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Introduction

Cracking the challenges of incentivizing avoidance of unwanted catch

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Effective tools, techniques, and strategies to improve commercial fish catches frequently seem to be overlooked or unused. The mixed success of two major approaches to avoiding or reducing unwanted catches, voluntary or mandatory use of more selective gear, and spatiotemporal shifts of effort based on resource distributions, inspired the call for this themed article set (TS). This TS sought to promote deeper consideration of these outcomes by encouraging research to investigate what is required to make alternative, more selective gear, and spatiotemporal avoidance more attractive to fishers. Of the eighteen articles in the TS, seven investigated the behaviour of fishers and applied existing or novel models to deepen understanding of motivations and incentives to change; little overlap among theories was found, and more and deeper consideration of this topic is needed. Five considered aspects of spatiotemporal avoidance; five described technical or other measures. Creative ideas on these topics continue to arise, but understanding of the motivations of fishers to initiate and maintain cooperative behaviours is still rudimentary. One used good, bad, and ugly experiences with policy implementers to promote governance research to crack open the understanding of interactions between policy implementers and policy advisors, and to identify changes needed to facilitate bottom-up initiatives.

Keywords: bycatch reduction, catch avoidance, change management, human behaviour, incentives.

This themed article set (TS), Challenges to incentivizing avoidance of unwanted catch, was inspired by the difficult experiences by researchers working to reduce the catches of marine organisms other than those targeted by fishers. Apparently effective tools, techniques, and strategies to improve catches frequently seem to be overlooked or otherwise unused. Many common incentives, such as setting quotas (including zero catch), are often not sufficient to mitigate unwanted catches. The consequences of this insufficiency can be high, including unacceptable mortality of protected, endangered, and threatened species, overexploitation of commercial species, and loss of fishing opportunities for fishers.

Filling quotas of individual species can "choke" the fishery on other species because the fishery would need to cease before other quotas have been exhausted, and fishers may consequently suffer economic losses due to the cost of acquiring additional quota or the need to stop fishing. Thus, incentives are created to continue fishing and to illegally land or to discard the unwanted catch. Illegal over-quota catches contribute to fishing mortality and often cannot be fully accounted for in the stock assessments on which the quotas are based. This hidden cost thus increases the uncertainty about the resource status and undermines appropriate management and confidence in stock advice.

The main approaches to avoiding or reducing unwanted catches are the voluntary or mandatory use of more selective gear (that is, fishing gear that reduces or avoids the catch or retention of unwanted specimens) and spatiotemporal shifts of fishing effort with respect to the distribution of the unwanted resource. Both options may lower the catch efficiency of the target species. Both have shown mixed success. For example, voluntary uptake of gear designed to avoid unwanted catch is often quite low, and where uptake is mandated, resistance among fishers can still be high.

Behavioural change, not only by fishers, but also of the other actors in the process, including managers, policymakers, scientists, institutions, and processes appears necessary. Specific contributions were encouraged to the TS that asked questions from these perspectives. For policymakers, do policies incentivize unwanted catch reductions effectively? If not, how can policies be reformed, with innovation in bycatch avoidance embedded in them?

For fishers, to what degree can they control mixed-fisheries catches technically or behaviourally? Are there case studies of changes by fishers to reduce unwanted catches?

For change agents, what models of human behaviour related to voluntary bycatch avoidance and capacity for change are useful? What outreach or messaging strategies are effective or ineffective? Can discourse analysis be used to understand perceptual differences among actors? Are there ways to explicitly account for the likelihood of uptake in designing bycatch avoidance programmes? Are there behavioural economics approaches, or economic instruments (including certification programmes) that have had, or may have, success in reducing unwanted catch?

Ultimately, eighteen articles were accepted for inclusion in this TS. A notable factor in nearly every contribution was the importance of working with and alongside fishers to accomplish reduction of unwanted catches, and to further understand their choices and decision making was a factor in most contributions. Some of the contributions directly addressed the specific questions that were encouraged. Some addressed related questions. Some questions went unanswered.

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Approaches to understanding human behaviour

As hoped, models of human behaviour were employed to develop insight into the past actions of fishers and provided guidance on how to improve uptake of bycatch reduction methods. Tookes *et al.* (2023) found congruence between literatures describing the Diffusion of Innovation and Traditional Ecological Knowledge and the general and successful acceptance of turtle excluder devices (TEDs) in Georgia, USA both retrospectively and currently. Using TED adoption and mitigation of dolphin bycatch in tuna purse seines as case studies, Jenkins (2023) described in detail how diffusion theory provides a solid foundation to create successful extension programmes, and suggested that combining emotion and sentiment with diffusion theory may be an approach that has the highest likelihood of achieving successful adoption. Jenkins, with other authors, (Jenkins *et al.*, 2023) identified widely-accepted "best" practices for successful change in fisheries that do not, in fact, appear to yield improved uptake. They pointed to the need for changes to the usual approaches and encouraged practices to empower change agents, and identified change readiness theory, particularly emotions, as playing an important role in the uptake of new ideas and changes. Eayrs (2023) expanded the role of change readiness in the blending of three existing change management models into one and applied this new model to two uptake case studies in Australia, advocating for the models' effectiveness and implementation in future uptake activities. Barz (2023) employed structuration theory to interview gillnet fishers and identify the attitudes and beliefs they held regarding the bycatch of seabirds and marine mammals.

These subjective and individual meanings and emotions can assist the co-development of mitigation management specifically, and generally to contribute to a common understanding among stakeholders. Steins *et al.* (2023) described how even fisher-led design, testing, and development of gear modifications did not yield voluntary uptake. To improve upon the "educated guesses" of scientists, they collected the views of fishers, and identified two behavioural components, which they termed willingness and ability. These in turn were linked to intrinsic motivations and beliefs, the perceived legitimacy of regulations, and strong beliefs among fishers about equity in compliance and enforcement. Ultimately, they recommended more emphasis on addressing factors associated with willingness as a key to encouraging more selective fisheries. Grønbæk *et al.* (2023) identified and explained specific factors leading to the highly successful cooperative campaign to reduce the bycatch of sponges and corals in the British Columbia, Canada groundfish trawl fishery. Building off game theory, a new theory was used to explain the individual and collective actions of fishers and environmental non-governmental organisations to reach agreements that led to drastic reductions in bycatch that were later implemented by the resource managers. Curiously, the specific strategies fishers used to avoid sponges could only be speculated upon, although spatiotemporal avoidance of these sessile species is a factor.

Spatiotemporal patterns of bycatch

Several contributions used large datasets to investigate spatiotemporal patterns of bycatch to inform potential preventative actions. Prado *et al.* (2023) analysed the spatiotemporal distribution of sea turtles, seabirds, and cetaceans using beach surveys of stranded megafauna from five years of stranding data and found similar temporal patterns. Certain species also exhibited spatial patterns related to local factors. The distant water tuna longline Chinese fishery was examined using a large amount of observer data in the light of quantifying bycatch ratios to identify fishing grounds susceptible to producing low bycatch-to-target species occurrences (Xia *et al.*, 2023). The open ocean fishery, as the one operating in the Pacific, yielded lower bycatch ratios than coastal fishing with the exception of bluefin tuna in the northern Atlantic. Fishing operations at greater depths (>500 m) resulted in lower bycatches. Two contributions used spatiotemporal data to understand fleet behaviours by French fleets to mitigate the impacts of the implementation of the Landing Obligation (LO). For the French mixed demersal fishery in the eastern English Channel, Lehuta and Vermard (2023) used modelling scenarios to find that netters benefitted from the LO, contrary to trawlers. The avoidance strategies, depending on main gear and vessel size, proved efficient to reduce unwanted catch of whiting and enabled unexpected protection of juveniles of sole. Results evidenced the trade-offs the LO implies among stocks, fish stages, fleets, and even sub-regions, beyond the usual biological versus economic balance. The LO had no noticeable effects on fishing effort allocation relative to either undersized biomass or discard rate distributions on the French bottom trawlers operating in the eastern English Channel (Marchal and Vermard, 2023). Fishing for historically important species was less attractive than targeting cuttlefish and squids. Calderwood *et al.* (2023) studied information sharing within a fleet in order to reduce unwanted catches. The authors analysed 12 case study examples from around the world that use existing information sharing schemes to determine fishers' incentives to join and share potentially sensitive catch information.

Technical, operational, and educational measures

Another group of contributions considered technical, operational, and educational measures to avoid and to reduce bycatch. Using different codends, Mytilineou *et al.* (2023) examined the size-selection patterns of the trawl gear and the fisher for seven bycatch commercial species in the eastern Mediterranean. The 40-mm diamond-mesh codend, still in use in non-EU Mediterranean fleets, was found unsafe for all stocks. Various codends were appropriate for different species. The use of larger mesh codends in the Falklands Islands targeting skate fisheries also significantly decreased the bycatch of commercially valueless small skates that would experience high discard mortality, as well as a reduction by 97–98% of all finfish bycatch (Arkhipkin *et al.*, 2023). The study, conducted initially by a fishing company, enabled the local authorities to implement minimum mesh sizes and contribute to conservation policy. Wosnick *et al.* (2023) surveyed best practices for the release of live sharks and rays as a measure to minimize incidental catches of these endangered species. It is argued that although onboard releases are taking place, these are treated rather as a secondary voluntary measure instead of as a priority conservation strategy. Educating and empowering fishers to act as ambassadors for live release was promoted. Fauconnet *et al.* (2023) also highlighted the need to engage fishers and find incentives to motivate avoidance of bycatch, in this case of deep-water sharks in hook-and-line fisheries in the mid-North

Atlantic, and provided insights into choices by individual fishers and perceived barriers to avoidance. Cronin *et al.* (2023) reviewed obstacles for mitigating bycatch of manta and devil rays (Mobulids) by combining survey and focus group data to synthesize knowledge of Mobulid bycatch and mitigation ideas in eastern Pacific Ocean purse seine fisheries. Beyond eliciting the fishers' creative ideas, the authors built a model that utilizes stakeholder input in the design of bycatch technology in large-scale fisheries.

The last word

In a unique contribution, Kraak (2023), used her good, bad, and ugly experiences providing collective expert recommendations to policy implementers to promote the need for governance research to understand interactions between policy implementers and policy advisors, and to identify the changes needed to facilitate bottom-up initiatives. The specific experience described in that contribution, plus the poor performance of technical measures generally and the Common Fisheries Policy overall, combined with a career of working creatively and imaginatively with all stakeholders, contributed to the planting of the seed by Kraak that grew into this TS. This final paper from her expresses deep frustration over all parts of the bycatch reduction puzzle.

That sole paper attempted to answer questions related to policymakers, and found mixed success at reforming management actions to elicit the desired bycatch avoidance. More contributions on this topic would have been welcome, particularly because little attention has been paid to the roles of these actors in the challenges of bycatch reduction. More exploration of this aspect of incentivizing the reduction of unwanted catches is needed.

In the contributions to this TS, the experience, wisdom, and contribution of fishers to solutions were highlighted. The ability of fishers to control the mix of what they catch was touched upon in one paper, but other than the possibility of changes in areas fished, no direct mechanism was identified. Only one case study was provided where fishers initiated gear modifications and then collaborated with researchers and managers to implement a solution to a bycatch issue, suggesting this kind of collaboration is very rare. Importantly, a contribution reviewed multiple case studies on the sharing of spatiotemporal information, some quite successful, and provided a list of possible reasons and explanations for these successes. Understanding the motivations of fishers to initiate and maintain cooperative behaviours is, however, still quite rudimentary.

Many different frameworks or models for understanding the choices of fishers towards changes to gear and other practices were presented. Importantly, many papers were looking only retrospectively when fitting models of behaviour. Left unexplored and untested to date is the implementation of behavioural insights when designing programmes to reduce unwanted catch and assessing their success. The possibility of broadly assessing outreach programmes for effectiveness was not taken up. Also, suggested approaches such as behavioural economics, economic instruments, and certification programmes were not fully addressed.

Little overlap among the many behavioural theories was found. This topic appears to require further exploration, testing, and synthesis, and researchers in the field might benefit from collaboration through working groups or colloquia.

This TS also showed that spatial tools and larger data sets are facilitating knowledge of how, when, and where bycatch is occurring at large scales. At the scale of the individual vessel, gear, or fisher, this TS demonstrated that creative ideas continue to arise over how choices of practices and operations can lead to improved sustainability. In addition to these general themes, many, many future research ideas can be found among the contributions, hopefully further cracking open our understanding of the challenges to incentivizing avoidance of unwanted catches.

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Conflict of interest

The authors have no conflicts of interest to declare.

Data availability

There are no new data associated with this article.

References

Arkhipkin, A, Skeljo, F, Wallace, J, Derbyshire, C, Goyot, L, Trevizan, T, and Winter, A. 2023. Industry-collaborative mesh trials to reduce bycatch in the Falkland Islands skate trawl fishery (Southwest Atlantic). ICES Journal of Marine Science, fsab259. https://doi.org/10.1093/icesjms/fsab259.

Barz, F. 2023. Identifying social practices to inform fisheries management—the case of bycatch practices of marine mammals and seabirds of German gillnet fishers. ICES Journal of Marine Science, fsac208. https://doi.org/10.1093/icesjms/fsac208.

Calderwood, J, Marshall, C. T, Haflinger, K, Alfaro-Shigueto, J, Mangel, J. C, and Reid, D. G. 2023. An evaluation of information sharing schemes to identify what motivates fishers to share catch information. ICES Journal of Marine Science, fsab252. https://doi.org/10.1093/icesjms/fsab252.

Cronin, M. R, Croll, D. A, Hall, M. A, Lezama-Ochoa, N, Lopez, J, Murua, H, Murua, J. *et al.* 2023. Harnessing stakeholder knowledge for the collaborative development of Mobulid bycatch mitigation strategies in tuna fisheries. ICES Journal of Marine Science, fsac093. https://doi.org/10.1093/icesjms/fsac093.

Eayrs, S. 2023. A road map to change: application of a comprehensive change management model to guide and inspire fishers to reduce bycatch. ICES Journal of Marine Science, fsac085. https://doi.org/10.1093/icesjms/fsac085.

Fauconnet, L, Catarino, D, Das, D, Giacomello, E, Gonzalez-Irusta, J. M, Afonso, P, and Morato, T. 2023. Challenges in avoiding deep-water shark bycatch in Azorean hook-and-line fisheries. ICES Jour-

nal of Marine Science, fsac178. https://doi.org/10.1093/icesjms/fsac178.

Grønbæk, L, Lindroos, M, Munro, G, Pintassilgo, P, and Turris, B. 2023. The avoidance of unwanted catch and cooperation: the case of the British Columbia groundfish trawl fishery. ICES Journal of Marine Science, fsac005. https://doi.org/10.1093/icesjms/fsac0005.

Jenkins, L. D. 2023. Turtles, TEDs, tuna, dolphins, and diffusion of innovations: key drivers of adoption of bycatch reduction devices. ICES Journal of Marine Science, fsac210. https://doi.org/10.1093/icesjms/fsac210.

Jenkins, L. D, Eayrs, S, Pol, M. V, and Thompson, K. R. 2023. Uptake of proven bycatch reduction fishing gear: perceived best practices and the role of affective change readiness. ICES Journal of Marine Science, fsac126. https://doi.org/10.1093/icesjms/fsac126.

Kraak, S. B. M. 2023. 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. ICES Journal of Marine Science, fsac037. https://doi.org/10.1093/icesjms/fsac037.

Lehuta, S, and Vermard, Y. 2023. Contrasting impacts of the landing obligation at fleet scale: impact assessment of mitigation scenarios in the Eastern English Channel. ICES Journal of Marine Science, fsac148. https://doi.org/10.1093/icesjms/fsac148.

Marchal, P, and Vermard, Y. 2023. Species targeting and discarding in mixed fisheries. ICES Journal of Marine Science, fsac095. https://doi.org/10.1093/icesjms/fsac095.

Mytilineou, C, Herrmann, B, Mantopoulou-Palouka, D, Sala, A, and Megalofonou, P. 2023. Escape, discard, and landing probability in multispecies Mediterranean bottom-trawl fishery. ICES Journal of Marine Science, fsab048. https://doi.org/10.1093/icesjms/fsab048.

Prado, J. H. F, Daudt, N. W, Perez, M. S, Castilho, P. V, and Monteiro, D. S. 2023. Intensive and wide-ranging beach surveys uncover temporal and spatial stranding patterns of marine megafauna. ICES Journal of Marine Science, fsac119. https://doi.org/10.1093/icesjms/fsac119.

Steins, N. A, Mattens, A. L, and Kraan, M. 2023. Being able is not necessarily being willing: governance implications of social, policy, and science-related factors influencing uptake of selective gear. ICES Journal of Marine Science, fsac016. https://doi.org/10.1093/icesjms/fsac016.

Tookes, J. S, Yandle, T, and Fluech, B. 2023. The role of fisher engagement in the acceptance of turtle excluder devices in Georgia's shrimping industry. ICES Journal of Marine Science, fsac062. https://doi.org/10.1093/icesjms/fsac062.

Wosnick, N, Giareta, E. P, Leite, R. D, Hyrycena, I, and Charvet, P. 2023. An overview on elasmobranch release as a bycatch mitigation strategy. ICES Journal of Marine Science, fsac164. https://doi.org/10.1093/icesjms/fsac164.

Xia, M, Carruthers, T, Kindong, R, Dai, L, Geng, Z, Dai, X, and Wu, F. 2023. Quantifying bycatch risk factors for the Chinese distant water fishery. ICES Journal of Marine Science, fsab210. https://doi.org/10.1093/icesjms/fsab210.