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Assessment of the implementation of the Action Plan for the management of Mediterranean Monk Seal

RAC/SPA - Tunis, 2009

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1 INTRODUCTION & BACKGROUND INFORMATION

This progress report mainly contains assessments of the Regional and National components of the activities carried out by RAC/SPA and by the Mediterranean countries since 2005.

The information has been extracted from the half year progress reports prepared by RAC/SPA (2005 – 2007 - 2009) and from the 2009 national reports of the Mediterranean countries provided to RACSPA. A questionnaire (Annex I) was also sent to all the Mediterranean National Focal Points calling for further information and clarifications, regarding the recent actions or/and programme.

The questionnaire aimed to find out amongst other things:

- If there are any ongoing research programme on the species
- If there are interaction between the species and the fisheries activities
- If any national action plans have been established for the conservation of the species
- If any breeding caves have been established as protected areas with adequate management plans

The following countries responded to the questionnaire in time to be included in this progress report : Greece, Italy, Israel, Malta, Spain, and Turkey.

2 REGIONAL LEVEL IMPLEMENTATION: ACTIVITIES UNDERTAKEN BY RAC/SPA

Activities achieved by RAC/SPA since 2005

RAC/SPA' efforts focused on improving knowledge on the status of the species, training national partners, public awareness and the identifying of potential critical habitats in low-density areas.

This identification of potential critical habitats concerned:

(i) The Albanian coastline, where an assignment was carried out in November 2005, by MEDASSET in collaboration with the national government. This action fell within the context of the National Action Plan (SAP BIO) for declaring a marine national park in the Karaburuni area.

(ii) The Akamas region in Cyprus, with habitat inventorying and population monitoring activities

(iii) The western coastline of Algeria: an assignment was carried out in summer 2006 in collaboration with national experts (University Oran). A wide awareness campaign was carried out at the same time. During the assignment the presence of few monk seals in the area was confirmed, thanks to surveys of fishermen. A young seal presence during the survey, initially reported by locals as a monk seal in distress, was confirmed by RAC/SPA expert on pinnipeds as a vagrant juvenile of the arctic species hooded seal *Cystophora cristata* after examination of photographs received from the University of Oran. A plan was suggested for conserving and managing sites identified as critical for the monk seal in the sector that was being explored.

(iv) (ii) The eastern coastline of Libya: An assignment was carried out, with EGA and ISPRA in May 2006. The aim, as well as prospecting marine caves in the sector, was

to gather information on recent observations (since 2002) and enhance national skills in order to enable monitoring actions to be set up.

Also, RAC/SPA organised an international conference in Turkey (September 2006) on the Conservation of the Monk Seal. This was done in collaboration with the Bonn and Berne Conventions, the Turkish Government, the Principality of Monaco, the International Fund for Animal Welfare (IFAW) and a Turkish NGO (SAD-AFAG). The aim was to promote information on successful examples of monk seal protection, and to exchange experience acquired in monk seal conservation with all the concerned parties and partners. Several dozen participants from the Mediterranean region and elsewhere took part in the Conference.

RAC/SPA provided to General Fisheries Commission for the Mediterranean (GFCM) a thorough study on interactions between fisheries and monk seals and possible mitigation measures (Annex II). The document served to the scientific exchanges at a GFCM workshop on by-catch incidental catches and mitigation measures on threatened species (Rome, Italy, 15-16 September 2008) aimed to pursuit future mitigation measures for endangered species bycatch in the GFCM area.

Recently, RAC/SPA co-organised with the Turkish Marine Research Foundation (TUDAV), a workshop on harmonization of Monk seal population estimate techniques, "Who are our seals? Moving toward a standardized population estimate approach for *Monachus monachus*", which was held in Istanbul, on 28 February 2009, as a side event within the 23rd Annual Conference of the European Cetacean Society (ECS). The event was sponsored by RAC/SPA and Pelagos-Monaco (Principality of Monaco). The workshop was attended by 38 participants coming from 12 countries. Mediterranean monk seal scientists working in the following geographical areas: Atlantic Sahara, Madeira archipelago, Greece and Turkey, presented a synthesis of their fieldwork involving population monitoring, and photo identification techniques applied to the Mediterranean monk seal. The RAC/SPA representative provided an overview on monk seal population monitoring and estimates and on the situation in other Mediterranean countries where the populations are rarer.

A large discussion took place on the usefulness of camera traps for population identification and estimation. These automatic cameras were considered by the participants as a very practical tool to be used (The workshop conclusions appear in Annex III).

Planned activities to be carried out by RAC/SPA at short term:

As a follow up to the Libyan coast investigation, a third field mission is under organisation, by RAC/SPA, EGA and ISPRA, of the following stretches of coast identified as "priority hot spots" for Monk seal presence by the study conducted in phase I (2002-2006):

- High rocky coastal stretch from Derna to Ras Tin
- Bardaa island

It's planned, during this mission the deployment of camera traps within the caves deemed most suitable for Monk seal presence in these areas.

In fact, within the framework of developing a Monk seal monitoring programme in the Mediterranean region, RAC/SPA has developed a schedule to provide assistance in several areas,

in the oriental and occidental basins which present appropriate Monk seal habitats (Cyprus, South Turkey, Balearic islands, Morocco...) to install camera traps, aiming to achieve further knowledge about the population estimate and its habitats.

At regional level, RAC/SPA is launching the preparation of sub-regionally tailored recovery plans for the species, through collaboration among Barcelona, Berne and Bonn conventions. For that purpose, the Centre aims to organise a first meeting involving the presence of the representatives of the concerned Conventions and experts working on the recovery of endangered species. The General Direction of Forest Environment and Species Protection of the Balearic Government is willing to host the meeting, which is scheduled for the end of 2009.

3 NATIONAL LEVEL IMPLEMENTATION: SUMMARY OF NATIONAL ACTIONS FOR THE MANAGEMENT OF THE MONK SEAL

Here are a summary of actions implemented by the Mediterranean countries regarding the monk seal or/and its potential habitats. Whenever a section or a Party does not appear, it implies that the related information was not provided by the respective country.

Countries	Summary of implementation of National Actions
Albania	**Seal protection:** Order of the Minister of Environment, Forests and Water Administrations, no.146, dated 8.5.2007 **Fishing regulation:** The Law "On fishing and aquaculture", no. 7908, dated 5.4.1995, amdended provides the prohibitions **Data collection:** A project funded by "Cooperazione Italiana" implemented in 2005 collected data for the monk seal in the country.
Algeria	Data collection within the framework of the implementation of the NAP for monk seal conservation
Croatia	**Seal protection:** Ordinance on Proclamation of Wild Taxa as Protected or Strictly Protected (*OG No. 7/2006*); **Fishing regulation:** yes **Data collection:** yes **Breeding monk seal population:**no
Cyprus	**Seal protection:** yes **Fishing regulation:** yes **Data collection**: yes **Awareness raising**: yes **NAP: no** **SPA for monk seal protection:** yes

Greece	**Seal protection:** The monk seal has been accorded protection status in the country since 1981 with the Presidential Decree 67/1981. **Fishing regulation:** There is a general ban in the country on the use of dynamite as a fishing technique. Firearms can be carried out on boats for hunting purposes. The use of driftnets was banned in 1993. Specific provisions regulate fisheries in the Alonissos Northern Sporades National Marine Park. Specific fishing techniques (e.g Purse Seine Netting) which pose a threat for monk seal pups are not allowed close to monk seal shelters. Penalties, according to national legislation, include confiscation of fisheries permit and gear, criminal prosecution and administarive fines **Data collection**: Data are collected mainly by the NGO MOm and the Management Body of Alonissos National Marine Park. The management Body of Alonissos National Marine Park is collecting data on population, distribution, habitats, births, deaths. MOm is collecting data on the wider country area that concern additionally to the previously mentioned parameters, food preferences, age identification, breeding behaviour, cases of nursing. Major MOm projects in the last biennium concern the Monk seal & Fisheries: Mitigating the conflict in Greek seas (Life-Nature project), Pilot implementation of new technology for the protection of Mediterranenan Monk Seal in the Natural Environment of Kimolos (Leader + project), Monitoring of the Status of the Population of the Monk Seal, in Karpathos and Saria (Contract from the Management Body through 3rd CSF). Under the frame of reporting to the Habitats Directive, a datasheet with information on parameters for evaluating the conservation status of the species, together with maps of range and distribution in a 10X10 km grid were produced and submitted to the EC in December 2007. **Awareness raising**: Within the framework of the National Programme for the Protection of the Mediterranean Monk Seal public awareness and sensitization programmes are carried out nationally and locally (from respective Management Bodies of protected areas and NGOs). The Management Body of Alonissos National Marine Park runs a small exhibition whereas the MB of Karpathos – Saria is running an information center with info also on monk seals. Both MB have produced and are disseminating information material. Within the Alonissos NMP an information center is operating by MOm. Additionally through MOFI Life-Nature Project (MOm, WWF and the National Institute for Fisheries Research), a handbook with instructions for the rescuing of wounded monk seals was produced, and training activities at local level took place. At local level other NGOs (Archipelagos of Aegean) are running also informational – public awareness activities. Exchange of experience between MOm and the Turkish organization SAD – AFAG has taken place in the past mainly through EU funding and through a DAC project in

Greece	2002. **NAP:** The implementation of the National Programme for the Protection of the Mediterranean Monk Seal (Archipelagos and MOm, 1996) is being continued. Activities include actions directed to reduce adult mortality, establishment of a network of marine reserves, research – data collection, rescue and rehabilitation and information – public awareness programmes. The effectiveness of the 1996 National Programme and of the actions conducted during the 1996-2008 has been evaluated by MOm in the context of the EU LIFE: MOFI Project with the assistance of an independent conservation expert. A new National Conservation Strategy and an Action Plan for the period 2009-2015 has been drafted by MOm. **SPA for monk seal protection**: The most important site for the population of the species (Alonissos – N. Sporades) is an SPA to the Protocol. Further on, sites in the country holding an importance for the species, including the SPA of Alonissos-N. Sporades National Marine Park, have been included in the European Ecological Network NATURA 2000. The operation of the National Marine Park of Alonissos- Northern Sporades contributes to the conservation of the largest population of the species. The Alonissos Northern Sporades National Marine Park is divided in a core and a peripheral area. Specific provisions regulate fisheries, passage of ships (special permission from the Management Body is demanded for entrance in the core area), and visitor disembarking and overnight stay. In the strictly protected area, (the island of Piperi), no human activity is allowed within 3 miles range around the island. Highest speed limit for ships passing at a distance of less than half nautical mile from the coastline of the core area is 10 nautical miles / hour. Passage of tankers holding cargoes over 500 tn as wells as ships carrying toxic or radioactive cargoes is prohibited Breeding monk seal population: MOm, The Society for the Study and Protection of the Mediterranean Monk Seal, has produced a status report in 2007 and 2008, including the latest census of the breeding caves and other habitats in the country that are important for monk seal conservation. This census is based on field surveys, it covers about 1/5 of the country's coastline and indicates around 569 terrestrial refuges of which 99 are breeding caves. Through various reports most monk seal important information has been communicated to concerned organizations

Italy		**Seal protection:** L. 157/92 *Norme per la protezione della fauna selvatica omeoterma e per il prelievo venatorio* **Fishing regulation:** Fishing with explosives is prohibited according to Art. 15, letter d), of the Law 963/65 subsequently modified by Art. 1 of Law 110/75 and Art. 1 of Legislative Decree 26.05.2004 n. 153. The penalties are: imprisonment from 2 months-2 years, or a fine ranging from 1.032 - 6.197 €. Furthermore the fishing gear and all fished products are sequestered. **Data collection**: yes **Awareness raising**: assistance programme with Libya **NAP:** no **SPA for monk seal protection:** yes **List of breeding caves:** yes
Lebanon		**Seal protection:** Decision no: 125/1 dated 23/9/1999: Protecting Wales, Monk Seals, Marine turtles and banning their fishing yes **Fishing regulation:** yes **Data collection**: yes **Awareness raising**: yes **NAP: no** **SPA for monk seal protection:** no **List of breeding caves**: no
Libya		**Seal protection:** no **Fishing regulation:** no **Data collection**: yes **Awareness raising**: yes **NAP: yes** **SPA for monk seal protection:** under development **List of breeding caves:** yes

Malta	**Seal protection:** Marine Mammals Protection Regulations, 2003 (Legal Notice 203 of 2003): Published: 12th August 2003. Flora, Fauna and Natural Habitats Protection Regulations, 2006 (Legal Notice 311 of 2006): Published: 7th December 2006no **Fishing regulation:** Fishing gear – No specific regulations exist locally on the banning of fishing gear, which could have an affect on monk seals, due to the fact that this species is considered vagrant. However, being a MS of the EU, MT adheres to provisions on the prohibition of certain fishing gears amongst which the ban on driftnet fishing in the Mediterranean with nets more than 2.5 km in length. Notwithstanding the above, the Marine Mammals Protection Regulations, 2003 (Legal Notice 203 of 2003) and Flora, Fauna and Natural Habitats Protection Regulations, 2006 (Legal Notice 311 of 2006) also state that no person shall pursue, take or attempt to take, deliberately capture or kill or attempt to kill, deliberately destroy, keep, transport, by any method sell, buy, exchange, offer for sale or for exchange, import or export and deliberately disturb the monk seal. Fire arms – Firearms are not to be kept on-board of fishing vessels, apart from the licensed use for hunting of game at sea. Infringement of provisions concerning the use of firearms will result in fines and possible imprisonment of not less than 3 months but not exceeding 5 years and/or fines as deemed just by the Court, as stated in Part XI, Article 51 of Chapter 480 of the Laws of Malta, Arms Act Use of Dynamite – Imprisonment for a term from 1 to 9 years, under Article 34 of Chapter 33 of the Laws of Malta, Explosives Ordinance **Data collection**: A study was conducted to gather information on 'Threatened and Endemic species in Malta'. Through this study it was concluded that *Monachus monachus* only occurs locally as a vagrant **Awareness raising**: Due publicity was given when the first law on marine mammal protection was issued in 1993, with the production of educational material. Such material was being regularly reprinted till recently due to requests, particularly by schools. **NAP: no** **SPA for monk seal protection: no** **List of breeding cave**:
Montenegro	**Seal protection:** no **Fishing regulation:** yes **Data collection**: no **Awareness raising**: yes **NAP: no** **SPA for monk seal protection: no** **Breeding cave**: no

Spain	**Seal protection:** Critical Endangered Species under Spanish Law (RD 439/1990). Extinct species under Murcia Regional Regulations (Law 7/95) Critical Endangered species under Canarias Regional Regulations (Law 151/2001) **Fishing regulation:** yes **Data collection**: Yes but through international cooperation in Cabo Blanco (Mauritania), but not in the Mediterranean, except for a recently arrived adult (since 2008) in the Balearic Islands. **Awareness raising**: Yes but through international cooperation in Cabo Blanco (Mauritania), but not in the Mediterranean. **NAP:** no **SPA for monk seal protection: no,** However there are several protected areas and Natura 2000 sites in Canary, Baleares and Chafarinas Islands that protect potential monk seal habitats. **Breeding cave**: no
Syria	**Seal protection:** At legislative level, a draft modified Law on Protection of Aquatic Life was developed, proposing stipulation prohibits the fishing of marine mammals in general **Fishing regulation:** no **Data collection**: yes, GCEA's biodiversity directorate, in cooperation with research institutions **Awareness raising**: yes, 2 workshops on monk seal protection were held in 2004 and 2005, **NAP: no** **SPA for monk seal protection**: The proposed combined-extended Oum-Ettoyour-El-Bassitt SPA involves potential monk seal habitats **Breeding cave**: Over the last decades monk seal was seldom sighted at some sites, particularly north of Lattakia, without definite proof on the presence of breeding populations.
Tunisia	**Seal protection:** no **Fishing regulation:** In addition to the measures relating to the fishing exercise (period and fishing zone, fishing devices, prohibited fishing methods, protection of aquatic species) recommended by the Law n° 94-13 of 31 January 1994, the law n° 68-4 of 8 March1968, accords particularly the protection of the Monk seal in the Tunisian territorial waters. **Data collection**: no **Awareness raising:** RAC/SPA documentation **NAP:** within the framework of the protection of Galiton and Zembra **SPA for monk seal protection:** Galiton island **Breeding cave list:** Galiton island and Zembra

Turkey	**Seal protection:** Environment Law (No:2872- Article 9) **Fishing regulation:** According to Environment Law (No:2872- Article 9) and Fisheries Law (No:1380), some penalties is implemented **Data collection**: Monitoring programme **Awareness raising**: yes, via NGOs **NAP:** yes, species action plan are prepared for 4 years **SPA for monk seal protection:** yes, potential 4 areas are determined in Izmir Province (2 areas), Mugla province(Bodrum) and Mersin province **Breeding cave list** : Some Breeding caves are established: in *Izmir Province (2 areas), Mugla province(Bodrum) and Mersin province*

4 MAIN CONCLUSIONS

The following conclusions were prepared taken into consideration the responses resulting from the questionnaires, the recommendations of the Antalya conference and the Monk seal workshop conclusions:

- There is a lack, in a number of Mediterranean countries, of population monitoring and surveying actions to achieve further knowledge about this species, its habitats and the problems affecting it, mainly in the countries with low density or vagrant population
- Interactions between fisheries and monk seal are not reported.
- information exchange, awareness and social support should be further promoted
- Creating a protocol for coordinated actions in emergency situations is pending.
- Establishing mechanisms to coordinate and finance the conservation actions of both action Plans (the Atlantic action plan and the Mediterranean action plan) would help the species recovery
- Organisation of training to serve knowledge about the protection of the species and their habitats in areas not covered by existing involved groups is a recurrent needed activity

ANNEX I: QUESTIONNAIRE TEMPLATE

Questionnaire sent to National Focal *Points for SPAs* to evaluate the implementation of the Actions at national level for the conservation of the Monk seal in the Mediterranean

No.	Description of the measures taken under the Action Plan	STATUS Please tick the most appropriate answer					DIFFICULTIES/CHALLENGES Please tick the most appropriate answer					
		Yes	No	Under development	Other	Not applicable	Policy framework	Regulatory framework	Financial resources	Administrative management	Technical capabilities	Public participation
1	Has the Party given the monk seal protection status? If yes, Specify the type and date of the regulation.											
		Remarks/Comments										
2	For fishing, does the Party explicitly ban the use of dynamite, the carrying of firearms on boats, and all fishing techniques that can endanger monk seals? If yes, what are the main penalties in case of the non respect of this interdiction?											
		Remarks/Comments										

3	If the Party still has breeding monk seal populations, have measures been taken to isolate monk seals from any human activity? If yes, specify.											
		Remarks/Comments										
4	In the Party's territory, have SPAs been created to conserve monk seal populations or their potential habitats? If yes, specify.											
		Remarks/Comments										
5	Has the Party established a list of breeding caves and other habitats that are of importance for monk seal conservation? Are the list of breeding caves and other habitats that are of importance for monk seal conservation communicated to the concerned organizations veiling to warrant the protection of those Habitats, such as Berne Convention, European Commission (fulfilling of Habitat Directive) and Barcelona Convention itself.											
		Remarks/Comments										
6	Has the Party carried out programmes for data collection on the monk seal? If yes, are these programme accessible? What did they concern (Etiology, population Dynamic…) Specify is there monitoring programme of the species and its habitats.											
		Remarks/Comments										

7	Has the Party developed programmes for awareness raising, information and training concerning monk seal conservation? Specify if your countries organize any exchange of data with other countries or appropriate organizations? Are there programme of assistance.											
		Remarks/Comments										
8	Does the Party have an action plan for the conservation of the monk seal and its potential habitats? Specify how your country assesses the working out of this plan.											
		Remarks/Comments										

ANNEX II: REPORT OF THE MONK SEAL WORKSHOP CONDUCTED WITHIN THE FRAMEWORK OF THE EUROPEAN CETACEAN SOCIETY ANNUAL CONFERENCE

"Who are our seals? Moving towards a standardised population estimate approach for *Monachus monachus*"

Workshop conducted within the framework of the Annual Conference of the European Cetacean Society
Workshop technical co-organisers: A.C. Gucu, G. Mo

February 28th, 2009
Istanbul, Turkey

Conclusions of the workshop presented within the framework of the conference

The workshop was attended by 38 participants coming from 12 countries. Mediterranean monk seal scientists working in the following geographical areas: Atlantic Sahara, Madeira archipelago, Greece and Turkey presented a synthesis of their fieldwork involving population monitoring, and photo identification techniques applied to the Mediterranean monk seal. Daniel Cebrian, expert of UNEP-MAP RAC/SPA provided an overview on monk seal monitoring techniques and priorities, and on the situation in other Mediterranean countries where the populations are rarer.

Very diverse, but on the other hand similar, methodological approaches emerged between and within the Atlantic and Mediterranean region due to diverse environmental scenarios that can be found throughout this species' range. Population estimates reported for the Atlantic Sahara population by two different working groups (Manel Gazo from Submon on behalf of the University of Barcelona and Pablo Fernandez de Larrinoa from CBD-Habitat) covering early and recent study periods and based on mark-recapture analysis of handheld photographic and videocamera images, indicated effective population monitoring of this colony. Most importantly, this monitoring was able to detect the reduction in number and age structure of the population following the 1997 mortality event and the colony's subsequent recovery.

The final workshop discussion approached the issue of the usefulness of questionnaires as a tool to first identify monk seal presence /absence and possibly distribution. Participants expressed the view that it is worth trying to exploit data from questionnaires, provided that there be a direct contact with the person providing the information and that corollary environmental data be collected as a control. Participants expressed concern over the need to overcome possible false-negative or false-positive responses that may be triggered for example by fear of future restrictions (i.e. fisheries) in the case of monk seal presence.

Monitoring changes in population level of a species that is widely distributed in low numbers was recognized as being a difficult problem in the Mediterranean sea. Lex Hiby from Conservation Research Ltd. suggested that repeated surveys of extensive coastline to record the proportion of caves showing fresh tracks/traces could be an efficient way of monitoring population changes provided that some artificial tracks were used to identify the caves that were likely to have been washed out since the last visit. Participants agreed that this method could be useful in monitoring changes in the trend of habitat use. However, Alexandros Karamanlidis suggested that, according to MoM's experience, it would be more efficient to concentrate available effort in monitoring only known breeding caves during the breeding season thereby estimating the population based on pupping counts. Cameratrapping / videocamera survey of selected breeding caves should, wherever

possible, be used to relate the all-age population to the observed number of pups born. There was diffuse concern of whether exhaustive knowledge over the distribution of pupping caves and the timing of the breeding season would be available in all areas of the Mediterranean. An alternative scenario proposed by Lex Hiby was population estimation by frequent relocation of camera traps leading to mark-recapture analysis. Many participants supported this alternative scenario.

Two participants specifically shared their working experience in the use of cameratraps but recognized that continuous improvement in camera technology may provide imminent useful alternatives for camera trap models. Based on present experience, the MoM expert found the use of camera traps equipped with an infrared flash most useful for the purpose of photoidentification. General advice given on the use of this camera trap type is to: mask the infrared flash surface with a water-soluble marker so as to reduce the visible component of the flash and thereby decrease the possible disturbance to the seals, set the camera to multiple exposure (times 3) and a short time delay (1 minute) between successive detections. Ali Cemal Gucu from METU found the use of an alternative camera trap type equipped with visible flash most suitable for photoidentification since it provides high quality picture rendering thereby facilitating scar pattern identification. General advice given on the use of this camera trap type is to: set the interval between successive detections at 30 minutes in order to minimise disturbance, orient the angle of view so as to encompass either only the haul-out area or the water surface, use low sensitivity setting when the camera is oriented towards the haul out areas to avoid detection of other cave fauna (bats, etc.) and medium sensitivity when the camera is oriented at the water surface so as to detect seals in the water.

Discussion took place on the usefulness of exchanging data and setting up a unique and regional photoidentification catalogue to better understand animal movements. Some participants agreed to the need of such a tool for the Mediterranean sea but MoM expressed disagreement at the time being for such a tool. Concern was expressed over the need to ensure that sufficient management resources and long-term commitment be allocated to the running of such a proposed scheme. Some participants requested that existing catalogues be made easily available immediately within the scientific community. Some participants expressed interest over the use of automated image matching software but general consensus was reached that it is currently not required as manual matching of images is effective. Some participants underlined the need of training further scientists to undertake monitoring in the seal areas still not covered by the existing teams.

Workshop technical co-organisers: A.C. Gucu, G. Mo

ANNEX III: RAC/SPA CONTRIBUTION TO THE GFCM SUB-COMMITTEE ON MARINE ENVIRONMENT AND ECOSYSTEMS (SCMEE) REGARDING THE MONK SEAL, TO SUPPORT THE 2008 GFCM WORKSHOP ON BY-CATCH.

SCMEE SCSA transversal Working Group on bycatch incidental catches (Rome, Italy, 15-16 September 2008)

Following the current memorandum of cooperation among the RAC/SPA and the GFCM on *"cooperation on fisheries and biodiversity preservation in the Mediterranean Region"*, RAC/SPA keeps regular collaboration with that institution in issues related to conservation of Mediterranean species and habitats affected by fisheries, including scientific advice within its Scientific Advisory Committee and Sub-Committees.

The SCMEE[1] SCSA[2] transversal Working Group on bycatch incidental catches met in Rome, Italy, on 15-16 September 2008. It compiled and discussed general information regarding estimates on bycatch and incidental catches of threatened species. It emphasized that relevant solutions should be urgently implemented to decrease the negative interactions of fishing gear with species of conservation concern.

The contribution provided by RAC/SPA to the Sub-Committee regarding the monk seal is attached herein.

Main excerpts concerning the monk seal future conservation, in relation both to fishing mortality evaluation and to mitigation measures are presented below. Further information may be found through the GFCM related documentation[3]:

Evaluation of bycatch and fishing mortality for threatened species in the Mediterranean Sea

A total of 15 presentations on the status of knowledge of bycatch of species of conservation concern at national and regional level were made. Main subject reviewed were the following:

- Interactions between fisheries and monk seal (*Monachus monachus*) in the Mediterranean
- Overview on marine turtles bycatch in the Mediterranean
- Status of knowledge at regional level on interactions between fishing activities and cetaceans

[1] Sub-Committee on Marine Environment and Ecosystems
[2] Sub-Committee on Stock Assessment
[3] GFCM, 2008a: *Report of the Transversal Working Group on Bycatch/Incidental Catches. Rome, Italy, 15-16 September 2008.* SAC11/2008/Inf 17 Eleventh Session of the Scientific Advisory Committee Marrakech, Morocco, 1-5 December 2008.
GFCM, 2008b: *Conclusions and Recommendations of the Four SAC Sub-Committees. Antalya, Turkey, 13–16 October 2008*. SAC11/2008/3 Eleventh Session of the Scientific Advisory Committee Marrakech, Morocco, 1-5 December 2008.

- Status of knowledge at regional level on interactions between fishing activities and elasmobranches
- Status of knowledge at regional level on interactions between fishing activities and sea birds

Implementation of mitigating measures

A thoroughly discussion was entertained by the Working Group trying to summarize all learnt lessons and good examples given by all participants, in terms of implementation of mitigation measures. A number of proposals were tabled. The proposals of concern for the monk seal conservation are highlighted below:

Concerning all issues carefully considered during the meeting, the Working Group concluded that:

- Although the information presented on bycatch events of elasmobranches, marine turtles and cetaceans was interesting and valuable, the lack of standardisation in data collection and analysis makes it difficult to translate it into management advice. Extrapolation of non-standardised bycatch rates is not only dangerous, but also wrong and detrimental for management. The scenario was worsened by the fact that the available information was not homogenously spread in geographic terms
- In general, reliable data on population structure and abundance of by-caught species are of fundamental importance, not only to understand the real status of species and populations, but also to evaluate mitigation measures. The Working Group strongly encouraged more studies on population dynamics (population size, structure and demographics) on species of conservation concern (also in terms of fishery management), aiming to both clarify the status of the populations and evaluate the efficiency and the cost effectiveness of mitigation measures
- Interviews and types of survey other than direct observations, even though may not be used for quantitative analysis, can be extremely valuable as indicators of the existence of a problem that needs more attention, especially in case of artisanal fisheries (small scale fisheries) where no other data could be collected
- For species of conservation concern, if a serious threat for a given species or population is suspected, mitigation measures should be applied promptly, without waiting for more information on their population size and structure. In this regard, the Working Group intend to propose at the next meeting of SCMEE specific mitigation measures that could be implemented immediately, for those species and populations

The Working Group suggested that SCMEE and SCSI[4] discuss further at their next meetings, among others, the following elements affecting also the monk seal, to finalise a formal proposal to the GFCM.

- To collaborate and promote, together with other relevant IGOs/NGOs, coordinated studies on population dynamics of species of conservation concern, such as sharks, marine turtles, mammals, birds
- To launch pilot projects on bycatch in specific gears or fishery, taking into account not only technological measures for mitigation, but also the social aspects connected with that gear (especially in artisanal fisheries) or fishery; so as to undertaking an ecosystem approach
- Drafting a protocol for data collection on bycatch of species of conservation concern, merging the draft protocols prepared for ACCOBAMS and MEDLEM;
- Evaluate existing data on bycatch, and identifying critical areas that could be eligible for local fishery management measures
- Organize a transversal workshop on selectivity improvement and by-catch reduction

Finally, and on terms of future general scientific work for the Sub-Committees, the SCMEE also recommended to follow-up on the below monk seal-related activities:

- Prepare a draft set of criteria to identify essential habitats for priority species, organised by GSA[5], to be submitted for consideration by the Eleventh session of SAC[6]. That SAC session has requested those criteria to be further elaborated during a 2010 SCMEE meeting
- Pursue promoting the implementation of EAF through the development of pilot studies and encourage the involvement of stakeholders from the beginning of the process
- Evaluate the existing data on by-catch, and identifying critical areas that could be eligible for local fishery management measures.

[4] Sub-Committee on Statistics and Information

[5] Geographical Sub-Area

[6] GFCM, 2008c: *Criteria for the identification of sensitive habitats of relevance for the management of priority species.* SAC11/2008/Inf 20 Eleventh Session of the Scientific Advisory Committee Marrakech, Morocco, 1-5 December 2008.

GENERAL FISHERIES COMMISSION FOR THE MEDITERRANEAN

COMMISSION GÉNÉRALE DES PÊCHES POUR LA MÉDITERRANÉE

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SCIENTIFIC ADVISORY COMMITTEE
Sub-Committee on Marine Environment and Ecosystems (SCMEE)
Sub-Committee on Stock Assessment (SCSA)

Transversal Working Group on by catch/incidental catches

FAO Headquarters, Rome (Italy), 15-16 September 2008

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Seals-fisheries interactions in the Mediterranean monk seal (Monachus monachus): related mortality, mitigating measures and comparison to dolphin-fisheries interactions

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Abstract

The frequency of interactions with trammel nets by Mediterranean monk seals (*Monachus monachus*) and dolphins was recorded at the island of Zakynthos, located in the south Ionian Sea, Greece.

Monk seals interact in the region mainly with static fishing gear. Zakynthos fishers endured an overall damage rate of 4.96% caused by monk seals out of 1632 net settings. Dolphins caused an overall damage rate of 6.19%. This rate is similar to the one attributed to seals, but the level of damage to each net was more severe.

Interaction of monk seals with trammel nets and related by-catch risk is related to the distance of the net placements to the caves where the seals rest. Damage becomes very low at distances along the coast higher than 5 nautical miles from the caves, and insignificant for distances higher than 10 nm. It might be possible to strongly reduce the level of this interaction, the main drive to extinction through by-catch and killing by fishers, by management of coastal fisheries based on this result.

Conservation actions for the seals could consider this knowledge as a tool to properly design MPAs or to create static net restricted Important Seal Areas, with marine boundaries according to the tolerable level of interaction with nets accepted by managers.

Fish obtained by the seals from the predated nets during the study would reach as a maximum 20.81 Kg/month. Such catch would hardly provide 1 Kg fish/seal to the seal population monitored. Hence, we disagree with the hypothesis that monk seals in the Mediterranean search for nets as a reaction to a depletion in the fishing shoals.

Introduction

The Mediterranean monk seal (*Monachus monachus)* is the most endangered pinnipedian worldwide, considered critically endangered by the I.U.C.N. Its remaining world population is located mainly in Greece, where 234-300 individuals out of less than 550 survive. They breed in marine caves, and because peak pupping in Greece occurs in September and October, they are very linked to the nearshore habitat in autumn and winter (Cebrián, 1998a).

The interactions of the species with fishing gears have negative effects both for humans and for the seals. Monk seals damage nets to eat fish trapped in them, and they frequently die either entangled (by-caught) or killed by fishers (Ronald and Duguy, 1979; Berkes et al., 1979; Harwood, 1987; Avellá, 1986; Avellá and González, 1989; Panou et al., 1993; Cebrián and Vlachoutsikou, 1992; Ozturk and Dede, 1995; Cebrián, 1998a; Ozturk, 1998). Entanglement rates in active fishing gear depends on the local characteristics of fisheries and does not seem to be a very significant cause of death in Hawaiian monk seal (*Monachus schauinslandi)* owing to protective measures. However some fisheries interactions occur, including entanglement in active and derelict nets (Gilmartin et al., 1983; Twiss and Reeves, 1999). Other species, like the harbour seal (*Phoca vitulina)* in Norwegian waters (Bjorge et al., 2001), endure the highest by-catch mortality rates in active gear.

The level of interactions between seals and trammel nets is traditionally exaggerated by the artisanal fishers. In contrast, damages to purse seines or trawls are reported to be rare by these fishers.

The fact that monk seals approach trammel nets with a certain frequency is a major problem for the future of the species.

This study addresses the magnitude of that problem, contrasts it with the damages attributed to dolphins, and suggests solutions to mitigate negative interactions, aimed to enhance the survival chances for the species.

Methods

The population studied

Zakynthos island, in the South Ionian Sea, was chosen as sample area for the study. It hosts a breeding population of monk seals, which we estimated by capture-recapture-method to be between 18 and 23 individuals during the nineties, excluding yearlings. The population is declining due mainly to illegal shooting related to their interaction with trammel nets. The species rests and breed in the south and west of the island with a yearly production of two-three pups along the nineties.

The National Marine Park of Zakynthos was declared in December 2000. Its main purpose is the protection of the populations and habitats of both the loggerhead turtle (*Caretta caretta)*, which breeds on Laganas Bay, and the monk seal. However the

declared protected area embraces only the marine sector and the coast around the bay. The seal caves located at the Laganas bay and at the northeast of the island were abandoned in the middle 90's because of shooting, habitat degradation by new public roads building and mass tourism activities. At present, the monk seal habitat is completely excluded, except for a few caves used only sporadically.

There is not a resident population of dolphins near the island. Damages can be sustained both by bottlenose dolphin (*Tursiops truncatus)*, a coastal species uncommon in Zakynthos, and by striped dolphin (*Stenella coeruleoalba)*. Although the latter is an oceanic species, Politi et al. (1992) found them to be very frequent in the Greek Ionian and they felt surprised by its systematic presence in shallow waters and close to the shore. We recorded several strandings of this species on the island due to the epizootic that affected them during the study period (Cebrián, 1995a). Common dolphins (*Delphinus delphis)* are frequent in the Central Ionian but we have not recorded them around Zakynthos, in the South Ionian.

Working area

The frequency of damages to nets produced by monk seals and dolphins was recorded at the island of Zakynthos, located in the south Ionian Sea, Greece (Fig. 1). For that purpose, the activity of artisanal fishing boats was monitored in the main fishing harbours on the island, Limni Keriou and Aghios Sostis, both of them located in the southern island bay of Laganas. These boats are wooden vessels usually less than 10 m long, with license to fish with trammel nets and bottom long lines. Usually only one fisherman and seldom two of them are onboard. These vessels fish on the south and west coasts of the island, as well as within the big bay of Laganas, open to the southeast. The nets are placed at dusk and pulled up shortly after dawn.

Data on monitored interactions presented in this study were collected from autumn 1990 to summer 1993. Some additional data on interactions and by-catch of monk seals with other fishing gear were collected from the Aegean Sea between 1990 and 2003.

For the monitoring, the location of the net settings on each trip, as well as the damage events to nets attributed to seals or dolphins were recorded from the fishers when they returned to port in the morning. Although the island underwater topography is steep, most of the trammel nets were set at depths shallower than -50m, since these fishers do not venture very far from the shore to fish. Interactions with long lines were not monitored since it is not possible to assign them with certainty to marine mammals. In order to calculate the frequency of damages per trip and to relate the geographical location of the damages to the fishing effort, data were used only if more than 50% of the fishing trips of a particular vessel had been properly recorded that month.

The damage events recorded were used to create a contingency table and analyzed with a G test, to relate their location with the presence of the closest caves inhabited by seals.

Results

Monk seal interaction with different fishing gears

Monk seals interact in the seas surrounding Greece mainly with static fishing gear. From 1990 to 2003 years we only have the following few records supporting the contrary: a fisherman from northeast Zakynthos killed at least two seals trapped in his small haul seine; an adult male in 1992 and another animal of uncertain age in winter 1994. The former seal was trapped together with a juvenile who managed to escape through a hole open in the net sac. Another juvenile was trapped with a similar gear, and released unharmed, in winter 1991 offshore of Spetches island in the east Peloponnesus, Aegean Sea. Seals also eat fishes trapped in bottom long lines. Fishers relate that the fish head is usually left together with the hook in the line, although we have two reports of seals eating the whole fish together with the hook. In one of these cases, near Naxos island, Aegean Sea on September 1991, a hooked juvenile seal was lifted onboard and released after cutting the long line. Although the animal had swallowed the hook, we did not record any seal death in the area during that period.

On the contrary heavy seal mortality related to interactions with fishing gear is endured by the species owed to direct killing (Cebrián, 1998b). The worst seal mortality record in Zakynthos for the last two decades was between summer 2000 and winter 2000-2001 with two adults of sexes, a subadult male and a youngster killed by humans. In spite of the severe decline, on October 2001 we counted at least 13 surviving seals in just two caves close to each other: three adult males, one subadult male, three adult females, four juveniles and two pups, without implementing a complete census of the island.

Difference between damages inflicted to nets by seals and dolphins

Damages by seals

When a monk seal captures a fish trapped in a trammel net, it usually produces three or more holes. One hole is in the place where the fish is pulled out and two or more other smaller ones are located to both sides of the former because the animal stands vertically holding the net with its forelimbs. The fish is usually swallowed together with a small piece of net as confirmed by the rests from nets found sometimes by us in the excrements and inside the stomachs of seal carcasses. For that reason the net can lack some filament fragments in the big holes and is just ripped in the small ones. This pattern repeats with each fish taken from the net, so the damage can be mended when there are not many fishes trapped, which is usual in these fisheries. Simple small holes, unassociated with other holes also occur, so the net presents a pattern of scattered small holes.

We have several reports from fishers around Greece that describe seals pulling fish out of nets and dropping them to the bottom to eat latter, whenever there are many fishes trapped. The only fish reported to be always left in the net is the scorpion fish (*Scorpaena* spp.) These animals have poisonous bones on their dorsal fins and opercula, and are represented in Greece by three species.

Damages by dolphins

Damages inflicted by dolphins are bigger in quality than the ones inflicted by seals. Dolphins usually catch the fish while passing through these weak nets, consequently leaving a very large hole on it for every fish eaten. They also rip big extensions of the net, possibly pulling it to become untangled. These gillnets are very thin and easily breakable if the dolphin's body is not too twisted in the net mantle or entangled with the float or weight-holding ropes delimiting the net. Dolphin attacks are inflicted in herds and the nets usually become completely destroyed, while attacks by groups of seals are less common.

Quantification of interactions with trammel nets

Relation between damages to nets and number of fishing trips

Zakynthos fishers endured 81 seal damage events out of 1632 settings. This means an overall damage rate of 4.96% (Table 1). It is worthy to mention that 48 of these events happened off the south and west coasts, which have rocky cliffs. Despite a lower level of fishing activity, about half level of fishing activity inside the bay with its mixed cliffs and sandy beaches, the former area accumulates a much higher proportion of damages than the latter, 8.53% and 3.09% respectively (Chi-square = 23.14, $p<0.001$)

In 65.6% of those cases in which a net had been predated by seals, fishers saw one or more seals in the setting area (other sightings during the fishing trip were not considered). This strongly suggests that seals usually predate on nets after sunrise. When damages were due to dolphins, the value ranged from 80% (bay) to 100% (west coast). Only in eight cases were dolphins seen around the net placement area without damaging them. Dolphins are much more conspicuous than seals and can be seen further away because they jump much more frequently than monk seals and are usually in pods, which are sometimes numerous. Seals that are reported attacking nets are usually alone, which makes them more difficult to see.

Dolphins caused an overall damage rate of 6.19% and this loss rate is similar between cliff and smooth coasts (Chi-square = 0.03, p= NS). The value is not significantly greater than the 4.96% damage rate obtained for seals (Chi-square = 2.33, p= NS) but the level of damage to each net was much severe, as stated above.

To further examine differences between seal and dolphin interactions with nets we calculated the correlation coefficients r for the damages relative to nets deployments. The association between quantity of damages and number of nets available every sampled season is stronger for the dolphins (r = 0.8, $p<0.001$, n = 12 seasons) than for the seals (r = 0.6, $p<0.05$, n = 12 seasons). This could indicate active searching and better efficiency at locating nets by the dolphins, maybe thanks to the help of echolocation and group foraging in contrast with seals, which lack echolocation and are usually solitary foragers.

Damages by seals were associated with proximity to the seal caves existing on the island. As Table 1 shows, from the 563 nets deployed in the west coast damages were inflicted to 48 (8.53%), while from 1069 nets set in the bay damages affected 33

(3.1%). All monk seal caves permanently occupied in the study area are located on the west coast. The greatest difference was in summer 1991, when 25% of the nets were affected by seals in the west coast, while the only damage within the bay happened in its western limit. Even excluding this exceptional season from the data, the total level of damages on the west coast was double the level from the bay.

A contingency table was created to estimate the effect of the coastal distance to used caves on the frequency of damages by seals (Table 2). Four categories of coastal belts have been displayed, each one having a length of 5 nautical miles. The first one utilizes data on damages incurred within areas with occupied caves at the time when the damage occurred. The other three ones utilize data on damages incurred at sequentially higher distances.

The first category, with inhabited caves, includes data from the west coast within the cave area and between the southernmost occupied cave to 5 nm north from it. This embraces all the caves monitored by us in the area. Data collected more than 5 nm north are rejected, since some caves not monitored there could be inhabited by seals and distort results. A total of 117 data points were rejected because their location did not allow a certain assignment to a specific category in relation to cave use by seals. Data collected in the west half of the bay when seals inhabited its caves are also included. A broken net within this last area would be 2 nm at most from an inhabited cave and probably less.

The second category includes all data from the coastal zone between the southern occupied cave in the west coast and the south cape of the island, which is 5 nm away from that cave. It also includes the data from the east half of the bay during periods in which its west half had seal presence on its caves. A damaged net would be from a few meters to 5 nm away from the closest used cave. In fact, the distance would be usually at least 2 nm, which is the distance from the more frequented caves to the inhabited belt limit.

The third category includes data from the west half of the bay, collected during periods when there were not seals inhabiting caves in this area (every winter, autumn 1992 and spring and summer 1993). A net predated here would be 5-10 nm away from the closest used cave.

The last category includes data from the east of the bay, collected during periods when there were not seals inhabiting the bay caves, all of them located on the western side of the bay. The caves used by seals were at those times at a minimum distance of 10-15 nm from a net damaged in this area.

A G test on the resulting table (Table 2) tested the null hypothesis that damages are independent from areas. The result ($G=25.54>X^2_{(05)\ 3}$) is significant, demonstrating that the damages are not independent from the belts. Consequently, damages to nets become less frequent as nets are placed further from an occupied cave. The frequency of damages on areas separated 5 nm would be respectively: 10.56%; 7.03%; 3.22%; 1.05%. The damage ratio would be given by the following equation:

$$Y = 10.312-0.65 * X + \varepsilon$$

Where X is the distance in nautical miles and Y is the damage expressed in %, and ε is the random error associated with the measure. In theory, we would not expect to have predation on nets at coastal distances higher than 16 nm from caves.

Phenological differences between seal and dolphin damages

The percentage of net predation by dolphins and seals by season is shown in Fig. 2. The main difference between dolphins and seals is the minimum number of damages produced by seals in spring, while there is a maximum for the dolphins during that season.

Discussion

Phenology and damages

Since there is not a resident population of dolphins near the island, their damage peak in spring may be related to higher dolphin presence in that season and not necessarily to higher predatory activity in relation to other seasons.

The minimum damage in spring for seals may be related to the peak of moulting, that we found to be in that season (Cebrián, 1998a). All the seal species where moulting have been studied fast or hardly eat during moult (Bonner, 1989).

The maximum for the seals in winter suggest that predation is higher in this season, when the animals forage in groups with pups. The biggest group sizes are recorded in the caves when the pups are still very dependant on land and can not swim very long distances, although they can swim inside the cave less than one week after birth. The biggest group size recorded resting together in Zakynthos was 10 individuals, including one pup. Maybe the shortening of foraging trips offshore because of the presence of pups or the group foraging itself, or both, increase the chances to find nets along the coast. However, this maximum could be just an artefact, since absolute values of damages in this season are low ($\overline{X}$ = 4.67, S.D.= 3.79, n= 3) but available nets in winter are five times less than in spring and summer. Considering that nets are a food resource that is in limited supply, each net would have a greater chance of predation.

Seal-nets interactions and learning

Damages to nets may increase due to cultural factors related to learning from other individuals. During a survey of the Adriatic Sea fishers did not report damages to their trammel nets, before the seals became extinct in Dalmatia as a breeding population. Instead seals used to break reed fish traps by crushing them with their bodies against the seabed. The only recorded damages to trammel nets had been produced by a vagrant juvenile in 1993, which we concluded was a dispersing individual from the Ionian Sea, the closest breeding area being located roughly 300 nm to the south south-east (Cebrián, 1995b). This does not mean that seals from the Adriatic never ate fish from nets, but just that the last remaining populations did not seem to do it. In the oldest records known to us on interactions of monk seals with nets, Brusina (1889) reports a poem by Mavro Vetranic Cavcic (1482-1576), which

refers to seal predation on nets off St. Andrija Island, close to Dubrovnik. Also Orbini (1601) records the report of "big damages to the fishermen" whenever monk seals entered in Meleda lagoon, on Mljet Island, as well as the trapping of the seals in nets deployed for that purpose across the lagoon entrance.

Learning from adults would explain why monk seals eat dead fish from nets, since they do not eat fishes thrown to them by fishers, at least in the Mediterranean. We recorded several reports of pups eating from the nets together with adults. The biggest group reported mentioned more than five seals, including pups, in SW Zakynthos. The group composition was verified by us during cave monitoring; six hours later there was a group of three females and two moulted pups resting in a cave just in front of the spot where the net had been broken that morning. Another pup was seen several times with an adult, which we assume was its mother, eating from the nets in the Bay of Milos Island, in the Aegean Sea. We also have several records of pups drowned in nets (Cebrián et al.,1995): one pup in a net off Keros Island, and two pups in different nets off Iraklia Island, both in the Aegean. These sightings show that pups forage together with their mothers and probably learn to eat fish from nets that way.

Interactions and seal foraging behaviour

The results of the contingency table suggest that seals predate on nets whenever they find them by chance on their foraging trips. Should they actively look for nets, a higher frequency of interactions than the one recorded would be expected at long distances, and the animals would have learnt to look for them in the bay, where nets are more abundant. A juvenile monk seal can travel more than 15 nm in less than one day, as we can infer from radiotracking data recorded by Reijnders and Ries (1989); also Mursaloglu (1984) reports 20 nm displacements in less than 24 hours. Therefore, at least some of the adults within our population would be physically able to reach the farther limit of our study area in less than one day.

The spatial distribution of damages suggests that the seals usually travel offshore from their caves to forage in unknown areas, possibly far away from the coast as grey seals (*Halichoerus grypus*) do (McConnell et al., 1999). The expected cumulative pattern of the population foraging trips would show a radial plotting centred in the caves proximity, towards unknown offshore feeding areas and not a linear one along the coast starting from them. The damages in the coastal trenches would be consequent with encounters when seals leave and especially when they return from these offshore trips. The departure is always from a haul out site, but the return to it depends on navigation skills, which surely are very good but cannot be 100% perfect, so the returning animal would travel along the coastline trench until it relocates the cave. That would explain the steep decrease in interactions found at distances relatively close for seal foraging capabilities. Active foraging along the coast would result in a homogeneous level of damage, since the distance is short enough to be covered every day.

The proportion of seal predation on nets might reflect the probability of nets being found as seals forage along the coast to the mentioned distances from the occupied caves. Given a frequency of 100% in the caves sector, where they leave from, we might assume a seal presence frequency of only 9.47% along the coast at a distance 10-15 nm from the caves. We do not know how far away the seals leave offshore

from the coast in their forages, but we have not managed to see them with binoculars from cliffs even 300m high. It is possible that the seals travel more frequently to good feeding grounds far offshore than along the coast near to the caves. Proper studies of home range and foraging behavior for the species would need the use of telemetry techniques.

Nevertheless, we have found temporary preferred hunting grounds for individual seals besides the shore on the northeast and the southwest of the island. These foraging areas were visited regularly by up to two individuals at a time, always males, but exact foraging locations did not overlap. These locations were respectively 3 nm and 3.5 nm from the caves where those seals habitually rested. Marchessaux and Muller (1987) also found in the West Sahara coastal foraging areas where the individuals kept contiguous territories which did not overlap, although at least some of those individuals rested on the adjacent secluded beaches and not in caves, as the individuals studied by us did. The pelage pattern of those individuals recorded by the authors indicates that all of them could be also males.

In our sample island, whatever net deployment on the way between the caves and the coastal foraging territory should have been actively located with very little foraging effort. However, we recorded a total of 21 and 20 net placements in the northeast and the southwest respectively that did not register damages during the period in which the seals were using the territories. Those records support our theory that seals do not actively search for nets, even in areas with high probability to find them.

The existence of offshore foraging areas would also explain the scarcity of coastal foraging areas close to the coast in relation to the size of the population studied.

Four of the five net predations inside the bay were recorded in spring and summer when its caves were not occupied (Table 2). Considering the seasons, it is possible that vagrant juveniles dispersing from their birth areas after weaning incurred all the damages to distances higher than 10 nm from used caves. In that case, damages to nets placed in the coasts away from the resident seals cave area would be even rarer than suggested by the contingency table.

Efficiency locating nets seems to be lower for seals than for dolphins. In these clear seas, light reaches usually more than 40 m depth, as we could verify by the presence of *Posidonia oceanica* prairies at –42 m in the bay of Zakynthos, a Mediterranean phanerogam. In spite of that transparency, a net is usually invisible underwater from a distance higher than 30 m. Monk seals might see under lower light conditions than humans underwater, since their eyes possess *tapetum*. On the other hand seals and dolphins lack blue sensitive cones, so the detection of contrast and brightness (i. e. non-chromatic cues) is very poor in the blue part of the spectrum (Peichl et al., 2001). Therefore, the distance reached cannot be much farther than mentioned above. Blind seals can survive and forage in the wild (King, 1983; Riedman, 1990; Mcconnell et al., 1999), but it is possible that their special senses (vibrissae use?, low frequency sounds?) allow them to locate benthic organisms like walruses do, but not locate pelagic prey. Under the low visibility range produced by the water environment, (little contrast and brightness dominated by blue wavelength) active foraging for nets does not seem to be more productive for a monk seal than foraging for fish, crustaceans and cephalopods. It seems easy for seals to pass close to a net without

noticing it, whereas cetaceans can echolocate nets.

Other studies on monk seal -nets interactions

Other researchers (Panou et al., 1993) obtained a level of predation on nets in the Central Ionian of 7.3% in 1864 fishing trips in an area near to occupied seals caves. This value falls close to the one obtained by us in our area, which seems to host a larger seal population than the Central Ionian.

It has been suggested that monk seals increasingly attack nets because of the depletion of fish stocks in the Mediterranean (Boudouresque, 1991; Karavellas, 1995; Ozturk and Dede, 1995; Karavellas, 1996), but none of the authors above present proof for their argument. The latter author recorded damage rates by seals in Zakynthos of 18.1% in 1994 and 21.7% in 1995 and concluded that damages are increasing as a reaction to impoverishment of the island shoals, so fishers complains are fully justified given the high proportion of damages. However, those conclusions are based on a record of less than 11 fishing trips per month (291 trips) (Karavellas, 1995 and 1996). Since fishing activity on those years did not decrease, we believe that the sampling effort (a fifth of ours) was at least too low to determine the real rate of net damages.

Boudouresque (1991) suggests that the monk seal switches its foraging strategy towards an active net search when the fish density decreases to a critical level. The weakness that we find in this argument is that nets are density-dependent traps and not active-attraction devices (as fish traps with bait), so the level of fish capture with nets would be very low, as seen already in Greece. Only bait attraction or active fishing as with well-trained speargunners or experienced long line fishers in Greece can provide satisfactory capture rates with low fish density. It does not seem that monk seals are more frequently hooked in long lines now than before, although the extent and severity of this interaction has not been properly evaluated yet in the Mediterranean seal. Hooked Hawaiian monk seals have been found both in the Leeward and the main Hawaiian Islands, and have caused deaths in some cases (Twiss and Reeves, 1999).

The Mediterranean monk seal is a stalk demersal hunter, which search behind reef corners, marine tunnels and holes, or waits for hours floating over selected shallow reefs, in order to surprise its prey from a short distance. They are astonishing fast sprinters, but probably slower than most fishes for long runs. In any case their natural foraging strategy seems much more efficient for hunting demersal preys than looking for almost empty nets.

Sociological factors must also be considered in these studies. Fishers tend to inform authorities (and complain) every time they endure damages in their nets, but not when they implement a good amount of fishing trips without damages. Many fishers cannot be trusted at all for collaborating with researchers. As an example, 80 fishing trips rejected for our study because of their doubtful net locations and dates comprised together a damage rate of 28.75% (filtering criteria for fishing trips data were always independent from the damage rate recorded on them). Only intensive monitoring of fishing activity can result in reliable damage rate data.

Exaggeration of damage rates produced by marine mammals to fishing gear incurred by scientists can become an additional threat for these species, since culling is then socially justified for the fishers, at the same time that authorities feel the impossibility of finding management solutions to mitigate the competition.

The 81 nets predated in our three-year sampling give an average of 2.25 nets/month. We calculated the catch for trammel nets in an eight years study of coastal fisheries in the Marine Park of North Sporades, Aegean Sea (Cebrián and Anagnostopoulou, 1995). The value was 3367 Kg/vessel-year, what means 9.25 Kg/vessel-day, caught with several Km. of trammel net. Zakynthos shoals are much poorer, but supposing a similar level of catch the fish obtained by the seals from the predated nets would reach as a maximum 20.81 Kg/month (eating all the fish from the nets, which rarely happens). Such catch would hardly provide 1 Kg fish/seal monthly to the seal population recorded at the time. Foraging for a single fish or an octopus would more easily render that amount of capture. The species might easily eat 10 Kg fish/day since their stomachs can hold much more than that amount (Cebrián, 1998a). Hence, we disagree with the hypothesis that monk seals in the Mediterranean search for nets as a reaction to a depletion in the fishing shoals.

Mitigating measures

By-catch by gill nets and trammel nets alone does not seem to constitute the most serious threat to the species but it plays an additive role, considering the presently spread presence of these gears in the sea. Essays on Population Viability Analysis considering a theoretical human related mortality provoked only by fishing nets bycatch (without intentional killing) still render high values of 83,5% extinction risk in Greece after 122 years (UNEP, 2005).

Reduction of by-catch might be achieved through management actions addressed to keep net settings away from main seal caves, where interactions concentrate.

If comparative Population Viability Analysis (PVA) essays are done considering all human related mortality and a situation without by-catch mortality in fishing gear (UNEP, 2005), it is verified that the difference in time passed until reaching extinction is less than an additional decade to the forty years predicted under the action of all causes.

Extinction risk would not be much reduced only by eliminating all by-catch by static nets, so why to attempt it? The answer is that seals are mainly killed by fishermen who consider them a threat for their nets and the motivation to kill the seals would not exist in those areas where such nets would not be used, while other methods with unsound interaction (e.g. long lines) might be allowed.. In such situation all human induced causes would disappear and the risk of extinction might be negligible.

The problem of implementing a full banning of static nets in certain regions inhabited by seals may be socially conspicuous.

A feasible mitigating measure to consider is eliminating the setting of static nets only in the proximity of areas where seal caves exist. Population Viability Analysis results allow to predict a reduction of by-catch through this method of at least 25%, without

closing areas too wide around the important caves. That might allow a strong reduction of the motivation to kill seals since damages to nets would be also strongly reduced.

An alternative mitigating measure would be banning static nets in coastal regions with sound seal populations, except in certain marine reserves, where fishermen would have the right to use them as far as intentional killing is not incurred (this is a real situation in the Greek Marine Park of North Sporades). That situation would make useless the fishermen practise to kill seals. Should such reserves embrace 25% of the seals population, that would imply a 75% reduction in seal by-catch. Having as an example Greece, three Marine areas cover such percentage of that country seal population North Esporades (North Aegean), Milos-Kimolos-Polyegos (South Aegean) and Zakynthos (Cebrian 1998b).

Theoretical low values of 6% risk of extinction might be reached, and that only after 166 years (Cebrian 1998a). That is a much acceptable risk. The advantage of such measure would be that static nets banning in other areas would be soundly justifiable by the tolerance in areas respectful to the species.

Conclusion

Interaction of monk seals with trammel nets in the sampled population is related to the distance of the net placements to the caves where the seals rest. The present study suggests that damage becomes very low at distances along the coast higher than 5 nm from the caves, and insignificant for distances higher than 10 nm. It might be possible to strongly reduce the level of this interaction, the main drive to the species extinction, by management of coastal fisheries based on this result. Conservation actions for the species could consider this tool to properly design MPAs or to create static net restricted Important Seal Areas, with marine boundaries according to the tolerable level of interaction with nets accepted by managers.

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Table 1. Trammel nets placed, damages and sightings recorded from autumn 1990 to summer 1993.

Interactions	Total	%	West coast	%	Bay	%
Fishing trips	1632		563		1069	
Seal damage	81	4.96	48	8.53	33	3.10
Seal sighted	53	3.25	31	5.51	22	2.06
Dolphin damage	101	6.19	34	6.04	67	6.27
Dolphin sighted	101	6.19	27	4.80	74	6.92

Table 2. Contingency table, showing events of seal damage to nets in contiguous coastal trenches inhabited by monk seals in relation to distance from their resting caves. nm: nautical miles.

Coastal Trench	Seal caves (A)	0 to 5 nm from A	5 to 10 nm from A	10 to 15 nm from A
Damage	36	23	12	5
No damage	305	304	361	469

Fig. 1. Location of the study area

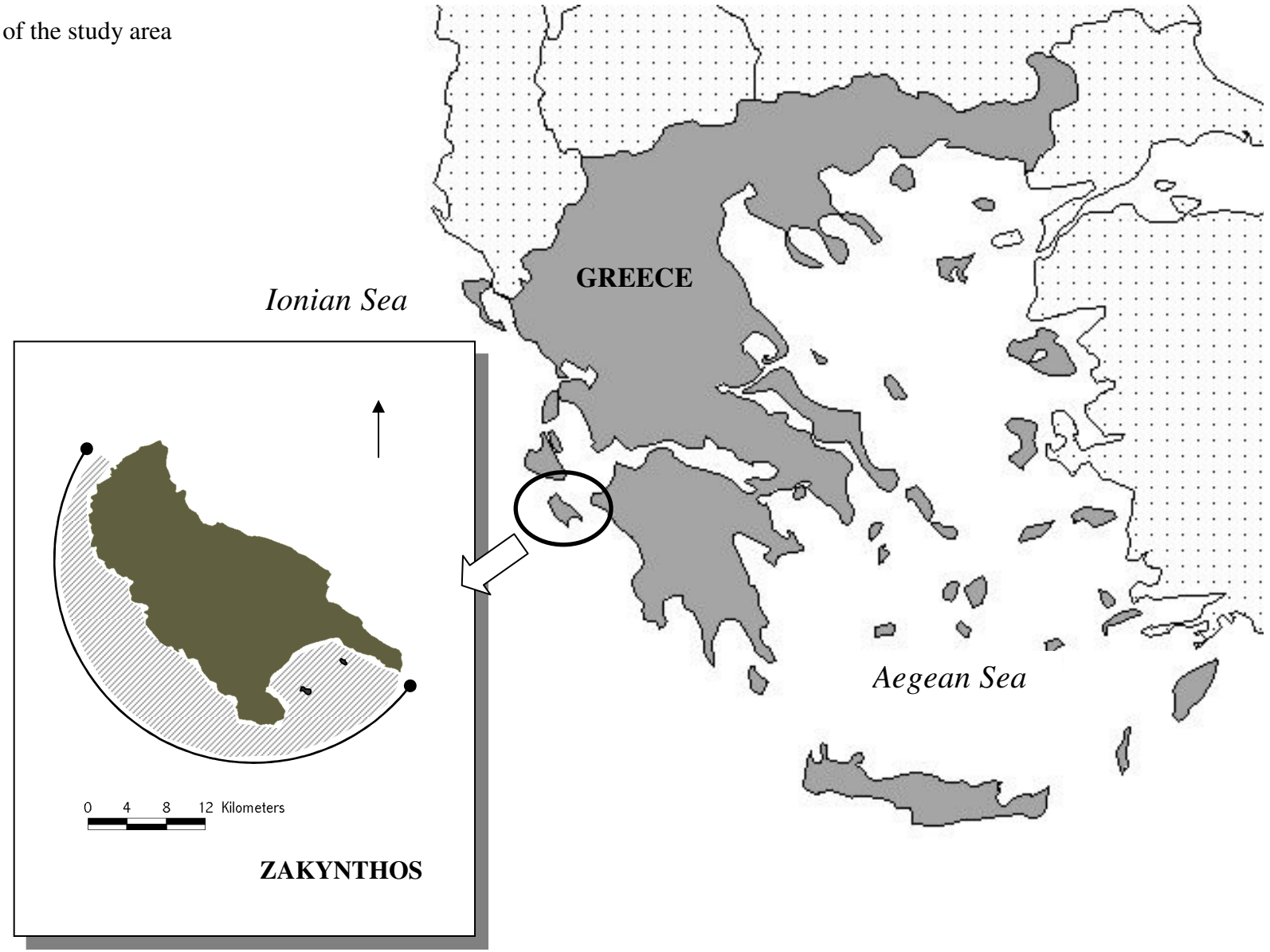

Fig. 2. Seasonal frequency of predation on trammel nets by dolphins and monk seals in Zakynthos Island.