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B. DI LORENZO[1], A. NGUYEN XUAN[1], M. PENNA[1], G. FRANCESCHINI[1], M. PULCINI[1], T. RUSSO[2], S. RAICEVICH[1], G. RIVA[3], L. NICOLETTI[1]

[1]ISPRA - Istituto Superiore per la Protezione e la Ricerca Ambientale, Via Vitaliano Brancati 48-60, Roma
[2]Università degli Studi di Roma "Tor Vergata", Roma
[3]Chioggia Stazione idrobiologica "Umberto D'Ancona", Università degli Studi di Padova, Chioggia (VE)
bianca.dilorenzo@isprambiente.it

VALUTAZIONE PRELIMINARE DELL'IMPATTO DEGLI ATTREZZI A STRASCICO SULL' INTEGRITA' DEL FONDALE MARINO SULLA BASE DI STIME DI LONGEVITA' DI SPECIE EPIMEGABENTONICHE

PRELIMINARY ASSESSMENT OF THE IMPACT OF TRAWLING GEAR ON THE INTEGRITY OF THE SEAFLOOR BASED ON LONGEVITY ESTIMATES OF EPIMEGAFAUNAL SPECIES

Abstract - *In the frame of the Italian application of the Marine Strategy (MSFD) for Descriptor 6 (Seabed Integrity), the spatial extent of benthic habitats subject to abrasion by fishing gear and the related impact on the status of the epimegabenthic communities inhabiting them were assessed. The analysis focused on Epimegabenthos data collected in the Adriatic Sea between 2016 and 2021, on different habitats subjected to different fishing pressures. For the quantitative assessment of the impact on the seafloor due to fishing abrasion, the Relative Benthic Status (RBS) model was adopted; it takes into account the fishing effort impact (as Swept Area Ratio), the Epimegafaunal biomass, the recovery rate to fishing physical disturbance (as median longevity) and the depletion rate that is gear specific. The study area showed low median longevity values and relative high average RBS values per habitat that seem to follow the fishing effort intensity distribution.*

Keywords: *Marine Strategy Framework Directive (MSFD), longevity, Relative Benthic Status (RBS), fishing pressure, epimegabenthic communities.*

Introduction - As part of the Italian fulfilment of the Marine Strategy Framework Directive (MSFD), with regard to Descriptor 6 (Seabed Integrity), the spatial extent of bottom habitats that are adversely affected by physical disturbance was calculated, focusing in the first instance on abrasion from fishing gear interacting with the seabed. To carry out this assessment, Benthic Broad Habitat Types (BBHT; *sensu* MSFD) were considered, the extent of which was calculated on the basis of EUSeaMap (2019). Subsequently, the impact of this pressure on the status of the epimegabenthic community was assessed. The Relative Benthic Status (RBS) was adopted for the quantitative assessment of the impact of fishing on the seabed. The model returns an impact value considering biomass, fishing effort and recovery rate, estimated in relation to the longevity of benthic species.

Materials and Methods - The dataset collected in the Adriatic Sea as part of the national MSFD monitoring of Descriptor 6 was analysed. Samplings of epimegabenthos on different habitats located in sites subject to different fishing pressure but with similar bathymetry and sediment texture characteristics were carried out. The data were collected by ARPA and ISPRA over the period 2016-2021. A total of 410 experimental fishing hauls were carried out at depths between -10 and -100 metres with a duration of 30 minutes. 161 out of a total of 455 taxa were considered, i.e. the taxa to which a longevity estimate could be associated. The sampling stations fall into 3 habitats:

Circalittoral mud or offshore circalittoral mud (70%), Circalittoral sand (25%) and Infralittoral sand (5%).
Fishing pressure is expressed as fishing effort in terms of Swept Area Ratio (SAR), which indicates the ratio of the total area explored by trawling fishing gears (Otter bottom trawl, OTB; Beam Trawl, TBB) to the area of the reference cell, on a grid of cells of size 1 km x 1 km. Annual SAR values are averaged for the period 2017-2019 (Fig. 1).

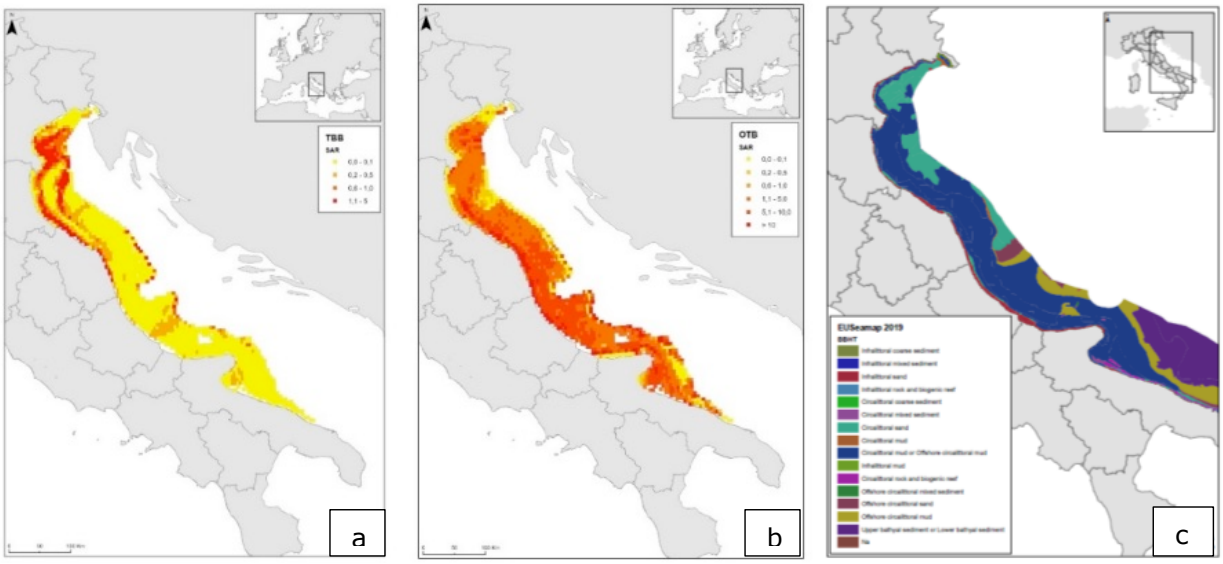

Fig. 1 – (a) Average OTB SAR for the period 2017-2019 in the study area; (b) Average TBB SAR for the period 2017-2019 in the study area; (c) Benthic Broad Habitat Types in the study area.
(a) OTB SAR media per il priodo 2017-2019 nell'area di studio; (b) TBB SAR media per il periodo 2017-2019 nell'area di studio; (c) Benthic Broad Habitat Types relativi all'area di studio.

The Relative Benthic Status (RBS) is a quantitative environmental risk assessment method based on the logistic growth curve. The model, developed by Pitcher *et al.* (2017), returns a value for the impact of fishing pressure on the epimegabenthic community in a 0-1 range. A high RBS value therefore indicates a good status of the epimegabenthic community. The RBS formula is as follows:

$$RBS = \frac{B}{K} = 1 - \frac{Fd}{R}$$

where B is the Biomass, K is the Carrying Capacity, F is the Fishing Effort, d is the Depletion Rate and R is the Recovery Rate. The Recovery Rate (R), i.e. the ability of an organism to recover after the disturbance exerted by fishing pressure, is estimated in relation to the Longevity of benthic species, which is used as an indicator of proper community functioning (Hiddink *et al*., 2017; Van Denderen *et al*., 2020).
Four longevity classes (expressed in years) were considered: < 1 year; 1-3 years; 3-10 years and > 10 years. Species are assigned to one of the classes using a fuzzy coding procedure, whereby the species is assigned to the class with a score ranging between 0 (no affinity to the class) and 3 (full affinity). These scores are then transformed into percentage frequencies.
As far as concern the longevity estimates, reference was made to the dataset defined in the context of the work of the 2022 workshop of the WGFBIT (Working Group on

Fisheries Benthic Impact and Trade-offs) of the ICES (International Council for the Exploration of the Sea), which merged the available european datasets (including the Italian one resulting from a working group coordinated by ISPRA and the University of Genoa) (Tab. 1). This shared dataset contains longevity estimates for about 2000 epimegabenthic species.

Tab. 1 - Longevity datasets collected in the frame of the ICES WGFBIT 2022.
Dataset della longevità raccolto nell'ambito dell'ICES WGFBIT 2022.

Dataset	**N taxa**	**Reference Area**
BTA EMODNET Life Span	616	Atlantico
SIBM Ispra	323	Mari Italiani
Solemon	219	GSA 17
Greece 21	1053	GSA 20, 22, 23
Greece 20	685	Atlantico
Data Longevity	1043	Atlantico

To calculate the median longevity, i.e. the longevity of 50% of the biota's cumulative biomass, the logistic relationship between cumulative biomass and longevity was modelled using a GLMER (Generalised Linear Model with Mixed Effects), which also takes into account other environmental variables, such as habitat and depth.

$$Cb \sim \beta_0 + \beta_1 \ln(l) + \beta_2 H + \beta_3 D + \varepsilon_1 + \varepsilon_2;$$

where $l = \log(L)$ is the logarithm of Longevity, H is the Habitat and D is the Depth, ε_1 is the random error with Binomial distribution and ε_2 is the random error with Normal distribution relative to the random effect. By checking all possible interactions between the variables, the final model is chosen on the basis of the lowest AIC (Akaike Information Criterion). The median longevity is used as an indicator of community sensitivity to fishing pressure, for each habitat considered.

Results – The application of the above mentioned methodology gave as result the median longevities (Tab. 2 and Fig. 2), the average RBS (Tab. 2) for each habitat analysed and the distribution of RBS in the study area (Fig. 2).

Tab. 2 – Median longevity and average RBS for the considered habitats.
Longevità mediana e RBS medio per gli habitat considerati.

Habitat	**Median Longevity**	**Average RBS**
Circalittoral mud or offshore circalittoral mud	4.72	0.70
Circalittoral sand	5.06	0.80
Infralittoral sand	5.03	0.97

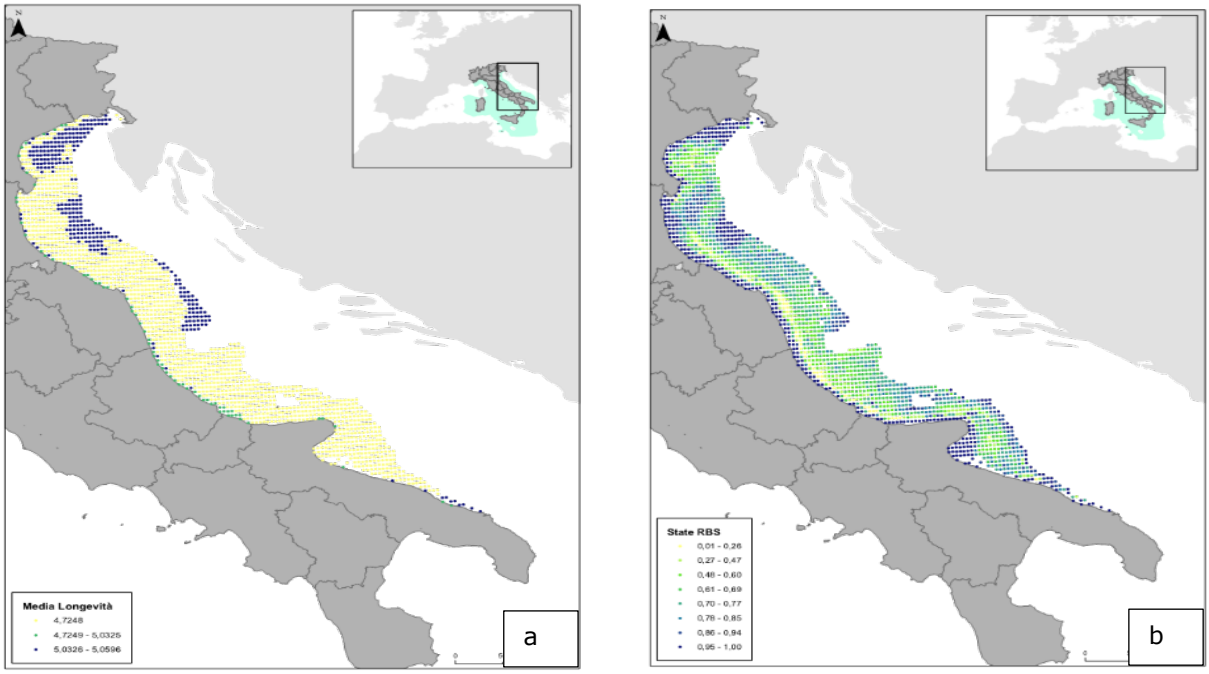

Fig. 2 – (a) Median longevity in the study area; (b) Average RBS in the study area.
(a) Longevità mediana nell'area di studio; (b) RBS medio nell'area di studio.

Conclusions - The median longevity showed low variability for the dataset considered. The estimated RBS reflects the intensity of trawling effort, thus showing a greater impact on muddy circalittoral communities despite the lower estimated median longevity (that corresponds to a lower sensitivity). In order to identify the SAR threshold values above which fishing generates a negative impact on the habitat, it is possible to estimate the *Degradation Point* using the relationship between Status and Pressure. At this point, calculated for each habitat analysed, the relationship curve changes its trend and the state becomes almost constant as pressure increases. This approach makes it possible to estimate the values necessary to assess the percentage of habitat subject to significant trawling pressure. The RBS index demonstrated good versatility with a sufficiently robust dataset.

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