Available online at www.sciencedirect.com
SCIENCE DIRECT®
Biological Conservation 116 (2004) 417–431
BIOLOGICAL CONSERVATION
www.elsevier.com/locate/biocon

Habitat use and preliminary demographic evaluation of the critically endangered Mediterranean monk seal (*Monachus monachus*) in the Cilician Basin (Eastern Mediterranean)

Ali Cemal Gucu*, Gul Gucu, Hasan Orek

Middle East Technical University, Institute of Marine Sciences, PO Box 28, Erdemli, 33731 Icel, Turkey

Received 27 March 2003; received in revised form 30 May 2003; accepted 9 June 2003

Abstract

Over the last few decades a dramatic decline in the number of Mediterranean monk seals (*Monachus monachus*) limited scientific studies on the biology, behaviour, and ecology of the species. This lack of information impaired the effectiveness of conservation strategies. Thus, any further information gathered on the monk seal has utmost value in the work to halt and reverse the plight of the species. A hitherto unknown Cilician Basin colony of the Mediterranean monk seal has been investigated during a 6-year period between 1995 and 2001. Results of direct in-cave surveys and land based seal-watch observations enabled the evaluation of habitat use and preliminary demographic information. A total of 39 caves were discovered among which only three were used for breeding. Scarcity of the breeding caves emphasised the importance of breeding habitat in the survival of the colony. Common features of the breeding caves are found as an entrance with a protective barrier against strong waves; a chamber with a wide beach; and a well-sheltered shallow pool. Supplementary data obtained from infrared monitors installed in three actively used caves were used to assess the number of individuals. Throughout the study period, 25 individuals were identified and 11 newborn pups were found. Evaluation of the results suggests the presence of sub-regions inhabited by an individually identified sub-group of monk seals. Recommendations for conservation guided by this information is a Marine Protected Area consisting of two zones; a restricted core zone prohibiting any human activity securing breeding habitat and a restricted fishery zone securing sustainability of the food source.

Keywords: *Monachus monachus*; Habitat use; Demography; Conservation; Cilician Basin

1. Introduction

The Mediterranean monk seal, *Monachus monachus* (Hermann, 1779) has been classified as "Critically Endangered" since 1966 by the Species Survival Commission of the World Conservation Union (IUCN) and today, it is protected by Bonn (Appendix I and II), Bern (Appendix II), CITES (Appendix I), Barcelona (Fourth protocol species), and Biodiversity (Eligible species) Conventions.

The Mediterranean monk seal is the rarest existing species in the Phocidae family and the sixth most threatened mammal in the world (Panou et al., 1993). In the seventies, around 600–1000 individuals were believed to survive in the Mediterranean Sea (Sergeant et al., 1978; Marchessaux, 1989). In 1997, the largest population of the species experienced a dramatic die-off in the western Sahara and approximately 200 seals died (Harwood et al., 1998). After this loss, other reproductive colonies in Maidera (Neves and Pires, 2000), Alonissos (HSSPMS, 1995; Dendrinos et al., 1996), Kefalonia (Jacobs and Panou, 1988), Foca (Guclusoy and Kence, 2001) as well as the less known, small fragmented groups scattered in few remote locations such as in the Cilician Basin, gathered substantial attention. Considering that the total number of monk seals throughout the range is estimated to be between 400 and 500 individuals, the collective number of the above mentioned fragmented colonies consist 60% of the entire population and have vital importance in terms of survival of

* Corresponding author. Tel.: +90-324-521-3434; fax: + 90-324-521-2327.
E-mail address: gucu@ims.metu.edu.tr (A.C. Gucu).

0006-3207/03/$ - see front matter © 2003 Elsevier Ltd. All rights reserved.
doi:10.1016/S0006-3207(03)00234-9

the species. The monk seals inhabiting the Cilician Basin in the eastern Mediterranean, corresponding largely to the Turkish province of Mersin, are among the last four remaining breeding groups. Until recently, the presence of monk seals in this region have not been reported, though large numbers of seal were historically observed according to local residence.

Recovery of the Mediterranean monk seal population requires information that can be used to justify implementation of management and conservation actions (RAC/SPA, 1998). This is especially true in the Cilician Basin where so little is known about monk seal biology, behaviour and ecology. In this study we characterized and identify monk seal territorial habitat and describe patterns of habitat use in relationship to monk seal demographics. Building on guidelines proposed by joint expert consultation on the conservation of the Mediterranean monk seal (UNEP/MAP, 1998), our results are used to begin the design of a comprehensive plan for recovery of the species in the Cilician Basin.

2. Methods

2.1. Study area

The study was conducted in the Cilician Basin of the north eastern part of the Mediterranean Sea along the Turkish coast of the strait between the island of Cyprus and the mainland. The study area included about 250 km of coast line from Gazipasa (Antalya) to Erdemli (Mersin, Fig. 1).

2.2. Research

Observation of near shore habitat use by monk seals were initiated in April 1995 and continued to September 2001 and they included identification of caves, remote monitoring of in cave use patterns, and documentation of seal occurrence outside of caves.

2.2.1. Cave habitat

2.2.1.1. Monk seal observations in caves. Surveys were conducted to identify caves actively used by seals. Teams, composed of one person swimming and at least one person recording data from an inflatable boat, surveyed the entire study area (Fig. 1). Beaches and other shallow shoreline areas, which are not suitable for underwater cave formation, were surveyed only from the boat. Caves were classified into four categories; *Active*—caves in which one or more seals were sighted or there was evidence of seal use (e.g., tracks, body depressions, faeces), *Breeding*—caves in which whelping occurred, *Abandoned*—caves in which seals were historically observed, but were no longer in use, and *Potential*—caves which met the requirements and

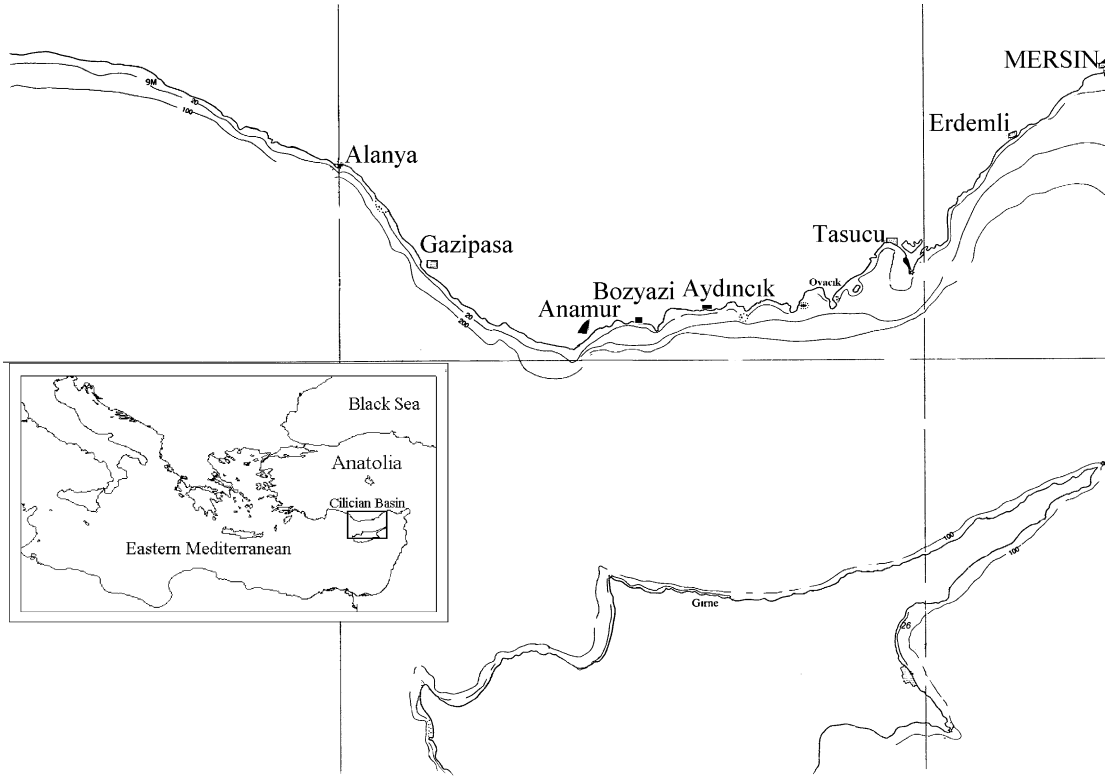

Fig. 1. Study area, the Cilician Basin.

descriptions[1] of a monk seal cave (IUCN/UNEP 1988), but lacked any sign of use.

A total of 282 cave surveys were conducted between March 1995 and October 1999. Some of the caves were visited only during whelping season. The caves near to the observation point (Boklu, Boz and Dehliz) were visited more often then the others to compare in-/out of cave activities and to evaluate cave preference. Visits to the other caves were carried out in an attempt to monitor monthly cave use pattern, however only Piramit, Balikli, Charlie and Catlak could be visited systematically (Table 1). The rest of the caves could not be visited more than 10 times throughout the study hence disregarded in the analysis.

Most of the entrances of the caves were only accessible from underwater. Therefore, snorkelling with submersible torches and cameras were required for this activity. SCUBA diving equipment disturbs seals and was not used to monitor seals in caves. In a few cases, caves could also be accessed from land, which provided a useful alternative for cave monitoring when sea conditions were unfavourable. Inside the cave, the evidences of seal presence (sleeping depressions, tracks) were recorded and smoothed over, if present. The evidences were classified as "new" (one day old), in which haul-out track recognizable on the splash zone; "moderately new" (2–3 days old), in which haul-out track visible but erased on the splash zone; and "old" (>7 days old) in which, tracks not visible; only sleeping depression clearly recognizable. In the analysis, in addition to the direct sightings, new and moderately new tracks were considered. The other evidences such as old tracks and remains were disregarded in the analysis and used only as an indicator of cave usage in cave classification.

From August 2000 to September 2001 only breeding caves were monitored to evaluate the reproductive success of the Cilician colony during the whelping season (August–November).

Percentage of seal evidence per in cave survey (PEc) was calculated with the following formula only for the caves, where the visits cover one-year period:

$$PEc_i = Ec_i/Tc_i.100$$

where PEc_i is the percent of seal evidences in cave in ith month; Sc_i is the total seal evidences in cave in ith month; and Tc_i is the total number of seal evidence in cave in ith month.

2.2.1.2. Monitoring activity in caves. A TrailMaster infrared monitoring system was used to monitor seal activity in caves. The transmitter and receiver were set and aligned 20–30 cm above the floor of the cave and the camera was placed in a location that permitted the best view of the seals. The transmitter emitted infrared pulses every 0.05 s and the receiver recorded an event when the infrared beam was broken for a second or longer (20 consecutive missed pulses = 1.0 s). This value was short enough to record a seals passing through the beam and long enough not to record a false event such as those caused by flying bats, water splashes, etc. Each event was stored in the receiver by date and time.

Furthermore, a 35-mm camera with a built-in flash was attached to the recording system. The receiver automatically activated the camera when an event occurred. To prevent depleting the entire roll of film by multiple events occurring shortly one after another, the camera was delayed for 90 min after an event.

Infrared monitors and cameras were installed in the three most actively used caves but two of the systems were destroyed during a storm. Data from two of the caves were disregarded, as the collection could not be applied for a complete year due to mechanical damage. The data recorded at cave Dehliz was later analysed for activity pattern (Table 2). Seal photographs from three of the caves were used for individual identification.

2.2.2. Monk seal observations out of caves

Behavioural observations of monk seals outside caves were made from a vantage point on land where high incidence of seal activity had been identified or previously reported (Gucu, unpublished data). Observations from land were conducted on 211 occasions and totalled 362 hours of observations from February 1995 to November 1999. Surveys occurred weekly but were not conducted in indecent weather conditions (high swell, storm, rain, etc.) since seals may not be recognized in rough sea conditions (Table 1). Two observers facing opposite directions carried out surveys with an observation time of 1:38 h, on average. Observation lasted over 30 min and was stopped if a seal did not appear after 2 h of observation or, when the sighted seal disappeared from sight. Information was collected on date and time of observation, weather conditions, time of seal sighting, seal morphology and behaviour.

Percentage of monthly seal sightings (PSo) for the representative sample site were calculated as follows:

$$PSo_i = So_i/To_i.100$$

where Pso_i is the percent of seal sighting out of cave in ith month; So_i is the total seal sightings out of cave in ith month; and To_i is the total number of observation out of cave in ith month

2.2.3. Preliminary demographic evaluation

2.2.3.1. Identification of individuals. Photographs and/or videos of the seals were taken whenever possible to

[1] A typical Mediterranean monk seal cave ideally has an underwater entrance and pebble or sandy beach above the reach of sea wave with provision of shelter.

Table 1
Monthly distribution of cave surveys and observations carried out throughout the study period

	Σ	January	February	March	April	May	June	July	August	September	October	November	December
Balikli	13	0	1	0	0	2	1	2	2	2	1	1	1
Charlie	11	1	1	1	0	1	1	1	1	1	1	1	1
Boklu	38	4	2	3	2	4	1	1	14	2	1	2	2
Catlak	12	1	1	1	0	1	1	1	2	1	1	1	1
Boz	45	5	2	4	2	3	2	2	8	4	4	4	5
Dehliz	87	8	18	4	3	6	4	8	16	4	7	4	5
Piramit	14	1	0	1	0	1	1	1	3	2	2	1	1
Observation	215	13	21	13	15	23	27	14	19	21	22	15	12

identify individuals. Sex, size, colour, natural marks, and scars were used as an individual's identification criteria (Marchessaux and Muller, 1985). The sex of an individual was determined from the morphological characteristics described by Samaranch and Gonzalez (2000) (Table 3) and size was estimated from photographs and video footage taken during the observations whenever available.

2.2.3.2. Evaluation of age. The ages of individual seals with known birth dates were abbreviated as A_{real}. The ages of other seals were estimated using the following formula.

$$A_{est} = (P - D)/365 + X$$

A_{est} is the estimated minimum age in years; D is the Julian date of first sight; P is the Julian date (31 December 2001); X is the age of the individual at first sighting.

X is rather difficult to determine and is formulated as follows: most females reach sexual maturity at 5 years of age and have their 1st pup at 6 years of age. The first successful mating of a male takes place when he is 7 years old (Scoullos et al., 1994). Therefore in order to estimate minimum age in years of an individual X is assumed to be 8 for BAM, 7 for LGS, 2.5 for MGS, 1 for J, 0.17 (2 months) for Y and 0 for the P (see Table 3 for the explanation of the abbreviations).

2.2.3.3. Evaluation of age/sex groups. The assessment of monk seal age/sex groups was done in two stages over a 195-kilometre coastline, omitting the abandoned part between Tasucu-Erdemli. Until the end of the second whelping season (December 1996) the individuals were identified using the identification criteria provided above. Later, colour (except for BAMs), scars and size were no longer considered in identification since these may change over time and lead to misidentification. The population numbers were then assessed with new information on births, deaths, group sightings, and simultaneous seal sightings/tographs at different locations.

Table 2
Results obtained with TrailMaster infrared monitors

Cave code	From	To	Days deployed	# Of events
Dehliz	9 November 1997	6 September 1998	301	1267
Charlie's	10 January 1998	28 January 1998	18	25
B.Oz	11 January 1998	16 March 1998	64	55
Total	9 November 1997	6 September 1998	301	1267

2.2.3.4. Identification of reproductive sub-groups. The locations of sightings of the identified seals were plotted on the site map, in order to investigate area partitioning amongst the Cilician Mediterranean monk seal colony and the existence of sub-groups. The results of this investigation were used to determine the boundaries of the sub-regions, which were used in further analysis and data presentations.

3. Results

3.1. Cave habitat

3.1.1. Monk seal observations in caves

In total, 39 caves were discovered along the Cilician Basin (Turkish coast) of which three were breeding, 16 were active, 18 were potential and two were abandoned (Table 4). One–three seals were observed in caves on 99 occasions.

Fig. 2 shows the percentage of seal sightings per visit for seven actively used caves. This figure excludes active caves visited less than 10 times. The highest percentage of sighting was in *Piramit*, which is one of the active breeding caves. Fig. 3 compares the monthly seal evidence in the most frequently visited caves (Table 5). *Dehliz* having the second highest overall percentage of seal evidence, continuously used by the seals all year round. Although, youngsters were often observed in it, here whelping never occurred. Overall, *Boklu* represented a low PEc value (Fig. 2), however there was strong seasonality in the seal existence (Fig. 3). Almost no seal evidence was found in this cave between June

Table 3
Morphological categories of the Mediterranean monk seal (after Samaranch and Gonzalez, 2000)

Category	External features	Sex
Black Adult Male (BAM)	Black pelage; belly with a white patch. Back and neck with white scars	M
Large Grey Seal (LGS)	Pelage is usually dorsally dark grey and light below. Back interrupted by white scars, frequently with a dorsal patch	M/F
Medium Grey Seal (MGS)	Pelage is usually dorsally dark grey and light below. Back interrupted by white scars, frequently without a dorsal patch	M/F
Juvenile (J)	Pelage is usually dorsally brown grey and light below. Body with few scars or without them	M/F
Youngster (Y)	Pelage is usually dorsally light grey and light below. Body with no scars. Fatty appearance	M/F
Pup (P)	Black pelage, belly with a white patch. Body with no scars. Body fur forming pleats in the first 10 days.	M/F

Table 4
Distribution of seal caves found in the Cilician Basin. (see also Fig. 1)

Region/cave	Breeding	Active	Potential	Abandoned	Total
Erdemli—Tasucu	–	–	–	2	2
Tasucu—Aydincik	1	2	4	–	7
Aydincik—Gozce	–	5	3	–	8
Gozce—Anamur	1	4	4	–	9
Anamur—Gazipasa	1	5	7	–	13
Total	3	16	18	2	39

and November. *Balikli* is another breeding cave with the third highest percentage of sighting. The last breeding cave, *Boz*, has a very low percentage of sightings and the sightings were aggregated in the three months that follow the whelping season (Fig. 3). The cave use pattern of the colony was given in Fig. 4, where the percentage of seal evidences found in seven most frequently visited caves were summarized (Table 1). The values increased from January to July and suddenly dropped in August. The cave use was again increased and from October until January the percentage of in-cave seal sightings was at its maximum (Fig. 4).

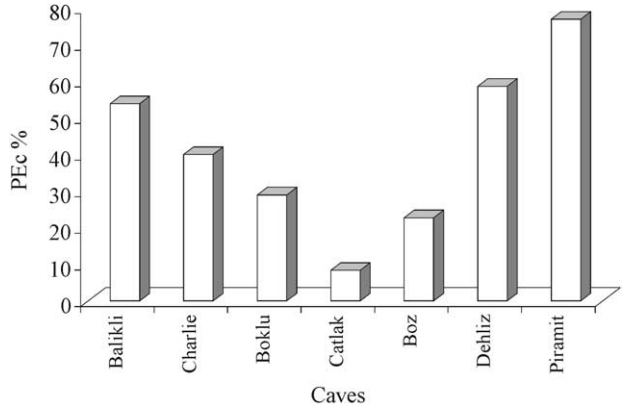

Fig. 2. The percentage of in cave seal evidence for seven actively used caves (numbers in parenthesis indicate total number of cave surveys).

3.1.2. Breeding caves and characteristics

Breeding was observed in only three caves; namely *Balikli*, *Boz* and *Piramit*. The Cave *Balikli* is located in a small bay protected from prevailing winds. There is a wide 0.8 m×3 m underwater entrance to the cave. The opening the cave provides an excellent shelter for the seals; even in stormy weather. A shallow pool is inside the cave and it is circled from right to left with a small platform, a beach, and some flat-topped rock blocks. The seals were observed mainly on these stone blocks. Evidence of seal use included tracks and depressions on the sandy beach and remains of mucous, fur, and faeces on the platform. The cave interior is always very dark.

The entrance of the cave *Boz,* although quite wide, is partially blocked with a fallen rock leaving only a very narrow opening as an underwater passage (1m×1m). This structure acts as a barrier against waves. After the entrance there is a narrow 50-m long tunnel leading to a beach at the very end. Approximately half way to the beach, there is a small, narrow refuge pocket. Several times the pups were observed here. The beach is partially illuminated in the late afternoon.

The cave *Piramit* has a very wide entrance (5 m×10 m). From the entrance towards the inside, the width of the passage gets narrower and becomes less than half a meter before reaching the main chamber. Because of this cone shaped structure, the height of the waves is amplified while travelling along the tunnel. Entering the inner part of the cave is, therefore, very difficult. Facing the narrow opening at the end of the tunnel, the waves break and lose their energy just before entering the broad inner chamber. Even during stormy weather, the inside is always calm. This chamber has a shallow pool surrounded by a broad and deep beach. At the right side, there are flat rock platforms. There are also small and narrow underwater hollows connecting the inner chamber to the tunnel. Similar to the cave *Boz*, there is a refuge pocket along the tunnel, however it is more complex. The pocket is a long, narrow underwater corridor with two openings. There are a couple of domes along the corridor filled with air. The seals are therefore

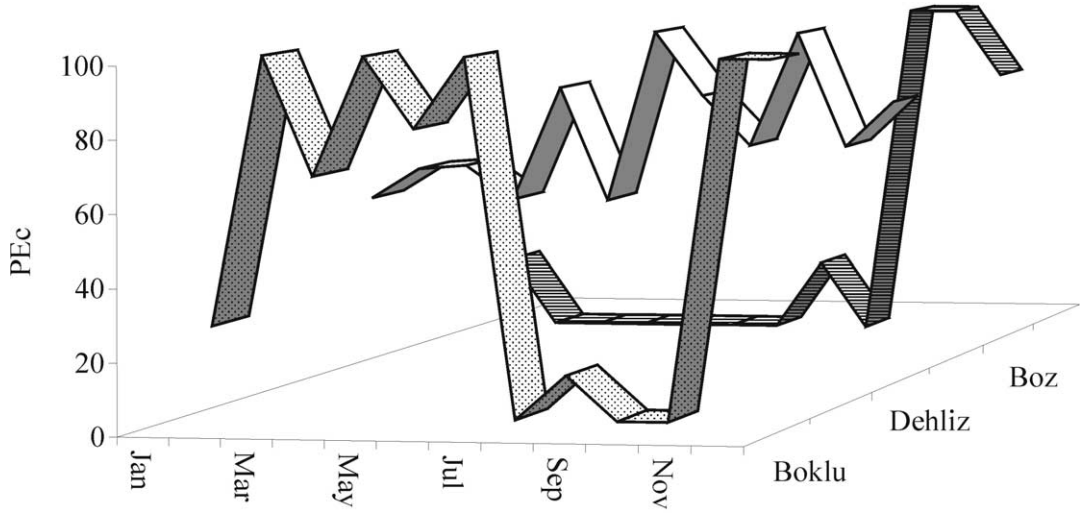

Fig. 3. Monthly variations of percentage of seal evidences found in most frequently visited caves.

able to breathe inside this pocket. The inner chamber is always dark.

3.1.3. Infrared monitors and level of activity in caves

Table 2 shows the number of events recorded in the three caves with the infrared monitors. The largest number of events was recorded in *Dehliz* with the longest period of deployment. The frequency of events recorded by the TrailMaster infrared monitors in *Dehliz* was plotted against time in Fig. 5. Since the transmitters and the receivers were aligned to record the level of activity on the in-cave retreat platforms, each event corresponded to a haul-out. The data showed a regular activity pattern. The period of lowest activity was recorded between 13:00 and 15:00 h. After 15:00 the level of activity increased reaching a peak around 01:00 after midnight. After this peak, the level of activity decreases until 13:00, completing the regular pattern. The only irregularity seemed to be the increased activity between 06:00 and 07:00 during sunrise.

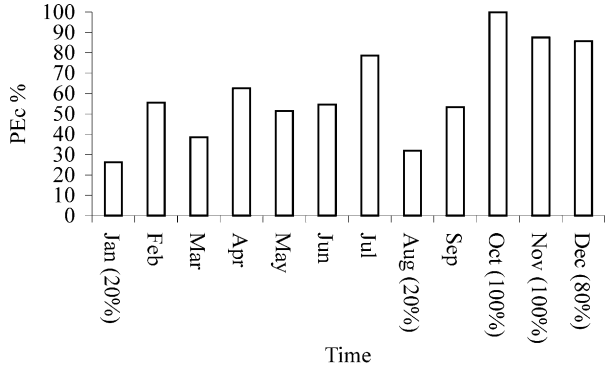

Fig. 4. Monthly percentages of seal evidences found in caves (PEc) per total number of all cave surveys. Percentages given in brackets indicate PEc values of the months when seals were observed in cave Boz.

3.1.4. Whelping

Between 1995 and 2001, 11 pups were found in the region (~2 births per year). Table 6 summarises the locations, estimated dates of whelping and the sex of the new born pups. With one exception, in which the pup was found rather late at "*youngster*" stage and therefore the exact birth date could not be precisely estimated, all whelping occurred between August and November.

In 7 out of 11 cases, the pups were found before they moulted the natal fur. The pups were observed to carry the natal fur for almost 6 weeks.

3.2. Monk seal observations out of caves

During the out of cave visual surveys from the established land based vantage point, one or more seals were sighted a total of 61 times (28%). Average group size

Table 5
In-cave seal sightings between March 1995 and October 1999; showing the total number of visits to each cave; the number of times a seal/seals were sighted; the total number of seals sighted; the maximum number of seal sighted at one time (see also Fig. 1)

Caves	# of visits	# of sightings	Σ seal sighted	Max
Balikli[a]	13	7	8	2
Besparmak	4	2	2	1
Soguksu	5	1	1	1
Charlie	11	4	7	2
Boklu	38	11	11	1
Catlak	12	1	1	1
Boz[a]	45	10	16	2
Dehliz	87	51	73	3
Piramit[a]	14	10	16	3
Selale	1	1	1	1
Havuz	2	1	1	1

[a] Indicates breeding cave

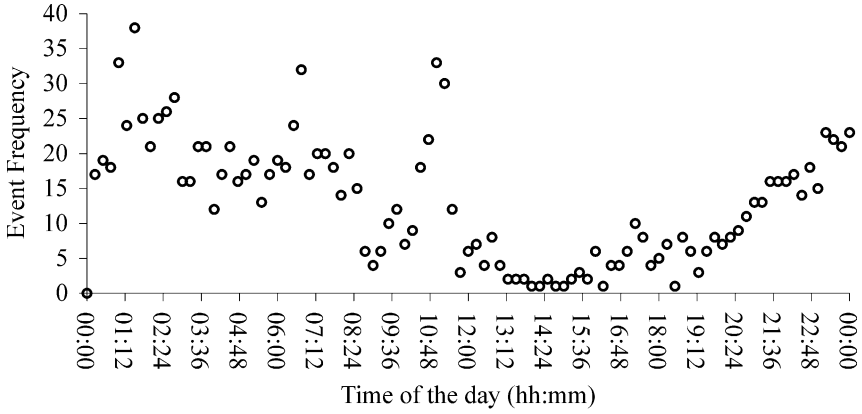

Fig. 5. Diel variation in the in-cave seal movements recorded in Cave Dehliz.

Table 6
The pups found in the Cilician Basin between 1995 and 2001

Seal ID	Sex	Birth date	Found on	Cave
I–P1	?	August–December 1994	30 July 95	Balikli
III–P1	F	August 1996	21 Aug 1996	Boz
III–P2	M	August–November 1996	15 November 1996	Boz
III–P3	M	August–November 1996	02 December 1996	Boz
III–P4	M	November 1997	09 November 1997	Boz
III–P5	F	October 1999	24 October 1999	Boz
IV–P1	F	August 1998	20 August 1998	Piramit
IV–P2	F	October.1999	23 October 1999	Piramit
IV–P3	M	August 2000	09 November 2000	Piramit
IV–P5	?	August 2001	29 August 2001	Piramit
IV–P4	?	August 2001	29 August 2001	Piramit

was calculated as 1.7 and maximum sightings at a time were four seal individuals.

The variations in monthly seal sightings are depicted in Fig. 6. The results of seal-watch operations followed a similar trend to those observed in the in cave surveys (PEc in Fig. 4). The lowest sighting per seal-watch (indicated by the columns) was obtained in January, and increased until December. There was again a remarkable drop starting from September to October but with delay for a month as compared with PEc values. The average number of seals per sighting (indicated by line) showed a sudden increase from April to May. During this month the maximum seals observed in a group (indicated by high–low bars) was the highest. In November and December although the percentage of sighting was at its maximum, the average number of seals in a group was low, indicating that the seals were no longer in large groups. As the averages and the maximum number of seals observed outside (Fig. 6) and inside (Fig. 4) the caves are compared, grouping was observed a month earlier in the cave.

3.3. Preliminary demographic evaluation

3.3.1. Identification of individuals

A total of 25 individuals were identified (Table 7). According to the estimated ages of the individuals and the categories defined by Samaranch and Gonzalez (2000), at the time the studies was accomplished there

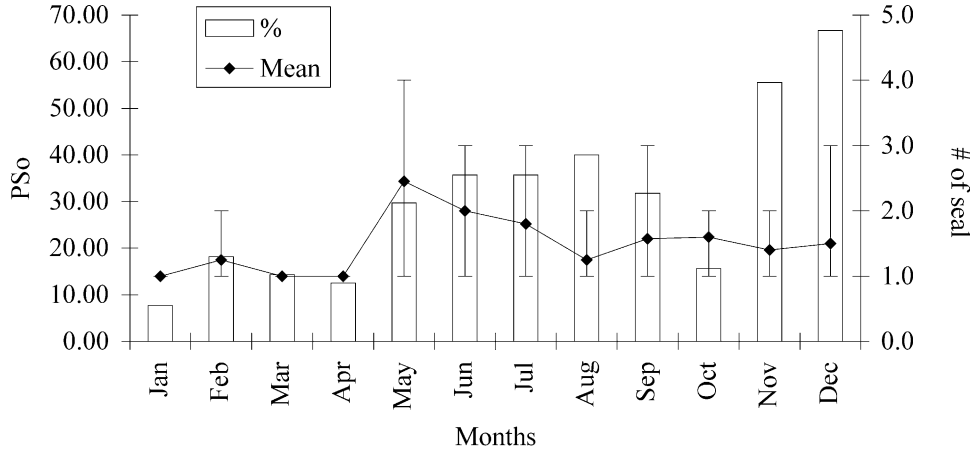

Fig. 6. Monthly distributions of the PSo (percentage of seal sighting out side the cave) and average number of seals per sighting; high-low bars indicate minimum and maximum number of seals in a group.

were 4 BAMs, 7 LGSs, 8 MGSs, 3 Js, and 2 Ps in the Cilician colony.

3.3.2. Evaluation of age/sex groups

The chart of the estimated age distribution of the Cilician monk seal colony is given in Fig. 7. The number of mature monk seal achieving sexual maturity at the ages of 7 through 9 are almost absent from the population.

3.3.3. Identification of reproductive sub-groups

The analysis of the observations in relation to the distribution of the monk seals in the Cilician Basin showed formation of sub-groups, selectively using certain caves (see horizontal dark lines in Table 8). The ranges of the sub-regions were assessed based on the location of these caves. Within each sub-region, the sub-groups using the area consisted of a single BAM, one or more adult females, and one or more sub-adults. The solitary seal, *X-X1*, was the only exception, observed only for a certain period, travelling singly from the eastern end to the western end of the entire study area. This seal was an older, large animal with grey pelage. Its sex could not be identified since the characteristics used in the sex determination (Table 3) were not present. Each of the sub-regional ranges, the total number of seal individuals using each sub-region and the sub-group category compositions are shown spatially on the site map (Fig. 8). There were no recorded monk seal observations in the eastern end of the study site, between Erdemli and Tasucu. The estimated numbers of seals in the sub-groups increase from East to West.

Table 7
Identified individuals of the Cilician monk seal colony, their sex, category and estimated age

Seal ID	Identified on	Sex	Categories at first encounter	Age (years)
I—M1	16-April-1995	M	BAM	14.7
I—F1	23-July-1995	F	LGS	13.4
I—P1	30-July-1995	?	Y	6.6
II—M1	19-August-1998	M	BAM	11.4
II—F1	11-October-1997	F	LGS	11.2
II—X1	11-October-1997	?	J	5.2
III—M1	10-May-1997	M	BAM	12.6
III—F1	24-April-1996	F	MGS	8.2
III—F2	04-August-1996	F	LGS	12.4
III—F3	21-August-1996	F	LGS	12.4
III—P1	21-August-1996	F	P	†
III—P2	15-November-1996	M	J	6.1
III—P3	02-December-1996	M	Y	5.2
III—P4	09-November-1997	M	P	4.1
III—P5	24-October-1999	F	P	2.2
IV—M1	24-August-1996	M	BAM	13.4
IV—F1	20-August-1998	F	LGS	10.4
IV—F2	13-March-1999	F	MGS	5.3
IV—P1	20-August-1998	F	P	3.4
IV—P2	23-October-1999	F	P	2.2
IV—P3	09-November-2000	M	Y	1.3
IV—P4	29-August-2001	?	P	0.3
IV—P5	29-August-2001	?	P	0.3
IV—X1	18-October-1998	?	J	4.2
X—X1	10-March-1998	?	LGS	10.8

BAM = Black Adult Male; LGS = Large Grey Seal; MGS = Medium Grey Seal; J = Juvenile; Y = Youngster; P = Pup; > = Deceased; ? = Unknown; ages at September 2001; † = Deceased; ? = Unknown; ages at December 2001.

4. Discussion

The results from this study of Mediterranean monk seal population has allowed us to characterize their critical habitat, define use patterns, and provide a preliminary demographic evaluation of the found in the Cilician Basin.

4.1. Whelping site

In the Cilician Basin, all monk seal pups were born in caves. This finding is consistent with reports of monk seal whelping sites in other parts of the Mediterranean and the Atlantic (Sergeant et al., 1978). Recent historical evidence, gathered from local fishermen indicates that monk seals parturition does not occur outside the caves. Some authors (Scoullos et al., 1994) believe that the monk seal was forced to abandon beach habitat due to harassment, habitat destruction and human disturbance. Similar evidence for other species (e.g., Guadaloupe fur seal, *Arctocephalus philippi*) indicates that the females retreated from open beaches into caves for reproduction due to intense hunting and disturbance (Hubbs, 1956). On the other hand the nearest surviving congeneric, the Hawaiian monk seal *Monachus schauinslandii* still breeds mainly on beaches (Gilmartin and Eberhardt, 1995). In the case of the Cilician colony, cave preference for whelping may be due to anthropogenic as well as geographic factors. The Cilician basin is characterised by ruggedness with steep mountains and

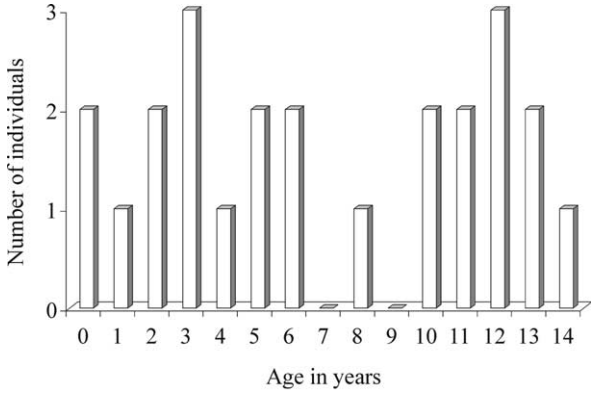

Fig. 7. Estimated demographic structure of the seals in the Cilician Basin.

shoreline cliffs plunging into the Mediterranean. Remote and isolated beaches are not common in the region and those that exist have been inhabited by humans for centuries. Thus, in the Cilician coast caves probably have always provided a more suitable whelping and nursing habitat for seals, especially after beaches became heavily used by humans.

4.2. Whelping location

Only three of 39 caves discovered along the Cilician coast were found to be used for whelping and 16 caves were used for hauling-out (active cave). Features common to all breeding caves included: an entrance with a barrier against strong waves; a deep and wide beach located at the very far end; and a shallow pool in front. The cave floor texture also gradually changed seaward from coarse gravel to fine sand. These features seemed to be the distinguishing cave characteristics, which provided a safe and suitable whelping and nursing habitat. Whelping did not occur in all active caves, probably because they lacked a beach and/or a pool inside and protection against storms and strong waves. In active caves, seals only hauled-out and slept on the narrow and flat rock platforms. Furthermore, the presence of a protected pool inside all the breeding caves provided a safe area for neonates to learn how to swim and to keep cool during warm weather conditions.

4.3. Seasonal patterns of habitat use

4.3.1. Whelping season

According to birth records all around the Mediterranean Sea, Sergeant et al. (1978) previously defined the seasonal range of whelping extending over the months between May and November, with a peak in September and October. Overall, this range gained wide acceptance (Scoullos et al., 1994; King, 1983; Jacobs and Panou, 1988; Dendrinos et al., 2000) but could represent regional differences. Gazo et al. (1999) reported the lack of well defined whelping period for the monk seals in the Atlantic, western Sahara Mauritania and suggested the lack of variability was due to stable environmental conditions and constant food availability.

Eleven monk seal pups have been born in the Cilician Basin between 1994 and 2001. All births were recorded between August and November (Table 6). The information presented here, although based on statistically very small sample size and need further continued monitoring to detect possible regional differences, encouraged us to postulate that Cilician colony has a definite and a relatively confined whelping season when

Table 8
The active caves and their usage by each of the identified seal (marked by X sign)

Seal ID / Caves	Balikli	Besparmak	Soguksu	Charlie	Dehliz	Boz	Boklu	Makale	Piramit	Havuzlu	Selale
I- M1		***X***									
I- F1	*X*										
I- P1	X										
II- M1			***X***	***X***							
II- X1				X							
II- F1				X							
III- M1					***X***		***X***				
III- F1					*X*	*X*	*X*				
III- F1					*X*	*X*	*X*				
III- F3					*X*	*X*	*X*				
III- P2					X	X	X	X			
III- P3					X	X	X				
III- P4					X	X	X				
III- P5					X	X					
IV- M1									***X***		
IV- P1									X		
IV- F1											X
IV- P1									*X*		
IV- P2									X		
IV- P3									X		
IV- P4									X		
IV- P5									X		
IV- X1										X	
X- X1	Not sighted within a cave. Observed all along the basin										

Seal names in underlined bold indicate BAMs and the names in Italic represent female LGSs. The horizontal dark lines indicate presumed subgroups and vertical dark lines show sub-regions.

compared with the rest of the Mediterranean and especially to the Atlantic populations. Based on larger sample size Dendrinos et al. (2000), reported more protracted whelping season in North Sporades (July–December).

A more confined seasonal range was observed for the colony inhabiting the Mediterranean coast of Turkey. Mursaloglu (1991) reported two births, from the Turkish coast of the Central Aegean: a male in October 1980 and a female in September 1981. Four other births were reported from the same area: three were in October 1997, 1998, 2000 and one in November 1999 (Guclusoy and Savas, 1997; Guclusoy, 2000; Guclusoy and Kence, 2001; Veryeri et al., 2001). There are no additional records of births outside this four-month range.

The seasonal occurrence of whelping in the Cilician colony may be associated with variations in environmental factors, which optimise survival of offspring. The timing and duration of pinniped reproduction is likely constrained by key environmental factors such food and temperature (Riedman, 1990, Goldsworthy and Slaughnessy, 1994, Gazo et al., 1999). The Cilician Basin exhibits noticeable seasonal changes both in water/ambient air temperatures (Gucu, 1987) and in food availability with a coincident maximum in the breeding season of the colony (Bingel, 1987).

4.3.2. Seasonal cave use

In August and September, while the in-cave seal sightings dropped remarkably (Fig. 4), the out of cave seal sightings were quite frequent (Fig. 6). In many phocid species, breeding females that haul-out on land are known to feed very little during lactation, while expending tremendous amounts of energy nursing their pups. These animals depend on their fat stores and feed intensively before the start of reproduction (Riedman, 1990). The results of the Cilician colony study indicated increased out of cave activity before the whelping season probably linked to an intensive feeding attempt by the females in order to store energy during the prenatal period.

In October, which coincides with the whelping season, the above situation was reversed; the in-cave sightings reached a peak while the out of cave seal sightings decreased. For the following three months the number of in-cave sightings was associated with whelping and the period of maternal care. It was not determined in this study if post-parturient females fast during lactation, and for how long before they begin alternating nursing with feeding trips. Monk seal females at the Cap Blanc colony start alternating feeding and nursing behaviour a few days after birth for over four months (Gazo et al., 2000). In the Aegean, Mursaloglu (1984)

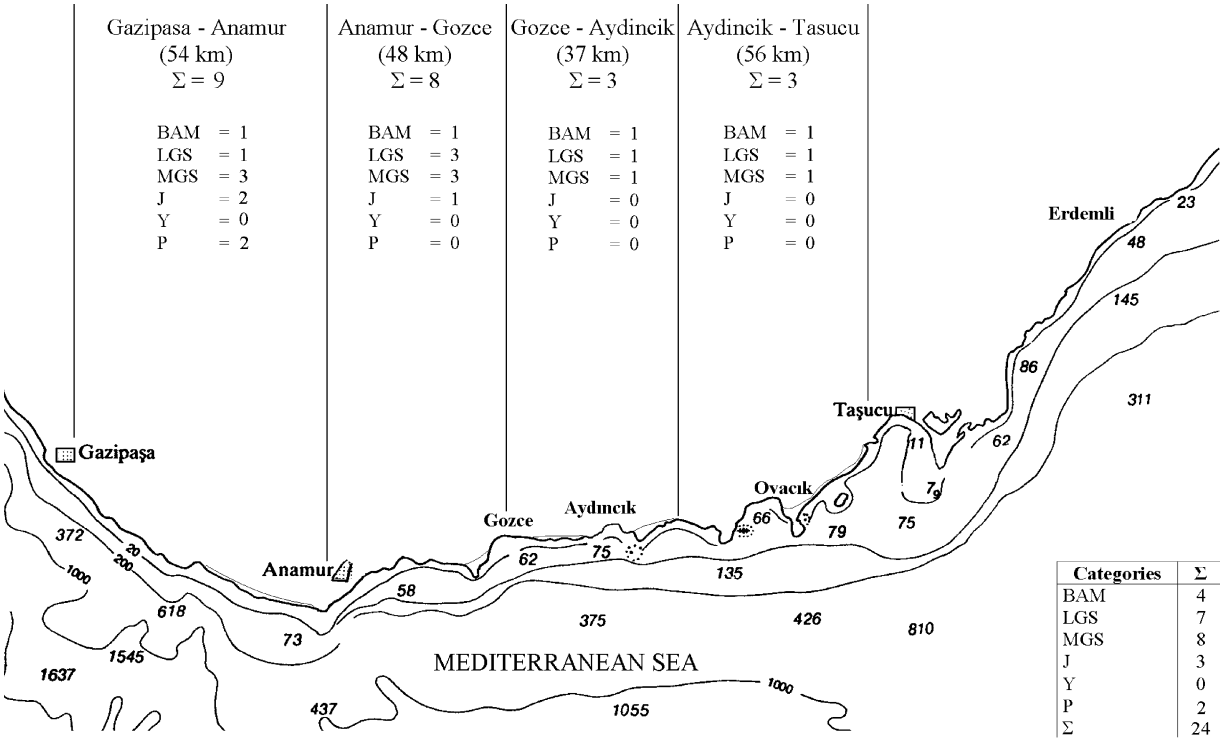

Fig. 8. Distribution of the seals along the Cilician Basin with the arbitrary ranges of the sub-regions, the total number of seal individuals using each sub-region and the sub-group category compositions. The data presented on the bottom right corner summarises the total numbers of seals in each category.

observed the mother starting to leave the cave for short diurnal feeding trips only after the second week.

The following months of November and December are when the season starts to turn into winter. The prevailing winds gradually change direction from the summer Westerlies into the winter Easterlies. The change in the wind direction does not affect two of the active breeding caves, namely *Balikli* and *Piramit*, with south-facing entrances. However the third one, *Boz* is affected due to its location on the eastern side of a cape. During the summer it is sheltered against the Westerly winds, but by the end of the whelping season its entrance becomes extremely exposed to the winter Easterlies. Cave survey results indicated that compared with the other two breeding caves, *Boz* seemed to be used mostly during the three months of the whelping season. At other times, seals were rarely observed in this cave (Fig. 3). It appeared that when the environmental variations disturbed the nursing habitat, the mother and the pup abandoned the breeding cave and moved to *Dehliz*. This cave is located 10 km on the other side of the cape and is sheltered throughout the year. In *Dehliz*, high percentages of seal sighting were recorded all year round. Thus, the movement by the mother and her pup into a more sheltered cave was confirmed with the direct in-cave observations and explained why *Boz*, though being a breeding cave reflected very low percentages of seal sighting; even lower than the adjacent non-breeding cave, *Dehliz* (Fig. 3).

In winter between January and February, during heavy weather and storms, the number of seal sightings both inside and outside the cave dropped considerably (Figs. 4 and 6). This was primarily due to high waves making the recognition of the seals by the observer difficult during the seal-watch operations. Similarly, harsh sea conditions did not permit cave surveys.

Between March and May, seals were observed in groups of up to four individuals, consisting of the new youngster, its mother and other juveniles of different ages. From time to time, other seals, mostly a MGS, joined the group. During this period, the group was continuously monitored with infrared monitors and was observed to leave the cave after sunrise and return before sunset (Fig. 5). Former studies on the diel rhythm of the monk seals failed to present a consistent pattern. Sergeant et al. (1978), based on field observations made by himself and Moroccan fisherman, reported high activity in early morning and in the evening. Other direct and indirect in-cave observations on a single male in the Ithaca channel, however, presented an irregular pattern of activity (Hiby et al., 1987; Panou et al., 1993). Mursaloglu (1984) reported lactating seal regularly left the cave once in the morning and once after 13:00, and sometimes at twilight returning at dusk, during the nursing period. Compared with these former investigations, the present study of the Cilician colony presents a more comprehensive investigation in terms of the number of seal individuals involved, the number of caves studied, and the extent of study time. Therefore, the results may be a better presentation of the monk seal's behaviour and for the Cilician seal colony showed diurnal activity pattern.

4.4. Age/sex structure and habitat partitioning

Repeatedly observing identified seals in certain locations, and in certain groups, indicated possible habitat partitioning (sub-regions) and sub-grouping amongst the monk seals in the Cilician Basin. Depicted in Table 8 and Fig. 8, there were four sub-regions in the area. The boundaries of these sub-regions were arbitrary and usually the margins coincided with heavily urbanised fragments of shore, like Anamur and Gozce. With one exception (Gozce–Aydincik), a breeding cave as well as one or more active caves were confirmed in each sub-region. Although lacking sufficient evidence, the occurrence of an entangled pup in 1994 (Yediler and Gucu, 1997), a possibly pregnant female and repeated observations of an adult male indicated the cave *Charlie* may be used for whelping.

The estimated home ranges of adult males, although arbitrary, varied between 37 and 56 km. These agreed with the 40 km home range for the Yalikavak group in the Aegean Sea proposed by Berkes et al. (1979). Within the range of a single adult male, the rest of the individuals tend to gather into small and separate groups. Each group was then observed using only certain caves within each of the sub-regions. This sub-group structure (a single adult male with one or more reproductive females using selectively the same caves) may resemble a form of polygyny. Although this is the first study questioning the possibility of a polygynous social system in the Mediterranean Monk Seal, it is a known phenomenon in other pinnipeds (Riedman, 1990). The majority of the data used to define subgroups came from cave surveys. Although members of the sub-groups classified in Fig. 8 and Table 8 never observed outside their respective sub-regions, there were no further evidences to claim that the sub-groups were rigidly segregated and that they never moved into the neighbouring sub-regions along the coastline.

Habitat partitioning by sub-groups exclusively using certain caves, the presence of home ranges for each of the BAMs, and the presence of a single BAM per social group were indicators of territorial behaviour. It is known that territories are generally formed for three reasons; foraging, mating and resting site (Odum, 1971). Also, a home range may become geographically identical to a territory at some part of the year, commonly during or prior to breeding with an important spacing role in many vertebrates (Colinvaux, 1993). In the Mediterranean monk seal foraging and mating are

aquatic while parturition is terrestrial. Although, aquatic territories by adult males were reported earlier for the Cap Blanc colony (Pastor et al., 1998), no supporting evidence, such as defence behaviour, of territories at sea was observed or reported during the study in the Cilician Basin. In Cap Blanc population, large groups containing several adult males, share a single cave where whelping takes place representing rather different in-cave behaviour. In the Cilician Basin, although the coast is karstic limestone and suitable for cave formation (Anon., 2000), as compared with Cab Blanc, the caves suitable for breeding (see above) are few and the existing ones are not large enough to hold more than one or two females. It, therefore, seemed that the number and size of suitable caves were limiting factors for reproduction success. The major reason for the formation of sub-regions used by discrete sub-groups was for the breeding site.

4.5. A colony in decline

Whelping was uninterruptedly observed every year throughout the study period. Therefore it is evident that there is no risk on viability of the colony. The calculated demographic structure presented in Fig. 7, however, illustrates an abnormal pattern with a few missing year-classes. Absence of 7 and 9 year classes in the colony may indicate a possible stress on the colony which ceased reproduction just before the onset of this study.

Estimated annual birth rate of the Capo Blanco colony ranged from 0.30 to 0.43 (Gazo et al., 1999). The authors noted that, compared to the other pinniped populations, Mediterranean monk seal represent extremely low birth rate. Since 1994, 11 pups were found in the present study. As the demographic structure of the Cilician colony is considered (Fig. 8) there are at least six sexually matured females. Thus, overall, annual birth rate is 0.23. This value is remarkably lower than the range given for the Capo Blanco colony, indicating that the factor(s) decreasing reproductive capability of the Cilician colony still exits. Low natality rate may be an intrinsic property of the species, however comparison of these two studies gives an impression that colonies with larger size have higher birth rates.

In 1994, six seals, including three BAM were found dead in the Cilician Basin (Yediler and Gucu, 1997). With this significant loss (32%) from in such a small sized colony, Allee (*underpopulation*) Effect which occurs when densities become so low that it is difficult for individuals to interact in some essential ways, may perhaps come into being (Kokko and Sutherland, 2001). The per capita birth rate may possibly decline at low densities because of distorted sex ratios and the increased difficulty of finding a mate. Polygynous and territorial male behaviour, observed in the colony may intensify the consequences of Allee Effect. Loss of a dominant male of a subgroup leads to overall failure of breeding in the respective group.

External environmental and other anthropogenic forces may also be responsible of low birth rate. Israels (1992) underlines two major threats that may reduce monk seal reproduction: pollution and lack of food. Pollutants, which may adversely affect reproductive success, such as heavy metals, PAH, and PCB's and insecticides, were not found in high concentration in the region (Kideys and Salihoglu, 1988; Kideys and Unsal, 1988; Yilmaz et al., 1991;Yediler et al., 1993). However, Kompanje et al., (2000) called attention to evidence of chronic lack of food in seals in the Aegean Sea. The increase in the industrial fishing power in the Cilician Basin and the subsequent reduction in the total catch of main target species is in an alarming level (Gucu and Erkan, 1999). The lack of food may therefore be linked to low reproduction rate and should be seriously considered as a threat to the survival of the colony.

5. Recommendations on Cilician Basin conservation strategy plan

Using the sparse but only data available on the habitat use and preliminary demographic evaluation of the Cilician Basin monk seal colony, the following high priority management and research needs for the conservation of the species were recommended.

In the Basin, consistent with monk seal behaviour in other parts of the Mediterranean, whelping occurred strictly in caves. Caves suitable for this purpose seemed to have distinct characteristics that separated them from other types. They are, therefore, very rare and in the study area, amongst 39 caves discovered, only three were used for whelping. It was also observed that detected home ranges of Black Adult Males (BAM) included at least one of these breeding caves in its territory, which was selectively used by his respective sub-group. This finding enhanced the significant role of the breeding caves, especially in effecting the distribution and the reproductive sub-grouping of the colony. Therefore, spatial distribution of these caves was thought to be an essential guide for the selection of high priority areas that are in need of strict habitat protection.

Furthermore, from six pups born in a colony adjacent to the Cilician, four died due to entanglement and one was rescued from the net (Guclusoy, personal communication). All the incidences were in front of or in the very near vicinity of breeding caves and indicated that the main cause of pup mortality in regions under heavy fishing pressure is incidental catch due to entanglement in fishing gear. Vulnerability to any form of human disturbance was especially heightened during the

first 6 months following birth. In these months, small groups were formed in and around the breeding cave where exploration, development of foraging skills and social bonding of pups and youngsters occur. Thus, emphasising the need for the development of protected areas especially in front of the caves to avoid the risk of entanglement to fishing gear. It is evident that protecting breeding caves as well as their respective coastal waters, not only during the whelping season but also during the following period of pup development throughout the year, is of primary importance for the survival of the species.

Fish stocks depleted as a consequence on heavy fishing pressure in another threat to the seals. It is also known that as food resource decline both in quantity and quality, the seals are forced to become more opportunist and feed on trapped fish from gill nets (Cebrian et al., 1990; Salman et al., 2001). Hence, the risk of getting entangled in a fish net and the enmity between seals and the owners of the fish net intensifies.

If no protective measures are taken, the further consequences of this decline on the survival of the monk seal species could be threefold. It would threaten them directly through decreased breeding success and through starvation, and also indirectly through deliberate killings by local fishermen who depend on the same resource. Thus, in addition to selecting special sites for habitat protection, a resource management plan aiming to secure food availability and sustainable fish stock use by artisanal fishermen are essential for an ecosystem based approach.

In guidance of the data collected on the biology of the Cilician monk seal colony, a Marine Protected Area, with two different zones, encompassing a number of small core zones is recommended. One of the main objectives of the Protected Area is to ensure successful reproduction. Therefore, the position and the number of breeding caves used by the seals should guide the selection/assignment of location and the number of core zones. This core zone(s), as also recommended by Berkes et al., (1979), should be an area where all uses and human activities, especially gill net fishery, should be banned. Since the major cause of pup mortality is incidental catch by fishing nets, exclusively by those set at the bottom, the offshore limit of this zone should be based on the diving ranges of 0 to 1 year old seals to significantly reduce the risk of their entanglement. Therefore further studies are needed on diving behaviour of pup and youngsters.

As a possible threat to breeding success, lack of food should not be overlooked. Reducing the existing fisheries pressure on the feeding ground of the seals and securing their food resources is of great importance for the survival of the species. In addition to the core zone, fishery regulation zone covering the entire extent of the sub-regions is therefore recommended.

6. Conclusion

Considering that the best estimate of the Mediterranean monk seal population size is a figure not more than 400–500 individuals in the world, the successfully breeding colony living along the Cilician Basin is highly important for the survival of this species. The whelping occurred throughout the study indicated that the breeding season is confined to the period between August and November. The results also presented a polygynous and territorial behaviour, adult males partitioning the suitable breeding caves which have peculiar characteristics and very rare. In this study, therefore the most important factor threatening the fate of the colony was found to be the number of suitable breeding caves along the coast that still remained undisturbed from human intervention.

The monk seal is an indicator species that reflects the plight of the Mediterranean Sea. Recovering the monk seal and protecting resources critical for its survival such as the fish stocks requires an ecosystem approach toward conservation management.

Based on the results, a Marine Protected Area is recommended for the conservation of the Mediterranean monk seal in the Cilician basin. Breeding caves and their respective coastal waters are designated core zones of habitat protection in which all human uses should be prohibited.

In a modern era where co-existence of man and monk seal is almost impossible, the fate of the Cilician monk seal colony depends largely on how much of the Mediterranean we are able to reserve for their exclusive use.

Acknowledgements

This work would have never been completed without the financial support of the following organisations over the years; WWF (World Wide Fund for Nature) International, United Nations Development Programme (UNDP), The Royal Netherlands Embassy, Office of the Counselor for Agriculture, Nature Management and Fisheries, Turkiye Is Bankasi, The PADI Foundation (USA), The Scientific and Technical Research Council of Turkey (TUBITAK). We are indebted to Dr. Ayfer Yediler and Dr. Luigi Guarrera for their invaluable contribution and their effort in the initiation of the project. We would also like to express our heartfelt gratitude to the many people who have helped us along the way, but especially to those who volunteered with us in the field, to the intern students and to many graduate students from the Middle East Technical University, Institute of Marine Sciences, in particular to Funda Erkan. We are also indebted to Ferit Gure and Ufuk Sarac and the members of the Underwater Research Society, the Monk Seal Research Group, specifically to

Ahmet Bolat, Yalcin Savas for their invaluable efforts throughout the study. We would like to thank to Dr. R. A. Griffiths from the University of Kent, Durrell Institute of Conservation and Ecology, and to Dr. P.J.H. van Bree from the University of Amsterdam, Institute for Taxonomic Zoology/Zoology Museum for the valuable critics on the manuscript. Also to Rebecca and William Boyd-Wallis for the linguistic corrections. Finally, our greatest gratitude goes to the Mediterranean monk seals of the Cilician coast that endure the human hostility up until this era and by their very existence, encourage us to believe we still have hope to reverse the plight of the Mediterranean Sea back to its healthy state.

References

Anon., 2000. Karst 2000 Guide Book, Hacettepe University International Research and Application Centre for Karst Water Resources.

Berkes, F., Anat, A., Esenel, H., Kislalioglu, M., 1979. Distribution and ecology of *Monachus monachus* on Turkish coasts. In: Ronald, K., Duguy, R. (Eds.), Mediterranean Monk Seal. Pergamon Press, England, pp. 113–127.

Bingel, F., 1987. Quantitative analysis of the coastal artisanal fishery in the eastern Mediterranean, Unpublished report to Turkish Ministry of Agriculture and Rural Affairs (in Turkish).

Cebrian, D., Fatsea, H., Mitilincou, C., 1990. Some Data on Biometry and Stomach Content of a Mediterranean Monk Seal Found in Santorini Island (Greece) Rapports et Proces-Verbaux des Reunions Commission Internationale pour L'Exploration Scientifique de la Mer Mediterranee. .

Colinvaux, P., 1983. Ecology 2. John Wiley & Sons, New York.

Dendrinos, P., Kotomatas, S., Tounta, E., 1996. Monk Seal Pup Production in the National Marine Park of Alonissos—N. Sporades. International Zoological Congress of the Hellenic Zoological Society, Athens, Greece.

Dendrinos, P., Tounta, E., Kotomatas, S., 2000. A field method for age estimation of Mediterranean monks seal pups. The Monachus Guardian 3 (2), 72–74.

Gazo, M., Aparicio, F., Cedenilla, M.A., Layna, F.J., Gonzalez, L.M., 2000. Pup survival in the Mediterranean monk seal (*Monachus monachus*) colony at Cabo Blanco Peninsula (Western Sahara-Mauritania). Marine Mammal Science 16 (1), 158–168.

Gazo, M., Layna, J.F., Aparicio, F., Cedenilla, M.A., Gonzalez, L.M., Aguilar, A., 1999. Pupping season, perinatal sex ratio and natality rates of the Mediterranean monk seal (*Monachus monachus*) from the Cabo Blanco colony. Journal of Zoology London 249, 393–401.

Gilmartin, W.G., Eberhardt, L.L., 1995. Status of the Hawaiian monk seal (*Monachus schauinslandi*) population. Canadian Journal of Zoology 73, 1185–1190.

Goldsworthy, S.D., Slaughnessy, P.D., 1994. Breeding Biology and haul-out of the New Zealand fur seal. *Arctocephalus forsterii* at Cape Gantheaume. South Australia Wildlife Research 21, 365–376.

Guclusoy, H., 2000. Pup drowns on Karaburun. The Monachus Guardian. International Marine Mammal Association Inc. Guelph, Ontario, Canada Available:http://monachus.org/mguard05/05mednex.htm#Turkey.

Guclusoy, H., Kence, A., 2001. Foca OCKA'nda Akdeniz foku koruma calismalarinin verimliliginin degerlendirilmesi. In: Özhan, E., Yuksel, Y., (Eds.), Turkiye'nin Kiyi ve Deniz Alanlari III. Ulusal Konferenasi, Turkiye Kiyilari 01 Konferenasi Kitabi; 26-29 Haziran 2001; Ýstanbul, pp.345–355.

Guclusoy, H., Savas, Y., 1997. The Current status of the Mediterranean monk seal *Monachus monachus* (Hermann, 1779) in Foca Protected Area, Turkey. In: Özhan, E., (Ed.), Proceedings of the Third International Conference on the Mediterranean Coastal Environment, MEDCOAST. 11–14 November 1997. Qawra, Malta, pp.51–59.

Gucu, A.C., 1987. Zooplankton Dynamics in the Northern Cilician Basin. Composition and Time Series. MSc thesis Middle East Technical University, Institute of Marine Sciences. Erdemli, Icel, Turkey.

Gucu, A.C., Erkan, F., 1999. Preliminary survey report of the monitoring project on the recovery rate of a once deteriorated ecosystem recently designated as a protected area—Phase I. Detrimental Effects Of Trawl Fishery On The Fish Stocks On A Narrow Continental Shelf. Unpublished report to Turkish Ministry of Agriculture and Rural Affairs (in Turkish).

Harwood, J., Lavigne, D., Reijnders, P., 1998. Workshop on the causes and consequences of the 1997 mass mortality of Mediterranean monk seals in the western Sahara Amsterdam 11–14 December 1997. IBN Scientific Contributions 11, 1–32.

Hiby, A.R., Panou, A., Jeffery, J.S., Parkes, R., Arapis, T., 1987. Results of surveys in Kefalonia and Techniques for monitoring abundance. In: Harwood, J. (Ed.), Population Biology of the Mediterranean monk seal in Greece. Natural Environmental Research Council, Sea Mammal Research Unit, Cambridge, England, pp. 19–39.

HSSPMS, Continuation of the monitoring of the monk seals in the National Marine Park of the Northern Sporades, 1995. Final report for the European Commission Project 4-3010 (92), 7829.

Hubbs, C.L., 1956. Back from oblivion. Guadalupe fur seal: Still a living species. Pacific Discovery 9 (6), 14–21.

Israels, L.D.E., 1992. Thirty years of Mediterranean monk seal protection, a review. Nederlandsche Commissie voor internationale natuurbescherming. Mededelingen 28, 1–65.

IUCN/UNEP, 1998. The Mediterranean monk seal. In: Reinjders, P.J.H., de Visscher, M.N., Ries, E., (Eds.). IUCN, Gland, Switzerland, 59p.

Jacobs, J., Panou, A., 1988. Conservation of the Mediterranean monk seal, *Monachus monachus*, in Kefalonia, Ithaca and Lefkada Isl., Ionian Sea, Greece, Report to the Insitut Royale des Siences Naturelles de Belgique, Project A.C.E. 6611/28.

Kideys, A.E., Salihoglu, I., 1988. Polychlorinated biphenyls in the sea water off Erdemli- Cilician Basin Rapports. Commission Internationale pour L'Exploration Scientifique de la Mer Mediterranee, Monaco 31 (2), 142.

Kideys, A. E., Unsal, M., 1988. Seasonality of PCBs in plankton off Erdemli, North-eastern Mediterranean. Environmental Sciences and Technologies Conference. 5–9 June 1988, Izmir-Turkey.

King, J.E., 1983. Seals of the world. British Museum (Natural History), London.

Kokko, H., Sutherland, W.J., 2001. Ecological traps in changing environments: Ecological and evolutionary consequences of a behaviourally mediated Allee effect. Evolutionary Ecology Research 3, 537–551.

Kompanje, E.J.O., Guclusoy, H., van Bree, P.J.H., 2000. Insufficient calcium intake as a possible cause of osteoporosis in an adult female monk seal *Monachus monachus* from Cesme, Turkey. The Monachus Guardian 3 (1), 27–28.

Marchessaux, D., Muller, N., 1985. Le Phoque Moine, (*Monachus monachus*): Distribution, Status et biologie sur la Cote Saharienne. Parc National de Port Cros.

Marchessaux, D., 1989. The Biology, Status and Conservation of the Monk Seal, *Monachus monachus*. Final Report to the Council of Europe. Nature and Environment Series 41. Strasbourg.

Mursaloglu, B., 1984. The survival of Mediterranean monk seal

(*Monachus monachus*), pup on the Turkish Coast. Annales de la Societe des Sciences Naturelles de la Charente-Maritime. Supplement 41–47.

Mursaloglu, B., 1991. Biology and distribution of the Mediterranean monk seal (*Monachus monachus*) on Turkish Coasts. Environmental Encounters Council of Europe Press, Strassburg, France 13, 54–57.

Neves, H.C., Pires, R.. O Lobo Marinho no Arquinpelago da Maderia, Parque Natural da Maderia.

Odum, E.P., 1971. Fundamentals of Ecology. W.B. Saunders Company, USA.

Panou, A., Jacobs, J., Panos, D., 1993. The endangered Mediterranean monk seal *Monachus monachus* in the Ionian sea, Greece. Biological Conservation 64, 129–140.

Pastor, T., Gazo, M., Aramburu, M.J., Cedenilla, M.A., Aparicio, F., Layna, J.F., Grau, E., Gonzalez, L.M., Aguilar, A., 1998. Reproductive parameters of the Mediterranean monk seal: new data for an old species. The World Marine Mammal Science Conference, Workshop on the biology and conservation of the world's endangered monk seals. Monaco, 19–20 January 1998.

RAC/SPA, 1998. Report of the Meeting of Experts on the Implementation of the Action Plans for the Marine Mammals (Monk Seal and Cetaceans) Adopted within MAP. UNEP(OCA)MED WG.146/5, 24 November 1998.

Riedman, M., 1990. Pinnipeds: Seals, Sea Lions, and Walruses. University Of California Press, Berkeley.

Salman, A., Bilecenoglu, M., Guclusoy, H., 2001. Stomach contents of two Mediterranean monk seals (*Monachus monachus*) from the Aegean Sea, Turkey. Journal of the Marine Biological Association of the United Kingdom 81 (4), 719–720.

Samaranch, R., Gonzalez, L.M., 2000. Changes in morphology with age in Mediterranean monk seals (*Monachus monachus*). Marine Mammal Science 16 (1), 141–157.

Scoullos, M., Mantzara, M., Constantianos, V., 1994. The Book-Directory for the Mediterranean Monk Seal (*Monachus monachus*) in Greece: Contract with the C.E.U., DG XI, 4-3010(92)7829.

Sergeant, D., Ronald, K., Boulva, J., Berkes, F., 1978. The recent status *Monachus monachus* Mediterranean monk seal. Biological Conservation 14, 259–287.

UNEP/MAP, 1998. Current status of Mediterranean monk seal (*Monachus monachus*) Population. Meeting of Experts on the Implementation of the Action Plan for Marine Mammals (Monk Seal and Cetaceans) Adopted Within MAP. Arta, Greece 29-31 October 1998 UNEP, Athens: 1-34p.

Veryeri, O., Guclusoy, H., Savas, Y., 2001. Snared and Drowned: Are Fishing Nets killing off a New Generation of Monk Seals in Turkey's Protected Areas?. The Monachus Guardian. International Marine Mammal Association Inc. Guelph, Ontario, Canada. Available:http://monachus.org/mguard07/07covsto.htm.

Yediler, A., Gucu, A.C., 1997. Human impacts on an ecological heritage—Mediterranean monk seal in the Cilician Basin. Fresenius Environment Bulletin 6, 1–8.

Yediler, A., Panou, A., Schramel, P., 1993. Heavy metals in hair samples of the Mediterranean monk seal (*Monachus monachus*). Marine Pollution Bulletin 26 (3), 156–159.

Yilmaz, A., Saydam, C., Ozturk, S., Salihoglu, I., 1991. Transport of dissolved/dispersed petroleum hydrocarbons in the north-eastern Mediterranean. Toxicology and Environmental Chemistry 31–32, 187–197.