RADAR SURVEYS FOR PETRELS ON JAMAICA:
RESULTS FROM AN EXPEDITION DURING MARCH 2016

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ABSTRACT - *The Black-capped Petrel is highly endangered due to human impacts. To address these challenges, in March 2016, we surveyed petrels using proven radar techniques to identify nesting areas and flight corridors in the Blue Mountains of Jamaica. Our team consisted of staff from both Environmental Protection in the Caribbean and Jamaica Conservation and Development Trust. Using radar, our team detected six petrel-like targets on the south slopes of the Blue Mountains, in the vicinity of the Cinchona Botanical Gardens. No petrels were detected visually or aurally.*

INTRODUCTION

Populations of the Black-capped Petrel, one of the most endangered Caribbean seabird species, have been in precipitous decline over the previous 50 years. It is estimated that only 1,000-2,000 pairs of petrels remain. Although they historically nested on islands in the Lesser Antilles and it is widely believed they still nest on Dominica, they are currently known to nest only on the island of Hispaniola. The dire conservation status of the Black-capped Petrel has prompted its listing by various authorities as Endangered (IUCN 2011), Threatened, by the International Council for the Preservation of Birds (Collar and Andrew 1988), and Critically Endangered by the Society for the Study and Conservation of Caribbean Birds (Schreiber and Lee 2000). Further, the North American Waterbird Conservation Plan considers the species to be Highly Imperiled, making it an official Focal Species of the U.S. Fish and Wildlife Service (USFWS).

In response to the plight, the International Black-capped Petrel Conservation Group was formed. Three workshops attended by a diverse group of international agencies, organizations, and individuals focused on the creation of the conservation plan. The document that was created from the workshops, the Conservation Action Plan for the Black-capped Petrel (Goetz *et al*. 2012), provides the framework for partnership-based conservation and management actions with the purpose of facilitating a collaborative international approach to Black-capped Petrel conservation. Top objectives of the recently published Conservation Action Plan are to discover additional breeding locations and to effectively manage critical on-land breeding locations.

Black-capped Petrels are currently known to nest in only two areas worldwide, both on high elevation limestone ridges, above 1600m on the Caribbean island of Hispaniola. The first is Massif de la Hotte in southwestern Haiti, and the second is the 100 km limestone ridge that spans the southern border of the Dominican Republic (Sierra de Bahoruco) and Haiti (Massif de la Selle).

Additionally, there is strong evidence to suggest that a nesting population persists on the high volcanic peaks on Dominica (Brown 2015). The island historically had substantial populations of Black-capped Petrels (Goetz *et al.* 2012). While nesting birds have not been found for decades, both adult and young petrels have recently been found inland near the high peaks, indicating the likely presence of a nesting population. Additionally, radar surveys completed in 2015 detected a high number of petrel-like targets flying between the sea and potential mountain nest sites (Brown 2015).
Offshore surveys for petrels along the north shore of Jamaica in 2010 by Shirihai *et al.* reported seeing Black-capped Petrels flying towards the mainland of Jamaica at sunset, leading to speculation that a population of nesting Black-capped Petrels might exist on Jamaica (Shirihai *et al.* 2010).

Because of the logistical challenges of expeditions to these remote, rugged sites, few researchers had historically visited them (Wingate 1964, Woods 1992, Simons *et al.* 2002, Goetz *et al.* 2012) so the species range and abundance is poorly known. Further, all of these researchers have explicitly noted the extreme limitations of using conventional aural and visual methods when surveying species such as petrels that visit breeding areas only at night. Because of these limitations, researchers are able to count

only birds visible within the beam of a spotlight, or those which are vocalizing within earshot, and cannot exclude the possibility of double counts. Researchers acknowledge that these limitations lead to counts with modest accuracy and broad confidence intervals.

From 2012-2015, we conducted parallel radar and conventional audio/visual surveys on Hispaniola and Dominica that demonstrated that Black-capped Petrel is a species for which radar is an effective observation and monitoring tool that far extends researchers' ability to observe and monitor them, and enables accurate, consistent counts (Brown 2012; Brown 2015).

Within the Hispaniola and Dominica mountain ranges, EPIC successfully located previously unrecorded flight corridors and nesting areas. Additionally, we established the first ever baseline population indexes for petrel activity centers throughout Hispaniola and Dominica. Furthermore, using this data, EPIC successfully mapped all known flight corridors as well as nest locations on Hispaniola and Dominica and prioritized areas of critical importance to the species.

RESEARCH METHODS

Among the Black-capped Petrel Conservation Action Plan's proposed actions, this project specifically addressed *"the development and refinement of search methodologies for nesting sites."* This EPIC project used proven marine radar technology to identify petrel flyways and nesting areas on Jamaica and estimate abundance of petrels at nesting sites.

As part of the current Black-capped Petrel conservation project, we conducted radar surveys for Black-capped Petrels during 18-23 February 2016.

During our radar expeditions to Hispaniola and Dominica in 2012-2015, we identified areas over which petrels fly when travelling to or from the known nesting areas. Based on the data from those expeditions, we determined that petrels were most often detected flying through watersheds that connect the nesting area to the sea.

Furthermore, radar observations showed petrels flying up these watersheds to nesting areas. These watersheds form a flight path for birds, creating a funnel through which a large number of petrels must fly in order to reach the nesting grounds. The radar monitor shows the birds at these sites fly in one direction, up the watershed, which removes the possibility of double-counting. Additionally, it allows surveyors to monitor populations traveling to multiple nesting areas, as the birds that funnel up these flight paths often end up in numerous nesting locations. The primary flight path locations that we find are ideal for setting up long-term monitoring sites, allowing researchers to observe population levels of petrels at discrete nesting areas.

For all surveys, we set up our radar within 1.5km of the potential nesting sites or fight corridors. Setting the range at 1.5 km is standard practice when surveying for seabirds as it allows the surveyor to detect targets at a substantial range while recording a clear and powerful target on the radar (Cooper *et al.* 1991). A laptop computer was attached to the radar unit and recorded all radar images, for subsequent review and analysis.

The radar operator monitored all targets that appeared on the radar's monitor, and recorded time, direction of flight (to the nearest degree), flight behavior (e.g. straight, erratic), velocity (to the nearest 5 km/hr), and if known, species and number of individuals detected.

A second surveyor was stationed at the base of the known nesting cliff or along the flight corridor with 10x binoculars for observations during dusk observations and a night-vision scope when daylight was insufficient. This observer constantly visually scanned the airspace above potential nesting habitat and all visible sky for flying petrels and listened for calling petrels.

Following each survey, we downloaded data and reviewed the recorded images of the radar survey. During this review, we re-analyzed all targets measuring flight speed, flight direction, and target size. This second evaluation of the survey assured researchers that no targets were missed or incorrectly measured

Following our survey period, we organized and analyzed the data. At each location, we overlaid bird detection locations and flight tracks over topographic images, mapping petrel activity. We highlighted locations with high detection densities, drawing attention to these areas as locations of interest for future audio/visual surveys and nest searching.

Locations of Surveys

On Jamaica, our goal was to survey areas with historical records of Jamaica Petrels, areas adjacent to recent records of Black-capped Petrel offshore activity, and areas with habitat similar to that within which we detected petrel species on Hispaniola and Dominica.

Prior to surveys, we mapped areas within the Blue Mountains which one of the above factors was applicable. Numerous sites were prioritized on both the south and north slopes including the Rio Grande valley, sub-valleys that feed off the Rio Grande, smaller valleys along the northwest corner of the Blue Mountains, the large valleys that are on the south slopes below Blue Mountain and the last known location petrels were recorded, at Cinchona Botanical Gardens.

RESULTS

We surveyed six stations over six nights in the Blue Mountains, four on the north slope and two on the south slope. Overall, the only locations we observed potential petrel targets was in the valley east of Cinchona Gardens.

Our initial survey effort was to be 21 days but we encountered severe bureaucratic issues getting the marine radar through customs and had to curtail our survey efforts accordingly.

Herein, we report from each survey location.

Rio Grande River

Station Number: BM-1
Location: 18.16692, -76.47424
Date: 3/18/2016
Elevation: 814 ft
Petrel-like Targets: 0

This station was located on the prominent ridge between the village of Port Antonio and the Rio Grande Valley. Our radar was searching for petrels that used the Rio Grande as a flyway. We anticipated detecting petrels that used any of the smaller valleys that forked from the Rio Grande to the higher peaks in the Blue Mountains. During the survey effort, early in the evening just after sunset but still during a well-lighted period, we detected targets on our radar flying faster than the speed cut-off

however; we simultaneously observed diurnal birds coming into roost areas flying at high speeds, including cattle egrets. This positive identification of non-petrels eliminated target as potential petrels. On other islands with petrels (Hispaniola and Dominica) we observed similar diurnal bird activity just after sunset. This diurnal bird activity stops just after the civil twilight ends.

Swift River
Station Number: BM-2
Location: 18.16521, -76.59212
Date: 3/19/2016
Elevation: 204 ft
Petrel-like Targets: 0

This station was located in the village of Swift River, at the gravel mine on the west side of the river, at river elevation. This station had a good vantage point of birds using Swift River as a flyway between the Caribbean Sea and the Blue Mountains. We had no detected petrel activity. We spoke with members of the community who came out to observe us surveying and asked them about any incidental observations of petrels historically. We also played them the call of Black-capped Petrels. No member of the community reported seeing or hearing any petrels in the Swift River valley.

Shirley Castle
Station Number: BM-3
Location: 18.14941, -76.62209
Date: 3/20/16
Elevation: 1,298 ft
Petrel-like Targets: 0

This station was located above Spring Bay at a point where the valley walls are close together and the valley is well defined. This site was approximately 9 km up the river valley from the sea. We were stationed about half way between the valley floor and the ridge top. This site was along a potential flyway but well below any potential nest habitat. There was very little human habitation in this area; it was more an active coffee growing region. There was no petrel-like activity or confusing targets detected in this area.

Dumfris
Station Number: BM-4
Location: 18.13364; -76.50814
Date: 3/21/16
Elevation: 1,124 ft
Petrel-like Targets: 0

This station was located on a tributary of the Rio Grande River adjacent to the small village of Dumfris. This station is located well up the drainage from the sea, approximately 16 km. We were located on the ridge top well above the valley floor. The station was along a potential flyway and had no potential nest habitat near the station. We talked to members of the village, showing them images of the petrels and playing them the call of the Black-capped Petrel, but no members were familiar with either petrel species. No petrel-like targets or confusing species were detected from this station.

Cinchona
Station Number: BM-5
Location: 18.07027; -76.65546
Date: 3/22/16
Elevation: 4,822 ft
Petrel-like Targets: 6

This station was located at the Cinchona Botanical Gardens and looked over the valley that feeds down from the highest peaks of the Blue Mountains, including Blue Mountain Peak. We were located on the ridgetop. We felt like we could record birds both using the flyway and potentially nesting in the area of Cinchona.

We detected our first petrel-like target 30 minutes after sunset. This target was flying from the sea towards the mountains. The target's velocity was 65 km/hr and was seen flying in a straight line flight pattern. The second petrel-like target (1:10 min after sunset) and the third petrel-like target (1:30 min after sunset) were flying from the mountains towards the sea along the same flight path, in a straight line flight behavior, and both at velocity of 65 km/hr. The fourth petrel-like target (2:15 after sunset) was following the same flight path as the previous two birds, also flying in straight line flight behavior, a direction from the mountains towards the sea and at a velocity of 55 km/hr. The fifth and sixth petrel-like targets (both within a few minutes of each other at 2:45 minutes after sunset), followed the same flight path as the previous three targets. These two targets were moving from the mountains towards the sea at a velocity of 65 km/hr and flying in a straight line behavior.

Quashi Gap
Station Number: BM-6
Location: 18.03845, -76.68102
Date: 3/23/16
Elevation: 3,598 ft
Petrel-like Targets: 0

This location was at a small peak that was located at the base of the valley that comes down from the Blue Mountains towards Kingston. The previous night, we had detected several petrel-like targets that appeared to fly towards and potentially over this peak. Based on that data, we felt we might have a chance to detect any petrel-like targets. The station would be detecting birds using the flight corridor not nesting areas. No petrel-like targets were detected from this location.

DISCUSSION

The targets that were identified flying in the valley east of Cinchona on the night of 22 March 2016, were the only petrel-like targets identified during this research trip to Jamaica.

Our work on the north slope of the Blue Mountains did not locate any petrel like targets. Following the observation of Black-capped Petrels offshore north of Jamaica, we hoped to locate petrel activity of birds using any of the valleys on this slope as a flight corridor. The Rio Grande valley is very broad and very large. Petrels that would be using any of the valleys that feed the higher peaks of the Blue Mountains would likely use the Rio Grande as a flight corridor. On the north slope, surveyed the largest north-south running valleys that feed the higher peaks, most of which are located along the western half of the slope. Due to time restrictions, we did not survey valleys that feed the satellite valleys that access the higher peaks on the eastern edge of the Blue Mountains. There is some probability of petrels using

these valleys, however, the peaks along this end of the range are more broad, are lower in elevation, and have fewer potential nest areas as compared to the central section of the Blue Mountains.

In talking to residents that live and work along the valleys on the north slope, nobody was familiar with either the Black-capped Petrel or the Jamaican Petrel. We showed images of both species and played the calls of the Black-capped Petrel to help with any potential identification, but received no positive identification.

Along the north slope, there is some potential of petrels nesting in the John Crow mountains. While there are no historical records of petrels nesting in this range, its remoteness, its proximity to the Blue Mountains and it's heavily forested nature made us consider investigating the range for potential nesting habitat. During our visit to Jamaica, we spent two day time periods visually investigating the north slope of this range for potential petrel habitat. We observed the range to be heavily forested and mostly uninhabited by humans. The slopes do not appear as steep as other known petrel nesting locations. The valleys that feed the higher peaks do not appear to be as steep and well defined as those at petrel nesting areas. We did not observe any nesting habitat in locations we visited.

On the south slope of the Blue Mountains, the well-defined valleys and steep upper slopes appear to hold some potential petrel nesting habitat. The area we initially visited on this slope was the last known location for the Jamaican Petrel, the Cinchona Botanical Garden. Nesting petrels were located in burrows while the initial construction and planting of the garden took place (*fide* Leo Douglas). Our radar was focused on the well-defined broad valley that comes southwards from the highest peaks towards the Caribbean Sea.

The targets that we detected at this location, while not definitively petrels, showed activity patterns that petrels have shown at other known petrel nesting locations. Initially, our first target was moving in from the sea toward potential nest locations. The later targets were moving downwards from the mountains towards the sea. We observe this behavior at other petrel nest locations in the Caribbean where birds that have been foraging at sea during the day move into nest locations and swap with their mates that have been incubating or tending the chick. The timing of the movements also matches well with other locations where birds moving inland do so as soon as it is completely dark. Birds that are leaving the colony do so over a more broad time scale and are often detected in pairs or small groups. We observed both of these behaviors from our Cinchona station.

Our follow up of the Cinchona observations at the Quashi Gap was unsuccessful. This location was immediately downslope of the area we detected the targets. We had hoped to detect or even see/hear petrels as they flew in the vicinity. We did not detect any targets or petrels from this location. There are a number of additional locations that these potential petrels flew, including jumping the ridge and entering the valley that feeds into the Kingston vicinity, or flown somewhat east and followed the river valley southwards to the sea.

We recommend follow up, with radar if possible, to the south slope of the Blue Mountains, focusing on the valley east of Cinchona. We would recommend a follow up survey at the same location as we detected targets, then a survey of all potential flight areas including valleys and ridges that are adjacent to the Cinchona area. Additionally, we would scout by foot, potential nest locations in the Blue Mountains and deploy Songmeter sound recorders at potential nest locations. These units have helped locate and define petrel activity in remote locations in Haiti and the Dominican Republic.

We left Jamaica unclear whether petrel species nest on Jamaica. Our radar provided evidence of potential petrel flight activity on Jamaica and provided additional geographic data to help future search expeditions. Additional surveys in the future, following up on data collected during this and previous expeditions, will have a greater chance at determining whether petrels continue to exist on Jamaica.

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APPENDIX 1

Table 1. *Station locations and results*

Station	Date	Location	Lat	Lon	Targets	Petrels Seen
BM-1	3/18/2016	Rio Grande River	18.16692	-76.47424	0	0
BM-2	3/19/2016	Swift River	18.16521	-76.59212	0	0
BM-3	3/20/2016	Shirley Castle	18.14941	-76.62209	0	0
BM-4	3/21/2016	Dumfris	18.13364	-76.50814	0	0
BM-5	3/22/2016	Cinchona	18.07027	-76.65546	6	0
BM-6	3/23/2016	Quashi Gap	18.03845	-76.68102	0	0

Figure 1. *Map of radar station locations*

Figure 2. Radar unit at BM-1, on a ridge north and above the Rio Grande. The antenna array is on the ground, the monitor is in the yellow box on the truck gate, the laptop recording the radar data is on the truck gate, and the batteries that run the unit are below the truck.

Figure 3. Radar station BM-4 near Dumris. We chose this location based on its location next to a main valley that connects the Rio Grande Valley to the north slope of the Blue Mountains.

Figure 4. Radar station BM-6 at Quashie Gap. This is the view of the south slope of the Blue Mountains. From here, you can see the valley seen below the large cloud that we had petrel-like activity in. The petrel-like targets flew up and down that valley. The ridge on the left side of the image leads up to Cinchona and radar station BM-5.

Figure 5. Petrel-like target flight path. Station BM-5 at Cinchona is labeled in the upper right quadrant of the photo. The red line indicates flight path of both incoming and outgoing petrel-like targets.