An ecosystem approach to Portuguese mixed fisheries

Authors: Inês Cardoso[1], Teresa Moura[1], Hugo Mendes[1], Cristina Silva[1] , Manuela Azevedo[1], Alberto Murta[1].*

[1] Divisão de Modelação e Gestão dos Recursos da Pesca, Instituto Português do Mar e da Atmosfera, I.P. Avenida de Brasília, 1449-006, Lisboa, Portugal

Corresponding author: Inês Cardoso, email: ines.cardoso@ipma.pt.

Summary
Fishing at sustainable levels is changing from single species based management towards mixed fisheries within an ecosystem approach. Mixed fisheries are usually characterized by complex interactions between fleets, fish species and the environment. These fisheries have a relevant contribution for the Portuguese fishing activity's revenue. However, as many other mixed fisheries, they present a combination of high uncertainty (e.g. several species without assessment), complex science (combining biological and technical interactions) and political choices (e.g. trade-offs between catch options). In this work we used regression trees to identify different fisheries based on catch composition and gears, as reported in logbooks. The relation between species vulnerability and their functional role at the ecosystem scale is explored by fishery. Hence, technical interactions among fishing gears, and species biological interactions are analyzed within and among fisheries. This approach allows us to identify key elements that can, ultimately, be incorporated on management plans for mixed fisheries.

Introduction
The term mixed fisheries refers to fishing activities where more than one species are caught simultaneously and one species may be fished by different gears. For many reasons mixed-fisheries present a harder challenge for fisheries management than single species fisheries (Wilson and Jacobsen, 2009), and the uncertainty can start at the definition of the target species. In these particular fisheries we have a large group of species that are caught being target or not, species with large landing values that are actually not target, and species with high economic value that can fall at the bycatch category. Although the dynamic of such fisheries is poorly understood and the effect/impact of this fishing activity at the ecosystem scale is not yet quantified, they are known to have a relevant contribution for the Portuguese fishers' revenue.

The present demand of sustainable fishing activities to ensure marine ecosystem preservation led towards an ecosystem approach where effort is being done to take into account biological and technical interactions on management measures and advice. Even in data poor cases, species vulnerability and susceptibility to particular fisheries can be assessed through flexible tools in permanent development and update (Hobday, 2011). Hence, fisheries impact can be assessed to some extent, and the functional role of target species can be evaluated through ecological networks such as food webs (Ings et al., 2009).

In this work we use logbooks data to explore and understand the activity of the Portuguese multi-gear mixed-fisheries. The main goals of the present work are: i) contribute to the current knowledge on Portuguese mixed-fisheries dynamics; ii) identify technical and biological interactions within and among gears through trips analysis; iii) assess the vulnerability of target and non-target species considering gear specificities; iv) and present a functional approach to species role through food web network analysis. Thus, the range of effects of particular fisheries at the ecosystem scale is inferred.

Materials and methods

Without any previous established concept of metier or fleet segments definition, we established groups of trips with similar landing profiles for the period 2009 – 2011. We used robust cluster analysis (CLARA) to identify groups of trips based on vessels landing profiles. Regression trees were used to identify different fisheries, based on the correspondence of a particular species or a group of species, within each cluster, to particular gears, as reported in logbooks. For a pool of species (target and bycatch for the most common gears) we've made a qualitative assessment of vulnerability using a productivity-susceptibility analysis (PSA), following the methodology presented by Hobday et al. (2011). The target species predator-prey relationships were examined through food web network analysis to describe key trophic interactions.

Results and Discussion

The mixed nature of the Portuguses multi-gear fisheries (using more than one gear per trip) is reflected on the landings species composition. Unlike other fisheries, where landings are considered a proxy for choice of rigging (Andersen, et al., 2012), for the Portuguese multi-gear this seems not to be the case. This reinforces the acknowledgement that the current centralized and "one size fits all" management might not account properly for the diversity of regional situations, particularly with regards to mixed-fisheries interactions (Ulrich et al., 2012).

In Portuguese mixed-fisheries, the use of both trammel and gill nets in one fishing trip is possible, and this raises the complexity regarding fleet segmentation based on logbook data. Although they can be distinguished when target species are evident (for e.g., hake for gill net, pouting for trammel-net), they have very similar fishing profiles sharing the same group of species at similar coastal environments. Results from the regression tree analysis identified two fisheries: the one targeting hake with gill nets and the one targeting pouting with trammel nets. These fisheries were chosen to explore the relation between species vulnerability and their functional role at the ecosystem scale. Hence, technical interactions among fishing gears and species biological interactions were analysed within and among fisheries. We've also highlighted the cumulative effect of both fisheries. Results show that a group of "key" species, with fundamental ecological roles, are affected by these gears and fisheries, one with low selectivity and no explicit effort regulation (pouting fishery), and the other with higher selectivity and with effort limitations for few vessels (hake fishery). We found that this range of biological and technical interactions goes beyond the fisheries in question. Strong ecological links between species caught by other fishing gears, such as trawl, were found. Giving evidence that management measures applied to a particular fishery and/or species have unforeseen direct and indirect effects, this fact may have unpredictable consequences if it's not taken into account. Our work reinforces the discussion on management units (Wilson et al., 2006), highlighting the urgent need of a broader scale of assessment and management that takes into account the fisheries effects (among and cumulative) at the ecosystem functioning scale.

References

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