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Anecdotal Observations of Open Beach Use by Female Mediterranean Monk Seals (*Monachus monachus*) and Their Pups in Greece: Implications for Conservation

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With global biodiversity in decline (Butchart et al., 2010), calls have been made for the use of the best scientific data in conserving threatened or endangered species and the ecosystems upon which they depend (Smallwood et al., 1999). Given the inherent difficulties relating to the study of rare and/or elusive species, anecdotal data (e.g., unforeseen and unique behaviors) have occasionally been used to better understand a species' life history (Frey et al., 2013; Surf et al., 2019) and to aid in defining management and conservation priorities (Bennett, 2016; Zapelini et al., 2020). Considering that use of anecdotal data in species conservation may occasionally lead to a false interpretation of the actual situation in nature (McKelvey et al., 2008), and therefore negatively impact subsequent conservation efforts, the acceptance of anecdotal data as empirical data should always be treated with caution.

The Mediterranean monk seal (*Monachus monachus*) is one of the rarest seals on Earth (Karamanlidis et al., 2016); the species has been listed as "Endangered" by the International Union for the Conservation of Nature (IUCN), and the global population has been estimated to number fewer than 800 individuals (Karamanlidis & Dendrinos, 2015; Karamanlidis et al., 2019). Three main subpopulations survive: one in the Archipelago of Madeira, one at Cabo Blanco in the Atlantic Ocean, and one in the eastern Mediterranean Sea, mainly around the islands and coasts of Greece, Turkey, and Cyprus (Karamanlidis et al., 2019). Improving our knowledge of the Mediterranean monk seals' life history, including habitat use, is essential to understanding the ecological needs of the species (Dendrinos et al., 2007c) and for designing and implementing effective conservation measures. In Greece, where the species' subpopulation is considered one of the most important worldwide (Karamanlidis et al., 2019), understanding habitat use and protecting critical habitat have been identified as conservation priorities (Dendrinos et al., 2020).

Mediterranean monk seals are coastal marine mammals. When at sea, the species in Greece roams widely within the 200 m isobath (Dendrinos et al., 2007a; Adamantopoulou et al., 2011) where it feeds (Karamanlidis et al., 2014) and rests (Karamanlidis et al., 2017). On land, these monk seals exclusively use marine caves to give birth and raise their pups throughout their range (Karamanlidis et al., 2016); however, this has not always been the case. Mounting evidence suggests that, like many other seal species, this monk seal used to frequent open beaches for some of its basic biological needs (Johnson & Lavigne, 1999; Johnson, 2004; González, 2015). This paper describes six examples of female Mediterranean monk seals and their pups using open beaches in Greece and discusses the implications of these anecdotal observations for the conservation of the species.

The observations were made between 1992 and 2022 throughout coastal and insular Greece (Figure 1) during field research conducted by MOm/Hellenic Society for the Study and Protection of the Monk Seal. When encountering monk seals on open beaches, we non-invasively photographed and/or videotaped them from a distance (i.e., most observations were less than 10 to 20 min; the supplemental video for this paper is available in the "Supplemental Material" section of the *Aquatic Mammals* website: https://www.aquaticmammals-journal.org/index.php?option=com_content&view=article&id=10&Itemid=147). Observations were also collected through the Rescue and Information Network (RINT), a nationwide citizen-science project in Greece (Adamantopoulou et al., 1999), but only after thoroughly reviewing the information provided to conclude it was reliable.

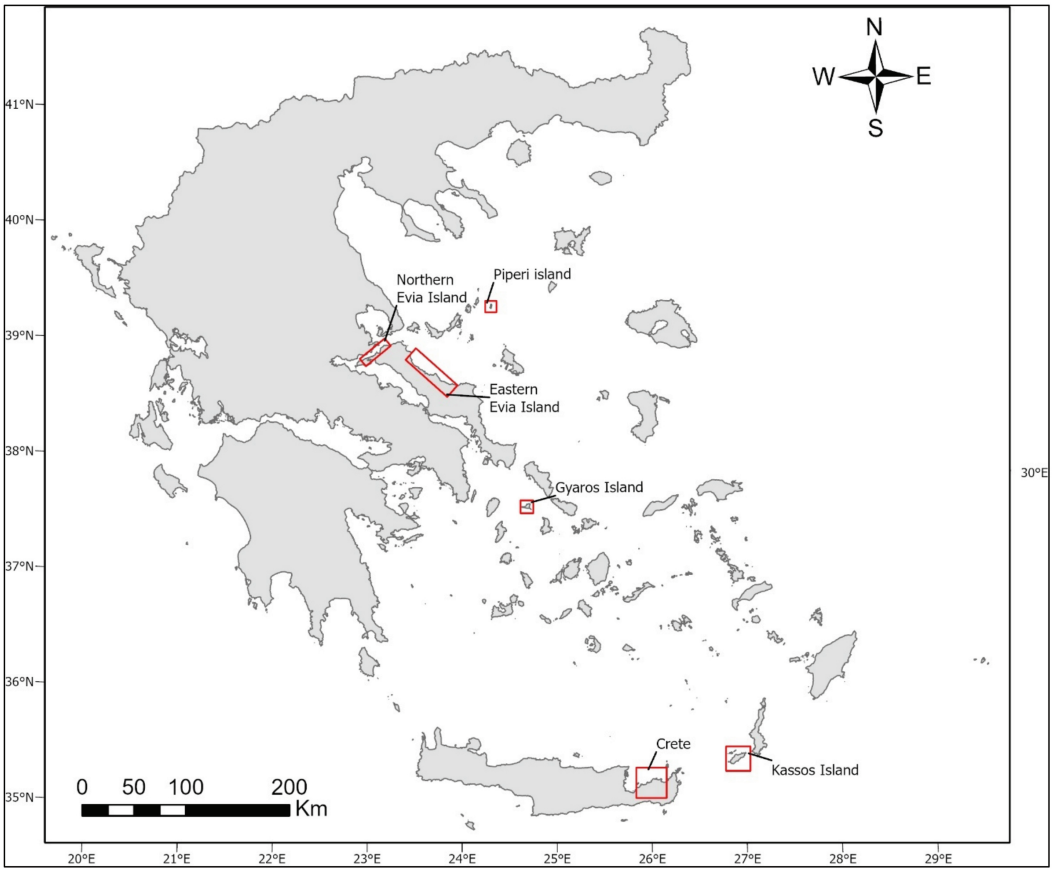

Figure 1. Map of Greece indicating the location of six areas where anecdotal observations of female Mediterranean monk seals (*Monachus monachus*) and their pups using open beaches were recorded

Case 1 – Kassos Island

A female Mediterranean monk seal and her pup were recorded on an open beach in Greece by the RINT on 1 September 1993 at the island of Kassos, part of the Dodecanese Islands (Figure 1). The observer reported a newborn pup suckling from its mother on an open beach at the southern part of the island with a placenta lying next to it. No photographs or videos of the observation were provided, but the description was so detailed as to be considered reliable.

Case 2 – Eastern Evia Island

In 2003 (15 October) and 2005 (29 October), the RINT received reports from observers that a female Mediterranean monk seal and her newborn pup were seen on the eastern part of Evia Island (Figure 1). In the first case in 2003, the newborn pup was suckling from its mother on an open beach, while in the second case in 2005, the newborn pup was observed on an open beach with its umbilical cord still attached. In both cases, no photographs or videos were provided, but the descriptions were considered reliable.

Case 3 – Gyaros Island

On 22 October 2004, the RINT received information from a remote (i.e., inaccessible to humans and therefore with low human activity) location at the uninhabited Gyaros Island (Figure 1) regarding an adult female and three pups resting on an open beach and/or swimming in the nearshore water. Photographs were provided (Figure 2A). On 7 November 2004, during an on-site inspection, we recorded three adult females and 11 newborn pups resting on an open, cliff-bound beach (~70 m wide, 15 m deep, covered with pebbles) and/or swimming in the nearshore water. On 5 December 2005, at the same location, we recorded four

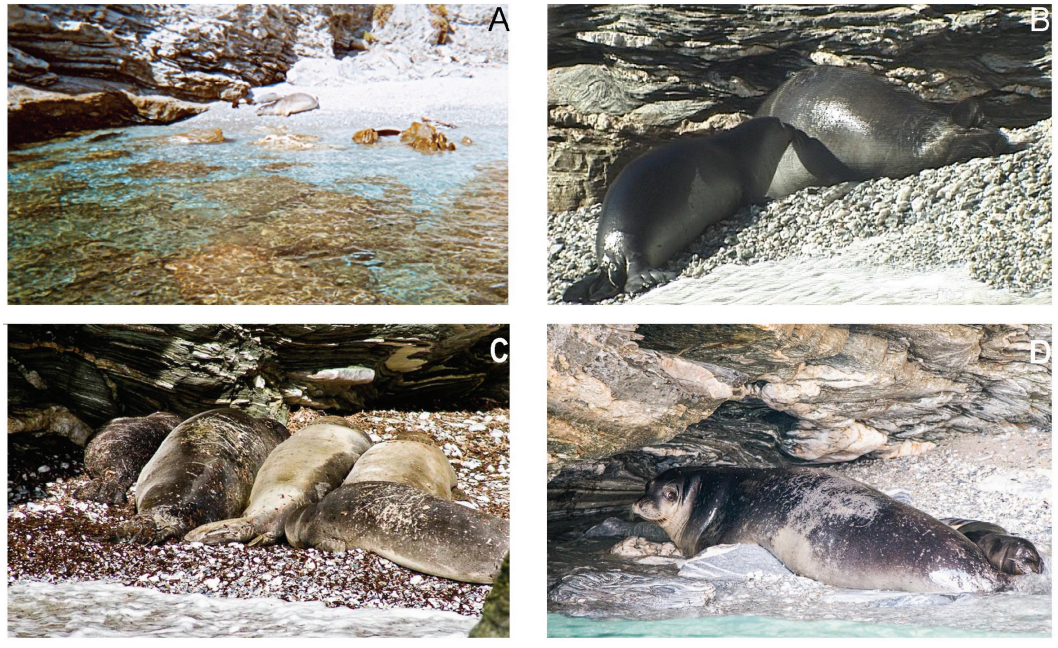

Figure 2. Anecdotal observations of female Mediterranean monk seals and their pups using open beaches at Gyaros Island: (A) a female monk seal and three newborn pups using an open beach on 22 October 2004 (©Dounavis); (B) a female monk seal and her pup using an open beach on 5 December 2005 (©Karamanlidis/MOm); (C) four female monk seals and a pup using an open beach on 20 November 2010 (©Karamanlidis/MOm); and (D) a female monk seal and her newborn pup using an open beach on 8 October 2015 (©Dendrinos/MOm).

adult females, one subadult, and three newborn pups on the beach and/or swimming in the nearshore water. One of the adult females was recorded suckling her pup (Figure 2B). Female monk seals and their pups were recorded again on 20 November 2010 (4 adult females and 1 pup; Figure 2C), 4 November 2011 (1 adult female suckling her newborn pup), and 8 October 2015 (1 adult female and her newborn pup; Figure 2D). All these seals were recorded on two open, cliff-bound beaches covered with pebbles, located 200 and 500 m to the east and west of the original observations in 2004.

Case 4 – Crete

On 5 September 2019, the RINT received information of a female monk seal and her pup on an open, cliff-bound beach at a remote location at the northeastern part of Crete (Figure 1). The observer reported blood and parts of placenta lying on the beach. Considering the information on habitat suitability for the species in the area (i.e., no suitable pupping cave nearby), we concluded that the pup was born on the open beach. On 17 October 2019, we recorded a female monk seal resting with her newborn female pup on the open, cliff-bound beach site (~15 m wide, 15 m deep, covered with sand, pebbles, and rocks; Figure 3A & B). Observers reported to the RINT that the mother–pup pair remained in the general area for at least another 2 mo. The same individual was reported again at the same location in 2020 (4 & 14 September; Figure 3B & C) and in 2021 (10 October), both times accompanied by female newborn pups. In 2020 and 2021, this pair was observed on an open rock formation.

Case 5 – Piperi Island

On 19 October 2021, an adult female monk seal and her newborn pup were observed using an open, cliff-bound beach (~150 m wide, 30 m deep, covered with fine sand and pebbles) at a remote location at Piperi Island, the core area of the National Marine Park of Alonissos, Northern Sporades (Figure 1). The mother–pup pair were observed resting at the least-exposed, left part of the beach (Figure 4A). The pair were observed again on 20 February 2022 at the right part of the same beach; the pup had undergone its first molt (Figure 4B) and was being weaned.

Figure 3. Anecdotal observations of a female Mediterranean monk seal and her pups using an open beach/rock formation along the coast of Crete: (A) a female monk seal and her newborn pup using an open beach on 17 October 2019 (©Dendrinos/MOm); (B) image from a drone showing an overview of the open beach habitat used by a female monk seal and her pup in October 2019 (©MOm); (C) a newborn pup and its placenta on an open rock formation on 4 September 2020 (©Marakis); and (D) image from a trap camera of a female monk seal and her pup using an open rock formation on 14 September 2020 (©MOm).

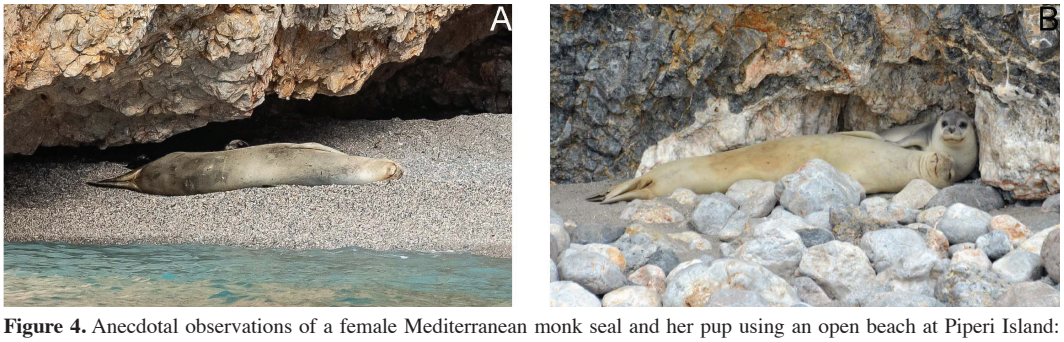

Figure 4. Anecdotal observations of a female Mediterranean monk seal and her pup using an open beach at Piperi Island: (A) a female monk seal and her newborn pup using an open beach on 19 October 2021 (©Dendrinos/MOm); and (B) a female monk seal and her molted pup using an open beach on 20 February 2022 (©Miskedaki/MOm).

Case 6 – Northern Evia Island

On five separate occasions in October and November 2021, we observed four adult female monk seals and their newborn pups using an open, cliff-bound beach (~30 m wide, 15 m deep, covered with sand, pebbles, and rocks) at the northern part of Evia Island (Figure 1). The seals were observed interacting with each other by vocalizing—both on land and underwater as determined by the use of a hydrophone (Charrier/MOm, unpub. data)—and suckling (Figure 5). In contrast to all previous observations, this open beach was close to an aquaculture installation, and human activity was at times intense, with boats frequently passing by, although no noticeable disturbance to the animals was documented.

Unlike most other marine mammals, pinnipeds are amphibious and return to land (or ice) to give birth and molt (Berta, 2018), thus rendering the

Figure 5. Image from a drone showing two female Mediterranean monk seals and three newborn pups using an open beach on 22 October 2021 at northern Evia Island (©MOm)

availability and spatial arrangement of suitable terrestrial habitat (i.e., "critical habitat"; *sensu* Ray, 1976) of utmost importance for their survival (Harwood, 2001). When looking for places to come ashore, pinnipeds seem to select places such as open beaches that are isolated (e.g., remote islands), likely to reduce exposure (i.e., they are cliff-bound) to terrestrial carnivores, as in the case of the Pacific harbor seal (*Phoca vitulina richardii*; Nordstrom, 2002), and/or humans, as in the case of the grey seal (*Halichoerus grypus*; Harwood, 2001), to reduce the overall threat to survival (Kovacs et al., 2012). Increased human/predator pressure has often displaced pinnipeds from their preferred open beach habitats (e.g., northern elephant seal [*Mirounga angustirostris*]; Rick et al., 2011), occasionally to the point of using unsuitable marine caves as critical pupping habitat (Stringell et al., 2014). Upon reduction of this pressure, however, monk seals may return to their preferred habitat (Culloch et al., 2012).

The aforementioned pattern of displacement from critical habitat due to increased human/predator pressure resulting in use of marginal habitat and return to use of preferred habitat once pressures have ceased to exist appears to be relevant also to the Mediterranean monk seal and its current conservation status. Once an open beach dweller (Johnson & Lavigne, 1999), this monk seal population experienced heavy hunting pressure throughout time (González, 2015; Morales-Pérez et al., 2017), gradually leading it to seek remote, difficult-to-access marine caves that offered protection against humans (Karamanlidis et al., 2016) but also other predators (De Waele et al., 2009). Marine caves currently used by monk seals for pupping in Greece share a set of common geomorphological features that are believed to protect them mainly from human activity (Dendrinos et al., 2007c). The combination of continued anthropogenic pressure and use of marginal pupping habitat, which, in turn, has resulted in reduced pup survival rates (Gazo et al., 2000; de Larrinoa et al., 2021), played an important role in the decrease of this species and its resulting precarious conservation status (Karamanlidis & Dendrinos, 2015; Karamanlidis et al., 2019). Considering the monk seals' conservation status, it has been suggested that the marginal cave habitat currently used by this seal might not be suitable for the survival of the species and that recovery of the Mediterranean monk seal will require a partial return to open beaches (Sergeant et al., 1978; Karamanlidis et al., 2016).

More recently, conservation efforts appear to have had a positive effect on habitat use patterns of the Mediterranean monk seal. In (protected) areas where human activity is controlled and therefore low, such as the marine protected area at the Desertas Islands in Madeira, reproductive females and their pups have been observed using open beaches, thus reacquiring their natural, original habitats and behavior (Pires & Neves, 2000). Our examples provide clear evidence that this is

occasionally also the case in Greece. Whether use of open beaches is a recent phenomenon or has persisted throughout time and been undetected by our monitoring efforts is difficult to evaluate. Given the limited availability of suitable pupping caves and the ongoing population recovery of the Mediterranean monk seal in Greece (Dendrinos et al., 2020; Adamantopoulou et al., 2022), we believe that open beach use is a recent phenomenon being driven by breeding females in their attempt to reduce intraspecific competition for space in pupping caves (Dendrinos et al., 2007b; Karamanlidis et al., 2021) by increasing the available pupping habitat. A (partial) return of the Mediterranean monk seal to open beaches could have the same beneficial effects to population demographics as in other seal species (e.g., the northern elephant seal; Lowry et al., 2014).

Regardless of the reasons Mediterranean monk seals in Greece are or have started using open beaches to cover basic biological tasks, this fact has important implications for the species' conservation in the country and across the species' range. The small (i.e., 10 to 100 m wide, 10 to 20 m deep), open, cliff-bound beaches may be considered potential critical habitat for the species. This type of habitat is very similar to the open beaches used by monk seals at Madeira (Pires & Neves, 2000) and should be included in planning of future research and management actions for the Mediterranean monk seal in Greece. Considering that use of open beaches will inevitably lead to an increase of human–seal interactions, we identify the following management actions that are consistent with conservation priorities identified in the new Action Plan for the Mediterranean monk seal in the country (Dendrinos et al., 2020):

1. Expand monitoring efforts of critical habitat throughout the country to include open, cliff-bound beaches.

2. Establish (local) Monk Seal Vigilance Teams tasked with mitigating (negative) human–seal interactions.

3. Inform and educate relevant conservation authorities (e.g., management bodies of protected areas, Port Police authorities) in Greece to the return of the Mediterranean monk seal to open beaches.

4. Include the return of the Mediterranean monk seal to open beaches as an issue in environmental education and public awareness activities. Within the framework of this activity, the *Mediterranean Monk Seal Watching Guidelines* (MOm, 2022) should be promoted.

Apart from the implications for the conservation of the Mediterranean monk seal in Greece, the results of our observations should be considered on a wider scale. In Cabo Blanco, where the subpopulation clings to perilously little habitat (i.e., 3 caves along ~1 km of shoreline; de Larrinoa et al., 2021), it has been recommended to test the viability of reintroducing monk seals to some portion of their previous range to increase total abundance and enhance population viability in the Atlantic (González, 2015). The results of our observations indicate that cave dwelling is not necessarily an innate characteristic of the species and that monk seals do use open beaches under specific circumstances. Creating these circumstances could improve conservation prospects for the species in the region.

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