Montenegrin Ecologists Society
Environment Programme

Composition and abundance of shark by-catch in Montenegrin fisheries

The Rufford Foundation

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Cover photo

Smoothhound in catch of set gillnets in the Bojana river area (Ulcinj, Montenegro). Credit: Ilija Ćetković

This logo has been produced within the framework of the above mentioned project in order to promote the conservation of blue shark (Prionace glauca) as one of the most common accidentally exploited species worldwide.

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BGF – Big game fishing
CPUE – Catch per unit of effort
DCRF – Data Collection Reference Framework
EnvPro – Environment Programme
FAO – Food and Agriculture Organization of the United Nations
GFCM – General Fisheries Commission for the Mediterranean
GNS – Anchored set gillnets
GTR – Trammel nets
IPOA – International Plan of Action
IUCN – International Union for Conservation of Nature
LHP – Hand-operated handlines and pole-lines
LLD – Drifting longlines
LOA – Length overall
MES – Montenegrin Ecologists Society
MONSTAT – Office for statistics of Montenegro
OTB – Bottom otter trawls
QGIS – Quantum Geographic Information System

Executive summary

Determination of Fishing Effort on Sharks by Montenegrin Marine Fisheries and Multi-Stakeholder Informing about Conservation of these Endangered Species project, funded by The Rufford Foundation was designed in order to address lack of data on sharks, low level of ecological consciousness among multi-level stakeholder groups and deficiency of knowledge among fishermen community. The study is a part of the project initiative for first comprehensive shark-dedicated research in Montenegro. Study area implied Montenegrin coastal waters (South-eastern Adriatic Sea) and project field activities included observations on board and at landing points in 2016, 2017 and 2018. The research took into consideration four types of fishing gears. From multiple gears used for commercial exploitation of marine resources, bottom trawls, entangling nets (gillnets and trammel nets together) and drifting longlines were targeted by the survey. The big game fishing targeting tunas and swordfish was selected for monitoring among the various forms of sport-recreational fishing. Next to the in the field observations, an interviewing data collection has been carried out using questionnaires for collecting species distributions data within the study area. Moreover, interviews were used to collect human well-being and fisheries sustainability related data which concerns sharks and their importance for the members of local professional fishermen community, across the project's period. Nine species of sharks were recorded as present in catches and landings of Montenegrin fisheries. This study provides created distribution maps of several assessed sharks and obtained fishery-depending, biological and socio-economic related findings. Abundance of the found species has been discussed and presented per surveyed fishing gears. Possibilities are identified to be exploiting of least concern species rather than threatened ones to reduce the existing fishing pressure they are exposed to. Needed conservation measures imply review and improvements in legislation and its enforcement as well as establishment of long-term monitoring regarding endangered sharks.

1. Introduction

1.1 Issues and concerns

Sharks and their relatives create a group of around 1000 species that are lurking throughout marine ecosystem for at least 400 million years which place them among the oldest living vertebrates (Worm *et al*. 2013). Elasmobranchs are particularly vulnerable to the increased mortality rate because of their slow growth and low reproduction rate with specific emphasis on those larger (Myers & Worm, 2005). Due to the rapid increase of fishing pressure across the whole world ocean in the past century, abundance of their representatives has declined significantly. This kind negative reflection of fisheries on elasmobranchs is occurred particularly in the seas with a long fishing history as the Mediterranean have, along with the Adriatic Sea as one of its parts. Ferretti *et al*. (2008) found great decline in abundance of Mediterranean pelagic sharks. Out of 20 predatory sharks which can be found in the Mediterranean Sea, authors who implemented the survey found only 5 of them as sufficient for their analysis. Not only pelagic species, but also other sharks are affected by strong fishing pressure within the region. Individuals of fourteen species of elasmobranchs are found to be available at the markets in the Northern Adriatic out of which 60% were smoothhounds (Barausse *et al*., 2014). Proof that the situation is even worse, lies in the fact that sharks are often considered as non-targeted species, incidentally suffering the intensive exploitation. Sharks ordinarily do not have a commercial value and thus they do not have much significance for fisheries. Owing to this, they are considered as a by-catch that can be either retained or discarded which depends on the species, individual's size and the fisherman himself. Beside the incidental mortality, there is certain demand for shark fins used for preparation of a fin soup which is unfortunately popular in some regions throughout the world. Mainly because of these reasons, majority of shark species have become threatened and are currently facing the risk of extinction. Sharks are expected to play an important role in the ecosystem due to their top positions in the food chains (Stevens *et al.,* 2000). As for their substantial functions, there is a high risk of multiple significant consequences and negative effects for the marine ecosystems due to their intensive removal measured in high numbers (Myers *et al*. (2007); Heithaus *et al*. (2008); Ferretti *et al*. (2010)). According to some analysis, global ocean has lost more than 90% of its large predatory fishes (Myers & Worm, 2003). As this conservation issue was poorly investigated in Montenegrin part of the Adriatic Sea, there is a major gap in knowledge for this area. This research aimed to collect and provide data about the observed problem, particularly concerning the diversity of shark species which can be observed in Montenegrin landings along with the frequencies and distributions of their catches.

Photo 1. Common smoothhound (Mustelus mustelus) caught and released during the survey Photographer: Evald Alivodić

1.2 Sharks of the Adriatic Sea

Adriatic Sea is home for 29 shark species (Lipej *et al*., 2004). They inhabit different parts of the Adriatic ecosystem depending on their ecological characteristics and life strategies. Some are in common and can be relatively easily found, such as small-spotted catshark (*Scyliorhinus canicula*) and the common smoothhound (*Mustelus mustelus*). These two, along with several other species, are representing the benthic sharks that can be found in the Adriatic. Sharks of this kind are often smaller in size and some of the species in the group are commercially interesting. From large pelagic sharks, most common are few predatory species with blue shark (*Prionace glauca*) and shortfin mako (*Isurus oxyrinchus*) in particular. Occasionally, they can be spotted offshore throughout the pelagic ecosystem. They are efficient predators feeding on pelagic fish and cephalopods, mostly squids. Furthermore, they represent significant cleaners of the marine habitats due to their practise of feeding on carcasses of fish, marine mammals and sea turtles. Beside the piscivorous ones, there is another representative of a large elasmobranchs, the basking shark (*Cetorhinus maximus*) which feeds on plankton. Concerning biodiversity, more species from both groups can be spotted in this part of the Mediterranean. Among them, present are angular roughshark (*Oxynotus centrina*), common thresher shark (*Alopias vulpinus*) or sandbar shark (*Carcharhinus plumbeus*).

1.3 Montenegrin fisheries

1.3.1 Commercial fisheries

Commercial fishing is the common traditional economy-related activity in the southern part of Montenegro for centuries and has helped many people to gain a certain amount of income and enable survival of their families. Nowadays, it is present through its various types, out of which some can be associated with sharks. In comparison to majority of Adriatic commercial fleets as Croatian or Italian, Montenegrin fishing fleet is small counting 135 vessels in 2016 according to MONSTAT[1]. Important ports for Montenegrin fisheries are placed in Budva, Herceg Novi and Bar which cannot be considered as strictly fishing ports (Pešić *et al*. 2011).

Artisanal (small-scale) fisheries

Trammel nets and gillnets are widely used artisanal fishing gears for the exploitation of demersal resources with fish at first place, but also crustaceans and cephalopods. Depending on the mesh size, habitat type or depth which is chosen for fishing, species that can be find in catches are different. Gillnets catch in this area is composed from Atlantic bonito (*Sarda sarda*), common pandora (*Pagellus erythrinus*) which are followed by amberjack (*Seriola dumerili*) and chub mackerel (*Scomber japonicus*). Trammel nets are used to catch Atlantic bonito (*S. sarda*), red mullet (*Mullus barbatus*), cuttlefish (*Sepia officinalis*) as well as several species more (Matić-Skoko *et al*.

Photo 2. Trammel net while retrieving close to the port of Budva

Photographer: Ilija Ćetković

1 MONSTAT is the state office for statistics of Montenegro.

2017).

Longlines used in the surveyed part of the Adriatic are divided into two groups, those targeting benthic species and those for large pelagics. Longlines are used to catch various fish, but due to the often happening difficulties in operating process, very common in this type of fishing, they are less used than nets. Drifting longlines fishery target only a few species which are among the biggest fish in the Adriatic Sea. Their primary target are bluefin tuna (*Thunnus thynnus*) and swordfish (*Xiphias gladius*), regularly accompanied with the larger specimens of false albacore (*Euthynnus alletteratus*) and dolphinfish (*Coryphaena hippurus*). On the other side, bottom set longlines are used to exploit demersal fish communities. Within this area, the most abundant species in catches of this kind longlines is European conger (*Conger conger*), followed by red porgy (*Pagrus pagrus*) and hake (*Merluccius merluccius*) (Matić-Skoko *et al*. 2017).

Bottom trawling

Trawls are located in bigger ports of Montenegro with most of them anchored in the port of Bar, but also a few in the ports within Boka bay or close to them. Within Montenegrin territorial sea, species of interest that are targeted by this fishery are European hake (*M. merluccius*), red mullet (*M. barbatus*), pink shrimp (*Parapenaeus longirostris*), monkfish (*Lophius spp*.) and John Dory (*Zeus faber*). Target species are often accompanied with bogue (*B. boops*), common pandora (*Pagellus erythrinus*), horse mackerels (*Trachurus spp*.) and a wide range of other teleosts. Besides fish, cephalopods are in common and are represented with squid (*Loligo vulgaris*), cuttlefish (*Sepia spp*.) and shortfin squid (*Illex coindetii*) as well as octopus (*Octopus vulgaris*). Bottom trawling often imply presence of a certain amount of elasmobranch by-catch. Regularly present are small-spotted catshark (*S. canicula*), rays (*Raja miraletus*, *Raja asterias*), with occasional catches of eagle rays (*Myliobatis aquila*), smoothhounds (*Mustelus spp.*) and dogfish (*Squalus spp.*)

Next to the previously mentioned types of commercial fishing, several other gears are relatively in common and present the tradition of coastal area communities. Often noticed can be beach seine nets used at coastline and purse seine nets used offshore whose catches are represented by small pelagic fish with European pilchard (*Sardina pilchardus*) and anchovy (*Engraulis encrasicolus*) in particular. Furthermore, different shape fishing pots and traps are used as well alongside whole coast.

1.3.2 Recreational fishing

From various fishing techniques which this type of recreation implies, those that could have significant interaction with sharks are rare in Montenegro. Common demersal elasmobranchs could rarely be found in catches and additionally in a small abundance. There is one certain type of recreational fishing whose way of implementing creates conditions for shark encountering. The big game fishing is widely distributed method for adrenaline and adventurous fishing for big pelagic species which becomes more and more popular in Montenegro. Desired and targeted species in this area are bluefin tuna and swordfish that drifting longlines are being used to catch as well. Because of fishing across the pelagic zone, large pelagic elasmobranchs are sometimes found as present in its catches.

1.4 Sharks in national legislation

According to the Law on Marine Fisheries and Mariculture (Official Gazette of Montenegro No. 56/2009, 47/2015), it is forbidden to remove the head, skin and fins from any shark or ray. It is required for all shark species to be kept and sold in the condition as in they was caught while fishing operation. Furthermore, it is forbidden to cut off shark fins for the market and throw back their bodies to the sea. Law provision fine for these infringements is 250 to 500 euros for individuals as well as 500 to 20.000 euros for legal entities. In addition, 16 shark species are protected by the law[2], for which their catch is constantly banned. These are: *Cetorhinus maximus, Carcharodon carcharias, Carcharias taurus, Galeorhinus galeus, Isurus oxyrinchus, Lamna nasus, Odontaspis ferox, Oxynotus centrina, Pristis pristis, Pristis pectinata, Sphyrna lewini, Sphyrna zygaena, Sphyrna mokarran, Squatina aculeata, Squatina oculata* and *Squatina squatina*. Each individual of these species must be released alive and unharmed if they are caught accidentally. In case of finding of an already dead shark, they must be landed in order to determine the cause of death. Additionally, basking shark (*C. maximus*) and great white shark (*C. carcharias*) are protected

2 Order on fishing ban of age classes of fish and other marine organisms (Official Gazette of Montenegro No. 26/15)

by the decision[3] declared in 2006 by the former institute for Nature Protection which is now part of the Environmental Protection Agency. Beside the strict protection of a few sharks, minimum allowed length for three commercially important species is stipulated[4] as well. For common smoothhound (*Mustelus mustelus*) minimum allowed length is declared to be 75 cm, for blackspotted smoothhound (*Mustelus punctulatus*) it is 60 cm and for spiny dogfish (*Squalus acanthias*) it is 65 cm. Big game fishing is still under the common recreational fishing licences in this country. There are no declared quotas for tuna, neither swordfish determined by the legislation for which the fishing season is constantly opened. Recreational fishing is regulated by the Law on Marine Fisheries and Mariculture (Official Gazette of Montenegro No. 56/2009, 47/2015).

1.5 Project objectives

This three-year lasting project and associated research have been initiated because of the lack of scientific data on statuses of sharks and other elasmobranchs in the Montenegrin waters. The main goal was to provide an insight into the interactions between local fisheries sector and the native shark species within target area. Low ecological awareness regarding these species of both general public and representatives of institutions, was found to be an issue. Since caught sharks are considered mostly as a non-targeted species they are often killed due to the widespread opinion that they are very dangerous for humans. This lack of knowledge and awareness of the fishing community has become contributing factor to the issues and was also subjected to the project's intervention.

Project's specific aims were:

1) *To collect data on sharks by-catch in the field*

This was carried out by fieldwork observations which included assessment and monitoring of the three commercial fishing fleet segments and big game fishing as a way of the human recreation. Diversity of shark species, definition of their interactions with fisheries and determining their abundances in catches were taken as the primary goals under this task.

2) *To collect socio-economic related data on specific shark species*

This was accomplished through review of the documentation on marine commercial fleet, related socio-economics and desktop analyses of the findings.

Photo 3. Catch of a single trawling haul (Bar, Montenegro) Photographer: Ilija Ćetković

3 Decision on protection of individual species of plants and animals (Official Gazette of Montenegro No. 76/06)
4 Order on fishing and selling ban of fish young, juvenile fish and other marine organisms (Official Gazette of Montenegro No. 65/2015)

In addition, interviews of fishermen/fish market actors on the economic importance of sharks and its relation to human well-being were conducted to obtain directly shark-dedicated data.

3) *To collect spatial data on different shark species in order to determine areas with their higher abundance*

This was conducted through the interviews with fishermen community members to supplement data collected from project fieldwork and aimed to collect local knowledge on sharks. As for their constant presence at the sea, these cognitions are found to be good sources of information and significant contributing factors.

4) *To assess the legislation and its enforcement issues, awareness and possibilities to reduce the level of incidental and intentional mortality of sharks*

This was done through raising awareness on multi-level, multi-stakeholder groups through providing educational material, media and social webs articles, school presentations and workshops about sharks. This task aimed to support improvements in knowledge and local communities' involvement into protection of these endangered species. As Montenegro declares itself as ecological state, such bad attitudes towards endangered species can negatively reflect on its declaration.

2. Methodology

The research on shark species by-catch was conducted in the period from 2016 to the end of 2018. Several approaches were combined in order to create ability to assess the situation in short period and identify major issues and what perpetrates them to be able to address the courses and provide recommendations for situation improvements. These are desktop analyses, in the field research and monitoring as well as interviews explained more in details below.

On board and at landing points field observations of four fleet segments were conducted including: from commercial ones, pelagic longlines, nets (both gillnets and trammel nets) and trawlers; while selected kind of recreational fishing was the big game fishing due to its high potential of interaction with large pelagic predatory sharks. Several other types of fishing gears as seine nets, purse seine or traps were not considered as those significant for this kind research due to low possibility of shark encounters and were not subjected to the assessment of shark by-catch. Main goal of the research was to define species that can be found in Montenegrin landings as well as to make preliminary assessment of their abundance in the catches of surveyed gears. As for multiple limitations, lack of human and financial resources, not all gears were surveyed within the project's three year lasting period constantly. Pelagic longlines and big game fishing teams were monitored for a longer time due to the lower abundance of large pelagic species and therefore it was needed more in the field time for collecting a certain amount of spatial and biological data sufficient for analyses. Trawlers were monitored only in the last year, but an insight into their interactions with sharks has been successfully accomplished.

2.1 Study area

Survey was conducted across the whole Montenegrin coastal waters. The only part of the area that was not covered was the inside part of the Boka bay due to its position deeply in mainland, prohibition of trawling and without usage of pelagic longlines and big game fishing within its surface. Surveyed gillnets and trammel nets were mainly present closer to the coastline at relatively lower depths, usually up to 30 meters. The area of interest of trawls, pelagic longlines and big game fishing was far offshore, often close to the international waters. Fieldwork was implemented using local fishermen' vessels from the ports of Herceg Novi, Tivat, Budva, Bar and Ulcinj or their nearby coastal settlements. For all on board samplings, spatial data of vessels path or position were collected using Garmin GPS device and were later used to supplement the distribution range of found species within the country's coastal sea. Locations of the all on board observations are shown on Map 1.

2.2 Fieldwork data collection

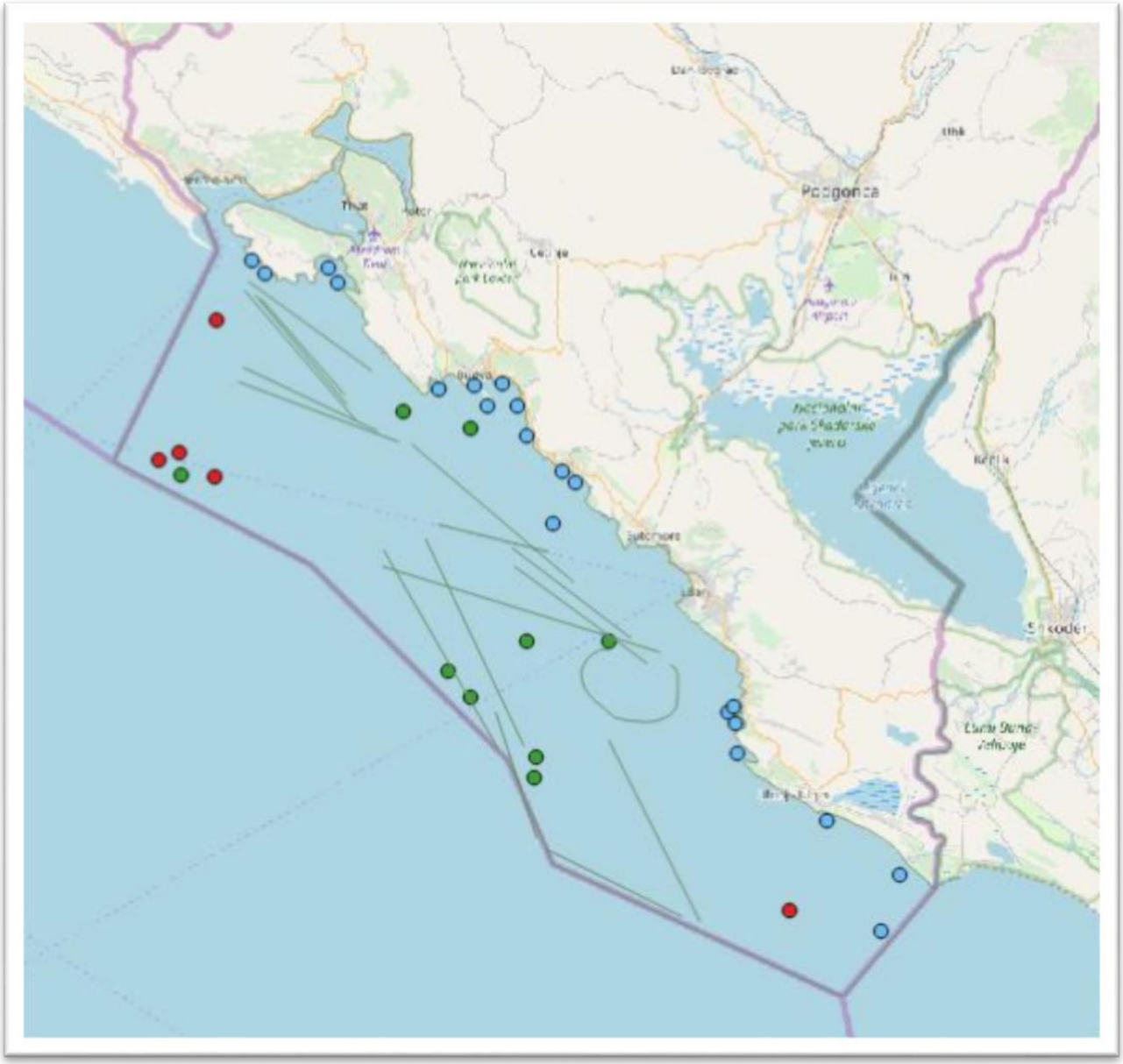
Monitoring of fisheries activity on the vessel

Fieldwork observations were done both on board of local fishing vessels and at their landing sites. Project team for collection of data was consisted of five persons, 3 biologists and 2 local fishermen interested in nature conservation actions. Fieldwork was performed mostly during the warmer part of the year (from March to November) during the fishing seasons of 2016, 2017 and 2018. The remaining part of the year was not surveyed in the field due to lower fishing activity, bad weather and therefore harder conditions for survey. Drifting longlines and big game fishing were monitored during colder part of the year in a few rare cases when they were lowered, but with establishment of regular contacts with fishermen whose gears were surveyed.

Drifting longlines and big game fishing teams were monitored during the all three years of survey. 70 fieldwork days were carried out to cover these two fishing activities operating in pelagic zone. In total, 700 hooks of drifting longlines were constantly monitored within the Montenegrin coastal sea. Concerning the big game fishing, activity of four fishing teams was observed during the whole three years by the mentioned in the field observations and by contacts with fishermen when not on board.

Observing of net related small-scale fisheries was done in 2017 and 2018, with trawl surveys conducted only in 2018 due to limitations in time and resources. As the goal was to determine the composition of sharks catch by each gear separately and the frequency of their occurrence in its catches, the difference among surveyed periods and its runtime was not considered as limitation of significant importance. Trammel nets and gillnets were sampled sporadically alongside the coast due to majority of

MAP 1. Locations where fieldwork observations were undertaken.



Lines – trawling hauls Green – big game fishing
Red – drifting longlines Blue – gillnets and trammel nets

Composition and abundance of shark by-catch in Montenegrin fisheries
Date: November 2018

variations in their types, target species and spatial/temporal differences in their utilization. Moreover, considering the above time limitation was an important factor for the possibility of regular surveying. Because of these reasons, data about shark catches in nets were additionally collected by interviews directly from fishermen.

Trawling data has been collected from 17 trawling hauls from the different areas of country's coastal sea. In total, 285.578 kilometres (154.2 nautical miles) of trawling have been processed. Research was done with 4 vessels out of 11 registered at the Ministry of Agriculture and Rural Development for the 2016. Trawling sample was supplemented by interviews with more fishermen belonging to this fleet segment, but results have not shown any variations in term of species composition neither their abundances.

Survey by interviews

Majority of distribution data were collected by fulfilling the questionnaires with a map of Montenegrin coastal waters prepared in free and open source Quantum Geographic Information System (QGIS) and overlapped with a grid. As kilometres are more common and practical in use than nautical miles, the grid had 2x2 km squares because 1 NM is almost equal to 2 km (1.852km), which enabled fishermen to be easily oriented due to their common expressions in nautical miles. Each fisherman was asked to provide information on species of sharks which he has caught, encountered or observed in a different way. After species were determined, he was asked to put the marks on the provided map for each one separately. Additional purpose of the interviews was to find out catches or encounters with species that was not possible to observe while implementing fieldwork observations.

Afterwards, socio-economic information related to sharks were collected. The aim of this part of survey was to determine the general opinion of fishermen community about importance of sharks for their economy, sustainability and personal well-being. In order to find out the socio-economic importance of this species group for each fisherman, the survey was conducted using prepared questionnaires to provide the following data:

- Information on species status: commercial/not commercial, is it target or by-catch (if by-catch: retained or discarded)

- Information about price if they sell the species

- The opinion on species importance for their well-being expressed as: very important, desirable or without importance

Photo 4. Interviewing the local fisherman

Photographer: Ilija Ćetković

One filled in complete questionnaire form is shown in Annex I. A total sample of 32 interviews has been fulfilled out of 57 vessels in Ministry of Agriculture and Rural Development database on population of active commercial fishing fleet[5] in 2016. Socio-economic data from 7 trawlers and 18 small-scale fishers was collected. Seven interviews more were completed with big game fishing teams for which exact estimation on the size of the segment was not available. Interviews filled out by BGF teams are without socio-economic data because they are considered under the recreational fishing and are not allowed to sell fish. The collected data was processed to find out commercial importance of each species separately and their average prices if they are subjected to sale.

Biological data collection

For biological data, total lengths of the individuals were collected, as well as weights. Total length (T_L) was defined as the distance between the snout to the point on the horizontal axis intersecting the perpendicular line that is extended down from the tip of the upper lobe of caudal fin and creates the right angle with the axis (Kohler *et al*. 1996). Weight was measured for all individuals separately with except of *S. canicula* due to the high number of individuals of the relatively similar size. For a few cases where it was not possible to measure weight due to occurred limitations (e.g. need for immediate release of the specimen) as for some individuals of vulnerable species, it was calculated using length-weight data obtained from FishBase[6] by the formula:

$W = a \times L^b$

Furthermore, data on sex were collected for each individual as well as data on life stage separated as following: newborn, juvenile and adult. Data on individuals' condition (dead or alive) if they were discarded was recorded for species considered as endangered, too. Data collecting form has been shown in Annex II.

The big game fishing is a specific type of fishery in comparison with other ones due to its implementing at the same place during the day which creates a need for chumming in order to attract the target fish. The chum is also responsible for the attraction of sharks. For this purposes, the used chum was consisted of European pilchard (*Sardina pilchardus*) and twait shad (*Allosa fallax*) from the Adriatic Sea.

A certain number of shark species has been characterized as threatened by the Appendix E of the General Fisheries Commission for the Mediterranean DCRF Manual[7] (Version 2018.1). Manual's Task III refers to the incidental catches of vulnerable species defined by the GFCM recommendations as well as those listed on Annex I and Annex II of Barcelona Convention[8]. For the species that are listed on the mentioned appendix, data were shown separately in the results in correspondence with DCRF manual's task III due to their vulnerability and need for detached monitoring of their catches. Furthermore, it is suggested to collect data for the rare species of sharks even if they are not included in the mentioned annexes thus such sharks were presented in the same way.

5 According to MONSTAT, 135 vessels were registered for commercial fishing in 2016. Data has been downloaded from: https://monstat.org/cg/page.php?id=265&pageid=162, on 02/11/2018.

6 Data for a and b parameters were obtained from FishBase and calculated as it is described in http://www.fishbase.org/manual/fishbasethe_length_weight_table.htm.

7 Appendix E – Vulnerable Species in Data Collection Reference Framework manual published by General Fisheries Commission for the Mediterranean. GFCM, 2018. GFCM Data Collection Reference Framework (DCRF). Version: 2018.1

8 Barcelona Convention: United Nations Environment Programme and Mediterranean Action Plan. 1995. Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean.

Photo 5. Chumming for tunas and swordfish in big game fishing (Bar, Montenegro) Photographer: Mirko Dragović

Photo 6. Measuring the total length of blue shark caught by a drifting longline (Herceg Novi) Photographer: Milica Zečević

2.3 Desktop data collection

Desktop research implied review of national legislation which includes or protects sharks. In addition, socio-economic data from the Ministry of Agriculture and Rural Development was used to give better overview of collected economy-related parameters and findings. Moreover, official data about characteristics of Montenegrin commercial fishing fleet have been found by research of websites of state agencies and country's office for statistics. Desktop review of published scientific literature was undertaken in order to obtain data about presence of other species of sharks which were not recorded during this survey.

2.4 Data analyses

2.4.1 Distribution data

Data from fieldwork samplings and interviews was input together into maps separately for the certain number of species. For those occurred once or a few times, data was jointed into the same map in order to provide an extenuating overview. Map of distribution of too abundant and least concern species as *S. canicula*, was not created.

2.4.2 Socio-economic data analysis

Answers provided by the fishermen were processed in order to obtain the most common opinions on discussed themes. As the type of used questions was mostly descriptive and lengthy, with individually characterized answers, they were described in the part about socio-economic findings without possibility of presenting them in figures except the opinions of species' statuses. Moreover, selected statistical data obtained from the Directorate for Fisheries was also included into the findings to provide a closer picture of socio-economic performance of Montenegrin fisheries. Included data implied information collected in socio-economic survey of the Ministry for the 2016.

2.4.3 Catch per unit of effort (CPUE) calculation

GPS tracks of trawls and data about other fishing gears were used to calculate the nominal[9] catch per unit of effort (CPUE) for the sampling period. GPS tracks were processed using Garmin HomePort software. Number of sharks caught by each fishing gear was divided with a different unit considered as suitable for each examined gear as following:

- trawling: the number of sharks/kilometre of trawling

- pelagic longlines: number of sharks/number of 100[10] hooks

- big game fishing: number of sharks/10 fishing days

Data obtained for surveyed gillnets and trammel nets did not satisfy the criteria for CPUE calculation and it served to supplement distribution data and identify the species that can occur in the catch of those fishing gears. CPUE was not calculated because of many different types of these nets and a large number of variations in their usage ways as it was already explained.

9 Raw CPUE, also called nominal CPUE, is simply the total catch divided by the sum of an observable measure of effort associated with the catch, e.g. total number of hooks for longline fisheries. CPUE is usually calculated for a defined time period (Maunder et al., 2006).

10 Nominal CPUE for sharks caught by pelagic longlines is more commonly expressed as number of individuals/1000 hooks, but due to the small amount of deployed hooks that could been surveyed it is reduced to 100. Moreover, drifting longlines are usually not main gear and not so common within the fleet, which is the reason for a small number of hooks available for surveying.

3. Findings and results

3.1 Biological data

3.1.1 By-catch composition and species diversity

During the surveyed period, 9 species of sharks have been observed as present in the catches of Montenegrin fishing fleet and those are:

- Common smoothhound (*Mustelus mustelus*)
- Longnose spurdog (*Squalus blainville*)
- Small-spotted catshark (*Scyliorhinus canicula*)
- Common thresher shark (*Alopias vulpinus*)
- Blue shark (*Prionace glauca*)
- Shortfin mako (*Isurus oxyrinchus*)
- Angular rough shark (*Oxynotus centrina*)
- Sandbar shark (*Carcharhinus plumbeus*)
- Bluntnose sixgill shark (*Hexanchus griseus*)

This represents 31.03 % of shark species diversity in the Adriatic Sea according to the used literature source. Beside the species that are found as currently present, there are potential evidences and fishermen testimonies from the previous years that are confirming the presence of other sharks. By the desktop research, presence of four more species has been confirmed in Montenegro. *Galeus melastomus*, *Scyliorhinus stellaris* and *Etmopterus spinax* were found in the area of Montenegrin territorial waters and nearby part of the Adriatic Sea during FAO Adriamed trawl surveys (Mediterranean Action Plan, 2009). *C. carcharias* was documented as present in Montenegrin waters (Regner & Joksimović, 1998). *S. acanthias* was also recorded according to the literature and was found to be present more than *S. blainville* (Regner & Joksimović, 2000), thus this species was not found as currently present during this survey except by testimonies of locals.

In talks with fishermen, catches or encounters with spiny dogfish (*S. acanthias*), basking sharks (*C. maximus*), sharpnose sevengill shark (*Heptranchias perlo*), other smoothhounds (*Mustelus asterias, Mustelus punctulatus*), porbeagle (*Lamna nasus*) and an encounter with hammerhead shark (*Sphyrna spp.*) were found to be possible in the previous period. Certainly, at least some of these species inhabit this part of the Adriatic, but due to their low abundance and relatively short period of the research, there was low

Photo 7. Longnose spurdog (Squalus blainville) caught by trawling

Photographer: Ana Jevremović

possibility of encountering them.

For the nine species observed the data on the International Union for the Conservation of Nature (IUCN) status and population trends as well as national legislation status were compared in order to analyse broad and local context of assessment and protection. It has been found that out of three critically endangered by IUCN Mediterranean status two are nationally protected with the permanent fishing ban. The rest are not protected by the provision of Montenegrin law. For details please see table 1.

Table 1: Review of IUCN Red list and national protection statuses of found species (Data downloaded on22/08/2018)

Species	IUCN status (Global)	IUCN status (Mediterranean)	National legislation	IUCN Population trend (Global)
M. mustelus	Vulnerable	Vulnerable	Not protected	Decreasing
S. blainville	Data deficient	Data deficient	Not protected	Unknown
S. canicula	Least concern	Least concern	Not protected	Stable
A. vulpinus	Vulnerable	Endangered	Not protected	Decreasing
P. glauca	Near threatened	Critically endangered	Not protected	Unknown
I. oxyrinchus	Vulnerable	Critically endangered	Permanent fishing ban	Decreasing
O. centrina	Vulnerable	Critically endangered	Permanent fishing ban	Unknown
C. plumbeus	Vulnerable	Endangered	Not protected	Decreasing
H. griseus	Near threatened	Least concern	Not protected	Unknown

3.1.2 Spatial analysis of distributions

Regarding the distribution of *M. mustelus* and *S. blainville* as commercially important species, are found to be present within the same areas and often together in catches (Map 2.). *S. blainville* presence was found only at localities with higher depth (often over 50 meters) and in very small abundance in comparison to *M. mustelus*. *M. mustelus* found to be abundant in the area of Bojana river estuary, in the area from the city of Budva to Petrovac, Bigova bay and a smaller part of Boka bay, respectively. Areas on Map 2. marked far offshore are determined by trawlers as those where they caught higher numbers of individuals of these two species in a single hauls. During the interview survey, other areas with occasional findings of one or a few individuals were marked by fishermen, but they are not displayed in order to have better overview of localities considered as important habitats for these species within the area.

A certain limitation can be found in assessing of distribution of pelagic species because of their intensive migrations. Despite this fact, still some locations are more attractive to their individuals and they can be found more likely there. As the survey showed, highly migratory species as blue shark (Map 3.) or shortfin mako (Map 4.), are often visiting pelagic zone around bigger reefs in Montenegrin coastal sea. Locations of those characteristics are located far from coastline, all of them with the distance of at least over 7 nautical miles from the closest location on mainland. The biggest and most important ridges are Barska seka[11], Budvanska seka, Petrovačka seka and Lega localities whose positions are close to border with international waters. Adults and older juveniles of pelagic sharks are found at these sites rather than in other areas, probably because of available food resources which are represented by higher concentration of different species of fish. Almost all individuals of pelagic sharks were found close to these areas, with blue shark and shortfin mako regularly present. Only newborns of blue shark are found in several localities close to coastline at lower depths probably because they are born there and such habitat was suitable for them until they grow up.

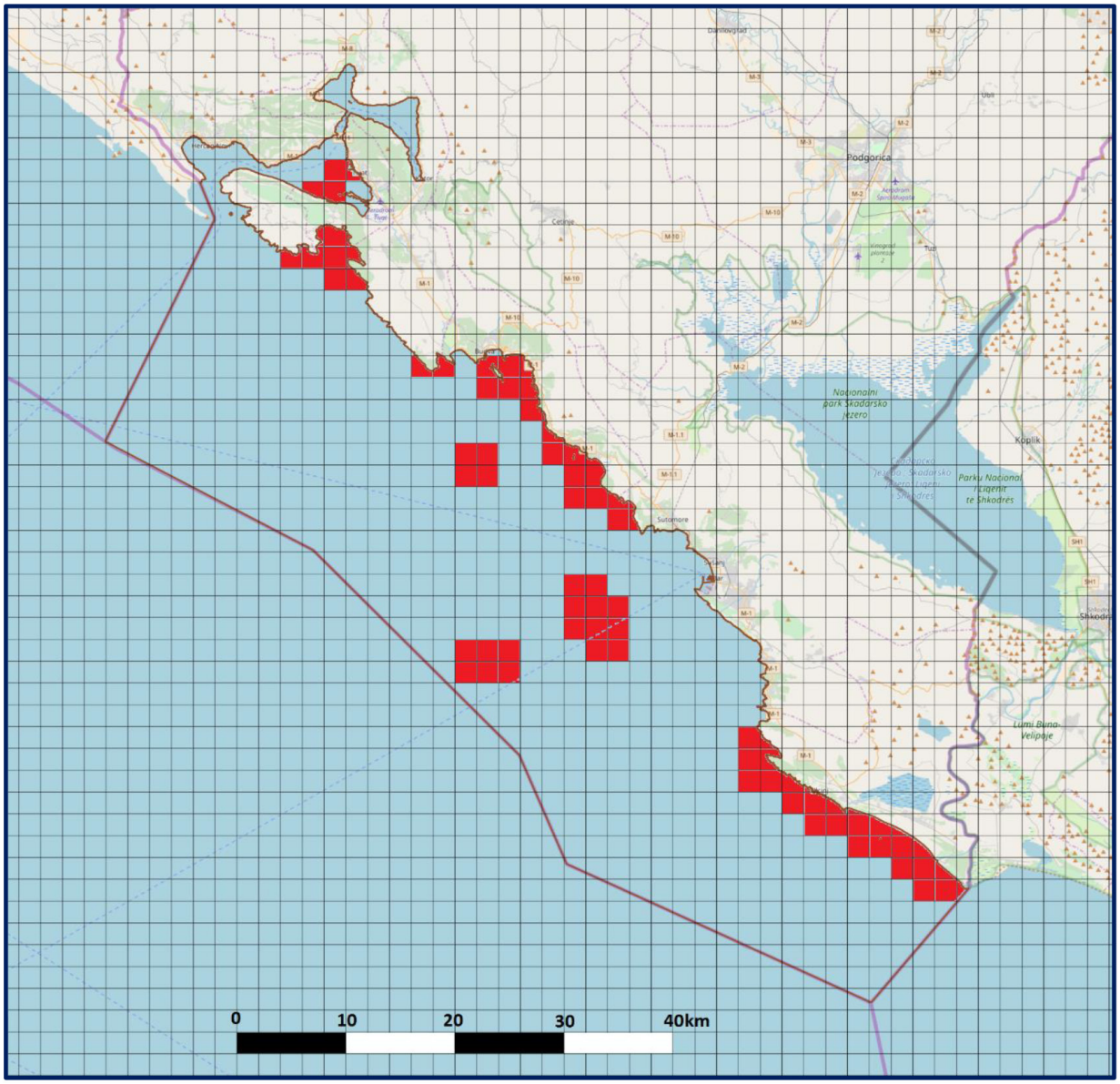
S. canicula as the most abundant species was not considered for the spatial analysis due to its wide distribution along the whole Montenegrin coastal sea. Besides the individually assessed sharks, a map more was created to display the single catches of rare species which were recorded during the survey (Map 5.).

3.1.3 Biological characteristics

The Table 2. presents the summary of collected biological data about individuals of each found species. Length range varied among the species, especially large ones. Among specimens of large pelagics as *P. glauca*, all life stages were observed as present in Montenegrin waters and found were all from new-

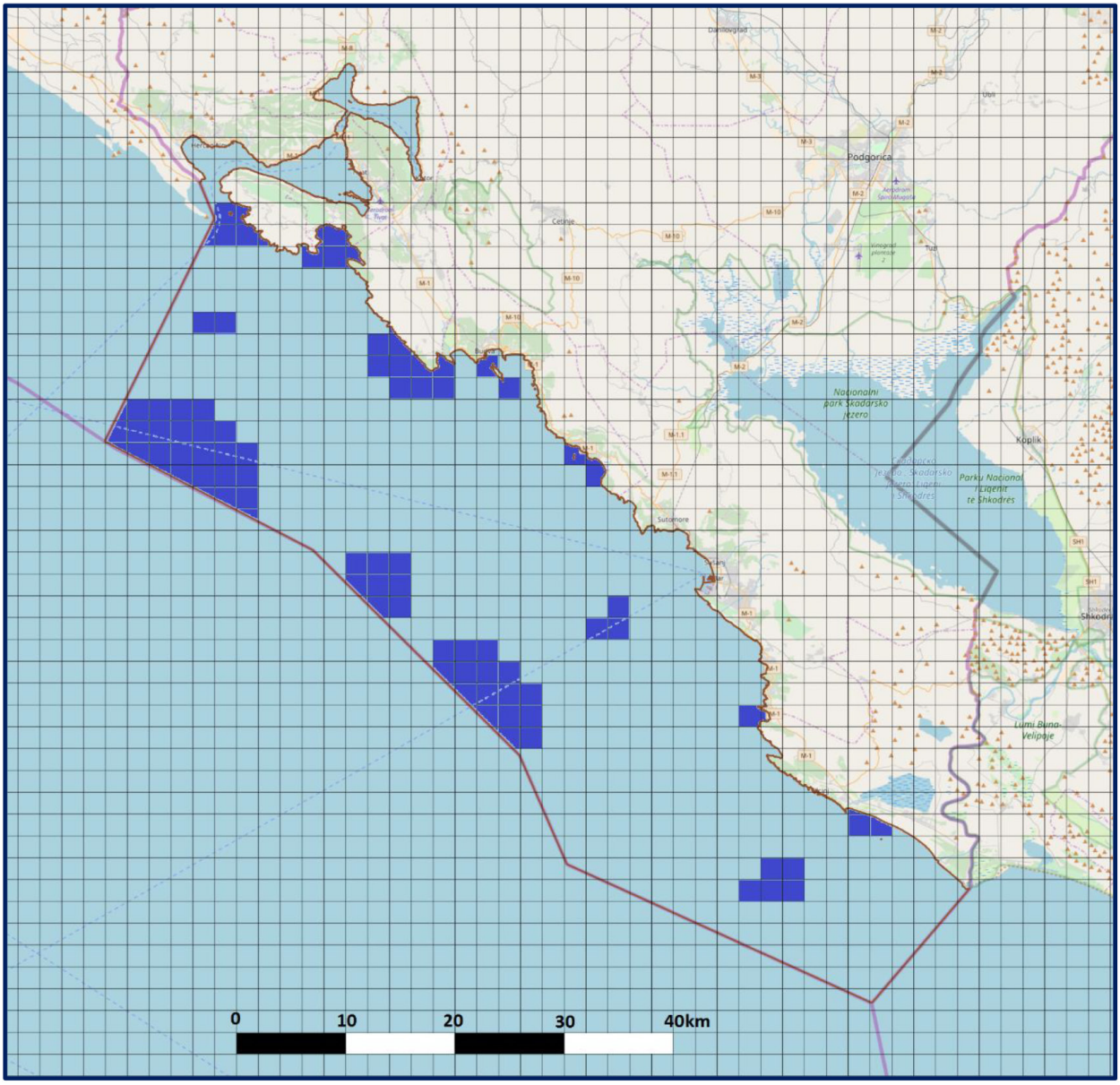
11 The Montenegrin word "seka" is equal to reef, ridge and those places are often named after the coastal settlements by local fishermen. Most of the far offshore fishing activities, both commercial and recreational are found to be performed at these areas or close to them.

MAP 2. Regions with higher abundance of common smoothhound (*Mustelus mustelus*) in the surveyed area.



Composition and abundance of shark by-catch in Montenegrin fisheries
Date: November 2018

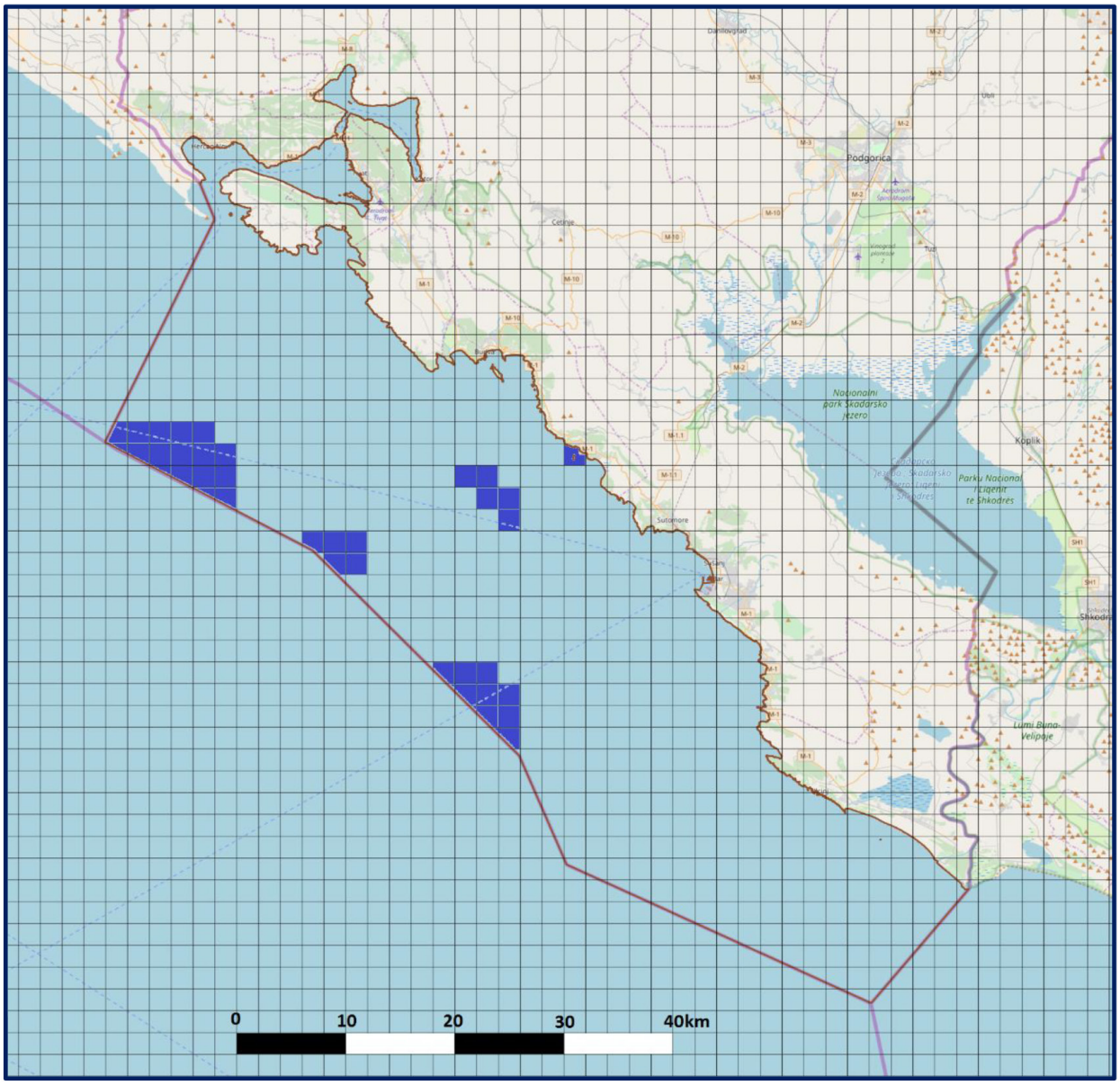
MAP 3. Distribution range of blue shark (*Prionace glauca*) within the study area.



CRNOGORSKO DRUŠTVO EKOLOGA

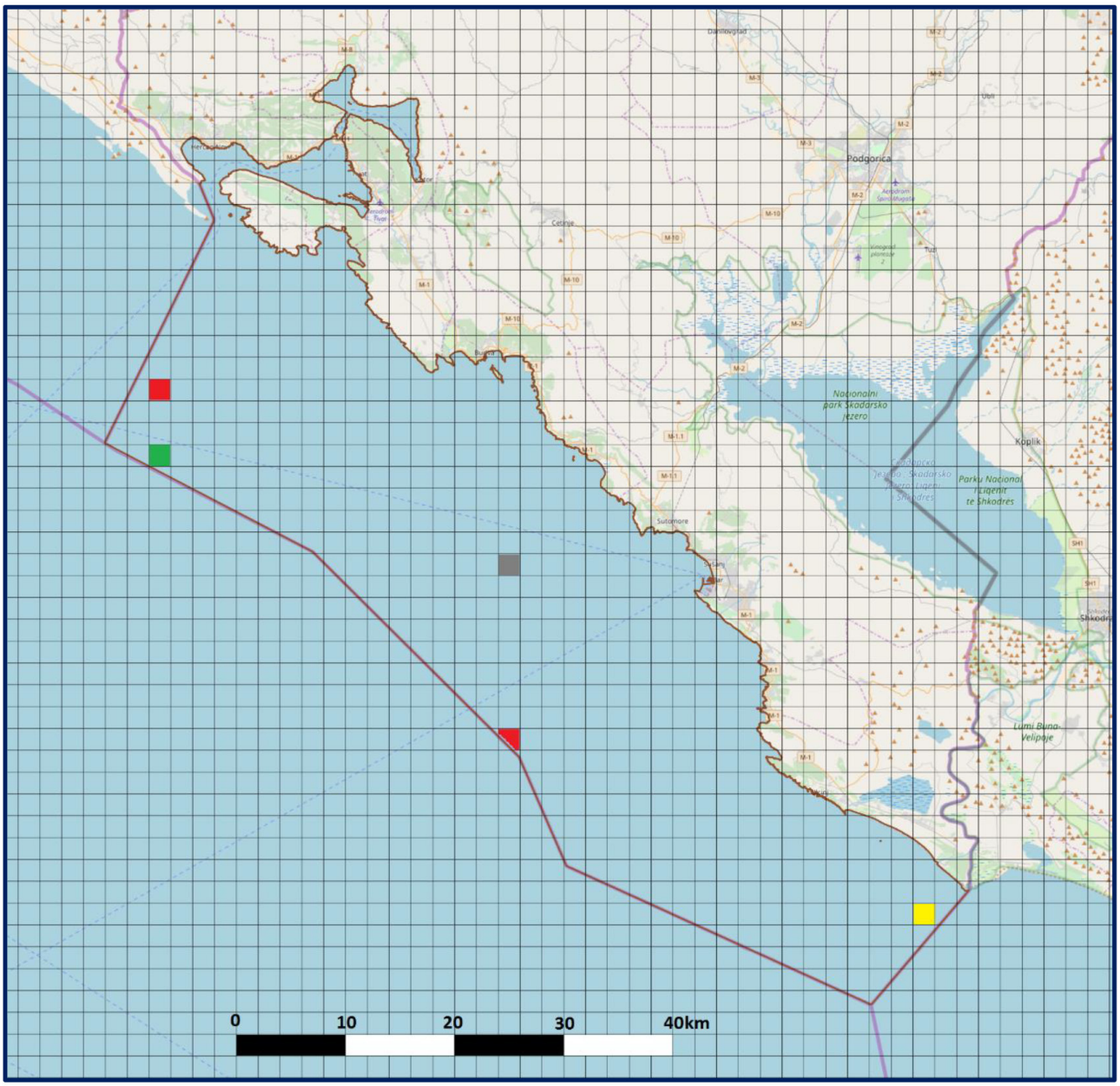
Composition and abundance of shark by-catch in Montenegrin fisheries
Date: November 2018

MAP 4. Localities of shortfin mako (*I.oxyrinchus*) occurrence within the surveyed area.



Composition and abundance of shark by-catch in Montenegrin fisheries
Date: November 2018

MAP 5. Records of rare shark species in Montenegrin waters found during the survey.



Red – *O. centrina* Green – *A. vulpinus*
Grey – *H. griseus* Yellow – *C. plumbeus*

Composition and abundance of shark by-catch in Montenegrin fisheries
Date: November 2018

born individuals up to larger adults with weight of 130 kg. Similar situation is found in the case of *I. oxyrinchus*, from which all specimens were juveniles, but with a single record of a newborn. For this species, larger adults weren't occurred during the observations, but several fishermen claim they had an encounter with a large mako shark.

Regarding the commercial species, especially *M. mustelus*, most of observed specimens were in the size allowed for exploitation or very close to it. Its biggest observed specimen was 1,48 m in length with 8 kg of weight and it was caught by a big game fishing team.

S. canicula was the most common shark species represented in high numbers within the Montenegrin coastal sea. According to the used literature source (Ellis & Shackley, 1997), all found individuals were not reached length at first size maturity. For 494 individuals recorded and measured, sex ratio was 45,2% opposite to 54,8 % in the favour of males.

Other species, *A. vulpinus*, *H. griseus*, *C. plumbeus* and *O. centrina* are found to be too rare in catches of this country's fisheries and their population structures can't be assumed and discussed as for the lack of data which can be collected in such short period.

In the data collection process researches faced some limitations. Some data types weren't obtained because individuals were released back to the sea due to poor health condition or other reasons. Both individuals of *O. centrina* were found in trawl catch, but due to the occasional poor look of the specimens and with it connected vulnerability, they were immediately released.

Moreover, 17 more individuals of smoothhounds were observed in landings of both trawls and gillnet fisheries next to the on board fieldwork observations. Those were not measured because of previous removal of their heads, skin and fins. Even the species was not possible to distinguish apart from the difference between *Squalus spp*. and *Mustelus spp*. due to the presence of spines close to dorsal fins in genus *Squalus*, so the fishermen would remember if they were present. Fishermen declared that none of the 17 individuals had spines, so it was assumed that they belong to the species from the genus *Mustelus*. The mentioned 17 sharks were not included in the Table 2. due to possible presence of other species from genus *Mustelus*.

As for some of the nine species observed there were not enough specimens analysed as they do not represent common catch in Montenegrin fisheries, some biological data are missing, as they would not be based on the statistically significant numbers. As most of the species found to be not so common catch in Montenegrin fisheries, there is a lack of statistically significant data.

Table 2. Biological characteristics of found individuals

Species	*M. mustelus*	*S. blainville*	*P. glauca*	*I. oxyrinchus*	*S. canicula*	*O. centrina*	*H. griseus*	*A. vulpinus*	*C. plumbeus*
Number of individuals	8	2	33	13	494	2	1	1	1
Minimum length (m)	0.795	0.578	0.535	0.83	0.198	-	-	-	-
Maximum length (m)	1.48	0.799	2.6	1.400	0.488	-	2.41	4.5	1.1
Average length (m)	1.057	-	1.227	1.192	0.369	-	-	-	-
Minimum weight (kg)	0.94	0.72	0.401	3	-	-	-	-	-
Maximum weight (kg)	8	1.12	130	35	-	-	115	140	2.8
Average weight (kg)	3.717	-	21.567	19.732	0.159	-	-	-	-
Number of males	1	-	7	-	271	-	1	-	-
Number of females	7	2	15	7	223	-	-	1	1
Unknown sex	-	-	11	6	-	2	-	-	-
Number of adults[12]	8	1	9	-	-	-	1	1	-
Number of juveniles	-	1	13	12	494[13]	-	-	-	1
Number of newborns	-	-	11	1	-	-	-	-	-

12 Life stages (adult, juvenile and newborn) were determined by the data about length size at first maturity obtained from FishBase and IUCN Redlist (http://www.fishbase.org, https://www.iucnredlist.org)

13 It is estimated that S. canicula reaches sexual maturity at 52-65cm of T_L for females and 49-55cm for males (Ellis & Shackley, 1997), so according to the collected length data, all individuals were not reached maturity.

3.1.4 Abundances per fishing gears

Taking into consideration the number of species caught by each gear (Figure 1.), on one hand there is no significance in the term of number of species between the surveyed gears, but on the other hand diversity of species varies. As it is expected, larger sharks are found as by-catch of the gears operating in the pelagic habitat as well as benthic species in those operating close to the bottom. Results showed that large pelagic species as *P. glauca* and *I. oxyrinchus* are caught only with gears that are targeting swordfish, tuna and its relatives. *P. glauca* and *I. oxyrinchus* as strictly pelagics are found only in landings of drifting longlines (LLD) and as catch in big game fishing (BGF). *P. glauca* was the dominant species in both pelagic gears, especially in the catches of drifting longlines. Regarding *I. oxyrinchus*, more of its individuals were recorded in catches of BGF teams which potentially can be explained by the chum use, so these efficient predators are attracted from the wider surrounding area.

Moreover, *P. glauca* was occurred in set gillnets (GNS), but those targeting medium-sized pelagic fish as bonitos, amberjacks and false albacores. Such nets are usually much higher than others, often above 7 or 8 meters in height. Individuals of *P. glauca* caught by this gear were newborns which can be occurred close to coastline where these nets are often lowered. Third large pelagic was *A. vulpinus* that was occurred only once. Moreover, big game fishing was another surveyed gear that affected both pelagic and benthic species. The cause lies in fishermen habit to use several rods with hooks placed on different depths, with some close to the bottom which can potentially catch smoothhounds or catsharks or their individuals are attracted by the chum to the upper water levels. Rare catches of benthic species can be considered as unusual and without importance, because pelagic ones are majority of this gear's by-catch.

Gears fishing close to the sea floor as trammel nets (GTR) and bottom trawls (OTB) as well as set gillnets had several species in the catches. Most abundant was *S. canicula* as the very common by-catch of all mentioned gears, particularly trawls. In the surveyed trawling hauls, 487 individuals were found (this number was excluded from the Figure 1. because of better overview)*. Few of them were recorded in trammel and gillnets and as by-catch in big game fishing. Second abundant species was common smoothhound (*M. mustelus*) represented with 6 individuals found in the fieldwork surveys among commercial gears and 2 more as catch of big game fishing teams. Additionally, 17 more individuals of *Mustelus spp*. were found in commercial landings, but the species was not possible to determine for sure as it was explained before. Another present in these three bottom operating gears were *S. blainville*, *O. centrina*, *C. plumbeus* and *H. griseus* as sporadically catches. Percent of species caught by each surveyed gear are shown in Figure 2.

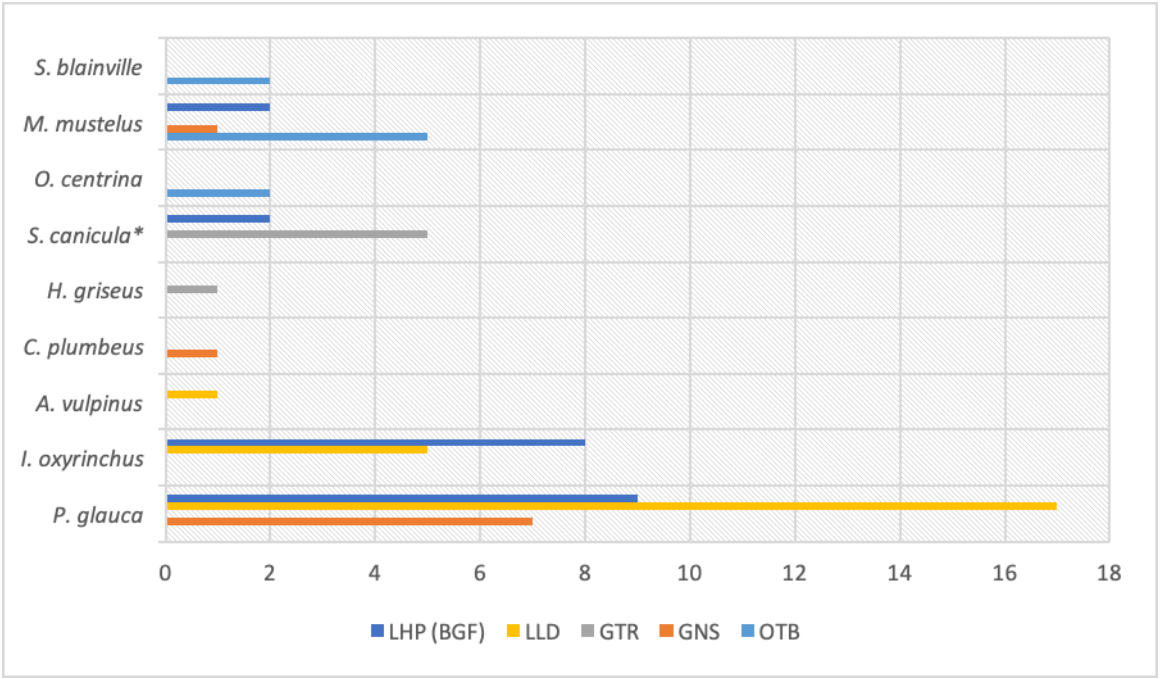


Figure 1. Number of species' individuals per surveyed fishing gears

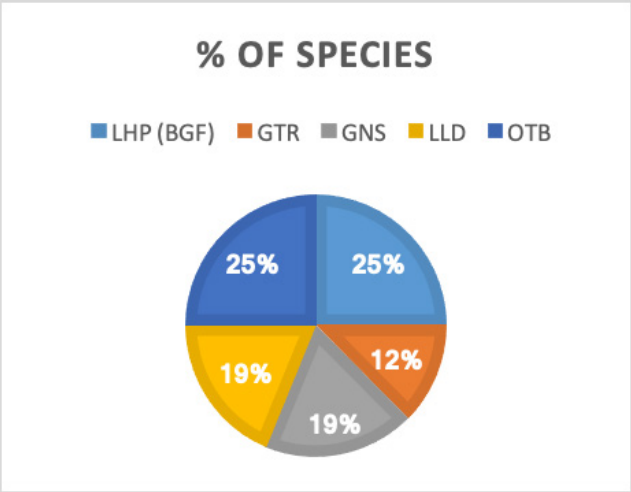


Figure 2. Number of species caught by each fishing gear from the 9 sharks recorded in total expressed in percentage

Species which are listed as vulnerable according to the GFCM's DCRF manual are shown separately in the Table 3., with the data concerning their catches. Mortality of individuals belonging to threatened species was recorded as well, both unintended and intentional (Table 4.). Entangling set gillnets were found to be the fishing gear to have highest mortality rate of endangered sharks with all of caught individuals found dead while net retrieving (100% mortality). After them, drifting longlines are occupying the second place with 16 dead individuals from 23 in total, with death caused either by gear or fisherman himself which represents the mortality of 69.56 %. At the end, big game fishing caused the mortality rate of 29.41 % with 5 dead individuals and 12 released alive. As fishing rod and reel cannot directly cause the death, all 5 individuals were killed by fishermen in order to obtain the trophy or because sharks damaged the fishing equipment, *I. oxyrinchus* in particular. Bottom trawling did not caused any case of endangered shark death. Both recorded individuals of *O. centrina* were in poor health condition, but still alive.

Photo 8. Taking morphometric measures of bluntnose sixgill shark (Hexanchus griseus) found in catch of a trammel net in the area of Buljarica

Photographer: Stefan Ralević

Table 3. Incidental catches of vulnerable species[14] during surveyed period separated by fishing gears

YEAR	2018		2017		2016-2018			
GEAR	OTB		GNS		LLD		LHP (BGF)	
Species	No. of Ind.	Total weight (kg)	No. of Ind.	Total weight (kg)	No. of Ind.	Total weight (kg)	No. of Ind.	Total weight (kg)
O. centrina	2	-[15]	-	-	-	-	-	-
C. plumbeus	-	-	1	2.8	-	-	-	-
A. vulpinus	-	-	-	-	1	140.00	-	-
I. oxyrinchus	-	-	-	-	5	98.72	8	157.80
P. glauca	-	-	7	4.93	17	401.50	9	305.30

Table 4. Number of individuals released alive and number of those found dead or killed by fishermen for species considered as endangered.

Species	No. of dead individuals	No. of alive individuals
O. centrina	-	2
C. plumbeus	1	-
A. vulpinus	1	-
I. oxyrinchus	6	7
P. glauca	18	15

Photo 9. Sandbar shark (Carcharhinus plumbeus) in catch of set gillnet (Ulcinj, Montenegro) Photographer: Ivo Knežević

14 Sharks listed in the Appendix E.1 – Vulnerable species of the GFCM Data Collection Reference Framework (DCRF). Version: 2018.1

15 Total weight for O. centrina was not recorded due to immediate release of both individuals. Project team released one due to bad health condition while another was released by the fisherman.

3.2 Estimated CPUE values

Assessment of shark catches per selected measures of effort for the three gears have been calculated from the data of the on board sampling observations in order to determine CPUE for the researched time period.

During the three years of survey, 700 hooks of pelagic longlines were constantly observed. Exact number of annual fishing days was difficult for counting due to the habit of some fishermen to leave their longlines constantly in the sea during the season (e.g. from March to November). In that situation, the checks of longlines are dependent of weather, fishermen free time and other factors. Due to this, checks potentially can be done every day, or there is a pause of one, two or even more days between two checks. Longlines are often without bait or damaged by ships between the checks and such period cannot be taken into consideration as fishing operation time. Because of this limitation, CPUE was calculated for the total period of survey. As for good relationships with the fishermen each catch of a shark was reported to the project team. In total, pelagic longlines caught 23 individuals of sharks. Estimated nominal CPUE for the surveyed period (3 years) was 3.2857 sharks per 100 hooks of drifting longline.

During the same period, four monitored big game fishing teams caught 21 individual of four species. In the surveyed 3 years, teams have made 230 days at sea. It was an average of 19 days per fishing team annually. Nominal CPUE for four monitored teams was found to be 0.9130 sharks per 10 fishing days. If this value become divided with 4, average CPUE for a single team was 0.2282 sharks per 10 days of fishing.

For trawling operations, CPUE was calculated as number of sharks per a single kilometre of trawling. A sample of 496 individuals of four shark species has been collected from 285.578 kilometres of trawling hauls with absolute domination of *S. canicula*. CPUE value was estimated to be 1.737 sharks per kilometre of bottom trawling.

3.3 Socio-economic findings

According to MONSTAT's data, fishing fleet in 2016 was consisted of 135 registered fishing vessels operating mostly within the territorial waters of Montenegro. However, according to the data obtained from Directorate for Fisheries of the Ministry of Agriculture and Rural Development, active population of fishing vessels in 2016 was 57. According to the Socio-economic analyses and study report produced[16], conducted within the Directorate's survey and project[17], this number was considered as more accurate for this analyses. Montenegrin fleet employed 129 fishermen on board and made an income of 1.5 million euros in 2016. Socio-economic analysis presented in Study report distinguishes four main fleet segments: polyvalent passive segment < 6m LOA[18], polyvalent passive segment 6-12m LOA, purse seine segment and trawler segment 6-24m LOA. From the mentioned segments, polyvalent passive segment <6m LOA had the largest fleet represented with 23 active vessels, but generated the third-placed value of income of 406 thousand euros value of landings. Regarding the value of income in 2016, polyvalent passive segment 6-12m LOA had the highest one and after were trawler segment 6-24 LOA, passive segment <6m LOA and purse seine segment, respectively.

This project's survey also showed that majority of fleet represented by small-scale fisheries operates mostly with gillnets, trammel nets and longlines, both bottom and drifting ones. Among large vessels, bottom trawls are in common, with a very small percent of purse seiners. As the only commercially important and therefore target species, found were smoothhounds (*Mustelus spp*.), particularly *M. mustelus*, followed by *Squalus spp.* (Table 5.). Fishermen consider these species mostly as non-target ones, but as important for their economy due to their delicious meat which is the main reason for the market demand with a certain importance for locals. Every commercial fleet segment retains individuals of these species except in case they are too small to be sold or below the threshold determined by the law.

M. mustelus has been found as the much more common species than *S. blainville* according to both fieldwork observations and fishermen inter-

16 Katnić A. (2018). Socio-Economic Analyses of the Marine Fisheries in Montenegro for the year 2016. Ministry of Agriculture and Rural Development, Montenegro.
17 ADRIAMED Scientific cooperation to support responsible fisheries in the Adriatic Sea programme.
18 Vessel's length overall measure.

views. Furthermore, the only shark-targeted fishery that can be found in Montenegro is dedicated to *M. mustelus*. Despite the fact that it is mostly considered as by-catch, some fishermen in the area around the Bojana river estuary are applying fishery that targets smoothhounds directly. Used gears are set gillnets with bigger mesh size which are placed in the mentioned area. Gillnets are lowered in a habitat characterized with predominantly sandy bottom, with high amount of different food sources and very suitable for these sharks as well as for other fish. For these fishermen, existent smoothhounds stocks represent significant source of income and are very important for the sustainability of their fisheries. Fishermen across the whole Montenegrin coast sell these two species from 8 up to 12 euros per kilogram of meat that is cleaned off skin and other unusable parts.

Table 5. Species retaining status per fishing gear: target = T or by-catch = B (retained = R or discarded = D)

Species	Bottom trawl	Gillnets	Pelagic longline	Big game fishing
M. mustelus	B (R)	T, B (R)	-	B (D)
S. blainville	B (R)	-	-	-
S. canicula	B (D)	B (D)	-	B (D)
A. vulpinus	-	-	B (R)	-
P. glauca	-	B (D)	B (D)	B (D)
I. oxyrinchus	-	-	B (D)	B (D)
O. centrina	B (D)	-	-	-
C. plumbeus	-	B (D)	-	-
H. griseus	-	B (D)	-	-

Besides these, other found species are not considered as commercial, are without any importance for fishermen and except in rare cases are always discarded. For example, sometimes large pelagic sharks are sold for small amount of money (up to 4 euros per kg) or changed for the certain amount of fish later used as bait for longlines (mackerels, sardines, etc.).

An interesting finding can be occurred in the case of *S. canicula*. Its individuals are discarded in almost all of the cases, but many fishermen claim that the meat of this shark is good as one of smoothhounds. It can be easily sold, but only if the individuals are cleaned off. Otherwise, it can be potentially sold for very small price (maximum 2-3 euros per kg) and with many obstacles while selling process. The reason why fishermen do not sell it lies in the fact that it is very difficult to clean off many individuals to get an amount with an economic significance. Moreover, such process takes a lot of time, so they discard all of them in majority of cases. Another fact is that cleaned *S. canicula* individuals can get price almost as high as smoothhounds (up to 8 euros). Therefore, this situation can be potentially used both to reduce the fishing pressure on commercial species of sharks and improve the socio-economic state of fishermen community. Individuals of this species are much more present in catches and are often discarded dead or in bad health condition anyway.

Photo 10. Shortfin mako shark (I. oxyrinchus) killed by a local fisherman and showed as a trophy (Budva, Montenegro)

Photographer: Ilija Ćetković

Photo 11. Cleaning of unusable parts from S. canicula individuals and preparing for selling

Photographer: Ilija Ćetković

4. Conclusions

Analyses of the gathered data provided insight into the situation of the shark by-catch composition, abundance and distribution in Montenegro. Moreover, it identified status in the legislation and its enforcement, fishermen practices and its socio-economic aspects. Following on this several concerns and recommendations are made. Main conclusions of the study are laid down below:

- Shark by-catch in the surveyed area is generally consisted of common species, regularly present in the Adriatic basin. The interaction of several species can be observed either usually or in occasional cases in correspondence with their natural abundance in the ecosystem. Smaller sharks, *S. canicula* or *M. mustelus* are present in catches of different gears in many cases. Another shark group, the large pelagics as *P. glauca* and *I. oxyrinchus* can be spotted offshore and as by-catch of pelagic fisheries, but much rare than previous sharks which is connected with naturally smaller abundance of large sharks as apex predators in marine food chains.

- Concerning biodiversity records, beyond the frame of common species, a few more sharks can be observed and are found to be present. Special focus should be put on *O. centrina* and *C. plumbeus* as a rare and endangered species in the Adriatic Sea. Moreover, occasional records of *A. vulpinus* and *H. griseus* should be taken into consideration too and subjected to long-term monitoring in order to collect better dataset on all of these highly threatened species. The monitoring should be established and undertaken because of possible records of other endangered sharks.

- Regarding the socially important and community's well-being role of sharks, Montenegrin fisheries are not dependent on these animals in general, neither have they targeted them. The only shark depending fishery was the explained gillnet fishery taking into consideration only smoothounds abundant at sandy bottom area close to Bojana river in the southern part of the country. Individuals of *Mustelus spp.* represent significant source of income for several local fishermen in the area who catch them mostly during the warmer part of the year. *S. blainville* is considered to have the same value as smoothhound, but it is far rarer in catches.

4.1 Concerns and recommendations

Several concerns are found:

- Non intentional catches of vulnerable species which are protected either by national laws or international legislation, particularly incidental catches of newborn and juvenile individuals of threatened sharks by small-scale fisheries as *P. glauca* and *C. plumbeus* which could potentially have significant negative impact on populations. Species that are threatened or prohibited for fishing and are suffering both incidental and intentional mortality are firstly *P. glauca* and *I. oxyrinchus*. These two most common pelagic sharks in the area are listed on Annex III of Barcelona Convention and Appendix III of Bern Convention[19]. Moreover, there is a permanent fishing ban designated by national stakeholders for *I. oxyrinchus*. Despite this, the intentional killing or hurting of their individuals are often present among fishermen because of its habit to damage fishing gears and baits, so they are subjected to intentionally caused mortality.

- Both fishermen and community's low consciousness and knowledge which directly creates conditions for intentional mortality of sharks without any concrete reason and which is often powered and justified by the negative media presentation of these animals. Among Montenegrin and regional web sites, social webs and other media, catch of a single shark often become a strike news especially during the summer season. Population of Montenegrin coastal area is dependent on tourism to a large degree and news with such bad reflection can damage the state's economy at some point.

- Low level of success in prevention of intentional killing and investigating of incidental catches of endangered sharks due to poor performance of fisheries inspection which is direct consequence of lack of both human and technical resources.

Recommendations

- Short to at least mid-term review of legislation despite the fact that it includes several shark species because some of the threatened species should be

19 Bern Convention: Council of Europe. 1979. Convention on the Conservation of European Wildlife and Natural Habitats.

included, in particular *A. vulpinus* and *C. plumbeus*, but *P. glauca* as well. Some of species included in national legislation are definitely threatened, but still too rare for this part of the Adriatic (e.g. *C. carcharias* or *Sphyrna spp*.) on the opposite of those endangered which are present more commonly as species mentioned before.

- Mitigation and improvements in fishermen opinions concerning sharks through talks and workshops. The same should be done in order to encourage fishermen to report incidental catches of these species either they were released or found dead or to record them into logbooks. They should be advised how to behave when encounter an endangered shark as it is done for sea turtles or marine mammals which are generally closer to people and easier for explaining to locals.

- Improve fisheries inspection performance at least at the level of investigating and documenting the occasional appearances of protected species landed in fishing ports or potentially subjected to trade.

- Establish official monitoring of catches of rare and endangered elasmobranchs in order to get significant dataset in the certain time period for better statistical and other analyses.

- As there is certain demand for shark meat, it potentially can be tried to promote products from least concern species which *S. canicula* is, because it suffers fishing pressure anyway and a lot of its individuals are thrown back to the sea either dead or in bad condition which represent direct waste of marine resources. On the other side, this could can potentially make a decrease of demand for meat of those species that are under strong pressure and declining in numbers as *M. mustelus* and contribute to their stocks recovering. This would also improve socio-economic performance of fishery sector, trawling in particular. Encouragement of full use of dead sharks is also in accordance with International plan of action for the conservation and management of sharks – IPOA - Sharks (FAO, 1999).

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6. Annexes

Annex I. Questionnaire for collecting of distribution and socio-economic data from local fishermen.

Shark distribution data collecting form

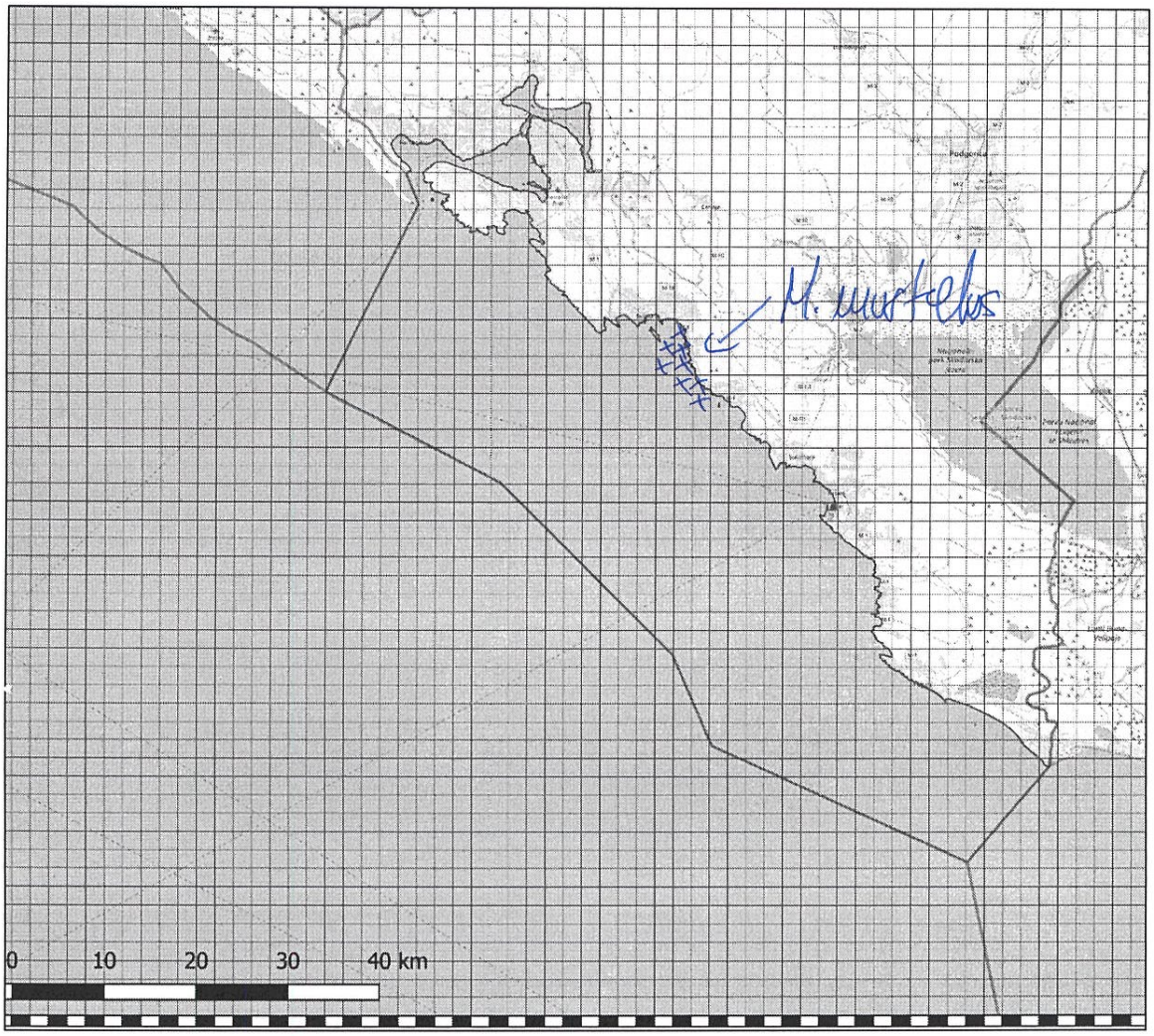
Date: 03/09/2018 Interviewer: Stefan Rakčević

Vessel's registration number: 94-BD Port: Bečići

Fishing gear: GTR, GNS

Species of sharks occurred: M. mustelus, S. canicula

Locations: Rafailovići, Ostrvo Sv. Nikola do Petrovca



Notes:

Socio-economic related data

1)

Species	Commercial/not commercial	Target/By-catch (retained/discarded)
M. mustelus	✓	B (R)
S. canicula	X	D

2) Species: Average price:

M. mustelus — 10 €

~~S. canicula~~

3) Species economy importance for fisherman

Species:

M. mustelus — very important /desirable / without importance

S. canicula — very important /desirable / without importance

_____ — very important /desirable / without importance

Annex II. Biological data collecting form.

Vessel: Sv. MARKO Date: 07.09.2018 Gear: OTB Locality: PLATAMUNI - AR

SPECIES	TL	FL	WEIGHT	SEX	NOTES
S. Canicula	421			M	
	412			M	
	356			F	
	394			M	
	351			M	
	403			M	
	454			M	
	417			M	
	432			M	
	463			M	
	439			M	
	419			M	
	357			M	
	430			M	
	427			F	
	367			F	
	303			M	
	355		3850	M	
	359			F	
M. mustelus	810		1050	F	