

Theme session M

Qualifying human footprints, indicators, and reference points for seabed impacts

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Bottom fishing is the most widespread direct human disturbance on the seabed. However, bottom fishing is also important for global food security, with bottom trawling providing about a quarter of the world's seafood catch. While there is much debate about the severity of bottom fishing impacts, there is a void of large-scale quantitative investigations of the actual extent and risks bottom fishing poses to the marine environment. Quantitative tools, indicators, and reference points are needed to assess the status of the seabed to support management practices that ensure fisheries are sustainable. This theme session addressed and discussed recent progress in synthesising and mapping bottom fishing footprints (e.g. from satellite and logbook monitoring of fishing effort) and in quantifying their impacts around the globe. This was in addition to statistical modelling methods and approaches for assessing the state of seabed habitats and fauna. The talks and posters in the session can be grouped into five broad themes.

Ways of estimating the footprint of human activity (e.g. fishing gear, dredging operations)

- Collie et al.: Modeling the intensity of bottom trawling footprints;
- van der Reijden et al. (poster): North Sea demersal fisheries prefer specific benthic habitats).

Methods to quantify the sensitivity of seabed habitats to human activities / Ground truthing of indicators that assess the impact on benthic ecosystems

- Dinesen et al.: Bottom trawling impacts on marine macrobenthos: Changes in ecological functioning and seafloor integrity interpreted by a biological multiple traits approach;
- Van Denderen et al.: Identifying benthic vulnerability, predicted fishing impact and values in a warming Barents sea;
- Atkinson et al.: Demersal trawl interactions with South African ecosystem types: spatial analyses and potential management actions;
- Hiddink et al.: Testing and selection of indicators for assessing and managing the bottom trawling impacts on seabed habitats;
- Bradshaw et al.: Effects of bottom trawling on benthic processes, sediment suspension and seafloor integrity;
- Cyrielle et al. (poster): Vulnerability of benthic habitats to trawling in the English Channel, the North Sea and the Mediterranean Sea.

Approaches that allow spatial upscaling of local findings to regional scale

- Pitcher et al.: Assessing seabed status in 24 trawled regions of the world

Management actions/plans that reduce the footprint of human activities or establish trade-offs between impact and economic revenue

- Breen et al.: A Bayesian network model for assessing ecological risk and economic impacts for spatial marine management options;
- Evans et al.: Testing uncertainty within a method to assess the impact of bottom towed fishing gear on sedimentary habitats: Defining data thresholds, limitations and resolution;
- Danto et al.: Identification of effective measures to reduce fisheries impacts on the seafloor: a bio-economic evaluation in the Baltic Sea;
- McConnaughey et al.: Best practices for managing impacts of trawl fishing on seabed habitats and biota.

The conveners also specifically asked for talks on the topic **Methods to establish threshold values for impact indicators, indicating adverse impacts or habitat degradation**, but none were received.

This overview of the talks clearly shows that this field of research requires further studies on how to scale up assessments, as well as studies on how to set ecologically relevant thresholds for determining acceptable and unacceptable impacts. The question of how much of specific habitats we need to protect in order to preserve proper functioning of the benthic (seafloor) ecosystem, and what intensity of an activity is acceptable, therefore remains unanswered. This needs to be addressed by ICES in order to inform Good Environmental Status.

Much of the presented work originated from research that was performed under the FP7 BENTHIS project and the Trawling Best Practices projects. The session showcased the work that is being carried out in the Working Group on Fisheries Benthic Impact and Trade-offs (WGFBIT), and that is contributing to guiding the development of standardized methods to assess EU's MSFD D1 habitat/D6 benthic, as well as in providing further guidance to member states for determining relevant indicator threshold values. This theme session provided an opportunity to review the applied assessment frameworks and to showcase the state of the art in this field.

Discussion was focused on the importance of providing assessments for guiding management decisions, the applicability of approaches in data-limited situations, and the application of such tools for the sustainability certification of fisheries. There are clear indications that good management for ensuring that exploitation of trawl fish stocks is sustainable is also very likely to result in a good state of the seabed, and fisheries with limited benthic data may be able to achieve a good benthic status simply by managing their commercial stocks sustainably (e.g. $F < F_{MSY}$ and/or $B > B_{MSY}$).

Other knowledge gaps that became evident during the session are as follows.

- The limited number of studies of trawling impacts in tropical areas, in deep water, and in the southern hemisphere limits our ability to generalise impacts globally.
- The effects of trawling on the functioning of ecosystems is often inferred, but is hardly ever directly measured. More studies of effects on biogeochemistry and food webs, e.g. food supply for higher trophic levels, are needed. If this is achieved, these approaches may also be able to feed in to D4 in the MFSD.
- The effect of smothering by resuspension of sediment on benthic ecosystems is barely known.
- Large areas globally have no trawling effort data at all at any resolution.
- Related to the threshold setting problem, a definition or description of a well-functioning benthic system is lacking. Such a baseline ideally needs to be based on scientific research, which is the major problem for the majority of investigated areas.
- In impact or status assessments, the quality and resolution of the data plays a very important role in the outcome. Much more attention, therefore, needs to be given to this uncertainty–confidence aspect in assessments.
- Quantifying the trade-off between ecological impacts vs. economic benefits is only just starting and could be developed much more, particularly the inclusion of quantitative and/or dynamics operational models for the ecosystem (rather than the qualitative/scoring system currently prevalent). This field of study would particularly benefit from a better understanding of the patterns of effort redistribution in response to management measures.

Some discussion focused on whether we have to accept that some marine areas are managed primarily for producing food, rather than for a combined nature conservation and food production, just like some agricultural areas on land are highly or completely modified from their original ecosystem.