LIFE Yelkouan Shearwater PROJECT

ACTION C1:
Evaluate impact of the Maltese fishing fleet on targeted birds and influence fishing practices

Report on Studies to Investigate Seabird By-catch by Maltese Fishers

Report by the Capture Fisheries Branch
within the Ministry for Resources and Rural Affairs

For the EU LIFE Yelkouan Shearwater Project LIFE06 NAT/MT/000097

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1.0 Brief

In this Action we undertook a multidisciplinary approach in order to comprehensively evaluate seabird by-catch in the Maltese long-line fisheries. Questionnaire surveys directed to fishers, onboard observations by scientists and self sampling by fisheries were used to assess the status of the impact of fisheries on seabird populations in Malta. For the first time, an informed understanding of the exact nature and extent of the by-catch on both *P.yelkouan* and other seabird species by the Maltese fishing fleet was developed.

2.0 Introduction

Very little attention had been paid until recently to the impact of Mediterranean fisheries on seabird populations. However, studies carried out in the last years, mainly in the northwestern Mediterranean region, have revealed strong and complex interactions of worldwide interest. The effects of fishing on bird populations may be directly responsible for mortality as when caused by low selective fishing practices, or more indirect as when play the role of external perturbations that fundamentally affect food supplies and subsequently lead to major modifications in trophic habits, demographic parameters and interspecific relationships. The key feature affecting seabird populations are precisely mortality rates. Procellariiforms, as well as Pelecaniforms and Laridae species are generally long-lived and their populations are highly sensitive to changes in survival. The additional mortality induced by accidental captures in fisheries is therefore a significant danger to them (Lebreton, 2000).

In 1999 the FAO Committee on Fisheries (COFI) designed an International Plan of Action for reducing incidental catch of seabirds in long-line fisheries, open to the voluntary adhesion of all countries with long-line fleets. BirdLife started a Program for the Conservation of Sea Birds in 1997 as a result of the resolution on Incidental Mortality of Sea Birds in Long-lines, adopted by the IUCN at its First World Conservation Congress. Three Mediterranean seabird species are currently covered by specific Action Plans designed by BirdLife International, approved by the Ornis Committee (EU DG Environment) and endorsed by the Bern Convention Standing Committee. They include Audouin's gull (*Larus audouinii*), the Balearic shearwater (*Puffinus mauretanicus*) and the Mediterranean shag (*Phalacrocorax aristotelis desmaresti*).

Malta is home to around 10% of the world’s population of Yelkouan Shearwaters and one third of these breed at Rdum tal-Madonna. These fascinating birds arrive in the Maltese islands from October to occupy traditional nest sites. The birds gather on the sea in ‘rafts’ during the late afternoon and only come in to land after nightfall. They nest in burrows deep in the cliffs and females lay just one egg from the last week of February. The parents take turns to incubate and the chicks are hatched around June. Once the chicks are fully grown, almost all of the birds leave the islands.

In recent years, the important Maltese colonies have been decreasing in both number and extent with several colonies becoming extinct in recent years. A number of threats have been identified as contributing to this decline.

The aim of the studies was to investigate if seabirds (with emphasis on *Puffinus yelkouan*) are caught as by-catch by Maltese fishers, and if so to what extent.

The studies were carried out on 3 fronts:

- ✓ By means of Questionnaires
- ✓ Fishers self-sampling
- ✓ Observers on board

1) The preliminary questionnaire (with 146 respondents) was to establish the perception of fishers regarding this problem and to assess both the extent and the gears involved so as to be able to plan the studies involving direct observation.

2) The Fishers self-sampling involved 7 fishers using both surface (DLL) and bottom (BLL) long-lining. Over a period of 2 years (May 2008 to end of April 2010), 443 fishing trips with the laying of 305,564 hooks have been recorded.

3) The on-board sampling involving both university students (2008) and an on board observer during the Bluefin tuna season 2009, was to employ unbiased observers to compare with the results of self-sampling. These investigated over 110 fishing days with the laying of over 143,600 hooks.

Data collected included: date, gear, number of hooks, bait, position and start and end of laying lines, as well as those of hauling. Soaking time was calculated as were Catch per Unit Effort (CPUE).

Although the results of the 3 studies will be presented and discussed, this report will only go into some detail on the Fishers self- sampling as this material has not yet been published, whereas reports/papers on the other studies have been published.

3.0 Questionnaire

3.1 Introduction

Mortality in long-line fisheries is the most critical global threat to a number of bird species (Gilman, 2001; Cooper *et al.,* 2003). Studies carried out mainly in the north-west Mediterranean have revealed strong and complex interactions of worldwide interest. The effects of fishing on bird populations are directly responsible for mortality by low selective fishing practices (Cooper *et al.,* 2003). One of the key features affecting seabird populations is precisely mortality rate induced by incidental by-catches. Procellariiforms, as well as Pelecaniforms and Laridae species are generally long-lived and their populations are highly sensitive to changes in adult survival. The additional mortality induced by accidental captures in fisheries is therefore a significant danger to them (Lebreton, 2000).

Data on mortality levels exist only for Spanish fisheries, Spain being only one of the 12 Mediterranean countries known to undertake long-line fishing. (Cooper *et al.,* 2003). A specific study addressing the impact of long-lines on Mediterranean seabird species has been carried out in the Spanish fishery around the Columbretes Islands, in the north-west Mediterranean (Martí, 1998). Incidental catches affected mostly *Calonectris diomedea*, accounting for 77% of the total bird by-catch, followed by the Yellow-legged Gull (*Larus cachninnans*) (14%) and the Northern Gannet (*Morus bassanus*) (9%). The incidence was higher for bottom long-lining (0.72 birds caught per 1,000 hooks, against only 0.22 for surface long-lining) (Martí, 1998).

In Malta, *Puffinus yelkouan*, a pelagic seabird, is becoming increasingly threatened due to various natural and human disturbances such as predation on the chicks by rats and weasels (Sultana & Gauci, 1982), light and noise pollution near the nesting sites and incidental capture by fishers. This species, which is listed in by the IUCN (International Union for Conservation of Nature) Red data list of threatened species, listed in Appendix II of the Bern Convention, Annex II of the Barcelona Convention and listed in Schedule 1 of the Maltese Conservation of Wild Birds Regulations of 2006, has a population of approximately 1,500 pairs breeding in burrows in the Maltese coastal cliffs, which accounts for approximately 10% of the species world population (Borg & Sultana, 2002)

The largest population of Maltese *Puffinus yelkouan* is resident at Rdum tal-Madonna, situated in the North of Malta (Figure 1) and designated as a Special Protection Area (SPA) and a Special Area of Conservation (cSAC) under the Natura 2000 EU programme. It is home to approximately 500 pairs of *Puffinus yelkouan* – about 33% of the Maltese population (Borg & Sultana 2002). The birds return to the cliffs every year to breed and rear their young from October to mid-July (Borg *et al.,* 2002). This study is part of an EU LIFE project and aims to assess the perceptions of fishers on seabird by-catch and to undertake a preliminary evaluation of the impact of the Maltese fishing fleet on incidental by-catches of birds using a questionnaire survey.

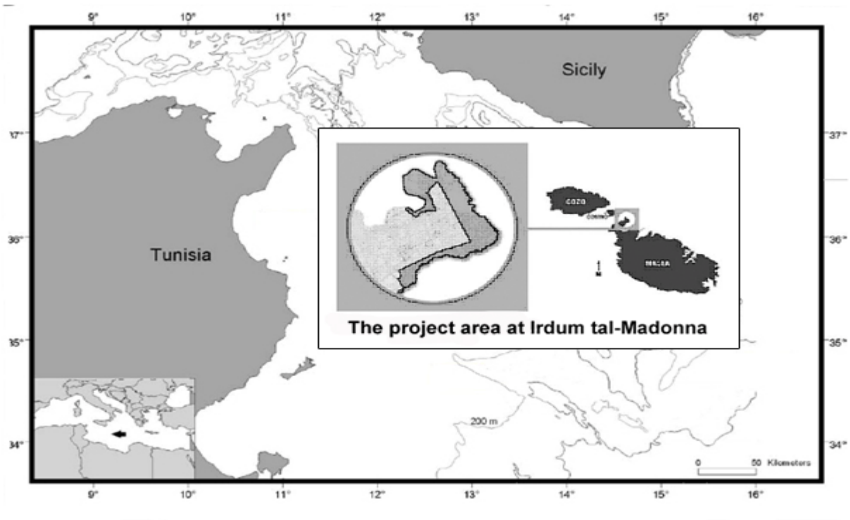

Figure 1. Showing the project site where the resident colony of Yelkouan Shearwater is present

3.2 Methodology

A questionnaire was designed to evaluate the awareness of the Maltese fishers about the project and to provide a preliminary assessment of seabird by-catch by the fishers. A random sample of fishers was surveyed by means of direct interview between October and December 2007 and represented the population of both full-time and part-time fishermen. The fishers were asked for full cooperation and in turn it was stated that the survey would be kept as simple as possible, so as not to take up too much of their time.

The questionnaire consisted of ten simple questions. Seven of the questions (yes/no) dealt with fishers' awareness of seabird by-catch (Table 1), whereas the other three obtained quantitative information by species caught and gear used (Table 2). The questions relating to the number of seabirds incidentally caught was specifically addressed to the number caught in 2006. Apart from the information requested from respondents, many interesting points/comments were recorded to increase our knowledge of fishermen – seabird interaction. Interview transcripts were entered into a Microsoft Excel database.

Questions about awareness of the project were converted into numerical scores, and percentage responses for each question were calculated. From the results obtained, the total number and mean of by-catch by species (*Calonectris diomedea* and *Puffinus yelkouan*) and by gear (surface and bottom long-lines) was calculated. Since Malta has recently conducted a study on the activity of the Maltese fishing fleet by gear (Darmanin and Dimech, 2007) an estimate catch of each species by gear could be extrapolated for the whole fishing fleet.

3.3 Results

A total of 146 full-time and part-time fishers were interviewed (10% of the population). The results (Table 1) of the questions pertaining to awareness of seabird by-catch by fishers in Malta indicate that though 26.7% are aware of the EU Community Plan of Action, only 16.4 % are aware of the EU-LIFE Yelkouan Shearwater project, with just 4.8% being aware of the fact that Malta has around 10% of the world population of this species. There is also a poor awareness (10.3%) of simple measures to prevent seabird by-catch. However over half (58.2%) of respondents indicated a willingness to use mitigating measures to reduce seabird by-catch. This together with the fact that 35.6% are willing to be involved in the project augurs well for the success of this initiative.

The interviews suggest that the fishing activity which may be responsible for the highest seabird by-catch, if at all, is bottom long-lining. The number of birds reported incidentally caught per year ranged from 0 to 50, a large range which is likely to in part reflect the stochastic nature of seabird by-catch. This figure would represent a very low average of 1.41 *C. diomedea* per bottom long-line fisher per year (Table 2). The estimates here must be considered as only very provisional, since they are based on interviews rather than direct data. However, these would suggest an estimated total annual incidental by-catch of *C. diomedea* by all the Maltese fishing vessels of 1220 birds, of which the vast majority (1214) would be caught with bottom long-lines (Table 2). On the other hand, the estimated total annual incidental by-catch of *Puffinus yelkouan* by all the Maltese fishing vessels would be 17 birds which are only reported by bottom long-lines (Table 3). 68% of the respondents declared that the incidental captures occurred both at dawn and at dusk, while 18% declared that the captures occurred mostly at dawn and 14 % at dusk.

Fishers also recorded occasional catches of *Calonectris diomedea* with trolling (mostly used by recreational fishers) lines (2 individuals in the whole sample), one individual of *Larus* sp. with trolling lines and one with surface long-lines. Fishers did not report any incidental catches with other gears including trawling, trammel and gill nets. It should be noted that trolling is normally used by recreational fishers and not by commercial fishers.

Table 1. Results of the questions pertaining to seabird by-catch awareness in Malta.
[A] - Fishers that use gears such as trawling, trammel nets or pots which do not catch seabirds;
[B] - Fishers who have never caught seabirds so the question is not applicable.

Question asked	% Yes	% No	% No response	% hesitant
Are you aware that the EU is developing a Community Plan of Action to reduce seabird by-catch?	26.7	71.2	2.1	
Did you know that the EU-LIFE Yelkouan Shearwater project was launched in March 2007 with the aim of reducing the by-catch of these birds?	16.4	81.5	2.1	
Are you aware that Malta is home to 10% of the world's Yelkouan Shearwaters' population?	4.8	93.2	2.1	
Do you know that there are simple, cheap and effective means of minimizing the number of seabird by-catch?	10.3	87.7	2.1	
Do you accidentally catch seabirds?	18.5	74.7	6.9[A]	
Are you willing to use simple mitigation measures to catch less seabirds?	58.2	15.1	17.8[B]	8.9
Would you like to be more directly involved in this project by helping the Fisheries Department in their studies?	35.6	43.8	8.2	12.3

Table 2. Annual Seabird by-catch by species and gear for the sample analysed.
BLL – Bottom long-line, SLL – Surface long-line.
Questions asked to fishers:
1. Do you lay your long-lines at dawn, dusk or both?
2. How many seabirds, and of which species do you catch in a year?
3. With which gear do you catch them?

Species	**Gear**	**No. of responses**	**Total no. of individuals**	**Mean per fisher**	**s.d.**
Calonectris diomedea	BLL	90	127	1.41	6.59
Calonectris diomedea	SLL	67	2	0.03	0.24
Puffinus yelkouan	BLL	99	2	0.02	0.14
Puffinus yelkouan	SLL	57	0	0	0

Table 3. Estimated total Annual seabird by-catch by species and gear for all the Maltese fishing vessels. BLL – Bottom long-line, SLL – Surface long-line.

Species	**Gear**	**No of Vessels**	**Mean per vessel**	**Annual Total**
Calonectris diomedea	BLL	861	1.41	1214
Calonectris diomedea	SLL	187	0.03	6
				1220
Puffinus yelkouan	BLL	861	0.02	17
Puffinus yelkouan	SLL	187	0	0

3.4 Discussion

The results of the awareness survey indicate that there is a need to increase awareness among fishers. This result is not unexpected, given the fact that prior to the LIFE project, no awareness campaigns had targeted fishermen specifically. The recent publication and distribution of a Seabird Guide for Fishers to all Maltese fishers (in March 2008) as part of this project, has helped to address this issue, like the planned direct communication between MCFS and fishers and via the co-operatives which should continue to increase awareness in the future. It is equally important to raise awareness of the simple measures that can minimize seabird by-catch, especially since a good proportion of fishers (58%) have indicated that they are willing to undertake these measures.

Results also indicate that the evidentially limited seabird mortality in the Maltese Islands is predominantly due to bottom long-lines (from comments obtained from the fishers). Although the aggregated number of *Calonectris diomedea* caught annually may seem high, the average catch per fisher is actually low (mean 1.41 per vessel per year). It is also particularly relevant to highlight the fact that the data was skewed by occasional high catches reported by a very small number of fishers and that, it is these catches that cause the most serious impacts on shearwaters. Among the 127 individuals of *Calonectris diomedea* reported as caught during the survey, 100 were attributed to just three fishers (note high s.d. = 6.59; Table 2). As these results are based on questionnaires and not direct data, they need to be considered with caution (Sciberras *et al.*, 2007). These ‘one-off’ incidents are similar to those reported in other countries ((Martí, 1998; Hackwell, 2007).

It should also be noted that, incidental captures of *Calonectris diomedea* by the Maltese fleet may consist of birds from other colonies in the Sicilian Channel since the Maltese bottom long-line fleet may fish up to 100 nautical miles from the Maltese Islands. The estimated number of *Puffinus yelkouan* accidentally caught is very low (17 individuals; mean 0.02 per vessel per year). With a breeding population of about 1,500 pairs on the Maltese Islands (Borg and Sultana 2002), an estimated 0.01% of the breeding population is at most being caught by the Maltese fishing fleet every year.

During the questionnaire survey, these findings were confirmed by the fishers, who pointed out that the species they predominantly catch incidentally are *Calonectris diomedea* with very rare occasional catches of *Puffinus yelkouan*. The results indicate that *Calonectris diomedea* is the most severely impacted seabird in this fishery (Dimech *et al.*, 2008).

4.0 Fishers self-sampling

4.1 Introduction

4.1.1 Fleet behaviour (Fishing Seasons):

The Maltese Fishing industry can be described as a multi-gear seasonal fishery. Most of the vessels are multi-purpose vessels and can be adapted to take any gear depending on the season, the target species and the appropriate gear.

For economic reasons the main seasons are the Bluefin Tuna (*Thunnus thynnus*) season (May-June), and the Lampuki Season (mid-August to end of December). Tuna are fished using Drifting surface long-lines.

The Lampuki (*Coryphaena hippurus*)/ kannizzati (FADs) fishery operates using a particular surrounding/seine net. In the winter months (Jan-March), many fishers supplement their income with bottom long-lining. In between the two main seasons (July –August), some fishers use surface long-lines to target swordfish. Although these are the main trends there are always some fishers who stick to long-lining all the year round and switch gears (DLL to BLL) according to various reasons (weather, economic, season, and preference).

4.1.2 Description of the Reference Fleet:

The Reference fleet consisted of 9 vessels (table 4) operated by 7 fishers (2 fishers changed their vessel during the sampling season). Five of the vessels were over 10 metres in length while the other 4 were smaller. The larger vessels used Drifting surface long-lines to fish for Bluefin Tuna (*Thunnus thynnus*) and Swordfish (*Xiphias gladius*), while the smaller ones fished for high value demersal fish using Bottom long-lines. The larger vessels are able to fish further offshore including outside the 25 Nautical mile Fishing Management Zone, where the Bluefin Tuna are more commonly present.

Table 4. The Reference fleet which carried out the sampling.

Vessel No	L.O.A (m)	GT	Gear	Fishing days	Effort(GT days)
1	15.17	24	DLL	25	600
2*	10.82	4.67	DLL	30	140
3	13.5	12.22	DLL	54	660
4*	12.8	12.22	DLL	19	232
4*	12.8	12.22	BLL	12	147
5	6.7	2.18	BLL	109	238
6	5.33	0.87	BLL	101	88
7	5.7	1.35	BLL	54	73
8*	7.75	4.33	BLL	4	17
8*	7.75	4.33	DLL	21	91
9*	10.7	8.58	DLL	14	120

* Fisher changed his vessel

NB. In this study, fishing trips were of 1 day duration.

4.1.3 Description of the sampling season and sampled trips:

Self sampling by fishers was carried out from May 2008 to the end of April 2010. The gears sampled were Bottom long-lining (BLL) and Drifting Surface long-lining (DLL). A total of 443 trips were sampled.

In 2008, 171 trips were sampled, in 2009 and in 2010, 72 were sampled.

Of these 280 (63%) were Bottom long-lining, while 163 (37%) were Drifting long-lining.

Most trips, 221 (58%) were sampled between May and August. This period includes the Tuna season (May-June). Apart from enjoying favourable weather conditions, thus permitting fishing, it is prior to the Lampuki season where many fishers stop using long-lines and start fishing with nets for lampuki in the kannizzatti (FADs) fishery. Despite this a limited amount of long-lining takes place throughout the year, and some trips were sampled every month.

During 2009 which was the only complete year of the survey, the effort in fishing days for the long-line fleet was 13,147 days for BLL, and 8,603 days for DLL.

4.2 Methodology

The selected fishers were given data sheets to be filled in for every fishing operation (Annex 1)

The information collected consisted of:

- Specific information: Vessel Registration number; date of fishing operation.
- Fishing operation: Type of gear; number of hooks; bait used; target species.
- Mitigating factors to reduce by-catch: side setting/ rear setting; weight on snood;
- Details of trip: Time and GPS position at start and end of setting and hauling.
- By-catch details: type by species and number caught.
- Problems encountered: winch/long-line.

4.2.1 Data Analysis:

To obtain average soak time (**t**), the difference between the mean setting time (**S**) and mean hauling time (**H**) was calculated:

$$\mathbf{t = H - S}$$

S was calculated using the following formula:

$$\mathbf{S = sf - ss}$$

Where ***sf*** = *time finish setting* and ***ss*** = *time start setting*. **H** was calculated using the following formula:

$$\mathbf{H = hf - hs}$$

Where ***hf*** = *time at which finish hauling* and ***hs*** = *time at which hauling starts*.

The Fishing Effort (**E**) in hook hours per trip was calculated by multiplying the number of hooks (**Hk**) by the average soaking time (**t**).

$$\mathbf{E = Hk \times t}$$

The Catch per Unit Effort (CPUE) per trip for each by-catch species was calculated in specimens caught per 1000 hooks per hour using the formula

$$\mathbf{CPUE = (nT/ E) \times 1000}$$

Where **nT** = *the number of specimens caught on that trip*.

When CPUE was very small (as in the case of seabirds) it was converted to either CPUE per trip or per 1000hooks for 10 hours.

The average soaking time for each trip was broken down into daylight hours, and twilight/darkness hours. Soaking time prior to sunrise, and after sunset was considered as twilight/darkness hours. The rest of the soaking time was considered to be daylight hours. Mean sunrise and sunset for each month was considered as the time of these events on the 15^{th} day of each month.

4.3 Results

4.3.1 Fishing time, period and no of hooks used:

The average soaking time for Bottom long-lining was 4.9Hrs (± 1). while that for Drifting Surface long-lining is twice as long at 10.0 Hrs (± 1.3).

In the case of BLL, most (4.1 hrs) of the soaking time was during daylight, this is possible because at the depths (>100metres) where this gear is used there is little difference in light intensity between night and day, and so it is not necessary to fish at night (table 5).

On the other hand the majority of the soaking time with DLL (6.9 hrs) as opposed to 3.1 hrs (daylight) is during twilight/night (see table 5. below).

Table 5. Soaking Time for the bottom long-line (BLL) and drifting surface long-line (DLL).

Gear	**Twilight/night hours (hr)**	**Daylight hours (hr)**	**Average Soaking Time (hr)**
BLL	0.9 (± 0.8)	4.1 (± 1.2)	4.9 (± 1.0)
DLL	6.9 (± 1.0)	3.1 (± 0.9)	10.0 (± 1.3)

The average number of hooks laid in Botttom long-lining is 451 (± 368), while that for Drifting Surface long-lining is 1100 (± 281). The main reasons for this are:

The large standard deviation in the case of BLL arises because one of the vessels using BLL in this survey was considerably larger than the others utilising this gear, and was therefore able to lay more hooks.

4.3.2 Average CPUE seabirds:

Only 1 seabird was caught with drifting surface long-lines. This could be due mainly to the large sized hook used in these long-lines. The average CPUE (Catch per unit effort) for this gear, was 0.00074 (± 0.0060) per 1000 hook/hr. With an average soaking time of 10 hrs, this is equivalent to 0.0074 per1000 hook/ trip.

With only 2 seabirds caught with Bottom long-lines throughout the sampling season, the average CPUE (Catch per unit effort) for this gear, was 0.00050 (± 0.0094) per 1000 hook/hr. With an average soaking time of 4.9 hrs, this is equivalent to 0.002 per1000 hook/ trip.

4.4 Discussion

Average soaking time was higher for DLL than BLL. This results mainly from the fact that the vessels using DLL were larger and laid more hooks than those fishing with BLL. Vessels fishing with DLL used more hooks because they were larger and could venture further out to sea and stay at sea for a longer period of time. Drifting long-lining is usually carried out at a time of year when weather conditions are more favourable, allowing for longer setting, soaking and retrieving times and the target species of DLL are large pelagics which are usually caught in small numbers, thus requiring the use of large number of hooks. The result shows that no Yelkouan Shearwater (*Puffinus yelkouan*) were caught. Whereas 1 Cory's Shearwater (*Calonectris diomeda*) was caught with DLL, 2 seabirds were caught with BLL. These were 1 Cory's Shearwater (*Calonectris diomeda*) and 1 Kittiwake (*Rissa tridactyla*) This resulted in a CPUE of 0.0074 seabirds/1000 hooks/10 hours for DLL, and a CPUE of 0.0050 seabirds/1000 hooks/10 hours for BLL. It is interesting to note that in the case of BLL, both were caught by the same fisher (possibly not using mitigating factors) and one was originally mis-identified as a Yelkouan Shearwater (*Puffinus yelkouan*). However overall this study concluded that the number of seabirds caught annually is in the region of 94 seabirds with BLL and 52 with DLL.

5.0 Observers on board

5.1 Introduction

In recent years there has been a global expansion of fishing activity without much regard for sustainable management resulting in more than two-thirds of global fisheries being categorized as fully exploited, overexploited or depleted (Botsford *et al.,* 1997). Another concern arising from this is by-catch, which refers to non-target organisms that become hooked or entangled in the fishing gear (Soykan *et al.,* 2008). Alverson *et al.,* (1994) estimated mean global by-catch at between 17.9-39.5 million metric tonnes annually, or 31% of total marine fisheries catch at that time. This makes by-catch a major management and conservation issue, especially with the incomplete data associated with fisheries worldwide. Data on by-catch are even more limited as this information cannot rely solely on reported landings but requires on-board observers or the keeping of logbooks, which is expensive (Lewison *et al.,* 2004).

Pelagic long-lines are one of the main methods of catching fish worldwide, targeting mainly tuna, swordfish and billfish. Erzini *et al.,* (1996) investigated species and size selectivity of long-lines using different hook sizes and found that all hook sizes caught a wide variety of size classes of non-target species. Apart from poor selectivity and widespread use, pelagic long-lines cover large spatial areas since a single long-line can be many kilometres in length. Therefore, the incidental mortality of elasmobranches, sea birds and turtles on these long-line hooks requires immediate attention (Brothers *et al.,* 1999).

The Mediterranean Sea, widely considered a biodiversity hotspot, is characterised by high fishing intensity; it is estimated that 2.3 million pelagic long-line hooks are set each year, with large pelagic species contributing ca 4% of the reported landings (Ancha, 2008). Here we present a preliminary assessment of non-target by-catch resulting from the Maltese tuna pelagic long-line fleet operating in the central Mediterranean. The influence of various environmental and spatiotemporal factors was also examined to determine their effect on catch rates.

5.2 Methodology

Field observations were made on board six different long-line vessels in the period 30 April to 30 June, 2008 during 85 fishing days, with a total fishing effort of 109,155 hooks and an average 1, 284 hooks/day. Fishing activity was concentrated in the Central Mediterranean, between N34’47.167, E012’19.850 and N36’50.200, E015’13.853 (Figure 2).

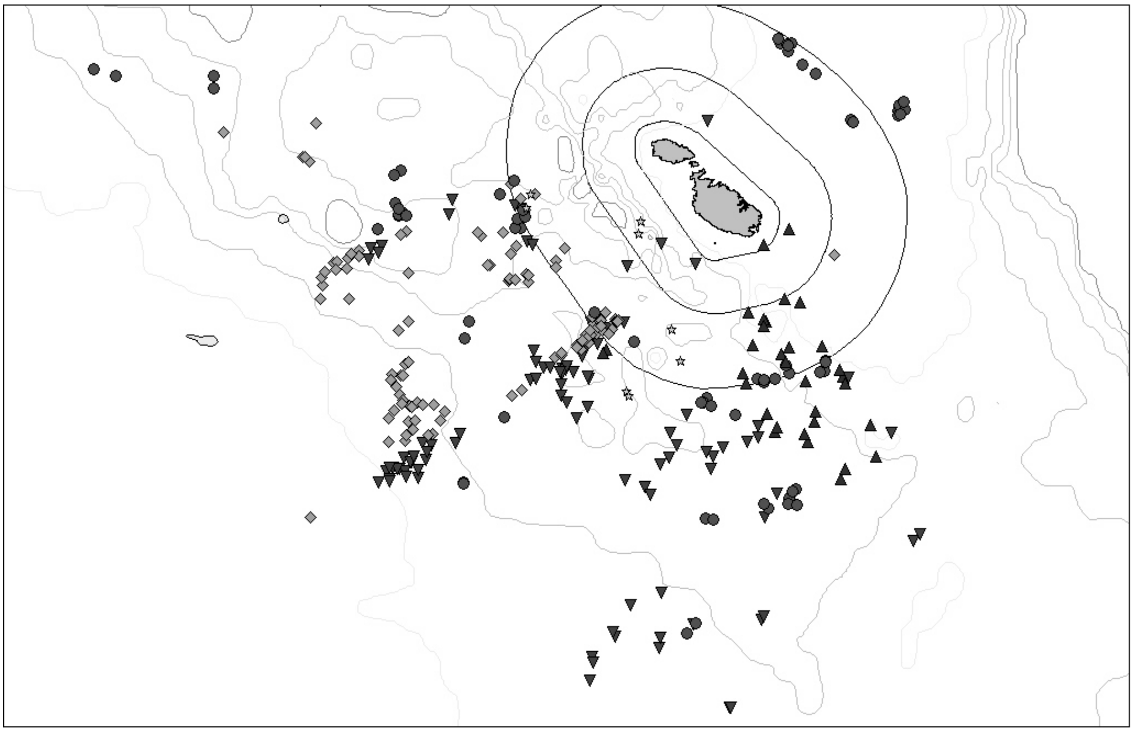

Figure 2 Map showing fishing stations for each vessel during the study period. Each symbol corresponds to a different fishing vessel. The 25 Nautical Mile isobar (the outermost one) indicates the boundary of the Malta Fisheries Management Zone.

The target species was Bluefin Tuna (*Thunnus thynnus*) and depending on the size of the vessel, between 500 and 1800 hooks were set on each line. The most common bait used was mackerel (*Scomber* spp.) and Japanese Squid (*Illex coindetti*). For each fishing operation, data on location, number of hooks deployed, and mean soaking time was recorded together with detailed data on the individuals caught including length (cm) and estimated weight (kg).

The mean soak time was defined as the difference between the mean setting time and mean hauling time. Catch-Per-Unit-Effort (CPUE) was expressed in number of individuals caught/1000 hooks/hour (N) and calculated for individual species on each fishing day using the following equation:

$$N = ((n/x)*1000)/t$$

Were $\boldsymbol{n}$ = *total number captured*; $\boldsymbol{x}$ = *total number of hooks deployed* and $\boldsymbol{t}$ = *average soak time*.

CPUE was also expressed as weight (kg)/1000 hooks/hour) (W) and calculated for individual species on each fishing trip using the following equation:

$$W = ((w/x)*1000)/t$$

Were w = *total weight/kg* of each species captured.

Hence two measures of CPUE were used for the analysis CPUE (wt) and CPUE (no).

Two separate analyses were made to investigate what factors influence CPUE (wt) and CPUE (no). Species, wind speed, wind direction, temperature, lunar phase, date, latitude and longitude were set as independent variables in a Generalized Linear Mixed Model (GLMM), using a Poisson distribution, a log transformation and CPUE (wt) and CPUE (no) as the response variables. The Poisson distribution and log transformation of CPUE were chosen on account that the data was over-dispersed (Elston *et al.*, 2001) while GLMMs were selected to allow fixed and random factors to be added; vessel and observer were included as random factors to account for variation resulting from these variables. All analyses were conducted in GenStat 6th edition (VSNi 2008). MapInfo Professional, version 8.5 was utilized to plot the location of the vessel on each fishing day.

5.3 Results

The observers recorded 94 individual Bluefin tuna (*Thunnus thynnus*) totalling 9,767.1 kg being caught on the tuna long-line, during this study. This represented only 11.8% of the total catch in number but 65.7% of the total catch in weight. The remainder of the catch consisted of 13 other marine species and no seabird by–catches were recorded during this study (Burgess *et al*., 2009).

5.4 Discussion

When measured as numbers of individuals captured, non-target species far outnumbered the target species (Bluefin Tuna), (Burgess *et al*., 2009).

In terms of weight of individuals captured, the target species accounted for the majority of the total catch, compared to the non-target by-catch. Two factors contributed to this: (a) weight of by-catch species was underestimated as not all observers provided weight data on these, and (b) the sheer weight of Bluefin Tuna compared to any of the other species captured. The average weight of an individual Bluefin tuna captured by the vessels under investigation was 105.3kg.

No seabird by-catch was recorded by the observer on board sampling. As the bulk of these vessels were fishing for tuna using DLL this is consistent with results of the questionnaire which indicated that locally, surface long-lines do not usually result in seabird by-catch.

6.0 Overall conclusion from all the three studies

I. <u>Questionnaire</u>: Results indicate that seabird by-catch occured only with BLL. When extrapolated for the whole fleet the results indicated that annual by-catch for *Calonectris diomedea* was 1220 individuals with a mean of 1.41 seabirds per vessel per year, that for *Puffinus yelkouan* was 17. (Note: see 'Discussion' as to caution in interpreting these results)

II. The result from the <u>self-sampling</u> programme shows that no Yelkouan Shearwater (*Puffinus yelkouan*) were caught. Whereas 1 Cory's Shearwater (*Calonectris diomeda*) was caught with DLL, 2 seabirds were caught with BLL. These were 1 Cory's Shearwater (*Calonectris diomeda*) and 1 Kittiwake (*Rissa tridactyla*) This resulted in a CPUE of 0.0074 seabirds/1000 hooks/10 hours for DLL, and a CPUE of 0.0050 seabirds/1000 hooks/10 hours for BLL. It is interesting to note that in the case of BLL, both were caught by the same fisher (possibly not using mitigating factors) and one was originally mis-identified as a Yelkouan Shearwater (*Puffinus yelkouan*). If the figures of seabird by-catch are raised for the whole fleet, based on data for 2009 with a total of 21,750 long-line fishing days, the annual seabird by-catch is in the region of 94 seabirds with BLL and 52 with DLL. However these estimates have to be taken with caution due to the low number of seabirds caught which make any raising statistically not significant.

III. No seabird by-catch was recorded by the observer on board sampling. As the bulk of these vessels were fishing for tuna using DLL this is consistent with results of the questionnaire which indicated that locally, surface long-lines do not usually result in seabird by-catch.

<u>Summary Table:</u>

Study Conducted	Fleet/Gear	Main Findings
Questionnaire	BLL	Estimate 1214 *Calonectris diomedea*/year 17 *Puffinus yelkouan* /year
	DLL	Estimate 6 *Calonectris diomedea*/year 0 *Puffinus yelkouan* /year
Self Sampling	BLL	Estimate 94 seabirds/year
	DLL	Estimate 52 seabirds/year
Observer on-board (2008)	BLL	No seabird by-catch
	DLL	No seabird by-catch
Observer on-board (2009)	DLL	No seabird by-catch

NB:

1) As previously stated the results of the questionnaire have to be considered with caution.

2) Extrapolations carried out from sample data of 1 or 2 specimens caught (as in the self-sampling study), can only give an indication of the extent of the situation.

3) If the magnitude of the difference between perceived by-catch (as in the questionnaire) and observed by-catch (as in self-sampling) is of a factor of 10, the actual probable by-catch of *Puffinus yelkouan* (assuming the identification was correct) is in the region of 2 specimens per year.

Though there is some difference in the magnitude of the problem as seen in different results in the questionnaire and the sampling, the main conclusions are in conformity.

- The main seabird by-catch of bottom long-lining (BLL) is the Cory's Shearwater (*Calonectris diomedea*).

- The Yelkouan Shearwater (*Puffinus yelkouan*) does not seem to be affected by the fishing activity of the Maltese fishing fleet. Although from extrapolation of the questionnaire data, it appears that Yelkouan Shearwaters were occasionally caught, this result was based on results from 2 fishers, and as later on in the project it was discovered that some fishers had problems with identification of the species, one can only conclude that these were seabirds (and not necessarily *P. yelkouan*). As the self-sampling study involved sampling of a considerable number of trips over 2 years, the results seem conclusive and so we can safely conclude that the population of Yelkouan Shearwater (*Puffinus yelkouan)* is not at risk from fishing activity of the Maltese fleet and no further studies on this point are necessary.

The difference between the results of the questionnaire (this was a preliminary survey), and the results from the surveys (the magnitude of the by-catch appears larger in the questionnaire), could be a result of one or a combination of the following:

- The questionnaire targets a larger population and so may be less biased.

- Mitigating factors which are now in use (like laying lines by night with aid of GPS) were not available in the past so perhaps the problem was greater in years when GPS technology was not used.

- Perception of fishers: In the questionnaire fishers were asked if they ever caught seabirds as by-catch and if in the affirmative how many. If a fisher caught a seabird once in 30 years of fishing he would say yes and give a figure of 1, but this would have been a one-off and not necessarily a regular occurrence. So in fact, details of seabirds caught over a long period of time were concentrated as if they were all caught in one year. This may have been an error in the response of the fisher leading to an over estimation of numbers caught.

- Problems with identification of seabirds (as mentioned above) resulting in fishers incorrectly claiming to have caught a *Puffinus yelkouan* – this has been tackled through the distribution of a seabird guide for fishers to aid identification.

From the studies carried out so far, by-catch of the Yelkouan Shearwater (*Puffinus yelkouan*) does not seem to be as large a problem in Malta as originally thought. However, the results from all the methodologies used indicate that negligible quantities of seabirds are being caught by the Maltese fleet. It is thus very important that the situation is monitored in the future, and if possible, further mitigation measures implemented.

As previously pointed out, the minimal amount of by-catch is probably due to a number of mitigating factors already in use. These include:

- ✓ Night setting

- ✓ Side setting

- ✓ Weight on snood
- ✓ Bait which has been defrosted

7.0 Recommendations

It seems that mitigating factors currently in use by Maltese fishers, have been effective to reduce seabird by-catch and should be recommended to ICCAT and the GFCM to be introduced by all flags fishing in the Mediterranean Sea.

Similar studies should be undertaken all over the Mediterranean Sea, and if results from any region show considerable seabird by-catch, follow-up studies comparing results with/or without other mitigating factors such as Tori lines should be investigated. These studies should include catches of target species (by weight and value), so that the economic impact if introducing any new mitigating factors can be estimated. An assessment of seabird by-catch should be conducted in future years in order to monitor the situation and if possible determine further mitigation measures should be implemented

In addition, new research abroad suggests that trawlers may increase or decrease seabird populations either by indirect effects such as food supplies by discards and/or direct mortality by the trawling nets – these are issues which should be investigated further in Malta.

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ANNEX 1

EU-LIFE Yelkouan Shearwater project - LIFE06 NAT/MT/000097

By-catch data sheet for Action E2

ISEM TAL-BASTIMENT

NUMRU TAL-BASTIMENT | DATA TAS-SAJDA

ISEM IL-KAPTAN

X'IRKAPTU UZAJT F'DIN IS-SAJDA?

KONZ TAL-QIEGH | KONZ TAL-WICC | IEHOR

NUMRU TA' SNANAR | X'LISKA UZAJT?

GHAL LIEMA SPECI HRIGT TISTAD?

FEJN QIEGHED IL-WINCH? | POPPA | LEMIN | XELLUG

POGGEJT PIZ MAL-BRAZZOL BIEX JEGHRAQ AKTAR MALAJR? | IVA | LE

DETTALJI TAS-SAJDA

X'HIN BDEJT TKALA? | X'HIN WAQAFT TKALA?

GPS TA' FEJN BDEJT TKALA

X'HIN BDEJT TERFA L-KONZ? | X'HIN WAQAFT TERFA L-KONZ?

GPS TA' FEJN WAQAFT TERFA L-KONZ

DETTALJI TAL-BY CATCH

X'TIP TA' BY CATCH WEHLET? | GHASAFAR | KEMM IL-WIEHED?

FKIEREN		KEMM IL-WAHDA?	
KLIEB IL-BAHAR		KEMM IL-WIEHED?	

KELLEK XI PROBLEMA BIL-WINCH FIS SAJDA?	IVA		LE	
KELLEK XI PROBLEMA FIL-KONZ FIS-SAJDA?	IVA		LE	