

Status of the Balearic shearwater (*Puffinus mauretanicus*) on the Galician coast (NW Iberian Peninsula)*

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SUMMARY: This paper aims to assess the status of the threatened Balearic shearwater *Puffinus mauretanicus* along the Galician coast (NW Iberian Peninsula) by studying its movements and numbers. Balearic shearwaters are detected off Galicia during their annual cycle although they are uncommon between November and May. Overall, 44 groups of over 150 birds have been recorded in seven main areas since 1976, especially in the Vigo Ria and the Pontevedra Ria and along the coast of Bergantiños (Sisargas-Baldaio). Birds have been observed moulting primary and secondary feathers, mainly in June. North-eastward migration is evident along the Atlantic coast (capes Silleiro and Fisterra, daily maximum of 476 birds per hour) between June and August, where it seems to overlap with local movement. However, south-westward migration is far more frequent between September and October (daily maximum of 360 birds per hour) along the Cantabrian coast. The results might be biased due to the methodological problems, on account of the existence of irregular flows, an important inter-annual variability and local movements, probably brought about by the distribution of food resources.

Key words: Balearic shearwater, *Puffinus mauretanicus*, Galician coast, important areas, movements, concentrations.

RESUMEN: SITUACIÓN DE LA PARDELA BALEAR (*PUFFINUS MAURETANICUS*) EN LA COSTA DE GALICIA (NO PENÍNSULA IBÉRICA). – Este trabajo evalúa el status de la amenazada pardela balear *Puffinus mauretanicus* en la costa de Galicia (NO Península Ibérica), estudiando sus movimientos y abundancia. Las pardelas baleares se pueden observar en el litoral gallego durante todo el ciclo anual aunque son escasas entre noviembre y mayo. En conjunto, 44 grupos de más de 150 aves se han registrado en 7 áreas principales desde 1976, especialmente en la Ría de Vigo, la Ría de Pontevedra y a lo largo de la costa de Bergantiños (Sisargas-Baldaio). Ha sido posible observar aves mudando primarias y secundarias, principalmente en junio. La migración hacia el norte es patente en la costa atlántica (cabos Silleiro y Finisterre, máximo diario de 476 aves/hora) entre junio y agosto, donde parece solparse con movimientos locales. Sin embargo, la migración hacia el sur es mucho más frecuente a lo largo de la costa cantábrica entre septiembre y octubre (máximo diario de 360 aves/hora). Los resultados pueden estar algo sesgados debido a cuestiones metodológicas teniendo en cuenta la existencia de flujos irregulares, una importante variabilidad interanual y la existencia de movimientos locales, probablemente relacionados con la distribución de recursos tróficos.

Palabras clave: pardela balear, *Puffinus mauretanicus*, costa de Galicia, áreas importantes, movimientos, concentraciones.

INTRODUCTION

The Balearic shearwater has been recently catalogued as critically endangered in Spain (Arcos

and Oro, in press), and it has also been the object of a European Union Species Action Plan (BirdLife, 1999) on account of its endemic nature and the recent decline of its breeding population. In 1991 ca. 3,300 reproductive pairs were estimated (Aguilar, 1997), though the figure dropped to

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1,750-2,125 in 2000 (Martí and Ruiz, 2001).

Outside the reproductive season, an important fraction of the population moves to the Atlantic Ocean and large gatherings can be seen along the coasts of western Portugal, Galicia and especially western France and the English Channel (Yesou, 1984; 1986; 2000; Le Mao and Yesou, 1993; Mayol-Serra *et al.*, 2000). However, some birds stay in the Mediterranean or reach the coast of northern Africa (Martí and Ruiz, 2001). These movements have been associated with a drop in summer productivity in Mediterranean waters and with the important sardine and anchovy fisheries linked to upwellings along the French Atlantic areas mentioned. (Le Mao and Yesou, 1993).

Despite some published works (Bárcena, 1977; Bárcena *et al.*, 1987; Versluys, 1992; Paterson, 1997) and a few mentions in Galician ornithological reports, the concentrations of birds off the Galician coast have been ignored in important documents (e.g. Blanco and González, 1992; SEO, 1997; Aguilar, 1997; Viada, 1999; BirdLife, 1999). This study shows the importance of Galician coastal areas for the Balearic shearwater, by compiling and analysing both published and unpublished information, including the migratory movements and coastal gatherings of this seabird species.

MATERIALS AND METHODS

Study area

Galicia is located in the north-west of the Iberian Peninsula, and has a 1,720 km long coast characterised by the existence of rias. The continental shelf is relatively narrow, ranging from 20 to 35 km wide (Penas, 1986). It is a very productive area (16 Tm/Km² annually, Xunta de Galicia 1993), under the influence of a system of upwellings linked to the current from the Canary Islands, and the emergence of waters rich in nutrients brought by north, north-easterly winds blowing parallel to the coast, mainly from April to September (Fraga, 1981). Linked to these series of upwellings, important fisheries concentrate on epipelagic species, especially the sardine (*Sardina pilchardus*) fishery, which experiences large natural fluctuations linked to recruiting failures. Catches recorded off the Galician and Portuguese coasts between 1945 and 1985, ranging between 67,000 and 250,000 Tm offer a good idea of such failures (Porteiro *et al.*, 1986). Secondarily,

horse mackerel (*Trachurus trachurus*), mackerel (*Scomber scombrus*) and sprat (*Sprattus sprattus*), in order of importance, as well as anchovy (*Engraulis encrasicolus*), have been practically absent since 1960 (Junquera, 1986).

The following information was considered:

- Records of resting and feeding gatherings, both published (Bárcena, 1977; Martínez Sabarís, 1995, 1996; Rodríguez Vieites, 1996; Rodríguez Vieites and Rodríguez Vieites, 1996; Martínez Sabarís and Rodríguez Pomares, 1998; De Souza, 1999; Pombo, 2000) and unpublished (pers. obs.; E.M. Sabarís, com. pers.; A. Bermejo, *in litt.*). Considering a maximum population of 15,000 birds, all gatherings representing over 1% of this estimate (i.e. >150 birds) were considered important and hence selected. It is also necessary to point out that, although a distinction was not made between *Puffinus yelkouan* and *P. mauretanicus*, the former seems to be extremely rare in Galicia.

- Analysis of the moulting patterns of feathers from the wings of 75 birds while in flight, observed from Caión and Estaca de Bares using a telescope between 4 June and 6 August 1999 and 2000.

- Monthly observation of migratory passages during 1999 and 2000, both north-eastwards to the Bay of Biscay and south-westwards back to the Mediterranean Sea. This observation was carried out from five different coastal headlands (Fig. 1, Table 1).

- Analysis of the autumn migratory passage through cape Estaca de Bares. Information was available from a total of 12 years, from 1967 to



FIG. 1. – Geographical situation of Galicia and the headlands from which observations of the passage of Balearic shearwater were conducted. Dots indicate the largest bird concentrations; big dots >500 birds; medium dots 150-500 birds; small dots 20-150 birds. Areas: (1) Ría de Vigo, (2) Ría de Pontevedra, (3) Ría de Arousa, (4) Ría de Noia, (5) Ría de Corcubión, (6) Ría de Camariñas, (7) Ría de Corme e Laxe, (8) Sisargas, (9) Baldaio, (10) Ría da Coruña.

TABLE 1. – Observations of the migratory passage of the Balearic shearwaters from 5 coast headlands from 1999-2000. We show total number of days and total number of hours of observation, day intervals per month (d/m), number of hours per day (h/day), and number of birds recorded during north-eastward and south-westward flows.

Locality	Days	Hours	Period	d/m	h/day	N-E Birds	S-W Birds
Cape Silleiro	57	89.5	19.02.99-21.02.00	1-7	1-4.5	2097	346
Cape Fisterra	6	18.25	19.03.99-13.06.99	1-2	1.25-4.25	352	19
Cape Fisterra	6	15	13.02.00-18.06.00	1-2	1.25-4	2	2
Pta. das Olas (Caión)	57	84.5	05.06.99-13.09.00	1-8	0.5-4.25	25	348
Torre de Hércules	49	41.75	17.02.99-01.12.99	1-9	0.5-1.83	10	35
Estaca de Bares	29	108.6	15.05.99-23.01.00	1-9	0.5-7	171	1003
Estaca de Bares	34	113.5	15.05.00-29.10.00	1-9	1-6.5	43	1162

2000, and was grouped together in accordance with the mean values of monthly ten-day periods between the second ten days of August and the second ten days of December (n=61). The highest daily values of each ten-day period were also considered. The information which was used, with unequal inter-annual representation, comes from the following sources: 1967 and 1968 (Huyskens and Maes, 1967, 1971); 1974 (Oliver, *in litt.*); 1988 (Ramón, 1989); 1989 (pers. obs.); 1990 (Ramón, 1991); 1991 (Grupo Naturalista Hábitat, 1991); 1993 (Grupo Naturalista Hábitat, 1993 and pers. obs.); 1997 (Duus and Sandoval, 1998); 1998 (pers. obs.); 1999 and 2000 (present study).

RESULTS

Flocks

Gatherings of Balearic shearwaters along the Galician coast were recorded throughout their annual cycle from 1976 to 2000, although groups of more than 150 birds were rare between October and May and 84.09% (n=44) of the records occurred between June and September (Fig. 2). In the winters of 1991 and 1997 large flocks (>150 birds) were observed at cape Silleiro. The January Aquatic Birds Censuses of the study area, although paying unequal attention to seabirds, only recorded evidence of a maximum of 8 birds per year between 1987 and 1999 (J.A. De Souza and M. Lorenzo, *in litt.*). The flocks gathered in 7 areas (Fig. 1), more than half of them (56.82%) in the Pontevedra ria and 22.73% in the neighbouring Vigo ria. These areas, together with the Bergantiños coast (A Coruña), between the Sisargas islands and Baldaio beach, are the places where groups of more than 500 birds were observed (Table 2). Apart from a concentration of birds in the Coruña ria (birds sheltering because of a strong south-westerly

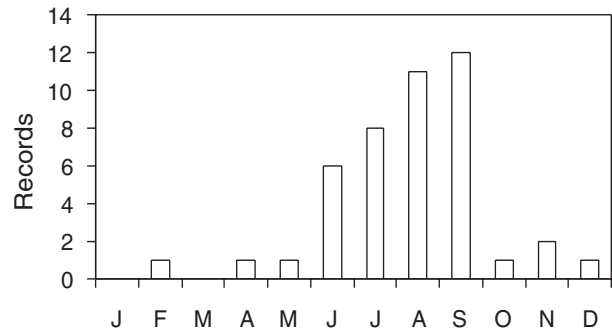


Fig. 2. – Monthly distribution of the records of more than 150 birds, obtained for the 1976-2000 period.

wind), there is no evidence of groups of more than 10 birds off the coast to the north of Bergantiños (A. Bermejo, *in litt.*, J.A. de Souza, pers. comm., A Gutiérrez, pers. comm.).

The location and size of these flocks were quite variable. In 92 replicates of a boat itinerary along an area of the Vigo ria (from Baiona to the Cíes islands, J. Cedeira, *in litt.*) performed between 25 July and 2 September 2001, birds ranging in number from 0 to 84 were recorded (5.58 ± 0.24 , mean \pm 95% C.I.).

Feeding

This species has been observed feeding near the coast and at the entrances to the rias, both in small

TABLE 2. – Records of the largest number of Balearic shearwaters (Nmax) for sites where groups of birds have been observed along the Galician coast.

Locality	N max.	Date	Reference
Ría de Vigo	618	10.09.91	Pers. obs.
Ría de Pontevedra	1,395	27.08.91	Pers. obs.
Ría de Arousa	200	14.08.99	A. Bermejo, <i>in litt.</i>
Ría de Noia	148	05.08.87	Pers. obs.
Ría de Camariñas	160	18.06.94	Pers. obs.
Ría de Corme e Laxe	50	26.07.97	Pombo <i>et al.</i> , 2000
Sisargas	100	08.06.94	Pers. obs.
Baldaio beach	577	25.07.83	De Souza, 1999
Ría da Coruña	400	07.06.97	Pers. obs.

and large flocks of more than a hundred, probably linked to the shoals of young sardine, a prey which forms a part of the diet of the Balearic shearwater (Le Mao and Yesou, 1993; Aguilar, 1997). They have also been observed feeding on sandeels (*Ammodytes* spp.) (A. Velando, pers. comm.). They often feed along with the European shag (*Phalacrocrax aristotelis*) and the yellow-legged gull (*Larus cachinnans*). They have been observed plunging simultaneously from a low height following a short flight and diving directly from the surface. There is also evidence that they take advantage of the remains of the unwanted fish discarded by the purse seine fleet (pers. obs.) responsible for catching sardine and horse mackerel, as well as by the trawlers (Valeiras, present volume; J. Cedeira, com pers.). The partial analysis of the contents of the stomach of one beached bird found at Pontevedra ria at the end of the summer showed that it had semi-digested Clupeidae that were identifiable on account of the scales, probably sardines.

Moulting

The earliest observations of moulting corresponded to a bird which started moulting secondary feathers on 12 April. Forty-eight per cent of the birds checked were moulting primary and secondary feathers (n=75). A larger percentage of birds moulted in June (64%, n= 50) compared to July and August (4%, n=25) ($G_{adj}=28.48$, n=75; $p<0,001$). All of the birds moulted their primary inner feathers with the exception of 4 birds which moulted their secondary feathers, one of them synchronically with the primary feathers, on 25 June. Birds moulting between July and September were also observed in the Pontevedra ria and the Arousa ria (pers. obs.; A. Bermejo, *in litt.*).

Movements

From cape Silleiro, shearwaters were observed every single month. The flows surpassed 10 birds per hour between 20 June and 29 October and 100 birds per hour between 18 July and 15 August, reaching a highest value of 476 birds, northwards, during one hour of observation on 15 August (Fig. 3). On 5 August 2000, 677 birds were observed during 4 hours of observation and 488 birds were also counted during two hours of observation on 11 July 1998 (Rodríguez-Vieites and Rodríguez-Gómez, 2000). The only period without observations was 21

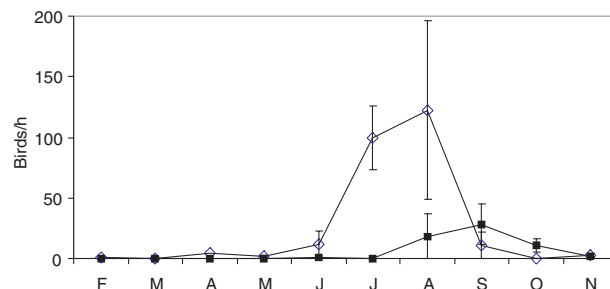


FIG. 3. – Monthly distribution (mean \pm SE) of the migratory passage (birds/h) at Cape Silleiro in 1999. Open symbols = northward migration; solid symbols = southward migration.

January to 21 February 2000. Northward migrations occur mainly in the period between July and the beginning of September and southward migrations, less obvious, between September and October, although in previous years there were some important migrations in November (e.g. 213 birds on 15 November 1991 during five and a half hours of observation, pers. obs.).

In Fisterra, a flow of over 10 birds per hour was only observed on 13 June 1999; during four hours of observation 343 birds northwards and 16 birds southwards were recorded.

In Caión (Fig. 4) a slight eastward flow was observed from June to August, reaching its maximum on 16 July 2000 (15.2 birds per hour, totalling 19 birds). Westward flows were observed from July, with a maximum on 12 October 2000 (30.4 birds per hour, totalling 38 birds). Between the months of July and October, movements of birds in both directions were frequently observed.

From the Torre de Hércules, Balearic shearwaters were only observed between June and October. Flights were in both directions and the highest value was 24 birds during one hour of observation on 6 August.

The observations carried out in 1999 and 2000 at Estaca de Bares detected no important movements towards the French coast in comparison with those detected at cape Silleiro in 1999. Between May and

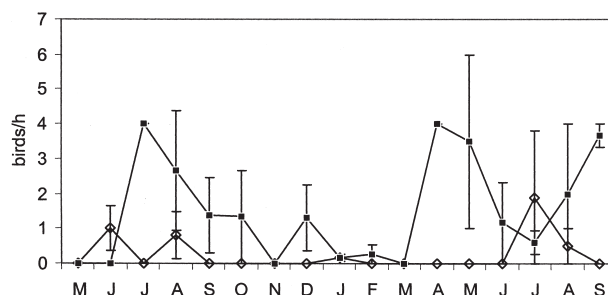


FIG. 4. – Monthly distribution (mean \pm SE) of the migratory passage (birds/h) at Pta. das Olas (Caión) in 2000. Open symbols = eastward migration; solid symbols = westward migration.

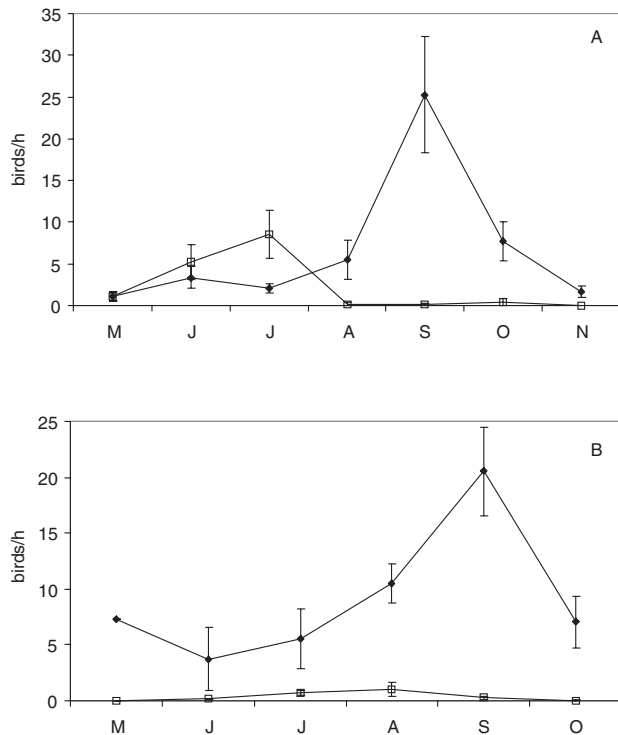


FIG. 5. – Monthly distribution (mean \pm SE) of the migratory passage (birds/h) at Estaca de Bares. A, 1999; B, 2000. Open symbols = eastward migration; filled symbols = westward migration.

August counts of less than 10 birds per hour in both directions were recorded, which extended notably to the month of September in 2000. In this month, a moderate westward passage was observed, reaching a maximum value of 75.7 birds per hour. These migratory movements decreased in October and disappeared in December (Fig. 5).

In the analysis of the information gathered from Estaca de Bares (1967-2000, $n=12$ years), a significant migratory passage back to the Mediterranean (westward direction) was observed from the second ten days of September to the end of October. The trend of the averages is in accordance with the trend of the highest daily passages (Fig. 6). Average flows of more than 100 birds per hour were only exceeded during the third ten days of September 1990 and the third ten days of October 1997 (maximum 360 birds per hour, 22 October 1997). No significant movements were recorded in August, November and December (Fig. 6), although the sample under consideration was small. Flows recorded during the ten-day periods with the largest sample size ($n=9$), the last two ten-day periods of September and the first of October, were extremely variable (second ten days of September, 15.72 ± 5.68 , mean \pm 95% I.C.; third ten days of September, 26.99 ± 11.78 ; first ten

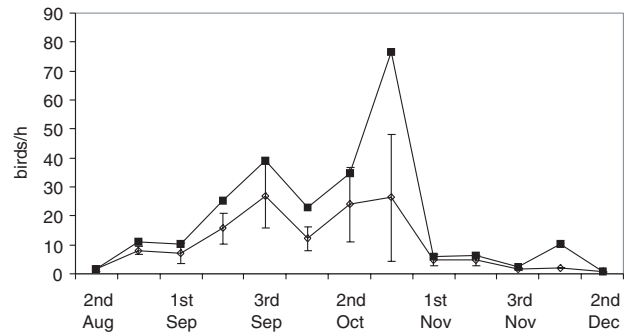


FIG. 6. – Distribution, in ten-day periods, of the migratory passage (birds/h) from Estaca de Bares, mean \pm SE of those years between 1967 and 2000 for which information is available. Open symbols = westward movements; solid symbols = maximum daily westward movements.

days of October, 11.67 ± 4.40). The fact that the information is widely dispersed could hide the true existence of flow variations, both inter-annually (Kruskal-Wallis test, $X^2_5 = 7,012$, n.s.) as well as between the ten-day periods mentioned (Kruskal-Wallis test, $X^2_2 = 1,384$, n.s.).

DISCUSSION

In their post-breeding movements, a high percentage of the world population of the Balearic shearwater leaves the Mediterranean and heads for the Atlantic. Large groups of 8,000-10,000 birds have been observed along the French sector of the Bay of Biscay, where they moult and take advantage of the high productivity of epipelagic fish, mainly sardines and anchovies (Yésou, 1986; Le Mao and Yésou, 1993; Mayol-Serra *et al.*, 2000). According to our results, the Galician coast turns out to be an important summer headquarter for the Balearic shearwater, where groups of hundreds of birds can be observed mainly between June and September. This period coincides with the end of the reproductive season and the gatherings in the Bay of Biscay. The most important areas are the Rías Baixas (especially the Pontevedra ria) and the coast of Bergantiños. However, some areas along the Galician coast, as well as the area of the continental shelf which cannot be seen from land, have scarcely been explored. Only one significant flock (250 birds) was recorded 5 miles away from Cape Silleiro on 15 August 1996. Versluys (1992) recorded between 2,500 and 3,300 Balearic shearwaters flying daily, from Cedeira to Pontevedra, in August 1998, which is proof of the large presence of birds in the main fishing grounds of the Galician platform.

Balearic shearwaters are first observed in frequent numbers in Galicia in the month of June, coinciding with the main migratory movements detected in the Straits of Gibraltar, the beginning of which takes place in the month of May (Aguilar, 1997). Observations made throughout the year in Galicia (Figs. 3 and 4, De Souza and Lorenzo *in litt.*, pers. obs.), as well as along the coast of Asturias (García Sánchez, 1997; Arce, 1998), including the observations of gatherings (Fig. 2), suggests that not all birds return to the Mediterranean and that migration must start before the month of May.

The main period in the year when Balearic shearwaters are first observed in Galicia coincides with the moulting period. The observation of birds moulting their secondary feathers in April considerably extends the moulting period described so far, the beginning of which was considered to happen by mid-May (Yésou, 1985). Moulting chronology would begin with the inner primary feathers and continue with the outer primary ones, and would end by mid-July with the secondary feathers, a process which would take approximately three months (*op. cit.*). Records of birds moulting their secondary feathers during June suggest that such model should be revised. Yésou (1985) points out that the simultaneous loss of several primary feathers during this period could come to affect the capacity of the bird to fly. In Galicia, only some of the feathers needed for flying were missing in the shearwaters observed and flying was not hampered. Taking into account the extensive period of time within which moulting is completed and the great capacity of the bird to fly long distances (Martí and Ruiz, 2001), we suggest that these groupings are probably not caused by moulting (e.g. Yésou, 1984; Aguilar, 1997). On the contrary, the existence of areas of summer-time occupation are probably conditioned (spatially and seasonally) by a high availability of trophic resources, with moulting taking place secondarily.

Our observations suggest that at least a large number of shearwaters migrate close to the coast. The large variability observed in the flow of birds is typical of the movement of all seabirds and is probably accentuated in the case of the Balearic shearwater by the small size of its population and by the methodology of observation. Hence, extrapolations of the flows are not advisable (e.g. Woutersen, 1993; Mayol-Serra *et al.*, 2000).

The largest north-eastward movements of birds were observed from capes Silleiro and Fisterra

between June and the beginning of September. Woutersen (1993) detected an important northward passage in Fisterra between July and September, with a maximum of 2,085 birds (180 birds per hour) on 28 July 1985. The most important south-westward movements occurred along the Cantabrian coast (Estaca de Bares), between the second ten days of September and October, and also in Asturias (García Sánchez, 1997), although occasionally at cape Silleiro as well. More hidden headlands along the coast, such as Caión and Torre de Hércules (Fig. 1) are less advantageous for recording movements. Movements of Balearic shearwaters show considerable inter-annual variability, taking into account the observations carried out at Estaca de Bares between 1967 and 2000. Given the limited population size of this species, records of more than 100 birds per hour suggest that movements concentrate in short periods. This unpredictability in time requires a large effort to monitor migratory flows correctly; this is probably the source of the seasonal differences observed between different areas. However, other factors could be involved as well, such as (a) the overlapping of local movements with migratory flow, (b) the existence of different migratory routes, and (c) the formation of feeding groups with the sporadic appearance of accessible trophic resources, which would generate short-lasting flows.

Local or nomadic movements in a direction opposed to the main one or to the one expected on that date were recorded at capes Silleiro, Caión and Estaca de Bares (Figs. 3-5; Huyskens and Maes, 1971), the Bergantiños coast (1,000 birds flying westwards, 25 July 1983, and a concentration of 577 birds, De Souza, 1999) and Fisterra, with a maximum of 440 southward-flying birds (42 birds per hour) on 28 July 1985 (Woutersen, 1993). This was probably caused by the settling of the species on the Galician continental shelf, as well as the existence of local movements linked to seasonal and spatial variation in trophic resources.

Overall, records of gatherings and movements of Balearic shearwaters in Galicia show considerable irregularity in numbers, both inter-annually and seasonally. Irregularities also occur spatially to a lesser extent, probably influenced by the local presence of food. The areas in which most of the feeding and resting flocks gather coincide with the main spawning and fishing areas of the sardine (*Sardina pilchardus*) in Galicia, south of cape Fisterra (Anadón, 1954; Wyatt and Pérez-Gándaras, 1986).

The location, size and duration of the flocks of Balearic shearwaters are quite variable and could be related to the recruitment in the rias of sardines of the 0-type class (119 mm average length). This circumstance would make shearwaters easy to observe in large numbers near the coast. Attracted by their high primary productivity, sardines enter the rias in trophic migrations, to eat phytoplankton, a basic component of their diet (Massutti, 1946). The fact that sardines are part of a simple trophic web influences natural fluctuations in their numbers, mainly due to recruitment failures linked to the intensity of the upwellings where they forage and to masses of eggs and larvae being dragged along with the movement of the water (Wyatt and Pérez-Gándaras, 1986; Xunta de Galicia, 1993).

Periods of food scarcity do not last for more than 10 years (Xunta de Galicia, 1993). Presently, it remains unknown how fluctuations in their prey affect the spatial and seasonal distribution of Balearic shearwaters in Galicia, as well as their abundance along the French coast. Changes in the distribution of the Balearic shearwater linked to the availability of resources have been evident, both in Mediterranean areas where it winters (Gutiérrez and Figuerola, 1995) and more recently along the French coast (Yésou, 2003). During periods of scarcity of natural prey, discards from commercial fishing vessels could take on greater importance, as occurs in the Mediterranean (Arcos and Oro, 2002).

Taking into account the large movement capabilities of these seabirds (Martí and Ruiz, 2001), nomadic movements conditioned by the availability of trophic resources could take place on the continental shelf between the English channel and the Atlantic coast of Andalucía. An undetermined number of shearwaters might not reach the French coast.

Conservation implications

The role of the Galician coast in the summering of the Balearic shearwater could be as important as that of the French Atlantic coast which, to date, was the only summering place described for the species (Martí and Ruiz, 2001). Further work is needed to evaluate accurately fluctuations in the number of birds and in their seasonal and spatial summering patterns. Fluctuations in sardine numbers (Porteiro *et al.*, 1986; Xunta de Galicia, 1991) and bycatch in longline fishing gears (Grupo Erva, 1992) could be the main threats for the conservation of this species in Galicia.

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