

Introduction

Seabirds are patchily distributed have shown that birds are not uniformly distributed over their oceanic habitats. This patchiness is frequently associated with physical oceanographic processes that vary in spatial and temporal scales, and are responsible for the concentration of prey near surface waters [1].

Cory's Shearwaters *Calonectris diomedea borealis* is an abundant seabird species in the North Atlantic Ocean, but very little is known about the relationship between its distribution at sea and oceanographic factors.

The main aim of this pilot study was, to understand if the data loggers could be successfully used, to store data on the at-sea distribution and behaviour of Cory's Shearwaters in Berlengas archipelago.

Methods

From 30 August - 7 of September 2005, 20 adults of Cory's Shearwater were marked and recaptured. We used 10 Compass/Temperature Devices (CTD; Figure 1a) and 4 Pressure/Temperature Devices (PTD). The principle of using data loggers requires to capture each bird twice; the first time to deploy the data logger on the bird, and the second time to retrieve the logger.

The main logger type used is the CTD logger (company: earth & ocean technologies, Kiel Germany). This device has an internal clock and stores information on the bearing of the bird (two channels). It has also a temperature sensor from which the activity of the birds can be derived [2]; flying, swimming and diving can be distinguished (Figure 1c). The flight track of the bird can be reconstructed using all the variables mentioned. The PTD loggers (company: earth & ocean technologies, Kiel Germany) measure dive depth and duration, which are key parameters in foraging ecology of all seabirds.

Results/Discussion

We obtain data on 16 Cory's adults with CTDs and 3 Cory's adults with PTDs. These results shown the high functionality of these devices (only one PTD did not work). Birds showed some preference for fishing at the beginning and at the end of the day, but there were some diversions at 2:00 - 3:00 h am, and in at 13:00 - 15:00 h pm the middle of the afternoon. Mean dive for 3 Cory's with PTD were = 1,18 ± 0,98 m (range = 0,29 - 3,55 m). Adults stayed close to the colony (maximum range = 63 km; Table I, Figure 3) and returned to the nest after a maximum of 2 days. The adults usually stayed at-sea during the night (Figure 2a). Males and females alternated in chick provisioning. The differences in foraging trip characteristics between males and females were not significant (Table I).

The results showed that the loggers technology can be successful used to study the feeding ecology, including diving patterns, and at-sea distribution of Cory's Shearwater. CTD loggers give a broader view of at-sea usage by seabirds because they also store data on different feeding behaviours (inferred by differences in temperature), as opposed to GPS loggers (which store only the position and velocity of the bird).

Further project purposes

- 1) Describe the at-sea distribution of breeding Cory's Shearwaters in the Azores, Madeira and Berlengas in relation to oceanographic characteristics.
- 2) Assess differences in the at-sea distribution between the incubation and chick-rearing periods.
- 3) Investigate the relationships between the at-sea distribution, diet, and trophic level using analysis of regurgitations, heavy metals and stable isotopes.
- 4) Cross the at-sea distribution data obtained from loggers, with the distribution and abundance of Cory's Shearwater obtained from ship transects along the coast of mainland Portugal, Azores and Madeira.
- 5) Use data on the at-sea distribution, diet and behaviour of Cory's Shearwaters to identify Important Bird Areas in the Portuguese sector of the North Atlantic.

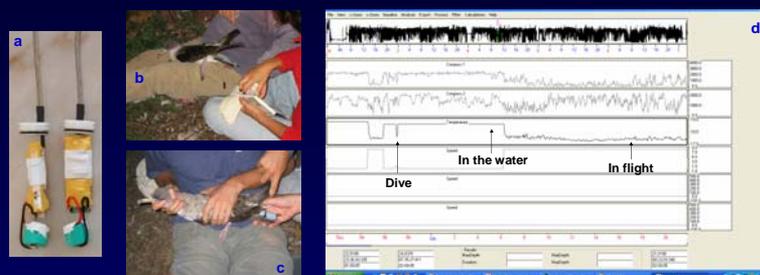


Figure 1. (a) - Aspect of the compass temperature devices (CTD). (b) - Their application on the bird tail feathers. (c) - Aspect of a pressure temperature device (PTD) applied on the tail feathers. (d) visualization of CTD-data and interpretation of different foraging behaviours.

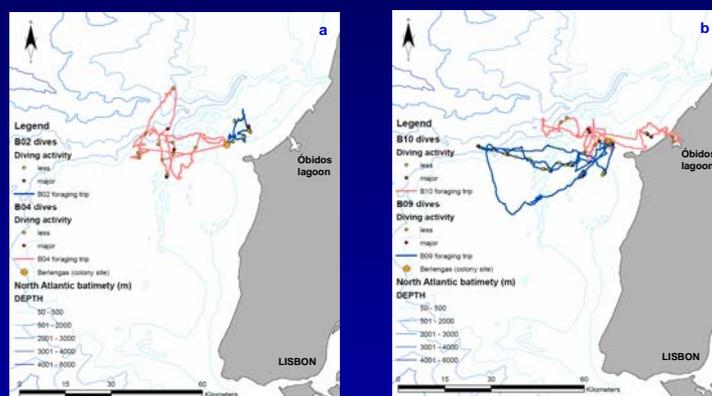


Figure 2. (a) - Foraging trips of 1 day (male B02) and 3 days (female B04). (b) - two different foraging trips, with diving points, for the same period (02/09 - 04/09/2005); the male B09 spent the night in the nest and the female B10 spent the night at sea.

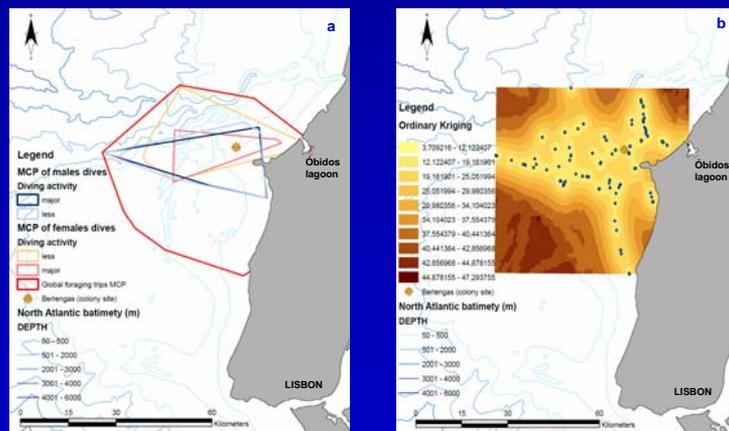


Figure 3. Representation of Minimum convex polygons for males, females and total foraging trips (a), and ordinal kriging of total feeding points, to create a prediction standard error map (b).

Table I. Foraging trip characteristics of Cory's Shearwater from 30 August - 7 September. Values are mean ± SD and range for each variable; t-tests comparing characteristics of males and females.

Distribution variables	Post-guard chick rearing period		Statistics	
	males (n = 9)	females (n = 7)	t_{11}	$P =$
Maximum range (km)	32.40 ± 18.62 (12.64 - 54.37)	43.16 ± 12.22 (31.87 - 62.94)	1.01	0.34
Maximum latitude (°)	39.48 ± 0.07 (39.40 - 39.54)	39.58 ± 0.10 (39.48 - 39.75)	1.88	0.10
Minimum latitude (°)	39.21 ± 0.15 (39.04 - 39.40)	37.27 ± 4.44 (29.34 - 39.36)	0.86	0.42
Maximum longitude (°)	-9.59 ± 0.25 (-9.96 - -9.41)	-9.75 ± 0.09 (-9.84 - -9.64)	1.35	0.22
Minimum longitude (°)	-9.31 ± 0.17 (-9.44 - -9.06)	-9.31 ± 0.14 (-9.47 - -9.15)	0.00	1.00

References

- [1] Weichler T, Garthe S, Luna-Jorguera G, Moraga J (2004) Seabird distribution on the Humboldt Current in northern Chile in relation to hydrography, productivity, and fisheries. ICES Journal of Marine Science 61: 148-154. [2] Wilson RP, Weimerskirch H, Lys P (1995) A device for measuring seabird activity at sea. J. Avian Biol. 26: 172-175.