ELECTRICA DEL VALLE DE MEXICO S. de R. L. de C. V.

EDF ENERGIES NOUVELLES

# FINAL REPORT OF THE MIGRATORY AND RESIDENT BIRD STUDY AT THE LA MATA – LA VENTOSA WIND POWER PROJECT, OAXACA

**FINAL**

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## Executive Summary

This report summarizes the results of the Fall 2007 and Spring 2008 seasons of pre-construction surveying of migratory and resident birds at the proposed wind farm project. The proponent of the Project, Electrica del Valle de México, has identified two places within the coastal plains of the Isthmus of Tehuantepec for the construction of the Wind Resource Area (WRA) with an energy producing capacity of 67.5 MW. At these sites will be installed a total of twenty-seven 2.5 MW wind turbines, producing a total capacity of 67.5 MW. These turbines will have a central rotor height of 80 m with a maximum vertical reach of 124.5 m above the ground (rotor diameter of 89 m), to the tip of the blades in a 12 o'clock position.

This evaluation is based on: 1) field work carried out from 13 October - 14 November 2007 and 18 March - 7 May 2008 within the two properties where the WRA is to be constructed; 2) a revision of relevant literature and available databases; and 3) a review of bird species with respect to those of conservation concern (including their environments), as indicated by concerning government agencies and international authorities. Collectively, this information indicates which species use – or are suspected to use – the area of the Project site, as well their relative abundance during the fall and spring seasons. Incorporated into the risk assessment, this information allows for the determination of the level of risk that the WRA could represent to birds.

The dominant vegetation type within the Project site is short dry forest, or regenerating stands of this type, with trees of short stature that in some places gradually convert to short thorn forest. This vegetation is very degraded in those places where there are moderate numbers of cattle or extensive sorghum fields. Where cattle cannot penetrate the forest, this vegetation maintains some quality of its original structure. Also present are extensions of land with *Acacia* sp., or "huizachales", which are dense trees of short stature supporting a low diversity of birds.

During visits to the Project site 175 species of birds were registered of which 88 are residents, 72 are winter visitors, 29 are transients (only use the area in passage on their migratory flights), one species a summer resident only and one species considered to be accidental in the area. Note that the sum of the species does not equal 175, owing to the fact that some species maintain both resident and migratory populations in the area, and are assigned to more than one status category. In the fall season 147 species were encountered and in the spring season 148 species were encountered; despite the similar number of species between seasons, the species composition varied both in population quantity and quality.

The habitat at the Project site is considered appropriate, or marginally so, for breeding of the majority of the resident species encountered, with a total of 40 species found breeding, representing 45.45% of all resident species encountered. During the visits to the property in the two seasons of study, the most common terrestrial birds detected were, in order of frequency, White-winged Dove (migratory and resident), Orange-breasted Bunting, White-lored Gnatcatcher, Common Ground-Dove, West Mexican Chachalaca, Franklin's Gull, Cinnamon-tailed Sparrow (federally endangered), Scissor-tailed Flycatcher and Stripe-headed Sparrow. Of note, Cinnamon-tailed Sparrow is a range-restricted endemic species and endangered at the national level, and it is one of the more common permanent residents within appropriate habitat.

Raptor species observed with high frequency during visits to the Project site were: Turkey Vulture, Black Vulture, Roadside Hawk, Crested Caracara, Swainson's Hawk (Special Protection, Pr). Raptors observed with less frequency were: Hook-billed Kite (Pr), Gray Hawk, Short-tailed Hawk, White-tailed Hawk (Pr), Red-tailed Hawk. Other species, uncommon to rare, were Great Black Hawk (Pr) and Harris's Hawk (Pr).

With respect to protected species, as mentioned previously, the federally endangered Cinnamon-tailed Sparrow was found to be common among resident species that breed within the Project site. The only species encountered with a status of nationally threatened, Green/Pacific Parakeet (impossible to separate these two species in the field),

is not suspected to breed anywhere within the Project site due to lack of suitable nesting habitat nor was it found to be common. A total of 16 species under national special protection status were observed at the Project site, most of these being raptors (10 species).

With respect to the phenomenon of bird migration, observations from the survey would indicate that the Project site is not located within a high bird traffic zone, in either the fall or spring seasons based on encounters during field work. It is important to mention, however, that the site is located adjacent to the most important migratory flyways in the region, those being along the Sierra de Tolistoque and through Paso Chivela to the North (from where migrants cross between coasts) and the southern part of the coastal plain along the Pacific slope. With respect to nocturnal migration, studies utilizing radar in the United States have revealed the majority of birds flying at night migrate at altitudes well above the height of wind turbines, with less than 10-15% of individuals flying within tower height.

Bird migration through the Isthmus of Tehuantepec, however, is significant. In this survey a total of 593,499 individual birds were recorded, within and outside the Project site boundaries, with the peak of migration occurring between the second and third weeks in October and between the second and third weeks in April. Only 47,213 of these individuals were observed flying over the Project site, with the great majority of these being raptors. More than 99% of the birds observed flying within the Project site correspond to the following four species: Turkey Vulture, Swainson's Hawk (Pr), Broad-winged Hawk (Pr) and Franklin's Gull. Migratory raptors generally flew at considerable altitudes, usually more than 300 m above the ground and the risk of collisions, as detailed in the report, is considered to be very low. It is important, however, to maintain, monitoring during the peak days of migration to corroborate that what was observed during this season is the general norm for local flight patterns. Furthermore, with the presence of "nortes" and rains these altitudes can vary significantly such that under these conditions thermals disappear and individuals can experience difficulty gaining altitude. The principal climatic factor encountered during the spring affecting flight altitudes of

migratory birds is the sudden arrival of late nortes, such that to fly facing the wind causes the loss of flight altitude or requires great energetic demands to sufficiently maintain elevation.

Waterbird migration was uncommonly observed during visits and the quantity of these birds was small in comparison to raptor numbers. Species observed include Franklin's Gull, American White Pelican, Wood Stork (Pr), and two species of shorebirds. As with raptors, these species can experience problems in the presence of strong winds and at times flew at low altitudes over the Project site.

With respect to potential impacts of the WRA, it is hoped that few displacements of birds from short dry forest will occur, owing to that forest birds appear less sensitive to the presence of wind turbines than birds of open country. As with most knowledge of birds in the tropics, however, more study is needed to improve the base for opinion on the subject. Nevertheless, the small loss of habitat resulting from the construction of the WRA could, conceivably, give rise to the loss of a limited number of territories of Cinnamon-tailed Sparrow and other protected and resident species. It is unlikely that the potential loss of territories would constitute an important ecological impact, owing to local populations of the sparrow appear to be healthy and international authorities (see IUCN) do not consider the species to be on the brink of extinction. The same is true for other protected resident species, which were found to be uncommon and are assumed to not breed within the Project site.

The vast majority of bird mortality studies carried out at WRAs in the United States and Europe have not demonstrated ecologically significant impacts at the species level. The Project site, however, is located near a major migratory corridor for raptors and other species, in which strong winds obligate birds at times to fly at low altitudes and in unintended directions. A more detailed study of how birds use the airspace is recommended, with the finality to deepen the knowledge of flight routes and hunting strategies with relation to wind conditions and existing habitats.

From the information collected, the following recommendations are suggested:

- More constant monitoring within the WRA, to determine the most influential factors in potential causes of collision.

- Within the WRA, the electrical net that connects to the turbines should be underground to outside the Project site boundaries.

- As much as possible permanent meteorological towers should be free-standing, without guy wires to support them, to avoid potential bird collisions.

- The size of access roads and turbine pads should be minimized, to reduce the amount of overall habitat alteration.

- In the case of nocturnal migration, of which practically nothing is known in the region or the country in general, the illumination of turbines and other structures (*eg.* substations, buildings) should be kept to a minimum and with special lights to reduce the potential for attraction of species that migrate at night.

- Owing to that at the Project site a nationally endangered and internationally near-threatened species breeds (Cinnamon-tailed Sparrow), a breeding bird study should be carried out to determine the distribution and density of this and other breeding species on the site.

- Owing to the considerable number of migratory raptors that transit the surrounding areas of the Project site, and on some days over the site, a more prolonged study of raptor migration should be carried out with the finality to improve the understanding of flight patterns and altitudes of these birds.

- The study of collision fatalities (after the installation of the WRA) should collect information about the total number of collisions and the characteristics of these

fatalities, as well as how to determine the potential accumulative ecological impact that future WRAs could have in Mexico and Central American countries.

- The removal of cadavers within the area of influence of the wind towers is important, since the presence of these is highly attractive to a range of bird species.

- Lastly, but not least important, to paint distinct and unconventional patterns on the rotor blades (in the place of being completely white or with only a pair of bands at the tips) could help birds to detect the blades more easily.

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## 1.0- INTRODUCTION

Historically, the first applications of wind energy basically initiated with the powering of sailing ships, the milling of grains, as well as pumping water, and it was not until the end of the last century that the generation of electric energy began. Utilizing the principle of the natural force produced by wind against a system of metallic blades employed on towers, the generation of this type of energy began. Specifically, wind turbines convert kinetic energy into electricity by way of rotor blades or helices that rotate via a central axis connected through a series of gears to an electric generator.

In Mexico, by mid-1994 the La Venta project in Oaxaca, a 1,575 kW wind power station, entered into operation constituted by 7 Vesta (Danish) wind towers of 225 kW per tower. Wind measurements had been taken at this site beginning in the year 1984. As a result of the findings of these studies, the La Venta station is located in one of the windiest locations in the Isthmus of Tehuantepec; this ministation represents the first experience for CFE of connecting wind towers to the main power grid.

In the present project, the property of Electrica del Valle de México is located in the southern region of the Isthmus of Tehuantepec, Oaxaca. The purpose of this study was to survey the possible impacts to birds derived from the operation of wind towers at the site, for both migratory and resident fauna of this taxonomic group. Consequently, one of the principal objectives is to census birds in the area to determine the diversity of birds present, as well as behaviour patterns to estimate if the operation of said project presents a potential risk to the avifauna. Based on this study, prevention measures were designed to mitigate the possible impact potential (in the case that it exists) of the project on the avifauna during the operation phase.

Equally, the dates chosen to carry out this study were based considering the two seasons of strong migratory bird movement (spring and fall), as well as covering in part the beginning of the breeding season which coincides with the end of the spring migration season. It is considered that in studying these cycles one is covering the most important

stages of bird activity in the region and thus the seasons with the highest potential for risky interactions with the wind towers. By the highest activity it is understood to mean pair courtship prior to the breeding season and migratory movements through the region, which can be heavy and involves much foraging activity and traffic in the area.

### 1.1- Previous Ornithological Works in the Area of Study

Within this area of the country very few avifaunal studies have been carried out, in spite of it being a site of high endemism. Many of the most significant studies in the area were carried out in the XIX century or in the first half of the XX century, and today still serve as the most important basis for regional distribution. Furthermore, the region of the Isthmus of Tehuantepec owing to its privileged location has served as the "type locality" origin for the first descriptions of many species. Beginning with the first scientific collections carried out in Mexico by the Prussian naturalist Ferdinand Deppe, specimens were taken in the region in the year 1825 of a number of species new to the world of science (Stresemann 1954).

After the period that we can call "the collectors era" exists a void of information for the area, with few exceptions of ornithologists that carried out brief visits. Among the most notable visitors we can mention A. R. Phillips (1962), who visited the area in 1960 and was the first to publish notes on the spring migration of raptors and of other species during fall migration in the southern Isthmus.

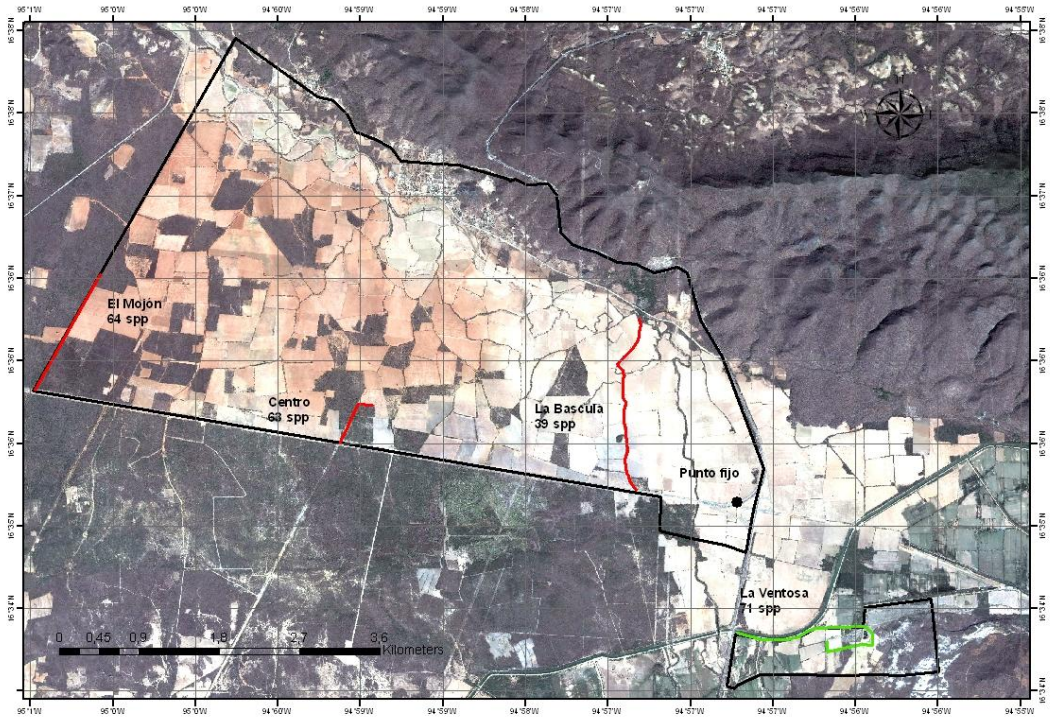
Binford (1989) suggested that the Isthmus of Tehuantepec plays an important role in the migration of birds from North America, using the site to pass between the lowlands of the Atlantic and Pacific slopes.

More recently, among the few references to mention is the field guide for Mexico and northern Central America by Howell and Webb (1995) in which several species are noted as having their entire populations migrate through this region.

## 2.0- STUDY AREA

The proposed site for the WRA is located near the southern part of the Isthmus, in an area known as the Plains of Tehuantepec, a subregion of the Pacific slope lowlands (Binford 1989). From a biogeographic point of view, the Isthmus is an important barrier that limits the distribution of many species. There are, for example, a number of North American species whose southernmost limit ends at the western edge of the Isthmus. On the other hand, many neotropical species reach their northernmost limits at the eastern edge of the Isthmus. Although the Isthmus is considered a biogeographic barrier, it is also an important migratory corridor for birds, those which use the Isthmus to cross between the lowlands of the Atlantic and the Pacific slopes.

The areas of study selected to develop the WRA are located within the vicinity of the towns of La Ventosa and La Mata, pertaining to the municipalities of Juchitan de Zaragoza and Asuncion Ixtaltepec, respectively (Map 1).




**MAP 1.-** Project site and location of the Fixed Point of Observation (Punto Fijo) and the four Line Transects.

The “La Ventosa” estate is composed mostly of cattle pasture, with irrigation canals bordered by the tallest trees found on the estate, living fences and in some parts of the estate is second-growth short dry forest and extensions of “huizachales” (dense stands of *Acacia* sp. trees). The majority of these pasturelands are flooded during the dry season.

The lands encountered within the La Mata ejido are used primarily for the cultivation of sorghum, with small extensions dedicated to cattle pasture. On these lands are also found remnants of short dry forest, huizachales and living fences. Compared to the La Ventosa lands, these are seasonally used (dependent upon dates and intensity of the rainy season) as there are no irrigation canals.

### 2.1- Vegetation

The area of study presents a high degree of fragmentation that in general has been the object of intensive use, principally for agricultural reasons. Within the mosaic of vegetation the following areas were identified: second-growth short dry forest, pastureland, huizachales and sorghum fields. The first is the most important from a biological point of view, since it contains original vegetation from the area and for this reason contains a higher diversity of native flora and fauna.

**Second-growth Short Dry Forest**

This is also known as tropical deciduous forest (Rzedowski 1978). The characteristic of this type of vegetation is that the plant cover is composed of vegetation types typical from tropical regions, dominated principally by tree species that lose their leaves in the dry season for a variable length of time, though generally lasting for 6 months.

Within the area of study exists a joining of vegetation types characteristic of hot climate zones, demonstrating a gradient of higher to lower humidity. This type of vegetation is located between tropical semideciduous forest and thorn forest, and its distribution is typical of the Pacific slope of Mexico. In the southern Isthmus of Tehuantepec, tropical

deciduous forest passes the continental divide continuing to occupy a great part of the central depression of Chiapas. Tropical deciduous forest, in its natural state or slightly disturbed, is usually a dense community and with this offers a notable contrast with respect to the majority of other vegetation groupings. Tree height comprising this vegetation type generally ranges between 5 and 15 m, though most frequently between 8 and 12 m.

**Huizachales**

This plant community is composed solely of trees of the genus *Acacia* and forms dense communities with individual trees of a maximum height of 3 m. Only in its most mature stages does this vegetation type permit the growth of a species-diverse understory.

## 3.0- OBJECTIVES

### 3.1- General Objectives

- To establish the setting prior to the installation of wind towers on the properties of Electrica del Valle de México, by means of surveying migratory and resident bird species.

### 3.2- Specific Objectives

- To collect biological and behavioural information on the migratory and resident avifauna during different seasons of the year in the area of study, including the area of influence.
- To identify bird species protected under at least one of the following: NOM-059-SEMARNAT, IUCN, and CITES.
- To collaborate with the regional coordinator of the WRA and its office.

## 4.0- METHODS

In the case of the La Mata – La Ventosa Wind Power Project, the sites are made up of diverse blocks of flat land. After exploring these lands, accessible sites were selected to carry out censuses on foot, such as along roads or paths of easy transit, with the premise to cover the variety of vegetation types represented. For each transect initial and final coordinates of the line traveled were used; the Datum used in taking these coordinates was WGS84. Also, a fixed observation point with a view of the entire property was selected from where one could observe bird migration and behaviour over the site.

### 4.1- Line Transects

For this methodology three line transects were selected for the La Mata lands (Transecto Centro, Transecto El Mojón, and Transecto Báscula) and one line transect for the La Ventosa lands (Transecto La Ventosa), all within or along the limits of the proposed WRA (Map 1).

Transecto Centro has a length of 1.4 km and runs along the Central-West portion of the property along a PEMEX pipeline; the vegetation along the southern and central portions of this trail is composed of huizachales, and the northern and northeastern portions are dominated by sorghum fields. The coordinates for this trail are: N 16°35’45.2”, W 95°00’30.37” at the extreme South; N 16°36’09.07”, W 95°00’01.6” at the extreme Northeast; N 16°36’11.5”, W 95°00’17.7” at the extreme North.

Transecto El Mojón has a length of 1.35 km and is located along the limits separating the La Mata ejido from its neighbour to the West, running along the western border of the property. The southern portion of this trail crosses a patch of short dry forest, changing to sorghum fields with living fences towards the northern half, and ending within a patch of huizachales. The extreme coordinates for this trail are: N 16°35’49.9”, W 95°00’57.9” at the extreme South and N 16°36’27.8”, W 95°00’35.9” at the extreme North.

Transecto La Báscula, with a length of 1.93 km, is located along the road known locally as San Martín, running essentially South-North within the eastern side of the La Mata ejido. Vegetation along this trail is sparse and consists principally of living fences with small patches of trees midway and at the end of the trail, with this latter patch containing trees of larger size. The rest of the vegetation along the trail consists of almost exclusively sorghum fields and small cattle pastures. The extreme coordinates for this transect are: N 16°35'13.31", W 94°57'20.5" at the extreme South and N 16°36'14.9", W 94°57'18.6" at the extreme North.

Transecto La Ventosa, with a length of 1.69 km, is located within the lands found in the La Ventosa ejido, to the South of the La Mata ejido, and 2 km to the North of the town of La Ventosa. Vegetation along this trail is diverse and consists principally of living fences, pastureland and abandoned fields, with remnants of short dry forest on the eastern side. Within the eastern portion of the property are several small bodies of water, which attract numerous species. This transect runs essentially along the northern and southern boundaries of this property. The extreme coordinates for this transect are: N 16°34'16.9", W 94°55'58.0" at the extreme Northwest; N 16°34'06.0", W 94°55'58.0" at the extreme Northeast; N 16°34'06.0", W 94°56'05.4" at the extreme Southeast; N 16°34'06.03", W 94°56'09.9" at the extreme Southwest.

Data collected along the transect censuses were scribed immediately into a field notebook and later entered into electronic formats designed for this study. Data collected during the transects were the following: species name, number of individuals, flight altitude and direction (if required), distance from the bird or flock to the observer as within or outside of a fixed 25 m limit, and if the birds were found within or outside of the study area for the El Mojón and La Ventosa transects. Each line transect was censused once per work period (on average once every 15 days), always during the first 2 hours of light and when climatic conditions were generally favourable (ie. little wind and without rain).

With the information collected by means of this methodology species lists for the Project site were made, species abundance per unit area was calculated (number of individuals per unit area [Ralph *et al.* 1996]) and species distribution was assessed.

**4.2- Fixed Point of Observation**

For the fixed point methodology, a vantage point was located at the edge of an overpass between federal highway 185 and the exit to the new toll highway to Salina Cruz (Map 1). From this point, the entire property within both the La Mata and La Ventosa ejidos could be observed. Furthermore, from this point is a perfect view of the Sierra de Tolistoque running Northwest to Southeast just North of the area of study and of Paso Chivela to the Northeast, two important orographic features of the local landscape for migratory birds.

From this point and for this methodology information referring to the behaviour of birds using the airspace within and outside the Project site was collected. Each interaction (flyover) was recorded in an independent manner, regardless of the whether the same individual was observed during the same hour or day.

Data collected from this point were scribed into a field notebook and later transferred into electronic formats designed for this study. Data recorded in the field were the following: species name, number of individuals, flight height and direction. These data were collected at hourly intervals, along with climate data at the top of every hour. Observations were carried out daily during each work period, for an average of 8 hours per day (0900-1700) unless climatic conditions were unfavourable (ie. rain or extremely violent wind).

Bird identification was complemented with the help of specialized field guides, such as Howell and Webb (1995), principally for year-round and summer residents, and Sibley (2000) for migratory species (including transients and winter residents).

**4.3 – Collision Risk**

This calculation provides estimates of the number of movements for each species (and grouped by species affinities) that are found under potential risk of collision with the turbines within the area of study. This has been calculated for turbines 124.5 m in height with 89 m diameter rotors, with 3 avoidance rates selected (95%, 98%, and 99%). Realistic avoidance rates are above 90%, and studies to date have revealed rates between 95 and 100% for a wide range of species in the majority of circumstances.

A way to quantify levels of collision risk for birds with the turbines is using Stage I calculations from the Band Collision Risk Model (Band *et al.* 2005).

To calculate the collision risk estimate we assume that birds will avoid colliding with the base of the wind tower, below the rotor blades. For the rotor swept area, we provide predictions for movements at altitudes of risk for each of the following avoidance rates: 95%, 98%, and 99%.

This preliminary report of risk evaluation, combining variables that are specific to the particular WRA and birds that inhabit the vicinity, includes the following:

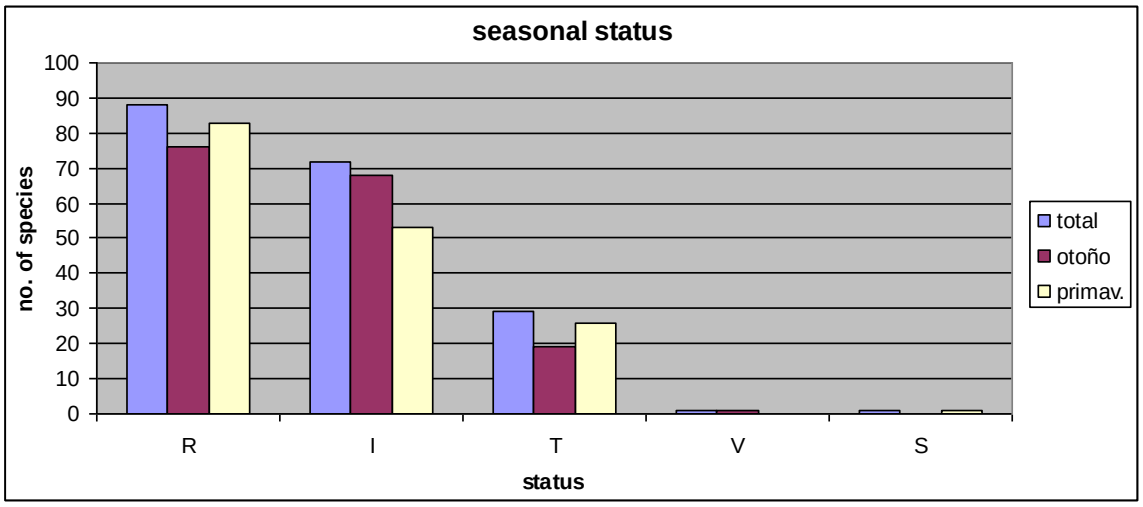
a) The number of birds flying at heights within the rotor swept area range and for which the blades present a risk of collision. These data were obtained from the collection of observations during the Fixed Point censuses during Fall 2007 and Spring 2008.
b) The rotor swept area ($m^2$) is the zone of risk for birds. We assume that birds can approach the turbines from any direction and share equal risk regardless of the direction of approach, thus presenting the worst case scenario for the estimation of preliminary risk.

## 5.0- RESULTS AND DISCUSSION

### 5.1- Avian Diversity

The diversity of birds within the area of the Project site for the fall season was evaluated as a function of the work carried out during the period from 13 October to 14 November 2007 and 18 March to 7 May 2008. During these periods a total of 175 bird species was encountered, pertaining to 43 bird families (Appendix 1). This total represents 16.26% of the 1076 species registered in Mexico. This percentage is high and represents a great diversity of species using the area.

Of the 175 species registered 88 are considered year-round residents (R), 72 winter residents (I), 29 transients (T), one species a summer resident only (S) and one accidental species (V) (Fig. 1). Note that the sum of the species does not equal 175, owing to the fact that some species maintain both resident and migratory populations in the area, and are assigned to more than one status category. Not surprisingly, year-round resident species dominate the total number of species at 50.28%.




R = Year-round Resident, I = Winter Resident, T = Transient, V = Accidental, S = Summer only.

Otoño = Fall season, primav. = Spring season.

**FIG. 1-** Species totals by seasonal status categories for all species encountered during Fall 2007 and Spring 2008 surveys at the Project site.

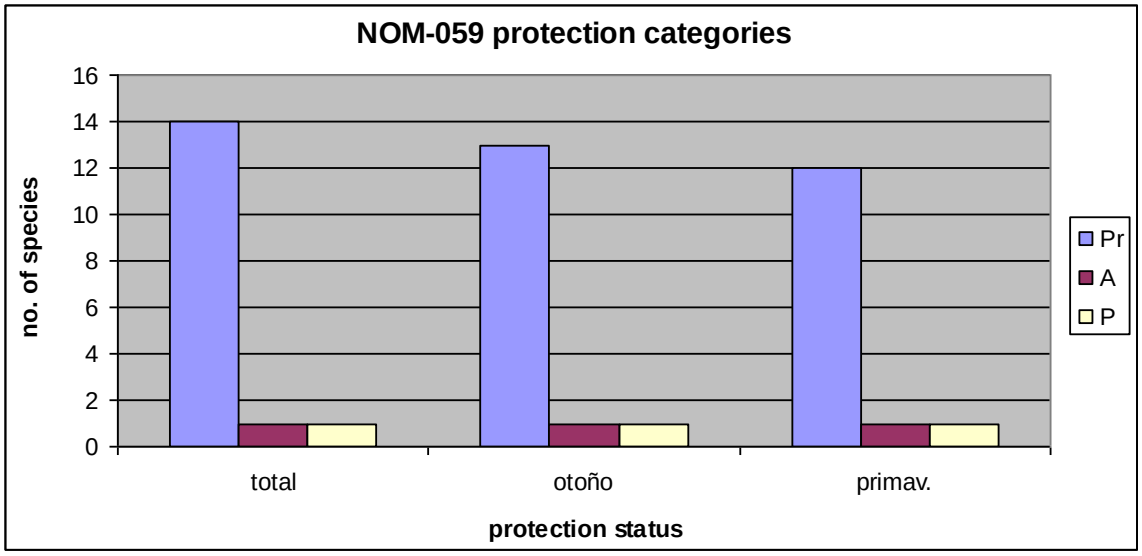
To clarify, 19 species of birds registered to date at the Project site have both year-round and winter resident populations such that the sum of the species for the five categories is greater than the total number of species indicated (175). This characteristic of populations is rarely referred to in the literature, but from an ecological point of view it is important owing to the increase in these populations for roughly half of the year.

During the fall season 147 species were registered pertaining to 39 families and in the spring season 148 species pertaining to 43 families. Despite the similarity between the season species totals there were 27 species that were not found between seasons, reflecting the difference in avifaunal composition existing between seasons of the year and supporting the importance of a long-term study. The dominant individuals during these two periods were year-round residents, with a total of 51.7% in the fall and 56.08% in the spring; the higher percentage of year-round resident individuals in the spring can be attributed to several of these species carrying our regional movements outside of their reproductive periods.

As to be expected, during the fall season more wintering species were encountered than during the spring season, since in the early spring many species have already begun their return migrations to the north. On the contrary, during the spring a higher number of transient species were recorded owing to many of these types of species carrying out an elliptical migration: using more easterly migration routes in the fall and more westerly routes in the spring. All of these movements are influenced by dominating wind directions through the different seasons.

**5.2- Nationally Protected Species**

The Mexican Official Norm is in charge of caring for species at risk within the republic. The NOM-059-SEMARNAT-2001, which is that concerning native flora and fauna of the country, has three risk categories following the status of bird populations: Special Protection (Pr), Threatened (A, in Spanish), and Endangered (P, in Spanish); this last category covers species with the highest degree of risk to their populations generally due to extremely low numbers of individuals. During the two seasons of field work, 16 species under national protection were found, divided in the following manner: 14 species under special protection (Pr), one (1) threatened species (A) and one (1) endangered species (P) (Appendix 1) (Fig. 2).




Pr = Special Protection, A = Threatened, P = Endangered. Otoño = Fall, primav. = Spring.

**FIG. 2-** Species totals by NOM-059-SEMARNAT-2001 protection status for all species encountered during Fall 2007 and Spring 2008 surveys at the Project site.

Thus, 9.4% of all species encountered at the Project site are under some degree of national protection according to Mexican law. This indicates that nearly one in every 10 species registered is under some degree of threat to their populations. Analyzing this further, 9 of the 16 species protected under the NOM-059-SEMARNAT-2001 are year-round residents, indicating the importance of these species due to their higher incidence of site use and these species can serve as better indicators of the conservation state of their environments.

Eleven (11) of the nationally protected species encountered are raptors, including seven (7) migratory species that only pass through the Project site and at least two (2) of them do so in relatively large numbers (Swainson's and Broad-winged hawks). Two (2) species pertain to the family Psittacidae (Orange-fronted and Green/Pacific parakeets), which normally fly at low altitudes over forest among nesting, roosting and feeding sites. Wood Storks were found only passing through the study area and their flight altitudes were generally greater than 200 m above the ground.

With respect to Cinnamon-tailed Sparrow, the only federally endangered species encountered, it is very unlikely that this species will suffer any risk of collision owing to that this species not being known for making exhibition flights and it is a year-round resident confined to forest that, to date, is known neither to undergo altitudinal migrations nor migrate through the Isthmus.

The number of species encountered under some degree of protection under federal law can be broken down in the following manner: under the category of Special Protection (Pr) 13 species were encountered in the fall and 12 in the spring; under the category of Threatened (A) one (1) species was found in each season; and under the category of Endangered (P) one (1) species was found in each season (Fig. 2). The distribution of these species between the two seasons was very similar owing to the presence of the year-round resident species in both seasons and the movement of nearly all migratory species along reversed migration routes between seasons.

**5.3- CITES List (Convention on International Trade in Endangered Species of Wild Fauna and Flora)**

The species listed by CITES-participating countries are under one of three levels of protection (referred to as Appendices I-III).

The Appendices are defined in the following manner:

- Appendix I.- Includes species threatened with extinction that are or could be threatened by commerce. The commerce of species in Appendix I may be used only in exceptional circumstances.
- Appendix II.- Includes species that are not actually endangered, but could arrive to this point if their commerce is not regulated. As well, includes species that need to be regulated such that their commerce can be controlled effectively; these species are commonly listed owing to their similarity to other species in CITES.
- Appendix III. - Includes species listed by any country to obtain international help in the control of its commerce.

From the results of this work, a total of 28 CITES species were encountered at the Project site with one (1) species under Appendix I (Peregrine Falcon, *Falco peregrinus*) and 27 species under Appendix II (Appendix 1). Peregrine Falcon has been listed owing to drastic population declines several decades ago due to certain pesticides thinning their eggshells, as well this species popularity among falconers (hunting with falcons).

This large number of species (28) listed in CITES reflects the international problem of the trafficking of wild species, principally a problem for long-lived species such as raptors for which the recuperation of their numbers due to loss of individuals requires much time.

The total number of CITES species for the fall season was 24 species, with one (1) species listed under Appendix I and 23 listed under Appendix II. For the spring season the number of CITES species was 26, with one (1) species under Appendix I and 25 under Appendix II. The small difference in CITES species between seasons can be attributed to a higher number of hummingbird species present in the spring season.

### 5.4- IUCN List (The International Union for the Conservation of Nature and Natural Resources)

In the present work, four (4) species were encountered within the IUCN list, all within the lowest threat category: Near Threatened (NT). These species are: Olive-sided Flycatcher (*Contopus borealis*), Bell's Vireo (*Vireo bellii*), Cinnamon-tailed Sparrow (*Aimophila sumichrasti*), and Painted Bunting (*Passerina ciris*) (Appendix I). Of these four (4) species, three (3) are included in the IUCN list owing to drastic declines in their populations in recent decades due to, principally, loss of habitat. Painted Bunting is also believed to be declining due to unsustainable commerce, particularly from trapping on its wintering grounds.

The fourth listed species, Cinnamon-tailed Sparrow (*Aimophila sumichrasti*), as mentioned in a previous section, is range-restricted and endemic to the Isthmus of Tehuantepec, making it susceptible to suffer population declines.

The four (4) IUCN listed species were found in both the fall and spring seasons, three (3) of them being migratory species and the aforementioned one (1) year-round resident.

**5.5- Endemics**

With respect to nationally endemic species, a total of five (5) species was encountered within the Project site: West Mexican Chachalaca (*Ortalis poliocephala*), Citreoline Trogon (*Trogon citreolus*), Rufous-backed Robin (*Turdus rufitorques*), Orange-breasted Bunting (*Passerina leclancherii*) and Cinnamon-tailed Sparrow (*Aimophila sumichrasti*) (Appendix 1). Cinnamon-tailed Sparrow is the only endemic species that is also protected under the NOM-059-SEMARNAT-2001.

It is important to mention that of these five (5) species endemic to Mexico, all but Rufous-backed Robin have very localized populations and are threatened by loss of habitat, specifically within short dry forest, the most extensive vegetation type on the Pacific slope. These species can be important indicators of the state of health of their ecosystems.

During the fall season four (4) nationally endemic species were encountered and five (5) endemics during the spring, with Rufous-backed Robin found only during the spring season. This number of endemic species represents the importance of the Isthmus of Tehuantepec as a point of species divergence in evolutionary terms, as is also the case for other flora and fauna in the region.

## 5.6- Distribution and Richness of Species: Description of Bird Communities

### 5.6.1- Distribution

The species encountered within the Project site were distributed principally within areas with some degree of vegetation cover, such as living fences though moreover huizachales and remnants of short dry forest; these latter two habitats contain more abundant vegetation and dense plant cover than the former. It should be noted the importance that remnants of short dry forest provide, found scattered and of varying patch sizes within the Project site. These remnants house many year-round resident species, as well as many winter residents with forest-related habitat requirements. To a lesser degree, however, some species encountered were open-area specialists, such as in pasturelands and cultivations; of these species were found both year-round and winter residents.

With respect to migratory species, these were distributed in a similar manner among the four transects: 44.59% Transecto Centro, 43.58% Transecto Báscula, 40.36% Transecto La Ventosa, and 47.5% Trasecto El Mojón. This is in agreement with what is generally understood for migratory species which, owing to their seasonal status, tend to have a greater plasticity and capacity for adaptation to different habitat types encountered along their migratory journeys; thus, the majority of these species use more disturbed habitats.

In contrast, year-round resident species generally have much more specific habitat requirements and are more sensitive to changes than migratory species, which represent 55.9% Transecto Centro, 56.42% Transecto Báscula, 59.64% Transecto La Ventosa, and 52.5% Transecto El Mojón. For these proportions, it should be taken into account that some species have both resident and migratory populations.

These species groups varied in proportion significantly among transects between seasons (Table 1). As can be seen in the table the proportion of migratory species is much lower during the spring, probably owing to the spring migration being much more dispersed

compared to the fall migration, as well as differences in climatic conditions and changes in flight routes.

**TABLE 1 -** Percentage of migratory species encountered during transects for the two field seasons.

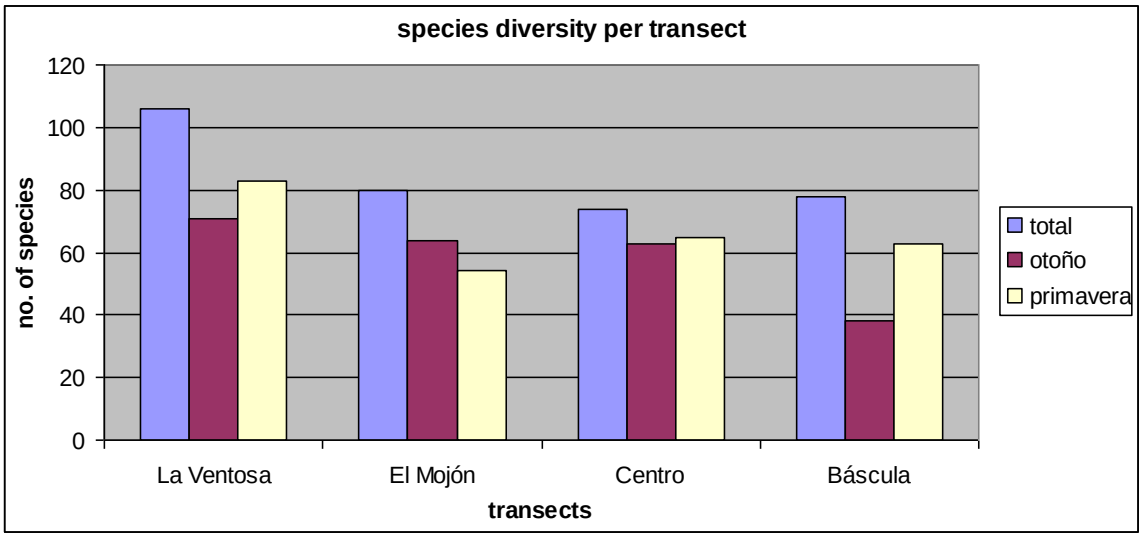
| | Centro | La Báscula | La Ventosa | El Mojón |
|---|---|---|---|---|
| **Fall** | 49.2% | 57.95% | 45.1% | 46.91% |
| **Spring** | 20% | 36.5% | 31.32% | 31.25% |

For their part, year-round resident species are much more conspicuous in the spring owing to the beginning of the breeding season and this makes them more easily encountered, such as during courtship display or increased foraging activity while raising chicks.

### 5.6.2- Species Diversity

Species diversity from the transect censuses was found to be very similar among three of them: El Mojón, Centro and La Báscula; the fourth transect, La Ventosa, had a higher diversity than the other three (Fig. 3). The La Ventosa transect was also the only transect proximate to a body of fresh water with an irrigation canal running along a significant portion of the transect length; this most probably helped to increase the relative number of species found owing to the paucity of fresh water in this area of the Isthmus, especially in the drier spring months.

Within the four transects was found a total of 140 species, divided as follows: 106 species at La Ventosa, 80 species at El Mojón, 74 species at Centro and 78 species at La Báscula. The great similarity between the second and fourth transect is obvious, both of which have moderate plant cover and heterogeneity of vegetation types with respect to the other two (Fig. 3).




Otoño = Fall, primav. = Spring.

**FIG. 3-** Number of species encountered in the Fall 2007 and Spring 2008 surveys for each line transect.

With respect to the spring season, a total of 113 species were registered in the transects with 83 species at La Ventosa, 54 species at El Mojón, 63 species at El Centro, and 63 species at La Báscula. In the fall season transects, a total of 107 species were encountered with 71 at La Ventosa, 64 at El Mojón, 63 at El Centro, and 38 at La Báscula.

As can be seen in Figure 3 species totals per season among the transects were similar, although the variation in the totals for each transect in the two seasons of study were a little different. A great influence among transects is the availability of water and diversity of habitats, principally in the spring season. In the spring, available water tends to be scarce, the sites being also occupied with a greater floristic diversity and lands, principally for migratory species. Although in the case of year-round resident species the situation is a little different, since the most conserved sites are used for purposes of reproduction.

### 5.6.3- Abundance

From transect data were found different bird abundances per unit area (hectare) (Table 2). In the results it can be seen again the importance of natural plant cover with the abundance of individuals registered, that which concurs with the diversity of birds found in the censuses. The high percentage of individuals found at the La Ventosa and El Mojón transects is influenced by the presence of great numbers of White-winged Dove (*Zenaida asiatica*) and Scissor-tailed Flycatcher (*Tyrannus forficatus*). Additionally, these transects are relatively close to large extensions of sorghum fields and are found between roosting and feeding sites of these species. Besides the influence of vegetation, the La Ventosa transect runs along one of the few bodies of water in the area, a large irrigation canal, attracting a large number of species and individuals.

**TABLE 2.-** Number of hectares surveyed per transect and the number of individuals per hectare per season.

| | La Ventosa | | | El Mojón | | | Centro | | | La Báscula | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fall | Spr. | Tot. | Fall | Spr. | Tot. | Fall | Spr. | Tot. | Fall | Spr. | Tot. |
| **No. Ind./ha** | 162.7 | 112.3 | 275 | 71.4 | 45.03 | 116.43 | 22.7 | 15.85 | 38.55 | 28 | 39.37 | 67.37 |
| **Hectares** | 8.45 | | | 6.75 | | | 7.0 | | | 9.65 | | |

**Note:** No. Ind./ha = number of individuals per hectare.

As can be seen in Table 3, the abundance of migratory individuals has a great influence on the community of birds during the fall and winter seasons. As per the previous table, the transects with higher bird abundances were those with a greater natural plant cover, as described previously for each transect.

**TABLE 3.-** Number of migratory and year-round resident individuals registered per hectare per season in each transect.

| | La Ventosa | | | El Mojón | | | Centro | | | La Báscula | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fall | Spr | Avg | Fall | Spr | Avg | Fall | Spr | Avg | Fall | Spr | Avg |
| **Migrants** | 141.6 | 34.3 | 87.95 | 41.7 | 6.2 | 23.95 | 11.7 | 2.7 | 7.2 | 23.2 | 12.3 | 17.25 |
| **Residents** | 21.1 | 77.9 | 49.5 | 29.6 | 38.8 | 34.2 | 11 | 13.1 | 12.05 | 4.8 | 27 | 15.9 |
| **Hectares** | 8.45 | | | 6.75 | | | 7.0 | | | 9.65 | | |

**Note:** Migrant and Resident quantities are expressed as number of individuals per hectare.

Compared like this, the transects are diametrically opposed in their composition between the two field seasons. While in the fall season migratory species dominate the total number of individuals per hectare, in the spring season the exact opposite occurs (Table 3). Again, this only demonstrates that the migration during the fall is more concentrated than during the spring, being more strongly used the Isthmus of Tehuantepec by migratory species in the southbound migration season and on the other hand it puts to manifest itself the greatest activity of year-round resident species occurs with the arrival of the breeding season.

With respect to species listed under the NOM-059-SEMARNAT-2001 and IUCN encountered during the transect censuses, abundances were low for the majority at less than one individual per hectare (Table 4). This can be explained from the point that a two-thirds of these species are migratory, which are generally found either singly or in pairs, especially outside of the breeding season, such as in the fall.

The protected species with the highest proportion of individuals per hectare is Cinnamon-tailed Sparrow; its strong presence due to remnants of short dry forest found almost throughout the El Mojón transect, which is the species's preferred habitat, as well as short closed shrubs mixed with some original short dry forest plants and in these sites combined with huizachales with dense cover provided by the understory. This same habitat is found within the southern portion of the Centro transect.

Again, differences between the two seasons were marked, with the fall season being more abundant in the number of species and principally number of individuals per hectare. This difference in the number of species and individuals per hectare is marked especially between seasons at El Mojón and Centro.

**TABLE 4.-** Number of individuals and individuals per hectare of NOM-059-SEMARNAT-2001 and IUCN listed species at each line transect per season.

| Species | La Ventosa | | El Mojón | | Centro | | La Báscula | |
|---|---|---|---|---|---|---|---|---|
| | Fall | Spring | Fall | Spring | Fall | Spring | Fall | Spring |
| **Cooper's Hawk** | - | - | 6 / 0.88 | - | - | - | - | - |
| **Green/Pacific Parakeet** | - | 5 / 0.59 | 3 / 0.44 | - | - | - | - | - |
| **Peregrine Falcon** | 1 / 0.11 | - | - | - | - | - | - | - |
| **Bell's Vireo** | 1 / 0.11 | 2 / 0.23 | 1 / 0.14 | 2 / 0.29 | 4 / 0.57 | 1 / 0.14 | 2 / 0.2 | 2 / 0.2 |
| **Cinnamon-tailed Sparrow** | - | - | 14 / 2.07 | - | 21 / 3 | 8 / 1.14 | - | 1 / 0.1 |
| **Painted Bunting** | 2 / 0.23 | 4 / 0.47 | 12 / 1.77 | - | 9 / 1.28 | - | - | 1 / 0.1 |

## 5.7- Fixed Point of Observation

From the count site, a total of 593,499 individuals were registered in 238 hours of observation. Of this total, 588,660 (99.18%) were migratory individuals flying over or outside of the study area, including the Sierra de Tolistoque. Only 47,213 (7.95%) individuals were seen flying over the study area at different altitudes, of which 46,699 (98.91%) individuals were migrants and the rest were residents.

The great majority of individuals recorded (541,084, or 91.16%) were observed flying along the Sierra de Tolistoque. The sierra is found to the North of the study area and serves to concentrate flocks of migrating raptors and aquatics, which were visible when they left the protection of the Sierra; migrating birds also use the sierra as a guide, and the updraft winds created along its ridges aid in migration (Fig. 4).

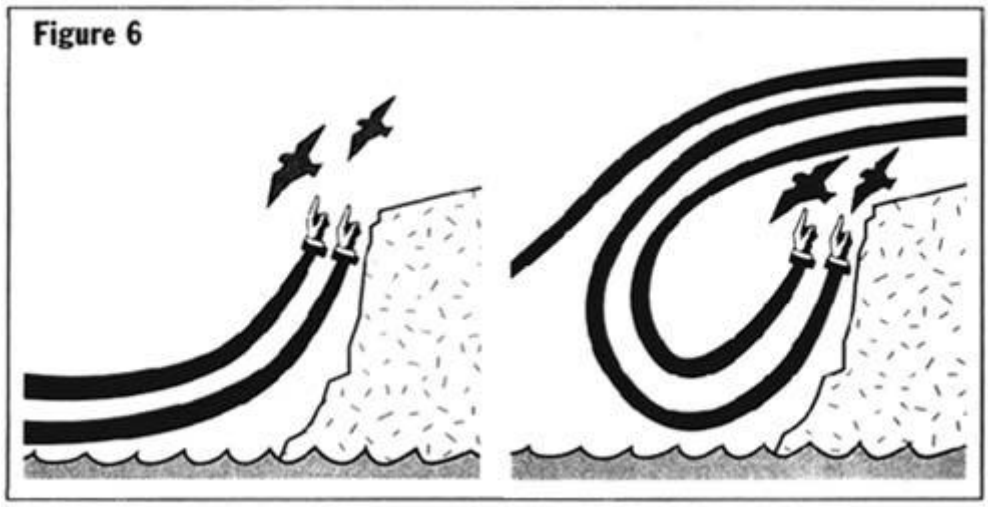
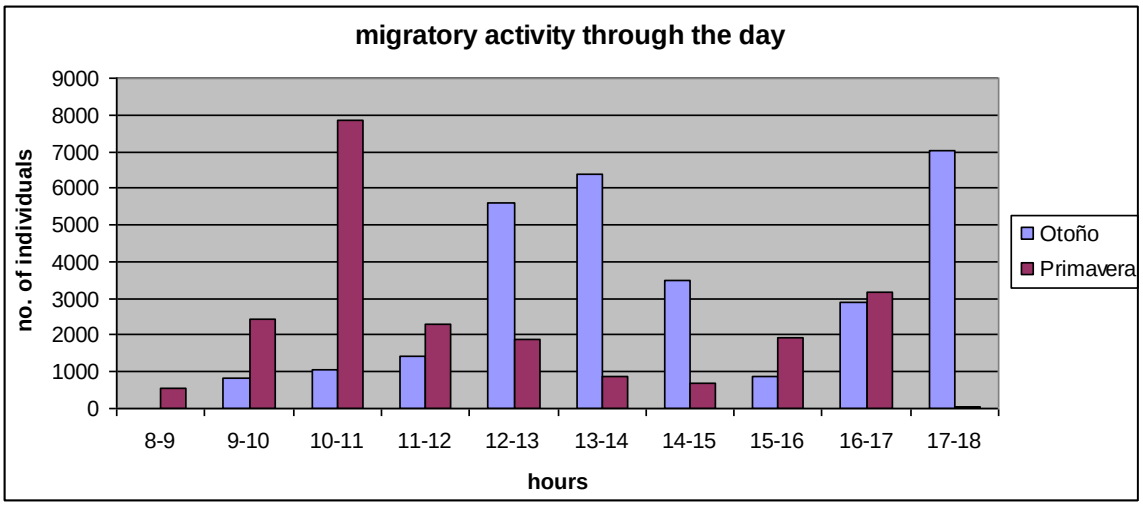



**FIG. 4-** The formation of updrafts around ridges.

Diurnal migration during the day was different in the two seasons, but with the similarity of always having a peak activity at the end of the day. During the fall season migration peaked around midday when climate conditions were most favourable, with higher ambient temperatures creating necessary thermals (Fig. 5). In comparison, the daily activity during the spring season had its principal peak at the end of the morning before temperatures were too hot and birds (migrants and residents) flew at very high altitudes such that in many cases these individuals flew at such high altitudes as to be nearly undetectable. The formation of currents of warm air, or thermals, is created by the heating of extensions of land, and they are unevenly distributed existing in more exposed parts of the ground with less plant cover.




Otoño = Fall, primav. = Spring.

**FIG. 5-** Total number of individual encountered by hour during the Fall 2007 and Spring 2008 seasons within the Project site.

Groups encountered migrating over the property were for the most part small, those which seemed to pass through the area known as Paso Chivela. Regardless of the migration season, these small groups were seen using the Sierra de Tolistoque as a reference and as protection from strong winds, indicating the importance of this sierra in the migratory routes of many species of raptors and large aquatic birds.

### 5.8- Flight Behaviour (height and direction)

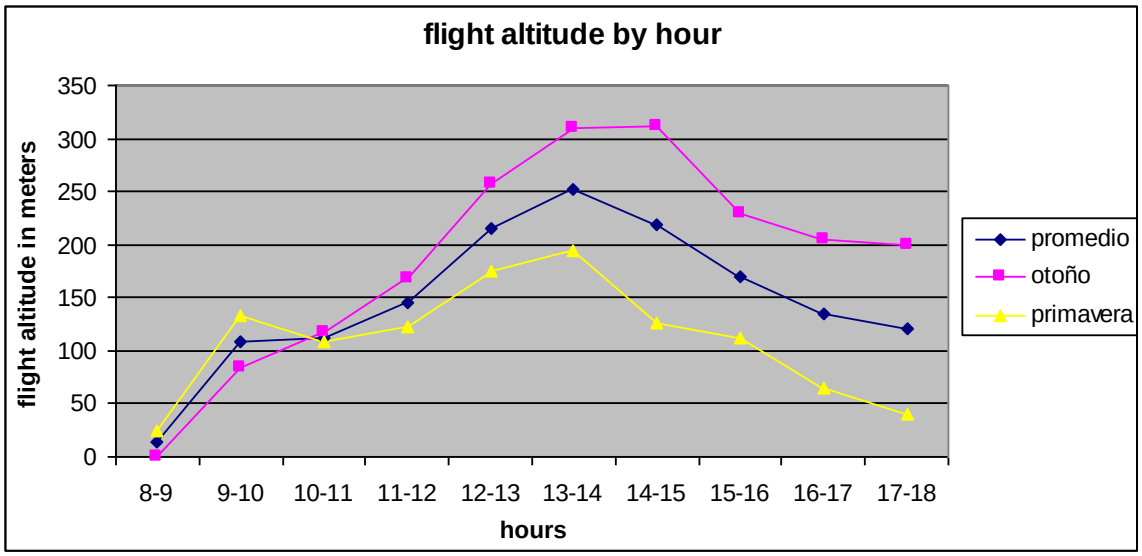
#### 5.8.1- Flight Altitudes

A very important variable within this study owing to the nature of the projects to be carried out is the height above the ground at which migratory and resident birds pass the Project site.

In the present work, it was found that flight behaviour of birds is strongly linked to the hours of the day and temperature, and thus the formation of thermals. Some species maximize the use of these rising currents of warm air for their migratory journeys and to

conserve energy (Fig. 6), as well as to increase their flight altitudes. In the figure, it can be seen in a general manner the flight altitudes increasing significantly from 1000 reaching its peak between 1300 and 1400, coinciding with the highest temperatures of the day. Among the factors that can affect these flight altitudes are wind (velocity) and if there is some climatic condition in the area, such as regional rains or storms.

It is important to mention that several species of raptors do not always use this resource (thermals), preferring to use a flapping method for the majority of their migration, principally species within the genera *Accipiter* and *Falco*. These species hunt in the first hours of light and at midday begin to use thermals to continue their migration.




Promedio = Average, Otoño = Fall, primav. = Spring.

**FIG. 6-** Average flight altitudes per hour per work period for the Fall 2007 and Spring 2008 seasons.

If we observe flight altitudes collectively for each of the work periods carried out (Fig. 6), it can be seen that in the fall flight altitudes are higher than in the spring, even though the flight pattern throughout the day is very similar, which generally correlates with respect to climatic conditions for flight in general.

The presence of the Sierra de Tolistoque definitely appears to influence the flight height of species, especially migrants, which make up the majority of the individuals registered in this study. This is due almost entirely to migratory individuals using the sierra as a guide while migrating, equally for individuals and flocks that found or directed toward the sierra or the lowest passes along it, in many occasions or depending on the season (arriving at higher altitudes during the fall owing to the strong use of the sierra by individuals arriving from the north), at least at 500 m in height. Resident species use the sierra as well, although more frequently along its foothills.

When the species leave the protection of the sierra or fly towards it, they begin to glide and experience a loss of altitude, which is reflected in the flight altitudes among species found flying within and outside the study area.

Flight altitudes were taken for each bird interaction observed within the study area. Later, these altitudes were grouped into three categories: less than 35 m above the ground; 35-125 m above the ground; and more than 125 m above the ground. The basis for these categories is with reference to the maximum and minimum reach of the turbine rotor blades (35-125 m), and the spaces below and above this range. The total number of individuals found within these three categories within the study area are as follows: 16,879 individuals below 35 m (32.99%); 5,049 individuals within 35-125 m (9.87%); and 29,230 individuals above 125 m (57.14%) (Fig. 7).

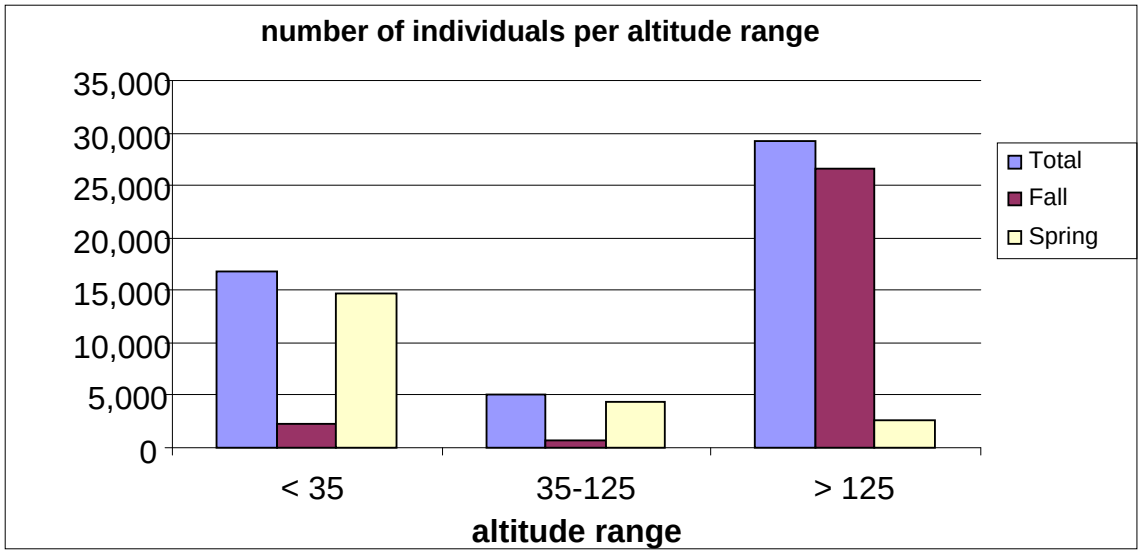



**FIG. 7-** Number of individuals per flight altitude category from the Fall 2007 and Spring 2008 study, within the study area.

As can be seen in the results one in each 10 bird interactions over the Project site occurred at altitudes that could be potentially risky in the rotor swept area, although there is to take into account that many registers refer to the same individuals.

A total of 34 species were encountered flying within the range of the rotor blades (35-125 m), of which 19 are year-round residents, 21 are winter residents, with 6 species considered to have both year-round and winter resident populations. Of the total number of individuals passing within the range of the rotor blades, 80.92% (5,049 individuals) was comprised of 6 species, of which four were migratory species and the other two have both year-round and resident populations: Franklin's Gull (*Larus pipixcan*, 3,128 individuals); Turkey Vulture (*Cathartes aura*, 867 individuals); Barn Swallow (*Hirundo rustica*, 348 individuals); Black Vulture (*Coragpys atratus*, 227 individuals); Violet-green Swallow (*Tachycineta thalassina*, 116 individuals); and American White Pelican (*Pelecanus erythrorhynchos*, 120 individuals).

With these numbers we can notice that regardless of the time of year they are almost the same species encountered flying at potentially risky altitudes. The comparison of the fall and spring seasons is important since the flight behaviour of birds is very different

between seasons. Beginning with the number of species that fly between 35 and 125 m, in the fall 25 species were registered of which 18 were migratory and 10 year-round residents (with three (3) species bearing both status categories); in the spring 26 species were registered of which 15 were migratory and 13 year-round residents (with two (2) species of both status). Despite the fall period registering the more species, the spring season presented a higher number of individuals passing through the rotor swept area (RSA) range, with only 693 individuals encountered in the fall in the RSA range compared to 4,356 individuals in this range in the spring. The majority of the individuals observed in the spring flying between 35 and 125 m on the Project site pertain to just one species, Franklin's Gull, representing 71.8% (3,128 individuals) of the individuals registered in the spring season and almost always during the first few hours in the morning, since in the hotter hours of the day birds gain more altitude using existing thermals to continue their journeys, unless there were winds with velocities greater than 40 km/h.

It is important to mention that the majority of the observed low flights were presented on days of strong north winds. In the fall flight altitudes decreased considerably when winds passed 50 km/h, and in the spring it was observed, principally with Franklin's Gull, that the flight altitudes are low when the wind passes above 40 km/h.

Of the 34 species registered within the rotor blade range 10 are protected under the NOM-059-SEMARNAT-2001, nine (9) of these with Special Protection (Pr) status and one (1) Threatened (A). Within the first category are: Wood Stork (*Mycteria americana*, 2 individuals); Hook-billed Kite (*Chondrohierax uncinatus*, 7 individuals); Cooper's Hawk (*Accipiter cooperi*, 9 individuals); Great Black-Hawk (*Buteo urubitinga*, 1 individual); Zone-tailed Hawk (*Buteo albonotatus*, 1 individuo); White-tailed Hawk (*Buteo albicaudatus*, 41 individuals); Broad-winged Hawk (*Buteo platypterus*, 2 individuals); Swainson's Hawk (*Buteo swainsoni*, 15 individuals); Peregrine Falcon (*Falco peregrinus*, 4 individuals). Under the category of Threatened were 50 individuals of Green/Pacific Parakeet (*Aratinga holochlora/strenua*). The total number of individuals encountered protected under the NOM-059-SEMARNAT-2001 was 128, which

represents 2.53% of all the individuals registered within the 35-125 m range. Seven (7) of these protected species are considered to be of transient status within the region.

The distribution of protected species observed in the 35-125 m range at the Project site during the two field seasons was eight (8) NOM-059 species registered in the fall and seven (7) during the spring. With respect to the number of interactions for each season, in the fall 60 individuals (1.18%) were encountered and in the spring 81 individuals (1.6%). These totals do not represent a significant portion of the total number of individuals recorded during the study period.

If we look at the flight altitudes throughout the hours of the day, the overall flight behaviour is well-defined during the hottest hours of the day, from after 1100 until 1700, when the number of flying individuals increases as well as the average flight altitudes and the number of low-flying individuals decreases. With this we can infer that the most dangerous hours for birds in flight with respect to the potential area covered by wind towers would be in the first hours of the day, before climate conditions are more favourable for higher flight.

There are definitely recognizable climate conditions that can predict conditions producing potentially dangerous flight altitudes for birds, such as cloudy and rainy days in the region. Generally, these conditions are associated with low clouds and little wind, principally at the end of the hurricane season and the beginning of the cold front ("nortes") season. These conditions are normally present at the end of October, which is also the month of greatest migratory bird activity. Another climatic situation which could be potentially dangerous for bird-wind tower interactions is beginning late October and through the month of November (Fig. 8), when low temperatures and strong constant winds from the North combine and prevent the formation of thermals, and flight altitudes can change drastically from one day to another.

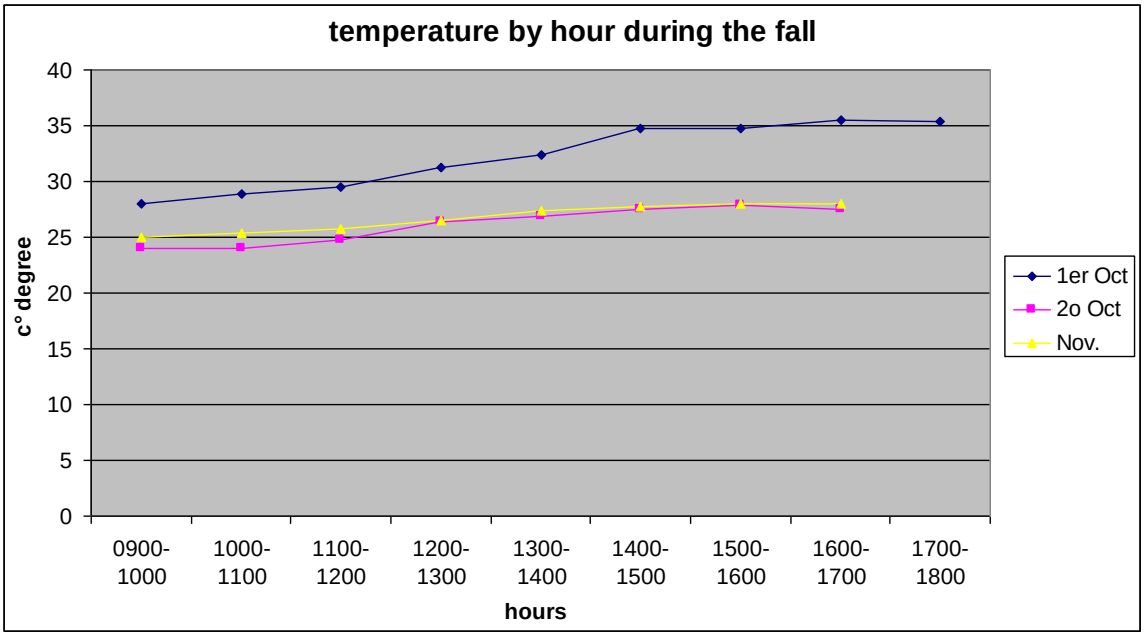



**FIG. 8-** Temperature changes per hour per period during the different periods in the Fall 2007 season.

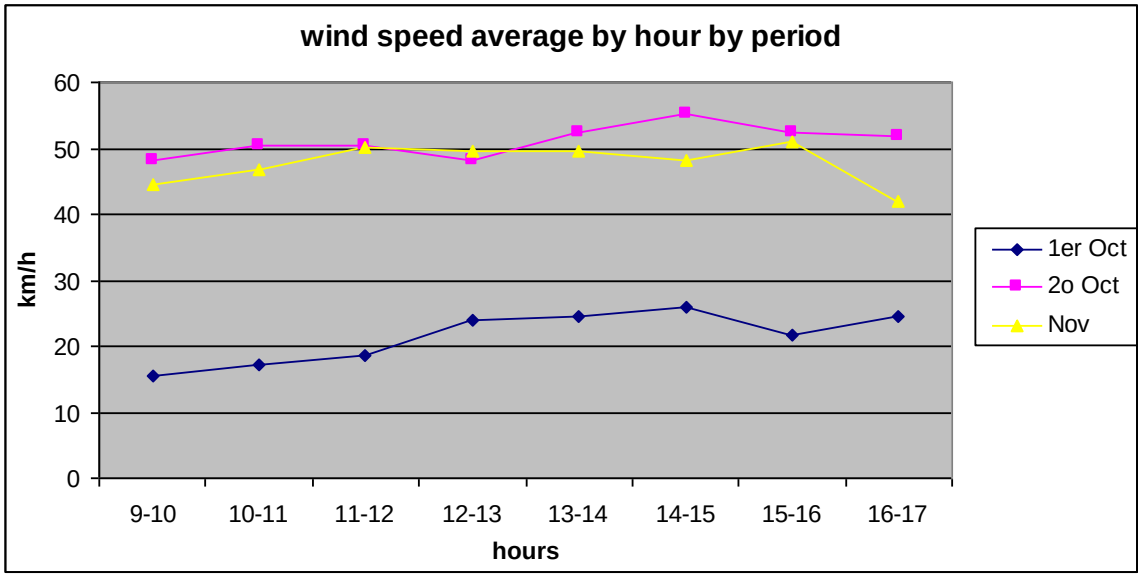



**Fig 9**.- Wind speed average per hour per period during the Fall 2007 season.

For its part, during the spring season (Figs. 10-11), which coincides with the beginning of the breeding season, climatic conditions could be potentially dangerous for flight

altitudes when there are strong winds from the north and migration to the north is occurring, since flying head on into the wind always obligates birds to lose flight altitude. With respect to year-round resident species, the spring season represents the greatest activity and use of the lands, increasing the probability of flights through the rotor swept area range. Temperature has an influence on flight altitude from the aspect that at higher temperatures birds can fly higher with greater ease, even when winds are strong. Temperatures during the spring period are more stable and their variations are not as well-defined when compared to the fall, when from month to month well-defined variations are presented. On the contrary, during the spring season wind conditions are more variable and less predictable, even though average wind velocities are greater during the fall.

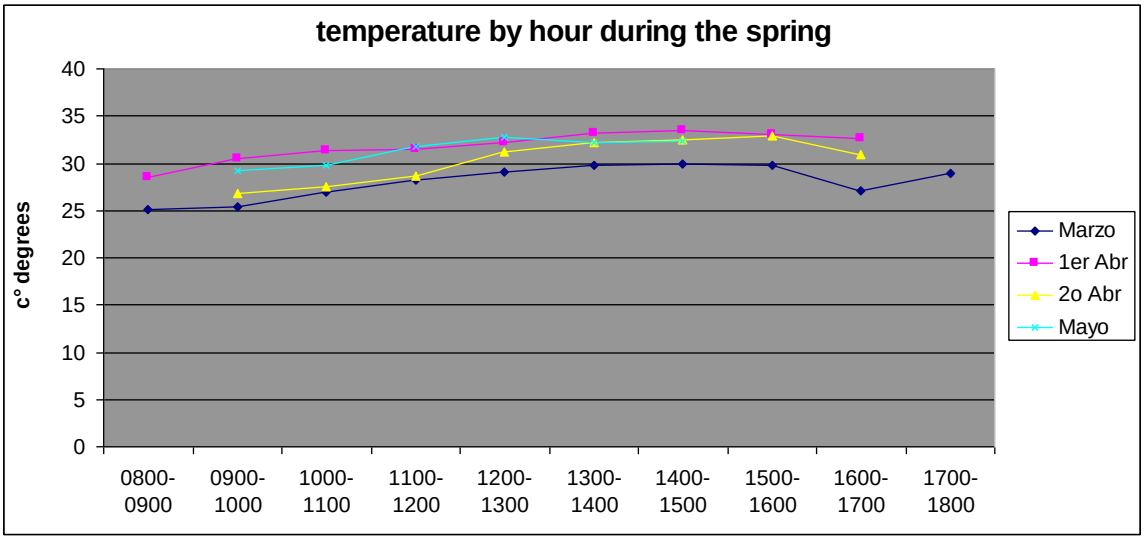



**Fig. 10**. – Temperature changes per hour per period during the Spring 2008 season.

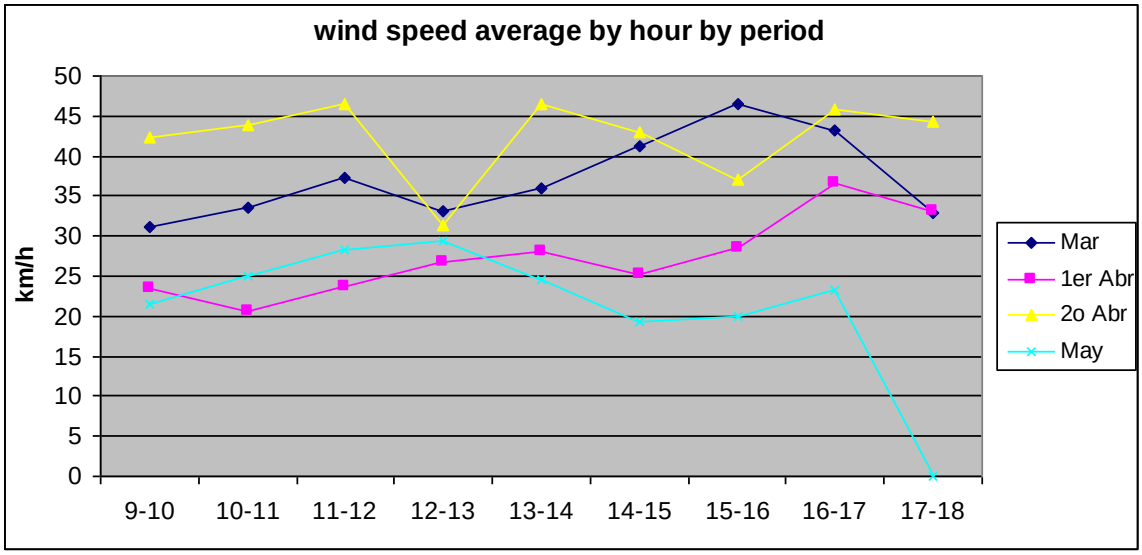



**Fig. 11.** – Wind speed average per hour per period during the Spring 2008 season.

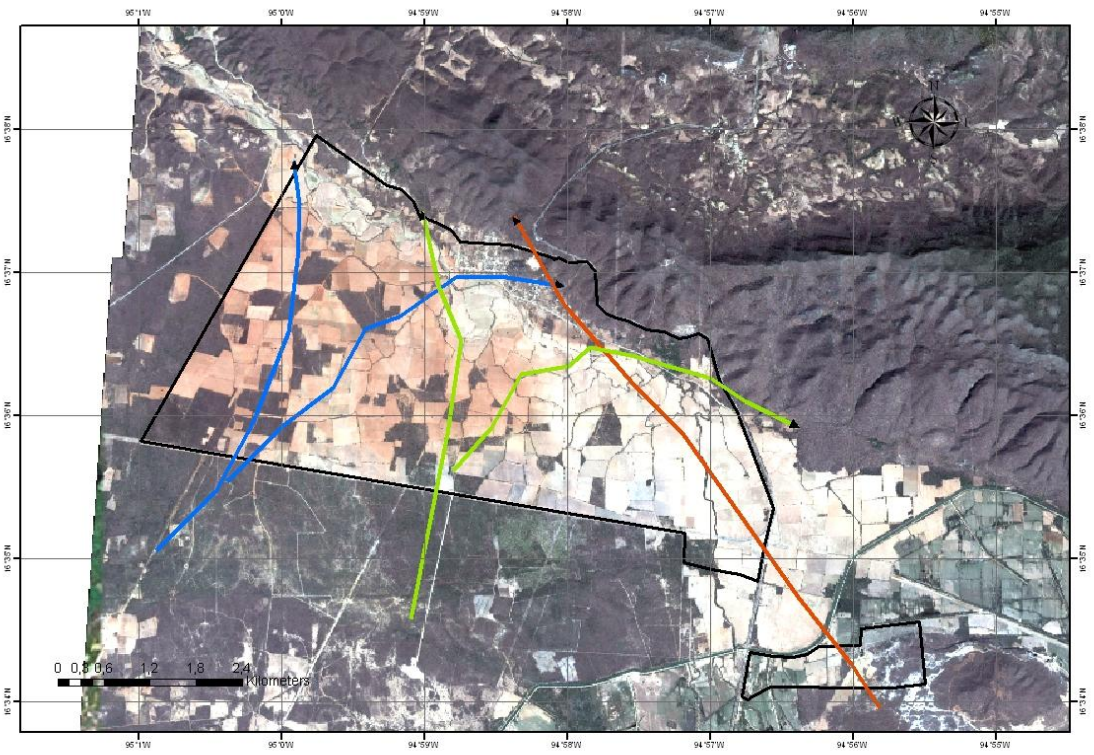
In the fall season, in addition to the change in climate and environmental conditions can be added the raptor migration phenomenon along the Pacific slope, which is practically unknown, in which birds arriving to the coastal plains of the Isthmus attempt to avoid strong winds in open areas as well as large bodies of water such as Lagunas Superior and Inferior, thus bee-lining for the sierras. To achieve this, migrating birds must fly in a South-North or Southwest-Northeast direction, signifying flying into or broadside strong gusts of wind, making it impossible for these individuals to gain altitudes higher than 200 or 300 m above the ground in most cases . A similar event occurs in the spring migration, where, as previously mentioned, north winds provoke that flight altitudes are lower with birds trying to combat head winds.

### 5.8.2- Flight Direction

This topic can be addressed from two different angles: year-round resident and migratory (winter resident and transient) species. During the study the behaviour of different species using the Project site was observed, and with time the ability to recognize year-round resident individuals and separate them from migratory individuals.

Year-round residents appear to have very defined flight patterns, generally related to North-South movements and viceversa, as well as another flight route entering from the South side of the study site and flying to the Northeast, the shortest distance to the foothills of the Sierra de Tolistoque. At this point birds gained altitude and individuals generally abandoned the study area from the East side (Map 2). When individuals entering from the South did not continue the route to the Northeast, they directed straight to the North disappearing within a pass in the sierra known as "Paso Chivela". Very few resident individuals were seen flying in directions or along routes that were not previously mentioned, though when it occurred it was usually in the directions Northwest and Southeast. The majority of year-round resident species seen in the study area were Black Vulture (*Coragyps atratus*), the year-round population of Turkey Vulture (*Cathartes aura*), White-tailed Hawk (*Buteo albicaudatus*), Short-tailed Hawk (*Buteo brachyurus*), Crested Caracara (*Caracara plancus*), Cattle Egret (*Bubulcus ibis*) and the year-round population of White-winged Dove (*Zenaida asiatica*). The interactions of these individuals occurred at variable heights, ranging from 2 m to more than 1,500 m above the ground.

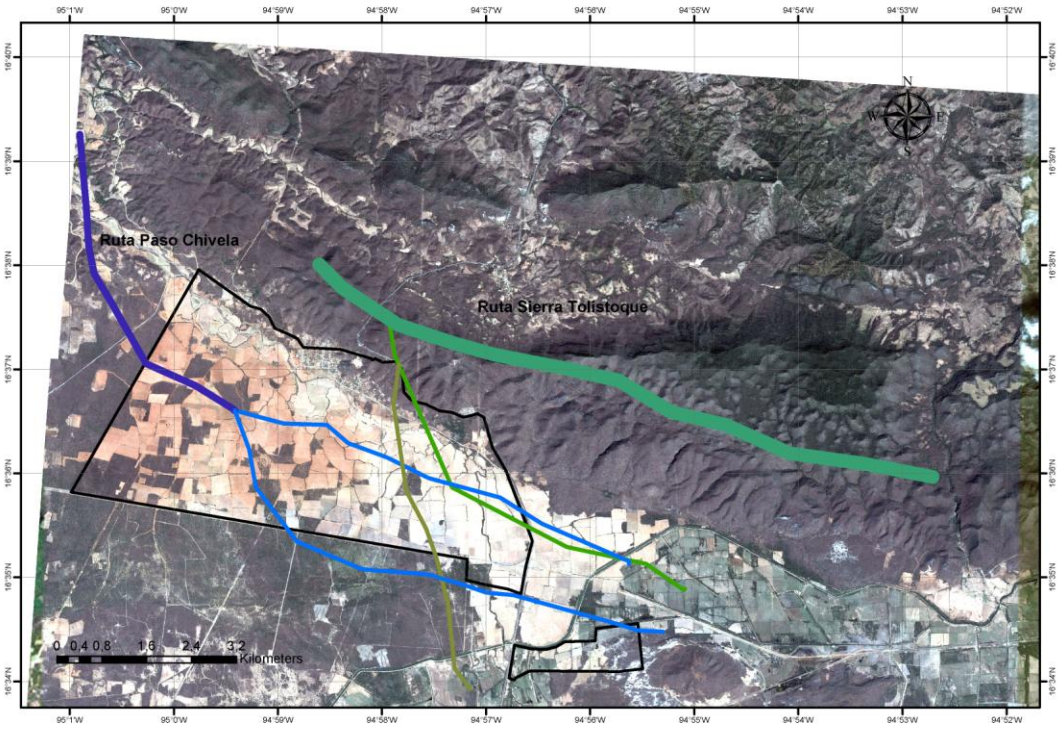
Movements of year-round residents were very similar between the fall and spring seasons, being practically the same routes and movements of individuals in North-South directions, and almost always appearing to be the same individuals using the same areas. These movements were more defined at the beginning and end of the day, when species moved between roosting and nesting sites to feeding zones. In the middle of the day these movements were less pronounced and are generally carried out by larger birds, such as raptors.




**MAP 2.-** Flight directions for year-round resident species over the Project site.

In the case of migratory species, flight directions were very different to those of the year-round residents, but equally marked and generally at greater altitudes, since in the fall season the great majority of these were individuals that left the top of the sierra and maintained this altitude for a certain distance, and in the spring these movements were reversed with migratory individuals generally directing themselves toward the sierra to continue their journey northward. As seen in the Fixed Point of Observation section, the majority of the migration that entered from the Atlantic slope kept to the protection of the Sierra de Tolistoque when arriving to the northern part of the coastal plains of the Isthmus, although at times the force of the wind made some groups or individuals leave the security of the sierra and fly over the coastal plain. Another flight route to the Pacific coastal plain that crosses the study site is through the area known as "Paso Chivela". These migratory species followed 3 directions in their flights across the area, the two principal routes being West-East and North-Southeast (birds starting from the North and curving to the Southeast), and a less used route of North-South, this latter route only in

the fall; in the spring there exists two principal routes, the most utilized being that which goes directly north over the Project site, regardless of where the individuals entered the property, and the other route commonly used running South-Southeast to the Northwest towards "Paso Chivela" (Map 3).




**MAP 3.-** Flight directions for migratory species within and adjacent to the Project site.

In the fall, when the winds were very strong species principally used the route to the Southeast and, when the winds were especially violent, the route shifted to the South. When the winds were lighter and the migration stronger, the route most frequently used was that which runs parallel to the sierra and runs practically West to East. For the individuals that left Paso Chivela, the route most used was to the Southeast, crossing in this manner a great part of the "La Mata" portion of the Project site, although always at altitudes well above potential rotor blade heights. When flocks left the Sierra de Tolistoque, they only used the East side of the Project site, being within the boundaries of the property for less time. It is important to mention that the individuals that left the cover of the sierra normally searched for the nearest landmark to continue their journey and, in

most cases, within the vicinity of the Project site this landmark was the hill known in the region as “La Llovizna”, located on the extreme eastern side of the study area.

When in the spring the north winds were very strong, those individuals trying to migrate towards this very direction were impeded from flying at high altitudes, being with this that the species encountered flying at lower altitudes than that which they should in partaking in this type of movement. The principal species found exhibiting this behaviour in relation to strong winds was Franklin’s Gull, the species making up the greatest number of individuals encountered flying through the rotor swept area range.

### 5.9- Collision Risk

As can be seen in the table 5, in addition to the number of individuals for each group with the potential for risk collision and in accordance with selected avoidance risk rates, the potential risk per tower is provided, assuming all towers share equal risk. This number of potential individuals per tower, especially for the highest avoidance rate, which is generally the most accepted and internationally used for calculating risk assessment, is very low being in all cases less than 0.5 individuals. At actual wind farms, however, rates among individual towers can vary owing to their location as well as avoidance rates.

**TABLE 5.-** Total potential collision risk estimates for the 27 turbines at 124.5 m height (89 m diameter rotor), calculated at 95%, 98% and 99% avoidance rates. For each avoidance rate the potential number of individuals and the number of individuals per turbine are provided.

| Species groups | 95% | 98% | 99% |
|---|---|---|---|
| All birds | 53.58/1.98 | 21.44/0.79 | 10.72/0.39 |
| Raptors | 12.27/0.45 | 4.91/0.18 | 2.44/0.09 |
| Aquatics | 36.22/1.34 | 14.48/0.53 | 7.24/0.26 |
| NOM-059 species | 1.27/0.04 | 0.50/0.01 | 0.25/0.009 |

Even when using the lowest avoidance rate percentage (95%) the quantity of individuals at risk is small, at less than 2 individuals per tower taking into account all individuals recorded, and slightly more than one individual per tower in the case of waterbirds; the

total number of waterbirds registered in the rotor swept area range is comprised almost entirely of one species, Franklin's Gull, which in the spring was found to fly at low altitudes when wind conditions were unfavourable (greater than 40 km/h from the north).

Comparing the two field seasons, risk estimates were found to be very different owing to the dynamic of birds in the different seasons and times of the year. The greatest difference between the two seasons is dominated by the frequent presence of and lower flying waterbird species in the spring. This greater number of aquatic individuals observed during the spring also influences the total number of individuals in the first category, even though despite this notable change, the total number of individuals that will be affected for each tower is a little more than 1.7 individuals, a relatively small number. Besides that in the fall all the percentages are driven by collision probabilities resulting in much less than one individual affected per tower.

**TABLE 6.-** Fall season potential collision risk estimates for the 27 turbines at 124.5 m height (89 m diameter rotor), at 95%, 98% and 99% avoidance rates. For each avoidance rate the potential number of individuals and the number of individuals per turbine are provided.

| Species groups | 95% | 98% | 99% |
|---|---|---|---|
| All birds | 6.69/0.24 | 2.68/0.09 | 1.34/0.04 |
| Raptors | 3.74/0.13 | 1.50/0.05 | 0.74/0.02 |
| Aquatics | 1.36/0.05 | 0.54/0.02 | 0.27/0.01 |
| NOM-059 species | 0.41/0.01 | 0.16/0.005 | 0.08/0.002 |

**TABLE 7.-** Spring season potential collision risk estimates for the 27 turbines at 124.5 m height (89 m diameter rotor), at 95%, 98% and 99% avoidance rates. For each avoidance rate the potential number of individuals and the number of individuals per turbine are provided.

| Species groups | 95% | 98% | 99% |
|---|---|---|---|
| All birds | 46.89/1.73 | 18.76/0.69 | 9.38/0.34 |
| Raptors | 8.53/0.31 | 3.41/0.12 | 1.70/0.06 |
| Aquatics | 34.86/1.29 | 13.94/0.51 | 6.97/0.25 |
| NOM-059 species | 0.86/0.03 | 0.34/0.01 | 0.17/0.006 |

It is important to mention this study and these estimates were carried out only during part of the migration periods of the spring and fall, according the authority requirements, but it will be recommended to cover the two remaining seasons of the year (summer and

winter) to calculate an annual risk collision estimate and lower the margin of error in these estimates.

In Appendices 2 and 3, individual species collision risk estimates for 27 towers at 124.5 m are summarized for nationally protected (NOM-059) species. In the fall season, eight (8) of these species were registered within the rotor swept area range and in the spring season six (6) were observed, with all of these species' collision estimates being relatively low. The NOM-059 species do not reach even 0.5 individuals using the lowest avoidance rate calculation, with the bare exception of Green/Pacific Parakeets in the spring season. But if we look at the calculations for the highest avoidance rate option, which is considered to be generally the most acceptable among most species, the risk of collision for these species drops to less than one (1) individual in 1000 . In Appendix 4 is a summary for both fall and spring seasons of collision risk estimates for the 36 species found flying within the rotor swept area range.

These results obtained, compared with other sites in the world, have low collision risk average, however as previously mentioned, conditions for individual wind farms are different and thus it is difficult to compare among them.

**5.10- Habitat Use**

When birds decide to take routes to distribute themselves geographically, they do so motivated to receive an energetic cost benefit by moving from place to another. What species look for with this movement is to take advantage of environmental resources that are not in the place where they are found and that will help to satisfy them with their basic needs: reproduction, feeding and roosting.

Within the Project site exists forest patches containing important habitat for these individuals: short dry forest. The remnants of this vegetation type attract a high diversity and number of birds, that which is necessary to conserve *a priori*. The patches of vegetation near existing water sources is greatly attractive to both migratory and resident

birds, including various species of herons, egrets and other aquatic species. These migratory species use water bodies to rest, feed and roost while resident species use them to carry out their entire life cycles.

As to be expected, during the fall season various species of resident and migratory species use cultivated lands to feed on grains as well as on the insects inhabiting within them. The most conspicuous of these species are White-winged Dove (*Zenaida asiatica*), Dickcissel (*Spiza americana*) and Scissor-tailed Flycatcher (*Tyrannus forficatus*), and Indigo Bunting (*Passerina cyanea*) as well as other species of seed-eaters and flycatchers, all of which are migratory. Among year-round resident species, the use of these cultivated areas is less intense, with some sparrows (*Aimophila* sp.) and Great-tailed Grackle (*Quiscalus mexicanus*) being the only residents found using sorghum fields. The great majority of all species, however, use existing vegetation or their ecotones (edge), including living fences, which owing to their size house many year-round resident species. The huizachales are another important component of the plant cover comprising the Project site, with these extensions of vegetation also maintaining an important proportion of the populations encountered during the study, including in an equally important manner many migratory species.

Raptors encountered on the Project site were for the most part in transit (ie. migrating), although some of them were observed hunting, principally within open lands used for cattle and sorghum. Among species observed hunting were: American Kestrel (*Falco sparverius*); Peregrine Falcon (*Falco peregrinus*); Cooper's Hawk (*Accipiter cooperi*); Crested Caracara (*Caracara plancus*); Short-tailed Hawk (*Buteo brachyurus*); and, the most commonly observed hunter, White-tailed Hawk (*Buteo albicaudatus*). This latter species hunts by hovering in the air then dropping quickly to the ground once it locates a prey item. Of these six raptors mentioned, the first three are winter residents and the latter three are year-round residents; all six species were encountered regularly during both field work seasons. Besides White-tailed Hawk, the two falcons Crested Caracara and American Kestrel were encountered using the Project site in a fairly constant manner for hunting. The other raptors, in general and especially resident species, used the Project site

more for transit and only occasionally for hunting. Migratory raptors were seen passing over the Project site and on very rare occasions, principally in the morning, hunting.

**5.11- Breeding**

During the present study 40 species were found to breed within the Project site. This represents 22.85% of the total number of species registered at the Project site and 45.45% of the year-round resident species. These two percentages are high, principally with respect to the percentage of year-round residents encountered breeding, being practically one in every two species registered.

During censuses oriole nests were found (*Icterus gularis, I. pustulatus*), conspicuous due to their large size and location on the outer extremities of branches, as well as nests of Rufous-naped and Banded wrens (*Campylorhynchus rufinucha, Thryothorus pleurostictus*), always located in spiny bushes and constructed in a unique shape, and lastly also nests of ground-doves species (*Columbina* sp.). Another method used to confirm breeding on the Project site was witnessing the act of copulation or nest-building, unequivocal signs of local reproduction, and towards the end of the spring season individuals carrying food to feed their young was recorded.

The transects wherein the greatest reproductive activity was recorded were El Mojón and La Ventosa, those which also have the greatest plant cover and with the greatest percentage of original vegetation present, giving to these two transects a greater importance at the hour of planning construction.

Of the species encountered nesting on the Project site, only one is protected under the NOM-059: Cinnamon-tailed Sparrow. This species was found most commonly nesting at the El Mojón and Centro transects. Additionally, three species listed under CITES were also found breeding on the Project site: Roadside Hawk (*Buteo magnirostris*), Crested Caracara (*Caracara plancus*), and Ferruginous Pygmy-Owl (*Glaucidium brasilianum*).

### 5.12- Possible Impacts at the Regional Level

Comparing the potential collision risk caused by turbines, as well as natural mortality and recruitment rate for each species affected, measures effectively the biological importance of mortality caused by turbines. Creating this yields estimations of the degree to which turbines adversely affect the population size of a species, its stability and distribution. To determine this requires extensive information concerning population distribution and demography occurring within and in the vicinity of the areas of study. The simple act of counting live birds on wind farm sites is inadequate for the purposes of knowing the possible impacts to populations at the regional level, because species abundance can change drastically depending on the season. Simple estimations can be many times over- or under-exaggerated by those individuals or species that live for a part of their lives or the year in other places. The dimensions of a wind farm can directly affect a number of species that occur over a large geographical area.

Thus, the geographic scale required to estimate impacts of species will be much larger than the size of the study area in question. For the reach of the present study and the area censused, it will not be easy to make inferences at the population level or to evaluate the possible impacts, however, it is important to consider that these impacts are possible and should be estimated based on further work and that perhaps a regional project addressing this issue should be conducted.

Among species that could receive some impact from the proposed WRA are local and some migratory raptors, not solely because some of these species are under protection but due to their flight behaviours and hunting styles. Species observed in the study area that could have problems in the future due to their small natural populations, hunting styles and regular use of the property are year-round resident hawks of the genus *Buteo* and Crested Caracara. Among species of migratory birds, it is recommended to take care especially with larger migratory species, such as hawks, pelicans, storks and, in the spring season, to be attentive to large groups of northbound Franklin's Gull whose flight altitudes are strongly influenced by local climatic conditions.

Special attention should also be placed on the populations of the two parakeet species (*Aratinga* sp.) since they use the area year-round, and more intensely during their breeding seasons (pers. obs.). Likewise, of the little that is known of year-round resident species dependent upon natural vegetation, regardless of their restriction to the protection of vegetation cover, it is unknown to what effect the wind tower construction and consequent habitat loss could have on them, even if this loss is small.

## 6.0- CONCLUSIONS

From the results obtained during the fall and spring surveys it can be somewhat understood the potential impact of the Wind Resource Area on bird populations. However, the potential for birds to collide with wind towers during their operation exists, although based on observations in the field and the results obtained from calculating risk collision estimates, it is not expected that the number of potential fatalities will be high nor provoke negative impacts on bird populations. Not withstanding and owing to the richness and abundance of birds registered at the study site, it will be important to continue monitoring, for some resident populations as well as the migration phenomenon within the study area and zone of influence when the wind towers are installed, to verify calculations of potential collision risk.

Collision risk estimates are nothing more than a tool in the process of evaluation and the results of these calculations have many uncertainties, which can be improved through further field work. Furthermore, it is important to mention that these estimation attempts to understand the possible risks of collision are the first of such in Latin America.

In the case of species protected under the Mexican Official Norm (NOM-059-SEMARNAT-2001), a high number of species under some degree of protection (16) was encountered on the Project site, making the work a greater challenge owing to the greater quantity of conservation variables to consider. Eight (8) of these protected species are

migratory and nearly all are raptors; all were found on the site as almost entirely in transit, although flying at times at the height of the rotor blades in small numbers (*i.e.* <1 individual/tower). Year-round resident species are those which will probably be under greater pressure owing to changes in the different existing habitats and possible interactions with wind turbines. Among nationally protected resident species with a higher probability of having a negative interaction with wind towers at the Project site are Green/Pacific Parakeet (*Aratinga holochlora/strenua*) and White-tailed Hawk (*Buteo albicaudatus*), owing to their higher frequency of use of the rotor swept area range at the Project site mostly for transit and hunting, respectively.

The species encountered in CITES and IUCN are almost all listed under the lowest categories of risk. In the CITES list 28 species were found on the Project site with only Peregrine Falcon (*Falco peregrinus*) under Appendix I, whose populations use the area almost entirely for transit, crossing the Isthmus to continue their migratory journeys. The 27 remaining CITES species fall under Appendix II, which protects them from commerce owing to the potential fragility of their populations in the event of excessive trade. For the four (4) species registered under the IUCN list, all are found under the category Near Threatened, which is the lowest category of concern and refers to species for which it is recommended to monitor such that their populations do not fall below a critical minimum. Three of these species are migratory and only one species is a year-round resident.

With respect to endemic species it should be mentioned that of the five (5) endemics found on the Project site all but Rufous-backed Robin (*Turdus rufitorques*) have localized and threatened populations due to habitat loss, specifically short dry forest, the most extensive vegetation type on the Pacific slope of Mexico. Owing to these species strong affinities to short dry forest and their year-round status they have the potential to be important indicators of ecosystem health. It is important to mention that one species, Cinnamon-tailed Sparrow, is exclusively endemic to the Isthmus of Tehuantepec, which owing to its very restricted distribution makes its populations exceedingly vulnerable.

In the case of year-round and winter residents (including some transients), the potential risk of collision with wind towers owes almost principally to flight behaviours, hunting, use of habitat at the Project site and specifically those species which fly over open areas or migrate through the area, to which climate conditions can greatly affect.

Speaking specifically of the migration of raptors and aquatic species that pass through the region, this was found to be most concentrated along the Sierra de Tolistoque principally during the fall, the sierra being located to the North of the study site. On some occasions in the fall, small groups left the protection of the sierra or crossed through "Paso Chivela" due to strong North winds and thus crossed the Project site to the South; in the spring, this migration was reversed with most birds flying North-Northwest towards Paso Chivela, generally entering the property at the Central-West portions of the Project site located in the La Mata ejido. There is definitely a relationship between climatic conditions and flight altitudes, for example, under rain and low clouds birds were unable to encounter thermals, moreover that they attempted to fly outside of storm zones. Another factor influencing flight altitudes is low ambient temperature and strong North winds resulting from the presence of "nortes", those which generally begin in late October, November and April, obligating individuals to fly lower than normal.

Lastly, to know the impact that wind farms can have on bird populations, it is necessary to carry out more rigorous studies pertaining to these aspects but at the regional level, the study of just one Wind Resource Area cannot give sufficient information to evaluate the situation of different populations, since the conditions from one site to another can vary immensely.

## 7.0- RECOMMENDATIONS

The following recommendations for the Electrica del Valle de México - Energies Nouvelles Project are based on the evaluation carried out at the site and a revision of the literature related to the avifauna that inhabits the Project site, and that which is known

pertaining to potential risks for birds in the development of wind energy from experience in the United States and Europe:

- More constant monitoring within the WRA, providing a better understanding of the relations among the levels of possible bird mortality, thus helping to determine the most influential factors in potential causes of collision. This plan should involve a constant effort monitoring of possible collisions and the observation of the behaviour of birds around the presence of the wind towers.

- Within the WRA, the electrical net that connects to the turbines should be underground, as well as all superficial electrical connections from the site and substation to the transmission lines.

- As much as possible permanent meteorological towers should be free-standing, without guy wires to support them, to avoid potential bird collisions.

- The size of access roads and turbine pads should be minimized, to reduce the amount of overall habitat alteration. Once construction has terminated, the regeneration of natural habitat or agriculture should be permitted (or encouraged), to the least possible distance of the turbines and roads, with the finality to minimize the fragmentation of habitat and impacts due to alteration or displacement.

- In the case of nocturnal migration, of which practically nothing is known in the region nor the country in general, the illumination of turbines and other structures (eg. substations, buildings) should be kept to a minimum to reduce the potential for attraction of species that migrate at night. Nocturnal illumination should be done with intermittent lights (red or white), with the maximum interval of intermittent off-time permitted. For nocturnal signals, lights left on permanently should not be used. Also, within any part of the WRA (eg. substations) sodium vapor lights, or reflective bulbs, should not be used except when in the case of a maintenance emergency.

- Owing to that at the Project site a nationally endangered species (Cinnamon-tailed Sparrow) breeds, and is considered to be common in some parts of the site, a breeding bird study should be carried out to determine the distribution and density of this and other breeding species. This study should include the creation of maps indicating the distribution of breeding birds with relation to the localities where roads and wind towers are proposed. The results of this study will be used to eliminate or mitigate the impact to these species, or their displacement.

- Owing to the considerable number of migratory raptors that transit the surrounding areas of the Project site, and on some days over the site, a more prolonged study of raptor migration should be carried out, with the finality to improve the understanding of flight patterns and altitudes of these birds. Among questions of special interest are to investigate the variation in strategies that birds use with the degree that wind intensity varies (and temperature). This study should also consider all diurnal migratory birds, should obtain information about the use of the site as a roosting spot, as well as patterns of hunting among resident species, and flight routes within different seasons.

- The study of collision fatalities (post-installation of the WRA) should collect information on the total number of collisions and the characteristics of these fatalities, as well as how to determine the potential accumulative ecological impact that future WRAs could have in Mexico and Central America. Additionally, this information will help to corroborate predicted collision risk estimates, or in its defect to learn if conditions in the tropics differentially influence the results of these predictions in countries other than in the North of the continent and Europe.

- The removal of cadavers within the area of influence of the wind towers is important, since the presence of these is highly attractive to a range of bird species. This can be an issue given the presence of small groups of cattle within the lands where the turbines will be located, as well as proximity to federal highways (eg. roadkill).

- Lastly, but not least important, to paint distinct and unconventional patterns on the rotor blades could help birds to detect the blades more easily. The colour black is preferred to augment the probability of birds detecting the blades before arriving to them, since black paint against the white blade background provides the highest degree of contrast.

## 8.0- LITERATURE CITED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## 9.0- APPENDICES

**Appendix 1. –** List of the 175 species registered from the Project site, their seasonal status, and protection status under the NOM-059-SEMARNAT-2001, CITES and IUCN, and confirmation of breeding.

| SPECIES | Status | NOM-059 | CITES | IUCN | breeding |
|---|---|---|---|---|---|
| | | | | | |
| **Podicipedidae (1)** | | | | | |
| Least Grebe | R | Pr | | | |
| | | | | | |
| **Pelecanidae (2)** | | | | | |
| Brown Pelican | R | | | | |
| American White Pelican | T | | | | |
| | | | | | |
| **Phalacrocoracidae (1)** | | | | | |
| Neotropic Cormorant | R | | | | |
| | | | | | |
| **Fregatidae (1)** | | | | | |
| Magnificent Frigatebird | R | | | | |
| | | | | | |
| **Ardeidae (7)** | | | | | |
| Great Blue Heron | I | | | | |
| Great Egret | R/I | | | | |
| Snowy Egret | R/I | | | | |
| Little Blue Heron | R/I | | | | |
| Tricolored Heron | R | | | | |
| Cattle Egret | R | | | | |
| Green Heron | R | | | | |
| | | | | | |
| **Threskiornithidae (2)** | | | | | |
| White Ibis | R/I | | | | |
| Roseate Spoonbill | I | | | | |
| | | | | | |
| **Ciconiidae (1)** | | | | | |
| Wood Stork | T | Pr | | | |
| | | | | | |
| **Anatidae (3)** | | | | | |
| Black-bellied Whistling-Duck | R | | | | |
| Blue-winged Teal | I | | | | |
| Green-winged Teal | I | | | | |
| | | | | | |
| **Cathartidae (2)** | | | | | |
| Turkey Vulture | R/I | | | | |
| Black Vulture | R | | | | |
| | | | | | |
| **Accipitridae (16)** | | | | | |
| Osprey | I | | Appendix | | |

| | | | | | |
|---|---|---|---|---|---|
| | | | II | | |
| Hook-billed Kite | R/I | Pr | Appendix II | | |
| Snail Kite | R | Pr | Appendix II | | |
| Northern Harrier | I | | Appendix II | | |
| Harris's Hawk | R | Pr | Appendix II | | |
| Cooper's Hawk | T | Pr | Appendix II | | |
| Sharp-shinned Hawk | T | Pr | Appendix II | | |
| Great Black-Hawk | R | Pr | Appendix II | | |
| Roadside Hawk | R | | Appendix II | | B |
| Short-tailed Hawk | R | | Appendix II | | |
| Gray Hawk | R | | Appendix II | | |
| White-tailed Hawk | R | Pr | Appendix II | | |
| Red-tailed Hawk | I | | Appendix II | | |
| Zone-tailed Hawk | I | Pr | Appendix II | | |
| Swainson's Hawk | T | Pr | Appendix II | | |
| Broad-winged Hawk | T | Pr | Appendix II | | |
| | | | | | |
| **Falconidae (4)** | | | | | |
| Crested Caracara | R | | Appendix II | | B |
| Peregrine Falcon | T | Pr | Appendix I | | |
| American Kestrel | I | | Appendix II | | |
| Merlin | T | | Appendix II | | |
| | | | | | |
| **Rallidae (1)** | | | | | |
| American Coot | R/I | | | | |
| | | | | | |
| **Cracidae (1)** | | | | | |
| West Mexican Chachalaca * | R | | | | B |
| | | | | | |
| **Phasianidae (1)** | | | | | |
| Northern Bobwhite | R | | | | B |

| | | | | | |
|---|---|---|---|---|---|
| **Burhinidae (1)** | | | | | |
| Double-striped Thick-knee | R | | | | B |
| | | | | | |
| **Charadriidae (1)** | | | | | |
| Killdeer | I | | | | |
| | | | | | |
| **Recurvirostridae (1)** | | | | | |
| Black-necked Stilt | R | | | | B |
| | | | | | |
| **Scolopacidae (8)** | | | | | |
| Greater Yellowlegs | I | | | | |
| Lesser Yellowlegs | I | | | | |
| Solitary Sandpiper | T | | | | |
| Upland Sandpiper | T | | | | |
| Spotted Sandpiper | I | | | | |
| Least Sandpiper | I | | | | |
| Western Sandpiper | I | | | | |
| Pectoral Sandpiper | T | | | | |
| | | | | | |
| **Laridae (3)** | | | | | |
| Franklin's Gull | T | | | | |
| Gull-billed Tern | I | | | | |
| Black Tern | T | | | | |
| | | | | | |
| **Columbidae (7)** | | | | | |
| Rock Pigeon | R | | | | |
| Red-billed Pigeon | R | | | | |
| Common Ground-Dove | R | | | | B |
| Inca Dove | R | | | | B |
| White-winged Dove | R/I | | | | B |
| Mourning Dove | R/I | | | | B |
| White-tipped Dove | R | | | | B |
| | | | | | B |
| **Psittacidae (2)** | | | | | |
| Green/Pacific Parakeet | R | A | Appendix II | | |
| Orange-fronted Parakeet | R | Pr | Appendix II | | |
| | | | | | |
| **Cuculidae (5)** | | | | | |
| Yellow-billed Cuckoo | T | | | | |
| Mangrove Cuckoo | R | | | | |
| Groove-billed Ani | R | | | | |
| Lesser-Ground Cuckoo | R | | | | B |
| Lesser Roadrunner | R | | | | B |
| | | | | | |
| **Strigidae (1)** | | | | | |

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|---|---|---|---|---|---|
| Ferruginous Pygmy-Owl | R | | Appendix II | | B |
| | | | | | |
| **Caprimulgidae (2)** | | | | | |
| Lesser Nighthawk | R/I | | | | B |
| Pauraque | R | | | | B |
| | | | | | |
| **Apodidae (4)** | | | | | |
| Vaux's Swift | R/I | | | | |
| Chimney Swift | T | | | | |
| White-throated Swift | R | | | | |
| Black Swift | T | | | | |
| | | | | | |
| **Trochilidae (5)** | | | | | |
| Green-breasted Mango | I | | Appendix II | | |
| Broad-billed Hummingbird | R | | Appendix II | | |
| Cinnamon Hummingbird | R | | Appendix II | | |
| Beautiful Hummingbird | I | | Appendix II | | |
| Ruby-throated Hummingbird | I | | Appendix II | | |
| | | | | | |
| **Trogonidae (1)** | | | | | |
| Citreoline Trogon * | R | | | | B |
| | | | | | |
| **Momotidae (1)** | | | | | |
| Russet-crowned Motmot | | | | | B |
| | | | | | |
| **Alcedinidae (2)** | | | | | |
| Belted Kingfisher | I | | | | |
| Ringed Kingfisher | R | | | | |
| | | | | | |
| **Picidae (1)** | | | | | |
| Golden-fronted Woodpecker | R | | | | B |
| | | | | | |
| **Tyrannidae (20)** | | | | | |
| Northern Beardless Tyrannulet | R | | | | |
| Olive-sided Flycatcher | T | | | NT | |
| Western Wood-Pewee | T | | | | |
| Willow Flycatcher | T | | | | |
| Yellow-bellied Flycatcher | T | | | | |
| Dusky Flycatcher | I | | | | |
| Least Flycatcher | I | | | | |
| Dusky-capped Flycatcher | R/I | | | | |
| Ash-throated Flycatcher | I | | | | |
| Nutting's Flycatcher | R | | | | B |

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|---|---|---|---|---|---|
| Brown-crested Flycatcher | R/I | | | | B |
| Tropical Kingbird | R | | | | B |
| Cassin's Kingbird | I | | | | |
| Western Kingbird | I | | | | |
| Scissor-tailed Flycatcher | I | | | | |
| Eastern Kingbird | T | | | | |
| Sulphur-bellied Flycatcher | S | | | | |
| Social Flycatcher | R | | | | B |
| Great Kiskadee | R | | | | B |
| Boat-billed Flycatcher | R | | | | |
| | | | | | |
| **Hirundinidae (9)** | | | | | |
| Mangrove Swallow | R/I | | | | |
| Violet-green Swallow | T | | | | |
| Tree Swallow | T | | | | |
| Northerm Rough-winged Swallow | R/I | | | | |
| Bank Swallow | T | | | | |
| Cliff Swallow | T | | | | |
| Barn Swallow | I | | | | |
| Gray-breasted Martin | R/I | | | | |
| Purple Martin | T | | | | |
| | | | | | |
| **Corvidae (2)** | | | | | |
| White-throated Magpie-Jay | R | | | | B |
| Common Raven | R | | | | |
| | | | | | |
| **Troglodytidae (2)** | | | | | |
| Rufous-naped Wren | R | | | | B |
| Banded Wren | R | | | | B |
| | | | | | |
| **Sylviidae (2)** | | | | | |
| White-lored Gnatcatcher | R | | | | B |
| Blue-gray Gnatcatcher | I | | | | |
| | | | | | |
| **Turdidae (2)** | | | | | |
| Clay-colored Robin | R | | | | B |
| Rufous-backed Robin | R | | | | |
| | | | | | |
| **Mimidae (3)** | | | | | |
| Gray Catbird | I | | | | |
| Tropical Mockingbird | R | | | | B |
| Northern Mockingbird | R | | | | |
| | | | | | |
| **Vireonidae (5)** | | | | | |
| White-eyed Vireo | I | | | | |
| Blue-headed Vireo | T | | | | |
| Bell´s Vireo | I | | | NT | |

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|---|---|---|---|---|---|
| Yellow-green Vireo | T | | | | |
| Philadelphia Vireo | I | | | | |
| | | | | | |
| **Parulidae (15)** | | | | | |
| Tennessee Warbler | I | | | | |
| Orange-crowned Warbler | I | | | | |
| Nashville Warbler | I | | | | |
| Lucy's Warbler | I | | | | |
| Northern Parula | I | | | | |
| Yellow Warbler | I | | | | |
| Yellow-rumped Warbler | I | | | | |
| Black-throated Green Warbler | I | | | | |
| Magnolia Warbler | I | | | | |
| Black-and-white Warbler | I | | | | |
| MacGillivray's Warbler | I | | | | |
| Northern Waterthrush | I | | | | |
| Common Yellowthroat | I | | | | |
| Gray-crowned Yellowthroat | R | | | | |
| Yellow-breasted Chat | I | | | | |
| | | | | | |
| **Thraupidae (5)** | | | | | |
| Red-legged Honeycreeper | R | | | | |
| Scrub Euphonia | R | | | | |
| Western Tanager | I | | | | |
| Summer Tanager | I | | | | |
| Scarlet Tanager | V | | | | |
| | | | | | |
| **Emberizidae (5)** | | | | | |
| Grasshopper Sparrow | I | | | | |
| Stripe-headed Sparrow | R | | | | B |
| Cinnamon-tailed Sparrow * | R | P | | NT | B |
| Lincoln's Sparrow | I | | | | |
| Lark Sparrow | I | | | | |
| | | | | | |
| **Cardinalidae (6)** | | | | | |
| Rose-breasted Grosbeak | I | | | | |
| Blue Grosbeak | R/I | | | | |
| Indigo Bunting | I | | | | |
| Painted Bunting | I | | | NT | |
| Orange-breasted Bunting* | R | | | | B |
| Dickcissel | I | | | | |
| | | | | | |
| **Icteridae (11)** | | | | | |
| Red-winged Blackbird | R | | | | |
| Eastern Meadowlark | R | | | | B |
| Hooded Oriole | R | | | | |
| Altamira Oriole | R | | | | B |
| Orchard Oriole | I | | | | |

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|---|---|---|---|---|---|
| Streak-backed Oriole | R | | | | B |
| Baltimore Oriole | I | | | | |
| Melodious Blackbird | R | | | | B |
| Great-tailed Grackle | R | | | | B |
| Bronzed Cowbird | R/I | | | | B |
| Brown-headed Cowbird | R/I | | | | B |

**Status Definitions: R=**Year-round Resident, **I=**Winter Resident, **R/I=**Year-round/Winter Resident, **T=**Transient, **V**= Accidental.
**NOM-059-SEMARNAT-2001 Categories: Pr=**Special Protection, **A=**Threatened, **P**=Endangered.
**CITES: Appendix I**= threatened species affected/possibly so by trade, **Appendix II**= species which may become threatened if trade not regulated.
**IUCN: NT**= Near Threatened.
***:** National endemic.

**Appendix 2.-** Fall season summary of NOM-059-SEMARNAT-2001 species encountered at the Project site with collision risk estimates for 27 wind towers at 124.5 m

| SPECIES | 95% | 98% | 99% |
|---|---|---|---|
| Green/Pacific Parakeet | 0.02 | 0.008 | 0.004 |
| White-tailed Hawk | 0.21 | 0.08 | 0.04 |
| Cooper's Hawk | 0.07 | 0.02 | 0.01 |
| Zone-tailed Hawk | 0 | 0 | 0 |
| Great Black-Hawk | 0 | 0 | 0 |
| Broad-winged Hawk | 0.02 | 0.008 | 0.004 |
| Swainson's Hawk | 0.05 | 0.02 | 0.01 |
| Hook-billed Kite | 0.05 | 0.02 | 0.01 |
| Peregrine Falcon | 0.02 | 0.008 | 0.004 |
| Wood Stork | 0.003 | 0.001 | 0.0006 |

**Appendix 3.-** Spring season summary of NOM-059-SEMARNAT-2001 species encountered at the Project site with collision risk estimates for 27 wind towers at 124.5 m

| SPECIES | 95% | 98% | 99% |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Green/Pacific Parakeet | 0.54 | 0.22 | 0.10 |
| White-tailed Hawk | 0.17 | 0.06 | 0.03 |
| Cooper's Hawk | 0 | 0 | 0 |
| Zone-tailed Hawk | 0.01 | 0.004 | 0.002 |
| Great Black-Hawk | 0.01 | 0.004 | 0.002 |
| Broad-winged Hawk | 0 | 0 | 0 |
| Swainson's Hawk | 0.02 | 0.008 | 0.004 |
| Hook-billed Kite | 0 | 0 | 0 |
| Peregrine Falcon | 0.02 | 0.008 | 0.004 |
| Wood Stork | 0 | 0 | 0 |

**Appendix 4.-** Fall 2007 and Spring 2008 summary of species encountered at the Project site with collision risk estimates for 27 wind towers at 124.5 m

| Species | 95% | 98% | 99% |
|---|---|---|---|
| Franklin's Gull | 34.63 | 7.25 | 6.92 |
| Turkey Vulture | 8.27 | 3.31 | 1.66 |
| Barn Swallow | 3.90 | 1.55 | 0.77 |
| Black Vulture | 2.40 | 0.96 | 0.47 |
| American White Pelican | 1.34 | 0.54 | 0.26 |
| Green/Pacific Parakeet | 0.56 | 0.22 | 0.10 |
| White-winged Dove | 0.48 | 0.19 | 0.09 |
| White-tailed Hawk | 0.38 | 0.14 | 0.07 |
| Violet-green Swallow | 0.37 | 0.14 | 0.07 |
| Brown Pelican | 0.22 | 0.08 | 0.04 |
| Scissor-tailed Flycatcher | 0.08 | 0.03 | 0.02 |
| Cooper's Hawk | 0.07 | 0.02 | 0.01 |
| Swainson's Hawk | 0.07 | 0.02 | 0.01 |
| Hook-billed Kite | 0.07 | 0.02 | 0.01 |
| American Kestrel | 0.06 | 0.02 | 0.01 |

| | | | |
|---|---|---|---|
| Unknown swallow sp. | 0.06 | 0.02 | 0.01 |
| Peregrine Falcon | 0.04 | 0.02 | 0.008 |
| Crested Caracara | 0.04 | 0.01 | 0.008 |
| Common Raven | 0.04 | 0.01 | 0.007 |
| Lesser Yellowlegs | 0.03 | 0.01 | 0.006 |
| Red-legged Honeycreeper | 0.03 | 0.01 | 0.006 |
| Red-tailed Hawk | 0.02 | 0.01 | 0.005 |
| Broad-winged Hawk | 0.02 | 0.008 | 0.004 |
| Short-tailed Hawk | 0.02 | 0.008 | 0.004 |
| Osprey | 0.01 | 0.006 | 0.003 |
| Great Egret | 0.01 | 0.005 | 0.002 |
| Gray Hawk | 0.01 | 0.005 | 0.002 |
| Northern Harrier | 0.01 | 0.004 | 0.002 |
| Roadside Hawk | 0.01 | 0.004 | 0.002 |
| Zone-tailed Hawk | 0.01 | 0.004 | 0.002 |
| Cliff Swallow | 0.01 | 0.003 | 0.002 |
| White-throated Swift | 0.004 | 0.002 | 0.001 |
| Dickcissel | 0.004 | 0.002 | 0.001 |
| Wood Stork | 0.003 | 0.001 | 0.00006 |
| Greater Yellowlegs | 0.003 | 0.001 | 0.00006 |
| Ruby-throated Hummingbird | 0.003 | 0.001 | 0.00006 |