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## FISHERIES-BIOLOGICAL AND SOCIO-ECONOMIC ASPECTS OF BOTTOM LONGLINE FISHING IN THE OPEN CENTRAL ADRIATIC AND PROTOCOL FOR LOCAL DATA COLLECTION AND MANAGEMENT OF THIS TYPE OF FISHERIES

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## ABSTRACT

Open-sea bottom longlines are a traditional way of fishing on the eastern coast of the Adriatic Sea, which has been practiced since ancient times mainly by fishermen from the island of Vis, especially from the town of Komiža. Throughout history, the area fished with these longlines has changed as well as the target species. Until the 1990s, fishing was mainly conducted in the wider coastal area around the outer islands of the central and southern Adriatic, and the main catches were rays, turbot and fish from the Sparidae family, which were caught on underwater reefs with shorter longlines and smaller hooks. Until the 1990s, few fishermen engaged in this type of fishing, and longlines were hauled in by hand, with total longline lengths for rays per vessel as long as 3-4 nautical miles per day, or up to 1000 hooks. In the early 1990s, rays became increasingly rare in the catches, and hake and tub gurnard began to dominate. At that time, a hydraulic winch was introduced to haul the longlines, which facilitated the conduct of this type of fishing, which spread outside the waters of the Vis archipelago (Vis, Biševo, Svetac, Jabuka and Palagruža to the central line of the Adriatic Sea and beyond), towards the open sea of the southern Adriatic and up to Molunat, mainly with the aim of catching hake and tub gurnard, and towards the north (outside the Jabuka pit in spring for catching turbot and tub gurnard). It must be emphasized that this type of fishing, which lasts up to three days in the open sea with small fishing vessels of 8 to 12 meters, is by far the most difficult and demanding compared to all others, as it involves the continuous work of two to three crew members and up to 15 hours per day, overnight staying in the open sea with standby duty, and usually a great distance of the fishing area from the coast and the landing port.

From 2000 to the present, the number of fishing vessels, that mainly carried out bottom longline fishing in the open sea from Komiža, has increased from 20 to a total of 60 to 70 active vessels, most of which come from the island of Vis and the rest from Šibenik, Trogir, Split and Dubrovnik areas. It should be noted that the total length of open sea bottom longlines has increased by an average of 8 to 15 nautical miles or 1,800 to 3,500 hooks per vessel per day. The establishment of a special fishing regime in the Jabuka Pit in 2015 and the establishment of the Protected Fishing Area in the Jabuka Pit by the General Fisheries Commission for the Mediterranean (GFCM) in 2017 had a positive impact on the demersal species of the open Adriatic, and indirectly on the increase of bottom longlines catches in the open sea. However, recently there has been a

sharp increase of costs in demersal open-sea fishery, which is reflected mainly in the increase of fuel and bait prices. Since this has not been accompanied by an increase of the fish price, the profitability of fishing has decreased. Also, according to fishermen, the number of Italian fishermen fishing with bottom longlines in the open sea in the entire area of the central and southern Adriatic up to the border of Croatian territorial waters, using twice as many longlines per vessel, has increased significantly in the last fifteen years, resulting in unattainable competition with Croatian fishermen. To compensate this situation, Croatian fishermen have also increased their fishing effort and thus the average catch, which can have a negative impact on the status of the resources.

When talking about the differences between the coastal bottom longline fishery and the open sea bottom longline fishery, it primarily refers to:

1. fishing area (open sea vs coastal sea and underwater reefs)
2. composition of the catch (hake, tub gurnard, rays and sharks, more than 80% vs sparid fish, groupers, conger, hake, etc.)
3. length of bottom longline and number of hooks used daily (8 - 15 NM, 1800 - 3500 hooks vs 0.2 - 1 NM, up to 2000 hooks)
4. hook size (hook size 8 and less vs hook sizes 9 – 13)
5. depth at which the longlines are normally set (from 80 to 300 m vs 10 to 80 m)
6. quantity of the catch (more than 100 kg vs 5 – 50 kg per fishing trip)

The open sea bottom longline fishery is a highly selective type of fishery (due to the hook size used as a standard), catching mainly large mature specimens, and with the majority of catch consisting of hake, tub gurnard, rays and sharks. Scientific assessments of the state indicate that these species are either overfished (e.g., hake according to the most recent estimates from Scientific, Technical and Economic Committee for Fisheries (STECF) and Scientific Advisory committee of GFCM (SAC GFCM) or extremely sensitive to exploitation due to their fishery biological characteristics (e.g., skates and sharks). Although open-water bottom longlines are not critical to their mortality, the effects of bottom longlines should not be ignored as they catch mature individuals i.e. spawning stocks.

Due to the high selectivity of bottom longlines in the open sea, the proportion of discard in catches is very low. Similarly, it was concluded from interviews with fishermen and data from official catch statistics, that specimens of sensitive and endangered species are rarely caught with bottom longlines (only a few specimens per year per vessel).

Because of the significant differences in target species, areas of exploitation, fishing effort, amount of catches, state of the target species, and, accordingly, challenges they are facing, it would be extremely important to distinguish in future legislation two types: open sea bottom longlines and coastal bottom longlines. The fact is that in the records of the Fisheries Department of Ministry of Agriculture, the total number of bottom longlines in commercial fisheries is more than 1000. The number of fishermen in the open sea longline fishery is expected to increase, which would put additional pressure on limited fishery resources. In addition, bottom longlines operate in the open sea in the same fishing area as trawlers, causing major problems and material damage caused by trawlers destroying longlines, and increasing fishing effort with this gear would have further negative impacts in this segment as well. As one of the possible solutions, the introduction of an authorization permit for open sea bottom longlines should be considered, also for bottom longlines in coastal waters, the number of hooks they are allowed to have on board should be limited.

Great care should be taken not to increase the fishing effort for this type of fishery and not to allow a future increase in the capacity of this part of the fishing fleet.

Considering all the peculiarities of fishing with bottom longlines in the open Adriatic and its importance for local island and coastal communities (especially on the island of Vis), it is extremely important to pay more attention to this type of fishing in the future, including finding adequate mechanisms to protect the resources, but also interests of fishermen who exploit them. The fished resources (mainly hake and tub gurnard) are migratory and fall into the category of shared resources of the Adriatic Sea. Therefore, it is necessary to agree and coordinate measures to protect the resources and regulate the fishery with other fishing fleets involved in the fishery. All this requires a participatory approach involving all relevant stakeholders in the fishery: fishermen and their associations, administration, scientists, non-governmental organizations, and other interested stakeholders. Similarly, various environmental factors that directly affect the survival of the (predominantly juvenile) specimens have a major impact on the

state of the resources. Long-term climate changes in the sea (global warming, acidification) and the arrival of invasive and alien species also have a major impact. Therefore, in describing the situation and proposing measures to regulate fisheries and protect resources, the ecosystem approach to fisheries should be applied whenever possible, which means considering the effects of as many factors as possible on the state of marine ecosystems, not just the effects of fishing. This includes assessing and monitoring the economic and social impacts of potential future fisheries regulation measures on this type of fishery.



## 1. INTRODUCTION

Fishing with longlines in the Adriatic Sea takes place in commercial, sport and recreational fishing, and they are basically divided on:

- floating longlines – intended for fishing pelagic species (mainly large blue fish)
- bottom longlines – intended for catching bottom species (Figure 1).

Bottom longlines are mostly used in the entire fishing sea of the Republic of Croatia - from the narrow coastal zone, all the way to the open waters of the territorial sea and the Exclusive Economic Zone (EEZ).

Bottom longlines are divided into two groups according to their purpose and fishing technique:

- Coastal bottom longlines – they are used in coastal and channel areas and are used mainly for catching coastal species such as hake, conger fish, cartilaginous fish, various species of fish from the Sparidae family etc. Mainly this type of longline is used in recreational fishing and small-scale coastal fishing.
- Bottom longlines of the open sea - they are used in the open sea, mainly in the middle Adriatic. This type of fishing mainly belongs to commercial fishing, and the catch is mostly hake, tub gurnard, rays, sharks etc. It is the longlines fishing in the open middle Adriatic that are the subject of research in this document.

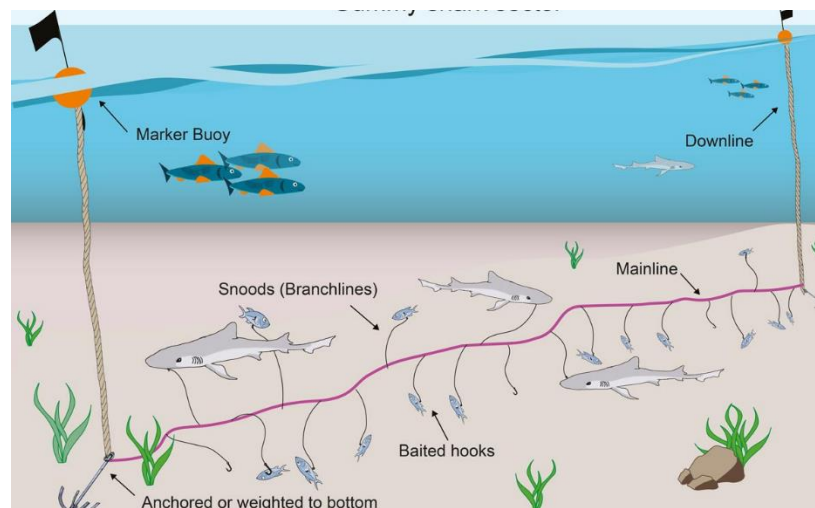


Figure 1. Schematic representation of a bottom longline

In the legislation and in the sea fishing statistics, these two types of fishing are not separated, and it is very difficult to have a clear picture of fishing effort and longline catches in the open sea.



## 2. DATA COLLECTION METHODOLOGY

Data on bottom longline fishing in the open Adriatic are limited, both on catch and fishing effort, as well as on the biological and fishing characteristics of the target species. Although this type of fishing is included in the National Plan for collecting data in Croatian fisheries, the main problem is that it is difficult to separate it from another coastal bottom longlines used in the Adriatic. The situation is relatively easier with the part of fishermen who, in addition to bottom longlines, also use pelagic longlines, because in that case they are obliged to use VMS, so it is easy to separate them from the rest of the fishermen.

When writing this document, various data sources were used.

One part of the data comes from **the official catch statistics** maintained by the Directorate of Fisheries, and they refer to the capacity of the fleet, catches and fishing efforts of bottom longlines in the fishing sea of the Republic of Croatia.

Information on the biological and ecological characteristics of exploited species comes from various **scientific researches** that have been carried out and are being carried out through national and international projects, and the most important part of the data comes from the MEDITS expedition. It is a matter of systematic research that has been carried out continuously since 1996 and describes benthic species and benthic communities. The results of targeted research in the Jabuka pit, which are carried out based on the recommendations of the GFCM, were also used, with the aim of monitoring the effects of the establishment of the FRA Jabuka protected area on the state of resources.

Describing the state of the hake stock, the most important species that is exploited by bottom longline in the open sea, is carried out within the framework of **annual state assessments** by STECF and SAC GFCM, and these data are also presented in this document. The assessment of the situation is done at the level of the entire Adriatic Sea and includes all countries participating in fishing and all key gears. This means that Croatian and Italian longlines in GSA 17 and GSA 18 are included in the analyses.

Very valuable and reliable data on catches were obtained by the Komiža **Fishing Cooperative**, which buys fish from a large number of fishermen. They refer to data on catch, fishing effort and catch value from 2015 to 2021. A large part of the data was obtained from the **purchase of Ancora Commerce d.o.o.** for about fifteen fishermen for the period from 2010 to 2022, and

includes data on the amount and structure of catches, values and information on fishing effort.



Figure 2. Fleet of bottom longlines in the open sea in Komiža

In order to collect the necessary information from fishermen, **two meetings** were organized in Komiža. The first one was organized on August 22, 2022 and was attended by a dozen fishermen from Komiža who engage in bottom longline fishing in the open Adriatic. The second meeting was organized on November 3, 2022, also in Komiža, and 25 fishermen were present at it. During these meetings, **surveys and interviews** were conducted with fishermen related to key topics: the history of bottom longline exploitation, former and current fishing areas, changes in catches and trends, the impact of the establishment of FRA Jabuka on fishing, competition with other fishermen, by-catch of commercial species and discarded catches of sensitive species, mitigation measures, critical review of existing fishing regulation measures, key problems in fishing, proposals for new fishing regulation measures.

### 3. BRIEF HISTORY REVIEW OF BOTTOM LONGLINE FISHING IN THE OPEN SEA

This type of fishing represents traditional fishing along the eastern coast of the Adriatic, which, until recently, was mainly done by fishermen from the island of Vis, primarily city of Komiža. At the beginning of the nineties, as a result of the increase in the price of fish, longline fishing in the open sea is rapidly developing and technologically improved, and it is becoming an increasingly significant competitor to bottom trawling in the exploitation of the renewable resources of the open Adriatic. From a purely local type of fishing related to narrow areas around the islands of the open middle Adriatic, fishing with bottom longlines is spreading to an increasingly large part of the open Adriatic and today includes most of the open territorial sea, the Exclusive Economic Zone, and part of the Italian continental shelf.



Figure 3. View of the harbor in Komiža with a fleet of bottom longlines in the open sea

Bottom longline fishing is a specific type of fishing that takes place with varying intensity throughout the year, and the intensity and area of work depend primarily on the availability of the target species of this type of fishing, but also on weather conditions. Likewise, the spatio-

temporal dynamics of work with bottom longlines also depends on the work of fishermen who use other fishing techniques. Thus, for example, fishing in the open sea largely depends on the presence of bottom trawls, which compete with longlines for the fishing area, but also for the resources that are caught (primarily hake).

Historically, fishing with bottom longlines was connected primarily to Komiža, where the main part of this fleet used to be, and still is today. In recent times, with the increase in the price of fish, fishermen from other places are also starting to engage in this type of fishing. Most fishermen engage in this activity only in one part of the year, and in the other part they engage in other types of fishing (e.g. fishing with floating longlines, gill nets or lobster fishing) or tourism. Fishing with bottom longlines historically took place exclusively along the islands of the open middle Adriatic (Vis, Biševo, Svetac, Jabuka, Sušac, Mljet) and in an area up to 7-8 NM from the coast. With the improvement of the equipment on the vessels (hydraulic winch, modern navigation equipment), and the increase in the price of fish, more recently bottom longlines have been used to exploit the majority of the open territorial sea of the Republic of Croatia (from Prevlaka all the way to Uniše and Susak islands), some channel areas (primarily Kvarnerić), and the largest part of the Exclusive Economic Zone and part of the Italian continental shelf. Fishing areas change throughout the year depending on the weather, availability and migration of exploited species, and competition for space and resources between bottom longline and other gears (primarily bottom trawls and gill nets).





Figure 4. Typical bottom longline fishing vessel in the open sea

Although there are about twenty species of fish caught by bottom longlines, it can still be said that only three target species of this fishery are: tub gurnard, turbot and hake, and they make up the bulk of the catch. Other important species in catches are sharks, rays and conger fish, while other species in catches occur with very low abundance. The composition of the catch depends very much on the area where fishing is done, but also on the part of the year in which it is caught.

Today's catches of bottom longlines are significantly different from those achieved throughout history. There was a drop in catches, but also significant changes in the composition of catches. Thus, for example, in the fifties of the last century, most of the catch was cartilaginous. Their share in catches was up to 90% of the total catch. The largest part was thornback ray, and the rest sharks.

Other species caught were hake (5-6 specimens per day), pink dentex (specimens up to 20 kg), and various species of fish from the Sparidae family. Turbot could also be accidentally found in catches (mainly from the outer side of the island of Svetac).

The share of hake in catches starts to increase in the early nineties, and the catches are more or less constant until today. After the establishment of FRA Jabuka, there was an increase in hake catches and an increase in hake catches in the total catch.

Back in the 1990s, tub gurnard was a rare species in catches (only 1-2 specimens per day), and the increase in its share in catches is temporally linked by fishermen to the disappearance of the thornback ray, and today gurnard is the second most important species in bottom longline catches in the open Adriatic.

The changes that have occurred in bottom longline fishing in the open sea have several causes. The most important among them is the level of fishing pressure, and the associated decrease in biomass and changes in the composition of communities. The decrease in the proportion of cartilaginous fish in catches can be explained by this cause. Namely, it is a well-known fact that cartilaginous fish, primarily rays, are extremely sensitive to increased intensity of exploitation due to their biological and ecological characteristics (large dimensions, slow growth, weak fecundity).

However, the differences in the catch and the composition of catches with bottom longlines should also be sought in changes in fishing methods, equipment and areas throughout history. Namely, throughout history fishing with bottom longlines took place in the areas around the islands of the open middle Adriatic (Vis, Palagruža, Svetac, Biševo and possibly Jabuka). The area of operation of the longline was limited to 7-8 NM from the coast, while today it covers a much wider area: the entire open middle and part of the northern Adriatic (including the Exclusive Economic Zone and part of the Italian continental shelf), and territorial waters of the southern Adriatic. While the trips used to last mostly one day (due to the impossibility of keeping fish at high temperatures), today one trip could last 2 to 3 (very rarely 4) days.



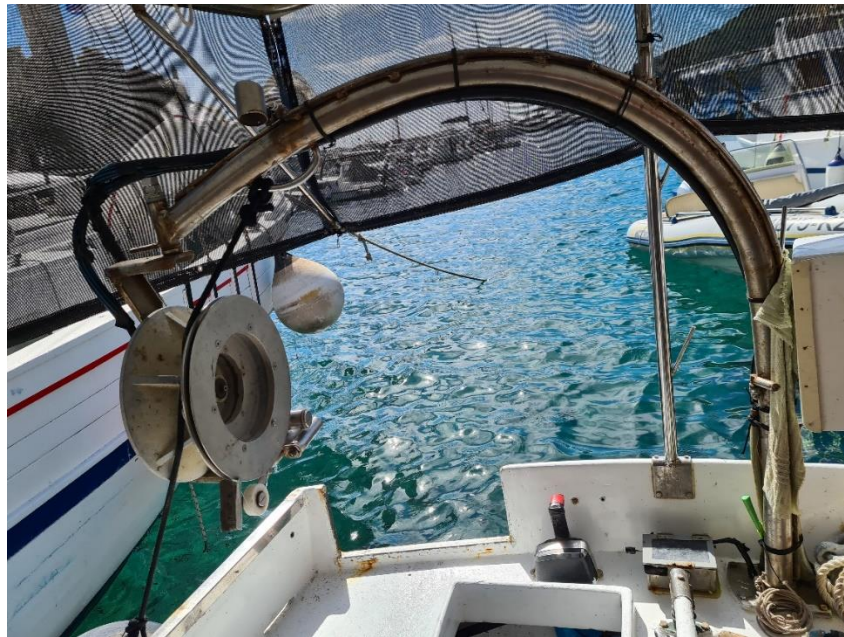


Figure 5. Hydraulic winch for hauling long lines

The main technological innovation that favored the development of longline fishing in the early 1990s was the introduction of a hydraulic winch, which enabled faster shooting and hauling of longlines. In this way, it was possible to increase the length of the longline and the number of hooks used, as well as the depth at which it is worked. Before the introduction of the hydraulic winch, the length of the longline was a maximum of 5 NM, and the hooks were placed at a distance of 3 "fathoms" (about 5 meters), while today up to 3,000 hooks are placed at a distance of about 5 "fathoms" (about 8 meters). Usually, the length of a longline today is about 10-12 NM, with hook size no. 8 (Mustad).

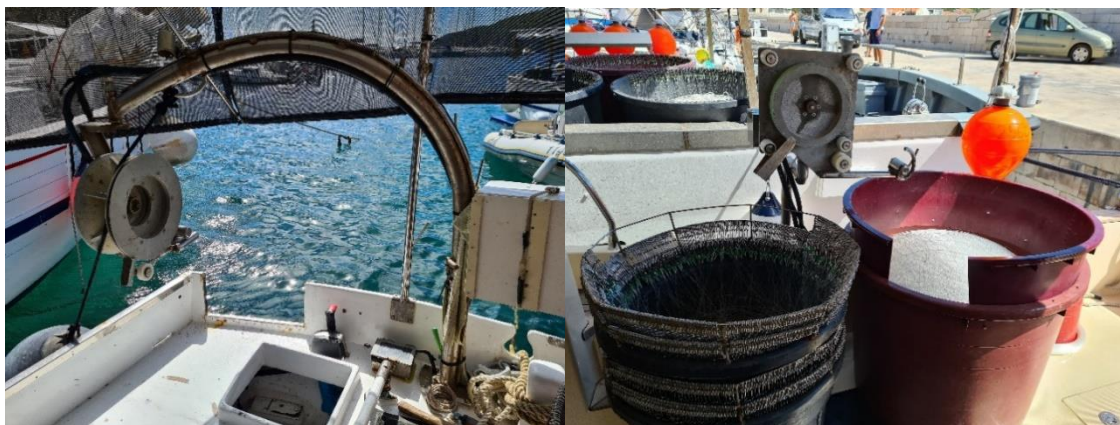


Figure 6. Typical equipment on an open sea bottom longline vessel



The improvement of fishing techniques through the introduction of echo sounders and GPS enabled the discovery of new areas where the density of fish is higher (primarily rocky bottom), so it is no longer fished "blindly".

Bottom longline fishing in the open sea is very often done in "bands" (groups of 2 to 3 boats). Fishing in "bands" is usually practiced when fishing further from the home port. In this case, the ships fish at different depths and in different directions, trying to discover the best fishing grounds, about which they exchange information. At the end of fishing, "band" often divide the common catch into equal parts.



Figure 7. Part of the navigation and electronic equipment on the vessel

A large number of fishermen fish with longlines only in one part of the year. In the second part of the year, they engage in other types of fishing (e.g. fishing with pelagic longlines, gill nets fishing, lobster fishing), or tourism.

#### 4. AREAS OF EXPLOITATION WITH BOTTOM LONGLINES OF THE OPEN SEA IN THE ADRIATIC

Exploitation with bottom longlines along the Croatian coast of the Adriatic has a long tradition, and the fishing areas have changed throughout history. In the beginning, fishing was done with primitive and poorly equipped vessels, which resulted in working exclusively along the islands of the open middle Adriatic. The largest part of the fleet was located in Komiža (as it is today), and the main fishing areas were up to 5-6 NM around the islands of Palagruža, Sušac, Vis, Biševo, Svetac and the islets of Jabuka (Figure 8). The limiting factor for the length of stay was the lack of conditions for keeping the catch and weather conditions at sea, so fishermen usually stayed at sea for one day.



Figure 8. Former areas of bottom longline exploitation

By improving the equipment (modern navigational devices, shooting and hauling the longline using a hydraulic winch, improving the space for storing fish), and by increasing the speed of the ships, the stay at sea is extended (today it is usually two, less often three days). In this way, it was possible to expand the area of activity of the ships, so that today it can be said that exploitation with bottom longlines takes place in the largest part of the open middle Adriatic, both in the territorial sea, as well as in the EEZ and part of the Italian continental shelf (Figure 9).



Figure 9. The main areas where bottom longlines are fished

Today, the main fishing areas are located from the southern border of the Croatian territorial sea, all the way to parts of the open northern Adriatic (almost to the island of Sušac). In recent times, exploitation has also begun in the canal areas of the northern Adriatic, primarily in Kvarnerić. Towards the open sea, exploitation usually takes place up to the border of the EEZ, but also in the Italian continental shelf.

After the establishment of the FRA Jabuka (protected fishing area of Jabuka) and the introduction of specific fishing regulations, longline fishing is prohibited in zone A (no-take zone) and is possible only in zone C and from Monday to Thursday.

Today's fishing with bottom longlines in the open Adriatic is such that the fishing effort achieved in this branch of fishing represents only a small part of the total fishing effort in the mentioned area.

Almost all species that are caught with bottom longlines are also the target species of other types of fishing whose fishing effort and negative effect on the state of the population is incomparably greater than that originating from bottom longlines. Thus, for example, the majority of tub gurnard catches are made with bottom trawls along the Italian side, and exploitation is mostly based on juvenile specimens in spawning and nursery area. The situation is similar with hake: it can almost be said that trawling in the open Adriatic is based on catching immature individuals of this species. Furthermore, as a consequence of intensive fishery, populations of cartilaginous fish, primarily commercially important rays, have been brought to the brink of extinction. The protection of the mentioned species is possible only by applying strict measures to reduce fishing effort in the areas of the most intensive exploitation, which are EEZ and Italian international waters.

The most important species in the longline fishing is the european hake, which is present in the fishing throughout the year. It is mainly caught in the open middle Adriatic, both in the territorial sea and in the EEZ. The most important fishing grounds are located in the Jabuka pit, then around Palagruža and in the area from Palagruža to open sea area below city of Dubrovnik (figure 10).



Figure 10. The main areas of hake fishing with bottom longlines

The second most important species is the tub gurnard, and fishing takes place with varying intensity throughout the year. The largest catches are achieved in the winter months and this species is caught in the entire open middle Adriatic, and the main fishing areas are located in the open sea area in front of Mljet and Lastovo, around Palagruža islands, in the marginal areas of the Jabuka pit, and to a lesser extent on the open sea area in front of Kornati and Dugi otok islands towards EEZ. Relatively good catches are achieved in certain parts of the year in Kvarnerić (Figure 11).





Figure 11. The main areas of kokot fishing with bottom longlines

Although throughout history rays represented the bulk of bottom longline catches (according to the old fishermen of Komiža, up to 500 kg were caught per day), recently the catch of rays with longlines is almost symbolic. Today, it can still be found in areas that are not exposed to trawl fishing due to obstacles on a bottom or there is large amount of by-catch. Fishermen from Komiža today still catch it in significant quantities only around Palagruža island (Figure 12).

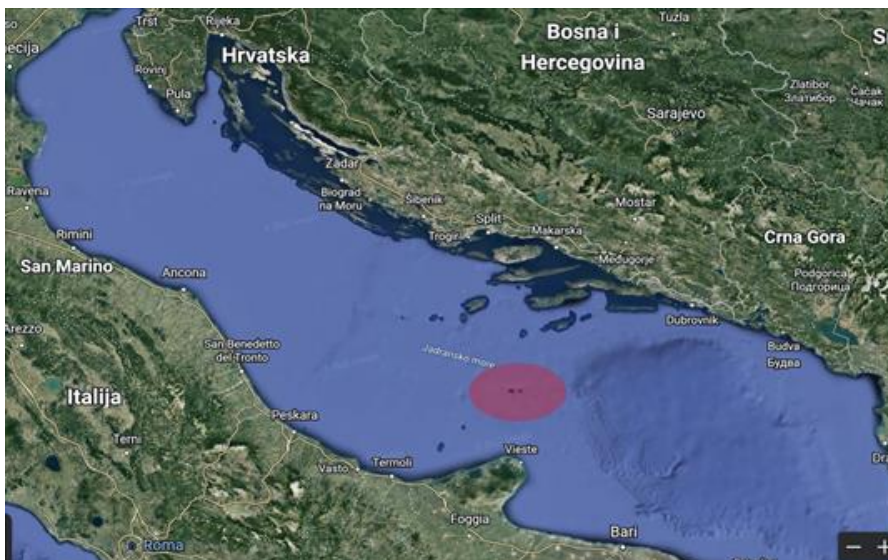


Figure 12. The main areas of thornback ray fishing with bottom longlines

## 5. COMPETITIVE RELATIONS OF LONGLINES WITH OTHER TYPES OF FISHING AND OTHER FISHING TOOLS

Bottom resources in the Adriatic Sea are exposed to the so-called "multigear exploitation" (fishing is carried out with a large number of fishing tools), and bottom longlines are only one of the tools used for exploitation. The target species of this type of fishing are at the same time the target species of other fishing tools in commercial and recreational fishing, and this primarily refers to the most important species - hake - which is also the object of fishing with bottom trawls, gill nets, bottom lines and other fishing tools.

The most important competition to bottom longline in the open sea is the bottom trawl net. These two tools are in direct competition for the species they fish (primarily hake and cartilaginous fish), as well as for the area where fishing takes place. Practically, the use of bottom longlines is very difficult or almost impossible in the areas and at the time when trawling is carried out due to the danger of the trawl "picking up" the longline. However, bearing in mind the long tradition of coexistence of these two types of fishing in the open Adriatic, these competitive relations very rarely result in conflicts between different fishermen at sea. The main reason is the spatial and temporal regulation of trawling, which leaves room for longline fishing in areas and times when trawling is prohibited. This primarily refers to the regulation of fishing in the Jabuka pit Protected Fishing Area (FRA Jabuka), as well as the ban on trawl fishing 12 miles around Jabuka during the weekend, and the fact that Italian trawling is not carried out in the Exclusive Economic Zone (EEZ) on Fridays, Saturdays and Sundays. Likewise, the extremely restrictive spatial and temporal regulation of trawling in the channel areas of fishing zone G leaves room for longline fishing. Nevertheless, it can be concluded that due to the competition with trawling, the number of potential working days of longline fishing is very limited. Furthermore, fishermen often emphasize the problem of conflicts with Italian trawlers in the EEZ, which do not respect the signal markings of the bottom longlines, and therefore fishing gear is often damaged. The fact that Italian trawlers enter restricted areas is relatively frequent, although this has become less frequent in recent times due to better control at sea and the obligation to use VMS and AIS.

Competitive relations also exist between fishermen who fish with **bottom longlines** from different Croatian and Italian ports. Usually, the competition between Croatian long-line

fishermen is smaller, because fishing in the open central and southern Adriatic is predominantly done by fishermen from the island of Vis, and partly from Hvar and Korčula. Other Croatian fishermen who use bottom longlines (from Zadar and Šibenik, and the those in channels of the northern Adriatic) generally do not fish in the open middle Adriatic. According to the fishermen of Vis, the key problem is represented by Italian longlines in the EEZ. Namely, recently (especially after the establishment of FRA Jabuka) there has been an increase in the number of Italian bottom longlines and an increase of the area in which they fish. The problem also lies in the fact that the boats used by Italian fishermen are significantly larger and therefore can stay longer at sea, work even in worse weather conditions, and the number of hooks they use per individual vessel is greater than that of Croatian fishermen (Italians can use up to 5,000 hooks per boat per day, while in our country the maximum is 3,500 hooks per boat per day in zones B, C and D, and up to 2,000 hooks in zones A, E, F and G. All this puts them in a more favorable position and makes them more competitive with Croatian fishermen.

There is no significant competition between bottom longline and drifting longlines fishery (although they take place more or less in the same area), because their target species are different, as is the time of fishing. A significant number of Vis fishermen use both types of longlines, but at different time.

In the conversation with the fishermen, we get information that there are no significant competitive relationships between longlines and gill nets fishery (although both have similar target species). The reason is that the standing nets are usually placed closer to the shore. Fishermen cite as a big problem the situation that happened fifteen years ago in the open northern Adriatic (dominantly zone B) and which was the traditional place for turbot longline fishing in the spring months. After uncontrolled and excessive fishing with gill nets, there was a drastic drop in the biomass of this species, and thus the catch. The situation has not recovered and turbot is almost no longer caught in the northern Adriatic. The fishermen emphasize the great competition between the standing nets and the pot traps for fishing large crabs in this area, and they believe that this is one of the issues that should be resolved as soon as possible.

According to fishermen, the biggest competition for bottom longlines is sport and recreational fishing. i.e. there is a large number of participants in this type of fishing, high-value fish species are targeted, and it is very difficult to supervise and control this fishing. During the survey, professional fishermen state the problem that fish from sport and recreational fishing appears



on the market, primarily in restaurants, thus creating unfair competition for commercial fishermen.

## 6. REGULATIONS OF BOTTOM LONGLINE FISHING IN THE ADRIATIC

Fishing with hooks fishing gear is regulated by the Ordinance on Commercial Fishing at Sea with Set Nets, Traps, Fishing Gear with hooks and Piercing Gears and Special Fishing Methods (NN 84/2015, 94/2015, 107/2015, 61/2017, 64/2017, 125/2020, 30/2021)

Longline fishing is specifically regulated by Articles 17 and 18 of this Ordinance.

### *Article 17.*

*(1) Long lines consist of a basic part - a long rope called the base or maestra, to which shorter ropes called picks or strands are tied at certain intervals, and hooks are tied to them. Constituent parts of the longline are ropes that are tied at one end to the base of the longline, and at the other end to a floating mark that indicates the position of the longline in the sea (spools). The longline must have at least two coils that are attached to the ends of the base of the longline, and there may be more of them distributed along the base of the longline.*

*(2) Standing long lines must be anchored at both ends of the base.*

*(3) Floating longlines are not anchored and move freely under the influence of sea currents and waves.*

### *Article 18.*

*(1) In fishing with angling tools, the use of natural or artificial lures that are placed on hooks, as well as the use of natural or artificial decoys, is permitted.*

*(3) In commercial fishing, it is prohibited to use:*

*- when fishing with standing longlines, more than 1,000 hooks per person on the vessel up to a maximum of 2,000 hooks per vessel in fishing zones A, E, F and G,*

*- when fishing with standing longlines, more than 1,000 hooks per person on the vessel up to a maximum of 3,500 hooks per vessel in fishing zones B, C and D,*

*- more than 500 hooks per vessel when fishing with floating longlines,*

*- more than 100 self-catching angling tools per vessel when fishing self-catching angling tools,*

*(5) The use of artificial lighting is prohibited in fishing with fishing tools, except in fishing cephalopods with hook lines.*

The establishment of a Protected Fishing Area in the center of the Jabuka pit (FRA Jabuka) is extremely important for bottom longline fishing in the open middle Adriatic. Namely, fishing with bottom trawling is prohibited in this area, which leaves the possibility for longline operation in

part of that area.

The mentioned area was established bilaterally (Croatia and Italy) as a temporary prohibition zone in 2015 and then in 2017. It was accepted in 2019 as Fisheries Restricted Area Jabuka/Pomo Pit for 3 years. In 2021, at the annual session of the General Fisheries Commission for the Mediterranean (GFCM), the FRA Jabuka area was established as a permanent protection area (Figure 13).

This area consists of 3 zones: zone A (no take zone) and buffer zone B - in the Italian continental shelf and buffer zone C in the Croatian economic zone. In zone A, all types of commercial and recreational fishing are prohibited, except for large pelagic fish fishing. In zones B and C, it is possible to fish with a bottom trawl for two days, and the rest of the time with longlines and set nets. In the Croatian part of the buffer zone (zone C), longline fishing is allowed from Monday to Friday and only for authorized vessels that have a VMS system. Furthermore, this area is closed to fishing during September and October for all types of fishing.

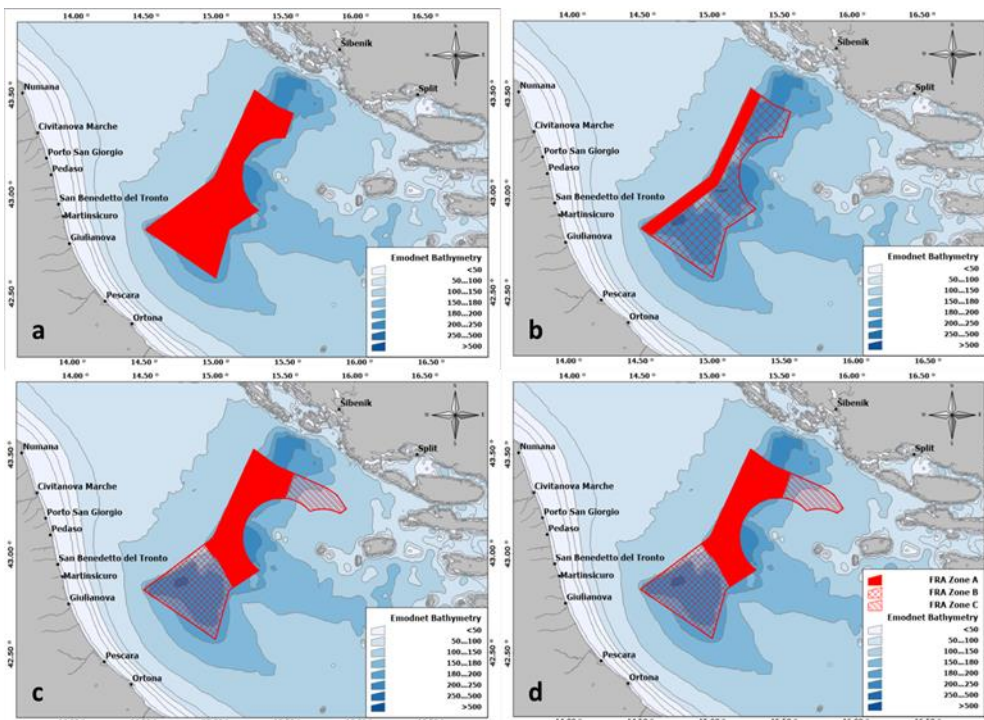


Figure 13. History of the establishment of the Protected Fishing Area in the Jabuka pit (a- 2015/2016; b-2016; c- 2017/2019; d- 2019/2022)

## 7. ACCIDENTAL CATCH OF SENSITIVE SPECIES IN THE BOTTOM LONGLINES OF THE OPEN SEA

Information on by-catch of sensitive species in bottom longline fishing in the open Adriatic was collected through interviews with commercial fishermen at meetings in Komiža. Through conversations with fishermen, information was obtained that the accidental catch of sensitive species is very small in bottom longlines, and somewhat higher in floating longlines (part of the surveyed fishermen with bottom longlines fish with floating longlines during part of the year).

When asked about the catch of sensitive species in the last trip to the sea, all the fishermen said that they did not catch any sensitive species. One turtle was caught during fishing trips in the last ten days. In the last month, two turtles were caught, one of which survived and was released into the sea. On average, fishermen catch 1 to 2 turtles per boat per year, and about half of them die while fishing.



Figure 14. Sea turtle (source Wikipedia)

Among the cartilaginous fish, blue shark is sometimes caught during the fishing, especially when pelagic longlines are used, and 2-3 specimens are caught per year per boat. They are mostly released alive into the sea.

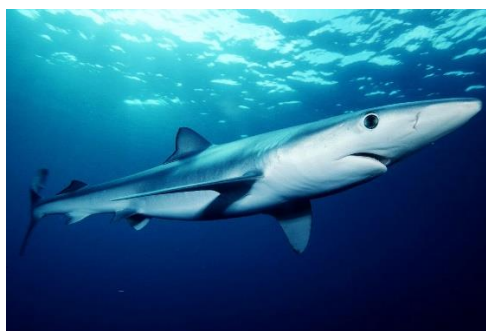


Figure 15. Blue shark (source Wikipedia)

And birds also are mostly accidentally caught in floating longlines, very rarely in bottom longlines. It is mainly Mediterranean shearwater (*Puffinus yelkouan*) species of bird that fishermen try to avoid because they eat their bait. Catches are 1-2 specimens per year per boat. Fishermen have already developed mechanisms to avoid and prevent bird catches, and these are empty plastic buckets that are placed on a longline and scare the birds away. They also emphasize that there are no birds bycatch when fishing at night.



Figure 16 Mediterranean shearwater bird (source Wikipedia)

The Oean sunfish (*Mola mola*) are caught sometimes (1-2 specimens per boat in a year).

The catch of specimens of commercial species below the minimum fishing length in bottom longlines is almost non-existent. This is also evident from the presentation of the length frequencies of the specimens that are caught in the bottom longline, which are presented in this report.

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## 8. LENGTH FREQUENCIES OF TUB GURNARD AND EUROPEAN HAKE COUGHT WITH LONGLINES

### European hake

The diagram of length frequencies of hake is shown in Figure 17. The length frequencies of hake caught with different commercial fishing tools are shown in different colors.

It can be seen from the picture that the smallest specimens of hake are caught with a bottom trawl and most of the specimens are below the MCRS (which is 20 cm for hake), and such specimens end up being discarded. In gill nets, specimens from about 20 cm to 50 cm are mostly caught. The length frequency range of coastal longline is also similar to gill nets catch, which is logical because both of these tools fish for adult hake in the coastal area.

Hake of a wide range of length frequencies are caught in longlines in the open sea - starting from 20 cm and up to 90 cm.

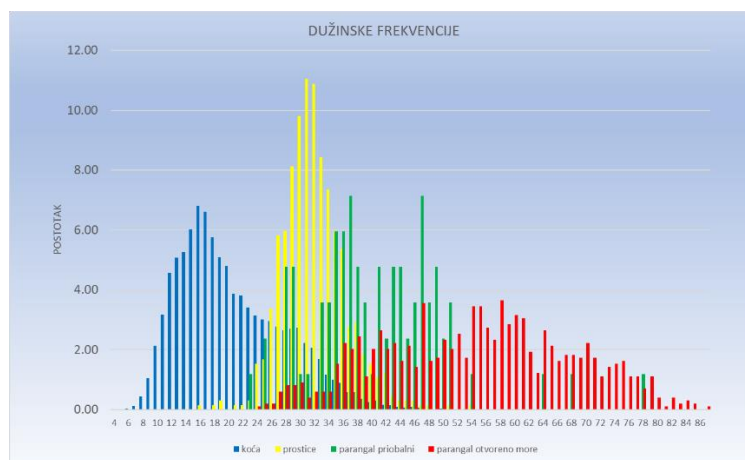


Figure 17. Length frequency distribution of hake; blue – bottom trawls, yellow – gill nets, green – coastal longlines, red - open sea longlines

### Tub gurnard

The much smaller specimens of this species are caught with a bottom trawl than with a longline in the open sea (Figure 18). There are specimens from 20 cm to 32 cm in the trawl catches, and specimens from 25 to 90 cm in the longline catches.

The situation along the Italian coast is different, and even smaller specimens are caught in trawls there, because along the western coast there are spawning grounds for tub gurnard.

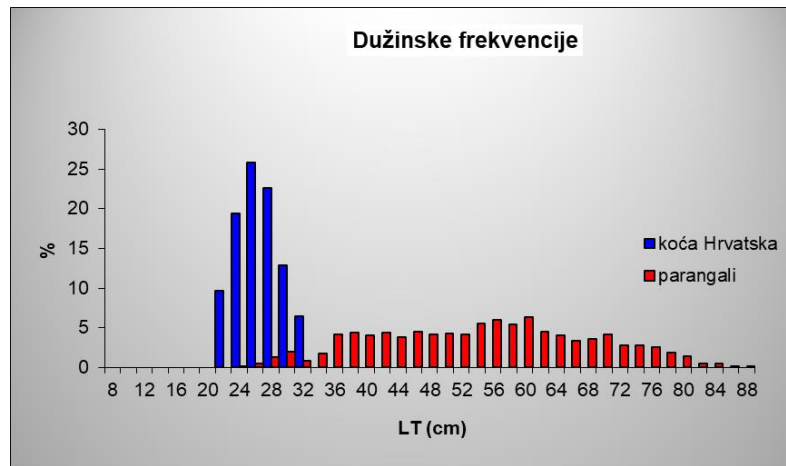


Figure 18. Length frequency distribution of tub gurnard: blue bottom trawls, red – bottom longlines



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## 9. CAPACITY AND DISTRIBUTION OF THE OPEN SEA BOTTOM LONGLINE FISHING FLEET

Bottom longlines form one of the most numerous fishing tools in the Croatian territorial sea, both in terms of the number of longlines and in fishing effort (number of trips). Bottom longlines are used in commercial and recreational fishing, and a large number of longlines are found in small-scale coastal fisheries.

Most of the bottom longlines operate in a narrow coastal area, using small vessels, less than 6 meters LoA; and target different coastal species: fish from the Sparidae family, hake, conger fish, catfish, cartilaginous fish. The topic of interest of this document is longlines in the open sea, which are dominantly used by participants in commercial fishing, and the target species of this fishing are hake, tub gurnard, rays, sharks (spiny dogfish and smooth-hound) and conger fish. The share of other species in catches is very small.

One of the key problems with bottom longlines in the open sea is calculating the capacity of the fleet, i.e. there are no clear data on the number of fishermen practicing this type of fishing.

In order to describe the catch structure and socio-economic aspects of this type of fishing, we used data from the catch register for the period from 2018 to September 2022.

The separation of coastal longlines for which longline fishing is usually a secondary (fishing) activity from open sea longlines was done in such a way that we excluded from the analysis all longlines whose total catch in the observed period (January 2018 to September 2022) was less than 2,000 kg (which represents about 5 kg of fish per day in the observed period). That's how we reduced **the total number of longlines from 1,047 vessels, to only 84 vessels** from 22 ports that operate with open sea bottom longlines. Out of the total number of ports, 11 of them have only one vessel belonging to this group, 3 ports have two and three vessels each, two ports have 4 and 5 vessels each, and one port, Komiža, has 43 vessels (Figure 19).

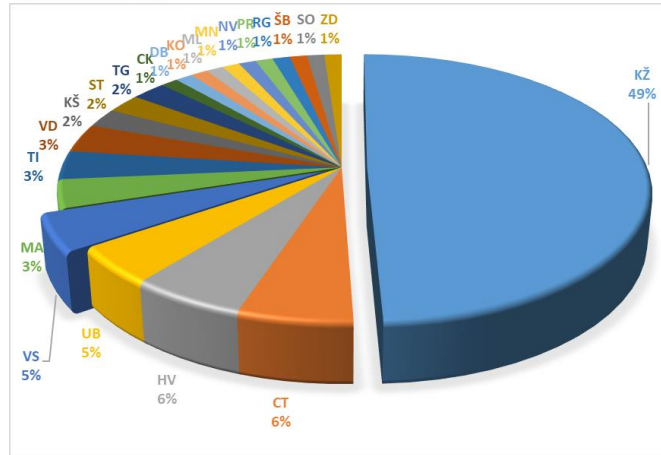


Figure 19. Display of the number of longlines in the open sea according to the ports of entry of the vessel

It can be seen that most of the **capacity of the fishing fleet**, more than half (54%) is connected to the island of Vis, namely the towns of Komiža and Vis. There is a total of 43 open sea longlines in Komiža (out of the total number of longlines in Komiža, which is 63), and 4 longlines in Vis (out of a total number of 9 longlines).

The dominance of the fleet of the island of Vis in fishing with bottom longlines in the open sea is even more visible when the **distribution** of catches by ports is observed. The fleet from Komiža accounts for 71% of the total longline catch, followed by Hvar and Kaštela with 4% each, and Cavtat, Vis and Split with 3% each. All other ports participate in the catch with 11% in total (Figure 20).

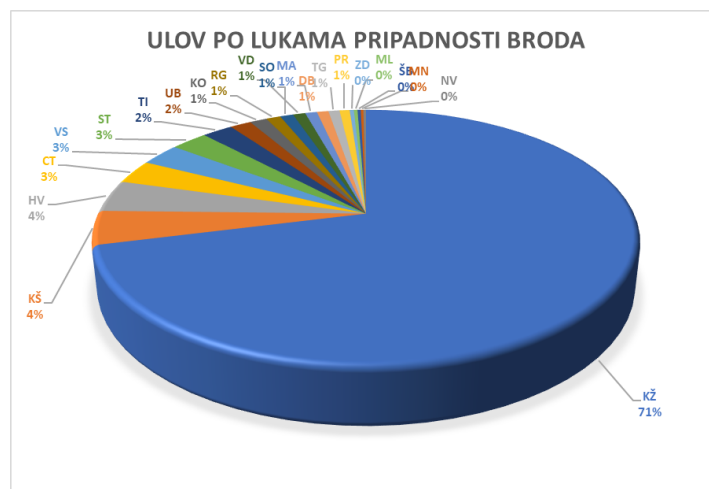


Figure 20. Presentation of the catches of bottom longlines according to the ports of entry of the vessel

Figure 21 shows the activity of longlines from individual harbors in individual fishing subzones. It can be seen that only a small number of longlines from a single port significantly participate in fishing in the open sea. These are primarily vessels from Komiža, Vis, Hvar, Korcula, Split, Trogir and Vodice.

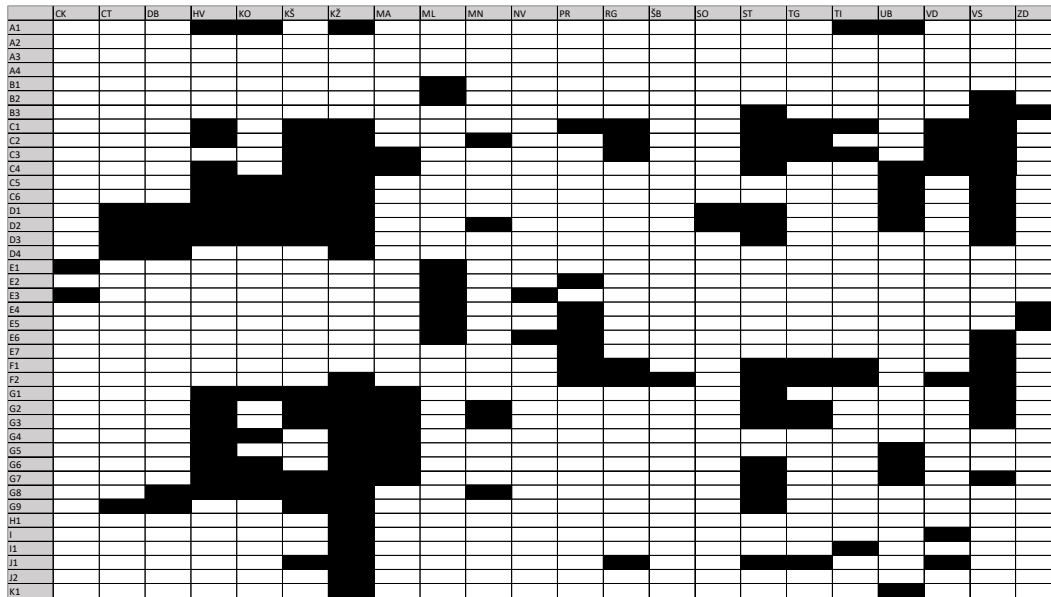


Figure 21. Activity of longlines from individual harbors in different fishing zones (black color shows in which fishing zone longlines from individual harbors are active)

In this document, we have concentrated on longlines originating from Komiža and Vis, because they make up the largest part of the open sea longline fishing fleet, cover the largest fishing area, and we were able to establish the best cooperation with them.

Figure 22 shows in which fishing subzones they fish. It can be seen that this area represents the entire open middle (fishing zone C) and southern Adriatic (fishing zone D). But fishing also takes place in the channel waters of the middle Adriatic (zones G and F), as well as in the channels of the northern Adriatic. Some fishermen work a certain number of days in zone B and only one recorded trip to zone A. Fishing also takes place in the Exclusive Economic Zone (zones I and J).

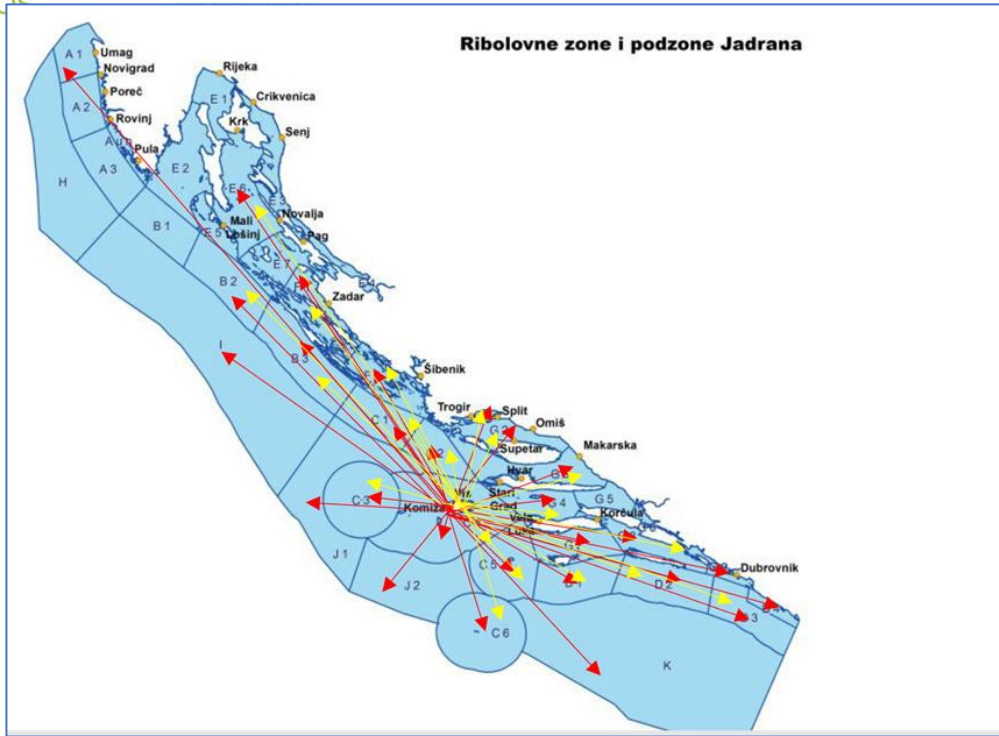


Figure 22. Longline fishing area from the island of Vis

## 10. CATCH STRUCTURE AND CHARACTERISTICS OF BOTTOM LONGLINE FISHING IN THE OPEN ADRIATIC

Figure 23 shows the distribution of bottom longline catches by individual fishing subzones. It is evident from the data that the largest part of fishing takes place in only a few subzones (C3, C4, J1, D2, C6 and C5), a share greater than 1% is still in subzones C2, d1, C1 and J2, while all other subzones participate in the total catch with an individual percentage of less than 1% (all together make up only 3% of the total catch).

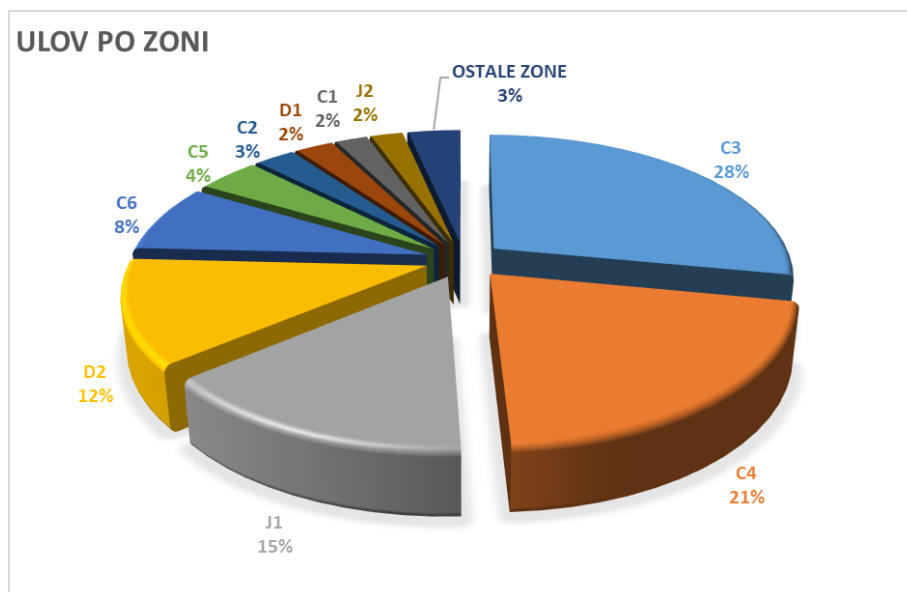


Figure 23. Longline catch by individual fishing subzones

The situation is similar with fishing effort, which is expressed as the number of trips (Figure 24). Here, too, the majority of fishing effort comes from two zones (C4, C3), and more significant fishing effort was recorded in zones C6, J1, D2 and C5. Zones D1, C1, C2 and J2 also have a share greater than 1%. Other zones are represented with a share of less than 1% and in total make up about 2% of the fishing effort.

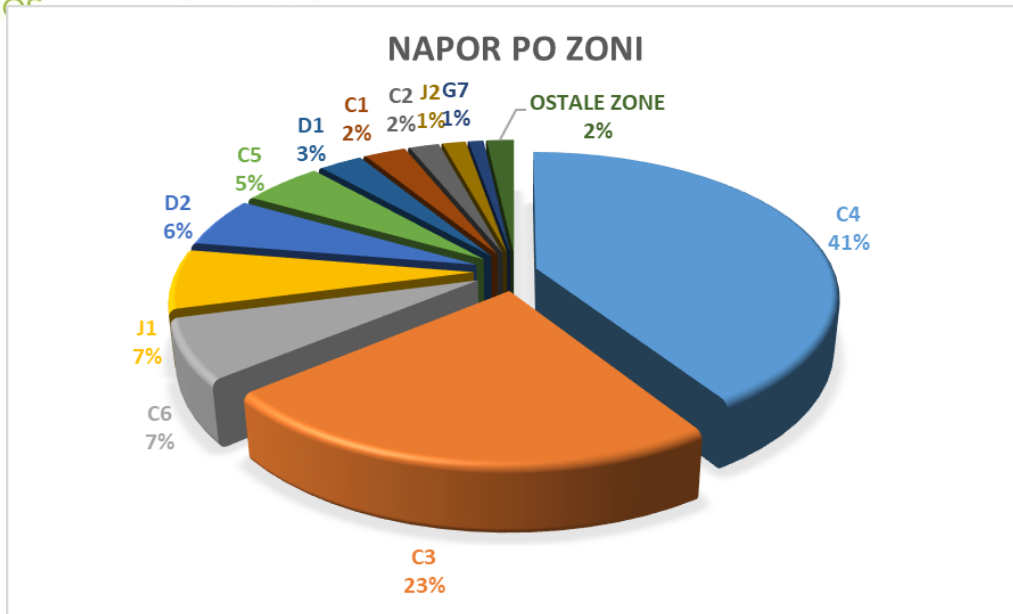


Figure 24. Longline fishing effort by individual fishing subzones

Figure 25 shows the average value of the catch per trip in different fishing subzones. The average catch was in the range of only 33.33 kg/trip in zone B3, and in that subzone both the number of trips and the total catch were very small. The largest catch per trip was recorded in zone D3 (332.72 kg/trip), J1 (306.1 kg/trip), D4 (299.3 kg/trip), D2 (298.3 kg/trip) and I1 (291, 5 kg/exit). The average value of the catch per trip for all fishing zones was 161.42 kg/trip.

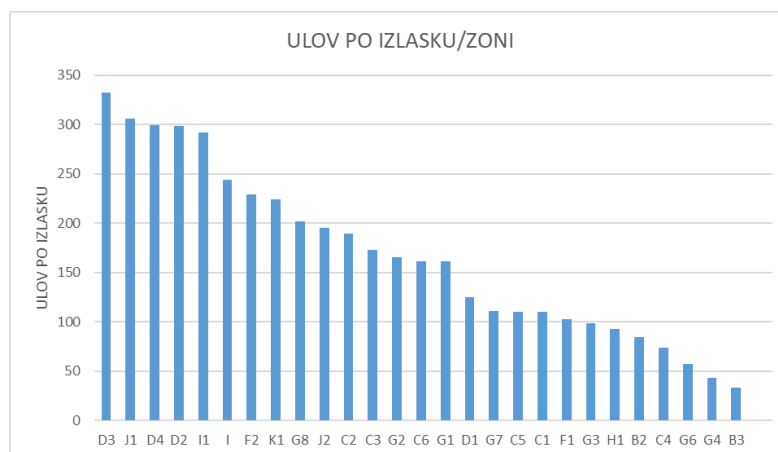


Figure 25. Average catch per longline trip by individual fishing subzones

Longline catches in the open sea were dominated by only a few species: hake and tub gurnard make up about 88% of the total catch (Figure 26). There are only the few species with a share in the total catch greater than 1%: rays, dogfish, conger and red scorpionfish. All other species make up only 3.8% of the longline catch.

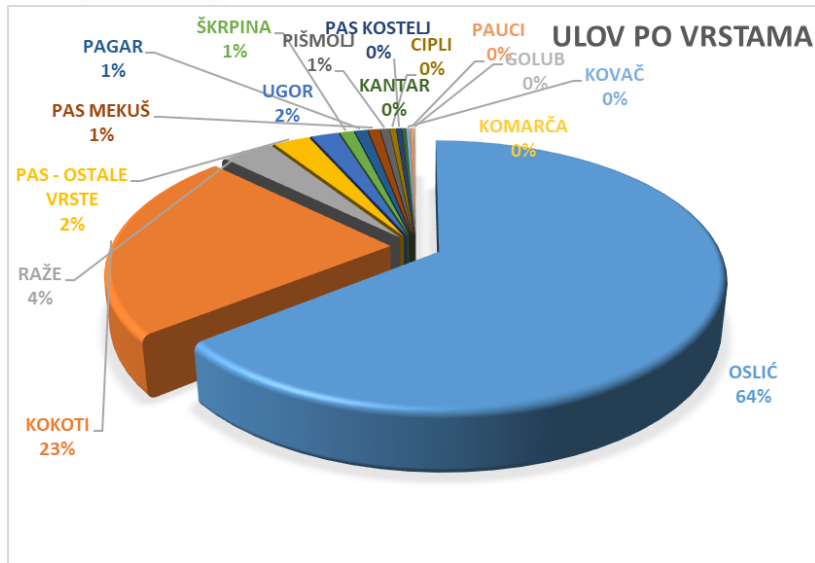


Figure 26. Share of main species in longline catches

The catch of the key species of hake and tub gurnard, as well as the total catch, are shown by month in the entire fishing area in Figure 27. It can be seen that the catches are highest in late winter and spring (February - March), and in May and June. In summer, catches decrease, only to increase again in September. The lowest catch values are recorded in November and December, when the sea weather is the least favorable.

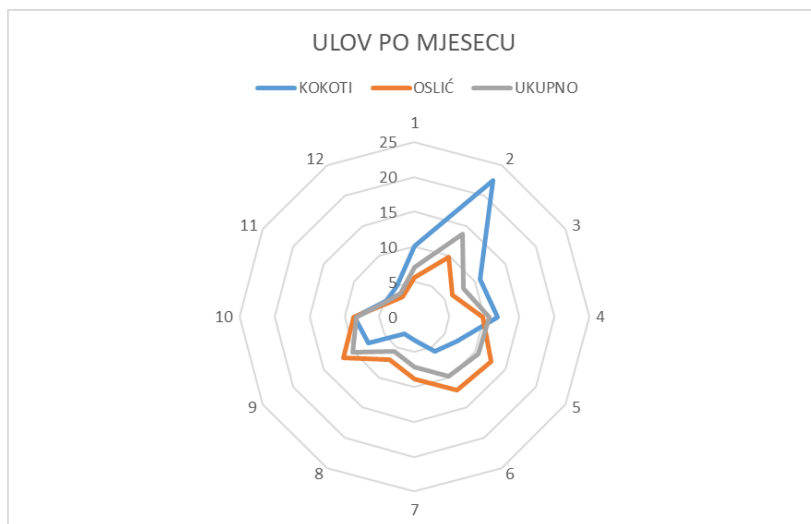


Figure 27. Percentage share of hake, tub gurnard and total catch by month

Figure 28 shows catches by month and fishing subzones. It can be seen that in most subzones, catches are highest towards the end of winter and the beginning of spring, and then in the autumn period. The lowest catch values are in late autumn and winter.



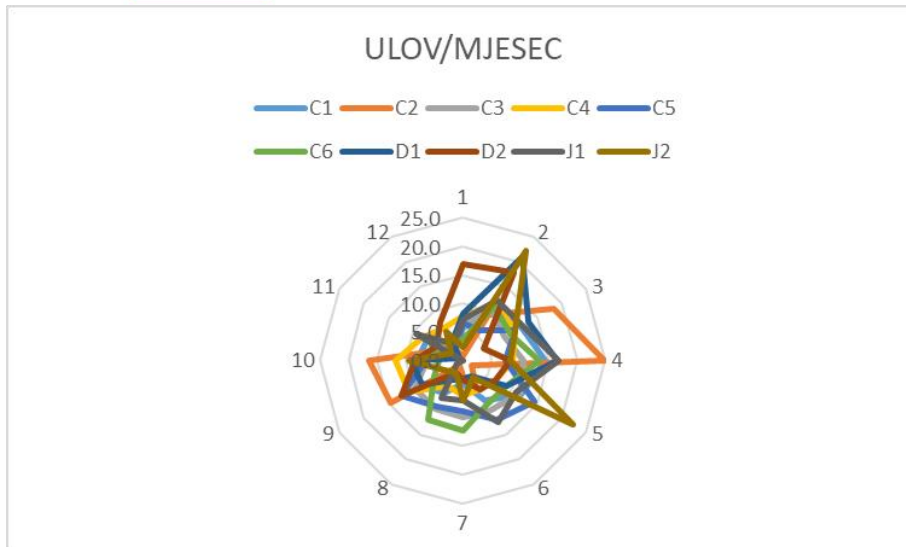


Figure 28. Catches by fishing subzones by month

The trends of effort are similar to catches; the highest fishing effort was in the spring and autumn periods in most of the fishing zones (Figure 29). The lowest values are found in the period from November to January.

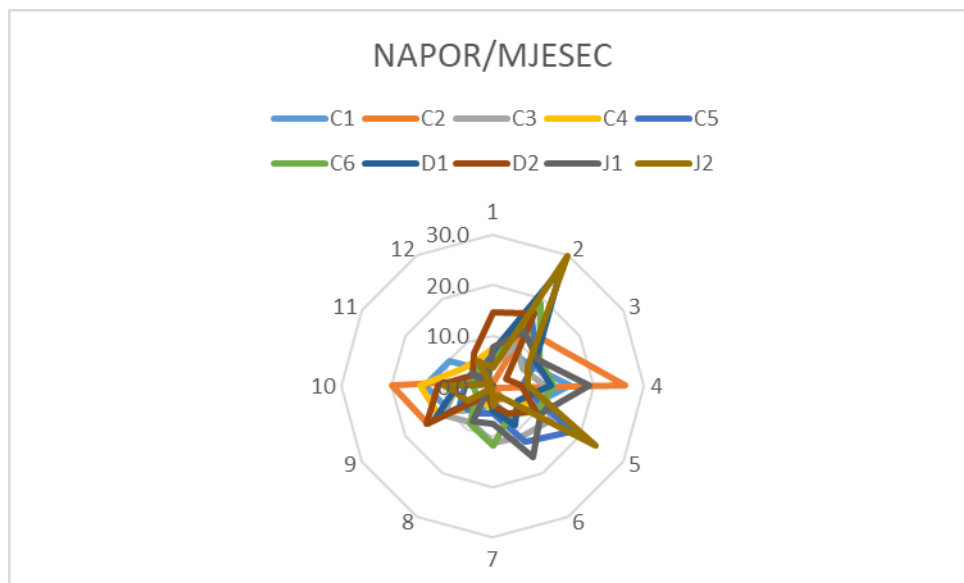


Figure 29. Average fishing effort by fishing subzones by month

The average value of the catch per trip (Figure 30) behaved somewhat differently during the year than the total catch and fishing effort. The highest average values of catch per day are recorded in the warmer part of the year (from May to September), and the lowest values are also recorded in December and January.

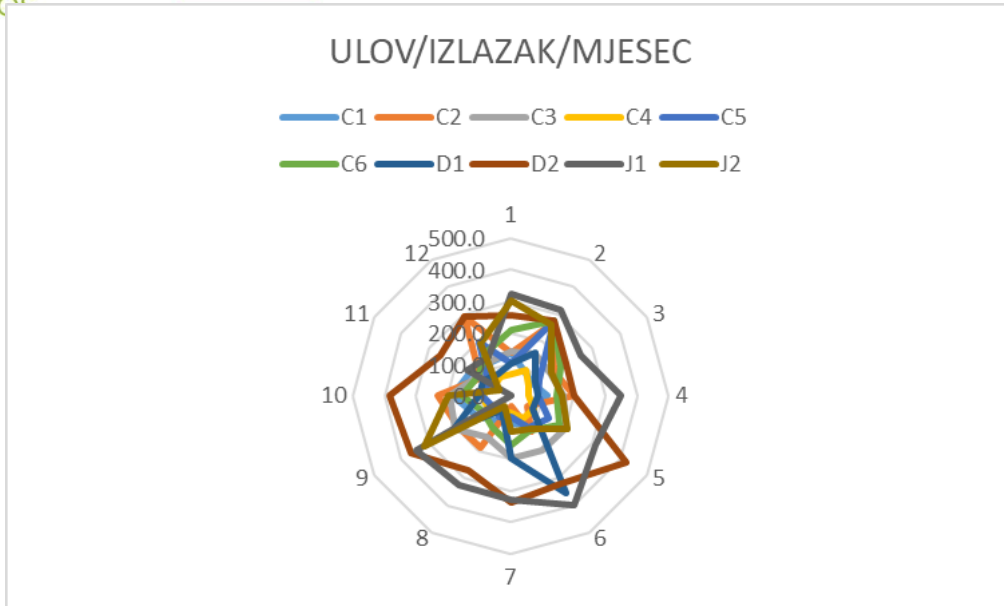


Figure 30. Average catch per trip by fishing subzone by month

### 11. AVERAGE PRICES OF INDIVIDUAL SPECIES IN LONGLINE FISHING DURING THE OBSERVED PERIOD

The average annual prices of the total catch were analyzed with the aim of studying the economic component of this type of fishing. Average price values are expressed as the mean value per species for a particular year. Figure 34 shows that the highest price was obtained for tub gurnard (around HRK 80/kg), followed by hake (around HRK 40/kg) and skinned sharks around HRK 30/kg. It is interesting to see the drop in the price of rayes, whose value was around HRK 30/kg until 2017, after which it dropped to around HRK 10/kg (Figure 34).

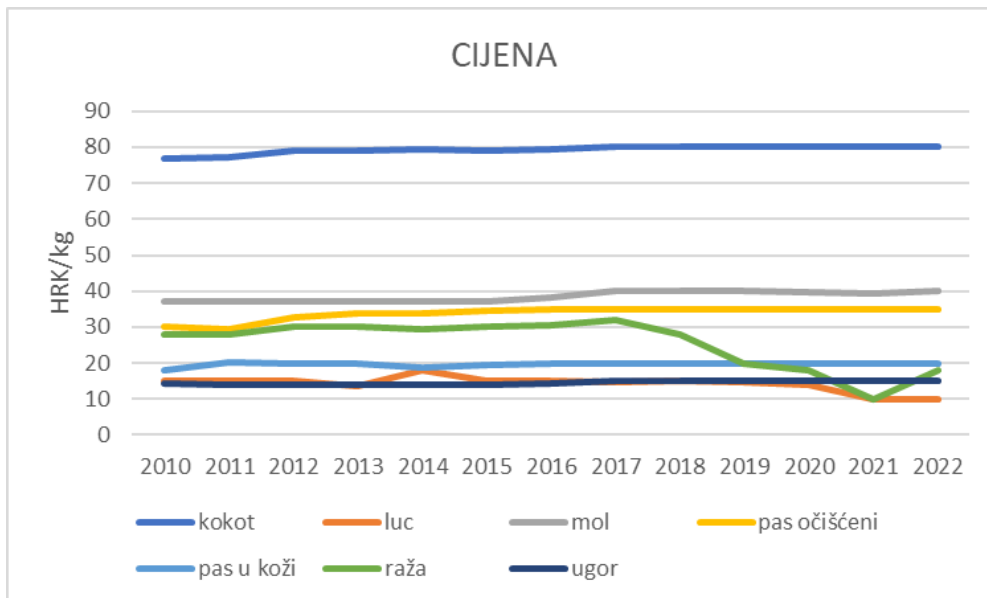


Figure 34. Average annual prices of individual species

## 12. TRENDS IN BOTTOM LONGLINE CATCH VALUES

The value of the longline catch was calculated as the product of the average annual price of a particular species and the average catch of that species per fishing trip. In this way, the average value of the catch per day was obtained.

The average value of the total catch per day was more or less stable until 2016 and was around HRK 6,000/day. This is followed by a marked increase and the total value of the catch rise to **almost HRK 10,000/day in 2022** (Figure 35). It is interesting to note that the value of the catch did not increase significantly due to the increase in the average price of fish, but due to the increase in the average catch per day. It is also indicative that the increase in the weight of the total catch occurred immediately after the establishment of the protected area in the Jabuka pit in 2015 and the declaration of the Jabuka FRA in 2018. The increase in the average value of the catch in the observed period is about 70%.

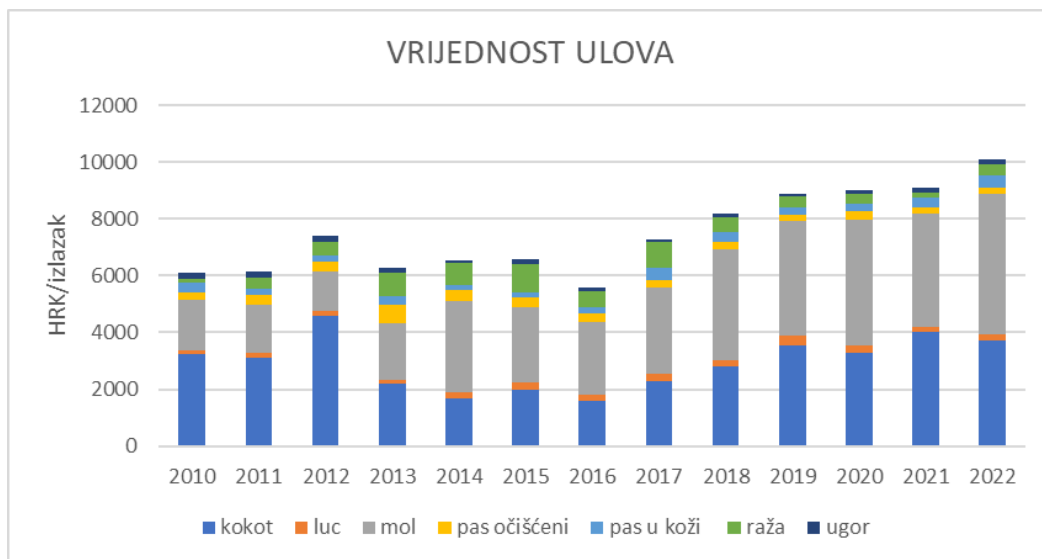


Figure 35. Value of catch of bottom longlines per trip

The share of individual main species in the total value of the catch is shown in Figure 36. The hake represents the largest share in the total catch value, especially after the establishment of the FRA Jabuka. Before that time, the share of tub gurnard in the value of the total catch was higher than that of hake (Figure 36). The share of other species in the value of the total catch is significantly lower than for these two main species.

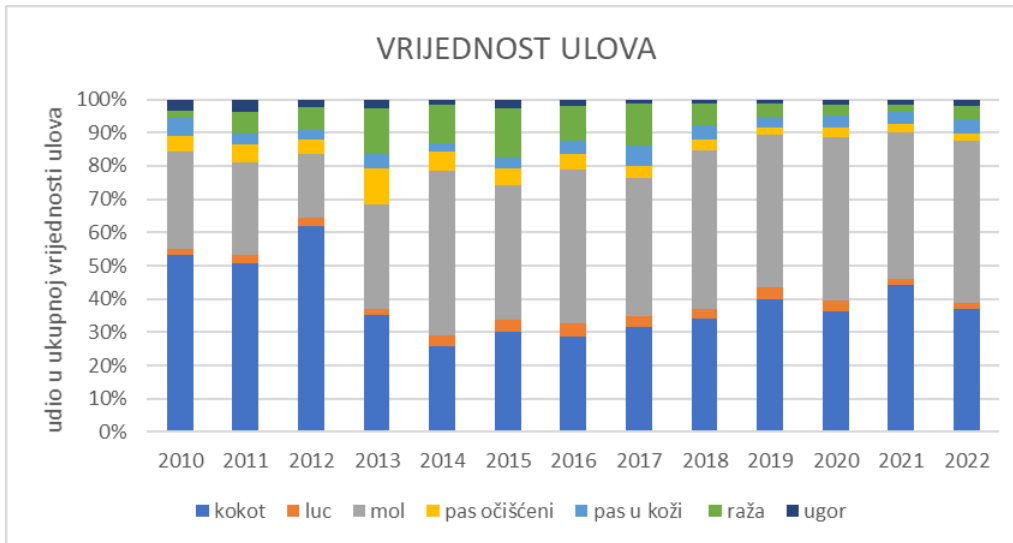


Figure 36. Percentage share of individual species in the total value of the longline catches

The catch values per trip for individual species are confirmed by the above. The value of tub gurnard was around 3500 HRK/day at the beginning of the time series and fell to around 2000 HRK/trip by 2016. After that, there was an increase and in recent years the value of the catch of tub gurnard is around 4000 HRK/trip. The value of the hake catch is constantly increasing, but the most intense increase in the value of the catch is after the establishment of FRA Jabuka. The value of the catch has increased from less than HRK 2,000/trip at the beginning of the time series to around HRK 4,000/trip in the last 5-6 years (Figure 37).

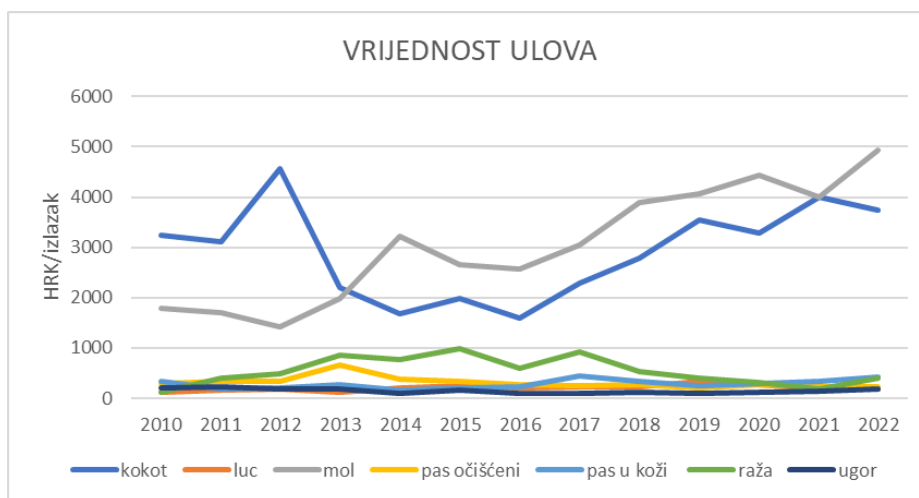


Figure 37. Catch value per trip of the most important species in bottom longlines fishery



### Relationship between the value of longline catches and the price of blue diesel

The analysis of the prices of blue diesel and the price of fish and the total catch is extremely important for the analysis of the economic effects of fishing. Namely, fuel has recently been a significant component in overall fishing, including longline fishing. The relationship between the average annual price of certain types of fish and the average price of blue diesel in those years is shown in Figure 38. It can be seen that the prices of blue diesel varied significantly more in the studied period than the prices of individual types of fish (Figure 38). The large increase in the price of blue diesel in the last couple of years was not accompanied by an increase in the price of fish, and in some cases, there was a decrease in the price of fish (e.g. for little tunny (*Euthynnus alletteratus*) and rays).

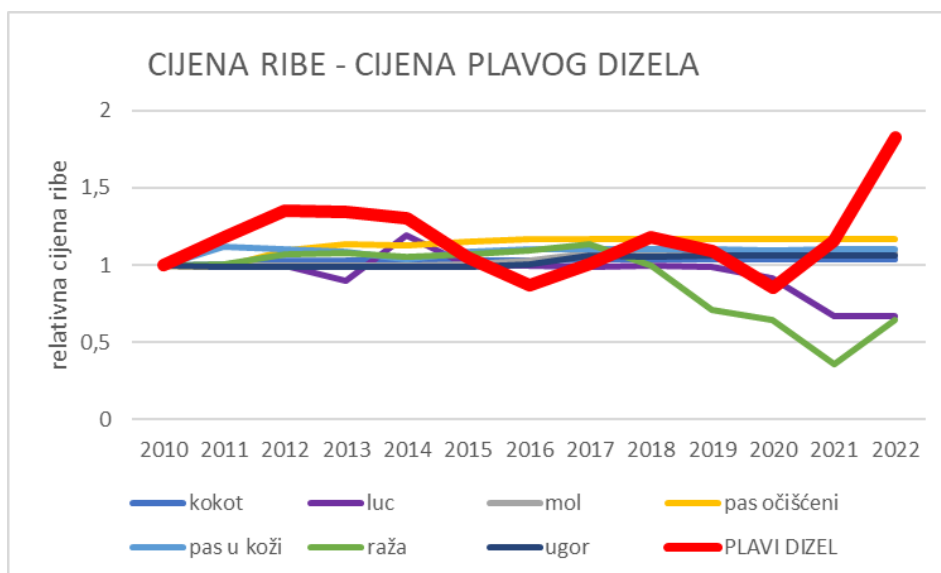


Figure 38. Trends of the average price of fish and the price of blue diesel

There is somewhat greater correlation between the total catch, the value of the total catch and the price of blue diesel. However, there are also big differences, especially in recent years. It is interesting to note that there is a certain positive correlation (but statistically weakly significant) between the price of blue diesel and the value of the total catch (Figures 39 and 40).

However, this correlation cannot be interpreted in the way that there is causality between these two phenomena. Namely, the increase in the value of the catch is not primarily the result of an increase in the price of fish (which would be expected considering the increase in the price of

blue diesel), but the increase in the value of the catch is primarily related to the increase in the catch weight of individual species and the total catch per trip.

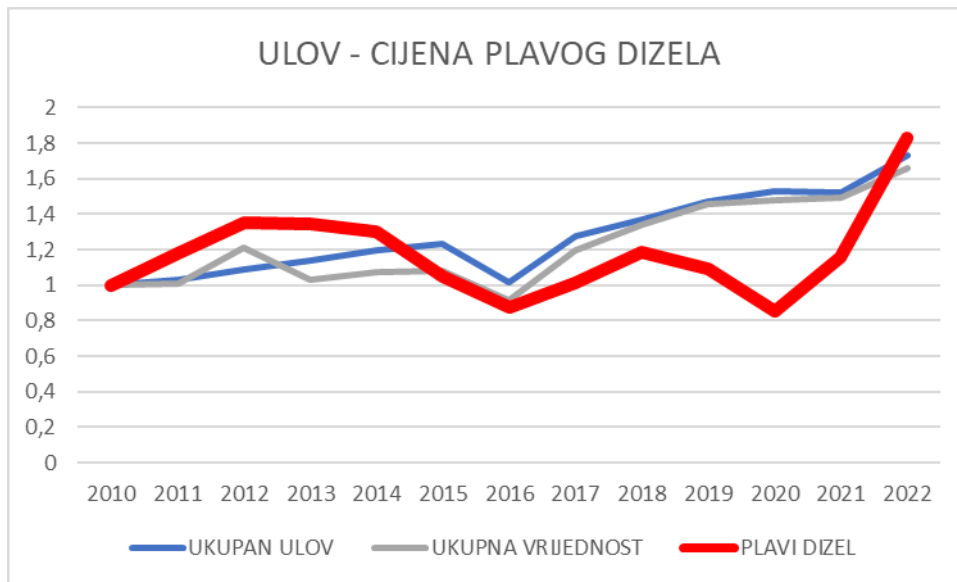


Figure 39. Trends of the average price of blue diesel and total fish catch

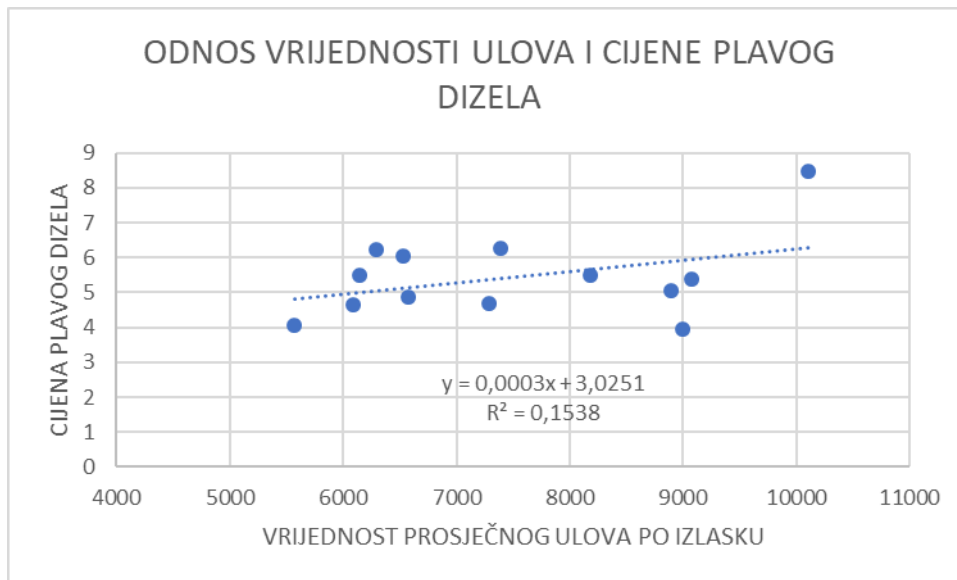


Figure 40. Correlation between the value of the total catch per day and the price of blue diesel

## Expenses

Although fishermen working with bottom longlines have small vessels and usually work alone or in company with another fisherman, the costs occurring during fishing activities are quite high, especially recently, after the increase in the prices of fuel and other necessities. Information on costs was collected through surveys with fishermen from Komiža.

**The price of a longline** used in fishing varies considerably depending on the material it is made of, the type of hooks that are placed on it, whether the fisherman makes the longline himself or buys it ready-made, etc. Mostly, the price of a ready-made longline that can be bought on the market is about 3,000 euros, i.e. the approximate price of a longline is about 1 euro per hook. Bearing in mind the frequent damages of longlines (by bottom trawlers, other longlines, caught fish, etc.), significant resources are used for additional maintenance. Likewise, according to fishermen, due to the above, the average duration of a bottom longline is about a year. An extremely important item in costs is **fuel**, and the consumption depends on the type of engine on the boat, the distance at which fishing is carried out, the time spent at sea, etc. In general, the share of the cost of fuel ranges around 10% of the value of the catch. Bearing in mind the recent increase in the price of fuel, which was not accompanied by a proportional increase in the price of fish, the share of fuel in the value of the catch has increased.

Fresh or frozen sardines are most often used as bait in fishing. The price of sardine has also increased significantly in recent years, so the price of bait makes up an additional 10% of the value of the catch. Most fishermen do not keep their own accounting data, but pay an **external accounting service** for it. The price of such a service is around 100 euros per month.

Usually, fishermen on board do not have a fixed salary, but the amount of **the fishermen's monthly income** depends on the value of the catch and is linked to a percentage of the value of the total catch. As a rule, the fisherman receives 20-25% of the value of the catch. From all of the above, it is evident that **operating costs** make up over 50% of the value of the catch.

Most of the fishermen do not sell fish themselves, but sell the fish to the fishermen's cooperative or purchase stations, and according to the fishermen, there are no major problems related to the

purchase of the catch. Problems with purchase occur in the part of the year outside the tourist season, because the possibility of placing fish on the market is reduced.

Fishermen cite as one of the most significant problems the fact that the price of fish caught with a bottom longline has remained relatively unchanged in the last few years, although all other prices are increasing. Likewise, they are aware that increasing the current price for end customers is not a realistic option.

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### 13. FINAL CONSIDERATIONS AND RECOMMENDATIONS

- Although there are over a thousand fishermen in Croatia who are engaged in fishing with bottom longlines, very few of them can be classified in the category of **open sea bottom longlines**. In this document, a very conservative approach was used to separate open sea longlines from coastal longlines: all longlines whose total catch in the observed period (1<sup>st</sup> January 2018 to 30<sup>th</sup> September 2022) was less than 2,000 kg (which represents about 5 kg of fish per day in the observed period) and thus there are only 84 fishermen left who are mainly involved in bottom longline fishing in the open Adriatic. Most of them are located on the island of Vis (Komiža 49% and Vis 5%), and only a few in other ports of the middle Adriatic.
- Fishing with bottom longlines is an **extremely selective type** of fishing in which mainly large, sexually mature specimens are caught, and the majority of catches are hake (64%), tub gurnard (23%), rays (4%) and sharks (3%).
- Throughout history, the fishing area of these longlines has changed, as has **the target species**. Until the nineties of the last century, fishing was mainly done in the wider coastal area around the outer islands of the central and southern Adriatic, and the main catches were rays, turbot and fish from the Sparidae family. After the 1990s, this type of fishing spread towards the open sea, mainly to the central line, and to the north (in the spring for turbot fishing) and to the chanell areas. Rays appear less and less in catches, and hake and tub gurnard begin to dominate. In the last 5-6 years, an increase in catches can be observed, which can be connected with the establishment of FRA Jabuka.
- The key resources exploited by bottom longlines in the open Adriatic are hake, tub gurnard and cartilaginous fish (sharks and rays). The latest **scientific assessments** of the state of bottom resources show that these species are either overfished (e.g. hake according to the latest assessments by STECF and SAC GFCM) or are extremely sensitive to exploitation due to their fishery biological characteristics (e.g. rays and sharks). Although the bottom longline of the open sea is not a key tool for their mortality, the influence of the bottom longline should not be ignored, especially bearing in mind the fact that sexually mature specimens in the spawning phase are caught with this tool.



- Bottom longlines in the open sea are in a distinct **competitive relationship** primarily with bottom trawls. This competition is reflected in the species that are exploited, as well as the area where the exploitation takes place. Recently, problems have appeared in the competition between Croatian and Italian fishermen who use longlines in the open sea of the Exclusive economic zone of Republic of Croatia. Fishermen cite competition with sport and recreational fishing as a major problem.
- Considering the high selectivity of bottom longlines in the open sea and the length structure of catches of commercially important species, it is obvious that the proportion of **discards** in catches is very small. Likewise, through surveys with fishermen, as well as from the data of official catch statistics, it is evident that **specimens of sensitive and endangered species** are rarely caught with bottom longlines. Birds, turtles and some economically unimportant sharks (blue shark) can be found in the catches. It is in average only one to two specimens per year per ship. In order to avoid catching these species, fishermen use mitigation measures (e.g. modifications on the longline to scare away birds, shape of the hooks, release of caught specimens of sensitive species alive). Although the catch of sensitive species in bottom longlines in the open sea is small, it is still necessary to educate fishermen about the importance of avoiding catches of these species as well as reporting catches through log books or catch reports.
- Bearing in mind the great differences in the target species they catch, the areas they exploit, the fishing effort, the amount of catch, the condition of the target species and, accordingly, the problems they face, it would be extremely important in the future if the legislation would **distinguish between bottom longlines of open sea and coastal bottom longlines**. As one of the possible solutions, the possibility of **introducing authorization for open sea longlines** could be considered. In doing so, one should be very careful not to increase the fishing effort of this type of fishing.
- Bearing in mind the very poor state of the resources exploited by bottom longline of the open sea (hake, tub gurnard, cartilaginous fish), **it should not be allowed to increase the capacity** of this part of the fishing fleet.
- As one of the important problems, fishermen cite the obligation that they can stay in the EEZ for a maximum of 36 hours, or otherwise, if they intend to stay longer, they should go to register at the **permanent border crossing control for the international traffic** of passengers

and goods in maritime traffic, which is located in Split. In this way, their ability to work in more remote parts of the open sea is reduced and they seem less competitive than the Italian fishermen who use larger vessels and can stay at sea for up to 4 days. Efforts should be made to resolve this issue as soon as possible by involving the various relevant authorities.

- The establishment of a **special fishing regime in the Jabuka pit** in 2015, and the establishment of the Protected Fishing Area in the Jabuka pit by the GFCM in 2017, had an extremely favorable effect on the demersal species of the open Adriatic, and indirectly on the increase in bottom longline catches (primarily catches of hake and cartilages fish). This mostly refers to the possibility of working in the FRA part (zone C - Croatian buffer zone - the so-called "pocket").
- Bearing in mind the positive changes that occurred after the establishment of the FRA Jabuka pit, as well as the obligation of the **Republic of Croatia to establish 30% of the protected sea by 2030 (the so-called "30 to 30")**, of which 10% should be a complete ban, in the foreseeable future additional areas under partial and full protection will be defined. It would be very worthwhile to consider the possibility of banning fishing in zone C within the Jabuka FRA (the so-called "pocket" or "Croatian buffer zone"), keeping in mind that it is one of the most important hake spawning grounds in the Adriatic. The same applies to a possible ban on bottom trawl fishing in parts of the sea deeper than 500 meters in the southern Adriatic.
- Recently, there has been a large **increase in costs** in bottom fishing in the open sea, which is manifested primarily through the increase in the price of fuel and bait. Considering the fact that this was not accompanied by an increase in the price of fish, there was a decrease in the profitability of this type of fishing. To compensate for this situation, fishermen have increased fishing effort and average catch, which can negatively affect the state of the resources.
- Considering all the specifics of fishing with bottom longlines in the open Adriatic, and its importance for the **local community** (primarily the island of Vis), it is extremely important to pay more attention to this type of fishing. This includes finding adequate mechanisms to protect resources, but also the fishermen who exploit these resources. **However, although fishing with bottom longlines is a typical example of a local type of fishing, the resources that are exploited (primarily hake and tub gurnard) are migratory species that fall into the**

category of shared resources of the Adriatic Sea, and therefore it is necessary to agree and coordinate the measures of resource protection and fishing regulation with other fleets participating in fishing. All this requires a **participatory approach** that will include all relevant participants in fisheries: fishermen and their associations, administration, scientists, NGOs and other stakeholders.

- As this type of fishing has different competitive, synergistic and cumulative effects on resources in the sea with other types of fishing, the problem of assessing the state of resources and proposing measures to protect resources and regulate fishing must respect this complexity and include **interactions between tools**.
- Similarly, various environmental factors (temperature, salinity, acidity, dissolved oxygen, etc.) have a great effect on the state of resources, which directly affect the survival of (dominantly young) specimens. Long-term climate changes in the sea (global warming, acidification), as well as the arrival of invasive and non-native species, also have a major impact. Therefore, in describing the situation and proposing measures to regulate fishing and protect resources, **the ecosystem approach** in fisheries should be used as much as possible, which will provide an insight at the effects of as many factors as possible on the state of marine ecosystems, and not just the effects of fishing.
- Since fishing is one of the important branches of the economy in the coastal area, when defining measures to protect resources and regulate fishing, the **economic and social effects of proposed measures** should be considered, and ensure that, in addition to preserving resources, fishermen and fisheries are also preserved.

#### 14. PROTOCOL FOR THE MANAGEMENT OF BOTTOM LONGLINES OF THE OPEN ADRIATIC

Data on commercial fisheries in the Republic of Croatia are collected within the framework of the National Plan for Data Collection in Fisheries, which is consistent with the relevant EU regulations in this area. This includes the collection of data for the main fishing tools, namely data on the composition of catches (including catch and bycatch), biological characteristics of exploited species, impact of fishing on marine ecosystems, fishing effort and fleet capacity, and basic economic and social data.

- Because bottom longline fisheries are recognized nationally as an important fishing tool (based on both catch and fishing effort), they are covered by the DCF data collection. However, a major problem is that the national data collection plan does not distinguish between coastal bottom longlines and open-sea bottom longlines. Considering the significant differences between these two types of fisheries (fishing capacity, fishing effort, catch structure, working area, socio-economic importance of the fishery), these two types of bottom longlines should be separated in the future and a sampling plan should be organized separately for each of them.
- When defining future measures to regulate fishing (spatial-temporal measures, technical measures, limitation of fishing opportunities, ...), coastal longlines should be separated from open sea bottom longlines. Therefore, the possibility of introducing an authorization for open-sea bottom longline fisheries as a mechanism for their separation should be explored.
- Since this type of fishing is of great importance for the local population (especially in the central Adriatic and on the island of Vis), in addition to collecting data at the national level for the purposes of national statistics, additional pilot studies should examine the economic and social characteristics of this type of fishing and its impact. Care should be taken to ensure that fishing effort and capacity are not increased in such a way that fishermen using longlines in the inshore fishery would not change gear and switch to open sea longlines.

- The assessment of the effects of open-sea bottom longlines on harvested species should consider the competing, cumulative, and synergistic effects of other fishing methods (trawls, longlines, coastal longlines...), and this issue should be considered through the so-called multigear and multispecies approach. Although bottom longline is highly selective, catching mainly large (adult) individuals, its significant contribution to total fishing mortality should be considered because it catches adult individuals during the spawning season, which can have catastrophic consequences for exploited fish populations if fishing effort is excessive. This should be considered when establishing fishery regulation measures (possible ban of fishing during the spawning season of main species in sensitive areas).

- Surveys conducted for the purposes of this document have shown that there are no significant amounts of bycatch of sensitive species in the catches. Because these studies (surveys) included a limited number of fishermen and were conducted only on Vis, bycatch of these species should be better studied in the future and the effects of various measures to mitigate bycatch should be investigated.

- Due to the increase in operating costs (mainly fuel, bait, crew wages), but also the impossibility to further increase the price of fish on the market, the profitability of this fishery has decreased significantly recently. As a compensatory measure, fishermen have increased their catches, further jeopardizing the status of populations of already overfished target species. Therefore, opportunities to diversify fishing activities should be explored, such as the use of other fishing methods that target other, less endangered species, fishing tourism, and the like, as well as the implementation of activities that add value through marketing, creating recognition (branding), labelling, traceability, etc.

- Since oceans have been undergoing extremely negative changes for many years due to long-term climate changes and various negative anthropological influences, future assessments of the situation and measures to protect the resources should, as far as possible, apply an ecosystem-based approach to fisheries, as well as a participatory approach involving all relevant stakeholders at national and regional levels, since the resources exploited in these fisheries are shared stocks.