Preliminary Report of Birds and Bats Monitoring Program in pre-construction stage of the "Tres Mesas" Wind Project, at the State of Tamaulipas, Mexico. Tres Mesas

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I. INTRODUCTION

Oak Creek Company intends to carry out the construction of two wind farms: one located at Mesa "La Sandía" and the second one at Mesa "La Paz" in the Tres Mesas Region, at the municipality of Llera de Canales, Tamaulipas, Mexico. The purpose of the creation of wind farms in Mexico is to generate clean energy without using fossil fuels so as to contribute to the reduction of CO_2 emissions into the atmosphere and the provisioned in the Special Program of Climate Change (2009-2012) and the commitments acquired with Kyoto Protocol.

Although wind energy has great benefits at a global level, direct impacts have been documented by inducing mortality of bats and birds in wind farms. Environmental impact statements (EIS) enable the assessment first of potential impacts of the installation of wind turbines on these groups, however, in order to evaluate actual impacts a more complete monitoring is required. It is recommended to carry out monitoring prior to the construction of the wind farms; these are called pre-construction monitoring. In addition, it is recommended to perform monitoring during the construction stage and continue and even intensify them during the wind farm operation stage (post-construction monitoring).

Pre-construction studies enable the establishment of a base line of information to describe the diversity of resident and migratory birds at the site; as well as the diversity of bat species existing in the area. This base line makes the comparison to data obtained during monitoring in construction and post-construction stage possible.

As for birds, the high richness of birds species in Tamaulipas due to its location in a transition zone between temperate and tropical climate regions containing species from both regions (Brush 2009) has been recognized and 615 species have been recorded for the state. The vegetation of the Tres Mesas area consists of submontane scrub, second most relevant habitat in the state for the maintenance of migratory birds. Short-term studies have reported about 170 birds species (Wauer 1998 and Ramirez-Albores et al. 2007, respectively) in this habitat, but the potential list generated for this report registers 350 species.

Rutas Central and Rutas del Mississippi exceed the territory of the state of Tamaulipas and some important migratory species as the Golden Eagle (Aquila chrysaetos) (Garza-Torres et al. 2003), Sandhill Crane (Grus cadensis - Roderick et al. 1996) and Peregrine Falcon (Falco peregrinus, McGrady et al. 2002, Garza 2001) have been reported in some of the studies carried out in the state.

It has been reported that spring migration in Texas, USA, can start mid-March and continue until mid-May (Gauthreaux and Belser 1999, Shackelford et al. 2005), so it is possible that migration occurs in Tamaulipas on similar dates. Considering that the implementation of wind farms has been recognized as high risk for some migratory species (Ledec et al. 2011) and the impact of the transformation of habitats around the migratory and flight routes on these groups; it is necessary to describe the migration behavior for the spring season at Tres Mesas, Tamaulipas, where the Tres Mesas wind project is intended to be built.

Likewise, the DGIRA-SEMARNAT establishes the obligation to carry out a monitoring study of birds and bats, both resident and migratory, throughout a year prior to the construction of the wind farm project. This study must include:

- Analysis on the diversity of resident and migratory birds throughout spring and autumn.
- Data on the distribution and abundance of species during spring.
- Data on the flight behavior of birds (arrival, flight height, flight directions, etc.)
- Location of nesting, feeding or perching areas for birds in the area and area of influence.
- Issue proposals and recommendations in order to minimize impacts on birds populations.
- Determine the distribution and abundance patterns of bats distributed throughout the project site and generate a base line for short, medium and long-term monitoring.
- Identify existing bat species included in some risk category as per the Mexican legislation and in international treaties of wild flora and fauna protection.
- Carry out an analysis on species more sensitive to installation of a wind power station and propose mitigation measure to reduce risks for bats.

In order to meet the latter, the DGIRA-SEMARNAT suggests companies the advice of experts in birds and bats preferring the participation of some research institution with experience in this type of studies. In this regard, the Instituto de Ecología A.C. (INECOL) has experience in monitoring fauna, mainly birds and bats in wind farms.

Global results obtained in pre-construction monitoring will be an integrating part of the Environmental Quality Follow-up Program (PSCA) for the pre-construction stage. The results set in this document are preliminary and related to the monitoring carried out in spring during March and April. The information generated made possible the determination of richness, abundance and behavior of resident and migratory birds in the area of influence of the project.

As for bats, this preliminary report analyzes information on a bibliographic basis for there was an adjustment in the methods used for monitoring this group of animals. Basically, information on bats activity will emerge from fix recording stations installed in meteorological towers and that are still in recording process and further analysis. This adjustment is due to the insecurity conditions prevailing in the region where the study was developed.

Finally, it is important to mention that this document is a **preliminary report** that has been prepared to respond to Oak Creek Energy's request to share information generated so far with the team that is preparing the Environmental Impact Statement of the Project. Due to the latter, this document contains relevant information that can be used in the assessment of impacts, mainly with regards to birds and bats. Information with further analysis will be presented in the **First Partial Report** which term for delivery is May 30 of this year.

II. OBJECTIVES

II.1 GENERAL

To monitor the main ecological parameters such as composition, richness and abundance of birds and bats during Spring in the pre-construction stage at Tres Mesas. The latter in order to detect possible changes due to construction activities.

II.2 SPECIFIC

- To determine potential resident and migratory birds in the region.
- To monitor resident and migratory birds within the premises where the wind farm is intended to be installed.
- To describe the flight patterns of birds present in the property.
- To determine the migratory flow
- To describe the composition of species of resident and migratory bats with ultra-acoustics detection systems.
- To search for shelters within the wind farm.

III. AREA OF STUDY

The wind farms in the Tres Mesas region are planned to be located in an area of 27,000 hectares at the municipality of Llera, 45 km south of Ciudad Victoria. In the areas of the polygon of Mesas La Paz and La Sandía, vegetation is composed by submontane scrub and sarcocaule (Oak Creek). In turn, there are areas with harvest land and some pasture and to the south of Mesa La Paz there is lowland deciduous forest (Figure- **1**).

Mesa La Sandía is around 15 m long and is located at 480 m above sea level. Mesa La Paz is 13 m long and is located at 430 m above sea level.

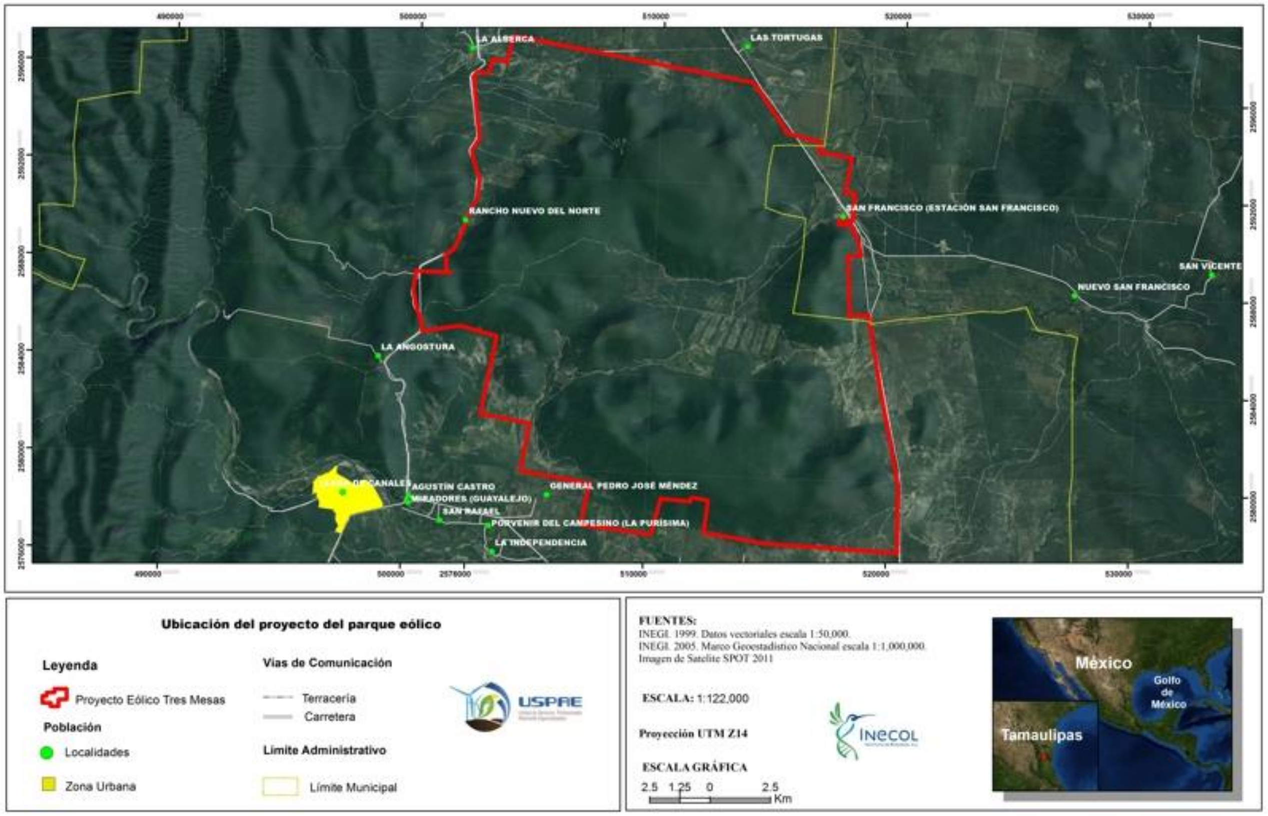

Figure- 1. Location of the premises where the Tres Mesas Wind Project will be established in the State of Tamaulipas.

IV. METHODS

IV.1 BIRDS

In order to generate more information about birds distributed in the premises for Spring monitoring during pre-construction stage, the following methods will be applied on the field:

- List of potential species
- Point counts
- Monitoring Station
- Use of ornithological radar

IV.1.1 List of potential species

The list of potential bird species was prepared according to the distribution and seasonality suggested by Howell and Webb, 1995 and Birdlife International. Four categories in relation to seasonality of species were distinguished: resident, summer resident, wintering, transitory, and with breeding colonies.

IV.1.2 Point counts

For point counts, six trips were carried out in total, three for each mesa, an a trip for March and two for April. Point counts constitute the main method for monitoring land birds in many countries due to its effectiveness in all types of land, habitats and mainly the utility of data from which to analyze changes over time. This method involves monitoring at fixed points for a certain period when the observer remains at the point and takes note of all the birds seen and heard in an area and a defined time period (Ralph et al., 1996).

This method allows the study of annual changes in populations, diversity of specific compositions according to the type of habitat and abundance patterns of each species. The radius of observation for points was 25 meters. The observers who conducted point counts have the skills and training necessary for visual and acoustic identification of bird species.

The location of points was performed systematically in an area considering accessibility and presence of roads as main factor for their location. For each mesa, the exact location of each point was determined with a GPS and is shown in Figure 2; said location was kept and will be kept constant for all samples. In order to have independence between each point; the distance considered for their location was 150 meters. For mesa la Sandía, 12 points were located with their corresponding replicates (24 in total), along a pre-existing path. For mesa La Paz, we have the support of the ejidatarios from the ejido Las Compuertas to clean a previously existing road and be able to make the journey. In this case, 12 points were located also with corresponding replicates (24 in total) (Figure 2).

The duration of the census at each point was five minutes and from these data a record was prepared including individuals identified in and out of fixed radius, ie, at more or less than 25 m. Likewise, the birds that flew in and out of the area were also considered. Seasonality and habits were defined with the data obtained.

IV.1.3 Monitoring Station

A monitoring station for the area of the mesas was operated and located outside the wind farm polygon in the Ejido La Angostura, because the site provided a view of the two mesas (**Error! Reference source not found.**).

The counting method is useful to monitor predatory birds and waterfowl during migration periods; this method consists of direct observations to the areas where the turbines will be installed. The birds detected flying above the areas of the mesas were observed with the aid of *Vortex* binoculars and telescope. The identification was made with the help of a guide to bird identification. For spring, the monitoring station served daily from 8.30 am to 4 pm over a period of two weeks.

IV.1.4 Ornithological radar

One single monitoring station was operated in a area considered for establishing a wind farm in the central-south zone of the state of Tamaulipas. The station was established approximately 40 Km south-southeast of Ciudad Victoria, at the west side of Mesa La Sandía (UTM, Long =500512, Lat = 2586251, Alt = 414 m above sea level (**Error! Reference source not found.**).

Radar equipment

A marine X-band radar (model *FR-1525 Mark 3* Furuno, Nishinomiya, Japan) mounted on a truck adapted as a mobile unit was used, which was transferred daily to the monitoring station, for the description of similar equipment, consult Cooper (1991) and Harmata et al. (1999). The radar transmitted with a frequency of 9410Mhz + / - 30Mhz through a two meter-long antenna with a maximum power output of 25kW and was operated with a pulse length of 0.07µs time (microseconds). The monitor screen has resolution of 35 meters, and the antenna emits a beam with a width of 1.23 ° (horizontal) x 20 ° (vertical) with lateral lobes ± 10 ° (Furuno 2002). The unit was powered by a low-noise electric generator.

The mobile radar unit was moved daily to the observation site, about 500 meters inside Mesa La Sandía entering the access located on Federal Highway 85. The monitoring station was established on the same service road, in an area where the surrounding vegetation was high enough to block the radar signal that would be reflected on the land (4-5 m), thus avoiding contamination due to ground clutter and allowing good visibility of the surrounding airspace. We used the horizontal and vertical operation mode of the radar for seven days between March 29 and April 7, 2013, coinciding with the period of early spring migration on the region (Gauthreaux and Belser 1999, Shackelford *et al*. 2005).

In horizontal mode, a radius of 3 kilometers detection was used because it is suitable for the detection of predatory birds (Cooper et al, 1991), main group of visitors near Ciudad Victoria (Gehlbach 1976); following Mabee et al. (2006) a 1.5-kilometer radius was used for vertical mode. Due to the study design, the dates and times of the observations, as well as the implemented method, we assume that the vast majority of targets detected were birds.

<u>Radar data collection</u>

The observations were made during six sessions of one hour each, from 8:15 until 14:15, although some days it was delayed due to weather conditions which did not allow the use of the radar. Each one-hour session was subdivided into: 1) a period of 10 minutes to prepare the antenna to work on horizontal mode, 2) a period of 20 minutes in horizontal mode to measure flight directions and record polar coordinates of detected targets trajectories, 3) a period of 10 minutes to change the antenna to vertical mode, and 4) a period of 20 minutes in vertical mode to measure flight heights of detected targets; for these groups maximum, minimum and average heights were detected. Before starting the horizontal mode operation, the orientation of the radar was adjusted north to allow precise collection of flight directions, which were measured using a card and an integrated radar screen compass. Polar coordinates represent three points along the trajectories of the targets: the starting point, a middle point and the end point. All data were captured on a laptop manually.

Data analysis

Flight directions were analyzed with the circular statistics software Oriana v. 4.01 (Kovach 2012), reporting average flight direction (μ) and length of main vector (*r*).

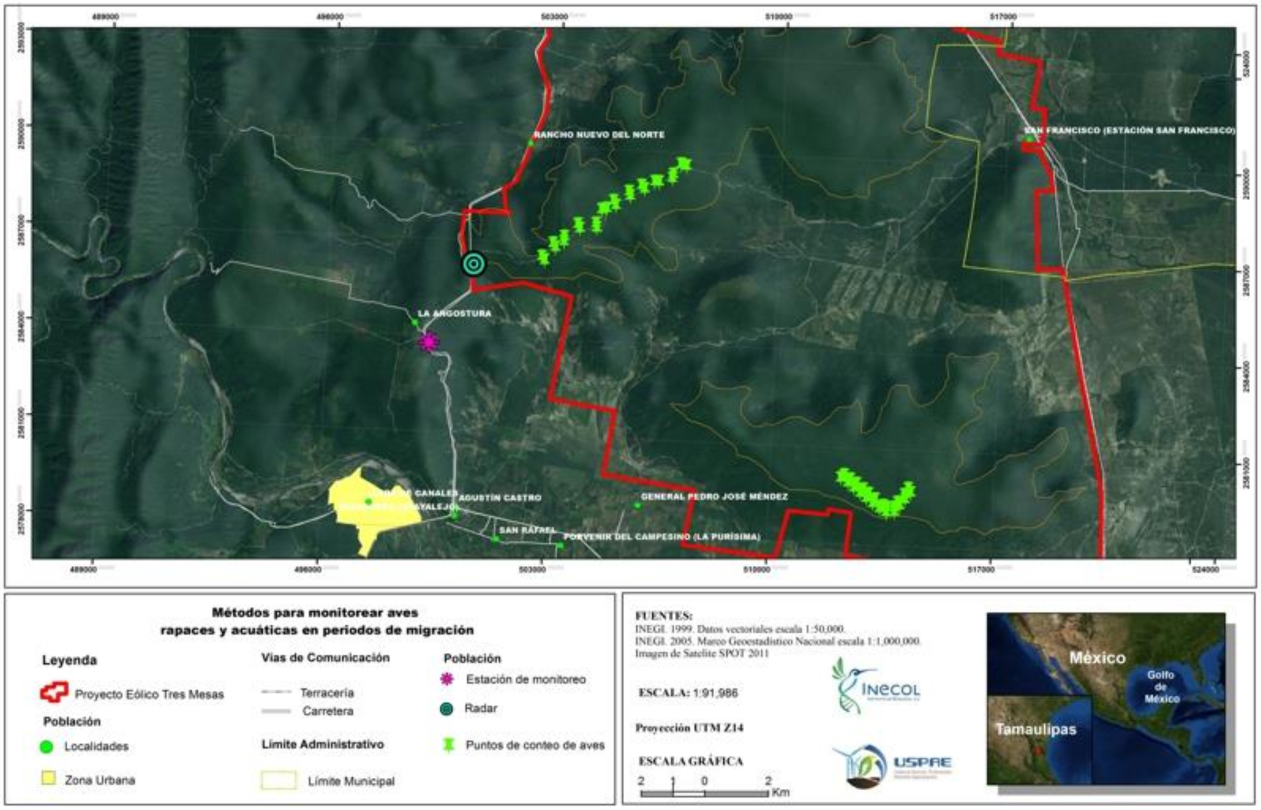

Figure 2. Location of sampling methods implemented for monitoring of migratory birds during spring within the premises of Tres Mesas Project.

IV.2 BATS

In order to generate more information about birds distributed in the premises for Spring monitoring during pre-construction stage, the following methods will be applied on the field:

- Ultra-acoustic detection

IV.2.1 Bats species with potential distribution in the study area

To describe the community of bats, a research of information was made in the literature about the species with potential distribution in the premises of Tres Mesas WP, Tamaulipas. The list of bat species was obtained from Villa (1966), Hall (1981), Medellín et al. (1997), and Ceballos y Oliva (2005). The nomenclature used was Simmons (2005). The conservation state of the species was obtained from the Official Mexican Standard NOM-059-SEMARNAT-2010 (SEMARNAT, 2010), CITES (2011) and IUCN (2012). Additionally, information on the natural history of the species was collected. Such information includes food guild, reproductive patterns, population sizes, colony formation, habitats in which there is greater chance of finding them and flight heights.

IV.2.1 Ultra-acoustic detection method

Due to the complex situation of insecurity in the region and secondly, to the fact that monitoring activities for bats take place mostly at night, for this particular case it was decided to use only the sampling method by detecting ultrasound (Griffin, 1958; Fenton, 1995). The ultrasonic detection method is mainly used to detect species of insectivorous bats, which vocalizations occur in high frequency (well above the audible range for humans> 20 kHz). Bats-caller detectors have been effective to describe the species of bats flying above the canopy at heights of over 3 m and therefore do not usually fall in mist nets.

The recordings are being carried out by the systems of ultrasonic detection of time expansion, which allows the accurate sampling of short sequences by a high-speed digital / analog converter (Fenton et al., 2001). Although this system does not allow continuous real-time recording, it does allow recording the original signal more accurately, providing higher level of resolution in the subsequent analysis (Parsons et al., 2000).

For ultrasound recording, SM2BAT (Wildlife Acoustics) detectors are used, equipped with an SMX-US broadband ultrasonic microphone. With a card with sampling rate of 384,000 it records the recording in digital format on SD cards.

Recordings of the so called echolocation of bats were obtained passively, ie two SM2BAT detectors were installed at two different heights (40 and 80 m) on a meteorological tower inside the premises, in the Mesa La Sandia. The monitoring was performed continuously from sunset. The main purpose of the passive method is to monitor bat activity in the two height categories.

The recordings obtained will be analyzed with BatSound Pro v.3.3 (Pettersson Elektronik AB) program to identify the signals in terms of species using determination criteria existing in books.

With the recordings obtained, the way bats use the airspace of the Project Area could be estimated, as well as the foraging activity of each species. For this, each pulse detected is classified into two forms: search and capture. The proportion of capture sequences regarding the total number of recorded sequences gives an estimate of how often the species are using the premises as a foraging area.

This preliminary report only reports information obtained by bibliographical review. Results of the analysis of bats will be included in the first partial report submitted according to the schedule established in the agreement.

V. RESULTS

V.1 BIRDS

V.1.1 Potential list

The potential list of bird species is included in Appendix I. Species cataloged in any protection category by NOM-059-SEMARNAT-2010 are observed in Table- 1.

Table- 1. Bird species with potential distribution at the area of study found cataloged in some protection category

Scientific Name	Common Name	NOM-059-SEMARNAT-2010	UICN (2012.2)	CITES (2012)
Crypturellus cinnamomeus	Thicket Tinamou	Pr	LC	
Cairina moschata	Muscovy Duck	Pr	LC	
Nomonyx dominicus	Masked duck	A	LC	
Crax rubra	Great curassow	A	VU	
Cyrtonyx montezumae	Montezuma quail	Pr	LC	
Tachybaptus dominicus	Least Grebe	Pr	LC	
Mycteria americana	Wood Stork	Pr	LC	
Botaurus lentiginosus	American bittern	A	LC	
Ixobrychus exilis	Least bittern	Pr	LC	
Tigrisoma mexicanum	Bare-throated tiger heron	Pr	LC	
Chondrohierax uncinatus	Hook-billed kite	Pr	LC	II
Elanoides forficatus	Swallow-tailed kite	Pr	LC	II
Ictinia mississippiensis	Mississippi Kite	Pr	LC	II
Ictinia plumbea	Plumbeous Kite	Pr	LC	II
Accipiter striatus	Sharp-shinned hawk	Pr	LC	II
Accipiter cooperii	Cooper's hawk	Pr	LC	II
Accipiter bicolor	Bicolored hawk	A	LC	II
Geranospiza caerulescens	Crane hawk	A	LC	II
Buteogallus anthracinus	Common Black Hawk	Pr	LC	II
Buteogallus urubitinga	Great Black Hawk	Pr	LC	II
Parabuteo unicinctus	Harri's Hawk	Pr	LC	II
Buteo lineatus	Red-shouldered hawk	Pr	LC	II
Buteo platypterus	Broad-winged hawk	Pr	LC	II
Buteo swainsoni	Swainson's Hawk	Pr	LC	II
Buteo albicaudatus	White-tail hawk	Pr	LC	II
Buteo albonotatus	Zone-tailed hawk	Pr	LC	II

Buteo jamaicensis	Red-tailed hawk	Pr	LC	II
Rallus limicola	Virginia rail	A	LC	
Heliornis fulica	Sungrebe	Pr	LC	
Megascops asio	Eastern screech owl	Pr	LC	II
Glaucidium sanchezi	Tamaulipas Pygmy Owl	P	LC	II
*Athene cunicularia (hypugaea) **	Burrowing owl	Pr	LC	II
Asio flammeus	Short-eared Owl	Pr	LC	II
Campephilus guatemalensis	Pale-billed woodpecker	Pr	LC	
Micrastur semitorquatus	Collared Forest falcon	Pr	LC	II
Falco femoralis	Aplomado Falcon	A	LC	II
Falco peregrinus	Peregrine falcon	Pr	LC	I
Aratinga holochlora	Green parakeet	A	LC	II
Aratinga nana	Olive-throated parakeet	Pr	LC	II
Ara militaris	Military macaw	P	VU	I
Amazona oratrix	Yellow-headed parrot	P	EN	I
Myadestes occidentalis	Brown-backed solitaire	Pr	LC	
Catharus mexicanus	Black-headed nightingale-thrush	Pr	LC	
Limnothlypis swainsonii	Swainson's warbler	Pr	LC	
Geothlypis flavovelata	Altamira yellowthroat	P	VU	

Red List Code: LC=Low concern, VU=Vulnerable; EN=Endangered
Code NOM-059-SEMARNAT-2010: P = Endangered, A=Threatened Pr = Under special protection
CITES: I= Species with the highest degree of endanger II= Species not necessarily threatened but that could be endangered unless their sale is strictly controlled

803 individuals total of 70 different species were identified. The detailed list of species is included in Appendix II.

The ten most abundant species were *Vireo griseus* with 11.71%, Asian Zenaida with 11.71%, *Cathartes aura* with a 9.34% Polioptila caerulea with 7.10%, *Buteo swansoni* with 5.98%, *Toxostoma longirostre and Arremonops rufivirgatus* both with 3.36%, *Baelophus atricristatus* with 3.24%, and finally, *Coragyps astratus* with 2.74% (Figure- 2).

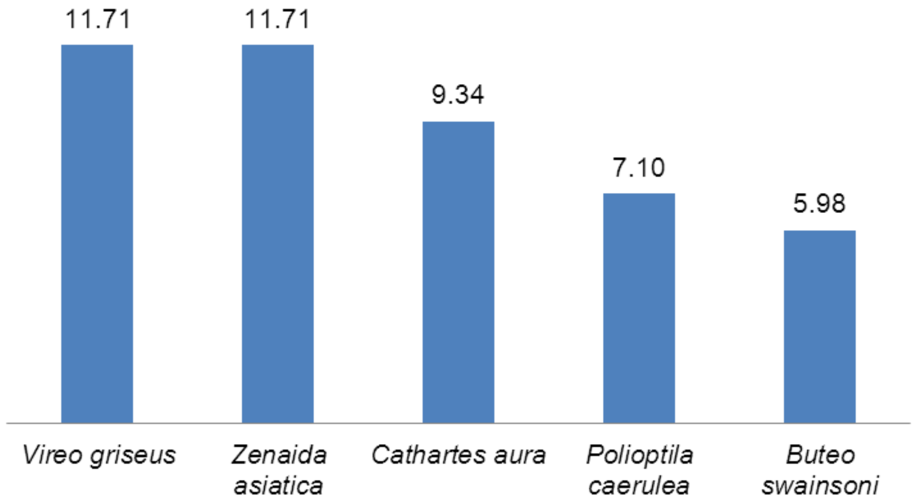

Figure- 2. Most abundant bird species registered with point count and monitoring station methods

In relation to the habits of the species recorded, 80.0% (56 species) correspond to species with terrestrial habits, 18.57% (13 species) to predatory birds and finally 1.43% (one species) to waterfowl (Figure- 3).

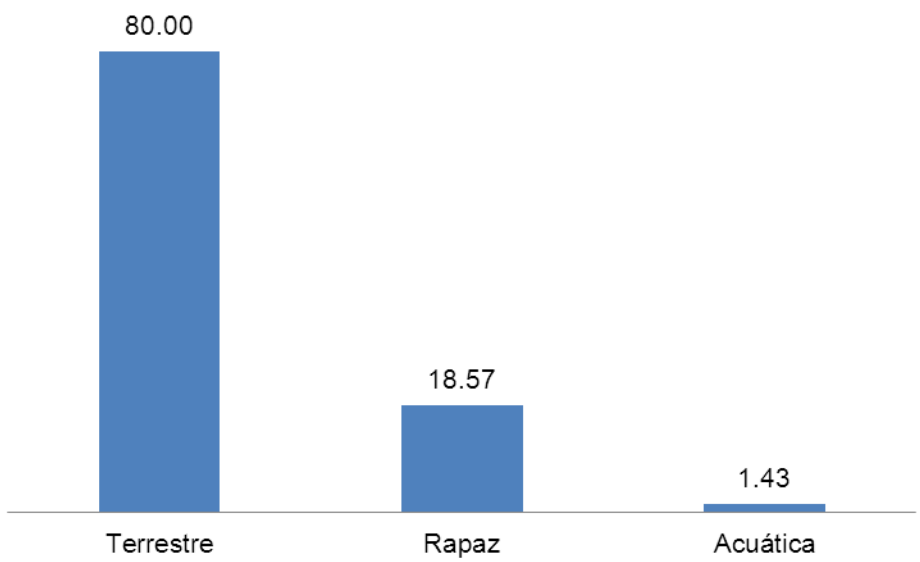

Figure- 3. Habits of species registered in point counts and monitoring station.

On the other hand, the highest percentage of species correspond to resident species with 71.43% (50 species), followed by wintering with 21.43% (15 species) and transient with 10.0% (seven species).

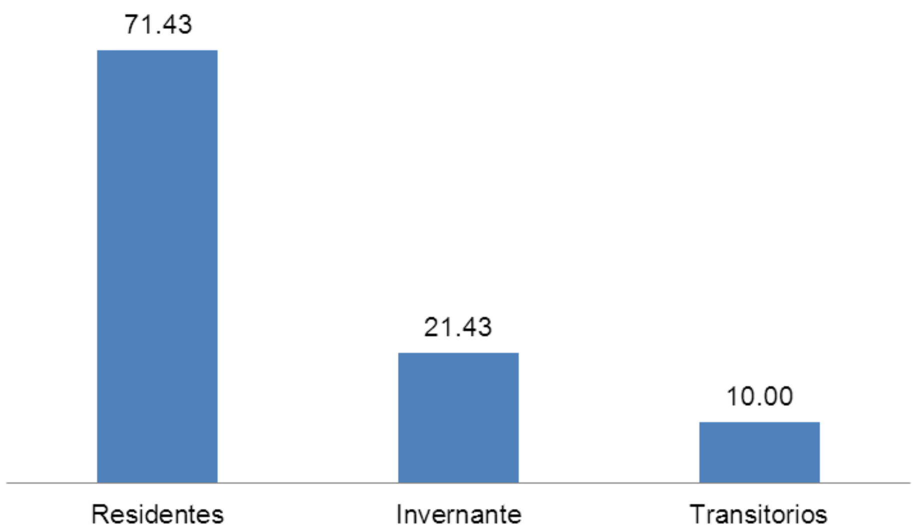

Figure- 4. Seasonality of species registered in point counts and monitoring station.

Protection status

From the 70 species of birds recorded so far only Swainson's Hawk (*Buteo swainsoni*) and White-tailed Hawk (*Buteo albicaudatus*) are under some special protection category by the NOM-059-SEMARNAT-2010.

IV.1.2 Point counts

During this period, three visits were carried out to Mesa La Sandia and La Sandia to implement count points established in each of them. A total of 552 individuals were registered, belonging to 56 species; it was impossible to identify one individual up to the species level.

The most abundant species registered in this period for both Mesas were: *Vireo griseus* with a total of 94 individuals registered, corresponding to 17%; *Zenaida asiática* with 88 individuals registered, corresponding to 15.94%; *Polioptila caerulea* with 51 individuals registered, corresponding to 9.2%; *Toxostoma longirostre* with five individuals registered, corresponding to 4.5%; *Arremonops rufivirgatus* and *Psilorhinus morio,* each with 24 individuals registered corresponding each to 4.3%.

To register individuals at point counts, four categories were recognized including: number of individuals registered in and out the radius; as well as number of individuals flying in and out the radius. The highest frequency of records was obtained by birds in and out the radius with 45.7 and 33.5% of the total, respectively. In the category inside the radius, the five most abundant species were *Vireo griseus, Polioptila caerulea, Arremonops rufivirgatus, Baeolophus atricristatus* and *Zenaida asiática* and for birds registered outside the radius, the five most abundant species were: *Vireo griseus Ortalis vetula, Psilorhinus morio, Toxostoma longirostre and Mimus polyglottos.*

The percentage of individuals registered in the category flying in and out the radius correspond to 4.35% and 16.5% respectively. The five most abundant species flying inside the radius were *Zenaida asiática, Corvus corax, Zenaida macroura, Corvus imparatus and Molothrus ater.* The most abundant species flying outside the radius were *Zenaida asiática, Cathartes aura, Coragyps atratus, Corvus imparatus* and *Buteo magnirostris*

Densities

The calculation of densities for each species showed that the five species with more density of individuals for each hectare were resident birds: these included the most abundant species such as *Vireo griseus* with density of ten individuals per hectare, *Polioptila caerulea* with densities of 5.4 individuals per hectare, *Toxostoma logirostre* and *Psilorhinus morio* with densities of 2.7 and 2.6 individuals respectively and finally *Tyrannus melancholicus* with density of two individuals per hectare The rest of the species showed densities below 1.5 individuals per hectare (Table- 2).

Table- 2. Densities of birds registered at point counts.

Species	Density/Hectares
Vireo griseus	9.97
Polioptila caerulea	5.41
Toxostoma longirostre	2.65
Psilorhinus morio	2.55
Tyrannus melancholicus	1.91
Icterus gularis	1.49
Mimus polyglottos	1.59
Ortalis vetula	2.33
Picoides scalaris	1.17
Peucaea ruficeps	1.80

Seasonality

Out of the 57 species registered at point counts for March and April, 73.68% of the species were resident species, 15.79% hibernating species and 7.02% transient species (Figure- 5).

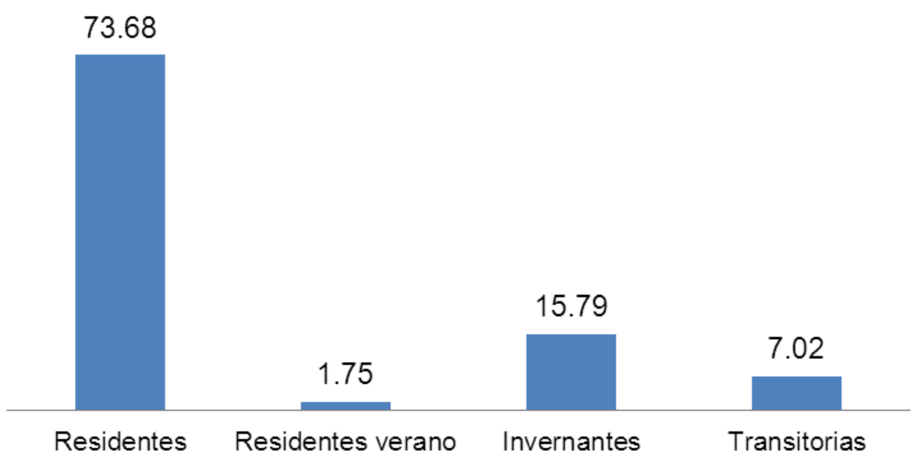

Figure- 5. Percentage of resident, wintering and transient species at point counts.

Habits

With regards to habits of species registered at point counts, 87.22% were terrestrial species, 14.54% predatory birds and no aquatic species was registered (

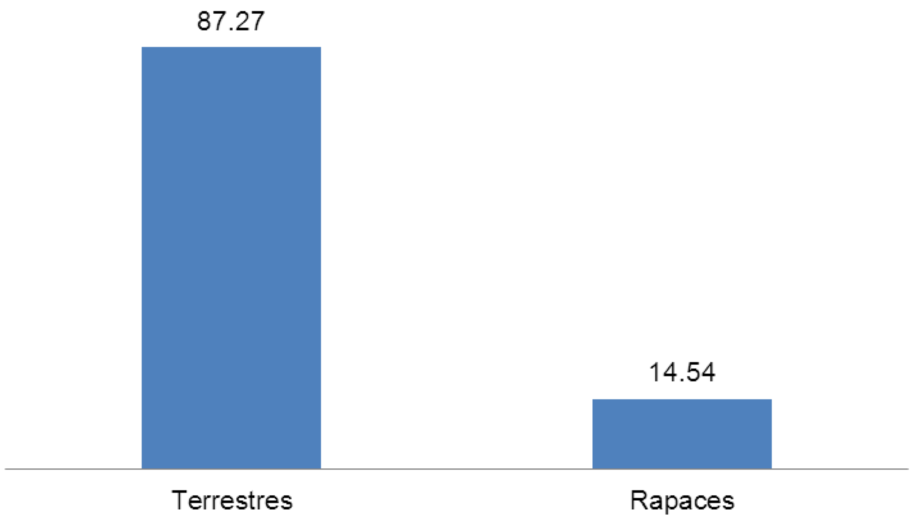

Figure- **6**).

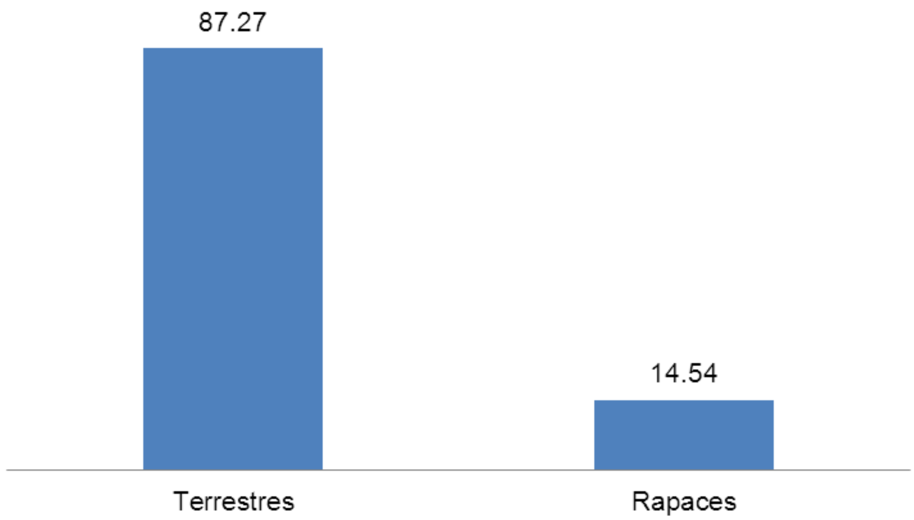

Figure- 6. Percentage of terrestrial and predatory species

Out of the 15 species identified as wintering or transient, 11 are terrestrial and only three: *Accipiter cooperii, Circus cyaneus y Buteo platypterus* are predatory.

V.1.2.1 Point counts for each Mesa

At Mesa La Paz, 236 individuals were registered, corresponding to 42.75%, and at Mesa La Sandía 316 individuals corresponding to 57.25%. At Mesa La Sandía a total of 34 species were registered and at Mesa La Paz a total of 44 species (

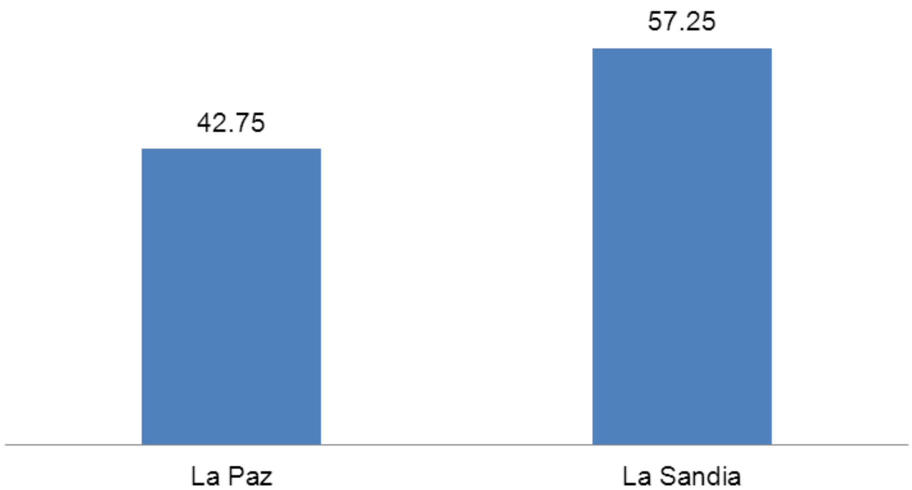

Figure- **7**, Appendix **I**).

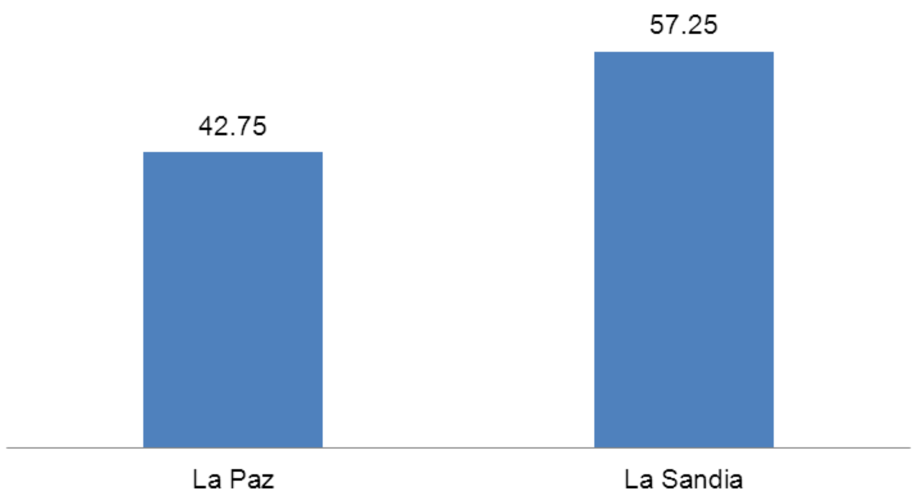

Figure- 7. Percentage of species for each Mesa

V.1.3 Monitoring Station

Birds abundance

At the monitoring station, a total of 252 individuals, corresponding to 40 species, was recorded. 56.57% of individuals: 142 were seen flying in the area of the polygon corresponding to the Mesas and 43.42% (109) were found outside the Project Area (

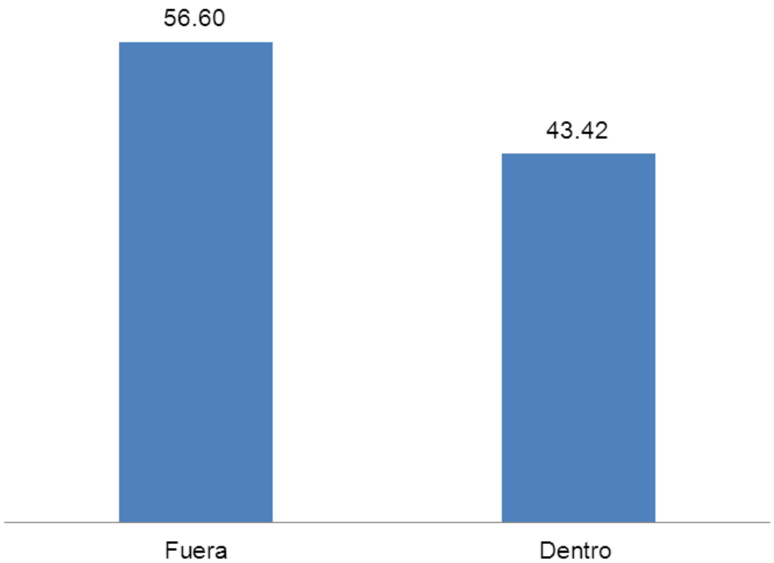

Figure- **8**). Except for one individual, the species of all birds observed were determined.

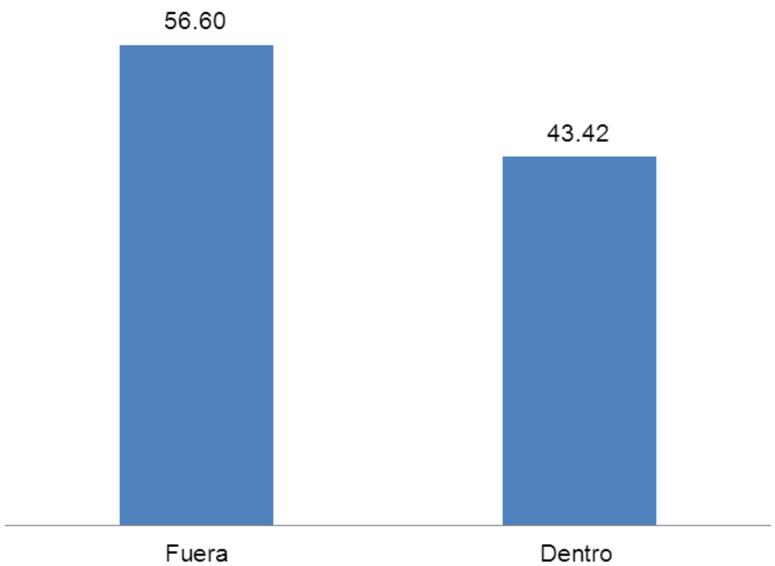

Figure- 8. Percentage from the total number of birds observed inside and outside the premises of Tres Mesas Project.

The aura vulture, *Cathartes aura,* was the most abundant with 26.69% (67 individuals) of the total registered, followed by Swainson's haws (*Buteo swainsoni*) with 19.12% (48 individuals) flying inside the park, the common buzzard (*Coragyps atratus*) correspond to 6.37% (16 individuals) and finally, the Psilorhinus morio and *Euphonia affinis* species with 4.87% (12 individuals) and 2.79% (seven individuals) registered (

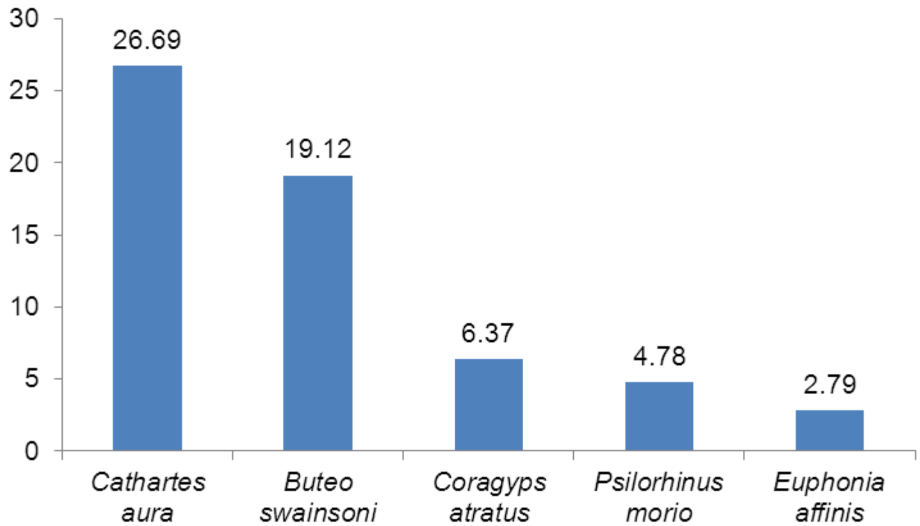

Figure- **9**).

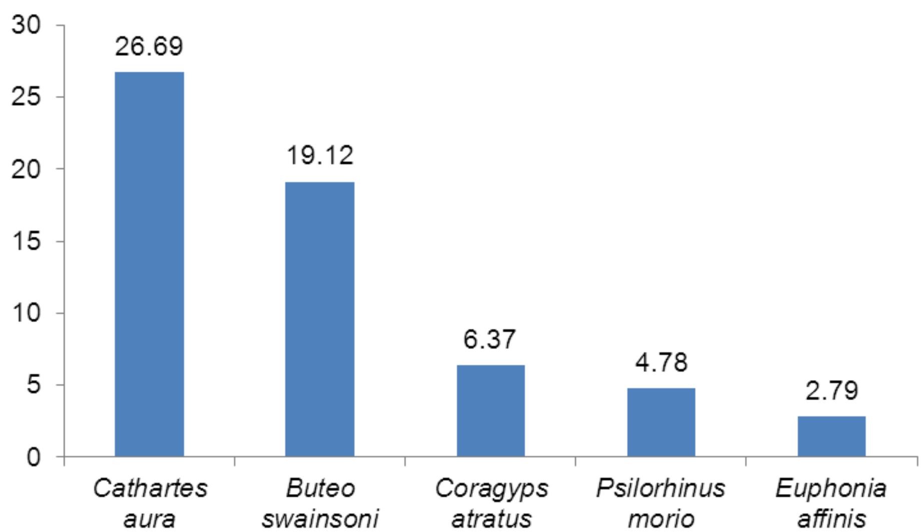

Figure- 9. Most abundant species registered at the monitoring station.

Of the species recorded flying within the Project Area, the five most abundant species were: Swainson's hawk *(Buteo swainsoni)* with 44.04% (48 individuals), the aura vulture (*Cathartes aura*), with 28.44% (31 individuals), *Coragyps atratus* with 10.09% (11 individuals), and finally the *Buteo brachyurus* with 3.67% (four individuals) (Figure- 10).

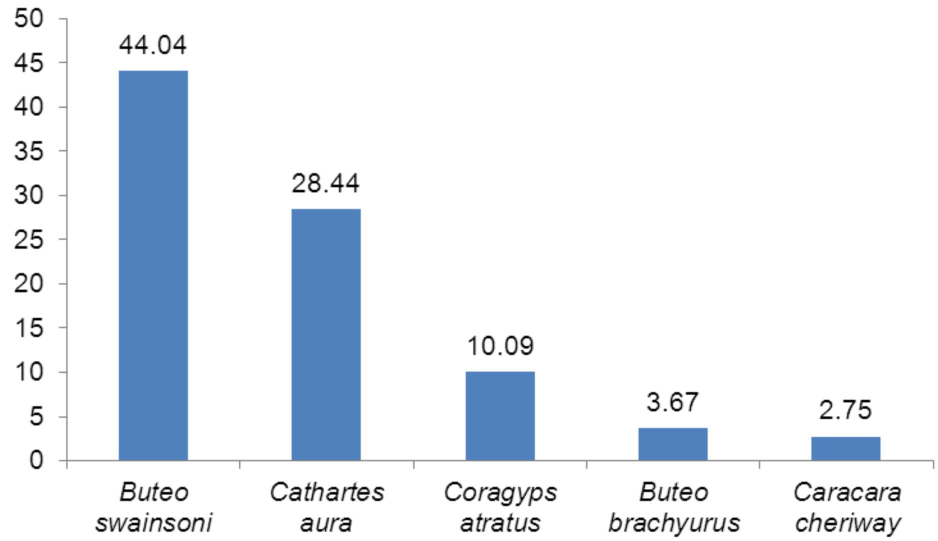

Figure- 10. Percentage of most abundant species flying over the premises of the Tres Mesas Project.

Collision risk

Collision risk was calculated for species flying within the polygon of the Mesas, to the above, data from individuals that flew between 26 and 75 meters high were considered. Individuals with high collision risk were those with p> 0.5.

The species with the highest probability of collision include the Common Buzzard (*Cathartes aura*) with a probability of 0.64, Swainson's hawk (*Buteo, swainsoni*) with a probability of 0.58, and short-tailed hawk (*Buteo brachyurus*) with probability of 0.5. The first two also correspond to the most abundant species.

Seasonality

Sixty-five percent of the species registered at the monitoring station are resident species, and the remaining 35% are species considered migratory species: wintering species 25% and transient species 10% (Figure- 11).

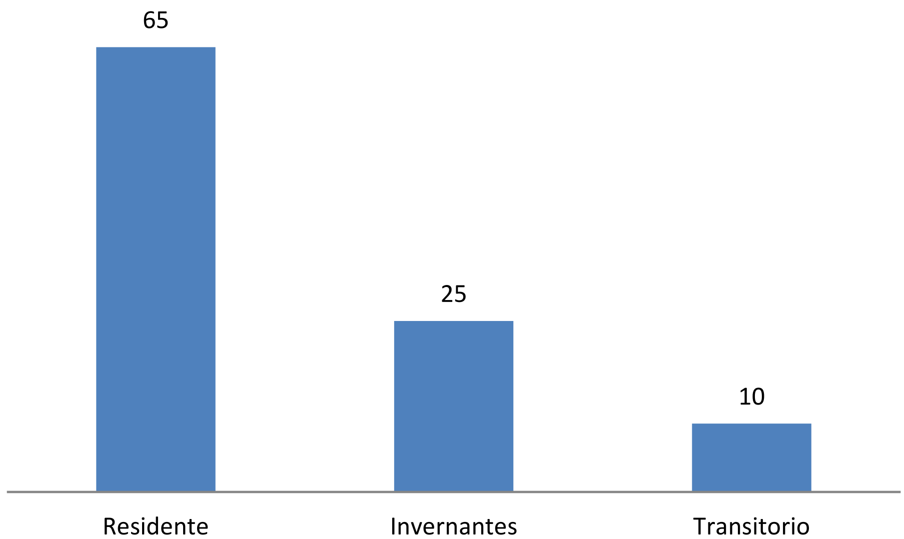

Figure- 11. Seasonality of the species registered at the monitoring station in the premises of the Tres Mesas Project.

Finally, from the 40 species registered at the monitoring station, 65% (26 species) are terrestrial birds, 32.5% (13 species) are predatory birds and 2.5% (one species) are waterfowl (Figure- 12).

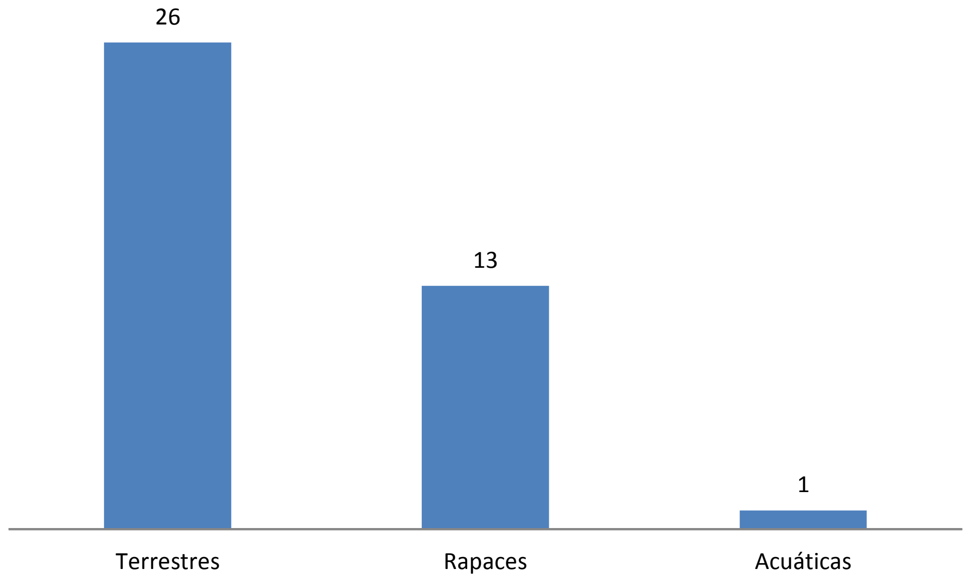

Figure- 12. Habits of the species registered at the monitoring station in the premises of the Tres Mesas Project.

V.1.4 Radar

We monitored the movement of birds during seven days, between 8:15 and 14:15 hours from March 29 to April 4, 2013, adding a total of 38 net hours of observations. In the first three days there were unfavorable meteorological conditions (light rain), preventing the use of the radar for bird detection; hence, it was impossible to carry out observations in the first 1 - 2 hours in the 29 and 30th day of March, as well as in the first day of April.

Flight trajectories

A total of 493 targets were registered, of which 30 were small groups, four were large groups and two were vortex. The rest (n= 457) were individuals. Figure- 13 shows the trajectories of all targets.

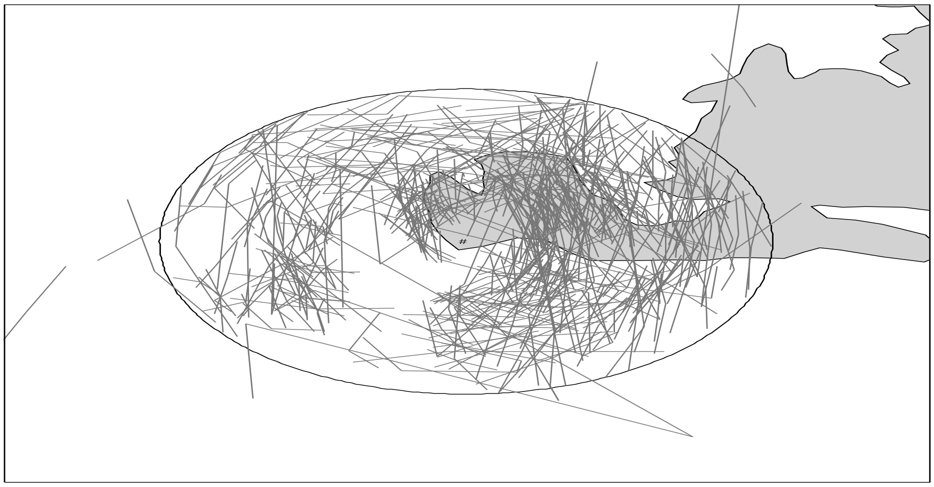

Figure- 13. Flight trajectories within the detection radius of 3 kilometers detected by the monitoring station with radar, located at the western border of Mesa La Sandía. Spring 2013. The gray polygon is representing the two Mesas and each line represents the trajectory of an individual.

Flight directions

Vortex are groups of birds (in this case with an unspecified number of members) flying in circles drawing hot air updrafts, so they do not show a particular direction of flight. However, the rest of the detected targets showed an average flight direction according to expected with the spring season, when Nearctic - Neotropical migratory birds return to their breeding grounds in North America (μ = 0.8 °, r = 0.4, n = 491, Figure- 14).

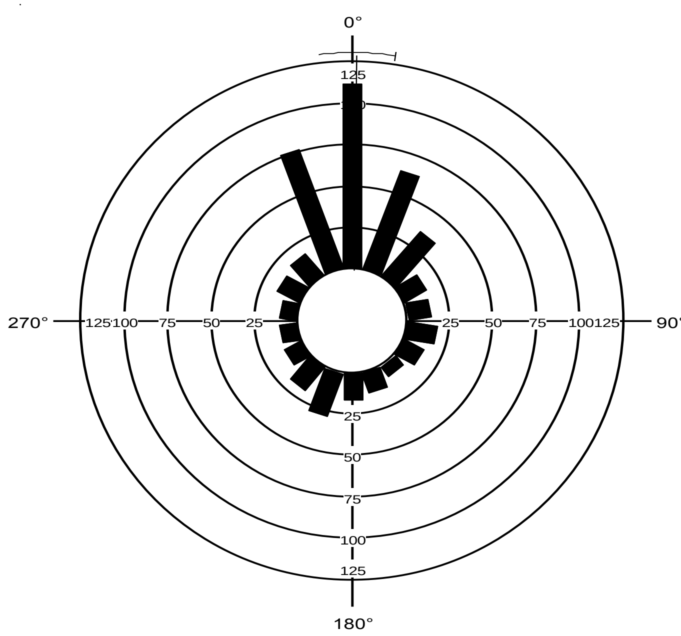

Figure- 14. Average flight direction of all targets detected in mesa La Sandía, municipality of Llera, Tamaulipas during monitoring with marine radar. Spring 2013.

Flight Heights

During the seven days of monitoring, the flight height was recorded for 2,530 individuals and 34 small groups, perhaps less than ten individuals. From the individuals identified, 4.6% flew at risky altitudes (<100 meters above ground level), while more than ~ 55% did so between 200 and 700 m agl (Table- 3, Figure- 15).

Table- 3. Flight heights in categories of 100 meters above ground level (m agl) of targets detected during monitoring with marine radar at Mesa La Sandía, municipality of Llera, Tamaulipas. Spring 2013.

Height Category (m AGL)	Number of targets by category	Percentage of targets by category
1 – 100	116	4.6
101 – 200	206	8.1
201 – 300	282	11.1
301 – 400	271	10.7
401 – 500	275	10.9
501 – 600	278	11.0
601 – 700	278	11.0
701 – 800	234	9.2
801 – 900	196	7.7
901 – 1000	150	5.9
1001 – 1100	101	4.0
1101 – 1200	62	2.5
1201 – 1300	44	1.7
1301 – 1400	28	1.1
1401 – 1500	9	0.4

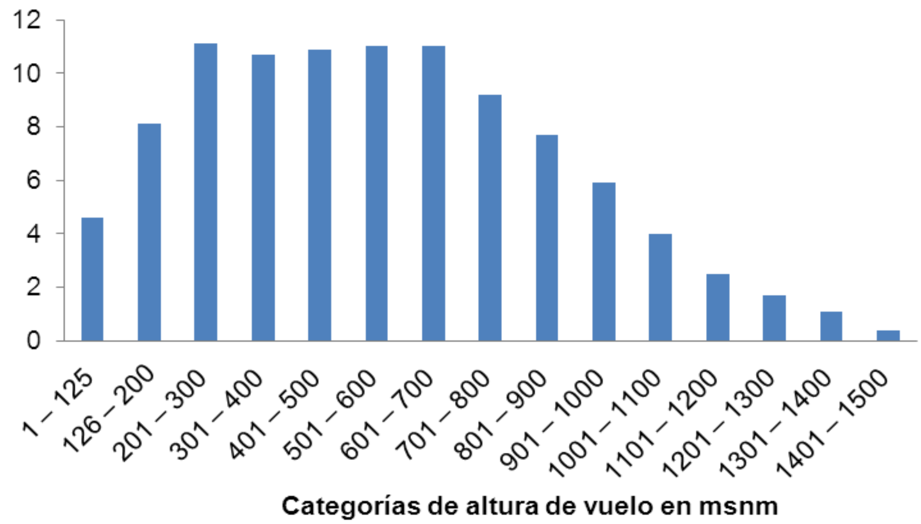

Figure- 15. Graph of flight height in categories of 100 meters above ground level (mAGL)

V.2 BATS

V.2.1 Bat species with potential distribution at the area of the Tres WP.

Based on the work of Villa (1966), Hall (1981), Medellín et al. (1997) and Ceballos y Oliva (2005), a list of 45 species of bats with potential distribution within the property was obtained. The 45 species represent 32.85% of the total species recorded for Mexico (Medellín et al, 1997;. Ramírez-Pulido et al, 2005;. Ceballos y Oliva, 2005). The species belong to five families and 33 genera (Appendix X). The family with the largest number of species is the Vespertilionidae (17 species), followed by Phyllostomidae with only one species less (16 species) (Table 4; Figure 18).

Table 4. List of species with possible distribution within the property of the project of Tres Mesas WF, Tamaulipas. It shows the food guild to which each species belongs.

Family	Species	Guild

Mormoopidae	*Pteronotus davyi*	Insectivore
	Pteronotus parnellii	Insectivore
	Pteronotus personatus	Insectivore
	Mormoops megalophylla	Insectivore
Phyllostomidae	*Macrotus waterhousii*	Insectivore
	Micronycteris microtis	Frugivorous
	Diphylla ecaudata	Blood-sucking
	Desmodus rotundus	Blood-sucking
	Diaemus youngi	Blood-sucking
	Glossophaga soricina	Frugivorous
	Leptonycteris curasoae	Nectarivore
	Leptonycteris nivalis	Nectarivore
	Anoura geoffroyi	Nectarivore
	Choeronycteris mexicana	Nectarivore
	Carollia sowelli	Frugivorous
	Sturnira lilium	Frugivorous
	Sturnira ludovici	Frugivorous
	Enchisthenes hartii	Frugivorous
	Artibeus jamaicensis	Frugivorous
	Artibeus liturarus	Frugivorous
	Centurio senex	Frugivorous
Molossidae	*Tadarida brasiliensis*	Insectivore
	Nyctinomops aurispinosus	Insectivore
	Nyctinomops laticaudatus	Insectivore
	Nyctinomops macrotis	Insectivore
	Molossus aztecus	Insectivore
	Molossus molossus	Insectivore
	Molossus rufus	Insectivore
Vespertilionidae	*Perimyotis subflavus*	Insectivore
	Antrozous pallidus	Insectivore
	Rhogeessa tumida	Insectivore
	Lasiurus blossevillii	Insectivore
	Lasiurus cinereus	Insectivore
	Lasiurus ega	Insectivore
	Lasiurus intermedius	Insectivore
	Corynorhinus mexicanus	Insectivore
	Nycticeius humeralis	Insectivore
	Eptesius furinalis	Insectivore
	Eptesicus fuscus	Insectivore
	Myotis auriculus	Insectivore

	Myotis elegans	Insectivore
	Myotis keaysi	Insectivore
	Myotis nigricans	Insectivore
	Myotis velifer	Insectivore
Natalidae	*Natalus stramineus*	Insectivore

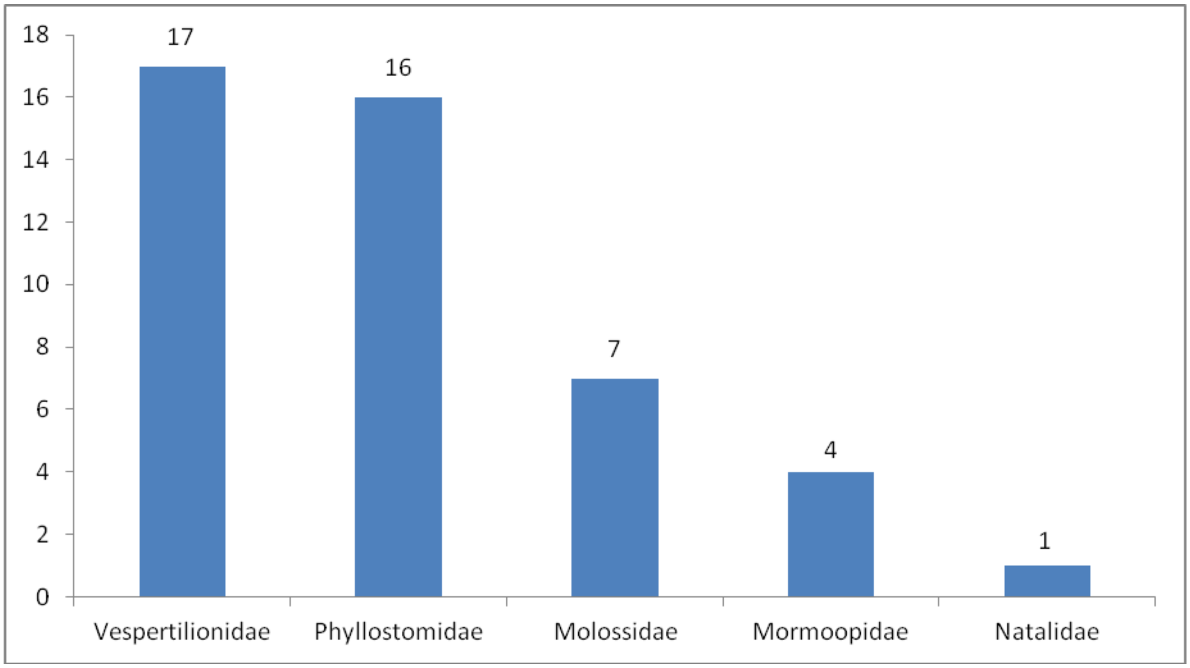

Figure 18. Number of species for each family of bats with potential distribution within the premises of the Tres Mesas Wind Project, Tamaulipas.

The majority of species (29) belong to the insectivorous food guild (Table 4). This clearly demonstrates that the bats comunity is dominated by members of this food guild (Figure 19).

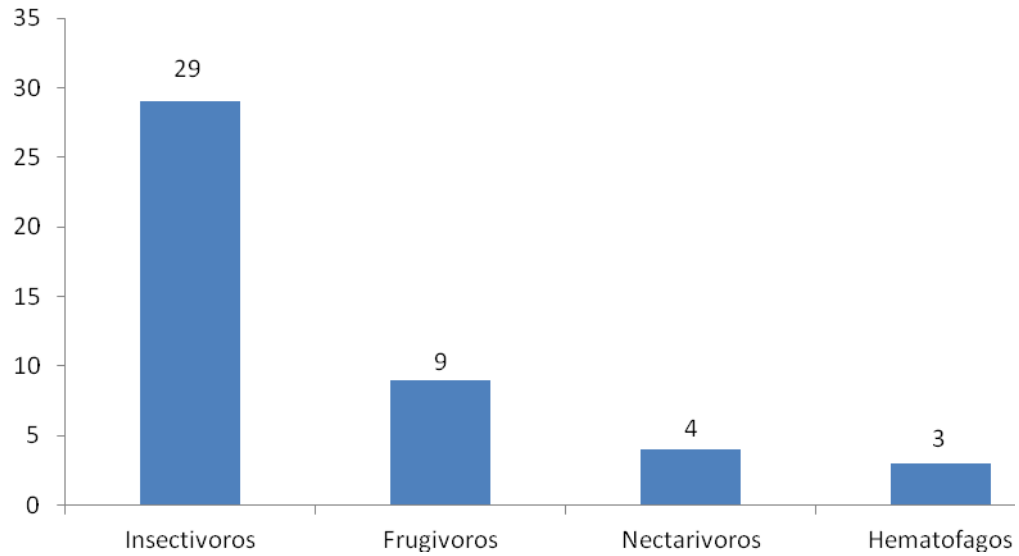

Figure 19. Food guilds to which the 45 species of bats with potential distribution in the area of the premise of Tres Mesas Wind Project belong.

The 19 species of the insectivorous guild with potential distribution in the premises are the ones that could be registered with SM2BAT ultrasonic detectors. With the recordings obtained, the way bats use the airspace of the Project Area could be estimated, as well as the foraging activity of each species classifying pulses as search and capture.

Of the species with possible distribution within the premises, *Diaemus youngi* and *Enchisthenes hartii* are in the PR category (subject to special protection), *Leptonycteris curasoae*, *Leptonycteris nivalis* and *Choeronycteris mexicana* are in the A category (Threatened), non native in the NOM-059-SEMARNAT-2010 (SEMARNAT, 2010). Leptonycteris curasoae *is in the VU (vulnerable) category,* Leptonycteris nivalis*in the EN (endangered) category , and* Choeronycteris mexicana in NT (almost threatened) category in the IUCN red List (2012). The rest of the species are not found within any category of risk in the NOM-059-SEMARNAT-2010, CITES (2011) and IUCN (2011).

VI. DISCUSSION

The results are broken down in general until referring to particularities related to the method used and in case of count points for birds, related to the site (Mesas La Sandía and La Paz).

In particular, the richness and abundance of species registered at point counts were higher for resident birds of terrestrial habits, finding low percentages of birds that fly above the canopy and also being mostly resident species. On the other hand, richness, abundance, and densities of birds recorded at point counts varied among the mesas. Although the vegetation in las mesas is similar and is considered submontane scrub, it was found that species richness and abundance is higher for mesa La Paz than mesa La Sandía. Several studies have increased the relevance of flora in species diversity. The abundance in terms of richness and abundance at Mesa La Paz could be related to its low degree of disturbance due to its lack of accessibility; and/or for having a border with the lowland deciduous forest. However, due to the low amount of samplings made for one single season, these data have to be complemented with outstanding sampling and thus consider seasonal variation in the composition of species.

The data collected from the monitoring station are used to determine migration patterns and predict the risk of collision of migratory and resident species that fly over the mesas during migration times, in this case spring. For this case, the highest proportion of individuals was found flying outside the Mesas areas. For the analysis, the species considered with the highest risk of collision include two migratory species, one is Swainson's hawk (*Buteo swainsoni*), the only species considered protected species. The abundance of birds recorded for the monitoring station during the sampling period is low compared to the abundance recorded for this season in other parts of the country, such as the Isthmus of Tehuantepec in Oaxaca where species can be counted daily for up to thousands of migratory birds . However, it is important to note that the main limitations of visual monitoring is its inefficiency under conditions of fog and low visibility as registered on the site over the monitoring period, and the inability to register individuals flying at high altitudes.

By the method of radar, information about flight trajectories of the targets recorded in mesa La Sandía was obtained. As a result, we found that 4.5% of the targets registered flew at altitudes from 0 to 100 m; there were higher records of targets flying at heights of over 125 meters.

According to the previous paragraphs, so far 70% of potential species for the site has been describe. The diversity and most abundant species include residents and terrestrial species not flying above the canopy and migratory species that flew off the mesas or at heights higher than 125 meters.

For migratory birds it is important to consider that most of them were found flying at heights above 125 meters. The effect of the wind farm construction on resident birds is likely to be related to habitat fragmentation related to the opening of roads.

Likewise, the diversity of Mexican bats is one of the largest in the world, comparable only to that in Indonesia, Brazil and China. Approximately one-third of the mammals in Mexico belong to the Chiroptera order (137 species, Ceballos y Oliva, 2005). This is because two bio-geographical regions converge in Mexico, the Neartic and the Neotropical (Rzedowski, 2006), and in addition to the complex topography of the country, it produces a great diversity of environments and high specific richness.

The State of Tamaulipas is located northeast Mexico. The western part of the State is located in the Neartic zone, whereas the east part is located in the Neotropical zone, therefore, the fauna in the south of the state, where the Tres Mesas Project is located, is similar in both regions. A general pattern regarding the behavior of mammals diversity in North America has been described. Mammals diversity, and in general their biodiversity, increase from north to south. It can be said that the group of bats conforms to this pattern; in the knowledge that in the northern regions of Mexico the number of species is significantly less than the number registered in southern States such as Veracruz, Tabasco, Chiapas and Oaxaca (Ceballos y Oliva 2005). However, this trend might not be clear because in a review of the diversity of bats in different regions in Mexico, researchers did not find that said trend of higher diversity from north to south is clear, and observed that there was greater diversity in a community in the State of Jalisco (center of the country) than in a community in the State of Chiapas (south of the country). In the same review, the number of species registered southeast Tamaulipas in the northern region of the Sierra Madre Oriental was higher with 47 species (León-Paniagua et al., 2004). Besides, with a fauna of bats dominated by species from the Vespertilionidae and Molossidae family in the north and changing its composition for species of the Phyllostomidae family as reaching the south (Torres-Morales *et al*., 2010). The diversity of bats with potential distribution for Tamaulipas does not follow the pattern of less diversity in the northern site, as described by

Ceballos y Oliva (2005), for 45 species could be registered using the acoustic detection method along with the traditional method using mist nets. The 45 species represent 32.85% of the species registered for Mexico (Villa, 1966; Hall, 1981; Medellín et al., 1997; Ceballos y Oliva, 2005). However, due to insecurity issues in the country, it is more feasible, technically speaking, to use only the acoustic detection method with which only insectivorous species will be registered. Even considering only insectivorous species, the diversity of bats to be registered in the premises could be higher with 29 out of 25 species registered for Tamaulipas, which represent 64.44% of the species registered in the state (Medellín et al., 1997; Ceballos y Oliva, 2005).

As for the families to which the species that could be registered in the Tres Mesas Project area belong, if the two sampling methods were used (nets and acoustic), they follow the intermediate pattern with a larger number of species of the Vespertilionidae (17 species) and Phyllostomidae (16 species) families, whereas for the Molossidae family only seven species were registered.

The bats community would be constituted mainly by insectivorous species (29 species). The relevance of insectivorous bats for performing relevant ecological features lies in the control over populations of nocturnal flying insects and over agricultural plagues (Medellín *et al*., 1997; Lee y McCracken, 2002; Wilson, 2002). Among them, we could register *Antrozous pallidus* with high specialization in insects, consuming mainly those of relatively large size (20-70 mm, including beetles, grasshoppers and scorpions), which are capture from the soil level or in parts of low vegetation (Ortega, 2005). The relevance of insectivorous bats for performing relevant ecological features lies in the control over populations of nocturnal flying insects and over agricultural plagues (Medellín *et al*., 1997; Lee y McCracken, 2002; Wilson, 2002). Or such as *Tadarida brasiliensis*, which eat mainly nocturnal moths attacking corn, cotton, tomato and many other crops. A colony of 20 million bats of *T. brasiliensis* could eat more than 200 tons of insects each night, most of them agricultural plagues (Medellín et al., 1997).

From the point of view of wind projects, insectivorous species are relevant because this guild includes species that forage at heights ranging between 10 and 30 m, making them more likely to interact with the blades of wind turbines. This group of bats can be divided into two groups. Aerial insectivores, which are characterized by narrow wings and small body that allows them to develop an acrobatic flight, and insectivorous with foliage that usually fly at lower altitudes (2-5 m) and are characterized by wider wings and greater body mass (Neuweiler 2000).

Species that could be registered within the project area belong to the group of aerial insectivores, except for the pallid bat (*Antrozous pallidus*) which forages in the undergrowth.

Some members of the Vespertilionidae family are the ones that have collisioned more frequently in wind farms in North America, whereas members of the second family Molossidae have been reported in collisions at the La Venta II WF, in the state of Oaxaca (CFE -INECOL 2008 and 2009). As for collisions, three species *Lasiurus cinereus, L. blossevillii* and *Tadarida brasiliensis* that could be registered within the Project Area have been reported in collisions in other farms in the United States (Erickson, *et al*, 2003; Johnson, 2003, Johnson *et al*. 2003; Fiedler 2004; Johnson, et al*. 2004; Koford, 2004; Arnett, 2005; Brown and Hamilton, 2006; Piorkowski, 2006; Arnett, et al*. 2008). The first two belong to the Vespertilionidae family and the last one to Molossidae family. Undoubtedly, the hoary bat (*Lasiurus cinereus*) is the species that has reported more collisions. It has been estimated that about 50% of collisions registered in the United States against wind turbines belong to this species (Arnett et al., 2008). This indicates that this species should be taken as a focal species for monitoring interactions of bats with the wind turbines to be installed at the Project Area.

With regards to vulnerability of species registered in the premises, including those of possible distribution, we found *Diaemus youngi* (hematophagous) and *Enchisthenes hartii* (frugivorous), are in the Pr category (subject to special protection), *Leptonycteris curasoae*, *Leptonycteris nivalis* and *Choeronycteris mexicana* (the three of them nectarivorous), are in the A category (Threatened), non-native in NOM-059-SEMARNAT-2010 (SEMARNAT, 2010). *Leptonycteris curasoae* (nectarivorous), is in the VU category (vulnerable), *Leptonycteris nivalis* (nectarivorous) in the EN category (endangered), and *Choeronycteris mexicana* (nectarivorous) in the NT category (almost threatened) in the red list of the IUCN (2012). The species mentioned fly at altitudes lower than five meters, so it is likely that the risk of collision with wind turbines to be installed be low.

As previously discussed, based on the bibliographical review made for bats and a more complete analysis it will complement the results obtained from recordings made at this moments in the premises.

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