



Food for thought from French scientists for a revised EU Common Fisheries Policy to protect marine ecosystems and enhance fisheries performance

Hilaire Drouineau, Fabien Moullec, Didier Gascuel, Francis Laloë, Sterenn Lucas, Nicolas Bez, Patrice Guillotreau, Jérôme Guitton, Pierre-Yves Hervann, Martin Huret, et al.

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Food for thought from French scientists for a revised EU Common Fisheries Policy to protect marine ecosystems and enhance fisheries performance

Keywords: Common Fisheries Policy, Consultation, Sustainable fisheries management, Best–worst scaling

Highlights :

- 10 years after writing a manifesto, a group of French Fishery Scientists gathered proposals for the Future of the Common Fishery Policy
- The study resulted in an ordered list of proposed measures, highlighting measures considered relevant and a priority by the scientists
- It highlights the need for more simplicity and transparency, for increased consultation, for moving forward into the Ecosystem-Based Approach to Fisheries, and for addressing the situation in the Mediterranean Sea
- Efforts are still needed to protect ecosystems and fisheries, especially in a context of climate and global change

Abstract

Since the 1980s, the Common Fisheries Policy (CFP) has shaped European fisheries. It has often been criticised for being too prescriptive and, above all, for failing to protect either fishermen or ecosystems. The last reform dates back to the early 2010s and has led to a slight but slow improvement in the state of ecosystems. Given that the CFP is in the process of

evaluation, a group of French fishery scientists set up an initiative to add to the debate on what should be retained, reinforced or added to a possible new reform. This initiative came 10 years after a previous manifesto that presented their vision for fisheries in Europe. Four major issues emerged from the current initiative: (1) a need for transparency and simplification in fisheries management, (2) a need for more consultation and dialogue between stakeholders, (3) the urgency of the situation in the Mediterranean Sea, and (4) the necessity of putting into practice all research developments for an ecosystem approach to fisheries. Compared to 10 years ago, the response of scientists shows that the focus is no longer on achieving the maximum sustainable yield, but rather on the following steps to protect ecosystems and fisheries. An ecosystem approach to fisheries remains indispensable for both ecosystems and fishing activities. To this end, scientists put forward numerous proposals to improve the CFP, acknowledging that the final solutions should emerge from consultation with stakeholders. Climate change, an issue raised much more than in the manifest, reinforces the need to act.

Introduction

Initially developed in the 1970s, adopted in 1983, revised in 1992, 2002 and 2013, the Common Fisheries Policy (CFP), the European Union's (EU) legislative instrument for fisheries management, has undergone profound changes over the past five decades [1]. These developments have fundamentally shaped European fisheries and the entire fishery sector [2,3]. Considered one of the most integrated policies in Europe [1], the initial aims of the CFP were to exploit fish stocks sustainably, to ensure the economic viability of Member States' fleets and to provide consumers with quality food at reasonable prices (EEC Council Regulation No. 170/83). These primary objectives were then overlaid with ecosystem-based

management goals aimed at minimising the impact of fishing on the marine environment (EU Regulation No. 1380/2013).

To date, the overall results of the CFP have been mixed [4,5]. Although the proportion of overexploited stocks has practically halved over the last 10 years (from 75% to 40% for stocks for which an assessment is available) and the biomass of assessed stocks has increased by around 35% in 20 years in EU waters [6,7], the stated objectives of exploiting 100% of stocks at Maximum Sustainable Yield (MSY) and achieving good environmental status in the marine environment by 2020 have not been met [5,8]. Worse, while the fishing pressure appears to decrease in the North-Eastern Atlantic, in the Mediterranean and Black Seas, fishing mortality in assessed stocks is still 2.1 times higher on average than that defined for MSY [5,9,10]. The socio-economic results of the CFP are also mixed. Although economic performance and fishermen's wages have improved in recent years, mainly for fleets exploiting stocks assessed as in good condition [11], the situation remains alarming in several Member States, particularly for small-scale fisheries, which are not profitable in several countries [11]. Based on figures from the EU's Scientific, Technical and Economic Committee for Fisheries (STECF), the World Wide Fund for Nature (WWF) recently estimated that 43% of EU fishermen were paid less than the national minimum wage in 2018 (reaching 70% of fishermen operating on craft smaller than 12 metres [12]).

Since the formal implementation of the CFP, and despite the integration of major changes (e.g. MSY as a management target, the obligation to land species under quota, the regulation on technical measures, and the strengthening of controls), the policy has received intense criticism from stakeholders in the sector (fishermen, NGOs, fisheries managers and scientists) [13–19], and is still being questioned today (e.g. [20,21]). The slow and partial

recovery of biomass [5] has not allowed a real return to profitability for a large number of fisheries [6]. Fisheries management still takes a single-species approach that largely ignores biological and technical interactions and the effects of global change [22–24], a far cry from a true ecosystem-based approach [19,25]. While single-stock approach can indirectly handle the side-effects of those interactions through yearly stock-assessment and recurrent update of reference points, it opens the door to side-effects such as increased discards in mixed-fisheries or to trophic cascades, especially on species that are not assessed, and poorly accounts for socio-economic consequences on fisheries. The CFP remains vertical, prescriptive and centralised, as illustrated by the introduction of the landing obligation in 2015, which is very poorly understood and negatively perceived by professionals [26–28]. The same applies to the Regional Advisory Councils (RACs). Created in 2004 to promote dialogue between stakeholders and initiate a process of regionalised co-management [16,29], then transformed into Advisory Councils (ACs) from 2013 onwards, these councils have since been regularly sidelined from debates in favour of political representatives from the Member States, to whom the European Commission turns in preference (e.g. [30]). This situation generates frustration among a certain number of Advisory Council stakeholders [31], and is partly responsible for the fact that the regionalisation of the EU fisheries management system seems to be stalling (e.g. [32,33]).

Moreover, new environmental, economic and social challenges have been added to the original concerns of the CFP [4,34]. Brexit has also changed the situation, entailing that the management of the majority of stocks exploited by the EU will now be subject to international fisheries agreements between the UK and Europe [35,36], as is already the case with Norway, for example. Anthropogenic pressures on the marine environment are increasing, particularly with the development of tourism, marine renewable energy, aggregate

99 extraction and coastal urbanisation [37,38]. Coastal development and the problems of
100 eutrophication and pollution are sources of increased conflicts of use in coastal areas (e.g.
101 [38]). The impacts of climate change are now being significantly felt and will inevitably
102 increase in the coming decades [39–41]. This is leading to declines in abundance, and even
103 the collapse of several large European stocks (e.g. cod in the Celtic Sea [42]), and to changes
104 in the spatial distribution of stocks (e.g. [43]): for example, the increase in cod in the Barents
105 Sea [44] or the arrival of boarfish (*Capros aper*) in the Bay of Biscay [45,46]. Total catches
106 are decreasing, their species composition is changing, and they are becoming more unstable
107 and less predictable overall [47–50]. Scientific recommendations and management procedures
108 are also being questioned [51–53]. Furthermore, the multiplication of uses in the marine
109 environment means that fisheries and marine ecosystems are at the centre of a patchwork of
110 interacting policies, both conservation policies (e.g. CFP, Water Framework Directive,
111 Marine Strategy Framework Directive) and spatial planning policies, without always being
112 properly coordinated. There is little question that the CFP needs rethinking to ensure that
113 future generations have sustainable and equitable access to fisheries resources.

114
115 In this context, and given that the European Commission must report to the European
116 Parliament and Council on the performance of the CFP before 31 December 2022 with a
117 view to its review (Article 49 of EU Regulation 1380/2013), there is a window for legislative
118 action to adapt and modernise the CFP on the basis of current scientific knowledge. Fisheries
119 stakeholders, in particular scientists, with their individual and collective expertise, therefore
120 have a role to play in informing policymakers. Although the degree of involvement scientists
121 should have in the public debate is sometimes the subject of controversy [54,55], it is
122 unanimously recognised that they need to provide the objective knowledge necessary for
123 decision-making [56], making it judicious to reduce the distance that can sometimes exist

between researchers and other stakeholders [55,57,58]. As far as fisheries research is concerned, the challenge is to coordinate the voice of the scientific community, multidisciplinary and multi-institutional by nature, in order to elicit the most relevant and consensual areas of improvement for the CFP – based on individual scientific expertise – without dodging the uncertainties and controversies.

In 2011, the Association Française d’Halieutique (AFH), a non-profit organisation of more than 100 French-speaking fisheries scientists, published a manifesto for sustainable fishing [59]. This manifesto highlighted the deep crisis of fisheries in the European Union and proposed a set of reforms and a paradigm shift to improve the CFP. Ten years later, in light of new scientific knowledge and emerging international issues, the organisation decided to take advantage of the CFP review to solicit the views of all its members on concrete political, economic or environmental measures that could be integrated into a new CFP in order to achieve its objectives, or to set new ones, in a changing world.

This paper describes how the AFH used a participatory approach to identify and prioritise areas for improvement of the CFP by seeking proposals from scientists, and outlines the measures that seem most suitable to face the challenges ahead, taking stock of the evolution of the CFP over the last decade.

Materials and methods

The main mission of the AFH is to coordinate French-speaking fisheries scientists from different disciplines. Its members come from different institutions, mainly scientific (e.g. universities and research institutes such as Ifremer, IRD, INRAE, Institut Agro, etc.), and it is open to scientists from stakeholder organisations (environmental NGOs, producers’

149 organisations, fisheries committees, etc.). Members do not represent their institutions. Those
150 up to date with their membership fees (i.e. who have paid at least once since 2017)
151 constituted the panel for this survey, i.e. 159 scientists. The directory of current members is
152 available online (<https://www.association-francaise-halieuistique.fr/annuaire-des-adherents/>).
153

154 In order to identify, select and prioritise proposals for measures to be considered in the CFP
155 reform, an approach similar to the MICESE (Multiphased, Iterative, and Consultative
156 Elicitation of Scientific Expertise) method was used [56].

157 Between June and October 2020 (Figure 1), the 159 scientists were contacted by email and
158 reminded once a month to propose measures they thought should be implemented in an
159 updated CFP on a virtual bulletin board (<https://padlet.com/dashboard>). This allowed each
160 participant to view all the measures proposed over time on the platform. As the aim was to
161 obtain as wide a range of opinions as possible, the instructions made it clear that the
162 proposals could be similar to, or contradictory to, other proposals. Participants were given the
163 opportunity to comment on the proposals in order to improve, expand on, clarify or challenge
164 the content, and each contribution had to be signed. A total of 43 scientists participated in the
165 call for proposals (submitting proposal(s) or comment(s) in response to them). An editorial
166 committee made up of six scientists who are members of the AFH and themselves
167 contributed to proposing measures, was then responsible for producing an initial summary of
168 the proposals in order to merge those that appeared redundant, and to edit and standardise the
169 content. From the 70 initial proposals, 50 distinct proposals emerged. Finally, in October
170 2020, the 43 participants were invited to verify the correct transcription of their original idea
171 by the editorial committee (Figure 1).

172 A Best–Worst scaling (B-W scaling) survey [60,61] was then implemented to prioritise the 50
173 measures, using a methodology similar to that of Rudd and Lawton [62] and Rudd [58], which

is well suited to ranking a large number of proposals. B-W scaling is used to rank proposals by assessing the preferences of respondents. It consists of subjecting the voter to several voting operations (called ‘tasks’), each of which concerns a reduced sub-group of proposals from which the voter must extract the most and least relevant (ranking). For each participant, the list of tasks was randomly constructed by selecting groups of proposals according to an experimental design (D-optimal design) that ensured the repeated random appearance of each proposal in the different tasks.

Each participant was assigned 36 tasks, each containing four proposals (exactly the number of tasks and proposals per task set by Rudd [58]). Thus, each proposal was evaluated three times on average by each participant. The experimental design was randomly generated for each participant so that the tasks, and thus the grouping of proposals, were different from one participant to another, ensuring an even greater mix of proposals. An invitation to vote was sent to the initial panel of 159 people (Figure 1). Each voter was given a unique voting opportunity to ensure a unique response. The survey was conducted between January and March 2021. For each task, when choosing the most and least relevant proposal, the voter was given the title of the proposal and an explanatory text (see Supplementary Material). Of the 159 respondents, 83 complete votes were cast. Only these 83 votes were analysed.

To analyse the survey results, a multinomial generalised linear model was fitted (the model sought to predict the probability of a proposal being considered most or least relevant in a task). It was used to assess the score defined as the utility (quantifying the probability that a measure is selected as most relevant) of each proposal [63,64].

At the end of the voting process, voters were asked to provide demographic and professional information in order to better characterise the panel, including:

- their current main professional activity (e.g. scientist, manager, NGO)
- their geographical location (country)
- their age group (26–35, 36–45, 46–55, 56–65, >65)
- their main discipline based on the classifications of the National Universities Council: sciences, law/economics/management, humanities

Results

Summary of the CFP reform proposals

The proposals were varied and addressed a multitude of topics that were grouped into four CFP-related themes (Table 1):

- Governance: 19 proposals (P32 to P50) addressed issues such as decision-making methods (e.g. P34), the place of science in decision-making (e.g. P36), methods for controls (TACs/quota calculation key; 33, 41, 42, 49), and the organisation of sectors (e.g. P35/P39). Most of the measures promoted greater consultation with stakeholders and greater regionalisation of the CFP (e.g. P34/P37/P39/P44/P47), as well as greater flexibility (e.g. P37/P38/P44) to deal with climate change and local contexts. Finally, better coordination of the CFP with other European directives and international initiatives (P32) was suggested, to prevent working in silos.
- Consumer information: four proposals (P28 to P31) concerned better consumer information on products available on the market, both in terms of the status of the marine population exploited and on the potentially negative impacts of fishing on

the stock, in particular via environmental labelling. The ultimate aim is to encourage more responsible consumption, a theme also found in other proposals (P35).

- Improved scientific assessment: eight proposals (P20 to P27) aimed to better integrate and capitalise on recent developments in ecosystem modelling (P20), redefine the acquisition of data used for scientific assessment (P21/P24/P26), and better take into account scientific knowledge on stock assessment (P22/P25) as well as the associated uncertainty and variability caused by climate change (P25). Several proposals called for a revision of management targets, questioning the principle of MSY management as insufficient for an ecosystem approach to fisheries (P23/P27). Other proposals aimed to develop participatory and collaborative research (P26), often in interaction with the governance issues previously mentioned (P36, P38, P39).
- Ecological protection and conservation: 19 proposals (P1 to P19) included a wide range of resource and ecosystem conservation measures, including technical measures for fisheries (mesh sizes, e.g. P4/P11; fish sizes, e.g. P3/P11; TACs, e.g. P10/P12), networks of marine protected areas, and individual financial incentives for taking into account environmental issues. They concerned a variety of biological scales (stocks, e.g. P5; communities, e.g. P15; ecosystems e.g. P8) and fleets (P6). Of these proposals and in line with the considerations on previously mentioned reference points, several proposals focused on the practical implementation of ecosystem-based fisheries management (e.g. P14/P15). The alarming situation in the Mediterranean was the subject of specific proposals (P5 and P10).

Ranking of proposals

Out of the 159 people contacted, 83 complete votes were cast. The characteristics of the panel showed a strong predominance of people working in France and on French and European fisheries (which was expected from AFH members), and a strong predominance of scientists in the life sciences compared to the humanities and social sciences (Figure 2). All age groups participated in the surveys, with a predominance of early-career scientists.

The 10 most relevant proposals (i.e. those with a significantly different score from reference proposal P2 according to the multinomial model) out of the 50 ranked by the panel (Figure 3) highlighted the need for a more holistic approach to the CFP and identified four main issues (presented here in no specific order) that can be summarized as follow:

- Issue 1: More transparency, less complexity: in response to the often-voiced criticism of the lack of transparency and the high complexity of the CFP, scientists put forward several proposals to improve the situation. Aligning all management units (i.e. the units on which TACs are set) with the functional units of biological populations (on which scientific assessment is based) was considered a priority (P46). These functional units correspond to the best scientific knowledge currently available on population distribution, and management at any other scale could be inefficient. This realignment measure was also considered necessary to make political decisions more transparent and to be able to compare them with scientific recommendations. Complexity also arises from directives and initiatives that are too ‘siloed’ (P32). Conservation policies could be made more fluid by establishing an overall strategic framework. Finally, transparency and complexity were also often linked to a lack of consultation and dialogue. According to the survey, consultation on decisions with all

the stakeholders in a sector is a prerequisite, particularly for implementing multiyear, multispecies management plans and for evaluating them afterwards (P34).

- Issue 2: More consultation with stakeholders to improve understanding and acceptability: the role of stakeholders was central to two of the first ten proposals. This was the case for the previously mentioned proposal on the concerted implementation of management plans (P34), but was also the focus of a proposal aiming to increase the practice of incentives for virtuous behaviour (in the form of allocation of fishing effort quotas or additional catch quotas, or real-time incentives, etc.) rather than the taxation/subsidy mechanisms currently practised (P39, P34). This mechanism could draw on Article 17 of the CFP, which has so far been little used. Here again, the types of behaviour to be promoted and the incentive methods should be developed jointly with stakeholders to ensure the system is effective.
- Issue 3: Fisheries resources in the Mediterranean: two of the proposals perceived as the most relevant concerned the Mediterranean (P5 and P10), underlining the extent to which the situation in this region is considered very concerning. In this respect, the panel members found it essential to improve knowledge on both the biology of the species and on their exploitation in order to better assess the status of exploited populations and to improve the settings of technical measures (e.g. see the discussion about size-at-maturity and in minimum landing size in [65], or [66]). They also recommended the introduction of quotas for Mediterranean species, as management by fishing effort has shown its limits when not linked to other conditions. Finally, it was proposed that the CFP should gradually align its approach in the Mediterranean with that in force in the North-East Atlantic.
- Issue 4: Ecosystem-based management: from theory to practice. The panel members noted that (i) the first calls for an ecosystem approach to fisheries date back several

decades, (ii) that little has yet been done in concrete terms to respond to this, while
(iii) operational instruments are nevertheless available and could already be enlisted.
As far as analysis tools are concerned, ecosystem models (end-to-end, trophic) have
multiplied, but are still used in a disparate and ad hoc manner, which does not allow
for long-term monitoring of the state of ecosystems, feedback on these tools by
scientists, and even less their adoption by decision-makers. The use of ecosystem
models and the knowledge they produce should therefore be made more routine and
regular (P20), and the data collection systems needed to inform and update them set
up (P21). Beyond tools and data, scientists gave even stronger support to two
proposals for measures to better protect ecosystems. Scientific knowledge has
highlighted the importance of protecting habitats and ‘forage species’ (P15). This
knowledge should enable the implementation of measures that take better account of
the seasonality, the heterogeneity of spatial distribution, and the trophic interactions
of exploited species – the most popular proposal (P9), which echoes proposals in the
top 10 (P15), or others that are slightly lower ranked (P8, P11, P22). Finally,
particularly in relation to climate change, which is causing changes in the distribution
range of species, and the tendency to exploit lower and lower trophic levels, the
scientists recommended that predefined rules, alongside clear criterion defining when
they apply, should be rapidly put in place to limit the expansion of fisheries towards
new species (either previously present but not yet exploited, or species that shift their
distribution), pending the acquisition of sufficient knowledge for their proper
management (P1 - see [67] for a review of international regulations on this question).

Discussion

An innovative consultation to collect opinions of French scientists on the CFP

This analysis proposes a rigorous survey of French scientists' opinions about fisheries management and concrete proposals for the future of the European Common fishery policy. The approach was collective, eliciting proposals and prioritising them based on proven methods [56,58,62]. For the time being, the survey was carried out only within the AFH membership to ensure a robust comparison with the 2011 manifesto [59]. This choice has certain limitations: only scientists, mainly French, were consulted for the study, with a predominance of researchers in the life sciences and an under-representation of researchers in the humanities and social sciences (Figure 2). This may explain the relatively small number of proposals concerning the organisation of the sector, marketing and consumer information, and the dominance of measures targeting environmental and species protection. Some cultural biases are also likely to occur. For example, the panel is composed mostly of French life scientists, this might explain the position about transferable fishing quota since the French quota allocation system is original [68].

The process was based on two steps: (i) the collection of proposals through an open online survey, (ii) then a ranking of these proposals through a statistically appropriate best-worst scaling procedure. It should be noted that care must be taken not to overinterpret the poorly ranked proposals, as this may also be explained by their proximity to other better ranked measures. For example, the measure aimed at giving the Advisory Councils a greater role (P47) is relatively low-ranked, but the panel unanimously recognised the need for a more regional approach and greater consultation, in which these councils have an important role to play (P34 and P39). Similarly, although no proposal on environmental labelling appears at

the top of the ranking, this could be explained by the existence of three fairly similar proposals of this type (P29, P30 and P31), which tends to disperse their respective individual weight. The scope of the measure may also constitute a bias: in a choice between a precise technical measure (e.g. increasing mesh size) and a more conceptual proposal expressing an objective (wishful thinking) rather than a means (e.g. taking into account spatial and temporal variability), it is likely that the means would win more votes, even if the concrete aspects of this remain to be identified. That's why, while looking at the best ranked proposals is interesting to detect the most urgent challenges, it is also very interesting to explore the diversity of themes and measures addressed in other proposals (all the proposals are the results of the MICESE steps of the approach and can thus be found in supplementary material).

Four critical challenges that echo the most frequent criticisms against the CFP

The top 10 ranked proposals highlight 4 critical challenges that are closely related to the main criticisms of the CFP. First, the dramatic situation in the Black Sea and in the Mediterranean Sea was highlighted in two proposals (P5, P10) and reminds that the CFP has failed to prevent the overexploitation for decades [14,69–71]. While progress has been observed in the North-eastern Atlantic since the last reforms of the CFP [6], this is not the case in some other regions [9,10,18,24,72]. Here, scientists have proposed to align the situation in the Mediterranean regions with the practices from North Eastern Atlantic. Since the implementation of adequate controls and management in Eastern Mediterranean region or Black Sea is likely to be challenging [73], those proposals are rather medium term objectives (P5 sets a 2030 objective). Nevertheless, it should be noted that recent efforts have been

369 made to improve the data collection and stock assessments, especially in the context of the
370 Mediterranean multiannual management plan [65,73]. This better monitoring of landings
371 might in turn facilitate the implementation of controls in longer terms. For sure, that should
372 not prevent immediate alternative actions in the meantime.

373

374 Among the top 10 proposals, there is a recurrent call for less complexity, enhanced
375 transparency and consultation. It echoes the frequent and recurrent criticism of a too siloed,
376 centralised and top-down policy [14,74–76]. To address those points, French scientists called
377 for more involvement of stakeholders to design management plans (P34). Indeed, the
378 example of the Scottish fishery showed that co-constructed transformations can yield
379 significant outcomes [75] and has demonstrated that it is not incompatible with the CFP. The
380 last CFP reform in 2013 promoted a regionalization of the management. However, at the
381 same time, consultative regional bodies such as Regional Advisory Councils (RACs) /
382 Advisory Councils (ACs) have since been regularly sidelined from debates in favour of
383 political representatives from the Member States, to whom the European Commission turns
384 in preference (e.g. [30]). As such, the benefits of regionalisation, as a step towards enhanced
385 stakeholder involvement, have not always been perceived [77]. While P34 proposes an
386 objective, specific tools to reach this objective are proposed in other proposals. More
387 specifically, shifting from a taxing, subsidies and bans approach, towards incentives approach
388 is mentioned in two top-ranked proposals (P39, P34) . Such a solution, to be negotiated with
389 stakeholders, has proved to be efficient in various countries [78,79]. Moreover, Article 17 of
390 the CFP Regulation already provides for this possibility. More generally, enhanced
391 consultation is likely to facilitate understanding of management measures (see [27,28] that
392 illustrate how the poorly negotiated discard ban led to misunderstanding and its unacceptance
393 by the industry), which is one of the main subjects emerging from the top-ranked proposals.

394 While consultation is not a panacea and co-management of fisheries has not always delivered
395 expected results [80], early consultation can help to detect issues early and to prevent latter
396 blockages [81,82].

397

398 Finally, the last main theme was about upscaling the management towards an EAF that
399 should account for all the threats due to the fishery [83]. The call for moving towards an EAF
400 is old [84], and AFH scientists are not the only ones to criticise the slow pace of
401 implementation [85,86]. While they note that tools exist to explore the impact of fisheries,
402 management measures, and other pressures on food webs and socio-ecosystems (e.g. [83,87–
403 93] and P20), their application in fisheries management or within other European
404 environmental policies remains relatively limited (e.g. [94–96] and P9, P20). Scientific
405 knowledge already exists to protect low trophic levels [97] and habitats through measures that
406 take into account the seasonality and spatial distribution of species (P15, P9 and [98–100]).
407 The recent framework developed by the STECF in the context of the Mediterranean
408 Management Plan, to assess the relevance of closed areas to protect multiple key target
409 species (but that can be extended to protect key habitats), that combines Vessel Monitoring
410 System and scientific survey data, is an interesting example of how most recent scientific
411 data can be used to support spatial management measures implementation [101]. Marine
412 protected areas can and should be a tool for EAF, (P9, and P8 though less well ranked) but
413 for this to happen they must have a truly effective level of protection and management,
414 contrary to what is currently observed in many cases [102]. Of course, moving towards the
415 EAF will require the use of more complex models to support the scientific advice and
416 constant discussion will be required with stakeholders [103]. P20 underlines that many
417 ecosystem models are available to support the scientific advice of an EAF (this is also
418 mentioned in P34 with the proposed generalised use of Management Strategy Evaluation).

Such ecosystem models do not aim to set measures such as yearly single-stock TACs, nor to replace single-species models which are well suited to carry-out short term predictions, but rather as complementary tools to holistically assess the relevance of management approaches or to monitor ecosystems and anticipate changes over the long term. This is even more critical in a context of climate change which will drastically affect fisheries [41,50]. However, to do so, their use must be made more routine so that scientists and decision-makers gradually learn to make the best use of them. Indeed, demonstrating the usefulness and the reliability of complex models to stakeholders and managers is critical to increase trust and confidence [90,103]. As such, the work initiated by ICES Working Group on Multispecies Assessment Methods [94] and ICES Ecosystem Overviews, and concrete proposals and examples that can be found in the literature [23,86,90,94,104,105], will hopefully be important starting points. The diversity of impacts of fisheries on ecosystems [83], and the increase of others anthropogenic pressures on the marine environment [37,38] urges the development of such holistic approaches and a better integration of CFP with other international biodiversity protection initiatives such as MSFD, EMFD or WFD (P32) to promote synergies and prevent negative interactions among them [106–108]. In continental waters, Drouineau et al. [109] underlined how initiatives to restore some migratory fish populations have interfered with the EU Renewable Energy Directive; these kinds of problems can only increase for marine fisheries.

A diversity of proposals that outline some progresses during the last 10 years but also many similarities

Ten years ago, the AFH made strong recommendations for fisheries management in Europe [59]. It is interesting to compare, a decade later, those earlier messages from 2011 with the

diversity of themes addressed in the current analysis. The main messages in 2011 were
(quoted and in italics):

- *“The sea is suffering from damage inflicted by humans, and fishermen are suffering too”*: since that time, scientists have recognised that the transition to MSY has been an important step forward (e.g. P27). Although progress has been slow [6,7] and the situation remains critical in some regions (P 32), fishing mortality has fallen and the biomass of some species is slowly rebuilding. A positive consequence of these changes is that the profitability of fisheries is generally increasing (excluding the Covid crisis) in the waters of the North-East Atlantic [11], although this recovery is slow [6]. However, many stocks are still overexploited and their biomass levels are low, making further efforts necessary. Our results indicate that all stakeholders (professionals and NGOs) should be put at the heart of the governance system (P34 is an iconic example, but also P47, P48), with the aim of improving the acceptability of decisions and implementing more effective and appropriate incentives for good exploitation practices to avoid blockages. Co-management and stakeholder involvement has indeed proved effective in many cases [75,79] and should be strengthened in European fisheries. Moreover, this must be done in consultation with all stakeholders. The resources of the sea and marine ecosystems are common goods, which can only be managed sustainably if communities are formed that feel truly responsible for the sustainability of this common good. This is all the more important given that the behaviour of fishermen remains one of the greatest sources of uncertainty in fisheries management [110], and that the failure to take into account interactions between ecosystems and the behaviour of stakeholders is one of the main causes of the failure of the CFP [78]. Greater involvement of stakeholders will require

progress in the regionalisation of fisheries management in order to adapt management measures to local situations and facilitate consultation between all parties.

- “*Reaching MSY requires considerable changes*”: this follows directly from the previous point. The level of overexploitation at the time was such that meeting the MSY objective seemed almost unattainable. This is no longer the case: while progress has been slow, it is significant. The recommendations of the AFH scientists have therefore gradually shifted to a post-MSY objective (e.g. P23, P27) , considering MSY as a necessary but insufficient step as a single-species target does not take into account trophic or technical interactions, impacts on ecosystems or income for fishermen [19,111]. Management targets that guarantee less impact on stocks, such as maximum economic yield (MEY [112,113]) or optimised mesh size management, are necessary, but, more generally, an ecosystem approach to fisheries was recommended in the recent survey. To achieve this, the scientists consulted consider that greater involvement and responsibility on the part of fishermen is essential.

- “*An ecosystem approach to fisheries (EAF) is a necessity*” This theme from the 2011 manifesto is still largely present in the top-ranked proposals, as mentioned earlier in the discussion, but also in many other proposals (see for example P6, P12, P14, P21).

- “*Overcapacity is not everything, access rights must be regulated*”, “*All management tools should be enlisted*”: this observation still seems valid according to our results, as a wide variety of measures were proposed to achieve sustainable exploitation objectives (e.g. P3, P4, P7, P8, P10,P42). These include individual quotas, recommended by other authors (e.g. [114]), that are non-transferable to avoid concentration of fishing rights [115,116], minimum fish sizes, mesh size changes, marine protected areas, and ecolabels. The management of mesh size and minimum fish size are also major tools for reducing impacts on exploited stocks. This set of

measures should make it possible to take into account species ecology and the ecosystem impacts of exploitation.

Strong consensus emerged on several points in this study. The first is the need to continue efforts to restore and protect ecosystems: healthy ecosystems are essential for healthy fisheries. To achieve this, scientists consider that MSY should only be an intermediate step and that ecosystem-based fisheries management will necessarily involve going further. To this end, a wide range of measures were proposed. Some are already recognised (e.g. catch limits and mesh size changes, individual quotas, P3, P4, P42). Others are more innovative and original (e.g. modification of the landing obligation, restriction of subsidies, circular economy, real-time incentives, P7, P17, P19, P35) and could be tested, requiring a framework to facilitate such experimentation (P37). This diversity of measures reflects the fact that there is likely no single miracle recipe, but several possible paths. The most appropriate measures should be chosen according to context, in consultation with stakeholders.

This was the second strong consensus of the study: the success of the CFP will necessarily depend on greater consultation with and empowerment of stakeholders, particularly fishermen, in order to develop appropriate regional management plans. Examples of the implementation of management and restoration plans in continental environments show that the involvement of stakeholders is one of the key factors for success: the process of implementing the plan being as important as the content of the plan itself [117,118].

The context of global change, in particular climate change, only adds to the urgency of reforming the CFP. The growing concern of scientists about these new challenges is the other salient fact that stands out in contrast to the 2011 manifesto [59]. Ten years ago, global

change was mentioned only once, and climate change was only mentioned in passing [59]. In the recent survey, climate is the subject of a specific proposal (P43) and is reflected in several others (P13, P32 and even P19). More broadly, the proposals show that scientists consider that management cannot be considered ‘in a vacuum’, neglecting the interaction of fish and fisheries with their environment. This is the essence of the ecosystem approach to fisheries, which was widely put forward in the survey, but which must also be able to adapt continuously and rapidly to the consequences of the environmental changes to come.

Author contributions :

Hilaire Drouineau: Conceptualization, Methodology, Software, Validation, Formal analysis, Data Curation, Writing - Original Draft, Visualization, Supervision

Youen Vermard: Conceptualization, Methodology, Software, Validation, Formal analysis, Data Curation, Writing - Original Draft, Visualization, Supervision

Francis Laloe: Conceptualization, Methodology, Validation, Data Curation, Writing - Review & Editing, Supervision

Didier Gascuel: Conceptualization, Methodology, Validation, Data Curation, Writing - Review & Editing, Supervision

Sterenn Lucas: Conceptualization, Methodology, Validation, Data Curation, Writing - Review & Editing, Supervision

Fabien Moullec: Conceptualization, Methodology, Software, Validation, Data Curation, Writing - Original Draft, Visualization, Supervision

542 Sigrid Lehuta: Data Curation, Validation, Writing - Review & Editing
543 Marc Léopold: Data Curation, Validation, Writing - Review & Editing
544 Patrice Guillaudeau: Data Curation, Validation, Writing - Review & Editing
545 Pierre-Yves Hervann: Data Curation, Validation, Writing - Review & Editing
546 Stéphanie Mahévas: Data Curation, Validation, Writing - Review & Editing
547 Nicolas Bez: Data Curation, Validation, Writing - Review & Editing
548 Marianne Robert: Data Curation, Validation, Writing - Review & Editing
549 Jérôme Guitton: Data Curation, Methodology, Software

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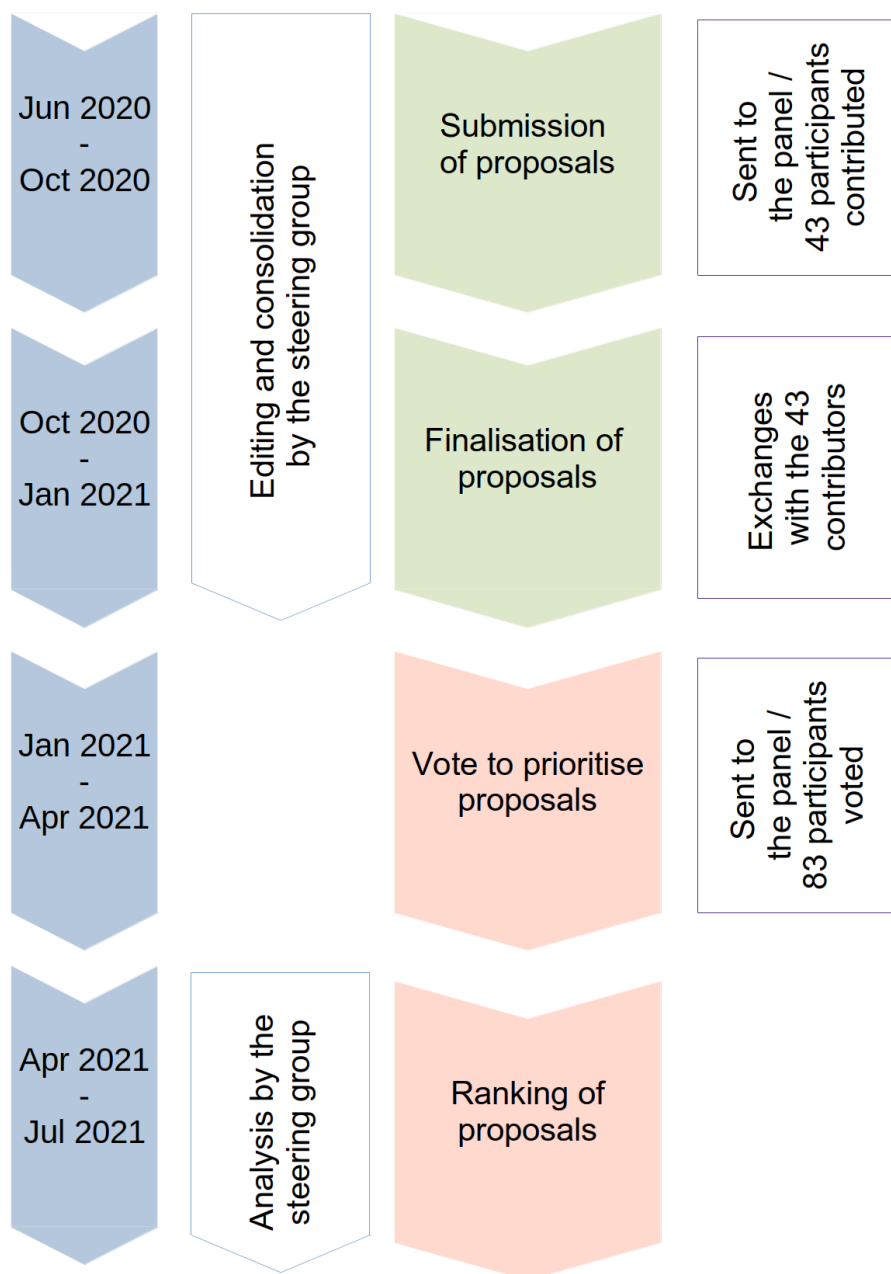
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FIGURES

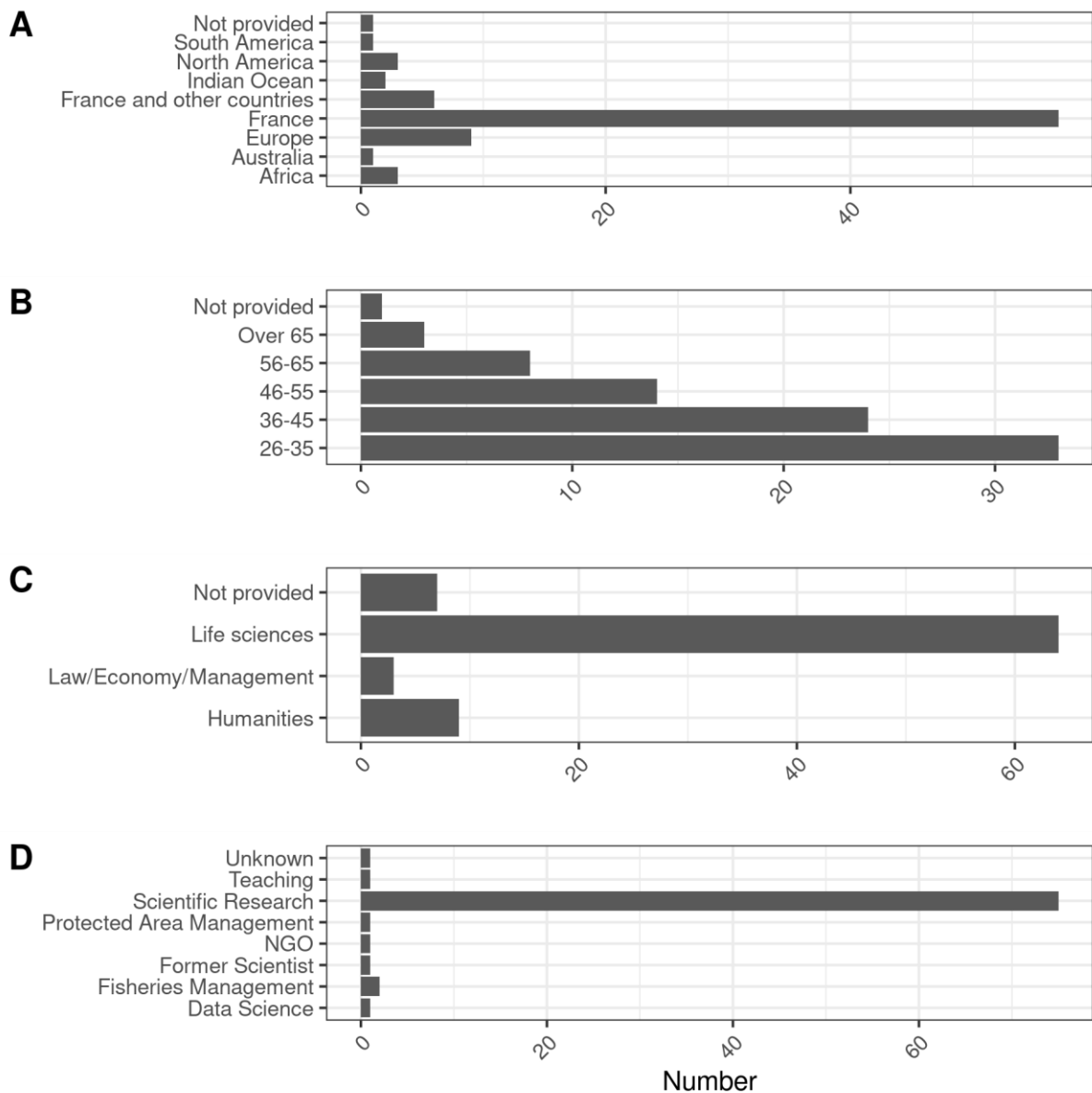


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989 Figure 1: Diagram summarising the main stages of the process (3rd column), the timetable

990 (1st column) as well as the work of the steering group at each stage (2nd column) and the

991 interactions with the panel of scientists (4th column)



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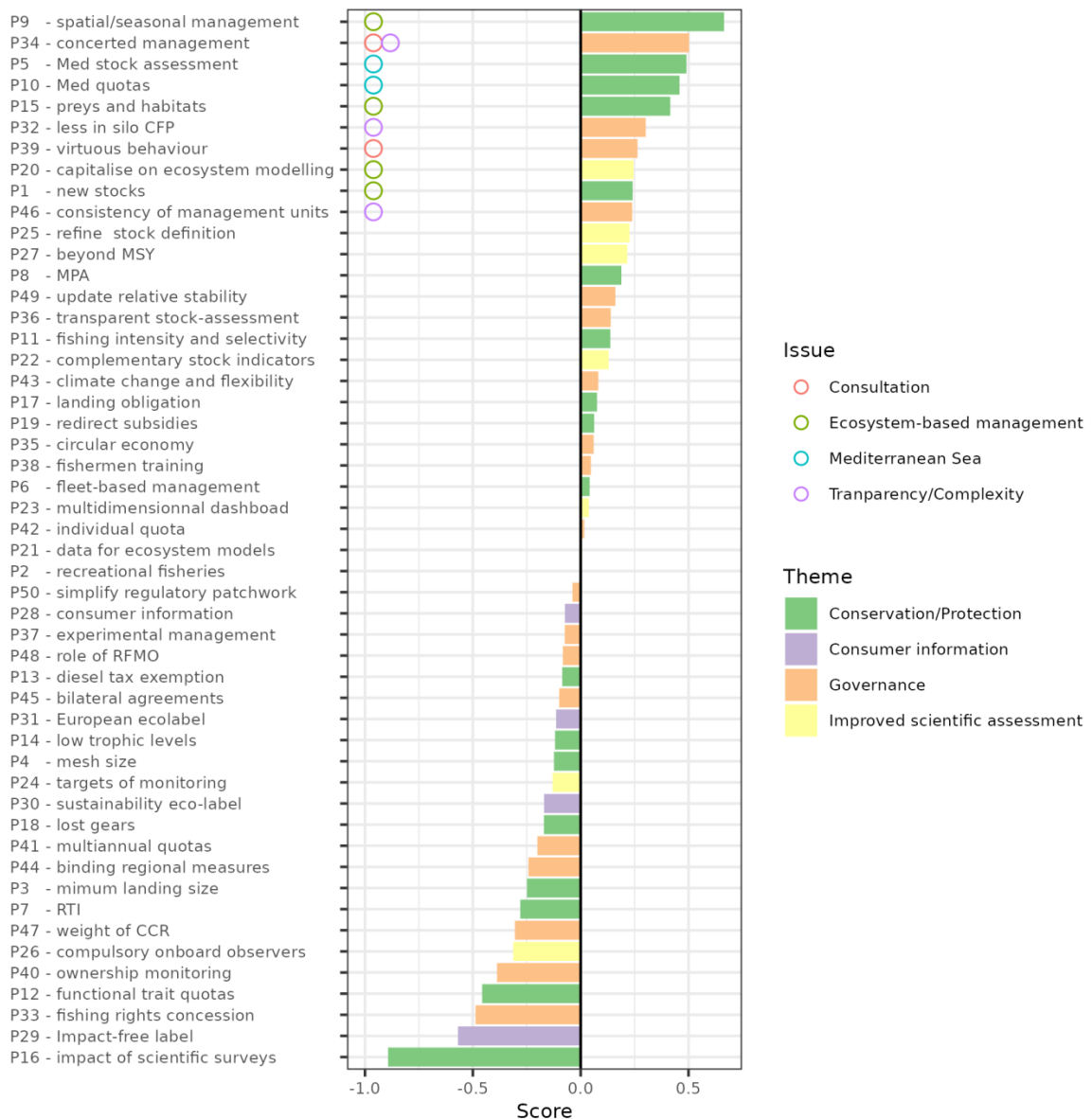
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Figure 2: Characteristics of the panel responding to the survey allowing the ranking of the proposals: geographical area of work (A – France and other countries stands for scientists that work both on French fisheries and foreign fisheries), age group (B), main academic category (C) and type of occupation (D)



1006 TABLE

1007 Table 1: Title of individual proposals, associated main theme, proposal number and ranking
 1008 following the Best-Worst scaling procedure (BW).

1009

Theme	Number	Title of proposal	BW
Conservation/ Protection	P1 new stocks	Take a precautionary approach to ‘new’ stocks	9
	P2 recreational fisheries	Improve knowledge and management of recreational fisheries	27
	P3 mimum landing size	Increase fish size limits and create size limits for all species caught	42
	P4 mesh size	Increase regulatory mesh size	36
	P5 Med stock assessment	By 2030, assess all exploited stocks in the Mediterranean	3
	P6 fleet-based management	Develop a fleet-based approach	23
	P7 RTI	Develop real-time incentive approaches	43
	P8 MPA	Develop a network of marine protected areas with a sufficient level of protection	13
	P9 spatial/seasonal management	Develop management that takes into account the spatial and temporal variability of the marine populations caught	1
	P10 Med quotas	Establish quotas in the Mediterranean (EU areas) for the main species exploited	4
	P11 fishing intensity and selectivity	Implement management based on	16

		exploitation pattern and fishing intensity	
	P12 functional trait quotas	Establish quotas by functional traits	47
	P13 diesel tax exemption	End the tax exemption for marine diesel	32
	P14 low trophic levels	Protect low trophic levels through	35
		ecosystem-based management	
	P15 preys and habitats	Protect prey and habitats through	5
		ecosystem-based management	
	P16 impact of scientific surveys	Reduce the impact of scientific campaigns	50
	P17 landing obligation	Review the landing obligation	19
	P18 lost gears	Deal with lost gear at sea	39
	P19 redirect subsidies	Subsidise transitions to sustainability	20
Improved scientific assessment	P20 capitalise on ecosystem modelling	Capitalise on the ecosystem modelling efforts produced across Europe for	8
		integrated ecosystem assessment	
	P21 data for ecosystem models	Collect the data needed to inform ecosystem models	26
	P22 complementary stock indicators	Consider indicators complementary to spawning biomass (e.g. size structure, condition) to assess the status of populations	17
	P23 multidimensionnal dashboard	Develop a socio-economic and ecological dashboard to analyse multidimensional trade-offs	24
	P24 targets of monitoring	Diversify/redirect the targets of monitoring programs	37
	P25 refine stock definition	Update the definition of stocks and	11

		populations for the assessment of certain species	
	P26 compulsory onboard observers	Make it compulsory to have observers on board	45
	P27 beyond MSY	Review the MSY management approach	12
Consumer information	P28 consumer information	Improve the display of the origin and species of fish for consumers	29
	P29 Impact-free label	Define impact-free labels	49
	P30 sustainability eco-label	Define a European sustainability label	38
	P31 European ecolabel	Define a public 'European sustainable fisheries' label for stocks managed according to EU objectives	34
Governance	P32 less in silo CFP	Align the objectives of the next CFP with international biodiversity conservation objectives; less siloed conservation/restoration policies	6
	P33 fishing rights concession	Define fishing rights in the form of concessions	48
	P34 concerted management	Develop management approaches in concertation with all stakeholders in the sector	2
	P35 circular economy	Develop circular economy approaches	21
	P36 transparent stock-assessment	Make assessment of resources and fisheries more transparent and accountable	15
	P37 experimental management	Facilitate experimentation with alternative	30

	management approaches	
P38 fishermen training	Standardise fishermen's training in Europe to improve safety at sea and raise awareness of respect for the environment and cooperation with scientists	22
P39 virtuous behaviour	Encourage virtuous behaviour	7
P40 ownership monitoring	Incorporate transparent monitoring of ownership of the means of production	46
P41 multiannual quotas	Establish multiannual rolling quotas	40
P42 individual quota	Progressively introduce individual non- transferable quotas	25
P43 climate change and flexibility	Implement more flexible management in the context of climate change	18
P44 binding regional measures	Enable the implementation of binding regional measures	41
P45 bilateral agreements	Take into account all existing forms of bilateral or private agreements in the context of fisheries agreements with non-EU countries	33
P46 consistency of management units	Realign management units with assessment units	10
P47 weight of AC	Reinforce the role of regional bodies (RACs)	44
P48 role of RFMO	Strengthen and review regional fisheries management organisations (RFMOs)	31

P49 update relative stability	Review catch records according to equity and sustainability criteria	14
P50 simplify regulatory patchwork	Build on existing regulations and simplify the regulatory patchwork	28

SUPPLEMENTARY MATERIAL

Theme	Number	Best-Worst scaling ranking	Title of proposal	Development	Refs
Protection/Conservation	P1	9	Take a precautionary approach to 'new' stocks	<p>In 1995, United Nations Article 6(6) on stock definition stated: "For new and exploratory fisheries, States shall adopt as soon as possible cautious conservation and management measures, including, inter alia, catch and effort limits. Such measures shall remain in force until there is sufficient data to allow assessment of the impact of the fishery on the long-term sustainability of the stocks, whereupon conservation and management measures based on that assessment shall be implemented. The latter measures shall, if appropriate, allow for the gradual development of the fisheries."</p> <p>Clear rules should therefore be defined within the CFP to apply these general principles to new stocks (mesopelagic fish, copepods or others). The aim is to avoid a windfall effect due to a legal vacuum (see e.g. consequences of deep-sea fishing) and to allow time for the acquisition of the necessary data for the promulgation of scientific recommendations. These rules could, for example, be inspired by the rules laid down by the Convention for the Conservation of Antarctic Marine Living Resources, the South Pacific Regional Fisheries Management Organisation and the South-East Atlantic Fisheries Organisation, which have clearly defined the concepts of new and exploratory fisheries. Access to these fisheries should be limited to data acquisition until they can be properly assessed and reference points defined.</p> <p>See Caddell 2018 for more examples. (https://doi.org/10.1163/15718085-13310013)</p>	[1]
	P2	27	Improve knowledge and management of recreational fisheries	It is recognised that recreational fisheries have significant impacts on certain stocks, which it is important to quantify in order to provide relevant and reliable scientific recommendations. When these stocks are subject to TACs and quotas, it is crucial to be able to regulate recreational fishing as well.	[2–5]
	P3	42	Increase fish size limits and create size limits for all species caught	Size limits for fish caught are one of the measures used to influence the exploitation pattern of a species. Increased size limits would increase the spawning biomass. Although the size threshold at maturity is often used as an example (although this is debatable depending on the lifecycle of the species), size limits only make sense if they are consistent with regulatory mesh sizes (for many species, the survival rate of discards is limited) and, above all, if they are used as a tool for optimal management combining fishing effort and exploitation pat-	[6–9]

				terns. These changes in size limits must be considered in conjunction with the landing obligation.	
	P4	36	Increase regulatory mesh size	Increased mesh size is among the measures that can improve the selectivity of fisheries and ultimately the productivity of the stock. While such measures have been implemented in some fisheries, no multispecies reviews of the effect of different mesh size scenarios have been conducted at the scale of eco-regions, in terms of landings/discards, biomass, income, etc. This should be one of the first objectives set for STECF, in collaboration with the RACs, in the framework of the next CFP.	[10]
	P5	3	By 2030, assess all exploited stocks in the Mediterranean	Many stocks in the Mediterranean are currently not assessed. Reference points should be defined and population status indicators established for all exploited stocks. The methods used to define these reference points (data limited to analytical assessment) may depend on the data available. This should be implemented as a priority in European waters of the Mediterranean, with Europe subsequently advocating its application to all GFCM waters.	[11–14]
	P6	23	Develop a fleet-based approach	The ecological impacts and economic and social performance of each European fleet should be evaluated, based on an evolving dashboard set up in consultation with stakeholders (professionals, NGOs, scientists, under the arbitration of policymakers), and these evaluations made public. Currently, this assessment is only carried out at stock level and no indicators are used at fleet level. The dashboard could be based on the work carried out by the STECF (SG-MOS 10-03: Ecosystem Approach in Fisheries Management). This fleet-based management should in particular better assess the impact of various types of fishing gear.	[15–17]
	P7	43	Develop real-time incentive approaches	Management by RTI consists of allocating fishermen a quota of points that they can use to fish in an area. The point maps are regularly updated and several criteria can be taken into account: ecological criteria (oversize, TACs reached, by-catch, etc.), socio-economic criteria (market conditions, technical interactions). This system makes it possible to optimise exploitation according to different criteria, encouraging fishermen to adapt their fishing strategy. The cost maps can be co-constructed within the framework of the regionalisation of fisheries to reflect the interests of the various stakeholders, and thus contribute to greater acceptability. Kraak, S. B. M., Reid, D. G., Gerritsen, H. D., Kelly, C. J., Fitzpatrick, M., Codling, E. A., and Rogan, E. 2012. 21st century fisheries management: a spatio-temporally explicit tariff-based approach combining multiple drivers and incentivising responsible fishing. ICES Journal of Marine Science, 69: 590–601.	[18–22]
	P8	13	Develop a network of marine protected areas with a sufficient level of protection	The creation of MPAs is a measure (perhaps the only measure?) that can preserve the whole ecosystem and benefit adjacent ecosystems (spillover), as well as serve as a tool for marine spatial planning. The Aichi Biodiversity Targets set a goal of 10% of MPAs worldwide. A French working group even set the bar at	[23–27]

				<p>20%. It is clear that this objective will not be reached globally (only 6% of the Mediterranean is currently protected, for example). Worse still, even in countries where the theoretical objective has been met, the level of protection put in place in MPAs is too low to make them effective. In 95% of MPAs, regulations are no more restrictive than outside their limits (Claudet et al. 2020). Less than 1% of the European EEZ would be classified as level 1 according to IUCN criteria (i.e. marine sanctuary, the highest level of protection) and only 1.8% (in 2019) of the EEZ was covered by MPAs with a real management plan in place (in France, this is currently around 5%). There is also a need for real experimentation with one or more MPAs with a high level of protection in order to be able to observe the ecological and fisheries consequences in European waters, particularly in the North-East Atlantic (this exists in small areas in the Mediterranean).</p> <p>It is thus necessary to continue to develop the network of MPAs in Europe, while backing them up with clear management plans that guarantee real protection of biodiversity. In addition to MPAs, it is necessary to integrate the protection of functional zones, and therefore to set up conservation areas within fisheries.</p>	
	P9	1	Develop management that takes into account the spatial and temporal variability of the marine populations caught	<p>Few measures yet take into account the spatial and seasonal ecology of species and their exploitation methods. However, many solutions can be envisaged (e.g. gear adapted to the area, seasonal moratoriums) to better adapt exploitation to the lifecycle, habitats and environment of the species. These measures should be developed to better protect essential habitats and species in their most vulnerable phases or in phases of high concentration in functional zones (nursery areas, spawning grounds; e.g. debate on the vulnerability of sea bass at the time of reproduction).</p>	[28–32]
	P10	4	Establish quotas in the Mediterranean for the main species exploited	<p>In the western Mediterranean, the management plan is currently based on fishing effort. As things stand, there is no clear link between this and fishing mortality (this has been tested by the STECF, for example) so this does not allow for sustainable management. As a first step, it is necessary to improve the quality of the effort data (change to fishing hours rather than days and cross-check this with VMS data). The example of the cod plan in the North Sea shows that a drastic regulation of effort can provide results if it is indexed on the F/F_{msy} ratio. However, the mixed fishery context in the Mediterranean further complicates this type of management, so it would be necessary to introduce a system of restrictive catch quotas, based on a scientific assessment of the stocks (even in a data-limited situation), although Member States are currently reluctant to accept controls given the number of landing points.</p>	[33,34]
	P11	16	Implement management based on exploitation pattern	<p>Currently, TAC calculations are based on the MSY for a given exploitation pattern. However, reaching MSY can have very different effects on the spawning</p>	[8,35]

			and fishing intensity	<p>biomass of stock depending on the dynamics of the species and the exploitation pattern considered. A sustainability criterion linked to impact on biomass should therefore be introduced into the calculation of quotas, which would guarantee a 'sufficient' level of biomass and encourage the joint optimisation of effort and exploitation pattern. For example, as a first step, it could be required that the TACs set should not result in a reduction of more than 50% of the biomass in the pristine state. This could be done either by lowering fishing mortality F under F_{msd}, or by increasing minimum fish size (and mesh size), or a combination of both. A transitional phase could be envisaged (as we are far from this target), which could be defined in the management plans. In the longer term, we could perhaps move towards 40%.</p>	
	P12	47	Establish quotas by functional traits	<p>At present, quotas are mainly set at species level and take little or no account of ecosystem functioning. Along the lines of the model that exists for technical interactions (F_{cube}) or certain trophic interactions (MSVPA), tools need to be designed to explore and discuss the impact of quotas on functional groups, and then to set quotas that (1) ensure a certain threshold of diversity of functional traits in a community or ecosystem and (2) ensure a certain threshold of functional diversity.</p>	[36,37]
	P13	32	End the tax exemption for marine diesel	<p>The increase in the capacity of fishing fleets during the second half of the 20th century has made it possible to amplify their efficiency and dramatically extend both fishing grounds and the range of species exploited. This has been achieved at the expense of rising fuel consumption (40 billion litres in 2011), increasing greenhouse gas emissions (179 million tonnes of CO₂-equivalent GHG, 4% of combined agriculture, fishery and livestock emissions Parker et al. 2018), and the sector's dependence on oil prices (between 30 and 50% of production costs are linked to fuel on average). This increase has been partly enabled by the tax exemption allowed for fishing vessels by Article 14 of the EU Directive 2003/96/EC (in France, marine diesel is zero-rated under Article 262 of the General Tax Code), limiting the cost of fuel. In the context of climate change and the urgency of reducing all greenhouse gas emissions, this exemption should be reversed. By re-taxing fuel, the increase in production costs would force a reduction in the distances travelled, thus reducing greenhouse gas emissions. This would also have the indirect benefit of limiting fishing effort in areas further from the coast. In the longer term, it would also reduce the dependence of fishermen on oil price fluctuations. For greater acceptability, this measure should be implemented gradually, and the revenue from taxation reinvested in the sector through subsidies to support sustainable development, the fight against climate change and technological research to reduce consumption. Co-constructed transitional compensation measures could be envisaged.</p>	[38]
	P14	35	Protect low trophic levels through ecosystem-based	<p>Low and intermediate trophic levels contain many species that are not or only marginally exploited, and which benefit from the exploitation of their competitors</p>	[29,30,39–41]

			management	and predators. This leads to a modification of species assemblages to the advantage of these uninteresting species (a terrestrial analogy could be made with 'weeds' as opposed to desirable plants). This sometimes leads to serious dysfunctions (e.g. jellyfish blooms). It is thus important (1) to limit the impact on species exploited at these low species-rich trophic levels: for example, by setting a high minimum biomass threshold (e.g. 2/3? of the pristine state); and (2) to avoid extending fishing to currently unexploited trophic levels (zooplankton, in particular), by adopting a precautionary principle: no fishing of trophic levels (or components of species assemblages) for which we are unable to estimate the fishing pressure on the productivity of each species.	
	P15	5	Protect prey and habitats through ecosystem-based management	The capture of forage species (and more generally of all prey species) has direct repercussions on their predators, which are generally not taken into account in the definition of management objectives and in the calculation of TACs. Conversely, minimum biomass constraints must be introduced that take into account this specific role of prey species, either by setting a precautionary threshold (e.g. 50%? of the biomass in the pristine state, or 60%? or more if the predators are themselves sensitive or threatened species), or by subtracting from the TAC a volume reserved for feeding predators. The definition of these thresholds should be systematically evaluated in the context of the implementation of multiannual management plans. The classification of a species on the IUCN Red List or the list of species protected by the CFP (Annex 1 of the technical measures regulation) should lead to a systematic scientific assessment of the state of the populations that serve as their prey and of the possible need to protect them beyond the usual rules of good management. The same principle of enhanced protection should also apply to the habitats of these threatened and/or protected species.	[40,41]
	P16	50	Reduce the impact of scientific campaigns	The collection of scientific data to assess the state of an ecosystem may disturb or impact it depending on the means of collection. It is important to consider and use collection methods that limit these disturbances and impacts by developing non-intrusive sampling methods and equipment.	[42,43]
	P17	19	Review the landing obligation	While the discard ban was a virtuous initiative, the way it is implemented often makes it counterproductive. The current regulation is too complex to be understood, the controls are insufficiently enforced, the level of effort reduction is ultimately lower than it was over the 2008–2018 period, and it is a source of food waste. Without calling into question the initial objective of drastically reducing waste, which is an absolute necessity, technological development aimed at reducing unwanted catches should be pursued (work on gear, fishing seasons and areas), prioritising incentives rather than top-down coercive measures (particularly for virtuous fleets) to obtain information on the total catch, to ensure that all catches (whether landed or not) are taken into account in the calculation of quota consumption, to provide adequate means of verification, and to avoid food	[44–46]

				waste generated by the measure.	
	P18	39	Deal with lost gear at sea	Currently, the United Nations Environment Programme estimates that 10% of the plastic in the oceans comes from fishing gear that has been lost at sea, and an estimated 46% of the Pacific garbage patch comes from fishing gear. In addition to the well-known problem of ghost fishing, pollution from lost gear is a major source of microplastics in the food chain. The CFP must take the necessary measures to encourage gear with a limited risk of loss, require gear recovery (e.g. recovery of gear by ROV in Corsica), and develop new materials that limit this source of pollution (bio-degradable gear).	[47–50]
	P19	20	Subsidise transition to sustainability	The perverse effects of certain subsidies on fisheries have been widely demonstrated and have led, in particular, to the structural overcapacity of the European fleet. Sustainable fisheries should not exist through subsidies. Financial aid should therefore be restricted or have the objective of achieving sustainability or improving safety onboard vessels. If subsidies are granted to encourage the transition to more sustainable practices, which is currently very limited, this should be done through a multicriteria evaluation by a group of stakeholders. These subsidies should not be intended to be long-term but to accelerate the transition at a given time.	[51–53]
Improved scientific assessment	P20	8	Capitalise on the ecosystem modelling efforts produced across Europe for integrated ecosystem assessment	<p>Despite the existence of a steering group on integrated ecosystem assessment within the ICES, few of the recommendations issued are truly integrated. Two examples of efforts in this direction include:</p> <ul style="list-style-type: none"> - Ecosystem overviews [https://www.ices.dk/advice/advisory-process/Pages/Ecosystem-overviews.aspx] which aim to integrate existing scientific knowledge on an ecosystem into a summary document - the WGSAM working group (Working Group on Multispecies Assessment Methods [https://www.ices.dk/community/groups/Pages/WGSAM.aspx]) which has built a standard procedure for the validation of multispecies and end-to-end models and, after validation, requests the annual production of key-runs based on updated data. This group produces natural mortality rates taking into account trophic interactions and used for the assessments of a number of North Sea stocks. <p>However, these examples represent only a fraction of the knowledge and models produced in national or European projects to answer specific ecological or management questions. The establishment of regularly updated 'benchmark models' for various ecosystems that could be used to answer questions requiring ecosystem expertise seems essential and would also encourage the greater integration of ecosystem considerations into stock assessment models.</p>	[54–56]

	P21	26	Collect the data needed to inform ecosystem models	While the EU Data Collection Framework has enabled the routine acquisition of data on long-exploited stocks, it focuses on the data needed to apply conventional single-species stock assessment models. This has resulted in a lack of information on biological data such as diets, juvenile ecology, and planktonic and benthic production. Efforts need to be stepped up to acquire this biological data, which is key for the trophic and ecosystem models used in an ecosystem approach to fisheries. Data assimilation procedures should be encouraged in a similar way to those used for meteorological and oceanographic models.	[49,57]
	P22	17	Consider indicators complementary to spawning biomass (e.g. size structure, condition) to assess the status of populations	At present, fisheries management is based primarily on monitoring fishing pressure and spawning biomass according to MSY. However, these composite measures can conceal very different population structures. The size/age structure of the population is little taken into account, nor the energetic state of the individuals. Yet it has been observed that changes in demographic structure due to fishing or environmental conditions can have long-term effects and be the source of genetic selection if maintained over the long term. Other indicators of population status such as average size or condition factors should therefore be additionally considered. This would allow the implementation of specific measures (e.g. dynamic protection of size classes by spatial management/selectivity), and would be complementary to the principle of optimising the exploitation pattern to minimise its impact on the population.	[58–60]
	P23	24	Develop a socio-economic and ecological dashboard to analyse multidimensional trade-offs	To date, scientific assessment and management objectives have been based mainly on MSY, neglecting ecosystemic, social and economic aspects. Rather than using a single-species ecological indicator, a global indicator should be used and a dashboard established that could be used to monitor stocks, fleets, regions and Member States. This indicator should include ecological indicators (fishing mortality, SSB, etc.), economic indicators (turnover, prices, etc.) and social indicators (number of jobs, income, etc.), as well as corresponding targets (e.g. MSY, MEY, etc.). By strengthening the use of integrated trade-off analysis methods (combining quantitative and qualitative indicators) and standardising the indicators provided, this tool would allow a more holistic view when evaluating alternative management plan scenarios by illustrating potential trade-offs between the different aspects of the problem, and thus better inform decision-making.	[61]
	P24	37	Diversify/redirect the targets of monitoring programmes	Monitoring programmes are defined at a national level and evaluated annually by the European Commission via the STECF. However, this evaluation mainly focuses on the capacity of these programmes to provide data on the assessment of commercial species, with a particular focus on species subject to TACs and quotas. It is important to develop these programmes for species/stocks that are not or little monitored, yet represent a strong economic interest, as well as for key species in the ecosystem (sentinel species), even if these are little exploited.	[62–64]

	P25	11	Update the definition of stocks and populations for the assessment of certain species	The notion of stock is defined as functional biological units. Their boundaries evolve as knowledge advances, and the delimitation of stock is still uncertain in many situations (e.g. sole in the eastern Channel or cod in the North Sea). This lack of knowledge can lead to bias in the assessment process and thus have consequences in terms of management, potentially leading to unsustainable exploitation. Efforts must be made to continue to acquire data in order to refine and validate the delimitation (e.g. multi-marker approaches including genetic methods).	[65,66]
	P26	45	Make it compulsory to accept observers on board	In many countries, observers are accepted on a voluntary basis. Although the DCF now collects statistics on refusals, this can lead to bias in the data, with only 'virtuous fishermen' tending to take observers on board, which is even more the case in the context of landing obligations. To prevent this, the acceptance of observers could be made conditional on the granting of fishing licences, as is the case in some countries.	[67,68]
	P27	12	Review the MSY management approach	MSY management, which is a step forward from the precautionary approach, is a single-species criterion for maximising catches for a given exploitation scenario. It does not take into account ecosystem impacts or socio-economic effects. The North American practice of using buffers around TACs to reflect uncertainty linked to trophic relationships (particularly on the basis of the results of trophic models and when a significant change is detected in the ecosystem – abundance of a predator, decline in prey, risk of carryover from a fishery whose main species is less accessible) could be used as a model. This practice could also help to approximate the MEY, which is generally reached at fishing pressure levels below the MSY.	[69,70]
Consumer information	P28	29	Improve the display of the origin and species of fish for consumers	The display of the origin of fishery and aquaculture products (FAP) must be systematised for all FAP, whatever their level of processing. The origin should be indicated at a more detailed level than the FAO's division into major fishing areas. The scientific name of the species must also be mentioned systematically, whatever the level of processing of the product.	[71–74]
	P29	49	Define impact-free labels	Some species are emblematic for the general public, and the impacts of fishing on these species are therefore critical and are sometimes the focus of shock campaigns by NGOs. While research efforts are needed to limit these impacts, Europe could introduce 'impact-free' labels guaranteeing the absence of impacts of a fishery/gear on these emblematic species. This notion of impact should be clearly explained and defined in consultation. One example is the case of marine mammals, which recently made the headlines.	[75–77]
	P30	38	Define a European sustainability label	All fishery and aquaculture products (FAP), whether from Europe or elsewhere but sold on the European market, should be given a sustainability score, according to a simple and transparent scoring system. This label would be intended to guide consumers by allowing them to compare FAPs in terms of sustainability. The creation of this label should take into account indicators common to all	[71–74]

				foodstuffs (e.g. carbon cost) but also specific to FAP (state of stocks, fishing area and technique, etc.).	
	P31	34	Define a public 'European sustainable fisheries' label for stocks managed according to EU objectives	A label should be created to identify fish caught in European waters according to EU sustainability criteria. This would have the double virtue of allowing consumers to know whether the sustainability criteria for exploitation were respected, and to be able to differentiate fish from those from more distant areas in order to encourage local consumption.	[73,74]
Governance	P32	6	Align the objectives of the next CFP with international biodiversity conservation objectives; less siloed conservation/restoration policies	The aim is to apply the same policy framework to the fishery and aquaculture sectors as for biodiversity. Clear targets (around 20) should be set and achieved by 2030 with the overall objective of 'living in harmony with nature' by 2050. These targets would be evaluated and monitored over time (annually) and space (at local, regional, national and European levels). In general, these targets (very similar to those for biodiversity conservation and restoration) should contribute to achieving (among others) the Paris climate agreements, UN Sustainable Development Goals (SDGs), and the revised Aichi Biodiversity Targets as part of the new Strategic Plan for Biodiversity renamed 'Post-2020 Global Biodiversity Framework'. It must also align with and make every effort to achieve the targets/ambitions announced under the United Nations Decade of Ocean Science for Sustainable Development (2021–2030). It must go further in addressing threatened species, bycatch and protected areas and promote nature-based solutions.	[78,79]
	P33	48	Define fishing rights in the form of a concession	The current fisheries system suffers from an inherent flaw: it pushes fishermen to catch as much as possible before the overall quota is reached. This race is exacerbated by fluctuating prices and, in some cases, by the lack of rules on the price of fish. One way to reverse the problem, to mitigate market price fluctuations, and to ensure a 'minimum'/fair income for fishermen would be to allocate quotas in the form of a concession allocating a certain amount of catch. As in an individual quota system, the fisherman's total catch would thus be known in advance. In such a concession system, mechanisms could be put in place to mitigate price fluctuations, with a basic buy-back price for fish that could be fixed in advance in the concession contract. This contract could be concluded, for example, between the fishermen and the government, which would thus act as an intermediary between fishermen and buyers. The conditions of the concession contract (basic price, etc.) could possibly be used as a lever for incentive measures (e.g. retrocession of a certain percentage of the surplus value subject to the acceptance of onboard monitoring observers).	[80,81]
	P34	2	Develop management approaches in concertation with all stakeholders in the sector	Several recent crises have shown that the acceptability of fishing practices on the part of those in the fisheries sector, other stakeholders and the general public can be strongly questioned (the so-called 'social licence to operate'). Prior consultation is one of the means of avoiding these crises and blockages and should be widely promoted, particularly in the context of the regionalisation of	[20,82–84]

				<p>fisheries. Within the framework of multiannual management plans, the implementation of gear, type of vessel, species, exploitation area, as well as measures (incentives, bans, access rules, etc.), should be co-constructed. It is recommended that the relevance of all of these modalities be evaluated through Management Strategy Evaluation (MSE), and that reviews of previous plans are also jointly constructed.</p>	
	P35	21	Develop circular economy approaches	<p>Developing circular economy approaches in fisheries and aquaculture markets would optimise the exploitation of marine bioresources, enhancing the use of the resource at all stages of the product lifecycle. This would reduce the environmental impact of the sector, while supporting the economy of areas dependent on marine resources.</p>	[85,86]
	P36	15	Make assessment of resources and fisheries more transparent and accountable	<p>In Canada, some assessments are carried out jointly by scientists, fishermen and managers (e.g. https://waves-vagues.dfo-mpo.gc.ca/Library/40708196.pdf). If scientists carry out the analyses, they present the results to all the participants and a joint recommendation is drafted. In this way, everyone has access to the scientific information used to make the decision. This way of working could be envisaged in Europe to facilitate a triangular dialogue between fishermen/managers/scientists, avoiding the distortion of information and allowing exchanges to take place upstream in the decision-making process rather than downstream. The transparency in the process would be aided by providing data in the greatest possible detail.</p>	[83,84]
	P37	30	Facilitate experimentation with alternative management approaches	<p>Historically, the CFP has appeared too prescriptive and restrictive of local initiatives; this has made the system sclerotic, making collaboration between stakeholders seem futile. However, several examples, such as in Scotland and Norway, have shown that local initiatives co-constructed by stakeholders have led to a virtuous reform of the entire sector. The regionalisation of fisheries could be a step towards making the CFP more flexible. To further stimulate these local initiatives, the CFP could promote local experimentation with alternative management approaches through an official framework. This should be based on specifications that clearly spell out the objectives, the methods of measurement and the means put in place to monitor effectiveness, all of which should be validated by an independent scientific body and subject to regular reporting. A rigorous framework would make it easier to share feedback.</p>	[87]
	P38	22	Standardise fishermen's training in Europe to improve safety at sea and raise awareness of respect for the environment and cooperation with scientists	<p>There is no standard in Europe for the training and certification of fishermen. Although since 2019 the European Commission has encouraged Member States to sign the International Convention on Standards of Training, Certification and Watchkeeping for Fishing Vessel Personnel (STCW-F Convention), not all have yet done so. (France has just signed and is consequently updating its training courses.) This results in highly heterogeneous training and qualifications of fishing professionals, raising questions about safety at sea. Fishing remains one of</p>	[88–90]

				<p>the most dangerous occupations in Europe, and inconsistency in safety training poses a problem in the context of free movement within the EU. The second aspect is the need to raise awareness among fishermen, particularly fishing captains, of ecological issues and the sustainability of fisheries. To achieve this, it seems essential that European fishermen have basic knowledge of the functioning of exploited marine populations, the effects and risks of overfishing, and more generally the ecology of species and the functioning of ecosystems. In this respect, the current requirements in France would seem to be a minimum. These include 20 hours of training on the environment and resource management (ranging from physical oceanography to population dynamics, including the biology and ecology of all the components of the ecosystem) in the 'Fishing Management' module for a fishing captain's diploma, or knowledge of the environment and resource management in the vocational baccalaureate 'Conducting and managing maritime businesses, fishing option'. The training requirements should also enlist scientists in the aim of encouraging exchange between fishermen and researchers.</p>	
	P39	7	Encourage virtuous behaviour	<p>At present, fisheries management is mainly based on taxation, subsidies and bans. In recent years, incentive-based management has proved successful in various countries (e.g. Scotland, Norway). These incentives should help fishermen to make a living from their profession, promote virtuous behaviour for the ecosystem or the industry, and encourage data acquisition. Incentives could take the form of compensation: additional effort (days at sea, real-time incentive credits or rate cards with reduced rates), more access to a region (in time or space), higher quotas, eco-certification, etc. In terms of quotas, the EU could, for example, use Article 17 of the CFP to set aside 10% of each TAC as an incentive reward (this regulation already allows this possibility). The choice of the best type of incentive, from the point of view of relevance and effectiveness, should be co-constructed with all the stakeholders.</p>	[83,91,92]
	P40	46	Incorporate transparent monitoring of ownership of the means of production	<p>At European level, the question of ownership of the means of production (vessels and fishing rights) in the fisheries sector is becoming an important issue. It is important to be able to assess the economic and social implications (concentration of capacity and production, impacts on the distribution of wealth) of fisheries policies and the methods of allocating fishing rights (quotas, licences, etc.).* Ownership of the means of production cannot be assessed solely at the level of vessels but needs to take place at the level of companies. In the European vessel fleet register, which is publicly available online, there is no information on the ownership of vessels by companies. However, in each country, companies are referenced by a unique identification number. Each Member State should provide the European Commission with the company registration data for each of the vessels in the fleet register so that the situation in the sector can be analysed in terms of ownership and concentration of production means</p>	[93]

				and fishing rights. * This is not a new issue: it was discussed at the last STECF Social Group [https://stecf.jrc.ec.europa.eu/web/stecf/ewg2014]	
	P41	40	Establish multiannual rolling quotas	More and more fishing stocks are subject to multiannual plans. To guarantee greater stability of fishermen's incomes, a further step would be to introduce multiannual rolling quotas. This would require being able to define the rules for interannual variations, as well as to formulate clear rules for reconsideration in the event of an exceptional situation.	[94]
	P42	25	Progressively introduce individual non-transferable quotas	Management based on individual quotas has shown positive results in many situations. It allows fishermen to take responsibility and gives them visibility over management. Yet transferability has led, in countries where this has been allowed, to a concentration of fishing rights in the hands of a few actors. Individual quotas should therefore remain public and verifiable in order to avoid inflation, speculation and concentration. Quotas could be allocated for 5 to 10 years, either directly to fishermen or to representative bodies such as producer organizations (POs). Inter- and intra-PO exchanges could be authorised, but the rules must be clear, public and transparent to avoid speculation.	[95–97]
	P43	18	Implement more flexible management in the context of climate change	In the current environmental context, the distribution of stocks and the biological productivity of species is bound to change, so management must be able to adapt quickly to these developments. This means that the definition of stocks and the allocation key between and within countries must be capable of evolving more rapidly than when the CFP was established. The same applies to reference points, the data collection system and technical management measures. This is important for the sake of future equity between stakeholders and to ensure the sustainability of species. Tracking allocation keys between countries as species distribution gradually shifts would ensure that stocks are fished by vessels that are close to each other, thus limiting a carbon-intensive import/export process.	[98,99]
	P44	41	Enable the implementation of binding regional measures	In the decentralisation of fisheries, if specific local regulations are implemented that are more restrictive than EU regulations, they should apply to all vessels fishing in the area concerned. While unilateral decisions cannot be taken by one country, the CFP should establish rules allowing more restrictive regional regulations (e.g. voting in RACs? 12-mile band for each country?), and then work to ensure that the more restrictive measures are applied by all (e.g. scallops in Normandy or seasonal closures in shared waters).	[100]
	P45	33	Take into account all existing forms of bilateral or private agreements in the context of fisheries agreements with non-EU countries	Fisheries agreements should not be based on the unfair concept of surplus, but on a principle of compensation (by the fleet owners and under EU control) for all social and economic impacts, direct or indirect, and subject to the establishment of a management plan for the fisheries concerned. The agreements should be fully transparent. The impact on EU fisheries should be assessed on the basis of all the activities of fisheries under the jurisdiction of the Member States, includ-	[101–103]

				ing those under bilateral or private agreements, as well as the activities of 'national' fishing companies that are de facto financed by European companies. All these actions should be undertaken by the EU, which must have the means to sanction Member States and companies that violate this general principle.	
	P46	10	Realign management units with assessment units	The management units on which TACs are set were defined at the time of the first CFP and have never been redefined since. They have gradually diverged from stocks as defined by scientists for assessment purposes, which have themselves evolved over time with advances in knowledge about fish populations. This leads to unnecessary complexity, opacity, the impossibility for managers to follow scientific recommendations as closely as possible and, in some cases, risks for the sustainability of species.	[104–107]
	P47	44	Reinforce the role of regional bodies (RACs)	When they were created in the mid-2000s, the Regional Advisory Committees (RACs) were supposed to be the consultation body at the heart of the regionalisation of fisheries, able to provide recommendations to the EU or respond to requests for measures to be implemented. Bringing together all stakeholders, they allowed for dialogue between industry, NGOs, fisheries managers, etc. However, their role has been limited in recent years, and they have had little influence on decisions taken at the EU level. Moreover, dialogue in these bodies has progressively stalled, and the EU now tends to bypass the RACs through the Member States. Yet the need for consultation and dialogue between stakeholders makes such structures essential. The RACs thus need to be revitalised, and to this end they should be involved earlier in the decision-making process (at the moment, consultations take place at a late stage, once the directives are almost ready), or given more responsibility for implementing local management measures. Their internal governance needs to be reviewed to remove the bottlenecks that have led to the current situation.	[108–110]
	P48	31	Strengthen and review regional fisheries management organisations (RFMOs)	The governance of RFMOs should be reformed with five objectives: (1) to make scientific recommendations more binding; (2) to revise quota allocation based on historical rights in favour of developing countries: e.g. 10% of TACs defined on the basis of development criteria (to be defined) and a gradual increase in this rate; (3) to give developing countries greater political weight; (4) to ensure NGOs are represented; (5) to provide financial support to developing countries that are members of an RFMO in order to strengthen fisheries research capacity, as well as the verification and enforcement of fisheries regulations.	[111,112]
	P49	14	Review catch records according to equity and sustainability criteria	While the allocation key for fishing rights between countries is managed at the EU level and has remained unchanged since 1983, intranational allocations are the responsibility of the Member States, which often delegate to producer organisations for a more detailed allocation. At all levels, allocation keys are based on past catches, which are sometimes out of date and therefore unfair. In the interests of equity (e.g. between small-scale and industrial fishing) and sustainability, the EU should regularly update its allocation key and make it explicit, and re-	[97,113]

				quire Member States to do the same at their level. Rather than relying solely on historical data, all stakeholders in the fisheries sector (producers, NGOs, policymakers, scientists, managers) should be involved. The key could also take into account local consumption to avoid a high import/export carbon footprint. These reforms could limit situations where discards are produced because of quota limits.	
	P50	28	Build on existing regulations and simplify the regulatory patchwork	A multitude of regulations exist at European (CFP, MSFD, WFD), national and even regional level, resulting in a complex system and a negative perception of regulatory red tape. Rather than proposing new rules, the reform of the CFP should be based on what already exists (CFP, MSFD, WFD), while identifying and removing bottlenecks. The aim should be less complex regulation that is accessible, understandable and less 'siloed' between directives. The CFP–MSFD dichotomy is largely obsolete and should be merged with spatial planning issues, both regulatory and financial. Better understanding and acceptance requires broad stakeholder consultation in this reform process, to ensure that regulation addresses a consistent number of performance objectives. Furthermore, regulations would benefit from taking into account the behaviour of stakeholders, drawing on the effects of behavioural sciences (social norms, peer effects, nudge, etc.: see Ingrid Van Putten's work) to improve their effectiveness.	[78]

Table MS1: The proposals grouped by theme, with the explanatory text provided to voters to help them rank their priority. The columns “title of proposals” and “Development” display the proposal exactly as they were presented during the online survey (except the translation from French to English). The column Ref lists some additional background literature that were added a posteriori.

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