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Report of a New Mediterranean Monk Seal (*Monachus monachus*) Breeding Colony in the Aegean Sea, Greece

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Abstract

Identifying and effectively protecting the last remaining Mediterranean monk seal (*Monachus monachus*) populations and their habitats is a key priority for the survival of this critically endangered species. Following the opening of a restricted naval area at the Island of Gyaros in the central Aegean Sea, Greece, the authors initiated efforts to verify the existence and assess the status of the species in the area. Using established monk seal habitat suitability criteria and survey techniques, the authors aimed to identify suitable habitat and document possible pup production of the species in this new area. Eight coastal caves were located throughout the coastline of the island, three of which were considered suitable for resting and pupping, while the remaining five were considered suitable for only resting. Pup production was recorded during the 2004, 2005, and 2007 pupping seasons, and a minimum of ten, four, and seven pups were identified, respectively. In addition, mother-pup associations and interactions on three open beaches, a behavior that has not been observed in this species in the Mediterranean Sea recently, were recorded. This newly discovered colony, with relatively high natality compared to other breeding sites in the Mediterranean Sea and the rare use of open beaches, is of outstanding conservation value and is in urgent need of effective protection.

Key Words: conservation, distribution, behavior, endangered species, status, Cyclades Islands, Gyaros, Greece, *Monachus monachus*, Mediterranean monk seal

Introduction

The Mediterranean monk seal (*Monachus monachus*) is the most endangered pinniped in the world (International Union for Conservation of Nature [IUCN], 2006). Once abundant throughout the Black Sea and the Mediterranean, and on the coast and islands off northwest Africa, the species has been severely affected by the impact of human activities, especially during the past century, and is currently reduced to three isolated subpopulations. One subpopulation is located in the archipelago of Madeira and consists of 30 to 35 individuals (Pires et al., 2008), while another one is located in the area of Cabo Blanco in the Western Sahara, where approximately 150 individuals survive at the single largest aggregated colony of the species (González et al., 2002). The largest subpopulation, approximately 250 to 350 individuals, survives in the northeastern Mediterranean, mainly at remote locations in the Ionian and Aegean Seas in Greece and Turkey and the Cilician Basin in Turkey (Güçlüsoy et al., 2004; Gucu et al., 2004; MOm, 2007). This subpopulation consists of many small breeding colonies. Human disturbance and the ongoing destruction, fragmentation, and deterioration of suitable habitat are the main reasons that have led to the species' current endangered status. Therefore, identifying and effectively protecting critical habitat is considered one of the outstanding priorities for the conservation of the species (Israëls, 1992; Johnson & Lavigne, 1998; Johnson et al., 2006). Furthermore, human disturbance has also led to a change in the social behavior of the Mediterranean monk seal: from a gregarious species that used to form colonies and occupy open beaches, Mediterranean monk seals have, throughout most of their distribution, become solitary animals that gather in small groups seeking the security of secluded coastal caves in order to rest and reproduce (Johnson & Lavigne, 1999a).

Most Mediterranean monk seals survive nowadays in Greece. With an extensive coastline of approximately 15,000 km and roughly 4,000 islands, the country has potentially large stretches of suitable coastal habitat. Since the initiation of efforts to protect the species, habitat availability and suitability has been investigated in several areas within the country (Marchessaux & Duguy, 1977; Harwood, 1987; Panou et al., 1993; MOm, 2007), but large areas remain unexplored. In 1991, MOm/Hellenic Society for the Study and Protection of the Monk Seal initiated, and has continually operated

since, the national Rescue and Information Network (RINT). The RINT is alerted by its members, who are distributed throughout Greece, whenever live or dead monk seals are sighted (Adamantopoulou et al., 1999). From 2000 to 2004, the RINT received several reports of Mediterranean monk seals from the Island of Gyaros; two reports, published in 2001 and 2004 (Plate 1), included unique photographic documentation of females and their pups resting on open beaches. Considering how little was known about the presence of the species in the area, in 2004, the authors initiated a study to assess the status of the species at the Island of Gyaros.

The specific aims of this study were to

- evaluate habitat availability and suitability for the Mediterranean monk seal at Gyaros.
- verify the existence of a colony and collect information on the demography and behavior of the species in the area.

Materials and Methods

Study Area

Gyaros is an arid, deserted island in the northern Cyclades, in the central Aegean Sea (37° 37' N, 24° 43' E) with a total area of 17.76 km^2 (Figure 1). The island was used from the end of World War II until 1974 as an exile island for political dissidents and up until 2000 as a target for the Hellenic Navy. Since then, Gyaros has been open to the public, but due to the presence of unexploded ammunition, human activity on the island has remained limited.

Evaluating Habitat Availability and Suitability

To evaluate habitat availability and suitability for Mediterranean monk seals at Gyaros the entire coastline of the island was circumnavigated with a small inflatable boat at a distance of 40 m from the shoreline to locate all potentially suitable coastal caves for resting and/or pupping. Once a cave was located, its GPS position was recorded and its suitability evaluated, based on a set of physical and environmental features defined by Dendrinos et al. (2007). Mediterranean monk seals tend to be more selective in their choice of caves used for pupping than for resting (Karamanlidis et al., 2004). Previous research indicated that the physical and environmental features used in this study are the most important predictors of the selection

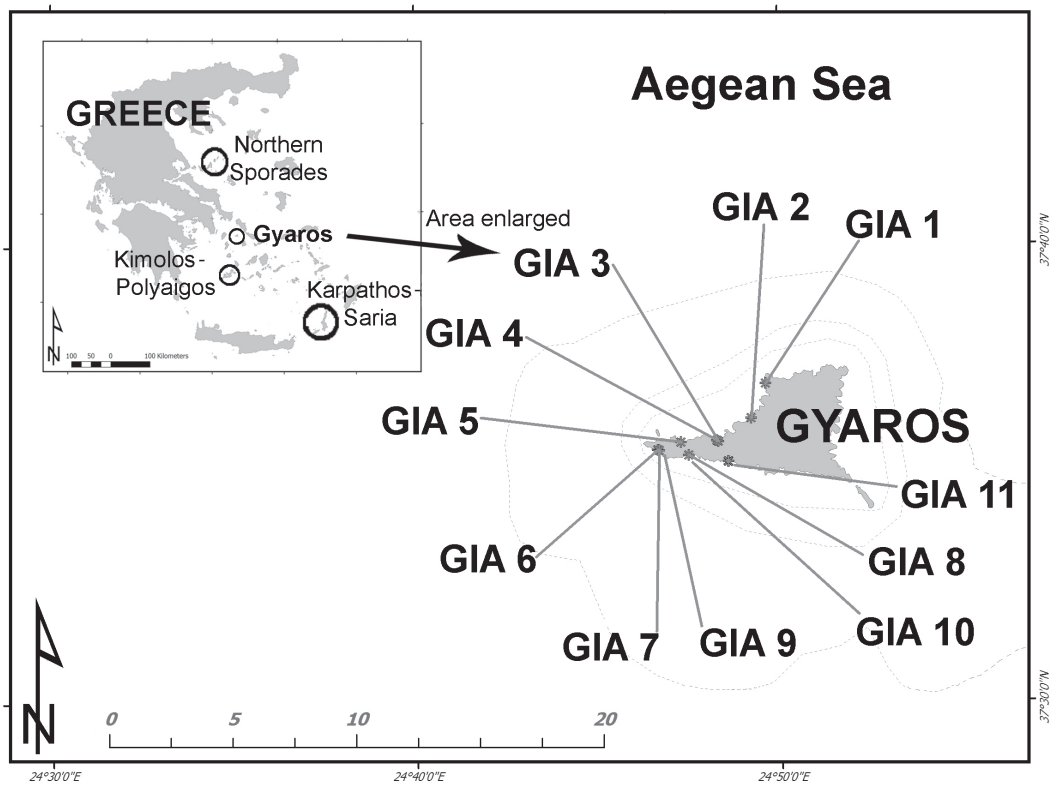


Figure 1. Map of Greece showing the Island of Gyaros, indicating the locations where suitable pupping and resting caves and beaches for Mediterranean monk seals were identified as part of this study

of a coastal cave as a pupping site by monk seals in Greece. Suitable pupping sites tend to have, among other features, multiple entrances, beaches in their interior with a soft substrate, a low risk of pup washout, and are not easily accessible to humans (Dendrinos et al., 2007). To minimize disturbance to the species, the caves were inspected and their morphological features recorded in early summer when in-cave seal activity in Greece is lowest (Dendrinos et al., 1994).

Demography and Behavior of the Species in the Area

The demographic composition of the seals in the area was assessed by inspecting the identified caves during 2- to 5-d field surveys near the peak of the pupping seasons (i.e., September to November), (Dendrinos et al., 1999a) in 2004, 2005, and 2007. Swimmers entered the caves and searched for the presence of recent signs of cave use such as tracks, scats, pieces of fur, or blood. If a seal was encountered in the cave, photographs or video were taken in order to enable future individual identification. Adults were identified based on the natural pelage scarring and their stage of development (Samaranch & González, 2000). Pups were identified based on their stage of development as well as the presence of the sexually dimorphic ventral patch of fur (Dendrinos et al., 1999b; Samaranch & González, 2000). Behavioral data were collected on an opportunistic basis during the inspection of the caves in the breeding season and while conducting the habitat survey and the circumnavigation of the island.

Results

Habitat Availability, Density, and Suitability

Throughout the 37.05-km coastline of Gyaros, eight suitable coastal caves were identified (cave density: one suitable cave per 4.61 km of coastline – Cave codes GIA 1-8; Figure 1). Considering the findings of Dendrinos et al. (2007), three of the caves were evaluated as suitable for resting and pupping, while the other five were evaluated as suitable only for resting. Cave GIA 4, in particular, possessed morphological features that led the authors to consider it ideal for pupping and resting. The cave had an entrance corridor approximately 50 m long, two resting areas above water, and possibly a third resting area accessible only under water. None of these resting areas were visible from the outside of the cave.

However, in view of unique observations of females and their pups using three open beaches (Codes GIA 9-11; Figure 1) as resting and possibly pupping sites during the 2004 and 2005 pupping seasons, suitable cave/beach density on the island increased to one suitable cave and/or beach per 3.36 km of coastline.

Demographic Characteristics

Due to the small number of photographs and footage collected during this study, only three adult females were uniquely identified (Table 1). During the field surveys in the breeding seasons of 2004, 2005, and 2007, ten, four, and seven individual pups were uniquely identified, respectively (Table 1). These values were used to calculate a mean value of 7.0 for the annual pup production across the three survey years. Due to the short-term nature of the field surveys, the number of pups identified represents only the minimum number of pups actually born in the area during the respective breeding seasons.

Behavioral Observations

During the field surveys in 2004 and 2005, females and their pups were encountered resting on three open beaches at the southwestern coast of the island. On one occasion in 2004, eight of the ten pups observed during that survey were recorded swimming along a 150-m-long stretch of coastline, and evidence was recorded that suggested that at least one of the pups was born on an open beach (i.e., the absence of suitable pupping caves nearby; healing wounds in the umbilicus region of the pup). In 2005, a female suckling her pup was observed on one of the open beaches (Plate 1). Upon inspection of cave GIA 4 in 2007, six newborn pups were recorded.

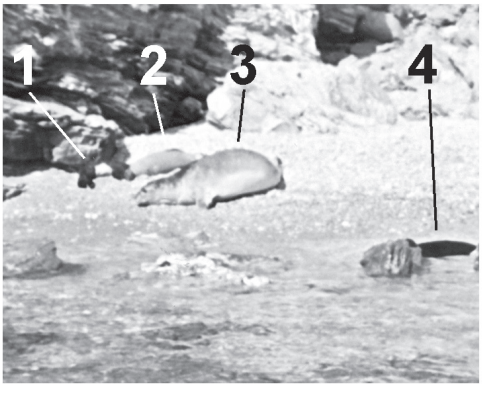
Discussion

Human disturbance affects the behavior and the abundance and distribution of pinnipeds (Mattlin, 1978; Mathews & Pendleton, 2006; Orsini et al., 2006). Depending on the level of human disturbance, reactions of endangered seal species have varied, ranging from no significant effect by New Zealand sea lions (*Phocarctos hookeri*) (Childerhouse & Gales, 1998) to the abandonment of pupping sites and the active search for new breeding locations away from human activities by southern fur seals (*Arctocephalus australis*) (Stevens & Boness, 2003). In the genus *Monachus*, human disturbance affected the hauling behavior of the now extinct Caribbean monk seal (*M. tropicalis*) (Adam, 2004) and has a current negative effect on the pupping and hauling behavior and abundance of the critically endangered Hawaiian (*M. schauinslandi*) and Mediterranean monk seals (Gerrodette & Gilmartin, 1990; Johnson & Lavigne, 1999a, 1999b). In Greece, Mediterranean monk seals seek out pupping sites that offer them the best protection against human disturbance (Dendrinos et al., 2007).

Table 1. Individual Mediterranean monk seals recorded at the Island of Gyaros, Greece, by field research during the pupping seasons of 2004, 2005, and 2007

Date	Location	Age	Behavior
07/11/04	SW coast	Adult female	Swimming
07/11/04	SW coast	Adult female	Swimming
07/11/04	SW coast	Male pup	Swimming
07/11/04	SW coast	Female pup	Resting on an open beach
07/11/04	SW coast	Pup	Swimming
07/11/04	SW coast	Male pup	Swimming
07/11/04	SW coast	Pup	Swimming
07/11/04	SW coast	Pup	Swimming
07/11/04	SW coast	Pup	Resting on an open beach
07/11/04	SW coast	Pup	Resting on an open beach
07/11/04	SW coast	Pup	Swimming
07/11/04	SW coast	Pup	Resting on an open beach
05/12/05	Cave GIA 4	Pup	Resting on a beach in a cave
05/12/05	SW coast	Pup	Swimming
05/12/05	SW coast	Pup	Swimming
05/12/05	SW coast	Pup	Suckling on an open beach
05/12/05	SW coast	Adult female	Suckling on an open beach
08/10/07	Cave GIA 4	Pup	Resting on a beach in a cave
08/10/07	Cave GIA 4	Pup	Resting on a beach in a cave
08/10/07	Cave GIA 4	Pup	Resting on a beach in a cave
08/10/07	Cave GIA 4	Pup	Resting on a beach in a cave
08/10/07	Cave GIA 4	Pup	Swimming in a cave
08/10/07	Cave GIA 4	Pup	Resting on a beach in a cave
08/10/07	Cave GIA 5	Pup	Swimming in a cave

a.



b.

Plate 1. Observations of Mediterranean monk seals on open beaches at the island of Gyaros: (a) four Mediterranean monk seals resting on an open beach (Photo: courtesy of Mr. G. Dounavis) and (b) a female Mediterranean monk seal nursing her pup on an open beach (Photo: A. A. Karamanlidis/MOm)

Thus, such habitat may progressively become a limiting factor for this species as human density increases. Identifying and protecting such locations in an environment increasingly under pressure from human development and fishing activities (Karamanlidis et al., 2008) is considered one of the highest conservation priorities for the survival of the species (Johnson & Lavigne, 1998).

The coastal caves suitable for Mediterranean monk seals identified at the Island of Gyaros are of similar quality to caves used by the species at the already known breeding locations in the Northern Sporades in the northern Aegean (Dendrinos et al., 1994) and Kimolos-Polyaigos and Karpathos-Saria in the southern and southeastern Aegean, respectively (MOm, 2005) (Figure 1).

One of the pupping caves at Gyaros possesses ideal morphological characteristics and had the highest number of pups ($n = 6$) ever recorded simultaneously in a cave in the eastern Mediterranean. In addition, Gyaros Island has the highest density of suitable caves/open beaches documented in Greece: one suitable cave/open beach per 3.36 km of coastline, compared to one suitable cave and/or beach per 9.36, 3.73, and 9.83 km of coastline in the Northern Sporades, Kimolos-Polyaigos, and Karpathos-Saria, respectively (MOm, 2007).

The minimum mean annual number of births ($n = 7.0$) recorded in the pupping seasons of 2004, 2005, and 2007 is one of the highest recorded for the species in the Mediterranean and could be higher if systematic assessments of natality were conducted throughout the breeding season at each site. Systematic surveys of annual pup production at Cabo Blanco in the Western Sahara (González et al., 2002), the Northern Sporades, Kimolos-Polyaigos, and at Karpathos-Saria (MOm, 2007) yielded counts of 25.0, 8.4, 7.9, and 3.7, respectively.

Until now, human disturbance in the area appears to have been minimal. Resting, suckling, and possibly even pupping on three different open beaches are behaviors which are considered indicative of low levels of human disturbance. Such behaviors have never been reported from the eastern Mediterranean in the past 50 y. Use of open beaches by mother-pup pairs has been reported only from the strictly protected core zone of the Desertas Islands Nature Reserve in the Archipelago of Madeira (Pires et al., 2008). Giving birth to pups, nursing pups, and resting on open beaches are characteristic of other monachids, like the Hawaiian monk seal and the Weddell seal (*Leptonychotes weddelli*), both species that have had little disturbance by humans or land predators. Perhaps the observation of open beach rearing of Mediterranean monk seal pups reflects the minimal disturbance at the Island of Gyaros and is an indicator of suitable habitat and a healthy population.

Conservation Implications

The present findings in respect to habitat quality and density, annual pup productivity, and, most importantly, the fact that the species uses in the area open beaches as pupping sites, show clearly that Gyaros represents an area of outstanding importance for the survival of the Mediterranean monk seal, despite the fact that long-term monitoring efforts have not yet been carried out in the area. Considering the unique value of the area, the critically endangered status of the species, and the increasing environmental pressures in the Mediterranean (Karamanlidis et al., 2008), the authors conclude that urgent protection of this newly discovered colony is of utmost importance for the conservation of the species.

The creation of a network of Marine Protected Areas for the conservation of the Mediterranean monk seal in Greece has been identified for more than a decade as a conservation priority within the Strategy for the Protection of the Mediterranean Monk Seal in Greece (Archipelagos & MOm, 1996) but also internationally (Ronald & Duguy, 1979, 1984; Johnson & Lavigne, 1998). The fact that the Island of Gyaros is so remote, uninhabited, and state-owned makes it an ideal candidate for a Marine Protected Area. MOm/Hellenic Society for the Study and Protection of the Monk Seal has proposed to the Hellenic Government the inclusion of Gyaros in the network of biologically important European sites and its designation as a NATURA 2000 site. Considering the significance of the area and its location in the central Aegean Sea, Gyaros would not only contribute towards the protection of the species in the Cyclades region, but could also act as a link between monk seal populations in the Northern Sporades in the north, Kimolos-Polyaigos in the south, Karpathos-Saria in the southeast, and the Ionian Islands in the west.

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Literature Cited

Adam, P. J. (2004). *Monachus tropicalis*. *Mammalian Species*, *747*, 1-9.

Adamantopoulou, S., Androukaki, E., & Kotomatas, S. (1999). The distribution of the Mediterranean monk seal in Greece based on an information network. *Contributions to the Zoogeography and Ecology of the Eastern Mediterranean Region*, *1*, 399-404.

Archipelagos & MOm. (1996). *Strategy for the protection of the Mediterranean Monk seal Monachus monachus in Greece.* Athens, Greece: Archipelagos–Marine and

Coastal Management; MOm/Hellenic Society for the Study and Protection of the Monk Seal.

Childerhouse, S., & Gales, N. (1998). Historical and modern distribution and abundance of the New Zealand sea lion *Phocarctos hookeri*. *New Zealand Journal of Zoology*, *25*, 1-16.

Dendrinos, P., Kotomatas, S., & Tounta, E. (1999a). Monk seal pup production in the National Marine Park of Alonnisos – N. Sporades. *Contributions to the Zoogeography and Ecology of the Eastern Mediterranean Region*, *1*, 413-419.

Dendrinos, P., Tounta, E., & Kotomatas, S. (1999b). A field method for age estimation of Mediterranean monk seal (*Monachus monachus*) pups. *Proceedings of the 13th Biennial Conference on the Biology of Marine Mammals.* Monaco.

Dendrinos, P., Tounta, E., Kotomatas, S., & Kottas, A. (1994). Recent data on the Mediterranean monk seal population of the Northern Sporades. *Bios (Macedonia/ Greece)*, *2*, 11-16.

Dendrinos, P., Karamanlidis, A. A., Kotomatas, S., Legakis, T., Tounta, E., & Matthiopoulos, J. (2007). Pupping habitat use in the Mediterranean monk seal: A long-term study. *Marine Mammal Science*, *23*, 615-628.

Gerrodette, T., & Gilmartin, W. G. (1990). Demographic consequences of changed pupping and hauling sites of the Hawaiian monk seal. *Conservation Biology*, *4*, 423-430.

González, L. M., Cedenilla, M. A., Larrinoa, P. F., Layna, J. F., & Aparicio, F. (2002). Changes in the breeding variables of the Mediterranean monk seal (*Monachus monachus*) colony of Cabo Blanco Peninsula after a mass mortality episode. *Mammalia*, *6*, 173-182.

Güçlüsoy, H., Kiraç, C. O., Veryeri, N. O., & Savas, Y. (2004). Status of the Mediterranean monk seal, *Monachus monachus* (Hermann, 1779) in the coastal waters of Turkey. *E.U. Journal of Fisheries and Aquatic Sciences*, *21*, 201-210.

Gucu, A. C., Gucu, G., & Orek, H. (2004). Habitat use and preliminary demographic evaluation of the critically endangered Mediterranean monk seal (*Monachus monachus*) in the Cilician Basin (Eastern Mediterranean). *Biological Conservation*, *116*, 417-431.

Harwood, J. (Ed.). (1987). *Population biology of the Mediterranean monk seal in Greece.* A report on research conducted by the Natural Environment Research Council's Sea Mammal Research Unit, with financial assistance from the Commission of the European Communities and the International Fund for Animal Welfare, Contract ENV 853 UK, DG XII. 72 pp.

International Union for Conservation of Nature (IUCN). (2006). *2006 IUCN red list of threatened species.* Retrieved 20 May 2008 from www.iucn.redlist.org.

Israëls, L. D. E. (1992). Thirty years of Mediterranean monk seal protection: A review. *Mededelingen*, *28*, 1-65.

Johnson, W. M., & Lavigne, D. M. (1998). *The Mediterranean monk seal: Conservation guidelines* (Multilingual ed.). Guelph, ON, Canada: International Marine Mammal Association, Inc. 152 pp.

Johnson, W. M., & Lavigne, D. M. (1999a). Monk seals in antiquity. The Mediterranean monk seal (*Monachus monachus*) in ancient history and literature. *Mededelingen*, *35*, 1-101.

Johnson, W. M., & Lavigne, D. M. (1999b). Mass tourism and the Mediterranean monk seal. The role of mass tourism in the decline and possible future extinction of Europe's most endangered marine mammal, *Monachus monachus*. *The Monachus Guardian*, *2*, 62-81.

Johnson, W. M., Karamanlidis, A. A., Dendrinos, P., de Larrinoa, P. F., Gazo, M., González, L. M., et al. (2006). *Monk seal fact files: Biology, behaviour, status and conservation of the Mediterranean monk seal,* Monachus monachus. Retrieved 12 September 2008 from www.monachus-guardian.org/factfiles/medit01.htm.

Karamanlidis, A. A., Pires, R., Silva, N. C., & Neves, H. C. (2004). The availability of resting and pupping habitat for the critically endangered Mediterranean monk seal *Monachus monachus* in the archipelago of Madeira. *Oryx*, *38*, 180-185.

Karamanlidis, A. A., Androukaki, E., Adamantopoulou, S., Chatzispyrou, A., Johnson, W. M., Kotomatas, S., et al. (2008). Assessing accidental entanglement as a threat to the Mediterranean monk seal *Monachus monachus*. *Endangered Species Research.* Retrieved 15 September 2008 from www.int-res.com/articles/esr2008/theme/Bycatch/bycatchpp7.pdf.

Marchessaux, D., & Duguy, R. (1977). Le phoque moine, *Monachus monachus* (Hermann, 1779), en Grece. *Mammalia*, *41*, 419-439.

Mathews, E. A., & Pendleton, G. W. (2006). Declines in harbor seal (*Phoca vitulina*) numbers in Glacier Bay National Park, Alaska, 1992-2002. *Marine Mammal Science*, *22*, 167-189.

Mattlin, R. H. (1978). Pup mortality of the New Zealand fur seal. *New Zealand Journal of Ecology*, *1*, 138-144.

MOm. (2005). *Status report of the Mediterranean monk seal populations in Kimolos-Polyaigos and Karpathos-Saria areas.* Final report to EC LIFE-NATURE 2000 Project (LIFE00NAT/GR/7248). Athens, Greece: MOm/Hellenic Society for the Study and Protection of the Monk Seal.

MOm. (2007). *Status of the Mediterranean monk seal (*Monachus monachus*) population in Greece.* Unpublished report to the Hellenic Ministry of Rural Development and Food. Athens, Greece: MOm/Hellenic Society for the Study and Protection of the Monk Seal. 41 pp.

Orsini, J-P., Shaughnessy, P. D., & Newsome, D. (2006). Impacts of human visitors on Australian sea lions (*Neophoca cinerea*) at Carnac Island, Western Australia: Implications for tourism management. *Tourism in Marine Environments*, *3*, 101-115.

Panou, A., Jacobs, J., & Panos, D. (1993). The endangered Mediterranean monk seal *Monachus monachus* in the

Ionian Sea, Greece. *Biological Conservation*, *64*, 129-140.

Pires, R., Neves, H. C., & Karamanlidis, A. A. (2008). The critically endangered Mediterranean monk seal *Monachus monachus* in the archipelago of Madeira: Priorities for conservation. *Oryx*, *42*, 278-285.

Ronald, K., & Duguy, R. (1979). First International Conference on the Mediterranean Monk Seal. Rhodes, Greece. *UNEP Technical Series*, *1*, 1-180.

Ronald, K., & Duguy, R. (1984). Proceedings of the Second International Monk Seal Conference. La Rochelle, France. *Annales de la Sciences Naturelles de la Charente-Maritime*, 1-120.

Samaranch, R., & González, L. M. (2000). Changes in morphology with age in Mediterranean monk seals (*Monachus monachus*). *Marine Mammal Science*, *16*, 141-157.

Stevens, M. A., & Boness, D. J. (2003). Influences of habitat features and human disturbance on use of breeding sites by a declining population of southern fur seals (*Arctocephalus australis*). *Journal of Zoology*, *260*, 145-152.