

**PHASE I AVIAN RISK ASSESSMENT FOR THE
WINDMAR RE PROJECT,
GUYANILLA, PUERTO RICO**

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Phase I Avian Risk Assessment for the WindMar RE Project, Guayanilla, Puerto Rico

Executive Summary

This report details a Phase I Avian Risk Assessment for the proposed WindMar RE Project (hereafter the “Project”), a medium sized wind power project located along the southern coast of Puerto Rico in the Municipality of Guayanilla. The assessment includes a literature review, interviews with local and regional experts (primarily agency staff), and site visits conducted by a wildlife biologist on December 3-5, 2002. Together, these sources of information provide an indication of the type of habitat present, as well as the number of birds that are known or suspected to use the Project site and the area surrounding the site. This information is then used to assess the degree of risk to birds from wind power development at the particular site. In addition, the concerns of agency biologists and regulators are determined and incorporated into the risk assessment.

The WindMar RE Project is projected to produce about 50 megawatts of emission-free electricity generated by about 28 to 60 turbines (900 to 1,800 kilowatt nameplate turbines). This is the equivalent of the energy consumed by nearly 20,000 households. The turbines would be mounted on tubular towers about 50-80 m (164-262 feet) in height. The rotor length would be about 26-40 m (85-131 feet). A subset of the towers would be lit according to U.S. Fish and Wildlife Service (USFWS) recommendations if permitted by the Federal Aviation Administration (FAA). Electrical lines on site would be underground with the exception of the interconnection to offsite transmission lines. Transmission lines of the Puerto Rico Electric Power Authority (PREPA) are located to within about 1-2 miles (1.6-3.2 km) to the northwest of the Project site.

The turbines would be located on private land owned by WindMar RE and situated immediately to the east of the Guanica State Forest, south of a banana and mango plantation and Guayanilla Bay, and north of the Caribbean Sea. Turbines would be located on three hilltop sites slightly less than one mile apart at elevations between about 15 and 80 m (50-262 feet) ASL. The turbines would be on level to gentle grades, although they would be near steeper terrain. Two of these hills are practically roadless, and the third has jeep trails. All of the hills are crisscrossed by trails, as documented in older aerial photos. All three hills are forested or scrubby with the exception of a few clearings. The forest where turbines would be located has a canopy of 15-40+ feet (4-13 m) that varies among sites. Punta Verraco consists almost entirely of dry forest with a canopy of about 13-26 feet (4-8 m) and includes some areas of cactus and low scrub. A mangrove swamp borders it to the north, and the Caribbean Sea is to the south. Cerro Toro is slightly less forested and more scrubby than Punta Verraco. Punta Ventana has taller and denser dry forest (like the adjacent Guanica State Forest) than Punta Verraco, but a broad area along the southern border with the Caribbean is grassy and scrubby, with much cactus. Between Cerro Toro and Punta Ventana, there is a beach, some sand dunes, scrub vegetation, and flats consisting of Salicornia marsh and bare dirt/mud. All of the dry forests were heavily harvested at one time or another to provide fuel wood for processing sugar cane. In

recent decades, these forests were harvested for fence stakes, supports for fruit trees, and wood for charcoal production. Clear evidence of this is the coppice-like structure of many trees.

Two federally endangered bird species are found at the project site. Another two federally endangered species have been recorded near the project site. Risk was assessed for all four. Brown Pelicans forage in the waters adjacent to the site and occasionally fly over the site, on their way between the Caribbean and Guayanilla Bay. Puerto Rican Nightjars nest on the site in what appears to be highly suitable dry forest habitat. Risk to this species would be largely limited to impacts on nesting habitat through construction activities. No published studies shed light on how a bird like the nightjar might react to the presence of wind turbines, but nightjars were heard calling close to the base of a functioning wind measurement tower in the heart of the Punta Verraco hilltop, an indication of the bird's adaptability. How the nightjar will react to the removal of some habitat for the wind turbine bases and access roads needs to be assessed, but it is conceivable that some opening of the habitat will benefit birds by increasing foraging opportunities. Properly designed access roads can also serve as firebreaks, thereby protecting nightjars.

The Yellow-shouldered Blackbird (federally endangered) is not presently known to nest on or visit the site, but the habitat in the low areas, where turbines would not be located, appears to be marginally suitable for the species. Roseate Terns (federally endangered) have been recorded nesting about 2 miles (3.2 km) offshore, but they are not likely to fly over the site, except perhaps on very rare occasions.

Because of the presence of these species, especially the nightjar, it is suggested that WindMar RE work with USFWS to produce a Habitat Conservation Plan (HCP). Based on the surveys called for in this report, the HCP would assess any impacts to nightjars and other species and design a habitat restoration and management program that would include a conservation easement and ongoing research to mitigate any potential incidental take of endangered species.

Field studies need to be conducted to sufficiently assess avian risk at the WindMar RE Project site. Nesting studies of Puerto Rican Nightjars and Yellow-shouldered Blackbirds are indicated, along with a study of overflights by Brown Pelicans and Roseate Terns. Excepting as yet undetermined impacts to endangered species, risk to birds occurring at the Project site is low and not likely to be significant. This assessment is based on what is known about avian risk factors at wind power plants in North America and Europe, the species (type and numbers of individuals) that frequent the Project site, and what was learned from the literature, site visits, and interviews.

The following recommendations are made to reduce the potential for risk to birds.

- Electrical lines on site should be underground. Above ground (if necessary) transmission lines and interconnects, as well as substations, should be insulated and configured per APLIC (Avian Power Line Interaction Committee) guidelines. These guidelines are accepted by USFWS as the best means for avoiding electrocution fatalities.

- Consistent with FAA guidelines, obstruction lighting should be white strobes (USFWS voluntary guidelines) with the longest possible off cycle permissible, and lighting should be kept to a minimum number of turbines (if possible no turbines should be lit). If white strobes are not permitted by the FAA, red strobes or red LEDs with the longest off cycle permitted should be used.
- Permanent meteorology towers should be free-standing, without guy wires to prevent collision fatalities among birds in the area of the wind park.
- A wetland delineation should be conducted to determine where wetlands are present within the project footprint so that they may be buffered by the project.
- A forest management plan that promotes the long-term safety of the forest for birds and other wildlife is recommended. That plan would provide for minimization of forest fragmentation resulting from clearing and cutting for turbines and roads. The forest management plan should take into consideration the reduction of the major threats to the forest community, including fire, feral animals, and invasive species. Clearings and cuttings should be managed not only to serve as fire brakes but also to increase species diversity and particularly plant species that would augment the insect population. In this regard, reforestation with rare, listed, endemic and under represented plant species would be highly desirable.
- Restoration of the mangrove swamp (~25 acres), degraded upland site on Punta Verraco (~7.5 acres), and the mildly degraded freshwater wetland habitat on site may be considered as potential remediation for project impacts to upland habitats. Post construction monitoring of these sites would determine whether these projects were successful.
- Because the Puerto Rican Nightjar nests on the Project site, a complete survey of the property to determine nightjar abundance and distribution during the nesting season is needed. Section 10 consultation with USFWS is recommended. A Habitat Conservation Plan (HCP) is likely in order because of potential disturbance to the nesting habitat of this species.
- Specific surveys for Yellow-shouldered Blackbirds should be conducted at lower elevations of the site. Also, behavioral surveys for flight over the site by Brown Pelicans and Roseate Terns are recommended. In the main text and appendices, please see the summary of surveys called for and their proposed methodologies.

Introduction

WindMar RE has proposed a wind power project of moderate size for a site near Guayanilla, Puerto Rico, along the Caribbean Sea (Figure 1). The facility, to be called the WindMar RE Project (hereafter the Project), will generate about 50 megawatts of power that will provide emission-free electricity for the equivalent of about 20,000 local households.

Because birds have been impacted at a few wind power sites in the United States and Europe, concern has been voiced at many proposed projects. The impacts of turbines on birds have included fatalities resulting from collisions with operating turbines and habitat modification/disturbance as a result of construction and new infrastructure at a particular site. The impacts, in general, have been minor and not ecologically significant.

This report is a Phase I Avian Risk Assessment contracted by WindMar RE. The purpose of a Phase I Assessment is to determine potential risk to birds at a proposed wind power site. Thus, the Phase I Assessment is designed to guide developers, regulators, environmentalists, and other stakeholders through the process of determining the degree of risk at a particular site and how impacts or potential impacts, if any are perceived, need to be studied in more detail. The initial assessment includes: (i) a site visit, (ii) a literature/database search, and (iii) interviews with wildlife/environmental agency staff.

The site visit was made by Paul Kerlinger, Ph.D., an avian ecologist with extensive experience in the wind power industry. The site and surrounding area were walked and toured by automobile. During the visit, habitat and topography were examined and the avifauna present was observed. The site visit is not meant to be a quantitative survey or inventory of birds on the site and surrounding area. Instead, the purpose of the site visit is to gain an understanding of the habitat and topographic features so that a list of species that might be present may be assembled, an idea as to use by those species determined, and the potential for risk to birds at the site assessed.

The literature search included examination of pertinent materials (printed, published, unpublished, and electronic media) relating to birds that nest on or near the site, migrate over or make stopovers on the site, forage on the site, and winter on the site. Interviews for this study consist of a series of questions asked of regulators (USFWS and Commonwealth agency biologists), USDA Forest Service biologists, and other avian experts (university professors and professional ornithologists). Information from these diverse sources are then integrated into a report like this one, summarizing what is present at a site, potential risk of wind turbine construction at the site, a comparison of risk at the site with other sites where risk has been determined empirically, and suggestions for further studies, if indicated.

In addition to the avian risk assessment, this report includes some information on sensitive habitats, wetlands, and endangered and threatened species.

Project Description and Specifications.

The WindMar RE Project will generate about 50 megawatts of power that would provide the equivalent of about 20,000 homes with emission-free electricity. The project will consist of between 28 and 60 turbines with nameplate capacity equal to between 900 and 1,800 kilowatts of power. Tower height would be about 50-80 m (164-262 feet) with a rotor length of about 26-40 m (85-131 feet). The total height when a rotor is in the 12 o'clock position would be a maximum of about 120 m (395 feet) AGL. Turbines would be mounted on tubular towers and lit according to Federal Aviation Administration guidelines. Roads for the project would run on exposed limestone bedrock. Electrical lines connecting the turbines and the turbines to the substation would be underground and linked via overhead or underground lines to existing transmission lines near the project site. The site and area surrounding the site for about one mile is a diverse array of terrestrial and marine habitats and there are no dwellings within a one-mile radius. Ownership of the lands is private, and there is currently little land use other than recreation. The land is in the Municipality of Guayanilla, which borders the Caribbean Sea.

Topographic/Physiographic and Habitat Description of the WindMar RE Project, Guayanilla, Puerto Rico, and Surrounding Area

Information regarding topography, physiography, and habitat of the site was first gathered using a 1:24,000 USGS topographic map, and later from ground truthing via a site visit (described below). In addition, several sources were examined to determine the type of habitat known to be present in the general vicinity of the proposed wind plant and, therefore, the bird communities and species that are likely to be present.

The project site is located along the southern coast of Puerto Rico on the Caribbean Sea just south of the town of Guayanilla. The project is situated within an 800+ acre, privately owned parcel of land that abuts the Guanica State Forest along its western border, Guayanilla Bay and some farmland to the north, and the Caribbean Sea to the south. The elevation within the site ranges from about sea level to slightly more than 80 m (262 feet) ASL. The turbines would be located on three hills shown in Figure 1. They are Punta Verraco, Cerro Toro, and Punta Ventana. The elevations at which the turbine bases would be placed range between about 15 and 80 m (50-262 feet) ASL. Habitat descriptions for each of the areas and habitat types are provided below. The site is relatively isolated. The fact that there are no houses for about a mile from the Project site strongly suggests the level of disturbance to the habitat and wildlife is minimal. Furthermore, the size and isolation of this site makes it very attractive habitat for wildlife.

Punta Verraco Dry Forest and Scrub. Turbines would be located on the highest ground of this hill, extending along an east to west axis. The forest varies depending on aspect. The forest on top of the hill consists of small trees and shrubs. In places, the vegetation is scrubbier and contains significant cactus. The canopy varies. Along the highest elevations, the canopy is about 12-20 feet (4-6+ m). Along the northern slope, where wind turbines would not be placed, the canopy is taller with trees extending to more than about 25 feet (8 m) in height. A 7.5 acre cleared area on the road leading into Punta Verraco was made by a previous owner. It was used

as a quarry and is now bare earth. The specific vegetation of the site has been described in detail in a previous report by Dr. Alberto Areces, a botanist contracted by WindMar RE.

Punta Ventana Forest and Scrub. Turbines would be located on this hill extending from about 100 m inland from the Caribbean for about $\frac{3}{4}$ of a mile inland. This forest borders the Guanica State Forest, and the vegetation is virtually identical to the forests within the state land. Vegetation close to the Caribbean is very low, consisting of many cacti, grasses, and shrubby vegetation. Within about 300 m from the Caribbean, however, the vegetation becomes taller and thicker. Most of this site is forested and, the forests are taller than those on Punta Verraco and Cerro Toro.

Cerro Toro Forest and Scrub. A dry forest, similar to that on Punta Verraco and Punta Ventana, dominates the top of Cerro Toro. In places, it is forest, and in other places, it is simply scrubby vegetation. The forest on this hill is naturally more stunted and fragmented than the forest on Punta Verraco and Punta Ventana, and the trees do not appear to reach the heights they do on the other hills. This site is relatively inaccessible because there are no roads or clearly marked trails. Turbines are proposed for the top of this hill.

Mangrove Swamp. A rather extensive mangrove forest extends along the north shore of Punta Verraco. It is narrow in places, but widens to several hundred yards at the base of the peninsula. Built by the former landowner, a wide, heavy-duty gravel road cuts through the swamp. To the south of the road the swamp is highly degraded, the result of blocked conduits that do not permit salt water to flow freely with tides into the southern portion.

Freshwater Wetlands and Mudflats. Between Cerro Toro and Punta Ventana is an extensive area of grasses, bare earth, and mudflat. Instead of being a tidal wetland, this area seems to be freshwater wetland. However, at times storms likely inundate this habitat with saltwater. Much of the ground is covered with pickleweed (*Salicornia*), which is irregularly inundated, or with drier wetlands. There are also acacia-like trees here and there along with low brushy vegetation that is no more than about a foot tall. These areas are not within the actual footprint of the wind park.

Guayanilla Bay. To the north of Punta Verraco is Guayanilla Bay. The bay is a shallow and has a soft bottom in places. There are also some sea grass flats. In various parts of the bay there are areas of mangrove. The bay is not part of the Project site.

Beaches. Perhaps one-half of the southern border of the project site is a narrow sand beach. In some areas rocky cliffs make these beaches isolated, although the extensive beach that extends from Cerro Toro to Punta Ventana is the most accessible and the most used by people. Along the fringing dune, there are some palms with other types of trees and grasses scattered here and there. There is a ruin of a building present, with the concrete foundation protruding from the sand. This beach is one of the better areas for shorebirds. Turbines would not be located within about one-quarter mile or more of these areas.

There is little existing infrastructure on the actual project site, other than narrow, unpaved roads and the larger gravel road. Within a mile of the project boundaries, there are no houses,

but there are agricultural areas (a banana and mango plantation) and broken down buildings that were once used to process the raw sugar cane that used to be grown on the adjacent farm. Farther away, on the north side of the plantation there are primary residences, garages, roads (both gravel and asphalt), and electric distribution lines. These dwellings are more than one-half mile from Punta Verraco and Cerro Toro, and a shorter distance from Punta Ventana. Transmission lines of the Puerto Rico Electric Power Authority (PREPA) run near the Project site, perhaps 1-2 miles (1.6-3.2 km) to the northwest.

Degraded Habitat Areas. There are, at least, three areas where habitat has been severely degraded. All could become high quality wildlife habitat if restored.

- A 7.5 acre site on Punta Verraco was cleared by a previous landowner and used as a quarry to mine limestone for the road that leads into that area. That area was scoured of plants and has remained barren earth for more than seven years.
- A mangrove swamp of about 25 acres locate to the south of the road leading into Punta Verraco is highly degraded. Most of the mangrove trees within the area are dead. The few living trees are near the conduits that run under the road and allow some salt water to flow into the swamp. The conduits have become clogged and do not allow salt water to freely flow with the tides to the mangrove areas.
- The marshy flats to the north of the road leading into Punta Verraco appear to have been degraded in places. The acreage of the disturbance was not determined. It appears that tidal flow into this area has occurred at times, but it has been restricted.

Site Visit to the WindMar RE Guayanilla Project

The project site and surrounding area were visited December 3-5, 2002, during which the habitat was examined. In addition to walking and driving around the project site during the visit, the surrounding area was toured by automobile. There are unpaved roads (some very narrow and some very wide) that traverse portions of the areas adjacent to the site, especially where there is farmland.

There are three areas on the highest hills within the 800+ acres of land within the Project boundary where turbines would be located. In the other areas within the Project boundary, there would be little or no infrastructure. Punta Verraco, the eastern portion of the project site, was accessed via a small road that extends more than one-half way to the end of the peninsula. From the end of that road, trails were used to access the easternmost end and portions of the southern coast of the peninsula. Cerro Toro has no vehicle access and trails are rudimentary. This portion of the site was not walked. The areas where there would be little or no project infrastructure include the mangrove swamp, the beach, the wetlands behind the beach, and the lower elevations of the hill. The mangrove swamp was viewed from the wide road that leads to the eastern portion of the Project site. The beach and flat areas between Cerro Toro and Punta Ventana were accessed via the dirt road that leads to the beach and areas were walked. Punta Ventana, the westernmost portion of the site was accessed via a road to the beach and then via a hiking trail up the limestone cliffs.

During the visit, an effort was made to observe wildlife habitat on and adjacent to the Project site, and determine what birds or ornithological phenomena might be present on site or nearby. Weather during the site visit was mostly clear and breezy. Winds were light to moderate winds (5-20 mph) and temperatures were warm (highs in 80s F), permitting excellent views of habitat and birds on and adjacent to the Project site.

Bird species diversity and abundance on and adjacent to the project site during the site visit was moderate to high. Fall migration had ended, and there were few migrants on the Project site. Species observed are detailed by habitat in the next sentences.

In the mangrove areas, there were Brown Pelican (foraging in Guayanilla Bay and perching at the edge of the bay), Osprey (1 perching in mangroves), Little Blue Heron (3-4), Tricolored Heron (5-6), Great Egret (6-8+), Snowy Egret (5+), Common Moorhen, Black-necked Stilt (~50), Spotted Sandpiper (1), Stilt Sandpiper (2), Belted Kingfisher (1), Yellow Warbler (5+), Bank Swallow (2-3), and Cave Swallow (12+). The herons and egrets were feeding and perching.

On the beach and adjacent marsh, there were about 40-50 shorebirds including Sanderling (30+), Semipalmated Sandpiper, Semipalmated Plover (5+), and Lesser Yellowlegs (2) – all foraging and resting. Two or three Royal Terns were seen over Guayanilla Bay.

In the Punta Verraco forest, there were White-winged Dove (dozens), Common Ground Dove (~12), Mangrove Cuckoo (1), Puerto Rican Nightjar (~7 heard, 2 seen), Puerto Rican Tody (2), Puerto Rican Flycatcher (1-2), Black-and-white Warbler (2), Adelaide's Warbler (2), Prairie Warbler (4+), Indigo Bunting (1), and Puerto Rican Bullfinch (3). At least 3 Brown Pelicans were observed flying over Punta Verraco.

In farm fields near the site, recorded were Red-tailed Hawk (1), Turkey Vulture (2-3+, and some within the Project site), Gray Kingbirds (many), Northern Mockingbird (2), Bananaquit (4+), Yellow-faced Grassquit (1+), Black-faced Grassquit (1+), Shiny Cowbird (1+), Greater Antillean Grackle (12+), and Red-faced Bishop (1).

Avian habitat quality within the project area is good to excellent with respect to dry forest and scrub nesting birds. The forest is relatively intact, despite its having been cleared historically to supply fuel for the nearby sugar cane facility, and despite more recent harvesting of fence posts, props for fruit trees, and wood for charcoal production. Many of the trees show a shrubby, coppice type of growth, from the harvesting just described.

The remoteness and relative inaccessibility of most of the WindMar RE Project site makes human use minimal. The beaches are the most used portions of the site, and one can be reached by driving. From the main beach between Cerro Toro and Punta Ventana, there is a trail to Punta Ventana, which shows signs of fairly extensive use by hikers. Other signs of human recreational use of the Project site included dove hunting (shotgun shells), crab digging, and windbreaks/sunscreens on the beaches. Overall use of the site by people is low and limited primarily to the beaches and easily accessed areas. The forests appear seldom used.

Notes on prey species. There was little sign of small mammals on the Project site, which would be prey for and attract Red-tailed Hawks and other predatory birds. It is possible that monkeys visit the site from time to time. There may be small numbers of rats and other small mammals in the lowland areas that could attract predators like hawks. Overall, however, there is little to attract raptors to forage on the Project site, particularly the areas where wind turbines would be placed.

Avian Overview (Literature Review and Habitat Assessment)

Endangered and Threatened Species

The US Fish and Wildlife Service (USFWS) maintains a list of endangered and threatened species, as well as candidate (species proposed for listing) species, under the U.S. Endangered Species Act. The list of endangered and threatened avian species that are known to occur in the area surrounding the WindMar RE Project site near Guayanilla, in the Commonwealth of Puerto Rico, includes the four species listed in Table 1. There are no other bird species that are considered by the federal government or by the Commonwealth of Puerto Rico as rare, threatened, or endangered that are likely to be present within the Project boundaries or nearby. These species will be considered below with respect to their likely presence on the Project site, their abundance and use patterns within the project site, and the suitability of the habitat within and adjacent to the project site.

Table 1 identifies federally listed and candidate bird species that are known to occur near the WindMar RE Project, Guayanilla, Puerto Rico. Also noted is habitat suitability for nesting at or near Project site (S = Suitable, MS = Marginally Suitable, NS = Not Suitable).

Table 1 – Federally Listed Endangered and Candidate Species

<u>Federally Listed Species</u>	<u>Status</u>	<u>Suitability of Project Site Habitat</u>
Brown Pelican	Endangered	NS – flyovers only, foraging nearby
Roseate Tern	Endangered	NS
Puerto Rican Nightjar	Endangered	S – much of site
Yellow-shouldered Blackbird	Endangered	MS/S – lowlands away from turbines

Puerto Rican Nightjar. The Puerto Rican Nightjar is an endangered, endemic species that nests in dry scrub forest in the southwestern portion of Puerto Rico. The literature reports more than 600 pairs nesting in the area surrounding Guanica State Forest, including the Guayanilla Hills to the east of the forest and the Susua State Forest to the northwest (Noble and Vilella 1986, Vilella and Zwank 1987). The bird was most likely more widespread throughout Puerto Rico (Diaz 1984). The main reason for its decline was habitat destruction. At one time, most of the forests in Puerto Rico had been eliminated for agriculture. Another factor that may have affected the

species was the petrochemical plants in Peñuelas, across Guayanilla Bay, the emissions of which suppressed insect populations downwind in the Guanica State Forest and adjacent areas (Miguel Canals, pers. comm.). The nightjar is an insectivorous bird.

In recent decades, the bird has expanded its range from limited refugia as forests came back. This is most certainly the case at the WindMar RE Project site, where the forest was historically cleared to provide fuel for sugar cane processing. The nightjar would probably continue to expand if the forests were allowed to regenerate on adjacent properties. There has been suspicion that the species is preyed upon by Indian mongoose, but in general the two species use slightly different habitats, with the mongoose preferring forests with available water (Vilella and Zwank 1993).

Miguel Canals, a biologist and the management director of the Guanica State Forest, has recently reported new probable nesting areas of nightjars in western Ponce, specifically at the Holiday Inn Hotel, the Las Cucharas prison, and between the Puerto Rican Cement plant and the Estancias Golf Club (San Juan Star 2002). This and other reports demonstrate that the species range continues to expand and the numbers of birds are increasing.

The project site is very suitable habitat for Puerto Rican Nightjars. On the evening of December 3, 2002, about 7 singing males were heard in the forest at Punta Verraco, some close to a functioning wind monitoring tower located at the hilltop. It is likely that these birds also nest on Punta Ventana and, to a lesser degree, Cerro Toro, because the vegetation is similar to that on Punta Verraco and these areas are nearby. As many as 25 nesting pairs of this species may be present on the Project site.

The USFWS has approved a recovery plan for this species (Diaz 1984). The bird prefers dry forests on limestone, with those of the Guanica State Forest thought to be ideal. These forests are dry, semideciduous forests that have a closed canopy. The height of the canopy in ideal situations is about 5-7 m. This is nearly identical to the forests on parts of all three hills of the Project site. The main threat to the species today is elimination of the forest habitats that these birds require. A recent overall population survey is lacking, but the reports cited above strongly suggest an increasing population.

Yellow-shouldered Blackbird. This endangered species is known from Puerto Rico and Mona Island. Its range in southwestern Puerto Rico is near the coast, and there were about 300 individuals known from this area in 1996. There is a recovery plan (Rivera 1996) in which the recovery objective is identified to be downlisting the species to threatened status. The species is threatened by loss of habitat primarily, and nest competition Caribbean Martins and brood parasitism by Shiny Cowbirds. They are also preyed upon by exotic mammals. It prefers to nest in areas of scattered mangroves and the edges of uplands. It nests in cavities and on branches, and has been known to readily make nests of sticks and other materials. In southwestern Puerto Rico near La Parguera, they frequently nest in large deciduous trees of two or three species and in royal palms. In other areas, they have nested in dense stands of black mangrove. They are also known to nest in artificial cavities such as pipes.

This species is not currently known to nest on the Project site. The nearest nesting to the Project site seems to be near La Parguera, more than 15 miles (24 km) to the west. The habitat on the WindMar RE site was judged to be marginally suitable to the species by Marelisa Rivera of USFWS, who made that judgment during a site visit on December 5, 2002. The area between the mangrove swamp and the beach may be suitable for nesting, as may be the mangroves, if they were to recover. A survey for these birds during the nesting season is indicated.

Brown Pelican. The Brown Pelican was originally listed, mainly because of pesticide poisoning. The recovery following the banning of certain pesticides has been dramatic in some locations, but in Puerto Rico the population has remained small. The nearest nesting colony to the Project site is known to be to the west near the town of Guanica, and farther west toward La Parguera (Collazo and Klaas 1986). The Brown Pelican Recovery Plan calls for protection of nesting, roosting, and foraging habitats. The pesticides that impacted this species are mostly no longer used within the United States.

This bird does not nest on the project site or within at least 4-5 miles of the site. However, pelicans do forage in Guayanilla Bay and in the Caribbean Sea adjacent to the Project site. Birds do soar on updrafts along the cliff faces and perch on those cliffs. They feed by soaring or gliding over the water and then diving from altitudes upwards of 50-100 feet (16-31 m). Pelicans also roost in mangroves and other trees along the edge of Guayanilla Bay. On occasion, these birds fly over Punta Verraco, as they move between the Caribbean and Guayanilla Bay. There does not seem to be suitable nesting habitat for the species on the WindMar RE Project site. These birds would be at risk only when crossing the Punta Verraco.

Roseate Tern. Roseate Terns are listed as a threatened species in the Caribbean although they nest over a wide geographic area. A small nesting colony is known to occur on one of the small islands or cays that are about 2-3 miles (3.2-4.8 km) to the east-southeast of Punta Verraco and another colony is known to occur at the La Parguera Cays, to the west of the project site. The sizes of these colonies are small. These birds forage almost exclusively over the ocean and rarely venture over land. They have declined for a variety of reasons, including pesticide poisoning, nest predation, and human disturbance. Their nesting areas are fragile and exposed; therefore, it is very easy to disturb this species. The likelihood of their flying over the areas where turbines would be erected is very low because these birds rarely fly over land. There is a recovery plan for the Caribbean Roseate Tern (Saliva 1993).

Nesting Birds

The types of birds that nest on the project site are, for the most part, common species that nest in dry forests and mangrove swamps, although there may be a few species that nest on cliffs over the sea and in the marshy, flat areas between Cerro Toro and Punta Ventana. There are no data bases on the birds that nest on the actual project site, although there is a large amount of data on nesting birds of the Guanica State Forest, just to the west of Punta Ventana. The birdlife there includes birds of tropical dry forest (on limestone), including several Puerto Rican endemics. Because of the vegetational differences between the Project site and the Guanica State Forest, the birds present are not identical. The forests at Guanica are larger in area and

more contiguous, and their trees are larger in many places than those at the Project site. The trees in the Punta Ventana portion of the Project site are the tallest on the Project site and most similar to those in Guanica. Many of the species on the list provided above in the Site Visit section probably nest on or near the site.

Migrating Birds

Puerto Rico is not known for large concentrations of migrating birds, although migrants certainly stopover in Puerto Rico and winter there. During their stopovers and during the winter period, they are spread over a wide area in Puerto Rico.

Nocturnal Songbird Migration

The migration of songbirds into, out of, and over Puerto Rico has rarely been studied. However, birders have long visited the habitats throughout Puerto Rico, and there do not seem to be many accounts of large concentrations of these birds anywhere on the island. We do know that some migrating songbirds actually pass east of Puerto Rico over the Lesser Antilles on their way to South America, but only a very few species are involved in that flight. It is likely that birds do fly into and out of Puerto Rico during spring and fall migration, but it is less likely that they make stopovers. The habitat along the south shore of Puerto Rico is not very conducive to migrant songbirds, as it is dry forest and not particularly suitable for most species that need to put on fat before continuing onward. There are still many unknowns about the Greater Antilles as a migratory bird stopover site. Baird (1999) explains some of the difficulties and factors involved in the migration of songbirds from North America to South America in the western Atlantic corridor.

Hawk Migration

There are very few locations in the Caribbean where large concentrations of migrating hawks have been documented (Heintzelman 1975, 1986). Zalles and Bildstein (2000) in their global directory of important migration sites for hawks named three sites in Cuba, but none in Puerto Rico. Even those sites listed for Cuba did not experience large numbers of migrants. Rodriguez et al. (2001) document Osprey migration in Cuba via banding recoveries and demonstrated that a sizeable number of these migrants do fly to or through Cuba during the winter. There is no comparable data for Puerto Rico, although Raffaele (1989) states that the species is common in Puerto Rico during winter. (On December 4, 2002, an Osprey was observed on a perch in the mangrove swamp at the Project site.)

Hawks do migrate through the Caribbean and frequent Puerto Rico, but these are limited primarily to species like Peregrine Falcon, Merlin, and Osprey that are not reluctant to cross water. These species are seen during migration in Puerto Rico in very small numbers, and small numbers do winter in Puerto Rico (Raffaele 1989). Northern Harriers and some other migrating hawks from the North American mainland also find their way to Puerto Rico in migration, and some winter there. The other species of hawks that nest in North America either do not migrate southward from the United States or they are very reluctant to cross more than a small body of

water (Kerlinger 1989). To reach Puerto Rico from the North American mainland requires crossing more than 100 miles (160 km) of open water, even when island hopping from Florida. The relative scarcity and unpredictability of thermals over water precludes using energy-saving soaring flight that most hawks use when migrating. It is highly unlikely that large concentrations of migrating hawks frequent or use the WindMar RE Project site.

Waterfowl, Shorebirds, and Other Migrants

The literature did not reveal that there are concentrations or large numbers of waterfowl, shorebirds, or other types of migrants at or within 10 miles of the Project site. No large concentrations of migrating waterfowl are likely at or near the Project site because the habitat is not suitable for these species. The coastal and inland habitats of Puerto Rico are generally not suitable for migrating shorebirds and the bulk of southbound migration of shorebirds flies over the Caribbean before stopping in South America, as is the case with White-rumped Sandpipers and many other species (Harrington 1999, McNeil and Cadieux 1972). However, there is a significant migratory stopover site for shorebirds more than 18 miles (28.8 km) to the west of the Project site at Cabo Rojo. The mudflats, beaches, mangroves, and saline lagoons at Cabo Rojo, both within the Cabo Rojo National Wildlife Refuge and adjacent private lands are known to be one of the most important migration stopover sites in the Caribbean for many species of shorebirds. More than 40,000 of these birds frequent this area during autumn migration. The species include Stilt, Least, and Semipalmated Sandpipers, among others, and there are a few Piping Plovers (a listed species in the U.S.) that migrate in and spend the winter in that area. This type of habitat is limited in Puerto Rico.

The Project site hosts some migrant shorebirds as was evident during the December site visit (see Wintering Birds section below for details). It is not known how many of these birds are present, but large numbers have not been reported. The reason is likely a result of the scarcity of suitable habitat. There are no large marshes, lakes, river corridors, mudflats, and other types of habitats that generally attract large numbers of these birds. However, there are mangroves and beach, as well as marshy flats within the Project boundary that probably attract some shorebirds during the migration seasons.

A majority of shorebirds migrating from North to South America do not make stopovers in Puerto Rico, and there are only a few locations in Puerto Rico where they do.

Wintering Birds

The winter climate and weather in Puerto Rico is mild, such that few Puerto Rican nesting birds leave the island in that season. There are likely to be more birds in Puerto Rico in the winter than in the nesting season because of an influx of North American migrants. These birds are from a wide taxonomic range of species and use a variety of habitats during their winter stay. The site visit did not reveal major concentrations of wintering birds. Forest songbirds were present in moderate numbers including Black-and-white Warbler, Prairie Warbler, and Yellow Warbler (of the latter species, these birds may all have been locally nesting individuals and not migrants). Very few hawks are on site during winter. Red-tailed Hawks were observed less than

a mile from the site and probably forage on the site at times, although they are not likely to forage in the actual forests where turbines would be erected. Turkey Vultures cruise the hills regularly in moderate numbers. An Osprey was seen, but these birds forage in marine and freshwater habitats, not the forested hilltops where turbines would be. Merlins and Peregrine Falcons are present in small numbers in winter, but they are unlikely to spend much time on the forested hilltops because they forage in open country, frequently over wetlands or beaches.

Shorebirds were present in the mangrove area and along the Caribbean beaches. All shorebirds listed in the Site Visit section were migrants from North America. The numbers were not large, with the exception of the more than 50 Black-necked Stilts, some or all of which could nest in Puerto Rico. These birds generally restrict their activity to the beaches and edges of the water where they roost and forage. Herons and egrets were present in large numbers. Some of these birds nest locally, but most were wintering birds. Their activities are mostly foraging and roosting on site, but they will be found almost exclusively along the water, not over the forests where turbines would be located. Brown Pelicans appear to spend much time on and near the site during winter. At least 7-8 individuals were observed, although it could have been as many as a dozen. These birds were diving on fish in Guayanilla Bay and in the Caribbean. A few of these birds did cross Punta Verraco from the Caribbean to the Bay.

Overall, there are some concentrations of wintering herons and egrets, as well as shorebirds, mostly associated with the waters of Guayanilla Bay and the Caribbean beaches.

Important Bird Areas, Parks, Nature Preserves, Sanctuaries, and Sensitive Habitats Near the WindMar RE Project, Guayanilla, Puerto Rico

National Wildlife Refuges, Parks, Grasslands and Forests. There are no national wildlife refuges, parks, grasslands, or forests within 10 miles (16 km) of the Project site. The nearest of these is the Cabo Rojo National Wildlife refuge some 18+ miles (28.8 km) to the west of the Project site.

Important Bird Areas. There is currently no Important Bird Area program (National Audubon Society or American Bird Conservancy) in Puerto Rico.

Nature Conservancy Properties. The Nature Conservancy does not have any preserves near the Project site.

Commonwealth of Puerto Rico Forests, Parks, and Wildlife Management Areas. There are several of these types of open space areas near the project. The Guanica State Forest (sometimes called the Guanica Dry Forest) is immediately to the west of the Punta Ventana section of the WindMar RE project. The Project site and the Guanica Forest share a border that extends for nearly a mile. The habitat on both sides of this border is continuous dry forest. The Susua State Forest is slightly more than 5 miles (8 km) to the northwest of the Project site and is separated from the Project site by developments and towns including Yauco. The Boqueron State Forest is about 15 miles (24 km) west of the Project site along the Caribbean shoreline.

Cayo Palomas, Cayo Maria Langa, Cayo Parguera, and Cayo Maria Langa are within about 2-3 miles (3.2-4.8 km) east of the project site.

Conclusion. The fact that there is a large state forest rich in various types of wildlife immediately to the west of the Project site is noteworthy. The presence of the Guanica State Forest immediately adjacent to the project site strongly suggests that the Project site may contain significant/important habitat for birds and other wildlife. That Guanica State Forest is known as an important, and in some ways critical, nesting area for some species of birds (Wheatley and Brewer 2001).

Interviews with Local Avian and Environmental Experts

The following people with specialized knowledge of avian or related environmental issues were consulted. They were invited to a meeting the WindMar RE Project site that was held on December 5, 2002. Others listed below were invited and could not attend or were interviewed via phone. During the site visit and during telephone interviews, they were asked about the birds at and near the WindMar RE Project site.

December 5, 2002 Meeting Attendees

U. S. Fish & Wildlife Service (USFWS)

Jorge Saliva, Ph.D.
Carlos Diaz
Marelisa Rivera

Puerto Rico Department of Natural and Environmental Resources (DNER)

Miguel Canals – Guanica State Forest
Eduardo Ventosa – Division of Terrestrial Resources
Jose Camacho (for Ricardo Lopez Ortiz) – Assistant Biologist
Carlos Sanchez – Energy Affairs (for Javier Quintana)

Invitees who could not attend or who were interviewed via phone

Wayne Arendt, Ph.D. - USDA Forest Service – interviewed

Invitees – via email, but did not respond

Jose Colón – Ciudadanos del Karso

Interviews and Requests for Information

Francisco (Tito) Vilella, Ph.D. – Mississippi State University
John Faaborg, Ph.D. – University of Missouri
Jim Wiley, Ph.D. – US Geological Survey (USGS), Mississippi
Herb Raffaele – USFWS, Arlington, VA
Alfonso Silva – Naturalist and Author – toured site with author

Alberto Areces, Ph.D., and Gabriella Ocampo – botanists who toured site with author

Risk Assessment and Comparison of Avian Risk at the WindMar RE Project, Guayanilla, Puerto Rico, with Existing Wind Power Facilities and Sites

Perhaps the best means of assessing risk to birds at proposed wind power project sites is to compare the avifauna, geographic setting, habitat, and topographic conditions, as well as known or suspected risk factors at that site, with projects where risk has been documented empirically. By comparing the species known and likely to be present on or using the WindMar RE Project site, and the forests, beaches, mangrove swamps, and other wetlands, bays, and the Caribbean Sea that are immediately adjacent to the project site, to species and habitats at facilities that have documented risk or lack of risk, an educated (probabilistic) assessment can be made as to the overall risk to birds that can be anticipated at the Project. The relevant information for such comparisons should include the number and types of species present, seasonal presence (how many months of the year), and behavior of birds that are likely to nest, forage, migrate, or winter in the Project vicinity.

Literature Review of Impacts, Risks, and Risk Factors

Two types of negative impacts to birds have been documented at wind power projects: habitat alteration/disturbance and collision fatalities. Habitat alteration and disturbance resulting from construction and the addition of wind turbines to the landscape may render an area unsuitable for birds to nest, forage, rest, or use in other ways. Direct mortality has resulted from collisions with moving rotors, meteorology tower guy wires, and electrocution.

Habitat Disturbance and Avoidance/Disturbance

The presence of new infrastructure – primarily turbines and roads – has been studied at many sites to determine whether birds are permanently displaced from a particular area as a result of this new feature on the landscape. This type of impact includes the disturbance factor resulting from wind plant construction, which is generally ephemeral. Construction activity rarely extends for more than a year and most human activity is reduced after several months of construction. This disturbance is not generally considered significant. The amount of habitat altered by a wind power project footprint is usually a small percentage of the area at a particular site (perhaps 3%), and after construction, land use at most sites continues as prior to construction.

Studies of disturbance-type impacts on grassland and open field birds have been conducted in Minnesota and Wyoming, as well as in several countries in Europe. A study done in Conservation Reserve Program (CRP) grasslands in southwestern Minnesota at a large wind farm, reduced nesting activity was detected among Savannah Sparrows, Western Meadowlarks, and some other songbirds close to wind turbines as opposed to farther from those turbines (Leddy et al. 1999). These species were less numerous within 200 m of wind turbines than farther away. At the Foot Creek Rim Wind Power Project in Wyoming use of an area by nesting

Mountain Plovers was shown to decline following construction of wind turbines and their productivity was apparently reduced (Johnson et al. 2000). Successful nesting of Mountain Plovers was noted within 200 m of operating wind turbines, however.

In Europe, studies have shown that some birds avoid the area immediately beneath wind turbines. Shorebirds may be the most sensitive species. For example, at a site in the Netherlands, shorebirds (lapwings and curlews) avoided the area within 250-500 m of wind turbines (Winkelman 1990). In Denmark, some shorebirds (golden plovers and lapwings) were displaced by up to 800 m by the presence of turbines (Pederson and Poulsen 1991). Reduced avian use near wind turbines by some waterfowl and songbirds has also been detected (Peterson and Nohr 1989, Winkelman 1990). A study of eiders and scoters at a site off the coast of Denmark demonstrated that these birds avoid flying within 200 m of wind turbines and did not forage within 100 to 200 m of them (Tulp et al. 1999). Other studies have shown that birds do habituate to turbines or are not disturbed by them (Ihde and Vauk-Henzelt 1999, Winkelman 1990). One such study from England reported that shorebirds (Purple Sandpiper and Sanderling), as well as gulls and seaducks (including eiders – see above), habituated to the presence of turbines mounted on a rock jetty at the edge of the ocean (in Lowther 2000). Studies of seaducks off the coast of Denmark demonstrated some avoidance activity, especially within 100-200 m of turbines in the sea (Guillemette and Larsen 2002).

These findings are interesting in light of observations at wind power facilities in Colorado and the Altamont (APWRA) of California by the author. At these grassland sites, Horned Larks, meadowlarks, and Loggerhead Shrikes forage beneath the turbines and even perch on them regularly. Other birds, including Common Ravens and various species of raptors perch on these turbines. The turbines in California have been operating for nearly 20 years, so birds seem to habituate to the turbines, at least after several years.

It should be mentioned that naïve birds, those who had never experienced a wind turbine previously, seem to avoid these novel structures. In a study done in the APWRA of California, a group of Red-tailed Hawks trained for falconry were brought to the turbines to study raptor flight and how these birds negotiated flight in close proximity to the turbines. Upon first seeing the turbines at 100+ feet (32 m), the birds would not fly. In time they habituated and flew closer to the turbines and their behavior appeared comparable to resident Red-tailed Hawks (R. Curry, pers. comm.). A study of migrating hawks in Vermont during autumn showed that the numbers of hawks that flew close to a hill with newly constructed turbines was much smaller than in the year prior to turbine construction and operation (Kerlinger 2000b). These migrants may have been avoiding the novel structures.

With respect to forested sites, only one short-term study has been conducted in the United States. At the Searsburg, Vermont, wind power project, one year of post-construction monitoring provides some insight as to how much disturbance results from turbine presence in a forest. At Searsburg, species such as Blackpoll Warbler, Dark-eyed Junco, Yellow-rumped Warbler, and White-throated Sparrows were found after construction in habitats within 100 feet (32 m) of the turbines, suggesting that turbine presence was not a major impact or that these species rapidly habituated to turbine presence. However, a few species, including Swainson's Thrush, a forest interior species, were present in smaller numbers following construction. It is

likely that either the forest clearings and/or the presence of the turbines disturbed this and other sensitive species. They were found farther from the turbines after construction.

It is interesting to note that American Crows and Brown-headed Cowbirds were not present during surveys in the year following construction, although American Robins and Blue Jays were more numerous. Crows and cowbirds are normally edge-dwelling species, and their presence is indicative of forest fragmentation. That crows and cowbirds were absent is a good sign, although the presence of robins and jays shows that these species found the opening in the forest rapidly. These findings suggest a very small, probably temporary, degree of fragmentation at the Searsburg site. The post-construction forest management plan at Searsburg demonstrates that fragmentation can be mitigated successfully.

It should be noted that a forest management plan that permitted brushy vegetation and short trees to grow up to the roadside and turbine bases was implemented at the Searsburg site. The plan was an effort to reduce the impact of fragmentation. Follow-up studies at the Searsburg site will provide some indication as to the long-term degree of habitat disruption/displacement and forest fragmentation, as well as whether forest interior birds habituate to the presence of turbines.

Risk of Disturbance and Displacement to Birds

It is possible to estimate the likely extent and degree of impacts to birds that nest on the WindMar RE Project site, including the endangered Puerto Rican Nightjar. It should be noted that no studies of the impacts of wind power projects on birds have been conducted to date in tropical habitats or for the species present at the Project site. Nevertheless, studies have been done elsewhere on similar species (see Searsburg discussion above). In addition, there is anecdotal evidence that bears on how the nightjar might react to the WindMar project. Much of the potential risk to birds inhabiting the site will depend on how the habitat is managed after construction. There is no doubt that some disturbance will occur during the actual construction, causing the nightjar and other birds to withdraw temporarily or even permanently from the turbines and new roads. But based on the following evidence, it is believed that the nightjar at least will habituate to the Project over a short period of time, perhaps several years.

During the site visit, nightjars were heard calling in the vicinity of a functioning wind monitoring tower, showing that the birds do habituate to the presence of some infrastructure. In addition, the literature reports that, during the period when the nightjar was thought extinct, a Civilian Conservation Corps (CCC) encampment in the Guanica dry forest complained about a loud, persistent nocturnal call, obviously that of the nightjar (Raffaele 1989) – further evidence that the bird can adapt to new features in the landscape. The fact that the species is now recorded in areas close to major roads, hotels, cement plants, and prisons, where trucks, cars, and people create a daily disturbance (San Juan Star 2002), strongly suggests that the species is tolerant of a wide degree of disturbance, if their habitat is not removed. Other nightjars, including the congeneric Whip-poor-will and Chuck-will's-widow do habituate to human presence and infrastructure, as is clear from their presence in forests adjacent to housing developments and on military bases. These anecdotes indicate that many species of Caprimulgids (nightjars and goatsuckers) can habituate to low levels of disturbance as long as their habitat remains.

Collision Fatalities

Avian fatalities are the second type of impact noted at wind power facilities. These fatalities result primarily from collisions with rotors and with guy wires of meteorology towers. Electrocutions were not uncommon in the Altamont because transmission wires within the site were above ground, unlike modern facilities at which such transmission is below ground. These impacts have been studied or monitored systematically and intensively at about 15 different wind-power project sites in more than a dozen states in the United States (Erickson et al. 2001; Appendix I) and at a similar number of sites in Europe.

The number of fatalities involved at project sites has, generally, been small, and population impacts have not been documented or suspected. Such fatalities are orders of magnitude smaller in number than collision fatalities at transmission lines, with windows, on highways, and at communication towers (Erickson et al. 2001). This is also the case with other human-induced mortality, such as pesticides, hay mowing, commercial fishing, house cats, etc. (www.currykerlinger.com). Turbine collision fatalities are also orders of magnitude smaller than hunting harvests permitted by professional wildlife managers (data from USFWS), indicating minimal or no impact on populations of the species involved, despite a regular and sustained harvest of a large portion of the populations of species involved.

The only wind power site in the United States where risk to birds has been suspected to be significant is the APWRA of California, where raptor fatalities have been reported for more than a decade. Golden Eagles, Red-tailed Hawks, American Kestrels, and some other species collide with turbines in varying numbers in the APWRA. Raptors are believed to be the most collision-susceptible group of birds (Anderson et al. 2000), although nowhere, including the APWRA, have such fatalities been documented to have negative impacts on populations of individual raptors species. A long-term study of the Altamont Golden Eagle population by Hunt (2002) concluded that, although fatalities of this species occur at a high rate, the population remains stable.

Large numbers of gulls, ravens, vultures, grassland songbirds, and other species fly amongst the APWRA turbines and rarely collide with the turbines. The situation with respect to raptor impact in the APWRA seems to be an anomaly, because it has not been found at other wind plants. Raptors generally appear to be at a higher risk than their numbers would suggest on several project areas and remain an important part of any risk assessment for any proposed area. Studies outside California have yielded a total of only about seven raptor fatalities, indicating that the APWRA is an anomaly and that raptor fatalities are rare events at wind plants.

Several factors (Table 2) are now believed to contribute to risk in the APWRA. They are: the world's largest concentration of operating turbines (N=5,400, reduced from about 7,000 several years ago); closely spaced turbines (<10 m [<30 feet] rotor to rotor distance) that may not permit birds to fly between them safely; the presence of very large numbers of foraging raptors throughout the year - a result of a superabundant population of California ground squirrels (which attract the raptors); steep topography with turbines placed in valleys and along canyon edges where more fatalities occur; turbines mounted on lattice type towers that encourage

perching by providing shade and cover from the sun and rain; and turbine rotors that revolve at high rotational rates (>40-72 rpm). These factors have been hypothesized to act alone or in concert (Howell and DiDonato 1991, Orloff and Flannery 1992, 1996, Curry and Kerlinger 2000) to produce mortality seen in the APWRA.

In the far western United States (Appendix I), avian mortality resulting from collisions with wind turbines has been studied at several sites. For example, the number of fatalities recently reported from the San Gorgonio Pass involved fewer than 40 birds (no raptors) at 120 turbines in two years of study (Anderson et al. 2000). In the Tehachapi Mountains, 84 birds were found at 180 turbines (Anderson 2000) in two years of searches. Small numbers of raptors were involved at these sites. One Golden Eagle was found at a wind turbine in the San Gorgonio Wind Resource Area. At a new wind power site in Oregon, at which there are 38 turbines in farmland, a one-year study documented no raptor fatalities, 8 songbird fatalities, and 4 upland gamebird fatalities (3 of which were alien species). Most of these projects have been situated in tilled agricultural fields or grazing lands and small numbers of fatalities have been documented. There has been no suggestion of population impacts at any of these facilities, nor have fatalities involved endangered or threatened species.

Studies of avian fatality have been conducted at the wind plants in grasslands in Colorado, Wyoming, and the small site in Kansas. After four years of systematic searches at 29 new turbines (expanded to 45 in the third year) in a short-mixed grass prairie-type habitat in northern Colorado, fewer than 30 fatalities have been documented. The fatalities include 5 Horned Lark, 1 McCown's Longspur, 2 White-throated Swifts, 1 teal, Lark Bunting, 1 American Kestrel, and some other songbirds (Dr. Ronald Ryder, Colorado State University, personal communication and Curry & Kerlinger, LLC, report to USFWS and Colorado Audubon). At the Foote Creek Rim project, also in a short-mixed grass prairie habitat, 90 fatalities were identified, 75 of which were at wind turbines and 15 of which were at meteorology towers with guy wires. Thus, about 17% of the fatalities resulted from collisions with guy wires at the meteorology towers and likely would have been avoided by using unguyed towers. A total of four raptors were found dead at the Foote Creek Rim project (3 American Kestrels and 1 Northern Harrier) and 48% of the fatalities were night migrating birds. Of the migrants, no species accounted for more than 5-7 (Chipping and Vesper sparrows) individuals. Finally, no fatalities were noted by Young (2000) at the two turbines, Jeffrey Energy Center in Pottawatomie County, Kansas.

Studies done in the Midwest in farmed areas also revealed few avian fatalities. At the Buffalo Ridge wind power facility near Lake Benton, Minnesota, small numbers of fatalities have been reported (Strickland et al. 2000) from the more than 200 wind turbines searched at this site during several years. The species composition included a variety of birds, including one raptor (Red-tailed Hawk), very few waterbirds, and some migrating songbirds (about 70% of the fatalities). A one-year study in the Kewaunee County peninsula of Wisconsin revealed about two-dozen songbird (mostly migrants) fatalities under 31 turbines situated in farm fields. A study of two modern wind turbines at Shirley, Wisconsin, revealed only one night-migrating songbird fatality during a year-long study (Howe and Atwater 1999). A study at a small wind plant in Iowa reported no fatalities.

In the eastern United States, fatalities have been examined at six wind power facilities. In Vermont, searches done in June through October 1997 (nesting through migration) revealed no fatalities at 11 new turbines situated on a forested hilltop (Kerlinger 2000a and 2000b). In upstate New York, several months of daily searches during spring and autumn migration beneath two wind turbines located in open fields revealed no carcasses (Cooper et al. 1995). At an older wind power facility with eight small turbines in a forested setting in Massachusetts, no fatalities were found (Jacobs 1993). Surprisingly, the wind power facility in Massachusetts is on Mount Wachusett, the site of one of the largest inland hawk watches in New England. At a facility with eight turbines located in farmland in Somerset County, Pennsylvania, 17 rounds of fatality searches conducted in June 2000 through May 2001 revealed no avian fatalities (unpublished data from Curry & Kerlinger, L.L.C.). During a year of study at a wind plant consisting of seven modern turbines in central New York, four fatalities were identified (Curry & Kerlinger, LLC, report in prep.). A one-year study of three turbines in a forested setting on a mountain in western Tennessee revealed about a dozen fatalities, mostly night migrating songbirds (Nicholson 2001).

Absolute numbers of fatalities at modern wind power facilities are smaller than the numbers reported from the APWRA and rarely involve raptors. Night migrating songbirds are the most numerous of fatalities at the projects overall. The fatalities at wind plants outside of the APWRA are spread among a variety of bird species such that very small numbers of a given species are involved. This reduces the probability of population impacts. From the recent studies at modern wind plants, it is clear that avian fatalities at wind turbine sites are rare events and, to date, population impacts have not resulted. Behavioral studies demonstrate that the reason collision fatalities are rare at wind turbines is a result of the fact that birds apparently see the turbines and recognize them as obstacles. Most birds change direction when they encounter turbines and fly around them.

The comparison of risk factors in Table 2 reveals that few of the factors known or suspected to present high risk to birds are present at the WindMar RE Project. It is not likely that migrating raptors will collide with the turbines at WindMar RE, because they hardly use the site. They simply fly by the site, unlike the raptors in the Altamont that hunt amongst the turbines all year long. Risk to these birds is likely to be low and not significant.

Table 2 provides a comparison of known or suspected collision risk factors at Altamont Pass Wind Resource Area, California, with the WindMar RE Project, Guayanilla, Puerto Rico.

Table 2 – Risk Factor Comparison

<u>Known or Suspected Risk Factors – APWRA</u>	<u>WindMar RE Project, Puerto Rico</u>
1. Large concentrations of turbines –5,400 (in 2001)	~28-60 turbines
2. Lattice towers - perching raptors	Tubular towers - no perching
3. Fast Rotating Turbine Blades - 50-72 rpm	Slow Rotating Blades ~12-18 rpm
4. Closely Spaced Turbines - 80-100 feet (<30 m) (Side to Side Turbine Spacing)	Widely Spaced Turbines ~650+ feet (>200 m)
5. Turbines in Steep Valleys/Canyons	Turbines on hilltops
6. Large Prey Base - Attracting Raptors	Prey Base Minimal – No/few raptors
7. Raptor and Susceptible Species Use of Area – High	Raptor and Susceptible Species Use of Area - Low

The issue of night migrating birds colliding with turbines is often a concern to wildlife agencies and, therefore, should be considered when assessing risk. None of the studies listed in Appendix I report significant numbers of night migrants colliding with wind turbines and some report no collisions. The incidents involve mostly single birds, unlike the large-scale events that occur almost exclusively at guyed communication towers greater than 500 feet (152 m) in height. The total numbers of nocturnal migrants that have been reported dead at all North American wind turbines may total in the hundreds of birds of more than two to three dozen species. The reason so few nocturnal migrants collide with wind turbines as opposed to tall communication towers is probably related to the shorter height of wind turbines and their lack of guy wires (Kerlinger 2000c). A majority of migrants fly between 300 and 2,500 feet (91-915 m) AGL (Kerlinger 1995, Kerlinger and Moore 1989), with small numbers flying above 5,000 feet (1,524 m) AGL. Except for landing and taking off, few migrants are below about 500-600 feet (152-183 m) AGL. Mean hourly altitudes usually exceed 1,200 to 1,500 feet (366-457 m) AGL.

The communication towers that are responsible for a vast majority of avian fatalities are greater than 500-600 feet (152-183 m; from literature review, recent unpublished studies, Crawford and Engstrom 2001) in height, much taller than wind turbines. Also, collisions involving night migrating birds occur mainly at towers in the eastern United States where night migrating birds are more abundant and dense in the night sky. The most recent literature surveys conducted by the USFWS and the U. S. Department of Energy (Trapp 1998, Kerlinger 2000b, Kerlinger 2000c) reveal virtually no large-scale mortality events at communication towers less than 500-600 feet in height, and often no fatalities at towers shorter than this height. With most migrants flying over 300 feet above ground level, they are above the turbine rotors and even higher above turbine lights (which are at about 65-80 m [213-262 feet]). The fact that there are

no guy wires on modern turbines is of crucial importance, because it is the guy wires of tall communication towers that account for most of the collisions. The conclusion is that turbines present less risk than tall communication towers, especially those greater than 500 feet (152 m) with guy wires.

Studies conducted in Europe have also revealed small numbers of fatalities (see European references in the Literature Cited section), with a few exceptions. In Spain, larger than expected collision fatalities have been found at Tarifa and Navarre. At Tarifa, a crossroad of migration for raptors and songbirds at the narrow crossing between Spain and Morocco, dozens of Griffon Vultures were found dead under the turbines in the early years of plant operations. Those numbers seem to have declined since then, and the fatalities do not seem to have led to local population declines of this species. Migrants do not seem to collide in large numbers with these same turbines. In northern Spain, at a site in Navarre where there are now hundreds of turbines, there are reports (unconfirmed at this time) that large numbers of resident raptors have been killed by the turbines.

In the Netherlands, where turbines were erected in lowlands adjacent to the Wadden Sea and in a lake, greater than average numbers of shorebirds, songbirds, and waterfowl were impacted. However, the impacts were considered to be not significant from an ecological perspective (Winkelman 1990, 1992, 1995). Small numbers of gannets and seaducks have been reported to be killed by turbines on jetties in the ocean as well at the turbines that are currently standing about a kilometer off those same jetties at Blyth Harbor in the UK. At all other sites in Europe, the fatality rates have been lower and have not been implicated in significant impacts to birds.

The type of turbines, their characteristics, and spacing at the Project site would be similar to those at modern projects now in the United States and Europe. As summarized above, studies at these and other sites have shown fatalities to be infrequent or rare events. No endangered or threatened species have been involved and only occasional raptor, waterfowl, or shorebird fatalities have been documented.

Risk of Bird Collisions at the WindMar RE Project, Guayanilla, Puerto Rico

With respect to fatality collisions at the WindMar RE facility, overall risk is likely to be low and not significant. Small numbers of fatalities would likely occur at the site. The numbers and species composition would, in all probability, be similar to those reported in the studies summarized in Appendix I although the species would, in part, include tropical residents. These fatalities are not likely to result in impacts to the populations of any species. This assessment is based on the weight of evidence that has accumulated during the past decade from empirical studies and from the characteristics and risk factors at the WindMar RE Project site.

- Night Migrating Songbirds – Low Risk – Fatalities of these birds would likely be numerically greater than any other species group because these birds are more collision prone. However, the migration of night migrating songbirds over the site would appear to be low. As a result, few of these birds are likely to be killed.

- Raptors – Low Risk – Fatalities of raptor are unlikely because so few raptors are present on the site, and use of the site by these birds is very low.
- Waterfowl – Low to No Risk – Because so few waterfowl frequent the area, they are not likely to collide with the turbines. These birds also rarely collide with structures.
- Shorebirds – Low Risk – These birds rarely collide with man-made objects and during migration they fly at very high altitudes.
- Hérons and Egrets – Low Risk – Although these birds are present in good numbers in the wetland habitats adjacent to the turbines, there is no reason for them to fly over the hills where the turbines would be placed. The turbines are not on any flight paths for these birds, so collisions are unlikely.
- Endangered Species:
 - Puerto Rican Nightjars – Low Risk – These birds seldom fly at altitudes that would put them at risk. Their behavior is mostly restricted to the forest and up to only a few feet above the canopy.
 - Brown Pelican – Low Risk – Pelicans occasionally fly across Punta Verraco to Guayanilla Bay and back. At these times, they might be at risk. Because most diurnal birds that are not engaged in foraging flight almost never fly into turbines, it is unlikely that pelicans will do so. However, more information about the flight paths and activity of these birds as they fly over Punta Verraco or other parts of the project site would be helpful for evaluating risk.
 - Roseate Tern – Low to No Risk – Virtually no Roseate Terns are likely to fly over the locations where wind turbines would be located.
 - Yellow-shouldered Blackbirds – Low to No Risk – These birds do not occupy the Project site and are therefore not at risk. However, because it is not certain if they nest on the Project site, a nesting survey would help evaluate potential risk. If this bird did establish itself on the Project site, it would inhabit the lowland areas, away from the turbines.

Cumulative Impacts and Alternatives Analysis

An examination of cumulative impacts and alternatives to development is often recommended or requested by regulatory agencies. For the WindMar project, the potential for negative impact to birds was examined above. Unlike many other forms of development, wind power has

With respect to alternatives for the WindMar property, the property could ultimately have several different uses. The impacts of those alternative uses are considered below.

- No Action – This alternative would lead to little or no impact on wildlife on the Project site. However, the no action alternative is unlikely because waterfront land along the Caribbean is extremely valuable, and its value continues to increase. Landowners are unlikely to leave land undeveloped or intact as a single parcel if it is currently not providing income. The

extreme high value of this property is reflected in the property taxes that are annually assessed. They are currently \$40,000 a year.

- Acquisition for Open Space Conservation – This alternative would result in little or no impact. Nevertheless, it is unlikely that the Commonwealth of Puerto Rico, US government agencies or private conservation organizations will step forward to purchase this property as open space. Little new land is being added as open space in Puerto Rico because of governmental budgetary constraints.
- WindMar RE Project – This project would result a combination of positive and negative impacts that would likely balance each other or lead to a net gain for wildlife and conservation. The amount of land within the property that would be used for wind turbines and other infrastructure would be less than about 3-4% of the entire tract. This would lead to minor impacts to wildlife, although those impacts are not likely to be ecologically significant. The two (or three) areas on the Project site that could be restored as part of a mitigation plan, would reduce or mitigate the minor impacts that are expected. The vast majority of the tract would remain undeveloped and would continue to improve as wildlife habitat as the forests grew. If a conservation easement were put on all or most of the WindMar tract, it would increase the size of the Guanica State Forest significantly and protect a large area of contiguous wildlife habitat. The WindMar tract would basically provide a long-term buffer zone for Guanica State Forest that is presently not guaranteed. It should also be noted that there are other positive impacts to wildlife that would result from the Project. The wind turbines would replace the need to burn fossil fuel for electricity for 20,000 homes. This would amount to a significant reduction in pollution from CO₂, SO_x, NO_x, (which increases ozone depletion and acid precipitation), heavy metals, and other noxious substances that are currently being blamed for reductions in birds and other wildlife populations, as well as contaminating these organisms. It is interesting to note that the amount of CO₂ emissions avoided by the WindMar Project would be equivalent to the amount of CO₂ that a 30,000 acre dry forest would sequester every year. The turbines would also reduce the need to extract and transport a large amount of petroleum, the fuel mainly used to generate electricity in Puerto Rico. It is almost a certainty that, overall, the project would have a net positive (cumulative) impact on wildlife and wildlife habitat on the site and over a much larger geographic area.
- Development for Housing or Tourism – This alternative would cause the greatest amount of environmental degradation of any of the alternatives listed here. Not only birds but all forms of wildlife that live on or adjacent to the property would be impacted by this development option. The property is zoned R-0, which allows housing development. Such development would result in massive impacts to habitat (clearing of forest, etc.), fragmentation of habitat, harvesting of trees for charcoal (and other purposes), introduction of cats, rats, and dogs that would roam throughout the property, electric distribution lines, bright lighting, and other infrastructure as well as greater human activity. This increased activity would also have a negative impact on the Guanica State Forest. The WindMar tract currently serves as a buffer to the State Forest. If the tract in its entirety or in part were developed, it would indirectly impact the wildlife of Guanica State Forest. This alternative is the most likely one to occur because this has been the disposition of much of the Caribbean coastline in Puerto Rico.

Potential Mitigation and Habitat Restoration

There are three areas on the WindMar RE Project site that are degraded and, therefore, suitable for habitat restoration. These restorations might become part of an overall mitigation program, if called for.

- Punta Verraco Upland Site – 7.5 acres – This site could serve as a lay-down area for the Project, reducing potential habitat degradation. Following construction of the turbines, it could be restored, thereby reducing the fragmented nature of the Punta Verraco dry forest by connecting forests that are currently not connected and filling in a major forest gap. The species that would be used would be native species, especially endemics that are currently growing on site. The area could also be used as a nursery following construction to generate more material for other restoration projects in the area. The area could become suitable foraging and nesting habitat for the endangered Puerto Rican Nightjar.
- Mangrove Swamp – 25 acres – The restoration of this area would require opening up conduits that were installed beneath the existing road to permit salt water to enter a portion of the project site. Those conduits have become clogged over the years. If they cannot be cleaned, new conduits can be put in. Recovery of the Black Mangroves in this area would most likely increase insect populations, which would benefit insectivorous birds, including the Puerto Rican Nightjar.
- Wetland area to the north of Cerro Toro – This area seems mildly degraded. A conversation with Marelisa Rivera of the U. S. Fish and Wildlife Service revealed that it looked like marginally suitable habitat for the endangered Yellow-shouldered Blackbird. The fact that this area is adjacent to the mangrove swamp that could also be restored makes it a good candidate for a restoration project aimed at creating suitable habitat for Yellow-shouldered Blackbirds. The actual restoration should be done following consultation with the USFWS to insure that the project would result in suitable habitat.

Some form of post construction monitoring could be conducted to determine the success of these restoration projects.

Findings

From what was observed of the avifauna, habitat, and topography of the WindMar RE Project site, and from results of the literature search and interviews, the following conclusions were made:

1. Human use of this privately owned property is minimal and is currently not being used for economic activity. No major land-use changes, other than wind turbine presence and maintenance, are anticipated.
2. The WindMar RE Project site has several different habitats including Caribbean beach and dune, dry scrub forest, mangrove swamp, marsh and ponds, rocky outcroppings along the Caribbean, and some degraded areas. The site is not classified by USFWS as critical habitat for any endangered species, but it does support the federally endangered Puerto Rican Nightjar.
3. The WindMar RE Project site supports a diverse array of mostly common, forest and scrub-nesting bird species, as well as some birds of wetlands (marsh and mangrove swamp). The Guanica State Forest immediately to the west of the Project site indicates that the general area (including the Project site) is an important area for birds that nest in dry forests.
4. Significant hawk, songbird, waterfowl, or other migration is not known to occur over the project site, nor is habitat there suggestive of migration stopover habitat. It is likely that small numbers of songbirds do stopover during migration. Shorebirds do stopover and winter in the wetland habitats on and adjacent to the project site, although there is no information on their numbers during migration (particularly autumn).
5. Winter bird use at the project site is likely to be greater than nesting season use, with species present being common residents, migrant songbirds, and shorebirds from the North American mainland in relatively small numbers.
6. The presence of endangered and threatened species on and adjacent to the Project site is of particular importance. Puerto Rican Nightjars nest on the site in apparently significant numbers. Brown Pelicans fly over the site at times and forage in shallow waters adjacent to the site. Roseate Terns nest about 2-3 miles from the site and forage nearby. And, Yellow-shouldered Blackbirds may visit the lowland areas of the site at times, but are not known to nest within several miles of the Project site. The presence of these species calls for further investigation and potential mitigation (i.e., a Habitat Conservation Plan) if incidental takings are anticipated (which they are not) as a result of wind turbine construction and operation.
7. Risk of avian collisions at the WindMar RE Project is low and not likely to be significant. The footprint of the project and the presence of new infrastructure are likely to cause some disturbance and potential displacement impacts to nesting forest birds, including the endangered Puerto Rican Nightjar. A forest management plan that incorporated some sort of mitigation and restoration would help minimize disturbance and fragmentation of the habitats.

Recommendations

Based on the site reconnaissance, literature review, interviews, and comparison with other sites gathered in the development of this risk assessment and on what has been learned about risk at wind power facilities during the past decade, the following recommendations are made for the WindMar RE Project.

- Electrical lines on site should be underground. Above ground (if necessary) transmission lines and interconnects, as well as substations should be insulated and configured per APLIC (Avian Power Line Interaction Committee) guidelines. These guidelines are accepted by USFWS as the best means for avoiding electrocution fatalities.
- Consistent with FAA guidelines, obstruction lighting should be white strobes (USFWS voluntary guidelines) with the longest possible off cycle permissible and lighting should be kept to a minimum number of turbines (if possible no turbines should be lit). If white strobes are not permitted by the FAA, red strobes or red LEDs with the longest off cycle permitted should be used.
- Permanent meteorology towers should be free-standing, without guy wires to prevent collision fatalities among birds using the wind plant.
- A wetland delineation should be conducted to determine where wetlands are present within the project footprint so that they may be buffered by the project.
- A forest management plan that promotes the long-term safety of the forest for birds and other wildlife is recommended. That plan would provide for minimization of forest fragmentation resulting from clearing and cutting for turbines and roads. The forest management plan should take into consideration the reduction of the major threats to the forest community, including fire, feral animals, and invasive species. Clearings and cuttings should be managed not only to serve as fire brakes but also to increase species diversity and particularly plant species that would augment the insect population. In this regard, reforestation with rare, listed, endemic, and under represented plant species would be highly desirable.
- Restoration of the mangrove swamp (~25 acres), degraded upland site on Punta Verraco (~7.5 acres), and the mildly degraded freshwater wetland habitat on site may be considered as potential remediation for project impacts to upland habitats. Post construction monitoring of these sites would determine whether these projects were successful.
- Because the Puerto Rican Nightjar nests on the Project site, a complete survey of the property to determine nightjar abundance and distribution during the nesting season, when habitat requirements are most stringent, is needed. Section 10 consultation with USFWS is recommended. A Habitat Conservation Plan (HCP) is likely in order because of potential disturbance to the nesting habitat of this species. The methodology for this work is included in Appendix II.

- A survey for Yellow-shouldered Blackbirds (federally endangered) is needed at the lower elevations of the Project site. The methodology for this work is included in Appendix II.
- A study of flight behavior by Brown Pelicans and Roseate Terns (both federally listed) over the project site at Punta Verraco is recommended. The study would examine the flight behavior of these birds when and if they fly over the Project site. The methodology for this work is included in Appendix II.

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Figure 1. Map showing the boundaries of the WindMar RE Project, Guayanilla, Puerto Rico, along with the provisional turbine locations and roads.

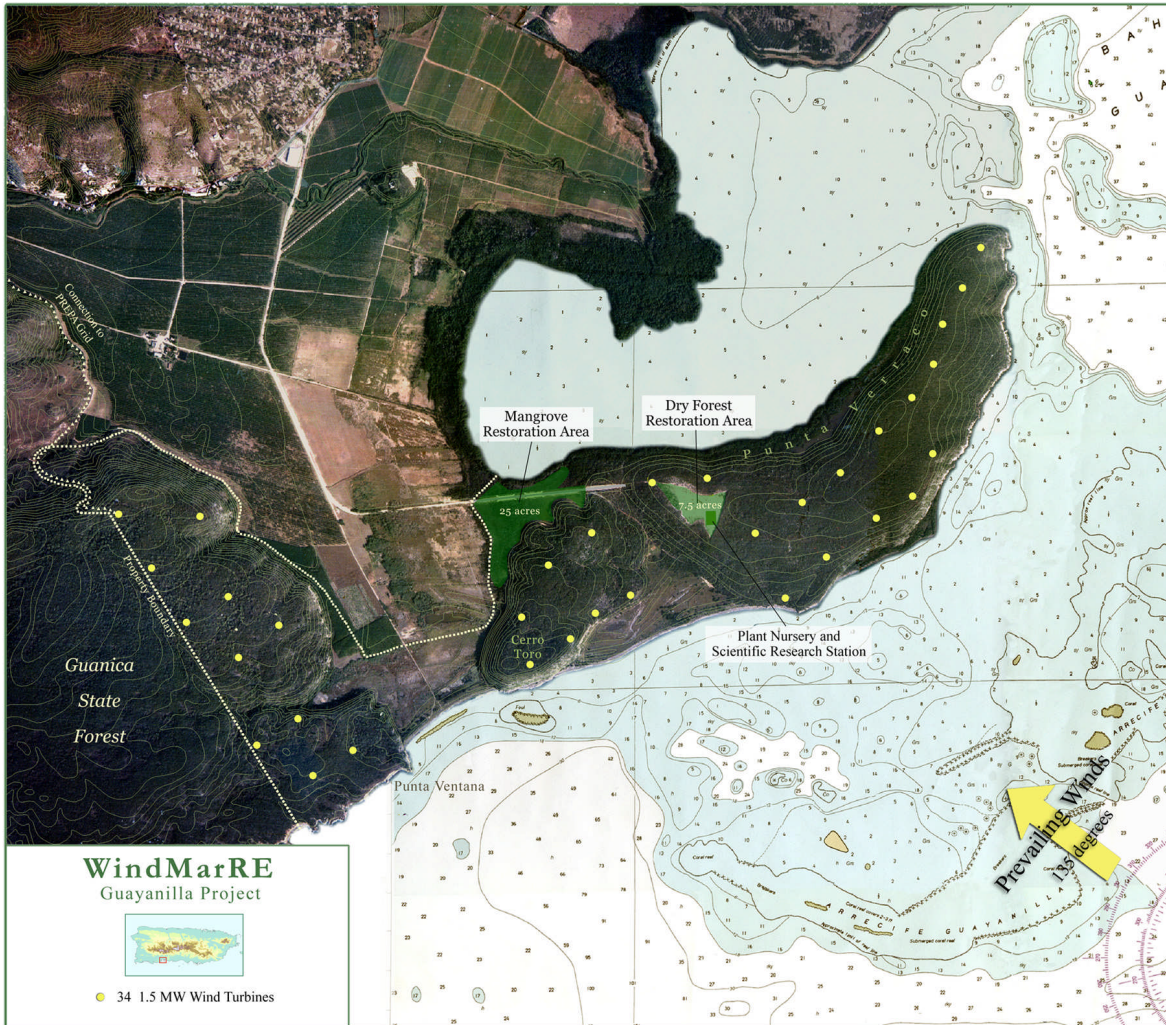


Figure 2. Photographs of the WindMar RE Project site, Guayanilla, Puerto Rico, showing representative habitat at site where turbines are proposed (Punta Verraco forest top and bottom).



Figure 2. Photographs of the WindMar Project site, Guayanilla, Puerto Rico, showing representative habitat at site where turbines are proposed (Punta Ventana top, Cerro Torro bottom).



Figure 2. Photographs of the WindMar RE Project site, Guayanilla, Puerto Rico, showing degraded areas at site (degraded upland top, mangrove swamp bottom).



Appendix I. Review of avian studies in the United States and Canada.UNITED STATES

- **Vermont** – Searsburg near Green Mountain National Forest, 11 modern turbines in forest on hill/mountain top, nesting and migration season, 0 fatalities, Kerlinger 2000
- **New York** - Tug Hill Plateau, 2 modern turbines on farmland, 2 migration seasons, 0 fatalities, Cooper and Johnson 1995
- **New York** – Madison, 7 modern turbines on farmland, 1 year, 4 fatalities (2 songbird migrants, 1 owl, 1 woodpecker), Curry & Kerlinger 2002, unpublished report.
- **Pennsylvania** – Garrett (Somerset County), 8 modern turbines, farm fields, 12 months, 0 fatalities, Curry & Kerlinger, LLC, unpublished report
- **Tennessee** – Buffalo Mountain, 3 modern turbines, forested mountaintop, 1 year, 12 fatalities (night migrating songbirds), Nicholson 2001
- **Massachusetts** – Princeton, 8 older turbines - type unknown, forest (hardwood) and brush, autumn & winter, 0 fatalities, Jacobs 1995
- **Minnesota** – Buffalo Ridge near Lake Benton, 200+ of modern turbines in farm and grassland, several years (1997-1999), 53 fatalities (mostly songbirds and 1 hawk); some displacement found among grassland nesting songbirds; Osborn et al. 2000, Johnson et al. 2000, Johnson et al. 2000, Johnson et al. 2000, Strickland et al. 2000, Leddy et al. 2000
- **Kansas** – St. Mary's, 2 modern turbines in grassland prairie, 2 migration seasons; 33 surveys, 0 fatalities, E. Young personal communication
- **Wisconsin** – Kewaunee County Peninsula, 31 modern turbines in farmland, 1+ year, 18 fatalities (3 waterfowl, 14 songbirds, some night migrants), report to Wisconsin Dept. of Natural Resources, Madison Gas & Electric, and Wisconsin Dept. of Public Service
- **Wisconsin** – Shirley, 2 modern turbines in farmland, 54 surveys, 1 fatality (night migrating songbird), report to Wisconsin Department of Natural Resources Bureau of Integrated Science Services and Richter Museum of Natural History Special Report
- **Iowa** – Algona, 3 modern turbines in farmland, three seasons, 0 fatalities, Demastes & Trainer (2000)
- **Colorado** – Ponsequin, 29 (44 in 2001) modern turbines in rangeland, 4 years - 1999-2002, 20+ songbirds, 1 duck, 1 American Kestrel fatality, Kerlinger, Curry, and Ryder 2002 unpublished

- **Wyoming** – Foote Creek Rim, 69 modern turbines in rangeland, 2 years, 75 turbine fatalities (songbirds – 48% night migrants - and 4 raptors), Johnson et al. 2001 (15 additional fatalities were at guyed meteorology towers)
- **Oregon** – Vansycle, 38 modern turbines in farm and rangeland, 1 year, 11 birds (7 songbirds [~ 4 night migrants], 4 gamebirds, Erickson et al. 2000)
- **California** - Altamont Pass Wind Resource Area (APWRA), 5,400 older turbines mostly on lattice towers in grazing and tilled land, many years, large numbers of raptor fatalities (>400 reported) and some other birds, Howell and DiDonato, 1991, Howell 1997, Orloff and Flannery 1992, 1996, Kerlinger and Curry 1997, 1999, Thelander and Rugge 2000
- **California** – Montezuma Hills, 237 older turbines, 11 modern turbines in farmland, 2+ years, 30+ fatalities (10 raptors, 2 songbirds, 1 duck), Howell and Noone 1992, Howell 1997
- **California** - San Geronio Pass Wind Resource Area, thousands of older turbines, 120 studied in desert, 2 years, 30 fatalities (9 waterfowl, 2 raptors, 4 songbirds, etc.), Anderson et al. 2000
- **California** - Tehachapi Pass Wind Resource Area, thousands of turbines, 100s of mostly older turbines studied, in Mojave Desert mountains (grazing grassland and scrub), 2+ years, 84 fatalities (raptors, songbirds), Mitchell et al. 1991, Orloff 1992, Anderson et al. 2000
- **Texas** - no reports available from more than 200 modern turbines, fatalities have yet to be reported, communication from FPL Energy official
- **Iowa** - no reports available from more than 200 modern turbines other than Algona, farmland, fatalities have yet to be reported, communication from official

CANADA

- **Quebec** - Le Nordais, Gaspé, 2 projects, 133 modern turbines in forest, 26 studied, two migration seasons, no fatalities, report to Province of Quebec Ministry of Environment 2000
- **Alberta** –Medicine Hat and Lethbridge, 2 projects, no reports of avian fatalities to date

Appendix II. Study plans and methodologies for preconstruction surveys of the federally endangered Puerto Rican Nightjar, Yellow-shouldered Blackbird, Brown Pelican, and Roseate Tern.

Puerto Rican Nightjar. The purpose of this study is to determine and map the abundance and distribution of nightjars in the Punta Verraco, Cerro Toro, and Punta Ventana areas of the WindMar RE property. The results of this study will help assess risk to the species and site turbine and road locations in order to minimize impacts on the nightjar population. This study will use the methodology described by Vilella and Zwank (1987). Because the habitat is difficult to walk through, narrow trails will be cut along transects through the vegetation prior to the commencement of surveys. These transects will be about 200-250 m apart, which will insure that all nightjars in these areas that vocalize are heard. The actual survey will be conducted by walking slowly and stopping when necessary to note the location of a vocalizing nightjar. These birds can be heard at up to 300 m according to Noble et al. (1986). On Punta Verraco, one of the transects would be the main (jeep) trail. The other would run parallel to the south of the main (jeep) trail. On Cerro Toro, a single transect will be used from the base to the top. On Punta Ventana, two transects will need to be established. One will run 200 m from the border with the Guanica State Forest, the other about 450 m from the border. These transects will provide for thorough sampling of all suitable hilltop habitat at the three hilltop areas. Two people will work together, both for safety and so that a larger area may be searched during the narrow window when the species is vocally active before sunrise and after sunset. Surveys will be conducted from about one hour before dawn (Civil Twilight) to just before sunrise and from just after sunset for an hour into darkness (until birds stop vocalizing). Transects should be conducted in opposite directions on the two nights they are surveyed. Observations should not be conducted during rain or when winds are greater than about 12 miles per hour (to maximize the ability to hear birds). All transects should be surveyed at least twice during March-May, although Vilella and Zwank conducted surveys in January, July, and August. Noble, Vilella and Zwank (1986) conducted surveys in similar months. The positions of all vocalizing birds will be noted by triangulating from GPS coordinates. The final report will include a map showing the locations of all territories on the Project site and could be used to microsite turbines in locations (e.g., outside of territories or where territories abut) so that they would minimize impact to territorial birds.

Yellow-shouldered Blackbird. Although Yellow-shouldered Blackbird has not been observed on the Project site, a study will be conducted to determine if the bird is present. The study will commence with an identification of the areas within the Project site that have habitat that is suitable for the species. These areas would likely include the wide-open flat area between Punta Ventana, Cerro Toro, and Punta Verraco. The habitat types to be checked would include the palms and brush along the beach, the forest edge at the perimeter of the wide-open area, and the mangroves along Guyanilla Bay. These habitats have been used for nesting by the species in other parts of Puerto Rico (as summarized by Rivera in 1996). All of these areas are easily accessed and surveyed. The species is relatively easy to identify. Males sometimes display on territories between February and November, although the period that includes April through August delineates safe dates for surveying. This study should focus on April through June, because the birds are likely to be most active at that time. The method for surveying would include six complete surveys of the suitable habitat areas. Each survey slowly walking the suitable habitat on site, during which the observer would search visually and listen for males

vocalizing. No strict methodology should be applied. Each habitat should be surveyed at a different time of day with all locations getting some attention early in the morning. Six thorough and exhaustive searches should reveal whether the species is present. If the species is present, its abundance and distribution will be mapped in a manner that thoroughly censuses the suitable habitat. Individuals that are found on territories should be the subject of subsequent visits to determine the status of the individual (whether it is on a territory or whether the bird was simply passing through the site). Territories will be marked via a GPS unit so that they may be found during subsequent trips.

Brown Pelican and Roseate Tern. These species do not nest on or within about 2 miles (3.2 km) of the property, although Brown Pelican is known to fly over Punta Verraco between Guayanilla Bay and the Caribbean Sea. Surveys for these species will entail conducting behavioral observations at varying times of day (between sunrise and sunset) from the highest elevation on Punta Verraco. An observation platform that extends above the forest canopy would facilitate observing a large area over Punta Verraco and Cerro Toro. Observations would last over a three-month period (May through July). Field observations would be conducted twice each week, during which two observation periods of about 2 hours each, separated by a 15-30 minute rest periods would be conducted. Information for each individual bird or flock should include: species, numbers of individuals, the height of flight in three categories (<100 feet above the canopy, 100-350 feet above the canopy – corresponding to the height of the rotor, and >350 feet above the canopy), direction of flight (crossing land between Guayanilla Bay to the Caribbean and vice versa or parallel to the axis of Punta Verraco in the area where turbines will be located, parallel to the axis of Punta Verraco but outside the areas where turbines would be located [over the Sea or cliffs along the Sea]), and notes on specific behavior (constant soaring over Punta Verraco, landing in trees or cliffs, etc.). Information for all birds observed flying over Punta Verraco and Cerro Toro should be recorded, although primary attention should focus on pelicans and terns. The information on other birds will be used to assess risk to non-listed species. The final report would summarize the data and provide a more refined assessment of potential risk.