

FIRST GPS-TRACKS OF PERUVIAN DIVING-PETRELS AND INCA TERNS IN SOUTHERN PERU*



Report presented to the Pacific Seabird Group Conservation Small-grant Program

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Background

Peruvian Diving-petrels (*Pelecanoides garnotii*, PDP) are endemic seabirds to the Humboldt Current breeding on islands off Peru and northern Chile (Murphy 1936). Habitat loss, human disturbance and poaching have been well-documented causes of population decline over the last 100 years (Coker 1919, Murphy 1936, Hays 1989, Jahncke and Goya 1998). In the last decades, it has been speculated that interactions between PDP and the commercial fishery is a main factor of PDP's population decline through incidental by-catch (Garcia-Godos and Goya 2006, Birdlife International 2008). This species is essentially confined to the inshore islands of La Vieja and San Gallan, on the central coast of Peru (Fig.1), with approximately 13,000 breeding pairs in 1995-96 (Jahncke and Goya 1998). Recent estimates have revealed that the breeding population size in these two islands has increased to approximately 36,500 breeding pairs (Zavalaga and Alfaro 2009). Because of the small population size, restricted distribution and increasing threats, PDP are categorized as globally Endangered (Birdlife International 2008).

Until December 2009, the Reserva Nacional de Paracas (Paracas National Reserve) located in southern Peru (Fig.1), was the only Marine Protected Area along the Peruvian coast with an extension of 217,594 ha. This area is the main breeding ground of several species of seabirds, including the endangered Humboldt Penguin (*Spheniscus humboldti*), Peruvian Diving-petrel and Peruvian tern (*Sternula lorata*). In December 2009, the Peruvian government officially approved the creation of a New National Marine Reserve that incorporates 22 islands and 11 guano points into the National Protected Area System. The incorporation of these sites increased the protected areas by approximately one million hectares. However, with the exception of some Peruvian seabird species (Boersma et al. 2007, Zavalaga et al. 2010) there is no empirical data on the extent of the area that needs to be protected around the breeding colonies (Birdlife International 2008). Thus, new information on seabird movements and foraging areas are necessary not only to implement an effective marine area for protection, but also to evaluate how seabird species interact with the fisheries around their colonies. In this study, we recorded the first three tracks of chick rearing Peruvian Diving-petrels (200 g) with small (<6 g) GPS loggers (GiPSy 2, www.technosmart.eu). Additionally, we report the first track of one breeding Inca tern, another small seabird (220 g) that have a foraging behavior different from that of a diving-petrel. Although the data are still preliminary, the tracks showed that some individuals use areas outside the boundaries of the Marine Protected Area. We also discuss how the quality of tracks is associated with the behavior and at-sea activities of the instrumented individuals.

Proposed Objectives

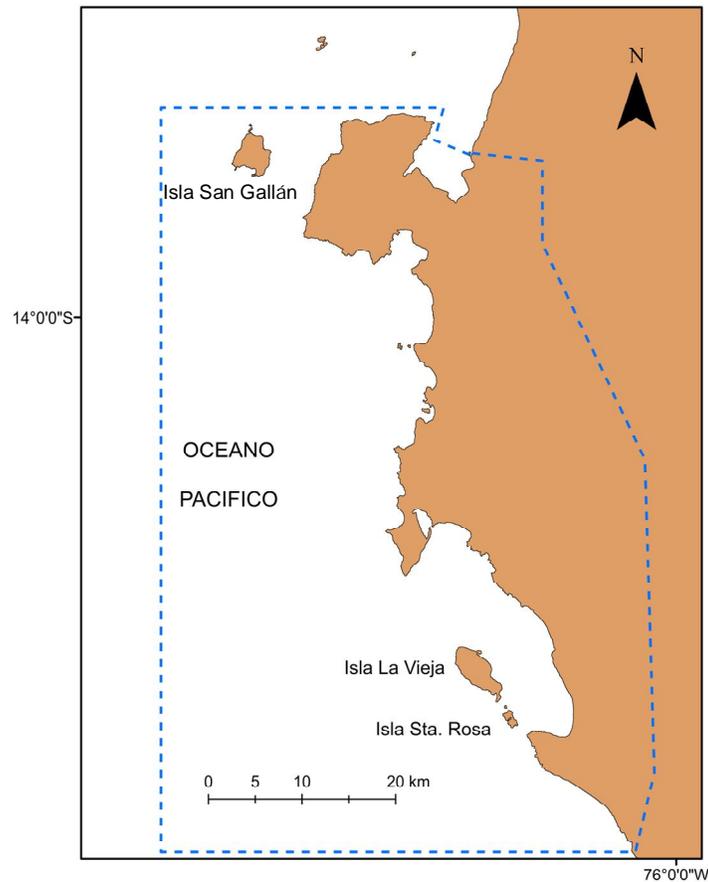
- To determine the foraging range and at-sea activities of PDP and overlay this information to the movements and fishing activities (e.g. areas of net setting) of fishing vessels.
- Based on the above information, I will estimate the extent of the ocean around PDP colonies that needs to be protected.

Proposed activities/actions

1. The study will be undertaken on Isla La Vieja (14°17'S, Fig. 1), Independencia Bay between the first and third week of April 2009 and Isla San Gallan (13°51'S, Fig. 1), Paracas Peninsula between the first and third week of May 2009.

2. Approximately 30 chick-rearing adults on each island will be captured in their burrows after sunset.
3. Simultaneously, a set of 30 nests will be chosen as controls. The birds in these nests will be captured in their burrows and marked with a small dot of paint in their chest. The nests will be checked following the same visit schedule used for experimental nests and the duration of the feeding trip will be used as a proxy for any handicapping effect of the loggers.

Figure 1. Location of Isla La Vieja and Isla San Gallán. The dashed line demarcates the boundaries of the Paracas National Reserve.



Actual activities/actions

1. The study was undertaken only on Isla La Vieja in August and November 2009. The fieldwork was postponed from April/May to Aug/Nov because a census of the population size of Peruvian Diving-petrels on Isla La Vieja and Isla San Gallan was conducted between May and July 2009. Likewise, the larger population size and easier logistic facilities restricted data collection to Isla La Vieja.
2. A total of 14 Peruvian diving-petrels were instrumented in August (5 birds) and November (9 birds) 2009.
3. No controls nests were selected due to the limited number of accessible nests with chicks.
4. Additionally, 5 Inca terns were instrumented with GPS-loggers.

Evaluation of the study

This study provides the first GPS-tracks of small seabirds (200-220 g). However, the results are still preliminary considering the small sample size and the limited number of position fixes recorded per trip. A higher monitoring effort during tag recovery, and an improved GPS data collection setting must increase the number and quality of tracks of Peruvian diving-petrels in future studies. These improvements are listed in detail below and can only be achieved by using the results of this study as a baseline.

GPS-loggers

Several diving-petrel burrows were inspected with a Peer-o-Roo infrared camera (Sandpiper Technologies) to select and mark 14 nests with adults attending medium-sized chicks. Birds were captured in their nests just after dusk and the loggers were attached to the dorsal feathers using 3 strips of Tesa tape. The GPS (GyPSi-2, www.technosmart.eu) weighed 1.8 g and was powered by a small battery of 50mA with a weight of 1.8 g. The GPS were heat-sealed in shrinking tubes (< 2 g). Overall, the logger, battery, shrinking tube and tape added approximately 7-8 g sealed to an average weight of 200-g diving-petrel (3.5 - 4% of the adult's body weight). To maximize the short lifespan of a small battery, the GPS were programmed to record one position fix every 3 minutes. If the GPS antenna did not detect satellite signals (e.g. birds were underwater), then the logger switched to a sleep mode for 30 minutes. Likewise, the GPS was set to switch ON only between 0500 h and 1900 h (local time, daylight period). This procedure considerably decreased the number of fixes recorded by the GPS, assuming that diving-petrels spend a considerable amount of time underwater or sitting on the sea surface.

Recovery rates and effects of the loggers

From the 14 instrumented birds, 5 were recovered (36%). We checked the nests twice a day (after dusk and before dawn) in an attempt to recapture instrumented birds that were missed, but these birds were not found in the nests in subsequent days. It is uncertain whether the loggers had an adverse effect on the birds because we did not monitor control nests.

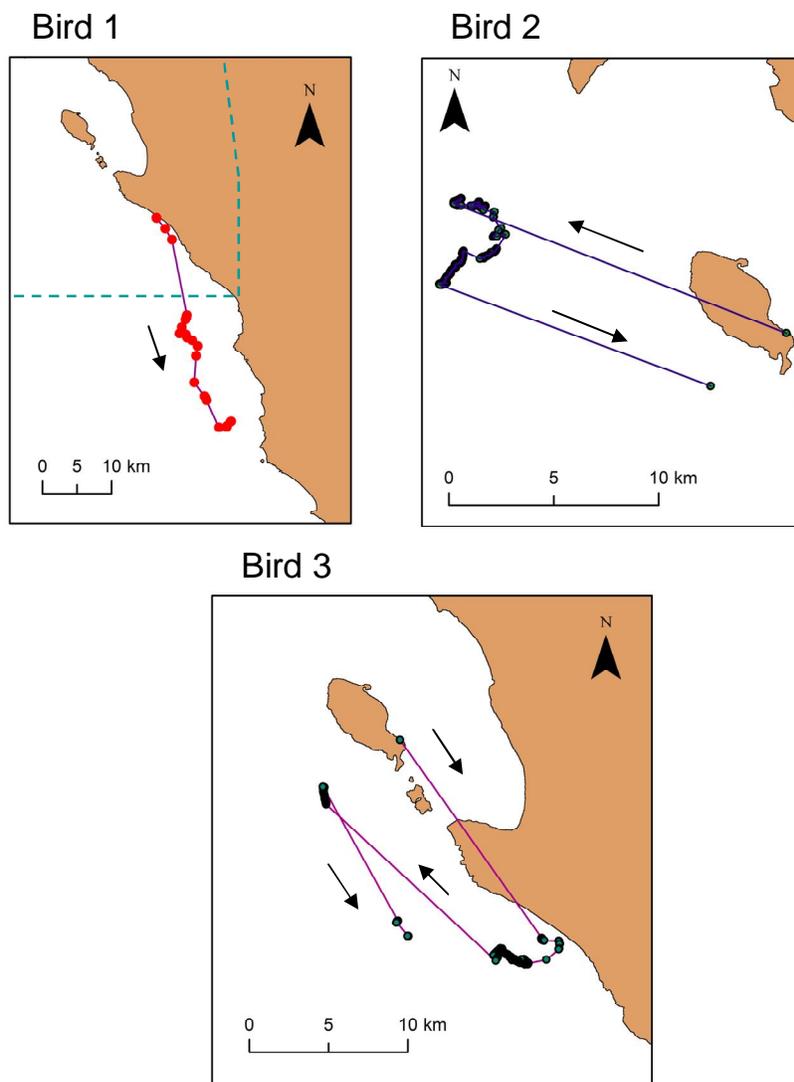
Diving-petrel tracks

From the 5 GPS recovered, I obtained records from only 3 GPS because two failed to record data. Diving-petrels foraged both south and north of the island (Fig. 2). No birds traveled to waters inside the bay. Tracks were truncated because i) the battery was completely consumed during the trip, ii) GPS remained underwater a high proportion of the feeding trip, or iii) GPS did not detect satellite signals when the birds were sitting on the water as the location of the logger was too low in the bird's back and the antenna may have been underwater during these resting periods. Despite these limitations some conclusions about the Peruvian diving-petrel foraging behavior emerged:

- 1) Some birds can forage outside the boundaries of the Marine Protected Area (Fig. 1 Bird 1).
- 2) The GPS recorded foraging distance up to 17 km (Bird 2), 18 km (Bird 3), and 47 km (Bird 1), which represent minimum estimates of foraging distances.
- 3) All birds departed from the colony before dawn.

- 4) Birds foraged at inshore waters along the coastline to the south and in inshore waters to the west.
- 5) No birds exploited waters inside the bay, which supports our observations of low numbers of diving-petrels in this area during our commuting trips to the island.
- 6) Flight speeds ranged between 43 and 50 km per hour.
- 7) Birds spent a high proportion of the foraging time underwater/resting on the sea surface as determined by long gaps observed in the foraging tracks.

Figure 2. GPS-tracks of three Peruvian Diving-petrels (*Pelecanoides garnotii*) breeding on Isla la Vieja in August-Novemeber 2009. The green dashed line in Bird 1 track symbolizes the boundaries of the Marine Protected Area of the Paracas National Reserve.

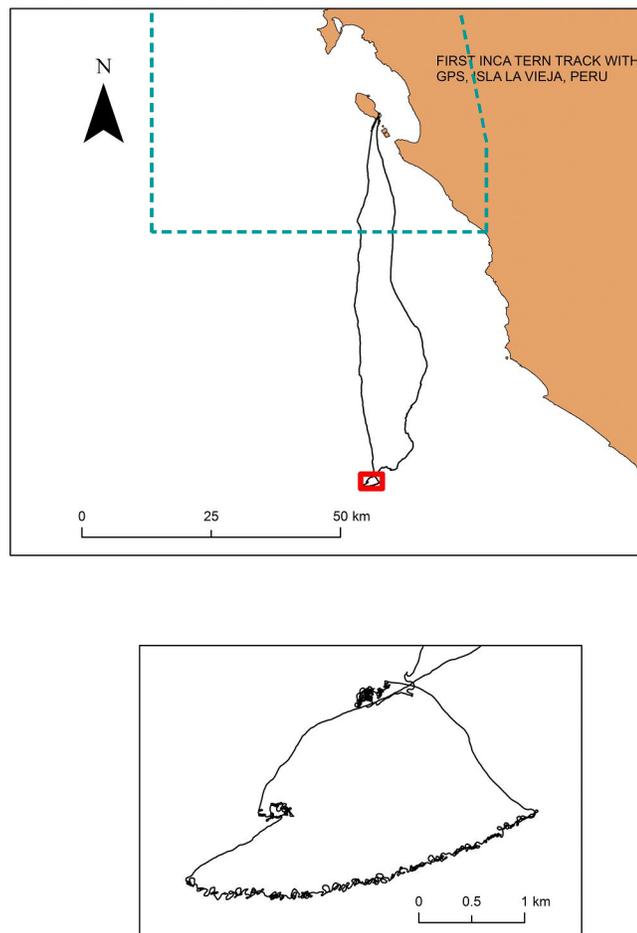


Inca tern track

We also attached GPS loggers to 5 inca terns (220 g). Inca terns are also burrow nesters and birds were trap inside their nests while incubating eggs or brooding small chicks. Four birds were recaptured, but only one logger recorded data (the others had technical failures). The bird that could not be recovered was present outside the nest, but could not be recaptured. The only complete track of an inca tern shows that the maximum foraging distance was 72 km south of the island (Fig. 3). The bird flew straight to the maximum foraging distance at a speed of 72 km per hour. At the extreme of the route, the bird increased the sinuosity of the flying path, indicating feeding activities. After 1.25 h, the bird returned to the colony at a speed of 86 km per hour. Once on the island, the bird spent 2 hours on a beach before returning to the nest. The trip was completed in approximately in 5.5 h. This bird also trespassed the limits of the Marine Protected Area.

The quality of tracks improved in relation to those obtained from diving-petrels because the GPS logger was set to collect data in a continuous mode at 1-sec intervals. Furthermore, the GPS was always exposed to the sky during the feeding trip (Inca terns spend a negligible amount of time plunge-diving).

Figure 3. GPS-track of a breeding Inca tern from La Vieja Island in November 2009. The inset shows details of the track during feeding activities. The green dashed line symbolizes the boundaries of the Marine Protected Area of the Paracas National Reserve.



Proposed Budget

<u>Items</u>	<u>US \$</u>
Bus transportation from Lima to Pisco (3 persons/round trips)	100
Hostal (4 nights/3 persons)	100
Local transportation, taxis Lima, Pisco, Laguna Grande	50
Boat Transportation round-trip to Isla La Vieja/San Gallan (\$ 150/trip)	600
Food for three weeks on each island (5 dollars per person per day)	630
Kitchen kit for camping (small gas stove, pots, dishes, etc)	100
2 Car batteries (deep-cycle batteries 9 cells) to recharge the GPS-logger batteries	150
AA batteries for headlamps (work mainly during the night)	100
TESA tape (2 rolls)	50
3 Flashlights	100
<u>Stationary</u>	<u>20</u>
	TOTAL 2000

Actual budget

<u>Items</u>	<u>US \$</u>
Bus transportation from Lima to Pisco (3 persons/round trips) (two trips in August and November)	200
Hostal (4 nights/3 persons) (two trips)	200
Local transportation, taxis Lima, Pisco, Laguna Grande	150
Boat Transportation round-trip to Isla La Vieja (\$ 200/trip) (two trips)	400
Food for five weeks in the field (5 dollars per person per day)	525
2 Car batteries (deep-cycle batteries 9 cells) to recharge the GPS-logger batteries	150
AA batteries for headlamps (work mainly during the night)	100
TESA tape (2 rolls)	50
3 Flashlights	100
Solar panel	200
<u>Permits</u>	<u>150</u>
	TOTAL 2225

This project received additional support of Joanna Alfaro-Shigueto from Pro-Delphinus that provided field assistants, hand-held GPS and other field material, and collaborated with us in this project; Dr. Giacomo Dell'Omo from Ornithologica and Technosmart who came to the island in November to supervise and lent us 15 GPS data loggers and other material needed for tracking seabirds (shrinking tubes, battery rechargers, etc), and Dr. Peter Hodum from Oikos who gave us the Peer-o-Roo camera. This work was possible with permit No-04-2009-SERNANP issued by the Peruvian Ministry of Environment and the direction of the Paracas National Reserve, and with permit No-024-2009-AG-AGRO RURAL-DO issued by the Peruvian Ministry of Agriculture, AGRO RURAL. This work would have not been possible without the assistance of Gina P. Mori, Francisco Bermedo, Celia Cáceres, Jeff Mangel, the island rangers and local fishermen from Laguna Grande.

Suggestions for further work

These are, to our knowledge, the first tracks of small seabirds (200-220 g) recorded with GPS dataloggers. These preliminary results will be presented in a poster in the World Seabird Conference to be held in Vancouver, September 2010.

These results suggest that detailed spatial data can be collected using small GPS loggers also in small seabirds, but the amount of data gathered can be affected by the foraging behavior at sea and GPS battery size and capacity. Small diving-birds that spent a high proportion of time underwater make complete tracks difficult to obtain because small batteries used by small seabirds restrict the deployment time and the setting for data collection intervals. When the small loggers were used in terns, which do not spend much time underwater, the data quality considerably improved. Ongoing technological advancements in miniaturization and performance of the units as well as more suited attachment of the tags and setting of the recording features will allow the tracking of small seabirds for more extended periods.

I will return to keep tracking diving-petrels and Inca terns in June 2010 on isla La Vieja. This time, I will modify the methods in relation to those used in 2009. These improvements involved:

- 1) To attach the logger to bird's back, but with the squared antenna pointed towards the head instead towards the tail as previously used. Birds can spend a large proportion of time sitting on the water surface and the antenna in the lower back may be underwater most of the time.
- 2) To include control birds (unequipped birds) to assess the causes of possible nest desertion.
- 3) To continuously monitor the nests from a spot (tent) during the night using infrared binoculars. This may increase the rates of recaptures in case the birds leave the nest at night after chick feeding.
- 4) To change the GPS setting to switch ON/OFF according to the daily bird activities. Thus, the battery lifespan will be maximized to allow the GPS the collection of more fixes at sea.
- 5) To obtain more tracks and overlay these spatial information to fishing areas of commercial fisheries around the island.

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Photographs of the fieldwork on Isla La Vieja, August/November 2009.



Adult Peruvian Diving-petrel



Checking nests with a Peer-o-Roo infrared camera



Tagging a diving-petrel with a GPS-datalogger



Carlos Zavalaga with two Peruvian diving-petrels



Inca terns on Isla La Vieja



An adult Inca tern tagged with a GPS