Theme 3: Physical loss and damage to seabed habitats

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WP 3.2 Deliverable 2: Development of and use of the fisheries impact tool in BalticBOOST

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1. Introduction

The BalticBOOST Fisheries Impact Evaluation Tool is a tool that allows users to:

- Calculate pressure arising from fishing activities with bottom-contacting gear,
- Assess the sensitivity of the ecological component of the seafloor, based on the longevity of the organisms composing the community,
- Obtain an evaluation of the impact from fisheries (or its reciprocal, an integrity index),
- Identify areas of high fish landings to guide management decisions on spatial fishery restrictions based on trade-offs between conservation objectives and socio-economic considerations.

The tool itself is available in the form of a set of R routines hosted by a specific github repository online (https://github.com/frabas/FisheriesImpactTool) that can be applied to new sets of fisheries and habitat data to quantitatively estimate the fishing pressure on the seafloor. The tool is described in detail in BalticBOOST WP 3.2 deliverable 1 'Fisheries Impact Evaluation Tool (FIT) with Application to Assess the Bottom Fishing Footprint in Western Baltic Sea' (Appendix 1).

To build this Tool, BalticBOOST reviewed the preliminary version of a management tool developed under the BALTFIMPA project in HELCOM. This Tool consisted of a matrix of gear/habitat interactions, derived from expert knowledge and literature, and was deemed insufficient and difficult to further implement according to the most recent developments in assessing sensitivity of seafloor.

2. Calculating pressure from fishing: VMS and mapping of fishing activity

VMS data provides information about the vessel, its position, instantaneous speed and heading, transmitted at regular intervals of approximately 2 hours. VMS data points can be linked to logbook data in order to get additional information about the ship, the applied gear and eventually also the catch.

Processed data, which were assumed to represent fishing activity, were assigned to a 0.05 x 0.05 degree grid, about 15 km^2 at 60^{o}N, using the approach of C-square reference (Rees 2003).

In order to calculate swept-area values certain assumptions about the spread of the gear, the extent of bottom contact and the fishing speed of the vessel needed to be made and thus a number of working steps were necessary. Vessel size-gear size relationships developed by the EU FP7 project BENTHIS project (Eigaard et al., 2016) or by the Joint Nature Conservation Committee (JNCC) were used to approximate the bottom contact (e.g. gear width). The swept-area information was additionally aggregated across métiers for each gear class (otter trawl, dredge, demersal seine) with two layers, one for surface abrasion and one for subsurface abrasion (as proportion of the total area swept To account for varying cell sizes of the GCS WGS84 grid, swept-area values were additionally divided by the grid cell area

3. Assessing the sensitivity of the ecological component: the longevity approach

Most other existing tools focus on the definition of sensitivity for the seafloor, as the definition of pressure intensity is assumed to be addressed at the local scale. Thus, a review of existing sensitivity assessments and methods for marine habitats was also completed.

Several of the existing methods for sensitivity assessments are qualitative (i.e. categorical information) and are based on expert judgement, similarly to the BALTFIMPA tool. These are:

Project MB0102
Commissioned in the UK by the Department for Environment, Food and Rural Affairs (Defra) to support the Marine Conservation Zone (MCZ) selection process under the Marine and Coastal Access Act 2009. The sensitivity scores were based on combined scores of resistance (tolerance) and resilience (recoverability) to a variety of marine pressures measured against pressure benchmarks (Tillin et al., 2010). A disadvantage is the fact that the magnitude of the pressures are not taken into account, both on spatial and temporal scales and that the benchmark level of the pressure is quite general.

Marine Evidence based Sensitivity Assessments (MarESA) and Features Activity Sensitivity Tool (FeAST)
MarESA follows the same method used for MB0102, but with an improved confidence assessment method (Marlin, 2015). Also similar product to MB0102, FeAST, was developed for Scottish habitats and species as part of the Scottish Marine Protected Area project.

French benthic habitat sensitivity project
The objective of this ongoing project is to produce standardized sensitivity assessments at a national level and to be consistent (insofar as possible) with other equivalent European methodologies. The methodological framework for assessing benthic habitat sensitivity and the assessment results of French Mediterranean habitats’ sensitivity to physical pressures are available online (INPN, 2016).

BH3 approach (OSPAR)
This approach utilizes the MB0102, MarESA and ecogroups based on characterizing species to categorically score sensitivity assessments at biotope (Eunis level 5), species and broad scale EUNIS Level 3 levels to increase the resolution of the sensitivity data available. For the moment, this approach is in development for the North Sea area and is not yet applicable/operational in all regions.

MarLIN approach
This method uses a categorical scale, like the MB0102 and MarESA methods, to assign sensitivities to the habitats. The full method is detailed on the MarLIN webpage.

Other methods are more quantitative, these comprise:

BENTHIS
BENTHIS uses two approaches to define sensitivity, one based on biological trait longevity and one on population dynamics (benthic biomass).

Kostylev/Desroy approach
This is a data driven approach that uses the "Disturbance" (Dist, reflecting the magnitude of change) and the "Scope for Growth" (SfG, environmental stresses inducing a physiological cost to organisms and limiting their growth and reproduction potential) to define sensitivities. Due to the lack of data it is not directly applicable for the moment.

BalticBOOST decided during the first Theme 3 workshop (BalticBOOST Theme 3 WS 1-2016), and after recommendations from ICES WKFBI to use a quantitative approach rather than a categorical one. The Workshop decided to use the BENTHIS sensitivity approach to provide a quantitative estimate based on longevity. This approach was further implemented and applied in BalticBOOST.

The sensitivity of the seabed habitats was estimated for the Western Baltic using the longevity approach developed in BENTHIS WP2 (Eigaard et al. 2016) for organisms characteristic of the communities living in Eunis habitats. The main principle of the approach is that if the reciprocal of the trawling intensity, which reflects the average time interval between two successive trawling events, is less than the life span of an organism, the fishing pressure compromises the survival of the organism (Rijnsdorp et al. 2016). In the Tool, sensitivity could be set using values from the Baltic Sea derived from the recently published Gogina et al. (2016) paper.

4. Evaluation of the impact from fisheries

The seabed integrity index (SBI) is a proposed measure of the impact of fishing pressure on seabed habitats and was estimated by overlaying the annual fishing intensity spatial estimates with the distribution of habitats, using community specific sensitivities derived from the longevity composition of the biomass from a reference (untrawled) area (Figure 1).

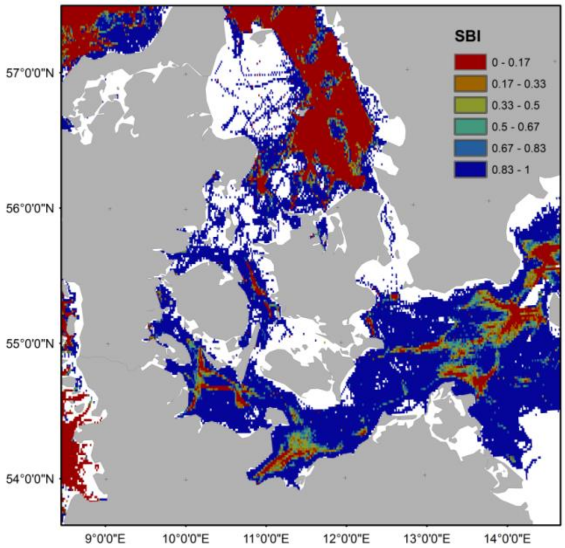

Figure 1. Seabed integrity index (SBI) values corresponding to the subsurface trawling impacts for the years 2010-2012. The seabed integrity index is 0 when all taxa are impacted and 1 when no taxa are impacted. The white areas show grid cells that were untrawled.

5. Potential fishing pressure mitigation options

Albeit no direct fishing pressure mitigation measures are proposed (or will be proposed) by BalticBOOST, by using the Tools it will be possible to further explore potential priority areas of interest for management and simulate scenario options.

In particular, the work of ICES evaluated possible alternative scenarios for the reduction of fishing pressure at the national spatial scale, based on benthic community life history traits (**Appendix 3, WP 3.1 Supporting material, Case study 6)**. Furthermore, with the Tool, a more detailed assessment of target species landings was attempted, which could be used in the future to explore fisheries spatial reallocation options, based on a trade-off between seabed integrity and economic value of landings. Clearly, given the patchy and variable spatial distribution of fisheries, further consideration needs to be given to the effectiveness of such measures.

6. The Tool test case(s)

Within the Tool development, test maps were produced for the Western Baltic. This sea area was selected because it is where the fishing activity utilizing bottom-contacting fishing gear actually takes place (ICES advice to HELCOM 2015).

The methodology derived from the Tool to calculate fishing intensity (pressure) was also used by test cases to estimate fishing pressure (**Appendix 3, WP 3.1 Supporting material, Case studies 4-6**). In the Swedish waters test case, fishing intensity was defined in a radius of 250 m from the biological sampling point whereas in the Femern belt test case the radius was extended to 1000 m, which could give further insight on the most appropriate spatial scale for these assessments. In both cases, the Tool methodology was applied to derive fishing intensity from national VMS databases by processing the raw VMS data and coupling it to fishery logbook data and different gears dimension estimates.

7. The inventory of fishing gear and its interactions with seafloor

There was no specific work on gear inventory during the Tool development, as most of it had already been completed in other projects. However, an extensive review of the available literature on gear dimensions and interactions with the seafloor is the basis of the Tool.

Most of the detailed work is described in Bastardie et al. (2010), Hintzen et al. (2012), and further combined in Eigaard et al. (2016a,b). The output of this work was knowledge on size and impact specific coefficients for each component of the gear. This information was at the basis of the estimation of gear-specific footprints, which take into account the spatial extent of specific gear use.

Gear types were analyzed separately in the Tool, which helped to underline that otter trawling is the most widely used gear in the Western Baltic for vessels larger than 12m (i.e. VMS-equipped). Demersal seining takes place nearly exclusively in the Arkona Basin, the south-eastern part of Mecklenburg Bight and a small part of western Kattegat. Dredging is restricted to Danish fjords, straits and coastal areas.

No information was available on the specific interactions of each gear with the seafloor of the Baltic Sea, as emerged during the review of the existing scientific literature. However, an estimate of the global interaction is offered through the Tool in the form of the seabed integrity index (SBI), which takes into account the gear footprint and the seafloor specific sensitivities.