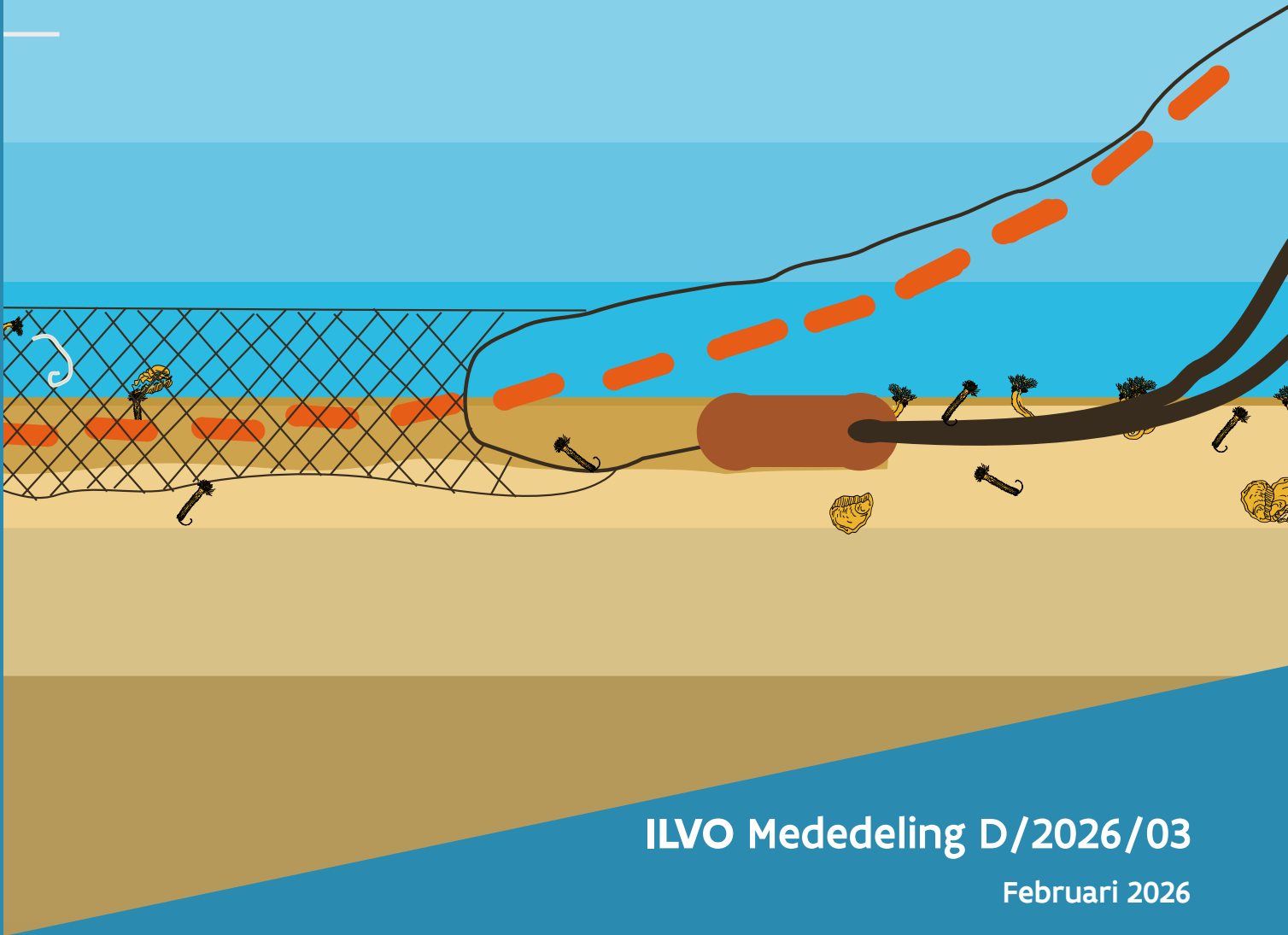




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**Assessing seafloor sensitivity
for the Belgian Fishing grounds:
comparison of two approaches
(OSPAR BH3 and ICES FBIT)**

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1. Executive summary

The Belgian Sea fishery focuses on bottom trawling for sole, plaice, and shrimp. However, concerns about the ecological impact of bottom trawling have arisen due to its link to reduced benthic biomass, diversity, and alteration of faunal community traits (Hiddink et al., 2019). Consequently, EU conservation policies, such as the Marine Strategy Framework Directive (MSFD), emphasize the evaluation and management of seafloor ecosystems. The UK is no longer bound to these EU policies and has established their own approach to improve the health of their waters through the Environment Act 2021. To achieve its targets, the country will implement stronger management measures for seafloor health, with a primary focus on Marine Protected Areas (MPAs). Since Belgium's fishing fleet predominantly uses mobile bottom contacting gear impacting the seabed, assessing seabed ecosystems is crucial. Benthic indicators have been developed to evaluate trawling impacts, categorized into risk and state indicators. This report section compares the sensitivity outcomes of two commonly used risk indicators, namely the OSPAR BH3 (UK approach) and ICES FBIT indicator, across Belgian bottom trawling regions. The goal is to enhance our understanding of seafloor conditions and aid policymaking and fishing practices that promote Good Environmental Status in EU waters and healthy sea-bottom ecosystems in UK waters.

We compared the sensitivity outcomes of two benthic risk indicators (BH3 & FBIT) to investigate: 1) if both indicators evaluate the same habitat as sensitive/least sensitive in each assessment region (similar outcomes) ; 2) if both methods are comparable (i.e., if there is a correlation between them) and 3) if habitat classification influences indicator outcomes as both indicators make use of a different habitat map to calculate their sensitivity. These questions are relevant for defining sea-bottom sensitivity, as these indicators are used to manage fishery impacts (E.g. excluding fishery in sensitive areas) and delineate MPAs (E.g. sensitive habitats to be protected).

ICES FBIT and OSPAR BH3 benthic sensitivity data for the Greater North Sea and Irish and Celtic Sea regions were obtained from the ICES GitHub repository and OSPAR QSR 2023, respectively. To ensure comparability, the FBIT shapefiles were aligned to fit the OSPAR regions. A merged dataset was created on the OSPAR regional reporting level, which includes FBIT outcomes, abrasion sensitivity scores (OSPAR sensitivity), and both EUNIS level 3 and MSFD broad habitat type (BHT) classifications for each grid cell.

Mean sensitivity was compared across the five major habitats (km²) in each region for both MSFD and EUNIS classifications, with ranking used to assess sensitivity similarities between both indicators. Additionally, a boxplot and jitter plot analysis were conducted at the grid cell level to examine indicator correlation and habitat classification influence. This approach enhances our understanding of benthic habitat sensitivity to fishing pressures across regions and habitat types.

Our analysis revealed inconsistencies between BH3 and FBIT indicators, as median longevity (FBIT indicator) did not consistently correlate with BH3 sensitivity classes across regions and habitat classifications. These discrepancies were further underscored by differences in mean sensitivity outcomes, particularly in identifying the most and least sensitive habitats within a region. This misalignment reflects methodological differences, suggesting that each indicator prioritizes different aspects of ecosystem responses. These findings support the use of multiple indicators to capture diverse ecosystem dynamics. However, discrepancies in sensitivity outcomes also highlight

the influence of habitat classifications, as variations in habitat data resolution between indicators may contribute to these differences.

Overall, our research offers valuable insights into bottom trawling impact assessment, aiding in understanding benthic habitat sensitivity. This work lays the basis for our follow-up study, Benthis Nationaal 2, where we aim to develop a more balanced approach to bottom disturbance impact assessments by comparing and integration a broader set of indicators. The goal is to create a sensitivity map, based on these integrated indicators, to support Belgian fisheries management strategies while aligning with EU and UK policies on seafloor protection measures. Additionally, this map will be made available onboard Belgian fishing vessels via the VISTOOLS platform, providing fishers with a practical tool to address bottom disturbance issues effectively and realistically in their daily operations.

2. Introduction

In the last 50 years, the Belgian sea fishery has shifted from the over-exploitation of herring and sprat in the 1970s to the prominence of bottom trawling for sole, plaice, and shrimp today (Omey, 1982). Beam trawling, a key technique in this demersal fishery heavily relies on the use of tickler chains or chain matrices to enhance efficiency (Scherrrens, 2023). However, despite its economic benefits, concerns regarding the ecological impact of bottom trawling have been raised as it has been linked to a reduction in benthic biomass, diversity, and species body size, and the altering of faunal community functional traits (Rijnsdorp et al., 2008). These impacts vary across gear types and habitats (van Marlen et al., 2014; Polet et al., 2018). Furthermore, bottom trawling stands out as the primary cause of physical abrasion on the seabed (Eigaard et al., 2017; Kenny et al., 2017). Therefore, the evaluation and management of seafloor ecosystems form an integral part of EU conservation policies, such as the EU action plan on the ban of bottom trawling, the EU biodiversity strategy, and the Marine Strategy Framework Directive (MSFD). The UK is no longer bound to these EU policies and has developed its own approach to improving the health of their waters through the Environment Act 2021. To meet its goal, the UK will strengthen management measures for seafloor health, with a primary emphasis on Marine Protected Areas (MPAs). For Belgium, evaluating the health of the seabed is crucial, as the majority of its fishing fleet uses active gear that impacts the seafloor. The most significant techniques are flatfish and shrimp beam trawling (45% and 16% respectively), followed by otter trawling for flatfish (17%) and Norwegian lobster (9%) (Lenoir et al., 2023). Additionally, UK waters are vital fishing grounds for the Belgian fleet, with around 40 to 50% of the landings coming from these waters. It is therefore essential to prepare for both EU and UK management actions regarding seafloor health and to understand how these will impact the Belgian fishing industry.

As a result of those different policies being set in place, benthic indicators have been developed to assess the state of the seafloor and evaluate specifically the impact of mobile bottom contacting fisheries. Currently, two distinct types of benthic indicators can be distinguished; 1) *risk indicators*, which use a modelling approach to estimate the effect of physical disturbance on the benthic faunal communities, and 2) indicators that judge the actual state of the benthic communities and which are based on monitoring data called *state indicators*. While these indicators provide valuable insights into the health and ecological integrity of benthic habitats, caution must be exercised in their selection and use. No single indicator can capture all ecosystem responses, emphasizing the importance of a multiple indicator approach. Moreover, indicator selection could influence the outcome of the analysis and subsequently lead to different management strategies being set in

place. In other words, it is crucial to avoid redundancy by selecting indicators which focus on the same aspect of the ecosystem. Simultaneously, the diverse range of selected indicators should be capable of detecting changes along a pressure gradient. Therefore, appropriate indicator comparability research is necessary if you want to select the most suitable set of indicators for assessing fisheries' impact.

This section of the report is dedicated to comparing the sensitivity outcome of two benthic indicators, ICES FBIT and OSPAR BH3, across regions where the Belgian fleet engages in bottom trawling activities. The OSPAR sensitivity classification, based on the UK MarESA (Marine Evidence-based Sensitivity Assessment approach (https://www.marlin.ac.uk/sensitivity/sensitivity_rationale)), assesses the resistance (tolerance against pressure) and resilience (recovery potential) of the benthic habitat and species to fishing impact, graded from 1 to 5, with 1 being least sensitive and 5 being most sensitive. In contrast, the FBIT sensitivity classification is based on the median longevity of the species, with a higher longevity indicating greater sensitivity to trawling disturbance. Median longevity is derived from trait datasets where species/genera are divided into four longevity classes: a) zero to one year, b) one to three years, c) between three years and ten years and 4) longer than ten years. Both indicators not only differ in methodology but also make utilize different habitat classifications to calculate their sensitivity score: OSPAR BH3 employs the EUNIS L3 habitat classification, while ICES FBIT uses the MSFD broad habitat types (BHT).

Our hypothesis is that if both methods are comparable, the average median longevity (sensitivity) of the benthic communities/habitats should increase with increasing OSPAR sensitivity class. Additionally, we aim to determine whether the EUNIS L3 and the MSFD BHTs, two habitat classifications used to calculate the OSPAR and FBIT indicators respectively, are the right classifications for those methodologies.

This analysis builds on insights required from the recent ICES WKBENTH workshops in 2022 and 2023 (ICES, 2022, 2023), thus keeping up with current international research. By comparing these indicators, we seek to enhance our understanding of seafloor conditions within fishing grounds frequented by the Belgian fleet. Additionally, this research can assist in identifying and selecting the most comprehensive suite of parameters that collectively represent the health and sensitivity of benthic habitats. The resulting analysis will also provide crucial information for policymakers and fishermen, empowering them to make well-informed decisions regarding core fishing grounds, especially in light of BREXIT (entrance in British waters) and MSFD objectives aimed at achieving Good Environmental Status (GES) in EU territorial waters.

3. Methodology

To compare the two widely utilized benthic risk indicators, namely OSPAR BH3 and ICES FBIT, we focused solely on the sensitivity component, disregarding the fishery footprint expressed as surface abrasion ratio (SAR), assuming similarity between the methods in this aspect. ICES FBIT sensitivities, represented by median longevity outcomes per grid cell, were obtained from the ICES FBIT GitHub repository for the Greater North Sea and Irish and Celtic Sea regions. Meanwhile, OSPAR BH3 sensitivities, calculated based on benthic community resistance and resilience, were represented as surface and subsurface abrasion sensitivity scores (SuAb and SSAb). Surface abrasion pertains to damage to communities living on the seafloor surface and upper layers of the sediment (< 2cm in depth). Whereas, subsurface abrasion involves penetration of the substrate

≥ 2 cm below surface, which can potentially harm communities living within the sediment, such as burrowing bivalves. OSPAR BH3 sensitivity data were acquired for the North-Central North Sea, Southern North Sea, English Channel, and Northern and Southern Celtic Sea regions from the OSPAR QSR2023.

Due to variations in region extents between the two indicators, the FBIT shapefiles were aligned with the OSPAR reporting region's extent. Subsequently, FBIT and OSPAR shapefiles for each assessment region were merged, ensuring that each grid cell contained FBIT median longevity outcomes, surface and subsurface abrasion sensitivity scores, MSFD habitat classification, EUNIS L3 habitat classification, and surface area (km²).

After merging the data, mean sensitivity outcomes were compared for both indicators across the five largest benthic habitats (km²) within each assessment region, considering both MSFD broad habitat types and EUNIS L3 habitat classification. From this analysis, a ranking of sensitivities, from most (1) to least sensitive (5), was calculated for each indicator across the habitats of each region (both BHT and EUNIS). This ranking table is used to assess the similarity in sensitivity outcomes between the OSPAR BH3 and ICES FBIT indicators for the five largest habitats in each assessment region. A boxplot analysis was conducted to further examine the comparability of both methods on the grid cell level, while disregarding the habitat layer. This plot aimed to reveal if there is a relationship between indicator outcomes without the habitat classification influencing the result.

An additional jitter plot analysis was conducted at the grid cell level, examining the general sensitivity outcome per grid cell for the five largest benthic habitats (km²) for each region, while also accounting for the two distinct habitat classifications. Furthermore, we explored whether the selection of habitat classifications influenced indicator outcomes.

All analytical procedures were performed using R Studio version 4.3.2 (R Core Team, 2023), employing the dplyr, ggplot2, and sf packages to ensure robust data manipulation, visualization, and spatial analysis (Pebesma & Bivan, 2023; Wickham, 2016 & Wickham et al., 2023). This comprehensive approach provides valuable insights into the comparative performance of OSPAR BH3 and ICES FBIT indicators across different regions and habitat classifications, contributing to a nuanced understanding of benthic habitat sensitivity to fishing pressure in these areas.

4. Results and discussion

4.1 Comparison on habitat level (MSFD BHT & Eunis level 3)

To compare the effectiveness of the ICES FBIT and OSPAR BH3 risk-based benthic indicators in assessing seabed abrasion pressure, sensitivity outputs were analysed across the Northeast Atlantic. Focussing on the North-Central North Sea, Southern North Sea, English Channel, Northern, and Southern Celtic Sea-key fishing regions for the Belgian fleet- sensitivity outputs for the five largest habitats (km²) were compared.

The ranked scores presented in **Tables 1-5** for MSFD BHTs and **Tables 6-10** for EUNIS L3 habitats assess whether these different risk-based approaches identify the same seabed habitats as most sensitive to bottom fishing and/or most at risk of adverse effects. However, it is important to note that differences in indicator method design and data availability for each region could lead to variations in sensitivity rankings between methods.

i. MSFD Broad habitat type classification

According to the OSPAR BH3 sensitivity method (SuAb and SSAb), the upper Bathyal sediment is identified as the most sensitive habitat in the North-Central North Sea region, while offshore circalittoral coarse sediment is considered the least sensitive (Table 1). However, according to median longevity, upper bathyal sediment is ranked as the least sensitive habitat among the five in terms of trawling impact. The FBIT median longevity method highlights circalittoral sand as the most sensitive habitat to bottom trawling, contradicting OSPAR's assessment where it's classified as medium sensitive. Concluding, both methods yield conflicting results in the North-Central North Sea, as they do not align in terms of ranked sensitivity outcomes for the MSFD BHTs.

Table 1: Indicator sensitivity outcome information for the five largest MSFD broad habitat types (BHTs) (km²) in the North-Central North Sea; ranked where 1 is the most sensitive and 5 is the least sensitive.

North-Central North Sea				
MSFD broad habitat types (BHT)	OSPAR (SuAb)	OSPAR (SSAb)	FBIT (median longevity)	Total area fraction size
Offshore circalittoral sand	4	4	2	0.43
Offshore circalittoral mud	2	2	4	0.25
Upper bathyal sediment	1	1	5	0.14
Offshore circalittoral coarse sediment	5	5	3	0.08
Circalittoral sand	3	3	1	0.06

In the Southern North Sea region (Table 2), both methods agree on which habitats are the most and least sensitive to bottom trawling impact, identifying offshore circalittoral mud as the most sensitive and offshore circalittoral coarse sediment as the least sensitive habitat, respectively. However, discrepancies emerge in the ranking of habitats between these extremes for both OSPAR Surface abrasion sensitivity (SuAb) and OSPAR subsurface abrasion sensitivity (SSAb), as well as between OSPAR sensitivities and FBIT median longevity.

Similar findings are observed in the English Channel (Table 3), where both methods identify circalittoral sand as the most sensitive and offshore circalittoral mixed sediment as the least sensitive habitat. Nevertheless, they disagree on the ranking of habitats in between. These results suggest that while both methods may align at the extreme ends of the sensitivity spectrum, they could still diverge in sensitivity for the other habitats.

Table 2: Indicator sensitivity outcome information for the five largest MSFD broad habitat types (BHTs) (km²) in the Southern North Sea; ranked where 1 is the most sensitive and 5 is the least sensitive.

Southern North Sea				
MSFD broad habitat types (BHT)	OSPAR (SuAb)	OSPAR (SSAb)	FBIT (median longevity)	Total area fraction size
Offshore circalittoral sand	2	3	2	0.47
Offshore circalittoral mud	1	1	1	0.18
Circalittoral sand	3	2	4	0.16
Circalittoral coarse sediment	4	4	3	0.07
Offshore circalittoral coarse sediment	5	5	5	0.07

Table 3: Indicator sensitivity outcome information for the five largest MSFD broad habitat types (BHTs) (km²) in the English Channel; ranked where 1 is the most sensitive and 5 is the least sensitive.

ENGLISH CHANNEL				
MSFD broad habitat types (BHT)	OSPAR (SuAb)	OSPAR (SSAb)	FBIT (median longevity)	Total area fraction size
Offshore circalittoral coarse sediment	4	4	2	0.61
Circalittoral coarse sediment	2	3	3	0.31
Offshore circalittoral mixed sediment	5	5	5	0.02
Circalittoral sand	1	1	1	0.02
Infralittoral coarse sediment	3	2	4	0.01

In both the Northern and Southern Celtic Sea regions (Table 4 and 5, respectively), we observe a pattern similar to other regions. While some habitats are ranked similarly, others show stark contradictions in sensitivity outcomes between the methods.

In the Northern Celtic Sea, offshore circalittoral mud is identified as the most sensitive habitat according to SuAb sensitivity, whereas both median longevity and SSAb identify offshore circalittoral mud sediment as the most sensitive. Offshore circalittoral coarse is considered the least sensitive habitat to bottom trawling according to both OSPAR sensitivities, while according to median longevity, offshore circalittoral mud is the least sensitive.

Similarly, in the Southern Celtic Sea, circalittoral mud is identified as the most sensitive habitat according to both median longevity and SSAb sensitivity. However, SuAb sensitivity identifies offshore circalittoral mud as the most sensitive, thus contradicting the median longevity outcome, which ranks it as the least sensitive. Following the OSPAR BH3 sensitivities, offshore circalittoral coarse sediment is the least sensitive habitat out of the five in the region.

Table 4: Indicator sensitivity outcome information for the five largest MSFD broad habitat types (BHTs) (km²) in the North Celtic Sea; ranked where 1 is the most sensitive and 5 is the least sensitive.

Northern Celtic Sea				
MSFD broad habitat types (BHT)	OSPAR (SuAb)	OSPAR (SSAb)	FBIT (median longevity)	Total area fraction size
Offshore circalittoral coarse sediment	5	5	3	0.39
Offshore circalittoral mud	1	2	5	0.27
Offshore circalittoral sand	4	4	4	0.27
Circalittoral sand	2	3	2	0.04
Circalittoral mud	3	1	1	0.03

Table 5: Indicator sensitivity outcome information for the five largest MSFD broad habitat types (BHTs) (km²) in the Southern Celtic Sea; ranked where 1 is the most sensitive and 5 is the least sensitive.

Southern Celtic Sea				
MSFD broad habitat types (BHT)	OSPAR (SuAb)	OSPAR (SSAb)	FBIT (median longevity)	Total area fraction size
Offshore circalittoral coarse sediment	5	5	3	0.3564
Offshore circalittoral sand	4	4	4	0.3205
Offshore circalittoral mud	1	2	5	0.2953
Circalittoral sand	3	3	2	0.0276
Circalittoral mud	2	1	1	0.0002

At the MSFD BHT level, discrepancies between the OSPAR BH3 and ICES FBIT indicators were observed, particularly in identifying the most and least sensitive habitats to bottom trawling. While some agreements were found at the extremes of sensitivity, such as in the Southern North Sea and English Channel, divergences emerged for habitats with intermediate sensitivity levels. For example, in the North-Central North Sea, conflicting results were obtained, indicating a lack of alignment between the methodologies. These results suggest that different sensitivity indicators prioritize distinct aspects of ecosystem responses, leading to varying interpretations of habitat sensitivity within risk models.

However, it's worth noting that mean median longevity fails to adequately discriminate between MSFD broad habitats in certain regions, as illustrated in **Figure 1** below. This indicates a lack of differentiation in sensitivity to trawling across the five largest MSFD BHTs within each assessment region. Furthermore, no clear longevity sensitivity pattern emerges across sediment types for the different depth zones in the Greater North Sea region (North-Central North Sea, Southern North Sea, and Channel), although such a pattern is discernible in the Celtic Sea regions. This finding suggests that there may be some limitation in solely relying on median longevity to accurately identify sensitive habitats in the Northeast Atlantic. Alternatively, it's possible that the selected habitat classification (MSFD BHT) lacks the necessary detail for calculating median longevity-based sensitivity.

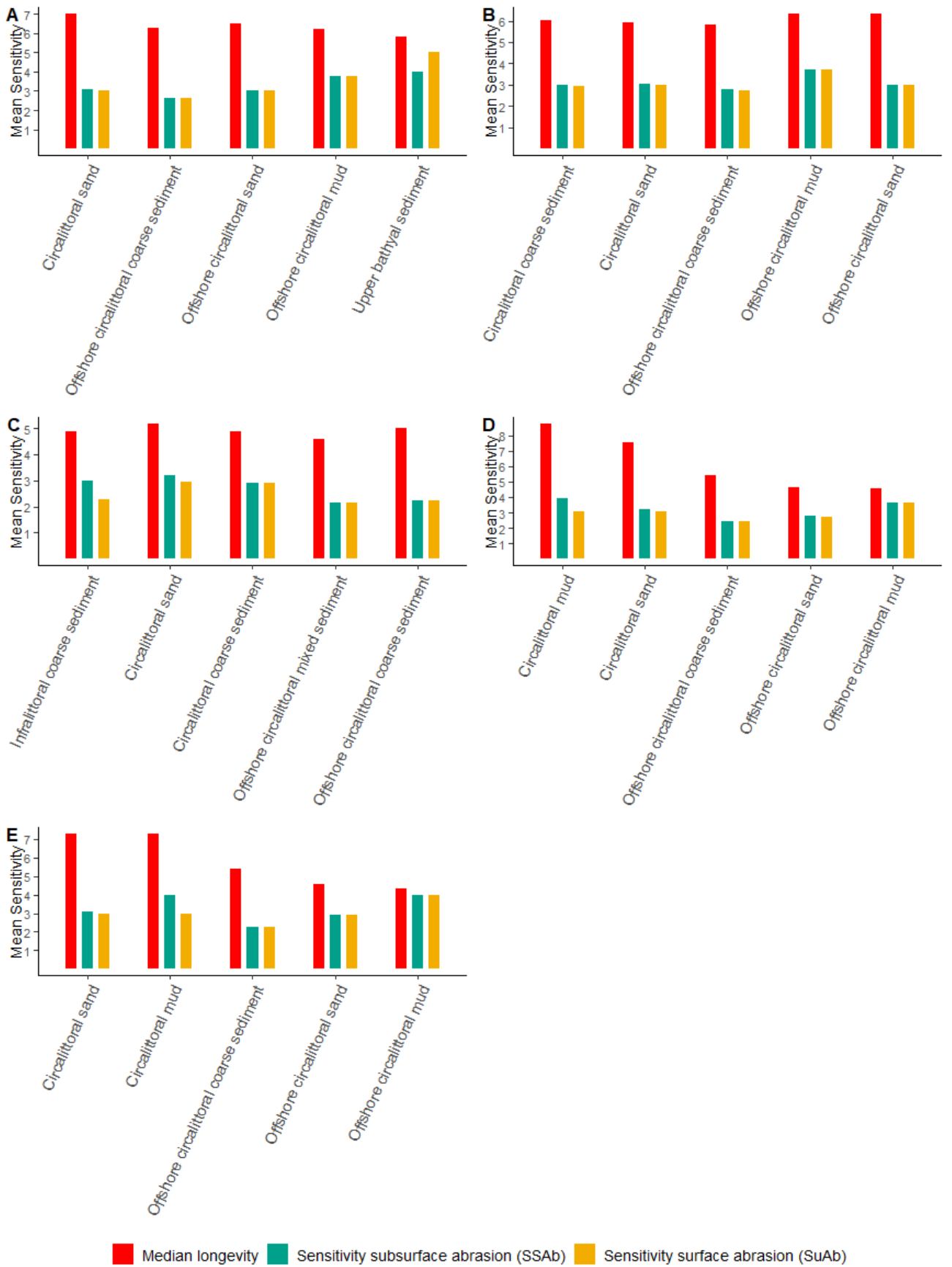


Figure 1: Mean OSPAR BH3 (SuAb and SSAb) and ICES FBIT (median longevity) sensitivity for the 5 largest MSFD broad habitat types (BHT's) (km²) in the a) North-Central North Sea, b) Southern North Sea, c) English Channel, d) Northern Celtic

Sea and E) Southern Celtic Sea. MSFD broad habitats are ranked based on mean increasing depth (m) from left (shallowest) to right (deepest).

ii. EUNIS (Level3) habitat classification

When examining the sensitivity outcomes for the five largest EUNIS L3 habitats in the Greater North Sea and Celtic Sea regions, we observe similar trends compared to the outcomes based on MSFD BHTs.

In the North-Central North Sea (**Table 6**), sublittoral mud is classified as a sensitive habitat according to both OSPAR indicators (position 2), contradicting the median longevity outcome where it is considered the least sensitive. Furthermore, median longevity suggests that sublittoral mixed sediment habitats are the most sensitive to bottom shear stress (trawling), while they are classified as not very sensitive according to the OSPAR BH3 outcomes. Deep-sea mud is identified as the most/very sensitive habitat according to OSPAR, and sensitive (second place) by FBIT, indicating some consistency in indicator outcomes. Additionally, sublittoral coarse sediment is deemed the least/not sensitive according to (sub) surface abrasion and median longevity metrics. The sensitivity classification of the largest habitat, sublittoral sand, aligns between both approaches, with both indicators assessing it as equally sensitive.

Table 6: Indicator sensitivity outcome information for the five largest EUNIS L3 habitat types (km²) in the North-Central North Sea; ranked where 1 is the most sensitive and 5 is the least sensitive. The habitats with an asterisk for SSAb actually had the same sensitivity value.

North-Central North Sea				
Eunis (L3) habitat type	OSPAR (SuAb)	OSPAR (SSAb)	FBIT (median longevity)	Total area fraction size
Sublittoral sand	3	4	3	0.61
Sublittoral mud	2	2*	5	0.28
Sublittoral coarse sediment	5	5	4	0.09
Deep-sea mud	1	1*	2	0.02
Sublittoral mixed sediments	4	3	1	0.01

In the Southern North Sea (**Table 7**), OSPAR classifies sublittoral sediment as the most sensitive, whereas the FBIT indicator, based on median longevity, produces the opposite result. Since the sediment type for this stratum is not defined and the total area is small, we do not include it in our comparison and instead focus on similarities in the second-ranking positions. Sublittoral coarse sediments are identified as the least sensitive habitats according to the OSPAR based sensitivities. This is in correspondence with the median longevity outcome. Furthermore, sublittoral mixed sediments are identified as the most sensitive habitat according to the FBIT indicator, while they are only classified as medium-sensitive according to the OSPAR BH3 sensitivity score.

Table 7: Indicator sensitivity outcome information for the five largest EUNIS L3 habitat types (km²) in the Southern North Sea; ranked where 1 is the most sensitive and 5 is the least sensitive.

Southern North Sea				
Eunis (L3) habitat type	OSPAR (SuAb)	OSPAR (SSAb)	FBIT (median longevity)	Total area fraction size
Sublittoral sand	4	4	2	0.624
Sublittoral mud	2	2	3	0.207
Sublittoral coarse sediment	5	5	4	0.136
Sublittoral mixed sediments	3	3	1	0.027
Sublittoral sediment	1	1	5	0.005

In the English Channel (**Table 8**), SSAb and median longevity-based sensitivity outcomes align

regarding the most sensitive habitat, which is sublittoral mud. However, there is a discrepancy in outcomes between the OSPAR sensitivity assessments. The Atlantic and Mediterranean high-energy circalittoral rock is identified as the most sensitive habitat according to the SuAb sensitivity outcome, whereas this habitat is classified as not very sensitive to trawling according to the OSPAR SSAb and FBIT indicator. Despite this difference, both OSPAR sensitivity assessments agree that sublittoral coarse sediment is the least sensitive habitat to trawling disturbance. According to the FBIT median longevity method, sublittoral mixed sediments should be classified as the least sensitive habitat. However, both OSPAR sensitivities classify this habitat as sensitive.

Table 8: Indicator sensitivity outcome information for the five largest EUNIS L3 habitat types (km²) in the English Channel; ranked where 1 is the most sensitive and 5 is the least sensitive.

ENGLISH CHANNEL				
Eunis (L3) habitat type	OSPAR (SuAb)	OSPAR (SSAb)	FBIT (median longevity)	Total area fraction size
Sublittoral coarse sediment	5	5	3	0.83
Sublittoral sand	4	3	2	0.05
Sublittoral mixed sediments	2	2	5	0.05
Atlantic and Mediterranean high energy circalittoral rock	1	4	4	0.03
Sublittoral mud	3	1	1	0.01

In the Celtic Sea region (**Table 9** and **10**), there is a lack of alignment between the OSPAR sensitivity and median longevity outcomes. In the Northern Celtic Sea (**Table 9**), sublittoral mud is identified as the most sensitive habitat to bottom trawling according to median longevity. Although this finding does not completely contradict the OSPAR-based sensitivity outcomes, as the habitat is labelled as sensitive according to this method, there are discrepancies. Both SuAb and SSAb sensitivities identify sublittoral coarse and mixed sediments as the most sensitive habitat out of the five in this region. Additionally, both methods differ in identifying the least sensitive habitat to bottom trawling. According to the OSPAR BH3 methodology, this should be the sublittoral coarse sediment, which is labelled as sensitive according to FBIT, while median longevity suggests it should be the sublittoral coarse and mixed sediments.

In the Southern Celtic Sea (**Table 10**), both methods identify different habitats as most and least sensitive to bottom trawling impact. Sublittoral coarse and mixed sediments (OSPAR SuAb and SSAb) and sublittoral mixed sediments (median longevity) are identified as the most sensitive habitats, while sublittoral coarse sediment (OSPAR SuAb and SSAb) and sublittoral mud (median longevity) are identified as the least sensitive habitat, respectively. Additionally, it should be noted that the habitat identified as least sensitive by one method is still identified as sensitive by the other indicator.

Table 9: Indicator sensitivity outcome information for the five largest EUNIS L3 habitat types (km²) in the Northern Celtic Sea; ranked where 1 is the most sensitive and 5 is the least sensitive.

Northern Celtic Sea				
Eunis (L3) habitat type	OSPAR (SuAb)	OSPAR (SSAb)	FBIT (median longevity)	Total area fraction size
Sublittoral coarse sediment	5	5	2	0.34
Sublittoral mud	2	2	1	0.26
Sublittoral sand	4	4	3	0.25
Sublittoral mixed sediments	3	3	4	0.13
Sublittoral coarse and mixed sediments	1	1	5	0.02

Table 10: Indicator sensitivity outcome information for the five largest EUNIS L3 habitat types (km²) in the Southern Celtic Sea; ranked where 1 is the most sensitive and 5 is the least sensitive.

Southern Celtic Sea				
Eunis (L3) habitat type	OSPAR (SuAb)	OSPAR (SSAb)	FBIT (median longevity)	Total area fraction size
Sublittoral sand	3	3	4	0.36
Sublittoral coarse sediment	5	5	2	0.32
Sublittoral mud	2	2	5	0.30
Sublittoral coarse and mixed sediments	1	1	3	0.01
Sublittoral mixed sediments	4	4	1	0.01

At the EUNIS L3 habitat classification level, a similar pattern of discrepancies between the two indicators emerges, mirroring the observations at the MSFD BHT level. OSPAR BH3 and ICES FBIT indicators rarely identifying the same habitat as the most or least sensitive to bottom trawling. Although some agreements were found, such as in the English Channel, overall, the lack of correlation between sensitivity classifications suggest caution in using these methods interchangeably. Moreover, the selected habitat classifications may influence these results, as the median longevity and OSPAR BH3 sensitivities are calculated on different habitat levels, namely MSFD BHT and EUNIS L3, respectively. Attempting to align these classifications after calculation could potentially impact indicator outcomes.

Examining **Figure 2** below, it becomes apparent that the mean median longevity is varying only a bit between the EUNIS L3 habitat types. However, the OSPAR BH3 sensitivities demonstrate slightly more discrimination on EUNIS L3 level compared to the MSFD BHT level, which is expected given that the method was developed at this habitat scale. Once again, there is no distinguishable pattern of longevity sensitivity across sediment types for the different depth zones in the assessment regions.

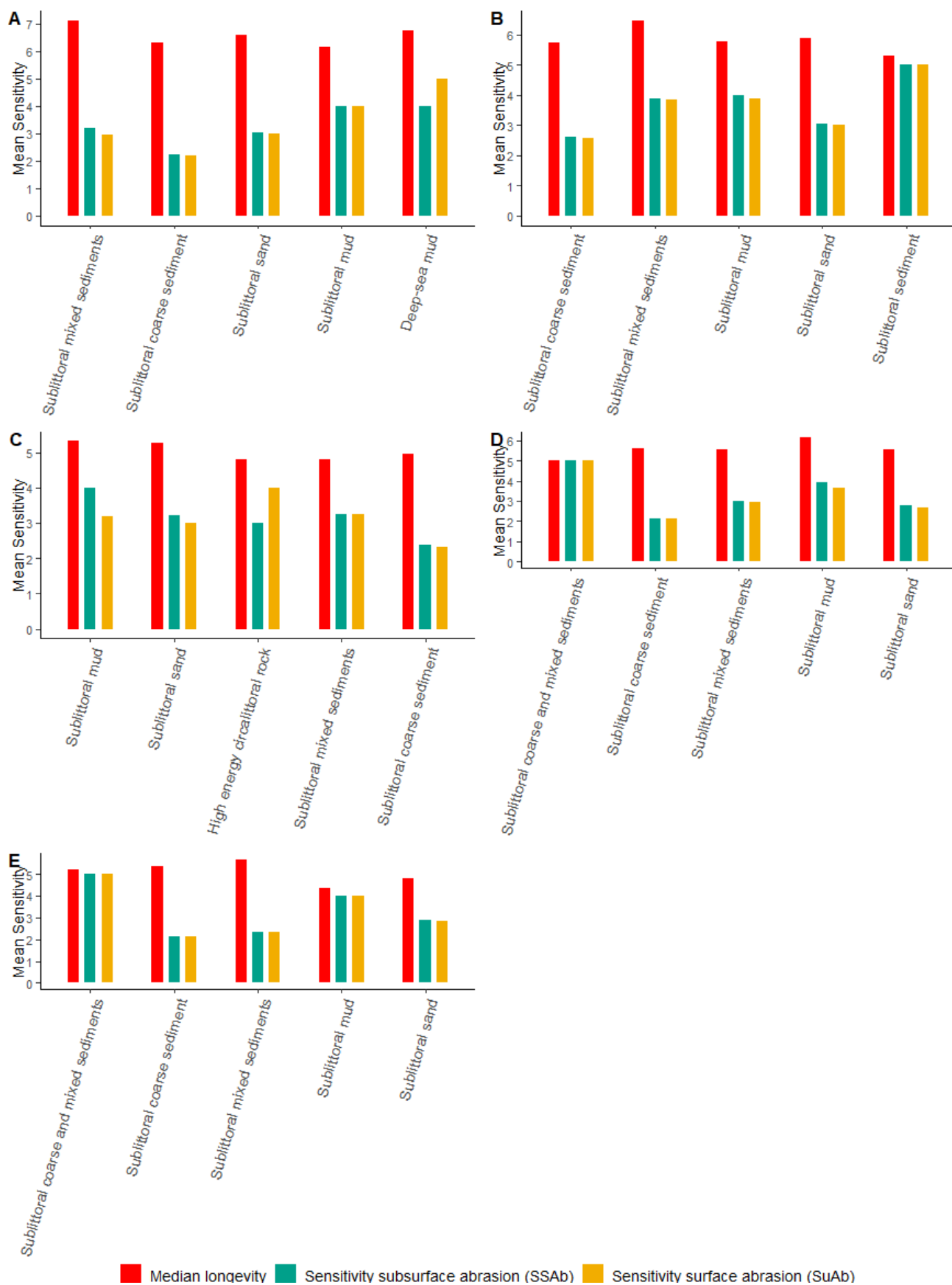


Figure 2: Mean OSPAR BHS (SuAb and SSAb) and ICES FBIT (median longevity) sensitivity for the 5 largest EUNIS L3 habitat types (km²) in the a) North-Central North Sea, b) Southern North Sea, c) English Channel, d) Northern Celtic Sea and e) English Channel

Southern Celtic Sea. EUNIS L3 habitats are ranked based on mean increasing depth (m) from left (shallowest) to right (deepest).

4.2 Direct indicator value comparison

In this section of the report, the sensitivity outcomes for both methods are examined at a grid cell level. Our focus will be on comparing the OSPAR surface abrasion sensitivity (SuAb) with the median longevity outcomes, as OSPAR sensitivities yield similar results. The comparison between longevity and subsurface abrasion sensitivity (SSAb) is provided in annex. Furthermore, comparisons of the indicator outcomes at the habitat level are provided for both habitat classifications, specifically focusing on the five largest habitats for each assessment region.

iii. General comparison between OSPAR and FBIT sensitivities per grid

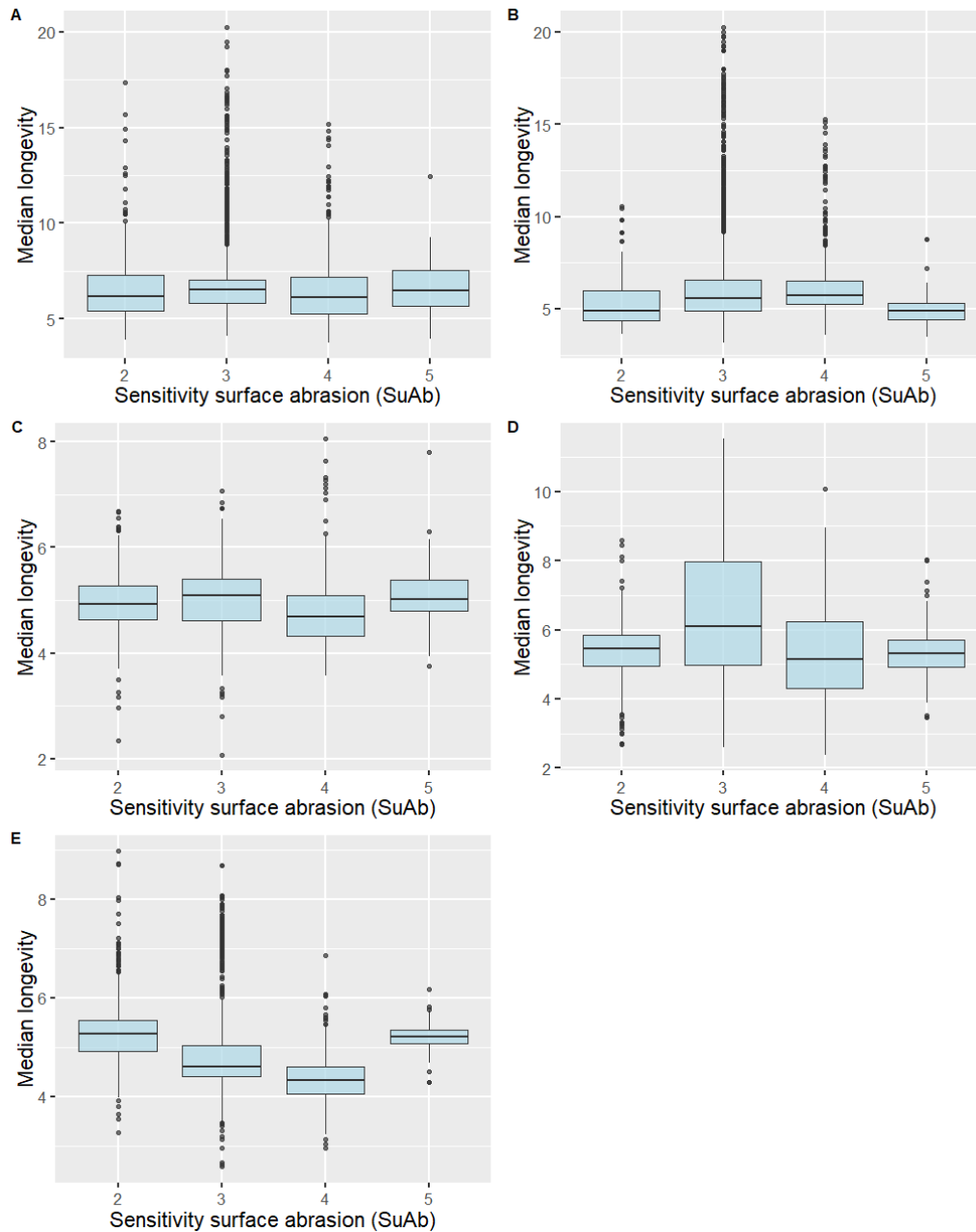


Figure 3: Boxplots comparing the ICES FBIT median longevity against the OSPAR BH3 Surface abrasion (SuAb) sensitivity for each grid cell in the a) North-Central North Sea, b) Southern North Sea, c) English Channel, d) Northern Celtic Sea and e) Southern Celtic Sea.

The boxplot comparisons in **Figure 3** do not account for the effect of different habitat classifications on sensitivity outcomes. Instead, these comparisons illustrate the relationship between both indicators at the grid cell level. If both sensitivity methods are comparable, the median longevity should increase (indicating higher sensitivity) with increasing OSPAR classification (ranging from class 1 to 5, representing a gradient from most to least sensitive habitat). However, these graphs support our earlier findings, as no clear pattern can be discerned between the OSPAR sensitivity and median longevity. This suggests that there is no correlation between both sensitivity classifications, meaning that a habitat classified with a low sensitivity according to OSPAR does not necessarily have a different median longevity than a habitat classified as highly sensitive. Moreover, in the Celtic Sea region (**Figure 3**, (D) and (E)), an opposite relationship between median longevity and OSPAR sensitivity class is observed, indicating contradictory results between the methods. This does not necessarily imply that either approach is incorrect but rather suggests that there is expected to be high variation between the outcomes.

iv. Comparison between OSPAR and FBIT sensitivities for the 5 largest MSFD and EUNIS habitats for each assessment region

1. 5 largest MSFD broad-scale habitat (km²)

In this comparison at the grid level (**Figure 4-6**) a different pattern can be observed as the habitats are taken into consideration. The labels above the facet grid correspond to the five largest MSFD habitats in the assessment regions ((A) North-Central North Sea, (B) Southern North Sea, (C) English Channel, (D) Northern Celtic Sea, (E) Southern Celtic Sea), and the colours on the graphs represent the corresponding EUNIS L3 habitats in each grid cell.

Looking at the figures it seems that using habitat classifications interchangeably after indicator calculation will alter the outcome, as MSFD BHTs consists of many EUNIS L3 habitats, and vice versa. Consequently, one MSFD habitat type may encompass multiple OSPAR sensitivity classes, thereby influencing the habitat sensitivity according to OSPAR for these habitats. However, it's important to note that some EUNIS L3 habitat classes also consist of multiple OSPAR sensitivity scores.

Additionally, the graphs demonstrate the lack of correlation between both methods, as median longevity does not consistently increase with increasing OSPAR sensitivity classification. In the North-Central and Southern North Sea and Northern Celtic Sea there appears to be a relationship between the MSFD BHTs and median longevity as some habitats have grid cells which fall within a higher sensitivity class (>10 years) compared to others (3-10 years). So, there is some discrimination of longevity within a habitat, indicating areas with higher median longevity. This aspect cannot be captured by the OSPAR scores as they are fixed values. However, in the other assessment regions, all the grid cells of the five habitats fall within the same sensitivity classification, indicating they would all be considered equally sensitive.

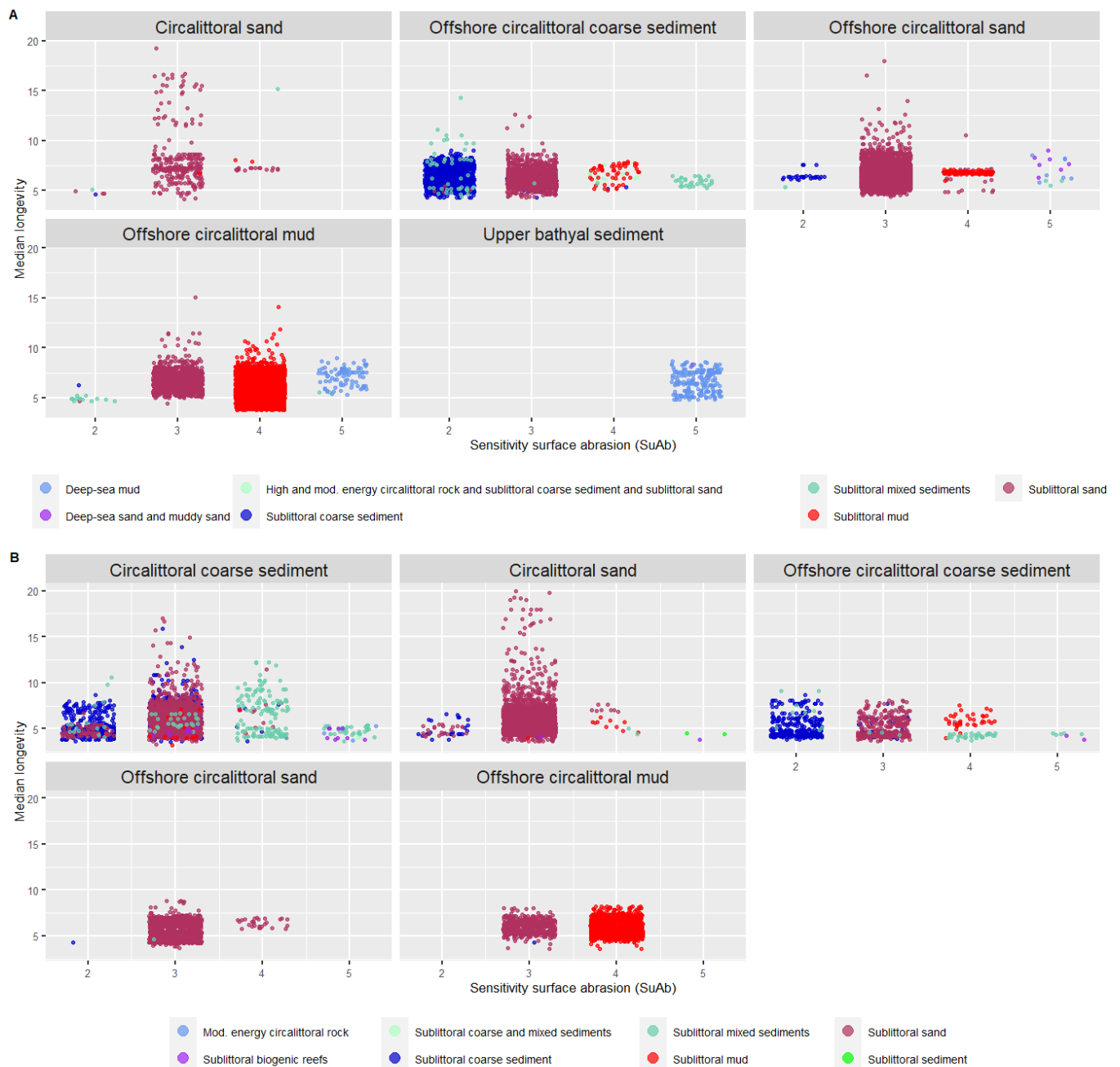


Figure 4: Jitter plots depicting OSPAR BH3 (SuAb) and ICES FBIT (Median Longevity) sensitivities for each grid cell. Each facet grid represents one of the five largest MSFD habitats (km²) in the North-Central North Sea (A) and Southern North Sea (B). Plots are arranged based on increasing mean habitat depth from left (shallowest) to right (deepest). The colours represent the corresponding EUNIS L3 habitat (abbreviated names, for full names see table 21) for each grid cell.

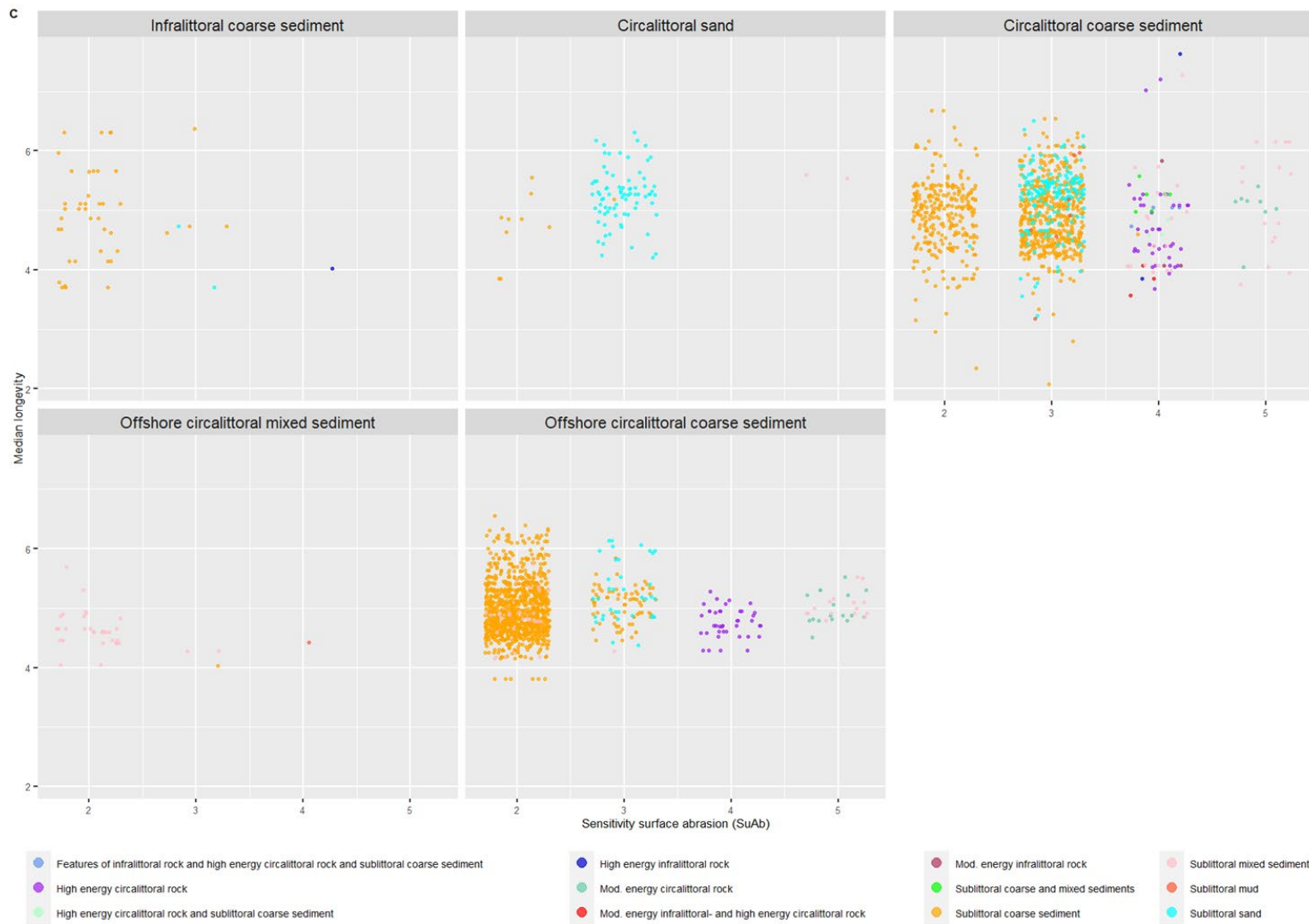


Figure 5: Jitter plots depicting OSPAR BH3 (SuAb) and ICES FBIT (Median Longevity) sensitivities for each grid cell. Each facet grid represents one of the five largest MSFD habitats (km^2) in the English Channel (C). Plots are arranged based on increasing mean habitat depth from left (shallowest) to right (deepest). The colours represent the corresponding EUNIS L3 habitat (abbreviated names, for full names see table 21) for each grid cell.

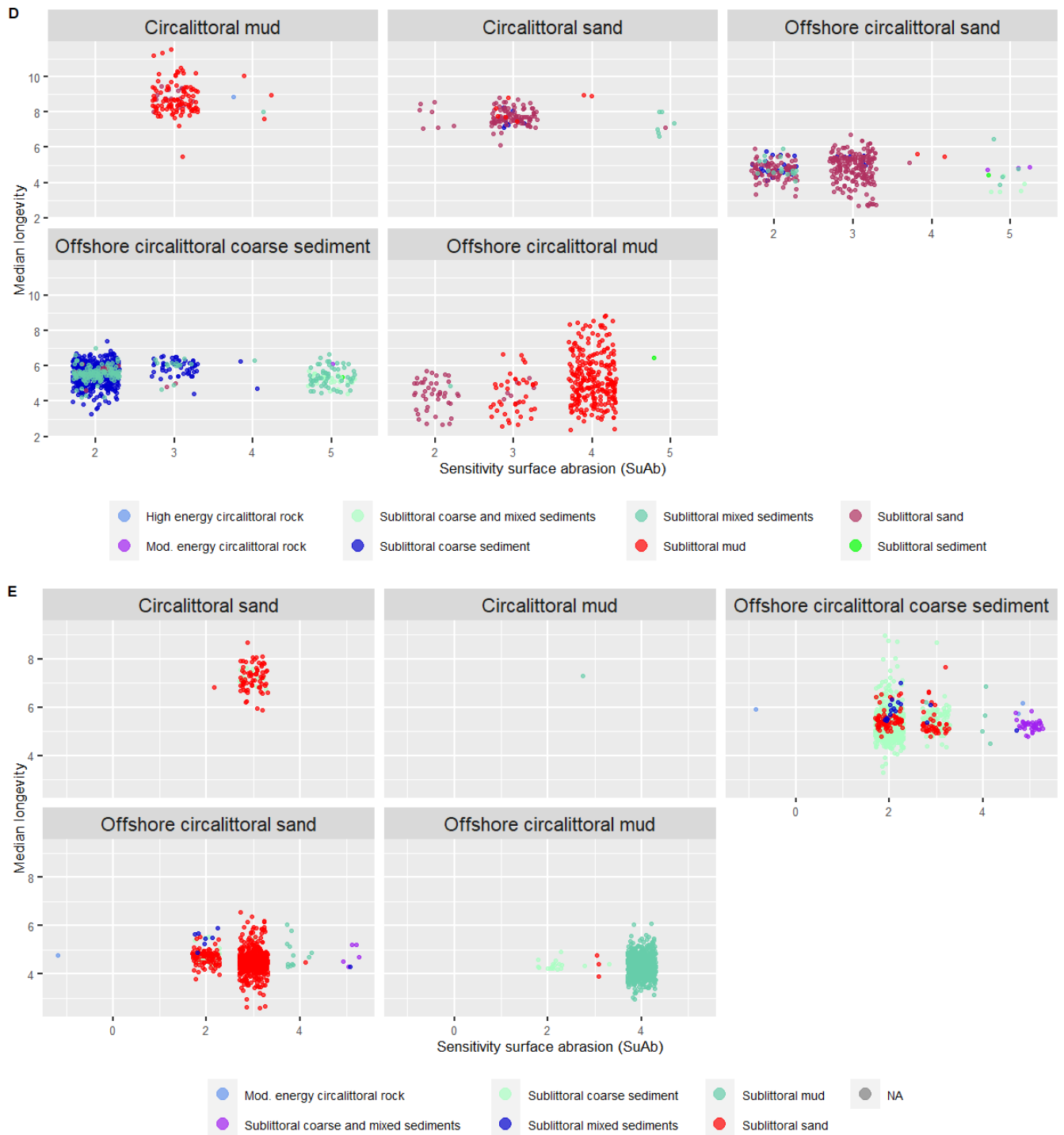


Figure 6: Jitter plots depicting OSPAR BH3 (SuAb) and ICES FBIT (Median Longevity) sensitivities for each grid cell. Each facet grid represents one of the five largest MSFD habitats (km²) in the Northern Celtic Sea (D) and Southern Celtic Sea (E). Plots are arranged based on increasing mean habitat depth from left (shallowest) to right (deepest). The colours represent the corresponding EUNIS L3 habitat (abbreviated names, for full names see table 21) for each grid cell.

2. 5 Largest EUNIS level 3 habitats (km²)

In conjunction with the previous jitter plot analysis (Figure 4-6), which considered the MSFD broad habitat types, the grid cell comparison based on the EUNIS habitat classification level 3 (Figure 7-9) provides additional insights. Looking at the grid cell comparison for all five assessment regions, we observe that most EUNIS habitat types encompass all sensitivity classifications, while others

(Such as Deep-Sea mud in the North-Central North Sea and sublittoral sediment in **Figure 7 B** (A) and (B)) have only one classification. Similar to the previous jitter plots, it is evident that these habitat classifications should not be used interchangeably, as one EUNIS L3 habitat consists of multiple MSFD BHTs. Additionally, there is no direct relation between the OSPAR sensitivities and median longevity, as median longevity does not increase with increasing OSPAR sensitivity classes. However, in the North-Central and Southern North Sea, and Northern Celtic Sea, there seems to be some relationship between the EUNIS level 3 habitats and median longevity. Some habitats exhibit a higher (> 10 years) median longevity values and therefore sensitivity compared to others. In contrast, in other regions, this relationship is absent, indicating that all grid cells within all habitats would be labelled as equally sensitive.



Figure 7: Jitter plots depicting OSPAR (SuAb) and FBIT (Median Longevity) sensitivities for each grid cell. Each facet grid represents one of the five largest EUNIS L3 habitats (km^2) in the North-Central North Sea (A) and Southern North Sea (B). Plots are arranged based on increasing mean habitat depth from left (shallowest) to right (deepest). The colours correspond to the corresponding MSFD broad habitat type (BHT) for each grid cell.

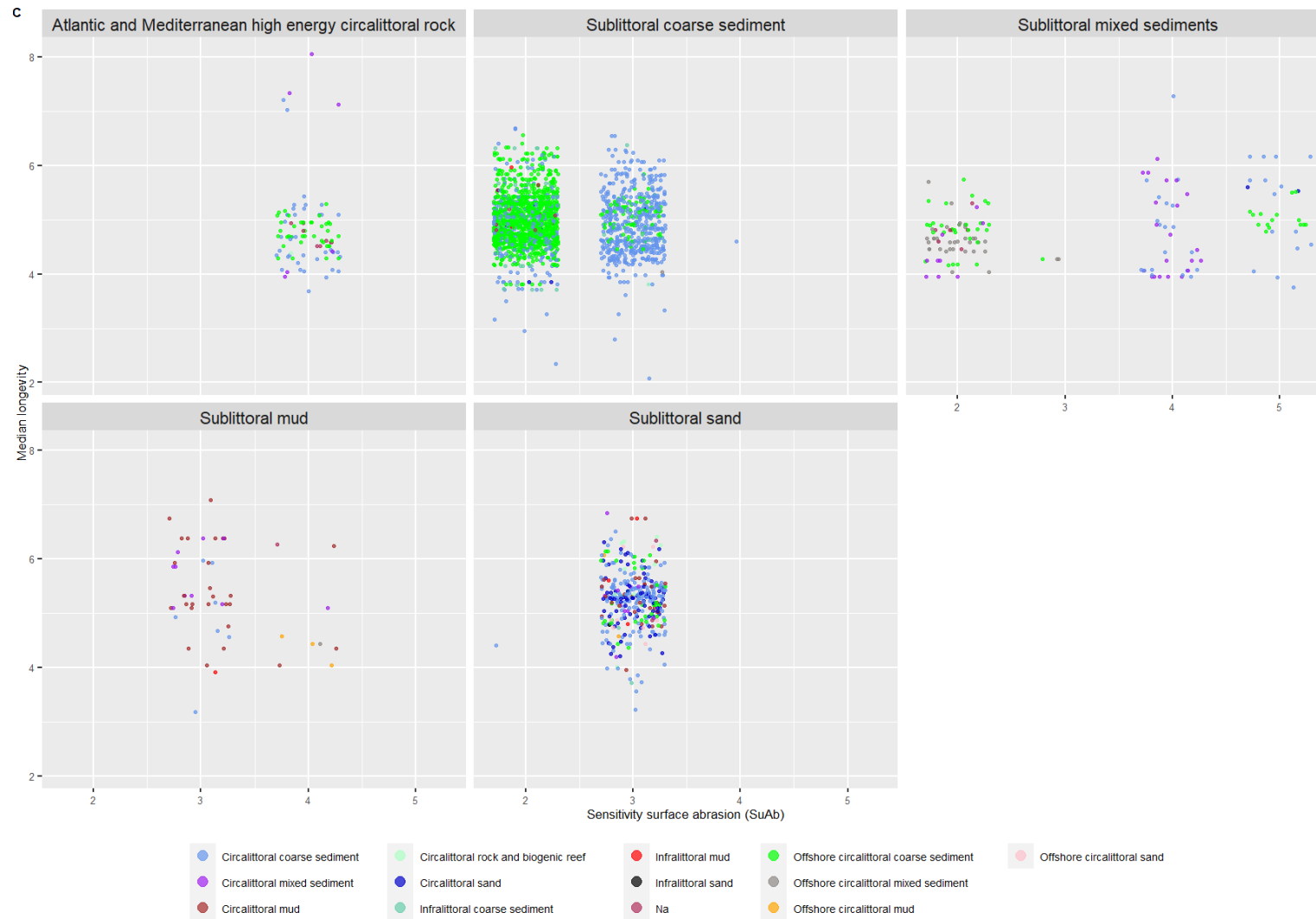


Figure 8: Jitter plots depicting OSPAR (SuAb) and ICES FBIT (Median Longevity) sensitivities for each grid cell. Each facet grid represents one of the five largest EUNIS L3 habitats (km^2) in the English Channel (C). Plots are arranged based on increasing mean habitat depth from left (shallowest) to right (deepest). The colours correspond to the corresponding MSFD broad habitat type (BHT) for each grid cell.

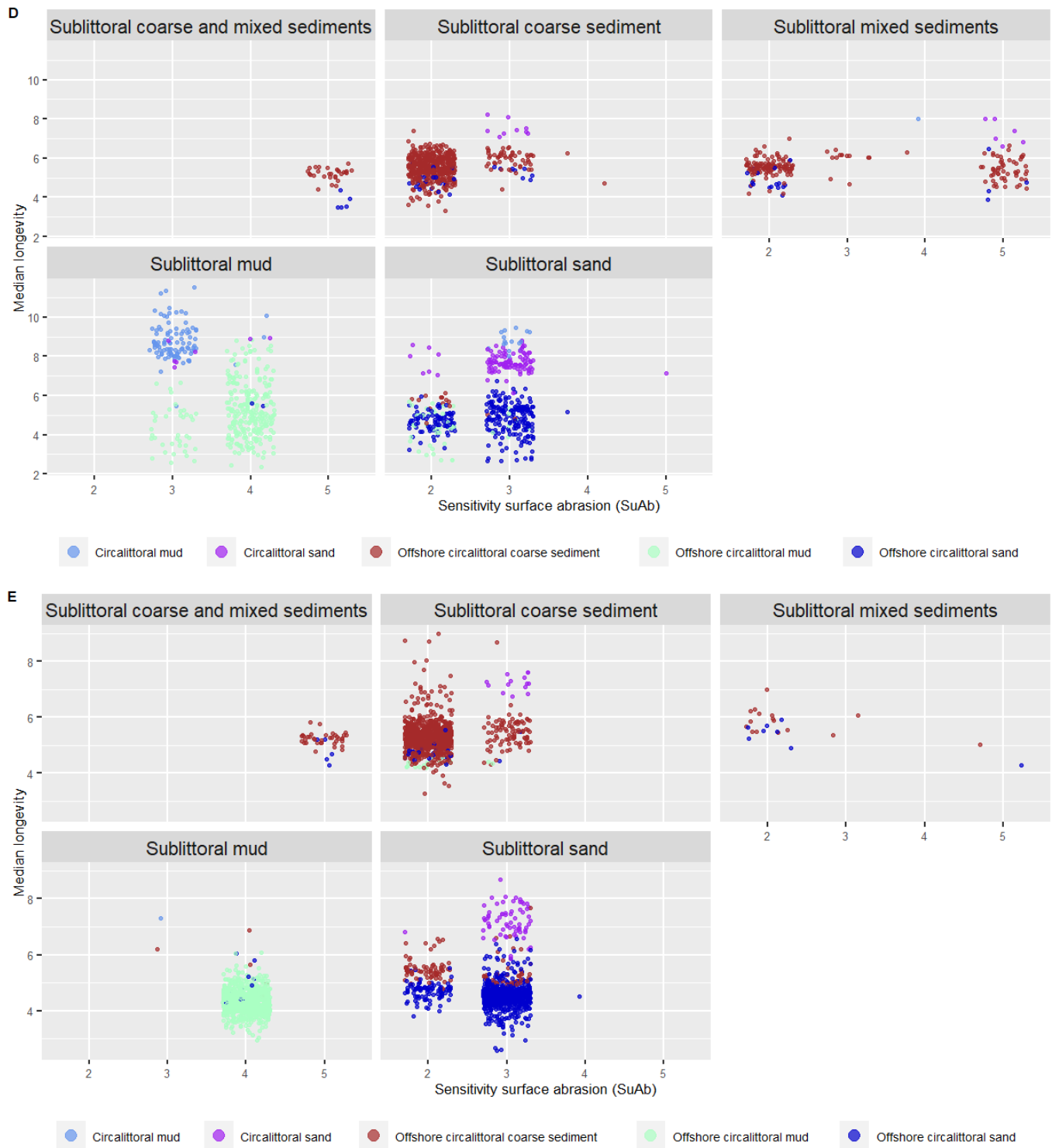


Figure 9: Jitter plots depicting OSPAR BH3 (SuAb) and ICES FBIT (Median Longevity) sensitivities for each grid cell. Each facet grid represents one of the five largest EUNIS L3 habitats (km²) in the Northern Celtic Sea (D) and Southern Celtic Sea (E). Plots are arranged based on increasing mean habitat depth from left (shallowest) to right (deepest). The colours correspond to the corresponding MSFD broad habitat type (BHT) for each grid cell.

5. Discussion

Our analyses reveal a lack of a direct relationship between OSPAR sensitivities and median longevity. Despite examining different habitat classification levels, median longevity does not consistently increase with increasing OSPAR sensitivity classes, leading to discrepancies in

sensitivity outcomes across regions. At both habitat classification levels, both indicators yield contradictory results in some situations when identifying the most and least sensitive habitats. However, at the MSFD level, some agreements exist at the extreme sensitivity ends, such as in the Southern North Sea and English Channel. Nonetheless, even in these cases, outcomes diverge for habitats with intermediate sensitivity levels. Our results align with a previous comparison of indicator sensitivity (ICES, 2023), where both indicators yielded similar outcomes in some regions while contradicting each other in others.

These conflicting sensitivity outcome results highlight a lack of alignment between the methodologies, emphasizing that different sensitivity indicators prioritize distinct aspects of ecosystem responses, leading to varying interpretations of habitat sensitivity within risk models. This aligns with the current indicator use advise, which discourages a 'one-size-fits-all' approach. Instead, the use of multiple, complimentary indicators is encouraged to encompass multiple facets of the ecosystem responses to a pressure gradient. While being mindful of avoiding redundancy in indicator selection and emphasizing the importance of selecting indicators capable of detecting changes along a pressure gradient. The latter is important when looking at our outcomes on a grid cell level, as our analysis reveals complex patterns in sensitivity outcomes. While some regions exhibit a relationship between habitat types and median longevity, indicating varying sensitivity levels, others show uniform sensitivity outcomes across habitats. However, it should be noted that the observed differences in indicator outcome could also be the result of variance in data availability and resolution, between assessment areas, required to apply each indicator.

Based on all the findings presented above, it becomes apparent that utilizing habitat classifications interchangeably after indicator calculations significantly influences the outcome. Additionally, the differences in habitat classification resolution between indicators could influence the sensitivity outcome. Here, the OSPAR BH3 and ICES FBIT indicator are calculated with different resolutions in their underlying habitat information layer, with median longevity being calculated on the MSFD BHT level while BH3-based sensitivities are defined at the broad-to biotope/community-level (e.g. EUNIS levels). The differences in our finding could thus be data (habitat layer) driven instead of the result of differences in indicator methodology.

Overall, the comparative analysis of OSPAR and FBIT sensitivities provides critical insights into bottom trawling impact assessment in Belgian fishing fleet regions. By shedding light on the strengths and limitations of each indicator and examining the influence of habitat classifications, this research contributes to a more nuanced understanding of benthic habitat sensitivity to fishing pressure. Additionally, this research forms the basis for our follow-up Benthis Nationaal 2, where we will continue our indicator analysis on a broader scale (more indicators and analysis). The goal is to then select a group of indicators that 1) come from different indicator families (not/less correlated to each other), representing different aspects of the ecosystem response to trawling and 2) are responsive to a fishing pressure gradient. These indicators will then be integrated into a sensitivity map, achieving a more balanced approach to bottom disturbance. As the Belgian fishing industry needs to find its place in an EU policy that increasingly emphasizes bottom-protective measures, improving the assessment of bottom impact through indicators and integrating them into fisheries management strategies is crucial. That's why the sensitivity output of Benthis Nationaal 2 will be made available as a tool for Belgian shipowners via VISTOOLS. This provides, shipowners and skippers the means necessary to realistically consider bottom disturbance issues in their operations.

6. Conclusion

Our comparison between the OSPAR and ICES FBIT-based habitat sensitivity outcomes in the Greater North Sea and Celtic Sea regions revealed a lack of correlation between the sensitivity classifications of both indicators. The following main outcomes were found in these analyses:

- **Divergent sensitivity rankings:**
OSPAR BH3 and ICES FBIT indicators rarely identifying the same habitat as the most or least sensitive to bottom trawling. This discrepancy is valid for both habitat classifications (MSFD BHT and EUNIS level 3).
- **Regional variations**
Both indicators best align in identifying the most and least sensitive habitats in the Southern North Sea and English Channel, while in other regions, they display greater differences. This suggests that relying on a single indicator to assess seafloor sensitivity of a region or across regions might not be sufficient.
- **Habitat classification impacts**
The sensitivity ranking for the Northern and Southern Celtic Sea are similar when using the MSFD habitat classification, but this pattern is less evident with the EUNIS Level 3 habitats. In the North Sea, particularly in the North-Central area, both indicators align more closely in identifying habitat sensitivities when using the EUNIS level 3 classification than when using the MSFD habitats. Additionally, the OSPAR BH3 approach considers two levels: surface and subsurface abrasion. When using the MSFD classification, sensitivity rankings for surface and subsurface habitats are similar. However, with the more detailed EUNIS classification, these rankings can diverge, revealing finer differences in sensitivity. This increased discrimination is expected, as OSPAR BH3 is inherently based on EUNIS habitat classes, a nuance lost when using the broader MSFD categories.
- **Sensitivity trends by sediment type:**
Both indicators typically score the muddy habitats as the most sensitive under the MSFD classifications, while in most regions, coarse or mixed sediments receive a higher (more sensitive) score when EUNIS level 3 is applied.
- **Interchangeability of Classifications:**
Our analysis indicates that using habitat classifications interchangeably after indicator calculation will alter the outcome, as MSFD BHTs consists of many EUNIS L3 habitats, and vice versa. It's important to note that some EUNIS L3 habitat classes also consist of multiple OSPAR sensitivity scores.
- **Indicator comparability considerations:**
While the median longevity metric within MSFD BHTs reveals variations in sensitivity with some grid cells showing higher sensitivity (median longevity >10 years) versus others (3–10 years), this intra-habitat discrimination is not captured by the fixed OSPAR scores. Overall there is no correlation between both indicators, meaning that a habitat classified with a low sensitivity by OSPAR does not necessarily exhibit a different median longevity than one classified as highly sensitive.

It should be noted that these outcomes do not indicate that one approach is wrong, but rather that scientists and policymakers should be wary of using these methods interchangeably.

Additionally, the discrepancies between methodologies emphasize the importance of integrating multiple indicators and considering various factors when assessing benthic habitat sensitivity to bottom trawling. Our results also demonstrate that sensitivity outcomes may vary between regions, suggesting that habitat characteristics and environmental contexts play a significant role in determining sensitivity to bottom trawling. Moreover, our findings indicate that habitat classification selection should be considered prior to indicator calculation as using classifications interchangeably after this step will alter indicator outcome. Improving the habitat mapping and harmonization between habitat classification methods is essential, as they form the basis for mapping sensitive areas and guiding of fishery management.

Finally, this analysis only scratches the surface of the indicator iceberg, as there is still an extensive list of benthic indicators we have not compared. Our findings emphasizing the need for further comparisons across multiple indicators. This next step forms the basis of the Benthic Nationaal 2 project, where we will compare more benthic indicators relevant for fisheries before selecting the right set of indicators fit for integration. Our general aim is to use our integrated indicators to create a new habitat sensitivity map for the Belgian fishing fleet fishing grounds, which will be fit for onboard purposes.

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8. Annex

Table 11: Mean OSPAR BH3 (SuAb and SSAb) and ICES FBIT (median longevity) indicator sensitivity for the five largest MSFD broad habitat types (BHTs) (km²) in the North-Central North Sea.

North-Central North Sea					
MSFD broad habitat types (BHT)	Mean surface abrasion sensitivity (SuAb)	Mean subsurface abrasion sensitivity (SSAb)	Mean median longevity	Total area (km ²)	Total area fraction size
Offshore circalittoral sand	3.02	3.02	6.51	145889.32	0.43
Offshore circalittoral mud	3.77	3.76	6.24	84470.70	0.25
Upper bathyal sediment	5.00	4.01	5.82	48568.73	0.14
Offshore circalittoral coarse sediment	2.62	2.62	6.26	25714.81	0.08
Circalittoral sand	3.05	3.07	7.02	18856.76	0.06

Table 12: Mean OSPAR BH3 (SuAb and SSAb) and ICES FBIT (median longevity) indicator sensitivity for the five largest MSFD broad habitat types (BHTs) (km²) in the Southern North Sea.

Southern North Sea					
MSFD broad habitat types (BHT)	Mean surface abrasion sensitivity (SuAb)	Mean subsurface abrasion sensitivity (SSAb)	Mean median longevity	Total area (km ²)	Total area fraction size
Offshore circalittoral sand	3.02	3.02	6.32	104793.11	0.47
Offshore circalittoral mud	3.71	3.71	6.35	40927.62	0.18
Circalittoral sand	2.99	3.05	5.92	34647.77	0.16
Circalittoral coarse sediment	2.97	3.00	6.03	16307.15	0.07
Offshore circalittoral coarse sediment	2.74	2.81	5.81	15730.01	0.07

Table 13: Mean OSPAR BH3 (SuAb and SSAb) and ICES FBIT (median longevity) indicator sensitivity for the five largest MSFD broad habitat types (BHTs) (km²) in the English Channel.

ENGLISH CHANNEL						
MSFD broad habitat types (BHT)	Mean surface abrasion sensitivity (SuAb)	Mean subsurface abrasion sensitivity (SSAb)	Mean median longevity	Total area (km ²)	Total area fraction size	
Offshore circalittoral coarse sediment	2.24	2.21	5.01	25424.36	0.61	
Circalittoral coarse sediment	2.88	2.90	4.89	12682.55	0.31	
Offshore circalittoral mixed sediment	2.13	2.13	4.60	734.82	0.02	
Circalittoral sand	2.96	3.19	5.18	734.40	0.02	
Infralittoral coarse sediment	2.32	3.04	4.89	572.18	0.01	

Table 14: Mean OSPAR BH3 (SuAb and SSAb) and ICES FBIT (median longevity) indicator sensitivity for the five largest MSFD broad habitat types (BHTs) (km²) in the Northern Celtic Sea.

Northern Celtic Sea						
MSFD broad habitat types (BHT)	Mean surface abrasion sensitivity (SuAb)	Mean subsurface abrasion sensitivity (SSAb)	Mean median longevity	Total area (km ²)	Total area fraction size	
Offshore circalittoral coarse sediment	2.43	2.45	5.44	28138.01	0.39	
Offshore circalittoral mud	3.62	3.63	4.55	20029.88	0.27	
Offshore circalittoral sand	2.71	2.78	4.62	19961.26	0.27	
Circalittoral sand	3.07	3.20	7.53	2889.69	0.04	
Circalittoral mud	3.04	3.92	8.77	1858.65	0.03	

Table 15: Mean OSPAR BH3 (SuAb and SSAb) and ICES FBIT (median longevity) indicator sensitivity for the five largest MSFD broad habitat types (BHTs) (km²) in the Southern Celtic Sea.

Southern Celtic Sea						
MSFD broad habitat types (BHT)	Mean surface abrasion sensitivity (SuAb)	Mean subsurface abrasion sensitivity (SSAb)	Mean median longevity	Total area (km ²)	Total area fraction size	
Offshore circalittoral coarse sediment	2.25	2.27	5.38	17255.58	0.3564	
Offshore circalittoral sand	2.89	2.92	4.57	15518.62	0.3205	
Offshore circalittoral mud	3.95	3.95	4.34	14297.44	0.2953	
Circalittoral sand	2.99	3.06	7.29	1336.77	0.0276	
Circalittoral mud	3.00	4.00	7.30	7.37	0.0002	

Table 16: Mean OSPAR BH3 (SuAb and SSAb) and ICES FBIT (median longevity) indicator sensitivity for the five largest EUNIS L3 habitats (km²) in the North-Central North Sea.

North-Central North Sea						
Eunis (L3) habitat type	Eunis (L3) corresponding habitat name	Mean surface abrasion sensitivity (SuAb)	Mean subsurface abrasion sensitivity (SSAb)	Mean median longevity	Total area (km ²)	Total area fraction size
A5.2	Sublittoral sand	3.00	3.01	6.59	137951.29	0.61
A5.3	Sublittoral mud	3.99	4.00	6.15	62535.68	0.28
A5.1	Sublittoral coarse sediment	2.20	2.25	6.29	20637.40	0.09
A6.5	Deep-sea mud	5.00	4.00	6.76	3510.85	0.02
A5.4	Sublittoral mixed sediments	2.95	3.18	7.12	1767.48	0.01

Table 17: Mean OSPAR BH3 (SuAb and SSAb) and ICES FBIT (median longevity) indicator sensitivity for the five largest EUNIS L3 habitats (km²) in the Southern North Sea.

Southern North Sea						
Eunis (L3) habitat type	Eunis (L3) corresponding habitat name	Mean surface abrasion sensitivity (SuAb)	Mean subsurface abrasion sensitivity (SSAb)	Mean median longevity	Total area (km ²)	Total area fraction size
A5.2	Sublittoral sand	2.99	3.05	5.88	71174.85	0.62
A5.3	Sublittoral mud	3.88	4.00	5.78	23569.20	0.21
A5.1	Sublittoral coarse sediment	2.58	2.62	5.73	15527.16	0.14
A5.4	Sublittoral mixed sediments	3.86	3.89	6.48	3078.15	0.03
A5	Sublittoral sediment	5.00	5.00	5.32	532.07	0.00

Table 18: Mean OSPAR BH3 (SuAb and SSAb) and ICES FBIT (median longevity) indicator sensitivity for the five largest EUNIS L3 habitats (km²) in the English Channel.

ENGLISH CHANNEL						
Eunis (L3) habitat type	Eunis (L3) corresponding habitat name	Mean surface abrasion sensitivity (SuAb)	Mean subsurface abrasion sensitivity (SSAb)	Mean median longevity	Total area (km ²)	Total area fraction size
A5.1	Sublittoral coarse sediment	2.32	2.37	4.96	29941.79	0.83
A5.2	Sublittoral sand	3.00	3.21	5.25	1964.29	0.05
A5.4	Sublittoral mixed sediments	3.26	3.26	4.80	1791.18	0.05
A4.1	Atlantic and Mediterranean high energy circalittoral rock	4.00	3.00	4.81	1078.67	0.03
A5.3	Sublittoral mud	3.18	4.00	5.31	458.90	0.01

Table 19: Mean OSPAR BH3 (SuAb and SSAb) and ICES FBIT (median longevity) indicator sensitivity for the five largest EUNIS L3 habitats (km²) in the Northern Celtic Sea.

Northern Celtic Sea						
Eunis (L3) habitat type	Eunis (L3) corresponding habitat name	Mean surface abrasion sensitivity (SuAb)	Mean subsurface abrasion sensitivity (SSAb)	Mean median longevity	Total area (km ²)	Total area fraction size
A5.1	Sublittoral coarse sediment	2.13	2.14	5.58	8763.81	0.34
A5.3	Sublittoral mud	3.65	3.90	6.12	6653.31	0.26
A5.2	Sublittoral sand	2.68	2.77	5.58	6512.12	0.25
A5.4	Sublittoral mixed sediments	2.97	3.02	5.54	3230.82	0.13
A5.1+A5.4	Sublittoral coarse and mixed sediments	5.00	5.00	4.99	548.78	0.02

Table 20: Mean OSPAR BH3 (SuAb and SSAb) and ICES FBIT (median longevity) indicator sensitivity for the five largest EUNIS L3 habitats (km²) in the Southern Celtic Sea.

Southern Celtic Sea						
Eunis (L3) habitat type	Eunis (L3) corresponding habitat name	Mean surface abrasion sensitivity (SuAb)	Mean subsurface abrasion sensitivity (SSAb)	Mean median longevity	Total area (km ²)	Total area fraction size
A5.2	Sublittoral sand	2.85	2.90	4.81	17407.44	0.36
A5.1	Sublittoral coarse sediment	2.11	2.11	5.33	15211.74	0.32
A5.3	Sublittoral mud	4.00	4.00	4.36	14118.04	0.30
A5.1+A5.4	Sublittoral coarse and mixed sediments	5.00	5.00	5.18	699.93	0.01
A5.4	Sublittoral mixed sediments	2.33	2.33	5.67	297.71	0.01

Table 21: EUNIS L3 habitats type (codes) with their corresponding full and abbreviated habitat name.

Eunis (L3) habitat type	Eunis (L3) corresponding habitat name	Eunis (L3) corresponding habitat name abbreviated
A3.1	Atlantic and Mediterranean high energy infralittoral rock	High energy infralittoral rock
A3.1+A4.1	Atlantic and Mediterranean high energy infralittoral- and circalittoral rock	High energy infralittoral- and circalittoral rock
A3.2	Atlantic and Mediterranean moderate energy infralittoral rock	Mod. energy infralittoral rock
A3.2+A4.1	Atlantic and Mediterranean moderate energy infralittoral- and high energy circalittoral rock	Mod. energy infralittoral- and high energy circalittoral rock
A3.2+A4.1+A4.2	Atlantic and Mediterranean moderate energy infralittoral- and high and moderate energy circalittoral rock	Mod. energy infralittoral- and high and mod. energy circalittoral rock
A3.3	Atlantic and Mediterranean low energy infralittoral rock	Low energy infralittoral rock
A3.7+A4.1+A5.1	Features of infralittoral rock and Atlantic and Mediterranean high energy circalittoral rock and sublittoral coarse sediment	Features of infralittoral rock and high energy circalittoral rock and sublittoral coarse sediment
A4.1	Atlantic and Mediterranean high energy circalittoral rock	High energy circalittoral rock
A4.1+A4.2	Atlantic and Mediterranean high and moderate energy circalittoral rock	High and mod. energy circalittoral rock
A4.1+A4.2+A5.1+A5.2	Atlantic and Mediterranean high and moderate energy circalittoral rock and sublittoral coarse sediment and sublittoral sand	High and mod. energy circalittoral rock and sublittoral coarse sediment and sublittoral sand
A4.1+A5.1	Atlantic and Mediterranean high energy circalittoral rock and sublittoral coarse sediment	High energy circalittoral rock and sublittoral coarse sediment
A4.2	Atlantic and Mediterranean moderate energy circalittoral rock	Mod. energy circalittoral rock
A4.3	Atlantic and Mediterranean low energy circalittoral rock	Low energy circalittoral rock
A5	Sublittoral sediment	Sublittoral sediment
A5.1	Sublittoral coarse sediment	Sublittoral coarse sediment
A5.1+A5.4	Sublittoral coarse and mixed sediments	Sublittoral coarse and mixed sediments
A5.2	Sublittoral sand	Sublittoral sand
A5.3	Sublittoral mud	Sublittoral mud
A5.4	Sublittoral mixed sediments	Sublittoral mixed sediments
A5.5	Sublittoral macrophyte-dominated sediment	Sublittoral macrophyte-dominated sediment
A5.6	Sublittoral biogenic reefs	Sublittoral biogenic reefs
A6.3+A6.4	Deep-sea sand and muddy sand	Deep-sea sand and muddy sand
A6.5	Deep-sea mud	Deep-sea mud

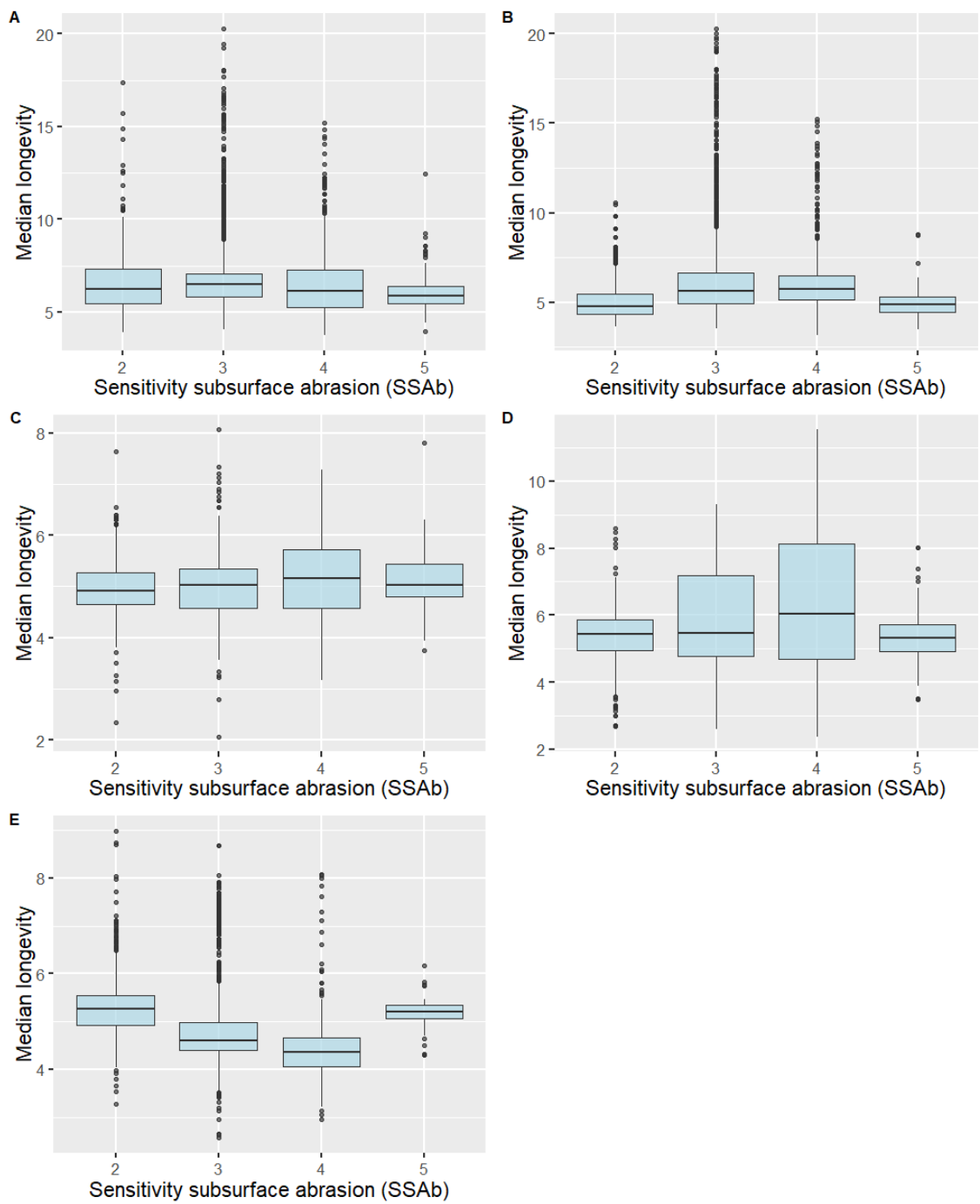


Figure 10: Boxplots comparing the ICES FBIT sensitivity (median longevity) against the OSPAR BH3 Subsurface abrasion (SSAb) Sensitivity for each grid cell in the a) North-Central North Sea, b) Southern North Sea, c) English channel, d) Northern Celtic Sea and E) Southern Celtic Sea.

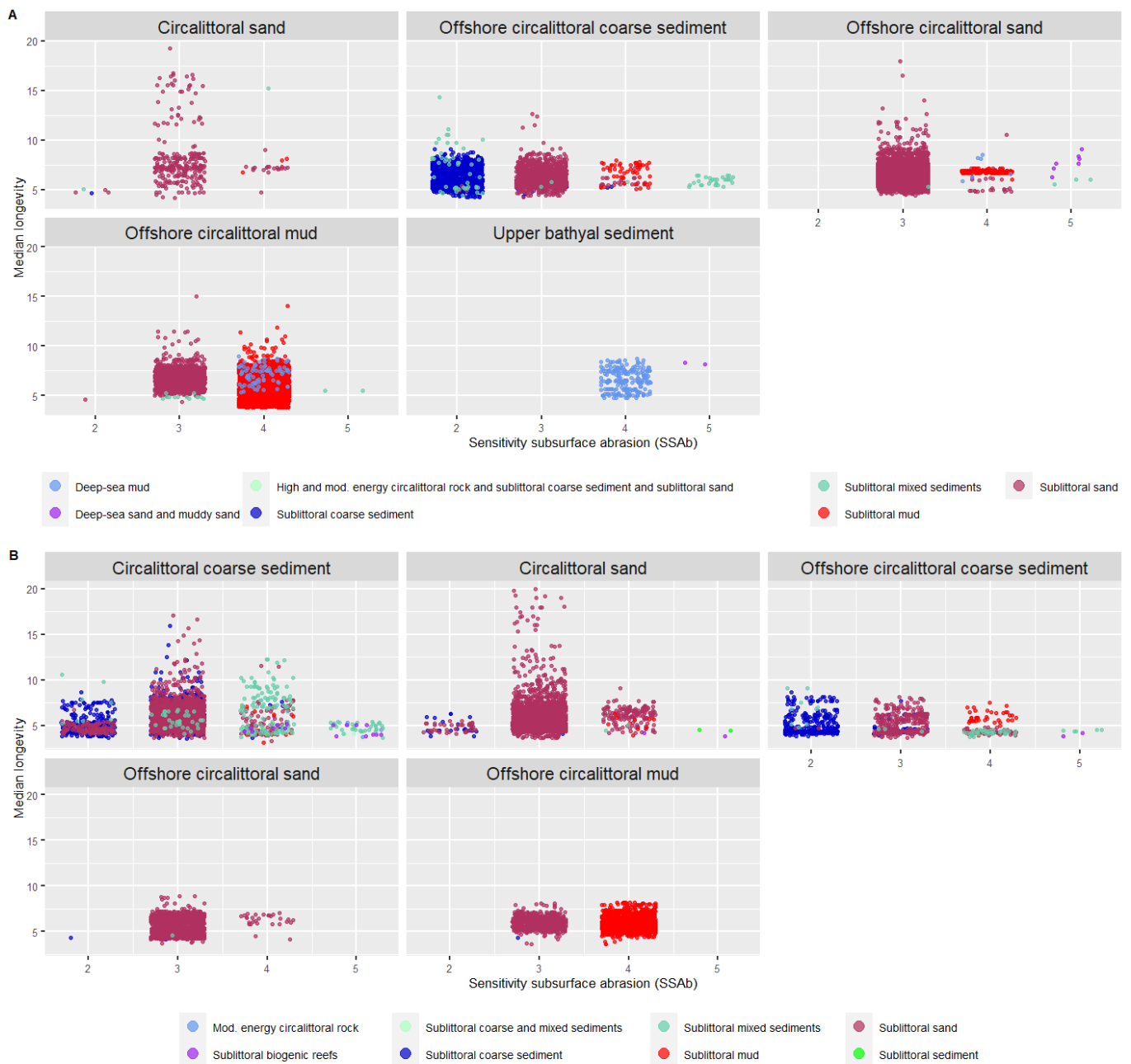


Figure 11: Jitter plots depicting OSPAR BH3 (SSAb) and ICES FBIT (Median Longevity) sensitivities for each grid cell. Each facet grid represents one of the five largest MSFD habitats (km^2) in the North-Central North Sea (A) and Southern North Sea (B). Plots are arranged based on increasing mean habitat depth from left (shallowest) to right (deepest). The colours correspond to the corresponding EUNIS Level 3 habitat, with abbreviated names (for full names, see Annex Table 21), for each grid cell.

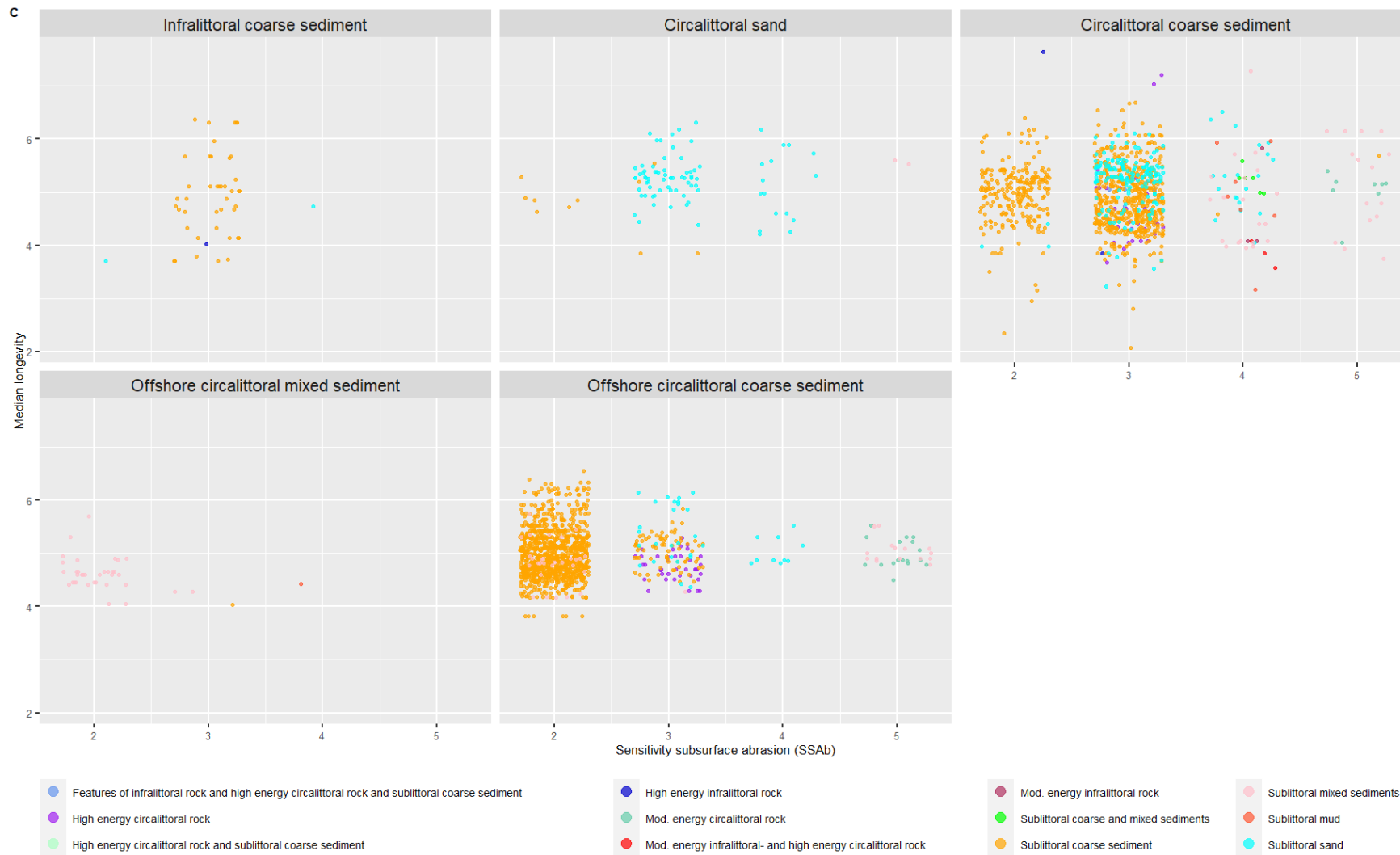


Figure 12: Jitter plots depicting OSPAR BH3 (SSAb) and ICES FBIT (Median Longevity) sensitivities for each grid cell. Each facet grid represents one of the five largest MSFD habitats (km^2) in the English Channel (3). Plots are arranged based on increasing mean habitat depth from left (shallowest) to right (deepest). The colours correspond to the corresponding EUNIS Level 3 habitat, with abbreviated names (for full names, see Annex Table 21), for each grid cell.



Figure 13: Jitter plots depicting OSPAR BH3 (SSAb) and ICES FBIT (Median Longevity) sensitivities for each grid cell. Each facet grid represents one of the five largest MSFD habitats (km²) in the Northern Celtic Sea (D) and Southern Celtic Sea (E). Plots are arranged based on increasing mean habitat depth from left (shallowest) to right (deepest). The colours correspond to the corresponding EUNIS Level 3 habitat, with abbreviated names (for full names, see Annex Table 21), for each grid cell.

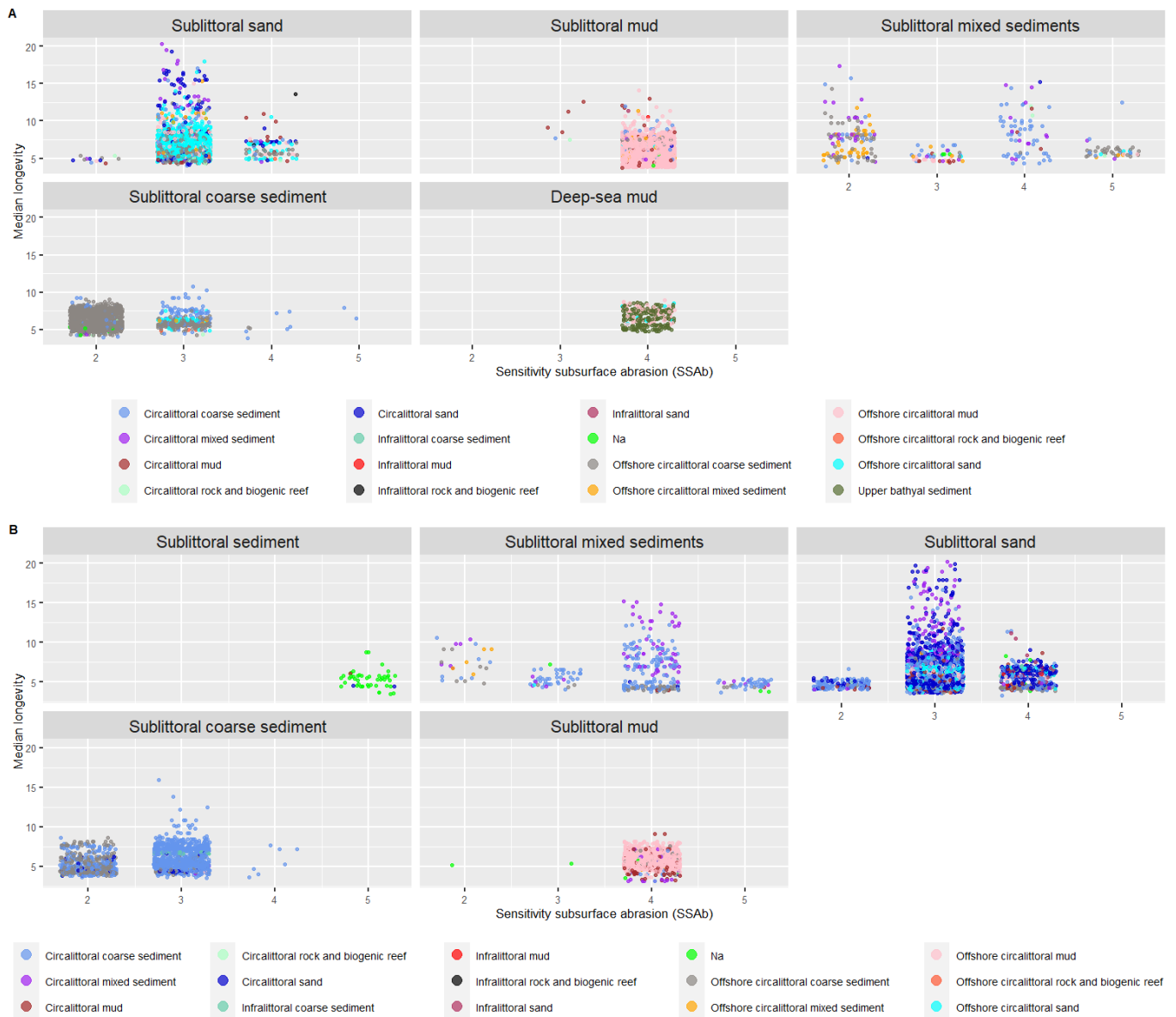


Figure 14: Jitter plots depicting OSPAR BH3 (SSAb) and ICES FBIT (Median Longevity) sensitivities for each grid cell. Each facet grid represents one of the five largest EUNIS L3 habitats (km²) in the North-Central North Sea (A) and Southern North Sea (B). Plots are arranged based on increasing mean habitat depth from left (shallowest) to right (deepest). The colours correspond to the corresponding MSFD broad habitat type (BHT) for each grid cell.

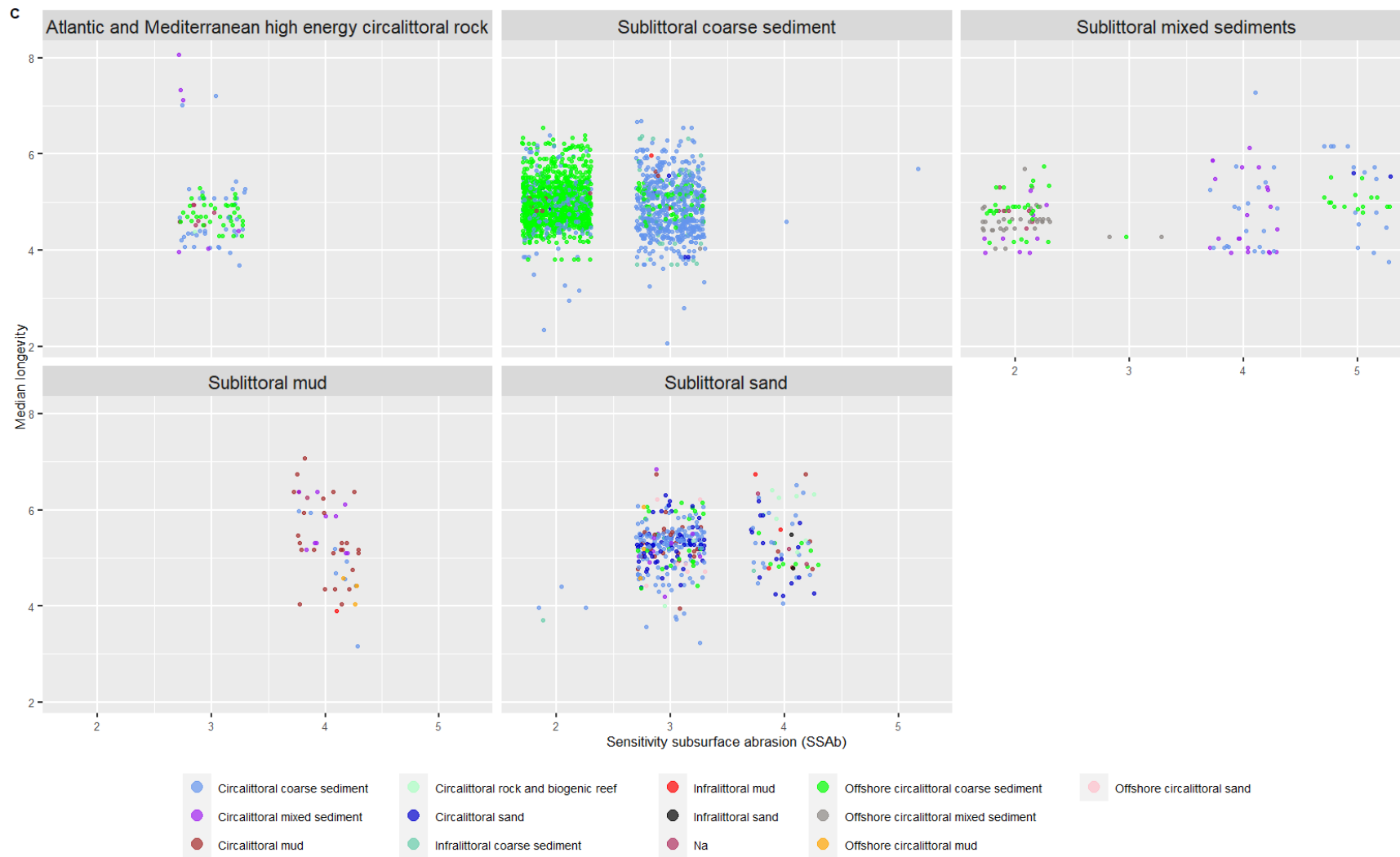


Figure 15: Jitter plots depicting OSPAR BH3 (SSAb) and ICES FBIT (Median Longevity) sensitivities for each grid cell. Each facet grid represents one of the five largest EUNIS L3 habitats (km^2) in the English Channel (C). Plots are arranged based on increasing mean habitat depth from left (shallowest) to right (deepest). The colours correspond to the corresponding MSFD broad habitat type (BHT) for each grid cell.

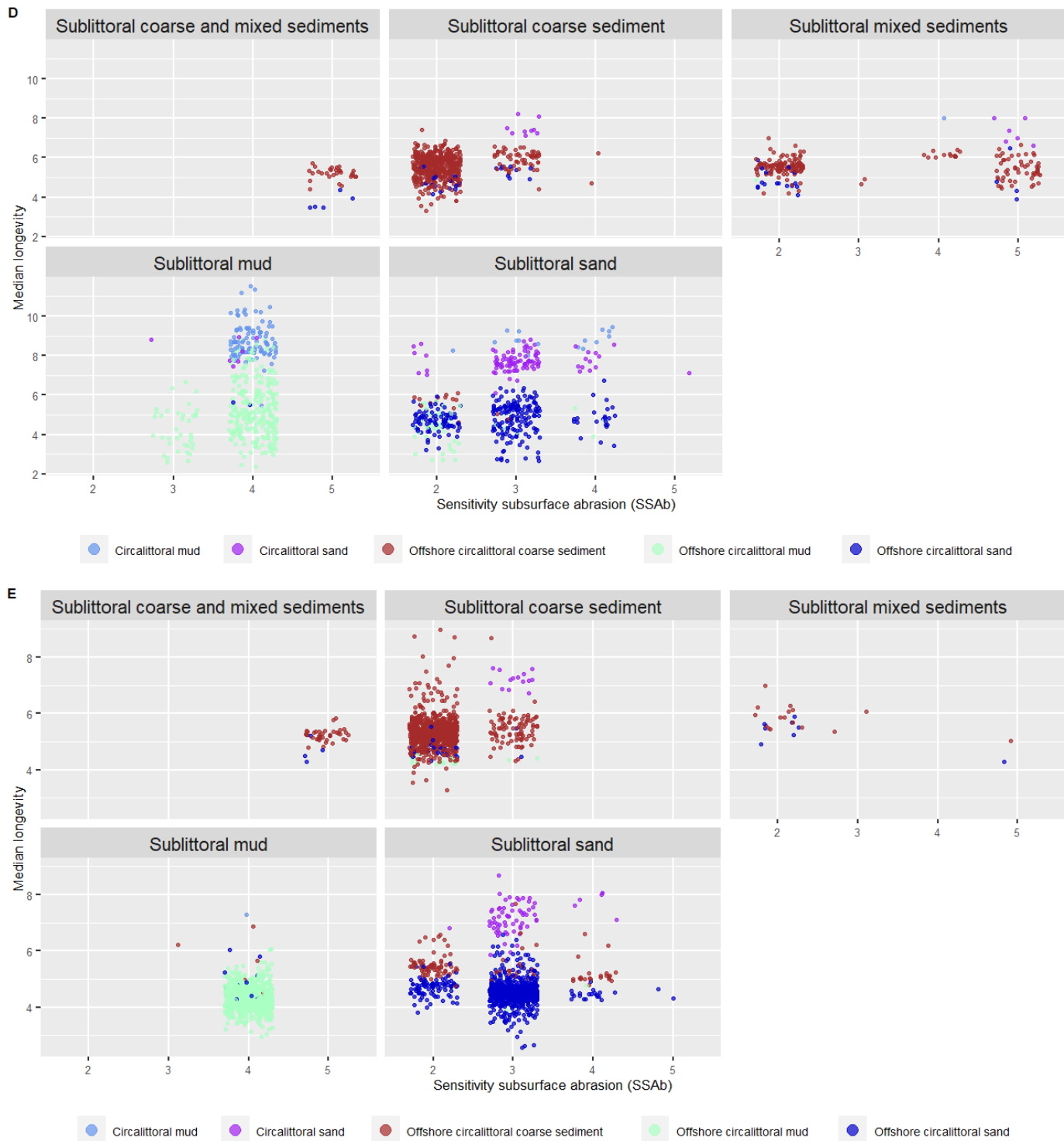


Figure 16: Jitter plots depicting OSPAR BH3 (SSAb) and ICES FBIT (Median Longevity) sensitivities for each grid cell. Each facet grid represents one of the five largest EUNIS L3 habitats (km²) in the Northern Celtic Sea (D) and Southern Celtic Sea (E). Plots are arranged based on increasing mean habitat depth from left (shallowest) to right (deepest). The colours correspond to the corresponding MSFD broad habitat type (BHT) for each grid cell.

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comparison of two approaches (OSPAR BH3 and ICES FBIT).
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