MONITORING AND CONSERVATION OF THE MEDITERRANEAN MONK SEAL IN THE TURKISH PART OF THE MEDITERRANEAN SEA

Meltem OK and Ali Cemal GÜCÜ

Institute of Marine Sciences, Middle East Technical University, Mersin, Turkey
meltemok@ims.metu.edu.tr

The Mediterranean monk seal, *Monachus monachus* (Hermann, 1779) is one of the rarest and most threatened species in the world. It is also Europe's most endangered marine mammal (Johnson and Lavigne 1998). Being the only representative of the genus *Monachus* (Scheel *et al.* 2014), the worldwide abundance of this elusive seal species is estimated to be fewer than 700 individuals (Karamanlidis *et al.* 2016). The International Union for the Conservation of Nature (IUCN) first classified the Mediterranean monk seal as endangered in 1966. The species was listed as "Critically Endangered" in years between 1996 and 2013. Due to the indications of small population increases in the subpopulations, as of 2015, this conservation status has been updated from critically endangered to endangered in keeping with the IUCN's speed-of-decline criteria, with a recommendation for re-assessment in 2020 (Karamanlidis and Dendrinos, 2015). The species is also protected by Bonn (Appendix I and II), Bern (Appendix II), CITES (Appendix I), Barcelona (Fourth protocol species), and Biodiversity (Eligible species) conventions and European Community's Habitats Directive (Annex II and Annex IV).

In general, there are three or four isolated subpopulations in the eastern and western Mediterranean, the archipelago of Madeira and the Cabo Blanco in the northeastern Atlantic Ocean **(Figure 1)**. Turkey is among the very few countries still providing a shelter to the species. The monk seal population size on the Mediterranean coast of Turkey was estimated as 35 individuals at the end of 1970's. Later, in a study carried out between 1987 and 1994 a total of 45 individuals were identified along the entire extent of the Turkish coast, including the Black Sea and the Sea of Marmara. In that study number of seals inhabiting the south coast of Turkey was given as 11 individuals (Öztürk 1994). In early 2000's, Güçlüsoy *et al.* (2004) estimated the monk seal population size utilizing the first hand sighting reports and recent research studies and reported 104 individuals, 37 of them inhabiting the south coast of Turkey. Finally in 2007, the population size estimated for the narrower coastal band between Antalya and Syria was given as 38 (Gucu *et al.* 2009a and 2009b). As can be noted, the number of individuals reported in the literature points out an increase in the survivors rather than a decline. Whatever the actual number is, the size of the monk seal population is low enough to put the Mediterranean monk seal in the list of the most endangered species.

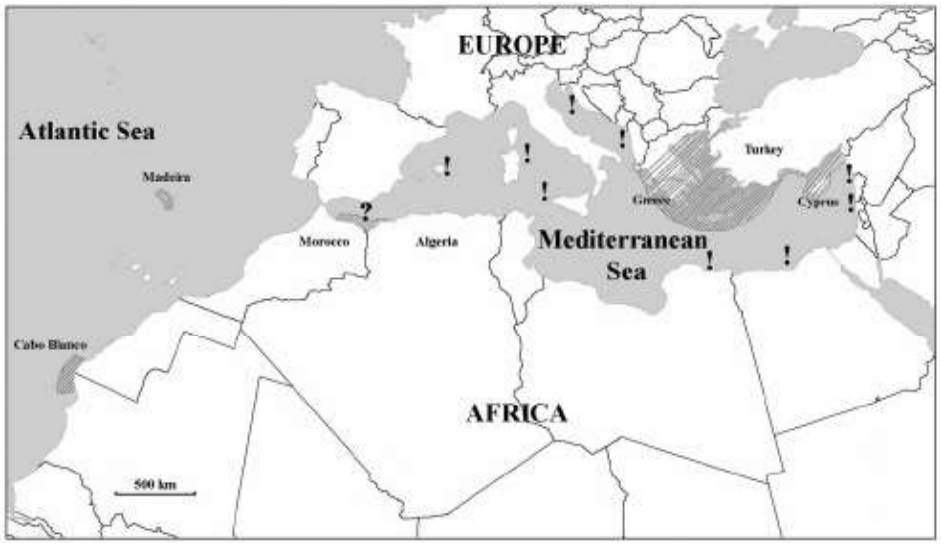

Figure 1. the current distribution of the Mediterranean monk seal. Cross-hatched areas indicate the geographical range of extant monk seal populations; the question mark indicates an area where the fate of the population is unknown; the exclamation marks indicate areas outside the current range where Mediterranean monk seals have recently been seen (taken from Karamanlidis *et al.* 2016).

A detailed study carried out between 1994 and 1996, represented that the largest and the only vital (retaining reproductive ability) colony of monk seals on the Turkish coast inhabits the west coast of Mersin (Gucu *et al.* 2004). In this study, the caves used by the seals for resting or breeding were discovered. Following this study, the importance of Mersin (Cilician) coast for the survival of the species has been recognized and the area has been set aside for conservation in 1997. The surroundings of the identified breeding caves, and the foraging areas has been designated as "No-take-zone" in the sea and on the land as "1st Degree Natural Asset". A follow up study conducted after the conservation remedies were enforced, indicated that the protected area hosted a breeding colony composed of 24 individuals. It was also observed that certain seals were using only certain caves. Therefore the region was subdivided into territories based on the home ranges of the territorial males. The habitat partitioning of the colony is represented in Figure 2. Among these sub-groups the fewest individuals were found in Taşucu and Aydıncık. Moreover, it was realized that the subgroup in this area did not breed throughout the study. In the same study, the ages of the seals were also estimated (Table 1). The demographic structure of the colony at the time of census (Figure 3) reflects an unusual adult dominated structure which indicated a very low reproductive success. Within the period between 1994 and 2000, six dead seals were found. As the locals of the region have reported this number might have been as high as 10 seals. These losses explain the abnormal demography in the colony. In ecological terms, this is a typical case of Allee effect (under-population effect) in which the

number of individuals is so low that reproductive (and some social) activities do not take place only because the individuals are not paired. The loss of harem forming dominant males had significant impact on the colony and reproduction has almost ceased. Consequently, despite the conservation efforts and positive response of the colony to the protective measure the sub-group inhabiting the coast especially between Taşucu and Aydıncık is still under high risk due to the increased industrial activities in the region (such as recently constructed marine terminal, cement plant and thermal power plant in the same region). In the same study it was found out that the seals partition the caves and the total number of suitable caves is one of the major factors limiting the size of the colony.

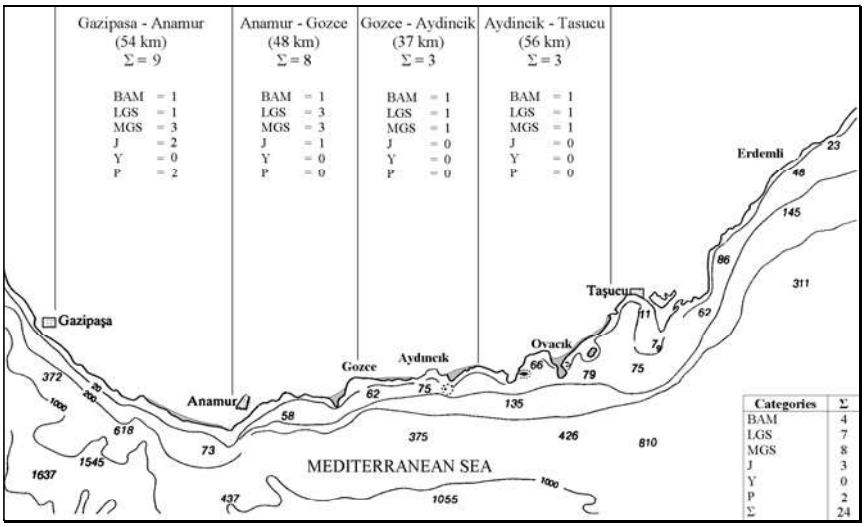

Figure 2. Distribution of the seals along the Cilician Basin with the arbitrary ranges of the sub-regions, the total number of seal individuals using each sub-region and the sub-group category compositions. The data presented on the bottom right corner summarizes the total numbers of seals in each category (taken from Gucu *et al.* 2004)

The further studies carried out right after the enforcement of conservation measures represented that the response of the seals in Mersin has been very positive. The breeding success which had been drastically reduced at the end of 1990's, has significantly increased after 2002 and reached to 5 pups per year (Table 2 and Figure 3) and so that the size of the colony has increased from 24 to 30. Gucu and Ok (2006) and Ok (2006) have analyzed the viability of the population based on population parameters presented by the colony before and after the protection. According to the analysis, the colony would not have survives if the protection had not been established. The risk of extinction within 10 year was almost 100% with the fecundity and mortality rates presented by the colony before the protection. After protection these rates have significantly modifies in favor of the species and as of today, the risk of extinction within the next 50 years is below 30%. However this estimation does not mean that the

monk seal population on the west coast of Mersin is in safe. With the increase in the population size, the pup mortality has increased remarkably. The major causes of pup mortality are entanglement in the fishing nets and being born in an unsuitable cave exposed to open sea. The mortality of the pups born in the caves where fishing activities are intense is almost 100%. The pups are entangled in the nets are drowned since they are not strong enough to tear off the fishing nets. Similarly they are not good swimmer during the first few weeks after birth and they can hardly survives if the waves wash them away from the their breeding caves during storms. This clearly indicates the necessity of the protection of the caves.

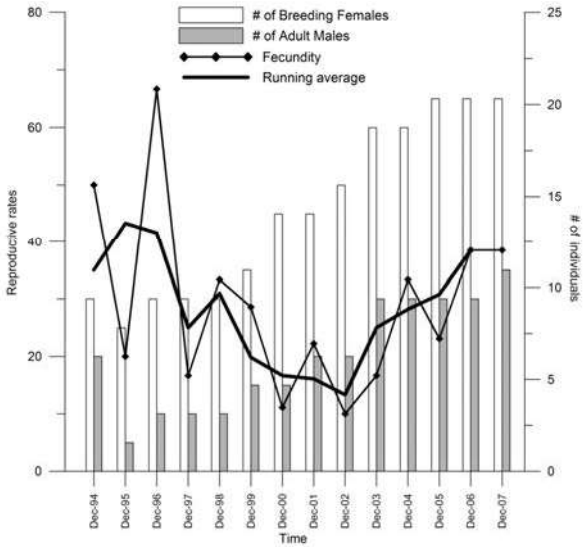

Figure 3. Reproductive activities in P1 (Taken from Gucu *et al.* 2012)

Further studies indicated existence of a small segregated breeding population of seals inhabiting the steep rocky coast at *i*) Turkish/Syrian border (P2), *ii*) north Cyprus (P3) and *iii*) Antalya (P4) (Figure 4). Three years after conservation, a young female was sighted between P1 and P2. The same individual frequented a formerly "abandoned" cave which had not been used by the seals within the previous 25 years (Gucu *et al.*, 2004). Later, a male sighted within P1 moved beyond the anticipated migration limits (Gucu and Ok 2004). Finally a dominant male of P1 sighted in Cyprus (Gucu *et al.* 2009a). All these individual events demonstrated that the P1 tended to further expand with the enlargement of the population size and the sub-region between Taşucu and Aydıncık mentioned above play a crucial role bridging the main colony (P1) with those found in Cyprus (P3) and in the Gulf of Iskenderun (P2).

Estimated overall demographic structures of the populations in the northeastern Mediterranean were given in Table 2 and 3. A total of 69 individuals are involved in the tables and as of year 2008, 50 individuals are believed to survive in four populations.

Table 1. Identified individuals of the Cilician monk seal colony, their sex, category and estimated age. BAM = Black Adult Male; LGS = Large Grey Seal; MGS = Medium Grey Seal; J = Juvenile; Y = Youngster; P = Pup; □ = Deceased; ? = Unknown; ages at September 2001 (Taken from Gucu *et al.* 2004)

Seal ID	Identified on	Sex	Categories at first encounter	Age (years)
I - M1	16-Apr-95	M	BAM	14.7
I - F1	23-Jul-95	F	LGS	13.4
I - P1	30-Jul-95	?	Y	6.6
II - M1	19-Aug-98	M	BAM	11.4
II - F1	11-Oct-97	F	LGS	11.2
II - X1	11-Oct-97	?	J	5.2
III - M1	10-May-97	M	BAM	12.6
III - F1	24-Apr-96	F	MGS	8.2
III - F2	04-Aug-96	F	LGS	12.4
III - F3	21-Aug-96	F	LGS	12.4
III - P1	21-Aug-96	F	P	†
III - P2	15-Nov-96	M	J	6.1
III - P3	02-Dec-96	M	Y	5.2
III - P4	09-Nov-97	M	P	4.1
III - P5	24-Oct-99	F	P	2.2
IV - M1	24-Aug-96	M	BAM	13.4
IV - F1	20-Aug-98	F	LGS	10.4
IV - F2	13-Mar-99	F	MGS	5.3
IV - P1	20-Aug-98	F	P	3.4
IV - P2	23-Oct-99	F	P	2.2
IV - P3	09-Nov-00	M	Y	1.3
IV - P4	29-Aug-01	?	P	0.3
IV - P5	29-Aug-01	?	P	0.3
IV - X1	18-Oct-98	?	J	4.2
X - X1	10-Mar-98	?	LGS	10.8

It is very likely that there was one single and large seal population in the past covering the entire extent of the northeastern Mediterranean. Later, because of intensive urbanization and industrialization within their habitat, and also because of deliberate killings, the population became fragmented into smaller isolated populations suggested in Figure 4 by the early 1980s. Today, the seals dispersed to Syria, Cyprus, the Gulf of Iskenderun and all along the northeastern Mediterranean may be the relicts of the same historical population. Depending on the level of disturbance and the size of the fragments, some groups may maintain their biological and social functions, as on the Cilician coast. Due to steep and mountainous topography on the west coast of Mersin,

human pressure and, in turn, habitat fragmentation, has not been as severe as on the east coast, as indicated by continued reproductive ability of the colony inhabiting there. However, the fate of the small colony in the Gulf of Iskenderun is uncertain, especially when the genetic bottleneck is considered — i.e. the probability of extinction may increase due to reduced genetic variability.

Table 2. Demography table of the monk seal population (P1) in the northeastern Mediterranean; underlined italic numbers are back-calculated ages, arrows show the movement between populations (Taken from Gucu *et al.* 2012)

Sex	Name	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
F	Tekin	***21.0***	***22.0***	***23.0***	***24.0***	25.0	26.0	27.0	28.0	29.0	30.0	31.0	32.0	33.0	34.0	35.0
M	Yula †	8.0	†													
M	Japon †	8.0	†													
M	Cecan †	8.0	†													
M	Bombacı	***7.0***	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	→			
F	Kır †	6.0	†													
F	Dede †	6.0	†													
F	Kokona	***5.0***	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0
M	Kamash	***5.0***	***6.0***	***7.0***	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0
F	Meryem	***4.0***	***5.0***	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0
F	Yasli	***4.0***	***5.0***	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0
F	Melek1	***3.0***	***4.0***	***5.0***	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0
M	Yagiz	***2.0***	***3.0***	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0
F	Anac	***2.0***	***3.0***	***4.0***	***5.0***	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0
F	Bozzy †	***0.0***	***1.0***	***2.0***	3.0	†										
F	Charlie †	0.0	†													
M	Yakisikli	***0.0***	***1.0***	***2.0***	***3.0***	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0
F	Ceren	_	0.9	1.9	2.9	3.9	4.9	5.9	6.9	7.9	8.9	9.9	10.9	11.9	12.9	13.9
F	Meltem	_	_	***0.0***	***1.0***	***2.0***	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0
F	Umit †			0.0	†											
M	Arap			0.3	1.3	2.3	3.3	4.3	5.3	6.3	7.3	→				
M	Ferit Jr.			0.9	1.9	2.9	3.9	4.9	5.9	6.9	7.9	8.9	9.9	10.9	11.9	12.9
F	Charlie				1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0
M	Askim				0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0
F	Ney					0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
M	Saklikuzu					0.3	1.3	2.3	3.3	4.3	5.3	6.3	7.3	8.3	9.3	10.3
F	Sedef						0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0
F	Sanda						0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	†
M	Yalcin							0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0
M	Uykucu								0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0
F	Amorti								0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0
M	Tarcin									0.0	1.0	2.0	3.0	4.0	5.0	6.0
F	Zeynep †										0.3	†				
F	Lal †										0.0	1.2	†			
F	Kay											0.3	1.3	2.3	3.3	4.3
M	Luigi											0.1	1.1	2.1	3.1	4.1
F	Rane											0.1	1.1	2.1	3.1	4.1
M	Afag †											0.3	†			
M	Levant												0.2	1.2	2.2	3.2

M	Tahta												0.1	1.1	2.1	3.1
F	Lamas												0.0	1.0	2.0	3.0
F	Aluna													0.2	1.2	2.2
F	Rüzgar													0.1	1.1	2.1
F	Çöplük													0.1	1.1	2.1
F	Filmi olan													0.1	1.1	2.1
M	Serdar													0.0	1.0	2.0
F	Aluna														0.2	1.2
F	Doğan														0.1	1.1
M	Photo														0.0	1.0
F	M. boncuk														0.3	†
F	Extra														0.1	†

Table 3. Demography table of the monk seal populations in the northeastern Mediterranean; underlined italic numbers are back-calculated ages, horizontal arrows show the dispersed individuals (Taken from Gucu *et al.* 2012)

ex	Code	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
P2 (estimated using the data in Ok (2006))																
M	Olen-1	*3.0*	*4.0*	*5.0*	*6.0*	*7.0*	*8.0*	†								
F	Olen-2			0.0	1.0	2.0	3.0	4.0	5.0	6.0	†					
F	Fırtına							*0.0*	*1.0*	*2.0*	*3.0*	*4.0*	*5.0*	6.0	7.0	8.0
F	Arap										→	8.3	9.3	10.3	11.3	12.3
F	Kınalı										*0.0*	*1.0*	*2.0*	3.0	4.0	5.0
M	Rüzgar													0.1	1.1	2.1
F	Ali Eksi-1														0.1	†
M	Ali Eksi-2														0.1	†
P3 (estimated using the data in Gucu et al. (2009a))																
M	Bombacı												→	19.39	20.39	21.39
F	YediDalga							0	1	2	3	4	5	6	7.00	8.00
F	Karpaz							0	1	2	3	4	5	6.00	7.00	8.00
F	Karpaz J												0.8	1.80	2.80	3.80
F	Karpaz P													0.80	1.80	2.80
P4 (estimated using the data in Gucu et al. (2009b))																
F	Cıralı	0.20	1.20	2.20	†											
F	Emine									*0.00*	*1.00*	*2.00*	*3.00*	*4.00*	*5.00*	6.00
M	IFAW-1					*0.00*	*1.00*	*2.00*	*3.00*	*4.00*	*5.00*	*6.00*	*7.00*	8.00	8.00	9.00
M	IFAW-2					*0.00*	*1.00*	*2.00*	*3.00*	*4.00*	*5.00*	*6.00*	*7.00*	8.00	8.00	9.00
F	ÜçAdalar									*0.00*	*1.00*	*2.00*	*3.00*	*4.00*	*5.00*	6.00
F	Adrasan												_	*0.50*	*1.50*	2.50
M	Erkek														*0.60*	1.60

The evaluation of survey results, however, reveals that the situation in the Northeastern Mediterranean is not as bad as first feared — and may even be promising. It is evident that the colony on the west coast of Mersin is increasing, and is also following an expanding trend. The caves recently repopulated by the seals are located right in the middle of the two fragmented colonies. At the moment we are not sure if there is sufficient genetic movement between these fragments. However, if the habitat and the caves used by the seals in particular, are kept intact it is very likely that there will certainly be a bridge between isolated populations. In fact, it seems that this is the only chance of the small colony in the Gulf of Iskenderun and Cyprus to survive. On the other hand if only one of the breeding caves in P1 is lost, that would certainly mean a disaster not only for the population in question, but also for the neighboring populations where breeding success depends on migratory individuals originated from P1.

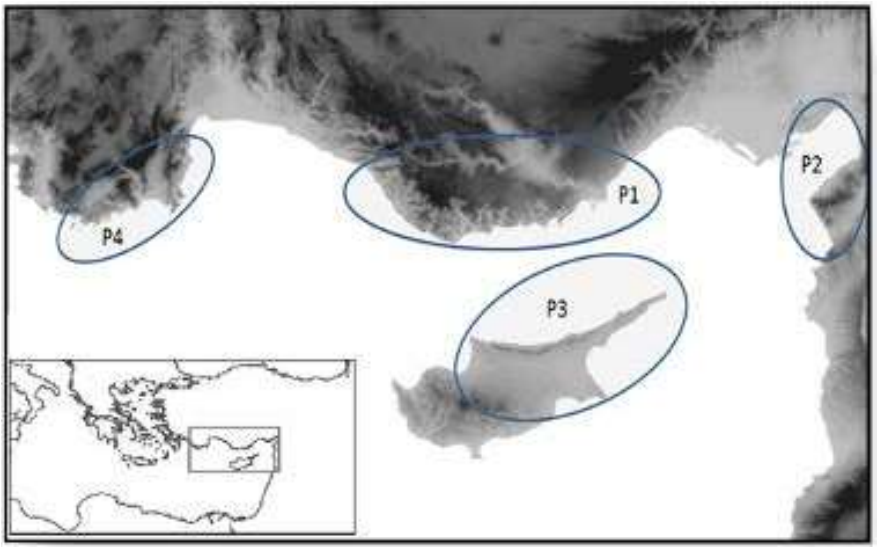

Figure 4. The regions used by the respective seal populations in Northeastern Mediterranean (taken from Gucu *et al.* 2012)

In general, the main accumulation of the seals is observed at the sites where the human interference is minimal, especially at the spots the main road is not in the near proximity. Therefore it would be wrong to conclude that the habitat preferences of the seals are driven by human activities around; the sites with dense human activities are avoided. As given above, the largest and the only viable seal colony inhabiting the east coast of Mersin dwell in a very delicate social structure. The caves that serve to fulfill significant biological requirements, such as resting and breeding play crucial role within this structure. Although karstic morphology on the land permits formation of coastal caves, number of caves bearing certain peculiarities sought by the seals is extremely limited. With this respect the caves has critical importance on the persistence of the colony on this region.

Competition for breeding habitat among Mediterranean monk seal females has never been reported. Moreover, it was observed that two different mothers gave birth in the same cave within the P1 (one month apart) in 2005 and 2006. However it was also observed that two pups died because they were given birth in unfavorable caves (Gucu 2008). Figure 5 shows the relation between number of pups and the pup mortality. In general high pup mortalities were observed when more than 2 pups were born in a harem in a year. Therefore it may be postulated that in addition to the number of suitable breeding caves, the maximum number of pups that can be born in a cave during a whelping season may be a limiting factor determining the reproductive success.

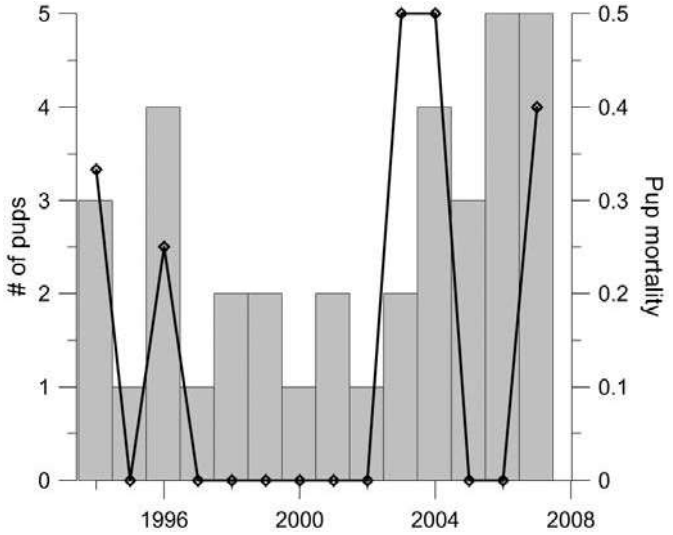

Figure 5. Number of pups (bars) and pup mortality (line) (taken from Gucu *et al.* 2012)

As mentioned above, Turkish part of the Mediterranean Sea hosts one of the last and continuously breeding populations of monk seal in the Mediterranean Sea. The scarcity and importance of breeding caves and the dwindling state of the fish stocks were the main concerns for the survival of the population. In such a situation the best solution seemed be enforcement of a conservation strategy i.e. establishment of a functional network of marine protected areas that will protect critical monk seal habitat and reduces the fishing pressure on main food source of the monk seal. During the last several decades important steps have been made in understanding this elusive species, but more needs to be done to ensure the future of the Mediterranean monk seal.

References

Güçlüsoy, H., C. O. Kıraç, N.O., Veryeri, and Y. Savaş. 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 2004, Volume 21, Issue (3-4): 201–210.

Gucu, A.C., G. Gucu and H Orek. 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.

Gucu, A.C. and M. Ok. 2004. Arab The Pilgrim. The Monachus Guardian, 7(1).

Gucu A.C. and M. Ok. 2006. How far the Cilician monk seal colony will go with the existing regulations?. Proceedings of the conference on monk seal conservation organized by United Nations Environment Programme [UNEP], Mediterranean Action Plan [MAP] and Regional Activity, Centre For Specially Protected Areas [RAC/SPA], Antalya, Turkey.

Gucu, A.C. 2008. Dead pup found on Cilician coast. The Monachus Guardian, 11 (2).

Gucu, A. C., M. Ok, and S. Sakınan. 2009a. A survey of the critically endangered Mediterranean Monk seal, *Monachus monachus* (Hermann, 1779) along the coast of northern Cyprus. Israel Journal Of Ecology & Evolution, 55, 77–82. doi: 10.1560/IJEE.55.1.77.

Gucu, A. C., S. Sakınan and M. Ok. 2009b. On the occurrence of the critically endangered Mediterranean Monk Seal, *Monachus monachus* (Hermann, 1779a) at Olympos-Beydağları National Park, Antalya, Turkey and its interaction with tourism. Zoology in Middle East. 46: 3-8.

Gucu, A. C., M. Ok, S. Sakınan,M. Tuer, E. Sahin, O. Tutar, D. İlter. 2012 Viability assessment of northeastern Mediterranean Monk seal (Monachus monachus) population (TBAG-111T681, supported by TUBITAK). METU/IMS, Mersin, Turkey. 42 pp

Johnson, W. M., and D. M. Lavigne. 1998. The Mediterranean monk seal. Conservation guidelines. Multilingual Edition. IMMA Inc., Guelph, Ontario, Canada: 1-152.

Karamanlidis, A. and P. Dendrinos. 2015. *Monachus monachus*. The IUCN Red List of Threatened Species 2015: e.T13653A45227543.http://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T13653A45227543.en. Downloaded on 1 December 2016.

Karamanlidis, A. A., P. Dendrinos, P.F. de Larrinoa, A.C. Gücü, W. M. Johnson, C. O. Kiraç and R. Pires. 2016. The Mediterranean monk seal *Monachus monachus*: status, biology, threats, and conservation priorities. Mammal Review, 46: 92–105. doi:10.1111/mam.12053

Ok, M. 2006. Past, present Status and future of the Mediterranean Monk Seal (*Monachus monachus*, Hermann 1779) in the Northeastern Mediterranean (Master's thesis, Middle East Technical University, Institute of Marine Sciences, Mersin, Turkey, 114pp).

Öztürk, B. 1994. Evaluation of the present status and trend of monk seal populations in Turkey. In: Present Status and Trend of the Mediterranean Monk Seal

(*Monachus monachus*) Populations. RAC/SPA (UNEP), Tunis, UNEP (OCA)) /MED WG.87/4, p.33.

Scheel D-M, G.J. Slater, S-O.,Kolokotronis, C.W. Potter, D.S. Rotstein, K. Tsangaras, A.D. Greenwood, K.M. Helgen. 2014.Biogeography and taxonomy of extinct and endangered monk seals illuminated by ancient DNA and skull morphology. ZooKeys 409: 1–33.