

EVALUATION OF SEABIRD BY-CATCH MORTALITY AS A CONSERVATION THREAT IN THE SOUTHERN IONIAN SEA (EASTERN MEDITERRANEAN)

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Abstract

Numerous studies worldwide have shown that incidental catches (by-catch) of seabirds in fishing gears might pose a considerable risk for the conservation of their populations. Nevertheless reliable data on by-catch rates of seabirds are patchy and need to be completed in the European marine ecosystems. This study constitutes a first attempt for the evaluation of the by-catch rates in the Southern Ionian Sea. Data were obtained by distributing a specific questionnaire to fishermen of Zakynthos Island. A number of 150 professional fishermen (owning 90% of the local piscatorial fleet) corresponded to our research, under an interview orientated methodological approach during July-December 2010. The collected information showed that commercial longline and (to a lesser extent) gillnet fishery gears cause incidental catches mostly of Cory's Shearwaters and Mediterranean Shags. The temporal analysis of the incidental bird mortality shows that seabirds were more susceptible to be trapped on fishery gears set around sunrise during spring and summer whereas spatial analysis of by-catch data indicated variations in the number of seabirds caught in different fishery areas.

Keywords: incidental catch, longline, gillnet, Scopoli's Shearwater, Mediterranean Shag

1. Introduction

Fisheries-Seabird interactions include both negative (e.g. prey depletion) and positive (e.g. food provision via fisheries discards) influences on marine birds' population (Tasker *et al.*, 2000; Montevecchi, 2002; Louzao *et al.*, 2011). Entrapment of seabirds in fishing gear constitutes one of the most significant direct negative effects of the fisheries industry. Numerous studies worldwide have demonstrated that incidental catches (by-catch) of seabirds in fishing gears potentially pose a considerable risk to their populations (Weimerskirch & Jouventin, 1987; Brothers *et al.*, 1999). The problem of seabird by-catch in commercial (mostly longline and gillnet) fisheries has been particularly acute in the southern oceans and has mainly affected various species of albatrosses and petrels (Brothers, 1991; Favero *et al.*, 2003). However, the available data on seabird by-catch mortality is less well known for European Union's marine ecosystems whereas in the Eastern Mediterranean are still patchy and insufficient to determine the rates of seabird by-catch and its impact on seabird populations (Cooper *et al.*, 2002).

In Mediterranean, species known to be implicated in incidental by-catch on fishing gears are Scopoli's (*Calonectris diomedea*), Balearic (*Puffinus mauretanicus*) and Yelkouan (*Puffinus yelkouan*) Shearwaters, Mediterranean Shag (*Phalacrocorax aristotelis desmarestii*), Audouin's (*Larus audouinii*) and Yellow-legged (*Larus michahellis*) gulls (ICES, 2008; Dimech *et al.*, 2009). Some of these species are long lived, characterized by naturally high levels of adult survival and late onset of breeding, a low reproductive rate and a long breeding cycle. Increased adult mortality in species with these life history traits may undermine the stability of the regional population in the

long term (FAO, 2008). Therefore, there is an urgent need to assess the magnitude of the by-catch problem in the region and to promote adequate conservation measures to reduce the negative impacts on seabird species.

The present study was carried out as part of the LIFE07/NAT/GR/000285 project titled as “Concrete conservation actions for Mediterranean Shag and Audouin's Gull in Greece including the inventory of relevant Marine IBAs” and attempts to improve the understanding of patterns and seabirds affected by by-catch in the Ionian Sea and more specifically in the Prefecture of Zakynthos Island, as well as to identify the main types of fishing gear responsible for it and to estimate its impacts on local populations of seabird species listed in Annex I of the EU Bird's Directive.

2. Materials and methods

The data were collected through a questionnaire-based survey which was conducted in collaboration with the Fishery Department of the Prefecture of Zakynthos from July to December 2010. The questionnaire was distributed to local fishermen and was consisted of closed and open-ended questions. The method used was based on personal interviews with fishermen and the obtained data were analysed in a time-spatial scale. The collected fishery data included, fishery characteristics, types of fishing gear used, fishing months per gear type, marine fishing areas, average fishing days per month and average daily fishing effort (number of hooks per days for longlines and meters of nets for nets). The data related to seabird by-catch included main by-catch seasons, marine areas and average annual number of seabirds caught per seabird species per type of fishing gear. The questions relating to specific species incidentally captured were accompanied by images so as to increase the reliability of the collected data based on interviews.

The annual fishing effort for each fishery gear type was estimated from identified fishing months, average fishing days per month and mean daily fishing effort. For fisheries which use more than one type of gear during particular month, the proportion of fishing days were equally weighted for each type of gear (i.e. if a particular fishery is using both nets and bottom longlines during a particular month and the average number of fishing days is 20, then 10 fishing days are attributed to nets and 10 to bottom longlines). Seasonal fishing effort was estimated by adding up the monthly fishing effort for the respective months. Fishing areas for each fishery were identified on maps using 10x10 nautical miles grid.

The average number of birds incidentally caught per unit effort (per 1,000 hooks and km of loglines and nets, respectively) was initially estimated by dividing the annual by-catch with the annual fishing effort. It has been observed that seabird by-catch rates vary significantly among seasons, therefore seasonal by-catch rates were estimated for each species. Data for the type of fishery gear from the estimated seasonal fishing effort and incidental mortality seasons per type of fishing gear were provided by the fishermen. In order to acquire a rough estimation of seasonal by-catch rates, it was assumed that, for each fishery, by-catch rates are the same during all seasons when incidental catches occur. Following this way, estimation of by-catch rates takes into account the variations in fishing efforts and fishing areas among fisheries. The estimation of seasonal by-catch rates per species per fishing type were acquired by averaging the seasonal by-catch rates over all fisheries. The accuracy of the estimation is limited due to the fact that fishermen could not provide information on the total number of seabirds caught per season.

The acquired data from questionnaires were stored in an Access data-base and were further spatially examined in Arc GIS 9.3 software. The produced distribution maps represent the core fishing areas used by the local professional piscatorial fleet as well as the main marine areas of the Southern Ionian Sea where by-catch seabirds mortality occur.

3. Results

3.1 FISHING EFFORT

Information on the actual fishing effort was of crucial importance so as to relate it to the by-catch mortality of seabirds. Even if incidental catches of seabirds may occur in many types of fisheries (Davoren, 2007; Karpouzi *et al.*, 2007), the effort was focused on longline and gillnet since these fishing gears correspond to the main local fishing methods.

According to EU Fleet Register there were 189 fishing licenses issued on Zakynthos till the time of the current research. The present questionnaire study covered almost 79% of the local registered piscatorial fleet (150). The main fishing gears used by these fisheries surveyed were nets, bottom longlines (BLL) and surface longlines (SLL) with an estimated overall annual fishing effort of i) 31,420,897 m of nets (total annual average length of nets per fishery operation: 225,312 m), ii) 5,902,030 BLL hooks (annual average number of hooks per fishery operation: 42,158 hooks) and iii) 602,048 SLL hooks (annual average number of hooks per fishery operation: 13,088 hooks). The average number of fishing days per month was 15.3 days. The main fishing areas were located primarily in the coastal regions of Zakynthos Island and nearby islands (Kefalonia, Echinades, Ithaki, Strofadia) (Figures 1, 2, 3 & 4). Estimated seasonal fishing efforts are provided in Table 1.

Table 1: Estimated Fishing effort

Season	Nets [m]	No. of fishers	Bottom longlines [hooks]	No. of fishers	Surface longlines [hooks]	No. of fishers
Spring	7,552,441	137	1,462,196	124	196,368	38
Summer	6,985,941	135	1,597,282	124	225,875	40
Autumn	8,264,297	135	1,421,276	105	110,380	30
Winter	8,618,218	117	1,421,276	70	69,425	8
Annually	31,420,897	139	5,902,030	133	602,048	48

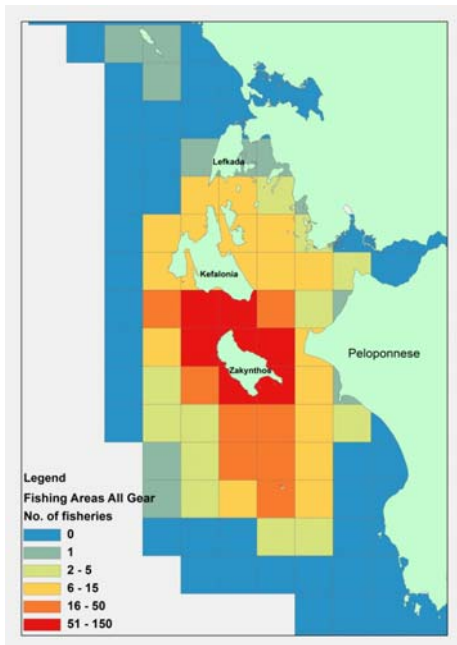


Figure 1. Fishing areas for all used fishing gears per year

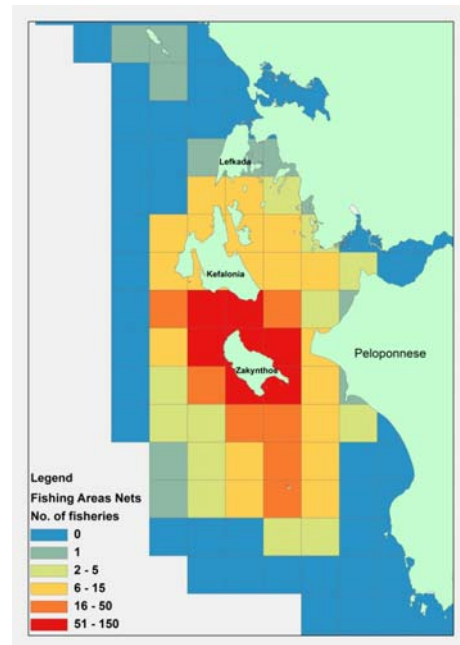


Figure 2. Fishing areas for nets per year

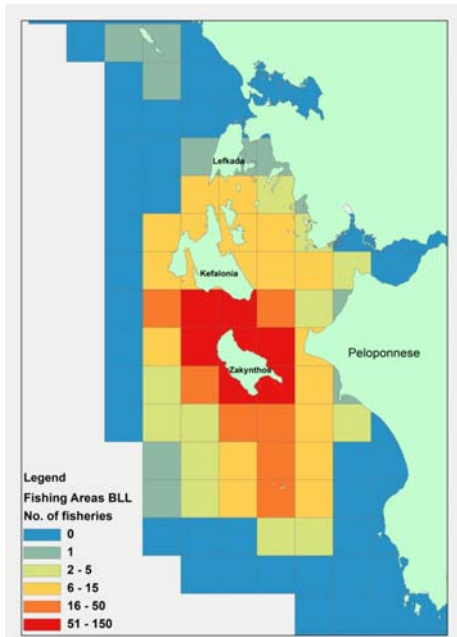


Figure 3. Fishing areas for Bottom Long Line per year

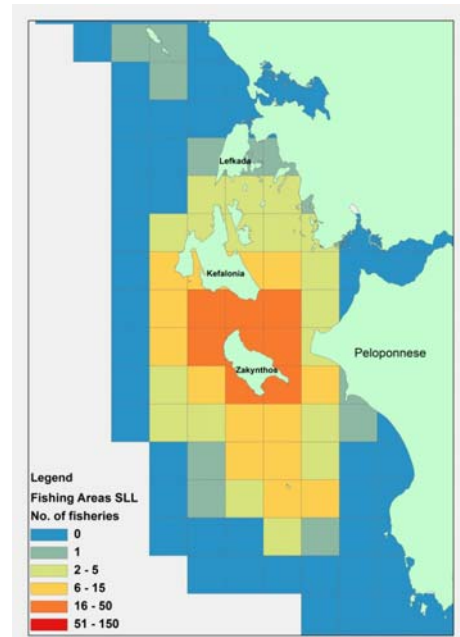


Figure 4. Fishing areas for Surface Long Line per year

3.2 BY-CATCH RATES

Incidental catches of seabirds occurred mainly in the coastal regions of Zakynthos Island, the southern coastal area of Kefalonia Island and the marine area around Strofades island complex (Figures 5, 6, 7 & 8). The initial estimation of by-catch rates was based on the total annual fishing effort and the total number of accidentally trapped birds per type of fishing gear per species.

The results (Table 2) indicate that Cory's Shearwaters are mostly susceptible to incidental mortality, primarily in BLL (by-catch rate 0.0626 birds/1,000 hooks) and SLL (by-catch rate 0.06976 birds/1,000 hooks). Mediterranean Shags have also been reported to be caught in BLL (by-catch rate 0.00071 birds/1,000 hooks) and gillnets (by-catch rate 0.00003 birds/km of nets) set near coastal areas which host small colonies.

On the other hand Audouin's Gulls as well as Yelkouan Shearwaters were not reported as species suffered from incidental catches in the Southern Ionian Sea.

Table 2: Estimated annual by-catch rates without considering seasonal variation of fishing effort and by-catch rates

Season	Nets [ind/1000m]	Total inds.	BLL [ind/1000hooks]	Total inds.	SLL [ind/1000hooks]	Total inds.
<i>Lar. audouinii</i>	0	0	0	0	0	0
<i>Phal. aristotelis</i>	0.00003	1	0.00071	4	0	0
<i>Cal. diomedea</i>	0	0	0.0626	351	0.06976	42
<i>Puf. yelkouan</i>	0	0	0	0	0	0

By-catch patterns were further elaborated by estimation of seasonal by-catch rates per species per gear type. Only Mediterranean Shag has been recorded to be caught in nets. Low number of caught birds resulted in low seasonal by-catch rates varying between 0.00001 and 0.00003 birds/km of nets. By-catch in nets has been recorded to occur during spring and summer (Table 3).

Table 3: Average by-catch per species per km of nets per season

Species	Total inds.	Annual	Spring	Summer	Autumn	Winter
<i>Lar. audouinii</i>	0	0	0	0	0	0
<i>Phal. aristotelis</i>	1	0.00001	0.00003	0.00003	0	0
<i>Cal. diomedea</i>	0	0	0	0	0	0
<i>Puf. yelkouan</i>	0	0	0	0	0	0

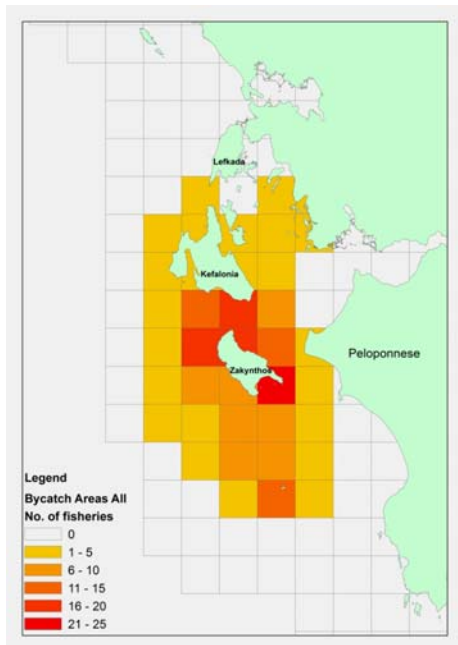


Figure 5. By-catch areas for all used fishing gears per year

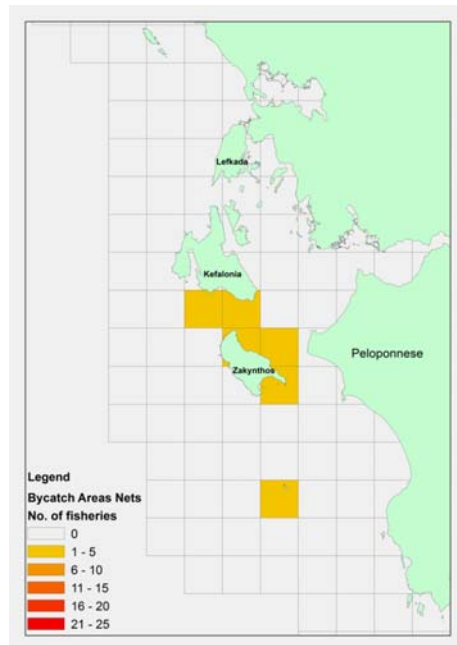


Figure 6. By-catch areas for nets per year

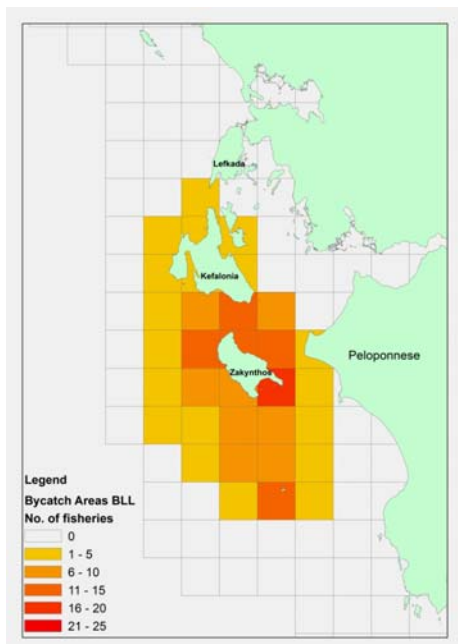


Figure 7. By-catch areas for Bottom Long Line per year

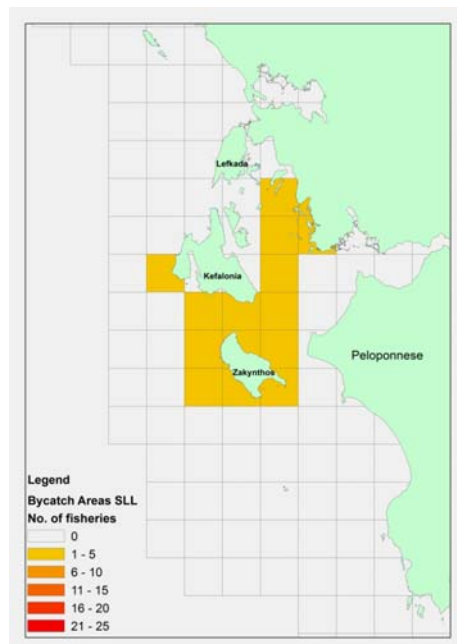


Figure 8. By-catch areas for Surface Long Line per year

BLL have been identified as a main type of fishing gear responsible for seabird by-catch. It is estimated that 351 Cory's Shearwaters are caught annually by the surveyed fisheries. The main by-catch seasons are spring and summer with by-catch rates up to 0.061 and 0.153 birds/1,000hooks respectively, however by-catch occurs also during autumn and winter months. In addition Mediterranean Shags are caught in BLL during spring and summer with by-catch rates to range from 0.00017 to 0.0042 birds/1,000hooks, respectively (Table 4).

Table 4: Average by-catch per species per 1000 bottom longline hooks per season

Species	Total inds.	Annual	Spring	Summer	Autumn	Winter
<i>Lar. audouinii</i>	0	0	0	0	0	0
<i>Phal. aristotelis</i>	4	0.00091	0.00017	0.0042	0	0
<i>Cal. diomedea</i>	351	0.05749	0.06175	0.15307	0.00405	0.00078
<i>Puf. yelkouan</i>	0	0	0	0	0	0

Among all seabird species only the Cory's Shearwater has been recorded to be caught in SLL. By-catch primarily occurs in summer (0.375 birds/1,000 hooks) and to a lesser extent during spring (0.0365 birds/1,000 hooks) (Table 5).

Table 5: Average by-catch per species per 1,000 surface longline hooks per season

Species	Total inds.	Annual	Spring	Summer	Autumn	Winter
<i>Lar. audouinii</i>	0	0	0	0	0	0
<i>Phal. aristotelis</i>	0	0	0	0	0	0
<i>Cal. diomedea</i>	42	0.04163	0.03655	0.375	0	0
<i>Puf. yelkouan</i>	0	0	0	0	0	0

4. Discussion

Entrapment in fishing gear constitutes a significant direct influence of fisheries on marine birds on a global level (Tasker *et al.*, 2000). On board observations, information from wildlife rehabilitation institutions as well as questionnaires have proven to be useful tools for the assessment of seabird by-catch (Belda & Sánchez, 2001; Dimech *et al.*, 2009). Previous experience in onboard surveys of by-catch in the Ionian Sea scarcely record seabird incidents due high cost and limited sampling coverage (Karris *et al.*, 2010), can be efficiently complemented by questionnaires to fishermen.

The five most abundant seabird species in the Southern Ionian Sea are Scopoli's Shearwaters, Mediterranean Shags, Yellow-legged Gulls, Audouin's Gulls and Yelkouan Shearwaters. All of these species have been identified to be implicated in incidental catches by fishing gear in the

Eastern Mediterranean (ICES, 2008), however, only the first two species have been recorded to be caught in significant numbers in the Southern Ionian Sea according to the current study.

Longlines, mainly BLL but also SLL have been identified as the main types of fishing gears causing seabird by-catch mortality in the study area. In general, seabird species which are more susceptible to longline by-catch are attracted to the fishing vessels in a first step as a result of food provision via fishery discards and used to forage near the sea surface, scavenge and steal bait from hooks (Montevecchi, 2002). This fact can explain the high rate of Scopoli's Shearwaters mortality on longlines which is in accordance with previous by-catch studies in the Mediterranean basin where the majority of individuals implicated in incidental by-catch referred to this long lived colonial pelagic species (Belda & Sánchez, 2001; Dimech *et al.*, 2009). In addition, incidental catches primarily occurred around sunrise and late afternoon, mainly by Cory's shearwaters and to a lesser extent by Mediterranean Shags which were waiting for the baited hooks to be deployed, and then attempted to capture the bait (usually sardines or squid).

In a species level and by extrapolating the by-catch rates to all 189 fishers registered in Zakynthos Prefecture, the estimated annual incidental mortality of 6.3 Mediterranean Shags in bottom longlines and nets represents approximately 3.0-5.1% of the 31-53 pairs breeding in Southern and Central Ionian Sea (HOS unpublished data). It is worthwhile to mention that gillnets have less negative effects than bottom longline hooks even if a recent study showed that the first fishery gear could pose a more significant threat for a coastal diving species as the Mediterranean Shag (Muntaner-Yanguela, 2004). The general aspect of by-catch rate of Mediterranean Shags in the Southern Ionian Sea gives a low level of incidental mortality. On the other hand the Greek population of this Cormorant species is estimated at 1,000-1,200 breeding pairs (BirdLife International, 2004) and the conservation pressure due to incidental catches should be further investigated.

Similarly, 495 Scopoli's Shearwater were estimated to be caught in longlines which represents 1.7-2.0% of the local population since Strofades island complex hosts about 5,000-6,000 breeding pairs (Karris *et al.*, 2009). Although by-catch of the Procellariiform species during pre-breeding period in early May affect birds which migrate via the Southern Ionian Sea to the Aegean Sea, the highest by-catch rates occur during summer months, when it can be assumed that the caught birds were originated from the colonies in the Southern Ionian Sea. It is evident that by-catch mortality of Scopoli's Shearwaters could be considered as a possible risk for the local colonies because this marine top predator show a long-term mate fidelity as well as a biparental care during the incubation of the single egg per nest and the consequent chick rearing duties. Additionally the significant mortality of Scopoli's Shearwater in the Southern Ionian Sea points out the need for transnational mitigation measures of by-catch, since the species numbers about 50,000 pairs and is considered as vulnerable as a result of continuous population decline during the last decades (BirdLife International, 2004).

Even if the study was based on non direct data through distributed questionnaires and they have to be considered with caution, an urgent need to assess the total magnitude of seabird by-catch problem in Greece is needed. Furthermore the assessment of the significance of this conservation threat is a prerequisite in order to propose and plan effective conservation actions to reduce the respective impact on seabird species.

5. Acknowledgements

The present study was carried out as part of the LIFE07/NAT/GR/000285 project titled as “Concrete conservation actions for Mediterranean Shag and Audouin's Gull in Greece including the inventory of relevant Marine IBAs”. This work would not have been possible without the contribution of the Fishery Department of the Prefecture of Zakynthos and more specifically of its Head Officer Giorgos Armenis. We are grateful also to the local professional fishermen who participated to our research by answering the respective questionnaires.

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