Preliminary evaluation of threats and possible mitigation actions for the natural re-colonization of the Mediterranean monk seal (*Monachus Monachus*) along the coast of Albania

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Internal report to the managing authority of the Marine National Park Karaburun-Sazan Regional Administrate of Protected Area -RAPA- Vlorë (AdZM), as beneficiary of the research study results.

In consideration of the sensitivity of the data reported none of the part of the present report should become publicly available without the contemporary consent of RAPA Vlorë and Archipelagos - ambiente e sviluppo, Italia.

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Introduction

Several threats have contributed to the reduction of population numbers and distribution of the Mediterranean monk seal (*Monachus monachus*) along its former habitat (Iraëls 1992) over the past centuries. However, over the last two decades seal sightings have been reported from most of the places where the presence was known or at least reported in the past, including Albania (Bundone et al. 2019a). This might represent a sign of recovery of the species (Notarbartolo di Sciara & Kotomatas, 2016). Within the frame of the project "*Sustainability, threats, presence and habitat use of the Mediterranean monk seal in Albania*" we conduct a preliminary assessment of threats that might act against the natural return and permanent presence of monk seals along this coast. Two possible threats were taken into consideration: anthropogenic pollution (plastic), and interaction with the fishery sector (particularly illegal fishing-dynamite fishing).

The project was designed to evaluate the potential threats that might affect the Mediterranean monk seals occurring on the Albanian coast aiming:

A) To assess the incidence of macroplastic accumulation in the environment of the study area (the National Marine Park Karaburun-Sazan, NMP K-S). The assessment has been carried out through visual analysis of the material accumulated inside marine caves (under monitor for the potential use by the Mediterranean monk seal);

B) Collection of debris accumulation at different beaches. Two beach cleaning events were programmed to be carried out involving the local community;

C) Organization of two workshops on assessing possible mitigations for the interaction of monk seals and fisheries (including the illegal fishery). The workshops were planned to include both the local citizens and stakeholders;

D) Collection of water samples to investigate the incidence of microplastic in the surroundings of the study area.

Due to bureaucratic and Covid-19 constraints, the project underwent slight variations from the original plan. In addition, the lack of previous knowledge of the area in a foreign country, the difficulties in exchanging both practical and local knowledge, the accessibility to the area due to travel and weather issues, as well as the Covid-19 pandemic implies some difficulties and reasonable delays. Nevertheless, very interesting results were achieved despite these circumstances which are explained in this report.

1 Plastic and microplastic pollution

Plastic has a constant presence all over the world oceans and seas, representing about 80-85% of marine litter. The wide distribution and use of plastics have expanded exponentially since the 1950s becoming the fastest growing segment of waste. Global production reached about 359 million tonnes in 2018, and is estimated to be about 2.000 million tonnes by 2050 (Auta et al. 2017; Cole et al. 2011; Cozar et al. 2014; PlasticEurope 2019; UNEP 2016). The number of floating plastics (macro and microplastic) in the oceans was estimated around 5.25 trillion pieces (Cozar et al. 2015; UNEP 2016), with a large portion represented by microplastics. Focusing on microplastics alone, it has been estimated that n between 15 and 51 trillion microparticles can be found in the world's oceans (van Sebille et al. 2015). Both, macro and microplastics, are considered to be grown since then. Land-based sources of macroplastics are basically from the construction sector, private houses, coastal tourism, food and drink packaging, as well as other general packaging. UNEP (2016) reported that the percentage of discarded materials entering the seas can be related to the efficiency of the collection and management of solid and water waste production. According to researchers in the sector only <5% of plastic discarded is recovered worldwide (Auta et al. 2017; Cole et al. 2011). Shipping and fishery sector do represent the main sea-based sources of plastic discards. Discarded or lost fishing gear (gosh nets) and aquaculture structures can contribute to significant quantities of plastic debris in marine environments (UNEP 2016).

The total annual input of plastic materials in the Mediterranean Sea has been estimated to range between 1.000 to 3.000 tons (Cozar et al. 2015), reaching and over 62 million plastic items floating on its surface (see Cincinelli et al. 2019; Ruiz-Orejón et al 2016; Llorca et al. 2020; Suaria & Aliani 2014). These values also will increase when microplastics are included in the estimations (see review Fytianos et al. 2021)

Microplastics (and other microdebris) have taken the interest of the community more recently (e.g. Ogunola & Palanisami 2016, Thompson et al. 2004). Fragments of plastics smaller than 5 mm are defined as microplastics (Frias & Nash 2018, GESAMP 2015). The sources of these microplastics can be primarily (manufactured as it is found) and secondary (fragmented from larger plastics already present in the waters) (Galgani et al. 2015, UNEP 2016).

Microplastic has been detected in all compartments of the marine environment (Bergmann et al. 2015) and they have been identified along with macroplastic as one of the major threats for marine mammals (e.g., Panti et al. 2019). The impacts of macrodebris, both entanglement

and ingestion, on these highly mobile top predators can be easily detected (Baulch & Perry, 2014), however, the incidence of microplastic is still unknown. In general, the assessment of the latter is carried out analysing the digestive tracts of stranded animals (e.g., Besseling et al. 2015; Hernandez-Milian et al. 2019; Lusher et al. 2015), and more information is needed to detect the potential impacts on these top predators.

Stomach content analysis has been carried out in previous studies investigating dietary patterns from stranded Mediterranean monk seal specimens (Cebrian et al. 1990; Muñoz-Cañas et al. 2012; Karamanlidis et al. 2011; Kiraç & Ok 2019; Lopez-Jurado et al. 1995; Pierce et al. 2011; Salman et al. 2001; Soriguer 1979; Tonay et al. 2016) and macroplastics have not been reported in any of them; only pieces of net were found in some of the specimens reported. However, due to constraints on the microplastic technique, microplastic incidence was not investigated in those studies. In addition, the limited global population number of the species requires the use of non-invasive techniques for scientific investigations: such as the use of scats to study interactions with anthropogenic pollutants such as (micro)plastics.

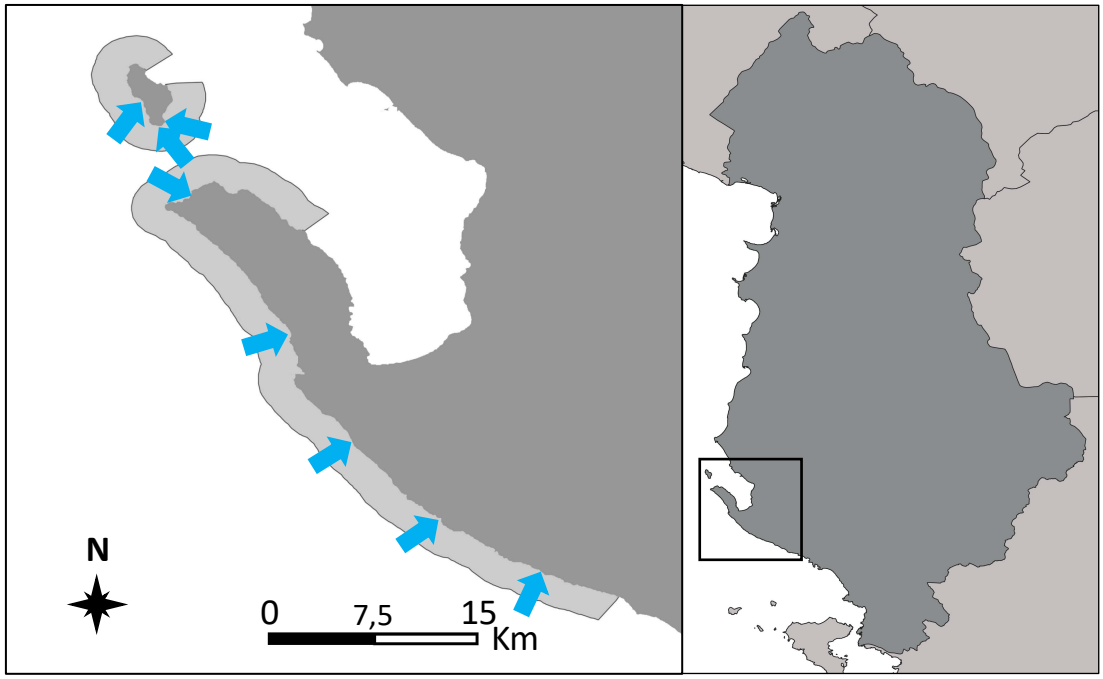
Monk seal faeces (scat) are collected from haul out or breeding sites. Despite their difficulties to be retrieved (e.g., areas of difficult access, sea waves might remove them before researchers arrive to the area), have been shown to be an efficient tool to investigate the incidence of microdebris, as well as an effective tool to collect ecological data from an endangered top predator (Hernandez-Milian et al 2018, 2020, *in press*).

Additionally, the Marine Strategy Framework Directive (MSFD - Directive 2008/56/EC) established that the Good Environmental Status (GES) of marine ecosystems should be assessed through 11 quality Descriptors. Within these Descriptors, abundance and distribution (D1, Biodiversity), trophic information (D4, Food webs), and impact of marine debris (D10, Marine litter) are among the ones with respect to top predators. In particular, there are two criteria (D10C3 and D10C4) that are focused on the ingestion and impact of marine litter in fauna. The use of collection of scats could be a useful tool for monitoring the incidence of this debris in top predators, using the Mediterranean monk seal as bioindicator species.

1.1 **Macroplastic**

1.1.1 Accumulation in caves

In August 2019 a survey along the ~65 km of the National Marine Park Karaburun-Sazan (MNP K-S) -see map 1-. was carried out to identify the potentially suitable habitat for the Mediterranean monk seals.



Map 1 The National Marine Park Karaburun-Sazan with the position of the caves mapped along with the contextualization of the study area in Albania

A total of eight caves were recorded showing the morphological characteristics of use by the species. Two of them, the ones with the best parameters as potential sites for pupping (breeding caves), were equipped with infrared cameras.

The plastic presence inside the caves was monitored and macroplastic was almost neglectable. Only a plastic bag and a rope were recovered from one of the internal beaches in one of the caves (Dafine cave). In addition, the cameras did not capture images depicting plastic debris incidence. This might be due to different reasons: the area does not present a sink area characteristic, strong currents during the survey might re-shaped frequently the internal beaches of the caves (as in figure 1), anthropogenic activities might not be close enough to facilitate the arrival of this material, etc.

Fig. 1 Above and below the variation of the beaches of the caves monitored according to sea level and waves.

1.1.2 Beach cleaning

Two beach cleaning events were planned within the frame of the project in coalition with RAPA Vlorë. These kinds of events help to sensitize the local communities regarding the issues of marine debris and their impacts. According to the changes in the project, described in the introductory paragraph, only one event was finally organized and economically supported, on the 21st October 2020 (figure 2). A total of 15 participants were trained to carry out the cleaning activities supported by two boats. Part of the participants was from RAPA Vlorë, from the prefecture and municipality of Vlorë, they were joined by other stakeholders in the work team (journalists, teachers, local NGO, and local fishing associations). During the beach cleaning, five beaches at the Eastern coast Karaburun peninsula (Table 1) were surveyed, marine litter was recovered and brought to MNP K-S Visitor Centre and delivered to the waste public service.

Table 1. Beach survey at the Eastern coast of Karaburun Peninsula in the NMP K-S

Bay	Latitude	Longitude	Surface	Material collected	Time*
Gjiri i Dafines	41°21'04" N	19°21'50" E	896 m^2	30 kg (mostly glass, 1 kg of cans, 0.2 kg plastic, 0.3 kg polystyrene)	30 min
Giiri i Brisanit	40°18'53" N	19°22'43" E	947 m^2	3 kg (2kg glass, 1 kg plastic)	15 min
Gjiri i Llovizit (Nezhet)	40°14'18" N	19°26'46" E	179 m^2	1 kg (0.6 kg glass, 0,6 kg plastic)	20 min
Gjiri i Grames	40°12'58" N	19°28'24" E	1805 m^2	8.2 kg (4kg glass, 0.7 plastic, 3.5 cans)	25 min
Gjir i Ingleziti	40°14'42" N	19°26'14" E	40 m^2	1.9 kg (1.5 kg glass, 0.3 plastic, 0.1 kg polystyrene)	10 min

** time spent in the bay for the cleaning activities*

The total beach surface covered was 3.867 m^2; around 44 kg of anthropogenic debris of which 3,2 kg were constituted by plastic. Polystyrene was separated from other types of

plastics as participants were able to identify them easily. The results obtained from this survey was available for public consultation at the local of the RAPA Vlorë web site[1]

Fig. 2 Beach cleaning on the 21st October 2020

1.1.3 Workshops with the stakeholders

During our project, two workshops with local stakeholders were originally planned to be organized. However, for different issues (see Introduction) none of the workshops took place. Nevertheless, Archipelagos - ambiente e sviluppo, Italia was invited to participate in the consultancy workshop "Support the implementation of a measure to prevent Marine Litter in Karaburun-Sazan National Marine Park (Albania)" in November 2019. The workshop was in line with the frame of the project "Sustainability, threats, presence and habitat use of the Mediterranean monk seal in Albania", in particular on the marine litter problems and their possible measures to be addressed.

The workshop was attended by 30 participants from RAPA Vlorë, UNDP, Regional Activity Centre for Sustainable Consumption and Production SCP/RAC, Ministry of Tourism, NGOs representative, and representative of the tourist sector operating in Karaburun (bars and restaurants owners).

The main aim of the workshop was the involvement of local stakeholders along with the managers of the MNP. The advisory panel of the workshop was composed of national and international experts which help to evaluate, to measure and to elaborate proposals to reduce the problem created by marine litter at the coast of NMP Karaburun-Sazan. The land source of litter at the National Park comes from the seasonal tourists spending time in the area. These tourists might bring litter and the waste management plan for the National Park needs to be improved to address this issue. The main measures proposed in accordance with all the participants included short-term measures:

1. Implementation of the collecting capacity providing recollecting cup available on the touristic structures in the territory of the park (beach bars),

[1] Rapa Vlorë FB website: https://bit.ly/33vOELf

2. Recollection and transportation of garbage in collaboration with the touristic boats, along with the implementation of waste recycling from local businesses and awareness and informative material for tourists and touristic activities.

The use of a biological method of waste treatment (Landfill Operation) and the implementation of fines for non-authorized abandonments of garbage within the park territory were proposed as long-term measures.

1.2 **Microplastics**

1.2.1 Microplastics in water samples

A microplastic assessment on the sea water superficial layer (figure 3) in the area was planned to be carried out collecting samples close to the caves to be monitored by infrared cameras twice or three times during the project. Two different issues were found during the surveys. As the choice of the spots was designed depending on the caves to monitor, only two samples were eventually possible for the collection. However, we adapted the original survey adding another six spots (Table 2) according to the different exposure to sources of marine litter (e.g., urban areas, harbour areas, touristic facilities). The second issue was the impossibility to carry out several samplings along the time along with the sample to be collected close to the Dafine cave due to the filtration system failure.

Fig. 3 Collection of water samples

Table 2. Water samples spot collection

Place	**Lat.**	**Lon.**	**Date**	**N***
Radhime	40°21’43” N	19°28’45” E	05-11-19	1
Vlorë	40°26’43” N	19°29’35” E	06-11-19	2
Palasë	40°10’19” N	19°34’24” E	28-03-2020	1
Grama	40°11’46” N	19°30’19” E	28-03-2020	1
Shen Vasil	40°24’19” N	19°22’56” E	28-03-2020	1
Shen Jan	40°25’58” N	19°19’53” E	28-03-2020	1
Dafine**	40°20’21” N	19°22’07” E	--	0

** Number of samples collected; ** The filtration system broke and it was not possible to collect the sample*

Water samples were collected with pre-washed 5 liters plastic bottles in each selected spot. Samples were filtered through a manual Millipore vacuum system (figure 4) using Millipore QM-A quartz microfiber filters (2.2 pore size). Particles retained in the filters were stored dry (figure 5) and sent to the Laboratory of Materials Characterization of the Ca' Foscari University of Venice (Italy) for further identification. Access to the Ca' Foscari labs is not allowed yet due to the Covid-19 pandemic, and the analysis is pending at the moment.

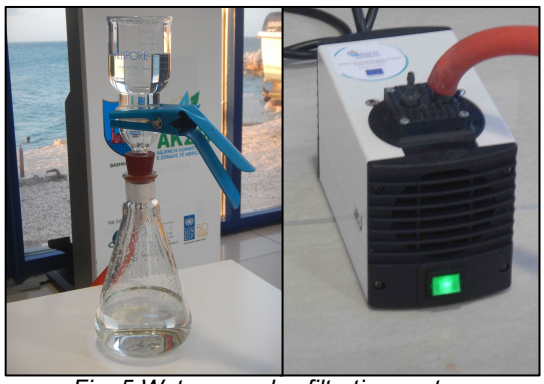


Fig. 5 Water samples filtration system

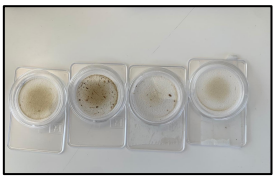


Fig. 4 Particles samples

1.2.2 Microplastic in monk seal scat

During the project, a monk seal scat was recovered from one of the caves examined at the coastline of the MNP K-S (figure 6). The collection of scats and their further analysis was not planned in the original proposal; however, as the scat was found the decision to analyse it was made. The scat collected was introduced in a one-use plastic bag to be sent to the Marine Research Institute- Spanish National Research Council (IIM-CSIC) in Vigo (Spain) for the analysis. All the Information related to the conditions of the cave, presence of debris and/or other animals, and the type of clothes used during the survey were recorded and provided for the lab's analyses. The scat was processed either for prey identification (see section 3) and for the incidence of anthropogenic debris, in particular to investigate the potential trophic transfer of microplastic pollutants. The laboratory was prepared to carry out the analysis following the protocol by Lusher & Hernandez-Milian (2018).

Fig. 6 The scat recovered

The sample was washed with pre-filtered water and passed through three sieves of different meshes: 1000µm, 350µm, 120µm (figure 7). The first two sieves were used to collect the anthropogenic items which included several fibers (2 yellow, 5 blue, and 2 black), a blue fragment, a piece of nylon and many small transparent anthropogenic fragments-possibly plastic (figure 8).

Fig. 7 The sieves used

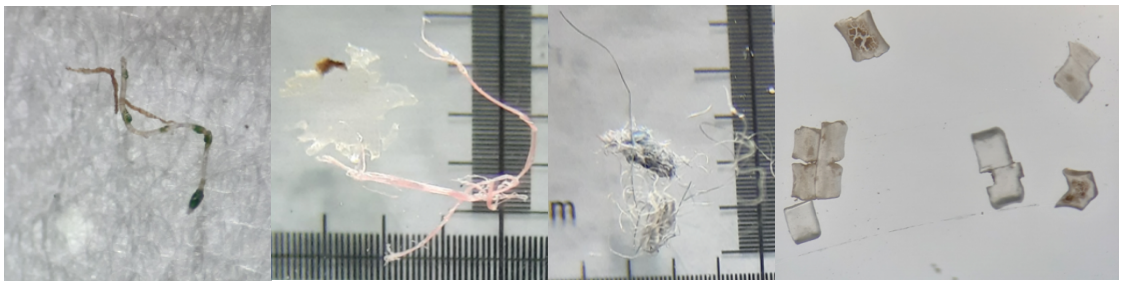


Fig. 8 The anthropogenic items recovered filtering the scat

The piece of nylon could belong to fishing or aquaculture nets and the small transparent particles were hypothesized to belong to the filtration systems used in aquaculture (see section 3). Debris particles were stored in clean paper envelopes and sent to the Norwegian Institute for Water Research (NIVA) in Oslo (Norway) for further microplastic analysis (polymer identification). The access to labs to carry out analysis is at the moment limited due to the pandemic.

2 Fishery and nature conservation trade-off

Nowadays, interactions with artisanal fisheries represent one of the biggest impacts on the survival of the Mediterranean monk seal. Seals can be entangled in fishing nets and drown or might get killed by fishermen; animals have been reported to be deliberately killed being shot or using dynamite as they are believed to damage the nets (Androukaki et al. 1999; Karamanlidis et al. 2008, 2016; Notarbartolo di Sciara and Kotomatas 2016; Panou et al. 1993; Pierce et al. 2011). The use of dynamite fishing, despite being illegal, is still practiced in some areas of the Mediterranean coasts with a negative effect on the entire marine ecosystem (e.g., Tudela 2004).

The competition between marine vertebrates and artisanal fisheries has grown during the last decades, along with the growth of the industrial fishery sector that has resulted in a worldwide depletion of fish resources (e.g., Hilborn et al. 2003; Pauly et al. 1998, 2002; Read 2008). The demand for seafood has increased in the last decades and the maximum potential capture in the main fishing areas of all oceans (FAO 2012), have contributed to the growth and diffusion of fish farms and is expecting to keep growing in the future (Bostock et al. 2010; FAO 2012; Goldburg & Naylor 2005; Subasinghe et al. 2009).

Researchers working along the coast of Turkey carried out a study addressing the damages caused by Mediterranean monk seals to fish farm cages (Güçlüsoy & Savas 2003). Similar results have been recorded in other areas of the species presence (Hernandez-Milian *Pers.*

Obs.). Therefore, negative interactions with fish farms should be taken into consideration as a potential threat in Albanian waters, with the possible and desired recovery of the species.

2.1 **Small scale fishery**

The artisanal fishery sector is relatively small in Albania (figure 9), mainly developed as an economical alternative source of jobs and income along coastal areas, with most of the fishermen principally employed or coming from the agriculture sector (Çobani 2005; Rajkovic & Kromidha 2014). There are two main ports in the study area, inside the Bay of Vlorë. Triport 5 km north of the town of Vlorë, and Orikum, located southwest in the Vlorë Bay, about 18 km south of Vlorë, plus minor harbours in the areas of Plazhi i Rhi and Plazhi i Vjeter (Vlorë), and in Radhimë.

Fig. 9 Fishery vessels in Radhimë (left). One boat fishing along Karaburun penisula (right)

The research carried out between 2015 and 2016 by Bakiu et al. (2018) in the area of Vlorë Bay and the Karaburun Peninsula, indicated that there are 50 licenses for small-scale fishery vessels. However, only 20 of them were effectively operating, with 15 based on Triport, and five based on Orikum (Bakiu et al. 2018).

Based on the data delivered by the fisheries Inspectorate (2018) the number of licensed small scale fisheries in the Vlorë Region is 65 boats, mainly based in Triport, Radhime and Orikum. However, the number included also the small scale fisheries vessels from Himarë and Sarandë, on the Southern Albanian coast (RAPA Vlorë, *pers. comm.*).

Data collected in 2019 (MARE Project), including licensed and non licensed fishermen for the Bay of Vlorë small scale fisheries vessels reports the following numbers: 45 for Triport to which add 35 from minor harbour marinas in Vlorë, 27 in Orikum to which add the 25 based in Radhimë (RAPA Vlorë, *pers. comm.*).

Although most of the operating vessels were using trammel nets, to a lesser extent also fish with gillnets and longlines (Bakiu et al. 2018).

The majority of small scale fishing boats from Triport-Vlorë are operating near Sazan Island; whereas, most of the Orikum-Radhimë vessels operate at the Karaburun peninsula (Bakiu et al. 2018; RAPA Vlorë, *pers. comm*.). It is worth mentioning that fishery in the South area of the park (Palasë) is practiced by boats coming from Himarë (RAPA Vlorë, *pers. comm*.).

In the original plan of our project, two workshops were proposed to be carried out involving local fishermen. Within the aims of those it was the evaluation of possible threats related to fishery that might limit the return and re-establishment of monk seals in the area, the potential mitigation measures, and the fishermen's willingness to accept or adopt the measures. Due to the constraints to organize these workshops, a questionnaire for fishermen adapted from previous studies (Bundone 2016; Bundone et al. *In prep*.), was forwarded to the personnel of RAPA Vlorë. The questionnaire intended to assess the attitude of the local fishermen towards their activity and nature conservation (trade-off). Additionally, it expected to evaluate if the current conditions are favorable for the natural establishment of a monk seal population.

The questionnaire (see annex for the text) was structured with 17 questions where the main themes were:

- general information on the fishers,
- general information on the fishing activity,
- information on fishery related problems, and
- proposals to mitigate such problems.

A total of 11 fishermen from the port of Radhimë and Marina of Orikum participated. Ages ranged from 24 to 54 years old, with an average age of 39 years old. Nine of them had a middle-grade education and only two had elementary-grade education. Interestingly nine of them were part of fishing cooperatives in the area. Despite most of them (82%) fishing all year round, about half of them (46%) also held second jobs working the in agriculture (2) or tourism (3) sectors. None of the fishermen questioned were from a traditional fishery family, starting their fishing activities from 16 to 33 years of age (with an average of 23.5 years old). In terms of vessel characteristics, most of the boats were 4-5 m long (91%), engines varied from 15 to 40 Hp (only one with a boat of 8 m and 200 Hp). All vessels were operated with only one fisherman except one which operated with two.

The Bay of Vlorë is the operating fishing area for all vessels, where three of them are also fishing along the Karaburun Peninsula. Mixed static fishing nets (trammel and gill nets) are used by all vessels, but other fishing instruments (e.g., fishing hooks) are also used by at least two fishermen. Fishermen reported different net damages during their activities based

on pre-codified answers. The question was built based on the characteristics of damages produced by different causes (e.g., physical and climatic condition, predator and differences between predators, etc.), obtained from reported literature (Bearzi 2002; Öztürk & Dede 1995; Panou et al. 1993) and through personal experiences. The results showed that:

a) Large vertical lacerations with twisted net parts were notified by one fisherman.
b) Wide lacerations from the bottom losing leads were notified by one fisherman.
c) Presence of single holes and stretches of nets were reported by eight fishermen.
d) Single holes or groups of three holes, each covering an area with 20-30 cm of diameter, were reported by one fisherman.

It is important to take into consideration that most of the fishermen indicated that they believe that there has been a decrease in catch through the years; in fact, 82% of questioned fishermen reported that the overfishing might be the main cause of this depletion, while only one fisherman pointed out to illegal fishing and another one to pollution.

In addition, fishermen were asked about which recommendation they think is the most effective measure for the protection of fish stocks in the area. Six out of 11 (55%) believed that the creation of no-fishing periods should be the most suitable measure. The second alternative was equally the prohibition of some fishing practices and the use of alternative fishing methods, each supported by two fishermen (18%). Only one fisherman (9%) supported the idea of the creation of protected areas to reduce overfishing.

When fishermen were asked about being implicated in the managing decisions for the protection of the marine territory, their answers were mainly positive (91%). In addition, fishermen were asked if they were willing to take part in scientific studies and 82% showed their agreement on such collaboration.

One of the lines of this project was to propose mitigation actions (see section 4). Therefore, we believe that fishermen's opinions are important to be considered. The last question lined up with these mitigation actions, and fishermen were asked which limitations they are willing to accept or negotiate for the protection of the territory (trade-off). The establishment of no-fishing zones was the most preferred option (eight out of 11 fishermen, 73%), followed by limiting the type of catch (2) and the fishing season (1).

Interestingly, our results are lined with the previous study in the area (Bakiu et al. 2018), confirming the high availability of the southern fishermen community of Orikum to collaborate with the MNP KS managing authority. Unfortunately, the issue of illegal fishing using dynamite was not possible to address within the frame of the project.

2.2 **Fish farm**

Despite the review of fish farms and their implications in the area were not included in the original proposal, this section was incorporated as the scat of a monk seal recovered from one of the caves presented some evidence of fish farm interactions. In order to evaluate the risks which, the Mediterranean monk seals might face in the area, it is important to consider the possible threats and or negative interactions with aquaculture facilities.

Fig. 10 Fish farms in the peninsula of Karaburun, Vlorë Bay

Fish farming in Albania has been established since 2000. The most important fish farm areas is located along the Eastern side of the Karaburun Peninsula, in the Bay of Vlorë outside the limit of the MNP KS (see figure 10), and present 7 out of 16 fish farms (Kostantinidis et al. 2020a, b) operating in the country: Vangjeli, Alba Adriatik, Xhiano, Belloj, Ensi Adriatik, Al Marina and Kola. They are all farming gilthead seabream (*Sparus aurata*) and European seabass (*Dicentrarchus labrax*). Although the annual fish farm production in Albania is paltry (0.38% in Europe - Floko 2003; Jimenez 2015), the tones produced of these species ranged from 4255 to 5106 tonnes annually (Kostantinidis et al. 2020a). Selling sizes of these species are ranging from 300 to 400g (Kostantinidis et al. 2020b) with an estimated size ranging from 28.8 to 31.6 cm[2].

3 Trophic ecology of the Mediterranean monk seal

The monk seal scat retrieved and described above (see 1.2.2), was also analysed for trophic assessment. Dietary remains were collected, sterilized in ethanol 70% during 24 hours, and stored dry. Prey identification was carried out under a stereoscope microscope. Species and reconstruction size of prey were done using the reference collection stored at the IIM-CSIC in Vigo and references available (Arechavala-Lopez et al. 2012; Bräger & Moritz 2016).

Most of the items identified were scales. However, the identification of the species was possible, finding three possible fish species: a sparid (most probably a gilthead seabream), a

[2] Estimated size from back calculation regression in Moutopoulos et al. 2013

European seabass, and a garfish (*Belone belone*). The three fishes were estimated to be 20 cm, 25 cm, and 17 cm length respectively (Table 3 and figure 11). Additional information could not be provided due to the high erosion condition of the scales, for instance, to identify if the scales belonged to wild or aquaculture sea bream and sea bass as in Arechavala-Lopez et al. (2012). No other items were possible to identify, although some seagrasses (*Posidonia oceanica*) were also present (Table 3).

Table 3. Preys identified in the monk seal scat recovered

Prey	**Length** (mm)	**Item**
Belone belone	17	Scale and bone
Dicentrarchus labrax	25	Scale
*Sparidae**	20	Scale
Posidonia oceanica	13	Piece of posidonia

**likely Sparus aurata*

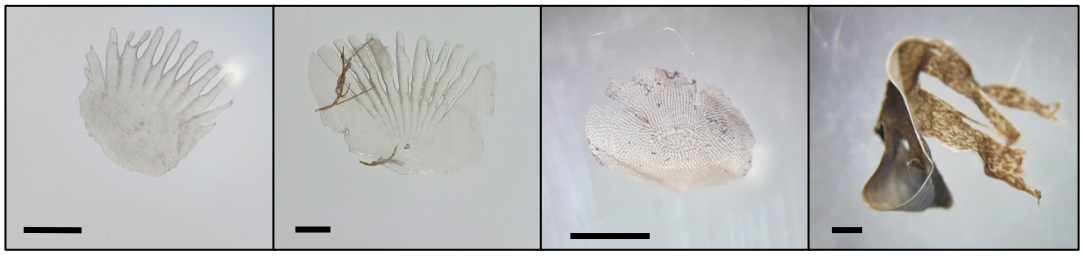


Fig. 11 Preys identified in the scat. From left to right scales of a seabass, a presumed seabream a garfish, and a piece of posidonia. Scale bars representing 1 mm

The Mediterranean monk seal has been reported to be feeding on a wide spectrum of species and octopuses were reported to make up to 50% of their diet (Muñoz-Cañas et al. 2012, Pierce et al. 2011). In this case, no cephalopods were detected in the scat; in previous studies, not all stomachs presented octopuses (Muñoz-Cañas et al. 2012, Pierce et al. 2011), and it could be that beaks get retained in the digestive tract of the seal or it did not feed on octopuses in its last meal. On the other hand, the species detected in the scat were also found in the study carried out in Greek waters (both from the Ionian and Aegean Seas). Although pelagic species were not detected in Pierce et al. (2011) study, in Mauritanian subpopulation has been reported to be feeding on pelagic species too (Muñoz-Cañas et al. 2012).

Although the sizes of prey consumed by the seal were smaller than those from selling sizes in fish farms, we cannot dismiss that the seal might be feeding on fish from fish farms. Both seals and cetaceans are usually taking advantage of these aquaculture structures for feeding in different ways:

- They can use the structures as a barrier to hit the wild fish and then hunt them,
- they can hunt fish attracted by the fish farm structures (Ballester-Moltó et al. 2017, Fernandez-Jover et al. 2008),
- they also can hunt those fish escaping from fish farm cages (Arechavala-Lopez et al. 2013), or
- they can get the fish directly from the fish farms.

In our opinion, the first two cases are the most likely to occur in the area, however, more research should be taken in the future regarding the last one. Our hypothesis is lined with this feeding activity as microplastics detected (see section 2.2) in the scats might come from aquaculture facilities.

4 Recommendations for mitigation measures

4.1 **Plastic pollution recommendations**

One of the objectives of this project was to propose mitigation actions from the results obtained. Legislation on marine pollution in Albania, in particular plastic waste, has been established since 2015. Measures to mitigate the economic, social, health, and environmental risks caused by plastic pollution have been pointed out for a favorable marine-based tourism industry (DCM 687 2015[3]). The European legislation established in 2008 the Marine Strategy Framework Directive (MSFD) aiming to reach a good environmental status (GES) of the marine European waters (EU 2008). Eleven descriptors were established, with a specific one regarding the marine litter assessment (D10). The evaluation of D10 should be carried out using indicators established for the four criteria indicated:

- D10C1: it assesses the composition, amount and spatial distribution of litter on the coastline, in the surface layer of the water column, and on the seabed, are at levels that do not cause harm to the coastal and marine environment.

- D10C2: it assesses the composition, amount and spatial distribution of micro-litter on the coastline, in the surface layer of the water column, and in seabed sediment, are at levels that do not cause harm to the coastal and marine environment.

[3] DCM no.687, dated 29.7.2015 “On rules for keeping, updating and publication of waste statistics

- D10C3: it assesses the amount of litter and micro-litter ingested by marine animals is at a level that does not adversely affect the health of the species concerned.
- D10C4: it assesses the number of individuals of each species which are adversely affected due to litter, such as by entanglement, other types of injury or mortality, or health effects.

The MSFD encourages collaboration between countries, regions and subregions. However, because Albania is not part of the EU, it is not committed to accomplish these assessments. But its strategic position in the Adriatic Sea (between EU countries) and the expectations to be included within the EU in a future soon encourage it to make a step forward on this legislation and take measures for the GES of its marine waters.

Few studies have been carried out regarding the first two descriptors (Gjyli et al. 2020; Kolitari et al. 2016). However, no studies were carried out yet regarding impacts on fauna. During the project we investigate the incidence of macro and microplastics in the suitable habitat of one of the most endangered marine mammals in the Mediterranean sea in Albania, and the incidence of microplastic ingested through trophic activities by this top predator.

Based on our results we suggest the following recommendations for plastic pollution mitigations:

1) Plastic collection within the NMP-KS. It is recommended to improve the macroplastic collection and recycling in the area. Following the recommendations of the workshop held in Vlorë in November 2019, a long-term basis waste treatment (Landfill Operation), in conjunction with fines for non-authorized abandons of garbage within the park territory has been envisaged. On a short-term basis, the correct disposal of garbage requires the implementation of specific recollection structures (bins with a semi enclosed open area to avoid scavengers collecting the little from them) and regular collection of the garbage. In addition, implication of the tourist sector is necessary as they use the beach facilities; awareness campaigns by the park authorities to be kept on be carried out encouraging the collaboration with tourist boats to bring garbage produce to specific bin areas. Also, awareness campaigns on recycling and reusing material will help to reduce the amount of garbage produced. During the workshop celebrated in November 2019 the participants indicated that it is necessary to involve the private sector and the local community (e.g., municipalities) to establish and improve recycling activities.

2) Microplastic research studies. Up to date the physical impacts of microplastics have been only detected in lab facilities studying invertebrates (see review GESAMP 2015).

But it is well known that microplastics might also work as vectors of other potential contaminants such as PCBs (Rochman 2015). During the process of this project, only the incidence of microplastics in the area (water surface) and the trophic transfer in the Mediterranean monk seal were investigated. The analysis of microplastics is still ongoing due to the constraints suffered to access lab facilities, however, some information was obtained during the analysis of scats. Following the recommendations from the MSFD, the long-term monitoring of both water samples and biota is necessary. The use of scats has been recently demonstrated that could be used as a non-invasive technique for D10C3 (Hernandez-Milian et al. 2020, Hernandez-Milian *in press*), and our results confirm the same result. Therefore, the collection of scats regularly should be implemented to assess the incidence of this type of pollutant in the area in combination with other monitoring tools.

4.2 **Fishery recommendations**

The fishing sector represents an important socio-economic income for Albania, and the related environmental issues have been pointed out previously (IPA 2016). The problems detected are basically related to technical and economic measures on fisheries governance, but not to environmental impacts due to interactions with top predators occurring in the area. During the project, these potential threats derived from possible interactions between fishing activities and the Mediterranean monk seal were investigated.

Small scale fishermen and seals are known to compete for the same resources. However, fishermen are the most likely to record occasional or stable presence of this marine mammal within their fishing area. Moreover, the use and integration of “fishermen’s knowledge” in scientific research studies have been increased in the last decades (Jacobs and Panou 1988; Panou et al. 1993; Neis et al. 1999; Panou et al. 1999a, b; Pirounakis et al. 1999; Johannes et al. 2000; Panou 2009; Moore et al. 2010; Maynou et al. 2011; McClenachan et al. 2012; Gonzalvo et al. 2015). They are probably the most important stakeholders for the protection of marine coastal ecosystems and management of Marine Protected Areas-MPAs and are necessary to get them involved in conservation decisions (Guidetti and Clauder 2009; Guidetti et al. 2010; Di Franco et al. 2014); in addition, it is necessary to consider that they are subjected to limitation more than others when environmental restrictions are put in place (e.g. no-fishing zone, no-fishing season).

During the course of the project, the interviews with the fishermen showed their willingness to collaborate in the management and protection process of marine natural resources. This collaboration might create opportunities to engage in mutually beneficial activities. For

instance, fishermen can provide useful information of top predators occurring in the area and their behaviour with their activities. On the other hand, fishermen might get an economical advantage from local authorities and administration (e.g., subsidies for net damage). It is worth mentioning that subsidies might cause fishermen to report more net damage by top predators that they really suffer (Bearzi et al. 2011). However, fishermen's involvement and long-term protection policy are essential to achieve effective conservation results for the Mediterranean monk seal; in other areas, the implication of artisanal fisheries in the protection of this top predator showed that the species began to re-use again the same coast which it was used years before (Hale et al. 2011; Pires 2001; Karamanlidis et al. 2002).

It is well known that other seal species in other areas (e.g., grey seals in Scotland) damage fish-farm cages when trying to hunt fish inside the cages. Based on this study and studies carried out in other areas, we believe that additional research on damages caused to fish farm cages by top predators is highly recommended and/or necessary for the area. The information obtained might help to prevent or mitigate any possible negative interaction that might arise from Mediterranean monk seals (re-)establishing in the area. To date, we cannot confirm that an increase of seals in the area might cause an increase of negative interactions, but the collaboration with fish-farms will provide useful information to investigate this potential threat.

4.3. **General recommendations**

The Blue Economy term is defined by the European Commission as "*All economic activities related to oceans, seas and coasts.*" On the other hand, the World Bank[4] defines the Blue Economy as the "*sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of ocean ecosystems*". Under both definitions, the activities related to the existing MPAs and extended marine areas under conservation are included. Although Albania is not part of the European Union (EU) yet, their implications on improving the blue economy in the country will line up with environmental and sustainable policies of the EU.

Top predators are considered as good candidates as bioindicators of the ecosystem status (Boyd et al. 2006; MSFD). Grey seals have been used as candidates of good environmental status in the North Sea (OSPAR QSR, 2010), therefore the Mediterranean monk seal might be a useful candidate in the Mediterranean too. Results obtained from this study revealed the importance of Albanian coast for the Mediterranean monk seal. In previous studies, it

[4] https://www.worldbank.org/en/programs/problue

has been suggested that the study area might represent an important ecological corridor for the species recovery along the Adriatic-Ionian region (Bundone et al. 2019a, b). To enhance this information, additional long-term monitoring and conservation activities regarding this top predator species are recommended. This includes the local knowledge of the presence of the species, the frequency that the species is detected, and to extend the protection actions to be taken over a network of countries within a wide regional approach. Lined with these activities, the collection of samples using non-invasive techniques have demonstrated that information prompted is of high value to understand not only the trophic ecology of the species, but also to investigate the trophic transfer of anthropogenic debris, and therefore provide information to assess the good environmental status of the Albania marine ecosystems.

The Mediterranean monk seal has not been sufficiently investigated but, as a top predator, which might interact with human activities and requires specific habitat characteristics, becomes a good candidate to assess the good environmental status of the Mediterranean Sea. As a highly mobile marine mammal, the study of this species requires collaboration among countries. The Mediterranean monk seals individuals' passages and presence in Albania should be considered in an Adriatic-Ionian context and as part of this area's population. We believe that the monitoring and conservation activities are essential for the protection of the species and they should be planned along with the rest of the surrounding areas (Ionian Sea, west of Greece waters, and Southern Italy -Apulia).

It is well known that in the Ionian Sea, Greece, there is a healthy monk seal reproductive population (Bundone et al. 2019c; Panou et al. 2019); meanwhile, in Apulia waters individual seal sightings are recorded with similar pattern and frequencies (Bundone 2016; Bundone et al. *in prep.*) as in Albania waters. This might indicate a possible movement and exchanges of individuals within the region. It is highly recommended for collaboration among countries (e.g., Croatia, Montenegro, Albania, Italy, and Greece) for the effective proper conservation of the species and expected recovery in number and distribution of the species.

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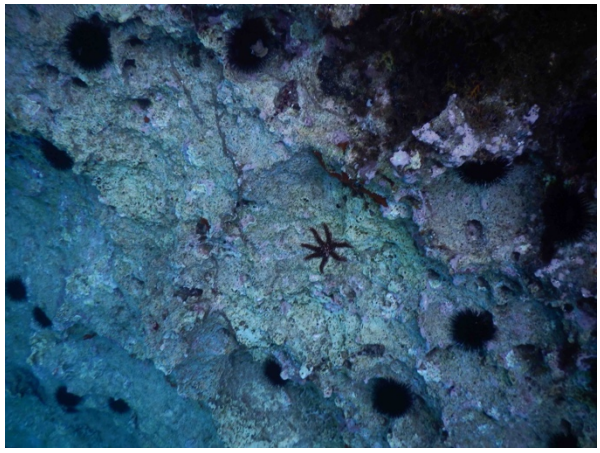

Annex

Data:	Località	N° intervista

1 Età:
2 Livello di scolarizzazione:
3 Appartiene a qualche cooperativa di pesca? Quale?
4 Oltre la pesca ha altre attività? Quale?
5 A che età ha iniziato a fare il pescatore?
6 Viene da una famiglia di pescatori?
7 Dimensioni della sua imbarcazione?
8 Quanti uomini fanno parte dell'equipaggio, incluso lei?
9 In quale periodo pesca?
10 In quale area pesca
11 Quale strumento da pesca utilizza?
12 Che tipo di danno che subiscono le reti?
A) Ampi squarci verticali con parti di rete attorcigliati; B) Ampi squarci dal fondo con perdita dei piombi C) Buchi singoli e pezzi di reti strappati D) Buchi singoli o in gruppi di tre con un diametro di 20-30 cm E) Nessun danno F) Non risponde
12 Ritiene che nella zona il pescato sia diminuito nel corso degli anni?
13 Secondo lei quale è la ragione principale di tale diminuzione?
A) Inquinamento B) Cambiamenti climatici C) Eccesso di pesca D) Pesca illegale E) Predatori F) Non sa G) Non risponde
14 Quale ritiene tra le seguenti proposte che sono state fatte per mantenere gli stock del pescato in zona la più efficace per risolvere il problema?
A) Creazione di aree protette B) Creazione di periodi di tutela C) Proibizione di alcuni metodi di pesca D) Uso di Metodi alternativi di pesca E) Non sa F) Non risponde
15 Ritiene che la categoria dei pescatori dovrebbe partecipare alle decisioni e alla gestione della tutela dell'ambiente e del territorio?
16 È disposto a collaborare in studi scientifici ospitando un osservatore sulla barca?
17 Quali limitazioni sarebbe disposto ad accettare o negoziare per la tutela del territorio?
A) Limitazioni del periodo di pesca B) Limitazioni delle aree di pesca
C) Limitazioni del tipo di preda