ISSN 1726-5886

CIESM
WORKSHOP
MONOGRAPHS

50

Engaging marine scientists and fishers to share knowledge and perceptions – Early lessons

Paris (France)
18 - 21 April 2018

The Mediterranean Science Commission

CIESM Workshop Monographs

Engaging marine scientists and fishers to share knowledge and perceptions – Early lessons

Paris, France, 18 – 21 April 2018

CIESM Workshop Monographs ◊ 50.

To be cited as:
CIESM 2018. Engaging marine scientists and fishers to share knowledge and perceptions – Early lessons. CIESM Workshop Monograph n° 50 [F. Briand, Ed.] CIESM Publisher, Monaco, 218 p.

This collection offers a broad range of titles in the marine sciences, with a particular focus on emerging issues. CIESM Monographs do not aim to present state-of-the-art reviews; they reflect the latest thinking of researchers gathered at CIESM invitation to assess existing knowledge, confront their hypotheses and perspectives, and to identify the most interesting paths for future action.

A collection founded and edited by Frédéric Briand.

CONTENTS

OVERVIEW[1]

This synthesis, sketched during the course of the workshop proper, was developed in the months thereafter on the basis of written contributions provided by most participants under Sophie Gourguet's coordination. Frédéric Briand edited the entire Monograph and extensively reviewed this introductory chapter. Céline Barrier was responsible for the physical production of the volume.

1. BACKGROUND

For thousands of years the marine realm has been used, shaped and exploited by our species. Examples of the most ancient marine human activities are fishing and shipping. More recently, the marine/coastal domain has been further occupied to accommodate extractive industries in the form of offshore oil platforms, wind farms and wave energy plants, and further developed for the tourism industry. The growing demand for marine resources and utilities by a rising human population is exerting unprecedented pressure on marine ecosystems, from coastal degradation to overfishing, compounded by global climatic change.

Impacts of human activities on marine biodiversity are extensively studied (CIESM 2000). However the opposite, i.e. the impacts of marine biota on human activities, are far less considered. Yet, if biodiversity is widely regarded as favorable for human activities, certain species may also negatively impact human well-being, through direct and indirect effects.

To explore this complex subject, some sixteen experts of various geographic horizons and backgrounds (marine biologists, marine economists, social scientists, fishers, etc.) were invited by the Mediterranean Science Commission (CIESM) at the Oceanographic Institute in Paris, in April 2018, with substantial representation of the CIESM committee on Coastal Systems and Policies.

In welcoming the participants (see list at the end of volume), Drs Frédéric Briand and Sophie Gourguet presented the overall background and objectives of the workshop, emphasizing the need to include a broad marine socio-ecosystem vision when considering the interferences of marine biota and human activities. Obviously, the knowledge and distinct perceptions of the various stakeholders – and in particular fishers – will be given central importance in the workshop discussions.

[1] to be cited as :

Gourguet S., Briand F., Marçalo A., Ünal V., Liu Y., Kaiser B., Katsanevakis S., Azzurro E., Maccarone V., Hemida F., Pita P., Kafaf O., Brotons J.M., Ramos J., Decugis Ch., Luisetti T. and A. Miliou. 2018. Engaging marine scientists and fishers to share knowledge and perceptions – An overview, pp. 5 - 27 in CIESM Workshop Monograph n°50 [F. Briand, Ed.] CIESM Publisher, Monaco, 218 p.

2. MARINE LIFE / HUMAN INTERACTIONS

2.1. Significant impacts

2.1.1 Marine mammals

By definition, competition between fishers and marine mammals is a mutually disadvantageous situation. It can occur directly when the two groups share a common prey species, or when marine mammals cause damage to fishing gear during depredation (see Marçalo *et al.*; Miliou *et al.*; Brotons; in this volume). It will also occur indirectly when a local cetacean population preys on species that enter the diet of commercial fish species (Plagányi & Butterworth, 2009). Such conflicts between humans and cetaceans are an issue for many fisheries worldwide (Harwood & Croxall, 1988; Trites *et al*., 1997; Yodzis, 1998) and are difficult to handle as they confront two sides of the same coin, often with dramatic connotations. One side amplifies the food demands of a human population on the rise, which would justify increases in fishing effort and overexploitation of resources. As a consequence, conflicts with marine cetaceans multiply, as fishers are tempted to blame them for targeting the same commercial species and overexploiting marine resources. On the other hand, marine mammals are increasingly impacted by incidental bycatch and entanglement in fishing gear (Kaschner and Pauly, 2005), by persistent contaminants (Aguilar *et al.*, 1999; Roditi-Elasar *et al.*, 2003; Marsili *et al.*, 2018; Monteiro *et al.*, 2016; Zaccaroni *et al.*, 2018) , acoustic pollution (Jepson *et al.*, 2003; Rolland *et al.*, 2012) and ship strikes (Fujiwara and Caswell, 2001; Akkaya Bas *et al.*, 2017), to the point where several populations are locally endangered.

In fact more and more species are now listed as “vulnerable” and even “endangered “in the IUCN Red List. Two sides of the story persist. One concerns the fishing industry where operational interactions between marine mammals and fisheries can take a number of forms and are mostly negative, resulting in injury or death to cetaceans and/or damage to fishing gear and target fish catch to the fishers. The other relates to the expanding economic value of cetacean species not only from an eco-tourism perspective, as flourishing whale-watching businesses provide revenues and jobs to coastal economies (IWC Whale Watching Handbook, 2018), but also as providers of ecosystem services. For example, large whales are known to contribute to the resilience of ecosystems they cross, and to enhance primary productivity of surface waters by concentrating nitrogen near the surface through excretions, a process known as “the whale pump.” The enhancement of primary productivity in ocean waters is an ecosystem service, which will ultimately result in more productive fisheries. Striking the right balance between human and environmental interests through ecosystem-based management practices is a global challenge, essential to the sustainability of our seas.

For fisheries economists, bycatch is considered as a negative externality, and in many analyses, the "cost" of accidental catches is not evaluated in the fishing cost (Lent, 2015). Fishing activities suffering from dolphin depredation do not take sufficient account of the externalities generated. While technologies are developed that will help maintain dolphins away from fishing areas or fishing nets (see Brotons, this volume), one should keep in mind that there exist examples where bottlenose dolphins and fishers are engaged in a form of mutualistic interaction (see Fig. 1).

Figure 1. Complex interaction between fishermen and bottlenose dolphin *Tursiops truncatus*: in this southern Brazil lagoon, some dolphins drive the fish towards the boats and when the fishers throw their nets, they feed on the escaping fish. This behaviour is known since 1850 at least and does not result from training [photo: A. Gandolfi].

The adoption of management measures via policy or subsidies reducing dolphin bycatch or fishing gear depredations could increase the fishing cost of target species, making the seafood product less plentiful and more expensive. Putting a price on dolphin-fisheries interactions could be used to manage bycatch or damages suffered, in order to assign a limited number of bycatch quotas and/or fiscal incentives to buy deterrent equipment. This management approach should be addressed to fisheries that have bought quotas or dolphins deterrent devices. Another possible solution could be to tax the fishing landings and/or evaluate the fishing gear damages through independent observers. The double-dividend taxation could be used to support monitoring and mitigation initiatives for dolphin conservation.

Another useful instrument for mitigating dolphin-fisheries interactions is seafood ecolabelling. Such initiatives are best promoted by both public and private organizations (Ward and Phillips, 2010) to signal sustainable fishing practices and products that support the protection of dolphins. In many cases, fisheries should adopt the eco-labels to achieve a better market position as customers demand sustainable products in line with dolphin protection. In this way, ecolabelling would be used as an additional instrument to reduce marine mammal bycatch and fishing gear damages.

Competition between marine mammals and fisheries is a real problem and there is no easy solution that will be found without a conscious conservation and co-management approach, which will imply the engagement of fishers (see Maccarrone; Brotons, this volume) and will be area, fishery and species specific. As we are approaching a level of exhaustion, some solutions will require the identification and creation of marine protected areas (MPAs), especially if there is a need to limit fishing effort in particular areas or seasons. The definition of these marine protected areas would coincide with the identification of biological hotspots currently under high fishing pressure and/or high levels of cetaceans/fisheries interactions associated with a high bycatch risk.

2.1.2 Invasive species

Maritime traffic, mariculture transfers, aquarium trade and above all entries via the Suez Canal contribute to the introduction of a large number of species to the Mediterranean, most of the time unintentionally, which may displace native species and change local ecosystems (CIESM, 2002; Katsanevakis *et al.*, 2013). As evidenced by the forthcoming 2nd edition of the CIESM Fish Atlas, the introduction of fish species, most of them originating from the Indo Pacific realm, has spectacularly accelerated in recent decades.

Some of the new settlers become ecologically and numerically dominant in the new environment with impacts, often negative, on biodiversity, human health, infrastructure, and ecosystem services. Other impacts, such as provision of food, creation of novel habitats or securing ecosystem processes, will be positive. Food provision through fisheries and aquaculture is the marine ecosystem service that seems most affected by alien species (Galil, 2008; Katsanevakis *et al*., 2014). This involves any of the following mechanisms (see Katsanevakis *et al*., in this volume for details):

- Algal blooms: many invasive phytoplanktonic species cause toxic blooms and incur high mortalities or reduced growth in both farmed and wild populations of fish and other invertebrates. During blooms, the production of high amounts of mucilage can also cause extensive clogging of fishing gear and aquaculture equipment.
- Degradation of important habitats: essential fish habitats that provide food, refuge and nursery grounds can be impacted; fish stocks can be substantially affected.

- Direct predation or competition: many invasive species can cause the decline of native fish stocks through intense predation or competition for resources.

- Fouling of shellfish, fishing gear and equipment: alien macroalgae and fouling invertebrates can have negative economic impacts on aquaculture and fisheries by fouling fishing gear, shellfish facilities and shellfish beds, by smothering mussels and scallops, clogging scallop dredges, interfering with harvesting, competing for space with cultured bivalves and so bring additional costs for sorting and cleaning fouled shells before marketing.

- Damage of catch and fishing gear, entanglement in nets: fishing activities can be interrupted due to massive swarms of invasive jellyfish that damage the catch, clog-fishing gear and sting fishers (Luisetti *et al.*, this volume). Certain fish, like the invasive silver-cheeked toadfish *Lagocephalus sceleratus*, attack the catch of nets or longlines and cause extensive damage to the fishing gear (Ünal and Göncüoğlu-Bodur, this volume). Significant damages from the invasive Red King Crab in Norwegian coastal fishing nets instigated the commercial fishing of the crab (Kaiser and Kourantidou, this volume).

- Disease transmission: alien species can transmit new diseases, causing increased mortality in native populations of commercially important species or in holding facilities.

There are also positive impacts. Introduced species may provide:
- New commodities: many alien species are edible, often with high market values and are targeted by fisheries. In the 1930s already, Gruvel (1936) remarked that some Erythraean fish migrants were exploited almost as soon as they entered Levantine waters with a notable economic value for markets in Palestine and Syria. Some alien species have even been introduced on purpose for aquaculture or fisheries.

- New food source for fish: some species enhance native populations of commercially important fish by providing new, important food sources.

- Biological control: some alien species benefit fisheries and aquaculture by controlling the populations of other harmful alien species, as was the case for *Beroe ovata* ultimately controlling the outbreak of *Mnemiopsis leidyi* in the Black Sea in the 1990s.

- New economic development or infrastructure in support of new commodities: instruments in the new Norwegian Red King Crab fishery range from new vessels to onshore processing rejuvenating communities (Kaiser and Kourantidou, in this volume).

Given the complexity of species interactions, the balance between positive and negative impacts is difficult to assess and stakeholders' perceptions may significantly diverge. In view of the large-scale community shifts induced by climate change in the Mediterranean and Black Seas (CIESM 2008, 2009), alien species could be advantageous overall in some area, as the south-eastern Mediterranean, by fulfilling lost ecological roles and providing novel exploitable sources for fisheries (Katsanevakis *et al*., this volume).

Converting the effects of invasive alien species into opportunities

Alien invasive species can severely impact the ecosystems in which they settle. Obviously, preventing their colonization through early detection should be favored as eradication a posteriori always proves very difficult. There might be cases, however, where the establishment of alien species can present opportunities for economic exploitation. For example, invasive jellyfish may be targeted for population control. This may take many forms, starting with the physical removal of the species which could become an opportunity if the species in question can be harvested and exported (in a dry form?) to a region where it is native and accepted as food item (for example Asia). Other opportunities for jellyfish exploitation may soon arise in medical research or cosmetic application.

New markets – A need for caution

Questions regarding how an invasion is likely to change an ecosystem require combined scientific, social scientific and stakeholder knowledge to understand the human welfare implications of the potential paths, risks and opportunities that the invasion presents. The creation of benefits from the ecological change can be expected to create more invested stakeholders and perpetuate the ecological change.

The invasive silver-cheeked toadfish *Lagocephalus sceleratus* is best known amongst the pufferfishes for its direct impacts (mostly negative) on humans. This aggressive predatory pufferfish is the most devastating and dangerous species to fish, mollusks, crustaceans as well as to humans such as commercial fishers, recreational fishers, fish consumers, divers, even people swimming in shallow waters. Since 2003, this species is now part of the Mediterranean marine ecosystem. It has been spreading across the region, posing severe health hazards as it contains tetrodotoxin (TTX), a strong neurotoxin. It causes further socio-economic impacts by damaging fishing nets, requiring extra labour and gear modification costs. For the time being, fishers seem to be the most affected group (Ünal and Göncüoğlu-Bodur, in this volume). On the other hand, there are some noteworthy utilization alternatives, particularly in the pharmaceutical-medical sector. Thus Nader *et al*. (2012) suggest assessing the economic value and potential of TTX as a pharmaceutical agent on the world market. Pufferfishes are also commonly used in aquariums worldwide, regardless of their toxicity (Corsini-Foka *et al*., 2014) Surprisingly this pufferfish also gained a symbolic "iconic" value (tattoo art, souvenir use, animated cartoon, etc.) nearly as soon as it entered the Mediterranean.

2.2. Dissemination of good practices

The issue of marine species interfering with human activities is not specific to one country or one region; it is a worldwide phenomenon. It is therefore important for stakeholders at local and international scales to exchange and disseminate their experiences of dealing with such impacts. In the context of accelerating global change, the exchange of good practices appears more and more crucial.

Marine mammals

Good practices to resolve marine mammals fishery interactions are suggested through the course of this volume, with the caveat that what is effective in a given area for certain types of fisheries, interacting with a given marine mammal species, will require adjusting to work in another area. Based on experience acquired elsewhere, modifications to commercial fishing practices should be adopted and implemented, and gear alterations suggested: for example fishers using gill nets in the Mediterranean and South Iberia who report gear or catch damage due to marine mammal interactions, could usefully switch to other fishing gears which suffer far less impacts from marine mammal interactions. Efficient implementation of the mitigation techniques proposed shall further depend on the development of a clear code of good practices that should be widely disseminated, adopted and implemented (Hamer *et al*., 2008; Ward *et al.,* 2018). In the Balearic Islands, a code of good practices minimizing marine mammals-fishery interactions was recently elaborated, but its effectiveness is hampered by the high diversity of the species and interactions involved and by cultural differences observed between sub-populations of the same dolphin species (Brotons, this volume).

While the approaches required will often be fishery specific, all solutions will rely on trustful, positive relationships between scientists, fishers and fishery managers, who should all take an active role in this process. The participation and dynamic engagement of fishermen at all stages of the management process is an essential prerequisite (see section 3 below), in order for cetacean bycatch reduction measures to be implemented successfully.

Invasive species

Early warning systems should be set up with the help of researchers to prevent invasions likely to displace fishes of high economic interest for the fisheries, with special attention to the Sicily-Tunisian biogeographic barrier that appears less and less resistant to crossing. Encouraging the participation of citizens in these initiatives can substantially contribute to early warning systems (Cardoso *et al.*, 2017) while promoting best practices and environmental awareness in the general public.

Priority should be given to the alien species having recently settled in the Mediterranean and considered so far only as a threat. The situation may evolve rapidly, once adaptation and mitigation measures are set in place and if there is evolution of consumers' tastes.

<u>MPA as a possible tool?</u>

Theory predicts that MPAs, owing to their high species richness and complexity, would provide biotic resistance to invasive species. Recent evidence (Giakoumi *et al.,* 2018) indeed illustrates that overfishing alters the ratio native : alien fishes in favour of the latter in the Mediterranean. The establishment of enforced non-fishing zones (NFZ), coupled with species-targeted removals in MPAs, would help protect the indigenous predators/competitors/parasites complex.

For instance, the well-enforced NFZ of Gökova Bay (Turkey) has seen the return of apex predators, while the harmful rabbitfish species *Siganus rivulatus* and *Siganus luridus* seem to be declining (Ünal and Kızılkaya, 2018). Clearly, such areas reduce the impacts of illegal fishing, habitat destruction and overfishing while creating healthy spillover effects in local fisheries. At this time, NFZs account for less than 1% of the total area of the Mediterranean Sea, but examples are growing (See Pita *et al.*, this volume) of fishers engaging in the design of new MPAs. Since many small-scale MPAs, especially in the Mediterranean, have been overwhelmed by invasive species (Galil *et al.*, 2017), enforced non fishing measures are urgently needed.

Law enforcement (illegal practices)

Illegal exploitation of fisheries worldwide (IUU[2]) severely threatens the sustainability of marine living resources, leading to ecological, economic, social and political unbalances in many coastal regions. For the last 50 years and with the upgrade of fleets worldwide, fishermen now harvest far more than is ecologically or socially optimal. Global fish stocks are under pressure: according to the FAO, as of 2013 almost 90% of global fish stocks were being fully or over-exploited, including 31.4% estimated as overfished, 58.1% as fully fished and 10.5% as underfished. In order to address overfishing and over-capacity, management authorities have introduced a wide range of regulations, including gear, effort or area restrictions, landing taxes, harvest quotas, minimum sizes and by-catch regulations, as well as mechanisms for the monitoring and control of fisheries practices. Yet law enforcement in fisheries is often immediately perceived by fishermen as lacking moderation or unfair. This is related to the fact that a fishery is a typical example of a common property resource that must be shared amongst a variety of stakeholders, which in turn requires shared governance.

In many cases, illegal or destructive fishery practices are not conducted by an individual fisherman, but by a collective entity, driven by social, market/ economic demands (e.g. from harvest to processing entities, a supply chain all the way to the consumer level). However, fishermen as primary stakeholders are the first to face regulatory obligations. At the same time, fishermen should be aware that these laws are created to provide recommendations for best resource exploitation and habitat protection based on scientific evidence. Thus co-management including several levels of stakeholders is crucial at this stage (see below).

Limitations to enforce law at sea from responsible authorities arise from the lack of money to monitor and patrol huge fleets over such a vast expanse of water. An optimal solution for this problem could be fishermen endorsing a primary role in protecting the marine resources and environments they exploit, by self-complying and reporting violations to agencies.

Harmonization between countries on management practices

The need for international cooperation in the fisheries sector is urgent and crucial, in order to improve management and provide lasting protection for marine resources. Given that the definition of illegal practices varies from country to country and the widespread variation in how states criminalize the different infractions, neighbouring countries have every interest to participate in summits in order to reach lasting agreements.

[2] Illegal, Unreported and Unregulated fishing

3. MEDITERRANEAN FISHERY COOPERATIVES – A LONG TRADITION

There is a diverse, long history of self-governance by fishers in the Mediterranean Basin, which goes back to the Middle Ages. Fishery cooperatives can be excellent forums to promote sustainable co-management participatory approaches and best practices across comparable regions. Our meeting was informed of, and discussed three specific examples:

3.1. Fishery 'Prud'homies' in the French Mediterranean

Since the 15th century, the management of fisheries in French Mediterranean coastal waters has been left to the responsibility of 33 prud'homies (see Fig. 2). These institutions find their origin in the corporations of the Middle Ages and have shown remarkable resilience.

Prud'homies are communities of artisanal fishermen owners ('patrons pêcheurs'). Born on the French coast of Provence in the Middle Ages, they succeeded in adapting to changes in political regimes – even surviving the French Revolution - under supervision of central authorities.

Figure 2. Localisation of "prud'homies" on the French Mediterranean coast.

The prud'hommes are experienced fishermen, elected by their peers every three years. They have regulatory, judicial and disciplinary power on their respective territory where their mission is to manage the fishing effort and ensure the sustainability of fishery resources.

A guiding prud'homal principle is that every fisher must be able to live by his specialized trade. Therefore prud'homies will prevent a given technique to fully outcompete the others and will keep overfished areas and species off limit to allow them to recover. They will encourage fishermen to diversify via the use of artisanal techniques rather than to intensify their modes of capture.

Today in decline, prud'homies deserve to be revisited and reinforced, as their ancestral mode of negotiated management appears surprisingly modern and may provide local answers to the challenge of global declining resources (Rézenthel, 1983).

3.2. Fishery 'Cofradies' in the Balearic Islands

Fishing is as ancient as man in the Balearic Islands, but it is with Pliny the Elder, under Roman rule, that we find the first references. Archives from the Middle Ages indicate that the College of the Honorable Fishermen of San Pedro was already established in Majorca in the thirteenth century.
Today "cofradíes" in the Balearic Islands are non-profit public corporations, acting as bodies of consultation and collaboration with public administrations in order to represent and promote the economic interests of fishers.

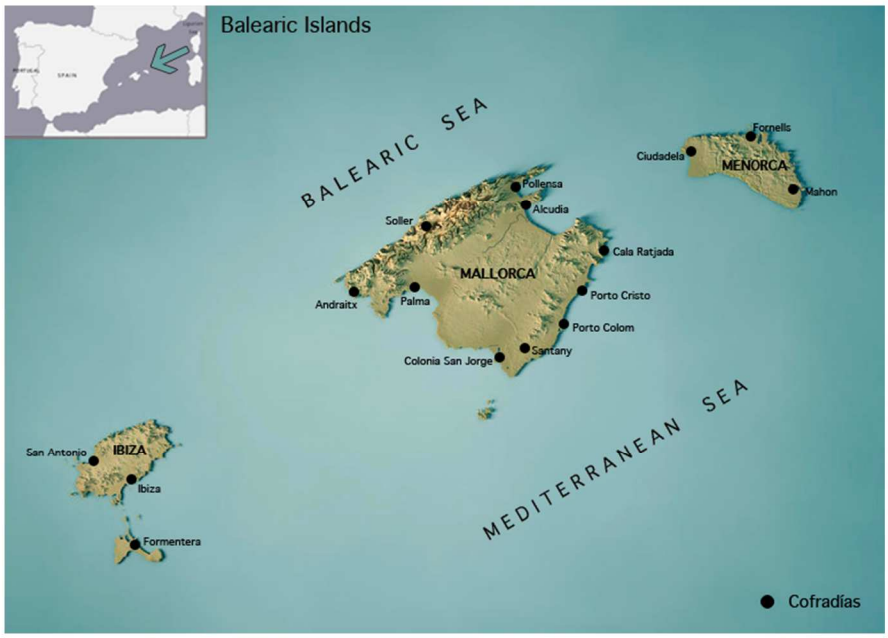

Figure 3. Location of Cofradies in the Balearic Islands. Adapted from Llabrés & Martorell, 1984.

Today we find a total of 16 "cofradies" (see Fig. 3): three in Menorca (Ciutadella, Fornells and Maò), ten in Mallorca (Pollensa, Alcúdia, Cala Rajada, Porto Cristo, Porto Colom, Santany, Colònia de Sant Jordi, Palma, Andratx and Sòller), two in Ibiza (Sant Antoni, Eivissa) and one in Formentera.

Membership in a "Cofradía" is limited to the owners of a fishing boat at a port in the Balearic Islands and to the employees of the extractive sector in the Balearic Islands. Among the main functions of the "Cofradíes" one finds: 1) acting as advisory bodies of the competent public administrations; 2) providing services to its members and representing their interests; 3) managing the inherited resources; 4) representing the fisheries sector to governments and other public or private entities (Llabrés and Martorell, 1984).

All "Cofradíes" of the Balearic Islands are united in a single Federation for a more efficient organization.

3.3. Fishery Cooperatives in Turkey

The roots of cooperative activity in Turkey actually go back to the 12th century *Ahi* movement. The first fishery cooperative, though, was founded much later, in Istanbul, on 11 February 1943, eight decades

after the establishment of the first cooperative movement in Turkey by Mithat Paşa (Ünal *et al.,* 2009). The president of the time became the first member of this cooperative in order to encourage organization among fishers. Another noteworthy development was the 1961 Constitution with the provision "The government takes the necessary steps to support and develop cooperative enterprises".

With the implementation of five-year nation-wide development plans, fishery cooperatives started gaining support. In particular the 3rd Development Plan (1973-1977) influenced the foundation and increase of a number of fishery cooperatives, thanks to provisions giving them opportunities to manage or own marketing and canning facilities. In 1965, the number of fishery cooperatives was 36; it had reached 413 in 2005.

After fishery cooperatives were given the rights to hire and run fishing ports, fishery cooperatives further increased and developed into a "three-tier system" of vertical organization : i) 270 primary cooperatives; ii) 15 region-based associations; and iii) one central union.

Despite chronic problems, fishery cooperatives in Turkey are now strong organizations, which embrace thousands of fishers, organize symposiums, panels, workshops, and have the power to influence decisions related to fisheries management. Today, many fishery cooperatives successfully promote their members' products, providing relatively cheaper input, helping with their legal procedures, representing them on related platforms and carry effective lobbying activities. And some of them (e.g. the Akyaka primary fishery cooperative) now play vital roles in the preservation of fishing resources and areas, the establishment of no-fishing zones, fighting illegal fishing or preparing local fishery management plans (as for Gökova Bay small-scale fisheries).

4. STAKEHOLDERS - ROLES, PERCEPTIONS AND POWER IN A COMPLEX WORLD

To set effective management practices, stakeholders have to be actively included in the decision process. It is therefore very important to take into account their knowledge and perceptions. Indeed, experience has taught us that the best fishing plans were those in which co-management prevailed over the classic top-down strategy (Pinkerton, 2011). Active engagement of fishers in management process will help build relationships between decision makers, other stakeholders and fishers, and yield long-term benefits to fisheries management. However, that is not an easy process, especially considering the following questions: who should be involved, why and how?

4.1. Stakeholders' identification and engagement

The sustainable development of society can be achieved only if we are able to generate "win-win" situations, in which social, economic and environmental needs will be simultaneously satisfied. Citizens and stakeholders' involvement at the local level is crucial. One of the most important drivers of better stakeholder governance is represented by the strengthening of stakeholders' involvement in the decision-making processes. In the past, however, the dialogue with stakeholders was seen more as an obstacle to achieving the goals of the organization. Today in the management activities, the stakeholder involvement plays a crucial role in the processes of strategic organization aimed to achieve the medium and long term objectives. Dialogue with stakeholders also wards off the crises of the parties involved, improving not only the decision-making processes but also the efficiency of the implementation strategy.

The crucial first steps, as detailed in Ramos (this volume), are to properly identify and engage the stakeholders (see Fig. 4). A useful diagram at this stage will combine the influence and the level of interest of each stakeholder, distinguishing between those in favour of the initiative (pro), those opposing it (against) and those not totally involved (ambivalent). It is important to seek different viewpoints, as a crucial part of the stakeholder management process will be to influence stakeholders and try to move them from opposition to support.

The involvement and participation in the management process does not just mean "to inform more" but concerns the collection of opinions and information from different points of view. Obviously, a fisherman does not know more about stock assessment than a fishery biologist. A participatory process always means cooperation and dialogue among persons with different skills. The fisherman will give a valuable and strong contribution to how a management plan works seasonally, while the coastal manager will have a technical vision of the marine ecosystem and legislation. In many cases one will be surprised to find out how fishermen and other actors take seriously the responsibility entrusted to them by a participatory process.

Very often consultations may be opened to the public, as in the case of coastal management plans or in cases where an eco-tourism plan of the area is to be implemented. In other cases, consultations will be limited to specific stakeholders as in the case of mining activities at sea or fisheries management plans. The tools available for stakeholder consultation are multiple, ranging from roundtable discussions, workshops, conferences, interviews to on-line discussion forums. In every case, all interested stakeholders should be invited to participate in the ongoing planning and review process.

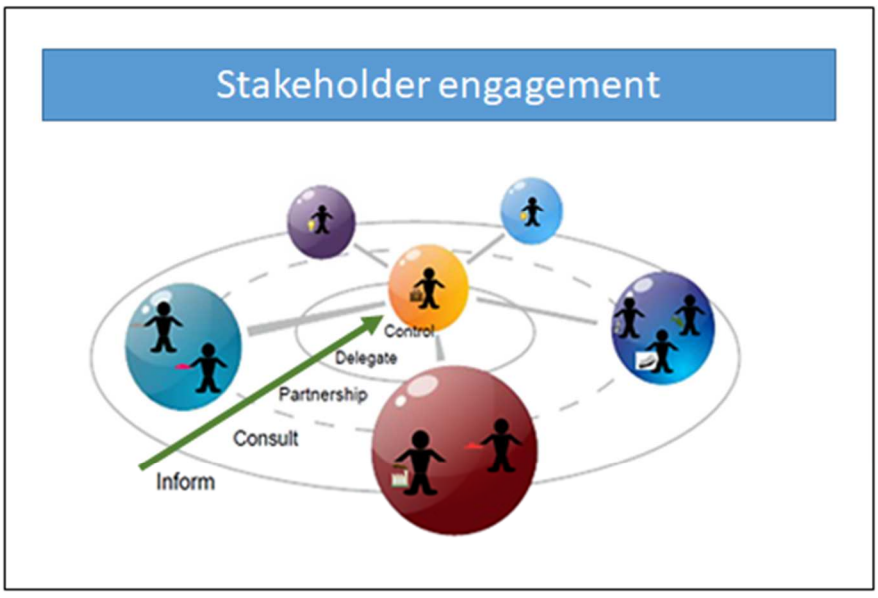

Figure 4. Bottom up engagement of stakeholders during the identification, planning and monitoring stages (Adapted from Meffe *et al.,* 2012).

The effectiveness of environmental policies is partly subordinated to the ability of increasing the stakeholders' awareness. Very often, the resistance encountered is due to poor knowledge of the problem, unawareness of the consequences of the choices and/or to cultural obstacles. For a proactive

contribution to environmental management plans from each actor, it is necessary not only to set up an effective communication system, but also to improve and verify the increase in knowledge and awareness of the problem by using participatory tools such as the Fisheries Local Action Group (FLAG) (Linke and Bruckmeier, 2015).

New governance regimes, such as community-based management and co-management that have the potential to address community development as an integral part of fishery resource management and increased use of local fishery knowledge, are recommended.

Experience shows that the development of institutions for self-governance requires time in the order of ten years. In Alanya, on the Mediterranean coast of Turkey, the local coastal fishery developed rules for resource allocation and conflict reduction, which made use of rotating turns at fishing sites. This development took 10 to 15 years, without government support or any other institution-building intervention (Berkes, 1986).

4.2 Perceptions and filters

Whose values should be taken into consideration for environmental decision-making? At the beginning of the new millennium, there was already much debate on what and who determine the value of nature. The anthropocentric value perspective - the one that is used to value the goods and benefits provided by ecosystems - exists when it is a human valuer who assigns a value to nature. Thus natural ecological processes become "services" only if humans utilise them either actively or passively (Fisher *et al.*, 2009). However, different stakeholders can perceive different benefits from the same ecosystem processes, which can also be conflicting benefits. That is the case of the carbon sequestration and storage service by forests, for example, which provide essential climate regulation at the global level. That is hardly perceived by the public, which finds it beneficial to harvest the forest as fuel wood. In fact, Turner *et al*. (2003) warn against the use of economic valuation for nature when there is uncertainty surrounding the natural functions and processes, and therefore ignorance around the welfare consequences of ecosystem degradation or collapse.

In the marine environment, stakeholders, either primary (mostly fishermen), secondary (managers, decision makers, regulators) or external (fish consumers, scientists, media, general public) face complex challenges. The human condition by nature is averse to newness, because it breaks daily routines. Cultural backgrounds (Kafaf, this volume) and geographies (Kaiser and Kourantidou, this volume) may be also averse to changes. Take for example the growing numbers of alien species: stakeholders perception at first is that alien species – particularly if they are invasive – only bring problems and are a burden that offers no opportunities (Katsanevakis and Rilov, this volume). Yet, stakeholder perception may evolve, depending on how the problem has been faced and overcome. For example, since the pufferfish *Lagocephalus sceleratus* was first recorded in the Mediterranean in the early 1930s, a love/hate affair developed between the public in general and this species (see Fig. 5).

Fishers were affected negatively by this species (gear damage, predation of valuable fish, toxicity, low potential as a protein source) whereas the economic value of the species increased in the "souvenir industry" and in the pharmacology sector (Ünal and Göncüoğlu-Bodur, this volume).

Figure 5. Poster illustrating the adverse impacts and associated economic losses linked to the arrival of *Lagocephalus sceleratus*. From Ünal and Göncüoğlu-Bodur, in this volume.

The concept of ecosystem services highlights the connection between science and society (Liu *et al*., 2010). It is a normative concept (i.e., value-laden), also called a 'stakeholder-driven' concept (Jax *et al*., 2013) since the value of ecosystem services is greatly influenced by the uses, needs, views and perceptions of the stakeholders who have an interest in resources and/or depend on ecosystems for their livelihood and well-being. The latter have a better understanding of the resource services and an urgent need of preserving them from anthropogenic pressures, even in the absence of a well-functioning market. Dependent on stakeholders' preferences and involvement, some ecosystem services will be considered as a source of benefits or losses (cost). In the case of jellyfish blooms, some consider that jellyfish can generate incomes for those who exploit it as a valuable resource, while others see jellyfish only as a 'pest' that generates costs for those who suffer from jellyfish blooming, like the *Periphylla* case on the Norwegian coast (see Liu, this volume). It is important therefore to take stakeholders' needs, preferences, views and perceptions into account and to execute management plans with a bottom-up approach. In particular, stakeholder-based approaches are important instruments to achieve multiple objectives and to evaluate different management strategies. The analysis of stakeholders preferences and perceptions will help in increasing the social acceptance and sustainability of the decisions (Paletto *et al*., 2014), and in making management legitimate.

Stakeholders have different social-cultural values that are driven by their tradition, culture and beliefs, knowledge of the resources, attachment to the ecosystem, their interaction with nature, etc. A good example is whale and seal hunting. Hunting whales and seals is a tradition that carries socio-cultural value for Faroe Islanders and Greenlanders, for Arctic First Nations, but for the rest of the world, hunting these animals is considered against nature, even 'criminal' and should be totally forbidden. The values

of ecosystem services are based on distinct socio-ecological systems, but social-cultural values have in turn affected resources and ecosystem services.

Consumer perceptions and reactions are widely impacted by diverse factors. In the forefront is culture, but other social aspects (e.g. the consumer' personal characteristics and surrounding environment, lifestyle, views on fashion and healthy food) will be also influential (Can *et al*., 2015). Together, these factors define what consumers perceive as important, shape their gastronomic preferences and define their purchasing behaviour. In the cultures of numerous human populations, seafood occupies a central position, making it not only an essential food component but also something that serves to define social, ceremonial and religious identities. For others, seafood has no part in the food habits, as it is not accepted in their culture. The occurrence of alien/invasive species poses new challenges. On the supply side, fishermen start to catch fish that they were not used to and they have to find an outlet for their catch (Hemida and Capapé, this volume). The initial doubt relates to the eventual acceptability of these new fish species. On the demand side, consumers seek species which they are used to, and if new species do appear, consumers may not be willing to try them out – also due to concerns about their possible toxicity.

4.3. Empowerment of fishers

As primary users of the resource, small-scale fishers are among the first victims of adversities such as climate change, invasive species, overfishing, illegal fishing, mismanagement and marine pollution. Given the circumstance one may expect them to take on a substantial role in combatting the above; but in reality the situation is rarely so. Often held responsible for the predicament fisheries are in, fishers mostly do their job: they fish. They may know the sea, fishing and fish dynamics better than anyone, yet the role they play in fisheries management is either null or insignificant in most countries. In other words, whilst fishers do the fishing, others manage the fisheries. But the concept of co-management is gaining prominence. Fishers spend their days at sea fishing. They have done this every day for years-some, even for generations. There is a growing recognition that they have accumulated an enormous amount of experience and knowledge. In our chaotic environment, it appears unwise to manage the resource and seek solutions to problems - both acute and chronic - without benefiting from their traditional and hands-on ecological knowledge and lore.

4.4. Accessing fishers' knowledge

We need reliable, relevant, accurate and timely data to improve the baseline information supporting decision making. As scientific surveys are often made in summer - the most comfortable period to be in the field – many gaps remain on the marine resources ecology in the other seasons. Most fishers spend many years performing direct continuous observations within small local fishing areas (Fisher, 2000), "sampling" marine resources (García-Quijano, 2009), and discussing the marine "ecosystem" and species on a daily basis (García-Quijano and Pizzini, 2015). They also possess a wealth of knowledge about marine resources which could never be gained in a classroom or by statistical analysis, including migration patterns, spawning behavior and areas, the stock structure, abundance and historical change (Begossi, 2015). From this perspective, the fishers' role has to expand from just providing data on the catch to sharing their knowledge and observations while providing sound advice on fisheries resource and management. Acknowledging each other's knowledge and competence coupled with an effective cooperation is no longer just an option but a necessity. Involving fishers and using their knowledge now appears indispensable to create sustainable fisheries, protect stocks and their habitats. Their collaboration (particularly in the case of "data poor" fisheries) with university and government scientists

would allow mapping habitats, producing more robust stock assessments, help improving the survey design, implementation and data analysis as well as swapping vessels and gears (Stanley and Ric, 2003). In return, fishers would increase their knowledge of the oceanographic environment and marine biodiversity, feel empowered and involved.

Fishers' knowledge (FK), Fishers' ecological knowledge (FEK), or, more broadly, the local Ecological Knowledge (LEK) of expert people, can be collected in varied ways and under several formats, from the extractive methods (oral, textual or digital) to collaborative approaches. The sensitivity of the data and the access level to the fishers' knowledge will depend upon the method adopted. For many years, fisheries authorities indirectly extracted basic FK (i.e. on catch, fishing effort and fishing grounds) through the Logbook programs, the catch database, and recently VMS records. Yet, the most recent studies confirm that, globally, the catches are vastly under reported (Pauly & Zeller, 2016), that the data on fishing effort and fishing practices do not reflect what is really caught on the water, and that many fisheries are not-assessed due to a crucial lack of data. The likely cause is mainly a failure of state scientists / managers to establish the necessary trust with the local fishers. Indeed field experiences with fishermen reveal a broad scepticism toward the ulterior motives of the traditional printed questionnaires and a rejection of the traditional (mainly top-down) mode of interaction between the fishers and the interviewers (Kafaf, this volume). As a result, the fishermen respond as briefly and superficially as possible.

Under increasing pressure from environmental change and the high demand for field observations, a growing number of researchers and agencies are promoting the integration of scientific *with* 'local' knowledge. Indeed, accessing the knowledge of people living in intimate relation with the natural environment has become a feature in a number of sectors such as forest conservation (e.g. Charnley *et al*., 2007), wildlife management (Milupi *et al*., 2017) and fisheries (Johannes, 1998; Neis *et al*., 1999; Azzurro in this volume).

Accessing the knowledge of local communities will include different methods such as semi-structured interviews; focus-group discussions; ranking and scoring captures and perceived abundances; participatory mapping; and diagramming techniques (see Azzurro, this volume). Participatory mapping is, for instance, a powerful tool to use in LEK research and is often a good technique to start with, as it involves several people and can stimulate much discussion and enthusiasm (see Pita *et al.*, 2016).

Although time consuming, open-ended interviews and conversations appear as most appropriate to get access to sensitive data such as the fishing grounds, the fishers' incomes and illegal practices (see Fig. 6.). Such questions should never be asked in the beginning but throughout the conversation. The interviewer earns the fishers' confidence when s/he is introduced by one or more local fishers, thus appearing independent from the fishing authority and when the language is not too technical (see Kafaf in this volume). Structured data elicitation techniques are further considered the most suitable to reveal patterns about the way fishers think about their resources and their environment (Orensanz *et al*., 2015). In general, all forms of partnership, based on an effective communication between scientists and fishermen will consolidate trust and provide a channel to exchange knowledge: as soon as scientists concretely acknowledge the fishers' value, they create opportunities for constructive dialogue and discussions, reinforce effective engagement and promote sharing perceptions, information and data. From this perspective, participative and collaborative research, assessment and even management could provide wide access to FEK.

Figure 6. Moroccan official scientist interviewing a fisherman [photo credit INRH].

In the collaborative approach the fishermen are involved in developing the research question and objectives, in designing and executing the research program as well as in the data collection. Their contribution is not passive, which makes them motivated and engaged. In this way, FEK is not only shared and directly applied, but also gets developed (Yochum *et al*., 2011). Moreover, the collaborative research will improve communication and enhance trust between stakeholders (Feeney *et al*., 2010), hence minimizing the suspicions and controversies that too often block access to fishers' knowledge.

Participatory monitoring programs are also a valuable tool in acquiring fishers' knowledge and generating information about fisheries and/or marine resources. This approach is gaining momentum as many case studies show encouraging results (Azzurro *et al.*, 2011; Dias *et al*., 2015). It carries long-term objectives and seeks to provide data on a continuous basis. The data are generally submitted by fishermen voluntarily involved in a partnership program with fishers' associations and scientists (whether national or independent). In certain participatory monitoring programs the fishers are considered as "experts", so they are encouraged to participate to the analysis and discussion of the results, which enhances access to, and use of, fishers' knowledge.

Considering the extreme variability of both social and ecological settings, methods for gathering data should at the same time fit the research circumstances, meet the needs of scientists and respect the attitudes of local communities. In other words, researchers must consider not only their research objectives but also the cultural contexts in which the interactions take place (Briggs, 1986). It is important that they are good listeners and also capable to critically review all the information. The core method of researching FEK is often a semi-structured interview. The interviewer introduces a topic using an open-ended question such as: 'What species have disappeared in the last decades?" This allows the respondents to spontaneously identify species, provide direction to the interview and describe problems in their own terms.

Not all persons within a local setting will have the same knowledge, and so one of the essential aspects in accessing LEK concerns the means by which local experts are identified (Davis and Wagner, 2003). It is therefore vital to design and conduct LEK research with a rigorous thinking and maintain high standards of accountability. Azzurro (this volume) distinguishes three different aspects, which largely

contribute to the reliability of LEK exploration regarding marine species: *i*) the characteristics of the target taxa; *ii*) the characteristics of the population interviewed and; *iii*) the questions of researchers. Fishermen are one of the best group of informants on the distribution and abundance of marine resources. It is nonetheless advisable to select people who together form a homogeneous subject, which can prove challenging, as in the case of small-scale Mediterranean fishery which is typically characterized by a great variety of techniques and traditions. Other relevant groups, such as recreational divers, may be considered as a potential target group provided they dedicate much time to their field activities. In any case, it is advisable to ensure that persons considered less knowledgeable are not mistaken as local experts.

Another important rule is to have a respect and a genuine interest in learning from the diverse stakeholders and follow ethical principles in conducting the research, so that community and individual rights are respected. Last but not least, every survey should respect the local legislation on privacy matters. It is therefore suggested to guarantee anonymity and clearly state the objectives of the research at the beginning of the interview. Such interactions are empirical, practical and underscore why LEK has become a significant touchstone in recent years.

4.5 FEK and intellectual property [3]

The valorization of LEK in different sectors, as an alternative to the exclusive use of "Western scientific knowledge", has been favored in recent decades by the recommendations of the UN Rio Summit in 1992, by the Convention on Biodiversity in 1993, and by the efforts of international institutions such as Unesco and FAO (Unesco, 2017). Lately IPBES - the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services - proposed the concept of "nature's contributions to people", which recognizes the fundamental role that culture (and thus LEK) plays in defining the links between people and nature (Pascual *et al.*, 2017; Díaz *et al.*, 2018).

In fact many national initiatives based in the collection and use of LEK have been lately put into force throughout the world, bringing to light issues concerning intellectual property rights of LEK-based goods (Davis and Wagner, 2003). In this sense, despite growing recognition of the right of local communities to be rewarded by the companies who tapped their knowledge, LEK is difficult to protect under intellectual property rights regulations because in many cases it is a collective knowledge and lacks novelty properties. In addition, the *ex-situ* storing of LEK is meaningless for the proprietary communities because this knowledge only makes sense in a social context as part of a social activity (Agrawal, 1995; Maurstad, 2002). Furthermore, intellectual property regulations promote liberalization of protected goods and services after some time, which poses additional problems for local communities because they will eventually face the loss of their exclusive rights over part of their culture in the future. Under this scenario, the incorporation of FEK into the management of common pool resources - beyond the technical difficulties derived from its collection, systematization and adaptation to the standards of scientific knowledge - raises issues related to confidentiality and ownership of the results. Thus, beyond the need for obtaining informed consent from the fishers, the other parties (researchers, managers and policy-makers), should be aware that their respective positions regarding the publishing and publicizing of the results may greatly differ. For fishers it is often important to keep things confidential; for scientists the value of the results increases as their paper is published in international journals and cited by other scientists, while coastal or fisheries managers can claim the property of the results and develop public policies with sometimes undesired implications for the fishers themselves. Consequently, the lack of

[3] this subsection was enriched by A. Garcia Allut and S. Villasante, who co-authored a chapter in this volume.

attention to the different agendas of the actors involved can negatively affect the fishers who shared their knowledge, time and money (Silver and Campbell, 2005) and damage future collaborative initiatives (Jacobsen *et al.*, 2012).

Another question to consider is the ultimate ownership of FEK: is it individual (anecdotal), or collective? And who will benefit, or be negatively affected if it is used in management, or just openly shared? These are critical questions that need attention in the sense that all the interested parties are fully represented in the initiative from the beginning. Scientists and policy-makers must be aware that fishers are more than just information providers: they should be active at the decision table; they should have a voice (and vote) on how to use their knowledge and how to participate in the derived management decisions.

Box 1. Practical Workshop recommendations

- Enhance exchanges between fishers, scientists and decision makers
- Production of a common scientific/stakeholder (e.g. fishers) glossary
- Develop joint fishers/scientific networks
- Encourage/ promote cross-training and good practices of fishers in different locations
- Promote communication (video where fishermen discuss their life, experience, etc.), with back up and advice from scientists
- Favor bottom-up co-governance design in marine spatial planning as a co-governance tool
- Promote good practices through festivals or through workshops for the exchange of experience between different countries
- Engage marine stakeholders more broadly, in particular young generations (Youtube, social media, etc.)
- Develop early warning systems for invasive alien species and promote participation of civil society
- Promote the potential utilization and commercial exploitation of invasive species in collaboration with fishers' associations
- Develop schemes where fishers are able to have an advisory role in the law enforcement process to combat IUU

Concluding remarks: communication gaps

We have reached a point where we really need scientists, fishers and managers to work closely together and develop trusting relations in order to understand each other. Issues, such as preserving of marine biodiversity or combatting global changes and effects of alien species at local, regional and global scales, lay a responsibility on scientists and decision makers to cooperate and understand each other. Yet they seem to live and act in completely separate worlds. They ponder on the same issues but cannot (maybe do not want to) speak the language of the other (see more in Briand, 2012). Sustainable maritime practices will be achieved only through the engagement of all parties.

References

Agrawal A. 1995. Dismantling the divide between indigenous and scientific knowledge. *Dev. Change*, 26: 413–439.

Aguilar A., Borrel A., Pastor T. 1999. Biological factors affecting variability of persistent pollutant levels in cetaceans. *J. Cetacean Res. Manag. Spec.*, 1: 83-116.

Akkaya Bas A., Christiansen F., Amaha Öztürk A., Öztürk B., McIntosh C. 2017. The effects of marine traffic on the behaviour of Black Sea harbour porpoises (*Phocoena phocoena relicta*) within the Istanbul Strait, Turkey. *Plos ONE,* 12 (3): e0172970.

Azzurro E., Moschella P., Maynou F. 2011. Tracking signals of change in Mediterranean fish diversity based on Local Ecological Knowledge. *Plos ONE,* 6 (9) e24885.

Begossi A. 2015. Local ecological knowledge (LEK): understanding and managing fisheries. In Fishers' knowledge and the ecosystem approach to fisheries, [Eds. Fischer J., Jorgensen J., Josupeit H., Kalikoski D. and Lucas C.M.], FAO.

Berkes F. 1986. Local-level management and the commons problem: a comparative study of Turkish coastal fisheries. *Marine Policy*, 10: 215-229.

Briand F. 2012. Making research count in marine governance- The communication challenge. *CIESM Marine Policy Series*, 3: 36.

Briggs C.L. 1986. Learning how to ask: a sociolinguistic appraisal of the role of the interview in social science re- search. Cambridge University Press, Cambridge, UK.

Can M.F., Günlü A. and Can Y.H. 2015. Fish consumption preferences and factors influencing it. *Food Sci. Technol.*, 35 (2): 339-346.

Cardoso A., Tsiamisk K., Gervasini E., Schade S. and 15 others 2017. Citizen science and Open Data: a model for invasive alien species in Europe. *Research Ideas and Outcomes*, 3: e14811.

Charnley S., Fischer A.P. and Jones E.T. 2007. Integrating traditional and local ecological knowledge into forest biodiversity conservation in the Pacific Northwest. *Forest Ecology and Management*, 246 (1):14-28.

CIESM 2000. Fishing down the Mediterranean food webs? CIESM Workshop Monographs n°12 [F. Briand, Ed.], 99 p., CIESM Publisher, Monaco.

CIESM 2002. Alien marine organisms introduced by ships in the Mediterranean and Black seas. CIESM Workshop Monographs n°20 [F. Briand, Ed.], 136 p., CIESM Publisher, Monaco.

CIESM 2008. Climate warming and related changes in Mediterranean marine biota. CIESM Workshop Monographs n°35 [F. Briand, Ed.], 152 p., CIESM Publisher, Monaco.

CIESM 2009. Climate forcing and its impacts on the Black Sea marine biota. CIESM Workshop Monographs n°39 [F. Briand, Ed.], 152 p., CIESM Publisher, Monaco.

Corsini-Foka M., Kondylatos G. and Santorinios E. 2014. The role of the Aquarium of Rhodes (Eastern Mediterranean Sea) on raising public awareness to marine invasions, with a note on the husbandry and trade of marine aliens. *Cah. Biol. Mar*., 55:173-182.

Davis A., Wagner J.R. 2003. Who knows? On the importance of identifying "experts" when researching local ecological knowledge. *Human ecology*, 31(3): 463-489.

Dias A.C.E., Cinti A., Seixas C.S. 2015. Participatory monitoring of small-scale coastal fisheries in Brazil and the Southern Cone: a literature review. In: 15th Biennial Global Conference International Association for the Study of the Commons, 2015, Edmonton'. IASC 2015 Book of Abstracts.

Díaz S., Pascual U., Stenseke M., Martín-López B., Watson R.T., Molnár Z. *et al*. 2018. Assessing nature's contributions to people. *Science*, 359 (6373): 270-272.

Feeney R. G., La Valley K. J. and Hall-Arber M. 2010. Assessing stakeholder perspectives on the impacts of a decade of collaborative fisheries research in the Gulf of Maine and Georges Bank. *Marine and Coastal Fisheries. Dynamics, Management, and Ecosystem Science*, 2: 205-216.

Fisher B., Turner R. K., Morling P. 2009. Defining and classifying ecosystem services for decision-making. *Ecological Economics*, 68: 643 - 653

Fisher J. 2000. Participatory research in ecological fieldwork: A Nicaraguan study. In Finding our sea legs. [Eds. Neis B., Felt L. John's St.], ISER Books: 4154.

Fujiwara M. and H. Caswell. 2001. Demography of the endangered North Atlantic right whale. *Nature (London)*, 414: 537-541.

Galil B., Marchini A., Occhipinti-Ambrogi A. and Ojaveer H. 2017. The enlargement of the Suez Canal-Erythaean introductions and management challenges. *Management of Biological Invasions*, 8 (2): 141-152.

Galil B.S. 2008. The price of change: the economic impacts of alien species and jellyfish outbreaks in the Mediterranean Sea. p. 41-45. In: Economic valuation of natural coastal and marine ecosystems. CIESM Workshop Monographs n°37 [F. Briand, Ed.], 112 pages, Monaco.

García-Quijano C.G. 2009. Managing Complexity: Ecological Knowledge and Success in Puerto Rican Small-Scale Fisheries. *Human Organization*, 68 (1):1-17.

García-Quijano C.G. and Pizzini M.V. 2015. Ecosystem-based knowledge and reasoning in tropical, multispecies, small-scale fishers' LEK: What can fishers LEK contribute to coastal ecological science and management? In Fishers' knowledge and the ecosystem approach to fisheries, [Eds. Fischer J., Jorgensen J., Josupeit H., Kalikoski D. and Lucas C.M.], FAO.

Giakoumi S., Pey A., Di Franco A., Francour P., Kizilkaya Z., Arda Y. ... & Guidetti P. 2018. Exploring the relationships between marine protected areas and invasive fish in the world's most invaded sea. *Ecol Appl*., doi:10.1002/eap.1809.

Gruvel A., 1936. Contribution à l'étude de la bionomie générale et de l'exploitation de la faune du Canal de Suez. Mémoires présentés à l'Institut d'Egypt, 29: 1-229.

Hamer D.J., Ward T.M., McGarvey R. 2008. Measurement, management and mitigation of operational interactions between the South Australian Sardine Fishery and shortbeaked common dolphins (*Delphinus delphis*), *Biol. Conserv*., 141: 2865-2878.

Harwood J. and J.P. Croxall. 1988. The assessment of competition between seals and commercial fisheries in the North Sea and the Antarctic. *Marine Mammal Science*, 4: 13-33.

IUCN 2017. The IUCN Red List of Threatened Species.

IWC 2018. Whale Watching Handbook. https://wwhandbook.iwc.int

Jacobsen R.B., Wilson D.C.K., Ramirez-Monsalve P., 2012. Empowerment and regulation–dilemmas in participatory fisheries science. *Fish. Fish*., 13: 291-302.

Jax K., Barton D.N., Chan K.M., de Groot R., Doyle U., Eser U., Görg C., Gómez-Baggethun E., Griewald Y., Haber W. and Haines-Young, R. 2013. Ecosystem services and ethics. *Ecological Economics*, 93: 260 - 268.

Jepson P.D., M. Arbelo R. Deaville I.A.P. Patterson P. Castro J.R. Baker E. Degollada H.M. and 11 others 2003. Gas-bubble lesions in stranded cetaceans: Was sonar responsible for a spate of whale deaths after an Atlantic military exercise? (Brief communication). *Nature*, 425: 575-576

Johannes R.E. 1998. The case for data-less marine resource management: examples from tropical nearshore finfisheries. *Trends in Ecology & Evolution*, 13 (6): 243-246.

Kaschner K. and Pauly D. 2005. Competition between marine mammals and fisheries: Food for thought. In D.J. Salem & A.N. Rowan [Eds.], The state of the animals III: 2005 (pp.95-117). Washington, DC: Humane Society Press.

Katsanevakis S., Acar Ü., Ammar I., Balci B., Bekas P., Belmonte M. and 34 others 2014. New Mediterranean Biodiversity Records (October 2014). *Mediterranean Marine Science*, 15 (3): 675-695. doi:http://dx.doi.org/10.12681/mms.1123

Katsanevakis S., Zenetos A., Belchior C. & Cardoso A.C. 2013. Invading European Seas: assessing pathways of introduction of marine aliens. *Ocean & Coastal Management*, 76: 64-74.

Lent R.J. 2015. Conservation benefits of an interdisciplinary approach to marine mammal science. *Front. Mar. Sci.*, 2. https://doi.org/10.3389/fmars.2015.00067

Linke S., Bruckmeier K. 2015. Co-management in fisheries - Experiences and changing approaches in Europe. *Ocean & Coastal Management*, 104:170-181.

Liu S., Costanza R., Farber S., Troy A. 2010. Valuing ecosystem services: theory, practice and the need for a trans-disciplinary synthesis Ecological Economics Reviews. *Book Series: Annals of the New York Academy of Sciences*, 1185: 54-78.

Llabrés M. and Martorell J. 1984. La pesquerìa de artes menores. Islas Baleares. Comunidad Autónoma de las Baleares, Spain.

Marsili L., Jiménez B., Borrell A., 2018. Chapter 7 - Persistent organic pollutants in cetaceans living in a hotspot area: the Mediterranean Sea. In: Marine Mammal Ecotoxicology: Impacts of Multiple Stressors on Population Health [M.C Fossi and C. Panti Eds], Academic Press. 512pp.

Maurstad A., 2002. Fishing in murky waters—ethics and politics of research on fisher knowledge. *Mar. Policy*, 26: 159–166.

Meffe G., Nielsen L., Knight R.L and Schenborn D. 2012. Ecosystem Management: Adaptative Community-based Conservation. Island Press.

Milupi I., Somers M. and Ferguson W. 2017. Local ecological knowledge and community based management of wildlife resources: a study of the Mumbwa and Lupande Game Management areas of Zambia. *Southern African Journal of Environmental Education*, 33 (1): 25-38.

Monteiro S., Torres J., Ferreira M., Marçalo A., Nicolau L.,Vingada J.V., Eira C. 2016. Ecological variables influencing trace element concentrations in Bottlenose dolphins (*Tursiops truncatus*) stranded in continental Portugal. *Science of the Total Environment*, 544: 837-844.

Nader M., Indary S. and Boustany L. 2012. FAO EastMed the Pufferfish *Lagocephalus sceleratus* (Gmelin, 1789) in the Eastern Mediterranean. GCP/INT/041/EC-GRE-ITA/TD-10.

Neis B., Schneider D.C., Felt L., Haedrich R.L., Fischer J. & Hutchings J.A. 1999. Fisheries assessment: what can be learned from interviewing resource users? *Canadian Journal of Fisheries and Aquatic Sciences*, 56 (10): 1949 - 1963.

Orensanz J.M., Parma A. M. and Cinti A. M. 2015. Methods to use fishers' knowledge for fisheries assessment and management. In Fishers' knowledge and the ecosystem approach to fisheries [Eds. Fischer J., Jorgensen J., Josupeit H., Kalikoski D. and Lucas C.M.], FAO.

Paletto A., Meo I.D., Salvatore U.D. and Ferretti F. 2014. Perceptions of Sustainable Forest Management practices: an application from the forestry sector in southern Italy. *International forestry review*, 16 (1): 55-66.

Pascual U., Balvanera P., Díaz S., Pataki G., Roth E., Stenseke M. et al. 2017. Valuing nature's contributions to people: the IPBES approach. *Curr. Opin. Environ. Sust.*, 26: 7–16.

Pauly D. and Zeller D. 2016. Catch reconstructions reveal that global marine fisheries catches are higher than reported and declining. *Nature communication*, 7: 10244. DOI: 10.1038/ncomms10244.

Pinkerton E. 2011. Co-operative Management of Local Fisheries: New Directions for Improved Management and Community Development. UBC Press.

Pita P., Fernàndez-Vidal D., Garcia-Galdo J and Muiño R. 2016. The use of the traditional ecological knowledge of fishermen, cost-effective tools and participatory models in artisanal fisheries: towards the co-management of common octopus in Galicia (NW Spain). *Fish. Res*., 178: 4-12.

Plagányi É.E. and D.S. Butterworth. 2009. Competition with fisheries. pp. 268 - 276 In Encyclopedia of Marine Mammals, [Eds. W.F. Perrin, B. Wursig, and H.G.M. Thewissen]. San Diego: Academic Press.

Rézenthel R. 1983. Les prud'homies de pêcheurs en Méditerranée : un défi au droit contemporain, in Droit maritime français, octobre 1983, p. 575–594.

Roditi-Elasar M., Kerem D., Hornung H., Kress N., Shoham-Frider E., Goffman O., Spanier E. 2003. Heavy metal levels in bottlenose and striped dolphins off the Mediterranean coast of Israel. *Mar. Pollut. Bull*., 46: 491-521.

Rolland R. M., Parks S. E., Hunt K. E., Castellote M., Corkeron P. J., Nowacek D. P., Wasser S. K., Kraus S. D., 2012. Evidence that ship noise increases stress in right whales. *Proc. R Soc. B.*, 279: 2363–2368.

Silver J.J., Campbell L.M., 2005. Fisher participation in research: dilemmas with the use of fisher knowledge. *Ocean Coast. Manag*., 48: 721–741.

Stanley R. D. and Ric J. 2003. Participatory research in the british columbia groundfish fishery. In Putting Fishers' Knowledge to Work: Conference Proceedings, - Fisheries Centre Research Reports, vol 11, 36 pp., Ed. Haggan N., Brignall C. and Wood L.

Trites A.W., V. Christensen, and D. Pauly. 1997. Competition between fisheries and marine mammals for prey and primary production in the Pacific Ocean. *Journal of Northwest Atlantic Fishery Science*, 22: 173-187.

Turner R. K., Paavola J., Cooper P., Farber S., Jessamy V., Georgiou S. 2003. Valuing nature: lessons learned and future research directions. *Ecological Economics*, 46: 493-510

Ünal V and Kızılkaya Z. 2018. A long process towards successful fishery management of Gökova Bay, Turkey. From Catastrophe to Recovery: Stories of Fishery Management Success. American Fisheries Society (in press).

Ünal V., Güçlüsoy H. & Franquesa R. 2009. A comparative study of success and failure of fishery

cooperatives in the Aegean, Turkey. *Journal of Applied Ichthyology*, 25 (4): 394-400.

UNESCO 2017. Local Knowledge, Global Goals. Paris.

Ward T. and Phillips B. 2010. Seafood ecolabeling. Handbook of marine fisheries conservation and management, 608-617.

Ward T., Ivey A., Carroll J. 2018. Code of practice for reducing accidental mortality of dolphins in purse-seine fisheries. *Marine Policy*, 87: 203-211.

Yochum N., Starr M.R. and Wendt D.E. 2011. Utilizing Fishermen Knowledge and Expertise: Keys to Success for Collaborative Fisheries Research. *Fisheries*, 36: 593-605.

Yodzis P. 1998. Local trophodynamics and the interaction of marine mammals and fisheries in the Benguela ecosystem. *Journal of Animal Ecology*, 67: 635-658.

Zaccaroni A., Andreini R., Franzellitti S., Barceló D., Eljarrat E. 2018. Halogenated flame-retardants in stranded sperm whales (*Physeter macrocephalus*) from the Mediterranean Sea. *Science of The Total Environment*, 635: 892-900.