



Agreement on the Conservation
of Albatrosses and Petrels

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Recent and current research on Balearic shearwater on colonies and in Atlantic and Mediterranean areas

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ABSTRACT

The Balearic shearwater *Puffinus mauretanicus* is the most threatened seabird in Europe. Several recent research and conservation programmes from different countries (Spain, Portugal, France, UK and Ireland), using various methodologies such as colony monitoring, at-sea surveys, tracking and coastal censuses, brought new information about the population status, behaviour and threats of the species. The global population can now be estimated in over 25,000 individuals, roughly twice than previous estimation. Mean extinction time is also revised to 70-80 years. For the first time, birds from Eivissa (i.e. the southern breeding population) were tracked and breeders appear to forage not only on the Iberian shelf and around breeding sites, but also in North African waters, seeking marine productive waters. During wintering, Balearic shearwaters appear to restrict their activity to few core areas off western Iberia or south-western Brittany. Some of the French coastal survey sites host large numbers of individuals (> 5,000 observed in Brittany in 2010) and should integrate the MPA network. Tracking surveys of breeders and of moulting adults caught-at-sea show that they can directly return to their breeding sites as early as 5 months before the beginning of the breeding season (egg laying, which takes place in early March). Data from observers onboard fishing vessels and questionnaires to fishermen show that bycatch is a big issue for the species in both the Mediterranean and the Atlantic area. Preliminary results suggest that Mediterranean bycatch mainly occur in longlining, whereas purse-seiners and trawlers could capture more birds in the NE Atlantic. Further work is required in order to obtain bycatch rates on a more representative fleet. The highly mobile Balearic shearwater is not attached to administrative boundaries and it is therefore essential to overcome legal limitations to provide its efficient protection. Transboundary programmes such as the Interreg FAME should be rapidly encouraged to provide efficient conservation measures for *Puffinus mauretanicus*.

RESUMEN

La pardela balear *Puffinus mauretanicus* es el ave marina más amenazada de Europa. Estudios recientes, enmarcados dentro de programas de conservación de diferentes países (España, Portugal, Francia, Reino Unido y Irlanda), han proporcionado nueva información sobre el estado de la población, el comportamiento y las amenazas, utilizando diversas metodologías como el seguimiento en colonias, censos en el mar, seguimiento remoto y censos costeros. La población mundial actual se estima en torno a 25.000 individuos, aproximadamente el doble que la estimación anterior. Gracias a la revisión del estatus poblacional, el tiempo medio de extinción es de 70-80 años. Por primera vez, se realizó un seguimiento remoto de la población del sur en Eivissa y los adultos reproductores no sólo se alimentaban en la plataforma ibérica y en zonas adyacentes a las colonias de cría, sino también en aguas del norte de África, en relación a la productividad marina. Durante la invernada, la presencia de pardela balear se concentró en 1-2 áreas frente a la costa occidental de Portugal y el suroeste de Bretaña. Algunos de los puntos costeros en Francia albergaron un gran número de individuos (> 5.000 observados en Bretaña en 2010), y deberían de integrarse en la red de Áreas Marinas Protegidas o, al menos, tener en cuenta la presencia de pardela balear. Los estudios de seguimiento remoto de adultos reproductores y de individuos que se capturaron en el mar mostraron que regresan a sus colonias de cría al menos 5 meses antes de la puesta de huevos. Los embarques de pesca y entrevistas a pescadores indicaron que la captura incidental es un gran problema para la especie en el mar Mediterráneo, así como en el Océano Atlántico. Los resultados preliminares mostraron que la captura incidental en el Mediterráneo se produce principalmente en el palangre, mientras que los cerqueros y arrastreros pueden capturar más aves en el Atlántico NE. Por tanto, es necesario seguir trabajando a fin de obtener tasas de captura incidental más representativas. La pardela balear no está ligada a fronteras administrativas, dada su gran movilidad, y por ello es esencial superar las limitaciones legales para facilitar su plena protección. Programas transfronterizos como FAME Interreg deberían de implementarse rápidamente para proporcionar medidas de conservación eficientes para *Puffinus mauretanicus*.

RÉSUMÉ

Le Puffin des Baléares *Puffinus mauretanicus* est l'oiseau marin le plus menacé d'Europe. Plusieurs travaux de recherche et programmes de conservation ont été menés récemment dans différents pays (Espagne, Portugal, France, Royaume-Uni et Irlande). Ils ont déployé différentes méthodologies telles que les suivis de colonie, les comptages en mer, les suivis côtiers et l'équipement télémétriques, qui ont apporté de nouveaux éléments sur le statut de la population, sur le comportement de l'espèce et les menaces qui pèsent sur elle. La population globale peut maintenant être estimée à plus de 25 000 individus, près du double des précédentes estimations. Le temps moyen d'extinction a également été réévalué, à 70-80 années. Pour la première fois, les oiseaux d'Ibiza (i.e. la population reproductrice du Sud des Baléares) ont été suivis par télémétrie et les reproducteurs ne semblent pas se nourrir uniquement sur le plateau ibérique et autour des colonies, mais également dans les eaux d'Afrique du Nord, où ils trouvent des zones très productives. Pendant l'hivernage, les puffins des Baléares semblent restreindre leur activité sur quelques secteurs clés sur les côtes ouest de la péninsule ibérique et en Bretagne Sud. Certains des sites français suivis depuis la côte abritent un grand nombre d'individus (> 5 000 ind observés en Bretagne Nord en 2010) et devraient dès lors être désignés en Aire Marine Protégée. Les suivis télémétriques d'individus reproducteurs et d'adultes en mue capturés en mer montrent qu'ils peuvent retourner rapidement vers leurs sites de reproduction, près de 5 mois avant le début de la saison de reproduction (période de ponte, qui a lieu début mars). Les données d'observateurs embarqués sur les bateaux de pêche et les questionnaires soumis aux pêcheurs montrent que les captures accidentelles sont un enjeu majeur pour cette espèce, aussi bien en Méditerranée qu'en Atlantique. Les premiers résultats suggèrent que les engins responsables sont plutôt les palangres en Méditerranée, alors que les captures en Atlantique Nord-Est concerneraient davantage les fileyeurs (senneurs notamment) et les chalutiers. Il est toutefois nécessaire d'approfondir ces études afin d'obtenir des taux de capture sur une flotte plus représentative. Le puffin des Baléares est très mobile et indépendant des frontières administratives : il est donc essentiel de dépasser leur cadre légal pour assurer efficacement sa protection. Les programmes transnationaux tels que l'Interreg FAME devraient être encouragés à court terme, pour fournir des mesures de conservation efficaces pour *Puffinus mauretanicus*.

1. INTRODUCTION

The status of the Balearic shearwater was recently reviewed with occasion of updating the International Action Plan (Arcos (compiler) 2011a). However, research has continued afterwards, and several research teams and conservation programmes from Spain, Portugal, France and England have recently brought new information about the species, worth reporting here.

The different threats have been identified in the International Action plan

Predation on breeding sites by introduced mammals - Critical,

- Bycatch - Critical,

- Acute pollution – (Potentially) high

- Fish stock depletion - Medium,

- Habitat destruction/degradation - Medium,

- Background pollutions – Low (unknown),

- Human harvest – very low and local,

-Offshore windfarms - Unknown.

2. TOWARDS NEW POPULATION ESTIMATION

The last estimate for the breeding population is 3,193 breeding pairs (Conselleria de Medi Ambient 2010). This figure is suspected to be underestimated, since the nesting sites are very hard to access and estimates are often based on indirect methods, subject to potentially strong biases.

The status of the species is under current review. Based on boat-based surveys in the western Mediterranean (Arcos 2011b) and land based counts from Gibraltar (a strategic bottleneck through which the whole population migrates; Arroyo *et al.* 2011a., Arroyo *et al.* *in prep.*), the global population is now estimated at over 25,000 birds, roughly twice than would be expected considering the figure of 3,200 breeding pairs estimated at the breeding colonies (Arcos *et al.* 2012a). Several alternative and non-exclusive hypothesis have been proposed to explain such discrepancies between estimates on the breeding grounds and off-shore (Arcos 2011b, Arroyo *et al.* 2011a, Arroyo *et al.* *in prep.*): 1) the number of pairs at the known colonies should be higher; 2) the existence of new undetected breeding colonies; 3) the proportion of non-breeding individuals (including juveniles, sub-adults and mature adults birds on sabbatical) might be unusually large (but this non-breeding population can, in itself, hardly explain discrepancies of such a magnitude). New information is also available on breeding success from different colonies and years (Louzao *et al.* 2006a, FAME results unpublished). With these new data, and modifying some assumptions of the former Population Viability Analysis (Oro *et al.* 2004), a new PVA has been built (Oro and Arcos, unpublished). Considering a range of values for the breeding population, from 3,200 to 7,000 pairs, the new PVA points to a mean extinction time of 70 to 80 years, with a decline to 10% of the current population within 23 years (i.e. less than 3 generations). With this information, despite the mean extinction time being about twice the previous estimate, the species still classifies as Critically Endangered following IUCN criteria. The most sensitive parameter influencing the PVA is adult survival, which was estimated in 2002 at 0.78, with information from two colonies (free of terrestrial predators). Since this is an unusually low survival rate for

a Procellariiform, updating this information is necessary to confirm the alarming declining trend of the species.

3. DISTRIBUTION IN THE MEDITERRANEAN AND THE ATLANTIC AREAS

3.1. Foraging areas during the breeding period

3.1.1. Southern population (Eivissa)

Present knowledge from at sea vessel-based observations of birds of unknown origin, suggests that this species has a coastal distribution over productive shelf areas (Louzao *et al.* 2006). Oceanographic features promoting areas of high productivity influence the distribution of small pelagic fish, which constitutes the main natural prey for Balearic shearwaters, apart from exploiting fishing discards (Arcos and Oro 2002, Navarro *et al.* 2009). During breeding (March–June), Balearic shearwaters forage along the Iberian continental shelf where different mesoscale oceanographic features result in productivity hotspots (Arcos and Oro 2002, Abelló *et al.* 2003, Ruíz and Martí 2004, Louzao *et al.* 2006, Arcos *et al.* 2009, 2012b).

They also forage around the breeding grounds in the Balearic archipelago (e.g. Menorca-Mallorca channel, South of Mallorca and the marine area surrounding Formentera and South of Eivissa) (Ruíz and Martí 2004, Louzao *et al.* 2006, Arcos *et al.* 2009). Furthermore, former satellite tracking data evidenced that Balearic shearwaters from northern populations (Menorca) were visiting marine areas close to Algeria (Ruíz and Martí 2004). However, evidence was inferred from sparse locations of 3 tagged birds (out of 7) and another 3 tagged birds from central populations (Mallorca) foraged over the Iberian shelf and breeding sites, whereas there were no data available from southern populations (breeding in Eivissa-Formentera). Thus, more research was needed to confirm the importance of Mediterranean western North African waters for this critically endangered shearwater.

During the Interreg FAME programme, miniaturized satellite transmitters were used to determine the key marine areas of the southern population of Balearic shearwaters breeding on Eivissa and spot the spatial connections between breeding and key marine areas (Louzao *et al.* 2012). This tracking study indicates that Balearic shearwaters do not only forage along the Iberian continental shelf but also in more distant marine areas along the North African coast, in particular West of Algeria, but also the North-East coast of Morocco. Birds recurrently commute to these shelf areas at the end of the breeding season. Species distribution models identified chlorophyll_a as the most important environmental variable in defining those oceanographic features characterizing their key habitats in the western Mediterranean.

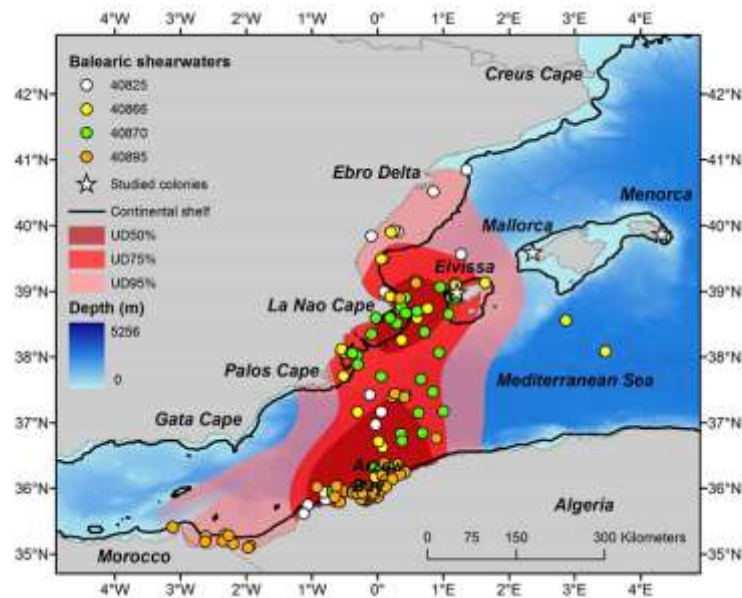


Fig 1. Filtered locations (each shearwater represented by different colours) and density contours (95%, 75% and 50% UD represented by black, dark grey and light grey lines, respectively) resulting from kernel estimation of the distribution of southern Balearic shearwaters during the chick-rearing period of 2011. Two main marine areas (indicated by the 50% UD) are identified: marine area around Cape La Nao and Arzew Bay in the Iberian and Algerian continental shelves, respectively. doi:10.1371/journal.pone.0035728.g002

The reason why shearwaters from Eivissa do not only forage over the closest productive area along the Iberian continental shelf could be related to the marine productivity of the western northern African coast and the relative proximity from the colonies (300 km). The dynamic of the Atlantic inflow along this biogeographic area is characterized by the Algerian Current where mesoscale instabilities create zones of enhancement of productivity (Morán 2001).

Transboundary conservation efforts are needed for the critically endangered Balearic shearwater. This is the main conclusion of the present study which tracked for the first time breeding birds from the southern population. Highly mobile animals are not attached to administrative boundaries and it is therefore essential to overcome legal limitations to provide full protection to highly threatened species. Within this framework, these results match previous studies in identifying similar key marine areas for the species over the Iberian continental shelf and improve our understanding by identifying key marine areas for Balearic shearwaters in southern Mediterranean waters. Along this biogeographic area, kernel analysis identified Arzew Bay as key marine area for tagged birds. Thanks to Species Distribution Models, we additionally were able to predict Balearic shearwaters distribution beyond observed data identifying all close bays along the northern African coast from Nador (Morocco) to Alger (Algeria) as potential key marine areas. These southern Mediterranean key areas could be integrated into a supranational conservation initiative to develop a successful network of protected sites across Mediterranean waters. We therefore highlight the importance of tracking studies and the establishment of long-term studies in order to comprehend how the current changing environment will impact on the distribution of species of high conservation concern in the future.

GPS tracking of 5 individuals by SEO/BirdLife in 2012, within the frame of LIFE+ Project INDEMARES, confirmed the eastern Iberian coast as (one of) the main foraging grounds for the species during the breeding period. Contrary to results from PTT the previous year (Louzao *et al.* 2012), on this occasion the tracked birds did not move towards the Algerian shelf, suggesting different foraging grounds in different years, probably related to environmental conditions. On the other hand some birds moved as far north as the French border area, suggesting that the foraging range of the species is larger than previously thought, and that birds from different colonies may mix in the foraging areas (but see Louzao *et al.* 2011a). Main foraging areas along the continental shelf of Iberia appear to be quite stable over time (Louzao *et al.* 2006b, Arcos *et al.* 2009, 2012b).

3.2. Towards a better understanding of the migration and pre-breeding behaviour

3.2.1. Migration and pre-breeding behaviour

Recent tracking studies using geolocator (GLS) on breeding adult Balearic shearwaters permitted the identification of the areas used by these birds during the non-breeding period. In total 28 individuals from Mallorca were tagged in 2010 and retrieved in 2011 (Guilford *et al.* 2012), and other 21 individuals from Eivissa were tagged in 2011 and recovered in 2012 within the Interreg FAME project. All tracked birds moved into the northeast Atlantic on post-breeding migration, returning to the colony in the autumn. This information, together with systematic coastal migration counts carried out from the southernmost point of the north coast of the Strait of Gibraltar (Programa Migres 2009) have revealed with precision the dates of migration through this migratory bottleneck. Balearic shearwaters leave the Mediterranean between late May and early July, with peaks of migration from last week of May and the first ten days of June. The adults exit mainly during June. They re-enter the Mediterranean from September to November. During this period, days when Balearic Shearwaters fly into the Mediterranean regularly alternate with days when they fly into the Atlantic (Arroyo *et al.* 2011b). During the non-breeding period all the individuals distribute in the northeast Atlantic. Spatially, birds during wintering appear largely to restrict their activity to one of two core areas off western Iberia (Figueira da Foz and Cabo Raso Marine IBAs) or southwestern Brittany. Under FAME project 1914 birds were counted in a boat-based survey inside MIBA Figueira da Foz in 11.08.2012. Only a few birds appeared to visit both areas. Individuals spend around a quarter of their year, the late summer, on migration at coastal sites relatively localized off northeast Atlantic coasts, especially Portugal and France, and then return directly to their breeding sites to spend around 5 months visiting the colony rather frequently even before egg laying (Guilford *et al.* 2012). These results help to crystalize the risk structure to individuals of this critically endangered species outside of the breeding season.

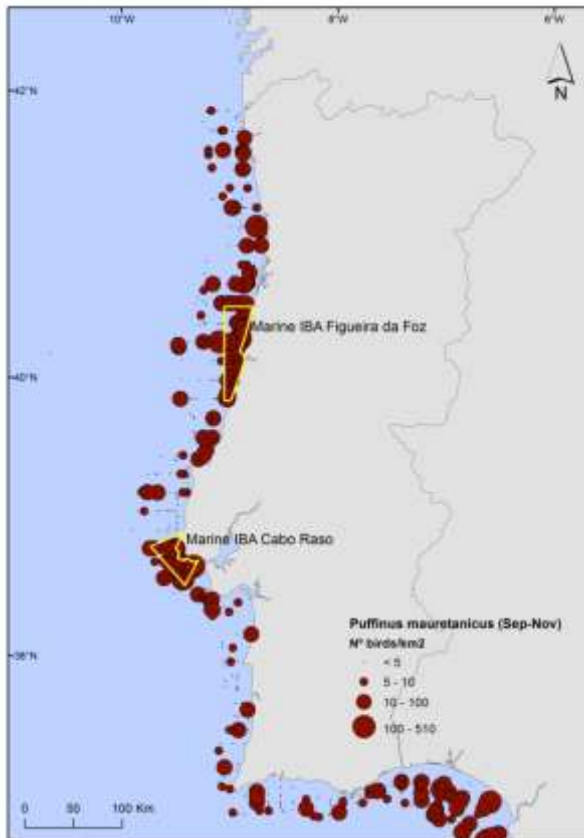


Fig 2: Abundance and distribution map of Balearic shearwater in the Portuguese coast, between September and November, based on boat-based ESAS surveys between 2005 and 2012

3.2.2. Coastal distribution during migration

Coast-based counts from strategically located vantage points in areas of concentration has revealed as an essential tool to monitoring local and global populations but also to show long-term population trends that may help to properly address conservation strategies for Balearic Shearwaters (Mateos *et al.*, 2012, Arroyo *et al.*, in prep).

Through the Interreg FAME programme, a coastal network has been set up in France to census seabirds from the coast, including the Balearic Shearwater. This network was based on the local previous experiences, in Brittany (Yesou, 2007), in Spain (RAM: Red de Observacion de Aves y mamiferos Marinos) and in Vendée (Barzic 2009). The objective was to synchronize censuses to obtain comparable results from one site to another. Each first Saturday of the month, between May and December, observers counted seabirds from the coast on around 30 sites from Haute Normandie to the Spanish boundary.

The 3 year dataset gathered brings new information about the aggregation sites functionality, and the lack of protection of some of them.



Fig 3: Coastal sites where more than 1% of the global population (250 ind) was observed during 1 year (green circles), 2 years (pink circles) or 3 years (orange circles) (LPO, 2013)

The importance of South Brittany (Morbraz), Baie de Lannion, Baie de St Brieuc, Baie du Mont St Michel, and coasts of Vendée was confirmed by the simultaneous censuses: these sites host more than 1% of the global population on a regular basis during migration (SPA designation threshold) (cf Fig 3).

These sites also host record numbers of individuals, such as in Baie de Lannion and in Baie de St Brieuc, where 5780 individuals were observed in July 2010.

Other coastal sites in Normandy and more south in Charente-Maritime, Landes and Pyrénées Atlantiques, see large amounts of birds migrating during summer.

Globally, more than 5,000 hours of observation have been performed, involving more than 300 observers, leading to a high quality dataset. This shows the important role that can be played by volunteer networks to improve knowledge.

Through the BirdLife initiative, this network could take an international dimension, by joining the Irish Seatrack programme, the RAM programme in Portugal and Spain, and the UK Seawatch SW programme (cf Fig 4).

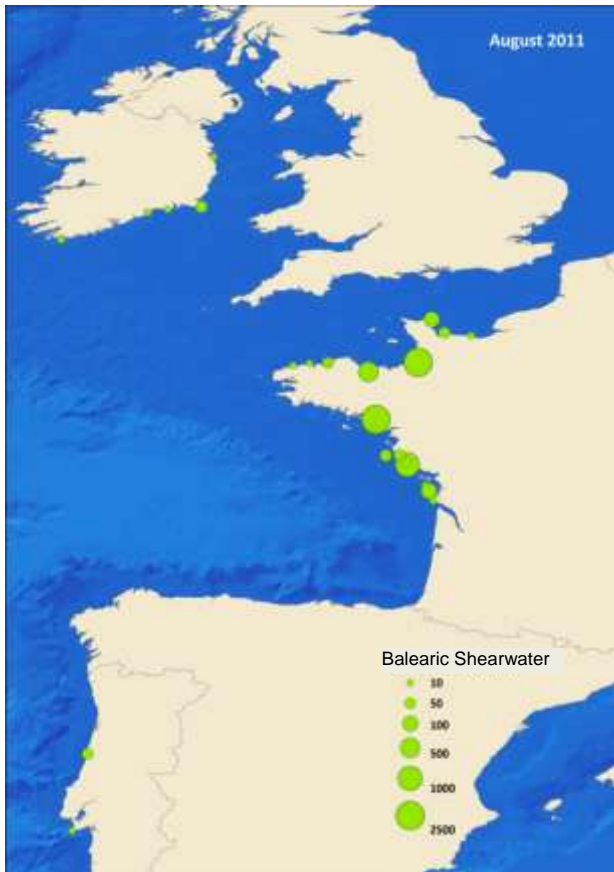


Fig 4 Maximal numbers of Balearic Shearwater observed from coastal simultaneous censuses in August 2011 through the FAME programme (LPO, 2013)

3.2.3. Tracking of caught-at-sea adults

Argos PTT satellite tracking of 3 adults from their wintering ground off France (southwestern Brittany), within the FAME program, revealed for the first time the end of wintering behavior and the beginning of migration back to Mediterranean. These individuals were captured at sea at the end of September, using a landing net from a boat, while interacting with a fishery vessel. They were all ending the moult of their remiges (primaries). Movements of the birds were restricted to the area where they were captured until mid-October and then initiated the migration. Migration back to Mediterranean was characterized by fast travelling (12 days) through the Bay of Biscay, moved up and down the coast of Northern Spain and of Portugal, staying a few days before re-entering the Mediterranean. One bird was tracked through the entire period of migration.

3.2.4. Tracking of fledging birds

Argos PTT satellite tracking of 5 juveniles at Eivissa revealed the migratory behavior after fledging. All the birds moved into the northeast Atlantic. The juveniles fledged in early July and tended to migrate directly to the Atlantic, unless the devices emitted for a short period (mean 8 days).

Tracking of migratory birds (adults or juveniles) were consistent with previous studies on the use of migratory corridors (Wynn and Yésou 2007). These results highlight the needs for transboundary conservation efforts for the species.

4. INTERACTIONS WITH FISHERIES

4.1. Atlantic area (Spain, France, Portugal)

Through the Interreg FAME programme several studies were conducted with fishermen, using direct interviews and questionnaires, to get information on the interactions they have with seabirds (cf Tab1).

Table 1: Fame Actions regarding Fisheries interactions assessment

		UK	Ireland	France	Spain	Portugal	Total
Fisheries Interactions	Nr of harbours	-	7	8	43	15	73
	Nr of interviews	-	43	166	378	357	941
	Nr of boat surveys	-	-	-	-	363	363

- French results

Following the Portuguese and Spanish experiences (see Tab 1), first qualitative results were obtained from questionnaires. Different methodologies (direct interviews, questionnaires spread in harbours and via Internet) were tested in France, showing that direct interviews give good rates of answer (38% of the contacted fishermen refused to answer). Though the sample had a limited size (n=23 for professional fishermen, n=143 for recreational fishermen), these results confirm that bycatch concern different gears such as longlines, gillnets and trawls (cf Fig 4) and that shearwaters are concerned by bycatch in the French Atlantic area too, enhancing the importance of building common project with fishermen to study this major issue.

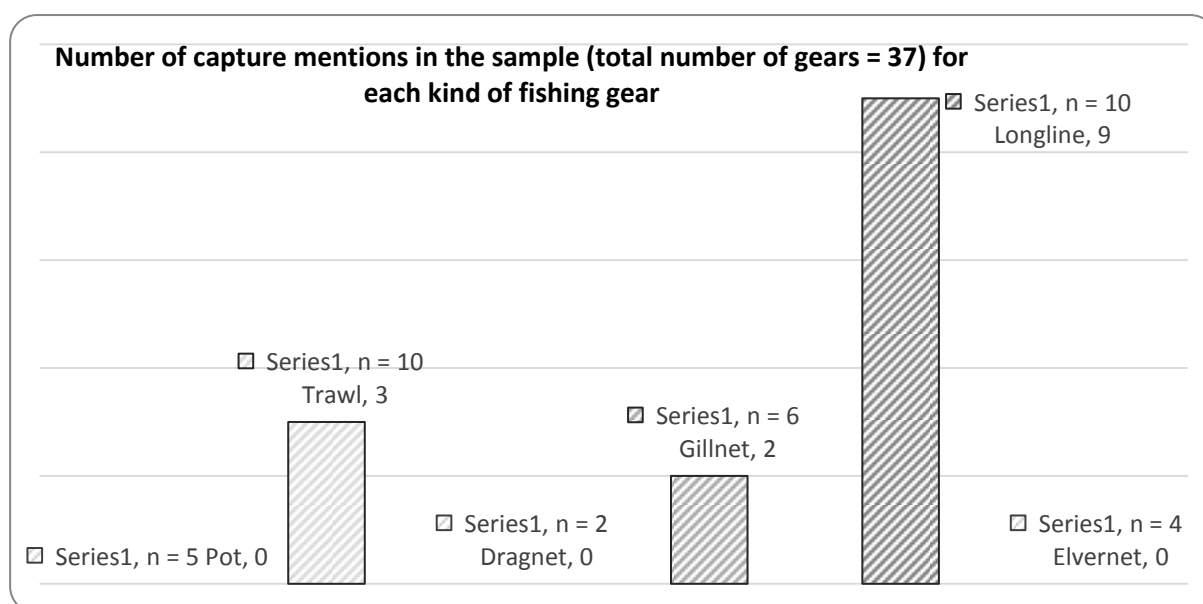


Fig 5: French FAME results about seabird (all species) capture mentions (FAME report)

- Portuguese results

From FAME questionnaires in Portugal, some very troubling numbers have been calculated for Balearic shearwater bycatch in the country (cf Tab 2).

Table 2: Balearic sheawater reported bycatch. Nr. of interviews with reported bycatch,% of interviews with bycatch report, nr. of birds caught due to bycatch, bycatch rate (mean/boat) and total bycatch estimate reported per year for the Portuguese fleet (for boats with less than 10m of length and more than 10m of length)

	Fishing gear	Nr. of interviews	%	N	Bycatch rate	Total estimate/year
< 10m	Nets & traps	1	0,99%	2	0,02	52,42
	Longline	2	5,56%	13	0,36	167,19
> 10m	Nets & traps	5	4,95%	144	1,42	490,45
	General longline	1	6,25%	100	6,25	1 043,75
	Purse seine	6	13,04%	989	21,5	1 913,5

This shows that an impressive number of 3667 birds per year (13% of the estimated world population) could be affected by this issue in Portugal alone, being purse seine the most prejudicial fishing gear for the species (responsible for 52% of the estimated reported bycatch number), although longline and nets & traps boats of the polyvalent fleet are as well gears that seem to contribute to this problem. Purse seine has higher number of birds caught, but lower mortality rates (29%), while boats fishing with longline have a mortality rate of 88,49% and nets & traps ones, 89,68%. This can result of 2121 dead Balearic shearwaters per year. Although questionnaire results are to be given some margin of error, these are very concerning numbers.

Regarding direct onboard bycatch monitoring, 557 trips were made in Portugal under FAME project, 2722 Balearic shearwaters were recorded attending fishing vessels, and 31 of them were caught (30 in purse seiners and 1 in polyvalent vessels). This means a 0,086 bycatch rate (individuals caught per fishing event) in purse seiners and a 0,003 bycatch rate in polyvalent vessels, and could be translated in 3066 individuals caught per year, which is a value not so far from the species bycatch estimates extrapolated by questionnaires.

- Spanish results

Results from Spain suggest that seabird bycatch occurs most often in demersal and pelagic longliners (40-50% of the vessels reported frequent catches; i.e. more than one event per year), but is also frequent in purse-seiners, trawlers and gillnets (over 30% in all cases). Demersal longliners reported up to 100 birds in a single line, whereas pelagic longliners did

not overpass 30 birds, purse-seiners and gillnets 20 birds, and trawlers 5-10 birds. This picture is slightly different to that in the Mediterranean, where trawlers and purse-seiners report only occasional seabird bycatch, whereas longliners report larger numbers of seabirds caught (up to 3900!). There is no information on bycatch at the species level, but shearwaters were reported to be caught in the four main fishing gear types commented above.

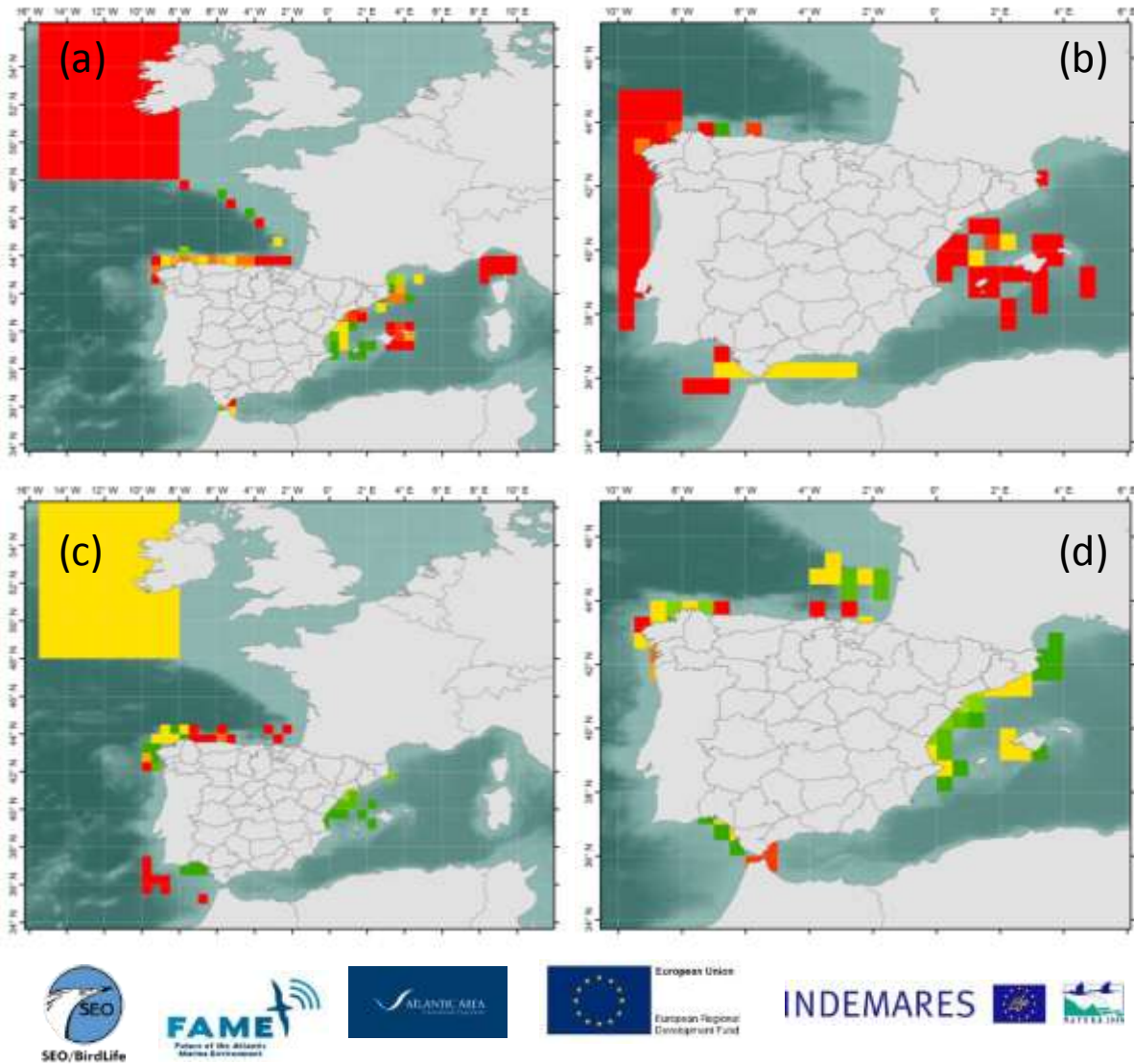


Fig. 4. Frequency of seabird catches per year (green less than one; red 3 or more events) in different fishing gear in Spain, according to questionnaires to fishermen conducted by SEO/BirdLife: (a) demersal longliners; (b) pelagic longliners; (c) trawlers; and (d) purse-seiners.

4.2. Mediterranean sea

It is widely documented that seabird bycatch is one of the most serious threats for seabirds at sea. Nevertheless in many longline fisheries there is still insufficient information to evaluate their effects on seabird populations, especially in artisanal vessels (Anderson *et al.* 2011). In the Mediterranean area where the breeding colonies of Balearic shearwater are located there is an important longline fleet mainly composed of artisanal boats and it operates within the foraging grounds of this species. The information available about seabird bycatch in this region showed a bycatch rate estimate ranging from 0.013 to 0.69 birds/1000

hooks and the highest values obtained were from the demersal longliners (Belda and Sanchez 2001, Laneri *et al.* 2010, García-Barcelona *et al.* 2010 a,b). The Balearic shearwater is one of the species affected although these studies have found a low mortality of this species.

Recent questionnaires to fishermen in the Mediterranean, conducted by SEO/BirdLife within the frame of LIFE+ Project INDEMARES (n = 236 questionnaires from 24 harbours), suggest that Balearic shearwater bycatch is fairly common but often occurs on an irregular basis, affecting large numbers of birds at a time in occasions, thus suggesting that the estimated catch rates out of a limited number of trips onboard fishing vessels could be largely underestimated, which confirm previous evidence from collection of corpses at ports and other indirect evidence (Ruiz and Martí 2004, Arcos *et al.* 2008, Louzao *et al.* 2011b, Cortés and González-Solís unpublished). A specific case reported up to 3900 birds, mostly Cory's shearwaters, but reports of over a hundred small shearwaters (Balearic/Mediterranean) are common.

Preliminary studies from fishing trips made in artisanal demersal longliners along the Catalan coast (NW Mediterranean) allowed checking that bycatch occurs sporadically and fragmented in the space which means it can be difficult to detect. Despite that it has been possible to show that there are particular periods or conditions that increase the likelihood of bycatch and which sometimes can entail a mortality of hundreds of birds, affecting especially small shearwaters (*Puffinus sp.*). The bycatch rate estimate during 3 years of study (2009 – 2012) for demersal longliners is 0.16 birds/1000 hooks (N = 63 settings). Contrary to previous studies, in this instance the Balearic shearwater was one of the main captured species, along with Cory's shearwater (*Calonectris diomedea*) and yellow-legged gull (*Larus michahellis*). In the case of the Balearic shearwater a bycatch rate of 0.06 birds/1000 hooks was obtained, based on this a conservative estimate of 676 birds/year would be caught in demersal longliners within the study area. It was also found a temporal and spatial variation of bycatch as well as an influence of other types of fisheries that generate more discards such as trawlers. In this way it was detected a higher attraction of birds to longliners when trawlers are closed (moratoria or holidays), this especially affects the Balearic shearwater and Audouin gull (*Larus audouinii*). This same result was also found in other studies in the Mediterranean range so is considered as a very important factor for seabird bycatch (García-Barcelona *et al.* 2010, Laneri *et al.* 2010).

Moreover new evidence suggests that fisheries, mainly demersal longline, as well as pelagic longline directed to small tuna species, are indeed the main threat for the species at sea. There is also evidence of more irregular bycatch by purse-seiners, and occasionally by trawlers (Abelló and Esteban 2013).

Mortality obtained in these recent studies is likely to be underestimated especially due to the difficulty of detecting large scale mortalities. For this reason more information is necessary to obtain an accurate mortality estimate and assess the real problem of bycatch in the Mediterranean sea. In any case, seabird bycatch in this region seems unsustainable, especially for the critically endangered Balearic shearwater.



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4.3. Use of discard

So far the species makes extensive use of discards, estimated in 40% of energetic needs during the breeding period (Arcos and Oro 2002, Navarro *et al.* 2008). Foraging patterns are also influenced by discard availability, as revealed by the analysis of tracking data (Bartumeus *et al.* 2010). Still small pelagic fish seems to be the relevant prey (Louzao *et al.* 2006a), and discard reductions should not have a too detrimental effect if small pelagic fish populations do recover at the same time (Louzao *et al.* 2006a, Arcos *et al.* 2008).

5. PERSPECTIVES

Following these new results, more work is needed

- To get precise updated information on population distribution and trends, at a transnational scale.
- To improve the monitoring of breeding population size, considering the possibility of finding new colonies elsewhere.
- To update estimation of demographic parameters of populations, particularly survival (through capture-recapture monitoring and modeling), and properly assess demographic trends
- To implement/keep monitoring programmes that allow collecting information on breeding and migration performance, demography and trends on the medium and long term, both at the breeding site and at sea.
- To implement programmes of predator control in the most affected colonies, particularly addressing the most challenging issue of feralcats.
- To get quantitative information on bycatch in the Mediterranean sea and in Atlantic area (i.e. better knowledge on the interaction with fisheries, and better information on fishing effort), test potential mitigation measures and implement the most relevant ones.
- To evaluate importance of fishery interactions (through assessment of effects of discards on the Balearic shearwater population).
- To assess interactions with other human activities (windfarms, acute and background pollutions)

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