ORNITOLOGÍA NEOTROPICAL
(2020) 31: 52–56
ORIGINAL ARTICLE
Sociedad de Ornitología Neotropical

GPS TRACKING OF THE FORAGING MOVEMENTS OF OILBIRDS (*STEATORNIS CARIPENSIS*) FROM THE DUNSTON CAVE AT ASA WRIGHT NATURE CENTRE, TRINIDAD

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Abstract · The ranging behaviors of the Oilbird (*Steatornis caripensis*) in Trinidad are not well defined and are required to better outline future conservation management parameters for this species. Due to the nocturnal foraging behaviors of the Oilbird, past observations were restricted to colony site observations, video recordings, and limited electronic tracking over short periods. Utilizing newly developed small-scale Global Positioning System (GPS) data loggers, we were able to determine the flight and foraging behaviors of two oilbirds that roost at the Asa Wright Nature Centre for up to 270 days. The use of backpack style GPS tracking devices provided high site resolution and accuracy of the movements and a better understanding of the annual foraging behaviors of the oilbirds in the Asa Wright Nature Centre colony. The oilbirds' home range was determined to be 3,564.6 km², with an average trip distance from Dunston Cave of 7.33 km, excluding an intermediary migration point in Venezuela. 48.5% of the foraging area consisted of locations within the Northern Range, while 27.7% of these trips remained within the Arima Valley, which is only partially protected from quarrying activities. This data document the previously unknown patterns of habitat use of the Oilbird and serves as a pilot study to determine the conservation importance of those habitats for the development of long-term conservation action plans for these iconic birds.

Resumen · Movimientos de alimentación del Guácharo (*Steatornis caripensis*) en Dunston Cave, Asa Wright Nature Centre, Trinidad
Los movimientos del guácharo (*Steatornis caripensis*) en Trinidad no están bien definidos y requieren de un mejor entendimiento para futuras acciones de conservación de esta especie. Debido al comportamiento de alimentación nocturno de los guácharos, las observaciones pasadas estuvieron restringidas a las colonias, grabaciones en video y seguimiento con dispositivos electrónicos por un corto periodo de tiempo. Mediante el uso de nuevos registradores GPS (Global Positioning System o GPS loggers) de pequeño tamaño pudimos estudiar, durante un máximo de 270 días, el comportamiento de vuelo y alimentación de dos guácharos que duermen en la Cueva Dunston, Centro Natural Asa Wright. El uso de estos registradores adheridos a la espalda nos proveyó de información detallada y de alta precisión para determinar los comportamientos de alimentación anuales de estos individuos en la colonia del Centro Natural Asa Wright. El rango de hogar de los guácharos fue de 3564,6 km², con una distancia promedio de viajes desde la Cueva Dunston de 7,33 km (excluyendo un punto intermedio de migración en Venezuela). Casi la mitad (48,5%) del área de alimentación se encuentra dentro del límite de la Cordillera Norte, mientras que el 27,7% de estos viajes ocurrieron dentro del valle de Arima, que sólo tiene protección parcial de actividades mineras. Este estudio documenta patrones previamente desconocidos de uso de hábitat por parte del guácharo y sirve como estudio piloto para determinar la importancia de estos hábitats para desarrollar estrategias de conservación a largo plazo.

Key words: Asa Wright Nature Centre · Conservation management · Wildlife tracking

INTRODUCTION

The Oilbird, *Steatornis caripensis*, the only extant member of the family Steathornithidae, is the only nocturnally frugivorous cave-dwelling bird in the world (Thomas 1999, Gonzalez-Quevedo et al. 2010). Oilbirds require large expanses of forest where ripe fruit is available year-round, as well as caves or gorges for roosting and nesting sites (Hilty et al. 1986, Thomas 1999). These birds breed in northern South America from northern Guyana, Trinidad, northern Brazil, and Venezuela, along the Andes in Colombia, Ecuador, and Peru into Bolivia (De Schauensee et al. 1978, Bosque 1986, Hilty 2002, Herrera 2003, Cisneros-Heredia et al. 2012, Murillo-Pacheco & Bonilla-Rojas 2016). The Oilbird is listed as a species of Least Concern by the IUCN, although its population trends appear to be decreasing (BirdLife International 2012). Limited protection is afforded within parks and conservation areas in South America (Bosque 2002).

Oilbirds may fly up to 240 km in one night, occasionally roosting in trees, and may undergo partial migrations in search of food during the non-breeding season when foraging conditions deteriorate near the breeding cave (Bosque & Ramirez 1988, Roca 1994, Holland et al. 2009). Their diet consists of fruit from tree species, belonging predominantly to the Lauraceae and

Receipt 31 October 2018 · First decision 10 January 2019 · Acceptance 21 August 2019 · Online publication
Communicated by Kaspar Delhey & Rafael Rueda-Hernández

Arecaceae families, but also to Burseraceae and Araliaceae to a lesser extent. Oilbirds serve as important dispersers of these large tree seeds, contributing to forest diversity and regeneration (Bosque et al. 1995, Herzog and Kessler 1997, Karubian et al. 2012).

Accurate data pertaining to Oilbird spatial ecology and ranging behavior is still lacking. Recent studies have focused on the distribution and dispersion of oilbirds utilizing site counts, video recordings, and limited use of electronic tracking (Tello et al. 2008, Holland et al. 2009). These studies were limited in scope, a single sighting or detailed tracking for a one week period in October, and this data involved ranging behavior and spatial parameters particularly when temporal elements were reviewed. Defining these parameters is important for improving future conservation measures that would focus on protecting foraging and nesting areas, and generating proper legislation to achieve those goals. This study expanded the temporal aspect to approximately eight months and coincided with both rainy and dry seasons.

Due to the nocturnal behavior of the oilbirds, observations are difficult when birds are not attending the roosting sites. Therefore, research has been historically biased towards colony site observations and limiting data collection on foraging activities. Insight into the individual foraging behaviors is limited, although knowledge of these behaviors would be essential in providing an understanding of the ecological role of the oilbirds and of the constraints acting upon them within the ecosystem. The use of electronic devices, attached to individual birds, is an effective method to investigate the flight and foraging behaviors in avian taxa (Wilson et al. 2002, Daunt et al. 2003, Grémillet et al. 2004, Garthe et al. 2007).

This paper presents data on GPS tracking of two oilbirds from the Dunston Cave site at the Asa Wright Nature Centre, in Trinidad. Our goal was to provide information on the ranging behavior of oilbirds to determine when these birds forage, the distances involved, where the oilbirds range and if alternative roosting sites are involved. Oilbirds are taxonomically unique, but are also of high value to the local communities in Trinidad, providing the remaining populations of this species with a higher conservation significance. The population at the Asa Wright Nature Centre, specifically within Dunston Cave, consists of approximately 200 birds (Asa Wright Nature Centre 2013) and is a major attraction to the facility that provides an economic driver to the adjacent communities. Studies indicate that oilbirds remain near the same cave year-round and exhibit natal site philopatry (Snow 1961). Quarrying activities currently associated with the area surrounding the Asa Wright Nature Centre property are of concern to the future of the birds. Studies of the quarry sites in Trinidad have demonstrated the destruction of vegetation, as well as the formation of dumping grounds with harmful minerals and chemicals that contaminate the soil (Atwell et al. 2018). We discuss our results in relation to previous studies and the need to further these efforts in the future.

METHODS

Study site. Our study involved the oilbirds in Northern Trinidad, at Dunston Cave (10.715ºN, 61.299ºW), within the protected area of the Asa Wright Nature Centre, Arima, Trinidad.

Tracking. Tracking devices were deployed on 13 November 2015. The initial timing of the study was determined to ensure that the colony had completed their normal breeding cycle and subsequent annual molt. We captured adult oilbirds using mist nets, set approximately 15 m outside of the Dunston Cave entrance. We deployed GPS data loggers on two birds, model FLR-V-14500 (Telemetry Solutions, 5051 Commercial Circle, Concord, CA 94520, USA, 30g; L 51 x W 16 x H 21 mm). The loggers, fixed to the bird's backs using a Teflon harness, were programmed to record daily GPS data at 19:30, 23:30, 00:30, 02:30, 05:00, and 12:00 h (local time) for the entire annual period. Deterioration of the adhesive should allow the equipment to become detached within a period following the study and eliminate the need for recapture. This data was stored for remote download to a portable receiver on a weekly basis by placing the base unit at the cave site, approximately ≤ 100 m of the roosting oilbirds. Before deployment, each bird was weighed using a spring balance. The loggers were attached only if the GPS unit was less than 8.5% of the mean body mass and the bird had a wing chord of ≥ 30 cm. The two birds studied had an average wing chord of 31.5 cm and an average body mass of 418 g, meaning that the loggers represented 7.1% of their body mass. The maximum logger weight to body mass ratio was determined not to be detrimental to foraging activities based on high wing load, known carrying capacity of feeding items for chick rearing of 160 g, and previous examination of minimal behavioral differences in oilbirds utilizing harness or glue-on systems (Holland et al. 2009). Measurements taken were limited to body mass and wing-chord to minimize handling time to less than five minutes.

Analysis. Daily flight distances were calculated by measuring the straight-line distance between locations that were defined by consecutive data points within the same day, with no differentials included for possible roosting versus flight activities. Daily activity was computed and recorded as the frequency of segments for an effective movement, defined as movements greater than the nominal accuracy of the GPS (± 25 m). We also calculated the daily/nightly distances covered by the oilbirds as the sum of the straight-line distances covered between consecutive locations in the same day/night.

Large bodies of water appear to be an impediment to Oilbird dispersal. At this particular site, there are large stretches of sea to the north and east; therefore, the Oilbird home range was estimated via the minimum convex polygon (100% MCP) approach (rather than more sophisticated methods, such as Kernel Density Estimate, which assumes no barriers to animal movement). Inputs were 386 GPS collar location records for the two individuals. The Minimum Bounding Geometry tool in ArcGIS 10.3 was utilized to create the MCP polygon and calculate home range.

This study was conducted under permits granted to the Asa Wright Nature Centre and were accompanied by staff members from that facility. All procedures performed were in accordance with the ethical standards of the Wildlife Conservation Society's Institutional Animal Care and Use Committee. We also were granted permission to conduct these activities by the Board of Directors of the Asa Wright Nature Centre.

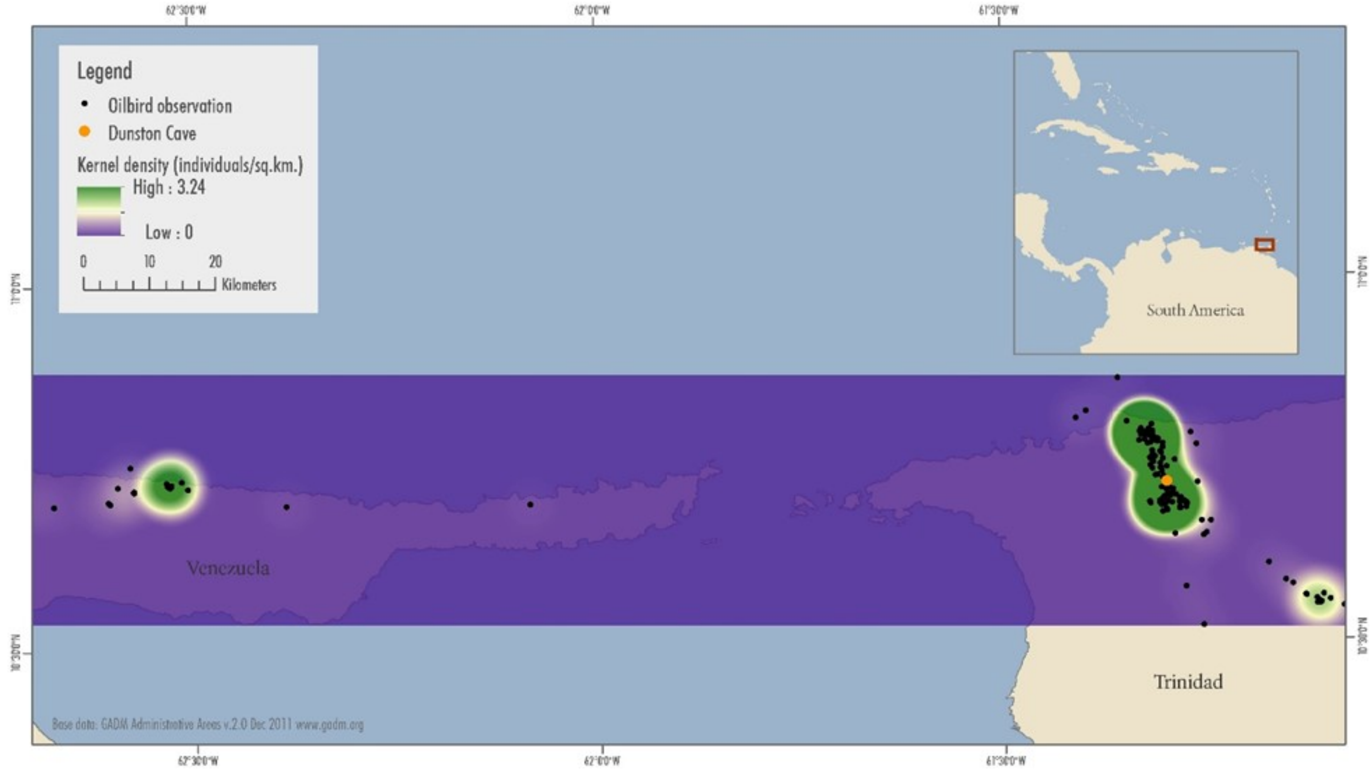

Figure 1. Density distribution of 386 positions recorded for two oilbirds from Dunston Cave (orange point) using GPS loggers. See the color scale for data densities and method section for details on data analysis and areas involved in Core Range (95% KDE) and Home Range (50% KDE).

RESULTS

One individual bird was tracked for 270 days and the other for 43 days, from 14 November 2015 to 27 August 2016, and 14 November 2015 to 26 December 2015, respectively. The oilbirds covered a mean hourly distance of 1.53 km (ranging from 0.00 to 24.30 km), which may include roosting and flight activities conjointly. The maximum distances covered (15.87 and 24.30 km) were en route to and from a site in Venezuela. Core range area was 23.0 km² and home range area 3,564.6 km² (Figure 1).

Prior to undetermined unit failures (e.g. battery failure or loss of equipment), data retrieval was strictly limited to the proximity of the GPS units to the base station, indicating that the birds returned on a nightly basis to the roosting site at Dunston Cave, excluding the period of 1-20 August 2016, when one individual moved to the Peninsula de Paria National Park area in Venezuela.

All foraging trips from the roosting site at Dunston Cave were oriented in a northward or southward direction. The combined foraging and partial migration locations were all found between 10.721ºN—10.858ºN and 61.458ºW—61.080ºW (Figure 1). The MCPs of the foraging locations show a high usage of areas associated to the Northern Range (Blanchisseuse area), southern Arima Valley, Sangre Grande, and Peninsula de Paria (Venezuela).

The average nocturnal trip distance from Dunston Cave was 7.33 km (SD = 6.52; range = 0.13—37.32 km), excluding the period when one bird remained at the Venezuela site. The intermediary or partial migration location points in Venezuela (N = 54) were 132.67 km (SD = 19.75; range of 134.40—153.80 km) from the cave. During this period at the Venezuela site, four GPS positions were recorded at 12:00 h, compared to the absence of data collection at that period of time during the remainder of the study; this indicates that these locations were likely open roosting locations and with clear transmission of satellite signals.

Based on the GPS locational data points (N = 217), the oilbirds spent the majority of the time foraging in the Northern Range (48.5%) from mid-November to the end of January, and from mid-March to the latter part of April. During these periods, individual birds would return to a site with a radius of ≤ 310 m on consecutive nights for 2-19 days. Specifically, the birds utilized the Northern Range from 14 November 2015 through 28 January 2016 and 15 March through 24 April. From 6 February through 3 March, the single bird foraged in the Tunapuna Piaro area, followed by a shift to the Sangre Grande region from March 4 through March 14. The birds used areas in the southern Arima Valley, within the Asa Wright Nature Centre, and areas north of the city of Arima, where quarrying activities are underway, between 26 April 26 through 29 July 2016. This represents 27.7% of the recorded GPS locations. Lastly, foraging activities in Venezuela were represented by 8.8% of the GPS points.

DISCUSSION

This study has provided a better understanding of the annual foraging behavior of the Oilbird colony at the Asa Wright Nature Centre. Our data indicates that these oilbirds may return to the roosting site at Dunston Cave on a daily basis for 91.2% of the year, following mean foraging distances of 7.33 km, and also engage in a partial migration period in which they travel up to 153.8 km. These findings diverge from previous findings by Holland et al. 2009, which describe birds in northern Venezuela averaging a nightly foraging range of 44.0 km, maximum distances of 73.5 km, and birds that roosted away from the nesting caves 66% of the days, which may be a result of forest distribution. Here, we followed birds throughout seasonal and life cycle changes, greatly expanding the temporal variables not included in previous studies. Based on this data, areas in relatively close proximity are of greater importance to the birds during the known peak breeding season of March, April, and May. There also appears to be a high site fidelity involving consecutive foraging trips to localized sites during the known reproductive period. Cave sites may be less frequented during the partial migration periods determined by the acquisition of GPS locations during the hours of daylight and only during these intervals. Locational data was unavailable in the cave environments, probably due to low satellite acquisition required to determine a global position point. A majority of the extensive foraging range is well outside the Asa Wright Nature Centre and the protection the centre provides beyond the roosting site.

The use of the GPS system that allows the remote download of data let us track the oilbirds for close to a one year period and to uncover previously unknown patterns of habitat usage by these birds. Advancements in this technology, in terms of location accuracy and miniaturization of equipment, may allow further refinements in determining Oilbird habitat usage, including alternative roosting sites and restricted flight patterns due to contact with large bodies of water, and to ascertain whether habitat conservation and/or enhancement will help protect this iconic species of Trinidad.

Conservation biologists seek to understand and manage the threats, such as those brought on by development, that challenge or impact species, populations, and ecosystems (Sawyer et al. 2006, Harju et al. 2011). This study allowed us to begin determining the conservation habitat value for the long-term conservation of the Oilbird population at the Asa Wright Nature Centre and its surrounding area. A more robust number of birds should be taken into account in future studies to better define the usage of habitat. Here, we have begun to identify the primary forests involved in the foraging activities of the Oilbird colony and the value of these areas for future conservation of these populations. Data strongly suggests that conservation efforts focused on the remaining intact forests and on halting further degradation of southern sectors of the Arima Valley, due to illegal quarrying activities, are paramount. Determining if land management practices can positively impact conservation in the disturbed areas, and whether such practices may enhance areas managed directly by the Asa Wright Nature Centre, would also be of significance. Although the assessment and protection of habitat are important in maintaining total species diversity, it may be necessary to focus on the oilbirds as a vulnerable species, one that is critical in terms of its importance as a seed disperser and the role it plays in the health of the ecosystem.

ACKNOWLEDGMENTS

We are deeply grateful for the comments of Jean Paré, Christine Shepard, the anonymous referee involved in the review of this manuscript, and Alejandro Kusch for the applicable Spanish translation. WCS provided the necessary funding and support for the program, for which we are again grateful.

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