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Food for Thought

Understanding perspectives and barriers that affect fishers' responses to bycatch reduction technologies

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Reducing the capture of non-target species and juvenile fishes through a variety of gear modifications and bycatch reduction devices are presumed to provide long-term biological and socioeconomic benefits and improve the reputation of fisheries. The adoption of these technologies by fisheries, however, has been low compared to research and development efforts. Research has focused on technical design and catch rate responses to these technological interventions with a limited focus on assessing fishers' attitudes towards these technologies. This essay gives a personal reflection, based on an extensive collaboration with fishers, of the perspectives and barriers that may affect their responses. I also provide suggestions on how to genuinely engage fishers in the process that could lead to agreeable solutions. Above all, change should be approached from the perspective of those whose behavior one is seeking to influence, acknowledging the heterogeneity among fisheries and fishers. The essential element for the success is fishers' motivation and readiness to the change. Fishers need a clear vision of what the changes mean for their livelihood and evidence that the technology to minimize bycatch performs sufficiently well in various conditions.

Keywords: attitudes, credibility, dialogue, incentives, motivation, participation, trust.

Introduction

Over the last 40 years there has been vast progress to develop gear modifications and devices (*hereafter collectively called bycatch reduction technologies*) that have been demonstrated to reduce the unintentional capture of non-target species and juvenile fish, generally called as bycatch (e.g. Hall et al., 2000; Valdemarsen and Suuronen, 2003; Madsen, 2007; Suuronen and Sarda, 2007a; He and Pol, 2010; Rose et al., 2010; Gilman, 2011; Clarke et al., 2014; Winger et al., 2016; Kennelly and Broadhurst, 2021; Poisson et al., 2021). Reduction of bycatch provides various potential benefits such as less waste of valuable natural resources, reduced sorting time, better product quality, and reduction of stakeholder conflicts. It may also improve market access and public respect.

There have been some remarkable successes in the use of bycatch reduction technologies. For instance, the introduction of turtle excluder devices (TEDs) in shrimp trawls in the Gulf of Mexico has dramatically reduced the bycatch mortality of endangered sea turtles (reviewed by Jenkins, 2012). The declines of finfish bycatches in many shrimp trawl fisheries have largely been the result of the sorting grids and selection panels introduced in these fisheries (Isaksen et al., 1992; Broadhurst, 2000). Changes in the construction and operation of tuna purse seines have significantly reduced the mortality of dolphins that are incidentally captured (Hall, 1996; Gjertsen et al., 2010).

Nonetheless, despite the progress made in the development of bycatch reduction technologies, bycatch continues to be a major problem in many fisheries worldwide (Read et al., 2006; Komoroske and Lewison, 2015; Gray and Kennelly, 2018; Dias et al., 2019; Gilman et al., 2020; Savoca et al., 2020; Moore et al., 2021). Fishers have often been slow to adopt new bycatch reduction strategies, and there are many fisheries where the uptake of bycatch reduction technologies has been weak or non-existent (e.g. Suuronen and Sarda, 2007b; Eayrs et al., 2015; Eayrs and Pol, 2019; Suuronen et al., 2020). Obviously, reduction of bycatch by technological solutions requires more than just the development of technology and proof of its efficacy.

Research on bycatch reduction technologies has focused on technical design with a limited focus on assessing fishers' attitudes towards these technologies. Apparently, there is a wide-ranging belief among fisheries scientists and gear technologists that the adoption of bycatch reduction technology will follow almost automatically as soon the technology has been developed and fishers are guided to use it. Hence, relatively little is known of the sentiments of fishers towards bycatch reduction technologies. Nonetheless, there has recently emerged promising new research activities on this topic (e.g. Campbell and Cornwell, 2008; Jenkins, 2015; Eayrs and Pol, 2019; Barz et al., 2020; Calderwood et al., 2021).

This essay gives a personal reflection, based on wide collaboration with fishers, of the perspectives and barriers that may affect their responses to bycatch reduction technologies. I have 40 years of experience working with fishers in Europe, Asia, Africa, and Latin America. My work has focused on the reduction of bycatch mortality in trawl fisheries (e.g. Suuronen and Millar, 1992; Suuronen, 1995; 2005), but I have worked also with gillnet, long-line, and trap-net fisheries (Tschernij et al., 1993; Suuronen et al., 2006; 2012; Gilman et al., 2016). In 2009–2017, when I worked at the Fisheries and Aquaculture Department of the Food and Agriculture Organization of the United Nations (FAO), my first task was to draft the International Guidelines on Bycatch Management and Reduction of Discards (FAO, 2011). My further responsibilities at FAO included the promotion of bycatch reduction in tropical

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trawl fishing where the bycatch and sustainability challenges are particularly difficult to resolve (Suuronen et al., 2020). In 2015–2017, I coordinated the preparation of the FAO Third Assessment of Global Marine Fisheries Discards (Pérez Roda et al., 2019).

I describe my own experiences about the complex reality faced by fishers in the face of change and discuss how to positively engage them in the process of reducing the bycatch through technological means. I argue that fishers in general are aware of the basic requirements for the sustainability of fishing. Harsh circumstances, however, often make it a complex and challenging undertaking. Furthermore, goals and solutions defined by fisheries scientists and managers do not always meet the reality faced by fishers. I emphasize the critical importance of fishers' motivation and readiness to take up bycatch reduction technologies. Fishers' fears and doubts should be taken seriously, and the objectives and solutions must be meaningful to them. Otherwise, it is difficult to make progress. I hope my insights and suggestions will give some new perspectives to advance the understanding on the topic.

Why the uptake of bycatch reduction technology is low?

Fishers frequently have a different perspective on the magnitude and impact of bycatch than other stakeholders. In general, fishers do not believe that their fishery poses a marked threat to the species caught as bycatch. They may see the utility of reducing bycatch of juveniles of commercially valuable species but are less convinced of the need to reduce the bycatch of species that lack commercial value (see also Campbell and Cornwell, 2008). This is especially the case when the bycatch rate of a species is relatively low. Fishers may not be fully aware that bycatch of species with low resilience to increased mortality can have profound impact on affected populations (Gilman et al., 2019).

Moreover, fishers often consider that the legitimacy of their livelihood is called into question by bycatch issues and feel that the claims demanding stricter regulations are often poorly documented. In their view, bycatch should not be held any more important issue than their right to pursue their livelihood and provide food for people.

Fishers commonly have concerns that the use of bycatch reduction technologies causes a loss of marketable catch and thereby loss of income (e.g. Tschernij et al., 2004; Suuronen et al., 2007; Campbell and Cornwell, 2008). Many fisheries and fishers operate at low economic margins; losing even a small amount of marketable catch can be extremely problematic for them. Especially in many fisheries in tropical regions, catch losses and the immediate reduction of income due to improved selectivity is often considered too high by the fishers (Suuronen et al., 2020). The problem is exacerbated by the highly multispecies nature of these fisheries. In reality, the effective mesh size of codend has decreased at the same pace as fish stocks are dwindling although the legal mesh size has been increased (e.g. Suuronen et al., 2020).

Commercial fishing by its nature targets species and sizes that yield the highest economic returns (e.g. Breen et al., 2016). Fishers are concerned that regulations dealing with bycatches may unnecessarily weaken their ability to compete and may create benefits to other fisheries which are subject to a less restrictive bycatch management framework. That is, those fishers who are making the sacrifices and carrying the costs, are afraid they may not benefit from these actions (e.g. Tschernij and Suuronen, 2002). The mere suspicion of unfair sharing of burden may lead to a reluctance by fishers to adopt bycatch reduction technologies (Suuronen et al., 2007). Clearly, the potential reallocation of economic benefits (and burdens) among fisher groups should be addressed before new regulations are imposed. Otherwise, fishers may feel being treated unfairly and refuse to comply with the rules.

It is also noteworthy that in any given fishery, the amount and composition of bycatch varies depending on the fisher and vessel. The reputation of the whole fleet may be stained by a few fishers who ignore the responsible behavior. Fishers in general do not like to be the victims of other fishers' omissions. Collective responsibility in general does not improve the motivation and may work poorly in fisheries management.

Furthermore, fishers often note that there is little evidence that the calculated long-term biological and socioeconomic benefits of bycatch reduction are realized as predicted (for these predictions, see for instance Kuikka et al., 1996; Kvamme and Frousa, 2004; Bahamon *et el*., 2007; Coll et al., 2008). Unfortunately, there are very few follow-up assessments of the effects of the uptake of a bycatch reduction technology. It is a challenging task because of many factors affecting simultaneously on fish populations and fisheries. Besides, bycatch reduction technologies are often designed to address problems within one species group although several species are captured. This may exacerbate bycatch of more vulnerable species leading to potentially conflicting mitigation outcomes (e.g. Garcia et al., 2012; Gray and Kennelly, 2018; Gilman et al., 2019; Swimmer et al., 2020). Gilman et al. (2019) challenge the piecemeal bycatch management paradigms, which often reduce the mortality of one taxon of conservation concern at the (unintended) expense of others.

An additional complication is the potential mortality of animals that escape the gear with the help of bycatch reduction technology. Although there are studies on this subject (e.g. Suuronen et al., 1996, 2005; Broadhurst et al., 2006; Gilman et al., 2013; Uhlmann and Broadhurst, 2015; Yochum et al., 2015; Tenningen et al., 2019), and it is well demonstrated that some species groups have a high survival, the fate of animals that escape the gear under highly variable fishing conditions is often poorly known. Fishers can rightly ask whether it makes sense to use a certain technology in case there is little evidence that the organism will survive.

There is often a lack of confidence among fishers regarding the practicality of bycatch reduction technologies developed by scientific organizations or other third parties. Fishers frequently note that experiments are conducted on a small number of vessels under conditions that do not adequately mimic the variable conditions and diversity of fishing gear designs and practices encountered under commercial fishing (see also Cox et al., 2007; Hall et al., 2007). Furthermore, factors such as economic viability, social acceptance, and safety of bycatch reduction technologies are seldom properly assessed. Fishers often see technical bycatch solutions as cumbersome, impractical, time-consuming, and imposed with little involvement from the fishing sector. They do not want to lose any control of their fishing operations due to inadequate bycatch reduction technologies.

Taking all the potential factors into account it is not surprising that commercial fishers are unconvinced about the predicted benefits from the adoption of bycatch reduction technologies. From fishers' point of view the use of a bycatch

Table 1. Summary of effects, challenges, and potential development actions of various measures and approaches in building a bycatch mitigation program that uses technological solutions.

Measure/factor	Potential effect	Challenges and potential development actions
Economic incentive	• Uptake is encouraged by economic benefit (e.g. higher catch rate, improved price, better market access, preferential access to a fishing ground) • Market-based mechanisms establish a situation in which fishers consider it is in their economic interest to reduce bycatch	• Benefits often inadequate to inspire a change in behaviour • May not affect the intrinsic motivation that is the key in achieving a permanent change in behaviour • Attention may not focus to the desired output
Social incentive	• Encourages individuals to behave in a socially valued and approved manner • Helps to gain a positive social reputation • Builds confidence in mutually agreed objectives and foster acceptance • Critically important where top-down regulation is not feasible and economic incentives are absent	• Role of social incentives is under-appreciated, poorly understood and often ignored • Social incentives can have a significant effect in reinforcing non-compliancy or strengthening the compliancy • Social and cultural meanings that fishers attach on their fishing practices should be considered carefully in bycatch management.
Participation	• Potential to enhance the quality of decisions by more comprehensive information inputs • Potential to facilitate the incorporation of local knowledge • Potential to build ownership and reduce suspicions and scepticism	• Little evidence that ensures adoption • Fishers often not sufficiently motivated to engage • Participation structure can easily erode • Fishers not willing to give their detailed knowledge because it may compromise their business • Needs a highly skilled facilitator
Legal framework	• Command and control approach which has a penalty for violation • When successful may lead to compliance • Potential to create a level playing field that benefits responsible fishers • Legitimacy of rules may act as an incentive for compliance	• Does not affect internal motivation and may not inspire—does not build a cultural change • Efficacy highly dependent on enforcement capacity of regulatory agency • May result to micromanagement and cause unnecessary cost • May result in inappropriate manipulation of gear • May deny fishers the flexibility required to innovate and adopt new technologies • May freeze the technological development
Trust building	• Enables constructive dialogue among scientists, fishers, and managers • Reduces the impact of incorrect information • Reduces misunderstandings and helps fishers to accept the goals and solutions • Reduces unnecessary tension	• Building trust is time-consuming and requires good understanding of fishers' attitudes, hopes and hidden emotions • Trust is complex by nature and is lost easily • Facilitation requires special skills-setting and education

reduction technology often appears a costly and even risky investment, more as a problem than a solution. If we want to better understand how fishers think about a bycatch reduction technology, it could be helpful to stand in the shoes of a fisher and try to think as if we were that fisher ourselves. What would motivate us to make a change when we firmly believe that the outcome would be highly uncertain, and the costs would be burdensome?

How to improve uptake?

In the following sections I discuss of the potential role of various types of incentives and actions aimed in facilitating a change. I also provide suggestions on how to engage fishers in this process for finding agreeable solutions. Table 1 summarizes the effects, challenges and potential development actions of various measures and approaches in building a bycatch mitigation program that uses technological solutions.

The role of economic and social incentives

Economic incentives, which include some types of financial benefit, often are assumed necessary for fishers to adopt modifications to their fishing gear or fishing operation (e.g.Hall and Mainprize, 2005; Gjertsen *et al.*, 2010). An example of a positive economic incentive is a case where the fishing efficiency increases by reducing the bycatch with a suitable technology. For instance, in some longline fisheries where the bycatch reduces the hooks available for the target species, the reduction of bycatch would transfer to a higher catch and income (Gilman et al., 2005; Hall *et al.*, 2007). Similarly, the use of a sorting grid in shrimp trawl may result in a clean and high-quality catch, and markedly reduce the sorting work on deck (Broadhurst, 2000). In such an ideal situation, fishers may voluntarily switch to a technology that reduces bycatch, although there are no guarantees for that.

Nonetheless, financial benefit is rarely a sufficient stimulus for fishers to make a voluntary change in their gear (Campbell and Cornwell, 2008; Eayrs and Pol, 2019). Fishers often

consider the economic rewards projected too small and uncertain to motivate a change in their behaviour. A large enough economic reward might be effective to launch a change, but it would not necessarily affect the intrinsic motivation that is the key in achieving a permanent change in behaviour. Besides, it is possible that the effect of any economic incentive would fade over time and as a result, the motivation to continue the use of a modified practice would require an additional economic reward. Clearly, both the magnitude and the frequency of the economic incentive should be sufficient to have an enduring effect, and even then, fishers may overlook the benefits and have little motivation to a change.

Market-based mechanisms are based on establishing a situation in which fishers are convinced that it is in their interest to make desirable choices for instance in relation to bycatch reduction (De Young and Charles, 2007). These mechanisms promote desired behaviour and penalize undesirable behaviour (e.g. by loss of market access). Certification schemes and eco-labelling belong to market-based measures and in general have been effective at helping major seafood buyers and consumers make informed decisions, potentially improving market position of the products coming from low-bycatch fisheries. Although there is little evidence that ecolabels lead to higher prices for seafood (e.g. Stemle *et al*., 2016), fishing fleets may have an incentive to obtain these labels only to ensure that they will continue to maintain their current market access. A fishery where end-markets do not differentiate between eco-certified and non-certified products, does not benefit from certification.

Evidence is mounting that non-economic factors can play a crucial role in motivating fishers to a change. Social incentives are rewards and motivations that inspire people to behave in a socially approved manner. Social and cultural factors can build confidence in mutually agreed objectives within fishing communities and may be highly influential in shaping the compliancy although they are still largely ignored in bycatch management (e.g. Hall and Mainprize, 2005; Campbell and Cornwell, 2008; Stephenson *et al*., 2016, 2019; Mackay *et al*., 2020; Brehm *et al*., 2021). Apparently, social interactions may strengthen or inhibit the acceptance of almost any change and are critically important where top-down regulation is not feasible and economic incentives are absent. Clearly, the socioeconomic context of a given fishery should be understood and taken in account in the introduction of a new bycatch reduction technology.

Participation as a means to incentivize acceptance

Most of the research and development work on bycatch reduction technology has been done by research organizations and other organizations, which have the human resources, capital, and expertise needed for such work. Although fishers have extensive practical expertise with fishing gears and operations, their interest in these development activities has not always been as great as would have been desirable. Nonetheless, some of the most widely adopted bycatch reduction technologies are those where the idea originated with fishers (Valdemarsen and Suuronen, 2003; Hall *et al*., 2007). One well-known example of such a technical solution is the Nordmøre grid that was originally developed by a Norwegian fisher. This grid physically inhibits the passage of larger fish into the trawl codend but allows the smaller shrimp to pass through. Its use has been mandatory in almost all North Atlantic cold-water shrimp and many other fisheries (Graham, 2006), and the principle has been the basis for many other successful solutions.

There can be several reasons for the relatively small interest by fishers. They may consider the objectives to be unimportant, unattainable, or even controversial, and may lack the interest and time needed for such work. Fishers can be fatigued by the constant changes. They may also feel that by participating in a development project they are risking their standing among other fishers. Besides, fishers are often assumed to donate their time and expertise without compensation. Fishers' enthusiasm may diminish quickly if their input is not properly compensated. To become inspired in the development process, fishers need to understand and accept the problem and believe that there is a functional and affordable solution.

Furthermore, fishers may suspect that by sharing their detailed knowledge of their bycatches, the consequence may be further restrictions of their fishing operations. Hence, they may limit the amount of knowledge that they want to share. Fishers may also become increasingly dissatisfied when their views are not given enough weight (see also Silver and Campbell, 2005; Reed, 2008). They may consider their participation as merely symbolic rather than a genuine collaboration where their views have influence on the final gear design and its implementation. Furthermore, fishers in general are more willing to participate in development activities that are conducted by practical actors (e.g. respected gear designers or manufacturers) who have close ties to the fishing sector. Fishers prefer quick and practical projects that reflect their core interests and concerns.

Despite all the obstacles, it is widely assumed that greater integration of fishers' knowledge and perspectives has a potential to result in more practical and acceptable solutions that could lead to more successful outcomes during the implementation. Nonetheless, there is little solid evidence that participation guarantees eventual adoption of these solutions (Eayrs and Pol, 2019). There is some evidence that fisher participation may help to incorporate valuable local knowledge in the process which may foster a sense of ownership and increase the credibility and acceptance of the decisions taken (Cox *et al*., 2007; Hall *et al*., 2007; Holm and Soma, 2016; Stephenson *et al*., 2016; Oyanedel *et al*., 2020). Reed (2008) and Thompson *et al*. (2019) emphasize that early involvement is fundamental to foster a sense of ownership and to make fishers feel valuable to the process. Unfortunately, the early involvement is rarely met.

Do legal frameworks act as incentives?

Fishers (as all people) are seldom enthusiastic about a regulation that would require a specific change in their routine practices or behavior. Forcing fishers to use a certain gear modification or bycatch reduction device is often difficult (e.g. Suuronen *et al*., 2007; 2020). Nonetheless, in many fisheries there is a regulatory framework that contains requirements to use specified types of bycatch reduction technology or minimum mesh size, and there is a penalty structure for violations of rules. A penalty in the form of fines, catch and gear seizures, or loss of fishing license is assumed to "incentivize" fishers to comply.

Apparently, when a fishery is profitable and fishers have a high interest to continue fishing, they are more likely to follow the requirements conscientiously and responsibly (Campbell and Cornwell, 2008). Likewise, when non-compliance threat-

ens the access to a fishing ground, there may be a motivation to follow the rules. If fishing is not particularly profitable or there is a small likelihood of getting caught in breaking the rules, interest in complying with the rules may be low. In many fisheries fishers ignore the rules simply because they have little to lose, penalties are not severe enough, or rules do not appear meaningful. Fishers are very skilful in finding ways to effectively circumvent technical rules related to their fishing gear.

Management systems usually require that all fishers involved in a fishery follow the rules; free riders may cause an erosion of compliance throughout the fishery (Nielsen and Mathiesen, 2003; Hall and Mainprize, 2005). Fisheries agencies often do not have adequate resources to effectively conduct surveillance and enforce regulations, and in some situations, fishers are not even familiar with the rules and regulations (e.g. Suuronen *et al*., 2020). Proper monitoring of bycatch reduction practices often requires extensive at-sea inspection which is difficult and expensive. Rapidly developing electronic technologies, however, provide new opportunities and lower costs for at sea compliance monitoring (e.g. Suuronen and Gilman, 2020). Even then, intentional manipulation of a bycatch reduction technology can go unnoticed. Fishers are skilled at evading the monitoring systems.

The EU Landing Obligation (LO), better known as EU discard ban, is an example of a regulation that aims to reduce discarding by incentivizing fishers to employ more selective fishing gear to avoid bycatch of unwanted species and sizes of fishes subject to the measure. The implementation of LO, however, has faced various problems such as broad-scale non-compliance, and discarding has not markedly decreased (Catchpole et al., 2017; Karp *et al*., 2019; Borges, 2021; Calderwood *et al*., 2021; Madsen *et al*., 2021). Clearly, when the acceptance of a measure is weak, attaining the adequate level of compliance (and potential benefits) will be challenging to achieve.

It is noteworthy, however, that a discard ban enforced in Norway over several decades has had relatively good industry support and is well integrated into the management system (Graham *et al*., 2007; Gullestad *et al*., 2015). This may at least partly depend on the fact that the adoption of bycatch reduction devices has allowed fishers to continue fishing in areas which would have otherwise been placed off-limits, and fishers have been given enough time to adjust. It may well be that in the long run also the EU Landing Obligation will show better results. That may require of testing the concepts used in for instance in Norway such as making closed areas conditionally accessible to fishers who can demonstrate appropriate use of bycatch reduction technologies.

It is apparent that top-down technical regulation has a poor chance of success in case fishers fail to understand the rationale. It is essential that the regulations address the issues for which they are intended, and the justification is clear and fair. Moreover, poorly designed regulations may freeze the development and innovation and may also cause extra costs for the fishing sector (see also Lent and Squires, 2017). It is important that fishers are allowed to retain at least some degree of flexibility in their fishing operations and gear rigging so that they can utilize their experience and skills to reduce bycatch. Flexibility is also needed in responding to changes in fishing conditions. A well-designed regulatory framework creates a fair playing field, encourages innovation, and benefits all responsible actors.

Constructive dialogue as a tool to build trust and readiness

I have attended numerous meetings where fishers and their representatives discuss of bycatch management with fisheries managers, scientists, and other stakeholders. These meetings do not always meet the definition of a good dialogue. Debate may be underpinned by tenacious beliefs and distorted interpretations of others' views. Fishers often find the conversation blaming but sometimes they use unnecessarily harsh language towards other participants. There are frequently a wide range and often opposite views around the problem and the potential solutions, and sometimes misleading and intentional misunderstandings. What fishers hear in the meetings may not match what others hear. Clearly, the lack of constructive interaction may effectively prevent a meaningful exchange of ideas and undermines the trust between stakeholders.

Fishers and their organizations often have strong perceptions of the issues under discussion. It is not uncommon that they are skeptical of new proposals. They may be frustrated by the earlier measures that have restricted their fishing and reduced the flexibility of their activities. The roots of mistrust may originate in some historical disappointment that has nothing to do with the issue that is the current focus. There can be strong suspicions about everything that is said. This is where fisheries scientists and managers, or a facilitator, should be able to help. Interventions should correct negative interpretations and highlight issues for which there is evidence. A good start is to discuss together why there are disagreements. An accurate and truthful picture of the situation is helpful and should be framed in an impartial and clear vision. It creates the foundation for a constructive debate.

To build trust, fishers need to become convinced that scientists, managers, and other key stakeholders understand their concerns and needs, and value their input. The process must be transparent and understandable to fishers. Trust is highly dynamic and multidimensional by nature, and it can be lost easily (see also Reed *et al*., 2014; Stern and Coleman, 2015; Lacey *et al*., 2018; Cvitanovic *et al*., 2021). Furthermore, even when the attitudes of fishers are positive and there appears to be a good element of trust, it does not necessarily mean that they are prepared to adopt the proposed change. Fishers are not a homogeneous group where everyone has the same perceptions and aspirations (see also Calderwood *et al*., 2021). Fishers are often competitors and their views and attitudes may differ greatly depending on the issue. There is seldom a consensus about the problem, and what should be done about it.

Respect for the views of the other parties is needed to build trust and move the debate forward constructively. When people trust each other, difficult topics can be raised more easily, and the expression of a dissenting opinion is not perceived as threatening. Empathy helps to build mutual trust. A well-facilitated and open debate assists the participants to recognize what is behind others' thinking. Thompson *et al*. (2019) have created a useful list of best practices for collaboration. Their list includes factors such as meaningful involvement of all parties; trust, respect, and commitment; and consensus on objectives. Eayrs and Pol (2019) suggest the use of change management models to facilitate the process.

It is noteworthy that effective change often requires champions among the fishing sectors. These cooperative individuals can help others to understand the true situation and the

need for change. If influential fishers adopt a solution, there is a good chance that others will follow. The timetable of a change is often critical for the fishing sector; step-by-step approach may work better than one massive leap.

Language is important element in any dialogue. Scientific concepts easily produce failures to comprehend for other participants and may lead to a *de facto* exclusion from the process. It is noteworthy that fishers are usually highly interested in seeing underwater videos that demonstrate the operation of the new technology in real conditions. Such a video can markedly increase the interest in and credibility of the suggested solution, and the acceptance can thereby dramatically improve. Furthermore, examples of successful introduction of similar type of bycatch reduction technologies in some other fisheries may help to find acceptance in situations where fishers have little faith in the functionality and meaningfulness of the proposed technology. Likewise, truthful presentations of non-successful solutions may increase the credibility in the process.

One example of a successful initiative that I often used during my FAO projects was the first tropical shrimp trawl fishery that in 2011 achieved the MSC certification in Suriname (http://suriname-seabob-stories.msc.org/). The certification allowed this fishery to markedly expand its market access which was a major benefit. Like many trawl fisheries, this fishery initially did not have proper measures in place for managing interactions with endangered species and other bycatch in the area. Fishers and vessel owners, however, recognized that collaborating with scientists, the government and other stakeholders would be critical to success, and little by little they achieved the requirements of certification (see also Southall *et al*., 2011; Willems, 2016). Trawls were equipped with turtle exclusion devices and escape panels to minimize the bycatch. Since becoming certified, this fishery has worked hard to further improve its operations to maintain the certificate.

Finally, in social media people often express their views without much hindrance and extreme opinions often gain large visibility. When distorted and false information is spread through social media, it can erode trust in institutions and misrepresent research. Clearly, some basic rules should be agreed on how stakeholders communicate in social media. It is also good to keep in mind that social media can be utilized in a positive and constructive way such as issuing joint statements.

Conclusions

Research into bycatch reduction technologies has made significant progress during the last decades. Nonetheless, there are still major barriers to the adoption of these technologies by commercial fisheries. Obviously, in case fishers' attitudes and motivation are not favourable, there is little hope that they would accept a technology, no matter how good this technology may be. The adoption requires willingness and readiness of fishers to accept a change.

Clearly, fishers' perspectives and attitudes have not been taken adequately into account. Better understanding of the attitudes and motivation could help to predict fishers' likely response towards these technologies and could assist in finding successful solutions. Furthermore, it is important to keep in mind that fishers are those whose behavior one is seeking to influence. Fishers should not feel alienated nor underestimated.

When there is a need to enforce a regulation on bycatch reduction technology, it is important to understand that the motivation of each individual fisher strongly affects the potential degree of compliance. Several factors may influence motivation, including market pressures, status of fisheries resources, and feeling of fairness. Solutions proposed must be meaningful in the socioeconomic context of a given fishery. Furthermore, rules on bycatch reduction technologies should not be enforced without adequate assessment of the likely benefits, costs, and other consequences. Besides, there should be a follow-up monitoring of these consequences.

It is also worth realizing that bycatch reduction solutions often must balance many conflicting goals in widely varying conditions. Decisions inevitably require trade-offs to be made between ecological, economic, social and sustainability criteria. No single measure or technology is likely to attain all the goals, and there is no single best way to mitigate bycatch problem (see also Sigurðardóttir *et al*., 2015; McConnaughey *et al*., 2020). There can be many alternative approaches that may produce adequate results. For instance, avoidance of bycatch hot-spots or a reduction of excessive fishing effort may work better in some cases although it is obvious that all solutions face some types of acceptance and compliancy challenges. Often a combination of actions is needed.

There is a growing public interest in the sustainability of fisheries, including the mitigation of problematic bycatch. It is likely that ever stricter targets will be set to eliminate bycatches. To improve the credibility, fishing sector needs to act effectively and transparently in reducing bycatches. Sector must accept the monitoring of their fishing actions as a necessary condition of operation. At the same time, the sector needs more recognition of the achievements it has made. A fisher who is respected and trusted by the society, and who believes in a positive future, is more likely to act responsibly and sustainably. At the end, fishers hold the key to solve the bycatch problem.

It is important also to realize that approaches available in the developed world are not always applicable to fisheries in the developing world. It is not just a question of fishers' attitudes and motivation, but also of the larger systems present in those regions. Conditions there do not always support sustainable and profitable fishing. Clearly, experts and fishers in the developing nations require assistance that is tailored to their needs. They need to be motivated to come up with the solutions that are practical and functional for them. At the same time, conditions must be created to make their fishing less vulnerable to changing conditions. Only through such actions is it possible to achieve sustainability goals in bycatch reduction.

The key lessons I have gained during my years working with commercial fishers is that fishers need a clear vision of what the suggested technologies means for their livelihood and evidence that these technologies perform sufficiently well in various conditions. The essential element for a change is fishers' motivation and readiness. While research can tell which measures can lead to a particular outcome, fishers' attitudes determine what the final outcome is.

Data availability

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References

Bahamon, N., Sardà, F., and Suuronen, P. 2007. Potential benefits from improved selectivity in the northwest mediterranean multispecies trawl fishery. ICES Journal of Marine Science, 64: 757–760.

Barz, F., Eckardt, J., Meyer, S., Kraak, S.B.M., and Strehlow, H.V. 2020. `Boats don't fish, people do´ - how fishers' agency can inform fisheries-management on bycatch mitigation of marine mammals and sea birds. Marine Policy 122, 104268. https://doi.org/10.1016/j.marpol.2020.104268.

Borges, L. 2021. The unintended impact of the european discard ban. ICES Journal of Marine Science, 78: 134–141.

Breen, M., Graham, N., Pol., M., He, P., Reid, D.G., and Suuronen, P. 2016. Selective fishing and balanced harvesting. Fisheries Research, 184: 2–8.

Brehm, J.M., Bulengela, G., and Onyango, P. 2021. Beyond rules and regulations: understanding the cultural and social significance of beach seine fishery on lake tanganyika, Tanzania. Maritime Studies, https://doi.org/10.1007/s40152-021-00249-8.

Broadhurst, M. K., Suuronen, P., and Hulme, A. 2006. Estimating collateral mortality from towed fishing gear. Fish and Fisheries, 7: 180–218.

Broadhurst, M.K. 2000. Modifications to reduce bycatch in prawn trawls: a review and framework for development. Reviews in Fish Biology and Fisheries, 10: 27–60. https://doi.org/10.1023/A: 1008936820089.

Calderwood, J., Pedreschi, D., and Reid, D.G. 2021. Technical and tactical measures to reduce unwanted catches in mixed fisheries: do the opinions of irish fishers align with management advice? Marine Policy, 123, 104290.

Campbell, L.M., and Cornwell, M.L. 2008. Human dimensions of bycatch reduction technology: current assumptions and directions for future research. Endangered Species Research, 5: 325–334.

Catchpole, T., Ribeiro-Santos, A., Mangi, S.C., Hedley, C., and Gray, T.S. 2017. The challenges of landing obligation in EU fisheries. Marine Policy, 82: 76–86.

Clarke, S., Sato, M., Small, C., Sullivan, B., Inoue, Y., and Ochi, D. 2014. Bycatch in longline fisheries for tuna and tuna-like species: a global review of status and mitigation measures. FAO Fisheries and Aquaculture Technical Paper No. 588. Rome, FAO. 199pp.

Coll, M., Bahamon, N., Sardà, F., Palomera, I., Tudela, S., and Suuronen, P. 2008. Improved trawl selectivity: effects on the ecosystem in the south catalan sea (NW mediterranean). Marine Ecology Progress Series, 355: 131–147.

Cox, T.M., Lewison, R.L., Zydelis, R., Crowder, L.B., Safina, C., and Read, A.J. 2007. Comparing effectiveness of experimental and implemented bycatch reduction measures: the ideal and the real. Conservation Biology, 21: 1155–1164.

Cvitanovic, C., Shellock, R.J., Mackay, M., van Putten, E.I., Karcher, D.B., Dickey-Collas, M., and Ballesteros, M. 2021. Strategies for building and managing `trust´ to enable knowledge exchange at the interface of environmental science and policy. Environmental Science & Policy, 123: 179–189.

De Young, C., and Charles, T. 2007. Creating incentives for the ecosystem approach to fisheries management: a portfolio of approaches for consideration in the benguela current large marine ecosystem. Pp 189–205. In: Report of the Third Regional Workshop, Cape Town, South Africa, 30 Oct –3 Nov 2006. Project LMR/EAF/03/01, Report Nr 4: 225 p. FAO, Rome.

Dias, M.P., Martin, R., Pearmain, E.J., Burfield, I.J., Small, C., Phillips, R.A., Yates, O. *et al.* 2019. Threats to seabirds: a global assessment. Biological Conservation, 237: 525–537.

Eayrs, S., Cadrin, S.X., and Glass, C.W. 2015. Managing change in fisheries: a missing key to fishery-dependent data collection? ICES Journal of Marine Science, 72: 1152–1158.

Eayrs, S., and Pol, M. 2019. The myth of voluntary uptake of proven fishing gear: investigations into the challenges inspiring change in fisheries. ICES Journal of Marine Science, 76: 392–401.

FAO. 2011. International Guidelines on Bycatch Management and Reduction of Discards. Rome, FAO, 73pp.

Garcia, S., Kolding, J., Rice, J., Rochet, M-J., Zhou, S., Arimoto, T., Beyer, J. E. *et al.* 2012. Reconsidering the consequences of selective fisheries. Science 335: 1045–1047.

Gilman, E. 2011. Bycatch governance and best practice mitigation technology in global tuna fisheries. Marine Policy, 35: 590–609.

Gilman, E., Brothers, N., and Kobayashi, D.R. 2005. Principles and approaches to abate seabird by-catch in longline fisheries. Fish and Fisheries, 6: 35–49

Gilman, E., Chaloupka, M., Dagorn, L., Hall, M., Hobday, A., Musyl, M., Pitcher, T. *et al.* 2019. Robbing peter to pay paul: replacing unintended cross-taxa conflicts with intentional tradeoffs by moving from piecemeal to integrated fisheries bycatch management. Reviews in Fish Biology and Fisheries, 29: 93–123. DOI/10.1007/s11160-019-09547-1.

Gilman, E., Chopin, F., Suuronen, P., and Kuemlangan, B. 2016. Abandoned, lost or otherwise discarded gillnets and trammel nets. Methods to estimate ghost fishing mortality, and the status of regional monitoring and management. FAO Fisheries and Aquaculture Technical Paper No. 600. Rome, Italy. 79pp. http://www.fao.org/3/a-i5051e.pdf

Gilman, E., Pérez Roda, M.A., Huntington, T., Kennelly, S.J., Suuronen, P., Chaloupka, M., and Medley, P.A.H. 2020. Benchmarking global fisheries discards. Scientific Reports,10, 10. Article number 14017. https://doi.org/10.1038/s41598-020-71021-x.

Gilman, E., Suuronen, P., Hall, M., and Kennelly, S. 2013. Causes and methods to estimate cryptic sources fishing mortality. Journal of Fish Biology, 83: 766–803.

Gjertsen, H., Hall, M., and Squires, D. 2010. Incentives to address bycatch issues. *In* Conservation and Management of Transnational Tuna Fisheries. Chapter 14, pp. 225–248. Ed. by R. Allen, J. Joseph, and D. Squires. Wiley-Blackwell, Oxford (UK). doi:10.1002/9780813820262.ch14

Graham, N. 2006. Trawling: historic development, current status and future challenges. Marine Technology Society Journal 40: 20–24. https://doi.org/10.4031/002533206787353231.

Graham, N., Ferro, R.S.T., Karp, W.A., and MacMullen, P. 2007. Fishing practice, gear design, and the ecosystem approach – three case studies demonstrating the effect of management strategy on gear selectivity and discards. ICES Journal of Marine Science, 64: 744–750.

Gray, C., and Kennelly, S. 2018. Bycatches of endangered, threatened and protected species in marine fisheries. Reviews in Fish Biology and Fisheries, 28: 521–541.

Gullestad, P., Blom, G, Bakke, G., and Bogstad, B. 2015. The "Discard ban package": experiences in efforts to improve the exploitation pattern in norwegian fisheries. Marine Policy, 54: 1–9.

Hall, M.A. 1996. On bycatches. Reviews in Fish Biology and Fisheries, 6: 319–352.

Hall, M.A., Alverson, D.L., and Metuzals, K.I. 2000. Bycatch: problems and solutions. Marine Pollution Bulletin, 41: 204–219.

Hall, M.A., Nakano, H., Clarke, S., Thomas, S., Molloy, J., Peckham, S.H., Laudino-Santillán, J. *et al.* 2007. Working with fishers to reduce By-catches. *In* By-catch Reduction in the World's Fisheries. pp 235–288. Ed. by S. Kennelly. Springer, The Netherlands, 288pp.

Hall, S.J., and Mainprize, B.M. 2005. Managing bycatch and discards: how much progress are we making and how can we do better? Fish and Fisheries, 6: 134–155.

He, P., and Pol, M. 2010. Fish behavior near gillnets: capture process and influencing factors. *In* Behavior of Marine Fishers – Capture Processes and Conservation Challenges, pp. 183–203. Ed. by P. He. Wiley-Blackwell, Blackwell Publishing Ltd, The Netherlands, 375pp.

Holm, P., and Soma, K. 2016. Fisher's information in governance – a matter of trust. Current Opinion in Environmental Sustainability, 18: 115–121. Doi: 10.1016/j.cosust.2015.12.005

Isaksen, B., Valdemarsen, J.W., Larsen, R.B., and Karlsen, L. 1992. Reduction of fish bycatch in shrimp trawls using a solid separator grid in the aft belly. Fisheries Research, 13: 335–352.

Jenkins, L. 2012. Reducing sea turtle bycatch in trawl nets: A history of NMFS turtle excluder device (TED) research. Marine Fisheries Review, 74: 26–44.

Jenkins, L.K. 2015. From conflict to collaboration: the role of expertise in fisheries management. Ocean & Coastal Management, 103: 123–133. https://doi.org/10.1016/j.ocecoaman.2014.10.006.

Karp, W.A., Breen, M., Borges, L., Fitzpatrick, M., Kennelly, S.J., Kolding, J., Nielsen, K.N. *et al.* 2019. Strategies used throughout the world to manage fisheries discards – lessons for implementation of the EU landing obligation. *In* The European Landing Obligation. Reducing Discards in Complex, Multi-Species and Multi-Jurisdictional Fisheries, pp. 3–26. Ed. by S.S. Uhlmann, C. Ulrich, and S.J. Kennelly. Springer Open Publication, Springer Nature Switzerland AG, Gewerbestrasse 11, 6330 Cham, Switzerland. 978-3-030-03308-8, (Chapter 1) (eBook), https://doi.org/10.1007/978-3-030-03308-8.

Kennelly, J.M., and Broadhurst, M.K. 2021. A review of bycatch reduction in demersal fish trawls. Reviews in Fish Biology and Fisheries, 31(1) DOI: 10.1007/s11160-021-09644-0

Komoroske, L.M., and Lewison, R.L. 2015. Addressing fisheries bycatch in a changing world. Frontiers in Marine Science 2, Article 83. doi: 10.3389/fmars.2015.00083

Kuikka, S., Suuronen, P., and Parmanne, R. 1996. The impacts of increased codend mesh size on the northern baltic sea herring fishery: ecosystem and market uncertainties. ICES Journal of Marine Science, 53: 723–730.

Kvamme, C., and Frousa, K.G. 2004. Assessing the effects on stocks of selectivity changes in a fishery. Fisheries Research, 69: 283–292.

Lacey, J., Howden, M., Cvitanovic, C., and Colvin, R.M. 2018. Understanding and managing trust at the climate science–policy interface. Nature Climate Change, 8: 22–28.

Lent, R., and Squires, D. 2017. Reducing marine mammal bycatch in global fisheries: an economics approach. Deep Sea Research Part II: Topical Studies in Oceanography, 140: 268–277. https://doi.org/10.1016/j.dsr2.2017.03.005

Mackay, M., Yamazaki, S., Jennings, S., Sibly, H., van Putten, I.E., and Emery, T.J. 2020. The influence of nudges on compliance behaviour in recreational fisheries: a laboratory experiment. ICES Journal of Marine Science, 77: 2319–2332. doi:10.1093/icesjms/fsz020

Madsen, N. 2007. Selectivity of fishing gears used in the baltic sea cod fishery. Reviews in Fish Biology and Fisheries, 17: 517–544.

Madsen, N., Ingólfsson, O.A., Nilsson, H., and Suuronen, P. 2021. Improving species and size selectivity in the baltic cod trawl fishery with two new codend designs. Fisheries Research, 236: 105846.

McConnaughey, R.A., Hiddink, J.G., Jennings, S., Pitcher, C.R., Kaiser, M.J., Suuronen, P. *et al.* 2020. Choosing best practices for managing the impacts of trawl fishing on seabed habitats and biota. Fish and Fisheries, 21: 319–337. https://doi.org/10.1111/faf.12431

Moore, J.E., Heinemann, D., Francis, T.B., Hammond, P.S., Long, K.J., Punt, A.E., Reeves, R.R. *et al.* 2021. Estimating bycatch mortality for marine mammals: concepts and best practices. Frontiers in Marine Science, 8: 752356. doi:10.3389/fmars.2021.752356

Nielsen, J.R., and Mathiesen, C. 2003. Important factors influencing rule compliance in fisheries lessons from denmark. Marine Policy, 27: 409–416.

Oyanedel, R., Gelcich, S., and Milner-Gulland, E.J. 2020. Motivations for (non-)compliance with conservation rules by small-scale resource users. Conservation Letters, 13: e12725. doi.org/10.1111/conl.12725

Pérez Roda, M.A., Gilman, E., Huntington, T., Kennelly, S.J., Suuronen, P., Chaloupka, M., and Medley, P. 2019. A third assessment of global marine fisheries discards. FAO Fisheries and Aquaculture Technical Paper No. 633. Rome, FAO. 78pp.

Poisson, P., Budan, P., Gilman, E., Kojima, T., Musyl, M., and Takagi, Y. 2021. New technologies to improve bycatch mitigation in industrial tuna fisheries. Fish and Fisheries, DOI: 10.1111/faf.12631

Read, A.J., Drinker, P., and Northridge, S. 2006. Bycatch of marine mammals in U.S. and global fisheries: bycatch of marine mammals. Conservation Biology, 20: 163–169. http://dx.doi.org/10.1111/j.1523-1739.2006.00338.x.

Reed, M.S. 2008. Stakeholder participation for environmental management: a literature review. Biological Conservation, 141: 2417–2431.

Reed, M.S., Stringer, L.C., Fazey, I., Evely, A.D, and Kruijsen, J.H.D. 2014. Five principles for the practice of knowledge exchange in environmental management. Journal of Environmental Management, 146: 337–345.

Rose, C. S., Gauvin, J. R., and Hammond, C. F. 2010. Effective herding of flatfish by cables with minimal seafloor contact. Fishery Bulletin, 108: 136–144.

Savoca, M.S., Brodie, S., Welch, H., Hoover, H., Benaka, L.R., Bograd, S.J., and Hazen, E.L. 2020. Comprehensive bycatch assessment in US fisheries for prioritizing management. Nature Sustainability, 3: 472–480.

Sigurðardóttir, S., Stefánsdóttir, E.K., Condie, H., Margeirsson, S., Catchpole, T.L, Bellido, J.M., Eliasen, S.Q. *et al.* 2015. How can discards in european fisheries be mitigated? Strengths, weaknesses, opportunities and threats of potential mitigation methods. Marine Policy, 51: 366–374. http://dx.doi.org/10.1016/j.marpol.2014.09.018

Silver, J.J., and Campbell, L.M. 2005. Fisher participation in research: dilemmas with the use of fisher knowledge. Ocean & Coastal Management, 48: 721–741.

Southall, T., Pfeiffer, N., and Singh-Renton, S. 2011. MSC sustainable fisheries certification - Suriname Atlantic Seabob shrimp. Public Certification Report. Food Certification International LTD, Findhorn House, Dochfour Business Centre, Inverness, Scotland, UK

Stemle, A., Uchida, H., and Roheim, C.A. 2016. Have dockside prices improved after MSC certification? Analysis of multiple fisheries. Fisheries Research, Special Issue: Fisheries Certification and Eco-labeling: Benefits, Challenges and Solutions, 182: 116–123. doi.org/10.1016/j.fishres.2015.07.022

Stephenson, R. L., Paul, S., Pastoors, M. A., Kraan, M., Holm, P., Wiber, M., Mackinson, S. *et al.* 2016. Integrating fishers' knowledge research in science and management. ICES Journal of Marine Science, 73: 1459–1465. doi:10.1093/icesjms/fsw025

Stephenson, R.L., Wiber, M., Paul, S., Angel, E., Benson, A., Charles, A., Chouinard, O. *et al.* 2019. Integrating diverse objectives for sustainable fisheries in canada. Canadian Journal of Fisheries and Aquatic Sciences, 76: 480–496. doi.org/10.1139/cjfas-2017-0345.

Stern, M.J., and Coleman, K.J. 2015. The multidimensionality of trust: applications in collaborative natural resources management. Society & Natural Resources, 28: 117–132. DOI: 10.1080/08941920.2014.945062

Suuronen, P. 1995. Conservation of young fish by management of trawl selectivity. Finnish Fisheries Research, 15: 97–116.

Suuronen, P. 2005. Mortality of fish escaping trawl gears. FAO Fisheries Technical Paper No. 478, FAO, 72p.

Suuronen, P., Chopin, F., Glass, C., Løkkeborg, S., Matsushita, Y., Queirolo, D., and Rihan, D. 2012. Low impact and fuel efficient fishing - looking beyond the horizon. Fisheries Research, 119-120: 135–146.

Suuronen, P., and Gilman, E. 2020. Monitoring and managing fisheries discards: new technologies and approaches. Marine policy, 116: 103554. DOI: 10.1016/j.marpol.2019.103554

Suuronen, P., Lehtonen, E., and Jounela, P. 2005. Escape mortality of trawl-caught baltic cod (Gadus morhua) – the effect of water temperature, fish size and codend catch. Fisheries Research, 71: 151–163.

Suuronen, P., and Millar, R.B. 1992. Size-selectivity of diamond and square mesh codends in pelagic herring trawls: only small herring will notice the difference. Canadian Journal of Fisheries and Aquatic Sciences, 49: 2104–2117.

Suuronen, P., Perez-Comas, J.A., Lehtonen, E., and Tschernij, V. 1996. Size-related mortality of herring (Clupea harengus L.) escaping through a rigid sorting grid and trawl codend meshes. ICES Journal of Marine Science, 53: 691–700.

Suuronen, P., Pitcher, C.R., McConnaughey, R.A., Kaiser, M.J., Hiddink, J.G., and Hilborn, R. 2020. A path to a sustainable trawl fishing in southeast asia. Reviews in Fisheries Science & Aquaculture 28: 499–517. doi.org/10.1080/23308249.2020

Suuronen, P., and Sarda, F. 2007. The role of technical measures in european fisheries management and how to make them work better. ICES Journal of Marine Science, 64: 751–756.

Suuronen, P., and Sarda, F. 2007a. Bycatch reduction techniques in european fisheries - traditional methods and potential new innovations. *In* By-catch Reduction in the World´s Fisheries, pp. 37–74. Ed. by S. Kennelly. Springer, The Netherlands, 288 pp.

Suuronen, P., Siira, A., Kauppinen, T., Riikonen, R., Lehtonen, E., and Harjunpää, H. 2006. Reduction of seal-induced catch and gear damage by modification of trap-net design: design principles for a seal-safe trap-net. Fisheries Research, 79: 129–138.

Suuronen, P., Tschernij, V., Jounela, P., Valentinsson, D., and Larsson, P-O. 2007. Factors affecting rule compliance with mesh size regulations in the baltic cod trawl fishery. ICES Journal of Marine Science, 64: 1603–1606.

Swimmer, Y, Zollet, E.A., and Gutierrez, A. 2020. Bycatch mitigation of protected and threatened species in tuna purse seine and longline fisheries. Endangered Species Research, 43: 517–542. doi.org/10.3354/esr01069

Tenningen, M., Pobitzer, A., Handegard, N. O., and Jong, K. 2019. Estimating purse seine volume during capture: implications for fish densities and survival of released unwanted catches. ICES Journal of Marine Science, 76: 2481–2488.

Thompson, S.A, Stephenson, R.L., Rose, G.A., and Paul, S.D. 2019. Collaborative fisheries research: the canadian fisheries research network experience. Canadian Journal of Fisheries and Aquatic Sciences, 76: 671–681. doi.org/10.1139/cjfas-2018-0450

Tschernij, V., Lehtonen, E., and Suuronen, P. 1993. Behaviour of baltic herring in relation to a poundnet and the possibilities of extending the pound-net season. ICES Mar. Sci. Symp. 196: 36–40.

Tschernij, V., and Suuronen, P. 2002. Improving trawl selectivity in the Baltic – Utökning av trålselektion i Östersjön. TemaNord 2002: 512, 56pp.

Tschernij, V., Suuronen, P., and Jounela, P. 2004. A modelling approach for assessing short-term catch losses of a mesh size increase. Fisheries Research, 69: 399–406.

Uhlmann, S.S., and Broadhurst, M.K. 2015. Mitigating unaccounted fishing mortality from gillnets and traps. Fish and Fisheries, 16: 183–229

Valdemarsen, J.W., and Suuronen, P. 2003. Modifying fishing gear to achieve ecosystem objectives. *In* Responsible Fisheries in the Marine Ecosystem. Pp. 321–341. Ed. by M. Sinclair, and G. Valdimarsson. FAO and CABI International Publishing, Italy and England. 426 p.

Willems, T. 2016. An ecosystem approach to fisheries management: the Atlantic seabob shrimp (Xiphopenaeus kroyeri) in Suriname. Thesis, Ghent University, The Netherlands, 310pp. DOI: 10.13140/RG.2.1.2048.1525

Winger, P., Lokkeborg, S., and Pol, M. 2016. Fish capture by baited pots. A review of fish behaviour. Journal of Ocean Technology 11: 1–12.

Yochum, N., Rose, C.S., and Hammond, C.F. 2015. Evaluating the flexibility of a reflex action mortality predictor to determine bycatch mortality rates: a case study of tanner crab (*Chionoecetes bairdi*) bycaught in alaska bottom trawls. Fisheries Research, 161: 226–234.

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