WORKING GROUP ON FISHERIES BENTHIC IMPACT AND TRADE-OFFS (WGFBIT; outputs from 2020 meeting)

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Contents

i Executive summary

The Working Group on Fisheries Benthic Impact and Trade-offs (WGFBIT) develops methods and performs assessments to evaluate benthic impact from fisheries at regional scale, while considering fisheries and seabed impact trade-offs.

In this report, assessments for as many ICES eco-regions as possible are presented. The group also further developed the format of one of its key products; a standard advice sheet with regional benthic assessments, intended as regular input to the next generation of the ICES Ecosystem and Fisheries Overviews. This new 2-page standard advice sheet was populated with the available assessments presented in the report, i.e. for the North Sea, Baltic Sea, Barents Sea, Norwegian Sea, Celtic Seas, and Italian waters. For most of these regions, the standard sheet serves as a proof of concept and a starting point for future regional assessments. For the North Sea a full standard assessment was produced, which is ready to feed into a review process towards publication in ICES Ecosystem and fisheries Overviews. This full North Sea assessment also represents a significant step forward, towards meeting the overall objective of the group 'to produce a framework for MSFD D6/D1 assessment related to bottom abrasion of fishing activity at the regional scale'. For each region the group identified and prioritized data gaps and obvious next steps towards fully standardized assessments and advice sheets.

Improvement potential of the current impact assessment methodology was also explored and a number of topics such as *biological traits category harmonization*, *ecosystem function*, *alternative assessments*, *the deep-sea* and *trade off* were identified as focus areas for future work.

ii Expert group information

Expert group name	Working group on Fishery Benthic impact and trade-off (WGFBIT)
Expert group cycle	Multiannual
Year cycle started	2018
Reporting year in cycle	3/3
Chairs	Gert Van Hoey, Belgium
	Tobias Van Kooten, the Netherlands
	Ole Ritzau Eigaard, Denmark
Meeting venues and dates	12–16 November 2018, ICES HQ, Copenhagen, Denmark, 28 participants
	7–11 October 2019, Ancona, Italy, 34 participants
	14–18 September 2021, online meeting, 29 participants

1 Introduction and overview

The objective of the Fisheries Benthic Impact and Trade-offs working group (WGFBIT) 2020 was to execute the benthic impact assessment framework for mobile bottom-contacting fishing gears (MBCGs) for as many regions as possible. The assessment framework follows earlier ICES advice in 2016 and 2017 in response to requests from DGENV.

WGFBIT held a series of online meetings which were focused on defining loose ends and way-forward for the regional benthic impact assessments. The group succeeded in involving scientists from other (sub)-regions (Eastern Mediterranean; Iberian Coast, and Bay of Biscay) to start the assessment process not yet included in the period 2018–2019. The group also managed to tackle some general methodological issues, concerning biological traits category harmonisation, alternative assessments, deep-sea and trade off issues (see sections 2 and 3). The group further developed the way to present the products (regional benthic assessments) to be considered as input toward the next generation of the ICES Ecosystem Overviews (link) by developing a 2-page standard advice sheet.

This report builds further on the ICES WGFBIT 2019 report by summarizing the assessments in this 2-page advice sheet and to report on the issues to be tackled per region for the next 3-years.

Progress overview

- Increased consensus and utility of executing the FBIT assessment framework.
- Inclusion of expertise and launch of the FBIT process for the Bay of Biscay, Iberian Coast and Western Mediterranean.
- More updated and region-wide fishing pressure data (mainly Mediterranean).
- Identification of better benthic data sources for full application of the FBIT assessment framework in several regions (e.g. Mediterranean, Celtic Sea).
- Work towards harmonization of the trait modality categories for longevity among the regions and depth zones (deep sea versus shelf areas).
- Further development of deep-sea longevity estimation methods, based on WGDEC input.
- Refinement of current trade-off approach in assessment (scenario, methodology and data availability) based on WKTRADE2 outputs and the DGENV trade-off request. This is worked out in the WKTRADE3 process, supported by WGFBIT.
- Further development of communication material addressing dissemination of the methodological details, the actual assessment procedures and standardized workflow, as well as the final regional advisory sheet output. In this work the requirements as input for the ICES Fisheries Overviews (FOs) and Ecosystems Overviews (EOs) is also addressed.

2 Regional specific reports

Table 2.1 provides an overview on how far the WGFBIT framework is implemented in each region and on which information the assessment is based. For certain regions (Bay of Biscay, Iberian Coast, Western Mediterranean, and Aegean-Levantine Seas) the process has to start from 2021 onwards. For each region, the group has executed the WGFBIT framework to a certain level, which proves the applicability of it. Of course, the assessments are preliminary and many steps need further developmental work, as indicated in the regional specific reports. Nevertheless, the group is currently at the stage where the proof of concept is made and we can start to refine the different steps and also focus more on validation and confidence.

Table 2.1. Overview of the progress in the implementation of the FBIT framework in each region.

	(sub)-REGION	Arctic Region		Baltic Region	Greathern North Sea Region	Celtic Sea	Bay of Biscay and Iberian Coast		Mediterranean region		
		Barents Sea	**Norwegian Sea**				**Bay of Biscay**	**Iberian Coast**	**Western Med.**	**Adriatic- Ionian Seas**	**Aegean-Levantine Seas**
STEP 1	**Pressure layer information**	ICES data 2018 (Otter trawls only)		ICES data 2009–2018	ICES data 2009–2018	ICES data 2015	Process started	Process started	Process started	BENTHIS Eigaard *et al.*, 2017	Process started
STEP 2	**Habitat information**	MSFD Broad habitat types									
STEP 3	**Longevity curves based on:**										
	Biological traits	Benthic data updated, more longevity classes		Benthis/ Tornroos & Bonsdorff 2012	Benthis	Benthis/ EMODNET	Process started	Process started	Process started	HCMR & Benthis	Process started
	Benthic samples	Incl. fishery gradient data		Only from low fishery, high oxygen data	Incl. fishery gradient data	Incl. fishery gradient data				Incl. fishery gradient data	
	Modelling basis (environmental variables)	Depth, temperature, sediment composition		Salinity, depth, wave exposure at the seabed (low oxygen areas omitted) van Denderen *et al.* 2020	Percentage mud and gravel, bottom-shear stress (fishing effect is fitted using sub-surface abrasion) Rijnsdorp *et al.*, 2018	EUSeamap habitats				EUSeamap habitats and depth	
STEP 4	**Impact assessment**	2018, preliminary		2009-2018	2009–2018	2015				Test of framework	
STEP 5	**Validation (alternative assessment availability)**			HELCOM	OSPAR BH3; Jac *et al.*, 2020	OSPAR BH3; Jac *et al.*, 2020		OSPAR BH1	Jac *et al.*, 2020		

STEP 6	**Confidence / uncertainty**	To do	To do	To do	Preliminary	To do				To do	
STEP 7	**Trade-off**	To do	To do	To do	ICES, 2017	To do				To do	

2.1 North Sea

General introductory text

For the Greater North Sea, no further method development was needed to run the assessment, as this was already completed in the 2018 report (ICES, 2018) and one published as ICES advice (ICES, 2017). However, an update to the MSFD broad habitat map (EUSeamap 2019) has recently become available, as well as recent data on the distribution of the fishing fleet. Below follows a brief summary of the output of the 2018 assessment, in accordance to the advice sheet draft outline (https://community.ices.dk/ExpertGroups/WGFBIT/under '0.7 Software/NorthSea').

Assessment results

Status in year 2018 of North Sea.

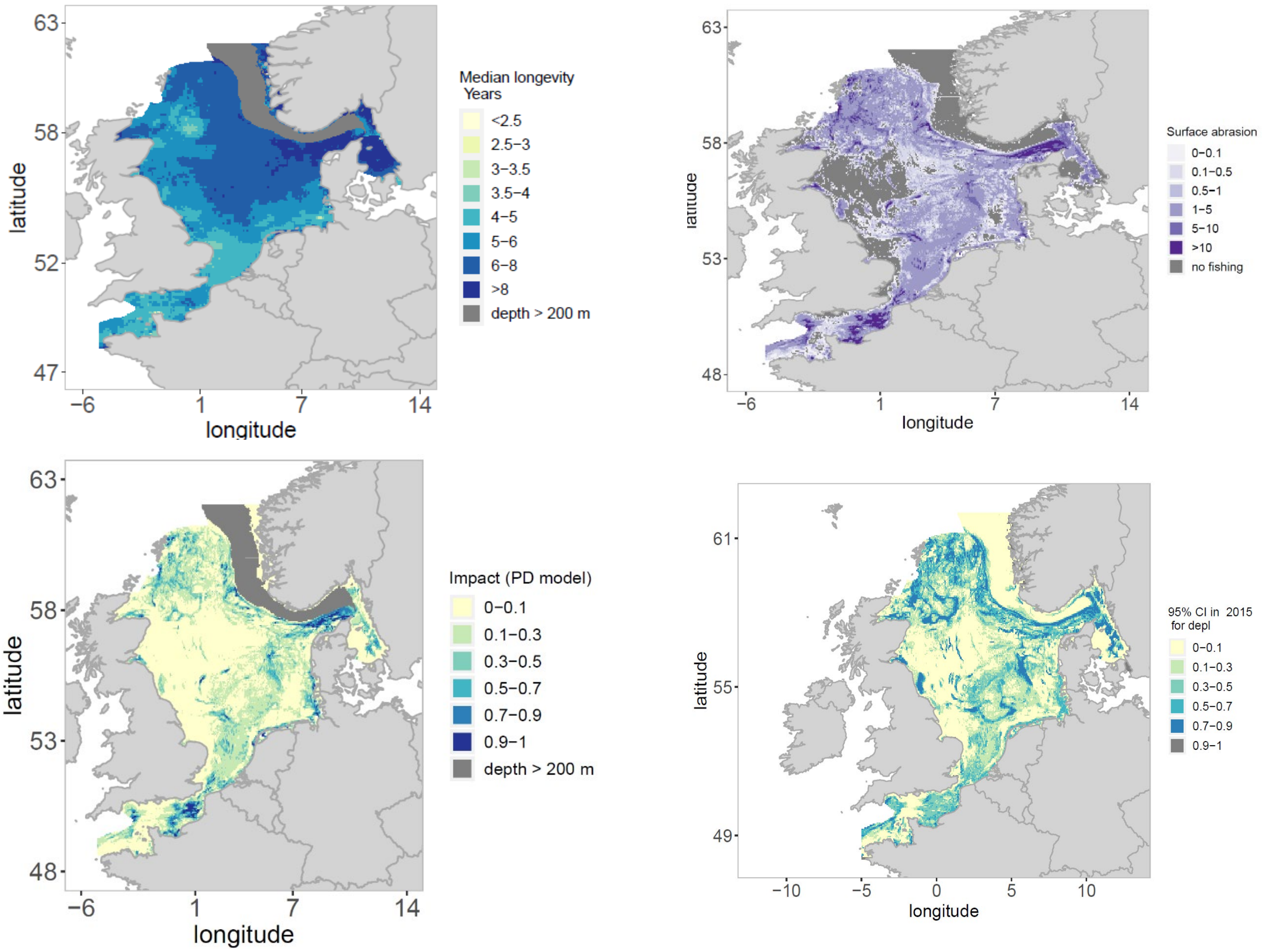


Figure 2.1. North Sea maps of i) predicted median longevity (top left); ii) surface (0-2cm sediment depth) based on VMS and logbook data for all mobile bottom-contacting gears (top right); iii) relative benthic impact (bottom left), and IV) Uncertainty of the depletion rates (95 percentile); (bottom right).

Table 2.2. Assessment estimates of mean fishing impact and proportion untrawled, per habitat type in the North Sea in 2018. The impact estimates are mean values across all c-squares of a habitat type and the fraction untrawled is an estimate based on total area swept irrespective of fishing intensity. Confidence intervals on mean impact and fraction untrawled are not yet available.

MSFD Habitat type	Area km2 (% of total)	Mean Impact	Fraction untrawled
Offshore circalittoral sand	40.39	0.09	0.23
Offshore circalittoral mud	18.18	0.22	0.05
Offshore circalittoral coarse sediment	12.90	0.12	0.22
Circalittoral sand	11.45	0.14	0.13
Circalittoral coarse sediment	5.02	0.07	0.33
Unknown	4.62	0.05	0.62
Infralittoral sand	2.13	0.08	0.36
Offshore circalittoral mixed sediment	1.22	0.17	0.2
Circalittoral mud	0.94	0.16	0.21
Circalittoral mixed sediment	0.79	0.1	0.34
Offshore circalittoral rock and biogenic reef	0.58	0.07	0.62
Infralittoral coarse sediment	0.52	0.09	0.18
Circalittoral rock and biogenic reef	0.43	0.04	0.54
Infralittoral rock and biogenic reef	0.24	0.03	0.67
Infralittoral mixed sediment	0.23	0	0.8
Infralittoral mud	0.23	0.04	0.74
Upper bathyal rock and biogenic reef	0.07	0.07	0.68
Upper bathyal sediment or Upper bathyal rock and biogenic reef	0.06	0	1
Upper bathyal sediment	0.02	0.18	0.22

Time trends

Time trends (Figure 2.2) indicate that impact is relatively stable. The impact in circalittoral sand was reduced in 2017, but has returned close to its long-term mean in 2018. The proportion of the habitat with impact scores below 0.2 (which we use as an arbitrary threshold for a favourable state here) is slightly more dynamic over time. The extent of impact <0.2 has decreased since 2015 for circalittoral course sediment, and has been quite variable for circalittoral sand.

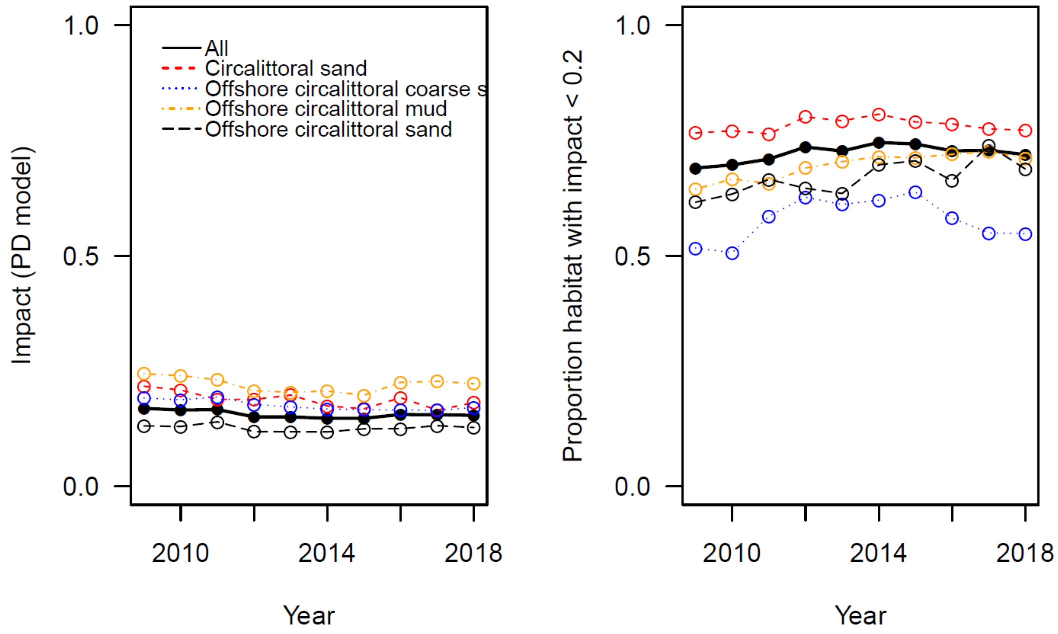


Figure 2.2. Time trends in impact (Left panel) and state above a hypothetical threshold value of 0.2 (Right panel) overall and in each of the 4 most dominant habitat types in the Greater North Sea ecosystem.

Brief interpretation of results

The method and associated code established and adopted by WGFBIT in 2018 has proven to be robust to updated input data.

The current abrasion map includes the effects of the three main bottom fishing métiers. These are otter trawls for crustaceans, otter trawls for demersal fish and beam trawls for demersal fish. The North Sea benthic sensitivity layer is based on a statistical analysis on a dataset that was a collation of box corer and Day grab samples from around the North Sea (Rijnsdorp *et al.*, 2018). These gears are generally considered to mostly sample small infaunal invertebrates and probably under sample the fraction of larger and mobile epifaunal organisms. This sensitivity layer therefore represents the sensitivity of infauna and smaller epifauna.

Impact, as measured by the PD method, has been relatively stable in the Greater North Sea as a whole, and within the main habitat types present. The extent of a (hypothetical) favourable environmental state has been more variable, in particular within specific habitats.

A first exploration of uncertainty in the input parameters to the assessment indicated that uncertainty in the depletion rates has a larger effect on the assessment outcome relative to uncertainty in benthic sensitivity.

2.2 Baltic Sea

General introductory text

The Baltic Sea is a semi-enclosed shallow sea with an average depth of 60 m. It is characterized by strong temperature and salinity gradients, from relatively warmer and saline waters in the southwestern part to cold and almost freshwater in the northernmost parts. Eutrophication is one of the main problems, whereas the bottom gear fishing is less active within this area. Nevertheless, an assessment of fishery pressure (physical disturbance) is briefly summarized in accordance to the advice sheet draft outline. The code is stored on the WGFBIT SharePoint at https://community.ices.dk/ExpertGroups/WGFBIT/under 2019 meeting docs '0.7 Software/Baltic'.

Assessment results

Status for year 2018 for the Baltic Sea.

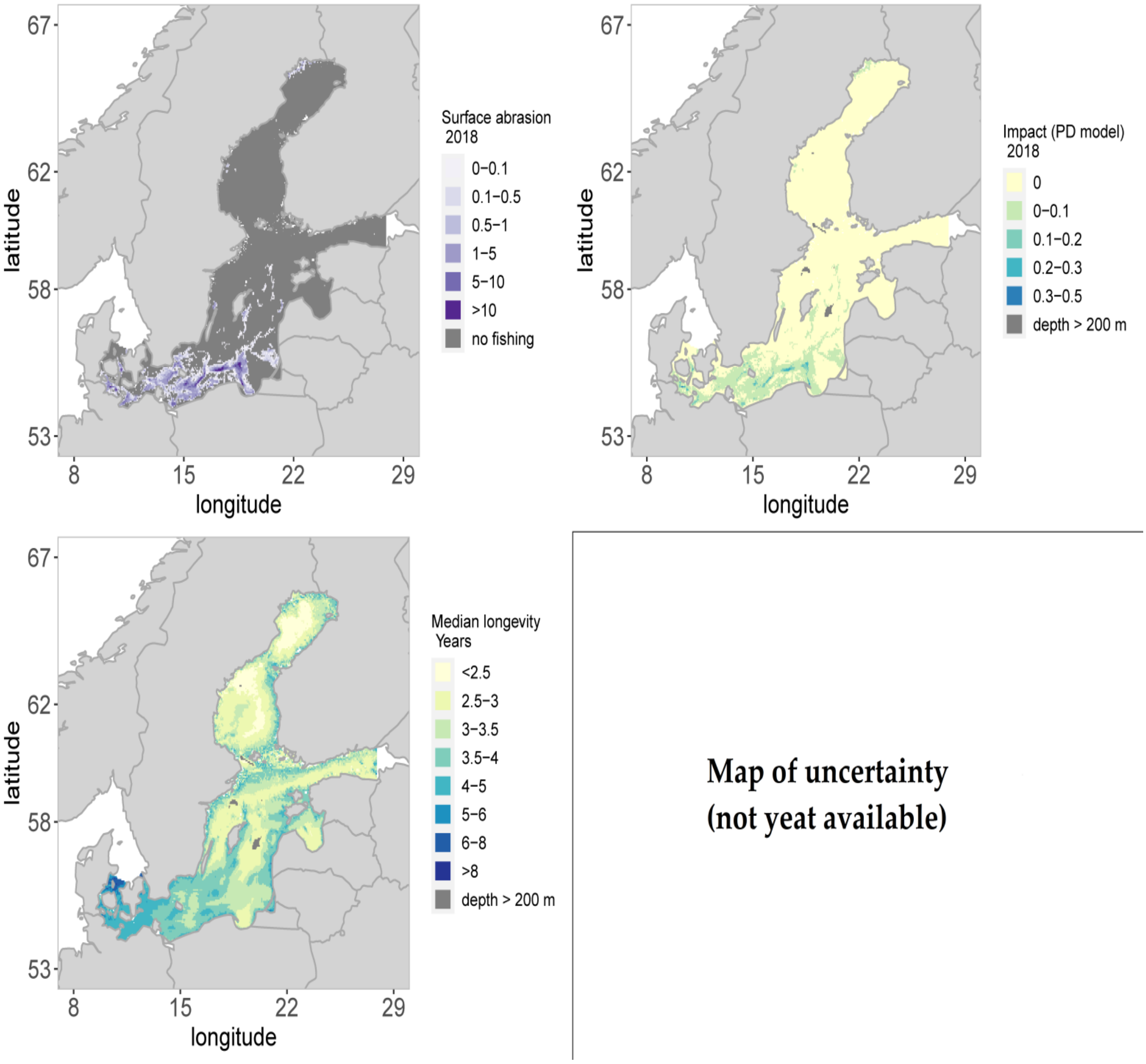


Figure 2.3. Maps of the Baltic Sea ecoregion of i) predicted median longevity (bottom left); ii) surface (0-2cm sediment depth) abrasion (top left) based on VMS and logbook data for all mobile bottom-contacting gears in 2018, and iii) relative benthic impact (top right). It should be noted that c-squares with low bottom oxygen levels (<3.2 mg L-1) were not excluded in the sensitivity and impact assessment.

Table 2.3. Assessment estimates of mean fishing impact and proportion untrawled, per habitat type in the Baltic Sea in 2018. The impact estimates are mean values across all c-squares of a habitat type and the fraction untrawled is an estimate based on total area swept irrespective of fishing intensity.

MSFD habitat code	Area km2 (% of total)	Mean Impact	Fraction untrawled
Circalittoral mixed sediment	107.6 (29.4)	0	0.98
Circalittoral mud or Circalittoral sand	51.7 (14.1)	0	0.98
Offshore circalittoral mud or Offshore circalittoral sand	32.6 (8.9)	0	0.99
Circalittoral sand	32.3 (8.8)	0.01	0.83
Infralittoral sand	22.9 (6.3)	0.01	0.82
Circalittoral mud	22.5 (6.1)	0.01	0.87
Offshore circalittoral mud	20.9 (5.7)	0.01	0.74
Infralittoral mixed sediment	20.2 (5.5)	0	0.99
Offshore circalittoral mixed sediment	19.5 (5.3)	0.02	0.79
Circalittoral coarse sediment	11.0 (3.0)	0	0.98
Infralittoral coarse sediment	6.6 (1.8)	0	0.97
Circalittoral rock and biogenic reef	6.2 (1.7)	0	1
Infralittoral rock and biogenic reef	3.8 (1.0)	0	1
Offshore circalittoral sand	2.7 (0.7)	0.03	0.61
Infralittoral mud	2.1 (0.6)	0.01	0.88
Infralittoral mud or Infralittoral sand	2.1 (0.6)	0	0.99
Offshore circalittoral coarse sediment	0.8 (0.2)	0	0.98
Offshore circalittoral rock and biogenic reef	0.3 (0.1)	0	1
Unknown	0.1 (0.0)	0	1

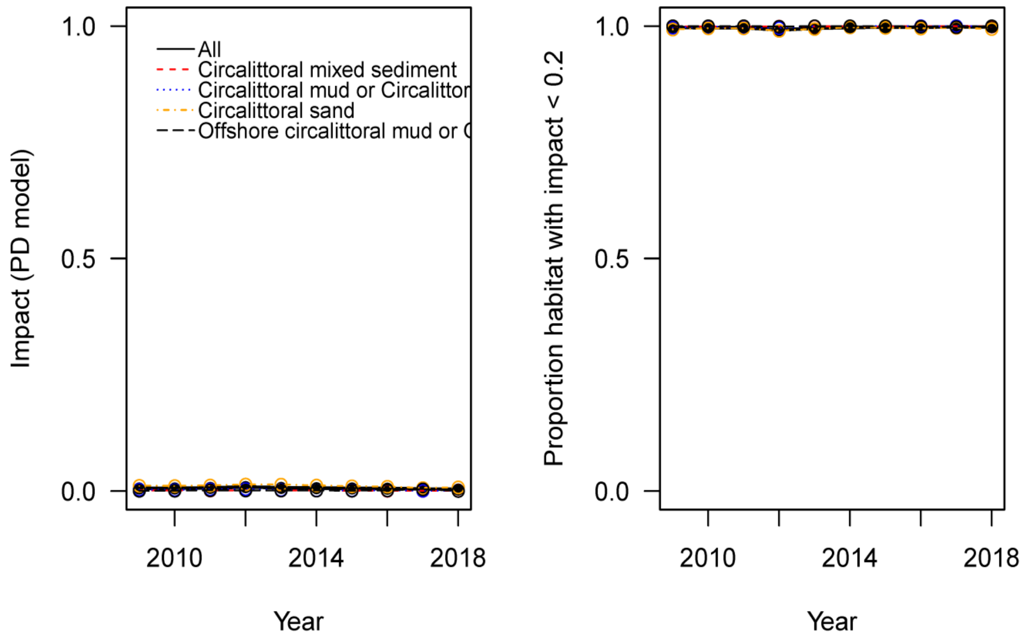


Figure 2.4. Time trends (2009–2018) in average impact and proportion below threshold impact (0.2) for the four most widespread habitat types in the Baltic Sea.

Brief interpretation of results

The impact of bottom trawling in 2018 is estimated to be very low and the state of the benthic habitats to be good across very large areas of the Baltic Sea (Figure 2.3). The total trawling footprint made up 5.2% of the ecoregion area. Within this footprint the fishery was very concentrated and had a substantial number of grid cells that were marginally fished.

Mean impact was low across all habitat types of the ecoregion (0.01) and also mean impact within habitat types was low, ranging from less than 0.005 (circalittoral rock and biogenic reef) to 0.03 (Offshore circalittoral sand); (Table 2.3).

The situation with low average impact across the Baltic ecoregion has been very stable since 2009 for all habitat types, and throughout the period close to 100% of the area of all habitat types have experienced an average grid cell impact below 0.2 (Figure 2.4).

The very low mean trawling impact estimated in the assessment is to a large extent an artefact of the choice of the entire eco region as the assessment unit, as very extensive parts of the northern Baltic Sea are never fished by bottom trawlers. Consequently, using sub-regional assessment units instead would likely provide significantly higher impact estimates for the western Baltic Sea.

Way forward, as defined in online meeting 2020 for the North Sea and Baltic Sea

Current status of the work

The Baltic and North Sea assessment of impact has been updated with bottom fishing activity data for 2018–2019. The outcome is available on github (https://github.com/ices-eg/FBIT) and can be used to produce a regional overview assessment sheet in 2021.

The group discussed ways to improve the North and Baltic Sea assessment and increase confidence and validation of the outcome. WGFBIT actions list is provided below.

WGFBIT action plan

1. Estimating uncertainty

   We will include a bootstrapped uncertainty of the depletion and recovery parameters for both NS and BS, following the script developed by Jochen in Ancona, and provide maps with 95% CI values. We further aim to include the uncertainty associated with the longevity prediction from each statistical model (Daniel/Josefine/Jochen).

   The issue of uncertainty is likely going to be addressed as a future ToR within FBIT. Rather than providing a lot of extra maps, we may be able to develop a best versus precautionary scenario.

2. Including small-scale sensitive areas

   We will parcel out VME/biogenic habitats and any other valued or sensitive areas, from the assessed region. We aim that there be a separation of assessment of such habitats and communities from those that are more widespread and often more used by human activities, following ICES advice in 2016. Everyone will try to provide shapefiles with biogenic, sensitive areas for their country by the next meeting that we will use to parcel out these areas in the assessment. We will further check the available polygons within EMODNET and the ICES working group on Deep Sea Ecology.

   In identifying particularly sensitive areas, it was further noted that we may be able to use maps with habitat features that are associated with sensitive species, e.g. hard bottoms in deeper regions are often associated with reefs.

3. Fishing impact at sub-regional scale

   We will evaluate fishing impact at sub-regional scale in both the North and Baltic Sea, i.e. HELCOM sub-regions and OSPAR reporting unit level 2. This is to account for uneven distribution of fishing effort and to have a sub-regional assessment of MSFD habitats (Grete/ Francois/ Ole/ Josefine/ Mattias/ Daniel)

   For the Baltic Sea: ask HELCOM shapefiles for the sub-regions and run the assessment. Further, improve the methodology to take into account Baltic areas with hypoxic and/or anoxic conditions.

   For the North Sea: OSPAR reporting unit level 2 (i.e. English Channel, Kattegat area, Southern North Sea, Northern North Sea) are included as a column in the North Sea assessment script. It is possible to re-run the script for each subregion.

4. Coastal region

   There are different ongoing projects investigating the FBIT methodology in more coastal areas, i.e. Danish mussel fishery (Denmark) and Dutch 12-miles zone (Netherlands). These projects may:

   - Produce AIS-based high-resolution fishing pressure maps and FBIT assessments at much finer C-square scale (e.g. 100x100m) (Ole, Josefine, Jeppe, Grete)
   - Include additional/coastal environmental variables in modelling of Longevity/Recovery (e.g. nutrient load)
   - Use coastal monitoring programs that cover large amounts of benthic sampling data

During the spring meeting, we will evaluate the work (Tobias and Justin /Ole and others of DTU) and discuss ways to integrate these coastal developments in the current, more off-shore, assessment.

5. Improvement of depletion rates

We will develop/implement methodology to better differentiate between impact (depletion rate) of the different towed gears (e.g. Rijnsdorp *et al.* 2020). This methodological improvement is also useful/required for properly accounting for trade-offs and informing management (Ole, Francois, Daniel, Jan, Marija, Justin)

- Include depletion rates for 10 different métiers following Rijnsdorp *et al.* (2020) in the assessment script and evaluate the impact predictions
- Discuss ways to validate/improve the gear differentiation in the next FBIT meeting

6. Model validation and improvement

There are three ways to improve/validate the benthic impact predictions: 1) add sampling stations in underrepresented regions, such as the Northern North Sea, to update the statistical model of the longevity prediction; 2) groundtruth the longevity composition with new data; 3) groundtruth the RBS predictions with trawling gradients in different areas.

Goal is to select as much data as possible for the Northern North Sea. We decide in the next meeting if we have enough data to update the statistical prediction, and/or use for groundtruthing

- Data scoping exercise for the data poor Northern North Sea (boxcores, grabs):
  - Data northeastern deeper North Sea 100–300 meters (Matthias)
  - Germany (Dario/Rabea?)
  - Norway (Lene B?)
  - Scotland
  - Kattegat area (Grete, Ole and others)

We further noted that we might be able to validate our predictions using sampling stations that are sampled on a temporal basis. These data allows evaluation of changes over time in data and PD model with changing fishing intensity.

Lastly, we will keep track of previous attempts to groundtruth longevity and impact predictions (Jan/Daniel). This may be done by yearly updating a table and provide an overview of each of these works.

Future plans that will require a longer timeframe

1. A meta-analysis by Sciberras *et al.* (in prep.) suggests that short-lived organisms and organisms that live deeper in the sediment have a lower depletion rate than long-lived organisms and organisms living closer to the surface. We might be able to use the meta-analysis (or an update) to assign a trait x gear type depletion rate. This complicates the PD model as the depletion rate will now change over time with a shift in the longevity/sediment position of the organisms due to trawling. This will need a temporal dynamic model. Examine the consequences in a case study area, e.g. the North Sea (Marija, Daniel, Jan).
2. Primary production seems to interact with trawling impact and recovery. First step is to quantify relationships and how they affect longevity/recovery rate/depletion rate.
3. Link trawling impacts to biogeochemical processes (direct impacts and indirect impacts through changes in benthic communities). Justin aims to provide a map of vulnerability of the biogeochemistry (Marija, Justin, Jochen). The incorporation of ecosystem functions

in the assessment, including biogeochemical processes, might become an overall goal of FBIT in the next cycle.

4. Scan the literature for evidence on technical gear modifications: Do technical gear modifications that lower gear penetration depth improve benthic status? And how do they change the catch?
   - Pulse/beam studies
   - Semi-pelagic trawl doors lift the otter boards from the seabed and reduce benthic impact (McHugh *et al.* 2015) without lowering target species too much
   - Benthos release panels (BRPs); (Fonteyne & Polet 2002; Revill & Jennings 2005)
   - Raised footrope trawls (link to report) – part of the gear is raised from the seabed (used in Celtic Seas for conservation measures to reduce bycatch of cod). Raised footrope trawls can reduce seabed impacts (He 2007; Winger *et al*. 2018).
   - ICES WKING report (2020) lists gear modifications that have been developed and implemented and is a good starting point for a literature scan
   - Update of the global meta-analysis with new data (depletion / recovery rates) (Marija/Jan)

2.3 Arctic Sea

General introductory text

During the 2019 meeting of the WGFBIT, two independent assessments were carried out in areas of the Barents Sea and Norwegian Sea Ecoregions using two distinct sources of data: a) By-catch data from bottom trawls (two periods: 2011–2013 and 2015–2017) conducted as part of the Joint Annual Norwegian-Russian Ecosystem Survey in the Norwegian sector of the Barents Sea (Jørgensen *et al.* 2015, 2016, 2019). b) Beam-trawl data from the national MAREANO programme mapping (2006–2014): bathymetry, geology, pollutants, benthos diversity and vulnerable ecosystems (Buhl-Mortensen *et al.* 2015 a, b). Each of the two assessments was carried out within a polygon defined by the proximity of the sampling locations, in order to avoid extrapolations to areas where no information is available about the distribution of benthic organisms. It follows the methods described in: https://github/Arctic.

Assessment results Barents Sea

Status in year 2018 of Barents Sea.

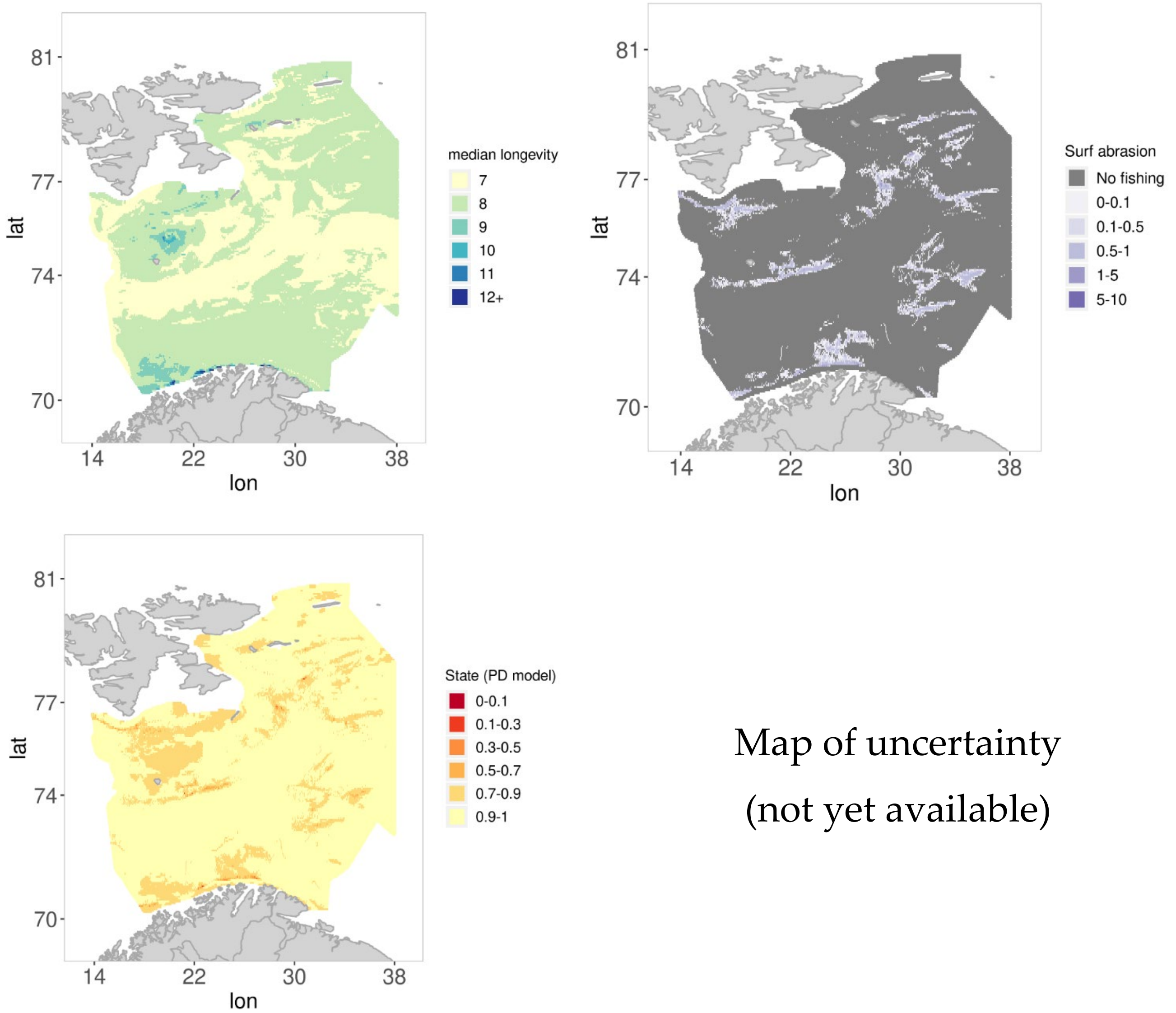


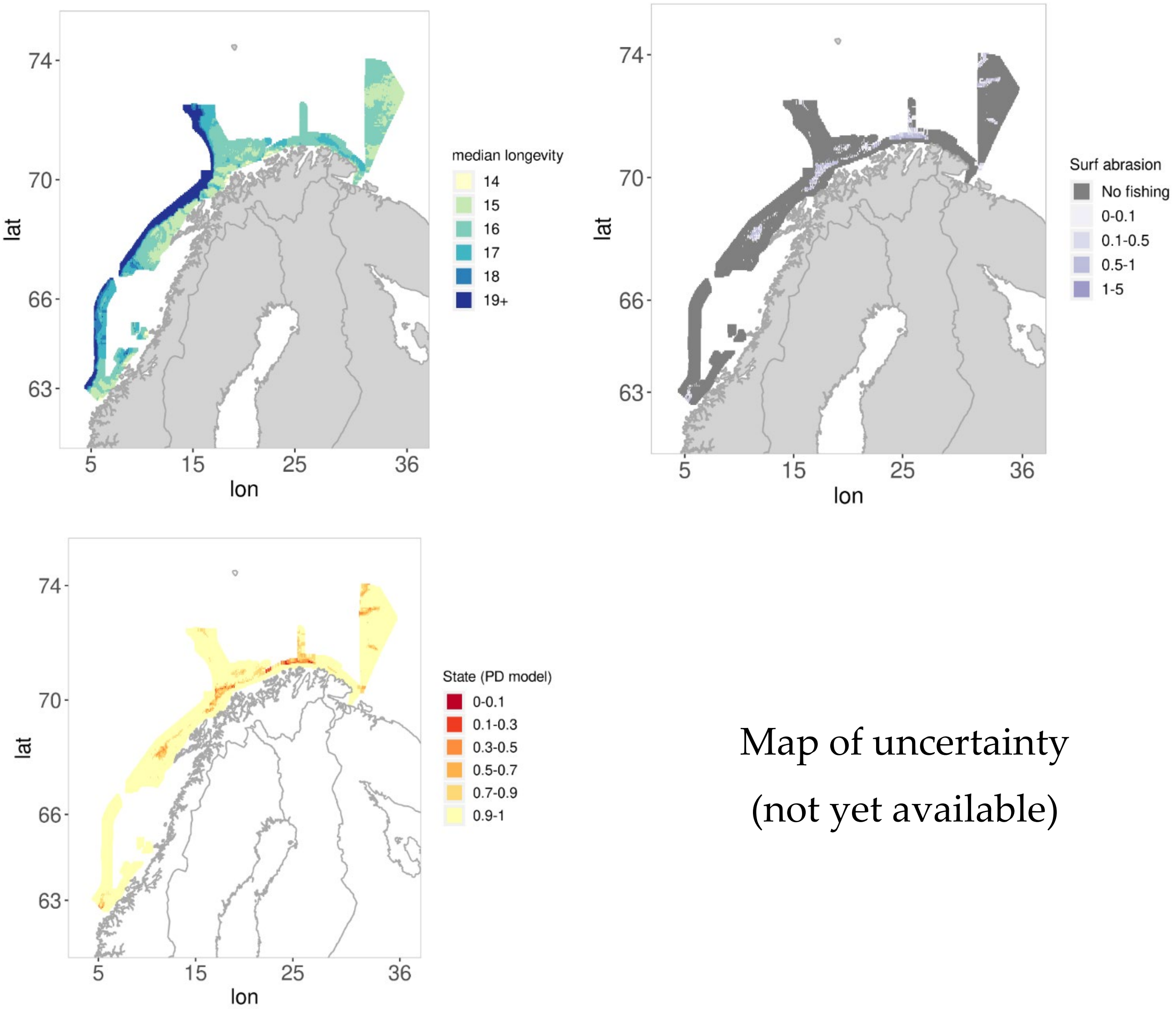
Figure 2.5. Maps for the Barents Sea of i) predicted median longevity (top left); ii) surface abrasion (>2 cm) (top right) based on VMS and logbook data for all mobile bottom-contacting gears in 2018, and iii) relative benthic impact (bottom left).

Table 2.4. Assessment estimates of mean fishing impact, per habitat type in the Barents Sea in 2018. The impact estimates are mean values across all c-squares of a habitat type.

Habitat type (Eunis lvl X)	Area km2 (% of total)	Mean Impact (+-CI)	fraction un-trawled (+-CI)
Circalittoral coarse sediment	19084 (3.54)	1.000	Not yet available, for future reporting
Circalittoral mixed sediment	734 (0.14)	1.000	
Circalittoral mud	6823 (1.27)	1.000	
Circalittoral rock and biogenic reef	675 (0.13)	1.000	
Circalittoral sand	709 (0.13)	1.000	
Infralittoral coarse sediment	266 (0.05)	0.995	
Infralittoral mixed sediment	5 (0.001)	1.000	
Infralittoral mud	7 (0.001)	1.000	
Infralittoral rock and biogenic reef	10 (0.002)	1.000	
Lower bathyal sediment	117 (0.02)	1.000	
Offshore circalittoral coarse sediment	15387 (2.85)	0.994	
Offshore circalittoral mixed sediment	15094 (2.80)	0.994	
Offshore circalittoral mud	99367 (18.43)	0.995	
Offshore circalittoral rock and biogenic reef	1229 (0.23)	0.999	
Offshore circalittoral sand	1358 (0.25)	0.987	
Upper bathyal rock and biogenic reef	1273 (0.24)	0.995	
Upper bathyal sediment	376835 (69.89)	0.991	
Total			

Assessment results Norwegian Sea

Status in year 2015 of Barents Sea.



Map of uncertainty
(not yet available)

Figure 2.6. Maps for the Norwegian Sea of i) predicted median longevity (top left); ii) surface abrasion (>2 cm) (top right) based on VMS and logbook data for all mobile bottom-contacting gears in 2018, and iii) relative benthic impact (bottom left).

Table 2.5. Assessment estimates of mean fishing impact, per habitat type in the Norwegian Sea in 2018. The impact estimates are mean values across all c-squares of a habitat type.

Habitat type (Eunis lvl X)	Area km2 (% of total)	Mean Impact (+-CI)	fraction un-trawled (+-CI)
Abyssal	776 (0.55)	1.000	
Circalittoral coarse sediment	469 (0.33)	0.971	
Circalittoral mud	11 (0.01)	1.000	
Circalittoral rock and biogenic reef	2025 (1.44)	0.991	
Circalittoral sand	56 (0.04)	1.000	
Infralittoral coarse sediment	20 (0.01)	0.799	
Infralittoral rock and biogenic reef	10 (0.01)	1.000	
Lower bathyal rock and biogenic reef	710 (0.51)	1.000	Not yet available, for future reporting
Lower bathyal sediment	4631 (3.29)	1.000	
Offshore circalittoral coarse sediment	16734 (11.91)	0.946	
Offshore circalittoral mud	4900 (3.49)	0.977	
Offshore circalittoral rock and biogenic reef	4557 (3.24)	0.990	
Offshore circalittoral sand	4190 (2.98)	0.953	
Upper bathyal rock and biogenic reef	3824 (2.72)	0.995	
Upper bathyal sediment	97624 (69.45)	0.979	
Total			

Time trends

No time trend analyses available.

Brief interpretation of results and way forward

The analysis presented were carried out in order to test the applicability of the assessment methodology on the Barents Sea and Norwegian Shelf. The results should be considered as preliminary.

Fishing activity is from otter trawlers and demersal seiners for the Barents Sea and the Norwegian Shelf, except for 2009 and 2018 when only otter trawlers were reported. Abrasion estimates for 2018 are shown. For the longevity factor, the biological longevity trait classes are reclassified into six longevity classes: < 2 years, 2–5 years, 5–10 years, 10–20 years, 20–50 years and > 50 years to better represent the fauna in the Arctic region and obtained by trawl samples. The model (GLLM) selected was used to predict the mean longevity in both assessment areas as function of bottom temperature, depth, and grain size. In general, the impact is low in the Barents Sea, whereas for the Norwegian Sea there were some highly impacted areas. Nevertheless, the majority of the area is estimated as low impacted. The abrasion impact values obtained from the beam-trawl data are higher than those obtained from the by-catch of the fishery survey in the Barents Sea

Further analyses are needed to confirm the validity of the longevity models. For the purposes of testing the assessment methodology we utilized three environmental variables to predict the longevity of the benthic community: depth, bottom temperature, and sediment grain size. It is apparent that these variables alone cannot predict with enough accuracy the distribution of longevity values in an area with high environmental variability and diversity of benthic habitats such as the Norwegian Shelf and Barents Sea. For example, recent biotope maps obtained by MAREANO for the southern Barents Sea revealed a diversity of benthic communities and spatial patterns that are not reflected in the maps of estimated mean longevity. We consider that is necessary to further develop the longevity models, by incorporating additional environmental predictors and by comparing the resulting patterns of predicted longevity with the longevity of the species in areas where detailed biotope maps are available.

The differences in mean longevity estimates and relative benthic status values obtained in the southern Barents Sea from both data sources, the Joint Annual Norwegian-Russian Ecosystem Survey (fish-trawl) and the MAREANO programme (2m beam trawl) suggest that the assessment methodology is susceptible to the degree to which the benthic community is represented in the samples. This introduces difficulties when comparing RBS values obtained in different areas with different sampling gear. Further work is necessary to understand the effect of different sampling gears in characterizing the distribution of biomass in the different longevity classes and its effect in the assessment results. In this regard, the analysis of predicted longevities in areas sampled with multiple gear types may provide some insights.

Additionally, more resources (expertise, analyse power) is needed to achieve updates and run data analyses.

2.4 Celtic Sea, Bay of Biscay, Iberian Coast

General introductory text

The regions Celtic Sea, Bay of Biscay and Iberian Coast were tackled together, as data and expertise overlap. Nevertheless, this summary assessment report is about the assessment of fishery pressure for Celtic Sea, which is based on 2015 data and follows the methods described in https://github.com/ices-eg/FBIT/tree/dev. This is a **preliminary assessment** to prove that the WGFBIT framework can be applied in the Celtic region.

The Celtic Seas ICES ecoregion is covering an area of 923608.5 km^2 and ranges from 47 to 67 degrees north and longitudes ranges from 2 degrees east to 15 degrees west. The area of interest cover the whole Irish Economic Exclusive Zone (EEZ) and partially the UK and French EEZs.

Preliminary assessment results Celtic Sea

Status in year 2015 of Celtic Sea.

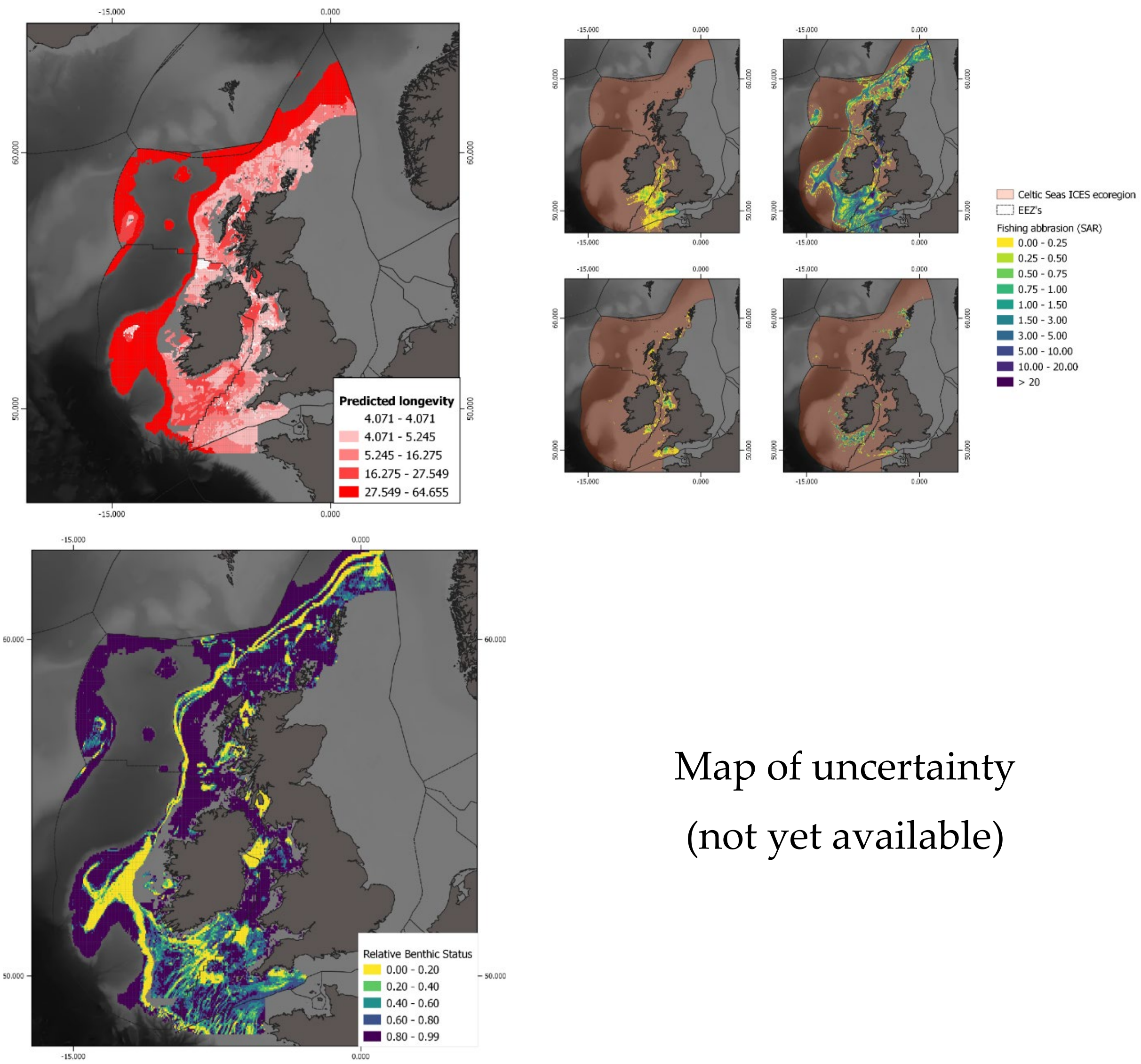


Figure 2.7. Maps for the Celtic Seas of i) predicted median longevity (top left); ii) fishing abrasion (top right) based on VMS and logbook data, and iii) relative benthic impact (bottom left).

Table 2.6. Assessment estimates of mean fishing impact, per habitat type in the Celtic Seas in 2015. The impact estimates are mean values across all c-squares of a habitat type.

Habitat type (Eunis lvl X)	Area km2 (% of total)	Mean Impact (+-CI)	fraction untrawled (+-CI)
Circalittoral sand	4808.4 (1.2)	0.95	Not yet available, for future reporting
Offshore circalittoral coarse sediment	94269.0 (23.2)	0.84	
Offshore circalittoral mixed sediment	4955.2 (1.2)	0.9	
Offshore circalittoral mud	61528.5 (15.2)	0.41	
Offshore circalittoral sand	112291.9 (27.7)	0.68	
Upper bathyal sediment	87307.7 (21.5)	0.66	
Total			

Time trends

No time trend analyses available.

Brief interpretation of results

This is a **preliminary assessment** to prove that the WGFBIT framework can be applied in the Celtic region. Therefore, no verbal reference is made on what the results indicate and how it relates to the fishing practices within the region. This is because of several factors in the assessment framework need to be improved or further re-fined. The next paragraph shortly describes the data and analyses that the preliminary assessment is based on.

The seafloor abrasion layer has been obtained from the outputs of ICES WGSFD, providing the abrasion indicator as the swept area ratio (area swept by a bottom contact fishing gear in a given c-square / c-square area). For this assessment, we have selected uniquely the data form 2015 since this year has more biological survey data associated with it (from UK Marine Protected Area survey programme [grab samples]; EVHOE survey [trawl samples]) available. In order to link the habitat information to the fishing intensity, habitat types have been transferred into the c-square grid. The MSFD broad habitat type with more presence (>50%) within a given c-square have been assigned to the whole c-square. The "standard longevity matrix provided by WGFBIT (Emodnet dataset from Beauchard, 2018)" has been utilized, the species longevity matrix being attributed mostly at the genus level. The longevity relationships for determining sensitivity is based on the Generalized Linear Mixed Models (GLMMs), which were defined to identify which parameters (currently only MSFD broad habitat type) have larger influence in the variability of cumulative biomass.

Way forward

During the 2020 online meeting, we determined the aspects to tackle within the WGFBIT assessment framework. The actions are grouped in accordance to the different assessment steps, which is also in alliance with the reporting template. This should allow us to perform an FBIT assessment for the Celtic region, Bay of Biscay and Iberian Coast in the period 2021–2023.

a) **Region of interest**

- The geographic area covered is extended to the Bay of Biscay and Iberian coast, but the available datasets from those regions are based on the megafauna as collected from fisheries trawling survey.
- The region blocks need to be defined as precise as possible.
    - Focus on depth region, which is relevant for management: e.g. 100–400m (Iberian coast)
    - Biogenic habitats and hard substrates are excluded for current assessment (cf coastal habitats in Bay of Biscay).
- Following region responsible are defined: Iberian Coast (José); Bay of Biscay (José –Pascal); Celtic (Roi – Stefan - Paul)
- Reduction in amount of habitats need to be done (cf list in FBIT report 2019). Following selection criteria: excluding habitats where we have no info or data (fishery, benthic abundance); Gridcells with 50% of biogenic or hard substrate habitats to be excluded (blanc). We flag them based on habitat or no data.

b) Fishery data

- ICES WGSFD
- Other type of fishery (gear): passive fishing, … For future work and part of WGSFD workplan.

c) Habitat types

- EUNIS 2019 July version!
- Coupling of habitat with c-square already done for all regions (action Daniel/ ICES). Also helpful for WGSFD, so recommendation of FBIT to ICES!
- If more environmental variables could be coupled with the c-square info, could be nice to streamline the FBIT assessments across the regions. But this aspect is less easy to harmonize among the regions (different environmental variables relevant). Tor in ICES SFD (Neil leading this).

d) Trait data

- Region will use the classes as agreed by the biological trait subgroup
    - 5 classes: <1; 1–3; 3–10; 10–50; > 50
    - Or <1; 1–3; 3–10; > 10
    - Adaptation of these classes need to be made for Iberian coast (action José)
    - Species list compiling, putting traits together (action all)
    - Biotic database status: is useful source, but the benthis spreadsheet has additional info.
- Comparison of longevity median distribution and/or sensitivity can be done. And in relation to fishery pressure (Action Stefan to keep this on the agenda and to explore this, practical analyze help from others need).
- Actions to come to update trait-species matrix
    - Ifremer: Still 100 species to classify for older classes (Pascale)

- Merging trait matrix for Bay of Biscay (Pascale and José)
- Paul to construct the Irish trawl species list.
- All: How to catalogue the difference in scoring for a certain subset. Intersessional skype to solve different scoring and to decide on this is needed.

e) Benthic dataset

- Trawl data is most widely available over the region: similar sampling Spain and France (Ifremer)?
- Grab data (JNCC; ± 100 points) used for part of Celtic area
- To list the available datasets and their coverage+ other relevant metadata (action all), so we have a larger dataset for the assessment analyses in 2021–2023.
  - Action Stefan: CEFAS data to check with one benthic for Celtic area…
  - JNCC data Celtic (Meghan)
  - José: Spanish data
  - Pascal: IFREMER data
  - Ireland: data compilation need some more work time. But at least species list for trait linking will be constructed.
  - The files (.csv) should be put on Github by 10 December and compiled in a database (Roi to check to have a spatial database structure behind it); (by 15 January).
- Subset of low fishery or no fishery has to be selected! A Fishery cut-off need to be defined, should be linked to the moment when you can quantify an impact.
- Other environmental variables to model the longevity (all).

f) General action

- Merging scripting Roi (assessment itself) and Pascale (explore data): Put it on the Github fbit Celtic! Action Roi and Pascale to have short skype meeting on it.

2.5 Mediterranean Sea

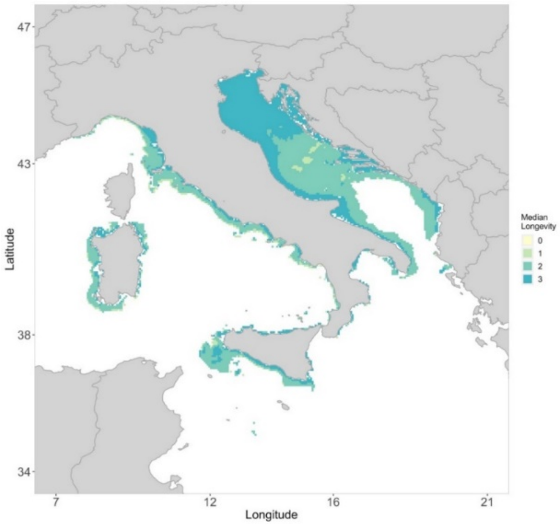
General introduction

For the Mediterranean Sea, we work with three sub-regions, wherefore the Italian waters (Adriatic-Ionian Seas) a preliminary ICES FBIT assessment was executed in 2019. For the other subregions (Western Mediterranean and Aegean-Levantine Seas), the process has started during the online meeting 2020.

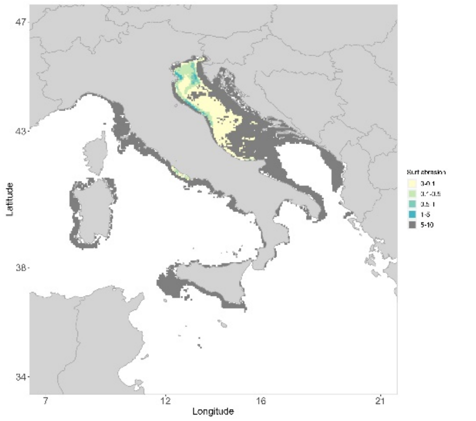
This is an assessment of fishery pressure for the Italian waters, which is based on benthis data (Eigaard *et al.*, 2017) and follows the methods described in https://github.com/d-lorenz/ICES_FBIT. ISPRA, through the elaboration of the data of the National Monitoring Plan, is working for the assessment of the national methodology regarding the criteria requested by the MSFD.

The following results provide a **preliminary assessment** to prove to what extent the WGFBIT framework can be applied in the Mediterranean Sea.

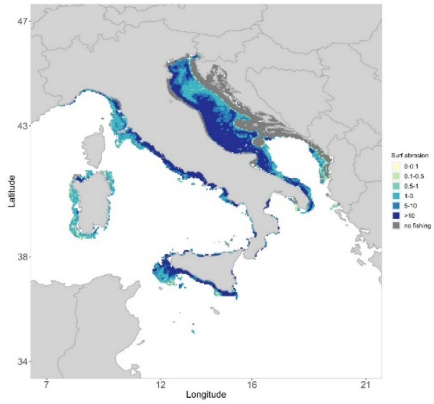
Preliminary assessment result Italian Waters

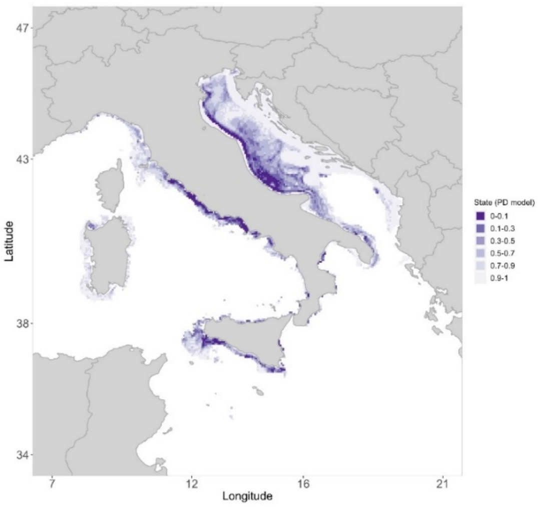


Surface abrasion (beam trawl)



Surface abrasion (otter trawl)





Map of uncertainty
(not yet available)

Figure 2.8. Maps for the Italian waters of i) predicted median longevity (top left); ii) fishing surfaceabrasion of beam trawl and otter trawl (top right) based on VMS and logbook data, and iii) relative benthic impact (bottom left).

Table 2.7. Assessment estimates of mean fishing impact, per habitat type in the Italian waters. The impact estimates are mean values across all c-squares of a habitat type.

Habitat type (Eunis lvl X)	Area km2 (% of to-tal)	Mean Impact (+-CI)	fraction untrawled (+-CI)
Shallow_sublittoral_mud		0.92	**Not yet available, for future reporting**
Shallow_sublittoral_sand		0.87	
Shelf_sublittoral_mud		0.63	
Shelf_sublittoral_sand		0.77	
Total			

Time trends

No time trend analyses available.

Brief interpretation of results

This is a **preliminary assessment** to prove that the WGFBIT framework can be applied in the Italian waters. Therefore, no reference in this report is made on what the results indicate and how it relates to the fishing practices within the region. This is because, several factors in the assessment framework need to be improved or further re-fined. Details of the analyses within the Italian waters are provided in the ICES WGFBIT report (2019). The next paragraph shortly describe on which data and analyses the preliminary assessment is based.

The Gebco shapefile (www.gebco.net) for bathymetry was used to clip the 3x3 nm grid. Likewise, the 3x3 nm grid, the EUSeaMAP shapefile was clipped to exclude depths below 1000 m. Each cell of the 3x3 grid was matched with the corresponding MSFD predominant habitat types from the EMODnet dataset along with the depth values from the GEBCO bathymetry data. Benthic data for calculating the longevity relationships was derived from two datasets. These concerned the Northern and Central Adriatic Sea and the Northern coasts of Sicily. Data from the Adriatic Sea were derived from the SoleMon project (Santelli *et al.*, 2017). Data from the Northern Sicily (Western Mediterranean) were derived from Romano *et al.* (2016). For testing the methodology to calculate the recovery based on longevity from benthic data, all data from both fished and unfished areas, are included. Generalized Linear Mixed Models (GLMMs), based on MSFD broad habitat type and depth as environmental factors, were used to determine the sensitivity.

Way forward

Overall aim: Conduct assessment of (as much as possible of) the Mediterranean, using the FBIT framework

We here report on a by-area basis on the progress and plans for the areas in which WGFBIT has conducted a preliminary assessment in 2019 (Italian Adriatic Sea and area North of Sicily), as well as on three areas which have not been assessed in earlier years, the French, Spanish and Greek Mediterranean waters. Status, progress and plans in each area is outlined along a fixed set of items corresponding to the components of the WGFBIT assessment framework:

1. benthos samples, biomass by species by surface area
2. species-level longevity trait data
3. environmental data for sampled location
4. Bottom trawl fishing intensity by gear
5. Gear impact per unit effort

6. Environmental data for total area to be used to calculate unfished longevity biomass distribution by location

The Med subgroup also had discussions on general issues relating to the successful assessment of fishing impacts in the region. The outcome of these discussions can be found in the 'conclusions and recommendations' section.

Italian Adriatic Sea

Focus will be on the update of the preliminary assessment by using more recent fishery pressure and benthic data. This all in line with the MSFD assessment progress on seafloor integrity. Currently the Italian National Institute for Environmental Protection and Research (ISPRA), in the context of the National MSFD monitoring programmes, is leading an effort in collaboration with other research institutes to develop a number of products that could allow, in the mid-term, to progress towards the implementation of the methods at national scale (Italian marine waters scales), including: estimates of SAR, functional traits and longevity, experimental assessment of mega-epifaunal composition under different trawling regimes.

In particular, a selection of more than 200species closely related to the bottom trawls have been ranked in the basis of biological parameters/traits (Position on the substate, feeding behaviour, body size, mobility and fragility) that reflects taxon vulnerability to fishing gear (cfr. de Juan, & Demestre, 2012), assign to each taxon a value ranging from 1–3 (with 3 highest vulnerability) for each of the parameters on the basis of literature and expert judgment weighed by biomass and taking into account longevity. This work is still ongoing for the definition of a sensitivity index.

It is foreseen progresses and achievements will be presented in the next WKFBIT activities.

Furthermore Epi-megabenthos Sensitivity INDEX (SI):

- Selection of species (>200) closely related to the bottom trawls and the biological parameters/traits (Position on the substate, feeding behaviour, body size, mobility and fragility) that reflects taxon vulnerability to fishing gear (de Juan, & Demestre, 2012)
- Assign to each taxon a value ranging from 1–3 (with 3 highest vulnerability) for each of the parameters on the basis of literature and expert judgment weighed by biomass and taking into account longevity
- Sensitivity Index: scores based on the integration of parameters – test of alternatives

Assign to each sampled station the corresponding Sensitivity Index

Associate sampled station sensitivity index to the corresponding habitat

Area North of Sicily

Middle Med (focus area: Sicily; reporter Cristina and Gabriele) the joint research team between the Integrated Marine Ecology Dept of Palermo (Stazione Anton Dohrn) and the Laboratory of Ecology (University of Palermo) is testing the FBIT approach, in co-operation with a PhD candidate (Gabriele Di Bona). At the next meeting, this progress will be presented (additionally the dataset from the North Sicily will be implemented and re-assessed).

Progress done up to date:

1. Benthos samples, biomass by species by surface area
   Benthic samples from otter trawl survey experimental and commercial survey (abundance and biomass). The Southern Sicily Channel is well represented thankful to a 2 years survey (in the framework of HARMONY project, INTERREG ITALY-MALTA collecting also main biological traits measurement per target species as Alcyonium an Seapens). The model will be adapted as in the study area it is very difficult to find areas with no pressure to be used as comparison/baseline. Several low-pressure areas have been highlighted.
2. Species-level longevity trait data
   Longevity data by using Stefan Bolam matrix (fuzzy coded epifauna-megafauna), eventually implemented by following Chris & Nadia matrices from Greece
3. Environmental data for sampled location
   Temperature, oxygen, pH, depth and sediment data available.
4. Bottom trawl fishing intensity by gear
   SAR evaluation by using VMS data (specifically for Otter-trawl) year 2013 round GSA10, GSA16, GSA19 (3 Geographic Sub-Areas surrounding Sicily)
5. Gear impact per unit effort
   Depletion rate data as by Hiddink *et al.* 2017 (values as from the other groups into the WGFBIT)
6. Environmental data for total area to be used to calculate unfished longevity biomass distribution by location
   Environmental data downloaded and cleaned (temperature, oxygen, pH). Sediments data have been collected by specific survey and collated from the literature and available databases (e.g. EUSeaMap 2019 from EMODnet)

Future work

1. Associate samples to habitat (3° level EUNIS classification) by using 'EUSeaMap 2019 + sediment features data from in situ survey (this latter data already collected and analysed)
2. Associate longevity values to benthos matrices
3. Associate bottom temperature, shear stress and SAR to samples
4. Apply logistic model to obtain median longevity from the longevity-biomass curves (when only abundance is available – from previous datasets)
5. Calculate the recovery rate from the median longevity, apply the PD approach and calculate the RBS around Sicily (areas overlapping and covering mostly GSA10, 16, 19).
6. New AIS and VMS data will be request, as well as MEDITS data.

French Mediterranean

Status of assessment components:

1. Benthos samples, biomass by species by surface area
   There are benthos samples of mega-epifauna from MEDITS standardized bottom trawl, 20mm stretched mesh size, 2012–2019), biomass by species by area available.
2. Species-level longevity trait data
   This is available for some species, which only amount to 20% of biomass. Update is urgently needed. Combining this with trait classification from Nadia and Chris (Greece) and from CEFAS (Stef Bolam) is an obvious first step. A first comparison

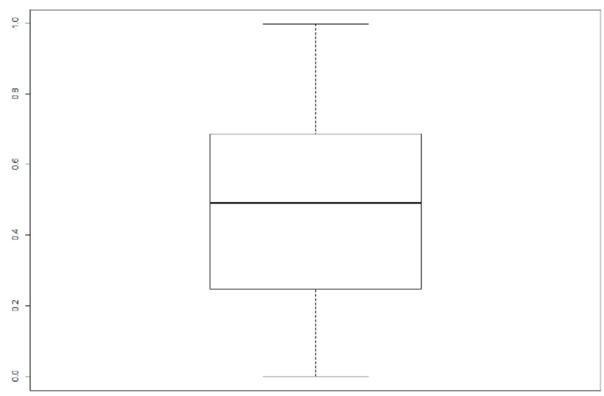
with the Greek database has been made during the 2020 working group, and results are attached below.

3. Environmental data for sampled location
   Available are depth, sediment type, EUNIS level4, seafloor stability proxies:
   https://sextant.ifremer.fr/Donnees/Catalogue#/metadata/e7f839fc-ae46-4607-8892-63b5b5c5342e
   https://sextant.ifremer.fr/Donnees/Catalogue#/metadata/0364bd13-ed7a-4b33-95d8-b02237035ac7b
   https://sextant.ifremer.fr/Donnees/Catalogue#/metadata/5b62e0c9-05ab-4b86-bd04-282fec733f87
4. Bottom trawl fishing intensity by gear
   Fishing intensity is available from 2009–2017. Update and disaggregation by gear is needed. See
   Jac Cyrielle, Vaz Sandrine. Abrasion superficielle des fonds par les arts trainants – Méditerranée (surface Swept Area Ratio). IFREMER
   http://dx.doi.org/10.12770/8bed2328-a0fa-4386-8a3e-d6d146cafe54
5. Gear impact per unit effort
   Jan Geert Hiddink's numbers can be used, which is done for all other areas as well
6. Environmental data for total area to be used to calculate unfished longevity biomass distribution by location.
   Unfished areas are very different (deeper/oligotrophic) from heavily fished areas. Biomass reconstruction methods by habitats may yield very biased results for fished shelf and coastal areas. This needs future consideration.

Cross-checking available FR-MEDITS data with longevity informed species list

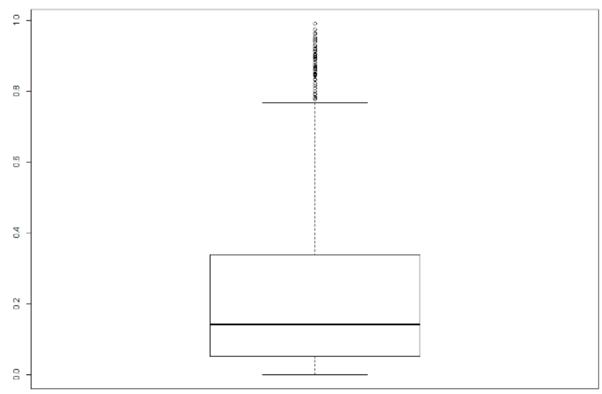
relative biomass contribution of uninformed taxons

```
Min.  1st Qu.  Median   Mean    3rd Qu. Max.
0.0   0.2476   0.4913   0.4690  0.6891  1.0000
```



relative biomass contribution of uninformed taxons (excluding cephalopods)

```
Min.  1st Qu.  Median   Mean    3rd Qu.  Max.
0.0   0.05174  0.14220  0.24133 0.33879  1.0000
```



Available data consisist mostly of MEDITS data complemented by EPIBENGOL (=MEDITS) and NOURMED (beam trawl coastal) surveys: 2012–2018 period, 716 trawl hauls in total

Overall, 485 mega-epifauna taxons were observed that were grouped into 340 genus or lower level taxons.

They were crossed with longevity data made available by HCMR (MacroTraitsGreece 150920.xlsx, 685 taxons) and longevity data available on WGFBIT sharepoint (Trait data_longevity. xlsx downloaded on the 15/09/20, 1042 taxons).

The analysis revealed that 138/340 FR MEDITS taxons (including 18 cephalopod taxons) lacked longevity information. The mean relative biomass contribution to each haul of these uninformed taxons was about 47% (24% if removing cephalopods).

Questions:

1. What relative biomass contribution threshold is used in the WGFBIT assessment framework? Should observation where over 50% (or 20% or 10%) of the observed biomass is not considered be removed from the analyses? If such threshold exists, I could evaluate how many observations will need to be removed.
2. Cephalopods may be very important portion of the observed biomass. Their longevity is notoriously short with obvious effect on the longevity-related sensitivity assessment. Should they be kept in or removed (if so only "large" ones or also small sepioids?)
3. Can the longevity information already available be "easily" completed for some of the missing taxons? Species lists provided in MEDITS_FR_missing_longevity.xlsx

Spanish Mediterranean

For the Spanish delegation, 2020 is the first year they have joined WGFBIT. For this year, they will focus on developing a working assessment for the Spanish North Coast area. In later years, more effort will be on the Spanish Mediterranean waters. It is expected that the assessment for the French Mediterranean waters can serve as a blueprint for the Spanish areas, as it will be based on the same survey (MEDITS), and we expect large overlap in the species composition.

Greek waters

Status of assessment components:

1. Benthos samples, biomass by species by surface area.
   There is a core set of 71 macrofaunal grab sampled stations (820 samples) around Greece with macrofaunal species and biomass. Station samples need further screening for representativity. More macrofauna stations are being added as they are sourced.
2. Species-level longevity trait data.
   All Greek taxon traits (BENTHIS traits with fuzzy logic) are elaborated in a database (currently 680 taxon) with new species added as available.
3. Environmental data for sampled location.
   Sediment analysis and depth are available for the core stations and consequently MSDF habitat type. Most stations are infralittoral and circalittoral (muds). Samples representing other MSFD habitats present in Greek waters will be sought.
4. Bottom trawl fishing intensity by gear.
   Only one gear is used in Greece, otter trawl. VMS data are routinely collected and processed with a time delay.
5. Gear impact per unit effort.
   Depletion, recovery and RBS will be estimated using the Hiddink (2017) methodology and their global depletion analysis.

6. Environmental data for total area to be used to calculate unfished longevity biomass distribution by location.
   Trial longevity distributions by MSFD habitat type have been recently established using the Rijnsdorp (2018) methodology (mixed, mud and sand MSFD habitats).

Future work

A trial assessment will be carried out for Greek waters by spring 2021 using the ICES WGFBIT methodology based on macrofaunal longevity and bottom trawling effort. This trial will be revised in future to isolate particular issues with respect to uncertainty and validity concerning macrofaunal sample representativity (samples per habitat, different sampling methods, geographic spread of stations and difference between geographical areas

Conclusions and recommendations

Based on the experiences in the work carried out so far for WGFBIT in the Mediterranean area, the group would like to bring to attention the following conclusions and recommendations.

Conclusions

1. There has been good progress in several Member State (Spain, France, Italy, Greece) countries in the Mediterranean towards assessment of trawling impacts.
2. There are a number of common methods and a number of different methods for assessing trawling impact. Common include using MEDITS invertebrate trawl survey data (some areas in Italy and France) and macrofaunal grab data (parts of Italy and Greece). Data from the National Monitoring Plan in Italy will be available.
3. FBIT framework methodologies are largely still in development/implementation for many regions.
4. Even with the common methods such as use of MEDITS trawl surveys, there may be area differences (even within countries) as to sample collection/handling protocols, which has a potential effect on outcome and comparability.
5. Coordination within the Mediterranean sub-regions/GSAs for assessing trawling impacts is lacking or fragmented
6. It is not possible at this time to undertake a single regional assessment for the Mediterranean, although in some areas environmental status can be assessed and compared.
7. Using trawl survey data, it is difficult to source “no impact” areas within the data. As those are scarce it is also difficult to extrapolate the longevity estimates of those no impact areas to the other areas.
8. Longevity data has been difficult to source, but HCMR is sharing their infauna dataset (680+ taxon) between Mediterranean participants.

Recommendations

1. To investigate modelling methods to assess biomass of “non-impacted” trawl areas.
2. Priority should be given to extend the longevity trait classification to cover all the Mediterranean species.
3. To investigate the role of ICES in promoting cooperation in the Mediterranean also through Regional Sea Convention, DGMARE & JRC (MEDITS) and DGENV (TGSEABED)
   More effort should be put towards reviewing/revising depletion relationships, by adding new data, particularly in deeper waters.

3 Methodological issues

Harmonisation of Biological traits

This subgroup has the aim to update and harmonize the trait classification, with focus on longevity, as this is an essential element of the FBIT assessment framework. Following questions were tackled:

- Try to avoid too many longevity classification systems (trait modalities)
- Trait modality classes: Which?
- Trait sources overview
- Longevity trait + other traits?

1. **Different longevity trait classifications**

e.g. Benthis, current FBIT	Arctic classification	Suggestion FBIT 2019 /Benthis	e.g. Beauchard	e.g. DelaTorriente (Spanish)
<1	**<2**	<1	<1	<1
1-3	**2-5**	1-3	1-3	<5
3-10	**5-10**	3-10	3-10	5-10
> 10	**10-20**	10-50	10-20	11-50
	20-50	>50	> 20	>50
	> 50			
				Will be adapted

In benthis and current FBIT assessment for North Sea, the 4 class system is used. For the Arctic assessment (Islandic, Norwegian Shelf, Barents Sea), a 6 class system is developed, with changing the lower classes and added more classes after 10 years. This to cover better the type of species living in the deeper ocean (>200m). To make a hybride, or keeping the lower classes, the FBIT 2019 suggestion was made. Besides, we have also the classification available according to Beauchard Oliver and the Spanish system linked to the BESITO classification.

2. **Trait modality classes per region**

An overview on which classification system is used, will be summarized in a table (updated according to final assessment).

	Trawl samples	Grab samples	Remark
North Sea	?	4 classes	
Baltic Sea	?	4 classes	
Arctic area	6 classes	?	
Celtic Sea	5 classes	4 classes	

Bay of Biscay/Iberian coast	Slightly adapting current longevity classification	?
Med-East / Mid?	4-5 classes	4 classes
Med-west	5 classes	

3. **Trait sources overview**

- Spanish trait list (José/DelaTorriente) → Longevity: 4 classes
- Benthis (Stefan) → Longevity: 4 classes
- Beauchard → Fuzzy coded, lifespan, 4 classes
- IMR/HCMR FBIT 2019 work → Six classes.

Action (Stefan, Gert, José) will be undertaken to merge the sources used for the FBIT assessments across regions, to have one file in accordance to the ICES TAF principles.

4. **Longevity traits + other traits**

It is useful and worth wile to have a connection with other traits (cf benthis traits & Spanish/Italian/French TD classification). Action can be up-taken in future workplan of FBIT.

5. **Other issues**

The assessment outcomes can also differ in relation to certain species groups that are included or excluded. Some common FBIT guidelines are defined:

- For benthic data it is good to determine "How much of total catch (% of total biomass) is included in the analysis"
- Species groups to exclude from trawl samples: Cephalopods (certain), target commercial species
- Homogeneity of datasets within (eco-)region need to be ensured.

FBIT assessments shall be based on epifauna or infauna driven data, which is regional depending. Therefore, a comparison between epifauna – infauna driven longevity, sensitivity maps need to be tested in different regions. A Celtic Sea examples is included in FBIT report 2019.

Alternative assessment methods

What do we consider under alternative assessment methods?

- We consider primarily assessment methods that were used or proposed for D6 "Seafloor integrity" assessments under the MSFD. This by countries or regional sea conventions. Those methods aim to assess areal extent of habitat that is impacted or under/above GES (D6C3 criteria).
- Secondary, there are of course various assessment methods to evaluate impact on benthos in relation to impact gradients or which are under scientific development. This are of relevance, but out of scope for the moment of FBIT to use them for assessment validation.

Comparison why? To avoid to compare apples with oranges…

- To highlight the complementarity

- Finding the locations that are really bad or really good. Areas that classify differently, need more analyses, attention.
- Difficulty to find the “threshold”, so comparison of methods can help…?
- Context dependency of the assessments/ specificity of the area, leading to difference within and among regions.

Which methodologies: an overview

In the next WGFBIT cycle (2021–2023), we will create an overview of methodologies (with very short description) that were around and useful for comparability testing. Information source to be thought about:

- Spanish D6 method: Besito is sensitivity classification for species; indicator D6C3 is under construction …
- French: Jac *et al.*, 2020 papers
- OSPAR BH3 (JNCC)
- HELCOM indicator…
- Assessment methods outside Europe … ; there are, but they have not the same legislative driver as in Europe.

Comparison/ground truthing: Case studies

Planned for WGFBIT cycle reporting 2021–2023:

- Iberian coast case: José
- French Med (Sandrine), where a comparison between the Jac *et al.* (2020) outcome and the FBIT assessment based on the Medits data. Warning: outcome type is not the same!
- JNCC work in the UK about comparison of different methodologies: report almost finalized
- Greece example (Nadia, Chris, Irini): FBIT versus Greece D6.
- Baltic area (DTUAqua): HELCOM indicator versus FBIT

4 General issues

4.1 Trade-off

WGFBIT has identified some aspects that need to be taken into account in the trade-off discussion. Some of those aspects were taken into account in dedicated work WKTRADE 3 shops, organised in spring 2021.

Does the trade-off only cover revenue versus impact:

- Are other aspects of marine harvesting important, e.g. food. Hence, are we going to look into fisheries weights as well as fisheries revenue? We expect we can include both but focus on revenue.

Do we miss management options:

- Can we include gear switching behavior? Nephrops fishing from trawl to pots. Difficult to implement, as we need some information on the fisheries revenue to static gears.
- There is no management option to reduce the spatial distribution of the fishing fleet (remove the c-sq. that are least fished).

Acknowledge:

- Acknowledge that there is a desire to protect nearshore areas. We need a bit of text explaining why we cannot evaluate it at the moment.
- VME are handled at a different scale. We manage these under a different mechanism. The current approach models broad-scale habitats.
- Acknowledge that there are multiple users, group cannot handle this, but it is important (refer to bedpress/loss).

How to operationalize the scenarios:

- Gear design and operations → reducing only the penetration depth of the gear does not lead to a trade-off. We could estimate the reduction in catchability from trawl experiments and/or assume a relationship between catch rate and impact.
- Removal of effort –> we can lower the effort per region, métier, EEZ; how would it change the distribution (check old maps of the distribution). Compare the distribution in a low and high effort year (comparison with historical data). One option is to start with total removal of one fleet segment. We don't have information at the vessel-level, makes it difficult to remove vessels.
- FBIT options, where do they fit? Mixture of Multipurpose habitat management/effort removal/spatial reduction of the fishing distribution.
- Multipurpose habitat management → we can exclude fishing in low fished c-squares until we reach a certain benthic status per habitat type.

Six-year management cycle

- EU has the opportunity to demand for change every six-year. Member states will need it on a more continuous basis to see if their changes make sense.
- UK reports on the attainment or non-attainment of GES at the end of the six-year cycle
- Year by year analysis is most sensible as management options can be introduced halfway the six-year cycle.

Gear groupings

- PD method used 3 different gears; economic analysis this is not a detailed enough gear grouping,
- We will rely on Rijnsdorp *et al.* 2020 to include 10 different métiers and 10 different depletion rates, these are available within the ICES data. We check if some métiers should be unmerged for some ecoregions (North Sea versus Med Sea) where these differences are more important.

Feedback WKTRADE 3

As response to a request for advice from EG-Environment, two workshops were conducted under the WKTRADE3: a stakeholder workshop and a technical workshop. In the stakeholder workshop, the participants were split into three groups: fisheries representatives, conservation NGOs and environmental managers to discuss and report back on trade-off questions: what is it that we 'trade-off', what is important, which management options to prioritize and what types of outputs are useful for the stakeholders. Where possible considering data availability, methods time and expertise available these inputs were picked up and used in output html files. In the technical workshop, an assessment of trade-offs in fisheries and seafloor habitats for regions and sub-regions building on the WGFBIT work was made, including impact assessment for MBCGs for the Greater North Sea and Baltic Seas and an overview of data availability and methods applied for Mediterranean countries. Trade-offs were illustrated for the management scenario that removes 5 to 99% of all MBCG fishing effort, starting from the c-squares with the lowest effort by MSFD habitat types. In addition, potential consequences to the ecosystem was reviewed and an analysis of spatial and temporal variation in core fishing grounds made. A disaggregation method to include variable costs from the STECF AER data to the ICES VMS data was explored. Work from the WKTRADE3 workshops can feed into and be followed up by ICES WGFBIT, e.g. gear modification management scenarios and optimization algorithms for defining core fishing grounds.

4.2 Deep-sea

Efforts to advise on and manage VMEs in deeper waters are quite advanced as evident from the recent ICES WKEUVME report (ICES, 2020). On this basis the below approach to applying region-wide integrated (covering both shelf and deep sea habitats) assessment was proposed:

1. Parcel out polygons of:
    a. designated (advised) Deep Sea VMEs from regional assessment area
    b. shallower water areas with VMEs or particularly sensitive or valuable species)
2. Ensure that the parameterization of the recovery/longevity model is based on fauna samples that cover both the deep sea and the shelf habitats and that the variable depth is included.
3. Use a trait/longevity classification that can accommodate both the typical shelf (shorter lived) and deep sea (longer lived) species when processing model input data
4. Assume that depletion rates by gear types can be extrapolated from the shelf based estimates (meta-analysis by Hiddink *et al.*) to the deep sea habitats.

5. Apply a one-size (all depths) fits all assessment by region/sub-region, but supplemented by an alternative approach for biogenic habitats (see 2019-meeting report action points below).

Potential weaknesses and improvement potential

- The fauna sample coverage across depths and sediments is often biased towards shallow areas and soft sediments, and a balanced coverage across depths and sediments can be difficult to obtain
- If deep sea fauna samples do exist these are often based on different sampling gears (beam trawls) than samples from the shelf areas (grabs and box-cores), which may require some level of standardization
- The extrapolation of depletion rates from shelf-based fishing impact experiments to deep sea fishing may not always be valid. Potentially deep sea habitats and organisms are more sensitive to fishing impacts (e.g. have a larger proportion of large, soft-bodied epi-fauna) due to different environmental conditions (e.g. less shear stress).

Research recommendation

- Fishing impact experiments in the deep sea to be used for estimating depletion and recovery rates
- Standardisation across sampling gears
- Increased sampling of benthic fauna in deep sea regions to improve estimations of community composition and longevity

Some final notes:

Last year, FBIT provided a step-wise approach to assess sedimentary habitats and biogenic habitats. For now, FBIT will parcel out biogenic habitats in the overall assessment and focus on sedimentary habitats. In case FBIT is tasked to provide an impact assessment of both sedimentary and biogenic habitats, we recommend the below approach for biogenic habitats:

1. Provide maps of the actual and potential distribution of biogenic habitats. These maps are likely to be at spatial resolutions higher than the c-square resolution used in the WGFBIT approach. Identify areas in which multiple biogenic habitats are likely to occur.
2. Estimate d for each habitat using the study of (Sciberras *et al.*, 2018) and other sources. Depletion is likely to be close to 1 for fragile hard structures but closer to 0.1 for flexible biota.
3. Evaluate if r is likely to be substantially > 0 for each habitat. If recovery is not considered likely over the time-scale of decades, it can be assumed that r = 0 for the purpose of the assessment. If recovery is likely to be faster, it can be estimated from the longevity of the biogenic structure using the relationship in (Hiddink *et al.*, 2019).
4. Apply the FBIT approach to estimate trawling impact for the mapped biogenic habitats.

The impact on sedimentary and biogenic habitats can then be reported together.

Expected contributions

Georgios Kazanidis is in discussions with colleagues to receive a deep-sea macrofauna data set from the Faroe-Shetland Channel area. Once received the data set will be examined about the presence (or not) of collected samples under gradients of fishing pressure. This data set will add on the efforts put during WGFBIT 2019 when Jan Hiddink and Georgios Kazanidis worked on the impacts of fishing activities on the deep-sea sponge aggregations at Faroe-Shetland Channel. In addition, Georgios has got access on a deep-sea peracarid data set from the continental slope in northwest Atlantic, thanks to Dr Oliver Ashford who has kindly provided access to his dataset. This data set has been brought to the attention of Jan Hiddink. Georgios will also get in contact with deep-sea sample collection curators at the National Oceanography Centre (UK) to ask about the availability of relevant samples/information (e.g. on benthic macrofauna) from the long-term time series collected from the Porcupine Abyssal Plain Sustained Observatory in the northeast Atlantic.

Annex 1: List of participants

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Annex 2: Resolutions

The **Working Group on Fisheries Benthic Impact and Trade-offs (WGFBIT)**, chaired by Tobias van Kooten, Netherlands; Ole Ritzau Eigaard, Denmark; and Gert van Hoey, Belgium, will work on ToRs and generate deliverables as listed in the Table below.

	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2018	12–16 November	ICES HQ, Copenhagen, Denmark	Interim report by 14 December	
Year 2019	7–11 October	Ancona, Italy	Interim report by 1 December	
Year 2020	14–18 September	by corresp/ webex	Final report by 1 November	physical meeting cancelled - remote work

ToR descriptors

ToR	Description	Background	Science Plan codes	Duration	Expected Deliverables
a	Building from 2017 ICES work (WKTRADE, WKBENTH, and WKSTAKE) produce a framework for MSFD D6/D1 assessment related to bottom abrasion of fishing activity at the regional / subregional scale and identify key ecological processes input requirements.	Provide a worked example on how science can operationalize EBM (ecosystem based management) and contribute towards IEAs (intergrated ecosystem assessment) as ICES advice products. Links (avoiding overlaps) will be established with key experts also attending WGECO, WGDEC, WGSFD, BEWG, WGMHM, WGIMM, WGMBRED, and WGMPCZM	2.1; 2.4; 2.7	Year 1, reviewed in year 3	A worked example with guidng principles, that can be reviewed by ACOM leadership and SCICOM chair/SSGs for feedback. Specific action points, to ensure year 2 assessments can be conduccted by appropriate sub region for the N. Sea, Celtic, Baltic and Barrents Seas
b	Apply the framework to make a regional assessment for the North Sea, Celtic, Baltic and Barents Seas	EU MSFD D6/D1 assessment and providing management options that can be applied also by non-EU ICES countries.	2.7; 6.3	Year 2	Regional assessments of the impact of bottom abrasing fisheries

Summary of the Work Plan

Year 1	For an EU MSFD D6/D1 assessment related to bottom abrasion of fishing activity at the regional / subregional scale identify key ecological processes required as input. Priority should be given to decide on a quantitative framework based on biological processes, and to improve the parameterisation of framework components. The framework should allow for an overall assessment of benthic status and for the exploration of alternative management options to improve GES. Worked-out examples (and findings from WKTRADE 2017) should be used to ensure that a framework for addressing the above is established. The framework should be generic enough that it allows cross regional comparison and specific enough that it addresses regional-specific trade-offs (i.e. incorporating other pressures than fisheries). The framework should take into account complementarity to the ICES Fisheries Overviews (FOs) and Ecosystems Overviews (EOs), and provide input to overviews. The group will work between sessions to ensure required information is worked up to conduct assessments using the suggested framework (in preparation for year 2 meeting and advisory products).
Year 2	Using the framework, produce aassessment (draft advice) for the Celtic Seas, Greater North Sea, Barents Sea and Baltic Sea by subregion. Consider how other ecoregions can be incorporated (e.g. Mediterranean, Black Sea, Bay of Biscay and Iberian Coast). Assessments should be conducted using the guiding principles of TAF (transparent assessment framework).
Year 3	Update advice from previous year, and produce new (draft) assessments for 3 other ecoregions (and associated sub-regions). Review framework produced in year 1, and produce technical guidelines for "a standard" ICES advice product for MSFD D6/D1 and alternative management options to improve GES. Technical guidelines for the assesment will be produced to support TAF (transparent assessment framework).

Supporting information

Priority	The activities of this Group will lead ICES into issues related to the ecosystem effects of fisheries, especially with regard to the application of the Precautionary Approach. Consequently, these activities are considered to have a very high priority.
Resource requirements	Experts that provide the main input to this group have been involved in successful EU funded projects (BENTHIS). It is envisoned that future funding will be availble and that this ICES working group experts can also provide an international platform to establish a consortium. This would allow to commit future resources to the group's work.
Participants	The Group is normally attended by some 20–25 members and guests.
Secretariat facilities	Meeting room facilities, as well as Assisting Sectrariat help, Data Centre support, and Professional Officer shadowing and attendance of working group meeting.
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	Advice products and working groups (e.g. WGECO and WGDEC).
Linkages to other committees or groups	There is a very close working relationship with all the groups under the Ecosystem Pressures and Impacts Steering Group. It is also very relevant to the Workings Groups WGECO, WGDEC, WGSFD, BEWG, WGMHM, WGIMM, WGMBRED, WGMPCZM.
Linkages to other organizations	EU (DG-ENV, DG-MARE), RSCs (Baltic's HELCOM, North Atlantic's OSPAR, Mediterranean's Barcelona Convention and Black Sea's Bucharest Convention), JRC, STCEF

Background to establishing this ICES working group

ICES now plays a central role as a facilitator for the setting of methodological standards for assessing EU's MSFD D1 habitat/D6 benthic, as well as in providing further guidance to Member States (MS) for the setting of threshold values to operationalize indicators.

The underlying basis for the recent ICES advice provided to EU (DG-ENV) has come from work that started in 2016 (WKFBI, 2016) and 2017 (WKBENTH, WKSTAKE and WKTRADE). These workshops have involved several ICES working group experts (WGSFD, BEWG, WGMHM, WGDEC), experts working closely with RSCs (HELCOM and OSPAR), as well as experts from European funded projects (BENTHIS). Given the success of these workshops, it has been the wish of expert particpipants to carry on this collaborative work by establishing a new ICES working group, WGFBIT (working group on fisheries benthic impact and trade-offs).

Given the foreseen increase in ICES advisory work with regard to EU's MSFD D1 habitat/D6 benthic and given the recent international scientific advances, establishing a group would ensure continuity and avoiding having to establish each year an *ad hoc* group. Such a group with targeted 3 year TORs would attract participation/collaboration from WGECO, WGDEC, WGSFD, BEWG, MHWG, WGIMM, WGMBRED, WGMPCZM members. In addition to advisory products (D6/D1 MSFD), scientific collaboration and research papers would ensure a stronger basis for working group reports and ICES advice. Such a group would also allow for participation by key experts also involved in RSCs, STCEF, JRC work – and encourage access to data.

Envisioned work on standardised methodolgies and critreria

Parameterization of a sensitivity model for different habitats and ecoregions, will require targeted studies on benthic community longevity composition and habitat relationship. Emphasis: other regions than the N Sea, broad range of environmental conditions (grain size, depth, salinity, bed shear stress, etc.), also include epifauna (at present box/grab sampling of infauna).

Targeted studies and modelling to incorporate regional scale heterogeneity: including habitat heterogeneity, as well as heterogeneity in successional state relative to connectivity (i.e. oceanography or distance between source and sink populations, in a multi species context).

Despite ICES 2017 advice, there is still no agreed upon method to determine where status is *"good"* in relation to fishing pressure. There is also limited ecological basis for setting good environmental status (GES) threshold levels for habitats that may span across different spatial scales, across an interconnected seafloor. If non-linear relationships exist between pressure and state of a habitat at a specific scale, the inflection point in these relationships (i.e. when a significant change in the relationship occurs) could be used to help define thresholds. However, at the current time, such thresholds have not been identified. The spatial heterogeneity in *'good status'* locations across a region may also affect recovery rates (e.g. habitat fragmentation, relative to dispersal and connectivity across the seabed).

ICES also noted in the 2017 advice that the outcome of the impact assessment (fraction of habitat unimpacted / fraction of habitat at a certain state) is dependent on the assessment method used and the spatial resolution of the fishing pressure data layer (now 0.05 x 0.05 degrees). A change in spatial resolution will result in an overall change in the assessed habitat state. This means that the setting of threshold values is method dependent.

Some of the tasks that WGFBIT would contribute towards in the next years 2018–2020 will ensure that ICES can continue to play a pivotal role in fully operationalizing an assessment of D6/D1. Some of the key milestones will include:

1) *TAF framework* – underlying assessment methods need to be understandable, transparent and accessible (TAF, link). This requires work to clean code used to run assessments and the production of a technical guidance document that describes the indicators for assessing pressure and impact on the seafloor from mobile bottom-contacting fishing, based on their ability to produce impact estimates on a continuous scale that can be used in trade-off evaluations.

2) *Benchmarking process* – the proposed pressure and impact indicators need to be reviewed and evaluated in an open workshop in terms of their MSFD assessment suitability. This needs to be done in dialogue with RSC with agreed upon guiding principles against which the benchmarking process can be run.
3) *GES thresholds* – As part of a complete technical guideline document for the operationalization of the indicators, threshold values will need to be specified. This will require scientific input in order to operationalize 1) quality thresholds for benthic impact, and 2) spatial extent of habitat that should achieve those values. Using available methods, the workshop will explore safe biological limits of impact that can be used to explore spatial up-scaling and down-scaling of GES thresholds.
4) *RSCs acceptance* – there needs to be dialogue with those management bodies and member country experts that are "end-users" of the indictors. This is an iterative process and may require training.
5) *Ecoregion calibration – targeted project and/or working group work will need to re-calibrate the proposed impact indicators in terms of regional specific conditions.*