Developing the Fisheries Impact Pathway – Operationalised in the Context of GLAM Phase 3

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1. Introduction

Marine biodiversity impact coverage is still scarce in the current Life Cycle Impact Assessment (LCIA) framework. This work supports the development of the recently proposed pathway for biomass removal by fisheries on ecosystem quality and promotes the work discussed in GLAM Phase 3.

Despite increasing recognition of the importance of marine ecosystems and the large number of threats they are facing, the coverage of impacts related to marine pressures is far from complete. However, this is a very active research area (e.g. marine plastic impacts (Lavoie et al. 2021; Høiberg et al. 2022) or ocean acidification (Scherer et al. 2022)), also under the umbrella of the life cycle initiative's GLAM project. Biodiversity loss caused by biomass removal by fisheries has recently been quantified by Helias et al. (2022) for LCA studies relating to wild-capture fish products. In GLAM Phase 3, the operationalisation of biomass removal by fisheries to the endpoint in a manner consistent with other impact pathways is discussed. Additional objectives are to incorporate a) the impact of discards and b) the temporal validity of Characterisation Factors (CFs) in relation to fisheries' trends.

Based on the stock model approach first proposed by Hélias et al. (2018), new CFs have been calculated to develop this impact pathway and to meet the requirements of GLAM to achieve harmonisation within the LCIA framework. As this is both a complex and novel impact pathway, challenges exist relating to temporal and data-driven limitations. The update presented here can be seen as an opportunity to explore the importance of certain elements in the CF whilst developing a more holistic impact quantification.

2. Materials and Methods

CFs are computed from depleted fractions of individual stocks (i.e., a species in a habitat), calculated from the interaction between fishing pressure, stock biomass and intrinsic stock renewal rates. It is regionalised at the scale of FAO major fishing area to provide global coverage with these newly available and operational CFs. CFs are provided per stock at regional and global perspectives, and per species without regionalisation when the origin is unknown from inventory data. Points of development include:

- Input data updated from 2015 to 2018 (rolling 3-year mean), enabling investigation into the impact this has on CFs (Figure 1) to determine questions of temporality in static CFs.
- Inclusion of additional but "invisible" impact of discards in fishing activity within the fisheries impact assessment.
- Regional to global impact conversion using both regional GEP (Verones et al. 2022) and a species-level alternative "GEP" to attribute a measure of vulnerability related to species endemicity.

As discarding unwanted by-catch from fisheries is a controversial, illegal activity, data is limited and inconsistent at the global scale. Estimates are periodically calculated by the FAO (Pérez Roda et al. 2019), and although midpoint indicators exist in the LCIA framework (Vázquez-Rowe et al. 2012), these are challenging to implement on a global, multi-stock scale consistent with the method of impact quantification used in this approach. The most robust FAO estimate (rate/FAO area) has been integrated into the CF as an additive impact. It is weighted according to the biomass of each stock present in the region, and applied to the average regional CF per region.

3. Results and Discussion

Results include an updated set of operational CFs for the depletion of individual stocks, within current data constraints and with an endpoint unit converted into PDF·year/kg biomass. The assumption that the depleted stocks are part of a wider ecosystem is used to convert the impact to ecosystem scale. The CFs should be consistent with Life Cycle Initiative guidelines and could be included in GLAM Phase 3, available for use in LCA studies.

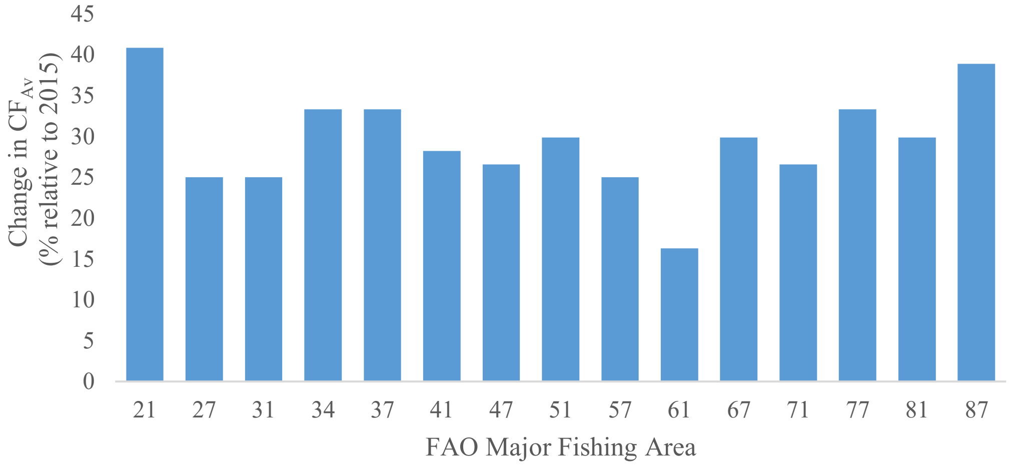

Figure 1:Temporal percentage change in regional CF (between 2015 & 2018), showing how CFs can change as a result of updating input data associated with the modelled impact.

The outputs of the two regional to global conversion factors are compared to understand whether it is possible to have a per-stock representation of impact at the global scale to give a measure of the endemicity of the impacted stock rather than an aggregation per region. This relates to an element of uniqueness in the fisheries' impact relating to wild capture activities and being both the impact and impacted medium.

The inclusion of discards increases the impact of depleting each stock by 52% on average. Due to a lack of explicit data, this first attempt is a regional estimation, with the likelihood of accidental capture and subsequent rejection based on the biomass present in the region only. In reality, this is a somewhat crude quantification, as discards vary greatly by fishery type and technique; however, a more detailed approach is not currently feasible at the global scale. The high levels of uncertainty introduced by spatial irregularity and substantial variation by fishing technique raise discussions on whether a more realistic impact assessment is indeed better if assessments have to be based on estimations.

4. Conclusions

The current format of the approach and CFs are highly relevant due to compatibility with fisheries management tools and show potential for inclusion in GLAM Phase 3. The inclusion of discards is an important point of progression for the fisheries impact pathway. The next step will further develop the fisheries impact pathway from an individual stock to ecosystem scale assessment, integrating the ecosystem dynamics of trophic interactions into the impact quantification.

5. References

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