Ecology of Oilbirds in Venezuela: Implications for Protected Areas

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INTRODUCTION

In recent decades, our biosphere has experienced unprecedented changes because of human-induced disturbances (e.g., global climatic fluctuations; air, water, and soil pollution; tropical- and temperate-forest destruction; and extinction of species). These changes have affected biodiversity negatively at all levels: gene pools, species, and natural community (World Resources Institute 1990).

The most efficient way currently accepted by wildlife managers to preserve biodiversity from human threats is to adequately manage critical habitats where natural communities and ecosystems occur. Five aspects of applied research are pivotal for the correct management of a park or protected area: flora and fauna inventories, research on species of special management significance, ecological relationships among key species of the ecosystem, monitoring and assessing dynamics of change, and socio-economics of the area (Thorsell 1990). Only recently, and then in just a few isolated cases, has applied research been used to design and manage parks of Latin America and the Caribbean.

The objectives of this paper are, first, to show how applied ecology from a species of special management significance (the oilbird *Steatornis caripensis,* or *guácharo* in Spanish) was used to manage and maintain the integrity of Guácharo National Park in Venezuela and to enlarge its limits; and, second, to show how park managers might include research on keystone species in their management strategies.

Guácharo National Park was created in 1975 with the aim of protecting the local watersheds, the Guácharo Cave Natural Monument, and the colony of oilbirds in the cave. When the park was created there was insufficient data about the ecology of oilbirds (Tannenbaum and Wrege 1978, 1984). Since one management aspect of Guácharo park was to conserve the colony, it was most consequential to determine the oilbird's habitat requirements and importance to the ecosystem. In this paper I am presenting two basic objectives of my research:

1. Foraging ecology:
   - ✦ Determine foraging ranges, habitat use, and dispersal patterns of oilbirds using radiotelemetry.
   - ✦ Evaluate the role of oilbirds as seed dispersal agents in tropical forests.
2. Conservation
   - ✦ Determine how habitat loss influences the foraging ecology of the species; in particular, how does the destruction and disturbance of the primary forest influence the foraging movements of both individuals and the colony as a whole?
   - ✦ Apply knowledge about the oilbirds' foraging ecology to the design and expansion of a new Guácharo National Park, and to provide a conservation model for future projects involving oilbird colonies in South America.

The natural history of the oilbird
Oilbirds are the only nocturnal frugivorous cave-dwellers in the world. They are the only species of the family Steathornithidae: Caprimulgiformes. These birds are about 46 cm long, average 400 g in weight, and have a wing span of 1 m. They guide their flight through dark caves by echolocation (Griffin 1953). They are monogamous and nest on ledges up to 50 m high. The normal clutch is two to four eggs. Both sexes incubate the eggs for about 32 days. Young oilbirds remain in the nest until they are 95-120 days old. During that time they accumulate the great deposits of fat that have led to their being exploited for oil. At about 70 days the young weigh much more than the parents (up to 600 g). The young are fed on whole undigested fruit during most of their development (Snow 1961, 1962). When oilbirds forage for fruit, they pluck and swallow it whole, digest the edible pericarp, and regurgitate the seed intact. In Trinidad, they forage on approximately 10 plant families and on at least 36 different species. Most of the species belong to the Palmae, Lauraceae, and Burseraceae (Snow 1962; Snow and Snow 1978; Roca 1991).

The range of the oilbird is restricted mainly to South America (Colombia, Venezuela, Trinidad, Ecuador, Peru, and Bolivia), but also occurs in Panamá. Despite its wide range, it is extremely vulnerable to human activities. Through both direct effects, such as the taking of nestlings from nests, and indirect effects, such as habitat destruction, the oilbird is suffering drastic reductions in numbers throughout its range. Snow (1962) reported the extinction of five of the thirteen known colonies in Trinidad. Bosque (1986) indicated that seven of fifty-four colonies in Venezuela have disappeared.

STUDY AREA AND METHODS

My field work was done during 1986, 1987, and 1988. The oilbird colony studied inhabits the Guácharo Cave close to the town of Caripe, in northeastern Venezuela. The cave is a Natural Monument (since 1949) existing within Guácharo National Park, a 15,500-ha area of seasonally dry mountainous forest. The park is included within the northeastern mountain range of Venezuela. The area has a seasonal rainfall pattern, but rains occur most of the year, with an average annual total of 1,178 mm. The average temperature is 21°C.

Radiotelemetry The major technique used in my study was radiotelemetry. Avian radiotelemetry is a powerful and reliable technique for monitoring movements and activities (Greenwood and Sargeant 1973; Gilmer et al. 1974; Erikstad 1979; Herzog 1979; Johnson and Berner 1980; Sayre et al. 1981). My portable radio equipment was obtained from the Telonics company of Mesa, Arizona, USA. The basic equipment consisted of two TR2 receivers, two hand-held Yagi antennas, two five-element Yagi antennas, two headphones, and twelve subminiature transmitters of 32 grams each. Each transmitter's weight was about 8% of the bird's weight, which is within the safe range (Caccamise and Hedin 1985). The equipment was tuned between 150 and 152 MHz. The two-stage transmitters were designed for an operating life of eight to ten months.

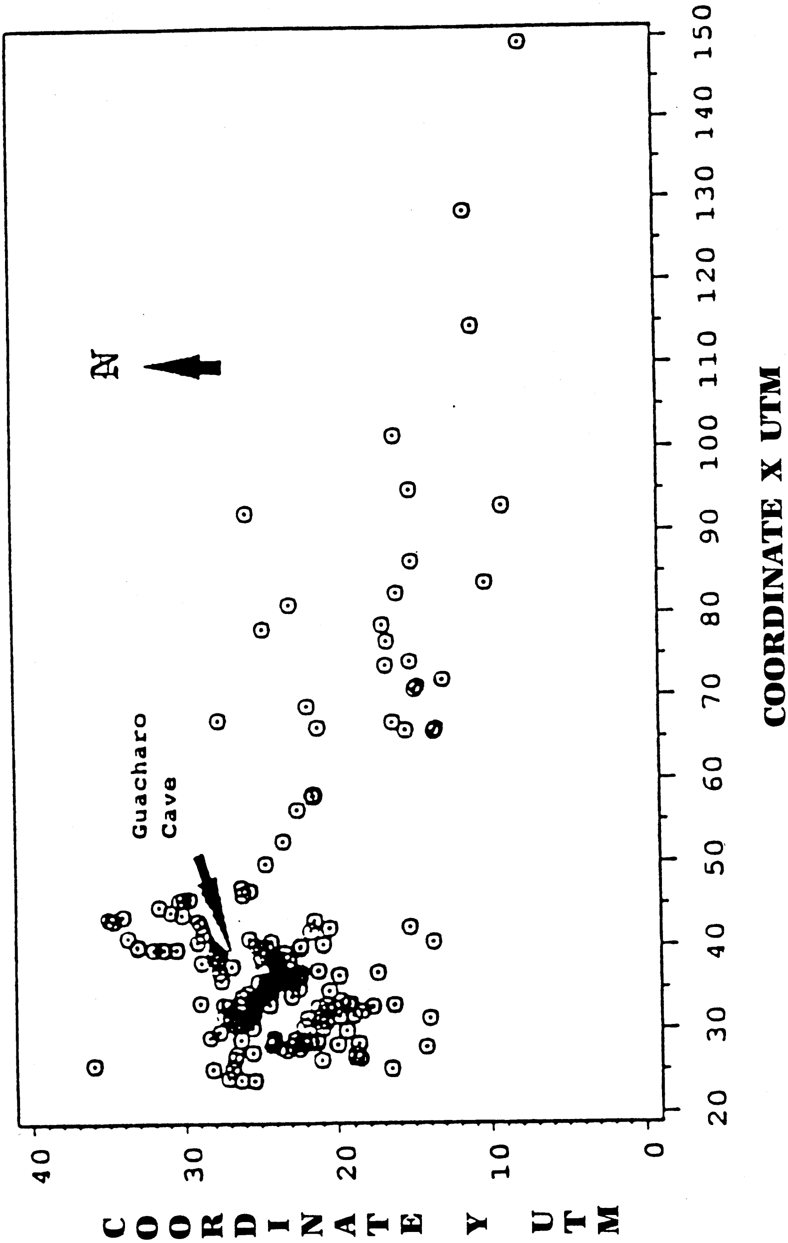
I selected the highest mountains of the area as monitoring stations. The elevations of my stations greatly increased the maximum reception distance. Nevertheless, due to the long distances flown by radio-tagged birds and the hilly topography, periodically we switched our radio stations. Twelve radio stations were used during the study.

The position of a tagged oilbird was ascertained by triangulation (Heezen and Tester 1967). We tracked oilbirds for two or three consecutive nights each week during the study. We recorded the bird's position continuously all night long due to their constant movement. We tracked individual birds every five minutes for up to an hour. Birds were located using both the average method and the loudest signal method (Springer 1979). Radiotelemetry information was subsequently analyzed by excluding all triangulation locations that presented an angle between bearings less than 45°. This criterion was especially important for selecting adequate remote foraging locations. Strong birds weighing between 370 and 410 g carried the transmitters without apparent problem. We used a cotton-nylon harness that would hold the transmitter on the back of the birds. Using this method, we radio-tagged 11 adults during the study.

RESULTS

Foraging areas Figure 1 shows the foraging places visited by ten tagged oilbirds during the breeding season. Each circle represents the area visited by a tagged bird at a given time. The blank areas among the circles were places never visited

Figure 1. Foraging areas of ten tagged oilbirds, 1986-1988



Note: Each circle indicates a location obtained by triangulation of 240 locations. The coordinates correspond with the Universal Transversal Mercator System (UTM). To simplify numbers, I included the last two digits of the Mercator grid. 1 UTM unit = 1 km.

by the tagged birds. Those areas, like blanks among the more clumped points, correspond with heavily disturbed habitat where towns, coffee plantations, and orange groves occur. The least-harmful crop for the oilbirds is coffee. When clearing the forest, local owners deliberately leave some tall shade trees for the coffee plants. Some of those trees are members of the Lauraceae and Burseraceae and are food plants for the oilbirds. The home range of the colony during the breeding season was 1,350 sq km. Oilbirds exploited discrete foraging patches of primary forest, showing long-term fidelity (six to eight weeks) to patches (Roca 1991).

Oilbirds show exceptionally long-range foraging movements. Every night oilbirds can forage at least 100 km away from the Guácharo Cave but most of their foraging areas occur in a 40-km radius from the cave. The variance-to-mean ratio (V/m = 10.96 / 0.841 = 13.02) clearly shows that the feeding areas of the oilbirds present a contagious arrangement. The foraging pattern of the birds corresponds with the clumped distribution of their foraging areas. The aggregation might be the result of both habitat destruction and preference for patches of primary forest. Although the birds foraged mainly within a radius of 40 km around Guácharo Cave, the long-range of their foraging movements is striking. The rest of the foraging localities were scattered mainly southeast of the cave. The maximum distance between feeding localities is about 150 km.

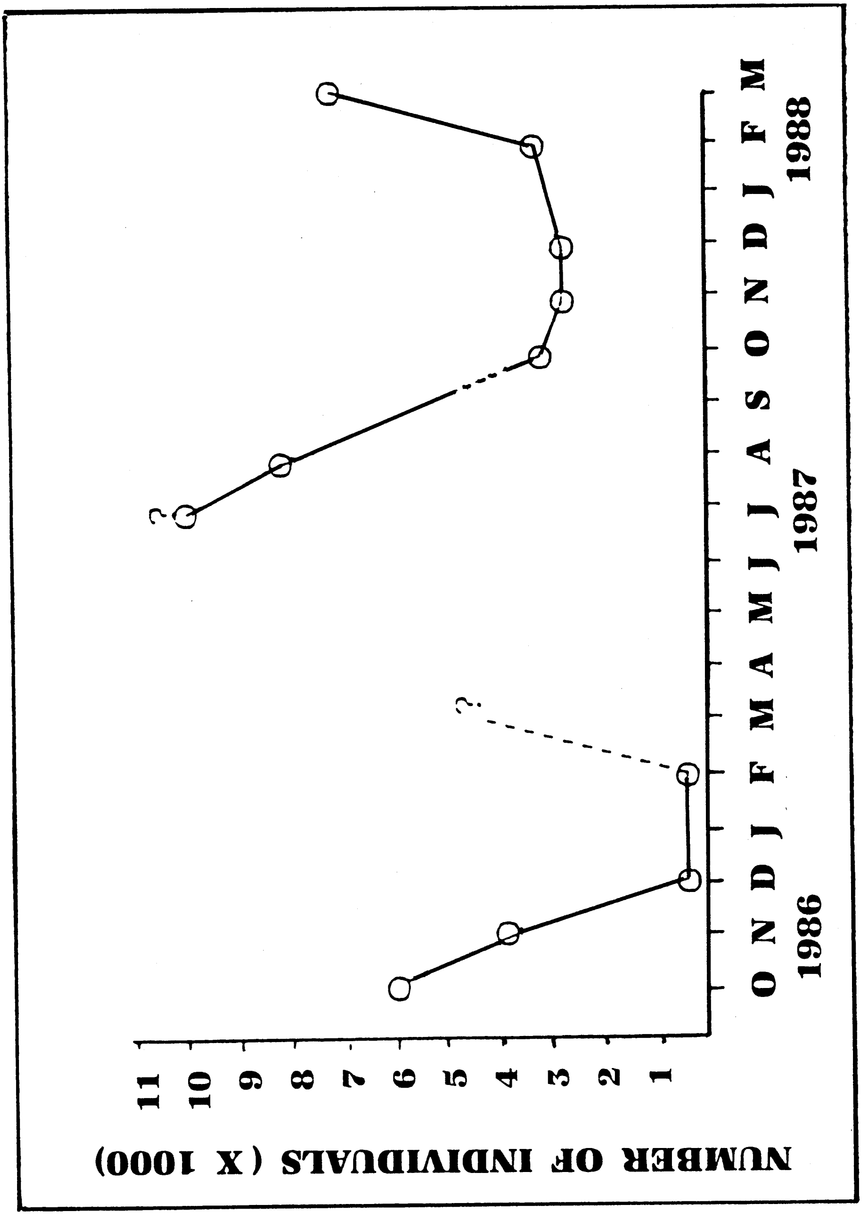
The colony showed an inverse relationship between the frequency of visits to specific places and the distance of those places to the cave. The colony used the habitat unevenly. Some places were visited more often than others. Oilbirds were observed in the same places up to 25 times during two months. Close foraging areas were visited repeatedly by breeding and non-breeding birds. Breeding birds used the habitat more intensively than non-breeding birds.

The birds foraged in the nearest patches of primary forest and then "skipped" the disturbed areas to forage in more remote suitable habitats. The distances involved were 20 km or more. Disturbed habitats not only deprived the colony of its resources but also forced it to forage farther (Roca 1991).

We censused oilbirds as they left Guácharo Cave through its only opening. We counted the number of birds leaving the cave per minute during the departure of the entire colony. The colony size fluctuated conspicuously and showed an annual cycle (Figure 2). There were monthly differences between 1986 and 1987 regarding times of both dispersal and return. At the end of both years the number of individuals roosting in Guácharo Cave decreased conspicuously. A small proportion of the colony stayed in the cave for two to four months. After that time, a massive return of oilbirds occurred, increasing considerably the colony size. The returning individuals nested and roosted in Guácharo Cave for five to six months. The cycle was then repeated. Post-breeding migration of oilbirds in various Venezuelan colonies have been reported by Bosque (1988).

Post-breeding foraging movements Oilbirds dispersed to the southeast, about 24 km from Guácharo Cave, to another cavern system in the region, Mata de Mango. They

Figure 2. Population dynamics of the Guácharo Cave oilbird colony, 1986-1988



Note: Based on censuses taken at the cave. The solid line indicates monthly trends. The dashed line shows predicted trends. The question marks are estimations of the colony size based on census data and personal observation.

switched foraging grounds and obtained fruits from an entirely different habitat. When not breeding, oilbirds foraged mainly outside the boundaries of the mountain range. At that time, they foraged in the extensive flooded plains of the Orinoco Delta. To reach their remote foraging patches, oilbirds were capable of flying at least 240 km both ways every night. Each night the birds averaged ten hours outside their caves. The guácharos foraged and dispersed towards the same area both years of the study.

Seed-dispersal analysis I analyzed seeds collected in seed trays placed underneath solitary nests of various brood sizes (Roca 1991). I also used my radiotelemetry data to determine the amount of time adults spent in the forest.

It is apparent that breeding pairs bring back to the cave mainly the fruits needed for their offspring. I observed no seeds in the seed traps while the birds were incubating their eggs. Additionally, my radiotelemetry data showed that both non-breeding oilbirds and breeding pairs late in the breeding season returned to the cave only once per night (Roca 1991). On the conservative side oilbirds might regurgitate, throughout the year, at least 60% of the seeds collected in the forest.

OILBIRDS: A "NATURAL MANAGEMENT TOOL" FOR PROTECTED AREAS

The oilbird's ecological attributes highlight the role of the species in the ecosystem. Their annual breeding cycle, long life span, short- and long-range foraging movements, large home range, post-breeding dispersal, broad diet, high densities, and function as good seed dispersal agents make them a keystone species for the tropical forest.

The highland and lowland forests benefit from having guácharo-dispersed seeds throughout the vast area that encompasses various plant communities. I have calculated a conservative estimate of the magnitude of their seed dispersal. An adult oilbird needs an average of 50 fruits per day to supply its daily metabolic demand. I used Nagy's (1987) field-metabolic-rate equation and my own calorimetry data. An individual bird regurgitates 1,500 fruits monthly. The guácharo colony regurgitates 15,000,000 seeds monthly. That amount represents a biomass of about 21 tons of seed, excluding the aril, that are regurgitated each month by the entire colony. Whether adults disperse all the seeds or only a fraction remains to be determined. My results suggest that oilbirds regurgitate seeds in the forest during both the breeding and non-breeding season.

Oilbirds constitute an excellent ally of mankind in the hard task of preserving wildlife areas. Oilbirds could be considered as a natural tool for management of regions, like Mata de Mango, that require special protection. Through their seed dispersal role, oilbirds may contribute to the maintenance of plant diversity of the watersheds. Limestone formations are particularly sensitive to erosion. The plant cover is the only way these geological processes are slowed. Any major element of the ecosystem that supports the forest structure, in this case oilbirds, is important and must be protected.

ENLARGEMENT OF GUACHARO NATIONAL PARK

I applied my information on the foraging ecology of oilbirds to assure the survival of populations occurring in my study area and most especially to adequately manage and protect a vast pristine patch of forest (Roca and Gutiérrez 1989). The central theme of the proposal was based on the information that oilbirds forage only on about 25% of the area of the existing Guácharo National Park (Roca 1991). Most of the colony forages outside the confines of the park preferring remote patches of primary forest and avoiding disturbed areas. I proposed to include the karst zone of Mata de Mango as part of Guácharo National Park. The annexing of this area to the existing park guarantees not only the protection of food and cavern resources for the oilbird colonies inhabiting the region, but also the protection of a complex hydrological network that supplies water to the local agricultural and oil activities.

Ecological value of the karst zone of Mata de Mango Mata de Mango comprises 34% of all the oilbirds colonies reported for Venezuela (Bosque 1986). Other colonies are scattered through the country. The area is probably the most important habitat for the species throughout its range.

Mata de Mango is also a natural refuge for the flora and fauna of the northeastern part of the mountain range. The area is like a "mountainous island" surrounded by small farming villages. Unfortunately, the size of the "island" is being reduced because of the slash-and-burn techniques practiced by the growing number of farmers, or *conuqueros,* of the area. Their activities not only threaten the fauna and flora but also undermine the fragile hydrologic network of the Caripe region. The conuqueros are catalyzing the sedimentation and erosion processes that normally should take thousands of years. Mata de Mango embraces 33 headwaters of a lowland river, the San Juan. Most of the San Juan waters are navigable. The river flows into Cariaco Gulf. Its characteristics make the San Juan the preferred route of fishermen and large oil tankers coming to the town of Caripito. The erosion and sedimentation of the hydrological network of the highlands would negatively affect the main economic activities of the area. It would have a major impact on the farms in the vicinity of Mata de Mango.

The enlargement of the existing park does not pretend to preserve the flora and fauna *per se,* and does not stop development projects of the Monagas state. If established and protected, the park complements and guarantees a sustainable development process in harmony with the region's natural heritage.

Annexing the proposed area Since the proposed area is about 15 km from the park, two methods of expansion are possible. First, the areas could be connected by means of a natural corridor, or "greenway." The new park would not be fragmented and some fauna, mainly mammals and birds, could use the corridor. Second, the areas would remain unconnected, but could be close enough for birds to commute. The first alternative would give unity to the park and be more beneficial to the flora and fauna as a whole. But, in reality, management of any land takes into account non-biological information. The desires of land owners, extent of private lands, and location of villages, agricultural zones, and state-owned lands are all important. The success of a proposal depends on its feasibility within this larger context.

An adequate natural corridor is difficult to determine. Most of the land between the current park and the proposed area is heavily populated. The town of Caripe, as well as various small villages and coffee and orange plantations along the Caripe Valley, pose numerous administrative and legal hindrances to the establishment of the corridor. The second alternative proved to be the more expedient.

The borders and size of the proposed area were delimited following four major criteria:

1. All the caverns and sinkholes of the area were included.
2. A large patch (66,400 ha) of mainly primary forest, similar to the home range size of the colony, was included.
3. All 33 headwaters of the San Juan River were included.
4. Most of the towns, small villages, farms, and private lands were excluded.

The second design was accepted without major changes by the government of Venezuela and its park authority, INPARQUES. The new and expanded Humboldt National Park is now a reality. In December 1989 the minister of the environment, Enrique Colmenares Finol, officially declared the extension of Guácharo National Park by 66,000 ha. The minister's action indicated the receptive attitude of the Venezuelan government towards the preservation of the country's natural heritage.

IMPLICATIONS FOR MANAGEMENT OF PROTECTED AREAS

First, research on keystone species is essential to determine critical habitats to be managed and protected within a park. Second, applied research on the ecology of important frugivores and their role within the ecosystem must be encouraged and included in long-term management strategies. Finally, whenever possible the boundaries of parks and other protected areas must be redefined using adequate information on species of special management concern.

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