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Bat community structure in the Tabasco Plain wetlands

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ABSTRACT

Objective: To describe the diversity of bat communities in two types of wetlands in the coastal region of the Tabasco Plain.

Methodology: Sampling was carried out at two different times of the year (dry and wet seasons) for three consecutive years, considering two types of vegetation (mangrove and popal-tular). The samples were collected during 3 effective days (6 h periods with 30 min monitoring intervals) per station, using mist nets.

Results: A total of 510 individuals belonging to 22 species of six families were recorded; the phyllostomid bats were the most diverse and abundant. The *Artibeus jamaicensis*, *Noctilio leporinus*, and *Glossophaga soricina* species were the most representative. The vegetation with the greatest diversity was the mangrove with 18 species, while 12 species were found in the popal-tular areas. The diversity of order 1 indicates that the mangrove has 0.78 more diversity than the popal-tular. Seven food guilds were present, including the dominant frugivorous animals. Only three species fall within a protection category, according to NOM-059-SEMARNAT-2010; they comprise 12% of the protected species in the state of Tabasco, Mexico.

Implications: In order to determine their diversity and abundance —and ultimately to develop base information—, communities in the wetlands must be evaluated.

Conclusions: The mangroves host the greatest diversity and abundance of bats to which they provide shelter and food. Therefore, they are considered crucial for their conservation and, overall, they are important habitats for this group.

Keywords: Abundance, diversity, chiropteran, wetlands.

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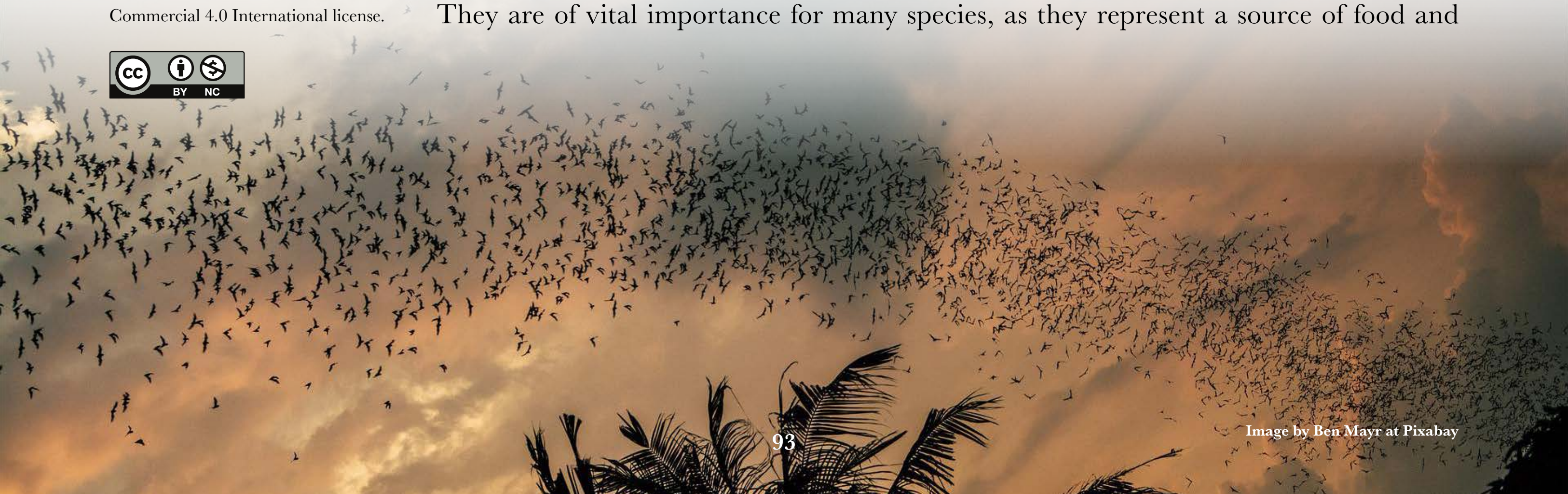
INTRODUCTION

Wetlands are important ecosystems. Their functions include stabilizing the coasts —they are a protection barrier against natural phenomena—, being a natural water filter —they eliminate pollutants—, and accumulating nutrients through sediment deposition —they become areas with great biological productivity (López- Portillo *et al.*, 2010). They are of vital importance for many species, as they represent a source of food and



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natural shelters. They provide spawning and development sites for fish and insects, and they serve as a nesting area for various migratory birds (Blanco, 1999; Gatto *et al.*, 2005; Villagran-Mella, 2006). Therefore, the conservation of these ecosystems is fundamental for the maintenance of biodiversity.

Meanwhile, these biotic systems are threatened by human activities: land-use changes and climate variations are the main factors behind the deterioration and fragmentation of these areas (Mitsch and Hernández, 2013). This situation reduces wildlife abundance in these environments, where ecosystem services can also be compromised and decrease in quality (Soberón, 2010; Badii *et al.*, 2015). In wetlands, bats are insect population controllers (Gómez-Naranjo, 2017). Emballonuridae, Mormoopidae, Vespertilionidae, and Molossidae are included among the most abundant families (Ceballos and Olivia, 2005). Establishing the vertebrates' abundance and diversity is of vital importance to determine the habitat's conservation degree (Tellería, 2013). Given the scarce information about chiropteran in the flooded environments of southeastern Mexico, data about the structure of the bat community in different wetlands of the Tabasco Plain must be obtained.

MATERIALS AND METHODS

The study area is located in the Gulf Coastal Plain and the Grijalva sub-basin sections, Tabasco, Mexico (Figure 1). It has an area of 8,475.77 km^2 and it includes the municipalities of Centla, Centro, Jalpa de Méndez, Macuspana, Nacajuca, and Paraíso.

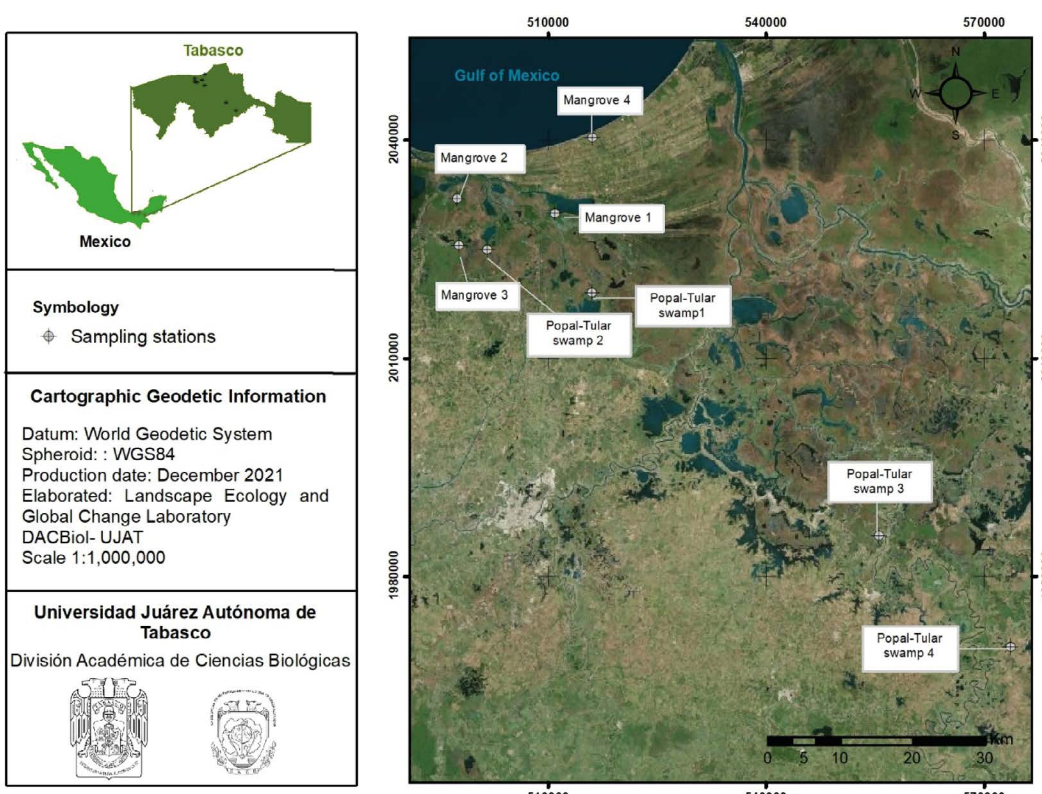

Figure 1. Delimited study area and location of sampling stations in the flooded area of the Tabasco Plain.

Only climatic group A is included in this the zone, represented by three types: Aw (in just one part of the eastern region of the territory), Am (in the east-west strip) (Galindo *et al.*, 2006). It has a mean annual temperature of 27 °C, with an average annual rainfall of 2,550 mm (INEGI, 2016). In Tabasco, the year can be divided into three climatic seasons: a) dry, from March to May; b) wet, from June to September; and c) North winds (nortes), from October to February (Moguel and Molina-Enríquez, 2000).

In this study, two types of vegetation (mangrove and popal-tular) were selected in each type of wetland, at four stations (Figure 1). Those sampling areas that met the selected types of vegetation (mangrove and popal-tular), that had a minimum area of 100 ha per vegetation fragment, that were easily accessible, and that guaranteed the safety of the work team were considered viable. The samples were collected during 3 effective sampling days per station in the dry and wet seasons. Data collected for three consecutive years were used.

During the sampling, four 12-m long × 2 m wide mist nets were installed, which remained open from 6:00 p.m. to 12:00 a.m. and were checked at 30-min intervals. The captured individuals were identified according to the field guide for bats (Medellín *et al.*, 2008), using the nomenclature developed by Ramírez Pulido *et al.* (2014). After they were identified, the bats were released at the capture point.

For data analysis, the Chao 1 estimator was used to determine the probable number of species observed. Specific abundance was determined as the total number of chiropteran species recorded. The species accumulation curve was used to determine the increase in species (observed abundance) during the seasonal sampling for each type of vegetation. The greater the sampling effort, the greater the number of species collected (Jiménez and Hortal, 2003), until the abundance reaches a maximum and stabilizes at an asymptote (Escalante, 2003). Diversity was analyzed with order 1 (Shannon index exponential). Consequently, all species are considered in the diversity value and proportionally weighted according to their abundance in the community (Hill, 1973; Jost, 2006, 2007; Tuomisto, 2010a, 2010b, 2011; Moreno *et al.*, 2011). These parameters were estimated with the EstimateS 9.0 software (Colwell, 2013).

Based on the existing bibliography on feeding habits, seven types of feeding guilds (frugivorous, omnivorous, insectivorous, carnivorous, nectarivorous, hematophagous, and piscivorous) were taken into consideration (Ceballos and Navarro, 1991; Ceballos and Oliva, 2005; Giannini and Kalko, 2004; Kalko and Hadley, 2001).

The conservation status of the identified species was established following NOM-059-SEMARNAT-2010 (SEMARNAT, 2010). The four categories used in the standard were considered: Probably Extinct in the Wild (E), Endangered (P), Threatened (A), and Subject to Special Protection (Pr).

RESULTS AND DISCUSSION

We captured 510 individuals belonging to 22 species from six families. The Phyllostomidae family has the greatest diversity (14 species) and abundance (420 individuals), followed by Vespertilionidae (4 species and 7 individuals), and Noctilionidae (1 species and 66 individuals). Only one species each has been recorded for the Molossidae, Emballonuridae and Morpoopidae families. The most abundant species is

Artibeus jamaicensis (273 individuals), followed by *Noctilio leporinus* (66) and *Glossophaga soricina* (43).

The mangrove was more diverse (18 species) and more abundant (417 individuals) than the popal-tular, where 93 individuals of 12 species were captured. Of the eight sampling stations, mangrove 4 and mangrove 1 have the greatest diversity (12 and 10 species, respectively) and the greatest abundance (268 and 81 individuals, respectively).

Regarding the sampling years, the greatest diversity was obtained in 2012 (13 species), while in 2010 and 2011 only 12 species were found. Regarding abundance, we captured 235 individuals in 2010, 127 in 2011, and 147 in 2012 (Table 1).

There was a greater abundance in the wet season (335 individuals of 16 species) than in the dry season (175 individuals of 15 species). The highest number of species (11) was recorded during the 2012 rains, followed by the 2010 rains (10). The highest abundance of individuals was recorded in the 2010 rains (171 individuals), followed by the 2012 rains (92 individuals).

The mangrove 1 and mangrove 4 sampling stations showed the greatest diversity by season (7 species) during the 2012 rains, followed by mangrove 4 in the 2011 rains (6 species). The highest abundance was recorded in mangrove 4 during the 2010 and 2011 rains (86 and 42 individuals respectively), followed by mangrove 1 in the 2011 rains (42 individuals) (Figure 2).

The species accumulation indicates that the observed diversity consisted of 22 species, equivalent to 81.48% of the species expected for the study area. However, according to the Chao1 index, 27 species should have been found. The diversity of order 1 indicates that the mangrove (5.49) has +0.78 more diversity than the popal-tular (4.71). That is to say, the popal-tular has 85.79% of the diversity of the mangrove. According to the sampling year, the greatest diversity was found in the mangrove for the years 2012 and 2011. The popal-tular had the greatest diversity in 2010 and the lowest in 2012 (Figure 3).

Bat communities include seven food guilds: frugivorous have the most diverse presence with ten species (all belonging to the Phyllostomidae family), followed by insectivorous with seven species. The remaining guilds (omnivorous, carnivorous, nectarivorous, hematophagous, and piscivorous) only have one species each. According to abundance,

Table 1. Richness and abundance of each sampling station per year.

Sampling station	2010		2011		2012	
	Richness	Abundance	Richness	Abundance	Richness	Abundance
mangrove 1	5	19	2	15	7	47
mangrove 2	4	21	4	16	1	2
mangrove 3	2	14	1	2	4	13
mangrove 4	7	107	6	89	9	72
popal-tular swamp 1	4	9	1	1	1	3
popal-tular swamp 2	4	17	2	2	2	3
popal-tular swamp 3	5	35	0	0	2	5
popal-tular swamp 4	3	13	2	2	3	3
Total	12	235	12	127	13	148

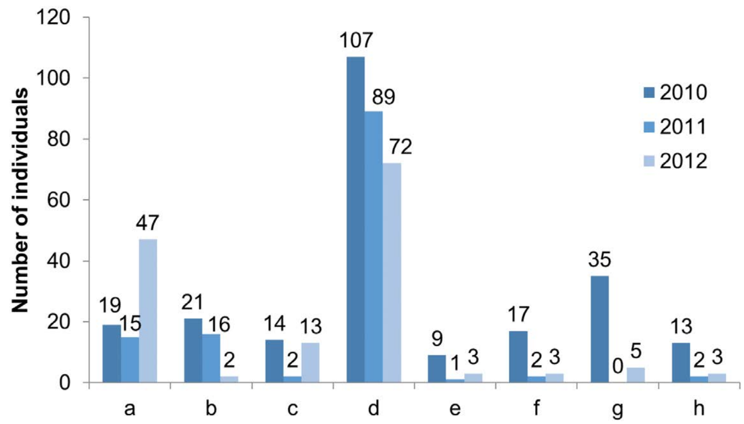

Figure 2. Abundance in sampling stations per year. a) mangrove 1, b) mangrove 2, c) mangrove 3, d) mangrove 4, e) popal-tular 1, f) popal-tular 2, g) popal-tular 3, h) popal-tular 4.

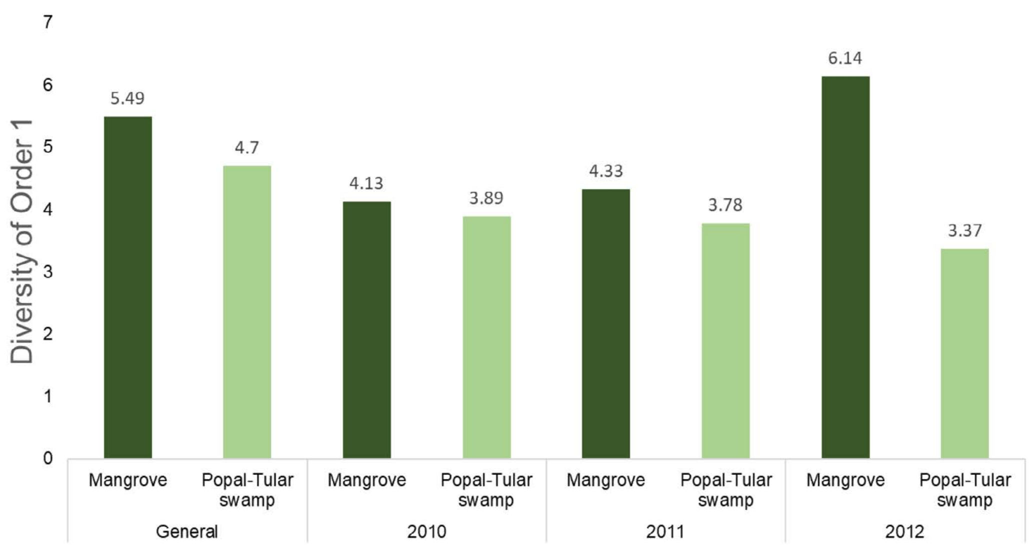

Figure 3. Vegetation diversity per sampling year.

frugivorous are the dominant species with 364 individuals (291 in mangroves and 73 in popal-tular), followed by piscivorous, with 66 individuals (55 in mangroves and 11 in popal-tular), and nectarivorous with 43 individuals. By number of species, frugivorous were the most abundant in both types of vegetation (9 and 5 species, respectively), followed by insectivorous with four species in both mangrove and popal-tular. Meanwhile, omnivorous and hematophagous bats were only present in the mangrove area.

Regarding the species protected by NOM-059-SEMARNAT-2010 (SEMARNAT, 2010), 21 individuals of three species are reported. *Rhynchonycteris naso* and *Myotis carteri* are "Subject to Special Protection (Pr)", while *Trachops cirrhosus* is " Threatened (A)". Both *M. carteri* and *T. cirrhosus* were reported in both seasons, while *R. naso* was only found in dry seasons and in the mangrove.

The diversity of bats obtained in the present study is similar to that reported by Sánchez-Hernández *et al.* (2005), Moreno-Bejarano and Álvarez-León (2003), Andrade *et al.* (2008), and Gordillo-Chávez *et al.* (2015), all of whom conducted their research in wetlands. The mangrove had the greatest diversity of chiropteran, because of its larger vegetation structures, which offer better shelter and food conditions. Other researchers have shown that the diversity of species in bat communities tends to increase in more complex habitats, since they provide bats with more options for food, shelter, and perch sites, as well as protection against predators (Castro-Luna *et al.*, 2007; Bobrowiec and Gribel, 2010; García-García and Santos Moreno, 2014; García-Morales *et al.*, 2014).

Frugivorous bats showed the greatest diversity and abundance in both types of vegetation. Most of the species that make up the guild —such as *Artibeus jamaicensis*, *Artibeus lituratus*, or *Carollia perspicillata*— are versatile in terms of food and shelter selection (Galindo-González, 2004; Ceballos and Oliva, 2005; Estrada-Villegas *et al.*, 2010). In this sense, wetlands have a high natural productivity, offering food and protection resources for frugivorous bats, which mainly depend on the availability of food. The presence of frugivorous bats benefits these types of environments because these bats disperse seeds (Galindo-González, 1998; Olea-Wagner *et al.*, 2007).

The second most diverse guild were the insectivorous bats. In this regard, it can be inferred that the type of sampling used did not match the foraging habits of the species belonging to this guild. García-Morales (2021) points out that insectivorous species are the most diverse in wetlands. Such is the case of *Molossus rufus*, *Pteronotus davyi*, or *R. naso*, which feed on the surface of water bodies or in clear spaces in the vegetation, in addition to having a more developed echolocation system that allows them to detect nets more easily (Kalko and Hadley, 2001; Andrade *et al.*, 2008). On the one hand, research carried out in wetlands near the study area include few or no records of insectivorous bats (Sánchez-Hernández, 2005 and Gordillo-Chávez *et al.*, 2015, Plasencia-Vázquez *et al.*, 2020). On the other hand, these species are more abundant in the wetlands of other countries —such as Colombia (Moreno-Bejarano *et al.*, 2003) or Brazil (Andrade *et al.*, 2008)— and are not under any category of risk. This situation would reaffirm the protection status assigned to species recorded in this study, such as *M. carteri*, *R. naso*, and *T. cirrhosus*, which are considered typical of mangroves. The protected species reported in this study are equivalent to 12% of the total chiropteran species reported for Tabasco, Mexico (Hidalgo-Mihart *et al.*, 2015; Valdez-Leal *et al.*, 2019).

CONCLUSIONS

The wetlands of the Tabasco Plain house 26.82% of the bat species distributed in Tabasco, Mexico. The Phyllostomidae family is the most diverse and abundant in the study area. The most abundant species within the study were *A. jamaicensis* and *G. soricina*, which rank as the most common species in most studies of neotropical bats. Based on seasonality, the greatest diversity in the mangrove was recorded during the dry season, while the greatest diversity in the popal-tular was recorded during the wet season. The greatest diversity was recorded in 2012 and 2010 for the mangrove and the popal-tular areas, respectively. The wetlands are home to bat species from seven different food guilds; frugivorous bats have the largest number and the most abundant species. Only three species of bats (*R. naso*, *M. carteri*, and *T. cirrhosis*) were recorded under some category of protection; these were the first species recorded in the wetland areas in the state of Tabasco. The greatest diversity and abundance of bats were recorded in the mangroves. Consequently, this type of vegetation is considered crucial for the conservation of this group of mammals.

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