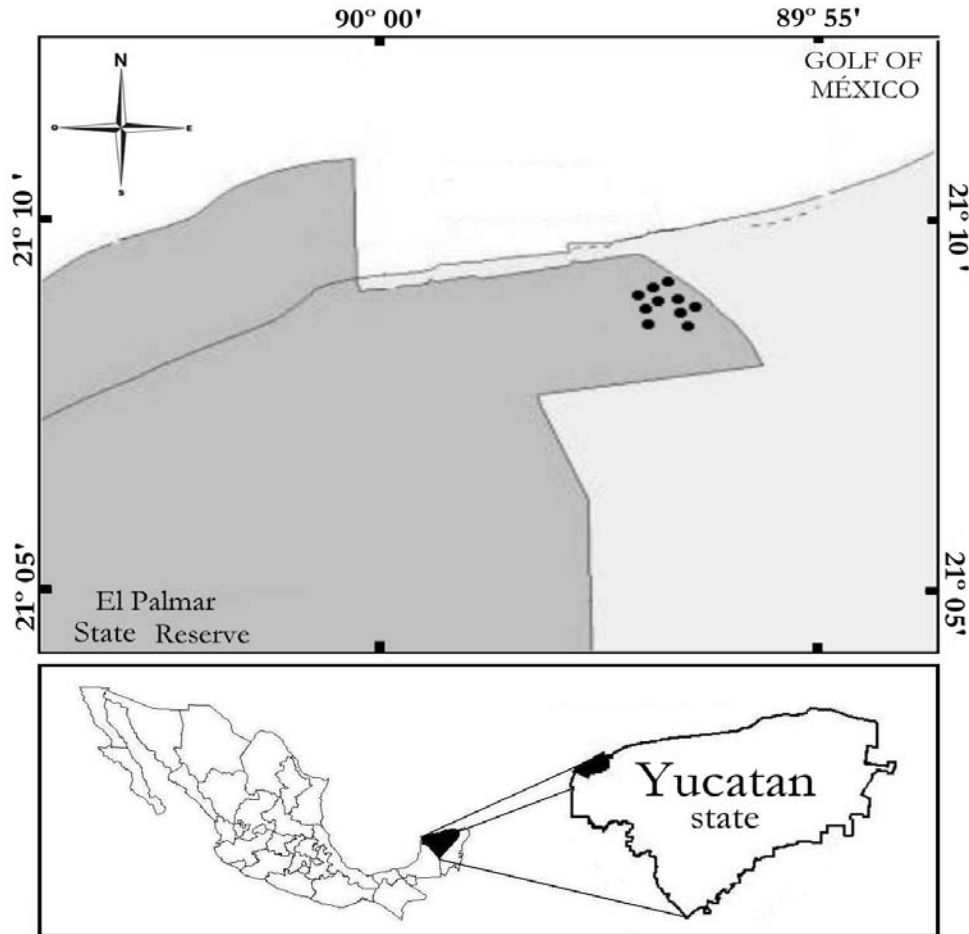


FIG.1. Map of study area. Black dots are petens of study.

endemic to Mexico and Mesoamerica (Correa *et al.* 2000). In November 2003, the reserve was declared a RAMSAR important international wetland and it forms part of the northern Yucatan coast within the Mesoamerican biological corridor (Ramírez 2003).

The study area is in a zone classified as having warm dry climate with average annual temperatures of 25.7°C. Precipitation is the lowest on the Yucatan Peninsula, with summer rains and an average annual rainfall of 576 mm (Duch 1991).

Following the classification criteria of Rico-Gray (1982), the petens in the study area are Type II, that is, predominantly forest vegetal species. They are located 2.45 km inland from the coast, dispersed within a wetlands zone dominated by hydrophytic grasses (*Cladium jamaicense*, *Eleocharis mutata* and *Typha angustifolia*). Around the exterior of each peten is a dense border of mangrove (*Laguncularia racemosa* and *Conocarpus erectus*), and the interior contains a large amount of decomposing organic matter as well as zapote (*M. zapota*)

TABLE 1. Density and frequency of occurrence of birds observed during the study.

Species	2005				2006										Total	Frequency ^a
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.		
<i>Tigrisoma mexicanum</i>				0.79				0.79							0.11	R
<i>Egretta thula</i>								0.79							0.06	R
<i>Cathartes aura</i>	0.79														0.06	R
<i>Buteo brachyurus</i>					0.79										0.06	R
<i>Herpetotheres cachinnans</i>			0.79									0.79			0.11	R
<i>Laterallus ruber</i>			2.38		1.59	0.79			1.59		1.59	1.59	0.79		0.74	LF
<i>Aramides cajanea</i>			0.79												0.06	R
<i>Zenaida asiatica</i>						0.79	1.59	1.59	0.79	1.59					0.46	LF
<i>Zenaida aurita</i>							1.59	1.59	0.79						0.29	LF
<i>Columbina passerina</i>						0.79									0.06	R
<i>Leptotila jamaicensis</i>					0.79										0.06	R
<i>Aratinga nana</i>					3.17	1.59									0.34	R
<i>Amazona albifrons</i>								0.79							0.06	R
<i>Coccyzus minor</i>		0.79									0.79				0.11	R
<i>Crotophaga sulcirostris</i>									3.17	0.79	1.59	1.59			0.51	LF
<i>Glaucidium brasilianum</i>			0.79												0.06	R
<i>Chordeiles acutipennis</i>											0.79				0.06	R
<i>Chordeiles minor</i>												0.79			0.06	R
<i>Amazilia yucatanensis</i>								0.79							0.06	R
<i>Amazilia rutila</i>		0.79			0.79			0.79	1.59		0.79	0.79	0.79		0.46	LF
<i>Trogon melanocephalus</i>									0.79						0.06	R
<i>Momotus momota</i>													0.79		0.06	R
<i>Chloroceryle americana</i>						0.79									0.06	R
<i>Chloroceryle aenea</i>			0.79					0.79							0.11	R
<i>Melanerpes pygmaeus</i>		0.79		0.79				1.59	0.79			0.79	2.38		0.51	LF
<i>Melanerpes aurifrons</i>	0.79	0.79		0.79	2.38	1.59	0.79	1.59	1.59	3.97	2.38	0.79	2.38	0.79	1.49	VF
<i>Picoides scalaris</i>					0.79										0.06	R
<i>Dryocopus lineatus</i>				3.17	2.38	0.79			1.59	0.79					0.63	LF
<i>Xiporhynchus flavigaster</i>			0.79												0.06	R

TABLE 1. Continued.

Species	2005				2006								Total	Frequency ^a		
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	Apr.	May	June	July	Aug.			Sept.	Oct.
<i>Todirostrum cinereum</i>	3.97	5.56	3.97	2.38	2.38	3.17	3.17	3.97	3.97	3.17	2.38	3.17	1.59	0.79	3.14	VF
<i>Empidonax minimus</i>														1.59	0.11	R
<i>Pyrocephalus rubinus</i>		0.79		0.79		0.79	0.79			0.79		0.79		0.79	0.40	LF
<i>Myiarchus tuberculifer</i>			0.79	0.79		0.79	0.79	4.76	0.79	0.79	3.17		0.79		0.97	F
<i>Myiarchus tyrannulus</i>	1.59					0.79				1.59					0.29	LF
<i>Pitangus sulphuratus</i>													0.79		0.06	R
<i>Myzetetes similis</i>	2.38	1.59				1.59	0.79	4.76	1.59		0.79	0.79	3.17		1.26	F
<i>Tyrannus melancholicus</i>	4.76	0.79	1.59	1.59		0.79	0.79	0.79	0.79	0.79	2.38	1.59	0.79	0.79	1.31	VF
<i>Tyrannus tyrannus</i>												0.79			0.06	R
<i>Vireo pallens</i>		0.79						0.79	0.79						0.17	LF
<i>Cyanocorax yncas</i>			2.38	0.79	2.38	11.90	2.38	3.97	0.79	1.59	0.79	3.17	1.59		2.29	VF
<i>Cyanocorax yucatanicus</i>													0.79		0.06	R
<i>Progne subis</i>						0.79	4.76	0.79							0.46	LF
<i>Stelgidopteryx ridgwayi</i>								0.79			1.59				0.17	R
<i>Petrochelidon fulva</i>								0.79							0.06	R
<i>Hirundo rustica</i>	1.59						0.79	0.79							0.23	LF
<i>Polióptila caerulea</i>		0.79													0.06	R
<i>Polióptila albiloris</i>		0.79			1.59			0.79							0.23	LF
<i>Dumetella carolinensis</i>		0.79		1.59	0.79	2.38	0.79								0.46	LF
<i>Mimus gilvus</i>	2.38	1.59	0.79	5.56	4.76	3.17	3.17	3.17	2.38	0.79	0.79	1.59	1.59	2.29	2.29	VF
<i>Parula americana</i>														0.79	0.06	R
<i>Dendroica petechia</i>		1.59	1.59	2.38	0.79	1.59	0.79	0.79					0.79	1.59	0.86	F
<i>Dendroica magnolia</i>		0.79	0.79	0.79											0.17	LF
<i>Dendroica coronata</i>				0.79	0.79										0.11	R
<i>Dendroica virens</i>													0.79	0.06	0.06	R
<i>Dendroica dominica</i>			0.79			0.79								0.79	0.17	LF
<i>Mniotilta varia</i>														0.79	0.06	R
<i>Setophaga rutinilla</i>				1.59	1.59		0.79							1.59	0.40	LF
<i>Seiurus noveboracensis</i>												1.59			0.11	R

TABLE 1. Continued.

Species	2005								2006						Total	Frequency ^a
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.		
<i>Seiurus motacilla</i>	3.17		2.38	0.79	0.79	0.79	1.59	2.38				0.79	1.59		1.03	F
<i>Geothlypis trichas</i>		2.38	2.38	3.17	2.38	9.52	7.94					0.79	1.59	0.79	2.17	F
<i>Geothlypis poliocephala</i>	0.79	0.79	1.59		1.59		2.38	1.59		0.79	3.17	0.79	1.59		1.09	VF
<i>Wilsonia citrina</i>					0.79										0.06	R
<i>Passerina cyanea</i>		4.76						2.38							0.51	R
<i>Agelaius phoeniceus</i>						0.79	2.38		2.38						0.40	LF
<i>Icterus prosthomelas</i>						0.79	1.59	3.17		0.79	0.79		2.38		0.69	LF
<i>Icterus mesomelas</i>						2.38	0.79	0.79	0.79	1.59		0.79		0.79	0.57	LF
<i>Icterus auratus</i>									1.59						0.11	R
<i>Icterus gularis</i>	0.79							1.59			0.79				0.23	LF
<i>Euphonia affinis</i>			0.79											0.79	0.11	R
<i>Euphonia hirundinacea</i>												1.59			0.11	R
Total	20.63	27.78	26.98	23.81	33.33	52.38	40.48	50.00	29.37	21.43	24.60	24.60	26.19	15.08		

^aFrequency: R = rare, LF = less frequent, F = frequent, VF = very frequent.

plantlets and small trees. The arboreal stratum consists primarily of large (9 m high) zapote trees, but also includes species characteristic of the region's forests: *Ficus cotinifolia*, *Sabal mexicana*, and *Annona glabra*. The bush stratum is dominated by *Bravaisia tubiflora* and small zapote trees, while in the herbaceous stratum the fern *Acrostichum aureum* predominates, especially at water's edge.

A total of 10 petens were studied: Sirena (21°09'09.5"N, 90°01'23.0"W), Palo (21°09'09.2"N, 90°01'24.9"W), Zapote (21°09'09.2"N, 90°01'30.9"W), Huech (21°09'04.6"N, 90°01'35.0"W), Coh (21°09'00.4"N, 90°01'37.0"W), Rana (21°09'04.4"N, 90°01'30.6"W), Seco (21°09'05.5"N, 90°01'26.6"W), Burro (21°09'00.4"N, 90°01'24.4"W), Perdido (21°08'59.5"N, 90°01'27.8"W), and Helecho (21°08'55.5"N, 90°01'27.8"W), with approximately 140 linear meters separating one from another. The Sirena, Huech and Rana petens also have well-developed bodies of water that harbor freshwater fish species endemic to Mexico (*Gambusia yucatanana*, *Astyanax altior* and *Poecilia velifera*) and Yucatan (*Rhamdia guatemalensis*).

Field work was done on monthly visits between September 2005 and October 2006. Bird observation and density estimation were done using the point count technique with a 20 m fixed radius and 20 m height. This technique is one of the most used and recommended for the study of bird communities in tropics (Hutto *et al.* 1986, Bibby *et al.* 1992, Wunderle 1994, Komar 2002), particularly in zones where displacement between study sites is restricted. Each peten was treated as a point count and all the birds present, or that arrived at the point during a 10 min period, were counted. Observations were made in the morning (06:00 to 09:00 h) and began with arrival at the count point; birds that flew away upon observer arrival were considered as having been present there (Hutto *et al.* 1986). Bird species were counted based on sightings and

vocalizations as long as they were observed making direct use of the peten (i.e., feeding, perching, reproducing or reproductive activities). Species or individuals observed outside the established count radius (e.g., flooded grassland or nearby puddles), or during times outside the fixed sampling periods, were annexed to the general list of species that use the flooded zone but were not included in the density estimation and diversity analysis.

Species residence classification was made according to Rappole *et al.* (1993), Howell & Webb (1995) and MacKinnon (2005): Resident (species that reproduce and spend all life in the zone), resident with migratory population, winter visitor, winter visitor with small summer population, winter visitor with small summer breeding population, transient (species passing through the zone during winter migration and with isolated records), transient with small winter population. Species were also grouped according to feeding habits (Ehrlich *et al.* 1988, Howell & Webb 1995), based on the most common diet in the region and field observations.

Species identification was done with the help of field guides (Howell & Webb 1995, National Geographic 2000, Sibley 2003) and employing the nomenclature suggested by the American Ornithologists' Union (1998, 2000, Banks *et al.* 2002, 2003, 2005, 2006, 2007). Common names were taken from Escalante *et al.* (1996).

Relative abundance was measured by estimating the density of recorded species within the area covered by the 10 count points (1.26 ha). According to Reynolds *et al.* (1980), calculating density of the more common species is possible with this technique when distances to observed birds is accurately estimated. However, differences in estimated density should be interpreted with caution, because they may reflect differences in detectability and not density (Komar 2002). Overall monthly density for the recorded species was calculated as

the sum of the individual densities, and total density as the average of the densities recorded during the 14 months of sampling.

Using a maximum observation frequency of the entire sampling period (14 months), the recorded species were grouped into categories: rare (20% or less of sampling period), less frequent (21 to 50%), frequent (51 to 70%), and very frequent (71% or more).

The species accumulation curve was generated using the point counts as sampling effort, and employing the Clench method to predict expected species (Soberón & Llorente 1993). The influence of point incorporation order into the total was eliminated by randomizing sample order 100 times with the EstimateS 7.5 program (Colwell 1997).

Monthly Shannon-Wiener (H') diversity, Pielou evenness and Berger-Parker dominance values were calculated. Monthly variation in the bird population was tested using the H' diversity values in a t-test, as modified by Hutchenson (Magurran 1988, Moreno 2001), and using the BIODIV 7.7 program (Baev & Penev 1995).

RESULTS

A total of 104 species were identified, which account for 75 genera, 34 families and 15 orders. The best represented orders were the Passeriforms (12 families), Ciconiiforms (4) and Charadriiforms (4).

Most of the identified species were resident (64), followed by winter visitors (19) and resident with a migratory population (10) (Appendix 1). Considering feeding habits, 29 were exclusively insectivores, followed in number by 21 species that feed on insects and fruits (Appendix 1).

Birds observed in point counts and densities. Within the area covered by the point counts a total of 524 individuals from 70 species (67% of total) were recorded (Appendix 1).

The most abundant species were the Common Tody-Flycatcher (*Todirostrum cinereum*), with an average density of 3.14 ind/ha, the Green Jay (*Cyanocorax yncas*) and Tropical Mockingbird (*Mimus gilvus*), each with an average density of 2.29 ind/ha, and the migratory Common Yellowthroat (*Geothlypis trichas*), with 2.17 ind/ha (Table 1). Species in the rare and less frequent categories were best represented, with 38 and 21 species, respectively (Table 1).

Resident species. Based on the density and frequency data, six resident species were the most common of the studied petens. The Common Tody-Flycatcher was present throughout the study period. This species was always observed making direct use of the petens by foraging among the branches and leaves of trees. In March and April, two pairs were observed building nests and raising young in the Huech and Rana petens.

The Gray-crowned Yellowthroat (*Geothlypis poliocephala*) was present during 10 months of the study period, both in the petens and surrounding flooded grasslands. This species apparently entered the petens in search of refuge and food.

The Golden-fronted Woodpecker (*Melanerpes aurifrons*) was present during 13 months, always in search of food; it emitted its characteristic sound as it perforated dry wood. A pair was observed nesting in the Burro peten in March.

The Green Jay was recorded for 11 months and its appearance apparently responded to the permanent availability of food, such as insects and fruit. It was most frequently observed in movement, foraging in large zapote (*Manilkara zapota*) trees or moving from one peten to another. Observed groups contained an average of three individuals and average density was 2.29 ind/ha.

The Tropical Mockingbird and Tropical Kingbird (*Tyrannus melancholicus*) were present

TABLE 2. Temporal variation of species richness and diversity.

Months	Species	Individuals	Residents	Non residents	Diversity (H)	Evenness	Dominance
Sept.	10	26	8	2	2.09	0.907	0.231
Oct.	18	35	13	5	2.59	0.9	0.2
Nov.	18	33	13	5	2.74	0.948	0.147
Dec.	17	30	10	7	2.67	0.944	0.133
Jan.	19	42	12	7	2.76	0.936	0.167
Feb.	25	66	19	6	2.69	0.835	0.227
March	21	51	14	7	2.75	0.903	0.196
Apr.	29	63	24	5	3.13	0.931	0.095
May	19	38	19	0	2.78	0.944	0.135
June	14	27	14	0	2.46	0.934	0.185
July	16	31	16	0	2.62	0.946	0.129
Aug.	20	31	15	5	2.85	0.952	0.129
Sept.	18	29	15	3	2.78	0.961	0.121
Oct.	15	18	7	8	2.65	0.98	0.105
Total	70	524	51	19	3.54	0.834	0.105

during 13 months. Their presence in the petens is likely the result of resource division in an effort to reduce intra-specific competition since those species are also common and abundant in other environments of the EPSR (e.g., coastal dune, forests, urban areas). Tropical Mockingbird was always observed feeding on *Ficus conitifolia* fruit, one of the most common in the studied petens.

Non-resident species. The migratory component was absent during May, June and July. Yellow Warbler (*Dendroica petechia*), Common Yellowthroat and Louisiana Waterthrush (*Seiurus motacilla*) were present during 7 or 8 months of the year (Table 1).

Six species were recorded only once and with a single individual, and in the literature two of these are considered as transients for this area: the Common Nighthawk (*Chordeiles minor*), and the Eastern Kingbird (*Tyrannus tyrannus*). Other species such as the Black-throated Green Warbler (*Dendroica virens*), Black-and-white Warbler (*Mniotilta varia*), Northern Parula (*Parula americana*) and Hooded Warbler (*Wilsonia citrina*) are Nearctic migrants that establish themselves on the

Yucatan Peninsula, but only in forested zones (Rappole *et al.* 1993, Howell & Webb 1995). Their low average density (0.06 ind/ha) (Table 1) suggests they were in transit through the studied petens en route to areas further inland.

Species diversity. The highest species richness and abundances were recorded in February, March and April, while the highest diversity (H') and lowest dominance were recorded during April 2006 (Table 2). Evenness was highest from August to October 2006. Comparison of total diversity (H') with the months of highest and lowest diversity showed significant differences in both cases ($t = 3.38$, $df = 251$, $P = 0.05$; $t = 8.97$, $df = 104$, $P = 0.05$). This shows that bird diversity in the studied petens was not homogeneously distributed during the study period.

The species accumulation curve exhibited continuous growth. It began to stabilize, but without reaching asymptotes, suggesting that new species have yet to be incorporated. The Clench model prediction indicated an estimated richness of 96 species ($a = 1.738544$; $b = 0.018215$). The Chao1 and first-order Jack-

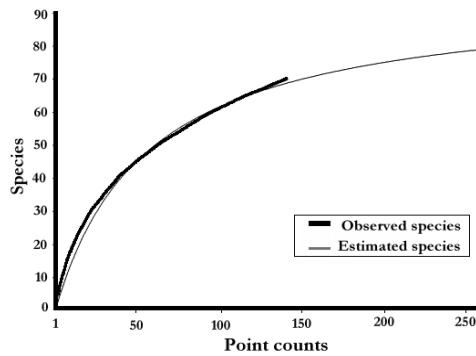


FIG. 2. Accumulation curve for the bird inventory according to Clench's model.

knife estimators, which estimate species based on the rare species present in a single sample (Moreno 2001), both indicated the expected number of species to be 97. Based on the 70 species identified with the point count method, the sample design confidence level and the results indicate that the species recorded here represent 73% of the bird fauna that uses the study area (Fig. 2). Using these estimates, and considering that the best-represented frequency categories were rare and less frequent species, it is probable that the species yet to be recorded in the count points are transient or occasional species.

Species protected under Mexican law. According to the Mexican law (NOM-059-SEMARNAT-2001), 10 species are legally protected under the "special protection" category (Appendix 1). These include the Wood Stork (*Mycteria americana*), raptors such as the Common Black-Hawk (*Buteogallus anthracinus*) and White-tailed Hawk (*Buteo albicinctus*), and herons such as the Bared-Throated Tiger-Heron (*Tigrisoma mexicanum*) and Reddish Egret (*Egretta rufescens*).

DISCUSSION

The species recorded here correspond to

19% of the bird species reported for the Yucatan Peninsula, 29% of the species known to be endemic to the Yucatan Peninsula (MacKinnon 2005), and 54% of species distributed in land habitats of the EPSR (Gobierno del Estado de Yucatán 2006).

Rico-Gray *et al.* (1988) reported that 29 of the species recorded here have been recorded previously in Campeche, although 75 species have been added to their list. Correa & De Alba (1998) stated that 108 bird species have been recorded in the petens of Campeche but not in those of Yucatan, 83 species are shared and 22 have been recorded in Yucatan but not in Campeche.

Discrepancies in results between studies may be due to sampling effort and the techniques employed, the vegetation structure of the studied petens, and/or the geographic location of the petens relative to the coast.

The studies done in Campeche included a larger number of petens (16), but with less sampling effort per peten. Also, nets were used as a complementary species detection technique in some of the studied petens in Campeche. Sampling effort in the present study was concentrated on visual and auditory detection, but this is unlikely to have significantly affected recorded species richness versus the use of nets, mainly because of the size and structure of the petens studied here.

Geographic location of the petens relative to the coast could also have influenced the resulting records. Some petens in the Campeche studies are located far inland and therefore have a greater presence of vegetal species characteristic of forests than the petens studied here. This can influence the presence of bird species with terrestrial and forest habits, such as the Thicket Tinamou (*Crypturellus cinnamomeus*), the Black-throated Bobwhite (*Colinus nigrogularis*) and the Ocellated Turkey (*Meleagris ocellata*). Many of the species recorded in Campeche have natural distributions that do not include the north

coast and are considered characteristic of the dry and subhumid forests of the central and southern Yucatan Peninsula. Examples are the King Vulture (*Sarcoramphus papa*), the Black Hawk-Eagle (*Spizaetus tyrannus*), the Great Curassow (*Crax rubra*) and the Collared Aracari (*Pteroglossus torquatus*).

The H' diversity varied over time throughout the study period. The high richness and abundance values recorded during February to April are apparently associated with the beginning of the mating season for regional residents and the end of the migratory season. During this season, regional species are much more active, singing in search of a mate, delineating territories and nesting, thus facilitating the identification of the most common species. This is also the end of the migratory season in the Mexican tropics (March and April) when migratory species become more active and species in transit arrive at the northern edge of the Yucatan Peninsula in preparation for the return flight to nesting grounds in temperate zones of the United States and Canada.

The higher observed evenness during August, September and October is apparently due to the migratory component beginning its season in the area. October 2006 was notable in that the resident and migratory components were represented at approximately 50% each.

Importance of petens for large raptors and herons. Eight raptors were observed making use of the studied petens. The Short-tailed Hawk (*Buteo brachyurus*) and Laughing Falcon (*Herpetotberes cachinnans*) were recorded within the area covered by the count points, and the remaining six species were recorded outside the systematic samplings. All were observed to perch for long periods, suggesting that the petens function as observation points from which raptors can monitor the surrounding area. They can also apparently serve as nesting

sites since two adult and one juvenile Short-tailed Hawk were observed perching in the Huech peten in December and January.

Most species in the heron group were recorded in flooded grasslands and on the periphery of the petens, where large numbers of small fish are to be found. Two Bared-throated Tiger-Heron nests were identified in the Huech peten between December and April. These were located in branches that hung out over the water, in an apparent effort to reduce predation by organisms such as raccoons. Unfortunately, no clutch was produced in either nest.

Overall, the present results indicate the existence of some broad differences between the bird fauna found in the petens of Campeche and Yucatan. Many of the species reported here had been reported previously as using petens, although 22 species were added to the list of birds that use the region's petens. This clearly highlights the importance of the petens and wetlands of the northwest coast of Yucatan state for the bird fauna of the Yucatan Peninsula.

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APPENDIX 1. Bird species observed during all the study.

Species	NOM ^a	Status ^b	Diet ^c
Ardeidae			
Bare-throated Tiger-Heron (<i>Tigrisoma mexicanum</i>)	Pr	R	F, AQI,
Great Blue Heron (<i>Ardea herodias</i>)*		R/W	F, SV, AQI
Great Egret (<i>Ardea alba</i>)*		R/W	F, SV, AQI
Snow Egret (<i>Egretta thula</i>)		R/W	AQI, F, I
Little Blue Heron (<i>Egretta caerulea</i>)*		R/W	F, SV, AQI, I
Reddish Egret (<i>Egretta rufescens</i>)*	Pr	R	F, AQI, SV
Green Heron (<i>Butorides virescens</i>)*		R/W	F, I, SV
Threskiornithidae			
White Ibis (<i>Endocimus albus</i>)*		R/W	F, AQI, SV
Ciconiidae			
Wood Stork (<i>Mycteria americana</i>)*	Pr	R	F, SV, AQI
Anatidae			
Blue-winged Teal (<i>Anas discors</i>)*		W	S, P, AQI, I

APPENDIX 1. Continued.

Species	NOM ^a	Status ^b	Diet ^c
Cathartidae			
Turkey Vulture (<i>Cathartes aura</i>)		R/W	C, V
Yellow-headed Vulture (<i>Cathartes burrovianus</i>)*		R	C, V
Accipitridae			
Common Black-Hawk (<i>Buteogallus anthracinus</i>)*	Pr	R	SV
Roadside Hawk (<i>Buteo magnirostris</i>)*		R	V, SV
Short-tailed Hawk (<i>Buteo brachyurus</i>)		R	V
White-tailed Hawk (<i>Buteo albicaudatus</i>)*	Pr	R	SV, I
Falconidae			
Collared Forest-Falcon (<i>Micrastur semitorquatus</i>)*	Pr	R	V, SV
Crested Caracara (<i>Caracara cheriway</i>)*		R	C, SV
Laughing Falcon (<i>Herpetotheres cachinnans</i>)		R	V, SV
American Kestrel (<i>Falco sparverius</i>)*		W	I, SV
Rallidae			
Ruddy Crake (<i>Laterallus ruber</i>)		R	I, AQI, S
Gray-necked Wood-Rail (<i>Aramides cajaneus</i>)		R	I, AQI, S
Sora (<i>Porzana carolina</i>)*		W	S, I, AQI
Charadriidae			
Killdeer (<i>Charadrius vociferus</i>)*		W/rs	I
Recurvirostridae			
Black-necked Stilt (<i>Himantopus mexicanus</i>)*		R/W	AQI, I
Scolopacidae			
Greater Yellowlegs (<i>Tringa melanoleuca</i>)*		W/s	I, AQI, F
Willet (<i>Catoptrophorus semipalmatus</i>)*		W/s	I, AQI
Spotted Sandpiper (<i>Actitis macularia</i>)*		W/s	I, AQI
Wilson's Snipe (<i>Gallinago delicata</i>)*		W	AQI, I, S
Laridae			
Laughing Gull (<i>Larus atricilla</i>)*		R	AQI, INV, I
Columbidae			
White-winged Dove (<i>Zenaida asiatica</i>)		R/W	S, FRU
Zenaida Dove (<i>Zenaida aurita</i>)	Pr	R	S, FRU
Common Ground-Dove (<i>Columbina passerina</i>)		R	S, FRU, INV
Caribbean Dove (<i>Leptotila jamaicensis</i>)		R	S, FRU, INV
Psittacidae			
Olive-throated Parakeet (<i>Aratinga nana</i>)	Pr	R	S, FRU
White-fronted Parrot (<i>Amazona albifrons</i>)		R	S, FRU
Cuculidae			
Mangrove Cuckoo (<i>Coccyzus minor</i>)		R	I
Groove-billed Ani (<i>Crotophaga sulcirostris</i>)		R	I, SV, FRU
Strigidae			
Ferruginous Pygmy-Owl (<i>Glaucidium brasilianum</i>)		R	I, SV
Caprimulgidae			
Lesser Nighthawk (<i>Chordeiles acutipennis</i>)		R	I
Common Nighthawk (<i>Chordeiles minor</i>)		T	I

APPENDIX 1. Continued.

Species	NOM ^a	Status ^b	Diet ^c
Trochilidae			
Buff-bellied Hummingbird (<i>Amazilia yucatanensis</i>)		R	N, I
Cinnamon Hummingbird (<i>Amazilia rutila</i>)		R	N, I
Trogonidae			
Black-headed Trogon (<i>Trogon melanocephalus</i>)		R	FRU, I
Momotidae			
Blue-crowned Motmot (<i>Momotus momota</i>)		R	I, SV
Alcedinidae			
Green Kingfisher (<i>Chloroceryle americana</i>)		R	F
American Pygmy Kingfisher (<i>Chloroceryle aenea</i>)		R	F
Picidae			
Red-vented Woodpecker (<i>Melanerpes pygmaeus</i>)	End	R	I, FRU
Golden-fronted Woodpecker (<i>Melanerpes aurifrons</i>)		R	I, FRU
Ladder-backed Woodpecker (<i>Picooides scalaris</i>)		R	I, FRU
Lineated Woodpecker (<i>Dryocopus lineatus</i>)		R	I, FRU
Dendrocolaptidae			
Ivory-billed Woodcreeper (<i>Xiphorhynchus flavigaster</i>)		R	INV, I
Tamnophilidae			
Barred Antshrike (<i>Thamnophilus doliatus</i>)*		R	INV, I
Tyrannidae			
Common Tody-Flycatcher (<i>Todirostrum cinereum</i>)		R	I
Eastern Wood-Pewee (<i>Contopus virens</i>)*		T	I
Least Flycatcher (<i>Empidonax minimus</i>)		W	I
Vermilion Flycatcher (<i>Pyrocephalus rubinus</i>)		R	I
Bright-rumped Attila (<i>Attila spadiceus</i>)*		R	I, FRU
Dusky-capped Flycatcher (<i>Myiarchus tuberculifer</i>)		R	I, FRU
Brown-crested Flycatcher (<i>Myiarchus tyrannulus</i>)		R	I, FRU
Great Kiskadee (<i>Pitangus sulphuratus</i>)		R	I, FRU, F, SV
Social Flycatcher (<i>Myozetetes similis</i>)		R	I, FRU
Tropical Kingbird (<i>Tyrannus melancholicus</i>)		R	I, FRU
Eastern Kingbird (<i>Tyrannus tyrannus</i>)		T	I, FRU
Vireonidae			
Mangrove Vireo (<i>Vireo pallens</i>)	Pr	R	I
Rufous-browed Peppershrike (<i>Cycularbis gujanensis</i>)*		R	I, FRU
Corvidae			
Green Jay (<i>Cyanocorax yucas</i>)		R	O
Yucatán Jay (<i>Cyanocorax yucatanicus</i>)	End	R	O
Hirundinidae			
Purple Martin (<i>Progne subis</i>)		T	I
Tree Swallow (<i>Tachycineta bicolor</i>)*		T/w	I
Mangrove Swallow (<i>Tachycineta albilinea</i>)*		R	I
Southern Rough-winged Swallow (<i>Stelgidopteryx ridgwayi</i>)		R	I
Cave Swallow (<i>Petrochelidon fulva</i>)		R	I
Barn Swallow (<i>Hirundo rustica</i>)		T	I

APPENDIX 1. Continued.

Species	NOM ^a	Status ^b	Diet ^c
Sylviidae			
Blue-gray Gnatcatcher (<i>Poliopitila caerulea</i>)		R/W	I
White-lored Gnatcatcher (<i>Poliopitila albiloris</i>)	Pr	R	I
Mimidae			
Gray Catbird (<i>Dumetella carolinensis</i>)		W	I, FRU
Black Catbird (<i>Melanoptila glabrirostris</i>)*	End	R	I, FRU
Tropical Mockingbird (<i>Mimus gilvus</i>)		R	I, FRU
Parulidae			
Northern Parula (<i>Parula americana</i>)		W	I
Yellow Warbler (<i>Dendroica petechia</i>)		W	I
Mangrove Warbler (<i>Dendroica erithacborides</i>)*		R	I
Magnolia Warbler (<i>Dendroica magnolia</i>)		W	I
Yellow-rumped Warbler (<i>Dendroica coronata</i>)		W	I, FRU
Black-throated Green Warbler (<i>Dendroica virens</i>)		W	I
Yellow-throated Warbler (<i>Dendroica dominica</i>)		W	I
Black-and-white Warbler (<i>Mniotilta varia</i>)		W	I
American Redstart (<i>Setophaga ruticilla</i>)		W	I
Northern Waterthrush (<i>Seiurus noveboracensis</i>)		W	AQI, I
Louisiana Waterthrush (<i>Seiurus motacilla</i>)		W	AQI, I
Common Yellowthroat (<i>Geothlypis trichas</i>)		W	I
Gray-crowned Yellowthroat (<i>Geothlypis poliocephala</i>)		R	I
Hooded Warbler (<i>Wilsonia citrina</i>)		W	I
Canada Warbler (<i>Wilsonia canadensis</i>)*		T	I
Cardinalidae			
Indigo bunting (<i>Passerina cyanea</i>)		W	I, S, FRU
Icteridae			
Red-winged Blackbird (<i>Agelaius phoeniceus</i>)		R	I, S
Black-cowled Oriole (<i>Icterus prosthomelas</i>)		R	I, FRU
Hooded Oriole (<i>Icterus cucullatus</i>)*		R	I, N, FRU
Yellow-tailed Oriole (<i>Icterus mesomelas</i>)		R	I, FRU
Orange Oriole (<i>Icterus auratus</i>)	End	R	I, FRU
Altamira Oriole (<i>Icterus gularis</i>)		R	I, FRU
Yellow-billed Caticue (<i>Amblycercus holosericeus</i>)*		R	I, FRU
Fringillidae			
Scrub Euphonia (<i>Euphonia affinis</i>)		R	FRU, S, I
Yellow-throated Euphonia (<i>Euphonia hirundinacea</i>)		R	FRU, S, I

^aNOM: Species protected by mexican law: Pr = special protection, End = endemic.

^bStatus: R = resident, W = winter visitor, R/W = resident with a separate winter migratory population, W/s = winter visitor with small summer population, W/rs = winter visitor with small summer breeding population, T = transient, T/w = transient with small winter population.

^cDiet: F = fish, V = vertebrates (birds, snakes), SV = small vertebrates (frogs, lizards, small mammals), I = insects, INV = invertebrates, AQI = aquatic invertebrates, C = carcasses, P = plants, S = seeds, FRU = fruits, N = nectar, O = omnivore.

*Species observed outside the area covered by point counts.