

# Evolution of EU technical measures for the avoidance of unwanted catch in the light of scientific evaluation and advice from the STECF; the good, the bad, and the ugly

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The EU deploys technical measures (TMs) to avoid unwanted catches—here, overquota catches and juveniles of commercial species—including gear specifications and closures. In 2012, the European Commission had asked its advisory committee, Scientific, Technical, and Economic Committee for Fisheries (STECF), to evaluate the TMs and provide recommendations for improvement. In 2012–2013, STECF judged that the TMs had failed to achieve their objectives and identified approaches for improvement: (1) regionalization and move away from top-down management; (2) bottom-up results-based management to internalize the costs to the resource into individual businesses; and (3) abandon threshold percentages of bycatch leading to perverse incentives. In 2014, the new EU Common Fisheries Policy came in force, with a landing obligation (LO), and regionalization. In 2019, the new TM regulation (TMR) came in force. Besides sets of regional baseline measures, the TMR allows for regional proposals for amendments and results-based bottom-up approaches (“the good”). However, the LO is not enforced, therefore, not providing the incentive for change in fishing practices; and despite avoidance strategies being available regional, innovative bottom-up practices are still rare (“the bad”). TMs still contain threshold percentages (“the ugly”). The onus for bottom-up initiatives is on the industry, although new governance structures are needed to facilitate this.

**Keywords:** bottom-up, discards, EU, landing obligation, micromanagement, regionalization, results-based, technical measures, top-down, unwanted catch.

## Introduction

Worldwide, fisheries managers attempt to curtail the catches of unwanted specimens, which are often discarded. Unwanted catch may consist of commercial species for which quotas are used up, juvenile specimens, or ETP (endangered, threatened, and protected) species. Unwanted catches may lead to overfishing of commercial species and unacceptable mortality of ETP species. Most jurisdictions regulate their fisheries with instruments that specify limitations to fishing input or output. The European Union (EU) technical measures (TMs; e.g. in the current technical-measures regulation (TMR); EU, 2019a) specify the conditions under which fishers are permitted to fish, in order to limit unwanted catches and the impact of fishing on marine ecosystems. These rules address the characteristics of fishing gear and the way it is used, the minimum size of the fish which may be caught or sold for human consumption, the composition of the catch in terms of percentages of species or juveniles, the closure or limitation to fishing in certain areas or during certain periods, e.g. to protect juvenile or spawning fish, and the preservation of sensitive species or habitats. In this paper, only those TMs are addressed that aim to limit unwanted catches of commercially exploited species, may they be overquota catches or catches of juveniles. TMs that aim to limit the bycatches of vulnerable species and impacts on habitats are not considered.

In two reports (STECF, 2012, 2013), the Scientific, Technical, and Economic Committee for Fisheries (STECF), which is a scientific committee advising the EU Commission (EC) on fisheries issues, had judged that TMs implemented in the

EU had failed, so far, to deliver the desired level of protection for juveniles and reductions in unwanted bycatch. The same reports provide an analysis of the institutional and regulatory settings and how these may, by design, favour or hinder reaching the objectives of the TMRs. This analysis is generic and relevant for other jurisdictions worldwide struggling with similar problems of non-achievement of management objectives. The EU regulations evolve through time and this evolution is accompanied by a dialogue between the EC and STECF, where the EC repeatedly asks advice from STECF on how to improve fisheries management. All STECF reports can be accessed at <https://stecf.jrc.ec.europa.eu/reports>. The aim of this paper is to provide a review of the evolution of the EU TMs for the avoidance of unwanted catch in the light of evaluation and advice from the STECF. It is checked whether the EU, in the course of time, did or did not incorporate or remove elements that STECF had identified as being likely to favour or hinder effectiveness of the TMRs. The current shortcomings are discussed in the light of the international literature.

Three periods are considered:

- (i) before the latest reform of the EU Common Fisheries Policy (CFP; before 2014);
- (ii) after the new CFP came into force but before the new TMR (2014–2019); and
- (iii) after the new TMR (EU, 2019a) came into force in August 2019.

In the first period, STECF was asked by the EC to evaluate the existing TMs as a preparation for the upcoming reforms.

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STECF advised on the shortcomings of the EU technical measures and made recommendations for improvement. The second period is characterized by two radical changes in the institutional and regulatory settings (the introductions of regionalization and the landing obligation), both in line with the STECF recommendations. In the third period, the new TMR is being implemented. These developments are reviewed against the advice of STECF and it is evaluated to what extent the identified shortcomings have been removed or still remain. This is followed by a discussion of how to further improve the effectiveness of TMs for the avoidance of unwanted catch.

### Before the latest CFP reform (before 2014)

The revised CFP was ratified in December 2013 and came into force the 1st of January 2014. Prior to that, in 2008, the EC had initiated renewal of the TMR that was in force (EC, 1998) through a proposal for a new regulation (COM, 2008). This proposal called for clearer, simpler rules, and a regional approach. However, the EC did not follow through with this proposal. In 2012, the EC established an STECF Expert Working Group (EWG) to assist in the development of TMs and to investigate possible new approaches to regulating TMs in the context of a reformed CFP. This EWG met in October 2012 and March 2013, producing two STECF reports under the title “Different principles for defining selectivity under the future TM [Technical Measures] regulation” (STECF, 2012, 2013). Both reports express the opinion that TMs implemented in the EU had failed, so far, to deliver the desired level of protection for juveniles and reductions in unwanted bycatch.

The first report (STECF, 2012) has an inventory of EU regulations containing TMs. Since 1980 and up to 2012, there had been 43 new regulations including amendments, implementing rules, and temporary TMs. In addition, there had been 31 regulations such as recovery plans that contain TMs, five regulations relating to TMs in non-EU waters, 10 gear specifications and operational measures, and two regulations on ecosystem measures. The first EU TMR was adopted in 1998 (EC, 1998). The report (STECF, 2012) stated that the fact that individual technical rules are seldom removed but in practice amended and added to, has led to a growth in the amount and complexity in technical regulations, which has led to increasing control and enforcement burden. This has necessitated continual up-skilling requirements for enforcement personnel, and overall has led to a reduction in control intensity of each rule (STECF, 2012). Complexity of the TMRs is added through the micromanagement by many conditional and detailed prescriptions, e.g. stating precisely which gear must be used where and when and under which catch compositions (stated as threshold percentages of species in the landings). Even more complexity is added when conditional derogations to the rules are given or when the rules are superseded by new rules for specific fisheries or areas or times of year or conditions.

According to the STECF reports (STECF, 2012, 2013), most of these TMs followed a top-down and highly prescriptive approach. This is likely to reduce buy-in from the industry and erode compliance (Kraak and Hart, 2019). This approach also resulted in detailed technical descriptions being specified in legislation and the measures were often difficult to monitor, control, and enforce. STECF (2012, 2013) also noted that TMs usually come at a business cost for the individual fishing

enterprise, due to accompanied loss of catch, while potential gains are in the future, highly uncertain, and shared across the entire fishery. This situation is not very conducive for the embracing of the measures by the fishers. At the same time, the costs to the resource and the ecosystem, caused by capture of unwanted catch, were external to the individual fishing businesses (STECF, 2012, 2013). Therefore, not only was the incentive to comply with the measures weak, but perverse incentives were created for the industry to focus on technical innovation to mitigate the potential losses of commercial catch, rather than on conservation or sustainability; this has resulted in a technological and regulatory arms race (STECF, 2012, 2013).

In the 2012–2013 STECF EWG (STECF, 2012, 2013), two changes were anticipated, because they had been proposed in the Commission’s Green Paper (EC, 2009), that were expected to improve the situation: regionalization and a shift towards results-based management. The first, already proposed by the Commission in 2008 (COM, 2008), constitutes a move to regionalized decision-making, meaning that only limited TMs would be agreed at Union level (i.e. under co-decision of the European Parliament and the Council of Ministers) with the majority of TMs developed regionally to the extent they are needed relative to the specificities of different fisheries. The CFP reform proposal (EC, 2009) proposed to move to a situation where member states are empowered and take responsibility for jointly agreeing on detailed TMs on the basis of a participatory, consultative process in the region, with measures then adopted at Union level.

The 2012–2013 EWG (STECF, 2012, 2013) considered results-based management as a positive development, because it would allow the industry some freedom and lead to a focus on achieving sustainability objectives such as minimum impact. Where the regulatory framework in force specified the technical details of how, where, and when fishing is permitted and not permitted (input), results-based management would rather focus on the intended and desired result (outcome), e.g. a specific catch profile or exploitation pattern, and leave it more open how to achieve that outcome. The EWG (STECF, 2012, 2013) thought that replacing technical specifications with catch-based targets, together with adequate monitoring, would reduce the tendency to negate measures and instead incentivize the development and application of gear and fishing tactics that would actually meet objectives. It was expected that, if management would focus more on the monitoring and control of outcomes and if the costs (to the resource) of the capture of unwanted catch would be internalized to the individual fishing business (e.g. fishers would experience closure of the fisheries as soon as they would exceed the target), there would be a stronger incentive for fishers to use gears and tactics that minimize these costs and it would allow freedom within the industry to choose the most appropriate tools to their business to achieve the specific targets. It was expected that the need for technical regulations would be minimal, as businesses would evolve to minimize unsalable catches and focus their exploitation patterns towards catch compositions that are economically optimal (STECF, 2012, 2013).

One example where a results-based approach had been applied in the EU is the now obsolete Long-Term Management Plan for Cod (EC, 2008; reviewed by Kraak *et al.*, 2013). This cod plan contained two possibilities for fishers to avoid the stipulated effort reductions. In a results-based manner,

if member states could demonstrate that a group of vessels had fishing tactics resulting in cod catches below a certain percentage, these vessels could be exempted from the effort restrictions. The fishing tactics could consist of, for example, fishing outside the cod distribution area or fishing with selective gear. Alternatively, member states could set up a so-called cod-avoidance plan, for example including real-time closures (RTCs) triggered by high cod catches (e.g. Needle and Catarino, 2011). If the member state could demonstrate that their plan would result in the required decrease of fishing mortality on cod, it could “buy back” some effort. The threat of effort reductions provided the incentive (the “stick”) to deploy tactics to avoid cod, but the EU cod plan left open by what means the cod catches would be kept low. This results-based setup has promoted bottom-up initiatives aimed at attaining set targets with measures that were more suited to local conditions (Kraak *et al.*, 2013). This experience has shown that given the right stimulus, the industry can rapidly develop and deploy fishing tactics, including gear and behavioural changes, when there are specific objectives and strong drivers to do so (e.g. exemption from the effort regime). It should be noted, however, that in this case, the role of monitoring and the burden of proof largely resided with the member states’ administrations. In order to expand catch-based management or results-based management approaches, it would be preferable that the burden of proof resides with the industry (STECF, 2012). Moreover, for such a burden of proof it is essential that all catches can actually be demonstrated, which was not the case and the cod plan did not achieve its objectives (Kraak *et al.*, 2013).

In the years just before the CFP reform, there were also pilot projects of so called Fully Documented Fisheries (FDF), i.e. Electronic Monitored (EM) fisheries, in combination with Catch Quotas (as opposed to the landings quotas that were in operation in the EU at that time). These schemes functioned by offering a reward (“carrot”) in the form of a quota top-up to participating fishers in return for providing full documentation of their catches for monitoring purposes (van Helmond *et al.*, 2015; Needle *et al.*, 2015; Mortensen *et al.*, 2017). These projects have stimulated fishers to fish more responsibly and to document and monitor their catches accurately (van Helmond *et al.*, 2020). Thus, the EU has tried out both carrot and stick incentives. The primary issue regarding results-based approaches, e.g. with catch quotas, is that it would require the comprehensive monitoring and quantification of catch (STECF, 2012, 2013).

Another problem that STECF identified is the setting of percentage thresholds in the catch composition that should not be exceeded to get access to exemptions or permissions, such as the effort-reduction exemption mentioned above if cod catches could be demonstrated to be below 1.5% of the catch (e.g. STECF, 2009a, b). In fact, many of the TMs consist of such micromanagement, linking permissions (to fish with certain mesh sizes in certain areas and times of year) to catch compositions. On the one hand, the catch compositions define the fisheries by minimum percentages of the target species in the (retained) catch. On the other hand, certain permissions are conditional upon maximum percentages of certain species, as in the cod plan just mentioned. Since these rules referred to the retained catch they were in effect landing-composition rules, requiring that fishers discard any fish caught in excess of those maximum percentages (STECF, 2015) but not hindering fishers to catch them. STECF (2011) has

warned against using maximum percentages, for the following reasons:

- Even when percentages in the catch are low, these catches can still contribute significantly to overall mortality of that species if overall catch or effort is high or when abundance of the species is low.
- Bycatch ceilings expressed as percentages of total catch also have a perverse incentive to maintain or increase catches of other species, and thus form a disincentive to improve selectivity for other species.
- Landing composition percentages for individual species can easily be met simply by discarding the fish in order to meet the prescribed rates.

STECF (2009a, b, 2011) thus concluded that such regulations do not help to avoid unwanted catches; STECF advised to rather use maximum absolute catch numbers (STECF, 2011; Kraak *et al.*, 2013), or, alternatively, to specify minimum selectivity standards and then to allow freedom for the industry to determine the specific gear characteristics required to achieve this (STECF, 2013).

In 2013, the EWG (STECF, 2013) also started exploring how TMs as drivers for changes in exploitation pattern (i.e. differential fishing mortality across age or size groups) can be formally integrated into multiannual management plans, along with existing measures, such as TACs, whereby positive adjustments in exploitation pattern could result in increased fishing opportunities. This could potentially be achieved by directly linking exploitation pattern and yield through a harvest-control-rule-type approach, e.g. in the catch advice, where the fishing mortality rate implying maximum sustainable yield ( $F_{MSY}$ ) is recalculated to consider changes in exploitation pattern. This would have the benefit of giving a transparent association, all else being equal, between improving selectivity and improved fishing opportunities thereby creating an obvious incentive to improve selectivity.

The narrative above is summarized in Table 1, listing the approaches that were discussed by the EWG (STECF, 2012, 2013) as solutions to the identified issues that were thought to lower the effectiveness of TMRs.

### After the latest CFP reform (2014–2019)

Under the new CFP (EU, 2013), which came into force the 1st of January 2014, two elements from Table 1 are addressed: regionalization and a step towards catch-based metrics. With regards to the latter point, it should be noted that no real results-based approach with comprehensive monitoring, control and enforcement, and quantification of the catch (e.g. with EM) have been established.

Regionalization has taken form in that seven so-called regional groups were established. *Via* these regional groups, “member states having a direct management interest affected by those [conservation] measures” (Article 18.1., EU, 2013) can submit to the EC so-called joint recommendations on selected fisheries aspects, which the EC can then transfer into delegated acts. Joint recommendations can comprise of, for example, regional discard or recovery plans or TMs.

Catch-based measures were introduced in the new CFP in the form of a Landing Obligation (LO), which was phased in over the years 2015–2019. Borges and Penas Lado (2019) describe the LO and how the policy evolved in detail. According to the LO, all caught specimens of stocks that are

**Table 1.** Approaches discussed by the STECF EWG (STECF, 2012, 2013) thought to offer solutions to identified issues and possible benefits. Note that regionalization and simpler rules had already been proposed by COM (2008).

Approach	Problems addressed (explicitly/implicitly)	Hoped effect	Hoped downstream effect
Regionalization	Top-down management	Improved legitimacy of regulations	Increased compliance
	Measures are not fit for purpose	More suitable measures	
Results-based approach, (i) based on catch-based target metrics and (ii) requiring comprehensive monitoring, control and enforcement, and quantification of the catch, e.g. by full documentation by the fishery (FDF)	Externality of costs	Internalization of the costs to the resources into the individual businesses	Reduced perverse incentive to negate measures Increased incentive to deploy fishing tactics through which objectives are met
	Threshold percentages in landings composition	Limit on unwanted catches Reduced perverse incentive to catch more of other species Reduced perverse incentive to discard the unwanted catch	
	Complexity and high number of detailed and prescriptive TMRs (micromanagement)	Increased buy-in and compliance	
	Top-down management	Increased buy-in, compliance, and trust More freedom to design solutions that are fit for purpose	
Linking exploitation pattern and yield in harvest control rules	Lack of transparency of the association between improved selectivity and improved fishing opportunities	Increased incentives to improve selectivity	

subject to catch limits and, in the Mediterranean, that are subject to minimum sizes must be landed. Thus, the LO—effectively a discard ban—forbids discarding, e.g. of undersized and overquota specimens. Undersized specimens must be landed but are not allowed to be sold for human consumption; this was done to prevent that new markets would incentivize the catching of juveniles. The quotas, which had been landings quotas before, now effectively became catch quotas. The LO was meant to incentivize fishing tactics (including the uptake of technology) through which fishers avoid unwanted catches, non-valuable specimens, as well as catches that would choke the fishery because their quotas would be rapidly exhausted meaning that fishing would need to be terminated even when other quotas would still be available. The LO aimed to constitute the internalization into the individual fishing business of the formerly external costs to the resources; this is because with the previous landings quotas and legal discarding the individual business would not be hurt by overquota catches, whereas under a LO with discard ban the individual fisher would need to stop fishing when the first quota would be exhausted. However, as mentioned in the section “Before the latest CFP reform” (see Table 1), STECF had argued that in order for this to work, comprehensive monitoring, control and enforcement, and full quantification of the catch, e.g. by EM, are required. Unfortunately, none of these requirements were included in any EU or national regulation.

Starting in 2014 (STECF, 2014), the regional groups submitted joint recommendations of discard plans in which they applied for exemptions to the LO for certain stocks in certain areas for certain gear groups and under certain conditions. These joint recommendations often included some TMs,

for example proposals to change minimum gear standards for certain fisheries in certain areas. After review by STECF (e.g. STECF, 2018a), the joint recommendations were transferred into delegated acts (e.g. EU, 2018a).

Although regionalization has meant that some TMs (e.g. those included in the joint recommendations mentioned above) are now specified by region and thus more fit for purpose, the regulations are still very prescriptive and still constitute a great amount of micromanagement. It is generally not clear to what extent the process of formulating the joint recommendations in the various regional groups is top-down or bottom-up (the meetings are not open and the agendas are not public). But STECF (2019) noted, for example, that the RTC system proposed in the “joint recommendation concerning implementation of the EU-Norway agreement on TMs in the Skagerrak” has been developed following extensive discussion involving experts and the industry.

Unfortunately, the member states did not often consider more selective gear or other options to avoid catches of choke species. An example is the situation that arose in 2019 in the North Western Waters. The International Council for the Exploration of the Sea (ICES) had given zero-catch advice for five stocks in the region because these stocks were in a bad state. According to the Fishing Opportunities for 2019 (EU, 2019b), the regional group for the North Western Waters committed to develop a bycatch reduction plan to ensure that bycatches of these stocks would be reduced through selectivity or avoidance measures. The plan promised that it would contain measures “such as more selective gears, area closures, RTCs, avoidance measures, and move-on rules” (see STECF, 2019). The plan, however, only included selective gears from



the baseline TMR to be adopted in August 2019 (COM, 2016), from the discard plan that was already in force since 2018 (EU, 2018b) and from the new discard plan proposed in the 2019 joint recommendation (see STECF, 2019), but no additional selective gears and no area closures, RTCs, avoidance measures, or move-on rules (STECF, 2019). STECF (2019) noted that the plan did not consider the potential gear options they had reviewed before (STECF, 2018b) that could improve selectivity in the identified fisheries (seven potential gear options identified, see Table 6.3.1. in STECF, 2019). Moreover, scientific research that had been exploring spatiotemporal solutions for that area (Calderwood *et al.*, 2020) had not been used. That study presents an interactive tool for stakeholders (<https://shiny.marine.ie/discardless/>) with maps of CPUE and catch compositions by species; the plan could have made use of such maps to determine where and when some species can be targeted while others are avoided.

The incentive that had been anticipated to arise from the LO to minimize unwanted catch as these would need to be deducted from the quota available to the individual fishing business (STECF, 2015), did not materialize, because the discard ban was not effectively enforced and quotas were increased to account for the former discards. An overview of the control and enforcement instruments used by the member states is given in EC (2021): the main control measures are traditional at-sea inspections and dockside/auction inspection of the landings/e-logbooks. As these control measures only have a deterrent effect and do not allow for detecting illegal discarding (as this would not happen during at-sea inspections), the measures are not considered effective by most stakeholders (EC, 2021). Because of the lack of sufficient monitoring and control, discarding practices have barely changed (Borges and Penas Lado, 2019; Savina, 2019). According to an analysis by Borges (2021), the discard ban has backfired as most EU TACs were increased to account for the part of the catch that was previously discarded and would now have to be landed, but since “discarding has not declined in EU fisheries at any significant level, the magnitude of these increases may likely have resulted in a substantial widespread increase in fishing mortality being exerted on European stocks” (Borges, 2021).

It should be noted that lack of enforcement is not the only reason that the LO failed to achieve its aims. For example, some choke-species problems are just too complex, owing to the “relative stability” and unequal access to quotas (Rihan, 2018). “Relative stability” refers to the stock-specific fixed keys according to which the EU TACs are shared among member states. Following these keys can imply that national quotas for some species can choke the fisheries of some member states but not of others, whereas the national quotas of other species can choke the fisheries of other member states. Thus, even if the international TAC is large enough, some national quotas may be too small. These problems can be partly solved through quota swapping (Zimmermann *et al.*, 2015).

In 2015, the EC asked STECF to continue their work on TM to assist the EC with the development of a new TMR. STECF (2015) considered that, in the context of a more results-based approach to TMs, it would be necessary to develop appropriate metrics to assess the relative contributions of individual fleets to the catches of juveniles and to assess how age-specific exploitation patterns may change over time within a fleet, e.g. resulting from the deployment of technical or tactical measures to avoid specific age groups. STECF (2015) also assessed and identified the key cod-end design features that

have been shown to have a significant influence on selectivity: mesh size; twine thickness/stiffness; presence or absence of lifting/strengthening bags; cod-end circumference; position; and mesh size of square mesh/escape panels. STECF (2015) considered that in order to maintain a minimum level of selectivity in demersal trawl fisheries, these factors will need to be considered in a legislative context. STECF (2015) advised that, because the catch composition rules, which were enforced as landing composition rules, required that fishers discard any fish caught in excess of predefined percentages, these would no longer be in agreement with the LO.

In 2017, STECF (2017) formulated advice on how to assess proposals for new gear or new measures coming from the member states or the industry through joint recommendations. The key would be a balance between the need for a robust assessment and the avoidance of overly prescriptive requirements of the types or amounts of supporting evidence. The latter would potentially stifle or discourage innovation. The assessment of alternative measures would need to be dealt with on a case-by-case basis; for example, if positive outcomes of a new measure would be very obvious, the need for elaborate trials would be reduced (STECF, 2017). STECF (2017) noted that there is often a tendency to delay implementation of a new measure in the face of repeated requests that “more science” is carried out. Trialling followed by careful monitoring of outcomes in a controlled fishery may be a more helpful approach (STECF, 2017). In this regard, STECF (2017) suggested “as a general principle, in the event of a limited initial trial to support the proposal, there should be a greater requirement to put in place close monitoring of the outcome together with the ability to rapidly halt the use of the measure [if the outcome is not as desired]” (see also Eliassen *et al.*, 2019). STECF (2017) also identified a wide range of tools for the assessment, evaluation, and (continued) monitoring of alternative gears or measures, including self-sampling, observer programmes, EM, last-haul analyses, and modelling techniques.

### After the new TMR

In 2016, the EC had again launched a proposal for a new technical regulation (COM, 2016) and the new TMR came into force in August 2019. Its objective is to “optimise exploitation patterns to provide protection for juveniles and spawning aggregations of marine biological resources” (Article 3.2.(a), EU, 2019a) and its relevant target that “catches of marine species below the minimum conservation reference size are reduced as far as possible” (Article 4.1.(a), EU, 2019a). The baseline measures are based on the existing technical rules for mesh sizes, minimum conservation reference sizes, closed areas, and nature-protection measures (STECF, 2017). The EC has an obligation to report every third year an evaluation that assesses the extent to which the TMs have contributed to the achievement of the objectives and targets (Article 31, EU, 2019a); the first report appeared in September 2021 (COM, 2021a, b).

The regulation embraces regionalization, in that it sets out detailed baseline TMs at regional level (Annexes V–XII, EU, 2019a) and it allows for the possibility that regional groups develop joint recommendations to amend certain regional baseline selectivity standards (Article 15, EU, 2019a), which can then be transferred into delegated acts. This permits the tailoring of detailed and technical rules so as to take regional

**Table 2.** A snapshot of Table 6.4.2. of the STECF report of the second plenary meeting in 2020 (STECF, 2020c), illustrating the complexity of the prescriptions, with nested logical conditions such as IF and UNLESS, and logical operators such as AND and OR. The table is for illustration of the complexity only and the specific content of this table or the footnotes that are referred to are not relevant for the understanding of this paper.

Joint recommendation  
for the Irish  
Sea—version May 2020

- If (trawl OR seine) and (7a)
  - 120 mm
  - Unless *Nephrops*. If *Nephrops* > 30%<sup>1</sup> and vessel > 12 m and mesh sizes between 70 and 100 mm, use additional devices among<sup>2</sup>:
    - 300 mm square mesh panel (200 mm if vessel < 12 m)
    - seltra, or 35 mm sorting grid
    - CEFAS Netgrid
    - Flip-flap trawl
  - Unless > 10% of haddock, cod and skates and rays combined<sup>3</sup> AND *Nephrops* < 30%. If vessels > 12 m, then choose gear among:
    - 120 mm cod-end
    - an eliminator trawl with 600 mm large mesh panels and a 100 mm cod-end.
  - Unless < 10% of haddock, cod and skates and rays combined<sup>4</sup> AND *Nephrops* < 30%. If vessels > 12 m, then
    - a 100 mm cod-end with a 100 mm squared mesh panel
  - T90–100 mm from the supportive study provided to STECF<sup>5</sup>

specificities into account. These joint recommendations might include proposals of new innovative gear or gear variations. Thus, there are opportunities for a regular evaluation of new gears. Such alternative measures should aim at achieving the objectives and targets (Article 15.4.(a), EU, 2019a) and, as a minimum, lead to benefits in terms of exploitation patterns that are at least equivalent to the ones provided by the baseline standards (Article 15.4.(d), EU, 2019a), which the regional groups need to demonstrate by providing scientific evidence (Article 16, EU, 2019a).

Besides the opportunities for bottom-up approaches *via* the joint recommendations, the regulation allows for bottom-up approaches in that it explicitly allows for “pilot projects with the aim of exploring methods for the avoidance, minimization, and elimination of unwanted catches” (Article 14.1., EU, 2019a) as well as “pilot projects that develop a system of full documentation of catches and discards based on measurable objectives and targets, for the purpose of a results-based management of fisheries” (Article 23, EU, 2019a). The regulation explicitly allows for RTCs and moving-on provisions (Article 19, EU, 2019a) and innovative gear (Article 20, EU, 2019a).

In 2020, some of the baseline TMs were superseded by measures such as the “remedial measures for cod and whiting in the Celtic Sea” under Article 13 of the 2020 Fishing Opportunities regulation (EU, 2020a) and the “remedial measures for cod in the North Sea” under Article 14 of the 2020 Fishing Opportunities regulation (EU, 2020b) to support the recovery of the respective stocks. In the latter case, for example, the regulation allows fishing in closed areas only if the percentage of cod catches does not exceed 5% of the total catches per fishing trip or if some prescribed highly selective gears are used or if gear is used of which it can be demonstrated that it results in at least 30% reduction in cod catches compared to the baseline requirements of the TMR or if vessels are subject to a national cod-avoidance plan ensuring that realized cod catches are in line with the intended catch as per national quota allocations. For example, a Danish national cod plan was proposed, speci-

fying conditions under which vessels would be allowed to fish in the prohibited areas (STECF, 2020a). Under this plan, in addition to some gear specifications and modifications, the deployment of EM for FDF would allow vessels to fish there. Furthermore, the Danish plan proposed closures to protect areas where there is an estimated high abundance of juvenile cod, strengthening the monitoring, control and surveillance, and an increase in RTC checks.

Current TMs are, thus a mixture of detailed prescriptive top-down micromanagement (not only in the baseline TMR but also in other adopted measures) and the allowance for piloting bottom-up results-based approaches such as alternative gears, national plans, and innovative industry-led approaches. Nevertheless, the micromanagement aspects, especially when baseline measures are superseded by new measures, result in enormous complexity (see Table 2 for an illustrative example). Unfortunately, the catch–composition thresholds for species to be avoided, which were criticized by STECF (see Section “Before the latest CFP reform”), have been retained, although not in the baseline regulation, but in the regional management plans and derogations.

STECF (2021a) notes that despite many experiments to test selective gears, there are still relatively few examples of such gears being proposed in the joint recommendations. Uptake of selective gears remains extremely low even in fisheries where unwanted catches remain high, in the absence of the use of such gears being mandatory under legislation (STECF, 2021a).

The STECF work on advising the EC on TMs is still ongoing. In 2020 a STECF EWG (STECF, 2020b) convened to help the EC prepare for their reporting-and-evaluation obligation under Article 31 of the new TMR to assess the extent to which the TMs have contributed to the achievement of the objectives and targets (see above) and a sequel EWG took place in October 2021 (STECF, 2021c) with probably more EWGs following in the coming years. These EWGs are tasked with establishing metrics, indicators, and references for the

**Table 3.** Approaches discussed by the STECF EWG (STECF, 2012, 2013) thought to offer solutions to identified issues, and whether they have been tackled in the new TMR. Note that regionalization and simpler rules had already been proposed by COM (2008).

Approach	Problems addressed (explicitly/implicitly)	Tackled through the new TMR?
Regionalization	Top-down management	Tackled, in the sense that management is now largely devolved to the regional groups; but it is not clear to what extent management at regional level is bottom-up
	Measures are not fit for purpose	Tackled, in the sense that baseline measures are regional and amendments can be proposed regionally and bottom-up
Results-based approach, (i) based on catch-based target metrics and (ii) requiring comprehensive monitoring, control and enforcement, and quantification of the catch, e.g. by full documentation by the fishery (FDF)	Externality of costs (through enforcement of catch quotas and discard ban)	Not tackled by the TMR itself but the TMR allows for it to be tackled in bottom-up initiatives
	Threshold percentages in landings composition	Tackled, but only in the sense that the baseline measures in the TMR do not mention threshold percentages; the regional plans and derogations still do mention threshold percentages
	Complexity and high number of detailed and prescriptive TMRs	Not (yet) tackled; this may change when more bottom-up initiatives are implemented
	Top-down management	Tackled in that the TMR allows for bottom-up proposals
Linking exploitation pattern and yield in harvest control rules	Lack of transparency of the association between improved selectivity and improved fishing opportunities	Not tackled

quantitative assessment of the relative contributions of individual fleets to the catches of juveniles and to assess how age-specific exploitation patterns may have changed over time within a fleet, e.g. resulting from the deployment of technical or tactical measures to avoid specific age groups. The first EWG in 2020 (STECF, 2020b) was of course too early to see any results of the TMR that had been in force for only 1 year. The second EWG was not tasked to determine how exploitation patterns had changed over time; instead this EWG estimated reference points under optimized exploitation patterns and quantified how far removed current exploitation patterns are from these reference points (STECF, 2021c).

## Discussion

In the course of the decade that this paper spans we have seen an evolution in the technical-measures approach of the EU. Advice from STECF at the start of this time span had identified three main solutions to problems of achieving the objectives of TMs (Tables 1 and 3). Of these, regionalization has been implemented to a certain extent. The problems it was meant to solve were a too high degree of top-down management and measures that were not fit for purpose; the hoped-for effects were improved legitimacy of the regulations, more suitable measures, and increased compliance. The current study cannot say whether, or to what extent, compliance increased. It can be expected that the measures are indeed more tailored to the regional situation because the baseline measures are now regional and amendments can be proposed regionally through the joint recommendations. With regards to legitimacy, the processes leading to formulating the joint recommendations are not very transparent (Eliassen *et al.*, 2015) and it is not clear to what extent the stakeholders are involved in the decision-making process as envisaged by Eliassen *et al.* (2019). The regional stakeholder Advisory Councils (ACs) give input *via* advice to the regional groups. Representatives of fishers' organizations argue that their role in drafting joint recommendations for regional discard plans should be clearer (Fitz-

patrick *et al.*, 2019). The fishers perceive the introduction of the LO as a top-down process (van Hoof *et al.*, 2019).

The second identified solution (Tables 1 and 3), to move towards results-based management, has, as yet, to a large extent failed to be implemented. The main reason is that the required comprehensive monitoring, control and enforcement, and quantification of the catch (e.g. with FDF) have not been established. Because the discard ban is not enforced, the costs of overfishing the quotas are still largely external to the fishing business. The new TMR is still largely very prescriptive micromanagement, but also allows for bottom-up results-based management in the form of the explicit allowances for national management plans and pilots. Thus, it seems that the approach of the EU has been a hybrid between not letting go (yet) of the old (micromanagement and prescriptive) approach to stay on the safe side but at the same time allowing for results-based approaches. With regards to decreasing the top-down nature of management, the EU cannot do more than allowing for bottom-up approaches; the actual bottom-up approaches themselves have to come (by definition) from the bottom up, not from the EU. Unfortunately, the momentum and drive towards FDF that was present in the first-half of the past decade, through the pilot projects mentioned in section "Before the latest CFP reform", seem to have halted (probably owing to lack of incentive for the industry since now top-ups of quotas are not conditional anymore upon participation; Borges, pers. comm.). Most joint recommendations and exemption requests from member states are not accompanied by proposals for extensive monitoring, control and enforcement, and quantification of the catch (e.g. ToR 6.5 in STECF, 2021b). According to van Helmond *et al.* (2020), EM can incentivize better compliance and discard reduction, but the fishing managers and industry are often reluctant to take it up. Improved understanding of the fisher's concerns, for example intrusion of privacy, liability and costs, and better exploration of the benefits may enhance implementation on a larger scale (van Helmond *et al.*, 2020).

The third identified solution (Tables 1 and 3), to link exploitation pattern and yield in harvest control rules, has not been implemented explicitly yet. The most recent EWG on TMs (STECF, 2021c) again alluded to harvest control rules and catch advice that are based on both exploitation rate and pattern, but STECF has not been asked to work out in detail how this should be done.

Interestingly, the baseline TMR itself has gone a long way in taking up the solutions that STECF had identified but mainly by leaving it up to regional levels to implement them (Table 3). The responsibility to implement them has shifted to the regional levels and it is at those levels that we should expect changes. There is room for more innovative management and bottom-up approaches, and the stakeholders should now take the opportunity to propose them.

Globally, there are few fisheries where enforcement of catch quotas is implemented through 100% observer coverage of the fishery (see review by Karp *et al.*, 2019). For example, the British Columbia (Canada) groundfish trawl fishery is managed through individual transferable quotas, 100% observer coverage and the deduction of discard mortality from quota. Despite the large number (22) of species covered, when TACs were increased for some species and reduced for others, fishers were able to adjust the species mixture in their catches (Branch and Hilborn, 2008). Moreover, the Alaska pollock fishery has 100% observers (and EM on some vessels; NOAA, 2021) and CCAMLR has 100% observer coverage in all the vessels fishing in their waters (CCAMLR, 2021). Tools and technologies for the monitoring, control, and surveillance of unwanted catches are reviewed and evaluated by James *et al.* (2019), ICES (2019), and van Helmond *et al.* (2020).

Van Helmond *et al.* (2020) argue that an important constraining factor of implementing full EM within the context of the LO, is that EM is considered as a mechanism to monitor compliance. Such compliance-driven measures involving EM were only successful when there was support from the fishing industry. Van Helmond *et al.* (2020) quote experiments that proved that incentives can make EM successful: increased flexibility in gear choice (Mortensen *et al.*, 2017), individual quota uplifts (van Helmond *et al.*, 2016; Kindt-Larsen *et al.*, 2011; Needle *et al.*, 2015), and permission to enter closed areas (Needle and Catarino, 2011).

Use of digital platforms has been considered as tools for fishers to be informed on the spatial distribution of wanted and unwanted catches. The information in these tools could consist of long-term, scientifically processed data such as in the tool from Calderwood *et al.* (2020). They could also be based on real-time information that is shared by the fishers (Bergsson and Plet-Hansen, 2016; Bergsson *et al.*, 2017; Eliassen and Bichel, 2016; Needle *et al.*, 2015) or sent from the fishers to scientists or managers and back. This information can be used for RTCs and move-on rules. Examples of success include the science–industry collaborative program that ran successfully between 2010 and 2016 in the US Georges Bank scallop fishery (O’Keefe and DeCelles, 2013; Cadrin *et al.*, 2018). Vessels shared near real-time location information about flounder bycatch amounts. Scientists compiled the information, identified bycatch hotspots, and provided daily advisories to vessels on the fishing grounds. Another example is the Shorebased Whiting Cooperative (SWC, formed in 2012) at the US west coast; information on location and catch is processed and distributed back to the members in near real-time, in the form of high-resolution maps, enabling them to make fine-scale decisions (Holland and Martin, 2019; Mc-

Quaw, 2019). Similarly, in the US northwest Atlantic mid-water trawl fishery targeting Atlantic herring and Atlantic mackerel, a voluntary bycatch avoidance program exists, as a partnership between industry, state government, and university, through near real-time information sharing of catches on a spatial grid (Bethoney *et al.*, 2013, 2017). Closer to home, in the Celtic Sea, the UK runs an industry–science collaboration project with a real-time self-reporting scheme to avoid bycatch of spurdog, whose zero (or low) TAC potentially chokes the fishery (Hetherington, 2014); here maps with grid cells and traffic-light colours are produced and sent back to participating fishers. Furthermore, the Scottish Fishermen’s Organization and the University of Aberdeen (Scotland) have set up a scheme, called BATmap, where catch data on potential choke species are sent through a mobile app; when catch values reach set thresholds an aggregate map showing locations of high bycatch is disseminated to participants, so that these locations can be voluntarily avoided (Marshall *et al.*, 2021). An up-to-date review of information-sharing schemes around the globe and what motivates fishers to participate is provided by Calderwood *et al.* (2022).

Using real-time EM data on catch and effort, a complete and holistic management system has been proposed under the name “real-time incentives” (RTI; Kraak *et al.*, 2012, 2014, 2015a; Pedreschi *et al.*, 2021). Under this fisheries-management system catch quotas would be replaced by annual credit-point allocations. The spending rates (tariffs) of these credit points would vary in space and (near) real time and would be displayed on colour-coded grid-cell maps. Areas with species or specimens that are to be avoided would have high tariffs, and thus fishing in these areas would be disincentivized. The highest “tariff” would be closure (permanent, seasonal, or real-time). The tariffs can change in (near) real time based on EM data. The crux of the RTI system is that the costs to the resource and the ecosystem would be internalized into the individual fishing business. Fishers would be free to fish when, where, and how they want as long as their credit points last, and the tariff-setting would thereby lead to the avoidance of unwanted catches. Similar approaches have been explored by other authors (e.g. Bellido *et al.*, 2019; see Kraak *et al.*, 2015a for others). The RTI system resembles RTCs, a flexible and highly responsive management measure that in the past has found favour with fishermen. The difference is that RTCs are black-and-white (open or closed), whereas RTI has (colourful) gradations of incentive/disincentive to fish.

ICES (2020) reviewed the current availability of innovative gear. For an increased adoption of selective gear, it is necessary to involve the industry. Involvement creates a feeling of ownership, which increases compliance levels (Kraak and Hart, 2019; Hart, 2021). Fitzpatrick *et al.* (2019) found that some fishers are interested in more selective gears and spatial and temporal closures and that fishers found it important to “integrate fishers’ local ecological knowledge into discard plans.” As noted above, the results-based setup of the 2008–2015 cod plan had promoted bottom-up initiatives aimed at attaining set targets with measures that were more suited to local conditions (Kraak *et al.*, 2013). This experience showed that given the right stimulus, the industry can rapidly develop and deploy fishing tactics, including gear and behavioural changes, when there are specific objectives and strong drivers to do so. Reid *et al.* (2019) reviewed bottom-up results-based approaches, looking at trials where fishers tried to reduce their unwanted catches by whatever (legal) means they thought best. In some cases, they were able to reduce unwanted catches, in others



they were less successful. O'Neill *et al.* (2019) reviewed ways to encourage and support fishers to design, develop, and test selective gears that will avoid unwanted catches. They also examined the success of science–industry collaborations and emphasized the benefits of a flexible regulatory environment.

Just before the adoption of the new TMR, Eliassen *et al.* (2019) discussed the role that fishers can play by actively participating in the development of gears and contributing to the scientific documentation of their selectivity. They concluded “that a more flexible system of gear development and evaluation would be possible by (a) involvement of fishers in proposing gear adjustments, self-sampling, and documenting results according to scientific protocols [...] and (b) [...] faster approval of gear use under a regionalized technical regulation regime with yearly adjustments of management plans.” The latter echoes the STECF (2017) advice. The manager could also consider to put in place appropriate incentives for behavioural change, for example in the form of a carrot or a stick or through “nudges.” Else fishers will not adopt behaviour that is costly to them in the short term in terms of reduced catches and higher costs (buying new gear etc.). One way of doing this is the internalization of the costs to the resource and the ecosystem into the individual fishing business; fishers will then try to avoid these costs. These developments will have to be instigated at the regional levels, since the EU-level baseline TMR already allows for them. However, giving back the responsibility to lower levels may be difficult because no facilitating governance structures are in place (Ramirez-Monsalve *et al.*, 2016; Linke and Jentoft, 2016; van Hoof and Kraus, 2017; Linke *et al.*, 2020).

## Conclusion

This Conclusion section uses the “scale” of “the good”—“the bad”—“the ugly” for the judgement whether developments have been in accordance with STECF proposals (“the good”) or not (“the bad” or “the ugly,” the latter for cases where the reluctance to follow the advice seems obstinate according to my subjective judgement).

The new EU-wide TMR that was adopted in 2019 has to a large extent accommodated the advice given by STECF on how to better achieve the objectives of TMs. The TMs are now formulated regionally and they can be amended based on joint recommendations from regional groups (“the good”). The TMR also explicitly allows for bottom-up and results-based approaches (“the good”). Nevertheless, only a few such approaches (e.g. Hetherington, 2014; Marshall *et al.*, 2021) have been implemented to date (“the bad”). Despite the existence of a long list of innovative gears, not many selective gears have been taken up (“the bad”). And despite examples elsewhere in the world and scientific explorations for EU waters, not many spatiotemporal avoidance schemes and programs have been implemented in the EU (“the bad”; but again, see Hetherington, 2014; Marshall *et al.*, 2021). Although flexibility has increased (“the good”), the rules are still very complicated micromanagement (“the bad”), as illustrated in Table 2. Despite devolvement to the regional groups (“the good”), management is still perceived by the fishers as top-down (“the bad”). The onus is on the regional groups to mobilize and use the innovative abilities of the fishing industry; ample research has been done on how to do this (see above, especially in the book edited by Uhlmann *et al.* (2019)). Never-

theless, as mentioned above, the current governance structures may not be conducive.

Unfortunately, the use of threshold percentages that was criticized by STECF on many occasions is still rampant in the TMs that get implemented as plans (“the ugly”).

Another major problem is that because of the lack of enforcement of the catch quotas (i.e. of the discard ban), the incentive to avoid unwanted catches through an internalization of the costs into the individual business did not materialize (“the bad” or even “the ugly”). Here again the onus is on the regional groups, because the TMR explicitly allows for it. Although it is clear that results-based management requires comprehensive monitoring, control and enforcement, and quantification of the catch, e.g. by FDE, large reluctance exists at all levels within the EU to implement these (“the ugly”).

Another advice from STECF that was not taken up is the linking of exploitation pattern and yield in harvest control rules and catch advice (“the bad”). This would have the benefit of giving a transparent association (all else being equal) between improving selectivity and improved fishing opportunities thereby creating an obvious incentive to improve selectivity.

One of the causes making it difficult to ease choke-species problems in some regions is the principle of “relative stability,” according to which the EU TACS are shared across the member states, often resulting in certain member states not having enough quota for certain stocks and other member states for other stocks. This problem was not mentioned in the reviewed STECF reports of 2012 and 2013 (STECF, 2012, 2013).

Although the TMR includes an obligation to evaluate every third year whether the objectives are being achieved, this evaluation only assesses the results in terms of reduced unwanted catches but not whether the means (such as creating the right incentives) have been implemented. The challenge still remains to create incentives that lead to the desired behaviour.

Social sciences are needed to better understand what drives fisher behaviour and what the most appropriate incentives would be for different types of fishers (e.g. Barz *et al.*, 2020). Apart from the studies mentioned above, more research could, for example, be devoted to understand the effectiveness of using the carrot or the stick to trigger desired behaviour (Kraak *et al.*, 2016). Research on “nudges” and behavioural economics (Kraak *et al.*, 2015b; Kraak and Hart, 2019; Hart, 2021; Wieczorek *et al.*, 2021) and behavioural change may be promising. Moreover, governance research is needed to understand how the mode of governance functions at the regional level and in interaction between the Commission and member states, as structural change is needed to facilitate bottom-up initiatives.

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## Conflict of interest

I have been a member of STECF from 2007 to 2015 and 2019 to 2022. I was a member of the STECF EWGs on technical

measures in 2013, 2020, and 2021 (the latter as co-chair) and of the EWG on the cod plan in 2011–2012.

## Data availability

This paper uses no data other than the published literature. All STECF reports can be found at <https://stecf.jrc.ec.europa.eu/reports>.

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