

**COMMENTS AND CRITIQUE OF ENVIRONMENTAL IMPACT STATEMENT  
AND PERMITTING FOR WINDMAR RENEWABLE ENERGY, PUNTA  
VENTANA, GUAYANILLA**

**CASE NUMBER 2006-61-0536-JPU**

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**SUMMARY**

The Environmental Impact Statement submitted on behalf of WindMar RE for the proposed project at Barrio Guayanilla, Puerto Rico is based on poor science. Its authors lack an understanding of basic ecological concepts relevant to the community in question. These problems include:

1. Flora and Vegetation Report (Areces Mallea & Ocampo Rocha 2003)
  - 1.1. The authors appear to be unfamiliar with the ecology of Puerto Rican dry forest. Their report contains numerous statements which contradict existing scientific knowledge.
  - 1.2. The authors appear to be unfamiliar with the relationship between species richness and habitat area (the species-area relationship) which is one of the most fundamental relationships in ecology. As a result, they suggest that the site in question is floristically poor, when in fact their data suggest that it is a typical, if not rich, example of Puerto Rican dry forest.
  - 1.3. The authors of the report interpreted the absence of endangered species to mean that the site was floristically poor. Rare species are unusual and their presence is something exceptional. A biologist who concludes that a site is poor, based on the absence of rare species, does not understand the meaning of 'rarity' in the context of community ecology.
  - 1.4. The site has species supports four of the six species that I found to be associated with floristically rich sites (Ramjohn 2004).
2. Reforestation Plan for the Texaco Quarry Area (Anonymous 2004; Appendix 12)
  - 2.1. The authors of the reforestation plan propose that 3000-4500 m<sup>3</sup> of topsoil and compost to trucked into the site to create a layer of soil 10-15 cm deep. Based on the description of the quarry site (and photographs in Kerlinger, 2003) the benefit of this would be uncertain

- 2.2. The authors of the plan suggest planting trees at a spacing of about 2.7 m by 2.7 m and irrigating them, and expect that they would, in 5 years, produce a 3.0-3.5 m canopy. It is more likely to produce a grass and vine laden site. After 5 years the authors propose planting additional trees, in the “understory”, which would produce a 4.5-5 m overstory in 10 years. This does not appear to be in keeping with measured growth rates for Puerto Rican dry forest trees, even from stump sprouts, let alone plants grown from seed.
  - 2.3. The proposed sequence of planting is puzzling; although the first set of plants are called “pioneers” and the second set “rare or uncommon” species, the separation does not appear to be based on the biology or the rarity of the species.
3. Puerto Rican Nightjar survey (Guarnaccia 2005; Kerlinger 2003, 2004)
    - 3.1. The authors’ preferred explanations for the change in nightjar density are contradictory, and their evaluation of options is incomplete. They ignore the most obvious difference between the surveys which is that the construction of roads changes the baseline for observations.
    - 3.2. The authors of the report minimize the risk posed by increased predation, and quote selectively from Vilella and Zwank (1993a) to create a misleading interpretation of what the paper says about mongooses and nightjars. They cite Vilella and Zwank 1993a that mongooses and nightjars occupy distinct habitats in Guánica Forest to suggest that that mongooses are not a threat to nightjars, and thus, that road construction poses no threat to the nightjar population. However, they ignore the fact that Vilella and Zwank specifically pointed out that this separation cannot be interpreted in the way that the authors of the reports interpreted it, and they strongly caution against additional road construction in nightjar habitat.

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## **1.0 INTRODUCTION**

As a plant ecologist, I am primarily interested in Caribbean dry forest ecology. I worked in dry forests in southwestern Puerto Rico from 1995-1997, and in that time I drove or hiked almost every back road from Ponce to the Morillos de Cabo Rojo. Over the course of my field work I inventoried over 65,000 individuals and measured over 11,000 stems on 4,700 trees.

While I was unable to obtain permission to work in what is now the WindMar site, I believe that I have an expert understanding of the ecology of the plant community that is the subject of this Environmental Impact Statement. Additionally, having contributed to environmental impact statements in the past, I have an understanding of the philosophy behind environmental impact assessment and what should and should not go into the baseline scientific studies. I present my comments as a forest ecologist but do not speak for the Department of Botany and Microbiology or the University of Oklahoma.

Given the realities of climate change I applaud WindMar's decision to invest in wind generation. However, I have concerns about the site selected for this project and the conclusions of the Environmental Impact Statement.

## **2.0 FLORA AND VEGETATION REPORT**

Puerto Rican dry forest typically has a short canopy (about 5 m tall) consisting of multi-stemmed trees. The multi-stemmed growth form appears to be the natural condition in these forests; Brian Dunphy and co-authors found documented the distribution of multi-stemmed trees in Guánica Forest (Dunphy 1997; Dunphy et al. 2000). He found that many multi-stemmed trees showed no obvious signs of cutting, and that many of them were of a size that made it unlikely that they had been present when the site was last cut. At least one mechanism for this growth form has been documented by Van Bloem and co-authors (Van Bloem et al. 2003, 2007) have documented that even trees with no visible damage will sprout additional stems after hurricanes. It was documented in Bahamian dry forest that coastal sites had more multi-stemmed trees than did more inland sites (Smith & Vankat 1992), a phenomenon that the authors attributed to the effects of winds and salt spray off the sea.

### **2.1 Structural Characteristics of Dry Forest**

The vegetation report (Areces Mallea & Ocampo Rocha 2003) shows that the authors are unfamiliar with this aspect of dry forest ecology. Their misconceptions about dry forest ecology led them to misinterpret their observations. On the subject of forest structure, Areces and Ocampo wrote (p.2):

*En cambio muchas otras especies tienen la capacidad de rebrotar desde el tocón para producir formas multicaules o “parasoles” que por lo común **no aparecen espontáneamente en la naturaleza.** [Emphasis added].*

This statement (unsupported by any references to the scientific literature) clearly establishes that the authors of the report are unfamiliar with Puerto Rican dry forest ecology. In this context, all of their conclusions deserve scrutiny. They go on to assert that hurricanes do not produce trees of this form (p.2):

*Estos parasoles se distinguen muy bien de los rebrotes originados en troncos derribados por vientos huracanados (éstos últimos se disponen en fila).*

an assertion that flatly contradicts the existing science (Van Bloem et al. 2003, 2007; Van Bloem et al. 2005). On an especially windy site (as this must be, given its selection for a windfarm), one would expect a greater prevalence of multi-stemmed trees than on a more sheltered site (Smith & Vankat 1992).

Areces and Ocampo also seem to be unfamiliar with other important aspects of dry forest structure. They write (p.2):

*También resulta curioso el tamaño de los árboles. A excepción de los Almácigos (Bursera simaruba) y Corcho Bobos de rápido crecimiento (Pisonia albida), cuyos troncos pueden llegar al pie de diámetro en área estudiada, la inmensa mayoría de los árboles de madura dura no llegan a alcanzar allí los 6-7 cm de diámetro basal.*

It is telling that the authors express surprise at what many observers of tropical dry forest ecology would consider commonplace. Stem diameters have been shown to increase at a rate of only a few millimeters each year in Guánica Forest (Murphy et al. 1995). The shortage of trees less than a 6-7 cm in diameter is not surprising, and does not mark this site as degraded.

In addition, Guarnaccia (2005) wrote (p.26):

*Mature Krugiodendron ferreum, Coccoloba diversifolia, Pictetia aculeata, and Gymnanthes lucida should have easily exceeded this size. It is as if, about a half century ago, the WindMar property was deforested to a high degree, and only since then has this dry forest had a chance to recover.*

and also (p.37):

*In our view, a plantation forest is much closer in structure to the nightjar’s ancestral habitat than the scrubby dry forests that now predominate within the nightjar’s range.*

Puerto Rican dry forest is dominated by small, multi-stemmed trees (Murphy & Lugo 1986a, 1986b, 1990, 1995; Murphy et al. 1995). There is no evidence that there ever was the sort of forest of large, tall trees that both Areces and Ocampo and Guarnaccia seem to imagine once occupied these areas. Their baseline appears to be little more than a flight of fancy. Trees on more sheltered sites are larger and have fewer stems per tree; trees on more exposed sites are smaller and have more stems (Castilleja 1991; Lugo et al. 1978). The WindMar site is relatively exposed – hence its value for the generation of wind power. A biologist familiar with the ecology of Puerto Rican dry forest would expect small, multi-stemmed trees to dominate the site.

Dry forests are able to recover after cutting – on sites used for charcoal production, fifty-year-old forests were indistinguishable from much older forests (Molina Colón 1998; Molina Colón & Lugo 2006). Thus, a site that was heavily deforested “a half century ago” would be largely indistinguishable from an older site, as long as root stocks remained intact. When the trees are killed and the site is converted to another use, the recovery is much slower – on such sites, fifty-year-old forest is notably species-poor, and is heavily dominated by species such as *Leucaena leucocephala* (Molina Colón 1998; Molina Colón & Lugo 2006), *Bourreria succulenta* (Ray 1993; Ray & Brown 1995), or *Pisonia albida* (Ramjohn 2004). While these species are present on the site, there is no evidence that they form the sort of pure stands that they do on sites that have recovered after being converted to non-forest uses.

## 2.2 Species-Area Relationships

The species-area relationship is fundamental in ecology. Species richness increases with the area sampled. The relationship between species richness and area is traditionally modeled using a power function of the form

$$S = cA^z$$

Values of  $z$  usually lie between 0.1 and 0.5, and can often be predicted by the ecological and evolutionary relationships between the areas under consideration (Rosenzweig 1995).

Areces and Ocampo consider the community to be floristically poor. They write: “*La relativa pobreza florística de las comunidades estudiadas en Verraco y Ventana contrasta con la mayor riqueza en especies del bosque protegido de Guánica.*” However, the species list presented in the report includes a total of 168 species. Although this table is widely repeated throughout the report, here, where it is presented in contexts, it says that this is a list of plants located in transects on Punta Verraco, which is only one of three areas within the site. (The table header on p.13 says: *Listado de Plantas Vasculares Localizadas en los Transectos de Punta Verraco y sus Alrededores.*) Thus, rather than representing a complete list of species found in the 290 ha site, this appears to be a list of species recorded in a 125 ha portion of the site.

Guarnaccia (2005) wrote (p.27):

*So far, botanists have recorded nearly 170 species of vascular plants at the WindMar site (see Appendix II), a diversity far below the over 700 species recorded in the Guánica State Forest.*

As mentioned previously, Areces and Ocampo stated that they found 168 species on Punta Verraco, not the entire WindMar site. In addition, while it is possible that Guánica Forest supports “over 700” species, Guarnaccia does not provide a reference for this number, so it is impossible to verify it. The most recent published estimate of which I am aware (Figueroa Colon 1996) puts the number of species at just over 650.

The WindMar site is about 7% the size of Guánica Forest; Punta Verraco, which accounts for less than half the area of the site, is about 3% of the size of Guánica Forest. In this area, Areces and Ocampo recorded 168 species, which is between 24 and 26% of the species in Guánica Forest. Calling this “a diversity far below...Guánica State Forest” as does Guarnaccia, is inconsistent with the facts. A site which supports a quarter of the species in Guánica Forest in a mere 3% of the area is floristically rich, not floristically poor. In addition, these numbers are not directly comparable – Guánica Forest includes habitats that are not present in the far smaller WindMar site, and the recorded species richness reflects the total number of species ever collected. Thus, any comparison with Guánica Forest is likely to make the WindMar site appear poorer than it actually is.

Based on a study of 39 forest fragments in southwestern Puerto Rico (Ramjohn 2004), I was able to estimate the parameters of the species area curve.

	Expected number of species based on		
	all fragments	fragments > 100 ha	fragments + Guánica Forest
125 ha	128	137	179
290 ha	142	154	223

Thus, a typical 125 ha site would have between 128 and 137 species, while a typical 290 ha site would have between 142 and 154 species. Because Guánica Forest is much more diverse than any of the other sites, it raises the estimate considerably. Nonetheless, the WindMar site is very close to what would be expected when Guánica Forest is included (168 versus 179 species). This suggests that, as dry forests in southwestern Puerto Rico go, the WindMar site is distinctly rich in species.

Guarnaccia continues (p.27):

*They [Areces and Ocampo] have also found that the Minimal Area (the area where 95% of the plant community’s species can be found) for the dry forest on Punta Verraco is significantly small, only 200 m<sup>2</sup>. In other Caribbean regions, including the Guánica State Forest, the Minimal Area for dry forest is usually larger than 500 m<sup>2</sup>. This confirms that the dry forest plant community on the WindMar site is poor and has been severely impacted. A management plan to help these forests recuperate is clearly in order.*

‘Minimal area’ is a tool for optimizing sampling; it is not biologically meaningful measure of community composition or species diversity. It cannot be used to “confirm” *anything at all* about the status of any community. Far more importantly, this does not appear to be a fair comparison. Guarnaccia asserts that ‘minimal areas’ in ‘other Caribbean regions including the Guánica State Forest’ are usually larger than 500 m<sup>2</sup>. Since Guarnaccia fails to cite any supporting studies, it is only possible to guess at his sources. Nonetheless, being familiar with most published studies about Caribbean dry forest, it seems safe to say that Guarnaccia is not comparing “apples to apples”. In the case of Guánica Forest, most if not all published studies have looked at trees with diameters greater than 1 cm (usually, greater than 2.5 cm). Areces and Ocampo did not provide details of their methods, but it is apparent from their species lists that they did not restrict themselves to trees – many of the species they list are herbaceous or are small shrubs which never produce stems large enough to be captured in these surveys. (Having measured over 11,000 stems on 4,700 individuals, I feel confident that I can make such a distinction). As a result of this, their plots contained far more individuals than did the studies to which Guarnaccia compared them. Since the number of species per unit area is a function of the number of individuals sampled, this comparison is highly misleading.

### 2.3 Endangered and Rare Species

While there are exceptions, endangered species are frequently species that have always been rare. This is especially true of endemic species with limited ranges. The absence of endangered species from a site does not mean that the site is species-poor – instead, the presence of rare species tends to indicate an exceptional site. Areces and Ocampo comment on the absence of endangered species (p.2):

*La relativa pobreza florística de las comunidades estudiadas en Verraco y Ventana contrasta con la mayor riqueza en especies del bosque protegido de Guánica. Por más que se les buscó detenidamente no se ha visto en el área estudiada un solo Bariaco (Trichilia triacantha), Palo de Rosa (Ottochulzia rhodoxylon) o Mitracarpus maxwelliae —por solo mencionar algunas de las especies más raras y amenazadas de Guánica, lo que nos hace pensar que impactos de degradación ambiental más severos que los que pudieron haber ocurrido alguna vez en el bosque seco de Guánica tuvieron lugar al este del límite oriental de esa área protegida, en los bosques de Ventana y Punta Verraco.*

As mentioned before, the absence of endangered species on a site does not indicate that the site is “floristically poor”. There are many areas within Guánica Forest where none of these species are present – for example, the most intensively studied plot in Guánica Forest lacks any of these species (Murphy & Lugo 1986b). The absence of a species from an area may indicate a lack of suitable habitat *for that particular species*. It may also indicate an absence driven by stochastic factors – large bodies of ecological theory are dedicated to addressing the fact that species are not present in all areas of suitable habitat. To make matters worse, the letter from Carlos A. Diaz of the US Fish and Wildlife Service (Appendix 1) clearly states that:

*The endangered plant species Mitracarpus maxwelliae and Mitracarpus polycladus are known from the Guánica State Forest. However, during our site visit of December 2002, we did not identified [sic] possible habitat for these species.*

The letter from Diaz is dated almost 3 months before the Areces and Ocampo report, and two years before the Guarnaccia Habitat Conservation Plan (which repeats this information). Hence, the assertion that a site is floristically poor because it lacks a species which no one expects to be present on the site indicates, at best, sloppy work. Once again it suggests a lack of understanding of fundamental ecological concepts (species distributions and rarity) by the authors of the report.

#### **2.4 Other Measures of Habitat Quality**

Based on the distribution of plant species, I found that certain species are strongly associated with species-rich sites (Ramjohn 2004): *Antirhea acutata*, *Coccoloba diversifolia*, *Cordia rickseckeri*, *Guettarda krugii*, *Plumeria alba* and *Savia sessiliflora*. Four of these species were recorded by Areces and Ocampo from the WindMar site. This also disagrees with Areces and Ocampo's conclusion that the site is 'floristically poor'.

### **3.0 REFORESTATION PLAN FOR THE TEXACO QUARRY AREA**

To mitigate the loss of forest, WindMar proposed to reforest 2.6 ha of a 3.1 ha abandoned quarry within the property. Their reforestation plan proposes that they truck in 3000-4500 m<sup>3</sup> of topsoil and compost, plant 1375 tree seedlings per hectare (3575 trees, with a spacing of about 2.7 m between trees). They propose to supply half a gallon of water per tree per day through a drip irrigation system.

After five years, to the original trees 'pioneer tree and shrub species' will be added 'rare or uncommon tree or shrubs' to enrich the community. After ten years 'the really rare species' are to be added.

#### **3.1 Site Preparation and Planting Plan**

The site, as it currently stands, is devoid of soil and largely bare of vegetation.



**Figure 1:** Texaco Quarry site (Kerlinger 2003)

Simply adding a thin layer of soil to this site is unlikely to encourage tree growth. In deciduous forest in Guánica Forest, only 57% of root biomass was concentrated in the top 10 cm of the soil. Thus, the addition of a mere 10-15 cm of soil may not provide an adequate rooting zone for the trees. It would probably be more reasonable to create an adequate rooting zone for each plant by ripping the existing rock or subsoil to the depth of about a meter around each sapling and adding topsoil and compost to that mixture.

The watering plan seems problematic as well. Trees in Guánica Forest have an extremely high proportion of belowground biomass (Murphy & Lugo 1986b; Murphy et al. 1995). Trees allocate biomass based on needs – trees in drought-prone areas allocate more resources to belowground biomass and less to aboveground biomass than do trees in more mesic areas. If these trees are going to be provided with water on a daily basis, they will allocate more resources to aboveground biomass and less to belowground structures. Consequently, if watering is stopped these trees are likely to have far more aboveground biomass (leaves and stems) than their roots can supply with water. They are also likely to have larger xylem vessels which are more likely to experience cavitation when faced with the extreme drought that these species regularly experience in the dry forest zone. An irrigated tree is likely to be poorly adapted structurally to life in the dry forest zone. Cessation of watering will probably result in massive die-back of trees raised under those conditions.

The spacing of the trees will leave large areas of bare ground between them. If the areas are being watered, this will probably result in the luxurious growth of grass. At a spacing of 2.7 m, the trees will be unable to shade out the grass. This is a major barrier to tree establishment in dry forest areas (Griscom et al. 2005). In addition, vines are likely to be a major problem in a plantation like this, especially non-native vines like *Jasminum fluminense*, which is already present at the site. Problems like this are not mentioned in

the restoration plan, which leads to the suspicion that the authors are unaware of concerns like these.

### 3.2 Projected Tree Growth Patterns

The restoration plan projects that after five years the initial planting will create a canopy 3.0-3.5 m tall, which after 10 years should be 4.5-5.0 m tall. The authors did not indicate what source they used to come up with these projected rates of growth, and it is unclear how they came up with them. There is limited data related to tree growth in Puerto Rican dry forest, and none that I am aware of regarding the growth rates of irrigated native trees. In light of this, it is worth considering the growth of native tree saplings without irrigation.

In 1981 the vegetation in five 10 m x 10 m plots in Guánica Forest were cut to ground level (Murphy & Lugo 1986b). Fifteen years later these cut plots were still very open, and most if not all of the trees were less than 3 m tall. While growth of irrigated trees is likely to be much faster than that of trees growing without irrigation, most of the trees in the cut plots originated from intact rootstocks. Consequently, they had considerable carbohydrate reserves unavailable to outplanted seedlings, and well-developed root networks. Even if growth rates are doubled with irrigation, the growth rates expected by the authors of the restoration plan are totally unreasonable.

### 3.3 Species Selection for Restoration Project

The restoration plan outlines three groups of species that are to be planted at different stages: pioneer trees and shrubs to be planted at the start of the project, rare or uncommon trees to be added after five years, and ‘really rare’ species to be added after 10 years. However, once again the plan fails to explain the basis for creating these groupings.

In the first phase of the restoration plan, the following ‘pioneer’ species are supposed to be planted ‘to cover and stabilize the soil’:

<i>Bourreria succulenta</i>	<i>Bourreria virgata</i>	<i>Bursera simaruba</i>
<i>Capparis cynophallophora</i>	<i>Capparis flexuosa</i>	<i>Clerodendron aculeatum</i>
<i>Coccoloba microstachya</i>	<i>Colubrina arborescens</i>	<i>Comocladia dodonaea</i>
<i>Corchorus hirsutus</i> †	<i>Croton discolor</i> †	<i>Croton lucidus</i> †
<i>Erythroxylum areolatum</i>	<i>Ficus citrifolia</i>	<i>Guettardia elliptica</i>
<i>Guettardia krugii</i>	<i>Gymnanthes lucida</i>	<i>Jacquinia armillaris</i>
<i>Krameria ixine</i> ††	<i>Lantana involucrata</i> †	<i>Leucaena leucocephala</i> †††
<i>Melochia tomentosa</i> †	<i>Pictetia aculeata</i>	<i>Pisonia albida</i>
<i>Pithecellobium unguis-cati</i>	<i>Randia aculeata</i>	<i>Reynosia uncinata</i>

While the majority of these species are canopy or subcanopy trees or tall shrubs, several of them (marked with †) are understory shrubs. I fail to see how using these species will

achieve the desired effects of creating a tree canopy. Another one of these species, *Krameria ixine* (marked with ††) is an herbaceous plant which grows in relatively open, rocky areas. I fail to see how this will fit into the proposed restoration plan. It seems more likely to me that this species will be crowded out by the grasses that will overrun the site. Finally, and most disturbingly, the restoration plan includes *Leucaena leucocephala* (marked with †††), a non-native plant capable of forming dense stands and producing large numbers of seeds. I fail to see why anyone would suggest the inclusion of this aggressive non-native species in the restoration plan.

In addition, while some of these species are fast-growing plants which readily play an active role in restoration, others are not.

After five years, ‘rare or uncommon’ species are supposed to be planted on the site:

<i>Amyris elemifera</i>	<i>Canella winteriana</i>	<i>Celtis trinervia</i>
<i>Coccoloba krugii</i>	<i>Colubrina elliptica</i>	<i>Consolea rubescens</i> ††
<i>Crescentia linearifolia</i>	<i>Crossopetalum rhacoma</i>	<i>Croton betulinus</i>
<i>Croton humilis</i> †	<i>Erythroxylum rotundifolium</i>	<i>Eugenia foetida</i>
<i>Eugenia ligustrina</i>	<i>Eugenia rhombea</i>	<i>Guaiacum officinale</i>
<i>Guaiacum sanctum</i>	<i>Gyminda latifolia</i>	<i>Helicteres jamaicensis</i> †
<i>Hypelate trifoliata</i>	<i>Jacquinia berteroi</i>	<i>Krugiodendron ferreum</i>
<i>Pilosocereus royenii</i> ††	<i>Reynosia guama</i>	<i>Rochefortia acanthophora</i>
<i>Schaefferia frutescens</i>	<i>Sideroxylon obovatum</i>	<i>Tabebuia heterophylla</i>
<i>Thouinia portoricensus</i>	<i>Trichilia hirta</i>	<i>Ziziphus reticulata</i>

Once again, there is no indication why these species are considered more uncommon than the ones planted at the start of the project. Only two smaller shrubs (marked with †) are included in this group, including *Helicteres jamaicensis*, a common weedy species which grows profusely in open areas. Its inclusion in this group is baffling. In addition, two cacti (marked with ††) are included in this group. Cacti are usually tolerant of drought, and do better in high-light environments, so their inclusion in the second group is puzzling. Many of the other species seem to be species that do well in open, high-light environments. In addition, many of them are not rare – some appear to be more common than some species included in group one. Since the authors of the restoration plan failed to provide any supporting citations, there is no way to determine how they delineated their groups. It is also unclear why certain species are excluded – although *Coccoloba microstachya* and *Coccoloba krugii* are included, *Coccoloba diversifolia* was left out.

Finally, the restoration plan suggests that ‘really rare’ species be added after ten years. No indication is given as to why these species are not included until this stage. Normally one might wait until a canopy is established before one adds shade tolerant species to a restored forest. However, there is no indication that these ‘really rare’ species are species which require shade. Waiting ten years to introduce them seems rather random.

#### 4.0 PUERTO RICAN NIGHTJAR SURVEY

A survey of Puerto Rican nightjar population on the site was carried out by Kerlinger in 2003 (Kerlinger 2003). A second survey was carried out a year later (Kerlinger 2004). The second survey found a 27% increase in the number of nesting pairs on the site, coupled with a small increase in the average size of the territories. The location of nightjar territories relative to the wind turbine locations led to a request for an incidental take permit for 12 nightjar based on the assumption that birds which lost more than 6.9% of their territory would be displaced from them. Kerlinger attributed the increase in the number of breeding nightjars to increased food resources created by the construction of roads on the site between the 2003 and 2004 surveys. Guarnaccia (2005) also suggested that there was little risk to the nightjars from road construction based on the fact that the habitat occupied by nightjars and mongooses do not overlap in Guánica Forest.

#### 4.1 Nightjar Population Dynamics

The 2003 survey estimated that there were at least 33 nightjar territories on the site. The 2004 survey found 27% more territories than the 2003 survey and found that these territories were, on average, slightly larger than the 2003 territories (Guarnaccia 2005). Kerlinger (2004) suggests three possible explanations for this increase:

1. The observers may have become more adept at finding birds; Kerlinger rejects that because “*because it is easy to hear nightjars and observers really did not need training to do the work in 2003.*” (p.24)
2. That there may have been an overall increase in the nightjar population; Kerlinger considers this unlikely, because the density of nightjars is higher than has been reported elsewhere. Kerlinger believed that increased population sized would lead the birds to disperse, rather than becoming denser on the site.
3. That the construction of access roads “*site provided better foraging habitat such that more territories could occupy the site. It is possible that openings in the forest make foraging easier and that such clearings are a limiting factor. ... [T]he trails at the WindMar site may now provide better foraging habitat that actually attracts nightjars from other areas or permits them to live on smaller territories by making foraging better.*” [Emphasis added] (p.24-25).

Reports like these are not peer-reviewed science – hypotheses are not rigorously tested. Nonetheless, explanations need to be consistent with the observations, and all reasonable explanations should be considered. Kerlinger rejects the idea that the population increase may have been a consequence of the team being better at finding birds. Nonetheless, he admits that the birds were easier to observe in 2004, after the construction of the roads (p.25):

*On one night at the Punta Ventana property, where more access roads were established, the data collection team reported an adult with two recent fledgling*

*nightjars foraging along one of the access roads, and another older fledgling foraging along another.*

Dry forests can be challenging to work in – the trees are dense and multi-stemmed, and many of them are thorny. This will be especially true at night. Although Kerlinger reports that they cut narrow trails for the 2003 study, in 2004 they were working along new roads. A change like this would be expected to make observations easier. It is also likely to have allowed the observers to move more quietly through the forest, creating less of a disturbance. Road construction would have altered the observation process fundamentally. But Kerlinger did not see it fit to consider this option.

The second explanation, that there was a real increase in population size, is dismissed because “*the density of nightjars on a per hectare basis was higher on the Wind Mar project site than has been reported in most parts of Puerto Rico. Given the high density, one would expect birds to disperse to other locations rather than become even denser at the WindMar site.*” (p.24) However, the recorded densities (0.132 nightjars/ha) are not extreme – densities as high as 0.332/ha have been reported (Vilella & Zwank 1993b). While such large population fluctuations seem unlikely, the population densities on the site are not extreme.

Kerlinger favored the third explanation – that road construction had improved habitat quality, allowing the site to support more birds. While an improvement in habitat quality is likely to result in an increase in population density, normally this would be coupled with a decrease in average territory size. Claiming and defending territory is energetically expensive for most birds, and it seems unlikely that they would expend the energy to defend a territory that was larger than what they needed to successfully fledge their offspring. Both Kerlinger (2004) and Guarnaccia (2005) reference this fact. Yet between 2003 and 2004 the average territory size increased. While option three is consistent with the observed increase in the number of nesting birds, it is inconsistent with the increase in territory sizes. An explanation which makes predictions which are the opposite of observations is not a credible explanation.

Guarnaccia states that more than half of the site is unoccupied by nightjar territories. However, he does not address whether these areas are suitable habitat for the birds. In addition, Guarnaccia describes the birds as defending a “core territory” with space between them. This appears to be based on the territory maps generated by Kerlinger (2003, 2004). While Kerlinger neglects to mention the techniques used to generate the territory maps – he merely reports that “[d]ata were plotted on electronic/GIS maps for analysis.” (p.8) Presumably some sort of statistical tool was used to group the observations into territories. The pattern generated – of neatly defined green circles, representing the territories of the birds – is almost certainly an artifact of the statistical tools used to generate the maps and should not be interpreted as if it were something biologically meaningful.

## 4.2 Altered Predation Risks

Among the concerns expressed by the Fish and Wildlife Service is the risk posed by the “[d]evelopment of open corridors for predators such as mongooses, cats, and Short-eared Owls” (Guarnaccia 2005; p.72).

The risk posed by mongooses is dismissed based on Vilella and Zwank (1993a) who observed that mongooses and nightjars do not overlap in Guánica Forest. Vilella and Zwank reported that mongooses were more common at lower elevations with more open habitat and available sources of water. Nightjars, on the other hand, were more common at higher elevations, in sites with closed canopies. Vilella and Zwank make it clear that this “inverse relationship” is purely correlational, and “we make no inference on causation” and went on to say that (p.28):

*Perhaps differences in habitat requirements of these two species restrict range overlap, rather than predation by mongooses eliminating the Nightjar from coastal areas and currently limiting the species to arid higher elevational areas. At Guanica Forest, higher mongoose numbers at lower elevations reflect availability of surface water, supplemental food sources and the mongoose’s preference for open grasslands and savannas. Nightjar abundance at higher elevations reflects the Nightjar’s preference for a closed canopy forest environment.*

Guarnaccia recast this to say that the observation (p.72):

*led Vilella and Zwank to hypothesize that differences in habitat requirements restrict range overlap in these species, rather than mongoose predation eliminating nightjars from certain habitats.*

While Vilella and Zwank simply posed an alternative to the conventional wisdom regarding mongooses and nightjars, they did not suggest that they favored one explanation over the other. Guarnaccia only presents one of the pair of alternatives, and uses it to conclude that mongooses do not pose a threat to the nightjars.

Guarnaccia goes on to note that (p.73):

*In addition, while WindMar biologists have observed mongoose and cats in the flat, grassy lowland sections of the WindMar site, we have not yet recorded them in the dry forest sections, despite many hours of observation. These findings lead us to believe that road networks can significantly increase nightjar density and reproductive output without a significant increase in mammalian predation.*

No indication is given of the methodologies used to search for cats and mongooses in the forested sections of the site. Almost all of the biological surveys done on the site appear to have been done prior to the construction of roads on the site. One clear exception, the re-survey of the nightjar populations, was done primarily at night. (The dates of Thomas’

non-avian vertebrate surveys were not reported; Thomas does not report on mammals other than bats). Thus, it would appear that Guarnaccia is talking about the state of the site prior to the construction and extension of roads. In addition, since he appears to be reporting on casual observations and not systematic surveys, this observation does not take into account that fact that it is far easier to see cats and mongooses in open areas. Guarnaccia's dismissal of concerns about Short-Eared Owls is similarly flawed.

Guarnaccia totally fails to account for changes that are likely to occur at the site if the project goes forward. Construction of the wind turbines and establishment of a site office will bring water and garbage onto the site. Establishment of a nursery and water storage facilities will bring water and open habitats into the site. It will also bring rats and mice onto the site. As Guarnaccia points out, lack of water may be an important factor separating mongooses and cats from nightjars. Alterations necessary for the project will change this.

While Guarnaccia cites Vilella and Zwank to support the idea that mongooses do not pose a threat to nightjars at the site, he ignores an important conclusion that they draw from their idea:

*Proposals to establish paved roads through the forest and development of adjacent private land threaten Guanica Forest, a UNESCO Biosphere Reserve. Such development would increase habitat for mongooses by providing non-forested roadway corridors, as well as supplemental food and water sources. Future management of arid forested uplands in Guanica Forest and adjacent private lands should not reduce forest canopy closure, nor increase water and/or food sources which would favor mongooses. (Vilella and Zwank 1993a; p.28)*

The proposed project would do all of these things – reduce canopy closure, increase water supplies and probably increase food resources for mongooses.

A similarly contradictory approach is taken with regards to Short-eared Owls. Guarnaccia suggests that the owls will not be attracted to the site because they forage in open areas. However, he records that the owls are present on the site, and may nest there. While touting the increased open areas as a boon for the nightjars ("*road networks can significantly increase nightjar density and reproductive output*"; p.73) he ignores that possibility that these same open areas will result in an increase in owl populations.

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