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## Bycatch and discards: from improved knowledge to mitigation programmes

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### Abstract:

Discarding is considered by many as an important problem in world fisheries. In many regions, data collection onboard commercial vessels has intensified, and the understanding of both human and ecological drivers of discards is improving quickly. Discarding patterns vary widely across regions, fisheries, gears, and species. Fishers' responses to regulations and markets explain these complex patterns, on top of resource availability partly driven by environmental fluctuations. This expanded knowledge base provides an appropriate basis for discussing the discard mitigation measures proposed in various settings. In September 2012, a theme session was convened at the ICES Annual Science Conference in Bergen, Norway, to discuss these issues. This themed set of articles includes several of the studies presented at the theme session. Owing to the wide diversity of drivers and reasons for discarding, no single management measure or even framework is expected to address the issue. Rather, discard mitigation measures need to be tailored to each particular fishery, or even species within a fishery, and the effectiveness of solutions is greatest when they are used in combination with other approaches. Bottom-up approaches to bycatch and discard management, which involve incentive-based solutions to bycatch problems, were agreed to be the most promising.

**Keywords:** bycatch and discards ; catch quotas ; compliance ; landing obligation ; landing quotas ; market incentives ; minimum landing sizes ; onboard observer programmes ; selectivity

Discarding continues to be an important problem in world fisheries. Discarding is considered by many as a waste of natural resources and a contribution to the depletion of stocks that are under high fishing pressure, but it can also be viewed as a way for fishers to adjust their landings to the legal and market constraints. In many regions, data collection onboard commercial vessels has intensified (e.g., the EU Data Collection Framework launched in 2008, Standardized Bycatch Reporting Methodology in the Northeast US, and increased at-sea observer coverage in other regions). Member states, the Sub-Group on Research Needs of the Scientific, Technical and Economic Committee for Fisheries of the EU Commission, several expert groups in the International Council for the Exploration of the Seas (ICES) and various research projects have undertaken analyses of these data. The understanding of both human and ecological drivers of discards is improving quickly, as well as the appraisal of the magnitude of the issue by fisheries and areas. This expanded knowledge base provides an appropriate basis for discussing the discard mitigation measures proposed in various settings, including the implementation of the landing obligation to be launched under the reform of the European Union Common Fisheries Policy (CFP). In September 2012, a theme session was convened at the ICES Annual Science Conference in Bergen, Norway to discuss these issues. The session was well-attended, illustrating the growing interest in this topic. This themed set of articles includes several of the studies presented at the theme session.

## **Advances in knowledge**

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There has been considerable progress in monitoring discards, estimating discard mortality and understanding factors that influence discards. The data available for measuring and analyzing patterns of discards has increased, ranging from traditional logbooks to at-sea observer data (Uhlmann et al., 2013; Tsagarakis et al., 2013) and more technologically advanced fisher-reporting systems for both commercial and recreational fisheries. A striking result is the diversity of discarding patterns across regions, fisheries, gears, and species (Uhlmann et al., 2013; Tsagarakis et al., 2013). These data can be modelled to predict discard rates as a function of fishing gear, fishing behaviour, season, location, resource availability, market conditions and regulations, and investigate discard causes (Catchpole et al., In review). Environmental factors can also be used to predict bycatch (e.g., Bethoney et al. 2013). The system of restricting landings, as is the case with the current system used in EU fisheries, is one cause of discards. Many EU fisheries catch a mix of species simultaneously, many of which are regulated by landing quotas. Currently, once the landing quota is fully utilised for one or more species, fishers will continue catching and discarding those species while targeting other species for which quota is available or unregulated species. Consequently, landings quotas often fail to deliver their main function of restricting fishing mortality. Fishers' responses to landing quota restrictions have been identified as an important driver of discarding and can be the principal reason for discarding in some fisheries (Catchpole et al., In review). Other important drivers of discarding include fish caught under the legal Minimum Landing Size (MLS), fish caught for which there is no market or an inconsistent market, fishers' responses to catch composition regulations, and damage to the catch (Catchpole et al., In review).

## Mitigation

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These advances in data availability, understanding the interactive behaviour of fish and fisheries, and exploring patterns of variation in discards can be used to develop mitigation programmes.

The anticipated change to discard management in the European CFP has influenced and was influenced by recent research. A reformed CFP was agreed upon in May 2013, which includes a move to catch limits and an obligation to land all catches, i.e. a discard ban, a strategy that is used in other countries e.g. Canada (Clucas 1997). The principle of these reforms is that all catches of restricted species shall be brought and retained on board fishing vessels and recorded and landed. European fisheries will come under the new obligation to land all catches in a phased approach between 2015 and 2019. Exceptions to the landing obligation will be made for species where high discard survival rates can be demonstrated. Other exemptions may also apply if certain conditions are met, for example if increases in selectivity are very difficult to achieve, or if the costs of handling unwanted catches is disproportionate (Council of the European Union 2013).

To maximise the revenue from the catch limit, fishers would be incentivised to avoid catching fish that if caught in sufficient quantity would result in a curtailment of the fishing season (sometimes referred to as 'choke species') and also to avoid catching undersized, juvenile and low value fish, which would be deducted from their quota for little or no profit (Condie et al., 2013). The catch limit approach is, therefore, intended to directly prevent discarding practices driven by quota and MLS restrictions. Catch limits come with the potential to increase the landings quota to a full catch quota, by including some or all of the previously discarded catches, so that total fishing mortality does not increase. Consequently, there is an economic incentive for fishers to transfer to this system and the strength of this incentive will depend on the level of quota increase and enforcement. Fleet-specific factors will impact on the incentive structure of catch limits (Condie et al., 2013), especially the catch and discard composition of vessels.

Creating incentives to encourage fishers to match their catch compositions with agreed target catch levels is a challenge for fishery managers. An approach widely used is the provision of conditional access to those fishers using more selective fishing methods. This can be either in the form of providing spatial access to fishing grounds (Macdonald et al., 2013) or allocating additional fishing effort. These measures are introduced on an ad hoc basis and are conventionally initiated as part of wider plans to rebuild over-exploited fisheries.

These conditional access agreements require changes to technical regulations, which suffer from low compliance, circumvention or unintended impacts (Tsagarakis et al., 2013). In the EU, technical regulations that constrain many aspects of fishing operations have proliferated. Requirements to discard through the current quota system and MLSs, coupled with the prescriptive management of fishing operations, has left the fishing industry facing regulations that can create inefficiencies in their business operations and in turn, incentives that are at odds with conservation objectives. Consequently, there is a need for a substantial change in the CFP recognised by fishers and managers.

If a successful incentive framework is developed it will ensure that the selectivity of the fishing fleets (gear type, gear configuration and temporal and spatial application of gear, Eliassen et al., 2013) will deliver the maximum economic return while meeting management objectives to conserve stocks. This optimum selectivity is likely to differ from current selectivity and result in different pressures on the ecosystem. However, it is not clear what the optimum selectivity will be. It can be postulated that while fishers will be attempting to avoid catching small, low value fish with associated catch limits by increasing gear selectivity, they will also be looking to catch a diversity of unregulated species to maximise revenue from fishing trips and avoid the premature end to the fishing season.

Owing to the wide diversity of drivers and reasons for discarding across fisheries, areas, and species, from regulatory reasons such as species protection, minimum landing sizes or landing quotas, to insufficient or unstable markets, no single management measure or even framework is expected to address the issue. Rather, discard mitigation measures need to be tailored to each particular fishery or even species within a fishery (Condie et al., 2013; Eliassen et al., 2013). Moreover, the effectiveness of solutions is greatest when they are used in combination with other approaches (O'Keefe et al., 2013). The importance of the dynamics of the fishing industry, which is bound to react to changes in regulation, was also outlined. The results of the studies presented (Eliassen et al., 2013; O'Keefe et al., 2013), the EU commission and industry perspectives, as well as opinions expressed during the theme session discussions, converged to support bottom-up approaches to by-catch and discard management, which involve incentive-based solutions. It may not be useful to establish comprehensive portfolios of management solutions – rather, setting targets and leaving it to fishers to solve the issues might be more efficient. Indeed the EU's new policy can be considered an obligation for people to find solutions to reduce discards. Such an incentive-based management system is expected to generate a need for research on technical measures, their consequences on markets, and above all the associated behavioural changes on the part of fishers.

## References

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- Alverson, D. L., Freeberg, M. H., Pope, J. G., and Murawski, S. A. 1994. A global assessment of fisheries bycatch and discards. FAO Fisheries Technical Paper, 339. FAO, Rome. 233 pp.
- Bethoney, N.D., Stokesbury, K.D.E. and Cadrin, S.X. 2013. Environmental links to alosine at-sea distribution and bycatch in the northwest Atlantic mid-water trawl fishery. ICES J. Marine Science doi: 10.1093/icesjms/fst013.
- Catchpole, T. L., Feekings, J. P., Madsen, N., Palialexis, A., Vassilopoulou, V., Valeiras, J., Garcia, T., Nikolic, N., and Rochet, M. J. Using inferred drivers of discarding behaviour to evaluate discard mitigation measures. – ICES Journal of Marine Science, doi:10.1093/icesjms/fst170.
- Clucas, I. 1997. A study of the options for utilization of bycatch and discards from marine capture fisheries. FAO Technical Paper 928: 57pp.
- Condie, H., Catchpole, T. L., and Grant, A. 2013. The short term impact of implementing catch quotas and a discard ban on English North Sea otter trawlers. ICES Journal of Marine Science, doi: 10.1093/icesjms/fst187.
- Council of the European Union. 2013. Position of the Council at first reading with a view to the adoption of a Regulation of the European Parliament and of the Council on the Common Fisheries Policy, amending Council Regulations (EC) No 1954/2003 and (EC) No 1224/2009 and repealing Council Regulations (EC) No 2371/2002, (EC) No 639/2004 and Council Decision (EC) No 2004/585

- Eliassen, S., Papadopoulou, N., Vassilopoulou, V., and Catchpole, T. L. 2013. Socio-economic and institutional incentives influencing fishers' behaviour in relation to fishing practices and discard. ICES Journal of Marine Science, doi:10.1093/icesjms/fst120.
- Macdonald, P., Cleasby, I., Angus, C., and Marshall, C. 2013. The contribution of quota to the discards problem: a case study on the complexity of common megrim *Lepidorhombus whiffiagonis* discarding in the northern North Sea. ICES Journal of Marine Science, doi:10.1093/icesjms/fsu009.
- O'Keefe, C. E., Cadrin, S. X., and Stokesbury, K. D. E. 2013. Evaluating effectiveness of time/area closures, quotas/caps, and fleet communications to reduce fisheries bycatch. ICES Journal of Marine Science, doi:10.1093/icesjms/fst063.
- Tsagarakis, K., Palialexis, A., and Vassilopoulou, V. 2013. Mediterranean fishery discards: review of the existing knowledge. ICES Journal of Marine Science, doi:10.1093/icesjms/fst074.
- Uhlmann, S. S., van Helmond, A. T. M., Stefánsdóttir, E. K., Sigurðardóttir, S., Haralabous, J., Bellido, J. M., Carbonell, A., et al. 2013. Discarded fish in European waters: general patterns and contrasts. ICES Journal of Marine Science, doi:10.1093/icesjms/fst030.