**Supplementary Information: limitations of the methodology**

**Limitations on sediment organic carbon content methodology**

**Table 1:** Estimates of organic carbon stored in the upper 10 cm of sediment within the FICZ, FOCZ, and total EEZ. Based on global estimates by Atwood et al. (2020) and Lee et al. (2019).

| **Zone** | **Area (km2)** | **Organic carbon pool (Tg), 0-10 cm, based on Atwood et al. (2020)** | **Organic carbon pool (Tg), 0-10 cm, based on Lee et al. (2019)** |
| --- | --- | --- | --- |
| **FICZ** | 222,188 | 167 | 98 |
| **FOCZ** | 233,043 | 138 | 89 |
| **Combined FCZs** | 455,231 | 305 | 187 |

Atwood et al. (2020) provided stock estimates for the upper 1 m of the sediment column. However, 84% of the observational data they used had to be standardized to 1 m, i.e., original measurements related to shallower depths and the stock values were scaled to 1 m assuming a uniform distribution of organic carbon in the upper 1 m of the sediment column. However, this assumption is unlikely to hold, as remineralization of organic carbon frequently leads to decreases in organic carbon content with depth. To provide more realistic estimates, we therefore divided the derived organic carbon pools by 10 to standardize these pools to the upper 10 cm of sediment. This yields organic carbon pools of 167 Tg and 138 Tg for the inner and outer conservation zones, respectively.

Additionally, we used global maps of organic carbon content (weight-%) and porosity provided by Lee et al. (2019) to calculate organic carbon stocks. Porosity can be converted to dry bulk density, assuming a constant grain density (2650 kg m-3 used here). The stock was derived by multiplying dry bulk density with the organic carbon stock (divided by 100) and the reference depth, for which the estimates were made (0.05 m in this case). Zonal statistics were used to derive mean values for the inner and outer zones and pool sizes derived as previously described. These were multiplied by 2 to standardize to the upper 10 cm. As previously outlined, this might have led to an overestimation. Despite this, values are lower than those derived from the data of Atwood et al. (2020). We estimate pools of 98 Tg and 89 Tg for the inner and outer zones, respectively.

**Limitations on broadscale offshore habitat mapping**

Offshore habitat mapping has been limited to either small-scale high-resolution surveys conducted to support offshore exploration of oil and gas (Nobel, 2014; FOGL, 2011) or broad-scale predictive modeling of VME taxa as proxies of VME location and extent (Brewin et al., 2020). These surveys have included unsupervised classification of the physical environment (Pearman, 2021) in support of fisheries Marine Stewardship Council (MSC) accreditation and mapping has largely focused on benthic environments between water depths of 300 - 3000 m. However, data informing these maps has principally come from water depths of 600 - 1800 m. The limited spatial extent of ground-truthed data coupled with the low resolution of environmental data used in these models is the main limitation of habitat maps (Guisan and Thuiller, 2005; Ross et al., 2015). Environmental data layers for the FICZ are only available from regional or global models for bathymetry, substrates and oceanographic properties (e.g. GEBCO, GLOBAL Ocean Sea Physical Analysis and Forecasting Products, Global Ocean Biogeochemistry Hindcast model, Bio-ORACLE and dbSEABED) (SI.2 Table 1). Unsupervised classification maps derived from these data can identify geomorphic features such as canyons or steep slopes (Hogg et al., 2016; Ismail et al., 2015) that are associated with VMEs (FAO, 2008, 2016). However, the low resolution of the environmental data outputs do not necessarily capture the scale at which these variables influence species spatial patterns, which can lead to inaccuracies (Lecours et al., 2015; Miyamoto et al., 2017; Porskamp et al., 2018). Low-resolution environmental data can also lead to over prediction of habitat extents (Ross et al., 2015). Furthermore, the high spatial uncertainty associated with bycatch records used to develop predictive VME taxa models introduces further uncertainty into predicted location and extent (Guisan and Thuiller, 2005) and often limits researchers and policy makers to presence only models.

**Limitations of areal extent estimates**

In order to establish the distribution of carbon-rich habitat using available VME datasets based on OBIS (2022), Brewin et al., (2020) and SAERI unpublished data (Manuscript fig. 2) we calculated VME areal extent in ESRI ArcGIS using a UTM21S projection chosen as the most representative for regional estimates. Areal extents were also calculated for functional groups based on Barnes and Sands 2017 for comparison where possible (Table 2.). This method uses polygons to determine an extent between nearby sampling locations, which means there is a level of imprecision of c. 20 - 25 kms. This imprecision assumes that suitable habitat might be between specimen locations, with a similar bathymetry (which is largely unknown).

VME indicator taxa are not well described in the South West Atlantic, and as a consequence species occurrences are aggregated into higher taxonomic groupings according to the CCAMLR VME Taxa Classification Guide 2009 (https://www.ccamlr.org/en/system/files/VME-guide.pdf) for the following taxa grouped by Phylum (Table 2.) - Annelida - Serpulidae; Arthropoda - Bathylasmatidae; Brachiopoda; Bryozoa; Chordata- Ascidiacea; Cnidaria- Actiniaria, Alcyonacea, Pennatulacea, Scleractinia, Antipathraia, Hydroidolina, Stylasteridae; Echinodermata- Crinoidea, Ophiurida, Cidaroida; Hemichordata; and Porifera (manuscript Fig. 1). Improved VME identification and reporting by fisheries observers, if added to existing protocols and resourced effectively, will also help to clarify these estimates in future studies. The inclusion of a number of habitat and environmental baseline surveys conducted to support offshore exploration of oil and gas (Nobel, 2014, FOGL, 2011 unpublished data) with small –scale high – resolution bathymetry (Manuscript Fig.1), imagery data and grab sampled fauna and sediment samples, also provide comparative data sets for future analyses across the FCZs. In this context, area estimates should be viewed as a first-level assessment with the amount and type of data currently held (in combination with that of other sources, compiled in SI.2 Table 1).

**Table 2.** Projected areal extent of VMEs and functional groups calculated in GIS based on OBIS, Brewin et al., (2020) and SAERI unpublished data in UTM21S geographic projection.

| **Functional group**  | **VME only km2**  | **All known fauna km2** |
| --- | --- | --- |
| **Pioneer sessile suspension feeders**  | 77,561.4 | 77,561.4 |
| **Climax sessile suspension feeders** | 90,895.2 | 90,895.2 |
| **Sedentary suspension feeders** | 44,571.2 | 44,696.4 |
| **Mobile suspension feeders** | NA | 15,337 |
| **Epifaunal deposit feeders** | NA | 8,889.2 |
| **Infaunal soft bodied deposit feeders** | NA | 10,266.4 |
| **Infaunal shelled deposit feeders** | NA | 32,051.2 |
| **Grazers** | 42,568 | 68,734.8 |
| **Soft bodied, sessile scavenger/predators** | 60,784.6 | 60,847.2 |
| **Hard bodied, sessile scavenger/predators** | 26,354.6 | 26,354.6 |
| **Soft bodied, mobile scavenger/predators** | NA | 18,341.8 |
| **Hard bodied, mobile scavenger/predators** | NA | 67,482.8 |
| **Jointed legged, mobile scavenger/predators** | NA | 53,335.2 |
| **All taxa from FCZs** | **174,216** | **174,654** |

Where depth data was available, we estimated the areal coverage of the Falkland Islands mesophotic zone (Table 3.). Fisheries GIS layers were used to assess the amount of area predicted as either restricted or closed to fishing for periods of time in the FCZs (Table 3.). Fisheries data are based on multiple fished species and areas (see Falkland Island Fisheries reports: https://www.falklands.gov.fk/fisheries/). Consequently, the area estimated herein requires further clarification across species, temporal and spatial scales for context.

**Table 3.** Predicted areal extent of mesophotic habitat and the area closed or restricted to fishing for periods of time within the FCZs calculated in GIS in UTM21S geographic projection.

| **Blue carbon type** | **Areal extent km2** | **% of FCZs** | **Reference** |
| --- | --- | --- | --- |
| Area currently closed to Fisheries in the FICZ; and area in which fishing is either temporarily closed or restricted  | c. 248,000c. 19,000 | c. 55%C. 4% | Falkland Islands Fisheries |
| Estimated mesophotic habitat  | c. 50,000 | c. 11.00 | OBIS, Brewin et al., 2020, SAERI unpublished data |

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