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Survey on Mediterranean Monk Seal (*Monachus monachus*) Sightings in Mediterranean Morocco

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Abstract

Knowledge on Mediterranean monk seal distribution throughout the central-eastern Mediterranean Moroccan coasts is not abundant and has not been consistently assessed throughout time. Results of a questionnaire survey directed at 205 artisanal fishers operating out of 18 landing sites of central-eastern Morocco, and extending over 210 km of coast, are hereby reported. The information on reported monk seal sightings amounts to 141 observations reported for the period 1971 to 2005, with the highest number of reported sightings for the year 2004 amounting to 32. More than 58% of the study area is characterized by rocky cliffs of alternating height, and monk seal sighting frequency was mostly reported for four subareas. However, only two of these, Cap Trois Fourches and Ras Kebdana, seem to be utilised in recent times and seem to be areas where immediate conservation actions should be enacted in order to safeguard remaining seal nuclei. The remoteness of these sites and the presence of the nearby nature reserve in the Chafarinas Islands may contribute to the protection of a nucleus of monk seals, which is likely to benefit from the proximity to the nearby Algerian border where monk seals could survive. Immediate conservation actions should be enacted in the identified subareas, and a regional strategy, including the nearby Algerian areas as well as the western Moroccan area of the Al Hoceima National Park, should be implemented so as to avoid further population fragmentation in this area of the western Mediterranean.

Key Words: Mediterranean monk seal, *Monachus monachus*, sightings, habitat suitability, fisheries, western Mediterranean, Morocco

Introduction

Information on the recent distribution of Mediterranean monk seals along the central-eastern Mediterranean coasts of Morocco is not abundant. Several authors have indicated the presence of a population in the region between Al Hoceima and Cap Trois Fourches (Avella & Gonzalez, 1984; Bayed & Beaubrun, 1987). Accounts from interviews conducted with fishers during the establishment of the marine park of Al Hoceima reported monk seal sightings until 2002 in the area of Al Hoceima and as far east as Cap Trois Fourches (Mo et al., 2004); however, these interviews did not fully consider the fishing community to the east of the port of Al Hoceima. Some information on the species' presence to the east of Al Hoceima was reported between 1997 and 2003 for the Chafarinas Islands, lying 1.7 nmi north of Ras Kebdana (Gena, 2001, 2002, 2003). The Mediterranean monk seal has suffered a severe decline in population numbers over the course of the last century and has a current total population estimate of 400 to 600 individuals. Its distribution in the Mediterranean sea is nowadays principally limited to the Greek and Turkish waters, while the other largest population lies 4,000 km distant in the Atlantic western Sahara. Recent studies have shown that the populations of these two geographic regions exhibit low genetic variation (Pastor et al., 2007), which can be combated by facilitating entry into the population of new individuals with diverse genetic diversity. Any knowledge on population fragments in the western Mediterranean is important as the survival of all remaining nuclei needs to be enforced in order to combat population fragmentation and loss of genetic diversity. This study reports the results of a questionnaire survey directed at artisanal fishers in order to systematically collect information on the presence of Mediterranean monk seals along the central-eastern Moroccan coasts.

Materials and Methods

A survey questionnaire of the type initially proposed by Boyd & Stanfield (1998) was provided

to small-scale fishers from November 2004 to February 2005. The advantages of this type of questionnaire are linked to its strict application to fishers as well as to the use of figurative images of marine species that the fishers are most likely to have encountered. Due to the inaccessibility of the terrain and the absence of roads, interviews were carried out at 18 landing sites, located along an estimated 210-km-long stretch of coast between Cabo Kelaté to Saïdia, which is the easternmost landing site found on the Mediterranean coast of Morocco (Figure 1). Interviewees were small-scale fishers, operating out of boats less than 12 m in total length and using small-scale artisanal gear (e.g., trammel, trolling, traps, and long-line), gill-netters, and multipurpose boats.

Questionnaires were conducted with one fisher at a time. Fishers were asked information on their fishing activity, and the spatial extension of their fishing area was drawn out on a map. Each fisher was presented with a series of eight plastified cards, measuring 15 × 20 cm, depicting coloured drawings of the species listed below (the species initials used throughout the present paper are indicated in parentheses after each species' name):

1. *Cetorhinus maximus*, basking shark (Cm)
2. *Caretta caretta*, loggerhead turtle (Cc)
3. *Monachus monachus*, Mediterranean monk seal (adult male morphology *sensu*; Samaranch & Gonzalez, 2000) (Mm)
4. *Monachus monachus*, Mediterranean monk seal (subadult pelage morphology) (Mms)
5. *Mullus surmuletus*, red mullet (Ms)
6. *Tursiops truncatus*, bottlenose dolphin (Tt)
7. *Dermochelys coriacea*, leatherback turtle (Dc)
8. *Diplodus bellottii*, Senegal seabream (Db)

The choice to use these species, apart from *M. monachus*, was based on the assumption that there should be at least one or more control species which are definitely known to be in the area and several protected and rarer species that are known or hypothesized as being present. Once all the cards had been displayed in front of a fisher, he was asked to point out those species which he knew best and which he had encountered during his entire experience of fishing activity. Effort was made to keep other fishers away from the person being interviewed to avoid the interviewee being influenced by others. When the interviewee chose a card, the interviewer took the card away and wrote down the species choice in the appropriate order in which the cards were chosen. If during the selection of cards the fisher had chosen one of the *M. monachus* drawings (i.e., Mm or Mms), he was asked to reflect again which one of the two he recognized, and the final choice was recorded. If the fisher claimed to recognize both morphologies, then care was taken to note this on the relevant interview sheet. If one of the *M. monachus* cards was chosen, a series of further questions was asked on location, date (year and possibly month or season), time of day, number of animals, physical characteristics observed, and estimated size. It was assumed that dates of sightings occurring in the last 5 y were more likely to be remembered with greater accuracy as opposed to older sightings. Sighting data occurring before the year 2000 was therefore considered separately (hereinafter referred to as historical), while sighting data occurring after 2000 was considered as being recent. Size differences between adults and juveniles were defined by asking the fisher if the individual's estimated length was more similar

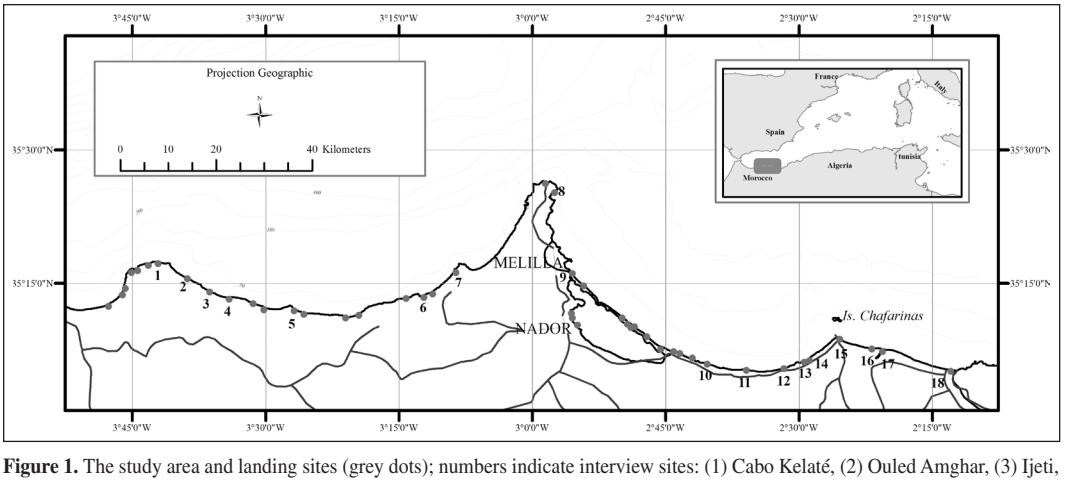

Figure 1. The study area and landing sites (grey dots); numbers indicate interview sites: (1) Cabo Kelaté, (2) Ouled Amghar, (3) Ijeti, (4) Sidi Driss, (5) Sidi Hssain, (6) Chamlala, (7) Kallat, (8) Tibouda, (9) Beni Ansar, (10) Ihriouine, (11) Sidi El Abed, (12) Sidi El Bachir, (13) Tamarssate, (14) Plage rouge, (15) Ras Kebdana, (16) Bouyahyaten, (17) Embouchure Moulouya, and (18) Saidia.

to that of an adult human or as small as that of a 3- to 5-y-old child. If the fisher had more than one sighting to report, then the same questions were asked for each individual sighting and noted on separate interview sheets.

During the conduction of the questionnaires, descriptive information was collected on the gross morphology of the coastal habitat of the wide study area by observing the coast to the east and to the west of each landing site from as many lookout points as possible. Different sectors were identified along the coast based on their morphology and on the basis of information regarding the interviewees' fishing areas.

The resulting information, together with landscape descriptions present in the literature (Istituto Idrografico della Marina, 1987), enabled the subdivision of the study area into geomorphological subhomogeneous units defined according to the six following standardized classes:

1. High rocky cliffs (more than 8 m in estimated height)
2. Cliffs of medium height (4 to 8 m in estimated height)
3. Cliffs of low-medium height (2 to 4 m in height) with beaches of various typology
4. Gravel and pebble beaches and limited rocky cliffs
5. Sandy beaches with low rocky cliffs (less than 1 to 2 m in estimated height)
6. Sandy beaches

Furthermore, the study area was arbitrarily divided into 26 sectors (named a-z westwards), and the sampled ports/landing sites were used as limits for each sector. The frequency of fishing presence of each interviewee throughout the 26 sectors was estimated on the assumption that the time spent in each indicated sector is equal. A fisher's frequency of presence, per used sector, was therefore calculated by obtaining the reciprocal of the total number of utilised sectors indicated by the fisher. The total fisher frequency of presence per sector was obtained by summing the frequency of presence values of all fishers for each given sector.

The cumulative value of each species' choice, which represents the interviewees' recognition of the species, was calculated to yield the overall recognition rate by all interviewees (total number of times each species was chosen expressed in percentage over the total number of interviewees). Subsequently the cumulative value of each species choice, according to the fisher's order of preference during the interview, was calculated to yield insight into the species' frequency, based on the assumption that the species recognized first should be more frequent in the study area than those recognized second.

Information on all reported monk seal sightings was analysed in terms of date, location, size, and sighting content. Sighting data was analysed to yield information on trends in choice of pelage morphology and time period, group size information, and environmental characteristics of the sighting locations. Monk seal sighting information was also analysed to identify sectors with numbers of total sightings over time and with highest number of historical sightings (i.e., sightings occurring before the year 2000) and recent sightings (i.e., sightings occurring after the year 2000). Monk seal sighting information per sector was then converted into fisher sighting frequency per sector by dividing the number of historic and recent sightings by the fisher frequency of use for every sector. Sighting frequency information per sector was plotted on a map containing information on the repartitioning of the six geomorphological coastal typologies to identify eventual correlations between trends in sighting frequency and coastal morphology.

A Geographic Information System (GIS) was set up in order to elaborate data regarding geomorphological subhomogeneous units, landing sites of interview with relative number of interviews, fisher's frequency of presence, and monk seal sightings according to frequency of fisher presence. The basic cartography used for coastline, hypsography, and landing site location was respectively Defense Mapping Agency (DMA [now, National Geospatial-Intelligence Agency (NGA)]; nominal scale of 1:250,000), ESRI Digital chart of the world (1:1,000,000 scale), and FAO-COPEMED (Rome). The above data rendering was elaborated onto maps in order to provide a spatial distribution of the collected information.

Results

Interviews were conducted with 205 small-scale fishers. Sampling effort exerted within the ports, was directed at an average of 20 to 30% of the registered fishers in each port (Damiano, 1999) with the exception of port Beni Ansar where the interviewees represented only 8% of the total estimated fishers. The overall recognition rate for each species for all fishers is reported in Figure 2. The species most often chosen was *Mullus surmuletus* followed by *Tursiops truncatus* and *Diplodus bellottii*—all chosen by over 95% of the fishers. The *Caretta caretta* was chosen 90% of the time, while the Mediterranean monk seal—both adult and subadult morphology combined—were chosen by 57% of the interviewed fishers. *Dermochelys coriacea* was recognized by 20% of the fishers,

and *Cetorhinus maximus* was observed the least, by 6% of the interviewed fishers.

The ranking of order of choice for each species can provide further information as to which species may be considered most common (Figure 3). *M. surmuletus* was chosen most often in the first, while *D. bellottii* was chosen most often in the second position. *C. caretta* scored the highest in the third and fourth position, while *T. truncatus* never outplaced any of the other three more common species (i.e., *M. surmuletus, D. bellottii,* and *C. caretta*) in terms of highest scores in any given order but was chosen with a roughly equal score in the first, third, and fourth position. *M. monachus* was chosen most in fifth position of order of choice, though it exhibits steadily increasing choice ranking value from the first to fourth position. *Dermochelys coriacea* was chosen most often in fifth and sixth position, while *Cetorhinus maximus* was recognized at each position but overall not very frequently.

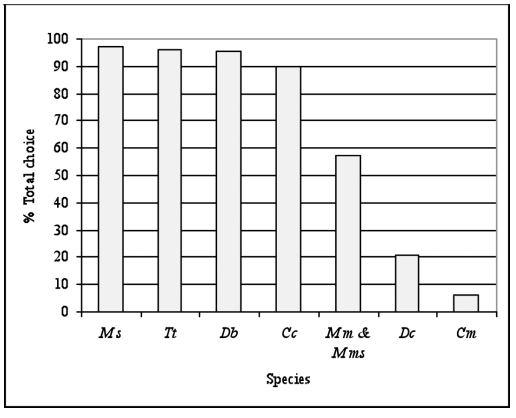

Figure 2. Percentage of fishers who recognized identified species (Cc = *Caretta caretta*, Cm = *Cetorhinus maximus*, Db = *Diplodus bellottii*, Dc = *Dermochelys coriacea*, Mm = *Monachus monachus* [both adult and subadult morphology], Ms = *Mullus surmuletus*, and Tt = *Tursiops truncatus*)

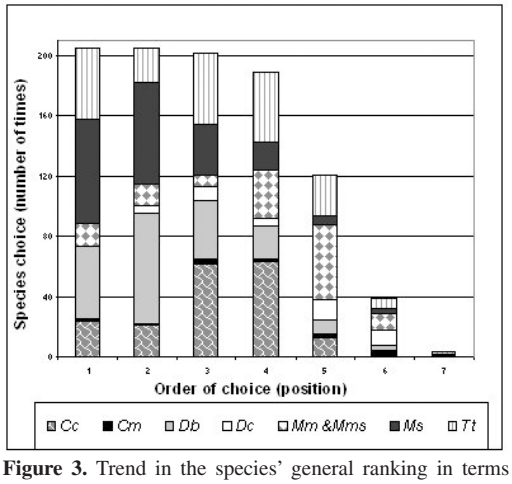

Figure 3. Trend in the species' general ranking in terms of their order of choice among the fishers (Cc = *Caretta caretta*, Cm = *Cetorhinus maximus*, Db = *Diplodus bellottii*, Dc = *Dermochelys coriacea*, Mm = *Monachus monachus* [both adult and subadult morphology], Ms = *Mullus surmuletus*, and Tt = *Tursiops truncatus*)

The information on monk seal sightings amounted to 141 observations reported for the period 1971 to 2005, 47 of which occurred before 2000 and 94 after 2000. The highest number of annual reported sightings, amounting to 32, occurred in 2004. Most sightings occurred in the morning hours (66%). Sixteen percent of fishermen recalled seeing monk seals during all hours of the day, while another 14% of fishermen reported sightings occurring only during afternoon hours. Very few fishermen (n = 4) reported sightings occurring during the evening hours. Almost half (48%) of all fishermen reported the presence of moustaches as a predominant characteristic observed on the seal's body. The reported color of the pelage was mostly black (76%), followed by black and white (12%), brown (6%), grey (3%), and grey and white (1%). More than half of the fishers (59%) recognized the subadult monk seal morphology (Mms), and another 18% recognized both morphologies.

From a gross geomorphological point of view, the study area was subdivided from east to west into ten units, the distribution of which is presented in Figure 4. The sectors with rocky cliffs of various heights, where coastal caves are more likely, amounted in total to 58.6% of the whole study area. Almost half of this is composed by the high rocky cliffs of sectors l, m, and n, amounting to 24% of the study area. Highest numbers of total sightings were reported for the following sectors (total number, historical, and recent sightings reported in parentheses): e (n = 54, 18 historical, 36 recent), q (n = 19, 1 historical, 18 recent), and m (n = 10, 1 historical, 9 recent); followed by v (n = 9, 7 historical, 2 recent), s (n = 8, 6 historical, 2 recent), a (n = 8, 5 historical, 3 recent), and b (n = 6, 2 historical, 4 recent). However, when the historical and recent reported sightings are related to fishers' frequency of presence, the resulting sighting frequency indicates four sectors in which recent monk seal presence is higher (sectors v, q, m, and e). If one observes the sighting frequency trend (Figure 4) and aggregates each of these sectors to the immediate nearby sectors with sightings, four distinct monk seal sighting subareas can be identified (hereby identified from 1 through 4). These subareas contain the following sectors: (1) a, b, c, d, e (peak), and f; (2) k, l, m

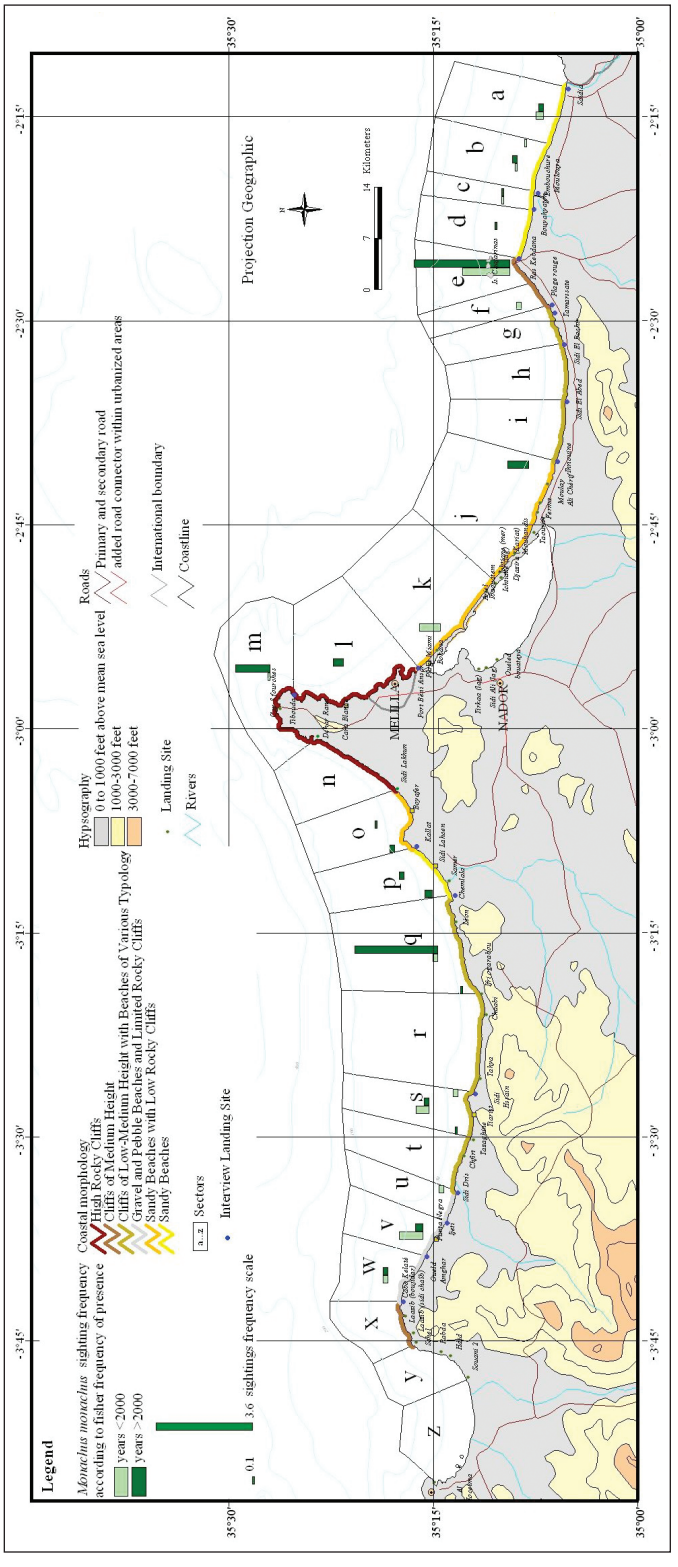

Figure 4. *M. monachus* sighting frequency distribution and coastal morphology according to sectors

(peak), and n; (3) o, p, q (peak), and s; and (4) t, u, v (peak), and w. Each of these subareas contain sectors having either high to medium (e and m) or low to medium (q and v) height. Multiple sightings were reported by only seven fishers, with a maximum number of three sightings each. Of 141 observations, only two were of dead animals: one observed many years ago on Tibouda beach, and the other concerning an adult-sized individual found in December 2004 in the Plage of the Oued Kert mouth.

Information on the estimated size and number of the observed individuals is presented in Figure 5. Information on the years of some sighting events is hereby reported in parentheses after the locations. The majority of sightings (92%) involved single animals, of which 122 were of reportedly adult-sized individuals, while another five observations were small-sized and observed in the proximity of port Tiarrist (1985), Ras Kebdana (1990), Cap Trois Fourches (2000), and Chafarinas Islands (2003, 2004). Pairs of animals were rarely reported; in two cases, they involved a large- and a small-sized animal observed both in Punta Negra (1999) and in a cave to the west of Sidi Hssain (2002); whereas the remaining ones involved adult-sized animals, of which the most recent (2002, 2003) were sighted at the Chafarinas Islands. A sighting of three to four individuals at a time was reported by only one fisherman for the Chafarinas Islands, and this sighting dates back to 1986.

The majority of sightings (61%) occurred in the coastal marine environment throughout the study area, while 17% occurred in proximity or within

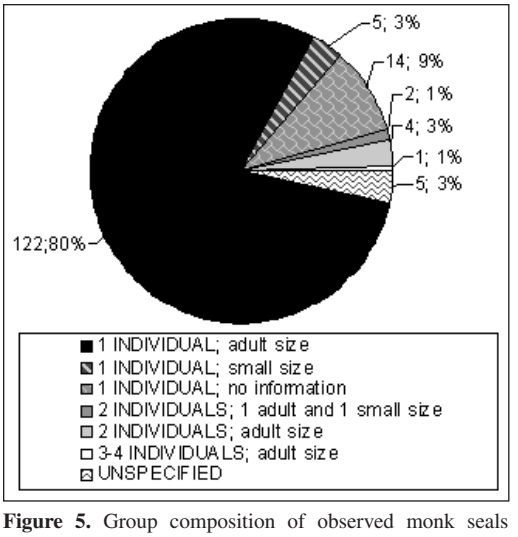

Figure 5. Group composition of observed monk seals (numbers preceding the percentages indicate the number of reported sightings)

the ports of Tiarrist (1%), Chemlala (3%), and Ras Kebdana (13%). Some fishers reported observing monk seals indiscriminately either on land or in the water, and this mostly involved sector e (14%). Sightings of seals observed exclusively on land were rare (6%): one involved a dead animal observed in sector o (2004), two regarded small-sized individuals in sectors m and e (2000, 2003), and one involved the observation of a pair of a large- and a small-sized individual observed in sector u (2002).

Discussion

The present study confirms the presence of the Mediterranean monk seal along the central-eastern Mediterranean coasts of Morocco. The relatively high recognition rate of the species and its order of choice, just after the most common commercial and protected species, indicates in fact that the species is well known to the fishers in the area, at least until 2004. The reasons for which some fishermen selected the monk seal in the first to third position with respect to other more commercial species remains purely speculative. A possible motivation in such cases could lie in the exceptional nature of the event, which, if occurring in recent years, may be particularly well-remembered and may have led the fisher to distinctly remember this species and to select it before other more common ones. Some fishers also may have opted to choose the monk seal before other more common species if, in their recollection, they considered the species to be frequently encountered. A similar trend in choice position was observed with *T. truncatus* which, in some cases, was also chosen before other common species. The explanation for which *T. truncatus* may have received priority in terms of order of choice could rest in the possibility that the species' presence is considered common during some fishing operations while it may slide to third or fourth position of choice when interaction with fishing operations is rarer or if species recognition is more oriented towards commonly fished species (i.e., *M. surmuletus*).

The large amount of reported recent monk seal sighting observations with respect to historical accounts confirms that the species was still present in the study area until 2004. The recognition rate of the subadult morphology (Mms) as well as that of the combined subadult and adult male morphology (Mm and Mms) also seems to suggest that fishers know the species well enough to be able to discern between the adult male and subadult morphology. The observations of monk seals in proximity of ports mostly involved adult-sized individuals of black or black and white colouring, which suggests that they may have been

adult male individuals. The observation of sightings observed on land and in water suggests that some individuals do not manifest an explicitly elusive and wary attitude. Since the majority of observations regarding individuals in port waters or observed on land were recorded in sector e, which encompasses the Chafarinas Islands, it is possible that the low human disturbance guaranteed by the establishment of the Nature Reserve (Refugio Nacional de Caza) on the Chafarinas Islands since 1979 may have positively influenced monk seal survival in the area and induced a more overt behaviour on behalf of the seals using this stretch of coast. The recent observations of small-sized individuals also allows the hypothesis that some recent reproductive activity may have occurred between 2000 and 2004 in the proximity of the Chafarinas Islands and Cap Trois Fourches, though this is purely speculative. Though it is assumed that most seal sightings involve the Mediterranean monk seal, it cannot be excluded that some of the reported sightings may pertain to vagrant individuals of other seal species such as the hooded seal (*Cystophora cristata*) and the harbour seal (*Phoca vitulina*), which have been occasionally recorded in the western Mediterranean (Mas et al., 1996; Bouderbala et al., 2007). However, since adult hooded seals and harbour seals have a distinctly different pelage pattern to that of adult monk seals, it is assumed that most of the reported adult-sized observations involved Mediterranean monk seals. Absolute confirmation of the presence of monk seals and of their numbers in the study area, however, need to be determined with specific *in situ* monitoring programmes in the high sighting frequency sectors.

The study also indicates that past monk seal presence occurred in all sectors characterised by rocky cliffs and in particular in Subareas 1, 2, 3, and 4. This implies that each subarea is likely to encompass marine caves and suitable monk seal haul-out sites—a factor which is supported by the past evidence of monk seal cave use in the Chafarinas Islands (San Felix, 1999) and the description of suitable monk seal caves identified by Bayed et al. (2005) in Cap Trois Fourches (Subarea 2) and Cap de l'Eau (Subarea 1). However, minimal recent sighting frequency was reported in Subarea 4, and fishers reported observing one dead adult-sized monk seal in sector p (Subarea 3) in winter 2004. Fishers interviewed in a prior study (Tunesi et al., 2003) had also reported the finding of a dead adult monk seal several years before in this area. This may imply that Subarea 3 may be currently used by fewer adult-sized animals than were observed in the past. Moreover, Bayed et al. (2005) mentioned that the coastal rocky coast of this subarea, and specifically the area proximate to Chemlala, was under strong habitat degradation pressure as a result of the construction of a coastal road. In conclusion, Subareas 1 and 2 seem to be coastal stretches where monk seal presence continues to occur and where immediate conservation actions should be implemented in order to safeguard any remaining seal nuclei. The remoteness of Cap Trois Fourches (Subarea 2) and its exposure to strong currents and the predominant winds represent on one hand a natural protection from human encroachment, while the presence of the nature reserve in the Chafarinas Islands (Subarea 1) may contribute to the protection of a second nucleus of monk seals.

The applied method proves that this type of investigation is useful in determining whether monk seals are present in the study area and identifies the stretches of coast most used by the species and, thus, orients future monitoring and conservation activities. These activities are compliant with the priority actions defined by UNEP-MAP RAC/SPA (2003) for low monk seal density countries. Immediate conservation actions should be implemented in the identified subareas to ensure conservation and recovery, and a regional strategy including nearby Algerian areas as well as the western Moroccan area of the Al Hoceima National Park should be implemented so as to avoid further population fragmentation in this area of the western Mediterranean.

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