Partnership for nature and people

Co-management & Bycatch

How fisheries co-management approaches and tools can support efforts to tackle bycatch of vulnerable species

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MedBycatch Project

This report was produced in the framework of the project "Understanding Mediterranean multi-taxa bycatch of vulnerable species and testing mitigation – a collaborative approach" (MedBycatch Project), funded by the MAVA Foundation from 2017-2022, and implemented through a partnership between the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS), the General Fisheries Commission for the Mediterranean (GFCM) of the Food and Agriculture Organization of the United Nations (FAO), the Specially Protected Areas Regional Activity Centre (SPA/RAC) of the United Nations Environment Programme/ Mediterranean Action Plan (UNEP/MAP), the International Union for Conservation of Nature – Centre for Mediterranean Cooperation (IUCN-Med), BirdLife Europe and Central Asia (BL ECA), the Mediterranean Association to Save the Sea Turtles (MEDASSET) and the World Wide Fund for Nature (WWF).

The project aims to address the gaps in knowledge regarding the incidental catches (bycatch) of vulnerable species during fishing operations in the Mediterranean, conduct trials of mitigation measures, and support the development of policies and formulation of national/regional strategies to reduce incidental catches and increase the sustainability of fisheries. Project implementation involves field observation programmes covering different fishing gears, together with trainings, awareness raising, identification and testing of mitigation techniques, and engagement on policy at national, European and regional levels with the aim of developing tools and building knowledge applicable to the entire region. Activities in the target countries are implemented in collaboration with national partners: BIOM and WWF Adria (Croatia), LPO (France), LIPU and WWF Italia (Italy), GREPOM and INRH (Morocco), AAO/BirdLife Tunisia, DGPAq, INSTM and WWF North Africa (Tunisia), SEO BirdLife (Spain), DEKAMER, Doga Dernegi, TUDAV and WWF Turkey (Turkey).

Preparation of this report

In the light of the ongoing development of EU policies related to fisheries management and biodiversity conservation, this study reviews the current knowledge and practices on co-management of fisheries and identifies and examines relevant case studies with the aim of identifying how co-management approaches and tools can support efforts to tackle the issue of bycatch of vulnerable species. The study builds on a theoretical analysis of co-management practices in the Mediterranean, in other European seas, and globally. A series of different approaches, practices, and tools were identified from the analysed case studies, with particular attention paid to those focused on the mitigation of bycatch, or which might be used for that aim.

Consultations were carried out with experts working on the topics of fisheries co-management and bycatch of vulnerable species. The aim was 1) to complete the case study analysis and the literature review and add a practical perspective on the feasibility of the considered approaches, and 2) to inform the development of a series of recommendations for the implementation of co-management. An online questionnaire was used to collect the opinions and experiences on managing bycatch of vulnerable species. The questionnaire was completed by 31 key experts from 16 countries (Albania, Croatia, Cyprus, Denmark, France, Greece, Italy, Malta, Morocco, Portugal, Spain, Tunisia, Turkey, with an additional three non-EU and non-Mediterranean countries), and from different stakeholder groups - international and local NGOs, fisheries industry and organisations, national governments, public bodies, and research institutions. In addition, to gather more detailed experiences, 14 interviews were conducted with experts from seven countries. Except where necessary to support the analysis, answers were anonymised. The information obtained informed the SWOT analysis (**Table 3**) and the development of recommendations (**Section 8**).

The report benefited from comments and suggestions received reviewed by the MedBycatch Partners and other experts.

Acronyms

AC	Advisory Council
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
CFP	Common Fisheries Policy
CRPMEM	Regional Committee for Maritime Fisheries and Marine Farming
EC	European Commission
EMFAF	European Maritime, Fisheries and Aquaculture Fund
EU	European Union
FLAGs	Fisheries Local Action Groups
GFCM	General Fisheries Commission for the Mediterranean
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICM -CSIC	Institute of Marine Sciences of Spanish National Research Council
LEK	Local Ecological Knowledge
MCS	Monitoring, Control and Surveillance
MPA	Marine Protected Area
NEAFC	North East Atlantic Fisheries Commission
NGO	Non-Governmental Organisation
NOAA	National Oceanographic and Atmospheric Administration of US
PO	Producer Organisation
RFMO	Regional Fisheries Management Organisation
SSF	Small-Scale Fisheries
SWOT	Strengths, Weaknesses, Opportunities and Threats
TEK	Traditional Ecological Knowledge
TURFs	Territorial Use Rights for Fisheries

Contents

Summary

The incidental capture or 'bycatch' of vulnerable species in fishing gear represents a significant threat to both marine taxa and the profitability and sustainability of fisheries. As such this issue has been receiving increased attention from fisheries managers.

Co-management refers to situations in which responsibility for resource management is shared between managing authorities and user groups and encompasses a broad spectrum of governance arrangements. It has typically been established in response to quota management crises and overexploitation of resources, market incentives such as sustainability certifications, and through projects demonstrating new models for the management of marine resources.

Generally, the most robust co-management processes are based on pre-existing structures that have resulted from many years of negotiation, and which are influenced significantly by the local political context. The design, composition, and responsibilities of co-management structures vary greatly among case studies, from local committees comprising a few members, to highly developed forums composed of large and diverse stakeholder groups.

Although there are no blueprints for implementing co-management, six common factors of importance for implementation were identified: (i) structure, (ii) time, (iii) level of power, (iv) level of organisation, (v) fishery size and type, and (vi) level of motivation.

Co-management must be understood as a negotiation, described by a six-step process: (i) problem recognition, (ii) participatory analyses, (iii) collaborative research, (iv) implementation, (v) monitoring, control and surveillance and (vi) communication, which will be shaped by the local context and opportunities (i.e., entry points).

Well-functioning co-management can provide the structure within which actions to address the bycatch of vulnerable species can be agreed, implemented, and monitored, and ensure that they are adapted to the specificities of the fishery, and thus accepted by fishers. Involving fishers from an early stage of the management process, building on their practical knowledge, and working collaboratively to develop solutions are all approaches that can support better management of fisheries.

However, addressing complex issues such as bycatch should be carefully planned. Research has shown that it can take 3-5 years just to organise and initiate activities and interventions at the community level to implement a co-management pilot process.

To be successful co-management requires a lot of time, motivation, and commitment from the participants which are typically result from the existence of common interests among the members of the group. Experience indicates that it is advisable to find management entry points to tackle new problems among stakeholders. The case studies analysed suggest that the combination of conservation goals within fishing interests promotes a more balanced co-management process e.g., the implementation of bycatch mitigation measures should include fishers' views and goals, to achieve not only a reduction of bycatch but also an improvement of fishing performance and yield. To this aim a good practice is to identify and work with champions among fishers who can serve as influencers for change.

Given the right conditions, co-management approaches and tools be successful in supporting efforts to tackle bycatch of vulnerable species and lead to lasting change. Recommendations are provided for organisations and practitioners that are involved in the establishment and implementation of fisheries co-management, and those engaged in tackling the bycatch of vulnerable species.

Photo: Lawrence Hookham - Unsplash

1. Introduction

Incidental capture in fishing gear, or bycatch, affects species from different taxonomic groups including marine mammals, sea turtles, seabirds, and sharks and rays. Bycatch not only represents a significant threat to marine biodiversity, but also to the profitability and sustainability of fisheries, thus jeopardising fishers' livelihoods. It is therefore an important aspect of fisheries management and one that is receiving increased attention from management authorities and bodies.

Despite an increased focus on the issue, progress in addressing the problem of bycatch and achieving reductions in bycatch rates and the number of bycaught individuals has been slow. Efforts have been impeded by a lack of adequate data collection on bycatch of vulnerable species[1] resulting in significant data gaps, and a lack of harmonisation between different data collection initiatives. Improved data collection, as well as increased efforts to identify, trial, and rollout mitigation measures in fisheries that present a significant risk of bycatch, are urgently needed.

The potential of co-management, whereby the responsibility for resource management is shared between managing authorities and user groups, has been highlighted in the scientific literature as a fisheries management strategy that can improve governance and management process. This is achieved by better incorporating local knowledge of resources and responding more closely to the needs and aspirations of resource users, leading to positive outcomes for fishers. The engagement of resource users in the formulation of rules to manage the resources, and in some cases the enforcement of the rules, can result in management that is better adapted to the local context and can foster an increased sense of ownership and responsibility leading to improved compliance. As such, co-management provides an interesting approach for addressing other issues of concern, in addition to fish stock management, related to the environmental sustainability of fisheries such as the bycatch of vulnerable species.

1 Vulnerable species refers to species whose conservation status is adversely affected by pressures arising from human activities. It includes species protected under relevant legislation. The term "sensitive species" is used in the EU and is defined in the Technical Measures Regulation (EU) 2019/1241.

While co-management is not a new approach there is an increasing focus on its application to address the weaknesses and failures of current fisheries management approaches, particularly for small-scale fisheries (SSF). In the EU, co-management is being explored as a means to further the agenda of inclusion and empowerment of stakeholders to achieve more effective and participatory decision-making.

This study aims to contribute to the current discourse on the use of co-management approaches to achieve fisheries management objectives.

FISHERY PARTICIPATION IN THE EU: THE COMMON FISHERY POLICY (CFP) APPROACH

In the EU, the centralised management system underwent an important change introduced by the 2002 CFP reform with the creation of Advisory Councils (AC), designed to encourage the participation of the fishing sector in the decision-making process. One of the objectives of this reform was to balance the governance system for European fisheries management by adapting it to a regional context. Fishers can use the ACs to develop recommendations and suggestions not only for the EC but also for regional and national governments with jurisdiction over the geographic areas covered by the ACs. The ACs are consultative in nature and can only give non-binding recommendations.

EU Fisheries Local Action Groups (FLAGs) have also been formed to encourage the active participation of organisations representing various local sectors (the fisheries sector as well as other social, economic and public sectors), although the main emphasis is on representatives of the fishing sector who hold at least half of the votes in the FLAG. The objectives of FLAGs include:

(i) helping the socio-economic development of communities that depend on fishing (defining strategies adapted to a given area).

(ii) diversifying the fishing industry to promote respectful and sustainable fishing activity.

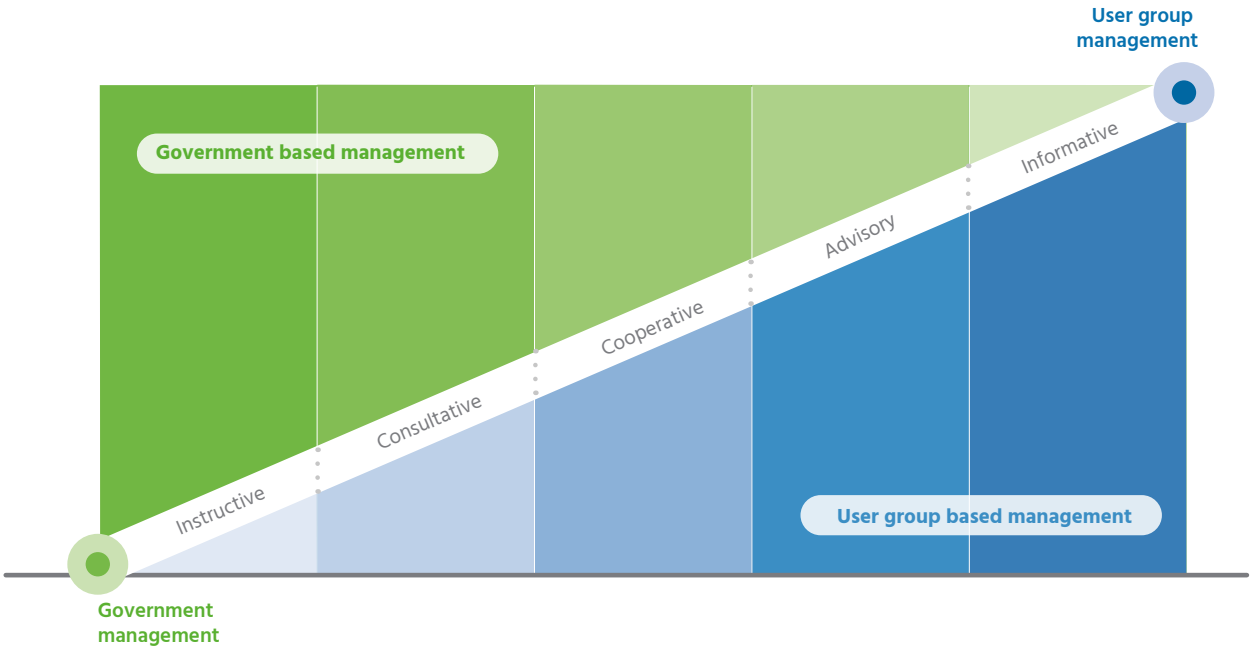
FLAGs receive funding from the EU to help them achieve these goals (Garza-Gil et al., 2020). User groups, mainly organised fishers (associations, cooperatives, trade unions, market representatives), must seek support through these structures to create co-management spaces.

2. Different forms and levels of co-management

According to Sen and Nielsen (1996), co-management of fisheries can be defined as an agreement in which responsibility for resource management is shared between managing authorities and user groups. Co-management encompasses a broad spectrum of governance arrangements that involve local communities and resource users (typically fishers, as well as civil society, scientists, and research organisations) in the decision-making processes. The different levels, structures, and processes underlying co-management vary significantly and depend largely on the local context. These agreements between the government, fishers, industry, researchers, environmentalists, and other stakeholder groups can take many forms, and involve many levels of interaction between the different groups, differing from one country to another, and even within the same territory.

Organisational structures can also vary (**Figure 1**). Arnstein (1969) described this as a ladder of participation, where the extremes are (1) the power of the government and (2) the power of the fishers. This vertical vision of fisheries management from the late twentieth century, with fishers at the bottom, still holds in many countries and is known as top-down management, where the government decides and acts unilaterally and fishers are obliged to adhere. At the other extreme, fishers have total control and organise and run their own management system, either through institutions that are essentially informal, or through a formal organisation such as a cooperative or a union.

Figure 1. Level of participation in co-management arrangements (adapted from Sen and Nielsen, 1996)



In an idealised co-management scenario this ladder of participation is horizontal and both government and user groups cooperate as equal partners in all management tasks. However, the level of power shared by authorities through co-management agreements is highly variable, and the ultimate decision-making power commonly remains with the government. Five broad types of co-management can be defined according to the role of government and resource users (**Table 1**).

Table 1. Levels of fisheries co-management (adapted from Sen and Nielsen, 1996 & Jentoft and MacCay, 1995)

Level	Description	Observations	Examples
Instructive	Minimal exchange of information between government and fishers. Government may restrict its role to informing user groups of the decisions it is ready to make.	Dialogue mechanisms with users are not institutionalized and often occur sporadically, generally when a major management problem is faced. Normally the government listens to fishers, but the decision-making process may not be transparent, and the final decision may only be known when it is officially published.	Octopus pot fishing in Portugal (Sonderblohm et al. 2017).
Consultative	Government consults with fishers but all decisions are still taken by the government.	Mechanisms exist for consultation such as through regional platforms (ACs, RFMOs, FLAGs).	Eastern Canada Fisheries.
Cooperative	All stakeholders have equal power in the decision-making process.	In this type of co-management government and fishers cooperate as equal partners in decision-making.	Comités Locaaux Des Pêches Maritimes, France.
Advisory	Fishers advise the government of decisions to be taken and the government endorses these decision.	Normally, after many years of co-management with satisfactory results, very well-organised fishers have been able to propose new regulations to be adopted without hesitation by authorities, however, there are always mechanisms to enable these decisions to be reversed.	Biesheuvel system, Netherland; Sweden, Fiskeristyrelsen.
Informative	The government has delegated authority to organised fisher groups who are responsible for informing the government of their decisions and reporting on the results.	Maximum level of co-management. This normally occurs in very remote places with weak or absent government institutions.	Norway's Lofoten Islands cod fishery; sand eel fishery of Catalonia.

3. Main benefits and challenges of co-management

The establishment of co-management can bring positive results both in terms of the effectiveness of the fisheries management process, and the performance for fishers. For example, most fisheries management experts consulted agree that fishers tend to comply better with rules that they have been involved in developing and have approved through consensus. The involvement of fishers from the early stages of conflict management allows them to develop solutions based on practical knowledge. Implementation of these solutions is considered more effective and commonly accepted by fishers (Ostrom 1990; Jentoft and McCay, 1995; Pomeroy and Rivera-Guieb, 2005). The involvement of resource users in the development of regulations increases their credibility and facilitates greater compliance with the regulations. Consequently, the need for controls and sanctions will be reduced, which implies a reduction in the costs associated with monitoring, control and surveillance mechanisms.

Another benefit widely cited in the literature concerns the involvement of fishers in the design of management measures. Depending on the level of shared power and the timing (the point at which fishers are called upon to participate), it is possible to benefit from fishers' knowledge to design new fishing regulations. In a mature co-management process, where the level of power exchange generally ranges from cooperative to advisory (**Table 1**), the identification of research priorities and their development through collaborative research can support better management measures. There are many examples in the literature where the union of scientific research combined with local and empirical knowledge, known as traditional ecological knowledge (TEK), has generated very positive results (Moller et al., 2004). Although much TEK has been lost or diminished in many places, the knowledge of fishers, and above all their desire to collaborate in fisheries research, drawing on their knowledge and experience, should always be seen as a good opportunity to promote co-management.

Co-management can also facilitate interaction between the different actors in a fishery, strengthening local institutions and their presence in fishing communities. When the rules and controls are commonly agreed upon and implemented by the various groups in a management process, the results of their decisions serve as learning so that the institutions and people involved can acquire new skills, which helps to strengthen each of the parties.

4. Challenges for tackling bycatch of vulnerable species through co-management

Co-management of natural resources can provide an alternative negotiation process, opening new spaces for parties to discuss common issues as part of a comprehensive management approach. Today, interdisciplinary teams dealing with complex management problems are gaining popularity, mainly in European countries where authorities have not achieved satisfactory results with current management frameworks. Some experts point out that the failure to manage bycatch of vulnerable species, and fisheries more generally, is due to a centralised management system. Fisheries departments often exist far away from fishing communities and their fishing grounds. In addition, the responsibility of managing many fisheries lies in the hands of a small group of individuals, generally with insufficient resources for collecting and analysing data, and a lack of time to adequately cover so many fisheries and processes. This can cause a lot of tension and distrust between fisheries managers and fishers.

Defining a problem such as bycatch of vulnerable species and agreeing on and implementing measures to tackle it are complicated processes requiring the active involvement of different stakeholder groups. The engagement of resource users in formulating rules and enforcing them can result in management decisions that are better suited to the local context and adapted to local needs. It can foster an increased sense of ownership and responsibility, leading to improved compliance. Regardless of the geographic area, political, cultural, or socio-economical metrics, fishers' compliance is an essential factor for the success of any bycatch mitigation process.

Institutional changes for addressing vulnerable species bycatch through co-management agreements cannot be planned according to blueprints, insights from technical reports, or a simple regulatory framework analysis. Instead, they have to emerge case by case from an interactive stakeholder participation process during which the role of user groups in the decision-making process will depend proportionally on their interests, negotiation skills, responsibilities, knowledge levels, and strengths. On the other hand, the level of power granted to users depends on the authorities' openness to delegate their obligations. On the final point the the current legal framework plays a fundamental role.

Establishing and developing a co-management process from scratch can be complex, costly, time-consuming, and challenging. Research has shown that it can take 3-5 years just to organise and initiate activities and interventions at the community level to implement a co-management pilot process. Fishers need time to organise into a pre-existing debate structure or create a new one: for example, local management committees, expert groups, local fishery councils, etc. The time committed by each member normally derives from the existence of common interests within the group. Thus, in the case of vulnerable species bycatch, if this problem does not constitute an interest for the majority of participants, then efforts to analyse the problem and find solutions through a co-management approach will be in vain. Therefore, the existence of a common interest between the parties and someone who will lead and organise the process is an important prerequisite.

Photo: Ercan Uc/Shutterstock - Yelkouan Shearwater (*Puffinus yelkouan*)

5. Co-management process: phases and tools to tackle bycatch of vulnerable species

This chapter identifies and describes six phases of a co-management process needed to address the bycatch of vulnerable species. **Table 2** identifies relevant tools that can be applied in each of the six phases to encourage fisher's cooperation and participation in the process.

Phase I: Problem recognition

Tackling bycatch of vulnerable species with co-management tools requires, firstly, that the parties involved all recognise vulnerable species bycatch as a common problem and agree that it should be mitigated. This phase of recognition of the problem and its participatory analysis should come at the beginning of the process, with efforts focused on building consensus on the definition of the problem, diagnosing its causes, and identifying how it can be addressed. Case studies indicate the importance of preventing confrontations with fishers by avoiding addressing pre-existing conflicts during this initial step.

Bycatch of vulnerable species is a complex issue, and exposure of the fishing methods, and their impacts, to public opinion can have negative consequences and undermine co-management approaches. However, the publication of news reports in the local press about the capture of vulnerable species (especially charismatic species such as dolphins and turtles) has been reported as the initial catalyst for certain fishing industries to reflect on the problem of bycatch and to seek help. In many cases, fishers and other stakeholders, including end consumers, do not recognise bycatch of vulnerable species as an important issue or are not even aware of it. This reinforces the importance of investing much of the initial effort on the recognition of the problem by stakeholders and understanding fishers' actions and drivers (Barz et al., 2020). For example, some threatened elasmobranch species are commonly caught as bycatch and commercialised in many markets in Spain and Portugal (Barria and Colmenero, 2019). This shows that in some cases bycatch of vulnerable species goes unrecognised by stakeholders involved in the value chain, hence the need to mainstream knowledge of the status of vulnerable species across the fishing sector as a priority. Multiple tools can be used to raise awareness including press releases, social media, identification guides, public events, etc. Dissemination workshops, newspaper articles and short video documentaries were identified as common tools for introducing the problem to fishers and sharing information on mitigation practices.

Photo: Sakis Lazarides - Green sea turtle (*Chelonia mydas*)

Table 2. Co-management process phases, tools, and examples to address bycatch of vulnerable species

Phase	Tools	Details	Examples
Phase I Problem recognition	Dissemination workshops; press releases; social media; public events; video documentaries.	Various tools can be used to support efforts to increase stakeholders' awareness of the issue of bycatch of vulnerable species and recognition of the need to take action to address the problem.	• Press article on threatened ray species commonly found in fish markets in Spain. • Video documentary of the Cyprus Bycatch Project.
Phase II Participatory analyses	Participatory mapping.	Participatory mapping encompasses a range of approaches and techniques for gathering, recording the representing the spatial knowledge of local communities (e.g., locations and periods in which bycatch occurs) in the form of a map.	• Participatory mapping in Tsimipaika Bay, northwest Madagascar, to develop a Fisheries Management Plan.
	Fishers experience exchanges; communication networks.	Exchange workshops and communication networks can provide a platform for fishers to share their experiences of measures to tackle bycatch of vulnerable species and inspire similar initiatives in other fisheries.	• Fishers' exchanges and workshops organised by MINOUW have proven to be a highly successful tool for promoting the adoption of more selective and sustainable fishing methods across the Mediterranean. • Catching the potential project to establish an international network of fishing academies and training institutes.

Phase	Tools	Details	Examples
Phase III Collaborative research	Traditional ecological knowledge (TEK)	The knowledge, practices and beliefs held by fishers about their relationship with the marine environment can provide valuable insights and approaches for addressing the issue of bycatch of vulnerable species.	• International Smart Gear competition encourages fishers and other stakeholders to develop bycatch mitigation measures.
	Multidisciplinary committee/task force	Bringing together participants with different disciplinary backgrounds can facilitate the identification of effective approaches to tackle the issue of bycatch of vulnerable species.	• Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS). • The International Whaling Commission's Expert Panel on Bycatch. • The Gulf of Alaska Trawl Bycatch Management Council for the pacific halibut and chinook salmon. • ICCAT Information on Bycatch of Tuna Fisheries.
	Testing of bycatch mitigation tools	Testing mitigation measures with the active involvement of fishers can ensure that the solutions developed are both effective and practical for fishers to implement in practice.	• Project Dragó to improve the selectivity and reduce the direct impact of trawling gear. • MedBycatch project.
Phase IV Implementation	Market oriented solutions	Creating market benefits for fishers using sustainable practices (e.g., higher prices or access to certain markets) can facilitate the adoption and implementation of measures to mitigate bycatch.	• Direct marketing to restaurants.
	Gear modification subsidizes	Providing funding to fishers to purchase alternative gears that reduce bycatch can facilitate the speed and scale of uptake.	• Whalesafe Gear Adoption Fund in Canada.
	Collaborative funding	Collaborative funding refers to financial transactions occurring directly between individuals without the involvement of traditional financial institutions. This is an alternative source of finance that can facilitate the uptake of alternative fishing gears/ gear modifications.	• Crowd-funding initiatives: Tridos Bank, Crowdfunder.

Phase	Tools	Details	Examples
Phase V Monitoring, control, and surveillance (MCS)	Bycatch self-reporting applications.	Self-reporting applications can facilitate the collection and reporting of data by fishers on bycatch of vulnerable species.	• Bycatch self-reporting application. • Development of a software for bycatch management and reporting (eCatch).
	Collaborative surveillance mechanisms.	Collaborative surveillance initiative involving local communities can reinforce surveillance capacity and improve compliance with existing rules and regulations.	• Guardian of the Sea Program in Maio, Cape Verde.
	Territorial Use Rights for Fisheries (TURFs).	TURFs are a form of spatial property rights in which fishers (either individually or collectively) are granted exclusive access to harvest resources within a geographically defined area.	• Chilean National Benthic Resources TURF System.
Phase VI Communication	Fishing champions (influencers)	Champions or influencers can help to encourage and drive forward collective community/ fishery level action to address issues of concern such as bycatch of vulnerable.	• Guardians of the Sea community initiative established in Cape Verde.
	Mainstreaming of current regulations, information	Facilitating access to information on existing regulations and measures to address bycatch can promote adherence and uptake.	• Bycatch Management Information System (BMIS) – an educational tool to support the adoption and implementation of science-based management measures to address bycatch.

Phase II: Participatory analyses

Addressing the problem together through a collaborative approach involving the different parties is a way of building a co-management process. The participatory review of factors causing bycatch is an excellent opportunity to bring to the table individual experiences and perceptions. Moreover, many authors agree that when fishers participate in the initial phases of management conflicts, there is a tendency for the proposed solutions to be more effective and better accepted by the group (Ostrom, 1990; Jentoft and McCay, 1995; Pomeroy and Rivera-Guieb, 2005). There are many tools that can be used to analyse the bycatch of vulnerable species together with fishers, such as the use of participatory techniques for discussion and analysis, (e.g., participatory mapping, Kyem,

2021), exchange of experiences with other fishers and learning networks, and information sharing (Arlidge, 2020). Creating a communication network among fishers to share knowledge on bycatch of vulnerable species across the region can be very useful. Hall et al. (2007) point out that showing fishers the gear changes and innovations from other fisheries can open the door to many new ideas.

Phase III: Collaborative research

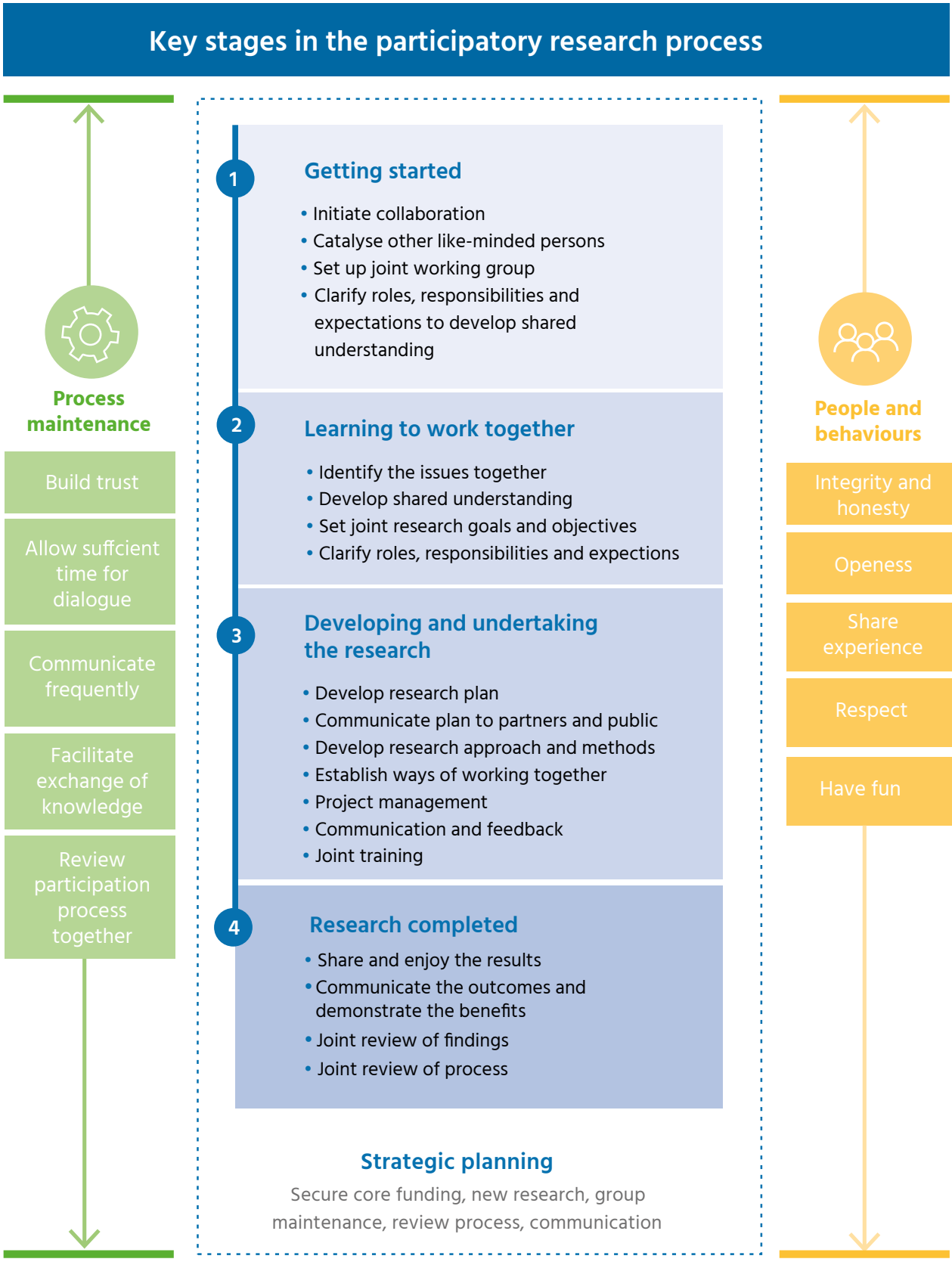
The development of solutions by combining scientific approaches and TEK through collaborative research on measures to mitigate bycatch of vulnerable species, has been reported as a successful strategy. Combining the best scientific research, the empirical knowledge of fishers, and the willingness of the industry to invest in solutions that improve their catch, while complying with regulations can result in positive solutions. Examples of this are the deployment of visual or acoustic deterrents to reduce seabird bycatch in some driftnet and gillnet fisheries (Melvin et al., 1999), or employing streamer lines, called 'tori lines' in longline tuna fisheries (Hall et al, 2017). The integration of TEK through collaborative research programs with fishers can be a very powerful management tool for addressing bycatch of vulnerable species and promoting fishers' engagement (Mackinson et al., 2015; Price and Rulifson, 2004; Pita et al. 2016).

The strategic integration of collaborative research can be visualised through different stages (**Figure 2**). According to Nichols (2003), these stages can be summarised in three key points: (i) building a conservation network of fishers, students, teachers, activists, researchers, observers, administrators, and other coastal people; (ii) taking advantage of these associations to derive new knowledge to develop practical solutions at the local level; and (iii) communicating this knowledge in a resonant and appropriate way to avoid bycatch and promote a sustainable ethic. Another fundamental point, mostly happening during the collaborative research phase, is the creation of a multidisciplinary committee/task force aimed at solving the problem. The composition of these committees and their functions varies from case to case. Defining a common goal such as the minimisation/elimination of bycatch of vulnerable species and improvement of the fishery yields can catalyse a co-management process from the initial phases. The members of this committee and its operating procedures must seek the interaction of the stakeholders in a transparent and balanced way, so that its results are part of the empowerment process of its members. Normally, committee meetings and decision-making processes are recorded in publicly available minutes. A good example at regional level is the *sonsera* fisheries co-management committees in Catalonia, Spain.

Phase IV: Implementation

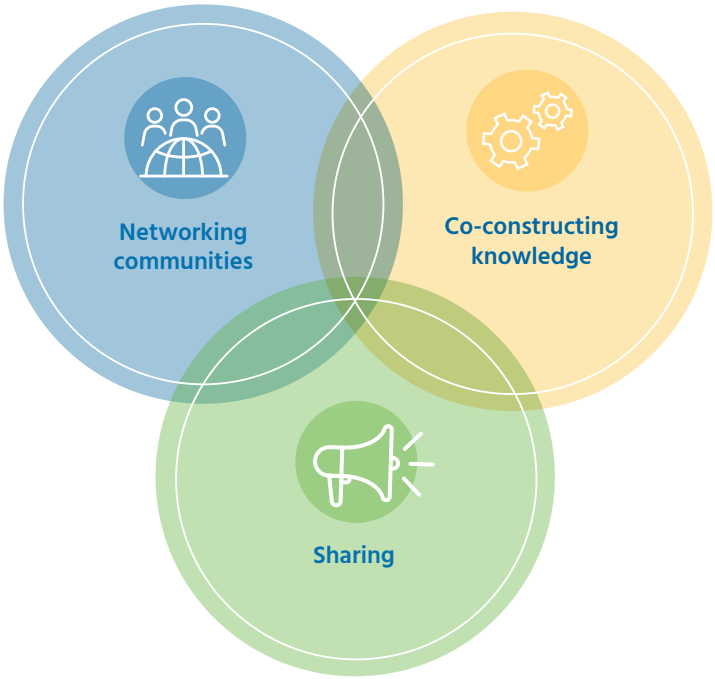
In most cases bycatch represents a waste of time and money for fishers. This can be used as an entry point to develop collaborative research programs between stakeholders (Rüttinger et al., 2014). Finding points of common interest between regional management objectives and the profitability of fisheries is an effective strategy. Marine research institutions and fisheries agencies through their research projects may finance the proposed solution for a small part of the fleet in a pilot phase. However, its continuity and expansion within the fishery should consider the introduction of incentives that motivate the rest of the fishers. Economic sustainability needs to

Figure 2. Diagram of a key stages in the participatory research process (adapted from Pomeroy and Ribera-Guieb 2005 based on social marketing approach)



be addressed, the investment capacity of the fishers and the cost benefit of the solution are key factors. For example, tuna and other large pelagic fisheries normally involve ship owners from quite lucrative companies with greater resources and therefore a greater capacity to participate in the process (Gillman, 2011). On the other hand, communities of small-scale fishers may need external support to acquire/modify fishing gear, purchase deterrent devices, fish in other, more distant, waters, etc. Local marketing schemes and sustainable fishing certifications are tools that can support the adoption of new practices, if the investment is rewarded in benefits for the fishers who implement them. For example, in Corsica, fishers belonging to the *prud'homies* have been actively participating in the commercialisation of their products, opening local shops and restaurants to offer high-quality fish, promoting the sustainability of their fisheries based on the principles of the circular economy[2].

Figure 3. Schematic of the conservation mosaic. Overlap of the three spheres of action reflects their integration (adapted from Hall et al, 2007)



Phase V: Monitoring, control, and surveillance (MCS)

Like any management plan or measure, the periodic evaluation of the functioning of the implemented measures is essential to guarantee their effectiveness. Normally, the measures taken to eliminate bycatch of vulnerable species within a fishery should be monitored, and their results analysed by a third party. It is common to include these measures within existing management plans and frameworks, or if they do not already exist, as a first draft of a plan. Within this, it is necessary to establish the MCS procedures. The tools at this stage can include establishing agreements with authorities, universities, research centres, NGOs, among others, to support the

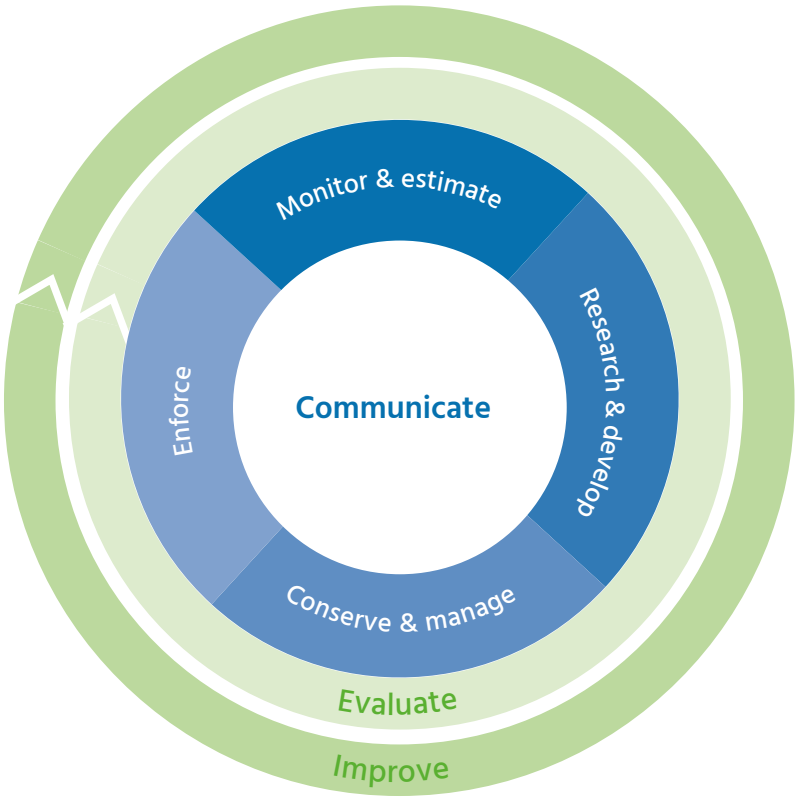
2 https://www.crpmem.corsica/Les-restaurants-appartenant-aux-pecheurs_a401.html

monitoring of the fishery through research programs with observers on board, self-sampling training programs, awareness raising activities, assessment of mitigation measures, among others.

For example, since 2016 the National Oceanographic and Atmospheric Administration of US (NOAA) has developed a National Bycatch Reduction Strategy, including a wide fishery observer program and supporting data sharing on bycatch between NOAA Office of Law Enforcement and the U.S. Coast Guard[3].

At EU level, the adoption of the GFCM discards monitoring programmes for the Mediterranean and Black Sea fisheries is a good example to comply with existing regulations (CFP, national legislation) and to possibly incorporate protection and/or mitigation measures in management plans and other binding instruments (Carpintieri et al., 2021). The participation of fishers through the use of bycatch self-reporting applications, the development and implementation of collaborative surveillance mechanisms (self-regulation) can be encouraged through tools such as territorial fishing rights (TURFs). In theory, TURFs reorient the economic incentives that motivate the behaviour of fishers from a "race to fish" under open access or regulated open access, to incentives that more closely align the private behaviour of fishers with social, economic objectives and ecological objectives, in this case, mitigating the bycatch of vulnerable species (Squires et al., 2014).

Figure 4. Graphical representation of the stages of a co-management process to address bycatch of vulnerable species (adapted from NOAA National Bycatch Reduction Strategy[4])



3 https://www.fisheries.noaa.gov/international/bycatch/national-bycatch-reduction-strategy#national-bycatch-reduction-objectives-&-actions

4 https://www.fisheries.noaa.gov/international/bycatch/national-bycatch-reduction-strategy#national-bycatch-reduction-objectives-&-actions

Phase VI: Communication

It is very important to capitalise the process through the communication of the acquired know-how on avoiding the bycatch of vulnerable species in resonant and appropriate ways, through outreach activities, capacity-building, and dissemination and sharing of the lessons learnt. This phase can be seen transversally throughout the process, being very important to share the progress and different insights among participants. It is necessary to find ways to encourage fishers' cooperation and participation. In essence, the model holds that for fishers to move from denial of a bycatch problem to a commitment to fix it, they must first push for change by providing information. A strategy that has been very successful is to identify champions among fishers who can serve as influencers for change. Fishers who act as guardians of the environment have commonly been used as a very successful strategy in various parts of the world, including in the Mediterranean Sea (Lalavanua et al., 2018; Di Franco et al., 2014). Evidence shows that solutions developed and accepted during the innovation and learning period (collaborative research) are later more easily adopted through peer pressure mechanisms. Thus, these move individuals beyond the exploration phase into commitment, so that improved approaches become accepted practice within the entire community.

Photo: Elvirkin - Istock

Case study of the Catalan *sonsera* fishery

The artisanal *sonsera* fishery along the Coast of Catalonia (Spain) targets two species of sand eels, using small seine gear. There are 26 vessels authorized for this fishery, all smaller than 10 m. About 75 fishers are involved, belonging to 7 fisher guilds. This is a traditional fishery in the area, with most of the catch sold locally. European Council Regulation (EC) No 1967/2006 of 21 December 2006 restricting the use of *sonsera* boat seins (among other gears) caused a crisis within the fishery, which risked being closed in 2012. Faced with this threat fishers organised themselves and reached out to the administration, NGOs and the scientists to assist them requesting an exemption from the European Commission (EC) based on the scientific justification. Fishers themselves financed the scientific studies. The four groups, composed of the fishers, two NGOs (WWF and Greenpeace), the administration (Directorate General for Marine Policy and Sustainable Fisheries of the Catalan Government) and the scientists (Institute of Marine Sciences, ICM-CSIC), formed the co-management committee for the sand eel fishery. In this co-management body, the four stakeholder groups actively participate with an equal share (25% of votes), carrying the responsibility of decision-making power. Namely, the Catalan Government ceded part of its power to the committee, allowing it to develop and implement a management plan. Due to the work presented by the co-management committee, the EC granted an eighteen month period for scientific fishing, in order to obtain data necessary to justify the requested exemption. All involved parties contributed with their knowledge, experience, time and effort and eventually the EC, in 2014, approved the developed management plan, which is currently valid until 2024.

Today, with 10 years of co-management, the committee keeps regular meetings where current topics are discussed: quotas, problem solving or compensations for non-complying members. Interestingly, and importantly, as a part of the management plan development, a census of fishing vessels was carried out resulting in the 26 vessels carrying permission for this fishery. Fishers of all 26 vessels are participating members of the committee. As a stakeholder group, they are given one vote, on which they need to agree beforehand. Topics placed forward by any of the four stakeholder groups are discussed and acted upon.

The issue of bycatch is not relevant in this case due to the selectivity of the fishing gear and fishing grounds, but this example illustrates the strengths and the opportunities of the co-management process. Namely, the established confidence between the group makes the communication, discussion and decision-making very efficient and productive so that the model has been replicated to 6 other fisheries in Catalonia. Those are all relatively young committees and are still in the phase of development of the confidence relationship between the groups. Yet, *sonsera* co-management committee serves as an example to follow when it comes to management of the fisheries. Advantages that played a role in

adopting co-management were a facing crisis, which motivated fishers to act and ask for help, and willingness of other stakeholders to react. In particular, an important role was the one of the administration, which granted decision-making power to the committee, giving it legitimacy and full meaning. Starting from the LEK of the fishers themselves, requesting and enabling the scientific support for the management was easier and more intuitive task. Small geographical scale, and small number of involved fishers and vessels made the process easier as well. It remains to be seen if and how this example can be scaled up and applied at larger spatial and organisational scale. Scaling-up might be one of the weaknesses of the co-management process, if viewed that way. Another one, when trying to replicate this model on other fisheries, showed up to be the time necessary to establish the relations between the different stakeholders' groups. For example, it is important to consider that most NGO initiatives and projects are relatively short in duration, usually 4 to 5 years, and establishing meaningful relationships and working groups which will function past the end of the project is very difficult.

6. Potential for the application of co-management approaches to tackle bycatch of vulnerable species

The experts consulted during the preparation of this report agreed that fisheries in the Mediterranean could implement co-management processes to address vulnerable species bycatch, but that the success would largely depend on the national regulatory framework. The majority of experts identified fishers as the most important, and also the most challenging, stakeholder group to approach when introducing co-management. The reluctance of some fishers to assume new management commitments was identified as an important factor in the interviews. On the other side, end consumers are perceived to be among the stakeholder groups least aware of the problem of bycatch, whilst NGOs and scientists were identified as groups most aware of the problem and with the greatest interest in solving it. For the fishing industry, fisher associations, national and local government bodies and consumer groups, interest will depend on many different factors.

Based on the relevant case studies, insights provided by the experts working on the topic and the questionnaire, a SWOT analysis was developed for the use of co-management tools and processes to address the problem of bycatch of vulnerable species (**Table 3**).

Photo: Vova Shevchuk

Table 3. SWOT analysis of the use of co-management tools and processes for addressing the bycatch of vulnerable species

Strengths	Weaknesses
• Builds on previously established structures between stakeholders. • Independent of changes of government and less dependent on changes to national policies. • Fishers' level of engagement is proportional to their motivation and the local context. • Proposals of topics to address come directly from the fishers, making it easier to ensure their engagement. • Co-management system established in one area can provide a motivation to start a similar process in other communities. • Eases the effective enforcement of legislation, and the surveillance, even within the group. • It is considered a participatory approach to problem-solving, usually a democratic decision-making process, resulting in consensual solutions between the parties.	• Co-management is a lengthy process, requiring a lot of time to set-up a functional co-management community. • Lack of capacities needed for the upscaling of co-management from pilot site level to national level. Establishment of co-management is a process that needs to be facilitated by experienced individuals or organisations, which are scarce in the EU and the Mediterranean region. • Lack of funds to support the process development and address the challenges encountered. • Prioritisation of activities can be viewed primarily from the fishers' point of view (commercial interests), and not be ecosystem or resource based. • Established co-management systems can be hindered by fishers that are not involved in the process. If the community lacks fishers with the required level of enthusiasm, it usually leads to lack of commitment from their side. • Consultative co-management results in a lack of binding results for change. An inability to solve the problems raised by fishers may affect their willingness to participate.
Opportunities	**Threats**
• Mitigation solutions built on LEK/TEK. • Fishers trust the researchers, NGOs and government, making it easier to address problems identified by any group (transparency). • Can serve as an example to other fisher communities (fishers exchange network). • Allows wider dissemination of project results through the engagement of the local community as a whole. • Further involvement of other stakeholders might be stimulated by fishers' commitment and joint actions (initial group cohesion). • The co-management process can help to organise fishers in cooperatives or producers' organisations, which can strengthen the value chain and provide the necessary push towards a sustainable blue economy. • Can support the establishment of community MPAs and no-take zones for the protection of vulnerable species. • Can support the development of new management tools such as TURFs to promote fishers' engagement.	• Unfunctional co-management structures, poorly supported, can hinder any kind of work, to the extent that it may be more difficult to address any problem than without the co-management structure in place. • If co-management is set-up artificially (top-down), the time necessary to achieve a functioning system will likely be further extended or it may not be possible. • Instability of the core team of stakeholders (i.e., working groups, project teams or co-management committees) can lead to a loss of confidence and result in a waste of time and effort.

7. Common factors for implementing co-management for fisheries

Through the examples from the literature covering different parts of the world, the existence of different co-management structures of varied forms and compositions have been identified. Despite their intrinsic differences, the different political, socio-cultural and economic contexts, it is possible to identify common elements that exist, regardless of the success or failure of each case, paying special attention to the architecture of the different organisations that participate in the management of fisheries in each site, and how these structures play a fundamental role in diverse management tasks, such as the bycatch of vulnerable species. Understanding the context in which these structures were established and evolved as part of a dynamic process, the levels of organisation of the participants, the tools used, and, above all, the motivation that has led to and, in many cases, maintained the difficult task of managing fisheries, has served as a reflection and learning for this work.

In context of EU and surrounding countries, it is necessary to understand how the existing management structures already institutionalised in the region, such as regional organisations for fisheries management (GFCM, ICCAT, NEAFC, etc.) and those contemplated in the CFP (ACs and FLAGs) interact with these new arrangements (for example, *Cofradias* in Galicia, *Prud'homies* in France). The case studies show the development of different and quite varied processes, where many of them have their origin in (i) crisis of quota management and overexploitation of resources (e.g., North Sea), others have been driven by (ii) market incentives such as sustainability certifications (for example, the fishers' associations in Galicia); and equally important (iii) support of innovative projects for fishing communities that try to test new models for the more sustainable management of marine resources. Although there are no blueprints to implement co-management processes, through the analysis of these case studies it was possible to describe the common elements that should serve as a practical guide to support those interested in finding practical solutions to implement co-management process for bycatch of vulnerable species (**Table 4**).

Table 4. Common factors for implementing co-management for fisheries

Factor	Description	Remarks
Structure	This is the architecture within which the negotiation process unfolds. It normally takes the form of a committee, group of experts, task force, or some other similar structure. It is present in all of the co-management case-studies reviewed and is normally created by the management authority (e.g., the national fisheries institute). Its design, composition and responsibilities vary greatly among the case studies, from a local committee of few members up to highly developed forums composed of large and diverse stakeholder groups. The structure is considered to be the cornerstone of any co-management process.	Generally, the most robust co-management processes are based on pre-existing structures resulting from many years of negotiation (e.g., fishing guilds in Galicia, Catalonia, *Prud'homies* in France, etc.) which are impacted significantly by the political context. Moreover, depending on the level of co-management and the maturity of the process, this structure may be officially recognised. For example, in Catalonia, decree 118/2018, recognises, empowers, and describes the composition, functioning and process for this committee. Instances where fishing management is fully transferred to regional institutions, or to even lower levels, tend to have the most developed examples of co-management.
Time	The establishment and operation of co-management can be complex, costly, time consuming and challenging. Co-management must be understood as a negotiation process, logically divided into three main phases: (i) planning, (ii) implementation and (iii) evaluation. The actions to develop and the strategy of negotiating the process during any phase will depend on the local context. Addressing complex issues such as bycatch of vulnerable species should be carefully planned. Experience indicates that it is advisable to find management 'entry points' to tackle new problems among stakeholders.	Research has shown that it may take 3 to 5 years just to organise and initiate activities and interventions at the community level. However, in some cases media attention has created an incentive for action. For example, the issue of dolphin bycatch in Pacific tuna fisheries, where a national TV channel in the US aired a story on industrial tuna purse seining catching dolphins and had a strong impact on consumers. Fishers were concerned about the impact of this problem on their jobs, and solutions started to develop in following years (e.g., the first dolphin-free labelling of tuna products).
Level of power	Most of the examples analysed in the literature review showed that advisory co-management is the most common form in Europe, whereby the fisheries administration consults with fishers, but their recommendations are not binding, and the government continues to make the decisions.	In recent years, the Galician government has allowed the guilds themselves to design and implement specific exploitation plans for target species (mostly sedentary species such as clams, oysters, cockles). The regional government, informed by scientific advice from governmental institutions (IEO), determines how much can be extracted, how many permits to grant and to whom at the regional level. At the local level the guilds can determine the number of individuals who can exploit these stocks, the total and individual catch quantities, and the fishery's opening and closing in accordance not only with species' biological cycles but also with seasonal markets.

Factor	Description	Remarks
Level of organisation	Co-management development is proportional to the level of fishers' organisation, commitment and responsibility. Fishing associations, producer organisations, fishing unions, and many other forums have played a fundamental role in co-management.	A large number of the cases analysed have been supported by the hard work of NGOs, universities, research centres, independent researchers, etc. For example, in Northern Cyprus, a local NGO – SPOT - together with the University of Exeter (UK) have been implementing actions (e.g., workshops) to engage fishers and stakeholders to solve the problem of bycatch of marine turtles.
Fishery size and type	Fishery size is an important factor. Groups of small-scale fishers from the same village are generally easier to organise than large industrial fleets, where the scale of investments provide a different context for management negotiations.	The levels of shared responsibility for decision-making are more easily distributed among few stakeholders. Large fleets tend to present much more complex power structures, therefore, their participation in any co-management process must consider these differences.
Level of motivation	Co-management requires a lot of time, motivation, and commitment from the participants in the process. Most of the processes studied have been developed voluntarily, with the time committed by each member for co-management activities driven by the existence of common interests among the members of the group. Thus, in the case of bycatch management, if this problem does not constitute a common interest for participants, efforts to analyse the problem and find solutions will be in vain.	Common property regimes as collective resource management systems have been shown to develop when a group of individuals is highly dependent on a resource and when the availability of the resource is uncertain or limited. If the resource problem is repeatedly experienced, such as low or no catch, and if it exists within a single community of users, fishers are likely to develop a collective institutional arrangement to deal with the problem. The principal problem faced by group members of a common property regime is how to organise themselves.

8. Recommendations for the application of co-management to tackle bycatch of vulnerable species

The following recommendations are intended for organisations and practitioners that are involved in the establishment and implementation of fisheries co-management, as well as for those who are engaged in tackling the bycatch of vulnerable species and are interested in applying a co-management approach.

Preparation phase

- **Integrate traditional ecological knowledge (TEK) and scientific knowledge through collaborative research** to gather robust data on the interactions between fisheries and vulnerable species as an important step to involve fishers in a participatory approach and to recognise their importance in the functioning of co-management. TEK must be integrated in long-term monitoring activities as a basis for adaptive management.
- **Ground co-management in existing structures.** In the EU context, the Advisory Councils (ACs) and Fisheries Local Action Groups (FLAGs) can play an important role in the implementation of co-management initiatives, providing regional and local support.

Starting the process

- **Identify an entry point to address the issue of bycatch of vulnerable species.** In most cases bycatch represents a waste of time and money for fisheries thus providing motivation to establish collaborative research programs between the parties to look forward for solutions.
- **Build on the collaboration.** Developing learning networks and information sharing groups among fishers in the region, e.g., through the GFCM Small-Scale Fishers' forum, is a way to connect and involve stakeholders. Finding existing spaces and structures to promote dialogue between scientists, industry, and authorities with useful information to develop collaborative approaches and 'state of the art' mitigation measures will support the implementation of any co-management approach.

- **Identify and define common interests.** To develop and implement bycatch mitigation techniques, combine the conservation objectives of the vulnerable species with the objectives of the fishers, to not only minimise/eliminate bycatch, but also to improve fishing performance. The combination of conservation goals with fishing interests promotes a more balanced co-management process, not only to comply with legislation, but also to improve fishers' yields.
- **Create an appropriate space for discussion.** Utilize a multidisciplinary committee/task force at the fishery level to discuss the problem of vulnerable species bycatch (if it does not already exist). The format of this working group, its members, and its operation may vary from case to case depending on its original purpose. Most examples of co-management are not focused on vulnerable species bycatch. Their committees are more general in nature, with the formation of "sub-committees" depending on the management objectives being addressed.

Implementation of the process

- **Communicate effective mitigation practises and share case studies** across the sector. This is especially important in the international context of the Mediterranean where different languages and socio-cultural activities must be considered.
- **Create incentives for fishers** to implement jointly developed vulnerable species bycatch solutions either through subsidy programs or driven by market opportunities (vulnerable species bycatch free certification schemes). In EU Member States the European Maritime, Fisheries and Aquaculture Fund (EMFAF) can be used to support the implementation of the bycatch mitigation measures.
- **Monitor the adopted measures to mitigate vulnerable species bycatch** within a fishery to understand their effectiveness. Monitoring and data analysis should be performed by third party experts with the results shared openly with all stakeholders.
- **Create collaborative strategies to address bycatch of vulnerable species** at different levels (fishing areas, country, region) to guide the development of coordinated programs and actions between parties. In the Mediterranean, this collaborative strategy must account for political differences and boundaries.

General recommendations

- **Mainstream knowledge on vulnerable species,** including on their identification, across the fishing sector.
- **Identify and work with "champions" among fishers** who can serve as influencers for change. This has proved a successful strategy in various parts of the world, including in the Mediterranean Sea.

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Annex: Case studies

Co-management case studies and projects in EU and the Mediterranean (EU and Non-EU) identifying main structures and levels of co-management according to the classification proposed by Sen and Nielsen, 1996.

Country	Designation	Co-management structure	Leading stakeholders	Initiation	Main tasks	Level of co-management	References
The Netherlands	Biesheuvel system	Steering committee	Producer Organisation (PO)	Quota management crises/fishery collapse	Fishing quotas allocation	Advisory (binding)	Symes et al. 2003; van Hoof et al. 2020
UK	Sectoral Quota Management	Sea Fisheries committee (England and Wales) Producers Organisations	PO	Quota management	Fishing quotas allocation	Advisory (binding)	Symes et al. 2012
Denmark	Cooperative	Regulation Advisory Board	Fishing cooperatives	Cooperative movement 18th century	Fishing quotas allocation	Advisory (not binding)	Symes et al. 2012
Norway	System of centralised consultation	Regulation council	Norwegian Seafood Council	N.R.	Fishing quotas allocation	Advisory (not binding)	Link
Ireland	Lobster V-Notching program	Inshore Fisheries Development Committees	Irish Lobster Association, National and Regional In Shore Fishery Forum	Lobster overfishing problem	Lobster V-Notching program	Advisory (not binding)	Link 1 Link 2
France	Comités Locaux Des Pêches Maritimes	A National committee; 12 regional committees (CRPMEM) and 13 departmental committees (CDPMEM or CIDPMEM).	elected professionals, union representatives, producer organisations and maritime cooperatives from all types of fisheries	N.R.	Definition of general policy orientations and positions, decisions relating to the management of fishery resources	Private law bodies entrusted by law with public service missions. They have legal personality. Advisory (not binding)	Link

Country	Designation	Co-management structure	Leading stakeholders	Initiation	Main tasks	Level of co-management	References
France	Prud'homies	General assembly	Fishers	Middle ages (X-XI century)	Manage coastal fishing areas	Private law bodies entrusted by law with public service missions. Advisory (binding)	Link
Spain	Cofradias de Pescadores	Own statutes according to each region	Fishers	Middle ages (X-XI century)	Represent economic interests of fishing shipowners and from extractive sector workers. manage coastal fishing areas	Public law bodies entrusted by law and advisory to regional administration policies (binding)	Link
Spain	Catalan Sonsera fishery	Co-management committee	Four equal groups: fishers, NGOs, the administration and the scientists	Threat of the ban of fisheries due to EC regulations	Sonsera fisheries management plan	Public law bodies entrusted by law and advisory to regional administration policies (binding)	STECF, 2018.

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