

**A Preconstruction Study of Abundance and Distribution of the
Federally Endangered Puerto Rican Nightjar at the
WindMar Re Project, Guayanilla, Puerto Rico**

August 30, 2003

Prepared for the WindMar RE Project
Victor Gonzalez, Project Manager

Prepared by:

Paul Kerlinger, Ph.D.
Curry & Kerlinger, LLC
P.O. Box 453
Cape May Point, NJ 08212
609-884-2842, fax – 884-4569
pkerlinger@aol.com

Executive Summary

A study of abundance, density, and distribution of the federally endangered Puerto Rican Nightjar was conducted between April 26 through June 23, 2003, at the site of the proposed WindMar RE Project in Guayanilla, Puerto Rico. The site is being proposed as a wind power development that would include 27 turbines.

Transects were established in three distinct areas within the WindMar RE property: Punta Verraco (2 major and 2 minor transects), Cerro Toro, and Punta Ventana. These transects sampled about 250 hectares of the WindMar RE property. A total of 95 listening points were established using a geographic positioning system (GPS) along the transects, each about 88 m apart (Punta Verraco - 63 listening points, Cerro Toro – 11 points, Punta Ventana – 21 points). Each transect was sampled 4 times during the study period during both pre-sunrise (3 hours before sunrise) and post-sunset (3 hours after sunset) periods by listening for calling nightjars, after which a tape recording of nightjar vocalizations was played if nightjars were not heard. The time the vocalization was heard as well as distance and compass direction of the calling bird from the transect point were recorded.

When 364 data points were mapped using GIS, a total of 33 nightjar territories were discerned at the three areas (Punta Verraco – 19 territories, Cerro Toro – 5 territories, Punta Ventana – 9 territories), revealing an overall abundance of 0.132 nightjars/ha, or a density of one nightjar every 7.6 ha. This mean abundance is nearly double what Vilella and Zwank (1993b) recorded for Punta Verraco and Cerro Toro (0.075 nightjars/ha). While Vilella and Zwank counted birds, our technique pinpointed them by collecting bearings and distances from known GPS coordinates, because we wished to understand territory distribution in addition to estimating the population. Therefore, our technique was a more intensive sampling of the Puerto Rican Nightjar than had been conducted previously.

Our territory maps show that singing male nightjars defend core areas, leaving gaps that appear not to be defended. Territory size ranges from 1.7 ha to about 5.6 ha, and averages 3.2 ha. This 3.1-ha average is 41% of the 7.6-ha site density (33 birds on 250 ha), a value in line with Vilella's study of home ranges (Vilella 1989). Using radio telemetry, Vilella calculated home ranges of 4.8 ha and 5.6 ha for two birds. His home range estimates are 62% and 72% of the 7.8 ha density obtained from call counts from that section of the Guánica State Forest. This suggests that dry forest habitat is not saturated with nightjar territories, and that a significant amount of buffer habitat exists around these territories.

With respect to impact from the proposed project, the turbines are unlikely to result in collision fatalities of Puerto Rican Nightjars because the birds rarely fly high enough to be struck by rotors. Disturbance and habitat alteration may extirpate a small number of territorial birds or cause them to shift territories into nearby habitat. The footprint of the wind turbines, new roads, and related infrastructure would amount to a reduction of 7.2 ha of habitat, the equivalent of 2.9% of habitat now available to these birds.

The proposed mitigation project would restore 3.1 hectares of a quarry on the Punta Verraco site. That represents a large portion of the habitat lost to the project footprint and would

fill in a gap between small patches of suitable territory. It would also improve forest connectivity between Punta Verraco and Cerro Toro, thereby reducing the current level of fragmentation. This could, potentially, make the narrow strips of habitat between and adjacent to these sites more attractive to nightjars and, therefore, potentially result in a net gain in nightjar territories on the site.

It is not known if these birds will habituate to the presence of turbines, although many forest and open country birds have demonstrated the ability to do so. Depending on the degree of habituation, the amount of impact will likely be nil. Post-construction monitoring will answer this and other questions about the degree of impact to this species resulting from wind power development.

Introduction

A Phase I Avian Risk Assessment (Kerlinger 2003) was conducted for the WindMar RE Project, near Guayanilla, Puerto Rico in late 2002 and early 2003. That assessment determined that the Puerto Rican Nightjar nested on site and that preconstruction studies were needed to examine the abundance, density, and distribution of that species within the boundaries of the proposed wind power project. An April 23, 2003, letter from Carlos Diaz of the U. S. Fish and Wildlife Service (FWS) emphasized that the species was likely present and that a study was needed.

This report details a field study conducted at the WindMar RE project site during spring 2003 that examined the abundance, density, and distribution of Puerto Rican Nightjars at that site. The study followed protocols recommended by Dr. Francisco Villela and others (Villela and Zwank 1987, 1993a and b). Furthermore, Dr. Villela was contacted and reviewed the protocols for this project. The information provided herein may be used for the preparation of a Habitat Conservation Plan for the WindMar facility as well as preventing and mitigating potential impacts of the project to nightjars.

Study Area and Methods

The study area included virtually all of the 290-hectare WindMar property that was deemed suitable as habitat for Puerto Rican Nightjars (Figure 1). The site is adjacent to Guayanilla Bay to the north and east and immediately east of the Guanica State Forest. The southern boundary of the property is the Caribbean Sea. The areas surveyed were those where there was a dry forest above 2 m in height. Areas that were not surveyed included mangrove swamp, grassland/savannah, beaches, dune, and other low elevation areas that are not inhabited by nightjars. A tour of the site with biologists of the U. S. Fish and Wildlife Service (FWS) and Department of Natural and Environmental Resources (DNER) of the Commonwealth of Puerto Rico in December 2002 confirmed that the areas surveyed were those that were most suitable at the WindMar site for nightjars.

A survey protocol was designed to be used in spring 2003 to determine the abundance, density, and distribution of territories of Puerto Rican Nightjars. The species likely nests on the site, although FWS did not record it as doing so (Diaz 1984). Three portions of the WindMar property were surveyed: Punta Verraco, Cerro Toro, and Punta Ventana. The field methods were a modification of the methodology described by Vilella and Zwank (1987, 1993a and b). First, transects were established on maps of the site. Their location was based on the habitat judged to be suitable to these birds and the distance (up to 300 m) at which these birds may be heard singing (Noble et al. 1986 and F. Vilella, personal communication). Because the habitat is so dense, making walking and even access difficult in many locations, narrow trails were cut along transects through the vegetation prior to the commencement of surveys. Four major transects were established, along with two minor transects (Figure 2). The transects at Punta Verraco were about 200-250 m apart and roughly parallel. This spacing insured that all nightjars in the areas where wind turbines are planned could be heard and that virtually all the dry forest habitat on the WindMar property could be surveyed. The numbers of listening points on the various transects are summarized in Table 2.

Along each transect listening points were flagged at approximately 88 m (100 paces). These points were flagged and logged into a GIS system using a Trimble GPS recorder. The flagging tape was labeled to distinguish each point as unique along its transect and enable it to be paired to a GPS location. On Punta Verraco, two parallel transects extended from east to west and a minor transect extended in approximately the same direction between the two major transects near the west end of Punta Verraco. Another, shorter transect was established to the north of the other transects near the tip of Punta Verraco to cover a small area that was well removed from the main transects. On Cerro Toro, one transect extended the length of this land formation roughly from east to west. On the Punta Ventana site, one long transect was established extending from north to south. That transect was situated about 200 m from the border of the Guanica State Forest and paralleled the border of the State Forest. A total of 95 listening points was established: 63 at Punta Verraco, 11 at Cerro Toro, and 21 at Punta Ventana.

The actual surveys were conducted by walking the transects and stopping at each listening points to determine whether nightjars were present. The procedure at each listening

point was as follows: Observations started at about 30 minutes after sunset and continuing for up to 3 hours and from three hours before sunrise and continuing until about 30 minutes before sunrise. The observer(s) listened for calling nightjars upon arrival at each listening point. If a nightjar was calling, data were recorded according to the instructions in Table 1 on a data sheet designed specifically for this project (Figure 3). If nightjars were not calling, a tape recording of a nightjar vocalization was played for a period of 20 seconds. As the tape was played, the tape recorder was slowly rotated so that the recording was broadcast in all directions. If nightjar responded within 2 minutes, data were recorded as detailed in Table 1 and then the observer(s) proceeded to the next listening point. If no nightjar called within 2 minutes, the observer moved to the next listening point. The listening transects provided for thorough sampling of all suitable dry forest habitat at the three hilltop areas.

Two people worked together on all nights, both for safety and so that a larger area could be searched during the narrow window when the species is vocally active before sunrise and after sunset. Field researchers included: Victor Luis Gonzalez, John Guarnaccia, Paul Kerlinger, Alfonso Silva, and Antonio Perez. Transects were conducted in alternating directions on successive survey nights when possible. Observations were not conducted during rain or when winds are greater than about 20 miles per hour (to maximize the ability to hear birds). All transects were surveyed during April 26 through June 23 with surveys distributed during this period. This time period represented the peak of nightjar territorial activity (Vilella, personal communication). It should be noted that Vilella and Zwank conducted surveys in January, July, and August. In an earlier study, Noble et al. (1986) conducted surveys in similar months to those surveyed in the present study. The study period chosen for the WindMar surveys corresponded to the period considered by researchers and other experts on Puerto Rican Nightjars as the best time for surveying nightjars. Some of those researches and experts helped formulate FWS's current recovery plan.

Data were plotted on electronic/GIS maps for analysis. A map of each survey (on a given date) at the three locations was made. These maps were used for the analyses that determined abundance, density, and distribution of nightjar territories, as well as risk from the WindMar project.

Table 1. Summary of instructions given to observers for taking data and completing the data sheets at the Puerto Rican Nightjar observation (listening) points at Punta Verraco, Cerro Toro, and Punta Ventana, WindMar RE wind power project, Guayanilla, Puerto Rico, spring 2003.

Observer – observers name or initials

Transect – name of transect per names provided on map (Verraco-N, Verraco-S, Verraco-M, Toro, Ventana)

Date-TimeStart – date (4/30/03) and the time listening was commenced at the first listening point of the transect (19:15, 04:00, etc.)

WindDir/Speed – wind direction (one of 8 cardinal directions) and approximate speed in miles per hour (provide a range by examining leaves in the treetops)

Temp – approximate temperature (5 degree ranges are appropriate) at start of transect

%Cloud – approximate percent of the sky covered by clouds (ranges are appropriate) at the beginning of transect and note thickness of clouds

Precip – note if any precip – no surveys are to be done in constant rain, although intermittent, light sprinkles are ok for doing transects

Point – record the letter of the transect (A-Z)

Time – record the time that point was done, only if a bird is heard

Direction – if a bird is heard, record the direction to the nearest 10 degrees (e.g., 30 degrees, 40 degrees, 340 degrees, 260 degrees, etc.) using a hand-held compass (correction for declination will be made after the study is completed)

Dist (M) – record the approximate distance of birds heard from the listening point in meters. Most distances will be in 25 m increments, although for birds heard at less than 50 m, they may be recorded to the nearest 10 m from the listening point.

Before – “B” = if the bird was heard before the tape was used; “A” = if the bird was heard after the tape was used (meaning that the bird responded to the tape)

Notes – record interesting behaviors, interruptions, and anything else that may be pertinent to the database. It is important to note whether a bird was the same one heard at a previous listening point.

Time End – record the time observer finishes the last listening point

NumbCallingAfter – in cases where the observer must rewalk a transect to return to the vehicle, an effort should be made to record the number of birds heard calling during the walk back

Table 2. Summary of transects, numbers of listening points (in parentheses), dates of surveys, and times of surveys at the three WindMar RE Project study sites, Guayanilla, Puerto Rico, April-June, 2003.

	Date of Survey	Time of Survey
Punta Verraco (63)		
Verraco Upper (23)	April 26	1900-2125
	April 27	1900-2145
	May 16	0407-0520
	May 30	0410-0524
Verraco Lower (26)	April 28	0352-0525
	May 15	1905-2112
	May 29	1910-2042
	June 22	0328-0522
Verraco Tip (7)	June 9	1918-2015
	June 21	1910-2-10
	June 10	0439-0518
	June 23	0440-0522
Verraco Mid (7)	May 18	0445-0515
	June 1	0444-0515
	June 10	1900-1950
	June 22	1927-1951
Cerro Toro (11)		
Cerro Toro (11)	April 27	0359-0530
	May 16	1905-1956
	May 31	1920-2000
	June 11	1910-2012
Punta Ventana (21)		
Punta Ventana (21)	April 27	1900-2045
	May 17	1905-2040
	May 30	1910-2044
	June 11	0328-0505
	June 12	0400-0328

Results and Discussion

Field surveys were conducted at the three sites between April 26 and June 23, 2003. During that period, all transects were sampled four times. Data from all surveys conducted within each of the three sites were pooled and analyzed as a single unit. That is, all nightjars heard during the surveys were plotted on a single map of each of the three sites for distributional analyses. These areas do not include all of the areas where Puerto Rican Nightjars may have territories on the WindMar RE property, but they do include the best available habitats. There are some areas that appear to be marginally suitable that were not surveyed, in part because they were small and, therefore, unlikely to support nesting nightjars, and in part because wind turbines and related will not be located in those areas. These areas include the narrow strips of forest to the north and west of the quarry area near the base of Punta Verraco.

Punta Verraco – Territories and Abundance. All four transects at Punta Verraco were pooled by mapping all birds on one map. There were a total of 147 contacts with birds singing prior to the tape being played and 93 contacts after the tape was played. Figure 4 provides the locations of all nightjars heard at the listening points on Punta Verraco prior to playing a tape and after a tape was played. From the distribution of birds heard, mostly before tapes were played, it is likely that there are about 19 territories along the transects surveyed on Punta Verraco (Figure 4). The territories are actually likely to be larger and some seem to overlap. In several cases, two or three birds were heard simultaneously from a single listening point. This suggested that there were two or three territories nearby with the boundary somewhere in the middle of the cluster – in some cases near the listening point. The fact that two birds were heard at a single listening point helped determine where territories were located and their approximate boundaries.

There was also another probable territory to the east of listening point 101 on the Verraco north/upper transect. This was based on birds responding to the tape player to the east of listening point 101 on two separate occasions. This bird (or birds) were more than 100 m to the east of the listening point. The abundance of nightjars on Punta Verraco was 0.152 birds/ha, or one bird every 6.6 ha. This abundance and density are based on the entire area of dry forest on Punta Verraco divided by the number of territories discovered during the surveys.

Cerro Toro – Territories and Abundance. Five territories appear to be present at Cerro Toro. This was determined from a total of 37 detections at the 11 listening points during the four surveys (Figure 4). Eighteen detections were of birds heard before the tape recording was played. On one of the four surveys, four probably distinct birds were identifiable, based on birds heard before the tape was played and the fact that two birds were at point 403. One bird was to the southeast and the other was to the north-northeast. These birds were separated by a minimum of about 200 m. Birds were spaced throughout, although few were heard on the hillside closest to the lowlands near the middle of the transect, and few were heard far to the north-northwest of the transect toward Guayanilla Bay. Based on these results, the abundance of birds is 0.109 birds/hectare, giving a density of one bird every 9.2 hectares.

Punta Ventana – Territories and Abundance. Nightjars were heard singing on 48 occasions prior to playing a tape during the four surveys of Punta Ventana listening points, and 39 times after the tape was played (Figure 4). There appear to be nine territories around the Punta Ventana

transect. Birds were always heard landward of listening point 501, which is within about 100 m of the coast. The habitat in this portion of the Punta Ventana transect seems less than suitable for nightjars because of its extremely scrubby nature. From the third listening point (503) from the coast to the north, territories were detected regularly. From a point 200-300 m north of the northernmost listening point (521) along the road out of the site, three different nightjars were heard. Two were heard from the direction of Guánica State Forest and the other was in that direction but within 30 m of the access road there. The mean abundance of nightjars at the Punta Ventana site was determined to be 0.114 nightjars/ha, yielding a density of one nightjar every 8.8 ha.

Overall Abundance and Density. Combining all three transect areas, there appear to be a total of at least 33 territories (Table 3). This number of territories constitutes a significant population of nightjars and increases the known number of pairs of this species by a significant number. It is conceivable that a more intensive sampling could double the mean abundance of nightjars in known areas, and turn up nightjars in new areas, which would increase the bird's population to above the minimum sustainable level recommended in the species' recovery plan. Given recent nightjar records in and around Ponce (San Juan Star 2002), it appears that, as forest cover has reestablished itself in Puerto Rico, the species has spread from various core populations, such as the one at Guánica State Forest, into other areas as succession has made those sites suitable for habitation by the species. It would be interesting to see if there are actually hundreds of territories in the thousands of acres of seemingly suitable habitat between Ponce and Boquerón – areas where the species probably nested before the forests were cleared on a massive scale in Puerto Rico.

It is likely that our method for determining abundance and territory size may have slightly overestimated nightjar abundance and underestimated territory size. However, without using radio transmitters to follow many birds through their territories, it is difficult to determine exact sizes of territories. Vilella (1989), however, used radio telemetry to calculate the home ranges of two male nightjars. His results of 4.8 ha and 5.6 ha were 62% and 72% respectively of the 7.8 ha density (0.128 nightjar/ha abundance) obtained from call counts for that section of the Guánica State Forest. Personal communication with Vilella suggested that the methodology used for the present study would reliably indicate where birds were and, therefore, where territories and territory boundaries were located.

The abundance we report for the WindMar site is higher than what Vilella and Zwank reported for Punta Verraco and Cerro Toro. Vilella and Zwank recorded 0.075 nightjars/ha from five surveys of 160 ha that recorded between 9 and 12 nightjars (Vilella and Zwank 1993b). The overall abundance for the WindMar site was 0.132 nightjars/ha. While there was some variation among the three areas of the WindMar property, all abundance figures were above what Vilella and Zwank had recorded. Punta Verraco had the highest abundance, with 0.152 nightjars/ha. The next highest was Punta Ventana, with 0.115 nightjars/ha. The lowest of the three was Cerro Toro, with 0.109 nightjars/ha. Interestingly, the mean abundance calculated by Vilella and Zwank for the section of the Guánica State Forest adjacent to Punta Ventana was 0.069 nightjars/ha, which is 60% of the value we determined. This suggests that the methods used for this study were robust and that the densities of Puerto Rican Nightjars at the WindMar RE site

are higher than densities in habitats nearby. It also suggests that the habitats at WindMar RE are very suitable for nightjars.

In addition to identifying individual calling birds, our survey technique allowed us to map their locations and define territories. The size of these territories can be found in Table 4, and the location of these territories relative to the project site plan is displayed in Figure 5. Our territory maps show that singing male nightjars appear to defend core territories, leaving gaps that appear not to be defended. Territory size ranges from 1.7 ha to 5.6 ha and averages 3.2 ha. This 3.1-ha average is 41% of the 7.6-ha site density calculated above (33 birds on 250 ha), a value in line with Vilella's study of home ranges (see above). This suggests that dry forest habitat is not saturated with nightjar territories, and that significant buffer habitat exists around these territories.

Risk Assessment

Because the Puerto Rican Nightjar is listed as an endangered species by the U. S. Fish and Wildlife Service, it is important that potential impacts to those individuals nesting on the WindMar RE project site be examined and assessed. The construction of turbines at the WindMar RE project site is likely to result in some habitat loss and disturbance to nightjars, which would amount to an "incidental take" of these birds. To determine the degree of disturbance and magnitude of impact to the species in terms of potential loss of individuals in the local population, a risk assessment is presented below.

With respect to causing direct mortality to Puerto Rican Nightjars, it is highly unlikely any will collide with wind turbines. These birds simply do not fly high enough to be within the rotor swept area where collisions could occur. Despite the fact that wind turbines have been erected in nightjar habitat (mostly Common Nighthawks and Lesser Nighthawks) in the United States, the numbers of nightjars that have been impacted has been negligible (only one to date, Erickson et al. 2001). The lists provided by Erickson et al. include the fatalities of all species summarized from studies in nearly a dozen states and at hundreds of turbines. These results are all the more important because nighthawks fly much higher than Puerto Rican Nightjars, which rarely fly more than a few feet above the forest canopy when foraging. The chance of collision mortality is so small as to amount to no potential for incidental taking of this species by this means.

The overall impact of the project with respect to footprint of the turbines (as well as within site transmission, roads, and other infrastructure) is calculated to amount to about 7.2 ha within suitable habitat for nightjars at the three sites. This is 2.9% of the 250 ha of dry forest on the WindMar site. It is also the equivalent of slightly less than one nightjar territory based on the 7.6 ha overall density calculated for the site (33 calling males on 250 ha).

Nevertheless, when we overlay the nightjar territory distribution with the project site plan (Figure 5), we see that some territories will be directly affected more than others. Of the 33 territories, 12 (36%) would not be intersected by the site plan, and 13 (39%) would be intersected less than 5%. In these 11 territories, the intersection is generally along their edges. Eight territories (24%), however, would be intersected at levels exceeding 5%, with only one above

10%. These territories are frequently bisected by the site plan. This disturbance and habitat modification could result in the disruption of nesting and territorial activity of a number of pairs of nightjars.

There is also likely to be some disturbance to nightjars during the actual construction process. During that process, trucks, cranes, and workers would create noise, movement, vibrations of the surface, and other disturbance in close proximity to foraging and potentially nesting nightjars. This disturbance is likely to last for only a very few months (perhaps 4-5 months) before the heavy equipment is removed from the site. If this process is done during the nesting season, it would likely result in disturbance to many pairs of nightjars. However, if the construction is done outside of the known nesting period for the species, there is likely to be minimal impact. Once the site becomes relatively quiet after construction, the disturbance will return to near, pre-construction levels. These birds are known to nest near a cement plant, a golf course, roads, and a hotel in the Ponce area (San Juan Star 2002), so the post-construction levels of human activity on site are not likely to have a significant effect on the bird. However, there is some level of uncertainty in this assessment because there have been no quantitative studies of this type of disturbance to nesting Puerto Rican Nightjars.

The proposed revegetation of the abandoned quarry area at the base of the Punta Verraco peninsula, the road edges, and the turbine erection areas, which is being suggested as a potential mitigation for habitat disturbance, would replace nearly all the acreage that would be lost to the turbine pads and new roads. The revegetation of the quarry area would also connect forests that are now fragmented on Punta Verraco in the area between Punta Verraco and Cerro Toro. This type of reconnection of the forests might actually improve the quality of the remnant forest that is to the north of the mitigation area and to the west of that area. Those forested patches are now separated from the larger forests, and by reconnecting them, the mitigation could allow for two or more new territories.

Although the mitigation suggested may offset the disturbance to Puerto Rican Nightjar habitat and territories, there are no guarantees because we have not studied how these birds are impacted by the presence of large, moving infrastructure. Other forest nesting species do not seem to be impacted (Kerlinger 2000), although the species are different. Because we are not sure as to the magnitude of the impacts, it is recommended that a post-construction study be conducted at the three areas within the WindMar RE project site to determine whether the turbines impact nesting nightjars and their territories. Such a study would ideally be conducted one year after construction and again several years after construction to measure potential habituation. Other species are known to habituate to large structures including wind turbines, but this cannot be determined until the vegetation has time to recover on the WindMar site.

Table 3. Number of Puerto Rican Nightjar territories found in each of the three study areas at the WindMar RE project site, Guayanilla, Puerto Rico. Also provided are the numbers of birds heard during surveys before and after a tape was played at the listening stations and two estimates of density.

Location	Before Tape	After Tape	Number of Territories	Density Estimate
Punta Verraco (125 ha)	147	93	19*	1 per 6.6 ha
Cerro Toro (46 ha)	18	19	5	1 per 9.2 ha
Punta Ventana (79 ha)	48	39	9	1 per 8.7 ha
Total (250 ha)	213	151	33	1 per 7.6 ha

*Another territory seems to have been located just west of the Punta Verraco Upper transect.

Table 4: Site Plan Intersection with Nightjar Territories

Area	Territory Number	Territory Area (m2)	Road Impact (m2)	Turbine Impact (m2)	Total Impact (m2)	% Impact
Punta Verraco	1	25,260	-	-	-	0.0%
	2	26,810	612	-	612	2.3%
	3	22,350	-	-	-	0.0%
	4	25,640	1,014	900	1,914	7.5%
	5	24,790	-	-	-	0.0%
	6	28,930	-	-	-	0.0%
	7	40,700	2,046	900	2,946	7.2%
	8	36,340	-	-	-	0.0%
	9	25,220	296	900	1,196	4.7%
	10	36,650	-	-	-	0.0%
	11	28,930	927	900	1,827	6.3%
	12	27,460	542	900	1,442	5.3%
	13	24,760	601	-	601	2.4%
	14	47,080	3,121	900	4,021	8.5%
	15	22,970	-	-	-	0.0%
	16	56,220	-	-	-	0.0%
	17	17,370	306	-	306	1.8%
	18	25,960	155	900	1,055	4.1%
	19	33,230	-	-	-	0.0%
Cerro Toro	20	28,150	994	-	994	3.5%
	21	35,690	574	-	574	1.6%
	22	27,780	-	-	-	0.0%
	23	19,260	1,399	900	2,299	11.9%
	24	25,450	1,109	900	2,009	7.9%
Punta Ventana	25	39,840	2,266	900	3,166	7.9%
	26	34,670	13	900	913	2.6%
	27	41,380	900	-	900	2.2%
	28	38,510	973	-	973	2.5%
	29	35,800	-	900	900	2.5%
	30	20,240	-	-	-	0.0%
	31	32,010	-	-	-	0.0%
	32	34,150	485	900	1,385	4.1%
	33	44,650	138	900	1,038	2.3%
Total	33	1,034,250	18,471	12,600	31,071	3.0%
Average		31,341	560	382	942	3.0%

Literature Cited

Diaz, C. A., 1984. Recovery plan for the Puerto Rican Whip-poor-will. U. S. Fish and Wildlife Service, Atlanta, GA.

Erickson, W.P., G.D. Johnson, M.D. Strickland, K.J. Sernka, and R. Good. 2001. Avian collisions with wind turbines: a summary of existing studies and comparisons to other sources of collision mortality in the United States. White paper – National Wind Coordinating Committee, Avian Subcommittee, Washington, DC.

Kerlinger, P. 2000. An Assessment of the Impacts of Green Mountain Power Corporation's Wind Power Facility on Breeding and Migrating Birds in Searsburg, Vermont. Proceedings of the National Wind/Avian Planning Meeting III, San Diego, CA, May 1998.

Kerlinger, P. 2003. Phase I avian risk assessment for the WindMar RE, Guayanilla Project, Puerto Rico. Report to WindMar RE, San Juan, Puerto Rico.

Noble, R. E., F. J. Vilella, and P. J. Zwank. 1986. Status of the endangered Puerto Rican Nightjar in 1985. *Caribbean Journal of Science* 22:137-143.

San Juan Star. 2002. Biologist: Guabairo's population increasing. April 19, pg. 7, San Juan, Puerto Rico.

Vilella, F. J. 1989. The reproductive ecology and population biology of the Puerto Rican Nightjar, *Caprimulgus noctitherus*, Ph.D. dissertation. Louisiana State University. 160 pp.

Vilella, F. J., and P. J. Zwank. 1987. Density and distribution of the Puerto Rican Nightjar in the Guayanilla Hills. *Caribbean Journal of Science* 23:238-242.

Vilella, F. J., and P. J. Zwank. 1993a. Ecology of the small Indian mongoose in a coastal dry forest of Puerto Rico where sympatric with the Puerto Rican Nightjar. *Caribbean Journal of Science* 29:24-29.

Vilella, F. J., and P. J. Zwank. 1993b. Geographic distribution and abundance of the Puerto Rican Nightjar. *Journal of Field Ornithology* 64(2): 223-238.

Figure 1. Map showing the boundaries of the WindMar RE property, Guayanilla, Puerto Rico.

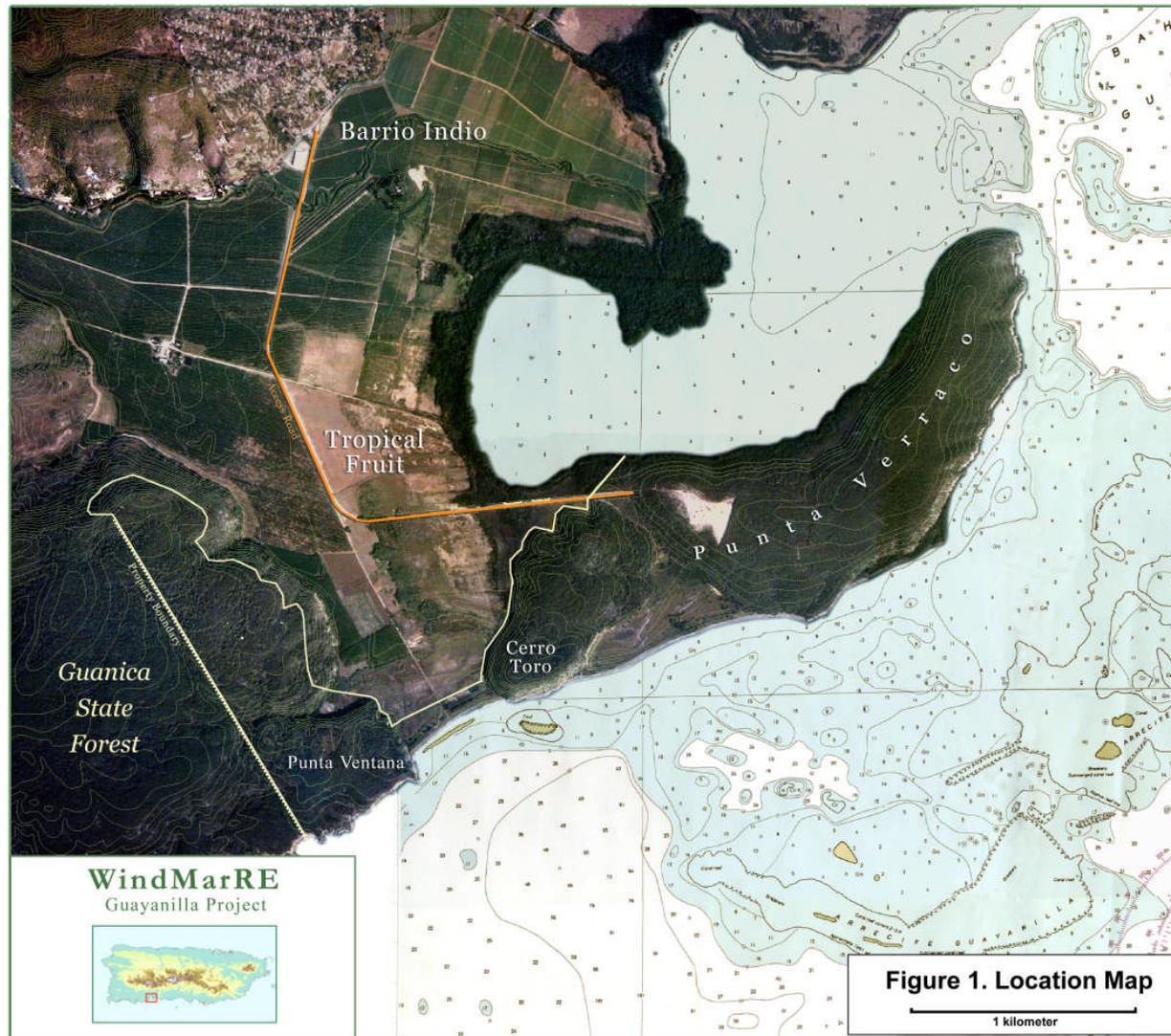


Figure 2. Map showing location of the observation (listening) points and transects at Punta Verraco, Cerro Toro, and Punta Ventana during spring 2003 used for determining the abundance and distribution of Puerto Rican Nightjars at the WindMar RE wind power project site, Guayanilla, Puerto Rico.

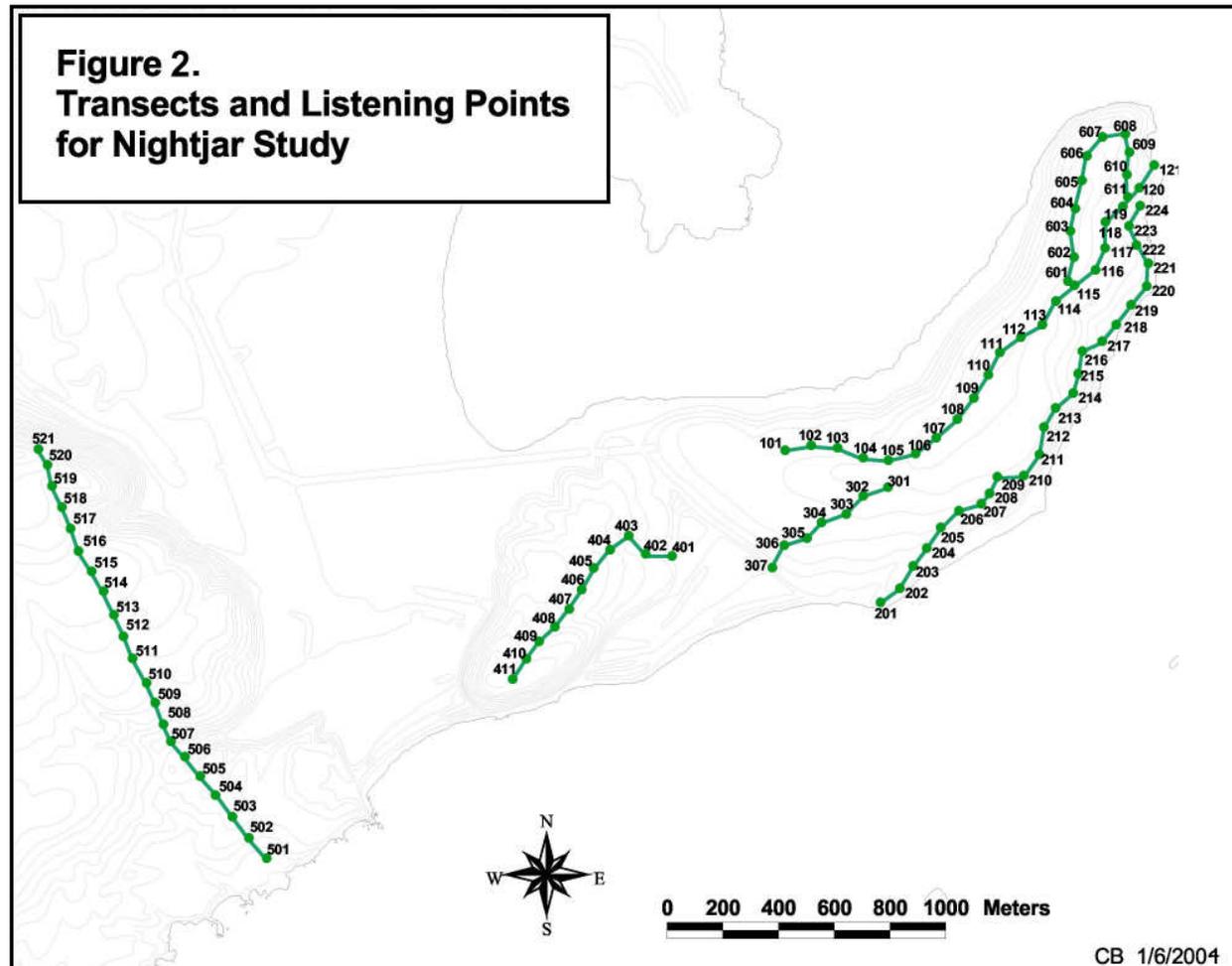


Figure 4. Map showing data points and territory boundaries for singing male Puerto Rican Nightjars at the WindMar RE property in Guayanilla, Puerto Rico, based on surveys conducted during April-June 2003.

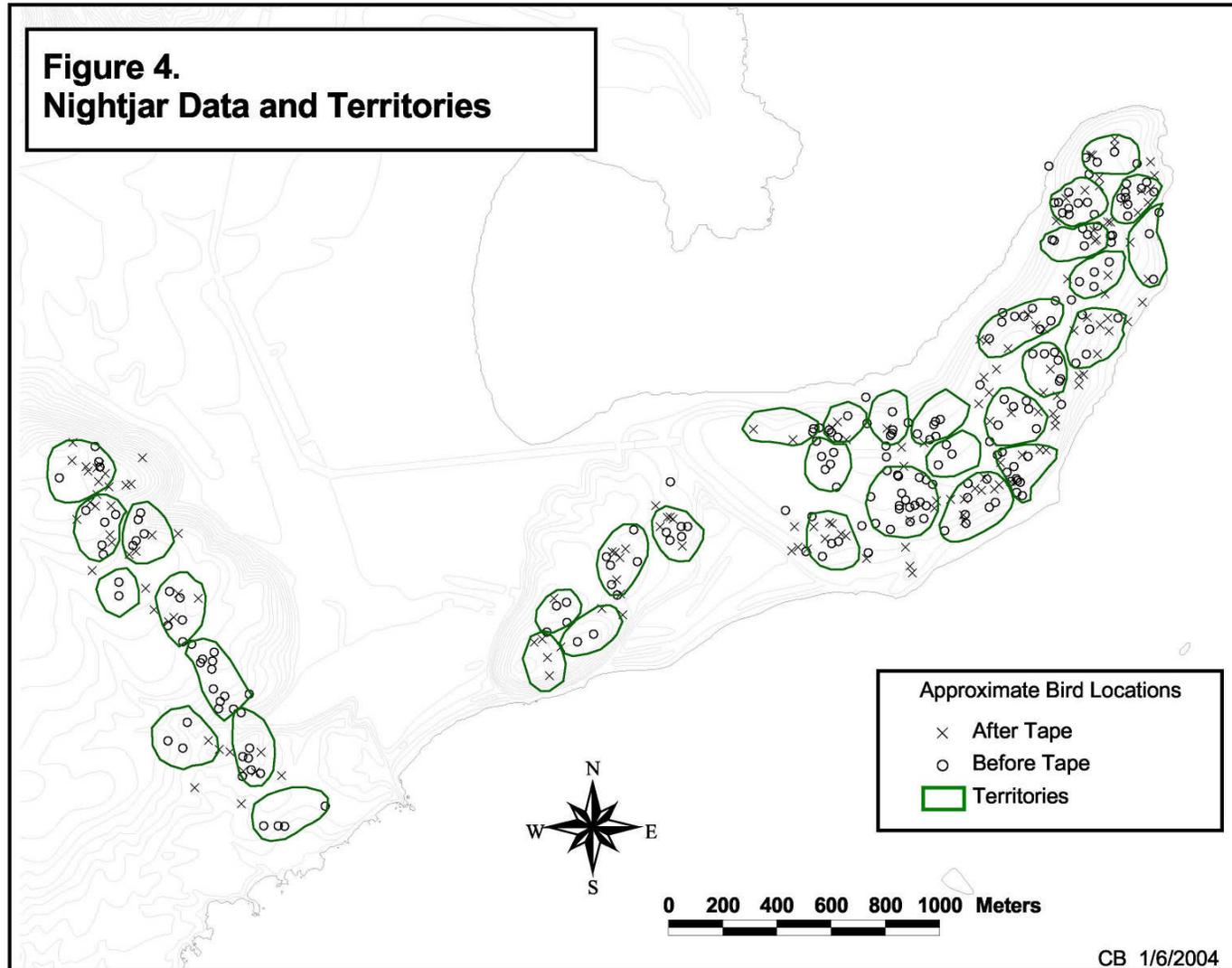


Figure 5. Map showing intersection of project site plan with nightjar territories as defined as a result of surveys conducted during April-June 2003.

