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Stakeholder perceptions in fisheries management - Sectors with benthic impacts

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ABSTRACT

The capture fishing sector causes direct and indirect impacts on benthic habitats and associated fauna and flora. Effectiveness of new mitigation measures depends on fishermen's perceptions; their acceptance of, and compliance to, those measures. Accordingly, by means of Advisory Councils (ACs), fisheries stakeholders are encouraged by the Common Fisheries Policy (CFP) reform to contribute to policy formulations. Still, the CFP reform remains unclear about how to possibly incorporate perceptions of specific conservation measures and objectives in practice. Against this background, this article aims at exploring a systematic multi-criteria approach that provides information about stakeholder preferences for objectives reflecting on what is more important to aim for ('what'), mitigation measures as strategies for reaching their objectives ('how'), and accountability options that can enhance trust in the people who carry out management ('who'). The approach applies a pairwise comparison approach to elucidate the stakeholder preferences, and to estimate the relative importance of the different options. It is conducted in the Black Sea, the Mediterranean Sea, the Baltic Sea, and the North Sea. The outcomes of the questionnaire survey succeed in transparently reflecting a diversity of preferences. It is advised that in order to inform the CFP, the ACs develop a user-friendly attractive online version of this approach that can reach multiple stakeholders across Europe and facilitate updates on a continuous basis. In this way the ACs could better facilitate bottom-up participation in fisheries management by representing a wide range of stakeholder perceptions.

1. Introduction

The mobile, bottom-contacting gears currently applied in the fishery sectors across Europe are increasingly criticised for having a large impact, both directly and indirectly on the benthic habitats and communities [1–4]. Direct impacts entail direct change in population dynamic parameters such as mortality, growth, reproduction, distribution, density, and abundance patterns of target and bycatch fish and shellfish species as well as benthic invertebrate communities and habitats. Other direct impacts are physical impacts, i.e. abrasion, on the benthic habitats and their physical structures. Indirect impacts include derived changes in species or food web interactions, long term changes caused by changed water turbidity and sedimentation, e.g. long term influence on recruitment, nursery and feeding habitats, etc. Additionally, the indirect impacts involve discards in relation to changes in food web interactions in high discard areas caused by the fishery. In a study comparing beam trawlers with demersal otter trawlers, gillnet, and sandeel fisheries in the German Exclusive Economic Zone of the North Sea, it was estimated that risks for direct effects in terms of mortality and disturbance effects are highest per unit of surface area swept for beam trawlers [5]. More specifically, different gear footprints can be distinguished for individual gear components, such as beam shoes, tickler chains, trawl doors, sweeps, and ground gear [7]. In research conducted by Kaiser et al. [4] it has been found that the benthic impacts of trawling not only depend on gear characteristics, but also on the bottom habitat types. The bottom-types can consist of different types of

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sand, mud and/or coarse sediment habitats, which have different physical and biological capacities, characteristics and sensitivities to impacts.

The Common Fisheries Policy (CFP) reform encourages an ecosystem based approach, in which benefits from living aquatic resources are ensured 'while the direct and indirect impacts of fishing operations on marine ecosystems are low and not detrimental to the future functioning, diversity and integrity of those ecosystems' [8–11]. Correspondingly, the CFP reform proposes a new general framework to manage EU fisheries, focusing on multiannual plans as a main tool to plan and define management goals for fish stocks, functioning as a roadmap for achieving sustainability objectives to preserve marine biological resources [8]. While the Member States have the ultimate responsibility for the formulation of plans (multiannual plans or discard plans), the Commission can draw up a plan if judging the plans of the Member State insufficient [10].

Previous lack of flexibility and adaptation at the EU level by means of top-down micro-management has been acknowledged in the reform of the CFP. Accordingly, the CFP reform stresses that to ensure good governance, appropriate involvement of stakeholders is needed to implement measures [8,12]. Stakeholders of the fisheries now contribute through the regionally based Advisory Councils (ACs) to formulate policies, and fisheries administrations are more closely linked to the regional problems. Notably, recommendations and advice provided by the ACs have no legal status in terms of implementation, but are limited to advising Member States and the Commission [10,13]. As such, the CFP reform remains unclear about how to involve stakeholder perceptions in fisheries management in practice.

Against this background, this article aims at exploring a systematic multi-criteria approach for identifying stakeholder perceptions concerning possible mitigation measures, sustainability objectives and accountability options in fisheries management, targeting sectors with benthic impacts. In particular, by means of a questionnaire survey conducted for the FP7 European project BENTHIS,[1] the intention is to identify stakeholder preferences of fishermen, fisher representatives, other private companies, civil society, government, science, and others, across four regions of Europe including; the Black Sea, the Mediterranean, the Baltic Sea and the North Sea. The importance of consulting with stakeholders is enhanced with this article, in accordance with one of the core intentions of BENTHIS, which is to: "develop in consultation with the fishing industry and other stakeholders on a regional scale, sustainable management plans that reduce the impact of fishing and quantify its ecological and socio-economic consequences".

This article first introduces the systematic multi-criteria approach on how to conduct stakeholder surveys in Section 2, and follows up with presenting identified options for mitigating benthic impacts of fisheries in Section 3. The results of stakeholder preferences identified in the four regions are presented in Section 4. In Section 5 the results are discussed, followed by concluding remarks in Section 6.

2. Methodological approach

Stakeholder perceptions in fisheries management can be shaped through at least three different channels; (1) preferences for objectives reflecting on what is more important to aim for ('what'), (2) preferences for mitigation measures as strategies for reaching their objectives ('how'), and (3) trust in the people who carry out management ('who'). In other words, stakeholder perceptions in fisheries management not only refer to 'what' they prefer, but also to ways in which mitigation measures are carried out, i.e. 'how - and by whom'. Multi-criteria analyses encompass a set of tools designed to deal with multiple dimensions of a problem, and can address multiple objectives, mitigation measures and accountability by assigning weights [14–19]. The method essentially follows the initial part of an Analytical Hierarchical Process (AHP) [16] which; identifies relevant criteria, arranges them into value-trees, and conducts a pairwise comparison technique to assign relative importance, i.e. weights. While an AHP proceeds with impact assessments to judge on alternatives by means of combining the weights with impact scores in advanced mathematical manners, this is not what the multi-criteria approach is aiming for in this study. Instead, here emphasis is put on involving multiple stakeholders to assign preferences, i.e. weights, as an outcome of the survey.

The systematic multi-criteria approach follows the following four main steps (adapted from [15,16,17,18])

1) Identify relevant stakeholders;
2) Identify relevant options and arrange them into hierarchies;
3) Design a questionnaire survey with pairwise comparisons based on options in the hierarchies;
4) Estimate relative importance for each option, across different stakeholder groups.

First, relevant stakeholders were identified. The numbers of stakeholders who filled in the questionnaire varied across case studies, with a total of 121 respondents, of which 26 contributed in the Black Sea, 44 in the Mediterranean Sea, 13 in the Baltic Sea and 38 in the North Sea. Whereas all the respondents in the Black Sea are from Turkey, the nationalities represented in the Mediterranean belong to Greece (55%) and Italy (45%), in the Baltic Sea respondents are from Denmark (54%) and Sweden (46%), and in the North Sea they are from Belgium (47%) and the Netherlands (53%). The response rate is hard to judge, as the questionnaire link was not only addressed to individuals directly, but also indirectly, for instance, in the Netherlands by means of newspapers and networks. It was noted that in the North Sea and the Baltic Sea, the fishermen in particular were sometimes hesitant to contribute.

In Table 1 the numbers of stakeholders who contributed have been listed by category in each of the four case studies; including fishermen, fisherman representatives, other private companies, civil society, governmental officers, science and others.

The stakeholder responses indicate attitudes that are relevant for the different groups. These attitudes may not be fully representative for the groups as this survey is not based on the idea of a statistical representative sample. However, main players are still included, i.e. people with formally assigned representative tasks, and as such the stakeholders provide views that are relevant to group opinions.

Second, the method is based on a multi-criteria approach, including an initial problem structuring phase generating a set of alternative management options and a set of criteria, followed by a phase with assessments by means of stakeholder priorities [14,16,17]. The experts in the BENTHIS FP7 project have identified *what* the relevant options are. In particular, the case study leaders of the Black Sea, the Mediterranean Sea, the Baltic Sea and the North Sea played a central role in defining what options should be included. The options included in the survey were identified in a two-step approach. At first, BENTHIS researchers discussed and identified preliminary options in a workshop. The outcome was a final list of options belonging to three categories identified as: (1) viable mitigations to benthic impacts of fisheries, (2) sustainability objectives, and (3) accountability options [20]. Secondly, after the most general options were identified, more specific options were discussed with the participants in follow up conversations face-to-face, by telephone and by emails. The general and the specific options were arranged into so-called hierarchies (see Figs. 2 and 3, and first column in tables in Appendix 1). Notably, levels in a hierarchy are not related to levels of importance but only to levels of specification. Presentations of options in hierarchies facilitate an open and transparent consideration of all relevant aspects and assist by informing and structuring different arguments during a conversation [18].

Third, the questionnaire survey is aiming at identifying different stakeholder preferences across case studies and groups of stakeholders.

[1] http://www.benthis.eu.

Table 1
Numbers of stakeholders taking part in questionnaire survey in the Black Sea, the Mediterranean Sea, the Baltic Sea and the North Sea.

	Black Sea	Mediterranean Sea	Baltic Sea	North Sea
Fishermen	7	14	1	11
Fishermen representative	1	0	1	4
Other private companies	4	6	1	2
Civil society	2	3	2	6
Government	3	6	4	5
Science	7	7	3	8
Others	2	8	1	2
Total	26	44	13	38

The questionnaire design is based on the structures of the hierarchies. The relative importance of the specified options is provided by stakeholders by looking at *what* is more important in relation to *whom*. The relevant priorities of the identified criteria are assigned by the stakeholders in a questionnaire survey distributed by email or by in-depth interviews. The approach is to show differences in priorities, as they may lead to different preferences for policy options, and should therefore be informed explicitly to the decision makers.

The method applied to conduct the questionnaire survey is referred to as a pairwise comparison technique because stakeholders are asked to compare two options at the same time on a scale of importance to find relative preferences [14,16,18,19,21]. See example in Table 2.

Fourth, estimates of the relative importance of the specified options for different stakeholder groups are based on the pairwise comparison technique by means of the eigenvalue methodology [16]. By comparing two options at a time on a semi-quantitative scale, the priorities are spread over the relevant options. This approach is based on the assumption that each interviewee can distribute a total of 100% importance priorities among the different options in a hierarchy. The share of preference provided to an option is referred to as the relative preference. The interviewee can be an individual stakeholder or a representative for a group of stakeholders. The programme Select Survey is used to design the questionnaire and to generate outcomes, the programme DEFINITE is applied for the eigenvalue methodology estimations to find the relative importance of the options specified in the hierarchies in Figs. 2 and 3 and Appendix 1 [14,16,22], while an Excel worksheet is used for designing the figures/ tables showing the relative importance of stakeholder preferences.

3. Options for mitigating benthic impacts of fisheries

The questionnaire survey consists of a total of three main sections, including identified options for sustainability objectives, measures and accountability options for mitigating benthic impacts of fisheries.

3.1. Sustainability objectives

Sustainability objectives address 'what' to actually aim for. The very basic interpretation of sustainable development stated by the World Commission on Environment and Development was; "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" ([23] p 43). In Fig. 1 the overall objective is referred to as sustainability objectives, with three underlying core categories of ecological, economic and social objectives. This is in accordance with the interpretation of sustainable development provided by the World Summit on Sustainable Development [24], stressing that "*protection of the environment and social and economic development are fundamental to sustainable development*" (p 2) and encouraging "*collective responsibility to advance and strengthen the interdependent and mutually reinforcing pillars of sustainable development - economic development, social development and environmental protection at the local, national, regional and global levels*" (p 1). These interpretations are referred to as basic interpretations of sustainability by the Directives of the European Union.

Fig. 1. Core sustainability objectives identified for mitigations of benthic impacts of fisheries

The green paper on reform of the CFP-reform [25] refers to the current CFP regulation which states that "*the Common Fisheries Policy shall ensure exploitation of living aquatic resources that provides sustainable economic, environmental and social conditions*" [26]. Although direct links are made to adopting a precautionary principle and an ecosystem approach, it is unclear how this relates to economic and social conditions. Therefore, in the CFP-reform (European Commission, 2009 p 9), it is clarified that because economic and social viability of fisheries can only be achieved if the productivity of fish stocks is not impaired, there is no conflict between ecological, economic and social objectives in the long term, although they can clash in the short term. The ecological sustainability is therefore a basic premise for the economic and social future of European fisheries. Ecological sustainability includes a move to fishing aiming for maximum sustainable yield, elimination of discards and ensuring a low ecological impact of fisheries. 'Sustainable exploitation' means the exploitation of a stock at levels that do not compromise the future exploitation of the stock and that it does not have a negative impact on the wider marine ecosystem. As stated in the introduction, the CFP (European Union, 2013) intends to ensure that fishing contributes to long-term (environmental, economic and social) sustainability and to the European 2020 Strategy for smart, sustainable and inclusive growth.

Even though the sustainability literature sometimes applies different interpretations of sustainability (e.g. some operate in global market contexts [27,28], others are focusing on local knowledge (e.g. [29,30])), it frequently shares the inclusion of ecological, economic and social objectives [14,31–33]. These broad interpretations of sustainable development provide opportunities for context-specific interpretations

Table 2
Example of pairwise comparison of two options at the time on a scale of importance.

Good labour conditions																Good governance
9	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

9 = This option is extremely more important than the other.
7 = This option is much more important than the other.
5 = This option is more important than the other.
3 = This option is slightly more important than the other.
1 = Both options are equally important.

of what is relevant; in this case for the fisheries management targeting sectors likely to cause benthic impacts in Europe (see Appendix 1).

3.2. Mitigation measures

Mitigation measures address 'how' to possibly achieve relevant sustainability goals. In Fig. 2 the overall aim is formulated as 'viable mitigations to benthic impacts of fisheries'. Six sub-categories are specified for mitigation measures to benthic impacts of fisheries, in which four of the six categories are further specified by sub-options ('restriction in effort', 'restriction in benthic contact/impact', 'marine habitat protection', and 'no change') and two are not ('restriction in output' and 'use of credit systems'). While most mitigation measures are included in Fig. 2 and explained below, the option 'restriction in benthic contact/impact' is further elaborated on in Fig. 3, because the use of fishing gears differs between cases.

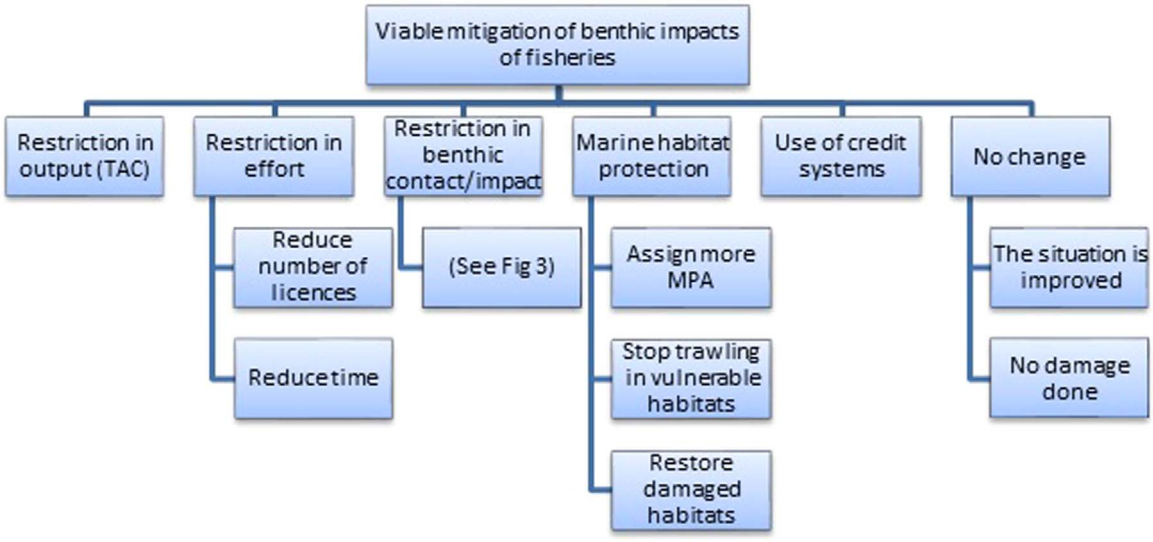

Fig. 2. Options of measures identified for viable mitigations of benthic impacts of fisheries.

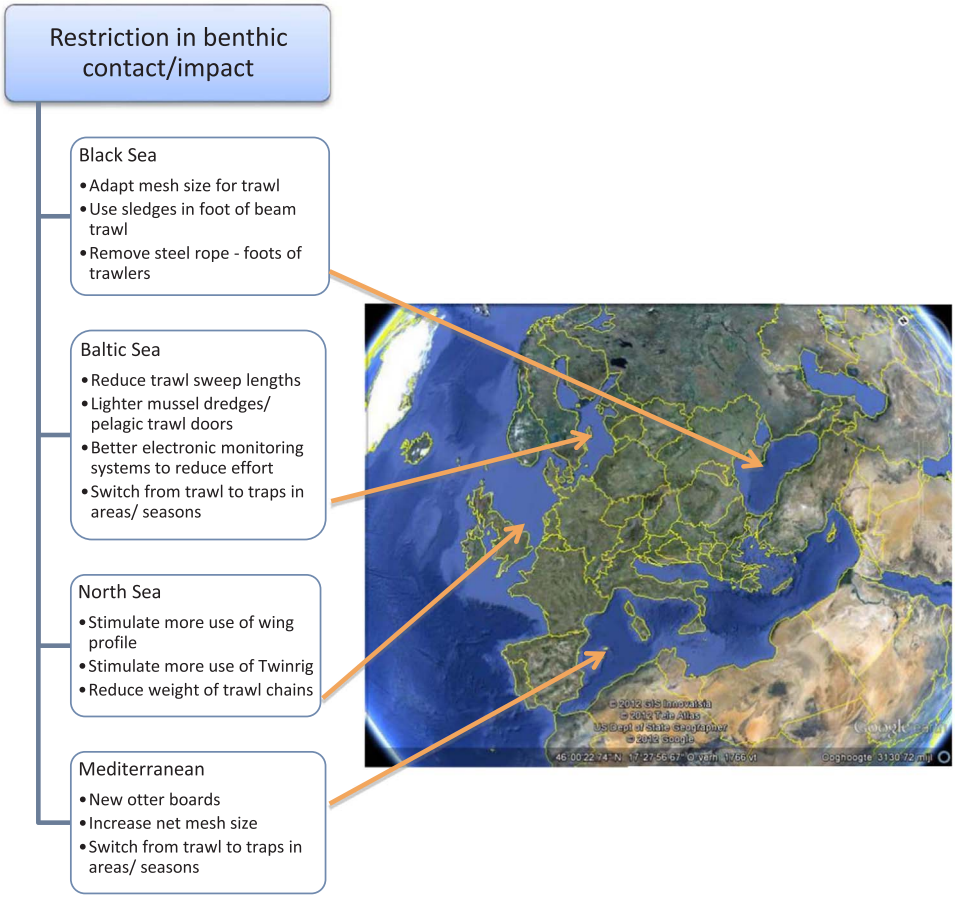

Fig. 3. Options identified for case specific mitigation measures for restricting benthic contact/ impact.

The six categories of viable fisheries measures to mitigate benthic impacts of fishing can be explained as;

1. Restriction in fisheries output; Total Allowable Catch (TAC) are catch limits (expressed in tonnes) that are set for most commercial fish stocks by the European Commission based on scientific advice on the stock status. While some are covered by multi-annual plans, TACs are set annually for most stocks.
2. Restriction in effort; is a combination of limitations of the fleet capacity and the amount of time that can be spent at sea by that fleet, and therefore the two sub-options have been specified as; 1) reduce number of licences and 2) reduce vessel time at sea.
3. Restriction in benthic contact/impact; refers to the substitution or modification of standard gears to reduce impacts on the seafloor. Because individual fleets/fisheries and standard gears differ substantially between areas, this part of the study has been specified differently across the case studies, which is further elaborated in Fig. 3.
4. Implementation of marine habitat protection; is management taking account of the benthic ecosystems by; 1) assigning more Marine Protected Areas (e.g. in pristine areas of high biodiversity), 2) stopping trawling in vulnerable habitats (e.g. certain deep-sea habitats), and 3) restoring damaged habitats. While option 1) is a preventive precautionary measure, option 3) is a measure restoring already damaged benthic ecosystems.
5. Use of a credit system; This is a new approach to mitigate fishing in vulnerable seabed habitats, using existing technology (e.g. VMS) to monitor fishing activities and reduce credits depending on the amount of damage caused to the seabed habitats (and which operates similar to quotas to control catches). Application of such a credit system should provide the incentives that stimulate fishermen's behaviour to avoid vulnerable areas. Note that the 'use of credit systems' was not familiar to some of the respondents, and had to be explained in more detail; it is a credit or tariff system similar to the fishing-impact credits, referred to as Real-Time Incentives (RTIs) [34].
6. No change; is an option which is favourable to people who insist that the efforts made to protect benthic ecosystems are useless, either because they argue that; 1) the situation has improved already, or that 2) there is no damage done.

In Fig. 3 the option 'restriction in benthic contact/impact' is treated separately, with a geographical illustration of where the four case studies are located.

3.2.1. The Black Sea

The Black Sea case study concentrates in the Samsun Shelf Area (SSA) along the Turkish Black Sea coast, and thus involves no EU member countries. While fishing can take place up to 75–80 m depth for bottom trawl fisheries, this area encompasses a special ecosystem with limited biodiversity due to anoxic waters over depths of 150 m. The bottom trawl fisheries have since the 1950s been targeting rapa whelk (*Rapana venosa*) which since 1980s is under high pressure from dragnets [35]. A total of three gear options have been included in this case; (1) use of 40 mm square mesh size for bottom trawl fisheries to decrease discards, (2) use of sledges on beam trawl feet for to decrease bycatch and mechanical impact in the sea snail fishery, and (3) removal of steel rope between the beam trawl feet to decrease bycatch and mechanical impact.

3.2.2. The Mediterranean Sea

The Mediterranean case study includes two EU Member States, Greece and Italy, and investigates the demersal fisheries in the Mediterranean Sea. These are typically multi-species mixed fisheries employing numerous artisanal gears as well as bottom trawl fisheries (operating from approximately 50 to 800 m depth). Key commercial species vary depending on gear, habitat and depth but often include Mediterranean hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*), rose shrimp (*Parapenaeus longirostris*) and scampi (*Nephrops norvegicus*) [36]. Both countries have sizable otter trawl fleets although other mobile, bottom-contacting gear types are also used (e.g. rapido trawls, and hydraulic dredges for clams in Italy) [37]. For the selected gear in this study three mitigation options are included; 1) accept new otter boards, 2) increase net mesh size, and 3) switch from trawl to traps in areas/ seasons. None of these options represent an officially foreseen or anticipated user strategy to be actually implemented in near future.

3.2.3. The Baltic Sea

The Baltic Sea case study interviews are conducted in two EU member countries; Denmark and Sweden. In this case study a series of technological mitigations have been investigated in order to re-allocate fishing effort and reduce benthic impacts of fisheries with mobile, bottom-contacting gears. The fisheries involved are Danish and Swedish creel and trawl fisheries targeting *Nephrops* as well as mussel dredging. The gear technological mitigations cover; (1) reduce trawl sweep lengths, (2) lighter mussel dredges and pelagic trawl doors, (3) better electronic monitoring systems to reduce effort and (4) switch from trawl to traps in areas/ seasons.

3.2.4. The North Sea

The North Sea case study covers the two EU countries Belgium and the Netherlands. In this relatively shallow sea, beam trawling, which was introduced in the early 1960s, is still a common fishing gear for catching demersal fish, foremost the flatfish species common sole (*Solea solea*) and European plaice (*Pleuronectes platessa*) [1]. However, there is a current shift observed towards more use of sustainable techniques [38]. Accordingly, the options included in this case study; (1) promote use of a total of three wing trawl options referred to as SumWing (with a nose profile on wings), Ecorol (with a nose profile including wheels on wings) and Pulse trawl (with lighter nets with electric power), (2) encourage use of Twin trawl (use of four cables to chase fish which are harvested by a net), and (3) reduce weight of the beam trawl chains.

3.3. Accountability options

Accountability options refer to performances that can enhance trust in people 'who' are carrying out the measures [33,39]. Trust goes beyond accountability, covering also the associated term legitimacy. Whereas accountability refers to the obligation to explain and justify management and leadership [40], legitimacy concerns affected parties' perception and support of a policy decision [41]. The trust relations can be encouraged in different ways. In this section, options have been identified which reflect on ways in which accountability of fisheries

Fig. 4. Accountability options identified for mitigating benthic impacts of fisheries.

management with relevance for benthic impacts of fisheries can be enhanced (Fig. 4). These options are explained below.

The following options have been identified as possible actions that can be performed for enhancing accountability and legitimacy in fisheries management;

1. Demonstrate management performance; which refers to the need for showing that existing mitigation measures have been successful, in a predominantly top-down structure.
2. Share the burden; which refers to the need for payment sharing by a fishery sector using a specific type of gear to cover damage costs caused to benthic ecosystems.
3. Assess the status of closed areas; which refers to the need for proof that can enhance accountability by convincing disagreed views that closed marine areas actually have led to improved benthic ecological conditions.
4. Adopt stakeholder involvement; which refers to the need for involvement of bottom-up stakeholders in policy making to actually attain any acceptance among stakeholders, as they desire to be part of the processes.
5. Adopt self-regulation; which refers to allowing the fishing sectors to take responsibility for the quality of benthic ecosystems themselves.

4. The identified stakeholder preferences

In this section the outcomes of the questionnaire survey exploring stakeholder perceptions in fisheries management are presented. The core outcomes of relative preferences in each of the three parts of the questionnaire survey are presented below, for; (1) sustainability objectives, (2) mitigation options, and (3) accountability options.

4.1. Relative preferences for sustainability objectives

This part of the questionnaire survey addresses core sustainability objectives with relevance to the fishery sector (Fig. 1). The relative importance of core objectives across regions and core stakeholders are provided in Fig. 5.

Comparing the selected stakeholder groups; fishermen, civil society and government, within the four regions in Fig. 5, priorities differ substantially (preferences for all stakeholders groups' are included in Appendix 1). Comparing the core objectives at the most general level; ecological objectives (green), social objectives (red) and economic objectives (blue), all stakeholders, but mostly the civil societies in the Baltic Sea and the North Sea give very high priorities to the ecological objectives. In contrast with this general trend, the fishermen in the North Sea give a lot more priorities to the economic and social objectives than most others. The economic objectives have relatively low priorities overall, but they have high priorities by the civil societies in the Black Sea, as well as by the fishermen in the North Sea and the Mediterranean Sea. The government in the North Sea also gives relatively high priorities to the social objectives.

4.2. Relative preferences for mitigation measures

This sub-section particularly examines the stakeholders' preferences for the viable mitigation measures intending to reduce benthic impacts of fisheries that were listed in Fig. 2. A comparison of preferences is provided across regions and countries (Fig. 6), and across stakeholders including individuals belonging to the groups; fishermen, civil society and government, in the different regions (all preferences are included in Appendix 1). It appears that 'implementation of marine ecosystem management' gains the highest priority among the included stakeholders in Italy and Belgium, whereas 'restriction in benthic contact' is particularly important to the stakeholders in Turkey, Denmark, Sweden and the Netherlands, and 'restriction of effort' is highly relevant to the stakeholders involved in Greece.

As mentioned earlier, the individuals cannot be seen as statistically representative of the group they belong to, but represent opinions which are relevant within the group. A well-populated group (e.g. Mediterranean fishermen) will provide both the main favoured

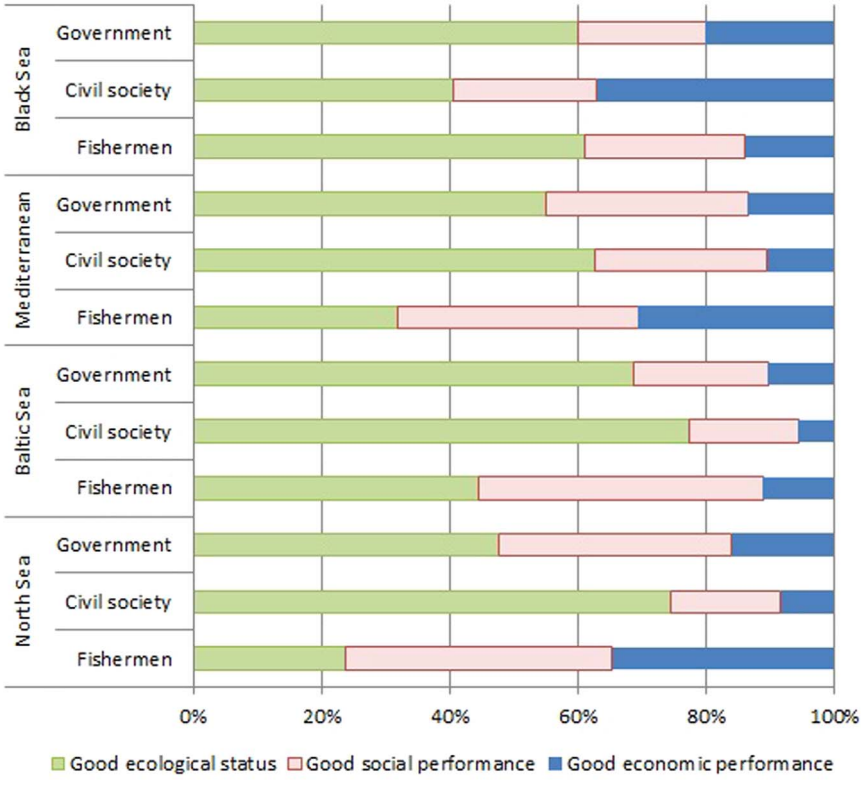

Fig. 5. Relative stakeholder preferences identified for sustainability objectives.

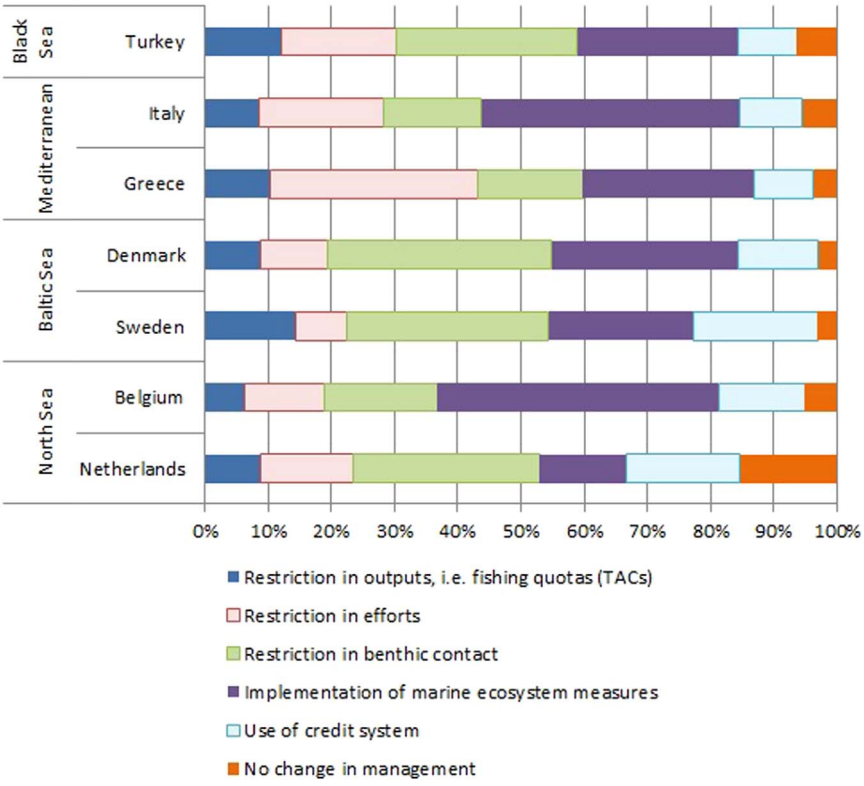

Fig. 6. Relative stakeholder preferences identified for viable mitigation of benthic impacts of fisheries.

response and other common views. Note, however, that in the case of the Baltic Sea, only one fisherman responded, which is too low to be representative for this group's opinion. Still, given the responses, it is evident that 'restriction in output i.e. fishing quotas (TAC) score around 10% in all regions and countries, and a little less in Belgium. The 'restriction in efforts' option has the highest priority by all stakeholders in the Mediterranean Sea, but also some by government in the Black Sea and the North Sea. The 'restriction in benthic contact/impact' has high priority by almost all stakeholders, except fishermen in the North Sea and the Mediterranean Sea. Comparing priorities for 'implementation of marine ecosystem measures' across stakeholders, civil society in the North Sea and the Black Sea, as well as the government in the Baltic Sea and the fishermen in the Mediterranean, give extremely high priorities to this option. 'Credit system' gets some priority by fishermen in the Baltic Sea and the North Sea, and also by civil society in the Baltic Sea and in the Black Sea. Only fishermen in the Black Sea and the Mediterranean Sea judge this option extremely low. Fishermen in the North Sea, the Black Sea and the Mediterranean Sea are favourable to 'no change in management', which contrast with all the other stakeholder groups who judge this option the very lowest.

Figs. 7–10 address the particular sub-options for 'restriction in benthic contact/impact' in the four regions separately (see Fig. 3). As mentioned earlier, this option can only partly be compared across regions because gear options fully depend on which vessels are used as well as other context specific factors. Priorities across stakeholder groups within the regions of the Black Sea, the Mediterranean, the Baltic Sea and the North Sea, are compared in the following.

In Fig. 7, the Black Sea, the priorities are similar across stakeholder groups; with most priority provided for 'remove steel rope - foots of trawlers'. For government and others, the use of 'sledges in foot of beam trawl' is second, whereas 'adapt mesh size for trawl' is second for fishermen, other private companies, civil society and science. The fishermen representatives provide equally low priority to these two options, and in contrast with the fishermen, they overall prioritize the measures for mitigating benthic contact/impact rather low.

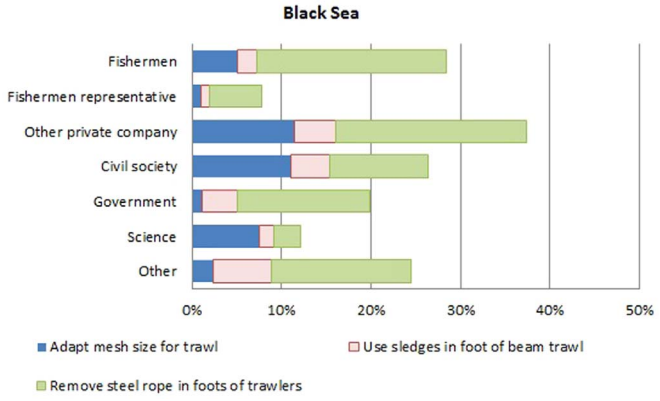

Fig. 7. Relative stakeholder preferences identified for viable mitigation of benthic impacts of fisheries in the Black Sea.

In Fig. 8, the Mediterranean Sea, it is shown that the option 'switch from trawl to traps in areas/ seasons' is highly prioritised by government and civil society, but not by fishermen. The fishermen and other private companies give, in contrast, highest priority to 'accept new otter boards'. The 'increase net mesh size' is highly prioritised by all, except the fishermen and the civil society. In the Mediterranean Sea, the fishermen give overall relatively low priorities to the measures for mitigating benthic contact/impact compared with the other mitigation measures included in Fig. 2 (lower than 10%).

In Fig. 9, the Baltic Sea, it shows that the 'switch from trawl to traps in areas/seasons' is a highly prioritised option by most stakeholders, although the fishermen representative favours 'lighter mussel dredges or pelagic trawl doors' and 'better electronic monitoring systems' the most. 'Better electronic monitoring systems' also gains some priority by the fisherman, government and science, but not the others. 'Reduce trawl sweep lengths' gets relatively high priority by science and others categories. Notably, as stated earlier, only one Baltic capture fishery

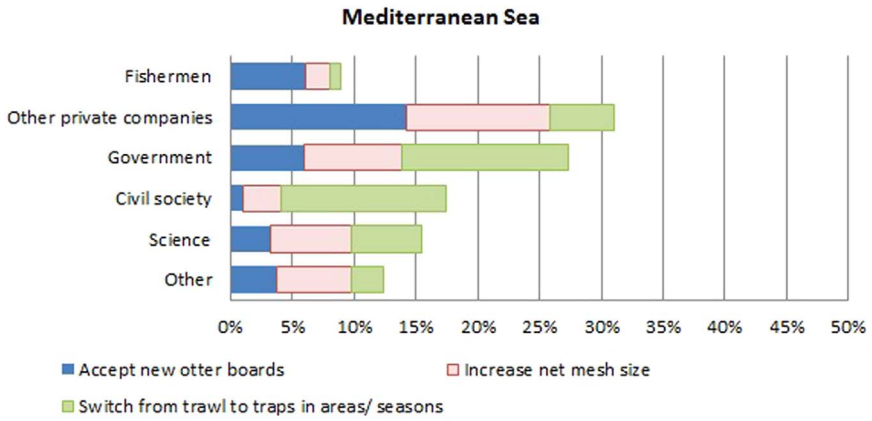

Fig. 8. Relative stakeholder preferences identified for viable mitigation of benthic impacts of fisheries in the Mediterranean Sea.

response makes this group's results particularly uncertain, and accordingly, should be taken with caution.

In Fig. 10, the North Sea fishermen, followed by fishermen representatives, give high priority to 'reduce weight of trawl chain (Beam trawl)', although the most prioritised option for most stakeholders is to 'promote more use of wing profile (SumWing, Ecorol, Pulskor)'.

4.3. Relative preferences for accountability options

This sub-section explores the accountability in fisheries management in more detail, based on the third part of the questionnaire survey with options listed in Fig. 4. These options have been identified as possible actions for enhancing the legitimacy and accountability of fisheries management. Stakeholder preferences are compared across core stakeholder groups in different regions, and relative importance of what is needed for enhancing accountability in those that carry out fisheries management is presented in Fig. 11. (All stakeholders groups' preferences are included in Appendix 1).

The priorities differ across stakeholders in different regions. Looking at the fishermen in Fig. 11, in the Mediterranean and the Black Sea they give highest priority to the 'demonstrate management performance' option, whereas in the Baltic Sea and the North Sea, they prefer to 'adopt stakeholder involvement'. 'Adopt stakeholder involvement' is actually highly prioritised across most stakeholders, only the government in the North Sea and civil societies in the Black Sea and the Mediterranean give low priority to this option. In contrast, civil society and fishermen in the Baltic Sea and the North Sea give very low priorities to 'demonstrate management performance' but their governmental officers as well as most other stakeholders give high priority to this option (see Appendix 1). 'Share the burden' is a highly prioritised option by Black Sea civil society and Mediterranean governmental officers, but less so to the others. The option 'assess the status of closed areas' is highly prioritised by civil society in the Mediterranean and the Baltic Sea government, as well as to all three stakeholder groups in the North Sea. Although 'self-regulation' generally gets little priority across all stakeholders, the fishermen in the Black Sea, Mediterranean Sea and the North Sea, as well as governmental officers in the North Sea, give more priority to this option.

5. Discussion

In this study, the systematic multi-criteria approach is applied to identify stakeholder preferences. The approach applies similar steps to the initial part of an AHP process [16], which identifies relevant criteria, arranges them into value-trees, and conducts a pairwise comparison technique to assign relative importance, i.e. weights. While an AHP proceeds with mathematically advanced impact assessments to judge on alternatives, this study aims to involve multiple stakeholders to assign preferences, i.e. weights, as the main outcome of the survey. The stakeholder preferences are supplementary information to existing impact analyses conducted successfully elsewhere. Extensive information and data have been sampled, compiled and elaborated lately, to identify benthic impacts of distribution and intensity of fishery with high spatial and temporal resolution [6,7,42–44]. This is critically important to guide decision-makers toward promoting the implementation of specific gears.

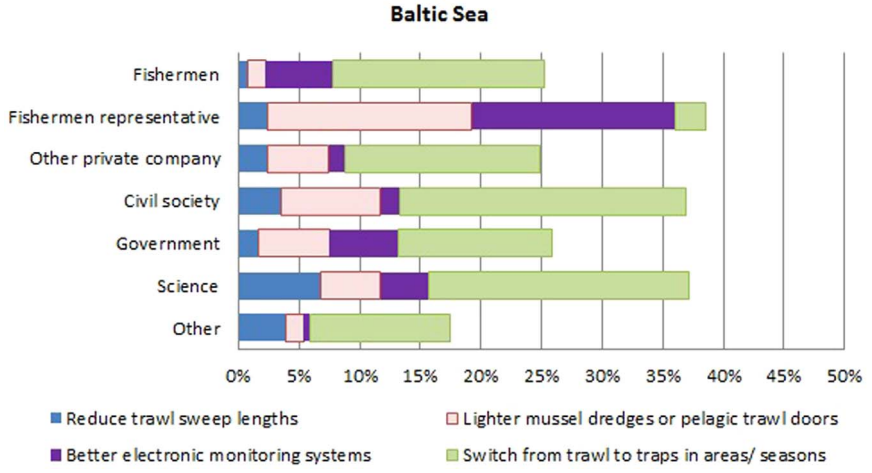

Fig. 9. Relative stakeholder preferences identified for viable mitigation of benthic impacts of fisheries in the Baltic Sea.

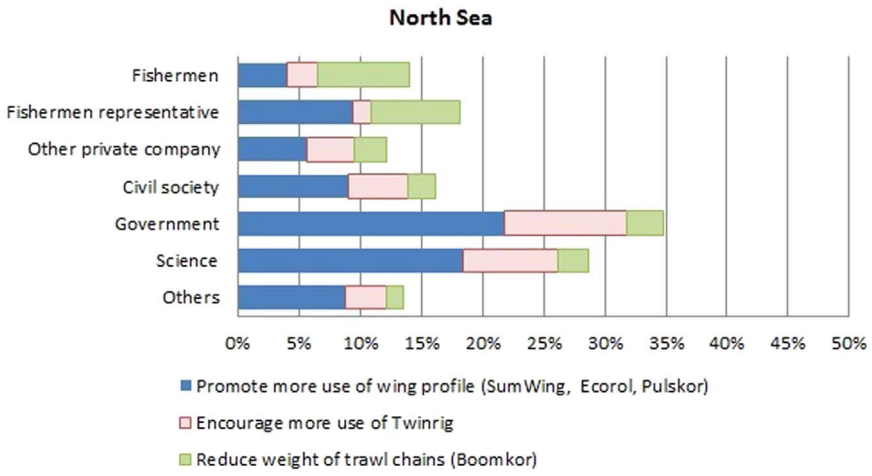

Fig. 10. Relative stakeholder preferences identified for viable mitigation of benthic impacts of fisheries in the North Sea.

It is acknowledged that fisheries management also heavily depends on human preferences; i.e. on what is regarded to be relatively more important from a number of relevant options. It has for instance been shown that the effects of beam trawling on the benthic megafauna has raised concerns among the public, at least in the Netherlands [45]. In order to deal with these societal concerns, the use of mitigation measures aiming at reducing fishing impacts on the benthic systems are intensifying. This may include implementation of; fishing closures of sensitive habitat areas, switch to passive gears, implementation of credit systems, as well as technical measures to reduce the footprint, changing selectivity and reducing by-catch/discard. Besides the quality of the data sampled on the fisheries, stocks, habitats and the wider ecosystem through monitoring, stakeholder preferences are seen to be influential towards fisheries management for obtaining compliance to policy strategies and thus, eventually, to improve the future state of the benthic ecosystem [15].

Whereas EU policy, such as the CFP reform, encourages stakeholder participation in fisheries management, it is not clear how to actually conduct the analysis and identify stakeholder perceptions. Accordingly, in this study stakeholder perceptions about 'what' to actually aim for, 'how' to carry this out, as well as trust and accountability of 'who' makes policy decisions have been identified, with the aim to explore a systematic multi-criteria approach for identifying similarities and differences in stakeholder perceptions in fisheries management across four regions; the Black Sea, the Mediterranean Sea, the Baltic Sea and the North Sea, including a total of seven countries; Turkey, Italy, Greece, Denmark, Sweden, Belgium and the Netherlands.

The systematic multi-criteria approach explored has shown the advantages of involving multiple stakeholders and transparently assigning their preferences about 'what' is important, 'how' to reach objectives and how to enhance trust to those 'who' carry out fisheries management. This approach can thus assist in gathering an overview of differences and synergies across different stakeholders about their perceptions with regard to benthic fisheries management. This is useful to inform decision-making processes because stakeholders are allowed to be part and thus feel ownership in new strategies. Moreover,

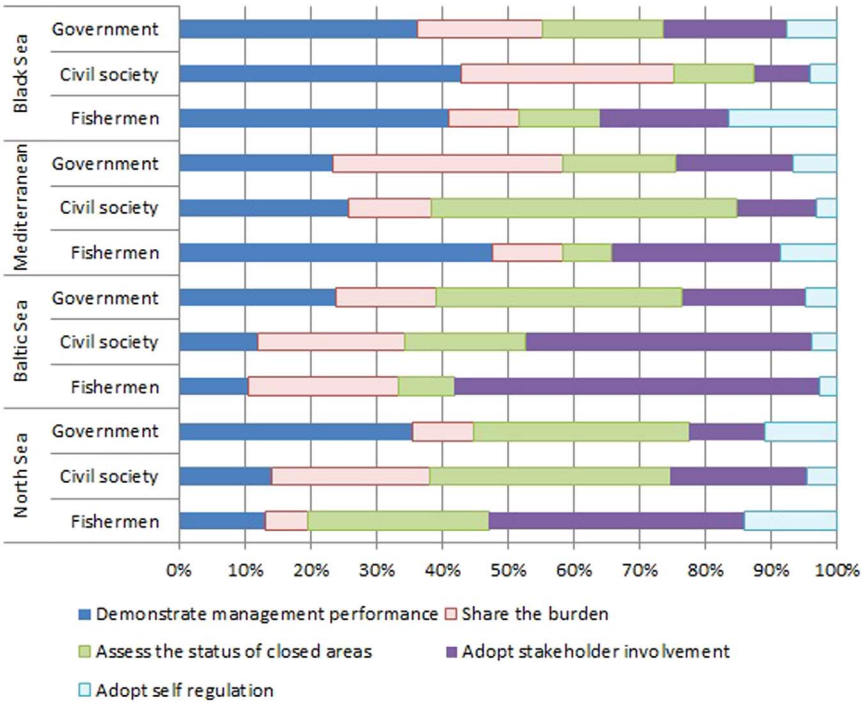

Fig. 11. Relative stakeholder preferences identified for accountability options for mitigating benthic impacts.

opportunities are increased for responsibly addressing the challenges throughout these processes. As such, the approach is not only suitable to provide bottom-up guidance to decision-making, but it is an approach that can support responsible leadership of decision-makers.

The methodological approach of pairwise comparison has been applied in other studies [14,17–19,21]. In this, as well as in the other studies referred to, it is further illustrated how the outcomes of including stakeholder preferences in fisheries management can; a) contribute as an additional multiple knowledge dimension to existing scientific based information considered in policy making, b) ensure transparent treatment of the different preferences, in which diversity is made visible in a series of figures, c) contribute to identifying most urgent issues for management of activities with benthic impacts in specific contexts, and d) give the opportunity to include norms about what is more important to enhance accountability of management of activities with benthic impacts. Also, such investigations can aid processes of co-management, and base these on better knowledge about how preferences differ across stakeholders.

As for any interaction between groups, framing (i.e. the active construction of meaning among multiple actors) can cause resentment [46]. In filling in the questionnaire, some respondents felt a cognitive burden because they are asked to compare, for instance, 'Assess the status of closed areas' with 'Demonstrate management performance' for judging on relative importance with regards to mitigation of benthic impacts. Comparing on a scale of importance is not always a familiar way of framing [47], and a more familiar approach might have yielded more responses. There are, however, different ways of overcoming low response rates, including; 1) conducting face to face dialogues between interviewers and respondents for further explanation and sharing of ways of interpretations, 2) convincing stakeholders about why and how issues are of high relevance/ urgency to them, and 3) arranging online user-friendly attractive tools for filling in the preferences that provides immediate results shown by image/figure. The last option will also solve another problem, namely the ambiguity caused by not knowing how framing in the analyses phases will impact the results. There is thus a framing issue between researchers and respondents that must be dealt with appropriately, which however appears to be relevant to most questionnaire surveys.

Moreover, outcomes of this study are meant to inspire further investigations concerning the approach. Accordingly, preference outcomes are thus not meant for direct policy implementation in respective regions. This is because group opinions cannot always be claimed to be representative, and to a certain extent there may be inconsistencies of preferences across responses. Inconsistencies exist if preferences (indicated with < and >) of options a, b and c result in; a > b > c, and c > a. They can be explained by unclear or changing interpretations of options by interviewees [18]. As such, a standalone application of the approach is less valuable. In order to take account of complexities and change, the approach should ideally be conducted on a continuous basis. Regularity would also clarify the exact meanings of each option to respondents, and reduce levels of inconsistencies.

Looking at the outcomes of the stakeholder perceptions presented, at least four core aspects need to be discussed further, including differences observed; (1) between fishermen in different regions, (2) in responses made by civil society between regions, (3) between countries within regions, and (4) in fishermen opinions compared with other stakeholders.

First, the results of this study show that differences between fishermen in different regions exist. For instance, the single fisherman from the Baltic Sea did not find it attractive to stick with no change in management, but all the other fishermen do (Appendix 1). Most fishermen are thus part of a system that they feel comfortable with, and do not see the need or urgency to change. It appears that some fishermen seem to use this survey as a possibility to inform public management that they do not want new or additional rules. Moreover, comparing the fishermen's preferences of accountability options (Fig. 11), the fishermen in the North Sea and the Baltic Sea are not giving high priorities to the need to demonstrate that management is actually performing well, but in the Black Sea and the Mediterranean Sea this is highly prioritised. This can be explained by the role the fishermen have in relation to the government, in terms of expectations of governments taking certain responsibilities about, for instance, long term marine ecosystem health, and not themselves. In certain areas (e.g. the Mediterranean), it could also be perceived as a sign of mistrust or worry that non-appropriate and ineffective measures are taken and implemented without due care and consideration (and communication/consultation with stakeholders). Such lack of trust can also be a result of low frequencies of management evaluation carried out (e.g. as of today, comprehensive evaluation of the many spatio-temporal closures has not been performed in Greece, [48]. Still, the fishermen in the North Sea - more than other fishermen - find it important to assess the status of closed areas. This can be explained by them having the opinion that a lot of the marine environmental protection measures actually do not work, with the argument that trawling is not as bad for the benthos as often is argued. The fishermen in the North Sea and the Baltic Sea also give higher weight to stakeholder participation than the others, which may be explained by their experiences made through long-term involvement in co-management settings. In the Black Sea and the North Sea, they are favourable to self-regulation, with the argument that they want more influence in decision-making processes. A similar picture of regional differences in fishermen perceptions towards management options was found in a study by Fitzpatrick et al. [49] who used a random utility modelling framework to reveal the preferences of Greek, Irish and Danish fishermen across alternative policy attributes. They concluded that solutions should be tailored within the context of specific fisheries.

The fishermen in the North Sea and also the one fisherman in the Baltic Sea do not prioritize marine ecosystem measures (Appendix 1), and are more sceptical to the ecological objectives (Fig. 1), compared with the fishermen in the Mediterranean Sea and the Black Sea who are favourable to these. The argument in the North Sea is that the fishermen have experienced considerable negative impacts on the fishing sector from ecosystem oriented measures, while in the Mediterranean Sea and the Black Sea, the argument is favouring the reasoning that healthier marine ecosystems will increase catches of fish and, thus, eventually income of fishermen. These differences in opinions also explain why fishermen in the North Sea and the Baltic Sea are a lot more hesitant to fill in the questionnaire, as they may be worried that outcomes would be unfavourable to their views. Actually, the issues addressed in this survey may be less delicate to the fishermen in the Mediterranean and the Black Sea where scientific research and advice might be more influential to policy making [50].

Second, differences in responses made by civil society across regions can be observed in Appendix 1. Whereas the civil society in the Black Sea and the North Sea strongly favour implementation of marine ecosystem measures, the civil society in the Baltic Sea is most favourable to restricting benthic contact/impact, and in the Mediterranean Sea the civil society gives a more balanced view; with some more emphasis given to effort restriction. In the Mediterranean, effort and capacity restrictions play a more important role in present management compared to the other regions [51], and is a widely accepted tool for lobbyists for nature conservation as well as for society in general. In addition, the civil society includes both informed NGOs about fishery impacts in favour of targeted measures, as well as nature conservation organisations in favour of holistic ecosystem protection actions. Lately, in the Baltic Sea, nature conservation organisations particularly focus on the benthic contact/impact, while in the Black Sea and the North Sea, nature conservation organisations emphasise the marine ecosystem from a more holistic point of view.

Similarly, looking at the civil society preferences for sustainability objectives (Fig. 1), a balanced view of different objectives is emphasised by the civil society in the Black Sea and a second priority goes to the

economic objectives, with the lowest priorities given to social objectives. Still, looking at the sub-objectives (Appendix 1), improvements of the state of the sea floor and lowering fishing impacts on the sea floor have the highest scores. This is followed by the economic sub-objective of ensuring fair distribution of costs and benefits in the Black Sea, and ensuring wages for fishing crew in the Mediterranean. Civil society in the Baltic Sea, the North Sea and the Mediterranean Sea seem to fully agree with an extremely high priority given to the ecological objectives, particularly aiming at improving the state of the sea floor.

When it comes to ways in which civil society prioritize accountability options, opinions differ across regions (Fig. 11). For instance, in the Black Sea the strategies of demonstrating management performance and sharing the burden are the most prioritised options, whereas in the Baltic Sea the civil society thinks that adopting stakeholder involvement will impact accountability the most. The civil societies in the North Sea and the Mediterranean Sea both find it most important to assess the status of closed areas.

Third, looking at differences between countries within regions (Fig. 6 and Appendix 1), it shows that the preferences for mitigation measures are rather similar in the Baltic Sea among Swedish and Danish stakeholders. In the Mediterranean Sea, the Italians are more favourable to implementation of marine ecosystem measures, while in Greece they favour more restriction in effort. In the case of Greece and Italy, they both favour a reduction in fishing time to reduction in fishing licences, although in terms of ecosystem measures, Italy favours protected areas whereas Greece favours termination of trawling in vulnerable habitats. Greece has many areas closed to fishing to protect seagrass meadows but certain vulnerable biogenic habitats are still being trawled [6].

In comparisons between Belgium and the Netherlands, Belgium showed a low priority for reducing the benthic contact/impact compared to the Netherlands. This is interesting because a similar attitude in both countries may be expected due to similar traditions in fishing methods and target species. However, in the last five years, the Belgian fishermen have stuck to their traditional way of fishing with a very low tendency to innovate, whilst in the Netherlands, a wave of innovation has occurred where the beam trawl has largely has been replaced by alternative gears, mainly the pulse trawl, the twin-rig and flyshoot gears, which reduce benthic contact/impact compared to the traditional beam trawl. While still uncertain why the trends differ in the two countries, this may explain the different priorities given in the questionnaires. Similarly, in the Mediterranean Sea a difference is observed between Greece and Italy with more emphasis on tradition and ease/familiarity of use by Greece, while Italy shows more investment in innovations, which can explain why Italy favours new otter boards and Greece favours an increase in mesh size.

Fourth, differences are observed when comparing fishermen with other stakeholders within a region, which can be explained by the fact that fishermen are more directly affected by potential restrictive management on their basic living conditions than any other stakeholder (see Figs. 7–10 as well as Appendix 1). Differences in perspective can thus clarify the levels of synergies among the groups. The representatives in the North Sea have similar views to fishermen about the gear options. In the Mediterranean Sea and the Black Sea, the relative importance of respective gear options are highly agreed upon, but the relative importance of restricting benthic contact/impact as such is not equally important. In the Black Sea, for example, fishermen put a higher priority to restricting benthic contact/impact compared with their representatives. While the ranking of the benthic contact/impact options with the governmental officers are not very different in the Black Sea, the ranking is different for scientists, who provide rather opposite rankings than the fishermen in this case. In the Mediterranean Sea and the North Sea, both the governmental officers and the scientists provide almost opposite priorities to the fishermen. In the Mediterranean Sea, the individuals within the government and science who took part in the survey favour reduction in efforts followed by restriction in contact, while fishermen favour implementation of marine ecosystem measures followed by the reduction of effort. This may be explained by the governmental focus on planning and management of a sector, while the fishermen are interested in ensuring that the shared marine resource will continue to support their living.

6. Concluding remarks

The CFP reform insists that enhanced bottom-up stakeholder participation, including the fishing industry, is needed to move closer to context-specific realities and to ensure bottom-up compliance to management. Although the ACs have been established to facilitate stakeholder participation in bottom-up advise to Member States concerning fisheries management, it remains unclear how to possibly incorporate stakeholder perceptions in fisheries management in practice.

The systematic multi-criteria approach explored in this study has shown that it facilitates bottom-up contributions to include stakeholder perceptions in decision-making processes by taking into account ‘what’ aims are more favourable, ‘how’ to reach objectives by implementing suitable measures and how to better increase trust in those ‘who’ are involved in implementation. It is thus deemed insufficient to only identify stakeholder preferences on, for example, objectives, because stakeholder considerations of preferable measures, or frustration linked with legitimacy and accountability of leadership would then be ignored.

The stakeholder preferences identified sometimes motivate needs for further investigations. For example, the pulse trawl options have been suggested as more sustainable alternatives to traditional beam trawling practices. However, these fishing methods are not currently legislated for in the EU; the pulse fisheries have temporary permission to fish with these gears. While it is suggested that the application of the pulse trawl in Europe is less damaging on benthic ecosystems than the traditional beam trawl, some difficulties remain. For instance, they have a high catch efficiency, which will require further restrictions to ensure sustainability of the benthic ecosystems [52].

Given that stakeholder perceptions are identified for sustainability objectives, benthic mitigation measures and accountability options, it is unclear how these are further brought into decision-making. In other words, although a systematic multi-criteria approach can allow bottom-up contribution and facilitate leadership, it is still up to the fisheries managers to decide. Not taking account of stakeholder perceptions would likely result in a lack of good governance in terms of poor legitimacy and accountability. The potential effects of how sometimes small adjustments in policy strategies can impact trust among stakeholders may be underestimated, and also how trust impacts compliance to benthic mitigation measures.

At least one core concern is striking, based on the individuals filling in this questionnaire survey; fishermen (in the North Sea and also one fisherman in the Baltic Sea) are not very positive to implementing ecosystem measures in the form of Marine Protected Areas. In fact, the relative importance for such ecosystem measures compared with the other mitigation measures are, for this group, judged at only around 10% importance (Appendix 1, Tables A1.3. Baltic Sea/4. North Sea). This could be partially explained by actual experiences made with national level marine planning and measures implemented, but also by the level of trust between the public sector and the fishermen. Given that the ecosystem-based management is instructed by the EU in the CFP, and specifically mentioned in the CFP reform, as well as the Marine Strategy Framework Directive (MSFD), as a way to achieve good environmental status and a sustainable exploitation of the marine resources [53], this study points to one core challenge that needs more attention in future research on management of activities with benthic impacts. This challenge refers to the ways in which multiple stakeholder views throughout decision-making processes are dealt with while ensuring trust among different stakeholder groups. Stakeholders need to be involved on a regular basis, in ways which do not demand

too much of their time and by means of framings that are both familiar and understandable.

The systematic multi-criteria approach could be advanced and applied by ACs on a continuous basis. A user-friendly online version could help to capture a large number of stakeholder perceptions. This would enhance transparency by reaching more stakeholders representing multiple stakeholder groups and thereby enhancing good governance in fisheries management.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.marpol.2018.02.019.

References

[1] M. Bergman, J.W. van Santbrink, Mortality in megafaunal benthic populations caused by trawl fisheries on the Dutch continental shelf in the North Sea in 1994, ICES J. Mar. Sci. 57 (2000) 1321–1331, http://dx.doi.org/10.1006/jmsc.2000.0917.

[2] N. Abel, R.M. Wise, M.J. Colloff, B.H. Walker, J.R.A. Butler, P. Ryan, C. Norman, A. Langston, J.M. Anderies, R. Gorddard, M. Dunlop, D. O'Connell, Building resilient pathways to transformation when "no one is in charge": insights from Australia's Murray-Darling Basin (art23), Ecol. Soc. 21 (2016), http://dx.doi.org/10.5751/ES-08422-210223.

[3] G.J. Piet, A.D. Rijnsdorp, M.J.N. Bergman, J.W. van Santbrink, J. Craeymeersch, J. Buijs, A quantitative evaluation of the impact of beam trawling on benthic fauna in the southern North Sea, ICES J. Mar. Sci. 57 (2000) 1332–1339, http://dx.doi.org/10.1006/jmsc.2000.0915.

[4] M.J. Kaiser, R. Hilborn, S. Jennings, R. Amaroso, M. Andersen, K. Balliet, E. Barratt, O.A. Bergstad, S. Bishop, J.L. Bostrom, C. Boyd, E.A. Bruce, M. Burden, C. Carey, J. Clermont, J.S. Collie, A. Delahunty, J. Dixon, S. Eayrs, N. Edwards, R. Fujita, J. Gauvin, M. Gleason, B. Harris, P. He, J.G. Hiddink, K.M. Hughes, M. Inostroza, A. Kenny, J. Kritzer, V. Kuntzsch, M. Lasta, I. Lopez, C. Loveridge, D. Lynch, J. Masters, T. Mazor, R.A. McConnaughey, M. Moenne, A.M. Nimick Francis, A. Olsen, D. Parker, A. Parma, C. Penney, D. Pierce, R. Pitcher, M. Pol, E. Richardson, A.D. Rijnsdorp, S. Rilatt, D.P. Rodmell, C. Rose, S.A. Sethi, K. Short, P. Suuronen, E. Taylor, S. Wallace, L. Webb, E. Wickham, S.R. Wilding, A. Wilson, P. Winger, W.J. Sutherland, Prioritization of knowledge-needs to achieve best practices for bottom trawling in relation to seabed habitats, Fish. Fish. 17 (2016) 637–663, http://dx.doi.org/10.1111/faf.12134.

[5] H. Fock, Integrating multiple pressures at different spatial and temporal scales: a concept for relative ecological risk assessment in the european marine environment, Hum. Ecol. Risk Assess. 17 (2011) 187–211, http://dx.doi.org/10.1080/10807039.2011.538634.

[6] O.R. Eigaard, F. Bastardie, N.T. Hintzen, L. Buhl-Mortensen, P. Buhl-Mortensen, R. Catarino, G.E. Dinesen, J. Egekvist, H.O. Fock, K. Geitner, H.D. Gerritsen, M.M. González, P. Jonsson, S. Kavadas, P. Laffargue, M. Lundy, G. Gonzalez-Mirelis, J.R. Nielsen, N. Papadopoulou, P.E. Posen, J. Pulcinella, T. Russo, A. Sala, C. Silva, C.J. Smith, B. Vanelslander, A.D. Rijnsdorp, The footprint of bottom trawling in European waters: distribution, intensity, and seabed integrity, ICES J. Mar. Sci. 74 (2017) 847–865, http://dx.doi.org/10.1093/icesjms/fsw194.

[7] O.R. Eigaard, F. Bastardie, M. Breen, G. Dinesen, N. Hintzen, P. Laffargue, L. Mortensen, R. Nielsen, H. Nilsson, F. O'Neill, H. Polet, D. Reid, A. Sala, M. Sko, T.S. ¨ld5, Chris Smith10, and A.D.R. Oliver Tully8, Mustafa Zengin11, 1National, Estimating seabed pressure from demersal trawls, seines, and dredges based on gear design and dimensions, ICES J. Mar. Sci. 73 (2016) 27–43, http://dx.doi.org/10.1093/icesjms/fss092.

[8] European Union, Regulation (EU) on the common fishery policy, Off. J. Eur. Union. L354 (2013) 1–40.

[9] Commission of the European Communities, The role of the CFP in implementing an ecosystem approach to marine management, Brussels. COM(2008) 187 final, 2008.

[10] R. Prellezo, R. Curtin, Confronting the implementation of marine ecosystem-based management within the Common Fisheries Policy reform, Ocean Coast. Manag (2015) 1–9, http://dx.doi.org/10.1016/j.ocecoaman.2015.03.005.

[11] K. Tsagarakis, A. Carbonell, J. Brčić, J.M. Bellido, P. Carbonara, L. Casciaro, A. Edridge, T. García, M. González, S. Krstulović. Šifner, A. Machias, E. Notti, G. Papantoniou, A. Sala, F. Škeljo, S. Vitale, V. Vassilopoulou, Old Info for a new fisheries policy: discard ratios and lengths at discarding in EU Mediterranean bottom trawl fisheries, Front. Mar. Sci. 4 (2017) 1–13, http://dx.doi.org/10.3389/fmars.2017.00099.

[12] K.N. Nielsen, M.M. Aschan, S. Agnarsson, M. Ballesteros, A. Baudron, M.D.F. Borges, A. Campos, R. Chapela, A.K. Dani´elsdo´ttir, K. Erzini, GregersenO´lavur, P. Holm, A. Lucchetti, S. Margeirsson, H.V. Mendes, P. Olsen, M. Rangel, A. Sala, J.L. Santiago, S. Sigurardo´ttir, C. Silva, D. Sykes, J.R. Viarsson, M. Virgili, L. Wise, P.G. Fernandes, A framework for results-based management in fisheries, Fish. Fish. (2017) 1–14, http://dx.doi.org/10.1111/faf.12257.

[13] J.L. Santiago, M. Ballesteros, R. Chapela, C. Silva, K.N. Nielsen, M. Rangel, K. Erzini, L. Wise, A. Campos, M.F. Borges, A. Sala, M. Virgili, J.R. Viðarsson, A. Baudron, P.G. Fernandes, Is Europe ready for a results-based approach to fisheries management? The voice of stakeholders, Mar. Policy 56 (2015) 86–97, http://dx.doi.org/10.1016/j.marpol.2015.02.006.

[14] J. Ramos, K. Soma, Ø. Bergh, T. Schulze, A. Gimpel, G. Fabi, F. Grati, J. Gault, T. Ma, Multiple interests across European coastal waters: the important of a common language, ICES J. Mar. Sci. (2014) 1–12, http://dx.doi.org/10.1093/icesjms/fsu095.

[15] O. Renn, Participatory processes for designing environmental policies, Land Use Policy 25 (2006) 34–45 〈http://www.sciencedirect.com/science/article/pii/S0264837704000882〉 (accessed 6 June 2013).

[16] T.L. Saaty, Decision making – the Analytic Hierarchy and Network Processes (AHP/ANP), J. Syst. Sci. Syst. Eng. 13 (2004) 1–35.

[17] K. Soma, Framing participation with multicriterion evaluations to support the management of complex environmental issues, Environ. Policy Gov. 106 (2010) 89–106, http://dx.doi.org/10.1002/eet.

[18] K. Soma, J. Ramos, Ø. Bergh, T. Schulze, H. Van Oostenbrugge, A.P. Van Duijn, K. Kopke, V. Stelzenmu, F. Grati, T. Ma, C. Stenberg, E. Buisman, The "mapping out" approach: effectiveness of marine spatial management options in European coastal waters, ICES J. Mar. Sci. 29 (2013) 1–13.

[19] K. Soma, How to involve stakeholders in fisheries management — a country case study in Trinidad and Tobago, Mar. Policy 27 (2003) 47–58, http://dx.doi.org/10.1016/S0308-597X(02)00050-7.

[20] G.J. Piet, B. de Vos, Evaluation of possible management measures, Deliverable 6.2. Benthis FP7 project. Brussels, 2014.

[21] M. Sparrevik, G.J. Ellen, M. Duijn, Evaluation of factors affecting stakeholder risk perception of contaminated sediment disposal in Oslo harbor, Environ. Sci. Technol. 45 (2011) 118–124, http://dx.doi.org/10.1021/es100444t.

[22] R. Janssen, On the use of multi-criteria analysis in environmental impact assessment in The Netherlands, J. Multi-Criteria Decis. Anal. 10 (2001) 101–109, http://dx.doi.org/10.1002/mcda.293.

[23] WCED, Our Common Future, United Nations, 1987.

[24] United Nations, Report of the World Summit on Sustainable Development. doi:A/CONF/20*, 2002.

[25] European Commission, GREEN PAPER Reform of the Common Fisheries Policy. https://dx.doi.org/10.2139/ssrn.1743387, 2009.

[26] Council of the European Union, COUNCIL regulation (EC) No 2371/2002 of 20 December 2002 on the conservation and sustainable exploitation of fisheries resources under the common Fisheries policy, Off. J. Eur. Communities L358 (2002) 59–80.

[27] M. Bailey, S.R. Bush, A. Miller, M. Kochen, The role of traceability in transforming seafood governance in the global South, Curr. Opin. Environ. Sustain. 18 (2016) 25–32, http://dx.doi.org/10.1016/j.cosust.2015.06.004.

[28] L. Huemer, Corporate social responsibility and multinational corporation identity: Norwegian strategies in the chilean aquaculture industry, J. Bus. Ethics 91 (2010) 265–277, http://dx.doi.org/10.1007/s10551-010-0618-7.

[29] A. Bundy, A. Davis, Knowing in context: an exploration of the interface of marine harvesters' local ecological knowledge with ecosystem approaches to management, Mar. Policy 38 (2012) 277–286, http://dx.doi.org/10.1016/j.marpol.2012.06.003.

[30] P. Holm, K. Soma, Fishers' information in governance–a matter of trust, Curr. Opin. Environ. Sustain. 18 (2016) 115–121, http://dx.doi.org/10.1016/j.cosust.2015.12.005.

[31] W. Qiu, P.J.S. Jones, The emerging policy landscape for marine spatial planning in Europe, Mar. Policy 39 (2013) 182–190, http://dx.doi.org/10.1016/j.marpol.2012.10.010.

[32] M. Elliott, The 10-tenets for integrated, successful and sustainable marine management, Mar. Pollut. Bull. 74 (2013) 1–5, http://dx.doi.org/10.1016/j.marpolbul.2013.08.001.

[33] K. Soma, J. van Tatenhove, J. van Leeuwen, Marine Governance in a European context: regionalization, integration and cooperation for ecosystem-based management, Ocean Coast. Manag. 117 (2015) 4–13, http://dx.doi.org/10.1016/j.ocecoaman.2015.03.010.

[34] S.B.M. Kraak, D.G. Reid, H.D. Gerritsen, J.K. Ciaran, M. Fitzpatrick, E.A. Codling, E. Rogar, 21st century fisheries management: a spatio-temporally explicit tariff-based approach combining multiple drivers and incentivising responsible fishing, ICES J. Mar. Sci. 69 (2012) 590–601, http://dx.doi.org/10.1093/icesjms/fss023.

[35] S. Knudsen, M. Zengin, M.H. Koçak, Identifying drivers for fishing pressure. A multidisciplinary study of trawl and sea snail fisheries in Samsun, Black Sea coast of Turkey, Ocean Coast. Manag. 53 (2010) 252–269, http://dx.doi.org/10.1016/j.

ocecoaman.2010.04.008.
[36] A. Sala, A. Lucchetti, A. Perdichizzi, B. Herrmann, P. Rinelli, Is square-mesh better selective than larger mesh? A perspective on the management for Mediterranean trawl fisheries, Fish. Res. 161 (2015) 182–190, http://dx.doi.org/10.1016/j.fishres.2014.07.011.
[37] A. Sala, J. Brčić, B. Herrmann, A. Lucchetti, M. Virgili, Assessment of size selectivity in hydraulic clam dredge fisheries, Can. J. Fish. Aquat. Sci. 74 (2017) 339–348, http://dx.doi.org/10.1139/cjfas-2015-0199.
[38] K. Taal, A. Klok, Pulswing - Ontwikkeling van een vistuig voor platvis waarin pulstechniek met de SumWing is gecombineerd, LEI Wageningen UR, The Hague, 2014.
[39] M. Lockwood, J. Davidson, A. Curtis, E. Stratford, R. Griffith, Governance principles for natural resource management, Soc. Nat. Resour. 23 (2010) 986–1001, http://dx.doi.org/10.1080/08941920802178214.
[40] M. Bovens, A comment on Marsh and McConnel: towards a framework fro establishing policy success, Public Adm. 88 (2010) 584–585, http://dx.doi.org/10.1111/j.1467-9299.2009.01804.x.
[41] R. Varjopuro, T. Gray, J. Hatchard, F. Rauschmayer, H. Wittmer, Introduction: interaction between environment and fisheries—The role of stakeholder participation, Mar. Policy 32 (2008) 147–157, http://dx.doi.org/10.1016/j.marpol.2007.09.001.
[42] A. Rijnsdorp, F. Bastardie, S.G. Bolam, L. Buhl-Mortensen, O.R. Eigaard, K. Hamon, J. Hiddink, N. Hintzen, A. Ivanovic, A. Kenny, P. Laffargue, J. Nielsen, F. O'Neill, G. Piet, H. Polet, A. Sala, C. Smith, P. van Denderen, T. van Kooten, M. Zengin, 1IMARES, Towards a framework for the quantitative assessment of trawling impact on the seabed and benthic ecosystem, ICES J. Mar. Sci. 73 (2016) 128–138, http://dx.doi.org/10.1093/icesjms/fsv207.
[43] N.T. Hintzen, B. Roel, D. Benden, M. Clarke, A. Egan, R.D.M. Nash, N. Rohlf, M.C. Hatfield, Managing a complex population structure: exploring the importance of information from fisheries-independent sources, ICES J. Mar. Sci. 72 (2015) 528–542.
[44] F. Bastardie, J.R. Nielsen, M. Eero, F. Fuga, A. Rindorf, Effects of changes in stock productivity and mixing on sustainable fishing and economic viability, ICES J. Mar. Sci. J. Du Cons. 74 (2017) 535–551, http://dx.doi.org/10.1093/icesjms/fsw083.
[45] R.A. Groeneveld, Framing and training to induce preference learning in choice experiments, Mar. Resour. Econ. 25 (2010) 233–245, http://dx.doi.org/10.5950/0738-1360-25.2.233.
[46] A. Dewulf, G. François, C. Pahl-wostl, T. Taillieu, A framing approach to cross-disciplinary research collaboration : experiences from a large-scale research project on adaptive water management 12 (2007).
[47] G. Munda, Social multi-criteria evaluation: methodological foundations and operational consequences, Eur. J. Oper. Res. 158 (2004) 662–677, http://dx.doi.org/10.1016/S0377-2217(03)00369-2.
[48] D. Petza, N. Maina, N. Koukourouvli, D. Dimarchopoulou, D. Akrivos, S. Kavadas, A.C. Tsikliras, P.K. Karachile, S. Katsanevakis, Where not to fish - reviewing and mapping fisheries restricted areas in the Aegean Sea, Mediterr. Mar. Sci. 18 (2017) 310–323, http://dx.doi.org/10.12681/mms.2081.
[49] M. Fitzpatrick, C.D. Maravelias, O.R. Eigaard, S. Hynes, D. Reid, Fisher's preferences and trade-offs between management options, Fish. Fish. (2017) 1–13, http://dx.doi.org/10.1111/faf.12204.
[50] S. Villasante, M. Do Carme García-Negro, F. González-Laxe, G.R. Rodríguez, Overfishing and the Common Fisheries Policy: (un)successful results from TAC regulation? Fish. Fish. 12 (2011) 34–50, http://dx.doi.org/10.1111/j.1467-2979.2010.00373.x.
[51] P. Carpi, G. Scarcella, M. Cardinale, The saga of the management of fisheries in the Adriatic Sea: history, flaws, difficulties, and successes toward the application of the common fisheries policy in the Mediterranean, Front. Mar. Sci. 4 (2017) 1–15, http://dx.doi.org/10.3389/fmars.2017.00423.
[52] F. Murray, P. Copland, P. Boulcott, M. Robertson, N. Bailey, Impacts of electrofishing for razor clams (Ensis spp.) on benthic fauna, Fish. Res. 174 (2016) 40–46, http://dx.doi.org/10.1016/j.fishres.2015.08.028.
[53] European Union, Establishing a framework for community action in the field of marine environmental policy (Marine strategy Framework Directive), Off. J. Eur. Communities 164 (2008) 1–22 (DIRECTIVE 2008/56/EC).