Report on the analysis of the findings of the scientific surveys and proposals for possible measures to protect the biodiversity in the considered habitats taking into account the socio-economical impacts

Activity 5.3 - Strategies to improve ecosystems and biodiversity conservation
WP5 - Ecosystem protection and sustainable fisheries
SUSHI DROP project (ID 10046731)

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Abstract

Overview

Adriatic continental shelf bounded between Croatia and Italy is one of the seas with the highest productivity and biodiversity which hosts habitats requiring specific conservation and management measures. The Adriatic Sea is an oligotrophic sea with different levels of primary production in some parts with some limiting factors such as low concentration of nutrient salts, primarily nitrogen and phosphorus. Nevertheless, there are between 6,000 and 7,000 different species of plants and animals in the Adriatic among which endemic taxa stand out classifying the Adriatic as a separate biogeographical entity of the Mediterranean Sea.

It is also heavily affected by human activities such as fishing, aquaculture, tourism, and hydrocarbons extraction. The natural balance in the Adriatic is affected by the extremely high fishing effort leaving more and more, directly and/or indirectly, negative consequences for marine organisms. Numerous fisheries regulation measures were introduced to help establish sustainable management of renewable stocks. Systematic scientific research and monitoring of the condition of economically important fish communities in the Adriatic Sea have been conducted, too. However, all these measures apply to the shallower areas of the Adriatic only where most of the fishing effort takes place. The deep parts of the Adriatic Sea are generally not covered by fishing regulation measures. Likewise, the fauna of the deep areas is poorly researched especially in terms of community composition and population dynamics of species.

Besides these different interests, this area is also severely affected by environmental risks such as those induced by global warming. The higher temperature of the Adriatic surface water is changing the biodiversity, and the “warmer” species (i.e., the ones which usually live in warmer seas) are entering into the Adriatic Sea changing its centurial life. Besides that, the Central–Northern Adriatic Sea receives most of the anthropic pollutants from rivers. Therefore, large quantities of land-derived contaminants are distributed in the water column and the sea bottom. They sink to the sediment where they are partially or totally degraded or accumulated

for different periods. It is very important therefore to evaluate the specific oceanographic and biological features of the Adriatic Sea.

Reliable and up-to-date information about the state of marine resources is essential to support sound management decisions for the protection of ecologically important areas. Conventional fish capture procedures are extremely onerous in terms of human resources, besides being extremely invasive for the ecosystem. This is why the use of capture methods such as trawls is prohibited in Marine Protected Areas. Thus, there is an urgent need to develop accurate and non-invasive methods for mapping the marine ecosystems to establish their condition, extent, and geographical location. The urgency of such a need is emphasized in the EUSAIR Action Plan and in the BLUEMED Initiative Strategic Research and Innovation Agenda.

The SUSHI-DROP project contributes to the protection of biodiversity by exploiting the capabilities of the developed autonomous robot technologies to increase the knowledge of the habitats of the Adriatic Sea, overcoming the limits of traditional methodologies. This project contributes to the achievement of the UN 2030 Agenda Sustainable Development Goals. It is of the utmost importance to monitor the effects of fisheries pressures (especially trawling), as well as pollution and habitat degradation, which could also affect the diversity of fish assemblages. A better knowledge of the monitored habitats will allow also to demonstrate the effectiveness of protection measures as well as to implement new evidence-based conservation actions, e.g., by promoting the establishment of new marine protected areas. The project overall objective is the implementation of an UUV-based sensing system capable to characterize benthic habitats in deep waters with acoustic and optical instruments. Such system will allow increasing the knowledge and monitoring spatio-temporal patterns of fish diversity not only in Natura2000 sites but also in relevant nursery areas characterized by deep waters (inaccessible to divers), the environmental status and estimation of fish abundance indices in marine areas characterized by rocky reefs and deep waters in which the classical fish sampling procedures are ineffective or inapplicable.

Within SUSHI-DROP a customized UUV has been developed and equipped with acoustical and optical technologies to implement a non-invasive mean to assess the environmental status of habitats, fish stocks population and generally to monitor the biodiversity of marine ecosystems, especially where traditional methodologies are not applicable. Thanks to the advanced technologies of the drone, such as the multibeam and high-resolution camera, it is possible to get a complete description of a given underwater area, from a morphological as well as a fauna point of view, emphasizing benthic communities, fish and rock formations.

The UUV technology has evolved over the last few years, from simple demonstrators developed by research institutes to commercial products. Nowadays applications in environmental research and ecosystems monitoring are emerging, thanks to the capabilities offered by UUV of carrying out researches without interfering with the sea bed and at reduced costs, if compared to the use of oceanographic vessels. Applications of the UUV technology in scientific research of marine ecosystems and fishery resources are also just beginning. Up to 50 m deep, existing knowledge has been consolidated by several years of surveys performed with fishing gears or directly with divers; at greater depths difficulties increase because divers have physiological limits and there are rough bottoms where nets cannot be towed.

Moreover, a dedicated open-access database system created to collect, maintain, and share the scientific data acquired by the UUVs should help in managing marine areas. One of the goals of the project was to combine the georeferenced information gathered by the UUVs and traditional methodologies, like trawl sampling and monitoring with divers, to help understand the habitat sensitivity to different pressures and design and implement more effective marine management plans. The development of such sensitivity analyses is becoming a priority for the preservation of biodiversity in the Adriatic Sea.

This document aims to provide possible measures and recommendations for biodiversity protection through the usage of the UUV to assess the environmental status of habitats, fish stocks population and generally to monitor the biodiversity of marine ecosystems, especially where traditional methodologies are ineffective or inapplicable. Since the SUSHI DROP project outcomes were presented in details in other deliverable reports, this report consists of an operational synthesis of the already existing materials, possible measures and recommendations made by experts and marine scientists along with the target audience's input about the usage of the underwater drone system in surveying sea beds, aiming to facilitate the implementation of conservation actions, such as the establishment of new marine protected areas as well as designing effective marine spatial plan in accordance with biodiversity conservation.

Proposal for possible measures to protect the biodiversity in the considered habitats

The fundamental requirement for biodiversity protection and conservation is the conservation of ecosystems and natural habitats *in-situ* and the maintenance and restoration of the population of species capable of surviving in their natural environment. The goal of habitat protection at the European level is to preserve habitat types important for protection in good condition in the long run which is especially elaborated in the European Union Habitats Directive (92/43 / EEC, 1992).

Due to the geomorphological features of the coast, formed in karst limestones, the marine habitats of the eastern part of the Adriatic are very diverse. However, these habitats are much less explored than terrestrial ones. As opposed to research on the land, research at sea is expensive and technically demanding. There are many limits like the amount of light, sea transparency, depth, and time of the *in-situ* surveys.

When deciding on measures for biodiversity protection and conservation, special attention must be paid to the socio-economic aspect of fishery in this area since it is one of the most important activities in the region.

Relevant Stakeholders

As part of the project, key stakeholders were identified:

- **General public**,
- **Local, regional, and national public authorities** - All the regional authorities on the Italian and Croatian side of the Adriatic basin, both Italian and Croatian ministries in charge for the regulation of fisheries,
- **Protected areas/natural heritage management bodies** - The management bodies involved in the two areas selected for the scientific survey,
- **Regional and local development agencies** - All the regional development agencies on the Italian and Croatian side interested in the Adriatic basin
- **Associations** – Regional and national associations conducting conservation activities of biodiversity and reduction of human impact on natural habitat
- **NGOs** - All the main NGOs committed to environmental issues and active on the Adriatic Sea
- **Education and training organizations** as well as universities and research institutes - research institutes and universities located in the Programme Area supporting research in Marine Biology, Robotic Systems Engineering and Geomatics

The aim of the project is to make the information available to the key stakeholders and to raise interest in biodiversity preservation, Natura2000 sites and Marine Protected Areas.
To improve cooperation and better understanding on the views of key stakeholders on the use of underwater drone technology, a short questionnaire was sent to more than 50 relevant stakeholders. The aim was to identify their views of possible disadvantages, advantages, possibilities of use and recommendations for the usage of this innovative technology. Total of 12 responses were received from which 50% of the respondents came from public sector, while others came from private sector (25%), NGOs (16.7%) and educational institution (8.3%). There were no responses from scientific research institution or other (Figure 1).

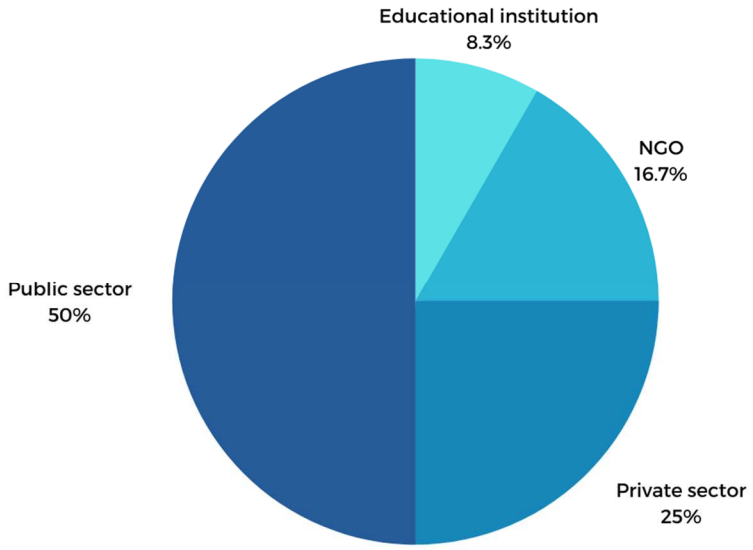

FIGURE 1 REPRESENTATION OF SECTORS AMONG RESPONDENTS

Half of the respondents replied they were well informed about the drone technology, while others were poorly informed.

When asked about the possible use of drone technology to help monitor the state of the fishing stock in areas where traditional sampling procedures are ineffective or inapplicable, 16% of the respondents answered that they neither agree nor disagree, 58,3% agree and 25% strongly agree.

When asked if the drone technology can help measuring and mapping the different oceanographic characteristics of a water column and if it can help monitor climate change and other disturbances in the marine environment, 8.3% of the respondents answered that they neither agree nor disagree, while 66.7% agree and 58.3% strongly agreed.

When questioned about the usage of drone technology for detecting habitats where new invasive species are present, helping mapping archaeological sites and exploring coral reefs, 58.3% of the respondents answered they agreed and 41.7% strongly agreed.

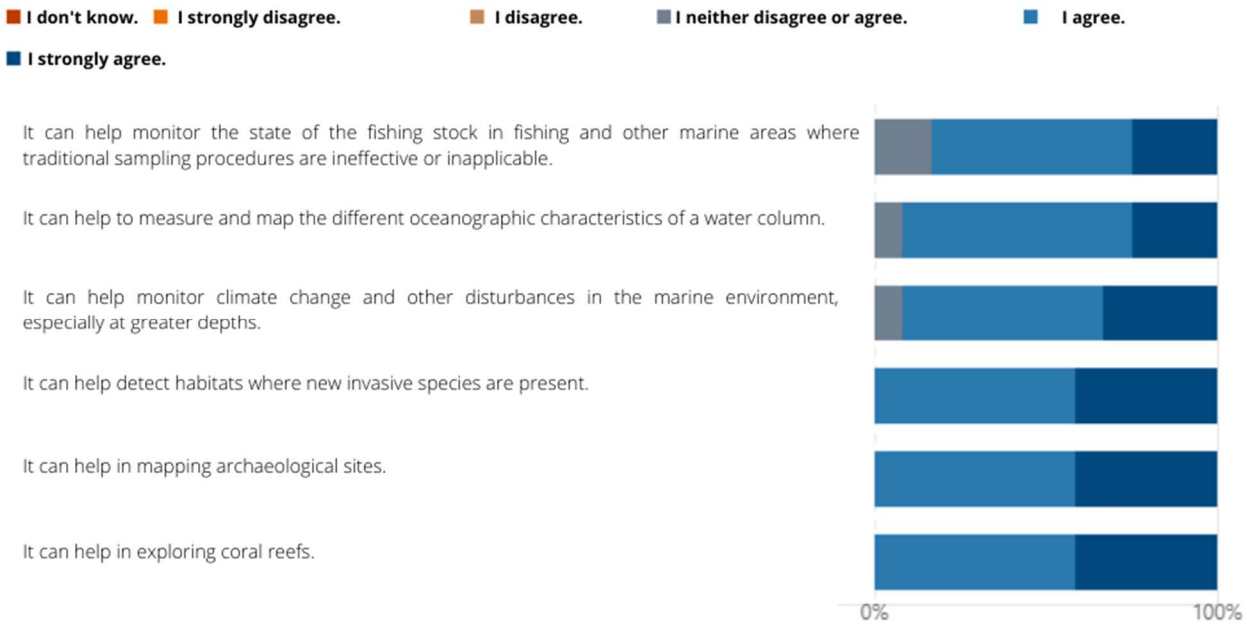

FIGURE 2 RESPONSES TO DIFFERENT STATEMENTS ON POSSIBLE USE OF UNMANNED UNDERWATER VEHICLE (UUV) BY RANKING

Additionally, one of the respondents noted that with underwater drones, it would be possible to conduct a study on the extent to which fishing tool has a detrimental effect on a particular fishing area.

The questionnaire also included a question regarding the main shortcomings of the development and application of robotic technology in the research of biological resources. When asked about the price of the service of the drone, 33.3% did not know if the statement was true or not, 8.3% did not agree, 16.7% neither agreed or disagreed while 16.7% and 25% of the respondents agreed, respectively strongly agree. Some respondents either did not know (9.1%) or disagreed (9.1%) that the legislation on the rules for the usage of underwater vehicles (UUV) for scientific research purposes was unclear, while 36.4% agreed, respectively 27.3% strongly agreed. The respondents agreed or strongly agreed that the development concept of robotic technology in Croatia was missing as well as that there was a lack of sufficient financial

resources for scientific and professional support to small and medium enterprises in the development of robotic technology (Figure 3).

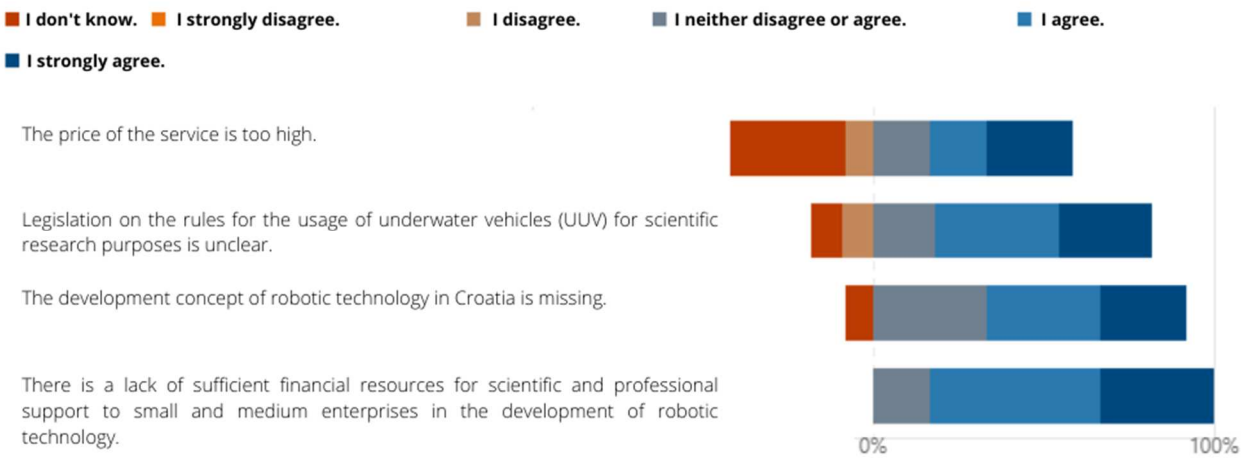

FIGURE 3 RESPONSES ABOUT THE MAIN SHORTCOMINGS OF THE DEVELOPMENT AND APPLICATION OF ROBOTIC TECHNOLOGY IN THE RESEARCH OF BIOLOGICAL RESOURCES

The respondents mostly agree or strongly agree that drone technology can help support the decision to proclaim exclusive economic and fishing areas and the development of measures for the spatial and temporal regulation of fishing areas. They also agree that it can be used as support in aquaculture facilities and that it can help find larger quantities of discarded fishing gear and other litter at the seabed.

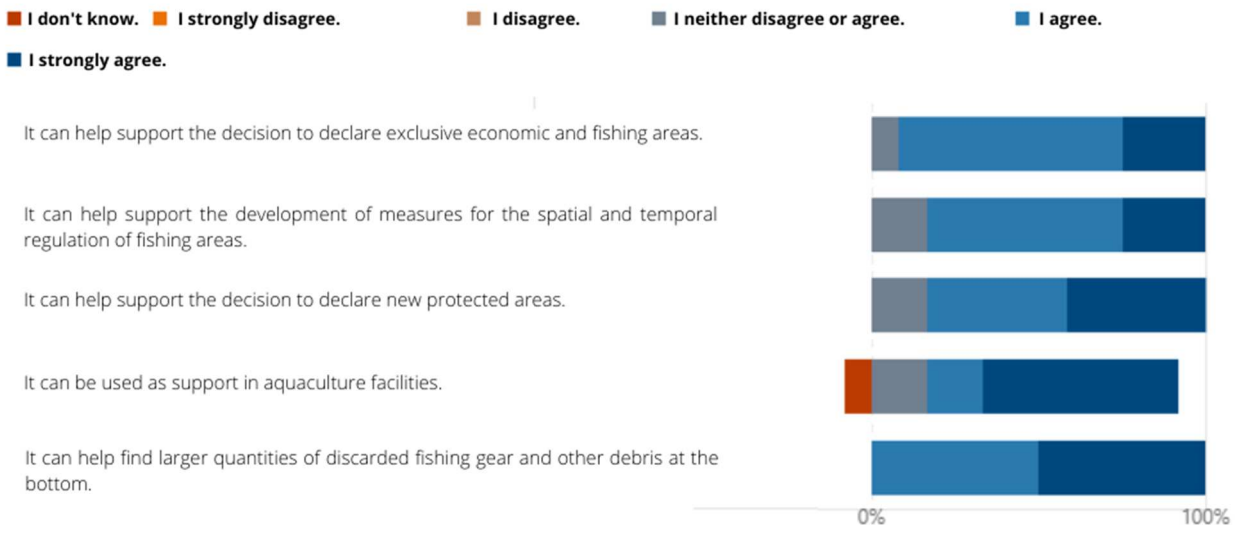

FIGURE 4 RESPONSES ABOUT THE EFFICIENCY OF UNDERWATER VEHICLES (UUV) FOR THE COLLECTION OF BIOLOGICAL AND GEOLOGICAL DATA WITH SPECIAL EMPHASIS ON THE AREAS OF ENVIRONMENTAL PROTECTION AND BIODIVERSITY

From all replies obtained by the questionnaire it is obvious that key stakeholders find drone technology as the next step in providing additional information about marine areas and that it can be of great help in future for marine spatial planning, the development of measures for the spatial and temporal regulation of fishing areas, different conservation actions etc.

Analysis of the findings of the scientific surveys

5.2.1 Report on the scientific survey operated with the UUV system in the first selected area, which preceded this one contains detailed description of the survey conducted in eastern part of the Adriatic Sea. With historical data and knowledge at our disposal, as well as with new data obtained with innovative technologies that were the goal of the SUSHIDROP project, we have created additional input on biodiversity of studied area.

The recent state of resources in the project research area is not satisfactory. Research of most species through SAC GFCM and STECF shows that they are in a state of overfishing. However, the situation is not the same in all parts of the Adriatic Sea: the situation is much better in those parts where fisheries regulation measures are more restrictive. This is exactly the case with the researched area of fishing zone G. Namely, this area is under extremely restrictive measures of fishing regulation throughout the year. These measures seem to be showing results. It is obvious that a significant share of catches in this area is cartilaginous, known as indicators of the condition of the formed communities. Biomass indices are especially high for sharks, but also for organisms of the order Rajiformes. The biomass values of these species are significantly above the values in the open sea and canal areas of the northern Adriatic.

The intensive exploitation of the most important commercial species definitely affects the entire marine ecosystem which can lead to negative changes in qualitative - quantitative species composition of demersal communities. These changes can manifest themselves as degradation of trophic levels (overfishing down the food web), depletion of resources through excessive fishing effort, the destruction of natural habitats, and others. The intensive exploitation can also adversely affect the demographic structure of population, such as: length frequency structure, sex composition, biomass of adults, recruitment, etc. Furthermore, it should be kept in mind that the demersal species are potentially threatened by synergetic effect of different fishing gear such as: bottom trawl net, setnets, traps and other gears. All these types of gear target the same important commercial species of different age structure in the entire exploited area, thus affecting the populations' recovery capacity.

Research conducted during the Sushi Drop project using a commercial trawl net shows a similar situation of demersal resources as those conducted through the MEDITS survey and DCF project (commercial fishing monitoring project). The catch shows that it is an area of great biodiversity, with 36 different species of fish, crabs and cephalopods found in the samples. Apart from being an area of great biodiversity, it is also an area of intensive fishing, both commercial and recreational.

The slow recovery of demersal resources, which is also visible in studies, can be largely attributed to the establishment of the Fisheries Restricted Area in the area of the Jabučka kotlina (Pomo Pit). As a consequence of this measure of fishing regulation, there has been a recovery of a large number of stocks whose life expectancy is related to the Jabučka kotlina, the main spawning and nursery area in the Adriatic Sea. The most obvious examples of recovery are those of hake and Norway lobster.

The fishing fleet of the fishing zone G, both for coastal fishery and bottom trawlers, is categorised by relatively small, old and poorly equipped fishing vessels. Due to this and the fact that southern Adriatic is known for unfavourable weather conditions (windy throughout the year), the fishermen have small number of working days during the year. Furthermore, very rugged coastline of this area (islands, bays, capes) in combination with ban for trawling 1.5 NM from the coast (in areas where the depth is less than 50 meters, trawling is banned 3 NM from the coats) and in areas that are declared as NATURA 2000 areas. Moreover, fishing activity is completely banned in areas with intense maritime traffic and in areas with underwater cables and watercourses.

Furthermore, there is a fishing ban during the warmer part of the year (from April 1st to November 1st). In the last three years, there is a fishing ban in outer adjacent zones (C and D) which could have affected the slight improvement of biomass and the situation of the fishing zone. In open fishing season, trawling is allowed in daylight and two days a week only, on Wednesday and Thursday. Trawling is prohibited for any vessel with engine power exciding 185KW.

Regarding the small-scale fishing, there are also several bans in fishing zone G: for shore seine 'migavica', fishing is allowed in period from November 1st to March 31st , for shore seine 'šabakun' fishing is allowed from April 1st to October 30th . There is also a general ban for all shore seines - fishing is carried out at specific stations and each vessel can be max away from a point within a radius of 250 meters.

Based on previous research, as well as those conducted within the SUSHI DROP project, the fact that the channel area studied is extremely large, biodiversity of flora and fauna is highlighted. The reason for this is the diversity of the seabed - from the rocky littoral area along the coast, through meadows of Posidonia and meadows of algae and coralligenous structures, all the way to sandy sediments in the central part of the channel. These areas are inhabited by numerous commercial species of fish, crustacea and cephalopod, which are the basis for various fishing activities. According to previous research, up to 200 different species of vertebrates and macrozoobenthic are found in catches, almost half of which are commercially interesting.

This area is one of the better explored parts of the eastern Adriatic coast due to the proximity of Institute of Oceanography and Fisheries hence the fauna and flora of this area is very well known.

Intensive commercial and recreational fishing takes place in the channel area. The most important fishing gear are set-net, hooks and longlines, purse seine and bottom trawl net. Fishing is carried out mainly by local fishermen through small scale fisheries which has a great economic, social but also traditional cultural impact on the local community. A large number of fishermen are the so-called ‘Complementary “- a type of semi-professional fishing in which fishermen can catch for their own needs, but also for the market a limited amount of catch (5 kg).

In this area there are various sensitive and habitats especially important for the life of marine organisms. These are spawning, nursery and feeding grounds of different species. The most important sensitive habitats are the Posidonia meadows, spawning and nursery grounds for many species most of all for family of Sparidae.

Most commercial fishing in the Adriatic Sea is based on the catch of specimens that are often juvenile. Most of the catches are specimens aged 0, 1 and 2 years. Therefore, the intensity of recruitment is of great importance for the level of available biomass, and thus of the catch: when the intensity of recruitment is high, there is a large biomass of young specimens in the sea, which results in high catches. This leads to large inter seasonal and inter annual oscillations in the biomasses and catches. In the years of poor recruitment, the number of juveniles decreases, and thus the available biomass and catches. Due to the large impact of recruitment on catches, it is difficult to find a strict correlation between fishing effort and resource status, which further complicates fisheries management, generally based on fishing effort regulation.

Apart from catching small pelagic fish, in which anchovies are mostly caught, most of the fishing in the Adriatic Sea is typical for multispecies fisheries. There is a large number of species in the catches (dozens) of which a large number refers to the economically important species and end up in landing places. Thus, there are up to hundred different species of fish, crustacea and cephalopods in trawl catches, of which about fifty economically significant. In such conditions, some species always show a decline in biomasses, others show increase of the biomasses, some are overfished, some show fluctuations without a clear trend - therefore, it is difficult to determine the state of a particular type of fishing and prescribe and apply measures that will be effective for all species.

Fishing in the Adriatic Sea is carried out by the fleets of six countries, of which three EU member states (Italy, Croatia and Slovenia), and three are not (Albania, Montenegro and Bosnia and Herzegovina). Therefore, fisheries policies are also different in the Adriatic Sea: The Common Fisheries Policy is applied in EU countries, while other countries have their own national fisheries policies. However recently efforts were made to establish a common fisheries policy in the Adriatic through the General Fisheries Commission for the Mediterranean (GFCM). Thus, multiannual management plans for different renewable resources in the Adriatic Sea (for small pelagic fisheries and for demersal fisheries) are already in force. There is also a large disproportion in the strength of fishing fleets in the Adriatic Sea and in the realized catches, so the intensity of exploitation is unequal in different parts of the Adriatic. As a result, the state of resources is different in different parts of the Adriatic, and it is extremely important for joint responsible management to agree to adjust measures to the state of resources and the intensity of fishing in certain parts of the Adriatic.

Furthermore, exploitation in the Adriatic Sea is a typical multi-gear exploitation: there are many types of fishing gear in commercial, recreational and sport fisheries. Therefore, the competitive, cumulative, and synergistic effects of different fishing gears are very significant.

Due to the great diversity of catches (multispecies fisheries) but also due to the fact that fishing is based on subadult and often juvenile specimens, there is a big difference in qualitative and quantitative composition of catches and landing, and a significant part of the catch ends up as bycatch and discard. It is extremely important therefore to work on reducing discards and unwanted bycatch.

Most of the stocks that inhabit the Adriatic Sea are biologically unique populations and their different life stages (spawning, nursery area, recruitment area, migration routes etc.) are located in different parts of the Adriatic. Sometimes the nursery grounds and adult specimens are located along the east coast and juvenile specimens along the Italian coast (eg. sole, red mullet, tub gurnard) and sometimes the main nursery grounds are located in the open deep sea from which migrations to shallow coastal waters and vice versa. This is the situation with the most economically important species of bottom trawling, such as hake: its main spawning grounds and habitats are located in the Jabučka kotlina area (Pomo Pit) and specimens from this area migrate when they grow up in shallower areas of the open Adriatic and channel areas. The situation is similar with Norway lobster, of which population is densest in the open central Adriatic.

Recent research shows that the resources in the Adriatic are not only exposed to intense negative anthropogenic effects (such as fishing, anthropogenic pollution, habitat loss, etc.) but resources and communities are increasingly changing due to long-term climate change. These changes are most noticeable in community changes due to the arrival of new and invasive species, as well as the spread of existing thermophilic species in the Adriatic Sea.

During the project, several mission tests have been carried out to confirm the capabilities and performances of the underwater vehicle even in adverse meteomarine conditions. During these tests we have gathered biophysical data, videos, and high-resolution images of the underwater environment of the Croatian coast . At the beginning, missions were conducted piloting in ROV (Remotely Operated Vehicle) mode connected to the main ship through the 500m long fibre optic cable. This mode of navigation allows the exploration of the seabed with high precision ensuring a flow of data and video in real time allowing the approach to specific hotspots that can be reached during the survey activities. Thanks to the advanced technologies of our vehicle, as multibeam and high-resolution cameras, it will be possible to obtain a complete description of the area of our interest, both from a morphological and a fauna point of view, highlighting benthic communities, fish, and rock formations.

The Implementation of the UUV platform performed in this project would be pointless in case just a reduced numbers of scientists use such platform after the project completion. Our ambition is to set new standard practises based on the UUV technology for biodiversity monitoring. To reach this goal it is important to divulge the benefits brought by UUV in terms of i) costs savings, ii) minimization of the risks associated to monitoring campaign performed by divers, iii) accuracy in abundance indexes calculation, and iv) unparalleled capability to assess the biodiversity in deep seabed.

When analysing results gathered by diving, the time of the diver's stay under the sea and the number of safe dives for one day is limited, while the maximum allowed depth of recreational diving is 40 m. Since the underwater drone has no restrictions like time and number of dives as well as the maximum possible depth is much deeper than the one the diver is allowed to work on, a much larger area would be mapped for the same time using an underwater drone. Apart from detecting changes in habitat, record depths, and GPS positions, additional features, such as high-resolution cameras and high-quality lighting fixtures, would make it possible to obtain quality photo documentation, especially at greater depths.

Furthermore, gathering data on salinity and temperature and other physical properties of the water column would potentially be very useful for reef research because, among other data, a correlation between temperature and the occurrence of marine mucilage in the area could be made. However, the gathering of such data is not enough, given that the underwater drone could obtain data on the current state of the study area only and would gain in importance only after a long period of monitoring these parameters, which is already done today with data loggers and probes. It can be used to monitor the condition of Posidonia meadows, coral extinction due to temperature, but also to monitor climate change.

The underwater drone is enabled to gather data for the production of detailed 3D views of the surveyed area, which can help researching not only the sea bottom but also reefs. Also the advantage of researching marine ecosystems by underwater drone at greater sea depths (i.e., the limit for most divers is at 40 m depth) lies in the fact that the exact boundaries of habitats could potentially be defined, and would provide a clearer picture of the area, for example, coastal detrital bottoms and reefs. Such monitoring of habitats with the help of an underwater drone is potentially beneficial for determining habitat changes like reduction or advancing of a habitat type, which is very important from a biological point of view.

When planning the research, it is necessary to estimate the costs based on the ratio of the price of using an underwater drone and traditional methods as well as the area that the chosen method can cover in a unit of time. It is also necessary to consider what type of data can be gathered by the selected method. In the price estimation, it is necessary to include the price of the researcher's work, logistics, and data processing. Based on this assessment, it will be possible to determine which method is more cost-effective to conduct research.

Possible measures proposal for biodiversity protection

All of the above mentioned should be kept in mind when planning and proposing future measures for biodiversity protection and conservation. Biological resources that inhabit the Adriatic Sea have several features that are extremely important and should be considered when assessing the state of resources, but also defining measures for sustainable management. Actions should avoid and minimise impacts on biodiversity as much as possible. Achieving and maintaining good status of biodiversity is the core objective of managing the marine environment.

Spatial-temporal regulation of fishing has proven to be the most important and most efficient measure of fishing regulation in the Republic of Croatia - and it is based mainly on the protection of certain areas (nursery and spawning grounds) in key periods - spawning and recruitment of the species. These channel areas are also under a complex system of spatial and temporal regulation. However, bearing in mind that most of the resources in the Adriatic are in overfishing, it is extremely important to make a critical review of all these regulatory measures, and in accordance with new knowledge about biology and behaviour of marine organisms, make possible modifications of spatial and temporal regulations.

Also, given the positive effects of **establishing a Fishing Restricted Area** (FRA) in the Jabučka Kotlina (Pomo Pit), it would be advisable to establish similar but smaller FRAs in channel areas, not only FRA but also the **establishment of new Marine protected areas** (MPAs), all for biodiversity protection and conservation.

Minimum conservation referent size (MCRS) is ordered for the most important stocks. However, this should be ordered for other commercially less important species as well as for unimportant species that are important for the functioning of the ecosystem. Likewise, **existing MCRS's should be reviewed** and sought to be adapted to protect as many juveniles as possible.

Given the large share of juveniles in the catches, it is extremely important to work more on **modifications of fishing gear and techniques in order to reduce discards**. This primarily refers to the modification and increase of mesh size in the fishing nets. Special attention should be paid to **modifications on tools and mitigation measures to protect sensitive species** found as bycatch in catches.

The state of shared stock populations in the Adriatic has so far been addressed through SAC (Subregional Committees for the Adriatic Sea), GFCM and STECF (Scientific, Technical and Economic Committee for Fisheries) and these estimates are made for the most important

species only. The number of species for which assessments are made should be increased and species of local importance should be included. **National administrations** should also be established **for all major fisheries and harmonized at the Adriatic level in line with the regional approach in the EU Common Fisheries policy**.

Besides the extremely negative anthropogenic effects (pollution, fisheries, habitat loss, etc.) on the marine biodiversity of channel areas, significant changes occur as a result of climate change. It is important to monitor their impact, predominantly by **monitoring the entry of new and invasive species and finding mechanisms for their elimination from the ecosystem**.

In these areas, fishing is not only a branch of the economy, it has an extremely important economic and social component. Given the limited and poor state of resources, special attention should be paid to the **diversification of fishing activities, as well as the promotion of added value to seafood**. A good example is fishing tourism which improves the economic situation of fishermen, increases the tourist offer of the local community and does not negatively affect the state of resources as classic traditional fishing.

Potential additional work should also be done on **adding value to sea products**, and one of the most important mechanisms is the branding and certification of sea products in order to improve the quality of the final product and increase its value.

It is necessary to **intensify research on the sea and fisheries** in order to obtain as realistic a picture of the state of fisheries and the state of resources as possible. This is the only way how it possible to **establish an Ecosystem based management in fisheries and an ecosystem approach in fisheries (EAF).** The UUV technology developed through this project can also make a great contribution to increasing knowledge.

In addition to the importance of establishing an EAF, it is important to **promote a bottom up and participatory approach in fishers and environmental protection** that will include all relevant stakeholders because only a common approach can establish long-term sustainable fisheries in a sustainable and preserved marine environment.

It is also important to **raise the awareness of individual citizens and different professional groups** of the management of the marine environment and the factors that contribute to its good status and to promote good practices and operating methods that reduce human-induced pressures on the marine environment.

Of great importance is **reducing the amount of littering and different pollutants** and **evaluating the specific oceanographic and biological characteristics of unexplored parts of the Adriatic Sea** since large amounts of pollutants from land are distributed in the water column and seabed. They sink into the sediment where they partially or completely decompose or accumulate for different periods. Therefore, it is very important to assess the specific oceanographic and biological characteristics of the Adriatic Sea. Discarded fishing gear poses also a threat to marine life because it can indiscriminately capture and kill marine animals including endangered species or of economic importance. Most of the fishing gear that is lost is made of non-biodegradable plastic sinks to the seabed or is carried away by currents. Once fishing equipment is lost at sea, it is considered as litter and accounts for a large share of total plastics in the sea. However, littering can be reduced through education and the provision of appropriate waste containers.

Conclusion

In compliant with the above quoted the underwater drone research, with its advantages and disadvantages, can contribute to data gathering and determining the situation in the survey area. Depending on the goal and purpose of the research it can be the only method in case it is not possible to conduct the research with the help of traditional methods or it can be used as an additional technology in research with traditional methods. The UUV technology can be used for characterization through extensive scientific research on biodiversity as well as to assess the state of the environment at greater depths.

An integrated approach is to one to be used when discussing for biodiversity protection and conservation. Although the Adriatic Sea is one of the most researched parts of the Mediterranean with a very long history of scientific research and data gathering some parts of the Adriatic are still poorly explored (primarily the deep southern Adriatic). Recently it is becoming clear that more attention needs to be paid to the impact of oceanographic features of the sea on resource status and catches and accordingly to make a shift from single species assessment and management to an ecosystem approach to fisheries. Additionally, it is clear that effective biodiversity conservation without appropriate mitigation measures with new technologies and approaches is not sufficient.