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Seabird bycatch in Spanish Mediterranean large pelagic longline fisheries, 2000-2008

Salvador García Barcelona, José M. Ortiz de Urbina, José M. de la Serna, Enrique Alot and David Macías[a]

Centro Oceanográfico de Málaga, Instituto Español de Oceanografía, Puerto pesquero, s/n 29640 Fuengirola, Spain

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Abstract – Incidental catch or bycatch represents a significant threat for the conservation of seabird populations. The western Mediterranean is an important fishing area where the Spanish pelagic and semi-pelagic longline fleet targeting swordfish (*Xiphias gladius*), bluefin tuna (*Thunnus thynnus*) and albacore (*Thunnus alalunga*) operates. Bycatch of these fisheries includes several seabird species. Given the importance of conservation of the bycatch species (marine mammals, turtles, sharks and seabirds), an on-board observer program was implemented by the Spanish Oceanographic Institute (IEO); this included collecting data on effort and catch, as well as weight and number of individuals of the main bycatch species. The aim of the present study is to report data on seabird bycatch collected by the on-board observer program of the IEO in the Western Mediterranean. Data on seabird bycatch were collected for the period 2000-2008, throughout the year. Six longline gears targeting large pelagic fish were identified operating in the area of study, but only three had an effect on seabird species. Differences in catch per unit effort (CPUE, birds per 1000 hooks) for each gear, as well as their effect on particular seabird species, are reported in this study. A total of 4 786 466 hooks were monitored, which yielded 182 seabirds belonging to 7 different species. The average CPUE for the studied period was 0.038 birds per 1000 hooks. Cory's shearwater (*Calonectris diomedea*) and yellow-legged gull (*Larus michahellis*) were the species the most highly represented in the catch. In contrast, Balearic shearwater (*Puffinus mauretanicus*) was only present in the longline fishery targeting albacore (CPUE = 0.005 birds per 1000 hooks). Our results suggest that Cory's shearwater is the species the most affected by the longline fishery in the Western Mediterranean, probably due to its biological characteristics, and corroborate the well-established downward trend in its population.

Key words: Bycatch / Seabird / CPUE / Western Mediterranean Sea / Pelagic longline

Résumé – Les captures fortuites ou accessoires représentent une menace considérable pour la sauvegarde des populations d'oiseaux de mer. La partie occidentale de la Méditerranée est une zone importante de pêche où la flotte espagnole de palangriers pélagiques et semi-pélagiques opère et cible l'espadon (*Xiphias gladius*), le thon rouge (*Thunnus thynnus*) et le germon (*Thunnus alalunga*). Les captures accessoires de ces pêches incluent plusieurs espèces d'oiseaux de mer. Étant donnée l'importance de la protection des espèces capturées accidentellement (mammifères marins, tortues, requins et oiseaux de mer), un programme a été mis en place par l'Institut espagnol d'Océanographie (IEO) : des observateurs étant à bord collectent des données d'effort de pêche et de capture, aussi bien que le nombre d'individus et le poids des principales espèces des prises accessoires. L'objectif de cette étude est de rapporter les données de captures accessoires des oiseaux de mer, collectées par ce programme de l'IEO et concernant la zone occidentale de la Méditerranée. Ces données concernent la période 2000-2008, collectées tout au long de l'année. Six types de palangres ciblant de grands poissons pélagiques sont identifiés et utilisés dans la zone d'étude, mais trois seulement ont un effet sur les oiseaux de mer. Des différences de capture par unité d'effort (CPUE, oiseaux par 1000 hameçons) pour chaque engin de pêche, aussi bien que leur effet sur une espèce en particulier sont rapportés ici. Un total de 4 786 466 hameçons a été analysé, qui comportait 182 oiseaux appartenant à 7 espèces différentes. La moyenne des prises par unité d'effort pour la période étudiée est de 0,038 oiseaux par 1000 hameçons. Le puffin cendré (*Calonectris diomedea*) et le goéland leucophée (*Larus michahellis*) sont les espèces les plus représentées dans les captures. En revanche, le puffin des Baléares (*Puffinus mauretanicus*) est seulement représenté dans les pêches à la palangre ciblant le germon (CPUE = 0,005 oiseaux par 1000 hameçons). Nos résultats suggèrent que le puffin cendré est l'espèce la plus affectée par la pêche à la palangre dans la zone occidentale de la Méditerranée, probablement due à ses caractéristiques biologiques, et corrobore la tendance à la baisse bien établie de sa population.

[a] Corresponding author: david.macias@ma.ieo.es

1 Introduction

Incidental catch or bycatch represents 8% of global fisheries production (Kelleher 2005). Bycatch is defined as any unwanted species caught during normal fishing operations and may include non-target fish species, marine mammals, turtles, sharks and seabird (Hall 1996; Alverson 1999). Seabirds represent less than 0.1% of the reported bycatch biomass, but this can significantly impact seabird populations (Croxall et al. 1990).

Bycatch by drifting longlines is considered an important threat to the conservation of several seabird species. Worldwide, Procellariformes appear to be highly affected by bycatch mortality due to their life history (Brothers et al. 1999). Seabirds attempt to feed on baited hooks deployed during fishing operations and can become hooked themselves (Brothers 1991). Scientific data on bycatch in the western Mediterranean are scarce (Belda and Sanchez 2001; Cooper et al. 2003; Valeiras et al. 2003; Guallart 2004), although this is an important fishing area where the Spanish pelagic and semi-pelagic longline fleet targeting swordfish (*Xiphias gladius*), bluefin tuna (*Thunnus thynnus*) and albacore (*Thunnus alalunga*) operates. Bycatch in these fisheries includes several seabird species (Valeiras et al. 2003; Guallart 2004).

Several studies have shown large inter-annual fluctuations in seabird bycatch rates (Klaer and Polachek 1997; Weimerskirch et al. 2000). Furthermore, fluctuations have also been observed on seasonal (Klaer and Polachek 1997), monthly (Weimerskirch et al. 2000; Jimenez et al. 2009) and diurnal (Barnes et al. 1997; Melvin et al. 2001) scales. The degree of overlap between longline effort and the preference of oceanic habitat by the seabirds can also influence vulnerability (McCracken 2001; Hyrenbach et al. 2002).

In this paper, we describe the seabird bycatch rates in the longline fisheries of the Western Mediterranean.

2 Materials and methods

2.1 Fishery description

The primary fisheries targets include swordfish (*Xiphias gladius*), bluefin tuna (*Thunnus thynnus*) and albacore (*Thunnus alalunga*). The Spanish surface longline fleet from the Mediterranean ports for the studied period consisted of 89 vessels (annual average) licensed by Spain for surface longline fishing all year round. Vessel length ranged from 12 to 27 m and fishing trips were often of short duration (1 to 6 days). In addition, more than 2000 smaller boats licensed for artisanal gears including surface/bottom longlines operated mainly in summer (http://www.mapya.es). But from 23 June 2009, only vessels licensed for surface longline were allowed to catch and land swordfish (Order ARM/1647/2009, 15 June of Ministry of Environment and Rural and Marine). The fishing grounds involved a large area of the western Mediterranean basin, between 36° and 44°N and 02°W and 05°E, and included 3 different fishing areas: (1) Alboran Sea, used at least once by approximately 5% of the operative fleet; (2) south-western Mediterranean Sea (primarily around the Balearic Islands and the Ibiza Channel), used by approximately 80% of the operative fleet; and (3) north-western Mediterranean Sea (primarily the Ebro Delta), where approximately 15% of the fleet operated (Valeiras and Camiñas 2003; Camiñas et al. 2006; Báez et al. 2007). A total of 2278 fishing operations were observed onboard from January to December, during years 2000 to 2008, which represented 4 786 466 hooks observed directly. We defined one fishing operation (set) as a daily cycle of longline setting and hauling.

Table 1. Measures of two components which take part in the depth of hooks.

	Length of rope from the buoy (a) in meters	Length of the hook line (b) in meters
Bottom longline (LLPB)	0.25	4.5
Traditional longline (LLHB)	4	7
American longline (LLAM)	7–15	12
Semi-pelagic longline (LLSP)	150	7
Bluefin tuna longline (LLJAP)	7–15	18
Albacore longline (LLALB)	6	6

We classified the fleet into six *strata*, according to differences in target species, operational depth and technical characteristics. A general scheme of these gears and differences in the measures that affect operational depth are shown (Fig. 1, Table 1), and the technical characteristics are summarized in Table 2. A short description of each gear is detailed below.

Traditional longline (LLHB)

The length of traditional drifting longline targeting swordfish is variable, ranging from 37 to 65 km and capable of setting 1500 to 4000 hooks. The main line hangs from floats and the information recorded by means of depth sensors indicates that the average depth of surface hooks is 30 m (maximum depth 50 m). The dimensions of the hooks used are 7.5 × 2.5 cm, usually baited with mackerel (*Scomber scombrus*) or chub mackerel (*Scomber japonicus*) ranging in size from 25 to 30 cm (total length). Depending on both the fishing season and bait price, hooks can also be baited with forage fish such as Atlantic saury (*Belone belone*) or silver scabbardfish (*Lepidopus caudatus*). In addition, chemical and electrical lights are used to attract prey. Setting of this gear begins in mid-afternoon and lasts until after sunset. Gear retrieval begins in the early hours of the morning and lasts until mid-morning. This gear is used throughout the year.

American longline (LLAM)

American long-line (monofilament) is a gear that was imported from the Italian and American long-liners in the early 2000s. After gaining a strong foothold in the fleet between 2003 and 2005, its use has been relegated mainly to the Atlantic fishing grounds.

Unlike the traditional longline, monofilament long line reaches 90 to 100 km in length with a smaller number of hooks (900 to 1100), implying a greater distance between each hook. Fishing depth is greater, with deepest hooks working at 70 m

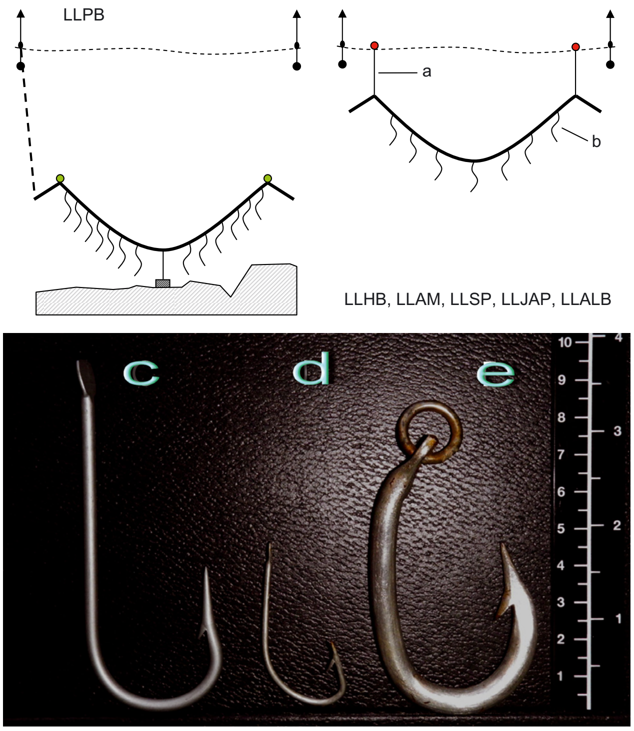

Fig. 1. Schemes of longline gears monitored in this study; *Left*: bottom longline (LLPB), *Right*: traditional longline (LLHB), American longline (LLAM), Semi-pelagic longline (LLSP), Bluefin tuna longline (LLJAP), and Albacore longline (LLALB); Float line length (a) and length of hook line (b) are the two main measures that affect the fishing depth. Pictures of different hooks (scale in cm and inches) used during this study: *J-shape hook* Mustad Nº 2 (c) for LLAM, LLHB, LLPB and LLSP, *J-shape hook* Mustad Nº 5 (d) for LLALB, and *C-shape hook* (e) for LLJAP.

below the sea surface. Monofilament longline allows the distance between hooks to be varied for each set. Normally, hooks are separated by 70 to 90 m, which allows faster hauling. Furthermore, soak time is larger than for the traditional longline.

Both the mainline and the branch lines are thicker than in traditional longline, and hooks are equipped with weights of 30 to 70 g, which increases the bait sinking rate. As regards the hook type and bait, both are the same as in traditional longline. Like the LLHB, the LLAM is used throughout the year.

Bottom longline (LLPB)

This gear is operated by the longline fleet mainly from July to October, although its use is not regulated by the current swordfish fishing legislation. It is also used by traditional vessels with small Gross Register Tonnage (GRT), operating in coastal waters or grounds near their home port. LLPB is a variant of the bottom longline targeting silver scabbardfish, consisting of a longline similar to the traditional one, but with a shorter distance between hooks and fixed at the bottom by means of a few weights or stones interspersed between floats. It is not a drifting longline and is usually employed close to the continental slope. The number of hooks in each fishing set does not usually exceed 900, reaching only 600 hooks in many cases. The bait used is usually mackerel (*Scomber* sp.) or round sardinella (*Sardinella aurita*).

Half water or semi-pelagic longline (LLSP)

Since 2006, an improved surface longline has been used by the fleet in the Mediterranean. The improvement involves increasing the depth of the hooks during the months when the sea surface temperature is higher (summer). Hooks work at depths around 150–200 m and deeper. The gear is similar to the traditional longline, but with the peculiarity that the number of hooks between floats is larger and some weights or stones are placed along the mainline (Fig. 2). These modifications give the gear greater stability against the currents and also enhance the depth of hooks in the water column. Because the speed of setting is less than for traditional longline, the number of hooks set does not usually exceed 1500. Bycatch at these depths is very small, with very low catches of sea turtles and sharks. The LLSP is used in a seasonal way, mainly from July to October.

Bluefin tuna longline (LLJAP)

This is a monofilament longline used exclusively during the months of May, June and the first half of July, which is the period when bluefin tuna enter the Mediterranean to breed. The differences between this gear and the swordfish monofilament longline are that the fishing depth is greater, the bait is almost always squid (*Illex* sp.) bigger than 500 g, and the gear remains working for 24 hours. The number of hooks by set does not exceed 1200.

Albacore longline (LLALB)

This is the shallowest longline gear. Both the size of the hook and the thickness and length of the fishing lines is lower than other longlines. Between 2000 and 7000 hooks are set and the bait used is sardine (*Sardina pilchardus*). LLALB is a drift longline, which operates in high-sea fishing grounds at bottom depths up to 1500 m and is employed mainly from July to October.

Only three of the six monitored gears in this study caught any seabirds: LLPB, LLHB and LLALB (1461 sets). The average CPUE for the studied period was 0.038 birds per 1000 hooks. The average CPUE for gears with bycatch was 0.049 birds per 1000 hooks. Table 5 shows the average CPUE per gear.

2.2 Data collection

Catch and effort data for the above-described fisheries were collected by the Spanish Oceanographic Institute (IEO) on-board observer training program, planned according to ICCAT recommendations. Observers were assigned based on strata. The positions of the fishing grounds and spatial distribution of gear effort are shown (Fig. 2).

The IEO on-board observer Program (IEO-OP) provided commercial fish catch and bycatch data collected on longline vessels from 1997 to 2009. Seabird bycatch data were collected from 2000 to the present day, so we only included the

Table 2. Technical characteristics of longline fishing gears operating in the Western Mediterranean.

Gear	Target species	Drifting gears vs stationary	Hook/set	Hook size (cm)	Distance between hooks (m)	Set length (km)	Time of day (Setting)	Setting duration (h)	Bottom (m)	Bait	Bait size (cm)	Light added	Weight added	Fishing period/year	Seabird incidence
LLHB	Swordfish	Drifting	1500.-4000	7.5 × 2.5	22	37.-65	Evening	3-4	> 80	Mackerel Small mackerel Chub mackerel Sardine Atlantic saury Round sardinella Silver sccabardfish Squid	23 16 23 17 25 20 70 18	Variable	No	All year but lesser activity from March to April	YES
LLAM	Swordfish	Drifting	900.-1100	7.5×2.5	70.-90	90.-110	Evening	4-5	> 250	Mackerel Chub mackerel Squid Round sardinella	23 23 22 20	Yes	Yes	From 2002 to 2007, all year expected May to July. Lesser activity in winter. Since 2008, greater activity in Atlantic Ocean	NO
LLSP	Swordfish	Drifting	900.-1500	7.5 × 2.5	33	37.-65	Early morning	3-4	> 300	Mackerel Chub mackerel Squid Round sardinella	23 23 22 20	Variable	Yes	Only since 2006. Mainly summer months after July until October	NO
LLPB	Swordfish	Stationary	600.-900	7.5 × 2.5	12	11.-28	Early morning	1-2	< 400 & > 80	Mackerel Chub mackerel Silver sccabardfish	23 23 70	Variable	Yes	Mainly summer months, since July to October. Some cases until December	YES
LLJAP	Bluefin tuna	Drifting	250.-1200	7.5 × 3.0	50-70	9.-90	Variable	1.-6	> 400	Great squid Great mackerel Bogue	30 33 16	No	Yes	Mid-May to early early July	NO
LLALB	Albacore	Drifting	2000.-7000	4.3 × 1.7	16	35.-90	Variable	3.-6	> 800	Sardine	15	No	No	Mainly summer months, since July to October	YES

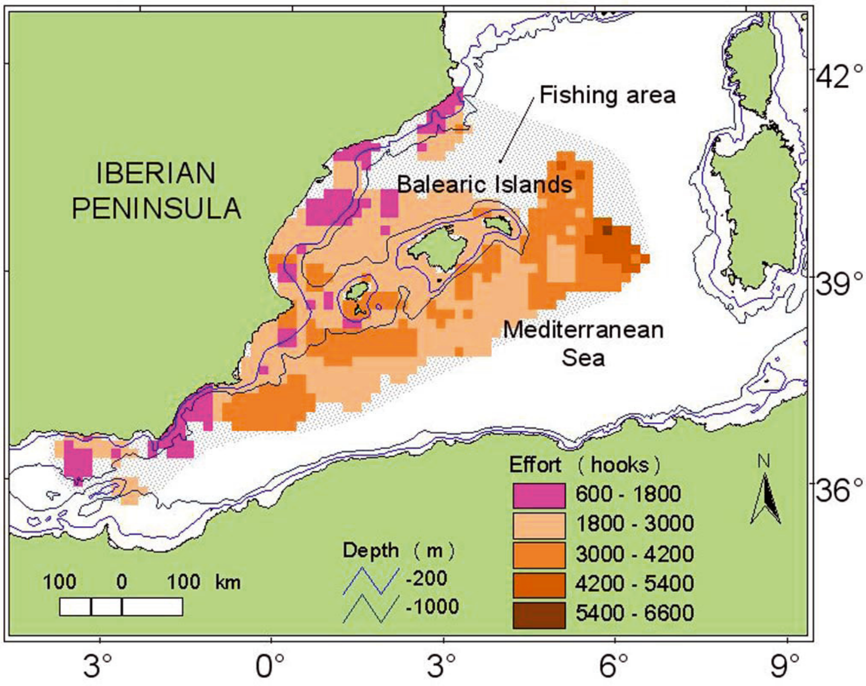

Fig. 2. Spatial distribution of observed fishing effort and known fishing grounds.

Table 3. Sampling effort with the annual catch of seabirds and CPUE.

Observed effort					Observed gear effort						Observed capture seabirds	
Year	On board period	No. of sets	No. of hooks	% Observed effort	LLHB	LLALB	LLPB	LLAM	LLSP	LLJAP	*n* observed	Annual CPUE
2000	29 Feb.-1 Dec.	450	1 219 346	8.74	1 034 192	18 650	19 200	0	0	147 304	47	0.039
2001	7 May-19 Nov.	255	712 851	4.55	651 774	0	2000	0	0	59 077	27	0.038
2002	17 May-27 Nov.	167	524 263	3.86	424 507	0	39 856	0	0	59 900	10	0.019
2003	8 May-20 Dec.	176	358 625	2.65	219 244	0	13 632	47 677	0	78 072	1	0.003
2004	13 May-4 Dec.	268	367 018	3.20	113 610	0	29 356	169 004	0	55 048	11	0.030
2005	2 May -19 Dec.	97	112 710	1.28	46 828	0	0	12 150	0	53 732	1	0.009
2006	5 May -5 Dec.	247	517 548	3.85	147 340	245 488	32 615	73 893	0	18 212	13	0.025
2007	22 Feb.-18 Dec.	274	459 742	3.03	215 840	87 202	83 767	6957	10 100	55 876	25	0.054
2008	28 Jan. -21 Dec.	344	514 363	3.95	236 394	39 904	34 208	23 378	156 031	24 448	47	0.091
Total		2278	4 786 466								182	0.038

2000-2008 period in the present study. For each fishing set observed, data were recorded on fishing set location, time of setting and hauling; environmental data (sea surface temperature, distance to the coast, depth and weather conditions), soaking duration; gear characteristics (total length, mean depth, number of hooks, etc.); type and size of bait; species composition; and corresponding biological information (size/weight). Within each sampled set, observers monitored 100% of the total hooks retrieved and recorded information on species composition, number and estimated weight of both target species and bycatch including seabirds. In addition, the environmental variables listed above were also recorded.

With regards to seabirds, the work of observers was to record captures and identify specimens to the lowest taxonomic level possible. However, at the beginning of the temporal series, as the observers had little experience with seabirds, many specimens could not be identified and/or recorded. The accuracy of the data improved gradually reaching and now has a high degree of precision. Table 3 shows the annual sampling coverage in terms of fishing season, effort and gear type.

2.3 Data analysis

We calculated annual seabird bycatch rates as the total number of individual seabirds caught in a year divided by the number of hooks deployed (CPUE). In addition, we calculated the average annual CPUE as the mean of CPUE per set (all sets in a year) and standard errors for the entire seabird group and also for Cory's shearwater, to explore patterns in the data. A

Table 4. Seabirds species caught by longline fisheries in the study period.

Species		IUCN status	Birds caught	Capture of seabirds: Sets that caught birds	Capture of seabirds: Average birds/set**	Capture of seabirds: Range**
Cory's shearwater	*Calonectris diomedea*	Least concern/Endangered*	67	25	2.7 (± 5.8)	1-30
Balearic/Mediterranean shearwater	*Puffinus mauretanicus/P. yelkouan*	Critically endangered/Near threatened	2	2		
Yellow-legged gull	*Larus michahellis*	Least concern	68	31	2.2 (± 2.6)	1-14
Audouin's gull	*Larus audouinii*	Near threatened	1	1		
Great skua	*Catharacta skua*	Least concern	1	1		
Northern gannet	*Morus bassanus*	Least concern	28	14	2.0 (± 1.7)	1-6
Shearwaters	*Calonectris/Puffinus* spp.		2	2		
Gulls	*Larus* spp.		8	3		
Cormorants	*Phalacrocorax* spp.	Least concern	5	1		

*Subspecies *C. d. diomedea*
**Sets with catches

Table 5. CPUE (birds per 1000 hooks) for LLHB, LLALB and LLPB (excluded unidentified birds).

	Calonectris diomedea	*Puffinus yelkouan/P. mauretanicus*	*Phalacrocorax* spp.	*Morus bassanus*	*Catharacta skua*	*Larus michahellis*	*Larus audouinii*	CPUE Total (including the unidentified birds)
LLALB	0.028	0.005	0.000	0.000	0.003	0.000	0.003	0.046
LLHB	0.008	0.000	0.000	0.009	0.000	0.022	0.000	0.041
LLPB	0.118	0.000	0.020	0.000	0.000	0.000	0.000	0.141

chi-square test (Sokal and Rohlf 1995) was used to test for statistically significant differences in number of seabirds caught between gear strata and between levels of fishing effort by year.

To estimate the average annual seabird bycatch, we calculated the observed annual CPUE (average annual CPUE per set). After that, we calculated the average number of seabirds caught each year, extrapolating the observed annual catch rates (CPUE) to the total annual effort. Finally, we calculated the mean number of seabirds and standard errors in the period studied. The average annual number of Cory's shearwaters was calculated using the same methodology.

2.4 Spatial representation of fishing area and effort

Geographical coordinates of all fishing operations (setting and hauling) were recorded using a GPS (Datum WGS 84). The begin set point was used to represent the fishing effort (number of hooks set). Afterwards, effort values were interpolated to grids of 15 × 15 km in order to maintain confidentiality requirements. Seabird bycatch of each set was represented using CPUE (birds per 1000 hooks). Maps were projected in UTM, zone 31N.

Spatial representations of fishing effort and seabird bycatch were made using ESRI ArcView 3.2 software and the Spatial Analyst and Xtools extensions.

3 Results

Bycatch of seabirds for the 2278 observed fishing sets in the 9-year period covered in this study (4 786 466 hooks) amounted to 182 birds of at least 7 species (Table 4). These included yellow-legged gull (37.4%), Cory's shearwater (36.8%), northern gannet (15.4%), cormorants (2.7%), Balearic/Mediterranean shearwater (1.1%), Audouin's gull (0.5%), and great skua (0.5%).

The gear with the highest incidental catch of seabirds was LLHB (n = 128 seabirds), followed by LLPB (n = 36 seabirds) and LLALB (n = 18 seabirds). There were significant differences in bird catch between fishing gears (λ^2 = 109.13, degrees of freedom 5, $p < 0.05$) as well as between levels of annual fishing effort for the years in the studied time series (Chi value 63.82, degrees of freedom 8, $p < 0.05$).

LLPB had the highest CPUE (0.141 seabirds per 1000 hooks) and mainly affected *Calonectris diomedea* (83%), *Phalacrocorax* spp. (14%), and one unidentified shearwater, probably *Calonectris diomedea* (3%). Seabird catches by LLPB were very rare; they occurred in only 3 of the 209 monitored sets, including one set with 30 *Calonectris diomedea* (Fig. 3a).

LLALB showed a CPUE of 0.046 seabirds per 1000 hooks, affecting mainly *Calonectris diomedea* (60%), *Larus* spp. (17%), *Puffinus mauritanicus/yelkouan* (11%), *Catharacta skua* (6%), and *Larus audouinii* (6%). Figure 3b shows spatial distributions of this gear and its corresponding seabird catch.

LLHB had an average CPUE of 0.041, slightly lower than that for LLALB. This gear mainly affected to *Larus michahellis* (53%), *Morus bassanus* (22%), *Calonectris diomedea* (20%), *Larus* spp. (4%) and 1% of other species. Figure 3c shows observed effort of LLHB and its corresponding bird catch values.

The average annual effort for the Spanish pelagic longline fleet is 13 164 660 ± 1 572 341 hooks. Based on the average annual effort for the Spanish pelagic longline and the average annual CPUE, an average total bycatch estimate for the fleet for this period was around 500 birds per year including approximately 200 Cory's shearwaters (Table 6).

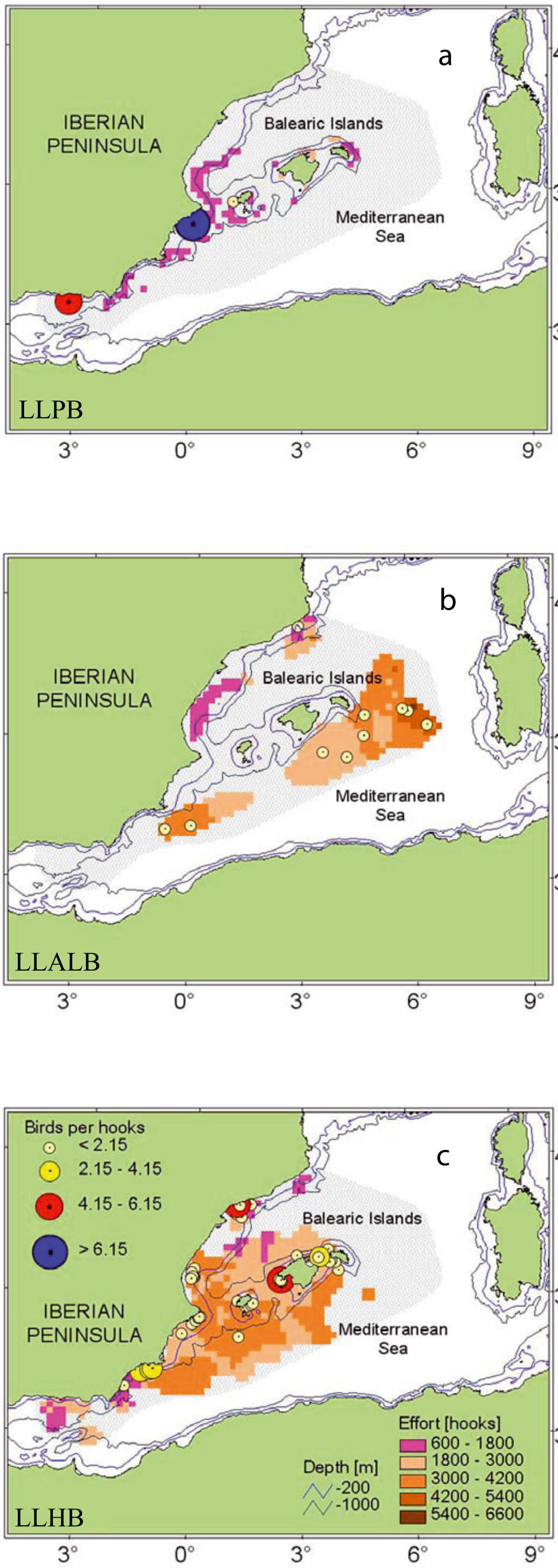

Fig. 3. Fishing effort (number of hooks) and CPUE of sets with by-catch (seabirds per 1000 hooks): Swordfish bottom longline (a); Albacore pelagic longline (b); Swordfish pelagic longline (c).

4 Discussion

The most common species caught by the longline fisheries in the western Spanish Mediterranean was the yellow-legged gull, followed by Cory's shearwater, northern gannet, cormorants, Balearic/mediterranean shearwater, Audouin's gull, and great skua. These results are similar to those of Valeiras and Camiñas (2003), Belda and Sanchez (2001) and Guallart (2004). In addition, our results indicate that the impact of the pelagic and semi-pelagic longline on the Balearic shearwater population (1750–2125 breeding pairs according to Arcos and Oro 2004) is particularly low (0.05%), in contrast with the higher effect (0.23%) on the Mediterranean Cory's shearwater population (14 000–17 000 breeding pairs according to Carboneras 2004). LLALB is the only gear with a real impact on Balearic shearwater. We suggest that other artisanal or bottom longlines fisheries targeting species like European hake (*Merluccius merluccius*) or porgies (Sparidae) could have higher impact on these seabird species. These other fisheries differ clearly from LLPB because these artisanal boats operate in the Winter-Spring season close to the coast, using smaller hooks and mainly sardine as bait. In fact, at least 60 Balearic shearwaters were reported to have been caught by a single bottom longline boat off the Catalonian coast (Alegre et al. 2008).

In our study, LLJAP, LLSP and LLAM had no catch of seabirds. Due to the fact that LLSP had the shortest temporal series (2007-2009) and that sampling coverage was lower, more attention should be paid to this gear in the future in order to determine its real impact on seabird populations. These data partially agree with those of Valeiras and Camiñas (2003). These previous authors monitored only four gears, LLALB, LLHB, LLPB and LLJAP, obtaining seabird catch only in LLALB and LLHB.

The overall CPUE for the three gears with seabird catch (LLPB, LLHB and LLALB) in our study was 0.049 birds per 1000 hooks, which is lower than that found by other authors in Columbretes Islands (0.220, Guallart 2004; Belda and Sanchez 2001), but higher than that found by Valeiras and Camiñas 2003 (0.013). Taking into account the annual average fishing effort for the Spanish pelagic longline, we estimated an average total bycatch for the fleet of around 500 birds per year. In a similar way to Valeiras and Camiñas (2003), our data indicate that incidental seabird catch rates by Spanish drifting longline fisheries in the Western Mediterranean are lower than those in other areas and other fisheries.

Our results indicate that LLHB shows the highest incidental catch of seabirds (mainly *Larus michahellis*) and LLPB has the highest CPUE (0.141 seabirds per 1000 hooks), affecting mainly *Calonectris diomedea* (83%). Differences in bycatch rates can be attributed to differences both in selectivity between gears and fishing strategy. In this sense, LLALB operates with smaller hooks and bait, affecting mainly shearwater; and LLHB high catch of yellow-legged gull could be explained by the setting of this gear close to the shore, near to the breeding areas of this species. Seabird catches of LLPB are very erratic, showing high catch concentrated in a few sets. Other authors provide records regarding the unusually high catch of Procellariformes in undefined longlines in North East peninsular waters: 32 *Calonectris diomedea* on October 5th 2004 (Ramos et al. 2009) and at least 60 *Puffinus mauretanicus* on

Table 6. Annual average total seabirds and average total Cory's shearwater bycatch estimates for the longline fleet.

Year	Effort (hooks)	Seabird CPUE	Estimated bird bycatch	Sm	Cory's shearwater CPUE	Average Cory's shearwater bycatch	Sm
2000	13 937 734	0.042	582.0	154.59	0.008	107.2	71.74
2001	15 644 579	0.027	417.4	133.35	0.014	216.4	86.55
2002	13 581 466	0.016	219.3	74.64	0.008	104.6	54.75
2003	13 528 859	0.002	31.4	31.43	0.000	0.0	0.00
2004	11 468 957	0.024	275.6	167.84	0.001	17.2	17.16
2005	8 747 653	0.006	50.1	50.10	0.000	0.0	0.00
2006	13 411 729	0.025	337.8	256.51	0.004	55.8	29.22
2007	15 151 908	0.039	598.9	399.53	0.004	67.9	52.28
2008	13 009 064	0.157	2042.2	1601.82	0.122	1584.7	1584.70

Average 2000–2008
Total bird bycatch: 506.1 ± 203.4
Cory'shearwater: 239.3 ± 169.7

May 16th 2008 (Carboneras, pers. comm.). The nature of the variables that could be causing such high seabird catch events in this area deserves a more in-depth study.

In conclusion, our results indicate that the main shearwater species affected by drifting longlines in this area is the Cory's shearwater. The impact on the Balearic shearwater population is particularly low. Population impact of drifting longlines on Cory's Shearwater and the variables that could be affecting its catch will be studied in the near future.

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