A holistic approach for the conservation of the Mediterranean monk seal on the Cilician coast of Turkey

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Summary

Ecological changes in the Kizilliman Marine Protected Area which was designated for the conservation of Mediterranean monk seal have been evaluated. The major parameters taken into consideration are *i*) the size distribution of the key trawl species, *ii*) changes in the daily catch records of the local artisanal fishermen, *iii*) Inside / outside MPA comparison of the diversity of fish in the near shore rocky habitats, and *iv*) annual breeding rate of the monk seal:

Key words

Mediterranean monk seal, conservation, fisheries regulations, MPA, Cilician coast

Introduction

Upon death of six Mediterranean monk seal in 1994, the Middle East Technical University, Institute of Marine Sciences (METU-IMS) conducted a brief survey on the world's one of the most endangered mammal inhabiting the North-eastern Mediterranean coast of Turkey and the north of the Cyprus Island where very little was known about this species. The outcome was surprising; 8 seals were identified and 21 caves bearing evidences of seal existence were discovered in the area. Further studies indicated that the colony was in danger. The demographic structure represented abnormal pattern with very low birth rate. The findings of the research on the biology and ecology carried out between 1994-1998 (Gucu et al., 2004) enabled to design a conservation strategy for the Cilician monk seal colony.

In the region, consistent with monk seal behavior 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

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area, amongst 39 caves discovered, only four were used for whelping. It was also observed that detected home ranges of adult males included at least one of these breeding caves in its territory, which was selectively used by his harem. This enhances the significant role of the breeding caves, especially in effecting the distribution and the reproductive success of the colony. Therefore, spatial distribution of the seal caves was used to select high priority areas that were in need of strict habitat protection.

As evidenced commonly, 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, emphasizing the need for the development of protected areas especially in front of the caves to avoid the risk of entanglement to fishing gear. Protecting the 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, was of primary importance for the survival of the species.

The fish stocks of the region (Gucu and Erkan, 2000) were depleted as a consequence on heavy fishing pressure. It is 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. The further consequences of this decline on the survival of the monk seal species were threefold. It 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 were 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 was establish on the coastal stretch given in Figure 1. 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 guided the selection/assignment of location and the number of core zones. These core zones, as also recommended by Berkes et al.,(1979) were designated as No-Take Areas where all uses and human activities, especially gill net fishery, were banned. Since the major cause of pup mortality was incidental catch by fishing nets, exclusively by those set at the bottom, the offshore limit of this zone was based on the diving ranges of pups to significantly reduce the risk of their entanglement. Hence, based on topography of the region 200 meters from the coast, where the depth exceeds 30 meters, was found appropriate.

Reducing the fisheries pressure on the feeding ground of the seals and securing their food resources was of great importance for the survival of the species. In addition to the core zone covering the breeding caves, the entire extent of the region, which embraces 16 n.miles coastal stretch, has been designated as fishery regulation zone. Within this zone, use of all

fishing types, excluding bottom long line and gill net owned by local small-scale fishermen, has been banned.

Figure 1. Conservation status on the Cilician coast (The Turkish Ministry of Culture - 1st Degree Natural Asset (1998); Turkish Ministry of Agriculture and Rural Affairs - Trawl and Purse Seine ban (1999); Turkish Ministry of Agriculture and Rural Affairs - Ban to all means of exploitation (1999); Turkish Ministry of Environment - Barcelona Convension Emerald Network – ASCI (2000); Turkish Ministry of Agriculture and Rural Affairs - Ban to Sports Fishing (2000))

Consequently, using the Mediterranean Monk Seal as the umbrella species embracing all the other components of this unique ecosystem under its canopy, Kizilliman Marine Protected Area, with a 16 nautical miles by 12 miles No-Trawling-Area, two 1 nautical mile by 0.1 mile No-Take-Zone, as well as a 75 km stretch of 1st Degree Natural Asset coast set for land protection, was established. This study evaluates the changes in the ecosystem during the post-protection period (1998-2004) and assesses responses of various ecosystem elements to the protection measures implemented in the area.

Material and Methods

To assess the recovery of the ecosystem 4 different parameters were used in the study.

The size distribution of the key trawl species: To monitor the consequences of fisheries regulations and changes in the state of the fish stocks, hence assess the availability of food to the seal, experimental trawl surveys have been carried out. *Mullus barbatus* is assumed to be an indicator species to the fish stocks on the sandy soft bottoms since it is the most common target species of the trawl fishery threatening to the fish stocks. The surveys have initiated following the designation of the protection and conducted twice a year before and after the fishing season. The length distribution of the *Mullus barbatus* in the catch was measured and evaluated.

Daily catch records of the local artisanal fishermen: Protection strategy applied in the area aims to increase the amount of the fish caught by the local small-scale fishermen, so that stop hostility towards seals. To assess the success, the catch of an artisanal fisherman has been recorded on daily basis. The catch was standardized according to the length and type of fishing device used.

Visual Fish Census: The diversity of fish in the near shore rocky habitats, which act as the main nursery grounds for the coastal fish species have been evaluated using the visual census technique described by Francour (). This work also aims to evaluate the effect of protection on the bio-diversity. A total 6 different sites have been visited and in each site 4 different transects were investigated.

Annual breeding rate of the monk seal: Birth rate of the colony is used as an indicator to evaluate how the seals react to the protection measures applied in the area. To estimate the rate, the caves discovered within the protected area were checked during the breeding season of the monk seal (August-December). Number of pups found in the caves was enumerated and the demographic structure of the colony was updated after breeding season using the formula given by Gucu et al. (2004). The number of adult females ready to whelp in a season and the number of pups reproduced is used to estimate annual birth rate of the seal colony.

Results

The size distribution of the key trawl species

The change in the length distribution of the *Mullus barbatus* between October 1983 and November 2004 was given in Figure 2. The first three data points on the figure represent the period of low fishery pressure when the trawl fleet of the country has not reached to the area due to lack of fishing ports. The mean size of the stock was around 13 cm with a relatively low variance. Towards the end of 1990's, the mean size of red mullet stock has been reduced dramatically, indicating that the parent stock was significantly reduced. Following the protection, the mean size of the fishes has steadily increased until May 2002. Then, a slight decreased has been observed, however the variance of the mean length has increased simultaneously. The high variance points to a wide length spectrum in the stock. It is also worth to note that the mean values after protection are higher then those sampled during the low fishing pressure period in 1980's.

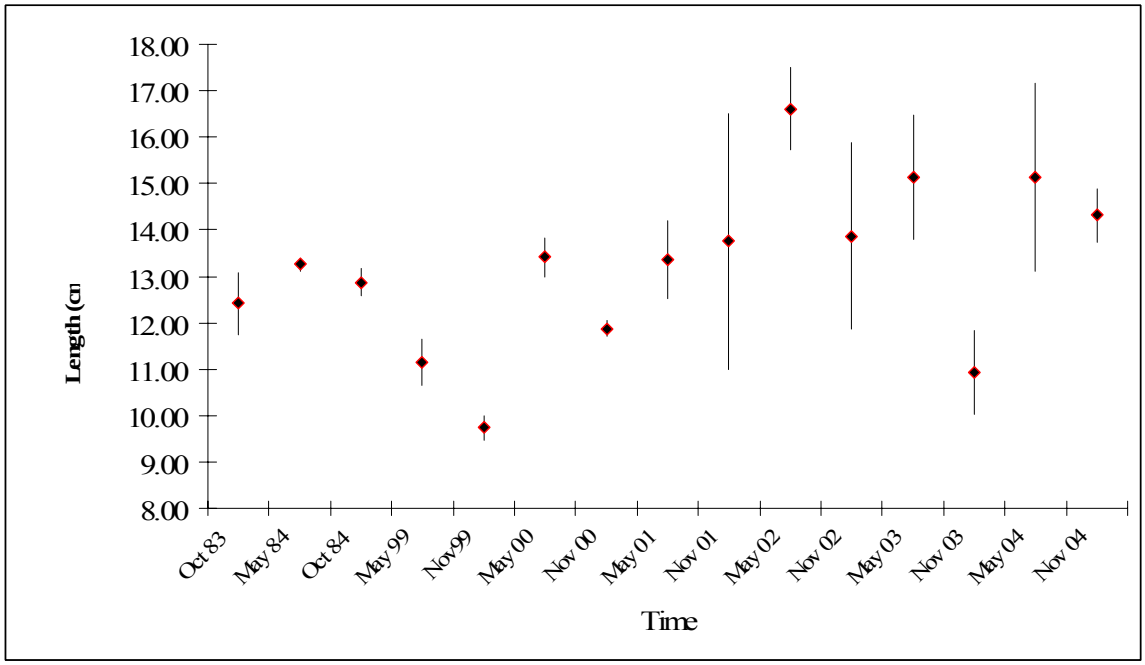

Figure 2. Time series of the mean length of the key trawl species, *Mullus barbatus*

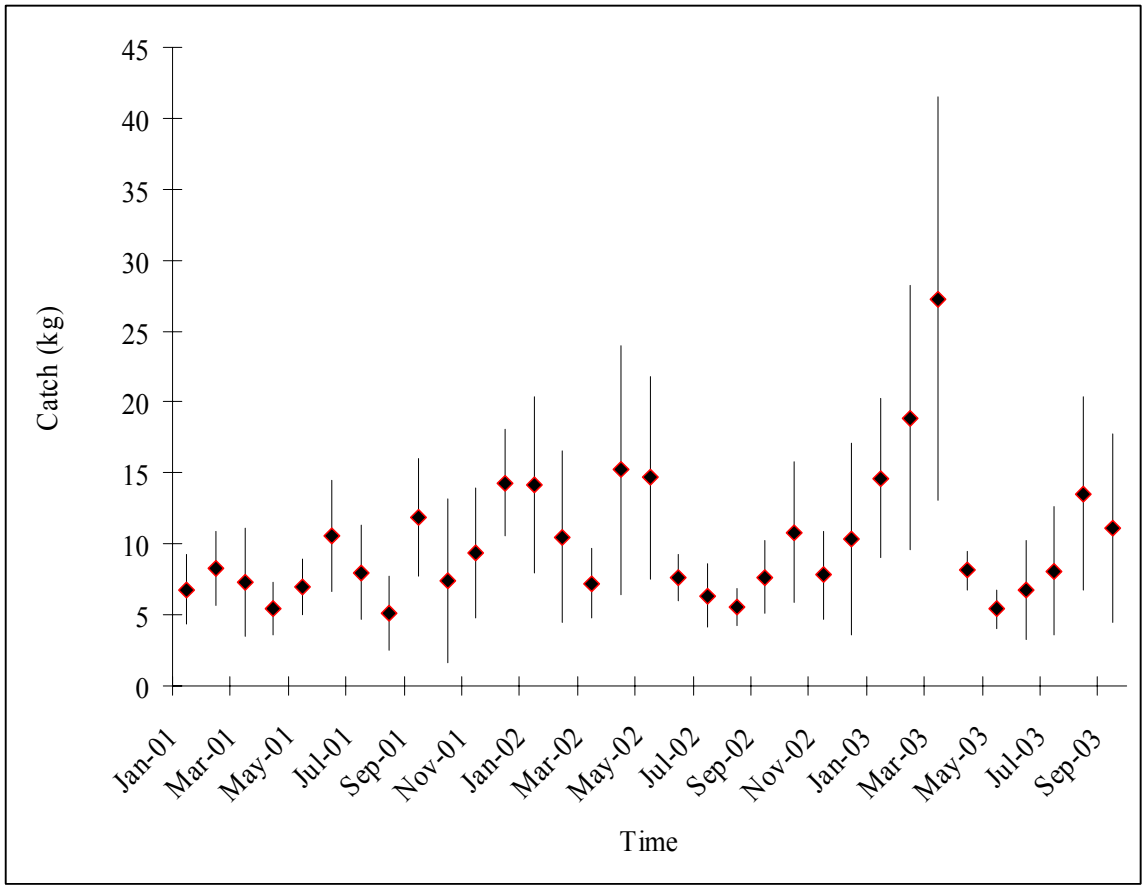

Figure 3. Monthly averages of the daily catch of a small scale fishermen (the bars indicate 95% confidence limits).

Daily catch records of the local artisanal fishermen

In the first year of the study, which is in fact 3rd year of the protection, the catch records were relatively stable (Figure 3). In the second year, variation between months was more noticeable. Also variance of the averages was strikingly high as indicated by longer bars on the figure. In the 3rd year, during spring, the catch values has attained to a very high value. When the data from 2001 and 2002 is compared, a 16% increase in the total yield of the fisherman has been observed. The increase from 2001 to 2003 is 50% (Figure 4).

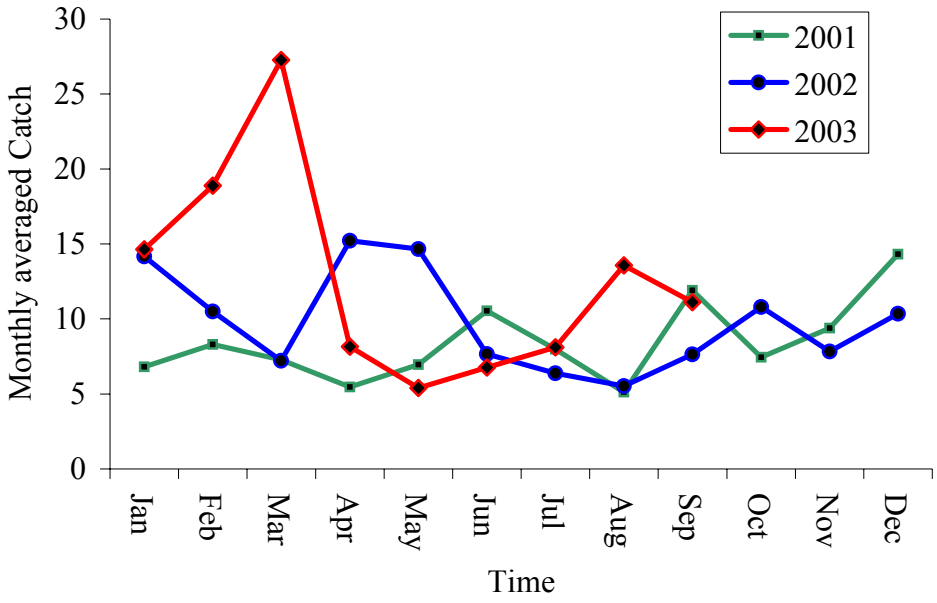

Figure 4. Comparison of the monthly averaged catch of a local small scale fishermen.

Visual fish census

The evaluation of the fish assemblages within the protected area and outside was depicted in figure 5. The sites named "Boz", "Akuakulture" and "Ahtapod" are located within the protected area; while "Sicamaz", "Toslaklar" and "Kizil-Bati" are not included in the protected zone. The stations outside the protected area have less diversity compared to those within the PA. When inside and outside transects were lamped together there is a remarkable difference in the cumulative values (see black and pink lines in Figure 5). Both lines leveled off through the end the study with 30 species differences.

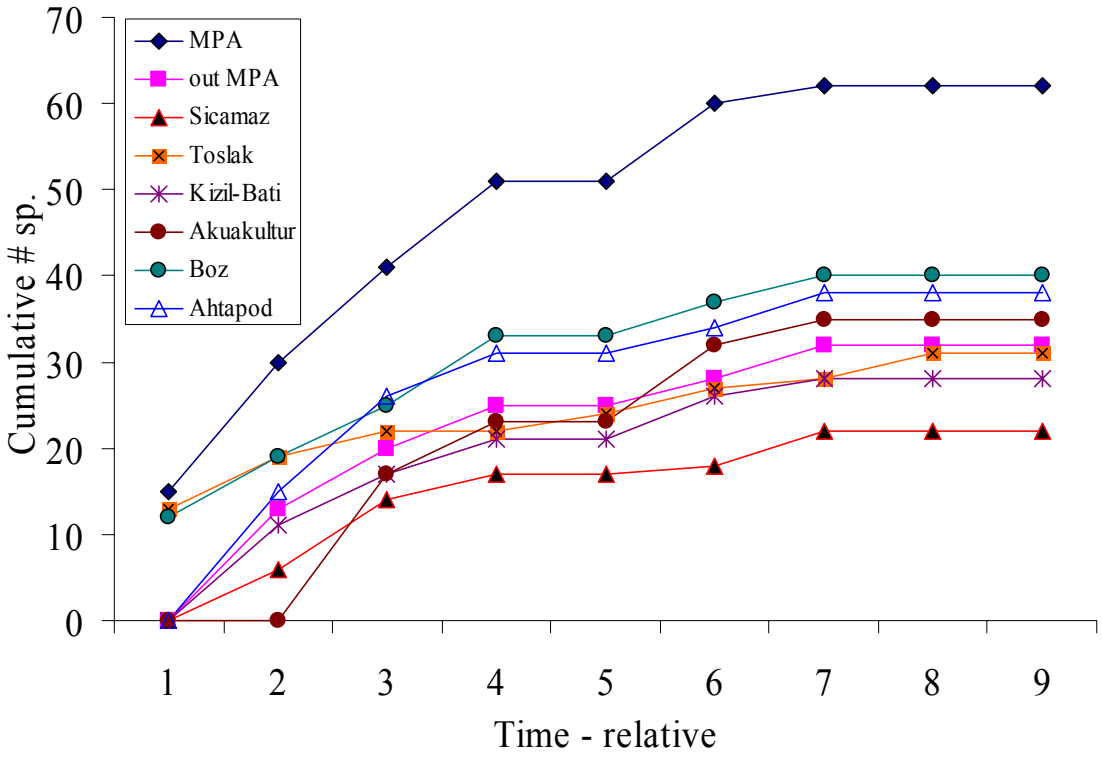

Figure 5. Cumulative number of fish species on the near coastal rocky habitat over time.

Annual breeding success of the monk seal colony

Table 1 summarizes the demographic structure in the monk seal colony inhabiting the Cilician coast. As most females reach sexual maturity at 5 years of age and have their 1st pup at 6 years of age (Scoullos et al.,1994), the females older than 7 years or attained to this age at the onset of the calendar year were assumed as potential mothers. Number of pups reproduced each year per potential mothers is the annual birth rate of the colony. Between 1998 and 2000, with 2 pups each year, the birth rate was estimated as 0.33. Unfortunately, in the breeding season of 2003 the study area has been fully surveyed. Therefore, although a juvenile has attained to sexual maturity, only one pup could be found during brief survey carried out within the breeding season. Therefore, it is not possible to explain the low whelping rate observed in 2003 since it is not clear whether this was due to insufficient surveying effort or there was a biological reason behind.

Finally in 2005, the number of pups has been increased and the annual birth rate has been doubled.

Table 1. Annual changes in estimated age distribution of the Cilician monk seal colony during the post protection period and the annual birth rate.

Individuals	Jan-98	Jan-99	Jan-00	Jan-01	Jan-02	Jan-03	Jan-04	Jan-05
F	12.45	13.45	14.45	15.45	16.45	17.45	18.45	19.45
F	11.41	12.41	13.41	14.41	15.41	16.41	17.41	18.42
F	11.36	12.36	13.36	14.37	15.37	16.37	17.37	18.37
F	10.22	11.22	12.22	13.23	14.23	15.23	16.23	17.23
M	9.72	10.72	11.72	12.72	13.72	14.72	15.72	16.72
F	9.37	10.37	11.37	12.37	13.37	14.37	15.37	16.37
F (died)	8.69	9.69	†	†	†	†	†	†
M	8.36	9.36	10.36	11.36	12.36	13.36	14.36	15.36
M	7.65	8.65	9.65	10.65	11.65	12.65	13.65	14.65
M	6.37	7.37	8.37	9.37	10.37	11.37	12.37	13.38
F	5.81	6.81	7.81	8.81	9.81	10.81	11.81	12.81
F	2.60	3.60	4.60	5.60	6.60	7.60	8.60	9.60
M	2.13	3.13	4.13	5.13	6.13	7.13	8.13	9.13
M	1.25	2.25	3.25	4.25	5.25	6.25	7.25	8.26
M	1.22	2.22	3.22	4.23	5.23	6.23	7.23	8.23
M	0.21	1.21	2.21	3.21	4.21	5.21	6.21	7.21
M	0.15	1.15	2.15	3.15	4.15	5.15	6.15	7.15
F (died)	†	†	†	†	†	†	†	†
M		0.81	1.81	2.82	3.82	4.82	5.82	6.82
F		0.37	1.37	2.37	3.37	4.37	5.37	6.37
F			0.19	1.19	2.19	3.19	4.19	5.20
F			0.19	1.19	2.19	3.19	4.19	5.19
M				0.32	1.32	2.32	3.32	4.32
F					0.34	1.34	2.34	3.35
M					0.34	1.34	2.34	3.35
F (died)						0.47	1.47	†
M						0.24	1.24	2.24
F							0.24	1.24
M (died)								†
F								0.26
?								0.09
F								0.08
?								0.02
∑ adult	9	10	11	11	11	13	16	18
∑ pups	2	2	2	1	2	2	1	5
∑ Female	6	6	6	6	6	7	7	7
Annual Birth rate	0.33	0.33	0.33	0.17	0.33	0.29	0.14 (?)	0.71

The mortality has reduced significantly, only 4 individuals were found death. These includes 2 pup died right after birth, a juvenile and a young adult drowned in the fish net.

Discussion

Pauly (1981) identifies three over-fishing phases; Growth over-fishing, occurs when the young fish that become available to the fishery (the "recruits") are caught before they can grow to a reasonable size. Recruitment over-fishing, occurs when the (parent) stock is reduced, by fishing to the extend that not enough young fish are produced to ensure that the stock will maintain itself. Ecosystem over-fishing occurs in a mixed fishery when the decline (through fishing) of the originally abundant stocks is compensated by the increase of non-exploitable animals. This is transformation of a relatively mature, efficient system into an immature (or stressed), inefficient system. The ecosystem of the Cilician basin is under the pressure of the Lessepaian species and therefore it is at great risk of ecosystem over-fishing. Recalling Figure 2, it is evident that the stocks were at recruitment over-fishing phase before fisheries regulations have come in to the force. However, the rapid increase in the mean lengths also indicates that the stocks were not entered into the last and irreversible Ecosystem Over-fishing phase. The wide length spectrum after protection is because the stocks hold good composition of small and large sized species. Having large sized individuals in the stock is a good sign for recovery yet to come soon; because large fish produce by far more ova than the small ones. Moreover, large fish produce larger eggs and the survival rate of the larvae hatched from large eggs are much higher than those hatched from small ones (Wootton, 1992).

Daily catch of the local fishermen represents irregular pattern with an average value not lower than 5 kg. These fluctuations are quite expectable within the internal dynamics of the local fish stocks. In general, the stocks of the eastern Mediterranean increase during spring due to recruiting young cohorts of Sparids. The second peak is observed in autumn when the juvenile Mullids settle (Bingel, 1987). Autumn, is the onset of the fishing season for the trawlers, therefore as the fish in the stocks are increasing on the one hand, a part is exploited by the fishery on the other. Depending on the pressure of the fishery on a region, the size of the stocks starts fluctuating. If the strength of the recruitment is sufficient enough, the stock size keeps increasing. However if the recruitment is not strong enough to cope with fishery, a decline is inevitable. In spring 2001, although the area had had been protected for 2 years, recruitment was not sufficient, which may indicate that the size of the parent stock in previous years was far below sustainable level. In a supportive agreement with the evaluation of the mean length distribution of the *Mullus barbatus*, the fish stocks were at the recruitment over-fishing phase before the protection. The effect of conservation, however, may be seen on year 2002, when the strength of the recruiting cohorts recovered the stocks. As also may be seen on Figure 2, the size of the individual fishes has increased significantly.

Local artisanal fishermen and the seals are the competing and threatening counterparts within the ecosystem. Both depend on the same resource. The seals damage the nets of the fishermen to eat the fish caught and the fishermen kill the seals to stop damaged incurred by the seals and also to reduce predation pressure on the stocks caused by the seals. The fisheries regulations applied in the area were in favor of local small-scale fishermen. Evidently their share in the stocks has been increased when the trawlers, purse seiners and all type of large scale fishing practices alike were excluded. Simply this helped stop the deliberate killing of the monk seal in the area. However, fish nets still pose a threat to sub-adults and young adults

although pups and youngsters are protected against fishing nets in front of their breeding habitats. .

Conclusion

The parameters examined to evaluate effects of conservation measures applied to protect Mediterranean monk seal, were all represented positive sign of recovery. The results proven that the survival of the Mediterranean monk seal requires holistic conservation approach addressing various ecosystem elements from fish to fisherman.

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