

Mediterranean Monk Seal (*Monachus monachus*): Fishery Interactions in the Archipelago of Madeira

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Abstract

Marine mammal and fishery interactions have increased concurrently with human population growth and subsequent increases in demand for fisheries products. As a result, populations of marine mammals and the livelihood of coastal fishermen have both been adversely affected. Mediterranean monk seals (*Monachus monachus*) are among the most endangered marine mammals in the world that have been impacted by fisheries. The aim of this study was to understand the nature and assess the magnitude of monk seal–fisheries interactions in the Archipelago of Madeira and to propose a set of conservation measures to mitigate them. Information on interactions was collected during questionnaire surveys conducted at the main fishing port of Madeira, where approximately 14% of all the fishermen and 59% of all fishing vessels in the Archipelago were interviewed. Most fishermen (91%) believed that fish stocks were declining in their region, but few (1%) considered the monk seal to be the principal reason for this negative trend. Furthermore, only 30% of the fishermen interviewed had experienced monk seal–fishing gear interactions. These interactions occurred mainly in summer, in the morning, at depths between 0 to 50 m and below 100 m, and affected mainly hand-lines for demersal species. At the same time, no records of entangled monk seals in fishing gear were reported. Compared to other areas in the species' range, the intensity of potentially negative monk seal–fisheries interactions in the Archipelago of Madeira is lower, and they do not currently constitute a threat to the survival of the species. We believe that this is due to the fact that the use of fishing nets in the region has been banned, and fishers have switched to alternative, less harmful fishing methods. Proposed conservation actions should include promoting environmental awareness, the production of a “Good Fishing Conduct” manual, and the increase in surveillance and enforcement of fishing regulations.

Key Words: Mediterranean monk seal, Madeira, *Monachus monachus*, conservation, monk seal–fisheries interactions, management, questionnaire survey

Introduction

Since the onset of industrial fishing activities in the beginning of the 19th century (Pauly et al., 2002), marine mammal and fishery interactions have increased (Northridge, 1991; DeMaster et al., 2001; Read et al., 2006). As a result, populations of marine mammals and the livelihood of coastal fishermen have been adversely affected (DeMaster et al., 2001; Read, 2008). A better understanding of marine mammal–fisheries interactions includes the assessment of the present extent and impact of the conflicts and the construction of predictive models such as those constructed for terrestrial mammals (Cozza et al., 1996). These steps are necessary to develop adequate mitigation strategies that will alleviate some of the concerns and problems and reduce financial losses, thus, ultimately promoting the conservation of endangered marine wildlife and the sustainable development of the fisheries industry.

The Mediterranean monk seal (*Monachus monachus*) is currently the rarest pinniped on earth (International Union for Conservation of Nature [IUCN], 2010), with an estimated world population of fewer than 600 individuals distributed over three disjointed populations in the northeastern Mediterranean Sea, the Cabo Blanco region in the Atlantic Sahara, and the Archipelago of Madeira in Portugal (Johnson et al., 2006). Negative interactions of Mediterranean monk seals with fisheries are considered one of the main threats impacting the recovery of this species (Johnson et al., 2006). These interactions, which include deliberate killing by fishermen and accidental entanglement in fishing gear, have been recorded since antiquity (Johnson & Lavigne, 1999; Johnson, 2004) and

are one of the main reasons for the extirpation of the species from large parts of its previous range (Johnson & Karamanlidis, 2000). Efforts to understand the nature and assess the magnitude of negative monk seal–fishery interactions and to find effective ways to mitigate them have been carried out throughout the range of the species but primarily in the eastern Mediterranean Sea where conflicts are particularly intense (Panou et al., 1993; Güçlüsoy & Savas, 2003; Güçlüsoy, 2008; Karamanlidis et al., 2008, 2011; MOm, 2009).

In Portugal, Mediterranean monk seals survive only in the Archipelago of Madeira, and the species is classified as *Critically Endangered* (Cabral et al., 2006). The Mediterranean monk seal is protected in Madeira under national and regional laws (Decree Law No. 263/81 and Regional Legislative Decree No. 6/86/M). Once abundant throughout the entire Archipelago, the monk seal population experienced a steep decline in population numbers since the early 1900s, mainly due to anthropogenic pressures that included negative interactions with fisheries (Neves & Pires, 1999). In 1980, the population was believed to be on the brink of extinction with only six to eight individuals estimated at the remote Desertas Islands (Reiner & dos Santos, 1984). To prevent the extirpation of the Mediterranean monk seal in the Archipelago of Madeira, the Parque Natural da Madeira Service (PNMS) initiated a Monk Seal Conservation and Monitoring Program in 1988; and in 1990, the Desertas Islands were declared a Nature Reserve (Pires & Neves, 2001). The new restrictions imposed by the reserve included banning all gill and trammel nets. To compensate for potential financial losses incurred by these restrictions, local fishermen were provided with alternative fishing gear and equipment (e.g., long-lines, buoys, etc.) by PNMS (Neves & Pires, 1999; Pires & Neves, 2001).

As a result of the conservation efforts carried out in the region, the local Mediterranean monk seal population has partially recovered and is now estimated to number 30 to 35 adult individuals (Pires et al., 2008). At the same time, monk seal sightings and interactions with humans, including fisheries, at the main island of Madeira, where suitable habitat for resting and reproduction exists (Karamanlidis et al., 2003, 2004), are constantly increasing; the species is considered to be recolonizing the island (Pires, 2001; Pires & Alves, 2006; Pires et al., 2008).

The purpose of the study was to understand the nature and assess the magnitude of Mediterranean monk seal–fisheries interactions in the Archipelago of Madeira and to use this information to propose a set of pragmatic and effective conservation measures that would help to mitigate monk seal–fishery interactions in the area.

Materials and Methods

Study Area

Situated in the northeastern part of the Atlantic Ocean, the Archipelago of Madeira is an autonomous Region of Portugal that lies between 30° 1' 38" and 33° 7' 3" North and 15° 51' 11" and 17° 15' 52" West. The Archipelago is located ~700 km from the African coast and 900 km from the coast of mainland Portugal (Biscoito & Abreu, 1998). The Archipelago consists of two populated islands, Madeira and Porto Santo, and two uninhabited sub-archipelagos, the Desertas (Ilhéu Chão, Deserta Grande, and Bugio) and the Selvagens Islands (Selvagem Grande, Selvagem Pequena, Ilhéu de Fora) (Figure 1).

The Reserve boundary of the Desertas Islands Nature Reserve includes all three islands in the Desertas Archipelago and is defined by the 100 m depth isobath. The entire northern half of the protected area has the status of a partial reserve, where human activity is controlled (i.e., navigation, snorkelling, and commercial and recreational fishing without nets is allowed). The southern half is a strict reserve and includes the most important pupping sites for the Mediterranean monk seal in the area (Silva, 1999; Karamanlidis et al., 2004). Human activity is prohibited, except for traditional tuna fishing, which is an important economic resource in the region and is not considered to be a threat to the species. The Reserve is guarded by wardens who patrol the area whenever weather conditions permit.



Figure 1. Map of the Archipelago of Madeira

The Madeira Fisheries Sector

The Archipelago of Madeira is part of Macaronesia. These islands in the North Atlantic Ocean are characterized by a narrow continental shelf and deep sea bottom depths close to the coast (i.e., 4.3 nmi offshore the average depth is 2,000 m). Due to the oligotrophic waters in the region, the fisheries industry has never played a significant role in the local economy and currently represents only 0.7%

of the Gross National Product of the Archipelago (Direcção Regional das Pescas, 2003). In 2007, there were 496 professional fishing licenses operating in the Madeiran Archipelago (49 for drifting long-lines, 115 for set long-lines, 89 for hand-lines for demersal fishes, 24 for troll lines, 49 “salto e vara” licenses—the traditional tuna fishing method that uses a pole and a line, 55 for traps, 56 for hand-lines for cephalopods, 51 for lift nets, and eight purse seines), and 766 fishermen were employed in the sector (i.e., 0.3% of the population resident in Madeira) (Instituto Nacional de Estatística, 2008). Since 2000, the use of gill and trammel nets has been banned in the Archipelago of Madeira.

Data Collection and Analysis

Data on Mediterranean monk seal–fisheries interactions were collected by interviewing professional fishermen who held a valid fishing license in 2008–2009. The questionnaire surveys were conducted at the main fishing port of Funchal on Madeira, where 83% of the fish catch in the Archipelago is landed. Fishermen operating from Funchal fish throughout the Archipelago, including the areas close to the Desertas Islands and the southeastern and southern parts of Madeira that are mostly frequented by Mediterranean monk seals (Pires et al., 2008). Interviews were conducted over a 12-wk period in 2009; we attempted to interview at least two fishermen from each fishing vessel, preferably after the night catch. Each interview lasted approximately 20 min.

The questionnaire had two types of questions—open vs closed-ended—which questioned the perceptions of the fishermen regarding specific fisheries-related issues. The questions were divided into the following six thematic groups:

1. *Group A* – personal information about the fisherman (i.e., gender, age, years of fishing activity, family, and employment details regarding fishing)
2. *Group B* – information regarding the type of fishing gear used
3. *Group C* – information regarding the overall state of local fish stocks and perception on monk seal impact
4. *Group D* – general information regarding interactions between marine species and fishing gear (i.e., damages and accidental capture)
5. *Group E* – specific information regarding damages caused by Mediterranean monk seals to fishing gear (i.e., type of damage, involved gear, depth, seasonality, and time of day)
6. *Group F* – general information regarding the attitudes of fishermen towards monk seals and their conservation

Data analysis was conducted using Microsoft Office Excel 2007™ and SPSS (Statistics Package for Social Sciences), Version 17 for Windows. Descriptive statistics were used to summarize results, and nonparametric (i.e., Mann-Whitney U test) and parametric (i.e., One-way ANOVA) tests when appropriate for comparisons (Siegel & Castellan, 1988; Zar, 1999), while an alpha level of 0.05 was used for all statistical tests.

Results

One hundred and thirteen questionnaires were evaluated in the study; this represented 14% of all fishermen and 59% of all fishing vessels operating in the region. All the fishermen interviewed were male, with an average age of 45 y (Mean: 45.77; SD: 10.64) and on average 26 y of professional experience (Mean: 26.56; SD: 13.41). Most fishermen interviewed came from a fishing family, and fishing was their main professional occupation and sole source of income (i.e., 93, 90, and 85%, respectively). They were multi-gear users, and their prevalently used fishing gears were hand-lines for demersal species (22%), followed by “Salto e vara” (19%), set long-lines (17%), drifting long-lines (16%), traps (11%), purse seines (7%), lift nets (5%), and troll lines (3%).

With respect to the overall state of fish stocks in the region, 91% of the fishermen believed that fish stocks were diminishing. The main reasons for the reduction of local fish stocks were anthropogenic, with overfishing being considered as the most important (33%). Only 1% of the fishermen believed that the decline in fish stocks was due to the Mediterranean monk seal (Table 1).

Table 1. Main reported reasons for the reduction of fish stocks in the Archipelago of Madeira according to 113 interviewed fishermen

Reason for fish stock reduction	Percentage (%)
Overfishing	33
Do not know/did not answer	16
Spawning season is not respected	15
Use of destructive fishing equipment and/or methods	12
Illegal fishing	11
Pollution	7
Other reasons	5
Monk seals	1

Most fishermen (58%) believed that sharks were primarily responsible for the damages to their fishing gear, while monk seals were not considered by the majority (67%) of the fishermen to be involved in such interactions. Only 30% of the fishermen

interviewed, claimed to have experienced monk seal–fishing gear interactions. Furthermore, none of the fishermen interviewed had caught a monk seal, while 5%, 36%, 20%, and 4% of them had accidentally caught dolphins, sharks, turtles, and birds, respectively. Fishermen who had experienced monk seal–fishing gear interactions claimed that the monk seals primarily removed the catch from the fishing gear (48%). Less frequent interactions included damaging or destroying the equipment (31%), scaring the catch away (13%), and damaging the catch (8%). From the fishermen who experienced interactions of monk seals with their fishing gear, 37% reported them occurring at depths between 0 and 50 m, and 37% at depths below 100 m. The contextual monk seal interaction was reported as often being observed directly by the fishermen themselves (74%) and affected all types of fishing gear, but mainly static gear and/or equipment set close to the shore such as hand-lines for demersal species (30%), set long-lines (22%), and traps (18%) (Table 2). From the fishermen who had experienced monk seal–fishing gear interactions, 37% claimed that interactions rarely took place, 40% that interactions occurred mostly during summer, and 31% that interactions occurred mostly in the morning.

Table 2. Types of fishing gear affected by Mediterranean monk seals in the Archipelago of Madeira

Fishing gear	Percentage (%)
Hand-lines for demersal species	30
Set long-lines	22
Traps	18
“Salto e vara”	12
Lift nets	9
Drifting long-lines	7
Purse seines	1

When queried about the methods used to deter monk seals from damaging their fishing equipment, 80% of fishermen answered that they did not do anything; 11% used stones, self-made bombs, and harpoons; while 9% refused to answer the question. The majority of fishermen (49%) did not know or did not answer the question regarding possible solutions for minimizing the financial losses caused by monk seals. “Receive compensation” was the most popular response for 20% of the fishermen who did respond with an answer (Table 3). The overall attitude of fishermen towards the return of Mediterranean monk seals to the main island of Madeira and their protection was either indifferent or positive (Figure 2). These responses of the fishermen were not affected by their age (ANOVA: $F = 0.649$, $p = 0.585$) but from

whether they had previously experienced damages to their fishing gear by the species (Mann-Whitney U test: $Z = -2.803$, $p < 0.05$). Those fishermen who already had experienced negative interactions with monk seals tended to have a more negative view than those who had not.

Table 3. Proposed solutions suggested by fishermen for minimizing financial losses caused by Mediterranean monk seals in the Archipelago of Madeira

Proposed solutions	Percentage (%)
Do not know/did not answer	49
Receive compensation	20
Confine monk seals within the park	8
Translocate monk seals	8
Find a proper place for the monk seals	6
Eradicate the monk seals	3
Stop bringing monk seals to Madeira	3
Do not fish where monk seals are	3

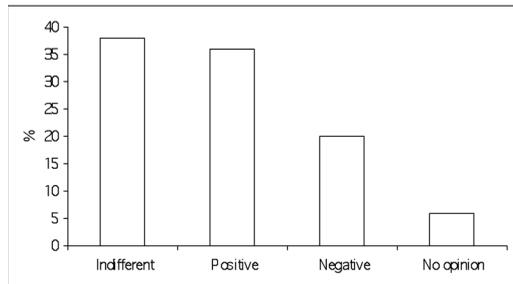


Figure 2. Overall attitude of 113 fishermen in the Archipelago of Madeira regarding the return of the Mediterranean monk seal to the region and its overall conservation

Discussion

Numerous studies have assessed the impact of fisheries on marine biodiversity (Jennings & Kaiser, 1998; Lewison et al., 2004; Baker et al., 2007) to develop effective management and conservation strategies that will mitigate negative interactions. Since the onset of international efforts to save the critically endangered Mediterranean monk seal, negative monk seal–fisheries interactions have been identified as a major threat to the survival of the species and efforts to resolve existing conflicts have been identified as an international conservation priority (Johnson & Lavigne, 1995). Efforts to study these interactions have been carried out mainly in the eastern Mediterranean Sea, where negative interactions are particularly intense. Recent studies in the last population strongholds in Greece and Turkey indicate that deliberate killing of monk seals by fishermen, who view the species as a competitor, and accidental entanglement

in fishing gear are among the most frequent causes of mortality for Mediterranean monk seals in the region (Veryeri et al., 2001; Androukaki et al., 2006; Karamanlidis et al., 2008, 2011). On the other hand, damage to fishing gear by monk seals, including aquaculture installations, can on occasion be substantial (Panou et al., 1993; Güçlüsoy & Savas, 2003; Güçlüsoy, 2008; Karamanlidis et al., 2008, 2011; MOM, 2009), thus making the already precarious financial situation of coastal fishermen in the region even more dire.

The results of the study indicate that despite certain similarities, such as some of the types of gears and the depths at which interactions occurred, monk seal–fishery interactions in the Archipelago of Madeira differed substantially from the ones recorded in the eastern Mediterranean Sea or even the ones recorded in Madeira prior to the establishment of the Desertas Islands Nature Reserve.

According to the fishermen interviewed in the Archipelago of Madeira, no monk seal in the region was accidentally entangled in fishing gear. This concurs with the population monitoring data of the Seal Conservation and Monitoring Program of the Parque Natural da Madeira Service (Pires et al., 2008) but is in contrast to fishermen responses throughout Greece (MOM, 2009). Prior to the establishment of the protected area at the Desertas Islands and the ban of gill and trammel nets throughout the Archipelago in 2000, their extensive use constituted a major threat to the survival of the small surviving monk seal colony as animals had been dying frequently by entanglement in abandoned “ghost” nets (Anselin & van der Elst, 1988). Currently, only traps, purse seines, and illegally used gillnets pose a minor threat of accidental entanglement to the species in the region.

Fishermen in the Archipelago of Madeira experienced damage to types of gear similar to what has been reported throughout the range of the species (Panou et al., 1993; MOM, 2009). However, the intensity of these interactions and the perception of negative interactions were considerably lower than what has been recorded in the eastern Mediterranean Sea. Only every third fisherman in Madeira claimed to have experienced monk seal–fishing gear interactions, while the majority of fishermen (67%) believed that the species does not cause damage to fishing gear or catches. This is in sharp contrast to the situation in Greece where fishermen operating in the main distribution areas of the species often experience damages to both fishing gear and catches (MOM, 2009). We believe that the small impact of the species on local fisheries in conjunction with the environmental awareness campaigns that have been carried out by PNMS since 1988 have led to the indifferent or even positive attitude of fishermen

towards monk seals and for not holding the species responsible for the overall reduction of fish stocks in the region. Again, this is in contrast to attitudes of coastal fishermen throughout Greece (Glain et al., 2001; MOM, 2009).

Management and Conservation Implications

In contrast to the past, monk seal–fishery interactions currently do not appear to constitute a threat to the survival or the range expansion of the Mediterranean monk seal in the Archipelago of Madeira, although the situation is still closely monitored. This apparent reduction in the threat is primarily due to the ban of nets in the proximity of the main resting and pupping caves of the species in the Desertas Islands Nature Reserve, which are almost exclusively responsible for accidental entanglements of the species (Cebrian et al., 1990; Veryeri et al., 2001; Karamanlidis et al., 2008, 2011). These nets are also most frequently damaged by monk seals (Güçlüsoy, 2008; MOM, 2009). We therefore conclude that the decision of PNMS to ban the use of nets within the main habitat of the species in the region and to help fishermen switch to alternative fishing techniques has been a very effective measure to mitigate the negative monk seal–fishery interactions and should serve as a conservation paradigm throughout the range of the species.

The fishing gears (e.g., hand-lines for demersal species, set long-lines, and traps) that were mainly damaged were used from the coastline to the 200 isobath and overlap with the activity patterns of the species (Dendrinou et al., 2007; Adamantopoulou et al., 2011). Although we cannot discount the possibility that such damages were overestimated by fishermen seeking compensation, such complaints should be considered and actively dealt with during educational campaigns and fishing monitoring programs. Fishers experiencing such damages could be encouraged to change fishing grounds or fishing patterns when encountering monk seal damage. For this measure to be successful, however, further information on the spatial distribution of the use of different gear types and the distribution of monk seal damages is necessary.

Based on our findings and considering the partial recovery and range expansion of the species in the area (Pires et al., 2008), we propose the following management and conservation actions, which are in accordance with the regional “Action Plan for the Recovery of the Monk Seals in the Eastern Atlantic” (Convention on Migratory Species [CMS], 2005):

1. Considering the fishermen’s perception that there is a small potential for negative actions

towards the species, public awareness campaigns, especially towards members of the fishing community, should be maintained.

2. Produce a manual following up the recommendations contained in the *Code of Conduct for Responsible Fisheries* (FAO, 1995).
3. Increase surveillance and enforcement of fishing regulations.

These actions should help alleviate some of the negative monk seal–fishery interactions while preventing their further increase and thus will improve the overall conservation status of the species in the region.

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