FIRST GPS TRACKING OF A BLACK STORM PETREL *HYDROBATES MELANIA*

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ABSTRACT

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The research reported here, conducted at Archipiélago de Espíritu Santo National Park, Baja California Sur, Mexico, establishes the first successful application of biologging on a Black Storm Petrel *Hydrobates melania*. Results yielded preliminary insights into this population's marine movements during nesting. The device used, weighing less than 3% of the bird's body mass, recorded a 181-km foraging trip. Subsequent trajectory analysis indicated navigation behavior that potentially was optimized to use crosswind assistance. The individual showed no weight loss post-retrieval, a finding that suggests this method is viable and unharmful, demonstrating the feasibility of using miniaturized tracking devices to unravel the ecology of this elusive seabird.

Key words: Black Storm Petrel, GPS tracking, flight performance, seabird, windscape

INTRODUCTION

The study of seabirds using tracking devices has been increasing in the last 20 years as a result of cost reduction and device miniaturization (Carneiro et al., 2024). However, the use of this technology remains a challenge for the smallest seabirds: the storm petrels. To date, tracking data are available for only nine species, all belonging to the northern storm petrels group (family: Hydrobatidae; Carneiro et al., 2024; Winkler et al., 2020). It was not until less than five years ago that the first tracking data for this group were obtained and published (Bolton, 2021; Collins et al., 2022; De Pascalis et al., 2021; De Pascalis et al., 2022; Rotger et al., 2020); a few studies were conducted in Mexico recently (Medrano et al., 2022, 2024).

The Black Storm Petrel *Hydrobates melania* is the largest storm petrel, and certainly the largest that nests along the Pacific Coast of North America, with an average weight of 60 g and with notably long wings (50–56 cm), leading to deep, languid wingbeats (Everett et al., 2021; Howell & Zufelt, 2019; Spear & Ainley, 2007). It is entirely sooty-black colored and has a distinctly forked tail (Onley & Scofield, 2007; Sibley, 2014). The global population is estimated at 600,000 individuals, and its conservation status is classified as Least Concern by the International Union for Conservation of Nature (BirdLife International, 2020); however, its population is apparently decreasing, and it is considered a threatened resident species in Mexico according to federal Mexican law (Norma Oficial Mexicana, NOM-059-SEMARNAT-2019, 2019). Like most procellariiforms, it is active in the colony at night, arriving in complete darkness and leaving before dawn to avoid predators (Everett, 1991). During the day, this species is at sea, feeding, commonly in pelagic areas adjacent to nesting colonies (Everett et al., 2021; Oppel et al., 2018; Spear & Ainley, 2007). Nonetheless, a recent study based on stable isotopes suggested that these seabirds have neritic foraging habits (Bedolla-Guzmán et al., 2021). Their high dispersion capability and low detectability, along with the logistics constraints for researchers to visit their colonies, can hamper the collection of data on life history and demography. In this note, we provide the first public tracking effort on the species, carried out to assess the feasibility of a future study investigating at-sea behavior.

METHODS

Study Area and Fieldwork

This study was conducted at Los Islotes, an islet in the Archipiélago de Espíritu Santo National Park, Baja California Sur, Mexico (24°35′55.73″N, 110°24′10.68″W; creation decree published in the Diario Oficial de la Federación [Official Gazette of the Federation] on 10 May 2007; Secretaría de Medio Ambiente y Recursos Naturales [SEMARNAT], 2014). At this location, a colony of Black Storm Petrels breed sympatrically with Least Storm Petrels *H. microsoma* (Carmona et al., 1994). Since 2018, researchers have visited the colony at least once per month, sea conditions permitting, as part of a long-term ringing program for both storm petrel species. The islet is very difficult to access and to explore. Nests are in narrow, vertical crevices, making it particularly complicated to inspect and reach the occupants. Therefore, only three nests were marked and monitored for capture of adults. On 26 February 2025, during the scheduled new moon visit, we captured an adult individual at approximately 22h00 (GMT −07h00), previously marked with alphanumeric ring E00343. The individual had already been GPS-tagged on 14 May 2024, but the instrument was lost. We deployed a nanoFix mini-GPS (PathTrack Ltd., UK) weighing 0.96 g (< 3% of the individual's body mass, which was 64.10 g). The device was fixed to the dorsal feathers using Tesa 4651 tape and programmed to record one location fix per hour (Fig. 1). On 06 March 2025, we revisited the colony at dusk to attempt recapture. At approximately 19h00, we retrieved the tagged bird and recovered the GPS device. Despite obtaining data for only a partial foraging trip (see Results), we could still obtain the trip structure and derive a set of movement descriptors.

Data Analysis

We calculated descriptive movement metrics, interpreting them with caution given the hourly GPS sampling interval. These included the bird's maximum and mean (±1 standard deviation) ground speed between consecutive locations and its maximum linear distance from the colony.

To analyze the wind conditions the bird experienced during its flight, we calculated point-based metrics of each GPS location. Surface-level wind components (u, v) were obtained from the National Centers for Environmental Prediction (NCEP)/National Center for Atmospheric Research (NCAR) Reanalysis datasets via the "RNCEP" package (Kemp, van Loon, et al., 2012). Wind speed (Vw) was calculated as the vectors' Euclidean magnitude (Pennycuick, 2008). Wind direction was derived using the *atan2* function to resolve directional ambiguity (Grange, 2014) and converted from meteorological to navigational convention. The bird's flight bearing (θ) and ground speed were derived from consecutive GPS points using the "argosfilter" (Freitas, 2022) and "geosphere" (Hijmans, 2022) packages, respectively. We then decomposed the wind into tailwind (Tw) and crosswind (Cw) components relative to the bird's bearing (θ, in degrees) using established methods (Shamoun-Baranes et al., 2017):

$$Tw = Vw \times \cos \theta$$

$$Cw = Vw \times \sin \theta$$

where Vw is the wind speed $\sqrt{u^2 + v^2}$.

To characterize the general windscape of the study area, we used zonal (u) and meridional (v) wind components from the ERA5 reanalysis dataset (0.25° resolution, hourly, at 10 m height), following the approach of Kemp, Shamoun-Baranes, et al. (2012).

RESULTS

We recorded a partial foraging trip consisting of 17 GPS fixes over 16 hr. During this period, the Black Storm Petrel covered a total distance of 181.58 km, reaching a maximum distance of 110.85 km from the colony. The mean ground speed was 3.15 ± 2.13 m/s, with a maximum speed of 7.9 m/s.

The individual departed from the colony and traveled northeast across the Gulf of California. Tailwind assistance values ranged from −2 m/s (headwind) to 4 m/s (tailwind), with the most favorable conditions occurring along the eastern portion of the route. Crosswind magnitude varied from 0 to 5 m/s, with the strongest lateral winds experienced near the continental coastline (Fig. 2).

A shift in flight direction toward the southwest coincided with changing wind conditions; the Black Storm Petrel initiated its turns as tailwind assistance increased and crosswind magnitude decreased. However, while flying the southwesterly course, crosswinds became the prevailing influence, increasing until the final fix located downwind of San José Island (Fig. 3).

DISCUSSION

Currently, there are no published GPS tracking data for the Black Storm Petrel (Carneiro et al., 2024). Therefore, these data, although partial, are the first GPS tracking data for this species and provide a brief glimpse into its daytime activity.

The tracked individual appeared to rely consistently on crosswinds and partially on tailwinds to support its travel. The alignment between movement direction and wind conditions suggests that the bird may have been selectively navigating through atmospheric corridors to optimize flight efficiency. Previous studies reported that this species typically flies at speeds of 7.31 m/s when aided by cross tailwinds (Spear & Ainley, 1997), which aligns closely with the maximum speeds observed in our dataset. Our findings indicate that this Black Storm Petrel predominantly used crosswind assistance throughout its flight (Fig. 3), in accord with Spear and Ainley (1997) and most procellariiforms. Our observations are consistent with observations of procellariiforms' flight behavior using crosswinds to gain speed during dynamic soaring (Thorne et al., 2023), although this type of flight has yet to be reported for this species.

Based on this work, we can reasonably exclude a negative impact of the devices on Black Storm Petrel for two main reasons. First, the individual had already been GPS-tagged, and although that device had been lost at sea, the bird nevertheless returned to the colony and resumed breeding, eventually fledging its chick, and indicating no apparent adverse effect. Second, the bird's body mass was identical before and after device retrieval (64.1 g in both cases), indicating that the tag did not impose additional energetic costs. Ultimately, our findings support the use and feasibility of tracking technologies to study this secretive seabird species.

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Fig. 1. Adult Black Storm Petrel *Hydrobates melania* (ring E00343) with a deployed nanoFix mini-GPS logger attached dorsally on the lower back feathers, not the tail. Photo credit: María Alejandra García Castro

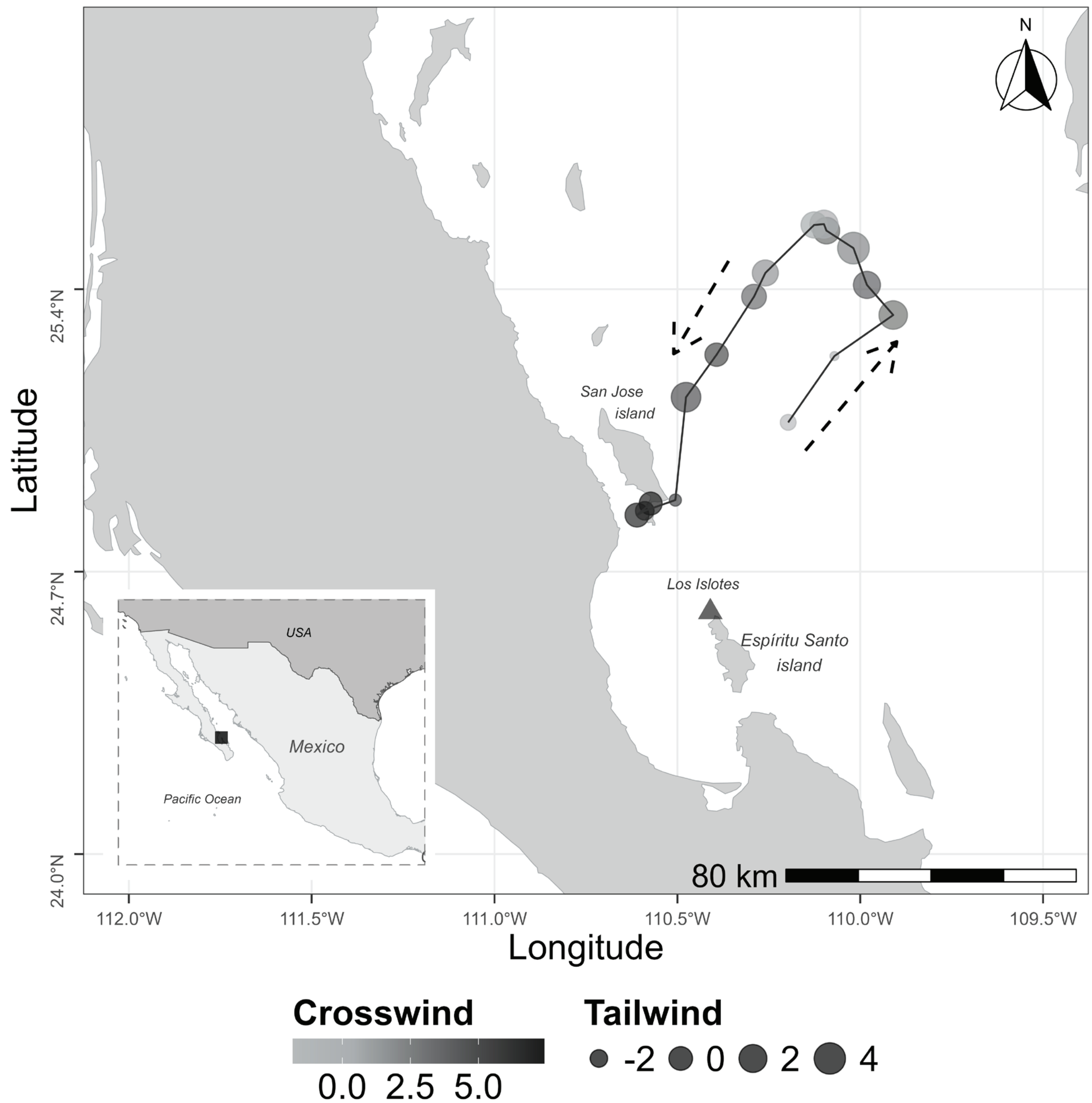

Fig. 2. Flight path of the Black Storm Petrel *Hydrobates melania*, showing travel direction (dashed arrows) and wind influence. Greyscale gradient represents crosswind intensity, and dot size indicates tailwind intensity (both in meters per second). The colony location at Los Islotes (Baja California Sur, Mexico) is marked with a triangle.

AUTHOR CONTRIBUTIONS

Conceptualization: JC, GA, JALH, CS, YVAB. Formal analysis: JC, GA. Funding acquisition: CS. Investigation: all authors. Methodology: JC, GA, CS. Project administration: CS. Writing—original draft: JC, GA, JALH, CS, YVAB. Writing—review & editing: all coauthors.

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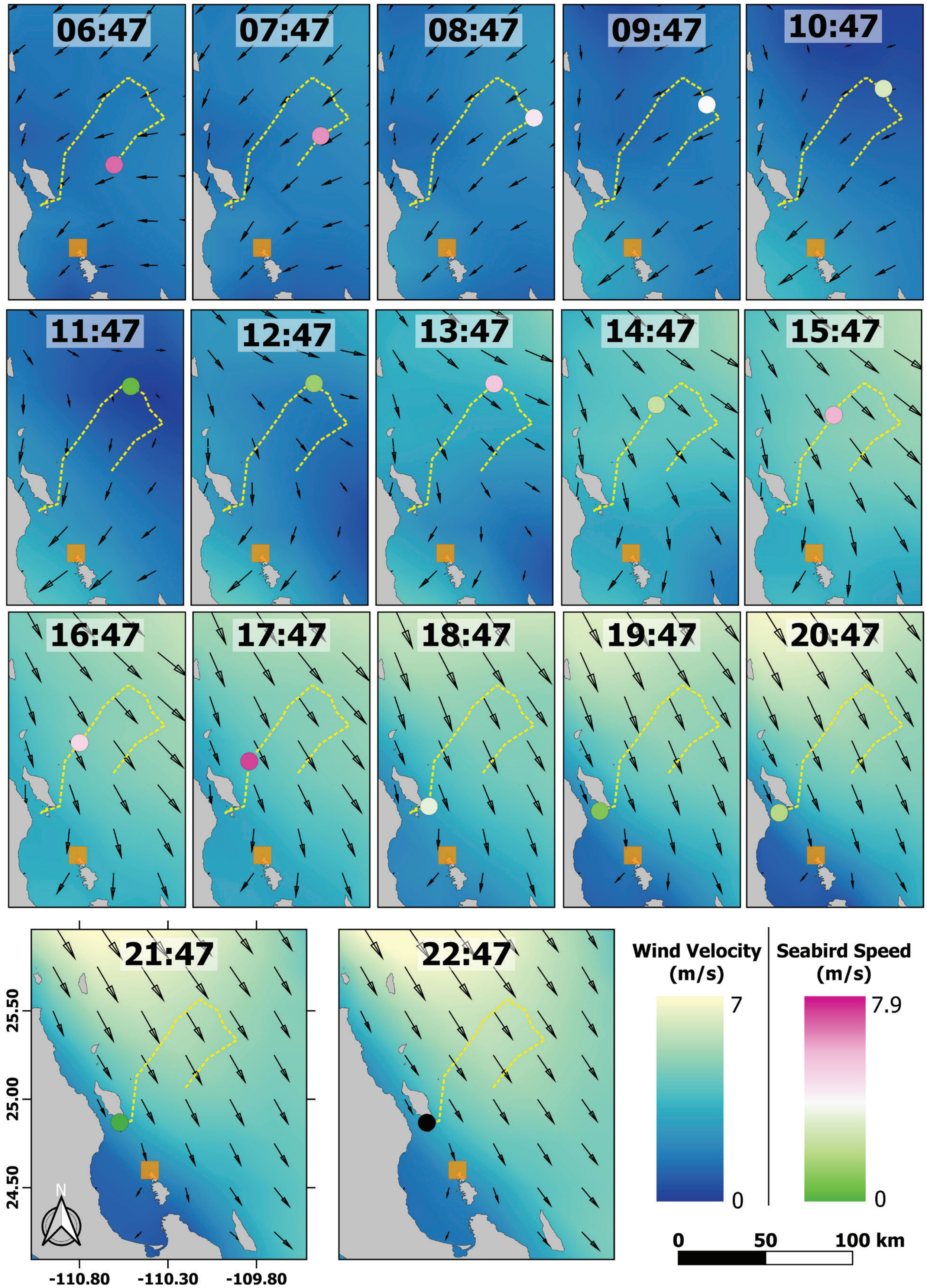

Fig. 3. Hourly windscape and flight path of the Black Storm Petrel *Hydrobates melania* recorded during the incubation phase. The track is shown in local time. Wind velocity (blue-yellow gradient) and direction (arrows) are shown. The bird's ground speed is overlaid on the track (green-pink gradient). The colony location at Los Islotes (Baja California Sur, Mexico) is marked by an orange square.

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