

Part 1: Population ecology and conservation of shearwaters

Assessing key conservation areas for Italian Scopoli's Shearwaters *Calonectris diomedea*

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Summary: Seabirds are the most threatened of all bird groups and their status has deteriorated faster over the last decades. Through the Important Bird Areas (IBAs) programme, BirdLife International aims to identify key areas for the conservation of seabird species. LIPU-BirdLife Italy is working at the national level to identify the IBAs in the marine environment. In this context, tracking studies of Scopoli's Shearwater *Calonectris diomedea* were carried out during the 2008-2011 breeding seasons in three Italian colonies in the Mediterranean sea (Linosa island, Tremiti archipelago, Tuscan archipelago). Overall, 138 Scopoli's Shearwaters were tagged with GPS loggers. Notable differences emerged between colonies and between reproductive phases in the core areas used by Scopoli's Shearwater.

Key words: Scopoli's Shearwater, *Calonectris diomedea*, IBA, marine conservation areas, Italy.

Introduction

The Important Bird Areas (IBAs) programme of BirdLife International aims to identify, monitor and conserve priority sites for the long-term viability of bird populations by means of quantitative, standardised and globally agreed criteria (e.g. Heath & Evans 2000). Since the 1980s, a global network of IBAs has been implemented by the BirdLife Partnership in both terrestrial and freshwater environments. IBAs have been accepted worldwide as a powerful and effective conservation tool, and they have been recognized in the European Union as a scientific reference for the designation of Special Protection Areas (SPAs) establishing the Natura 2000 network under the Birds Directive (2009/147/EC, the codified version of Directive 79/409/EEC ; rulings of the European Court of Justice in Case C-3/96, Case C-202/01, Case C-240/00 and Italy Case C-378/01).

Although seabirds are the most threatened of all bird groups (Butchart 2004, Croxall *et al.* 2012),

the process of identifying IBAs in the marine environment is much more recent. This delay is mainly due to technological and logistic difficulties associated with obtaining distribution data of bird species at sea. Nevertheless, in the last decade BirdLife International has been developing a standard methodology to extend the IBA network into the marine environment (BirdLife International 2010a) and several BirdLife partners are currently collecting data in order to complete the IBA network at sea (BirdLife International 2010b). In this context, LIPU (Lega Italiana Protezione Uccelli, the BirdLife partner in Italy) is working at national level to identify the priority sites for the conservation of seabirds, including, among others, pelagic species such as the Scopoli's Shearwater *Calonectris diomedea*. Up to 2002, forty-one IBAs had been identified as seaward extensions of breeding colonies of seabirds (LIPU 2002). More recently, a further seven areas have been classified as candidate marine IBAs through a project funded by the Italian Ministry of Environment (LIPU 2009, BirdLife International 2010b). These candidate marine IBAs have been identified using vessel-based survey and tracking data, collected in compliance to the standard BirdLife International methodology. In particular, the GPS tracking of Scopoli's Shearwaters is a core activity that has been continued beyond the above-mentioned project until 2011, in three colonies of the Mediterranean Sea (Linosa island, Tremiti archipelago, Tuscan archipelago). In the present study we report the results of GPS tracking of Scopoli's Shearwaters showing the most frequented areas by tracked birds during the incubation and chick-rearing periods. These areas will be useful in identifying candidate marine IBAs.

Materials and methods

Tracking activities were carried out during the breeding seasons 2008-2011 in three Italian (group of) colonies: (1) Linosa island, located on the Tunisian marine Plateau in Gulf of Sidra region (35° 51'33" N; 12°51'34"E) between Sicily, Tunisia and Libya, which hosts one of the biggest colonies of Scopoli's Shearwater in the Mediterranean with an estimated 10,000 breeding pairs (Baccetti *et al.* 2009). On this island, field work was carried out during both the incubation (June 2008) and chick-rearing (July-August 2008 and 2009) periods. (2) Tremiti Archipelago (42°08'19"N; 15° 30'52"E), one of the biggest breeding colonies of the species in the Adriatic Sea, which comprises approximately 400 breeding pairs (Baccetti *et al.* 2009). There, field work was carried out on the islet of Capraia, during the incubation period only, in two seasons (June 2009 and 2010). (3) The islet of La Scola, located in the Tyrrhenian Sea, within the Tuscan Archipelago which hosts, on the whole, 200-400 pairs (Baccetti *et al.* 2009). There, field work was carried out during the chick-rearing period in two seasons (August 2010 and July 2011).

GPS logger deployment

We located shearwater nests by inspecting crevices and burrows. During incubation one pair partner is away foraging at sea while the other bird broods the single egg for several days. This makes it easy to catch the brooding bird by hand. After hatching of the chick, the adults spend the day foraging at sea and leave the chick alone in the nest, returning to the colony only at night. Consequently, during the chick-rearing period adults were caught at night just after they had fed their chick.

Birds were weighed and a mini-GPS logger was attached to the back feathers using 3-4 strips of Tesa® marine cloth tape (Tesa SE, Hamburg, Germany) (see Guilford *et al.* 2008). Birds

were sexed during handling by recognition of their sex-specific vocalizations or indirectly by sex determination of their partner. Total handling time was kept below 10 minutes and birds were returned to their nests immediately afterwards. We monitored all nests once every day. When a tracked bird eventually returned to the nest it was recaptured and the GPS logger removed by peeling away the tape from the feathers.

Three types of mini-GPS loggers were used: one by Earth & Ocean Technologies (Kiel, Germany), weighing 19.4 g (with a battery of 500 mA) and provided with an active antenna; and two different types by Technosmart (Guidonia, Italy) with chip antenna, weighing 11.9 and 9.8 g and provided with two different batteries (500 and 250 mA respectively). The deployment of lighter GPS loggers despite the drawback of their shorter life-span allowed us to track lighter birds. Device weight was always less than 3% of the bird's weight. All GPS loggers were configured to record both the position and the instantaneous speed of the bird every 10 minutes.

In order to assess whether handling and GPS deployment negatively affect the reproductive phase, we compared the hatching success of Linosa colony in 2008 from nests where at least one breeder was tagged to that one from nests where breeders were not manipulated. No significant difference resulted between the hatching success of the former group (63.3%) and that one of "control" birds (60.4%) ($\chi^2 = 0.066$; $df = 1$; $n = 78$; ns.).

Data analysis

In order to avoid replication inconveniences, we considered only one trip for each tracked bird. We considered the departure from the nest as the beginning of the trip and either the return to brood-guarding during incubation, or the first return to the colony during the chick-rearing period, as the end of the trip. Following previous experiences from BirdLife International partners (see Ramirez *et al.* 2008) we computed kernel analyses using only GPS positions with an instantaneous speed of less than 10 km/h. This threshold has been used by several authors (Pichegru *et al.* 2007, Guilford *et al.* 2008) to identify positions where seabirds were actually using the environment for either resting, searching for food, or diving, excluding positions where the bird was travelling. In the analysis of the data we computed the kernels separately for birds that performed long lasting trips (> 4 days) and those that performed short lasting trips (≤ 4 days) in order to identify important areas far from the colony where GPS positions were less dense which would have been lost if using all data in the same analysis. Then, the two kernels (from long and short trips) obtained from the same colony and in the same period were merged and cut in order to exclude islands and mainland. Fixed kernels were computed at the following probability level: 50%, 75% and 95%. Percentages of overlap were computed by dividing the overlapped area by the mean of the associated kernels and multiplying by 100. All spatial analyses have been performed using Esri ArcGIS 9.3.

Results

A total of 138 Scoploi's Shearwaters have been tagged with GPS loggers, but 29 devices did not contain any data after being recovered. In addition, two devices set to record positions continuously were excluded from analyses. The sample sizes for each colony in each field season are reported in Table 1. Figure 1 shows the kernels obtained by combining data from each colony recorded in different years but during the same reproductive phase. Table 1 reports the sizes of all kernels obtained for each field season. The percentages of overlap are shown in Table 2.

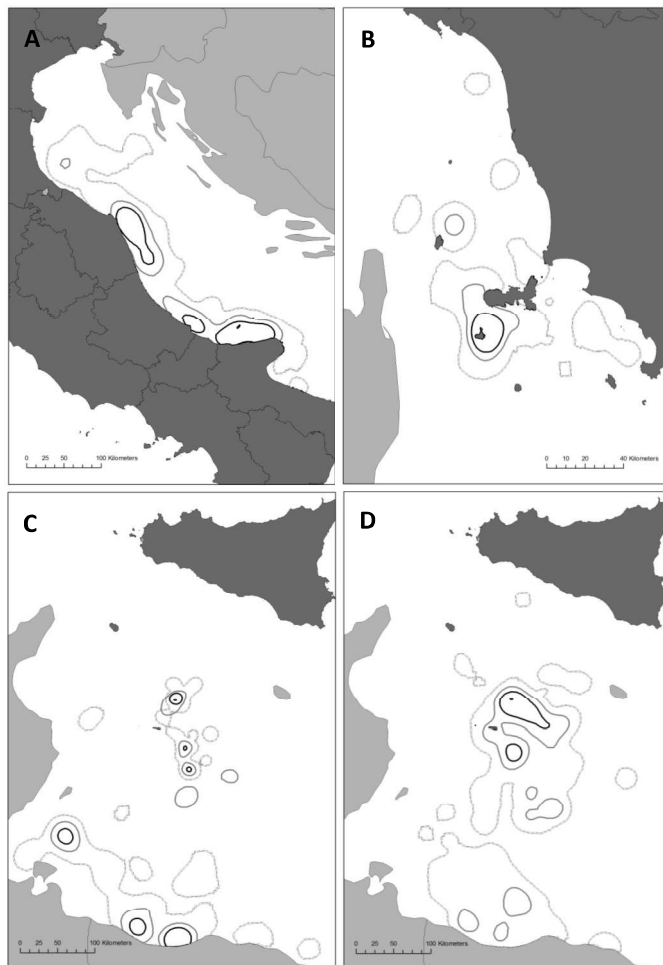


Figure. 1. Kernels obtained using GPS positions for Scopoli's Shearwaters with instantaneous speed < 10 km/h and combining data recorded at

(A) Tremiti Archipelago during incubation (2009-2010);

(B) Tuscan Archipelago (La Scola islet), during chick-rearing (2010-2011);

(C) Linosa island during incubation 2008;

(D) Linosa island during chick-rearing (2008-2009).

Black line = 50% prob; gray line = 75%; hatched line = 95%.

Discussion

In the last decade, the use of light GPS devices provided scientists with a large amount of information about bird movements, even on the open sea (see for a review: Wakefield *et al.* 2009). Despite this, only one paper (Dell'Arciccia *et al.* 2010) based on 17 tracked Scopoli's Shearwaters from an Italian colony was published. Using mini GPS loggers, we identified for the first time the main areas used by Scopoli's Shearwaters breeding in some of the biggest colonies of the central Mediterranean.

Comparing the sizes of the estimated kernels, marked differences can be noticed between colonies and between reproductive phases (Table 1). During incubation, despite the fact that birds from Linosa used mainly areas further away from the breeding site compared to Tremiti birds (Figure 1), the total size of core areas (50% fixed kernel) was slightly smaller than the size estimated for Tremiti birds in 2009 and considerably smaller than the size estimated for Tremiti birds in 2010. It is known that at large and meso-scales, seabirds are able to move directly from the breeding site to the most favoured and profitable foraging areas (Weimerskirch 2007). Thus, we can hypothesize

colony	period	year	birds	long lasting trips	position speed <10km/h	Kernel 50% (ha.)	Kernel 75% (ha.)	Kernel 95% (ha.)
Linosa Is.	incubation	2008	14	64.29%	8,916	173,049	637,986	2,551,582
	chick-rear.	2008	18	38.89%	9,021	200,249	1,213,556	4,205,731
	chick-rear.	2009	28	14.29%	8,111	681,798	1,825,973	4,720,180
	chick-rear.	2008-09	46	23.91%	17,132	296,814	976,992	4,642,604
Tremiti Arch.	incubation	2009	11	63.64%	5,919	247,257	516,611	1,134,799
	incubation	2010	15	66.67%	7,048	477,195	1,409,564	3,529,522
	incubation	2009-10	26	65.38%	12,967	409,662	857,501	2,525,286
Tuscan Arch.	chick-rear.	2010	10	30.00%	2,327	39,563	83,058	402,353
	chick-rear.	2011	11	9.09%	2,467	28,388	90,207	432,350
	chick-rear.	2010-11	21	19.05%	4,794	26,590	80,390	404,050

Table 1. Sample size, proportion of Scopoli's Shearwaters that performed long lasting trips (> 4 days) and kernel sizes obtained from each field season and combining data from different years recorded at the same colony and reproductive phase; only one trip for each bird was considered.

Colony	overlapped kernels	kernel 50%	kernel 75%	kernel 95%
Linosa island	incubation 2008 and chick-rearing 2008-2009	9%	25%	44%
	incubation 2008 and chick-rearing 2008	12%	25%	44%
	incubation 2008 and chick-rearing 2009	5%	22%	34%
	chick-rearing 2008 and chick-rearing 2009	30%	41%	56%
Tremiti Archipelago	incubation 2009 and incubation 2010	32%	50%	48%
Tuscan Archipelago	chick-rearing 2009 and chick-rearing 2010	45%	45%	43%

Table 2. Scopoli's Shearwaters: percentages of overlap computed by dividing the overlapped area by the mean of the associated kernels and multiplying by 100%.

that Linosa birds managed to reach known profitable areas travelling as far as the Libyan coast (> 300 Km) in order to use more restricted areas than those used by Tremiti birds.

During chick-rearing, birds from Linosa used larger areas than those used during incubation (Table 1).

In this reproductive phase, Scopoli's Shearwaters can alternate short trips for chick provisioning with longer trips for self-provisioning (Magalhaes *et al.* 2008). As a consequence of this behaviour, birds were constrained to use areas closer to the colony which could be less profitable and thus implying the use of larger areas for foraging. Birds from the Tuscan Archipelago used smaller areas closer to the colony than those used by Linosa birds during chick-rearing, suggesting the presence of profitable areas close to the breeding site (Figure 1).

The kernels at 50% and 75% identified during incubation and chick-rearing from Linosa had a very low (5-25%) degree of overlap, suggesting that, at least for this colony, it is essential to collect data during both periods in order to correctly identify key conservation areas for Scopoli's Shearwaters. Interestingly however, there was a relatively high overlap (30-56%) from year to year between kernels obtained from the same colony during the same reproductive phase.

Following the methodology proposed by BirdLife International (BirdLife International 2010a), all areas determined using the core areas can be considered as candidate marine IBAs. Nevertheless, as demonstrated in this study, medium to long term studies are needed to assess how the areas used change from year to year and which areas can be considered as marine IBAs.

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