

**RWE Renewables UK Dogger Bank
South (West) Limited**

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Dogger Bank South Offshore Wind Farms

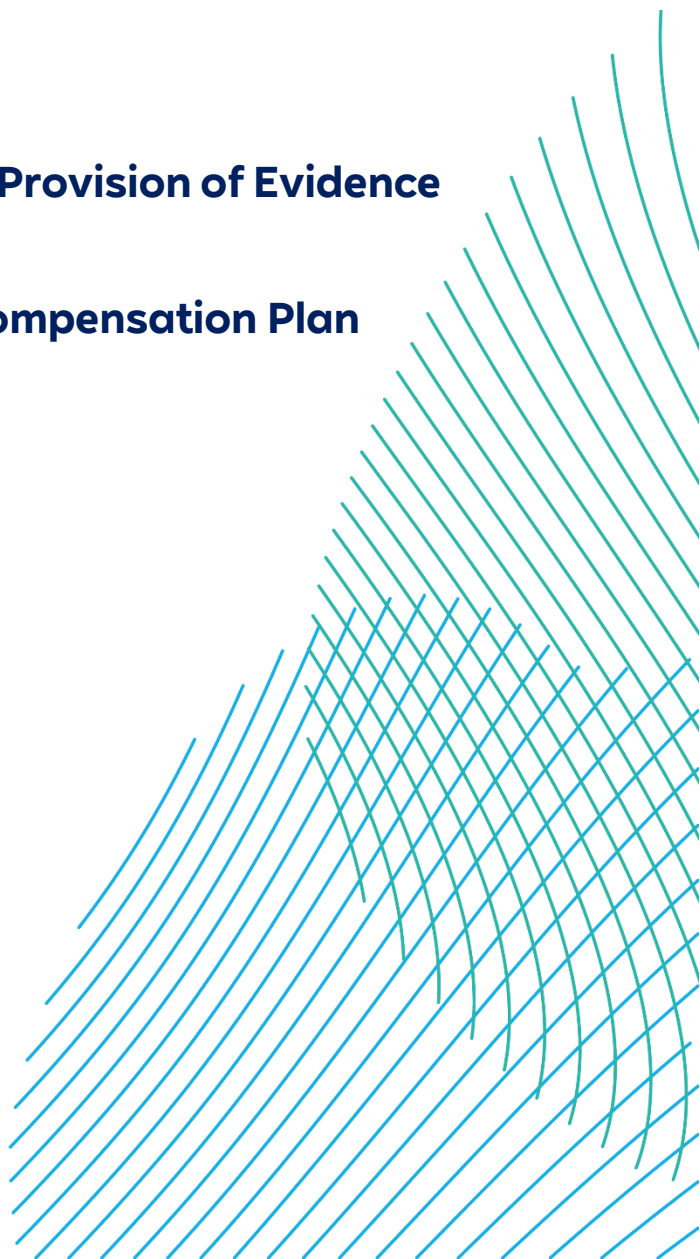
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Volume 6
Round 4 Dogger Bank Strategic Compensation Plan**

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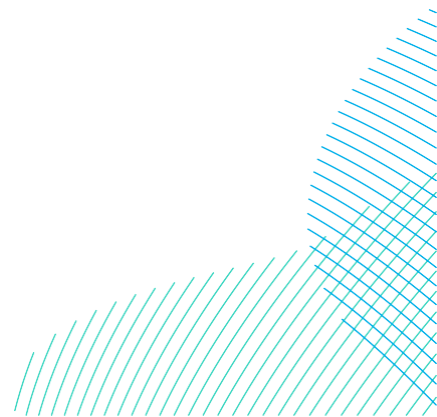
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Offshore Wind Leasing Round 4

Dogger Bank Strategic Compensation Plan

The Crown Estate

Date: 25th April 2024

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1 Introduction

1.1 Round 4 Plan HRA

- 1.1.1 The Crown Estate adopted the Offshore Wind Leasing Round 4 Plan ("Round 4 Plan") in January 2023 with the objective of generating between 7 to 8.5GW of additional offshore wind farm capacity. As a competent authority, The Crown Estate was required to undertake a plan level Habitats Regulations Assessment (the "Round 4 Plan Level HRA") to meet its obligations under the Conservation of Habitats and Species Regulations 2017 (as amended), and the Conservation of Offshore Habitats and Species Regulations 2017 (as amended) (collectively referred to as the "Habitats Regulations" within this document). The Crown Estate adopted the Round 4 Plan when it decided to proceed with entry into agreements for lease for the six projects comprised in Round 4.
- 1.1.2 NIRAS Group (UK) Ltd ("NIRAS") was commissioned as technical adviser to The Crown Estate on the Round 4 Plan Level HRA. In this capacity, NIRAS also completed the Report to Inform Appropriate Assessment ("RIAA") (NIRAS, 2021). The RIAA recommended that The Crown Estate's "Appropriate Assessment" (The Crown Estate, 2022) conclude that the Round 4 Plan alone and in-combination will not have an adverse effect on the site integrity ("AEOSI") of the majority of Protected Sites¹ considered. However, in the case of Annex I sandbanks slightly covered by seawater all of the time (hereafter "sandbank") as a feature of Dogger Bank Special Area of Conservation ("SAC") and black-legged kittiwake *Rissa tridactyla* as a feature of Flamborough and Filey Coast ("FFC") Special Protection Area ("SPA"), it was not possible to recommend a finding of no AEOSI, in view of the impacts assessed for those sites.
- 1.1.3 This report relates to the sandbank feature of Dogger Bank SAC and two Round 4 projects which contribute towards the conclusion of AEOSI for this Protected Site: Dogger Bank South West ("DBSW") and Dogger Bank South East ("DBSE") in Figure 1.1.
- 1.1.4 Based on this recommendation, The Crown Estate's Appropriate Assessment concluded that an AEOSI of the sandbank feature of the Dogger Bank SAC could not be excluded due to the effects of the Round 4 Plan and specifically the two Round 4 projects shown in Figure 1.1 alone or in-combination with other plans and projects. Although mitigation was identified (Table 1.1), and is secured in obligations within the agreements for lease with DBSW and DBSE, to reduce the effects of the Round 4 Plan, this was not considered sufficient to avoid an adverse effect in light of the site's unfavourable status with respect to sandbank habitat. Under the derogation provisions of the Habitats Regulations, the Round 4 Plan can still go ahead notwithstanding a finding that there will or could be an AEOSI of a Protected Site. This only applies where: (a) there is no alternative solution which would be less damaging or avoid damage to the Protected Site; (b) there are imperative reasons of overriding public

¹ In accordance with the Habitat Regulations, "Protected Sites" include European sites and European offshore marine sites which comprise the following designations: Special Areas of Conservation ("SAC"), candidate SAC ("cSAC"), Special Protection Areas ("SPA"), potential SPA ("pSPA") and Sites of Community importance ("SCI"). As a matter of government policy, Ramsar sites (designated under the Convention on Wetlands of International Importance) are also treated as Protected Sites, as are areas secured as sites compensating for damage to a Protected Site. This list aligns with recent HRA guidance published by DEFRA (DEFRA, 2021).

interest ("IROPI") to proceed with the Round 4 Plan; and (c) any necessary compensatory measures can be secured (to ensure the overall coherence of the UK National Site Network).

Table 1.1 Mitigation measures and related impacts relevant to Dogger Bank SAC identified through The Crown Estate's Appropriate Assessment

Protected site	Feature	Impact(s)	Mitigation
All Protected Sites	All features	Climate change effects	Prioritise sustainable practices. Ensure efficient movements of marine vessels.
All Protected Sites screened into the Export Cable Risk Assessment ("ECRA")	Applicable to all Protected Site features assessed within the ECRA	Multiple potential impacts as described in the ECRA, including habitat loss, damage and both direct and indirect effects.	Preparation of a cable route selection and burial feasibility studies including consideration of alternatives and explicit justification where there is interaction with protected feature(s). Development of focused mitigation where required, e.g. limitation on the use of specific methods such as cable protection.
Dogger Bank SAC	Sandbanks which are slightly covered by sea water all the time (extent and distribution)	Habitat Loss	Conditions on limiting the extent of infrastructure and the provision of specific information to The Crown Estate on infrastructure characteristics.

- 1.1.5 A "Derogation Case" in support of the Round 4 Plan was produced alongside the Appropriate Assessment (Chapter 8 of The Crown Estate, 2022). This demonstrated that there were no feasible alternative solutions to the Round 4 Plan which would meet the Round 4 objectives and be less damaging or avoid damage to Dogger Bank SAC, there were clear IROPI to proceed and that a robust framework for the delivery of the necessary compensatory measures to offset the adverse effect would be secured. These compensatory measures only apply to DBSW and DBSE which the Round 4 Plan Level HRA identified as a source of potential additional habitat loss and direct physical damage.
- 1.1.6 The Crown Estate's Derogation Case included a commitment to develop a Dogger Bank Strategic Compensation Plan ("DBSCP", this document) which must be adhered to by the DBSW and DBSE projects, secured through their seabed lease agreements. The overall objective of this DBSCP is to detail the development and delivery of strategic compensation to ensure the overall coherence of the UK National Site Network. Strategic compensation for the purposes of the Round 4 Plan is defined here as compensatory measures delivered collectively to address the AEOSI of Dogger Bank SAC from the Round 4 Plan.
- 1.1.7 This document sets out the DBSCP associated with the Dogger Bank SAC. It describes the proposed strategic compensation for the effects on the sandbank feature of Dogger Bank SAC and how this can be secured, delivered, monitored and adapted.
- 1.1.8 Further details on the precise delivery method for the measures included in this DBSCP will be provided in a Dogger Bank Strategic Implementation and Monitoring Plan ("DBSIMP") submitted to the Secretary of State at the Department for Energy Security and Net Zero ("DESNZ") prior to the

operation of any wind turbine generator at DBSW and DBSE. The DBSIMP would be approved by the Secretary of State (DESNZ) in consultation with the Department for Environment, Food and Rural affairs ("Defra"), the Marine Management Organisation ("MMO") and/or local planning authority and Natural England ("NE") or the Joint Nature Conservation Committee ("JNCC") as the relevant Statutory Nature Conservation Body ("SNCB"). An outline version of the DBSIMP (which details its proposed content) is presented in Appendix A.

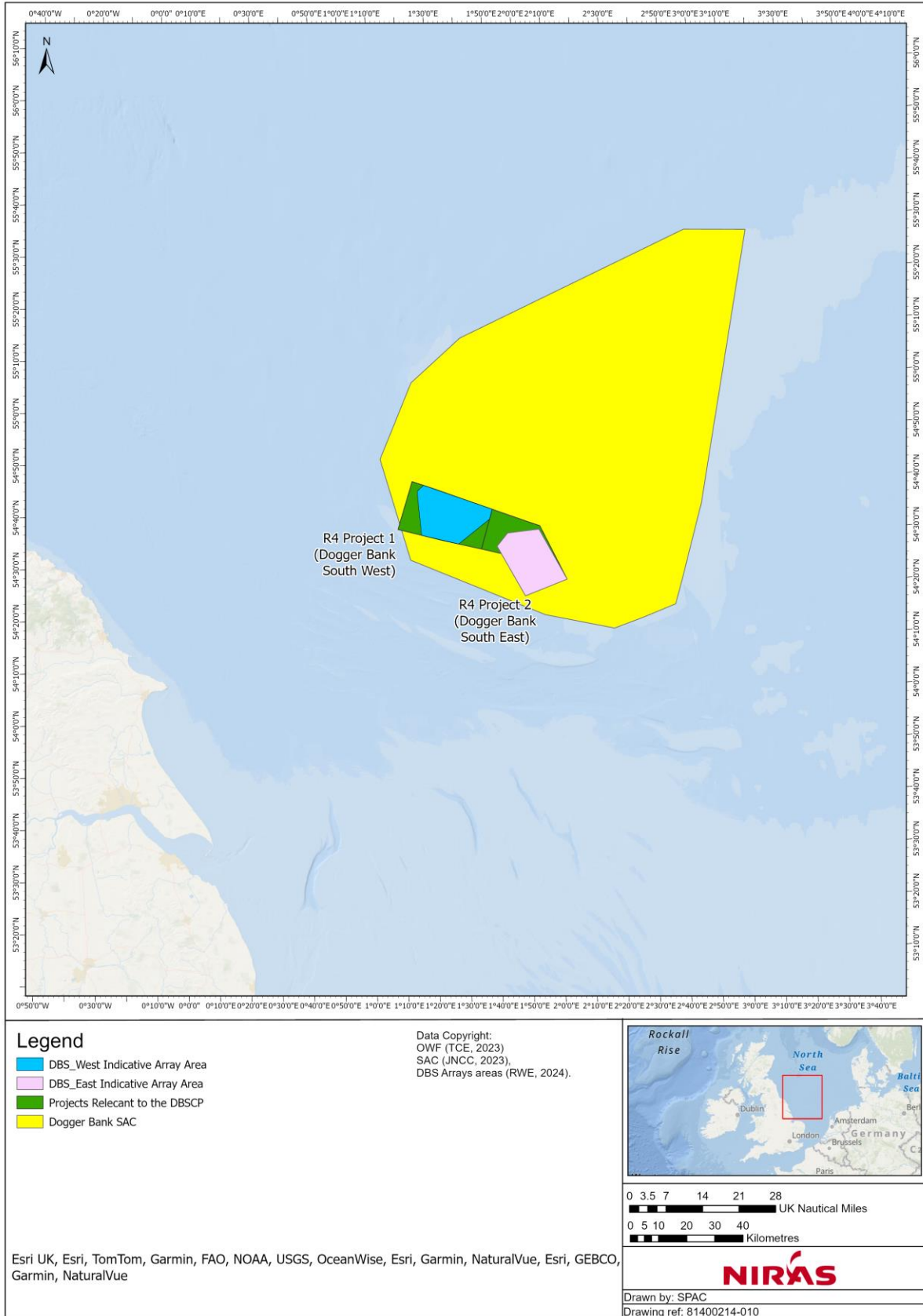


Figure 1.1 Dogger Bank SAC in relation to the two relevant Round 4 projects to the DBSCP.

1.2 Secretary of State Letter of Acceptance

- 1.2.1 On the 15th July 2022, the Secretary of State for Business, Energy & Industrial Strategy (“BEIS”) issued a letter of acceptance of The Crown Estate’s Notice of Derogation (Appendix B). This letter stipulated a number of key factors which must be attained by the Round 4 compensation required as a result of the Round 4 Plan, and obligated The Crown Estate to comply with the commitments made within its Derogation Case.
- 1.2.2 Of particular note is the Secretary of State for BEIS’ request that *“agreement of the compensation plan within each Steering Group is required before submission of DCO applications”*. This has been achieved by the steering group established for the DBSCP (see Section 2) and is demonstrated within the Agreement Log (see Section 4 and Appendix C). The letter of acceptance (Appendix B) also outlined the importance of monitoring and adaptive management associated with the Round 4 compensatory measures. These aspects are considered in detail in Section 10 and Section 11 respectively.
- 1.2.3 A key purpose of this DBSCP is to demonstrate that compensatory measures can be implemented, with confidence, to offset the potential impacts to the sandbank feature of Dogger Bank SAC as a result of the Round 4 Plan.

2 Steering Group Engagement Process

- 2.1.1 A Round 4 Plan Strategic Steering Group for habitat compensation (hereafter referred to as the “Steering Group”) was formed by The Crown Estate in accordance with agreed Terms of Reference. The Steering Group has overseen the development of this DBSCP.
- 2.1.2 The Steering Group consists of a nominated representative from the following organisations:
- The Crown Estate, with NIRAS as its technical advisor
 - NE;
 - JNCC;
 - Defra;
 - DESNZ; and
 - Developer of DBSW and DBSE – RWE Renewables.
- 2.1.3 Steering Group meetings have also been attended by Offshore Wind Industry Council, as a guest in an observation capacity, to tie in with their parallel work on strategic compensation through the Collaboration on Offshore Wind Strategic Compensation workstreams. The Wildlife Trusts have also attended from meeting 11 in an observational capacity.
- 2.1.4 Steering Group meetings have been held in a hybrid manner with attendance in person and via Microsoft Teams. Meetings have been approximately three hours in duration and held once every two months as a minimum (but closer to once every month on average) from December 2022 while this DBSCP has been in development, and will be ongoing at least quarterly throughout the year and otherwise as frequently as monitoring reports are received and as appropriate throughout the delivery of the relevant compensatory measures. Meetings have been and will continue to be chaired by The Crown Estate and facilitated by NIRAS as technical specialists in benthic ecology and compensation. Meeting minutes have been and will continue to be captured, along with the use of an Agreement Log (Appendix C) which outlines key areas of Steering Group agreement and disagreement, to assist

the Secretary of State (DESNZ) in determining the acceptability of the compensation proposed within this DBSCP at the project consenting stage.

2.1.5 This DBSCP is written in accordance with the Terms of Reference and should be read in conjunction with the Agreement Log (Section 1 and Appendix C).

2.1.6 A breakdown of meetings and key areas of discussion is presented in Table 2.1.

Table 2.1 Overview of Round 4 Plan strategic compensation Steering Group meetings

Meeting #	Meeting date	Main focus of Steering Group discussion
1	15 th December 2022	Recap of background to the Round 4 Plan compensation process to date including details of the derogation case and potential measures that have been identified. Potential options were discussed and recorded and evidence gaps explored.
2	9 th March 2023	Further discussion and refinement of potential options. Exploration of key compensation aspects, including scale & ratio, timing & duration, delivery mechanisms, monitoring, adaptive management and success criteria.
3	28 th March 2023	Development of roadmap for refining and agreeing compensation measures. Further discussion of options and key aspects including: <ul style="list-style-type: none"> • Strategic Compensation Roadmap • What a package may look like • Delivery mechanism • Adaptive management
4	25 th April 2023	The delivery mechanism was reviewed, outlining potential compensation packages. The potential of including some measures lower on the hierarchy was discussed. Scale, ratio and potential option locations for the proposed compensation measures were also considered. <ul style="list-style-type: none"> • Approaches to delivering compensation (the minimum level of compensation required) • Application of compensation ratios • Delivery mechanism
5	24 th May 2023	Discussion focused on refining compensation measures lower on the hierarchy in line with guidance.
6	21 st June 2023	Proposed compensation measures lower on the hierarchy were reviewed and linked back with compensation objectives. Scale and ratio for the measures were discussed.
7	2 nd August 2023	Potential site locations for compensation options were considered. Potential compensation package composition was outlined.
8	30 th August 2023	The discussion was around the remaining options under consideration; removal of future activities, site designation / extension, sea grass oyster and non-native invasive species (NNIS) were discussed. The use of alternative metrics, to area, in defining scale in compensation measures for determining scale

		was discussed. Delivery mechanisms including financial support to existing habitat creation / restoration initiatives were outlined. Adaptive management principals were introduced to the group.
9	11 th October 2023	The discussion was around some of the remaining options under consideration; site designation / extension, seagrass oyster and NNIS were discussed. Details on the site selection process utilised were outlined and potential metrics to be used to help to inform scale were also considered. Potential delivery mechanisms and monitoring were also discussed.
10	29 th November 2023	Discussion focused on the contents and methodology of the proposed compensation packages. It was discussed that the impact of the project could be split into habitat loss & habitat damage – habitat loss will require 100% of the area to be compensated for, but as damaged habitat has scope for recovery, a starting point of 20-25% of the area to be compensated for was initially proposed to the group.
11	23 rd January 2024	This meeting was post the first Expert Working Group (EWG) & Steering Group review of the compensation plan. Discussion was focused on key areas of feedback, highlighted in the review and how to resolve them. The group discussed the following topics: New site designation, fishing by-laws, monitoring/adaptive management, compensation measures (in general) & scale/ratio. The DBSCP was revised post meeting as per the groups Steering Group's comments and suggestions.
12	21 st February 2024	Following the information in the email provided to the group from Defra on 01/02/2024, site designation/extension has been approved as an appropriate form of strategic compensation. The DBSCP was updated to reflect this, and this was presented to the Steering Group. Other major changes made to the DBSCP, as discussed in meeting 11, were reviewed and agreed with the Steering Group.
13	10 th April 2024	This meeting was post the Steering Groups second review of The DBSCP (v2.2). Discussion was focused on key areas of feedback. The group finalised the wording for the justification of why measures were not taken forward. The seagrass restoration potential maps were reviewed and position on subtidal and intertidal seagrass addressed. The group discussed feedback received from DTA Ecology, the implications of the recently published 'Draft Defra MPA Guidance Consultation' and the status of the restriction of future offshore wind options. NIRAS updated The DBSCP based on the discussion and comments.

2.1.7 Engagement with the HRA Expert Working Group (“EWG”), which supported The Crown Estate with the Round 4 HRA process, has also been undertaken. The EWG has been provided with written updates following each Steering Group meeting including a summary of the discussion and high-level programme, a verbal update at a workshop held on 7th June 2023, bi-lateral meetings as requested by EWG members and a draft of this DBSCP for review for consultation held between 1st December 2023 and 12th January 2024. A version of the revised draft was also provided to EWG members on 8th March 2024 for information, with feedback welcomed, considered and incorporated as appropriate. The EWG have not received a copy of the final version of this DBSCP. The role of the EWG (in relation to the DBSCP) is to offer advice to the Steering Group on the process of determining compensation and recommendations on outcomes. The EWG consists of the following organisations:

- NE;
- JNCC;
- DEFRA;
- DESNZ;
- Natural Resources Wales;
- NatureScot;
- Marine Scotland;
- Department of Agriculture, Environment, and Rural Affairs (Northern Ireland);
- MMO;
- The Wildlife Trusts;
- Royal Society for the Protection of Birds (“RSPB”); and
- Whale and Dolphin Conservation.

3 Proposed Compensation Approach

3.1 Overview

- 3.1.1 The requirement for compensation specifically relates to the predicted loss and damage of Annex I sandbank habitat at Dogger Bank SAC.
- 3.1.2 The Round 4 Plan Level HRA estimated that up to 2.035 km² of Annex I sandbank habitat would be lost and up to 32.209 km² damaged through construction and operation of DBSW and DBSE on Dogger Bank SAC (as defined in RIAA Appendix J, (The Crown Estate, 2022)). Habitat loss and damage are further defined in the RIAA; however, briefly, loss is associated with the covering of Annex I sandbank habitat by wind farm infrastructure such as wind turbine foundations and rock armour, damage includes all direct and indirect effects on sandbank habitat, other than habitat loss/change, encompassing a range of pressures such as abrasion, penetration and smothering.
- 3.1.3 The impact of habitat loss was considered in the RIAA as effectively a permanent impact since it would persist for the lifetime of the Round 4 projects, specifically DBSW and DBSE, which is currently expected to be as long as the impact persists, up to 60 years (the duration of the lease). Recovery from habitat damage would be expected (e.g. BEIS, 2019) but the Round 4 Plan Level HRA recognised that sandy mound sandbanks such as Dogger Bank have limited recovery ability compared to more dynamic current tidal sandbanks. For this reason, habitat damage was included as part of the reason behind the conclusion of AEOSI of the sandbank feature of Dogger Bank SAC, alongside habitat loss.
- 3.1.4 The habitat damage value represents the seabed area expected to be affected by activities such as

cable burial (where not followed by rock protection, for which habitat loss is assumed), placement of temporary anchors and jack-up barge legs etc. Habitat recovery from damage would be expected (e.g. BEIS, 2019) but the Round 4 Plan Level HRA recognised that sandy mound sandbanks such as Dogger Bank have limited recovery ability compared to more dynamic current tidal sandbanks. Recovery from habitat loss would not occur until decommissioning has been completed, and, may take 10-25 years (based on Natural England's advice). Such impacts would delay restoration which would be contrary to the conservation objectives of this the Dogger Bank SAC. This impact can be reduced with mitigation that limits the extent of infrastructure within the SAC, but not to levels at which an AEOSI can be discounted.

- 3.1.5 Measures are therefore required to compensate for the impacts of habitat loss and habitat damage.
- 3.1.6 The Steering Group identified and evaluated a longlist of potential compensatory measures (Appendix D) which represent a range of options that were evaluated as more or less preferred according to the hierarchy of compensatory measures for the marine environment in draft guidance published by DEFRA (2021). This guidance recommends that, in simple terms, the selected compensation will by preference address the same impact (sandbank habitat loss and damage) at the same location (Dogger Bank SAC), but if this is not possible then measures which support the same or comparable ecological function at other locations may need to be considered but could still be regarded as providing adequate compensation.
- 3.1.7 At the time of writing there is ongoing consultation on policies to inform updated guidance for Marine Protected Area (MPA) assessments, including approaches to compensation. Documentation circulated as part of this consultation includes an updated compensation hierarchy which emphasises the ecological effectiveness of measures (Defra, 2024). Having reviewed this documentation it is considered that the DBSCP aligns with the proposed new hierarchy in prioritising the ecological effectiveness of measures; however, noting that the proposed new hierarchy is contained within a consultation document which may undergo further changes this Plan refers to the Defra (2021) draft guidance.
- 3.1.8 The measures which are taken forward in this Plan are identified in Table 3.1 which also summarises the principal reasons for not including other measures. In subsequent sections of this document the measures which are taken forward are presented in order of preference according to the evaluation against the Defra (2021) hierarchy.

Table 3.1 Long list of measures considered by the steering group, with reasons for inclusion or exclusion from The Plan.

Measure	Primary reason(s) for inclusion or exclusion of measure (where applicable)
New site designation	This measure remains under consideration for this Plan.
Extension of existing site	This measure remains under consideration for this Plan.
Restriction of future activities/licences in existing SAC with sandbank feature	<p>For fishing: This measure remains under consideration for this Plan.</p> <p>For future OWF: The Crown Estate is a public authority for the purposes of subsidy control. A subsidy occurs when a public authority provides financial assistance (which is defined very broadly) to a specific enterprise/group of enterprises that gives them an economic advantage. Were TCE to enter into commitments to sterilise other parts of its estate to enable the Project Companies' projects to proceed, that may be construed as a subsidy.</p> <p>For aggregates: Aggregate extraction is required to be managed to allow recovery. Therefore, it is unclear if restricting this activity would compensate for habitat loss. Analysis indicates that overlap with Annex I sandbank is limited and so it is also the case that the potential to provide compensation is small.</p> <p>For O&G: DESNZ have confirmed that based on the knowledge that geological stores are fixed assets and in light of current energy targets it is unlikely to be possible to deliver this measure within this Plan.</p>
Reduce pressures from other activities in Dogger Bank SAC	There are currently no relevant activities within Dogger Bank SAC that can be feasibly be managed at a suitable scale which are not already being managed.
Reduce pressures from other activities in sites (outside of MPA network) that contain sandbanks	<p>This measure is taken forward for fishing.</p> <p>For future OWF: The Crown Estate is a public authority for the purposes of subsidy control. A subsidy occurs when a public authority provides financial assistance (which is defined very broadly) to a specific enterprise/group of enterprises that gives them an economic advantage. Were TCE to enter into commitments to sterilise other parts of its estate to enable the Project Companies' projects to proceed, that may be construed as a subsidy.</p>
Seagrass restoration	This measure remains under consideration for this Plan.
Lease seabed for the purposes of conservation	Conflicts with obligations under The Crown Estate Act & The Energy Act.
Removal of structures within Dogger Bank SAC	<p>No/not enough structures that could be approved & removed within the timescales of this plan.</p> <p>The practical ability to remove structures is also uncertain and there is a significant cost/difficulty in the removal of rock coupled with risk of damage to existing feature.</p>

Measure	Primary reason(s) for inclusion or exclusion of measure (where applicable)
Removal of structures at other SACs with sandbank feature	As per Removal of structures within Dogger Bank SAC.
Removal of debris	This is not considered as a compensation measure. See Appendix D for further details.
Sandbank recreation/restoration	No sites identified in need restoration other than by management of activities. No evidence that the physical restoration could be successfully delivered.
Invasive species eradication in Dogger Bank SAC	Not understood to be a current risk to the conservation objectives of the site. Uncertainties around ability to deliver and maintain the measure for this Plan.
Invasive species eradication at other SACs with sandbank feature	Uncertainties around ability to deliver and maintain the measure for this Plan.
Reef creation/enhancement	Not considered to provide comparable ecological function to Annex I sandbank. So not an appropriate measure for this Plan.

3.1.9 Much of the discussion by the Steering Group, and supporting work by NIRAS, revolved around a number of key topics which were considered critical to development of the DBSCP:

- Selecting appropriate compensatory measures through a process of identifying the ecologically suitable, rejecting those which would be unsuitable (for whatever reason) and challenging measures where there was uncertainty;
- Relating the function of sandbank habitat to the function of potential compensation measures;
- Developing approaches to allow compensation measures to be scaled, especially in order to provide comparable metrics to area where simple areal comparisons may not represent the best approach, in order to quantify compensation;
- Providing confidence that there are suitable locations for compensation measures to be implemented;
- How the proposed compensation will be delivered, success confirmed through monitoring and, if necessary, the use of adaptive management to ensure success if monitoring raises concerns about delivery.

3.1.10 These key topics are reflected in the structure of this document. The remaining paragraphs in this section summarise the three compensatory measure options selected from the longlist (Appendix D) for further consideration at this time, and which are included in this DBSCP. The measures are shown in order of ecological preference, as considered by the Steering Group.

3.2 New site designation or site extension

3.2.1 It is agreed by the group Steering Group that new site designation or site extension (new areas or features added to existing sites) is the recommended compensation measure of in this DBSCP and this follows advice received from Defra that this is an available strategic compensation measure that can

be used to compensate for habitat loss and damage caused by the Round 4 Plan.

3.2.2 New site designation or extension aims to provide protection to Annex I sandbank habitat outside of the existing marine protected area (MPA) network. In doing so, the integrity of the MPA network can be maintained, despite the loss and damage to sandbank habitat within Dogger Bank SAC as a result of the Round 4 Plan. New sites would be afforded at least the same level of environmental protection as other designated sites. The management and monitoring of a new site(s) is under discussion but is likely to fall to the MMO and SNCBs, with funding from the developers, on a basis to be agreed. Newly designated areas of the marine environment would be subject to nature conservation law and enforcement. This measure could be applied to Annex I Sandbank or other habitats of comparable ecological function.

3.2.3 Several forms of site designation or extension have been explored:

- Extension of Dogger Bank SAC;
- Designation of a new SAC or extension to an existing SAC (other than Dogger Bank SAC) for the protection of sandbank feature;
- Designation of a new MCZ for the protection of a sandbank feature; and,
- Amending SAC citation to protect or enhance associated habitat (e.g. troughs between sandbanks).

3.3 Restriction of future activities (Fishing byelaws)

3.3.1 Using byelaws to reduce fishing activities that damage the seabed is a potential compensatory measure that is currently being explored by workstreams within the Collaboration on Offshore Wind Strategic Compensation ("COWSC"). While this measure shows potential promise to compensate for benthic impacts there are still evidence gaps and uncertainties to work through. This measure would also need to be agreed by Defra's Secretary of State and can only be delivered by Defra in conjunction with the MMO or Inshore Fisheries and Conservation Authorities (IFCA's). Defra has not committed to implementing this measure at this stage. Fishing restrictions are already in place to protect the Dogger Bank SAC so, if taken forward, this measure would need to be delivered elsewhere to protect an area of Annex I Sandbank that is not currently protected in this way (i.e. it is also the case that any such restrictions at other sites would need to be additional to existing statutory management).

3.4 Seagrass meadow restoration

3.4.1 Seagrass meadows have an important role in supporting biodiversity (Attrill *et al.*, 2000; Lee *et al.*, 2001; Barnes, 2017), nutrient cycling (Welsh 2010; Tarquinio *et al.* 2018) and sequestering atmospheric carbon (Röhr *et al.*, 2018; Johannessen, 2022). It has been estimated that, owing to disease and direct (e.g. anchoring boats, fishing, and other recreational and commercial activities) and indirect (e.g. sedimentation and eutrophication) pressures between the 1920s and 2005, 85% of the UK's seagrass had been lost (Hiscock *et al.*, 2005; Dunic *et al.* 2021; Potouroglou *et al.*, 2021; Turschwell *et al.* 2021). Recent estimates indicate that the UK contains 8,493 ha of mapped seagrass (Green *et al.* 2021), although there is considerable uncertainty as methods used to quantify area, and the definitions of seagrass beds, vary considerably (Potouroglou *et al.*, 2021). Furthermore, many spatial mapping data sources lack metadata and many maps are out of date (Potouroglou *et al.*, 2021).

3.4.2 Although lower on the compensation hierarchy than the other measures, seagrass meadows do occur on some sandbanks within coastal subtidal and intertidal zones and seagrass is a sub-feature of other

designated Annex I sandbanks, such as those within Fal and Helford SAC and Plymouth Sound and Estuaries SAC (Natural England, 2023a; Natural England, 2023b). Suitability as compensation for sandbank is supported by the listing of seagrass as a flora associated with sandbank in Natura 2000 (now National Sites Network) guidance habitat guidance (European Commission, 2013). Nonetheless, seagrass restoration is a lower preference measure compared to those supporting the same ecological function of the habitat being compensated for.

- 3.4.3 The Steering Group had significant concerns about the deliverability of seagrass restoration, even on a small scale as there have been no long term successes with seagrass restoration in the UK. Seagrass restoration is included as a potential measure only where it would be a minor part of a wider package in terms of the required compensation. Given the intention to compensate for Annex I sandbank habitat, which is by definition a subtidal habitat, seagrass restoration for the purpose of compensation for DBSW and DBSE projects shall be limited to subtidal seagrass. The measure is retained in the DBSCP as an additional option which could potentially be employed if the Steering Group considered that it was necessary to supplement other measures, or potentially as an adaptive management response.

4 Agreement Log

Table 4.1 Round 4 Compensation Dogger Bank – Steering Group Agreement Log. Table also available as Appendix C.

ID	Topic area	Agreement	Comments	JNCC	NE	DEFRA	BEIS/ DESNEZ	RWE	TCE	Decisions/ response by TCE
1	Site Designation / Extension	The group is in agreement with the recommendation of the plan to propose strategic site designation/extension as the most ecologically beneficial compensation measure.		Agreed but needs to recognise that there are differences between the different types of site designation (KR 27/03/24)	Agreed recognising that it is a sandbank site that should be designated, starting from that which most closely matches the habitat being lost at Dogger Bank (AF 10/4/24)	Agreed, noting and agreeing with SNCB comments (SV 11/4/24)	Agreed RW 22/03/24	Agree 21/3/24	Agreed - BL 06/03/2024	N/A
2	Restriction of future activities - Fishing byelaws	It is agreed that fishing bye-laws will be included in the plan as a measure - as a high level concept, further details are to be refined if the measure is required at plan level. Fishing restrictions are already in place at Dogger Bank SAC so, if taken forward, this measure would need to be delivered elsewhere to protect an area of Annex I Sandbank (either inside an alternative Marine Protected Area, or an area of Annex 1 sandbank outside a Marine Protected Area) where there are currently no restrictions.		Agreed recognising that any restrictions need to be in addition to those already in place or planned through standard processes (KR 24/4/24)	Agreed recognising that any restrictions need to be in addition to those already in place or planned through standard processes (AF 24/4/24)	Agreed recognising that there are risks and uncertainties around this measure and Defra SoS agreement will be needed before it can be delivered. Any restrictions will need to be in addition to those already in place or planned through standard processes (SV 24/4/24)	Agreed RW 22/03/24 noting and agreeing with Defra comments.	Agree 21/3/24	Agreed - BL 06/03/2024	N/A
3	Strategic compensation measures	It is agreed that new site designation or extension, and restriction of future activities can and should benefit multiple projects. Therefore, as compensation measures, new site designation or extension and restriction of future activities should only be undertaken strategically.		Agreed for designation and extension. Ideally restriction of future activities should be undertaken strategically (even at a site level) but this requires all regulators to be on board with the process (KR 27/03/24)	Agreed for site designation or extension. Not agreed for restriction of future activities as there may be opportunities to do this strategically or at a site level and it requires regulators to be involved. (AF 10/4/24)	Agreed for new site designation or extension. Not agreed for restriction of future activities as it might depend on individual cases (SV 11/4/24)	Agreed RW 22/03/24	Agree 21/3/24	Agreed - BL 06/03/2024	N/A
4	Seagrass restoration	It is agreed by the group that seagrass restoration is considered as a viable option for Round 4 compensation as a small part of a package, with other measures only.		Agreed as only a very small part of a package and only for subtidal seagrass (KR 18/04/24)	Agreed as a small part of a package and only for subtidal seagrass (AF 10/4/24)	Agreed as a small part of a package (if necessary) (SV 11/4/24)	Agreed RW 22/03/24	This was included only as contingency if designation failed to deliver sufficient compensation	Agreed - BL 06/03/2024	N/A
5	Oyster reef restoration	The group agree to remove oyster reef restoration from the plan as the measure does not provide suitable compensation for Sandbank.		Agreed (KR 27/03/24)	Agreed (AF 10/4/24)	Agreed (SV 11/4/24)	Agreed RW 22/03/24	Agree 21/3/24	Agreed - BL 06/03/2024	N/A

6	Habitat damage	<p>It is agreed that habitat loss and habitat damage should be viewed differently with respect to the area of compensation required.</p> <p>Loss implies the permanent removal of habitat and the provision of similar compensation measures should seek to replicate the area lost on a direct basis (subject to the further inclusion of any additional compensation ratio).</p> <p>Damage, is agreed to represent a partial and differential alteration of the character of a habitat. Whereas the HRA assumed, simply, that habitat damage occurred uniformly and completely across a buffer zone around seabed works, in practice it is considered that the alteration arising from these works would be observed as a gradient of change from 100% close to the works and reducing to 0% at the extremity of the assumed buffer. Furthermore this change would not be permanent, with some recovery occurring over time.</p>	as discussed in SGDM10 and 12	Agree that these are different things but there is still a need to consider the same things in terms calculating the amount of compensation required as for loss e.g. recoverability, delivery timeframes etc which will determine the amount, as opposed to setting arbitrary amounts or ratios. (KR 27/03/24)	Agreed but further discussion and evidence is needed to understand the impact of damage on Dogger Bank SAC and potential for recovery to inform any reduction in area. The precautionary principle should assume 100% unless otherwise agreed. (AF 10/4/24)	Defer to SNCB advice on this point (SV 11/4/24)	Agreed RW 22/03/24	<p>RWE do not agree that damage should contribute to the AEOL conclusion. SNCBs have not provided evidence of recovery taking 10+ years, RWE believe available evidence (including from the Dogger Bank) indicates effects are short-term.</p> <p>Notwithstanding the above RWE agree that if damage were included, recovery would be along a gradient both spatially and temporally and compensation should reflect this. 18/4/24</p>	Agreed - BL 06/03/2024	The Crown Estate note RWE's position that damage should not contribute to AEOL conclusion. However, The Crown Estate's HRA and Derogation are final and include the consideration of damage to farm part of the AEOL.
7	Habitat damage	It is agreed, however, that, at the present time there is a lack of empirical evidence to appropriately quantify these areal and temporal characteristics of habitat damage in the context of the relic sandbank that forms the Annex I Sandbank feature of Dogger Bank SAC and for the purposes of this Strategic Compensation Plan habitat damage should be treated the same as habitat loss, until more evidence is available to do otherwise.	as discussed in SGDM10 and 12	Agreed (KR 27/03/24)	Agreed (AF 10/4/24)	Defer to SNCB advice on this point (SV 11/4/24)	Agreed RW 22/03/24 DESNZ will defer to SNCB comments, but also note comments from DBS on the consultation log concerning their results on habitat damage and recovery. All evidence must be used in coming to the conclusion on AEOL and amount of compensation required in terms of habitat damage.	RWE do not agree that damage should be treated the same, we believe the conclusion was that the impact would be <100% of habitat loss with no agreement on the quantum	Agreed - BL 06/03/2024	N/A
8	Compensation level	It was agreed that simple area based comparisons between sandbank and dissimilar habitats, such as seagrass, may not be optimal. An alternative approach which sought to use ecosystem function metrics such as production was investigated; whilst this may have merit there was insufficient time to develop this adequately. Should a package be required which includes seagrass restoration, this work should be revisited.	as discussed in SGDM11	Agreed (KR 27/03/24)	Agreed (AF 10/4/24)	Agreed (SV 11/4/24)	Agreed RW 22/03/24	Agree 21/3/24	Agreed - BL 06/03/2024	N/A

9	Seagrass restoration	It is proposed that one potential option for implementation is via existing seagrass restoration funds/ projects to enhance the chance of successful implementation and one option for the implementation is for it to be developer lead. Due to the benefits the group favoured the option to deliver through existing restoration projects/funds so long as it proved to be additional.		Not agreed - the best ecological option should be used to restore sub-tidal seagrass if this measure is taken forward as a very small part of a package. This may not necessarily be through existing projects. (KR 18/04/2024)	Not agreed , should this measure be taken forward for sub tidal seagrass restoration as part of a package then the best ecological option should be identified. This may be contribution to an existing project where the benefits can be show to be additional or restoration of a new area of subtidal seagrass (AF 18/04/24)	Defer to SNCB advice on this point, but if implemented via existing projects, compensation will need to be demonstrated to be truly additional (SV 18/04/24)	As per Defra comments RW 18/04/24	Agree 18/4/24	Agreed - BL 19/04/2024	The views of SNCB's Defra and DESNZ are noted. Both developer led and utilising existing seagrass restoration projects are presented as opportunities within the plan, and the Steering Group will have the opportunity to influence the appropriate way forward should this measure be required. The indication that utilising existing projects was 'favoured' was intended to indicate that utilising existing knowledge and expertise would be beneficial where possible, but it is noted and agreed that any seagrass restoration would need to be proved to be 'additional'.
10	Aggregates	This was excluded as a viable measure for this Plan due to the small areas available and the fact that the aggregates industry is managed to ensure sandbank recovery.		Not agreed - this measures has not been discussed in detail and sufficient evidence has not been presented to suggest that it is not viable. This is a measure that could be delivered as part of a package (although outside of DB SAC) to benefit Annex I Sandbank. (KR 18/04/2024)	Not agreed . This measure was not explored in detail and there is not sufficient evidence to conclude it is not viable. We consider that this could contribute to a package of measures and that this could help to remove pressure on Annex 1 sandbank. (AF 18/04/24)	Not agreed. This measure was not explored in detail and we don't have the evidence to conclude it is not viable. There could be benefits in some situations, e.g re-locating aggregates activities that currently occur within MPAs (SV 18/04/24)	As per Defra comments. Although I agree that the aggregates industry is managed to allow recovery by leaving a minimum of target substrate in place, I take the Defra/SNCB points around removal of pressure in a site which is already under pressure and re-locating activities that currently occur in MPAs. RW 18/04/24	Agree 18/4/24	Agreed - BL 19/04/2024	The view of the the SNCB's and Defra are noted, however, it was discussed during the Steering Group meetings that whilst there may be opportunity to reduce some pressure from aggregates within MPA's the number of aggregates sites within protected sites, and their scale was such that there was limited viability for this measure to be taken forward.
11	Ratio	A ratio of 1:1 has been stated as the compensation value for restriction of future offshore wind as this is a like for like measure. There is no requirement for like for like to be more than 1:1 ratio		Not agreed, this has not been discussed with the steering group and no evidence has been presented on a suitable ratio. (KR 24/4/24)	Not agreed , the steering group has not seen potential areas for restriction of future offshore wind and has not had any discussion on what ratio would be required should this measure be taken forward at any stage. Further work is needed to understand how ecologically meaningful the measure is and to enable discussion on appropriate ratios. (AF 24/4/24)	Not agreed. This has not been discussed with the steering group and further work is needed to understand how ecologically meaningful this measure is and therefore appropriate ratios (SV 24/4/24)	Not agreed - while it sounds sensible in principle, it hasn't been discussed/explored/tested with the steering group. There may well be nuances, caveats and exceptions to this. RW 24/04/24	Agree 24/04/2024	Agreed - BL 24/04/2024	The Crown Estate note that this point is not agreed across the Steering Group, but this is based on existing precedent for like for like measures in DCO decisions, and is included to reduce risk of inefficient use of The Crown Estate's assets in the future, whilst noting that this position does not fetter the discretion of the Secretary of State to make a discretion on appropriate compensation.

12	Monitoring	<p>It was agreed that the monitoring requirements for a new or extended designated site should be appropriate to the purpose of monitoring. It is understood that monitoring for site designated as part of compensation are yet to be agreed and may differ to current monitoring, but we recommend they are appropriate to the requirement and purpose of the monitoring in relation to this Plan. This follows discussion in M9 to ensure the developers and the SNCB's concerns are adequately and fairly addressed.</p>	<p>SGDM9 Paolo Pizzolla - evaluating success in this instance would have to be with a long-term watching brief. This would need to be factored into the ongoing adaptive management of the group. Monitoring proposal would have to be in line with the monitoring process in the existing MPA network and should be proportionate to what is currently undertaken for the existing network.</p>	<p>Agree that any monitoring of the designated site as compensation should be appropriate for understanding the condition of the site and it's contribution to the MPA network in terms of success and management (KR 24/5/24).</p>	<p>Agree that any monitoring of the designated site as compensation should be appropriate for understanding the condition of the site and it's contribution to the MPA network in terms of success and management. Monitoring would be designed for compensation sites alongside the rest of the MPA network by the relevant SNCB(s). Monitoring requirements have not been discussed yet and more time is needed to work through the details. (AF 24/4/24)</p>	<p>Agree that any monitoring of the designated site as compensation should be appropriate for understanding the condition of the site and its contribution to the MPA network in terms of success and management. Monitoring requirements have not been discussed yet and more time is needed to work through the details (SV 24/4/24).</p>	Agreed - RW 24/04/24	Agree 24/04/2024	Agreed - BL 24/04/2024	N/A
13	Questions at DCO	<p>It was agreed that The Crown Estate will continue to chair the Steering Group following the submission of DCO applications for DBSW and DBSE. Examiners' Questions related to this DBSCP during the DCO process following the submission of the DBSCP should be directed to the relevant project applicant who will then provide those questions to The Crown Estate to ensure consistent alignment of responses which take account of Steering Group discussions and responses. The Terms of Reference for the DBSCP Steering Group still apply following DCO submission and until the Steering Group is dissolved in accordance with those Terms of Reference.</p>	<p>This follows discussions in earlier meetings relating to questions on the strategic Plan level compensation and is in keeping with the aims of the ToRs</p>	<p>Not agreed. As site leads for Dogger Banks SAC JNCC will be providing statutory nature conservation advice on the project via the delegation agreement with Natural England. For this reason it would not be appropriate for us to be involved in formulating response to questions posed to TCE on the plan (KR 24/4/24).</p>	<p>Not agreed. As NE will be providing statutory nature conservation advice on the project into examinations, we do not consider it appropriate for us to also be involved in formulating responses to any input requests regarding the R4 Plan Level compensation. The plan would be clearer if 9.5.3 reflected this. We hope to continue to provide steering group advice on other matters during the DCO processes subject to availability. (AF 24/4/24)</p>	<p>We are content that examiners questions are directed at the project applicant and agree with the points made by SNCBs. The ability to provide statutory advice shouldn't be compromised. We would be open to a discussion on the role of the steering group during DCO examination. (SV 24/4/24)</p>	<p>Not agreed. Given the quasi judicial nature of the DESNZ SoS decision on each consent, DESNZ will need to take a decision on any involvement during the examination.</p>	<p>Not agreed. Although DBS ,as the applicant, will respond to Examiners questions where appropriate and possible to do so there is frequently a fast turnaround on written questions and instant answers expected at hearings. Waiting on the SG to meet and respond will not be a workable solution during Examination. We also note that JNCC and NE do not plan on being involved in the SG during Examination. Agreement on the appropriate parties to be involved and how questions on the SCP can be resolved during the Examination will be required. CM 24/04/2024</p>	Agreed - BL 24/04/2024	<p>It is noted that there is not agreement across members of the Steering Group as to the continuation of the Steering Group during project Examination, namely due to capacity issues during a very busy process, and potential for conflicting advice to be submitted in response to Examiners Questions on the DBSCP and in individual organisations statutory roles in the process. It should be noted that all members have signed the Terms of Reference that describe the role of the Steering Group and that it will remain vested until post consent to consider monitoring and adaptive management requirements. The Examining Authority will have the right to ask questions of the DBSCP and it is appropriate that the Steering Group, being responsible for the development of the plan, respond to these questions and The Crown Estate will provide opportunity for members to feed into any response. Noting the individual organisations concerns, it will be for individual organisations to determine if and how they engage with the Steering Group during Examination.</p> <p>The Crown Estate are open to further discussions with Steering Group members regarding process during Examination.</p>

5 Ecological Function

- 5.1.1 Compensatory measures targeted at sandbank habitat will closely offset the lost or impaired ecological function and supporting processes provided by the impacted habitat at Dogger Bank SAC, as defined in its conservation objectives. For measures based on other habitats, e.g. seagrass restoration, it is important to consider their ecological function to understand how this can be related to sandbank function and hence the contribution to offsetting impacts which they could result in loss of function. Furthermore, if elements of function which are common between sandbank and other habitats can be quantified this may offer a mechanism to scale compensation. This section provides a summary of the conservation objectives for Dogger Bank SAC, focused on ecological function, with a view to developing such approaches to scale compensation.
- 5.1.2 The compensatory measures described in this DBSCP are aimed at offsetting the AEOSI of the sandbank feature of the Dogger Bank SAC. The Dogger Bank SAC, proposed as a draft SAC in 2008 and formally designated in 2017, is located in the Southern North Sea, approximately 150km north-east of the Humber Estuary. The SAC comprises the majority of the extent of the sandbank feature in UK waters, a calculated area of 12,331km², and is the largest continuous expanse of shallow sandbank in UK waters. Water depth ranges from under 20m at the crest of the sandbank to 35-40m within the SAC, with the bank structure extending down to over 50m in UK, Dutch and German waters.
- 5.1.3 The sandbank feature within the Dogger Bank SAC provides a range of ecosystem services, with examples including: nutrition, by functioning as a feeding ground for multiple species of commercial importance; supporting local wildlife tourism, by contributing to the conservation of charismatic bird and cetacean species; and climate regulation, by deposition and storage of carbon in seabed sediments (JNCC, 2022).

5.2 Conservation objectives

- 5.2.1 The conservation objectives for Dogger Bank SAC are for the feature to be in favourable condition thus ensuring site integrity in the long term and contribution to Favourable Conservation Status of Annex I Sandbanks which are slightly covered by seawater all the time, by maintaining or restoring, subject to natural change the following three attributes:
- The extent and distribution of the qualifying habitat in the site;
 - The structure and function of the qualifying habitat in the site; and
 - The supporting processes on which the qualifying habitat feature relies.
- 5.2.2 Supplementary advice on the conservation objectives was updated in late 2022, following the closure of the SAC to bottom trawling fishing gear (JNCC, 2022). This advice is considered in the following paragraphs, addressing each objective in turn.
- 5.2.3 With respect to the extent and distribution of the feature, an objective of 'restore' was advised, due to the continued subjection of the site to activities resulting in a change to the extent and distribution of the sandbank feature within the SAC. This has previously included bottom trawling, although this no longer occurs within the site, and currently includes offshore wind farms, cabling, and oil and gas industry activities. The report advises that activities must look to minimise changes in substratum within the site as far as is practicable, in order to minimise further impact.

- 5.2.4 With respect to the structure and function of the site, an objective of 'restore' was also advised. Both ongoing and historical activities are understood to have resulted in a change to the finer topography, sediment composition and distribution, and characteristic communities of the feature within the SAC, and may have ongoing effects. As above, where practicable, activities must look to minimise disturbance and changes to the finer scale topography, sediment composition and biological communities within the site.
- 5.2.5 Within this objective, the following sub-attributes were considered, and an objective of 'restore' advised:
- Finer scale topography of the feature. Given the relatively static nature of the sand waves, recovery is expected to be slow, and JNCC does not provide advice on the timescale for full recovery;
 - Sediment composition and distribution of the feature;
 - Characteristic communities of the feature within the site. The report advises the importance of conserving the natural spatial distribution, composition, diversity and abundance of the main characterising biological communities of the sandbank within the SAC in order to support its health and avoid diminishing biodiversity and ecosystem function; and,
 - Function within the site. This objective was based on impacts to the characterising communities and peat deposits from both ongoing and historical activities.
- 5.2.6 Additionally, JNCC consider that a variety of key and influential species, including bioturbators, predators and grazers, may play a critical role in maintaining the structure and function of the protected habitats, but with insufficient information available to support an understanding of this role and its significance, it was not considered possible to set an objective for this sub-attribute.
- 5.2.7 With respect to supporting processes, an objective of 'maintain' was advised. Again, as far as practicable, activities must look to avoid impairing the hydrodynamic regime acting upon the site and exceeding Environmental Quality Standards. Within this attribute, 'maintain' objectives were also advised for:
- The hydrodynamic regime within the site;
 - Water quality within the site, noting that aqueous contaminants must be restricted to comply with water column annual average (AA_EQS) according to the amended EQSD (2013/39/EU) or levels equating to High/Good Status (according to Annex V of the Water Environment Regulations 2017); and
 - Sediment quality within the site, as restoration of contaminants in the water is not currently considered to be feasible.
- 5.2.8 Considering the three attributes, Biological Structure and Function are expected to be more relevant as potential sources comparators with non-sandbank habitat than physical structure which relates specifically to the sandbank feature (Figure 4.1).

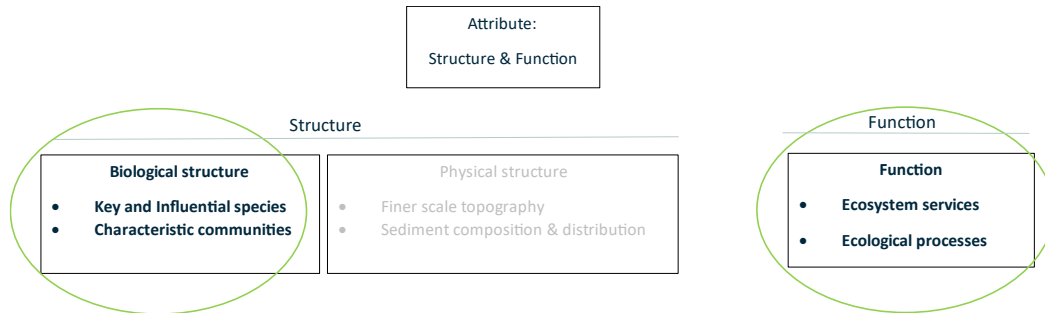


Figure 4.1 Sandbank feature attributes (sub-attributes considered further within this DBSCP are circled)

5.3 Linking compensation measures with the conservation objectives for Dogger Bank SAC

5.3.1 The seagrass restoration measure was explored in terms of its ability to provide similar ecological functions to sandbank, or support ecosystem services, listed within the conservation objectives for Dogger Bank SAC (Table 5.1). It was concluded that seagrass restoration could potentially be related to sandbank in terms of ecological functions and support some ecosystem services provided by sandbank habitat within Dogger Bank SAC; however, there are significant evidence gaps that prevent a robust evaluation of functioning between the habitats from being taken further in the timeframe available.

Table 5.1 Ecological functions and ecosystem services listed in the conservation objectives for Dogger Bank SAC

Ecological functions	Ecosystem services
Biodeposition	Nutrition (food provision)
Bioengineering	Bird and whale watching
Nutrient cycling	Climate regulation
Secondary productivity	
Supply of recruits	

6 Amount of compensation required

6.1 Background to determining the amount of compensation

6.1.1 The purpose of the DBSCP is to provide a clear, logical structure through which the required compensation can ultimately be delivered. Whilst it is not possible at this stage to prescribe the scale of compensation that will be required for individual measures, or a package of measures, it is considered important that the process through which this will ultimately be determined is established. Risks associated with not doing this include the ultimate compensation solution being arbitrarily scaled to reflect the amount of available resource and while potentially acceptable provided that the scale of impact is more than offset, for strategic (i.e. Plan level) compensation it is important that the quantum which is allocated to individual projects can be clearly understood.

6.1.2 A stepwise approach, as outlined in Figure 6.1, is proposed for determining the amount of compensation required. This is intended to enable an adaptable approach to accommodate the compensation measure(s) that is/are ultimately implemented, and the impact ultimately requiring compensation at project level.

- 6.1.3 Step 1 (calculate the impact) was estimated at a plan level for the two relevant Round 4 projects (DBSW and DBSE) through the Round 4 Plan Level HRA. This is expressed in area terms (km²) for habitat loss and damage and values of 2.035km² and 32.209km² respectively represent current understanding of the Round 4 Plan Level Impact. These values may be revised when more refined project level information is available, currently the project values are predicted to be 2.25km² and 30.7km² for loss and damage respectfully. Therefore the scale of the impact requiring compensation will be refined by the Steering Group and defined within the DBSIMP once project level impacts have been finalised.
- 6.1.4 Step 2 (determine the compensation level) and Step 3 (apply the compensation multiplier) are discussed in this section. For the purposes of this DBSCP, the compensation level means the amount of each compensation measure required, either alone or together where there is more than one measure, to offset the impacts of the Round 4 Plan projects on Dogger Bank SAC. A multiplier may then be applied to the compensation level in order to provide confidence that the level of impact can be fully offset.

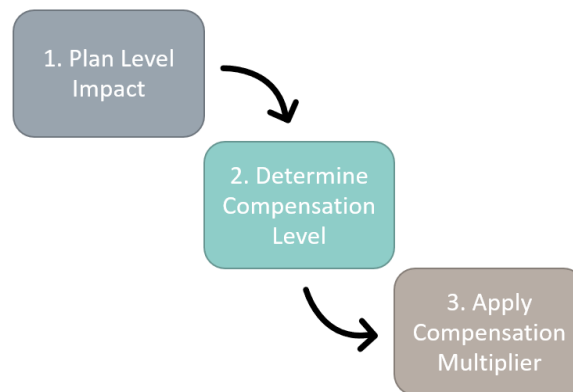


Figure 6.1 Simplified schematic showing the stages of determining the scale of compensation

6.2 Determining the compensation level

- 6.2.1 The compensation level is the amount of compensation, however measured, necessary to offset the level of impact. A ratio of at least 1:1 (impact to compensation) is the minimum, but in practice it is expected that the amount of compensation will need to be greater than the impact. The higher the position of a measure in the compensation hierarchy the greater the certainty that the measure would provide suitable compensation, and therefore the closer to 1:1 the compensation level is likely to be. Conversely, any compensation provided by measures which are further down the hierarchy, or where there is a risk that delivery of the compensation would have an extended timeline, is likely to require compensation levels substantially greater than 1:1.
- 6.2.2 Once an appropriate compensation level is established, it is expected to be necessary to plan to deliver above this amount to account for uncertainties and be sure that the required compensation level is met; this will be ensured by use of a compensation multiplier (see below). It is important to distinguish between any ratio(s) used to arrive at the compensation level and the separate compensation multiplier applied subsequently.

- 6.2.3 For the measures which involve the protection of sandbank habitat (Site Extension/Designation and Restriction of other Activities), area is considered to be the most appropriate metric to describe both impact and compensation levels. Thus for habitat loss the level of compensation that is currently understood to be required is at least 2.035km². The ratio applied to this figure may be close to 1:1 if it can be demonstrated that the compensation habitat is very similar and geographically close to that lost at Dogger Bank, but may increase above 1:1 in other circumstances. Larger ratios again would be expected for measures which are lower down the hierarchy.
- 6.2.4 In relation to habitat damage the Round 4 Plan Level HRA concluded that this would contribute towards the conclusion of AEOSI, but it should also be recognised that recovery over time is expected. Habitat damage is not a binary impact like habitat loss; instead, a range from more to less severe effects on aspects such as ecological function can be expected within the impact area and in this respect a compensation level that is less than 100% of the nominal upper estimate for area of habitat damage is likely to be appropriate.
- 6.2.5 Although recognising that it may not be necessary to set the compensation level at 100% for habitat damage (notwithstanding any further compensation multiplier which may be necessary), no single value was agreed upon by the Steering Group. It is recognised that an evidence base will need to be developed in order to refine this figure. In the absence of such evidence, it would be necessary to adjust the compensation level for damage conservatively, i.e. closer to 100%.
- 6.2.6 In summary, the Steering Group do not agree that a simple value (e.g. 25%) to represent required level of compensation for damage can currently be supported. Whilst some value below 100% is likely to be justified, (Natural England indicated during consultation that the habitat recovery time of Dogger Bank is 10 to 25 years), further study to develop a robust figure will be required. In the absence of this the compensation level for habitat damage should be considered as 1:1 in line with the precautionary principle.
- 6.2.7 For seagrass restoration, which seeks to deliver comparable ecological function, area may not be the most appropriate metric to calculate the level of compensation. Seagrass ecosystems differ from sandbanks, such as Dogger Bank. Consequently, the extent to which relevant ecological functions deliver services may be very different and an arbitrary areal metric could significantly misrepresent the level of compensation in these terms. Alternative metrics could include indicators of biodiversity, biomass, production or carbon sequestration. These were explored by the Steering Group but it was concluded that evidence to support the metrics could not be developed sufficiently within the required timeframe in order to provide a useful alternative to area.
- 6.2.8 Currently, an area based approach, as assumed for measures relating to sandbank habitat, would be needed if the seagrass restoration measure were to be included as part of a wider package of compensation.

6.3 Compensation multiplier

- 6.3.1 A compensation multiplier will be applied to ensure that the compensation that is delivered fully meets the compensation level, accounting particularly for uncertainties relating to success of the measure(s). Ratios close to 1:1 are appropriate in circumstances where confidence in delivery is high. Where there is less certainty around the success of a measure higher multipliers are appropriate in order to ensure that the amount of compensation, as determined by the compensation level, is delivered.

- 6.3.2 A range of ratios have been agreed for compensatory schemes on a case-by-case basis, but the following are recent relevant examples. The Norfolk Boreas project proposed a 2:1 ratio of native oyster habitat creation to *Sabellaria spinulosa* reef habitat (Royal Haskoning DHV, 2021). Hornsea Project Three are required to implement a debris removal campaign which should equate to no less than 41.80 ha at North Norfolk Sandbank and Saturn Reef SAC and 2.77 ha at North Norfolk Coast SAC (Royal Haskoning DHV, 2022) which are understood to match (i.e. 1:1) the predicted spatial extent of habitat loss at these two protected sites (Orsted, 2020). These are not compensation multipliers in the sense used in the DBSCP, where compensation level is implemented as an intermediate step, but are understood to have been applied in that manner.
- 6.3.3 To compensate for sandbank habitat loss caused by the Round 4 Plan, the final amount of compensation will at least match the compensation level. A compensation multiplier of one (1.0), based on an area metric, may be appropriate for measures targeting Annex I sandbank habitat (site extension/designation and restriction of other activities) where there is high confidence in delivery. If confidence is reduced for any reason then a multiplier of >1 may be required. For any compensation provided by measures delivering compensation through the restoration of other habitats a higher compensation multiplier would be justified. A value of two (2.0) is proposed. This figure is presented here as starting point and is not agreed upon by the Steering Group.
- 6.3.4 With respect to habitat damage, it may not be appropriate to apply a compensation multiplier since the compensation level will be set using an adjustment to area (e.g. 25% in the unagreed worked example in Section 6.2). The Steering Group will determine if any further multiplier is required.

7 Location

7.1 New Site Designation or Extension of an Existing Site

- 7.1.1 It is agreed by the group Steering Group that new site designation or site extension (new areas or features added to existing sites) is the recommended compensation measure of in this DBSCP and this follows advice received from Defra that this is an available strategic compensation measure that can be used to compensate for habitat loss and damage caused by the Round 4 Plan. It states that any new site/ site extensions will be determined by Defra and be designated as a strategic compensation measure which will benefit multiple projects. This DBSCP recognises that a team in Defra will work to identify potential areas for designating new sites, or extending existing sites, working closely with Natural England and JNCC. The information presented in this report is included as supporting evidence that the measure is appropriate for the specific purposes of the DBSCP, but without prejudice to the future outcome of the Defra-led process.
- 7.1.2 To ensure there is confidence in this measure, potential site locations have been identified in this DBSCP, but it is important to note this is not an exhaustive list. Full details are provided in the Site Selection Study (Appendix E), however the approach and current shortlisted sites for each measure are summarised below. It should also be noted that there are uncertainties pertaining to the sites, including the extent and the condition of the feature, and the pressures impacting the feature. There is a need to gather more evidence, which may be undertaken through desk studies and surveys, to aid decision making around site selection for new site designation or extension. In the case of site designation/extension, the locations shortlisted have been shared with Defra to be considered alongside other potential locations.

- 7.1.3 Figure 7.1 shows potential areas of search (AoS) for a new site designation, or extension to an existing site. The areas were identified by mapping locations of Annex I sandbanks using the JNCC Annex I sandbank data layer (JNCC, 2019). All of these potential AoS are located within the southern North Sea. There is high confidence that they would provide sufficient sandbank area to compensate for more than 100% of the compensation level requirement for the Round 4 projects DBSE and DBSW (worst case of loss and damage combined).
- 7.1.4 For AoS 19, to the north of Dogger Bank SAC, the shapefile was provided by RWE. The area within the boundary of AoS 19 is 3197.6km². Further survey work has been undertaken; the report, provided as Appendix F, indicates that Area 19 contains habitat consistent with Annex I sandbank.. Sand was the dominant sediment type, equivalent to EUNIS Broad Scale Habitats A5.2 Sand and muddy sand or A5.1 Coarse sediments, with little gravel or mud content. Moreover, benthic communities of AoS 19 were shown to be similar to those described as the "North-Eastern Community" of the Dogger Bank SAC (Wieking and Krönke, 2003; Diesing et al., 2009; Eggleton et al., 2016). Based on Appendix F an extension of the SAC to the north may provide equivalent area and comparable functioning of one of the habitats present within Dogger Bank SAC.

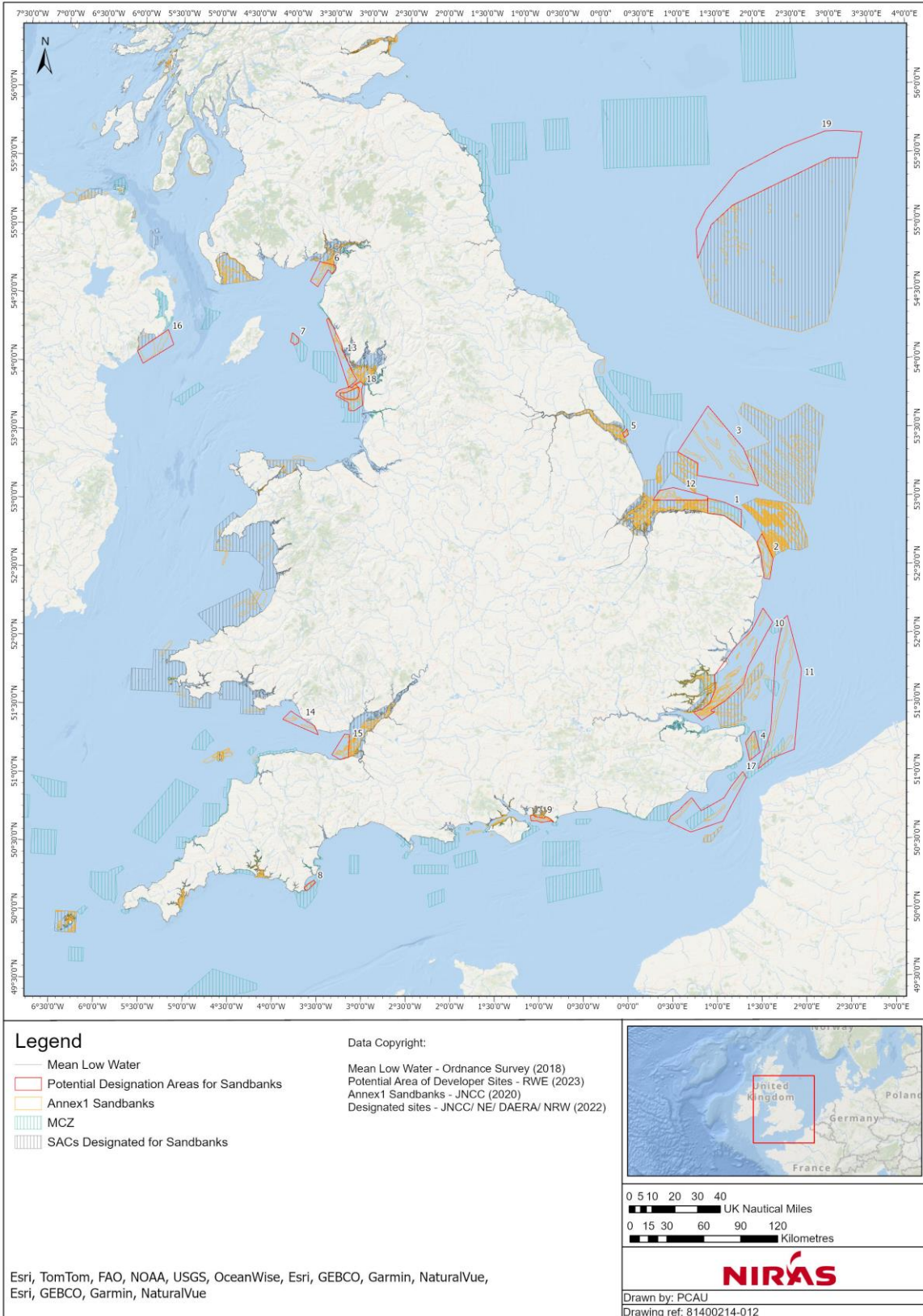


Figure 7.1 Annex I sandbanks with potential sites (red & pink) for New Site Designation/Extension. Pink are discussed further in Appendix E.

7.2 Restriction of activities (Fishing)

7.2.1 As indicated in section 3.3.1, this measure would need to be agreed by Defra's Secretary of State and can only be delivered by Defra in conjunction with the MMO. Fishing restrictions are already in place to protect the Dogger Bank SAC so, if taken forward, this measure would need to be delivered elsewhere to protect an area of Annex I Sandbank that is not currently protected.

7.3 Seagrass

7.3.1 Potential locations for seagrass restoration were mapped using the Environment Agency's 'Potential Seagrass' data layer which has been derived using wave and current energy, elevation and salinity criteria (EA, 2021). Additionally, Natural England's National Seagrass data layer which presents the extent of current areas of subtidal and intertidal seagrass based on monitoring data were mapped alongside the areas with potential for restoration to inform identification of 28 geographically discrete areas (Figure 7.2).

7.3.2 It is not possible, based on information currently available, to confidently distinguish between intertidal and subtidal potential seagrass restoration areas. Based on the position of this data layer relative to mean low water and the proportionate distribution of intertidal versus subtidal seagrass habitat in the National Seagrass data layer it is clear that the majority of potential restoration areas are intertidal, while providing confidence that there are opportunities for subtidal restoration. The recommendation of the Steering Group is for any seagrass restoration included as part of the DBSCP to be subtidal because of the closer relevance to Annex I sandbank in terms of ecological function and position on the compensation hierarchy. Notwithstanding this point, all areas of potential seagrass restoration are currently included and tidal status would need to be considered at a later stage in the DBSIMP.

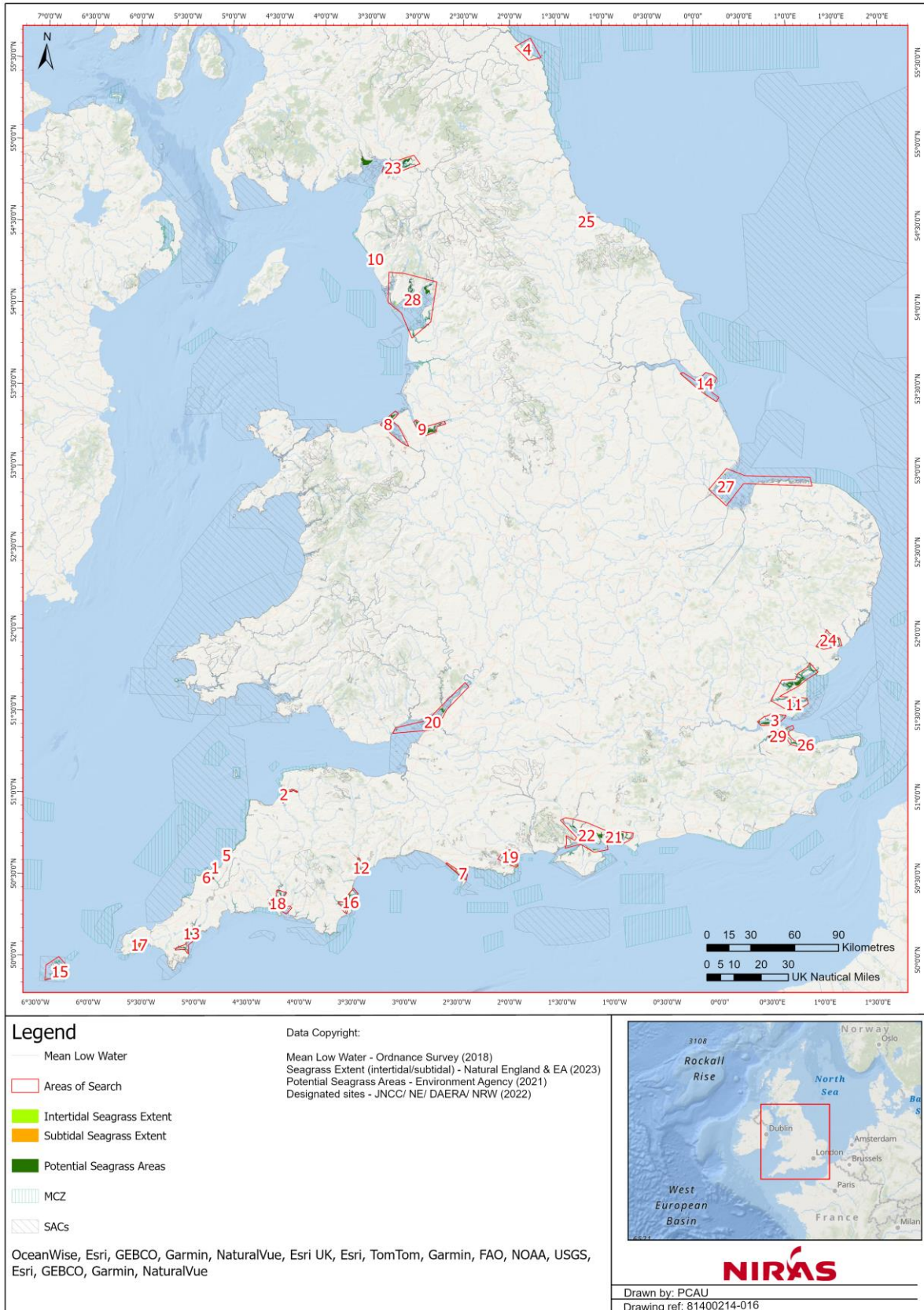


Figure 7.2 Potential sites for seagrass restoration based on the Environment Agency's seagrass potential layer (EA, 2021) and the Natural England's national seagrass layer (NE, 2023).

- 7.3.3 Notwithstanding the similarities in terms of ecological function between seagrass meadows and sandbanks (outlined in Section 5.3), there are fundamental differences between designating a site and restoring seagrass habitat. As such, site consideration criteria for seagrass were modified from that for site designation/extension. For example, seagrass has never been recorded from Dogger Bank SAC, so a site suitable for seagrass restoration would not be expected to provide a good representation of the habitat lost from Dogger Bank SAC, as a result of construction of DBSE and DBSW. As such 'Degree of representativity of lost or damaged habitat' was dropped from the criteria for seagrass site selection.
- 7.3.4 Figure 7.3 and Figure 7.4 present examples areas where seagrass restoration could be implemented as part of strategic compensation for Round 4 projects. Although proximity to the area of impact is relevant to the connectivity of the site with the impacted habitat, presently there are no sites where subtidal seagrass occurs on the east coast of England. Based on NE and JNCC advice, restoration for the purpose of compensation should be restricted to subtidal seagrass. It is not yet understood if there are historical records of subtidal seagrass meadows along the east coast of England and whether there is a possibility of restoring such habitat. Should this not be the case, seagrass restoration may be limited to sites outside of the southern North Sea.

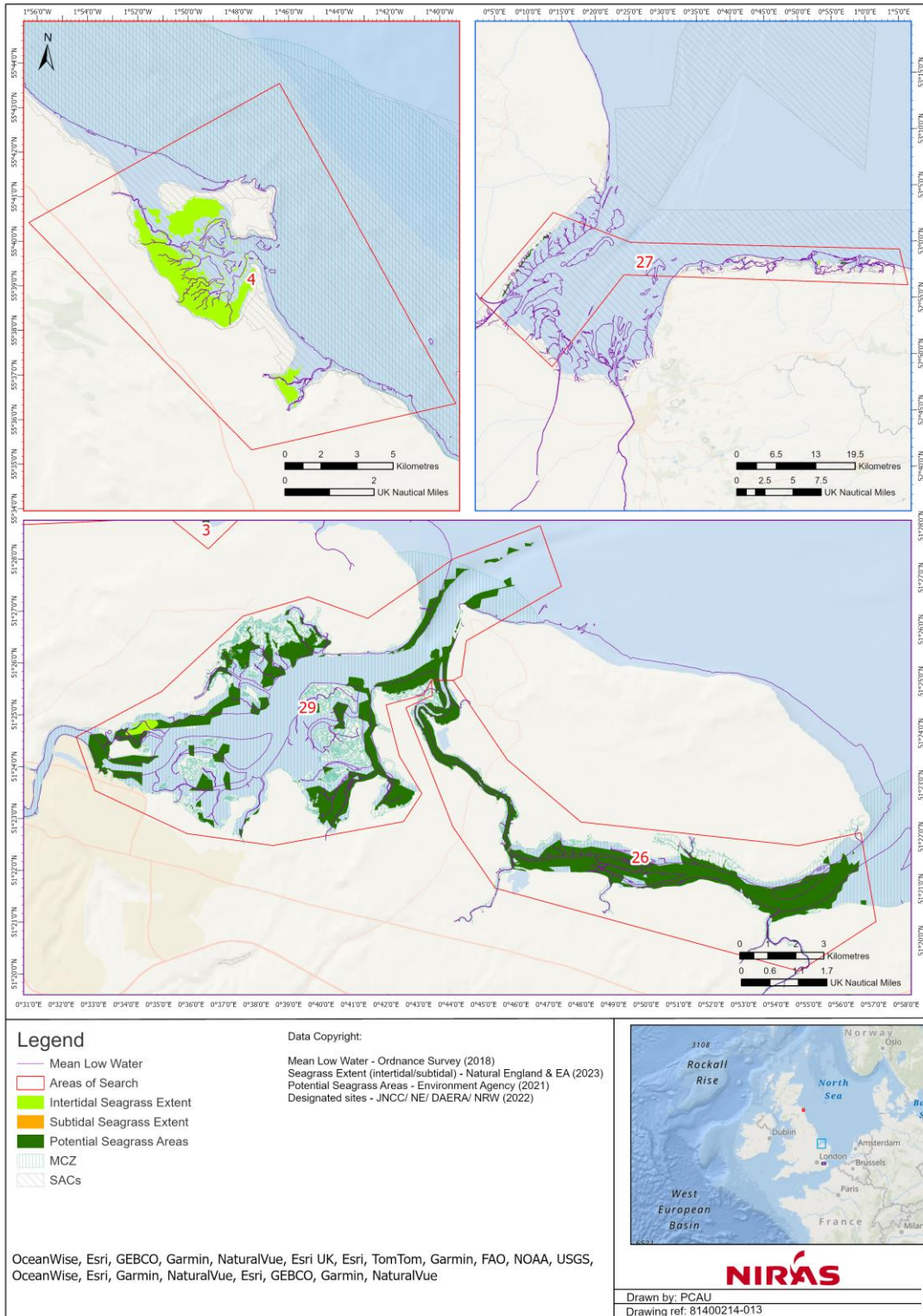


Figure 7.3 Potential sites for seagrass restoration on the east coast of England.

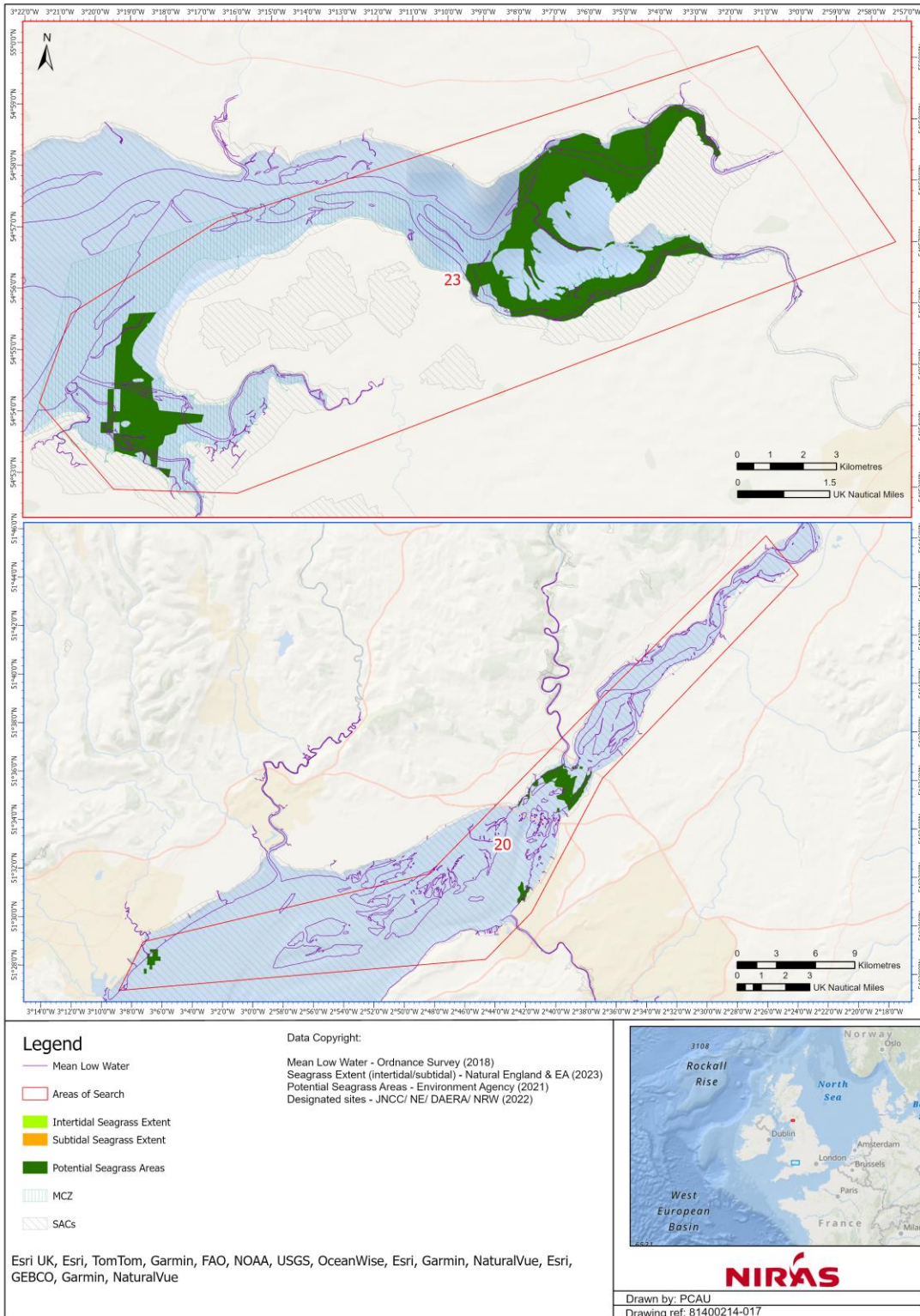


Figure 7.4 Potential sites for seagrass restoration on the west coast of England.

8 Proposed compensation solution

8.1.1 The compensation solution may be comprised of a single measure or a package of measures. It was agreed by the Steering Group that those lower down the hierarchy are only included as part of a package (as indicated in Figure 8.1). Where possible, compensation will be fully delivered by one or more measures high in the compensation hierarchy, the preferred method recommended by the group is designation of a new site or extension of a designated site. Other measures would only be incorporated to provide increased confidence in the overall success of the package and to ensure the package fully compensates for the impacts. This process is indicated in Figure 8.1.

8.1.2 Within each of the three proposed categories of compensatory measure there are a number of alternative delivery routes (schemes). For site designation or extension, all alternatives (namely, extension of Dogger Bank SAC, designation of a new SAC/protected site, extension of an existing SAC/protected site and protection of sandbank trough habitat) will be considered. Should the scale of compensation from this measure fall short of 100% of the required compensation, the DBSCP would seek to include restriction of fishing activity. The Steering Group considered that seagrass restoration could contribute only as a minor part of a wider package.

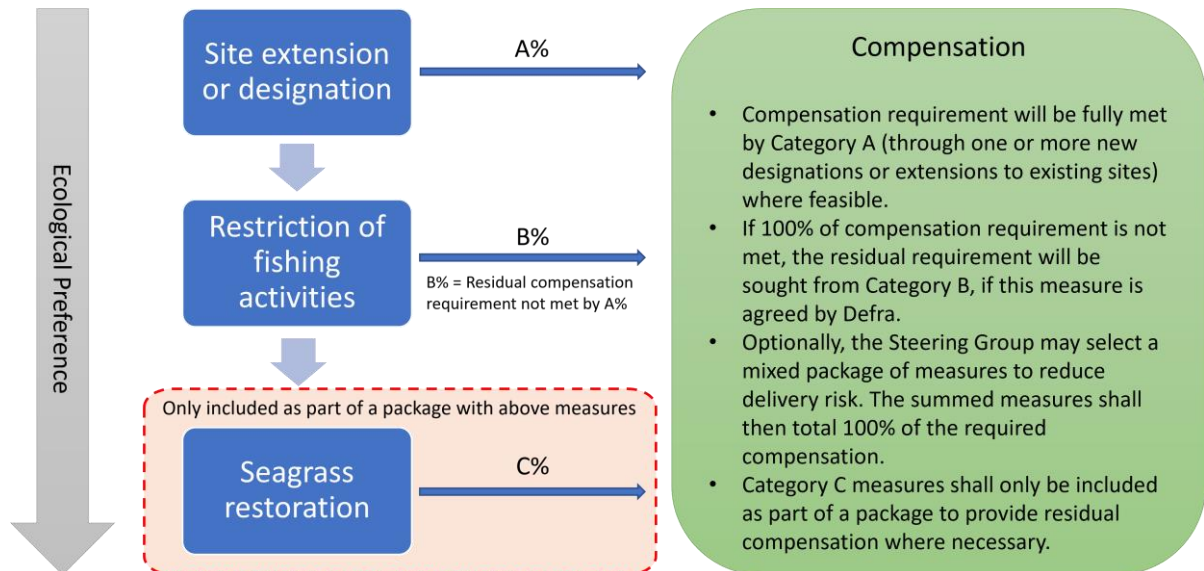


Figure 8.1 Compensation package development process. The option in the red box will only be considered as part of the package.

8.1.3 It should be noted that these measures, and alternative delivery routes for the same measure, are on different levels on the hierarchy of compensatory measures (Table 8.1). For example, should Dogger Bank SAC be extended, this measure would be at Level 1 on the Defra hierarchy, but a new designation elsewhere or an extension of another SAC would be Level 2. Similarly, restricting activities from within Dogger Bank SAC would be at level 1, whereas restricting activities within another SAC designated for the protection of Annex I sandbank would be at level 2. The Steering Group has judged that seagrass restoration to be at Level 4 on the Defra hierarchy. However, were seagrass restoration undertaken at another site designated for the protection of Annex I sandbank habitat, for which seagrass is a sub-feature, a case could be made that seagrass restoration would be at Level 2.

Table 8.1 Compensation hierarchy (Defra, 2021).

Level	Hierarchy of Measures	Description
1	Address same impact, same location	Address the specific impact caused by the permitted activity in the same location (within the site boundary). <i>e.g. On-site creation, restoration or relocation of feature that will be harmed/lost.</i>
2	Same ecological function, different location	Provide the same ecological function as the impacted feature; if necessary, in a different location (outside of the site boundary). <i>e.g. Off-site creation or restoration of feature that will be harmed/lost.</i>
3	Comparable ecological function, same location	Provide ecological functions and properties that are comparable to those that originally justified the designation in the same location as the impact. <i>e.g. On-site creation or restoration of a similar feature to the one that will be damaged/lost.</i>
4	Comparable ecological function, different location	Provide ecological functions and properties that are comparable to those that originally justified designation; if necessary, in a different location (outside of the site boundary). <i>e.g. Off-site creation or restoration of a similar feature to the one that will be damaged or lost.</i>

9 Delivery Mechanism

- 9.1.1 The preferred measures, site designation/extension and restriction of activities, require areas that are large enough to be practically implemented and managed. This is likely to be significantly larger than the area required to provide compensation for the Round 4 Plan. New site designation or extension, and restriction of future activities, can therefore benefit multiple plans and projects.
- 9.1.2 Both site designation/extension and restriction of activities measures will require implementation to be led by government agencies, which will take time and resources. The Defra Secretary of State has indicated that Defra will only designate sites to provide compensation strategically and benefit multiple projects, not on an individual project basis.

9.2 New site designation or extension of an existing site

- 9.2.1 The process for designating a new site for the protection of sandbank habitat, or extending an existing site, is outside of the control of the developer. Ultimately, the measure must be delivered by Defra with the support of the Statutory Nature Conservation Bodies (SNCBs) and regulators, as per the current UK practice and guidance. An announcement was made by Defra on 1st February 2024 that sites will be designated and/or extended in English waters to deliver strategic compensation for impacts associated with offshore wind, including for Round 4 projects. Contributions by the developer, e.g. in terms of providing information on area(s) of search and surveying/gathering evidence are still to be agreed. In line with the polluter pays principle, any new site designation or extension delivered for strategic compensation is proposed to be fully funded by the developer throughout the lifetime of the project, including management and monitoring stages. As this measure is a strategic measure with sites selected to cover multiple projects, this will be agreed during the development of the DBSIMP in conjunction with the Marine Recovery Fund and COWSC, who will establish how this cost is shared across the multiple projects benefiting from this compensation solution.

- 9.2.2 The new sites/extensions designated by Defra will be designed, and be sufficiently large, to fully compensate for multiple offshore wind projects, including those comprised in the Round 4 Plan. This measure is expected to be delivered through the Marine Recovery Fund and will follow the full legal process required for designation, including public consultation.
- 9.2.3 It is important to note that this measure is not without uncertainties. In the first instance, suitable sites would need to be identified and proposals for site designation would be subject to public consultation. As such, there is a risk of objection from other sea users and there may be a requirement to provide financial compensation to secure the measure.

9.3 Restriction of Activities (Fishing)

- 9.3.1 This measure has not been agreed by the Defra Secretary of State, but if confirmation were to be given in the future, the MMO would be responsible for producing byelaws, to restrict fishing activity. However, if fishing restrictions are to be put in place in an area <6nm from the coast, the IFCA would lead on producing byelaws with the support of the MMO.
- 9.3.2 As with new site designation or extension, the area in which fishing activities are to be restricted must also be sufficiently large to be charted. Uncertainties also exist; there is a need to identify suitable sites to impose fishing byelaws for compensation, and any site proposed would be subject to public consultation. Should this measure be implemented there may also be a requirement for financial compensation for other sea users that face restrictions, which would be provided by the developer.

9.4 Seagrass restoration

- 9.4.1 Efforts to restore seagrass meadows at coastal locations around the UK are in their early stages. There are major challenges which relate to existing pressures, which have led to declines in health and coverage of these habitats, and continue to do so. Although, experience with restoration is growing rapidly, uncertainties remain regarding the restorability of seagrass habitats, including the scale of habitat that can be restored, whether it could become self-sustaining and over what timeframe this could be achieved. It should be noted that, in regard to seagrass restoration as a measure of compensation, uncertainty translates in to risk to successful delivery.
- 9.4.2 There are two possible routes for the delivery of seagrass restoration as part of a strategic compensation package. Seagrass restoration could be led by the developer. For this option, in the first instance, further investigation of the site conditions and pressures would be required before final site selection. It should be noted that sites with the most suitable conditions may still require further reduction of pressures (e.g. relocating moorings, improving water quality, excluding trawling and dredging) to maximise the chances of successful restoration. This approach would require public consultation and engagement with stakeholders, and may be costly and time consuming.
- 9.4.3 Another option is to deliver compensation through existing restoration initiatives. Under this scenario the developer would pay into a fund to support existing projects. One example may be Life Recreation ReMEDIES (Save Our Seabed, 2019), however there other projects that could be supported through compensation. By delivering compensation through a wider programme resources will be placed in the hands of those with the greatest knowledge and experience, who have already been through the site selection process and project planning stages. This money will support an additional new or extended area. Furthermore, additional funds should be provided to support activities that can aid success, such as the development of less damaging anchor systems, or activities to improve water quality. However, careful consideration will need to be given as to how to demonstrate the success of

these additions, which can be worked out with the partner organisations as appropriate to the activity being undertaken. Should this approach be implemented we propose that it is included alongside supporting restoration at a new site, and thus this further support would be considered as additional to help the success rate.

9.5 Securing Compensation

- 9.5.1 The DBSCP will be submitted alongside the project submission to outline the compensation proposals agreed between the Steering Group. The DBSCP provides the relevant information required to show how the compensation will be committed to while also allowing a certain level of flexibility to account for potential changes in scale of impact and subsequent compensation levels. The DBSIMP will be developed post consent and include the necessary details relevant to the final compensation requirement and will detail how the Projects will commit. Once this DBSCP has been agreed, development consent order (“DCO”) applications can be submitted by the developers of the Round 4 projects and the compensatory measures identified in those applications will accord with the agreed DBSCP and it can be expected that those measures can be included as requirements of any DCO that is made.
- 9.5.2 Under the agreements for lease with The Crown Estate, developers of DBSW and DBSE must participate in the processes required by this DBSCP and comply with, undertake and maintain (as necessary) the compensatory measures required to be adopted pursuant to this DBSCP. The DBSIMP (which forms a part of and is a requirement of the DBSCP and will provide further detail on the delivery and implementation of the measures) will dictate which measures will be undertaken, where, how and other specifics. The DBSIMP will secure the funding and ensure the benefits are shared across the Round 4 Plan and do not remain with any individual developer, regardless of who has undertaken the build, for example should ownership of any project change in the future. The DBSIMP will also set out any necessary agreements between The Crown Estate and the developers necessary to deliver the compensation. Costs will be shared between the relevant developers and this will be agreed in advance of commercial agreements being secured. Monitoring will be specified in the DBSIMP and coordinated to ensure consistency across the relevant projects to this DBSCP. It will ensure the data is collated and presented at a plan level and not in piecemeal fashion from each project separately on a project by project basis. The DBSIMP will require developers to comply with the detail set out within the DCO or Deemed Marine Licence (dML) condition.
- 9.5.3 The Crown Estate will continue to chair the Steering Group following the submission of DCO applications for DBSW and DBSE. Examiners’ Questions related to this DBSCP during the DCO process following the submission of the DBSCP should be directed to the relevant project applicant who will then provide those questions to The Crown Estate to ensure consistent alignment of responses which take account of Steering Group discussions and responses. It is requested that due to the requirement of input of the Steering Group the Examiners put forward Written Questions where practicable. The Steering Group will be responsible for providing oversight of delivery, and of the responses related to the DCO process regarding the DBSCP, reviewing monitoring data and if applicable identifying adaptive management measures. The Terms of Reference for the DBSCP Steering Group still apply following DCO submission and until the Steering Group is dissolved in accordance with those Terms of Reference.

10 Monitoring

10.1.1 The primary role of monitoring is to demonstrate the success of the measure and inform potential adaptive management interventions.

10.2 New site designation or extension of an existing site

10.2.1 The process for measuring the success of a new site designation or the extension of an existing site will be determined by Defra. There are no prior examples of site designation or extension for the purpose of compensation, and monitoring requirements have not yet been determined. As the new or extended sites become part of the network monitoring requirements may fall under the responsibility of Natural England or the JNCC as part of statutory condition assessment obligations. Under such a scenario it is expected that funding to support monitoring of the newly designated area will be secured from the developer. Any such additional monitoring, should be appropriate to monitoring of similar habitats within the MPA network. As this measure is a strategic measure with sites selected to cover multiple projects, including but not limited to Round 4, will be agreed during the development of the DBSIMP in conjunction with the Marine Recovery Fund and COWSC, who will establish how this cost is shared across the multiple projects. This will also need to consider how that contribution may change over time if the compensation measure is shared with additional projects.

10.2.2 The measure has a high probability of success. However, the process for designating or extending an SAC can be time consuming, Defra have advised the process may take up to 7 years. Notwithstanding this, it is anticipated that this measure will have been secured when candidate SAC sites or recommended MCZ (cSAC or rMCZ) have been selected (cSAC and rMCZ are afforded the same level of protection through UK policy as fully designated sites) or when the Examining Authority has confidence in their security through another mechanism; at the time of writing Defra are working on providing further comfort on the security of this measure. The measure can be considered to have been successfully implemented once the sites are fully designated and appropriate management measures are in place. Defra has advised that they will be working with DESNZ, The Crown Estate, and others, with the aim that any new or extended sites designated to provide compensation will receive greater protection in future to avoid a need for additional compensation at these new sites.

10.3 Restriction of activities (Fishing)

10.3.1 This measure has not been agreed by the Defra Secretary of State, but if confirmation were to be given in the future, and this measure was taken forward, fishing activity will be monitored to ensure compliance. This will be done through standard government-led processes. The process for measuring the success of the restriction of activities will be determined by Defra in conjunction with the MMO. It is expected that the developers would provide funding to support this monitoring and enforcement of fishing restrictions.

10.4 Seagrass restoration

10.4.1 To determine whether restored seagrass is self-sustaining, indicating the success of the measure, long-term monitoring would be required. If restoration were to take place within an MPA where seagrass was a designated feature or sub-feature, monitoring would fall within the remit of a SNCBs, such as Natural England. However, as part of funding seagrass restoration, funding for monitoring will be secured by the developer, and this will be agreed during the development of the DBSIMP.

10.4.2 Ideally the site undergoing restoration would be compared with a minimum of two healthy seagrass meadows at reference sites (other locations with similar physical and environmental characteristics)

(Hendy *et al.*, 2021). If in the long-term, the restored seagrass beds meet or exceed the structural, functional and genetic indicators at those reference sites a restoration project can be considered successful (Hendy *et al.*, 2021). Indicators would also need to be compared with previous years and the baseline condition to determine trends over time. Table 10.1 lists suggested metrics for indicators and provides an indicative timeline for monitoring (Hendy *et al.*, 2021). As noted in Section 7.3, subtidal seagrass beds are absent on the east coast. Should seagrass restoration be implemented as compensation, comparisons could be made with the nearest subtidal seagrass beds, which are on the south coast. However, these sites may be subject to different pressures and environmental conditions and it will need to be determined whether comparisons are appropriate.

Table 10.1 : Suggested timeline and metrics for a seagrass restoration monitoring programme, modified from Hendy *et al.*, 2021 (£ = cheap, ££ = medium expense, and £££ =expensive; * = optional indicators to assess seagrass status). Before year five there will be minimal underground carbon storage. Thus, carbon would be assessed as a functional indicator post year 5. "Destructive" indicates an extractive or damaging activity.

Structural Indicators				
Timeline	Year 0	Years 1–5	Year 6+	Note
Cover/extent	After 1, 3, 6 months	Yearly	Yearly	£
Shoot density and leaf morphology	After 1, 3, 6 months	Yearly	Yearly	£
Biomass*	Once	Yearly	Yearly	££ (destructive)
Epiphyte cover and disease assessment	After 1, 3, 6 months	Yearly	Yearly	£
Functional indicators				
Timeline	Year 0	Years 1–5	Year 6+	Note
Biodiversity – epifauna and fish	Before-Once	Year 5	Yearly	£££
Water quality	Once	Yearly	Yearly	£
Sediment structure*	Before-Once	Year 5	Yearly	££
Carbon stock assessment sequestration measurements	Before-Once	Year 5	Yearly	£££ (destructive)

10.4.3 When measuring restoration success, the resistance of the restored habitat to disturbance should also be assessed. An accepted approach is to measure the natural parameter value range of the restored seagrass meadows and compare that of the reference sites. If the natural parameter value ranges of restored seagrass meadows falls within the ranges of the reference seagrass meadows it can be assumed they can resist disturbance (Hendy *et al.* 2021). Where annual variability has been recorded, this can be used to define the limits for the natural parameter value range, if not variability across space can be used (Hendy *et al.* 2021).

11 Adaptive Management

11.1.1 Adaptive management will be applied after the DBSW and DBSE projects become operational. The Steering Group will remain engaged until its objectives, (as agreed in the Terms of Reference,) have been met, including consideration relating to monitoring and adaptive management, and it is dissolved in accordance with its Terms of Reference..

11.1.2 Adaptive management is an iterative process that combines management measures with ongoing

monitoring to ensure the effectiveness of the measure. It may be needed to rectify unforeseen impacts caused by the introduced compensation measure(s), and should contribute to updating knowledge and improving decision-making over time. It is expected that the detailed approach to developing the compensation measures will minimise the risk that adaptive management would need to be implemented. Nonetheless, adaptive management will play a crucial role in the compensatory measures, serving as a tool to address unexpected issues or deviations from the anticipated outcomes of the compensation.

- 11.1.3 Adaptive management thresholds (i.e., the point at which adaptive management is actioned) will be developed and detailed in the DBSIMP. Triggering of thresholds will be informed by monitoring of the compensatory measure. The link between specific adaptive management actions and how they will be informed by monitoring has been presented to Steering Group members and it was agreed that ongoing engagement on the need for adaptive management will be undertaken with the Steering Group post Round 4 compensation implementation. Adaptive management thresholds will depend on the final compensation solution. Some factors impacting the success of the measure may be beyond the control of DBSW and DBSE. The Steering Group shall review such cases to determine responsibility for remedial actions.
- 11.1.4 It is not necessarily appropriate to set quantitative timescales for trigger points in relation to adaptive management due to the complexity of potential issues. At this stage, quantitative trigger points would only permit hypothetical and therefore potentially incorrect timescale estimates. A more appropriate approach, which has been agreed within the Steering Group, is presented in
- 11.1.5 Figure 11.1. This sets out the process of determining trigger points based on a review of monitoring at a frequency which will be agreed with the Steering Group post-consent. This will also permit the monitoring results to be viewed in the context of baseline monitoring results and that of data and trends at a wider regional or national level, if appropriate.
- 11.1.6 If necessary, this process will inform the most appropriate response in terms of adaptive management. Potential adaptive management options will be dependent on the final compensation solution. As a result, potential adaptive management options will be determined with Steering Group members post-consent, but may include:
- Extending measure/s to different areas, identified through the site selection process.
 - Identifying pressures leading to failure and implementing measure to reduce those pressures.
 - Use marine recovery fund or similar strategic route, if available.
- 11.1.7 If relevant, Steering Group members will be informed, and agenda items will be established for the Steering Group meetings. Final adaptive management options and approach will be refined post-consent following agreement of key specifics of the compensatory measure (such as compensation solution). This information will be agreed with the Steering Group and presented within the DBSIMP (an outline of which is provided within Appendix A). An overview of the adaptive management approach is provided below in Figure 11.1.
- 11.1.8 Approaches to adaptive management for the Round 4 Plan compensatory measures were presented and discussed during Steering Group meetings. Overall, the Steering Group members agreed that the approach was suitable and appropriate to support the Round 4 Plan compensation solution.

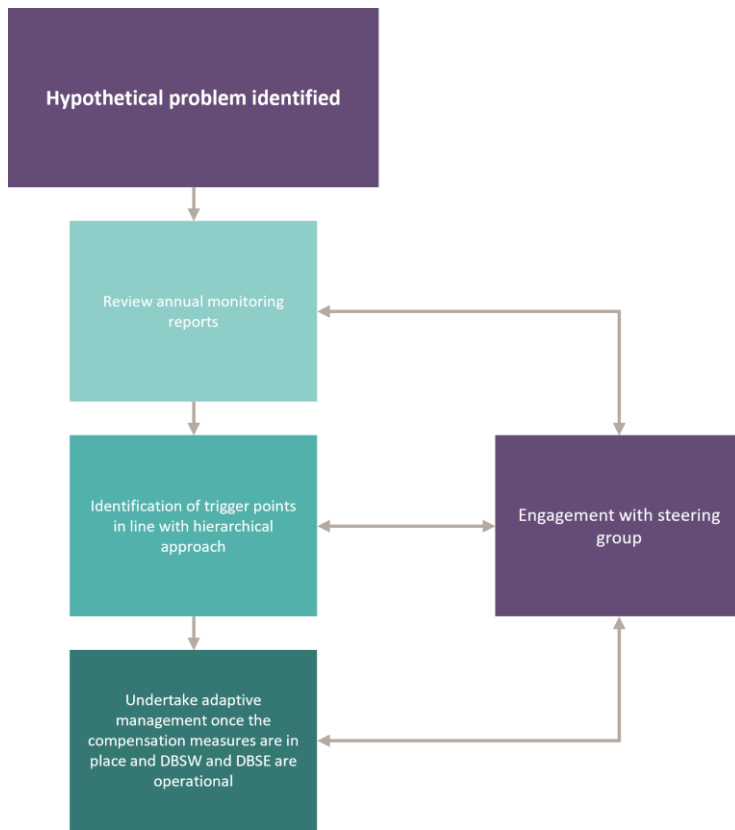


Figure 11.1 Overview of adaptive management approach

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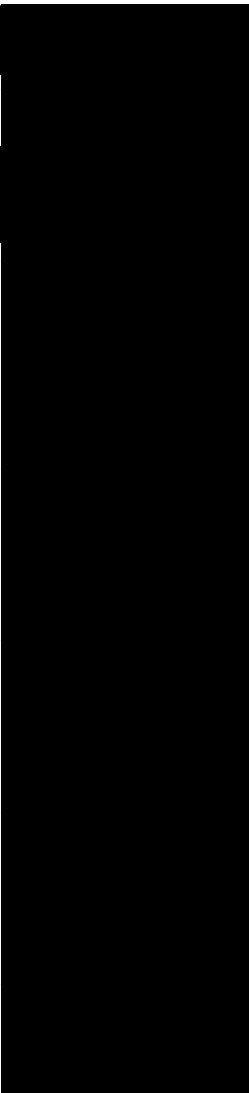
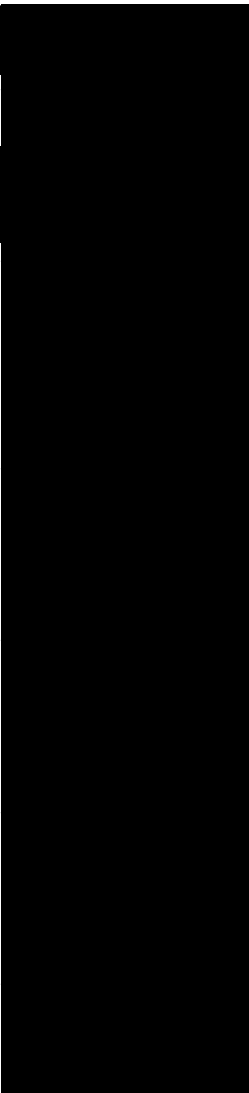
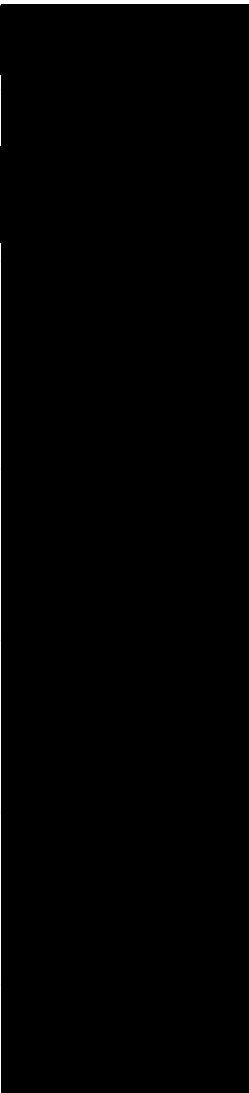
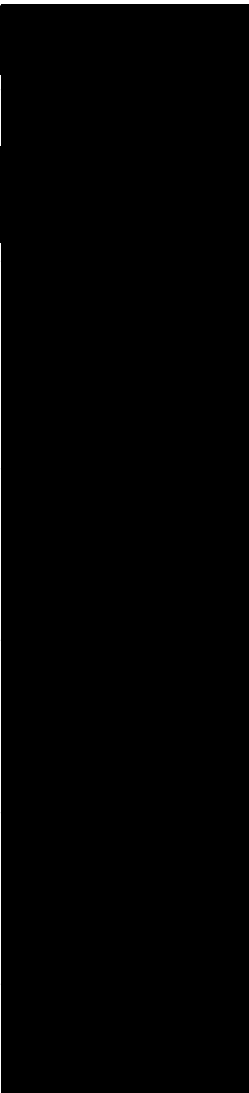
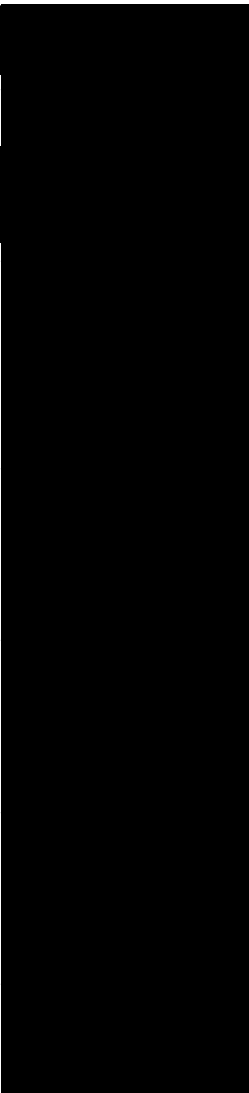
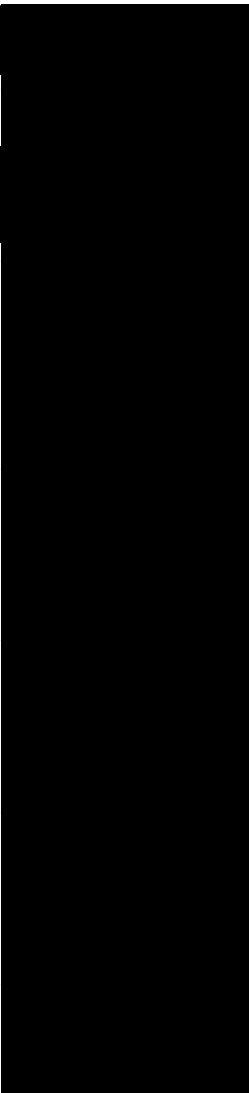
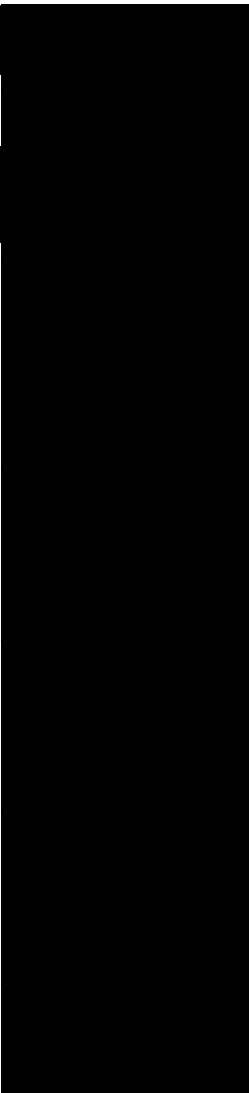
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13 Signatories

13.1.1 The below signatories, all members of the Dogger Bank Strategic Compensation Plan Steering Group, confirm that this Dogger Bank Strategic Compensation Plan has been developed in accordance with the agreed Terms of Reference for the Steering Group. Where an individual member does not agree with the content of parts of the Plan, this is documented in the Agreements Log, which should be considered as part of the Plan.

Organisation	Named Signatory	Signature	Date
Steering Group Chair – The Crown Estate	Ed Salter		25 April 2024
The Crown Estate	Ben Lander		25 April 2024
Department for Environment, Food and Rural Affairs (Defra)	Sophie Vickery		25 April 2024
Department for Energy Security and Net Zero	Rebecca Walker		25 April 2024
Natural England	Alex Fawcett		25 April 2024
JNCC	Karema Randall		25 April 2024
RWE	Colin McAllister		25 April 2024

Appendices

Appendix A – Outline DBSIMP

Available as a separate document.

Appendix B – Letter of acceptance from the Secretary of State

Available as a separate PDF.

Appendix C – Agreement log

Available as a separate excel document.

Appendix D – Long list

Available as a separate document.

Appendix E – Site selection report

Available as a separate document.

Appendix F – DBS SAC Extension Benthic Survey Technical Report (Supplied by RWE)

Available as a separate document.

Certificate Of Completion

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Certificate Pages: 7 Initials: 0 Claire Gorringe
AutoNav: Enabled [REDACTED]@thecrownstate.co.uk
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Signer Events

Alex Fawcett
[REDACTED]@naturalengland.org.uk
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Signature

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Ben Lander
[REDACTED]@thecrownstate.co.uk
Security Level: Email, Account Authentication (None), Authentication

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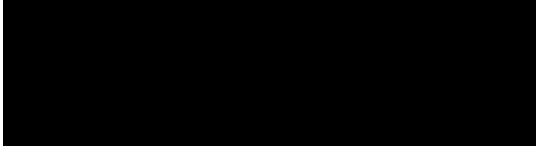
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Signature

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SMS Auth:



Electronic Record and Signature Disclosure:

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Colin McAllister

@rwe.com

Security Level: Email, Account Authentication (None), Authentication

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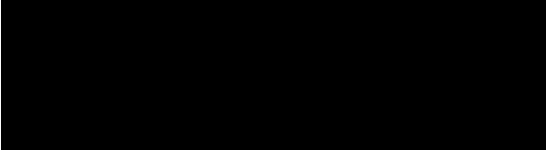
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Electronic Record and Signature Disclosure:

Accepted: 25 April 2024 | 11:19



Karema Randall

@jncc.gov.uk

Security Level: Email, Account Authentication (None), Authentication

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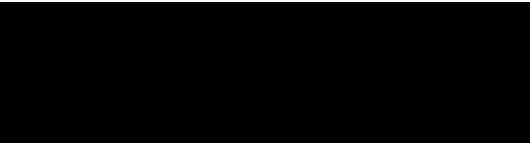
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SMS Auth:



Electronic Record and Signature Disclosure:

Accepted: 25 April 2024 | 12:03



Signer Events

Signature

Timestamp

Rebecca Walker
[Redacted]@energysecurity.gov.uk
Security Level: Email, Account Authentication (None), Authentication

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Electronic Record and Signature Disclosure:

Accepted: 25 April 2024 | 10:55
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Sophie Vickery
[Redacted]@defra.gov.uk
Security Level: Email, Account Authentication (None), Authentication

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Electronic Record and Signature Disclosure:

Accepted: 25 April 2024 | 10:56
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Ed Salter
[Redacted]@thecrownestate.co.uk
Mr
Security Level: Email, Account Authentication (None), Authentication

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Round 4 Compensation

Dogger Bank Strategic Compensation Plan Appendix A – Outline Dogger Bank Strategic Implementation and Monitoring Plan

The Crown Estate

Date: 27th October 2023
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Rev.no.	Date	Description	Prepared by	Verified by	Approved by
1	01/10/23	Draft template	FRCA	IGP	SPAC

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1 Introduction

- 1.1.1 This document sets out the outline for the Dogger Bank Strategic Implementation and Monitoring Plan (“DBSIMP”) that will be developed by the Offshore Wind Leasing Round 4 Plan (“Round 4”) strategic steering group for Dogger Bank compensation (the “Steering Group”) should consent for the Round 4 Dogger Bank South West (“DBSW”) and Dogger Bank South East (“DBSE”) projects be granted. The DBSIMP will be developed in accordance with the Dogger Bank Strategic Compensation Plan (“HSCP”), of which this document is an Annex, which provides a detailed account of the strategy supporting the potential compensation measures for Dogger Bank habitat. The DBSIMP will be a requirement of the DCO and will need to be submitted to the Secretary of State for approval.
- 1.1.2 The following sections of this document set out the proposed content of the DBSIMP. The DBSIMP will be structured as follows:
- Section 1: Introduction
 - Section 2: Background
 - Section 3: Consultation
 - Section 4: Strategic artificial nesting structure
 - Section 4.1: Scale and location of compensation
 - Section 4.2: Design
 - Section 4.3: Routine management
 - Section 4.4: Delivery mechanism
 - Section 4.5: Commercial agreements
 - Section 4.6: Monitoring and adaptive management
 - Section 4.7: Reporting
 - Section 4.8: Programme for implementation and delivery
 - Section 4.9: Discharge of consent condition

2 Background

- 2.1.1 This section will provide context to the DBSIMP, confirming the reason for its need, its aims and objectives, and the latest project status.

3 Consultation

- 3.1.1 This section will summarise all relevant consultation that has taken place through the Steering Group process in the development of the DBSIMP. It will capture any key decisions, agreements, and where relevant any outstanding issues under discussion (with clarity as to the steps necessary to resolve any such matters). Ongoing engagement, for example to provide updates on monitoring, (post-discharge of the DBSIMP) will be outlined here.

4 Scale and location of compensation

- 4.1.1 This section will identify the scale of compensation proposed to be provided and how this relates to the consent decision made by the Secretary of State. This section will then also detail the specific

location(s) at which the compensation will be delivered and how the necessary seabed rights and/or property rights in those locations have been/will be secured. The evidence base included in support of the HSCP will help inform these aspects.

5 Design

- 5.1.1 This section will identify the design for the required compensation measure(s) provided within the compensation package. The evidence base provided in support of the HSCP and engagement with the Steering Group will be important in informing the specific design aspects of the measure(s).

6 Routine management

- 6.1.1 This section will describe the management responsibilities for the measure(s), including anticipated routine maintenance.

7 Delivery Mechanism

- 7.1.1 This section will confirm the nature and status of all consents, land or seabed access agreements, as well as any other relevant approvals and/or funding arrangements that are necessary to secure the implementation of the compensation measure(s) and include a programme for delivery of any outstanding consents.
- 7.1.2 This section will also outline key members involved in the delivery, their role in the process and responsibilities associated with implementation.

8 Commercial Agreements

If a decision is made to progress a measure(s) which requires commercial agreement between parties then this section will provide a high level summary of the agreement with the relevant members. Furthermore, this section may also include agreements between parties to ensure the implementation of the measure.

9 Monitoring and adaptive management

- 9.1.1 This section will identify the monitoring and adaptive management principles and processes that have been agreed with the Steering Group, including the scenarios under which adaptive management measures are required. It will be developed in line with the evidence base that has been provided in support of the HSCP. Following discharge of the DBSIMP, the Steering Group will be engaged in relation to implementing adaptive management if required as outlined in the Consultation section above. Specific topics of discussion for inclusion within the Steering Group, and therefore the purpose of the group, will be regarding site selection, project/ study design, monitoring, adaptive management options and associated triggers. The focus of the Steering Group will be specifically to deliver the compensation for DBSW and DBSE therefore other topics beyond this will be out of scope

for the DBSIMP.

10 Reporting

- 10.1.1 This section will set out the reporting requirements associated with the monitoring and adaptive management. In doing so, it will confirm the necessary objectives and timescales for the reporting.

11 Programme for implementation and delivery

- 11.1.1 This section will confirm the programme for the implementation and long-term delivery of the compensation.

12 Discharge of consent condition

- 12.1.1 This section will confirm how, based on the content of this report, the Secretary of State can discharge the condition relating to the delivery of the compensation required for the required feature of the protected site.



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15 July 2022

Dear Dan,

The Crown Estate's Fourth Seabed Leasing Round: Habitats Regulation Assessment

I refer to The Crown Estate's letter of 20 April 2022 on the Plan Level Habitats Regulations Assessment for the Fourth Seabed Leasing Round. I am content that The Crown Estate has fulfilled its obligations under regulation 64 of the Habitats Regulations 2017, and regulations 29 and 30 of the Conservation of Offshore Marine Habitats and Species Regulations 2017. I am content that The Crown Estate has appropriately assessed the impacts of the plan on the protected sites within the National Site Network that may be affected and am content for the plan to proceed subject to the condition set out in this letter.

I am satisfied that an appropriate evaluation of alternative solutions has been carried out and we accept that there are no alternative solutions to the preferred options that would have a lesser effect on the integrity of the sites in our National Site Network, whilst meeting our decarbonisation and renewables ambitions under the British Energy Security Strategy (BESS).

There is also a strong case to justify the anticipated damage to sites within the National Site Network on grounds of imperative reasons of overriding public interest, based on the importance of dealing with climate change and meeting our decarbonisation and renewables ambitions, and more recently the need for energy security.

I note that it has been difficult to provide the level of detail necessary to identify all potential impacts and that where this is the case, further assessment has been deferred to the project level HRAs, where further assessment, and consultation will take place with Government, Statutory Nature Conservation Bodies (SNCBs) and environmental NGOs.

I understand that impacts on the Dogger Bank SAC and Flamborough and Filey Coast SPA will be compensated through developing compensation plans for each of the affected sites. However, I note that a lack of certainty on the efficacy and longevity of certain measures was raised by some respondents to The Crown Estate's consultation. I am encouraged that you will be exploring a suite of potential compensation measures to ensure there is the flexibility needed to develop effective compensation. I am also supportive of the steering groups being set up for each

compensation plan, with a condition added to developer's Agreement for Lease (AfL) that agreement of the compensation plan within each steering group is required before submission of DCO applications. I note that both BEIS and Defra will be invited to participate on the steering group for each compensation plan. This is essential so Government understands future compensation needs, potential opportunities and allow us to ensure that the compensation packages can learn from ongoing research programmes such as OWEC (Offshore Wind Evidence and Change Programme) and align with the new policies and arrangements being developed under the British Energy Security Strategy, such as the Offshore Wind Environmental Improvement Programme.

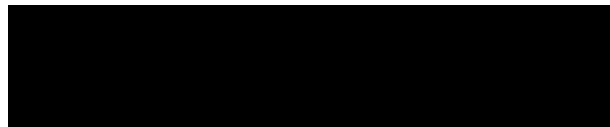
Given the uncertainty in the efficacy and longevity of certain compensation measures, monitoring will be essential to ensure the measures are working, and adaptive monitoring will be required if the initial measures do not work as planned. A condition of my approval is:

- The Terms of Reference for each steering group require the steering group to monitor each measure and the compensation plan as a whole, at intervals that experts within the steering group consider appropriate,
- Require the steering group to put in place adaptive management if necessary,
- Require the steering group to take into account any recommendations from the advisory group, and
- Require the steering group to take into account wider Government policies (such as requirements within the BESS) when monitoring and adapting.

My Department is happy to work with The Crown Estate on the practicalities of undertaking this monitoring review as part of our membership on each steering group.

On the basis of the condition proposed above, I am content that appropriate steps have been taken to ensure that compensatory measures will be in place to offset predicted losses to the Dogger Bank SAC and the Flamborough and Filey Coast SPA. Consequently, I can confirm that BEIS has no objections to The Crown Estate's approval of the Strategy.

Yours sincerely,

A solid black rectangular box used to redact the signature of the Secretary of State.

RT HON KWASI KWARTENG MP
Secretary of State for Business, Energy & Industrial Strategy

ID	Topic area	Agreement	Comments	JNCC	NE	DEFRA	BEIS/ DESNEZ	RWE	TCE	Decisions/ response by TCE
1	Site Designation / Extension	The group is in agreement with the recommendation of the plan to propose strategic site designation/extension as the most ecologically beneficial compensation measure.		Agreed but needs to recognise that there are differences between the different types of site designation (KR 27/03/24)	Agreed recognising that it is a sandbank site that should be designated, starting from that which most closely matches the habitat being lost at Doger Bank (AF 10/4/24)	Agreed, noting and agreeing with SNCB comments (SV 11/4/24)	Agreed RW 22/03/24	Agree 21/3/24	Agreed - BL 06/03/2024	N/A
2	Restriction of future activities - Fishing bye-laws	It is agreed that fishing bye-laws will be included in the plan as a measure - as a high level concept, further details are to be refined if the measure is required at plan level. Fishing restrictions are already in place at Dogger Bank SAC so, if taken forward, this measure would need to be delivered elsewhere to protect an area of Annex I Sandbank (either inside an alternative Marine Protected Area, or an area of Annex 1 sandbank outside a Marine Protected Area) where there are currently no restrictions.		Agreed recognising that any restrictions need to be in addition to those already in place or planned through standard processes (KR 24/4/24)	Agreed recognising that any restrictions need to be in addition to those already in place or planned through standard processes (AF 24/4/24)	Agreed recognising that there are risks and uncertainties around this measure and Defra SoS agreement will be needed before it can be delivered. Any restrictions will need to be in addition to those already in place or planned through standard processes (SV 24/4/24)	Agreed RW 22/03/24 noting and agreeing with Defra comments.	Agree 21/3/24	Agreed - BL 06/03/2024	N/A
3	Strategic compensation measures	It is agreed that new site designation or extension, and restriction of future activities can and should benefit multiple projects. Therefore, as compensation measures, new site designation or extension and restriction of future activities should only be undertaken strategically.		Agreed for designation and extension. Ideally restriction of future activities should be undertaken strategically (even at a site level) but this requires all regulators to be on board with the process (KR 27/03/24)	Agreed for site designation or extension. Not agreed for restriction of future activities as there may be opportunities to do this strategically or at a site level and it requires regulators to be involved. (AF 10/4/24)	Agreed for new site designation or extension. Not agreed for restriction of future activities as it might depend on individual cases (SV 11/4/24)	Agreed RW 22/03/24	Agree 21/3/24	Agreed - BL 06/03/2024	N/A
4	Seagrass restoration	It is agreed by the group that seagrass restoration is considered as a viable option for Round 4 compensation as a small part of a package, with other measures only.		Agreed as only a very small part of a package and only for subtidal seagrass (KR 18/04/24)	Agreed as a small part of a package and only for subtidal seagrass (AF 10/4/24)	Agreed as a small part of a package (if necessary) (SV 11/4/24)	Agreed RW 22/03/24	This was included only as contingency if designation failed to deliver sufficient compensation	Agreed - BL 06/03/2024	N/A
5	Oyster reef restoration	The group agree to remove oyster reef restoration from the plan as the measure does not provide suitable compensation for Sandbank.		Agreed (KR 27/03/24)	Agreed (AF 10/4/24)	Agreed (SV 11/4/24)	Agreed RW 22/03/24	Agree 21/3/24	Agreed - BL 06/03/2024	N/A
6	Habitat damage	It is agreed that habitat loss and habitat damage should be viewed differently with respect to the area of compensation required. Loss implies the permanent removal of habitat and the provision of similar compensation measures should seek to replicate the area lost on a direct basis (subject to the further inclusion of any additional compensation ratio). Damage, is agreed to represent a partial and differential alteration of the character of a habitat. Whereas the HRA assumed, simply, that habitat damage occurred uniformly and completely across a buffer zone around seabed works, in practice it is considered that the alteration arising from these works would be observed as a gradient of change from 100% close to the works and reducing to 0% at the extremity of the assumed buffer. Furthermore this change would not be permanent, with some recovery occurring over time.	as discussed in SGDM10 and 12	Agree that these are different things but there is still a need to consider the same things in terms calculating the amount of compensation required as for loss e.g. recoverability, delivery timeframes etc which will determine the amount, as opposed to setting arbitrary amounts or ratios. (KR 27/03/24)	Agreed but further discussion and evidence is needed to understand the impact of damage on Dogger Bank SAC and potential for recovery to inform any reduction in area. The precautionary principle should assume 100% unless otherwise agreed. (AF 10/4/24)	Defer to SNCB advice on this point (SV 11/4/24)	Agreed RW 22/03/24	RWE do not agree that damage should contribute to the AEOL conclusion. SNCBs have not provided evidence of recovery taking 10+ years, RWE believe available evidence (including from the Dogger Bank) indicates effects are short-term. Notwithstanding the above RWE agree that if damage were included, recovery would be along a gradient both spatially and temporally and compensation should reflect this. 18/4/24	Agreed - BL 06/03/2024	The Crown Estate note RWE's position that damage should not contribute to AEOL conclusion. However, The Crown Estate's HRA and Derogation are final and include the consideration of damage to farm part of the AEOL.
7	Habitat damage	It is agreed, however, that, at the present time there is a lack of empirical evidence to appropriately quantify these areal and temporal characteristics of habitat damage in the context of the relic sandbank that forms the Annex I Sandbank feature of Dogger Bank SAC and for the purposes of this Strategic Compensation Plan habitat damage should be treated the same as habitat loss, until more evidence is available to do otherwise.	as discussed in SGDM10 and 12	Agreed (KR 27/03/24)	Agreed (AF 10/4/24)	Defer to SNCB advice on this point (SV 11/4/24)	Agreed RW 22/03/24 DESNZ will defer to SNCB comments, but also note comments from DBS on the consultation log concerning their results on habitat damage and recovery. All evidence must be used in coming to the conclusion on AEOL and amount of compensation required in terms of habitat damage.	RWE do not agree that damage should be treated the same, we believe the conclusion was that the impact would be <100% of habitat loss with no agreement on the quantum	Agreed - BL 06/03/2024	N/A
8	Compensation level	It was agreed that simple area based comparisons between sandbank and dissimilar habitats, such as seagrass, may not be optimal. An alternative approach which sought to use ecosystem function metrics such as production was investigated: whilst this may have merit there was insufficient time to develop this adequately. Should a package be required which includes seagrass restoration, this work should be revisited.	as discussed in SGDM11	Agreed (KR 27/03/24)	Agreed (AF 10/4/24)	Agreed (SV 11/4/24)	Agreed RW 22/03/24	Agree 21/3/24	Agreed - BL 06/03/2024	N/A
9	Seagrass restoration	It is proposed that one potential option for implementation is via existing seagrass restoration funds/ projects to enhance the chance of successful implementation and one option for the implementation is for it to be developer lead. Due to the benefits the group favoured the option to deliver through existing restoration projects/funds so long as it proved to be additional.		Not agreed - the best ecological option should be used to restore sub-tidal seagrass if this measure is taken forward as a very small part of a package. This may not necessarily be through existing projects. (KR 18/04/2024)	Not agreed, should this measure be taken forward for sub tidal seagrass restoration as part of a package then the best ecological option should be identified. This may be contribution to an existing project where the benefits can be shown to be additional or restoration of a new area of subtidal seagrass (AF 18/04/24)	Defer to SNCB advice on this point, but if implemented via existing projects, compensation will need to be demonstrated to be truly additional (SV 18/04/24)	As per Defra comments RW 18/04/24	Agree 18/4/24	Agreed - BL 19/04/2024	The views of SNCB's Defra and DESNZ are noted. Both developer led and utilising existing seagrass restoration projects are presented as opportunities within the plan, and the Steering Group will have the opportunity to influence the appropriate way forward should this measure be required. The indication that utilising existing projects was 'favoured' was intended to indicate that utilising existing knowledge and expertise would be beneficial where possible, but it is noted and agreed that any seagrass restoration would need to be proved to be 'additional'.
10	Aggregates	This was excluded as a viable measure for this Plan due to the small areas available and the fact that the aggregates industry is managed to ensure sandbank recovery.		Not agreed - this measure has not been discussed in detail and sufficient evidence has not been presented to suggest that it is not viable. This is a measure that could be delivered as part of a package (although outside of DB SAC) to benefit Annex I Sandbank. (KR 18/04/2024)	Not agreed. This measure was not explored in detail and there is not sufficient evidence to conclude it is not viable. We consider that this could contribute to a package of measures and that this could help to remove pressure on Annex 1 sandbank. (AF 18/04/24)	Not agreed. This measure was not explored in detail and we don't have the evidence to conclude it is not viable. There could be benefits in some situations, e.g re-locating aggregates activities that currently occur within MPAs (SV 18/04/24)	As per Defra comments. Although I agree that the aggregates industry is managed to allow recovery by leaving a minimum of target substrate in place, I take the Defra/SNCB points around removal of pressure in a site which is already under pressure and re-locating activities that currently occur in MPAs. RW 18/04/24	Agree 18/4/24	Agreed - BL 19/04/2024	The view of the the SNCB's and Defra are noted, however, it was discussed during the Steering Group meetings that whilst there may be opportunity to reduce some pressure from aggregates within MPAs the number of aggregates sites within protected sites, and their scale was such that there was limited viability for this measure to be taken forward.
11	Ratio	A ratio of 1:1 has been stated as the compensation value for restriction of future offshore wind as this is a like for like measure. There is no requirement for like for like to be more than 1:1 ratio		Not agreed, this has not been discussed with the steering group and no evidence has been presented on a suitable ratio. (KR 24/4/24)	Not agreed, the steering group has not seen potential areas for restriction of future offshore wind and has not had any discussion on what ratio would be required should this measure be taken forward at any stage. Further work is needed to understand how ecologically meaningful the measure is and to enable discussion on appropriate ratios. (AF 24/4/24)	Not agreed. This has not been discussed with the steering group and further work is needed to understand how ecologically meaningful this measure is and therefore appropriate ratios (SV 24/4/24)	Not agreed - while it sounds sensible in principle, it hasn't been discussed/explored/tested with the steering group. There may well be nuances, caveats and exceptions to this. RW 24/04/24	Agree 24/04/2024	Agreed - BL 24/04/2024	The Crown Estate note that this point is not agreed across the Steering Group, but this is based on existing precedent for like for like measures in DCO decisions, and is included to reduce risk of inefficient use of The Crown Estate's assets in the future, whilst noting that this position does not fetter the discretion of the Secretary of State to make a discretion on appropriate compensation.

12	Monitoring	<p>It was agreed that the monitoring requirements for a new or extended designated site should be appropriate to the purpose of monitoring. It is understood that monitoring for site designated as part of compensation are yet to be agreed and may differ to current monitoring, but we recommend they are appropriate to the requirement and purpose of the monitoring in relation to this Plan. This follows discussion in M9 to ensure the developers and the SNCB's concerns are adequately and fairly addressed.</p>	<p>SGDM9 • PP - evaluating success in this instance would have to be with a long-term watching brief. This would need to be factored into the ongoing adaptive management of the group. Monitoring proposal would have to be in line with the monitoring process in the existing MPA network and should be proportionate to what is currently undertaken for the existing network.</p>	<p>Agree that any monitoring of the designated site as compensation should be appropriate for understanding the condition of the site and it's contribution to the MPA network in terms of success and management (KR 24/5/24).</p>	<p>Agree that any monitoring of the designated site as compensation should be appropriate for understanding the condition of the site and it's contribution to the MPA network in terms of success and management. Monitoring would be designed for compensation sites alongside the rest of the MPA network by the relevant SNCB(s). Monitoring requirements have not been discussed yet and more time is needed to work through the details. (AF 24/4/24)</p>	<p>Agree that any monitoring of the designated site as compensation should be appropriate for understanding the condition of the site and its contribution to the MPA network in terms of success and management. Monitoring requirements have not been discussed yet and more time is needed to work through the details (SV 24/4/24).</p>	<p>Agreed - RW 24/04/24</p>	<p>Agree 24/04/2024</p>	<p>Agreed - BL 24/04/2024</p>	<p>N/A</p>
13	Questions at DCO	<p>It was agreed that The Crown Estate will continue to chair the Steering Group following the submission of DCO applications for DBSW and DBSE. Examiners' Questions related to this DBSCP during the DCO process following the submission of the DBSCP should be directed to the relevant project applicant who will then provide those questions to The Crown Estate to ensure consistent alignment of responses which take account of Steering Group discussions and responses. The Terms of Reference for the DBSCP Steering Group still apply following DCO submission and until the Steering Group is dissolved in accordance with those Terms of Reference.</p>	<p>This follows discussions in earlier meetings relating to questions on the strategic Plan level compensation and is in keeping with the aims of the ToRs</p>	<p>Not agreed. As site leads for Dogger Banks SAC JNCC will be providing statutory nature conservation advice on the project via the delegation agreement with Natural England. For this reason it would not be appropriate for us to be involved in formulating response to questions posed to TCE on the plan (KR 24/4/24).</p>	<p>Not agreed. As NE will be providing statutory nature conservation advice on the project into examinations, we do not consider it appropriate for us to also be involved in formulating responses to any input requests regarding the R4 Plan Level compensation. The plan would be clearer if 9.5.3 reflected this. We hope to continue to provide steering group advice on other matters during the DCO processes subject to availability. (AF 24/4/24)</p>	<p>We are content that examiners questions are directed at the project applicant and agree with the points made by SNCBs. The ability to provide statutory advice shouldn't be compromised. We would be open to a discussion on the role of the steering group during DCO examination. (SV 24/4/24)</p>	<p>Not agreed. Given the quasi judicial nature of the DESNZ SoS decision on each consent, DESNZ will need to take a decision on any involvement during the examination.</p>	<p>Not agreed. Although DBS, as the applicant, will respond to Examiners questions where appropriate and possible to do so there is frequently a fast turnaround on written questions and instant answers expected at hearings. Waiting on the SG to meet and respond will not be a workable solution during Examination. We also note that JNCC and NE do not plan on being involved in the SG during Examination. Agreement on the appropriate parties to be involved and how questions on the SCP can be resolved during the Examination will be required. CM 24/04/2024</p>	<p>Agreed - BL 24/04/2024</p>	<p>It is noted that there is not agreement across members of the Steering Group as to the continuation of the Steering Group during project Examination, namely due to capacity issues during a very busy process, and potential for conflicting advice to be submitted in response to Examiners Questions on the DBSCP and in individual organisations statutory roles in the process. It should be noted that all members have signed the Terms of Reference that describe the role of the Steering Group and that it will remain vested until post consent to consider monitoring and adaptive management requirements. The Examining Authority will have the right to ask questions of the DBSCP and it is appropriate that the Steering Group, being responsible for the development of the plan, respond to these questions and The Crown Estate will provide opportunity for members to feed into any response. Noting the individual organisations concerns, it will be for individual organisations to determine if and how they engage with the Steering Group during Examination.</p> <p>The Crown Estate are open to further discussions with Steering Group members regarding process during Examination.</p>



Round 4 Compensation

Appendix D – Compensation Measures Long List

The Crown Estate

Date: 23rd April 2024

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Rev.no.	Date	Description	Prepared by	Verified by	Approved by
1	26/10/23	First Draft	PCAU / IGP	SPAC	TNO
1.1	17/11/23	Revision following TCE review	PCAU / IGP	SPAC	TNO
1.2	28/02/24	Revision following EWG/SG review, Defra advice on site designation/extension & SGDM11 / SGDM12	PCAU / IGP	TNO	TNO
1.3	08/03/24	Revision following TCE / TL review	PCAU	SPAC	TNO
1.4	05/04/24	Revision following SG review	PCAU	MCLA	IGP
1.5	12/04/24	Revision following TCE / TL review	IGP	MCLA	SPAC
1.6	19/04/24	Revision following SG review	IGP	MCLA	SPAC
1.7	23/04/24	Revised following further feedback	IGP	SPAC	SPAC

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1 Introduction

- 1.1.1 The Crown Estate, as the Competent Authority for Offshore Wind Leasing Round 4 (Round 4 Plan), completed a Habitats Regulations Assessment (HRA). The HRA could not rule out an adverse effect on site integrity (AEOSI) of the Annex I habitat 'sandbanks slightly covered by seawater all of the time' (hereafter sandbank), a feature of Dogger Bank Special Area of Conservation (SAC).
- 1.1.2 Notwithstanding that conditions (mitigation measures) were imposed to minimise the impact, the Round 4 Plan HRA concluded an AEOSI in relation to sandbank due to the footprint of subsea infrastructure resulting in habitat loss, and construction methods with potential to damage seabed habitats, associated with offshore wind leasing Round 4 projects Dogger Bank South East and Dogger Bank South West. The Crown Estate decided to progress with the Round 4 Plan, putting forward a derogation case to the Secretary of State for the Department of Business, Energy and Industrial Strategy (BEIS). In the absence of any alternative solutions to achieve the objectives of the Plan, it was considered that the Plan should progress for reasons of over-riding public interest (IROPI). It was agreed with the BEIS that The Crown Estate would proceed with the Round 4 Plan on the basis of the derogation, subject to appropriate strategic environmental compensation plans being developed. There was no objection from Welsh Ministers.
- 1.1.3 A Round 4 strategic Steering Group for habitat compensation (hereafter referred to as the "Steering Group") was formed by The Crown Estate in accordance with the Secretary of State's approval letter of the derogation case. Strategic measures to compensate for loss and physical damage to sandbank feature of the Dogger Bank SAC as a result of the Round 4 Plan were investigated through the Steering Group on behalf of The Crown Estate. This document presents the long list of measures considered and summarises the conclusions reached as to which measures should be progressed as potential options to deliver sandbank compensation for the Round 4 Plan. Key areas of agreement have been captured within the agreement log (see Appendix C). These conclusions do not represent comment on the wider suitability of any measure to provide sandbank or other habitat compensation, particularly in the case of measures which are not currently being progressed for the purpose of strategic compensation for the Round 4 Plan.

2 Compensation hierarchy

- 2.1.1 The long list was initiated from a previous study (NIRAS, 2022) and added to during the decisions of the Steering Group. A fundamental consideration for each measure is its position in a preference hierarchy which, for the purposes of the Steering Group, was based on guidance by Defra (2021), also taking into account as far as reasonably possible the potential future direction of this guidance and policy updates afforded through the participation of Defra on the Steering Group. This guidance provides a framework to help advisors, regulators and developers devise and evaluate appropriate compensation. The guidance recognises that, in the marine environment, the highest preference compensation measures that address the same impact at the same location cannot always be delivered. Defra's framework presents definitions for a hierarchy for compensation measures (Table 2.1). Each step down the hierarchy moves further from the optimum solution, in this case a measure that provides sandbank habitat within Dogger Bank SAC.

Table 2.1 Compensation hierarchy (Defra, 2021)

Level	Hierarchy of Measures	Description
1	Address same impact, same location	Address the specific impact caused by the permitted activity in the same location (within the site boundary). <i>e.g. On-site creation, restoration or relocation of feature that will be harmed/lost.</i>
2	Same ecological function, different location	Provide the same ecological function as the impacted feature; if necessary, in a different location (outside of the site boundary). <i>e.g. Off-site creation or restoration of feature that will be harmed/lost.</i>
3	Comparable ecological function, same location	Provide ecological functions and properties that are comparable to those that originally justified the designation in the same location as the impact. <i>e.g. On-site creation or restoration of a similar feature to the one that will be damaged/lost.</i>
4	Comparable ecological function, different location	Provide ecological functions and properties that are comparable to those that originally justified designation; if necessary, in a different location (outside of the site boundary). <i>e.g. Off-site creation or restoration of a similar feature to the one that will be damaged or lost.</i>

2.1.2 At the time of writing there is ongoing consultation on policies to inform updated guidance for Marine Protected Area (MPA) assessments, including approaches to compensation. Documentation circulated as part of this consultation includes an updated compensation hierarchy which emphasises the ecological effectiveness of measures (Defra, 2024). Having reviewed this documentation it is considered that the Dogger Bank Strategic Compensation Plan (DBSCP) aligns with the proposed new hierarchy in prioritising the ecological effectiveness of measures; however, noting that the proposed new hierarchy is contained within a consultation document which may undergo further changes this document refers to the Defra (2021) draft guidance.

3 Compensation measures

3.1 Overview

- 3.1.1 For each of the potential measures identified, evidence and expert opinion were compiled and assessed by the Steering Group. Measures were evaluated in relation to the five principles of compensatory measures set out in Defra (2021) guidance, namely: link to the conservation objectives for Dogger Bank SAC; provision of the same or comparable ecological function to Annex I sandbank; not negatively impacting any other sites or features; ensuring the overall coherence of designated sites and the integrity of the MPA network; and ability to be monitored.
- 3.1.2 When measures were evaluated in relation to the five principles of compensatory measures this was done on the basis that each measure would be successfully implemented; however, other factors which were considered for each longlist measure included delivery risk, expected timeframe to deliver, and the scale of compensation which could be provided. Attention was also given to the practicality of implementation.
- 3.1.3 Measures remain under consideration to provide compensation for the Round 4 Plan unless concluded otherwise by the Steering Group. Each measure in the longlist thus either:
1. Remains under consideration; or,

2. Is not currently under consideration for the DBSCP at this time.

3.1.4 A short statement of current status is made following a description of each measure, below, followed by a summary of the overall position and affirmation of the measures currently being progressed. It should be noted that where it has been concluded that measures will not be considered further for inclusion in the DBSCP, this should not be taken to imply that those measures might not be appropriate strategic compensation measures in other contexts.

3.1.5 For context, the conservation objectives for Dogger Bank SAC are *'For the feature to be in favourable condition thus ensuring site integrity in the long term and contribution to Favourable Conservation Status of Annex I Sandbanks which are slightly covered by seawater all the time'* (JNCC, 2022).

3.2 New site designation or extension of an existing site

3.2.1 New site designation or extension aims to provide at least the same level of protection to Annex I sandbank habitat outside of the existing network as the sandbank that is subject to loss and damage in the Round 4 plan. In doing so, the integrity of the marine protected area (MPA) network can be maintained despite the loss and damage to sandbank habitat within Dogger Bank SAC as a result of the Round 4 Plan.

3.2.2 The following forms of site designation or extension have been explored:

- Extension of Dogger Bank SAC;
- Designation of a new SAC or extension to an SAC for the protection of sandbank feature;
- Designation of a new MCZ for the protection of a sandbank feature; and
- Amending SAC citation to protecting or enhance associated habitat (e.g. troughs between sandbanks).

3.2.3 Should Dogger Bank SAC be extended, this measure would be at Level 1 on the Defra hierarchy, but a new designation elsewhere or an extension of another SAC would be Level 2 (Table 2.1). Designation of a marine conservation zone (MCZ) on Dogger Bank would also be at Level 2 on the Defra hierarchy because sandbank would be defined differently in a MCZ compared to SAC, and as such this would not contribute directly to the protection of the feature in the National Sites Network. Were the citation for Dogger Bank SAC to be amended to include associated habitat, this measure would be at Level 3. However, given that Dogger Bank SAC is a large relic sandbank and the entirety of the SAC is designated for the Annex I sandbank feature, this form of site extension would be implemented at another designated site. In such a circumstance the measure would be at Level 4.

3.2.4 Designation of a new site or extension of an existing site as a measure of compensation can be delivered and there is a high probability of success. Ultimately, the measure must be delivered by Defra's Secretary of State with the support of Defra and statutory nature conservation bodies (SNCBs) and regulators, as per the current UK practice and guidance. Defra have advised that this is an available strategic compensation measure that can be used to compensate for habitat loss and damage caused by the Round 4 Plan. Contributions by the developer, e.g. in terms of providing information on area(s) of search and surveying/gathering evidence are still to be agreed.

3.2.5 The process for measuring the success of a new site designation or the extension of an existing site will be determined by Defra. There are no prior examples of site designation or extension for the purpose of compensation, and monitoring requirements have not yet been determined. As the new

or extended sites become part of the network monitoring requirements may fall under the responsibility of Natural England or the JNCC as part of statutory condition assessment obligations. Under such a scenario it is expected that funding to support monitoring of the newly designated area will be secured from the developer. Any such additional monitoring, should be appropriate to monitoring of similar habitats within the MPA network. As this measure is a strategic measure with sites selected to cover multiple projects, including but not limited to Round 4, contribution to monitoring requirements will be agreed during the development of the Dogger Bank Strategic Implementation and Monitoring Plan (DBSIMP) in conjunction with the Marine Recovery Fund and the Collaboration on Offshore Wind Strategic Compensation (COWSC), who will establish how this cost is shared across the multiple projects. This will also need to consider how that contribution may change over time if the compensation measure is shared with additional projects.

3.2.6 An established mechanism for new designation or extension of an existing site exists (there being an existing network of sites protected by designations under the Conservation of Habitats and Species Regulations (as amended) 2017 and The Conservation of Offshore Habitats and Species Regulations (as amended) 2017 (Habitats Regulations) and Marine and Coastal Access Act 2009) and there is evidence that the measure could provide compensation at a ratio greater than 1:1.

3.2.7 The Steering Group have agreed that new site designation or site extension be taken forward as part of the package of compensation measures for inclusion in the DBSCP.

3.3 Reduce pressures from existing/ future activities

3.3.1 The Steering Group has examined whether Annex I Sandbank could be protected by limiting future licenced activities, such as aggregate extraction, oil and gas activities, renewable energy construction and fishing, and considered potential delivery mechanisms by not issuing seabed leases in certain areas. This measure would be at Level 2 on the Defra hierarchy (Table 2.1).

Dogger Bank SAC

3.3.2 To reduce pressures and allow for the recovery of the sandbank, removal of other activities from within Dogger Bank SAC was proposed as a compensation measure. This measure would be at Level 1 on the Defra hierarchy (Table 2.1). However, there may be limited options to reduce activities within Dogger Bank SAC. On the 13th of June 2022, the Dogger Bank Special Area of Conservation (Specified Area) Bottom Towed Fishing Gear Byelaw 2022 came into force, banning bottom towed fishing from the entire Dogger Bank SAC as such methods of fishing have been determined to be adversely affecting the conservation status of the sandbank habitat.

3.3.3 Therefore, the measure does not remain under consideration.

Other sites designated for sandbanks

3.3.4 To reduce pressures and allow for the recovery of the sandbank, removal of activities at other SACs designated for the protection of sandbank was considered. This measure would be at Level 2 on the Defra hierarchy (Table 2.1). Sandbank habitat is sensitive to fishing, aquaculture, aggregate extraction and subsea cables (Natural England, 2023) and any other activity which occupies or damages the feature, including renewable energy and oil and gas.

Oil and Gas & Carbon Capture Storage (CCS)

3.3.5 Whilst there are other activities such as oil and gas and CCS, it is unlikely that these activities will be restricted. DESNEZ have confirmed that based on the knowledge that geological stores are fixed

assets and the current energy targets to meet net zero it is unlikely this would be possible for CCS. Consequently, the measure is not currently under consideration for the DBSCP at this time.

Aggregates

- 3.3.6 A desk study was undertaken to determine if there are any designated sites where sandbank is a qualifying feature which have overlapping aggregate licences. Five sites had such an activity. During the discussions it was noted that the actual extraction volumes and areas within the licence area would need to be identified but is likely to be very small. The SNCBs and DESNEZ also raised that recovery following extraction should be expected provided that extraction is managed in line with current best practice. In particular, this best practice guidance recommends leaving part of the resource when dredging ceases: the remaining layer of seabed sediment must be a minimum of 0.5m in depth on average across the dredged area and must be similar to that which existed before dredging began (The Crown Estate, 2020). Therefore it is not clear whether restricting this activity would compensate for the habitat loss at Dogger Bank SAC. Consequently, the measure is not currently under consideration for the DBSCP at this time.

Offshore wind

- 3.3.7 It was determined that removal/ prevention of future activities from building on sandbank areas would be beneficial. The Crown Estate have undertaken an initial high level assessment and have considered areas where they would consider restricting future leasing of offshore wind. Some of these areas fall within existing SACs designated for sandbank features and therefore would protect against future damage to designated sandbank features. There is also potential for offshore wind to be leased on areas identified as Annex 1 sandbanks outside protected sites which could also be removed from future offshore wind leasing rounds. The Crown Estate would prevent such extension through marking these areas as hard constraints in future offshore wind plans.
- 3.3.8 This measure would be delivered on a 1:1 spatial scale against both loss and damaged habitat as assessed in the Round 4 plan level HRA, however, there are arguments that, as damage has potential to recover during the lifetime of the project, a ratio of less than 1:1 may be appropriate for damage.
- 3.3.9 Despite the potential benefits of this measure The Crown Estate must consider its obligations as a public authority; The Crown Estate is a public authority for the purposes of subsidy control. A subsidy occurs when a public authority provides financial assistance (which is defined very broadly) to a specific enterprise or group of enterprises that gives them an economic advantage. Were The Crown Estate to enter into commitments to sterilise other parts of its estate to enable the relevant Round 4 Project Companies' projects to proceed, that may be construed as a subsidy.
- 3.3.10 As such, The Crown Estate is not able to take this measure forward for the projects specific to this DBSCP. However, The Crown Estate will continue to explore the feasibility of this measure should compensation be required under HRA for the impacts of future offshore wind leasing rounds.

Fishing

- 3.3.11 Using byelaws to reduce fishing activities that damage the seabed is a potential compensatory measure that is currently being explored by COWSC. While this measure shows potential promise to compensate for benthic impacts there are still evidence gaps and uncertainties to work through. This measure would need to be agreed by Defra's Secretary of State and can only be delivered by Defra in conjunction with the MMO. Fishing restrictions are already in place to protect the Dogger Bank SAC so, if taken forward, this measure would need to be delivered elsewhere to protect an area of Annex I

Sandbank that is not currently protected. These sites would need to be determined by Defra in conjunction with the MMO, in consultation with stakeholders.

- 3.3.12 Through this measure there may be scope to allow for the recovery of sufficient sandbank area to deliver compensation at a ratio greater than 1:1.
- 3.3.13 As data evidence includes the use of multiple types of fishing gear, further work may be needed to understand where different fishing gear are being deployed. Nonetheless, confidence is high that the area of sandbank currently being impacted by fishing activities exceeds the area of loss or damage as a result of DBSE and DBSW.
- 3.3.14 The Steering Group has agreed that reduction of pressures from future activities be taken forward as part of the package of compensation measures for inclusion in the DBSCP.

3.4 Seagrass meadow restoration

- 3.4.1 Seagrass is not a sub-feature of the sandbank within Dogger Bank SAC, nor would it be able to grow within the site owing to the depth of the water. Therefore, seagrass restoration can only be implemented outside of Dogger Bank SAC, in coastal locations.
- 3.4.2 Although, lower on the compensation hierarchy than the other measures, seagrass meadows do occur on some sandbanks within coastal subtidal and intertidal zones and seagrass is a sub-feature of other designated Annex I sandbanks, such as those within Fal and Helford SAC and Plymouth Sound and Estuaries SAC (Natural England, 2023a; Natural England, 2023b). Suitability as compensation for sandbank is supported by the listing of seagrass as a flora associated with sandbank in Natura 2000 (now National Sites Network) guidance habitat guidance (European Commission, 2013). The Steering Group has judged the measure to be at Level 4 on the Defra hierarchy (Table 2.1), however a case could be made that seagrass restoration is at Level 2 in certain cases. The Steering Group has expressed a clear preference for subtidal seagrass over intertidal habitat; the latter is not universally supported by the whole Steering Group even if only a minor part of a wider package of compensation.
- 3.4.3 The restoration of seagrass meadows has been identified as a potentially suitable measure of compensation, but only when considered as a minor part of a compensation package with other higher ranked measures. Seagrass restoration involves harvesting adult shoots from an existing seagrass meadow and transplanting them at the restoration site. Replanting must be done by hand by divers, so it is labour-intensive and time consuming (MMO, 2019; Potouroglou *et al.*, 2021). Reseeding involves collecting wild seed and performing targeted redistribution of that seed. To generate a self-sustaining meadow, seagrass restoration must occur at sufficient scale to facilitate positive feedbacks (van Katwijk *et al.*, 2016).
- 3.4.4 There are two possible routes for the delivery of seagrass restoration as part of a strategic compensation package. Seagrass restoration could be led by the developer, as part of a strategic compensation package. For this option, in the first instance, further investigation of the site conditions and pressures would be required before final site selection. This approach would require public consultation and engagement with stakeholders, and this may be costly and time consuming. Alternatively, compensation could be delivered through ongoing seagrass restoration projects. Under this scenario the developer would secure funding to support existing seagrass restoration initiatives. One example may be Life restoration ReMEDIES (Save Our Seabed, 2023), however there are other

initiatives that could be supported through compensation. The advantage to this approach is compensation would be delivered through a wider programme which is managed by those with the most experience, who have already been through the site selection process and project planning stages. Furthermore additional funds or work could be provided to support with activities that can aid success, such as the development of less damaging anchor systems, or activities to improve water quality.

- 3.4.5 The Steering Group have agreed that seagrass restoration be taken forward as part of the package of compensation measures for inclusion in the DBSCP.

3.5 Lease an area of seabed in place of formal designation

- 3.5.1 The formal process to designate a new marine protected area (MPA), or extending an existing MPA, is time consuming. As such, as a potential measure it was proposed that The Crown Estate (TCE) could lease an area of the seabed for the purpose of conservation to provide a level of protection within a contracted timeframe. This measure would be at Level 2 on the Defra hierarchy (Table 2.1).

- 3.5.2 The Crown Estate has considered this measure and outlined their position. The Crown Estate manages the seabed of England, Wales and Northern Ireland within UK territorial seas (within 12 nm from the coast). Outside of UK Territorial Waters, the Energy Act 2004 (the 2004 Act) vests certain rights in The Crown Estate within the Renewable Energy Zone, as defined by the 2004 Act, which fall under part V of the United Nations Convention on the Law of the Sea (UNCLOS) regarding:

- a. Exploitation of areas for the purpose of energy from wind or water;
- b. Exploitation of these areas in connection with the production of energy; and
- c. Other purposes connected with exploitation for production of energy (including transmission, distribution, and supply of electricity).

- 3.5.3 Although these rights allow for the issue of leases for compensation, outside of 12 nm any lease for this purpose would need to be associated with an energy project. A lease cannot be issued pre-emptively for strategic compensation to be assigned to a project at a later date. The Crown Estate is also concerned that leasing an area of the seabed for compensation would conflict with its other obligations, and that it would not offer the same level of protection as formal designation. Negotiations on leasing could proceed on a case by case basis once further detail on the requirements of the lease are available. Until specific details of the proposed compensation are known and understood, proper consideration against The Crown Estate's decision cannot be undertaken.

- 3.5.4 Furthermore, the use of conservation covenants was also considered. art 7 of the Environment Act 2021 which deals with conservation covenants extends only to England and Wales. Under the Interpretation Act 1978, in absence of anything to the contrary, the terms "England" and "Wales" are to be defined by reference to local government areas and do not include the seabed.

- 3.5.5 The measure is not under consideration for the DBSCP at this time.

3.6 Removal of structures

- 3.6.1 The footprint of artificial structures installed on a sandbank reduce the availability of sandbank habitat. Therefore, decommissioning those structures would effectively restore sandbank habitat. Artificial structures that remain on the seabed include, oil and gas structures, rock protection and mattresses, as well as redundant exposed cables and pipelines.

3.6.2 Evidence from the oil and gas sector raised concerns around the safety and feasibility of decommissioning infrastructure on the seabed (Peritus International Ltd, 2022). Data indicated that, with the exception of grout bags and concrete mattresses, most infrastructure was not totally removed. Decisions regarding whether infrastructure should be decommissioned were made through a comparative assessment process. Many structures, including pipelines and some mattresses, were left in place as the structure was buried, and leaving them in situ would minimise seabed disturbance and reduce risks to personnel (Peritus International Ltd, 2022). Some structures were left in place to maintain stabilisation of pipelines (Peritus International Ltd, 2022). Conversely, where rock dump was placed on the seabed it was left in situ because total removal of this loose material would be expensive and very time consuming (Peritus International Ltd, 2022).

From Dogger Bank SAC

3.6.3 This measure would be at Level 1 on the Defra hierarchy (Table 2.1). However, the Department for Energy Security and Net Zero (DESNZ) advised there were no oil and gas structures that within Dogger Bank SAC that can be decommissioned. There may be some rock but this is unfeasible to remove. A report is due to be published from OPRED and it is expected to formally confirm this. Consequently, the measure is not under consideration for the DBSCP at this time.

From other sandbanks

3.6.4 This measure would be at Level 2 on the Defra hierarchy (Table 2.1). However, as with Dogger Bank SAC, it was considered that there are too few structures in place on other sandbanks that can be decommissioned in this area of the north sea. DESNEZ advised there are no structures identified and a report from OPRED is expected to confirm this from the oil and gas industry. For cables, there is now a requirement for decommissioning and it is only beneficial to remove historic cables if they are on the surface and are not largely associated to with rock placement. It was deemed by the Steering Group that removal of the small quantities that would be available would be too impractical. Consequently, the measure is not under consideration for the DBSCP at this time.

3.7 Removal of debris

3.7.1 Removal of debris was proposed as a potential measure of compensation, which included an awareness raising campaign which intended to reduce discarded fishing gear. If this measure were implemented within Dogger Bank SAC it would be at Level 1 of the Defra hierarchy (Table 2.1). However, if it were implemented within another SAC designated for the protection of sandbanks, or an area that has not been designated for the protection of sandbanks, it would be at Level 2 or 4 respectively.

3.7.2 During discussions with the Steering Group, a number of issues were raised in regard to this measure by Defra and the statutory nature conservation bodies (SNCBs) (Natural England and JNCC). Defra and the SNCBs do not consider removal of marine litter to be a compensation measure (JNCC 2021). In addition, developers note that removal of debris would be costly and time consuming with a significant carbon footprint associated with the very large areas which may potentially need to be searched in order to identify and then recover sufficient material. Furthermore, the amount of debris that could be removed, in combination with that which could be prevented, would not allow for recovery of Annex I sandbank habitat at the scale required. The measure is not under consideration for the DBSCP at this time.

3.8 Restoration of sandbanks

3.8.1 Possible mechanisms for restoring sandbanks were explored. These included recharging the sandbanks using material such as crushed shell or gravel. This technique has been trialled by the aggregates industry to accelerate recovery. This measure is not applicable to the type of Sandbank within Dogger Bank SAC. If implemented elsewhere it would be at level 2 of the Defra hierarchy (Table 2.1). A desk study was undertaken to identify the category D sandbanks that potentially could be restored to category A-C. The reasons for why they were categorised as category D was investigated to determine if this was due to the quality of the feature and therefore where restoration was possible. It was identified that this was not the case and therefore there were no sites that could easily be restored in this way and that any restoration to degraded sites would be through removal of activities or structures.

3.8.2 The measure is not under consideration for the DBSCP at this time.

3.9 Eradication of invasive non-native species

3.9.1 In respect to the eradication of invasive non-native species (INNS) from sandbanks the two species of concern are slipper limpets (*Crepidula fornicata*) and Pacific oysters (*Magallana gigas*). Slipper limpets are an invasive species of gastropod, native to the US eastern seaboard, that was transported and introduced to Europe on the hulls of ships. Dense communities of slipper limpets can contain several thousand individuals per m² (Thieltges, 2005). Pacific oysters are an invasive gastropod, native to the northwest Pacific and sea of Japan. Pacific oysters were introduced to Europe, North America, Australia and New Zealand, mainly for the purposes of aquaculture for human consumption (Miossec *et al*, 2009; Syvret *et al*, 2021). Pacific oysters preferentially settle on sheltered intertidal rocky substrates, but settlement can also occur in predominantly soft sediment habitats. In Europe, Pacific oysters have spread to large parts of all coastal biotopes (Hansen *et al.*, 2023).

Eradication of non-native species from Dogger Bank SAC

3.9.2 If this measure were implemented within Dogger Bank SAC then it would allow for restoration of sandbank habitat and would be at Level 1 of the Defra hierarchy (Table 2.1). In considering this measure, the Steering Group noted that the INNS is not an issue effecting the condition of Dogger Bank and therefore conservation objectives for Dogger Bank SAC do not include a target to reduce the introduction or spread of non-native species and their impacts. As such, this measure would not support the conservation objectives. The measure is not under consideration for the DBSCP at this time.

Eradication of invasive species from other designated sites

3.9.3 Consideration was given to other sites designated for the protection of sandbanks. Supplementary advice for conservation objectives and site improvement plans were reviewed. A list of SACs for which the conservation objectives include a target to reduce the introduction or spread of non-native species and their impacts were compiled. This list was filtered to exclude sites where slipper limpets and Pacific oysters had not been recorded. This generated a list of five SACs (Table 3.1).

Table 3.1 SACs with targets to reduce the introduction or spread of Pacific oysters and slipper limpets

Site	Invasive species present
Essex Estuaries SAC	Pacific oyster and slipper limpet
Fal and Helford SAC	Pacific oyster and slipper limpet
Morecambe Bay SAC	Pacific oyster
Solent SAC	Pacific oyster
The Wash and North Norfolk Coast SAC	Pacific oyster and slipper limpet

- 3.9.4 Action to eradicate slipper limpets and Pacific oysters from these SACs would be in line with their conservation objectives and would be at Level 2 on the Defra hierarchy (Table 2.1). Action to eradicate INNS from other areas, that are not designated for the protection of sandbanks, would be at Level 4 on the Defra hierarchy.
- 3.9.5 Physical removal of slipper limpets and Pacific oysters relies on people, often volunteers, to completely remove pacific oysters by hand from soft sediments. Physical removal or culling by hand in intertidal habitats is limited to the lowest spring tides. Another alternative for removing wild INNS is dredging (RAPID Life Project, 2018), although the impact to the habitat would outweigh the benefit of removing INNS.
- 3.9.6 Few costs estimates have been given for INNS management and control programmes. Natural England have provided (through personal correspondence) costs that range from £5,000 for Pacific oysters in Fal and Helford SAC over an unspecified time, to £30,000 for Pacific oysters in Essex Estuaries SAC over 2 years.
- 3.9.7 To date, there has been little success in eradicating invasive species from marine habitats. During a Steering Group meeting it was highlighted that Natural Resource Wales (NRW) had successfully eradicated slipper limpet from a site in Wales. As such, some questions were put to NRW regarding the mechanism for delivery, practicalities of implementation, and maintaining habitat free of invasive species. NRW responded to confirm that work had been done to eradicate slipper limpet from the Menai Strait. However, whilst it had been thought to have been successful slipper limpet was reported in high numbers in 2020. It is unclear whether slipper limpet has re-invaded the Menai Strait, or if after efforts to eradicate, slipper limpet had remained in low numbers and had recently increased in abundance.
- 3.9.8 It is thought that once Pacific oysters have become established they cannot be eradicated (Natural England personal correspondence; Hansen et al, 2023). Owing to high densities of Pacific oysters in the UK sufficient brood stock is likely to remain so that settlement will continue following any removal activities (RAPID Life Project, 2018). It was noted that there is evidence that local control has some positive effects in the short term (McKnight and Chudleigh, 2012; Morgan et al., 2021), but no long-term assessment of control measures has been undertaken and any gains could be eroded by a good year for spatfall.
- 3.9.9 It was agreed within the Steering Group that active intervention would be labour intensive. Moreover, any intervention would need to be repeated at regular intervals, possibly in perpetuity, to maintain sandbanks that are free of invasive species. Moreover, in order to reduce the risk of re-invasion, *slipper limpet and Pacific oyster* would also need to be eradicated from adjacent habitats and the surrounding area (over 10s of kms), and this will also have to be maintained. Given the practical challenges and low rates of success, the Steering Group agreed that investigation of invasive species

eradication should not be progressed further. The measure is not under consideration for the DBSCP at this time.

3.10 Reef creation/restoration

- 3.10.1 Reef creation/restoration was separated in to two main groups, creation of a stony reef and restoration of biogenic reefs. Both groups were investigated as potential compensation measures for Round 4 projects DBSE and DBSW.
- 3.10.2 Dogger Bank SAC has been designated in its entirety for the protection of sandbank habitat. As such, were any form of reef creation or restoration implemented within Dogger Bank SAC it would be at the expense of the designated feature. Therefore, reef creation or restoration could only be implemented outside of Dogger Bank SAC. Also, reef creation or restoration would not provide sandbank habitat. Conversely, were reef creation or restoration undertaken within a site designated for the protection of sandbanks, location would have to be carefully considered to ensure that the reef habitat did not result in a loss of sandbank habitat. Thus, this measure is at Level 4 on Defra hierarchy (Table 2.1).

Stony reef

- 3.10.3 Creation of a stony reef amounts to laying stony material (e.g. boulders or concrete blocks) on the seabed to create hard substrate for settlement by epibenthic communities and to provide shelter for mobile fauna. During Steering Group meetings, it was noted that hard stony substrate is not limited in the southern North Sea. In addition to stony reefs or bedrock, there are a variety of submerged artificial structures as well as boulders placed for cable and scour protection. Artificial reefs differ from Annex I bedrock and stony reefs and creating artificial stony reef as a measure of compensation is not supported by SNCBs. The measure is not under consideration for the Plan at this time.

Biogenic reef

- 3.10.4 Of the potential options for generating biogenic reef, the restoration of European oyster (*Ostrea edulis*) beds would be the most appropriate, as a measure of compensation. The main methods for restoring oyster beds involve laying shell cultch to provide suitable substrate for settlement before seeding the habitat with sprat (juvenile oysters) or translocating adult oysters (MMO, 2019). Oyster supply is a limiting factor in restoration efforts and sourcing oysters outside of the restoration area can present biosecurity risks (e.g. introduction of invasive species or disease) (Helmer et al, 2020). In addition, if translocating oysters from another site, the impact on the donor population must be considered (Helmer et al, 2020). Sourcing oysters or sprat from farmed stocks is an alternative and potentially better solution in the long-term (Helmer et al, 2020).
- 3.10.5 There are ongoing European oyster restoration projects. The preferred pathway to delivering compensation through oyster restoration would be for the developer to pay in to a fund to support existing restoration projects. The advantage to this approach is that compensation would be delivered through a wider programme which is managed by those with the most experience, who have already been through the site selection process and project planning stages.
- 3.10.6 As a compensation measure for sandbank habitat, oyster reef restoration was not supported by the Steering Group for the principal reason that the ecological benefits were not considered to be sufficiently similar to sandbank habitat.
- 3.10.7 Other forms of biogenic reef restoration, such as: *Sabellaria spinulosa* reef restoration were explored. *S. spinulosa*, is a tube building polychaete which, in dense concentrations with a good supply of

suspended sand grains, can build reef like structures at least several centimetres thick (Maddock, 2008). There is no mechanism by which *S. spinulosa* reefs can be actively created without other pressures, such as trawling, being restricted. Therefore, restoration would amount to removal of other activities. The measure is not under consideration for the DBSCP at this time.

4 Conclusion

- 4.1.1 Through the Steering Group meetings, and the evaluation of current evidence, it was agreed by the Steering Group that four compensation measures were to be included in the DBSCP, which must be adhered to by the Round 4 projects DBSE and DBSW. These are presented in order of preference according to the Defra (2021) hierarchy in Table 4.1.
- 4.1.2 Where possible, compensation will be fully delivered by one or more measures high in the compensation hierarchy. The preferred method recommended by the Steering Group is designation of a new site or extension of a designated site. Other measures would only be incorporated to provide increased confidence in the overall success of the package and to ensure the package compensates for the impacts.
- 4.1.3 Seagrass restoration is the least preferred option and would only be incorporated should new site designation or extension and the reduction of future activities provide insufficient compensation. Work was done to compare seagrass meadows, along with oyster reefs, to Annex I sandbank habitat in order to demonstrate comparable function and determine equivalent scale for the delivery of ecosystem services. However, it was agreed that more work was needed to further develop the methodology. Due to evidence gaps this could not be achieved in the timeframe available. Significant uncertainties around deliverability for seagrass restoration were also noted.
- 4.1.4 It is noted that SNCBs will only support subtidal seagrass only as part of a package, as is captured in the agreement log (Appendix C).

Table 4.1 Measures determined to be suitable to form part of a package of compensation.

Measure (ranked in order of preference)	Hierarchy Level (Defra, 2021)
Extension to Dogger Bank SAC	Level 1
Other new site designation or extension of an existing site	Level 2
Reduce pressures from other/ future activities (fishing)	Level 2
Seagrass meadow restoration	Level 4

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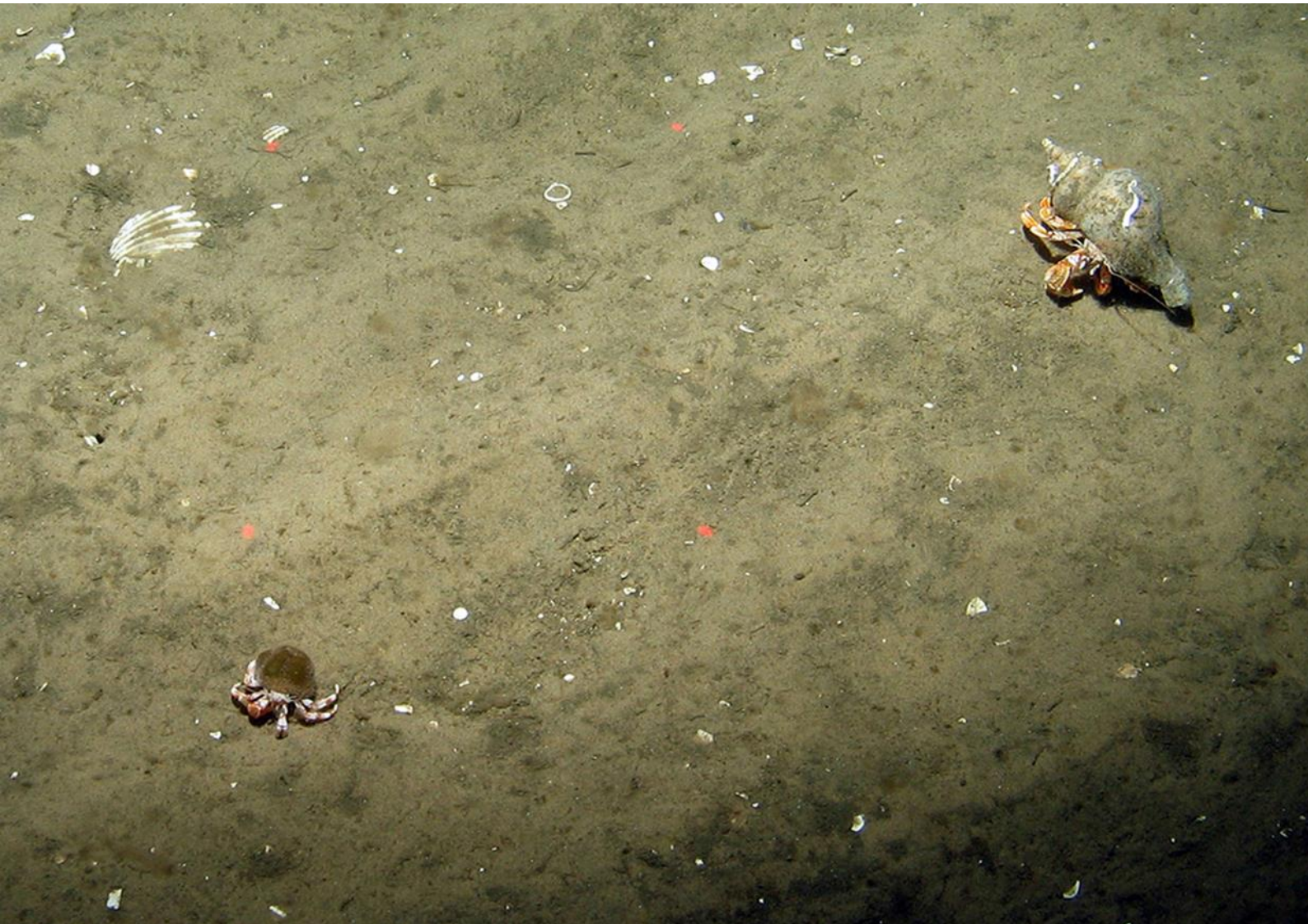
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Round 4 Compensation

Potential site locations for Dogger Bank Compensation measures

The Crown Estate

Date: 19th April 2024

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1.0	06/10/23	Technical Note	PCAU	IGP	SPAC
1.1	10/10/23	Revised due to comments	PCAU	IGP	SPAC
1.2	17/11/23	Updated with main report	PCAU	IGP	SPAC
2.0	28/02/24	Revision following EWG / SG review, Defra advice on site designation/extension & SGDM11 and SGDM12	PCAU / IGP	TNO	TNO
2.1	08/03/24	Revision following TCE / TL review	PCAU	IGP	SPAC
2.2	05/04/24	Revision following SG review	PCAU	MCLA	IGP
2.3	12/04/24	Revision following TCE / TL review & SGDM13	IGP	SPAC	TNO
2.4	19/04/24	Revision following SG review	SPAC	MCLA	IGP

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1 Introduction

- 1.1.1 The Round 4 HRA concluded an AEOSI in relation to sandbank at Dogger Bank SAC due to the footprint of subsea infrastructure, and construction methods with potential to damage or disturb seabed habitats, associated with offshore wind leasing Round 4 projects Dogger Bank South East (DBSE) and Dogger Bank South West (DBSW) (the projects). The Crown Estate decided to progress with the Plan, putting forward a derogation case. In the absence of any alternative solutions to achieve the objectives of the Plan, it was argued that the Plan should progress for reasons of overriding public interest (IROPI). It was agreed with the UK Government that The Crown Estate would proceed with the Plan on the basis of a derogation, subject to appropriate strategic environmental compensation plans being developed. There was no objection from Welsh ministers.
- 1.1.2 Special areas of conservation (SAC) with marine components are designated for the protection of Annex I habitats or Annex II species in the marine environment (JNCC, 2020). Conservation objectives for SACs are set to maintain or restore those features to favourable conservation status. Dogger Bank SAC has been designated in its entirety for the protection of the Annex I feature 'sandbanks which are slightly covered by sea water all the time' (sandbank). Strategic (Plan level) measures to compensate for loss and physical damage to the sandbank feature of the Dogger Bank SAC are currently being investigated by NIRAS on behalf of The Crown Estate, in conjunction with an appointed Steering Group.
- 1.1.3 A long list of potential compensation measures was developed based on expert opinion and precedent from other projects. Evidence for each measure was compiled and is being discussed with the Steering Group. This note looks at potential site locations for the following measures:
- New site designation or extension
 - Seagrass restoration
- 1.1.4 Identification of candidate locations where these measures could be implemented is a key requirement and it is important that the optimum locations are selected where alternatives exist. It is therefore important that clear criteria are established to support objective selection of sites. Furthermore, it is essential that criteria for measuring success are also identified at an early stage.
- 1.1.5 This note presents proposed criteria used to identify a potential sites and evaluate deliverability and success for each of the measures. It is the first step in identifying compensation sites. It is expected that those sites identified as a result of this process will undergo further evaluation, which may include other desk studies and environmental surveys, before final site selection.
- 1.1.6 Whilst restriction of activities are included as potential measures, determination of the sites are to be undertaken by the licensing authorities and in consultation with the SG have not been included at this time.

2 New site designation or extension

- 2.1.1 Based on the Round 4 Plan Level assessment, it is expected that the Round 4 projects will result in damage to 32.209 km² of sandbank and the loss of 2.035 km² from Dogger Bank SAC, which represents a risk to the conservation objectives of the site. New site designation or extension aims to compensate for the lost and damaged habitat by providing at least the same level of protection to Annex I sandbank habitat outside of Dogger Bank SAC, thereby maintaining the integrity of the

marine protected area (MPA) network.

2.1.2 Through the steering group several forms of site designation or extension have been explored:

- Extension of Dogger Bank SAC;
- Designation of a new SAC or extension to an existing SAC for the protection of sandbank feature;
- Designation of a new MCZ for the protection of a sandbank feature; and, Protecting or enhancing associated habitat (e.g. troughs between sandbanks).
- Amending SAC citation to protect or enhance associated habitat (e.g. troughs between sandbanks).

2.2 Method

2.2.1 Potential locations for either a new SAC designation, or extension of an existing SAC, were identified using following the categories:

- Annex I Sandbanks present outside any protected site (for Annex I sandbank) using the JNCC (2019) Annex I sandbank layer;
- Sandbanks that fully or partially overlap MCZ areas; and;
- The area identified and currently being surveyed by RWE.

2.2.2 A technical report on the spatial assessment of benthic compensatory habitats (Ward *et al.*, 2022) was also reviewed, however this did not lead to the selection of additional sites. It is important to note there may be other potential options available.

Site consideration criteria

2.2.3 Site consideration criteria were developed to identify sandbanks most suitable as compensation habitat and inform preferred sites. The selection criteria for sandbank habitat was modified from criteria developed by the JNCC (2009), with input also from strategic marine compensation ecological assessment criteria developed by The Wildlife Trust (2023). The flow diagram (Figure 2.1) presents the criteria (orange boxes) in order of importance from top to bottom.

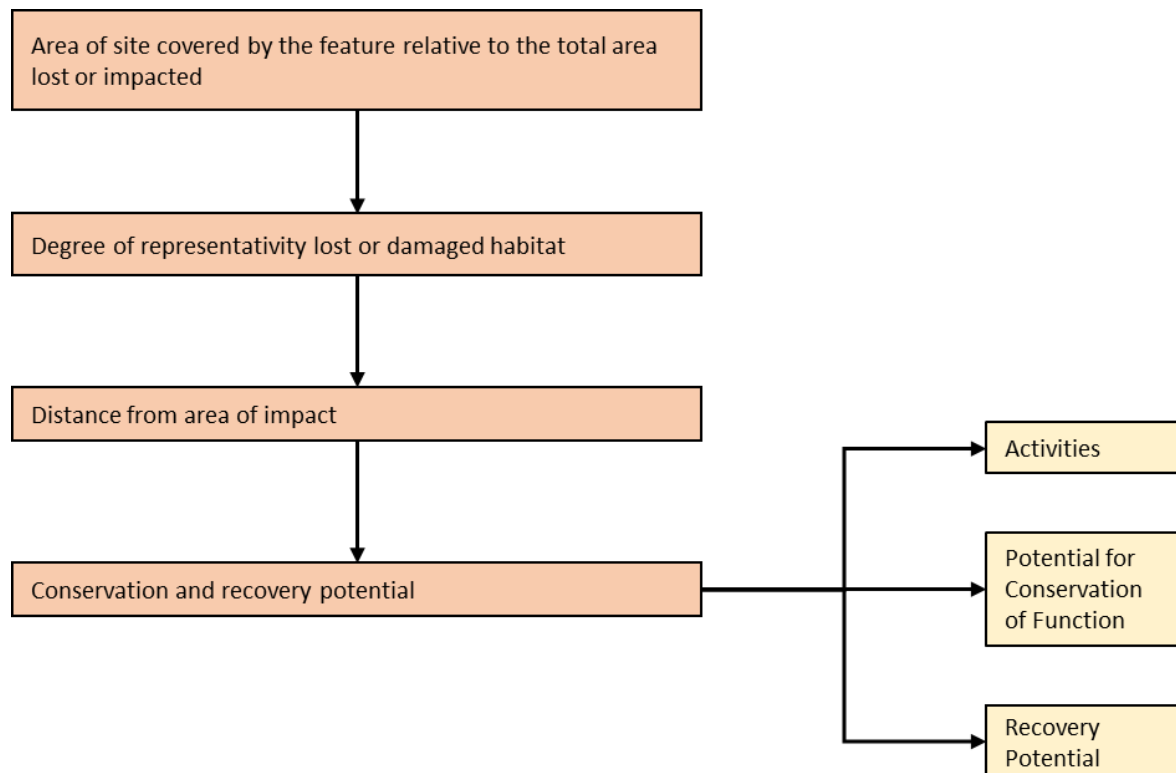


Figure 2.1 Site consideration criteria for new site designation or extension. Conservation and recovery potential is separated in to sub-criteria 'Activities', 'Potential for Conservation of Function' and 'Recovery potential'.

Area

- 2.2.4 The first criterion relates to the area of coverage of the feature within the proposed site relative to the area lost and damaged within Dogger Bank SAC. Areas with greater Annex I sandbank coverage, preferably greater than 100% of the area expected to be lost or damaged, are preferred.

Representativity

- 2.2.5 Representativity pertains to the degree to which the feature within the proposed compensation site represents that within Dogger Bank SAC. Sites that more closely reflect the habitat within Dogger Bank SAC are preferred.

Distance from the impacted area

- 2.2.6 Relevant to the connectivity with the impacted habitat, which in turn is relevant to the integrity of the MPA network. Sites that are in close proximity to the impacted area (e.g. adjacent to the area, or offshore and within the same regional sea) are preferred.

Conservation and recovery potential

- 2.2.7 This criterion is separated into three sub-criteria:

- Activities: relates to human activities taking place within the site, or having taken place within the site historically and are still affecting site condition.
- Potential for conservation of function: relates to ecological functioning within the ecosystem (e.g. productivity, carbon sequestration and nutrient cycling). As ecological functioning is challenging to quantify, particularly in the marine environment, function in this context is taken to mean the

prospects (capacity and probability) of the habitat to maintain its structure, the biotic and abiotic characteristics of the habitat (e.g. species composition and geomorphology) (JNCC, 2009).

- Recovery potential: is the extent to which recovery is possible and relates to the conservation of functions and activities taking place within the sites.

2.2.8 The subcriteria "Potential for conservation of function" and "Restoration potential" could not be given full consideration at this stage as the necessary data was not available, but they should be utilised for the final site selection.

2.3 Results

2.3.1 Using the site consideration criteria, potential sites for new SAC designation or extension were identified. Examples are outlined and discussed in this section, but all sites identified are shown in Figure 2.2 Category D sandbanks, which do not meet the criteria to be classified as Annex I sandbanks, have not been included in the map and are not listed here as this is covered under a different measure.

2.3.2 Many sites are expected to provide sufficient sandbank area to compensate for more than 100% of the estimated area of impact from the Round 4 projects. For Site 19, the shapefile was provided by the developer. The area within the boundary of Site 19 is 3197.6 km², based on the shapefile as provided by the developer. However, the extent of Annex I sandbank habitat within Site 19 was unknown. It is assumed here that most of this area is sandbank habitat, and would therefore provide compensation.

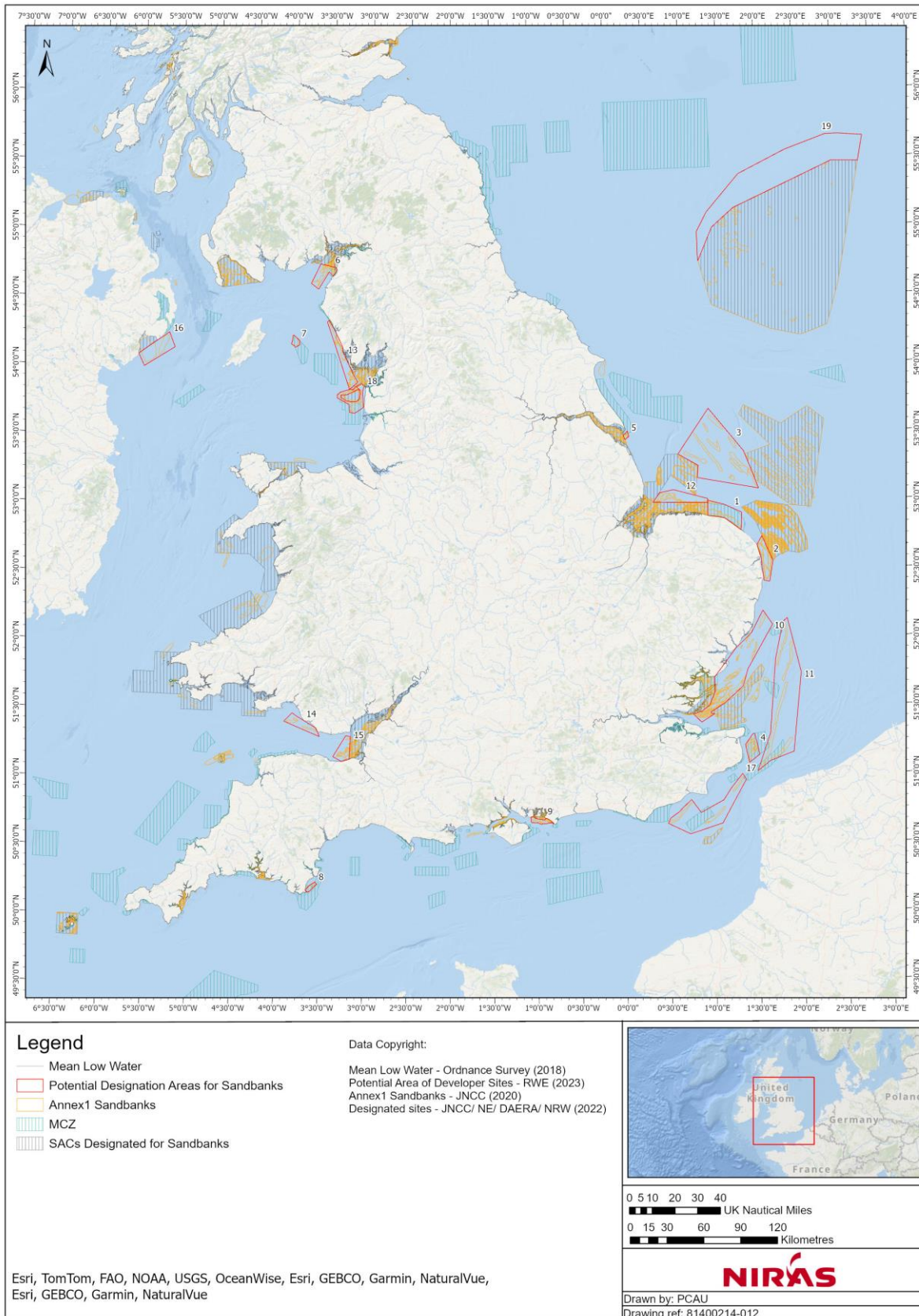


Figure 2.2 Annex 1 sandbanks with potential sites for New Site Designation/Extension.

- 2.3.3 Sites 19 and 3 are entirely offshore, beyond the 12 nm limit. Site 15 is predominantly offshore, but the southernmost sandbank within the site is located within 12 nm from the coast. Multiple activities are currently taking place in all of the potential sites.
- 2.3.4 Site 19 is located to the North of Dogger Bank SAC. This is an area of search that is being investigated as a possible site for the extension of Dogger Bank SAC. Although results are not yet published, surveys have taken place to characterise the habitat and communities within the area. Data on sandbank habitat within this area was not available for use in mapping. The shapefile for Site 19 was provided by RWE.
- 2.3.5 An extension to Dogger Bank SAC represents the most similar option of the compensation measures proposed. Should it be determined that the habitat within Site 19 meets the classification of Annex I sandbank it is likely to provide a good representation of the sandy mound habitat lost or damaged as a result of the projects.
- 2.3.6 Of the sites with sandbank area available, Site 3 contained the largest sandbank area. All sandbanks within this site are offshore (beyond 12 nautical miles from the coast), but not adjacent to Dogger Bank SAC. It is located between North Norfolk Sandbanks and Saturn Reef SAC (NNSR SAC) and Inner Dowsing, Race Bank and North Ridge (IDRBNR) SAC, both of which have been designated for the protection of Annex I sandbanks. Therefore, Site 3 presents a potential area for extension of either of the existing SACs. Both NNSR SAC and IDRBNR SAC contain current tidal sandbanks (JNCC, 2019b), which differ from the relic sandbank within Dogger Bank SAC.
- 2.3.7 Site 2 stretches north from Lowestoft, and the northern area of the site lies between the coast and Haisborough, Hammond and Winterton (HHW) SAC, which has been designated for the protection of sandbanks. The site presents a potential area for extension of HHW SAC. As HHW SAC contains current tidal sandbanks. The sandbank is coastal, and may lie within 100 m of the coast at its closest point.
- 2.3.8 Sites 1 and 12 are located to the south of site 3 and north and east, respectively, of The Wash and North Norfolk Coast (TWNNC) SAC, which is an MPA designated for the protection of sandbanks. To the North of site 12 is IDRBNR SAC, which has also been designated for the protection of sandbanks. To the East of site 1 is HHW SAC. The surrounding sites contain current tidal sandbanks (Foster-Smith and Sotheran, 1999; JNCC, 2019b). Both sites 1 and 12 are coastal, lying within a few hundred metres and 10 kms of the coast at their closest points respectively. Both sites present potential areas for extending TWNNC SAC. Site 1 also presents a potential area for extension of IDRBNR SAC.
- 2.3.9 Site 10 is located within the Outer Thames Estuary and Site 11 is located outside of the Outer Thames Estuary. Sandbanks within Site 10 extend from the coast of Southend on Sea, between Essex Estuaries SAC and Margate and Long Sands SAC, north east to Sizewell, north east of Alde, Ore and Butley Estuaries SAC. Sandbanks within Margate and Long Sands SAC are highly mobile (JNCC, 2023). All sandbanks within Site 10 are located within 12 nm of the coast. Both Essex Estuaries SAC and Margate and Long Sands SAC have been designated for the protection of sandbanks. Thus Site 10 presents a potential area for extension of either of the existing SACs.
- 2.3.10 Sandbanks within Site 11 stretch from the Strait of Dover north to a point approximately 17 km east of Alde Ore and Butley Estuaries SAC. Most of the sandbanks within site 11 are located beyond 12 nm from the coast, with the exception of the southernmost sandbank, which falls within the 12 nm boundary. Site 11 presents a potential area for a new SAC designation.

2.4 Discussion

Success

- 2.4.1 Through mapping sandbanks, it was found that there are multiple suitable areas where new sites may be designated or existing sites extended, provided the area meets the established criteria for designation and the impacts on other sea users is taken into account. Moreover, the area of undesignated sandbanks is sufficient to provide significant over-compensation. Within HHW SAC alone, an extension of 120 km² was proposed as a possible measure to compensate for habitat loss of up to 0.03 km² as a result of Norfolk Vanguard offshore wind project (Royal Haskoning DHV, 2020).
- 2.4.2 Evaluating the success of the measure would require analysis of the available evidence and where necessary, surveying the sandbank habitat prior to designation to determine the condition of the sandbank and whether there is sufficient sandbank habitat within the area to offset the area of impact. Any sandbank designated for the purpose of compensation should have the potential to be brought in to favourable condition. If the site is in unfavourable condition prior to designation, there may be a requirement that a larger area of sandbank be designated to account for the time it would take to achieve favourable condition.
- 2.4.3 There are no prior examples of site designation or extension for the purpose of compensation, and monitoring requirements have not yet been determined, however as the new or extended sites become part of the network, it is considered that monitoring requirements may fall under the responsibility of NE or the JNCC as part of statutory condition assessment obligations. Under such a scenario it is expected that funding to support monitoring of the newly designated area will be secured from the developers.
- 2.4.4 Although the measure has a high probability of success, Defra have advised that the process for designating or extending an SAC may take up to 7 years. If sandbanks within selected sites that are in unfavourable condition there may also be a need to reduce pressures from damaging activities, such as fishing, to allow recovery. As such, there is a potential for conflict with other sea users. Byelaws could take an additional 2 years to establish (Steering Group correspondence). Collaboration on Offshore Wind Strategic Compensation (COWSC) expert working group 6 are undertaking work on the feasibility of using MMO byelaws as a tool to deliver strategic compensation for benthic impacts, however the output of this work may not be available within the necessary timeframes for strategic compensation for the projects.

Deliverability

- 2.4.5 Designation of a new SAC or extension of an existing SAC for the protection of sandbanks or supporting habitat is a deliverable measure. However, the process for delivery is largely outside of the control of the developer. Ultimately, the measure must be delivered by Defra's Secretary of State with the support of Defra and Statutory Nature Conservation Bodies (SNCBs) and regulators, as per the current UK practice and guidance. Although, the developer can provide support with developing an area of search, surveying/ gathering evidence and submitting a draft SAC (dSAC) to the UK government and through the consultation (Royal Haskoning DHV, 2020). This measure is expected to be funded through the Marine Recovery Fund, which the developer would pay in to, and will follow the full legal process required for designation, including public consultation.
- 2.4.6 Of the areas identified, an extension to Dogger Bank SAC would be the preferred option from an ecological perspective. However, this assessment relies on several assumptions about the habitat. Survey data is yet to be made available which would allow for a complete and accurate assessment of

the habitat. Ultimately, the site may prove to be unsuitable and an alternative would need to be selected.

- 2.4.7 There are other sites which could provide the level of compensation required, although these sites are likely to be less representative of the habitat within Dogger Bank SAC. North Norfolk Sandbanks and Saturn Reef SAC could be extended to incorporate sandbanks identified in site 3. Alternatively, Inner Dowsing, Race Bank and North Ridge SAC could be extended to incorporate sandbanks in sites 3 and 12.
- 2.4.8 Once designated, management of the site falls within the remit of the regulators with NE and JNCC advising on conservation advice on the management. For an extension to an existing site, management can be aligned with the existing management for that SAC (Royal Haskoning DHV, 2020). Management would need to be funded by the developer as part of the compensation package.

Conclusions

- 2.4.9 Based on our findings, it is concluded that designation of a new site or extension of an existing site as a measure of compensation can be delivered and that there is a high probability of success. There is evidence that the measure can provide compensation at a measure significantly greater than 1:1. However, due to the timescales involved, there is a risk that compensation will not be in place and contributing to the MPA network prior to any impact taking place within Dogger Bank SAC.

3 Seagrass restoration

- 3.1.1 Seagrass meadows have an important role in supporting biodiversity (Attrill *et al.*, 2000; Lee *et al.*, 2001; Barnes, 2017), nutrient cycling (Welsh 2010; Tarquinio *et al.* 2018) and sequestering atmospheric carbon (Röhr *et al.*, 2018; Johannessen, 2022). There are two species of seagrass in UK coastal waters; *Zostera marina* is the largest and predominant species. It typically occurs in shallow (up to 10 m), fully marine conditions on relatively coarse sediments (MMO, 2019). Although *Z. marina* can tolerate reduced salinity levels (e.g. 20ppt) their performance is reduced with extended exposure (Salo *et al.*, 2014). *Zostera nollii* better tolerate large fluctuations in salinity and extended periods of desiccation, and are typically found high up in the intertidal zone (MMO, 2019).
- 3.1.2 In Northern Europe, the population of *Z. Marina* was heavily impacted in the 1930s by a major outbreak of eel grass wasting disease (*Labyrinthula zosterae*) (Den Hartog 1987; Short *et al.*, 1988; Muehlstein 1989). This led to a loss of up to 70% of the seagrass extent in north west Europe (Fonseca *et al.*, 2009). Declines continued through the second half of the 20th century due to direct (e.g. anchoring boats, fishing, and other recreational and commercial activities) and indirect (e.g. sedimentation and eutrophication) pressures on seagrass habitats (Dunic *et al.* 2021; Potouroglou *et al.*, 2021; Turschwell *et al.* 2021). It was estimated that, between the 1920's and 2005, 85% of the UK's seagrass had been lost (Hiscock *et al.*, 2005). Recent estimates indicate that the UK contains 8,493 ha of mapped seagrass (Green *et al.* 2021), although there is considerable uncertainty. Methods used to quantify area, and the definitions of seagrass beds, vary considerably (Potouroglou *et al.*, 2021). OSPAR (2009) define seagrass as having a minimum 5% density, although much higher densities may be needed for beds to be self-sustaining. Furthermore, many spatial mapping data sources lack metadata and many maps are out of date (Potouroglou *et al.*, 2021).

3.1.3 Generally, there is an urgent need for seagrass to be restored. However, seagrass restoration for the purpose of compensation for Round 4 projects Dogger Bank South East and Dogger Bank South West is a non-feature specific measure; the habitat being restored is different to the habitat being damaged by the development. It is also in a different location. Therefore, as a compensation measure, seagrass restoration is low on the hierarchy of compensation measures (Defra, 2021). Restoration of seagrass meadow could, however, provide comparable ecological function to the habitat being impacted (Defra, 2021). As such, when identifying potential sites for restoration, consideration must be given to whether seagrass can provide benefit to a sandbank.

3.2 Method

3.2.1 Using the seagrass potential data layer from the Environment Agency (2023), potential areas of seagrass were mapped to identify possible sites suitable for restoration. All potential areas of seagrass were considered in mapping, but particular attention went in to identifying areas of seagrass within:

- SACs where seagrass is a designated subfeature of Annex I sandbanks
- SACs where seagrass is a designated subfeature of a feature other than sandbanks
- MCZs designated for the protection of seagrass
- SPAs that contain seagrass.

Site consideration criteria

3.2.2 Due to fundamental differences in the measures, site consideration criteria for seagrass was modified from that for new site designation and extension. For example, as a non-like-for-like measure of compensation, sites suitable for seagrass restoration would not be expected to provide a good representation of the habitat lost from the projects. As such 'Degree of representativity of lost or damaged habitat' was dropped from the criteria for seagrass sites. The flow diagram (Figure 3.1) presents the criteria (orange boxes) in order of importance from top to bottom.

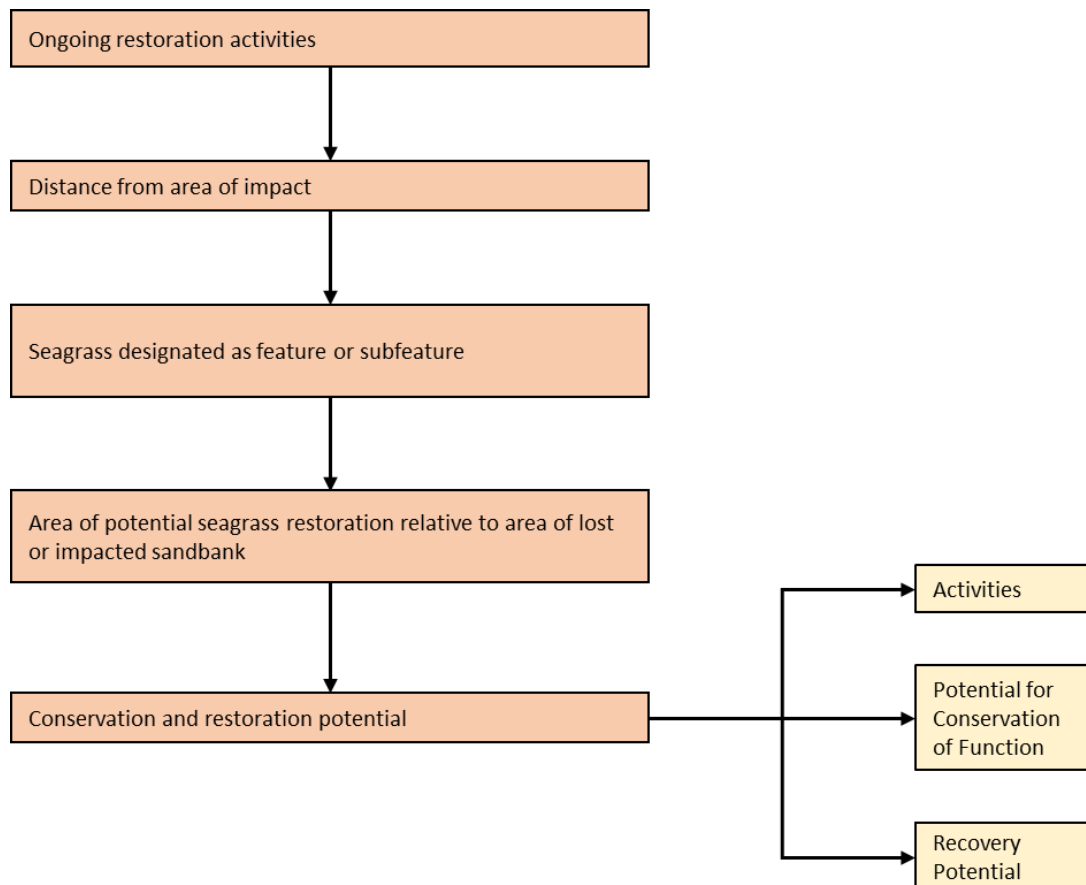


Figure 3.1 Seagrass restoration site consideration criteria. Conservation and recovery potential is separated in to sub-criteria 'Activities', 'Potential for Conservation of Function' and 'Recovery potential'.

Ongoing restoration activities

- 3.2.3 The principal criteria is whether seagrass restoration activity is taking place within the site. It has been determined by the steering group that supporting existing restoration projects is favoured. This could include funding a new area not currently being restored (due to funding restrictions for example) or funding work in an area of ongoing restoration to accelerate recovery or improve success rates. However, in areas where seagrass restoration is ongoing, demonstrating that additional seagrass has been provided as a result of the funding would be challenging. Therefore, sites where restoration activities are not already taking place were prioritised in identifying potential areas for restoration. Restoration was found to be taking place within 9 sites in England and 1 site in Scotland). Although not currently active, a seagrass restoration project was conducted in Pembrokeshire Marine SAC on the coast of Dale in Wales, and there are other projects planned (Project Seagrass, 2023).

Distance from the impacted area

- 3.2.4 As with for site extension or new designation, this criteria is relevant to the connectivity of the site with the impacted habitat. However, given that this is in relation to a non-feature specific measure, this does not in turn support the connectivity of the MPA network. Rather, seagrass restoration, particularly on sandbanks, may support functional benefits similar to those provided by the sandbank habitat within Dogger Bank SAC, such as carbon sequestration. For this criteria, an area within the same regional sea (e.g. Southern North Sea) is preferred.

Seagrass designated as a feature or subfeature

3.2.5 There are coastal SAC's, designated for the protection of sandbanks where seagrass has been designated as a subfeature of the sandbank. Such sites were preferred, followed by sites where seagrass habitat was not a subfeature of a sandbank but seagrass was a feature in itself (e.g. within an MCZ), or subfeature of another habitat, with priority given to subtidal seagrass.

Area

3.2.6 In the case of seagrass restoration, at this stage the area criteria is considered less important than for new site designation or extension. As a non-feature specific measure of compensation, direct comparison in terms of area may not be the most suitable metric. Seagrass habitat provides a similar level of some benefits over a different scale.

3.2.7 It should also be noted that the layer used in identifying potential seagrass areas was based on outputs from large scale models, through which potential seagrass habitats were derived from wave and current energy, elevation and salinity criteria (Environment Agency, 2023a). It provides an indication and the true coverage of seagrass would need to be surveyed prior to final site selection.

Conservation and restoration potential

3.2.8 As with new site designation and extension, this criteria is separated in to three sub-criteria:

- Activities: relates to the other human activities taking place within the site, or having taken place within the site historically and are still affecting site condition.
- Potential for conservation of function: relates to ecological functioning within the ecosystem. As ecological functioning is challenging to quantify, particularly in the marine environment, function in this context is taken to mean the prospects (capacity and probability) of the habitat to maintain its structure, the biotic and abiotic characteristics of the habitat (e.g. species composition and geomorphology) (JNCC, 2009).
- Restoration potential: is the extent to which restoration is possible and relates to the conservation of functions and management of activities taking place within the sites, and environmental conditions. For example, it may not be possible to replace all traditional moorings in shallow water depths and this may limit the area that could be restored.

3.2.9 The subcriteria "Potential for conservation of function" and "Restoration potential" could not be given full consideration at this stage as the necessary data was not available, but they should be utilised for the final site selection.

3.3 Results

3.3.1 Using the site consideration criteria, potential sites where seagrass restoration may be implemented as part of strategic compensation for the Round 4 projects were identified and discussed further in this report, a full list of sites can be seen in Figure 3.2. These include areas that overlap 5 SACs that have been designated for the protection of sandbanks.

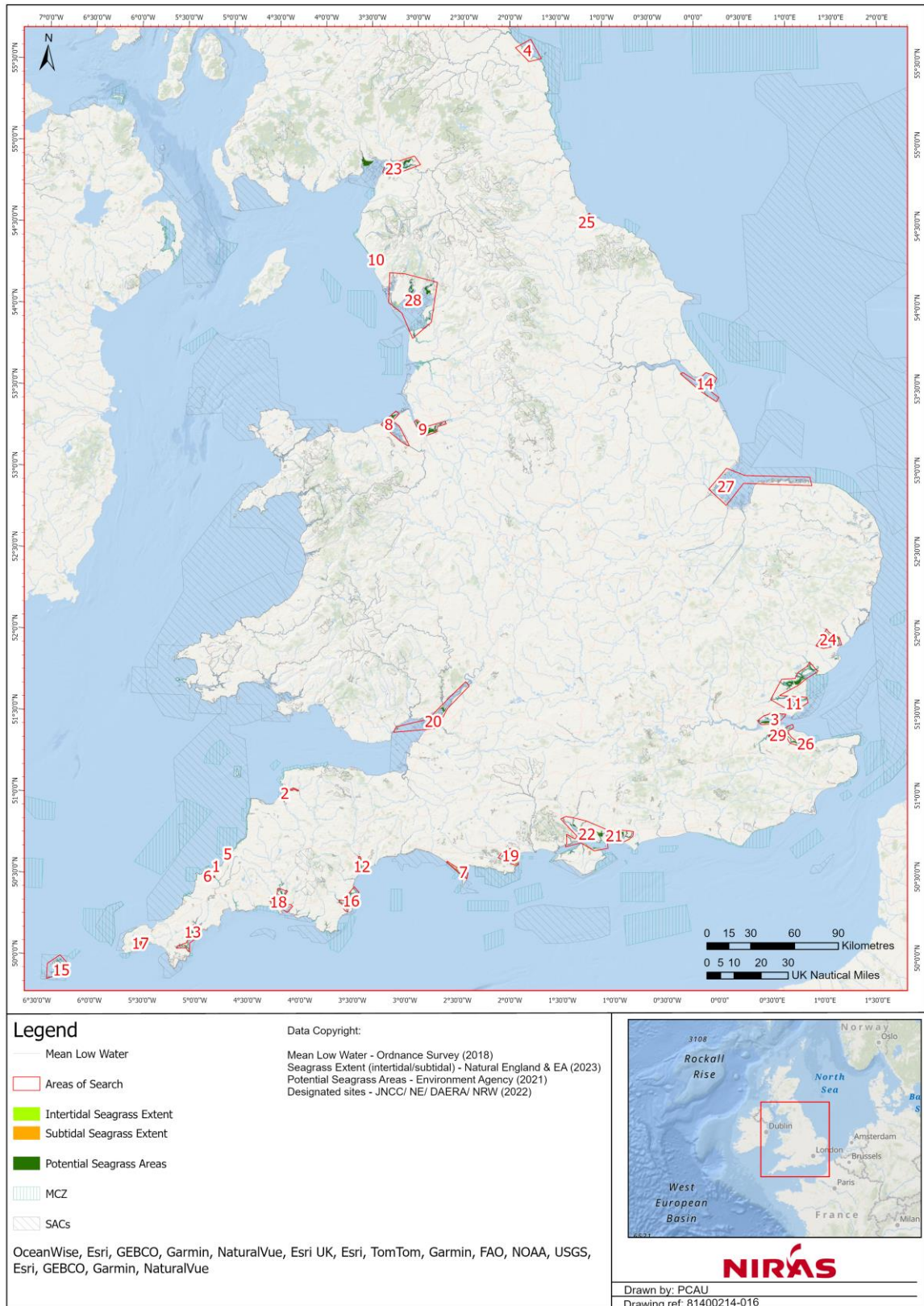


Figure 3.2 Potential sites for seagrass restoration based on the Environment Agency's seagrass potential layer (EA, 2021) and the Natural England's national seagrass layer (NE, 2023).

- 3.3.2 Sites on the east coast of England are shown in Figure 3.3. Site 27, which overlaps The Wash and North Norfolk SAC, is located on the East coast of England in the Southern North Sea. It is within the closest proximity to Dogger Bank SAC and it has been designated for protection of the Annex I sandbanks. Subtidal seagrass is not a subfeature of sandbanks, or other features within the site, intertidal seagrass is a subfeature of "Mudflats and sandflats not covered by seawater at low tide". The area of seagrass is low compared with the area of impact from the Round 4 projects, and multiple activities are taking place within this area.
- 3.3.3 Site 4 is located within Berwickshire and North Northumberland Coast SAC, which has been designated for the protection of other Annex I habitats including "Mudflats and sandflats not covered by seawater at low tide"; Intertidal seagrass are a subfeature of this feature within the SAC. The area of seagrass is low compared with the area of impact from the Round 4 projects. Of the activities considered, none are taking place within this area.
- 3.3.4 Sites 26 and 29 are adjacent to one another. They are The Swale Estuary and Medway Estuary, and they drain into the Southern Thames Estuary. Neither site overlaps SACs designated for the protection of sandbanks. They do overlap MCZs but they are not designated for the protection of seagrass. Of the activities considered, none are taking place within site 26 but multiple activities are taking place within site 29.
- 3.3.5 The Wash and North Norfolk SAC is the only SAC designated for the protection of sandbanks with the potential for seagrass restoration located on the east coast where restoration is not already taking place. Active restoration work is underway within Humber Estuary SAC and Essex Estuaries SAC, through Wilder Humber and Project Seagrass respectively.
- 3.3.6 Other sites that overlap SACs designated for the protection of Annex I sandbanks with the potential for seagrass restoration are located on the West Coast (Figure 3.4). Site 28 overlaps Morecambe Bay SAC on the west coast of England, site 20 overlaps Severn Estuary SAC on the border between England and Wales, and site 23 overlaps Solway Firth SAC on the border of England and Scotland. It should be noted that, whilst subtidal seagrass is not a subfeature of sandbanks within Morecambe Bay SAC, intertidal seagrass habitats are a subfeature of mudflats and sandflats not covered by seawater at low tide as well as large shallow inlets and bays.

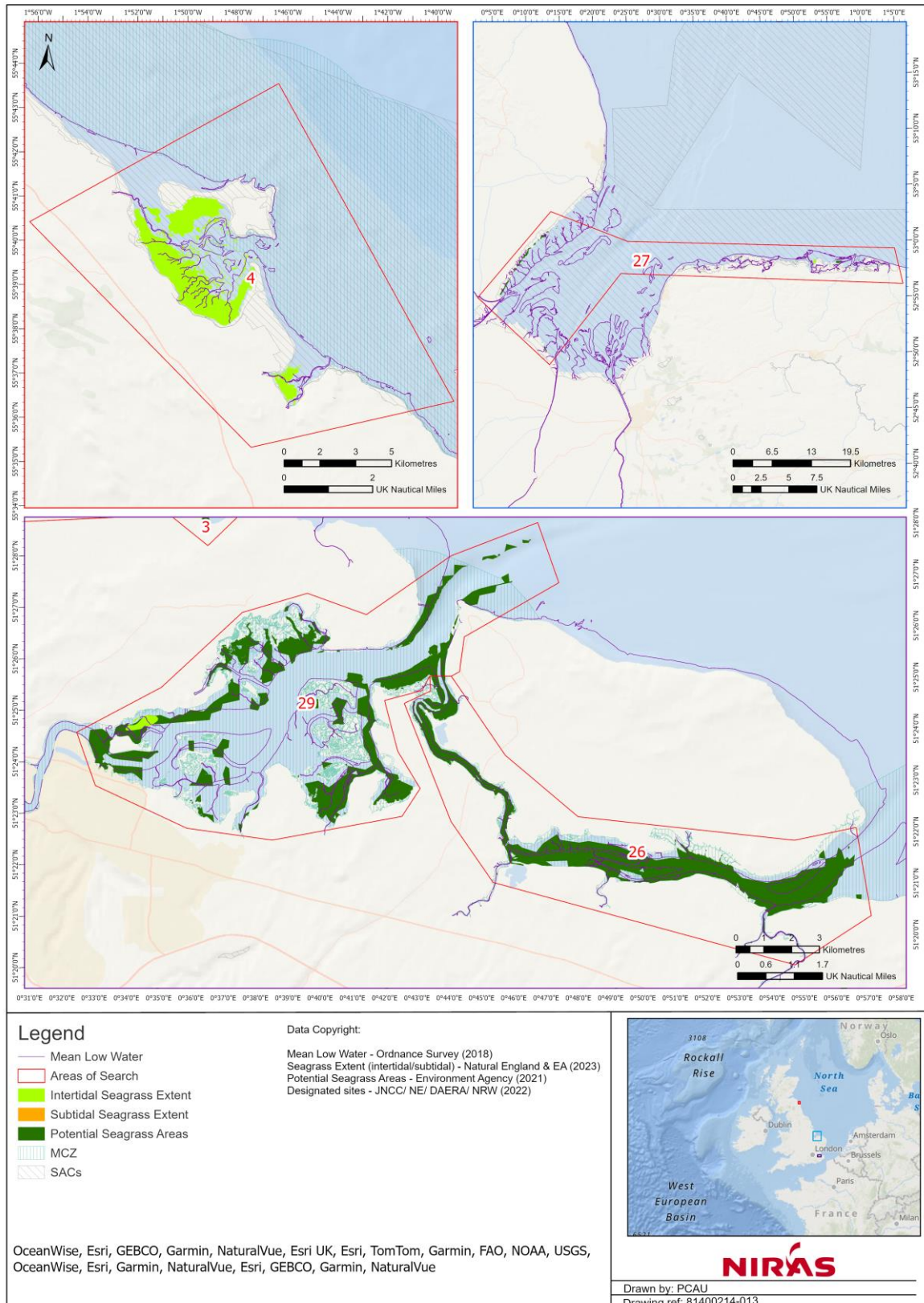


Figure 3.3 Potential sites for seagrass restoration on the east coast of England.

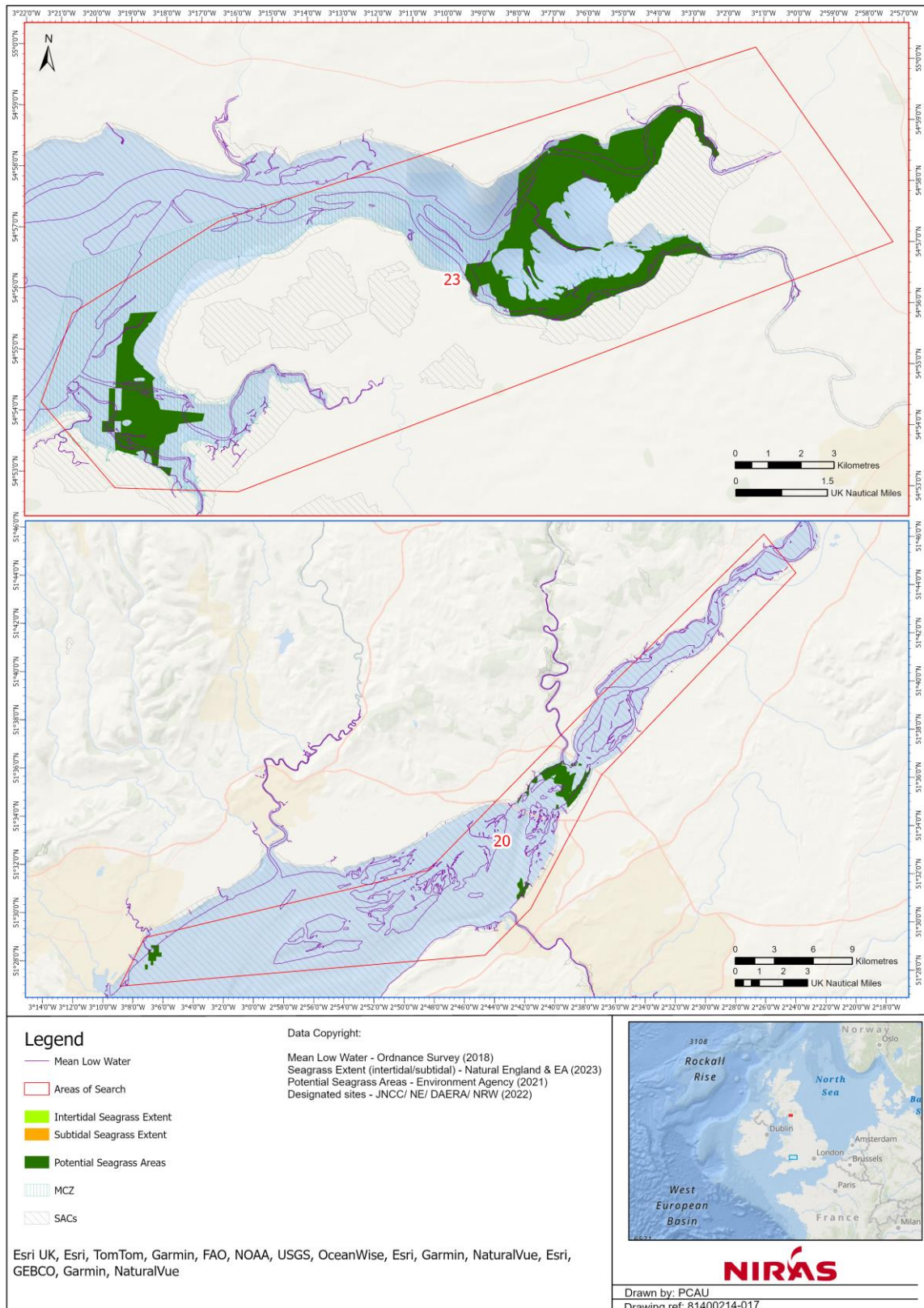


Figure 3.4 Potential sites for seagrass restoration on the west coast of England.

3.3.7 Although proximity to the area of impact is relevant to the connectivity, presently, there are no sites where subtidal seagrass occurs on the east coast of England. Based on NE and JNCC advice, restoration for the purpose of compensation should be restricted to subtidal seagrass. It is not yet understood if there are historical records of subtidal seagrass meadows along the east coast of England and whether there is a possibility of restoring such habitat. Should this not be the case, seagrass restoration may be limited to sites outside of the southern North Sea, such as along the south coast of England (Figure 3.5).

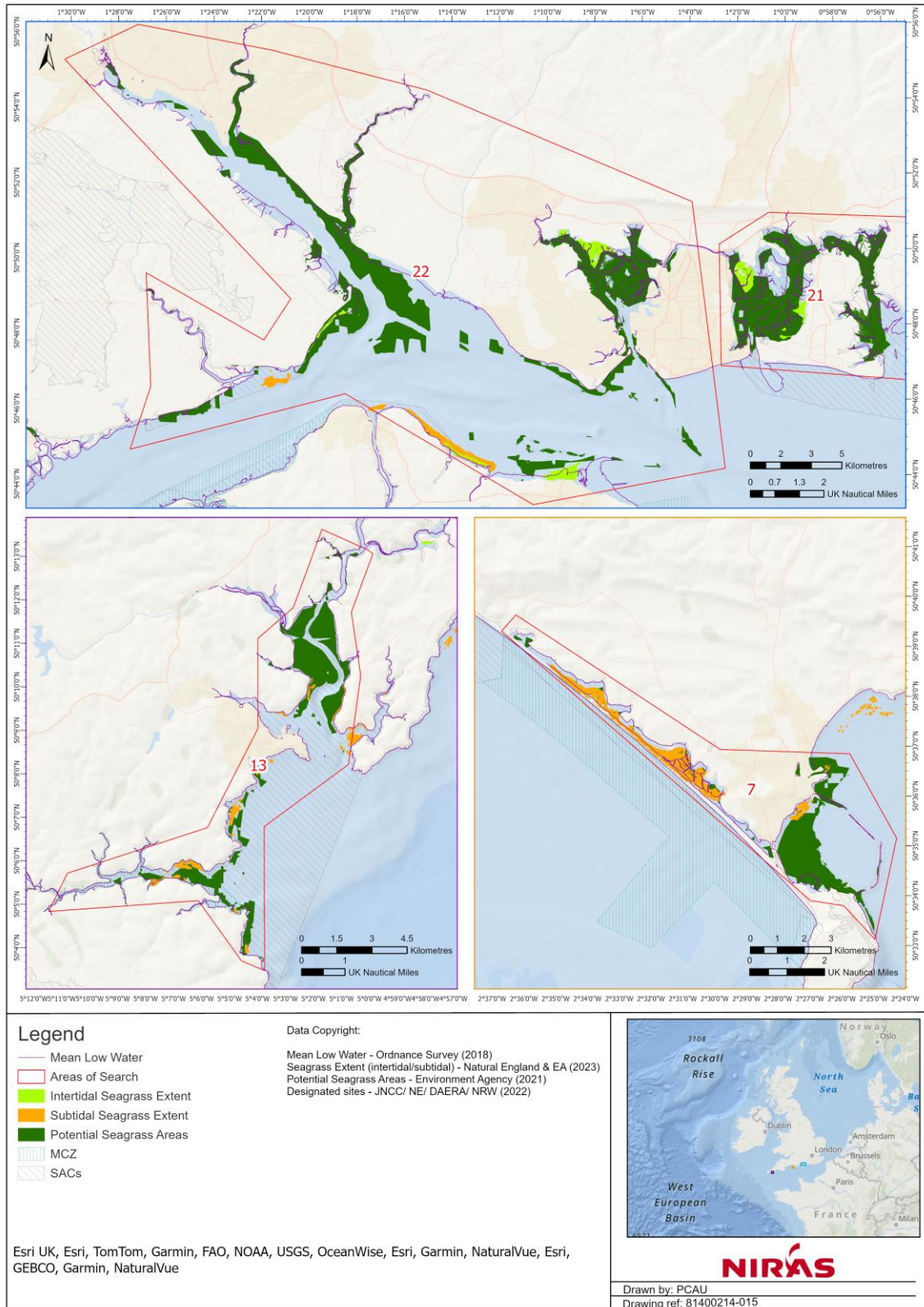


Figure 3.5 Sites located on the south coast where subtidal seagrass occurs. These sites may be used as reference areas for east coast subtidal restoration projects.

3.4 Discussion

3.4.1 The seagrass potential layer indicated where it may be possible to implement seagrass restoration. However, restoration projects are already in place at a number of the sites identified. The focus of the site selection was on sites where seagrass restoration was not in place.

Success

3.4.2 For seagrass restoration to be successful, restored seagrass meadows must sustain themselves long-term. To determine whether seagrass is self-sustaining, long-term monitoring would be required. If restoration were to take place within an MPA where seagrass was a designated feature or subfeature, monitoring would fall within the remit of a SNCBs, such as Natural England. Delivery of the measure, and subsequent monitoring, is expected to be funded through the Marine Recovery Fund, which the developer would pay in to.

3.4.3 Ideally the site undergoing restoration would be compared with a minimum of two healthy seagrass meadows at reference sites (other locations with similar physical and environmental characteristics) (Hendy *et al.*, 2021). If in the long-term, the restored seagrass beds meet or exceed the structural, functional and genetic indicators at those reference sites a restoration project can be considered successful (Hendy *et al.*, 2021). Indicators would also need to be compared with previous years and the baseline condition to determine trends over time. Table 3.1 lists suggested metrics for indicators and provides an indicative timeline for monitoring (Hendy *et al.*, 2021). It should be noted that subtidal seagrass beds are currently absent on the east coast. Should seagrass restoration be implemented as compensation, comparisons would need to be made with the nearest subtidal seagrass beds, which are on the south coast. These sites may be subject to different pressures and environmental conditions.

Table 3.1 : Suggested timeline and metrics for a seagrass restoration monitoring programme from Hendy *et al.*, 2021 (£ = cheap, ££ = medium expense, and £££ = expensive; * = optional indicators to assess seagrass status). Before year five there will be minimal underground carbon storage. Thus, carbon would be assessed as a functional indicator post year 5. "Destructive" indicates an extractive or damaging activity.

Structural Indicators				
Timeline	Year 0	Years 1–5	Year 6+	Note
Cover/extent	After 1, 3, 6 months	Yearly	Yearly	£
Shoot density and leaf morphology	After 1, 3, 6 months	Yearly	Yearly	£
Biomass*	Once	Yearly	Yearly	££ (destructive)
Epiphyte cover and disease assessment	After 1, 3, 6 months	Yearly	Yearly	£
Functional indicators				
Timeline	Year 0	Years 1–5	Year 6+	Note
Biodiversity	Before-Once	Year 5	Yearly	£££ (destructive)
Water quality	Once	Year 5	Yearly	£
Sediment structure*	Before-Once	Year 5	Yearly	££
Carbon stock assessment sequestration measurements	Before-Once	Year 5	Yearly	£££ (destructive)
Genetic monitoring*	-	Yearly	Year 10	£££

3.4.4 When measuring restoration success the resistance of the restored habitat to disturbance should also be assessed. An accepted approach is to measure the natural parameter value range of the restored seagrass meadows and compare that of the reference sites. If the natural parameter value ranges of restored seagrass meadows falls within the ranges of the reference seagrass meadows it can be assumed they can resist disturbance (Hendy *et al* 2021). Where annual variability has been recorded, this can be used to define the limits for the natural parameter value range, if not variability across space can be used (Hendy *et al* 2021).

Deliverability

- 3.4.5 There are ongoing efforts to restore seagrass meadows at coastal locations around the UK. Two main methods have been used in seagrass restoration, replanting and reseeding, which can be used in combination (MMO, 2019; Potouroglou *et al.*, 2021). Replanting involves harvesting adult shoots from an existing seagrass meadow and transplanting them at the restoration site. Replanting must be done by hand by divers, so it is labour-intensive and time consuming (MMO, 2019; Potouroglou *et al.*, 2021). Reseeding involves collecting wild seed and performing targeted redistribution of that seed. To generate a self-sustaining meadow, seagrass restoration must occur at sufficient scale to facilitate positive feedbacks (van Katwijk *et al.*, 2016).
- 3.4.6 Whilst restoration programmes are at an early stage, experience with restoration is growing rapidly. Nonetheless, to date success in restoring seagrass meadows has been limited. A major challenge relates to existing pressures, which have led to declines in health and coverage of seagrass meadows and continue to do so. Should seagrass restoration be implemented as part of a strategic compensation package, in the first instance further investigation of the site conditions and pressures would be required before final site selection. There is a high risk of failure if little consideration has been given to the habitat requirements for seagrass and continued exposure to pressures (MMO, 2019). It should be noted that sites with the most suitable conditions may still require further reduction of pressures (e.g. relocating moorings or improving water quality) to maximise the chances of successful restoration. This may be, costly and time consuming; it would involve public consultation and engagement with stakeholders. Identifying suitable mechanisms for reducing pressures (e.g. implementing bye-laws) requires further consideration.
- 3.4.7 Should habitat be restored within any MPA, consideration must also be given to the potential for loss of other designated features. Careful consideration around the location of the restored habitat within the MPA and management of that habitat is required to minimise the risk to other features.
- 3.4.8 The Steering Group had significant concerns about the deliverability of seagrass restoration, especially on a small scale as there have been no long term successes with seagrass restoration in the UK. Successful examples from abroad such as in Chesapeake Bay occurred at a large scale (3,600 ha).
- 3.4.9 There are existing seagrass restoration initiatives, for example Life Recreation ReMEDIES (Save Our Seabed, 2019). An alternative pathway to delivering seagrass restoration as a measure of compensation is for the developer to pay in to a fund to support existing seagrass restoration projects. There are several advantages to this route. Firstly, compensation would be delivered through a wider programme rather than by the developer. This puts resources for restoration in the hands of those with the most experience, who have already been through the site selection process and project planning stages. Furthermore additional funds or work could be provided to support with activities that can aid success, such as the development of less damaging anchor systems, or activities to improve water quality. Careful consideration would need to be given as to how success would be

proven, but if this approach were included alongside supporting restoration at a new site, then it is considered that it could be considered as additional.

Conclusions

- 3.4.10 There are questions around the deliverability of seagrass restoration and, therefore, its potential value as a compensation measure. It is also a lower preference compensatory measure (Defra, 2021). Notwithstanding these comments, the measure has potential to benefit subtidal sandbank habitat.
- 3.4.11 It is recommended that seagrass restoration be retained as an option, but only as a potential part of a package of higher preference compensation measures and pending collation of further evidence to support implementation at an appropriate scale.
- 3.4.12 For seagrass restoration to provide compensation, it must provide ecological benefits, particularly to sandbank habitats. Therefore a significant coverage of seagrass meadow would need to have been restored and be self-sustaining before compensation could be said to be delivered. Seagrass restoration is, however, a long-term endeavour; success would need to be measured over a number of years using multiple indicators. To minimise the chances of failure, existing pressures would need to be identified and reduced, which would add to the timeline for delivery of the compensation.

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Abbreviations

AFDW	Ash Free Dry Weight
AOI	Areas of Interest
BMP	Benthic Monitoring Plan
BSH	Broadscale Habitat
Cefas	Centre for Environment, Fisheries and aquaculture Science
CLOC	Clear Liquid Optical Chamber
DBS	Dogger Bank South
DDC	Drop Down Camera
DDV	Drop Down Video
DVV	Dual Van Veen
EUNIS	European Nature Information System
GPS	Global Positioning System
HD	High Definition
HDD	Hard Drive Disks
IDA	Industrial Denatured Alcohol
INNS	Invasive or Non-Native Species
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
MBES	Multibeam Echosounder
MCA	Marine and Coastal Agency
MEDIN	Marine Environmental Data and Information Network
MLWS	Mean Low Water Springs
MPA	Marine Protected Area
MMO	Marine Management Organisation
MP	Megapixel
MU	Management Unit
NMBAQC	Northeast Atlantic Marine Biological Analytical Quality Control Scheme
nMDS	Non-metric Multidimensional Scaling
OEL	Ocean Ecology Limited
OWF	Offshore Wind Farm
PSD	Particle Size Distribution
SAC	Special Area of Conservation
SBAS	Satellite-Based Augmentation System
SCI	Site of Community Importance
SOWF	Sofia Offshore Wind Farm
SSS	Sidescan Sonar
SVP	Sound Velocity Profiler

UPS	Uninterruptable Power Supply
USBL	Ultra-Short Baseline
UTC	Universal Time Coordinated
UTM	Universal Transverse Mercator
VER	Valued Ecological Receptor
WoRMS	World Register of Marine Species

1. Non-Technical Summary

Ocean Ecology Ltd. (OEL) were contracted to undertake a benthic survey across an area of seabed adjacent to, and overlapping with, the northern boundary of the Dogger Bank Special Area of Conservation (SAC). The key aims of the project were to inform RWE on the character of the benthos within this area by identifying species and habitats of conservation importance, in particular the overlapping Dogger Bank SAC designated features, and identify whether the infaunal communities found in the area of interest are equivalent to those described by (Wieking & Kröncke 2003) and (Diesing et al. 2009).

The benthic survey was undertaken in March 2023 and involved the collection of seabed imagery and grab samples across 58 stations arranged in 12 transects across the Dogger Bank SAC extension survey area. All samples were analysed for macrobenthos and sediment distribution and assessed with univariate and multivariate statistics to test for any significant differences and groupings of macrobenthic communities. This was then used to assign biotopes to macrobenthic groups and identify whether the infaunal communities sampled across the area were equivalent to those described as the North-eastern community (Wieking & Kröncke 2003) and/or communities K and J (Diesing et al. 2009).

Sediments across the survey area were generally homogenous, with all but two stations dominated by sand. Mud and gravel content was low throughout the survey area with the exception of two stations which contained high levels of generally poorly sorted gravel. The majority of samples were comprised of sand (S) and slightly gravelly sand ((g)S) representing EUNIS Broadscale Habitat (BSH) A5.2 'Sand and Muddy Sand'. A small number of stations were classified as Sandy Gravel (sG) or Gravelly Sand (gS) representative of EUNIS BSH 'A5.1 Coarse Sediment'.

A diverse macrobenthic community was identified across the survey area with key taxa including the bristle worms *Scoloplos armiger* and *Protodorvillea kefersteini* as well as the amphipod *Bathyporeia elegans*. Multivariate analysis on macrobenthic data identified 7 macrobenthic groups and two outlier stations across the survey area. The majority of stations fell within macrobenthic Groups F and G suggesting that macrobenthic diversity was evenly distributed across the survey area. Macrobenthic Groups G, A and E exhibited distinction from other macrobenthic groups, with most stations within these groups falling within the boundary of the Dogger Bank SAC and area of known Annex I sandbank in the shallower region of the survey area. Macrobenthic Group A (stations with higher gravel content) were also distinct from other groups with a macrobenthic community similar to those previously described as characteristic of gravelly regions of Dogger Bank. Three notable taxa were identified including two species included in the OSPAR list of threatened species (Ross worm, *Sabellaria spinulosa* and the Ocean quahog, *Arctica islandica*) as well as one taxon of economical importance (clams of the Veneridae family).

Particle Size Distribution (PSD) and macrobenthic data showed that whilst there were significant differences between macrobenthic groupings, the majority of stations closely aligned with the

biotope "A5.252 *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand". The assignment of this biotope to multiple macrobenthic groups highlights the even distribution of macrobenthic diversity across the survey area.

The North-Eastern community as described by (Wieking & Kröncke 2003) is documented as being dominated by *B. elegans* and *S. armiger*, both of which were amongst the most abundant taxa recorded during the Dogger Bank SAC extension survey. Similar macrobenthic communities were observed in Group G of the present study, the Bank community (Wieking & Kröncke 2003) and Group K (Diesing et al. 2009). The two amphipod species *B. elegans* and *Bathyporeia guilliamsoniana* were both present as well as the burrowing bivalve *Fabulina fabula*. Some similarities were also observed between Macrobenthic Group F and the North-Eastern community described in Wieking & Kröncke (2003). *Spiophanes bombyx*, *B. elegans* and *S. armiger* were present in abundance in both groups along with taxa belonging to the genus of clam *Dosinia* and family of sea anemones Edwardsiidae.

2. Introduction

2.1. Project Overview

The Dogger Bank South (DBS) Offshore Wind Farm (OWF) projects are planned to be located over 100 km off the northeast coast of England on a shallow (<65 m) offshore area of the North Sea known as The Dogger Bank.

DBS will be made up of two separate sites, DBS East, and DBS West, each with a proposed installed capacity of up to 1.5 GW. In January 2023 RWE entered into "Agreements for Lease" for the two projects with The Crown Estate, giving RWE exclusive seabed development rights for the sites. The number of turbines for each site has not yet been determined, however, the design allows for up to 300 wind turbines (a maximum of 150 for each project). The final number will be dependent on the size of turbines eventually installed.

2.2. Background Information

Ocean Ecology Ltd. (OEL) were contracted to undertake a benthic survey across an area of seabed adjacent to, and overlapping with, the northern boundary of the Dogger Bank SAC (Figure 1) to inform RWE on the character of the benthos within this area. The area of study was selected as it is likely that the infaunal communities found in the area may be equivalent to those described as the North-Eastern community (Wieking & Kröncke 2003) and/or communities K and J (Diesing et al. 2009) within previous studies of the Dogger Bank SAC. The distribution of these communities in the vicinity of the Dogger Bank SAC is of interest to DBS for consenting purposes. The results of this survey will therefore be used to assist with the development of consent applications.

2.3. Aims and Objectives

The key aims of the survey were to:

- Identify whether the infaunal communities found in the area of interest are equivalent to those described by (Wieking & Kröncke 2003) and (Diesing et al. 2009).
- Help to identify species and habitats of conservation importance, in particular the overlapping Dogger Bank SAC designated features (Annex I 'Sandbanks which are slightly covered by sea water all the time').

The survey involved the collection of seabed imagery and sediment samples followed by subsequent macrobenthic and PSD analysis.

2.4. Site Information

2.4.1. Site Location

The survey area is situated approximately 36 km northeast of the DBS OWF projects (DBS West and DBS East), 100 km off the northeast coast of England in an area of the southern North Sea called The Dogger Bank.

The Dogger Bank is a significant topographical feature covering an approximate area of 17,600 km² within the central North Sea. It is the largest sandbank in UK waters, extending out and into both Dutch and German waters.

It is surrounded by a series of mobile sandbanks, linear ridges, and deep pits. The sediment is typically comprised of sands, muddy sands, coarser gravelly sands, and gravels. The infauna and epifauna of The Dogger Bank has been widely researched (Diesing et al. 2009), the composition of which is diverse and separated into several spatially distinct communities largely determined by sediment characteristics and depth (Diesing et al. 2009). The area is of high importance for fisheries, as The Dogger Bank and surrounding seabed supports abundant sand eel populations, a significant prey source for predators including many commercial fish species (Diesing et al. 2009).

Seabed sediments within the majority of the survey area are thought to be characterised by circalittoral sand, with some areas of circalittoral coarse sediment (Figure 2). Area of seabed that qualify as Annex I sandbank habitat is expected to occur within the southern region of the survey area that falls within the Dogger Bank SAC (Figure 3, Section 2.4.3).

2.4.2. Designated Sites

The survey area intersects and lies close to a number of Marine Protected Areas (MPAs) as set out below and presented in (Figure 2). These sites form part of a network of UK wide and internationally recognised MPAs.

Dogger Bank SAC

The survey area intersects the northern boundary of the Dogger Bank SAC, a 12,331 km² area designated in 2017 to protect sandbank features classified as Annex I Habitat ('1110 - Sandbanks which are slightly covered by seawater all the time') under the EU Habitats Directive. The Dogger Bank SAC overlaps with the north easterly extent of Southern North Sea SAC. Fisheries bylaws were put in place within the SAC from June 2022 by the Marine Management Organisation (MMO), whereby the use of bottom towed fishing gear (demersal, seines and semi-pelagic) throughout the whole SAC was prohibited (Figure 2).

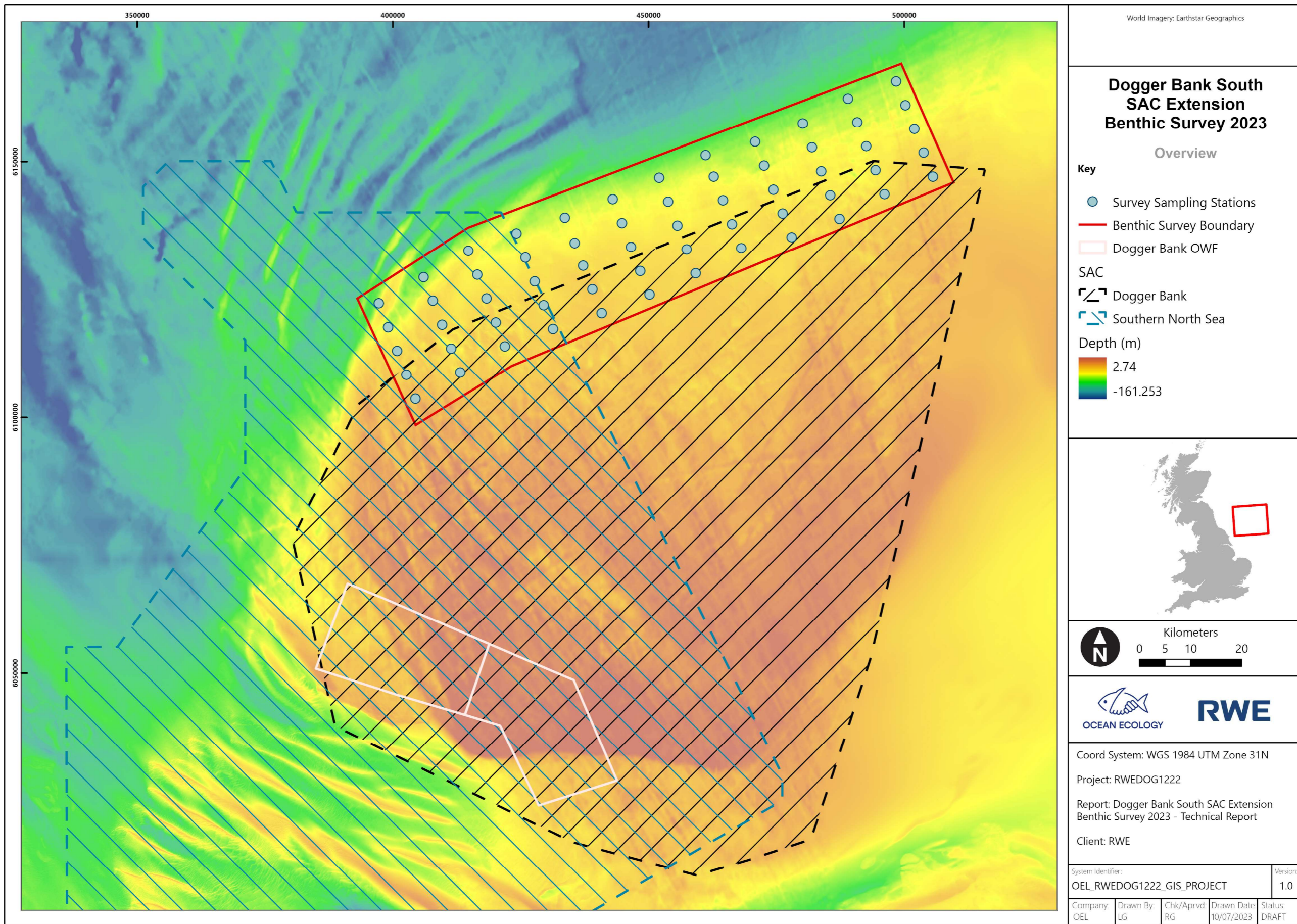


Figure 1 Overview of the Dogger Bank South OWF SAC Extension survey area.

Southern North Sea SAC

The survey area intersects the northern extent of the Southern North Sea SAC. A 36,951 km² predominantly offshore area characterised by sandy, coarse sediments. It spans from The Dogger Bank in the north to The Straits of Dover in the south. It was designated in 2019 to protect harbour porpoise (*Phocoena phocoena*). The SAC is recognised as supporting 17.5% of the UK North Sea Management Unit (MU) population, with the northern extent of particular importance during the summer season (Figure 2).

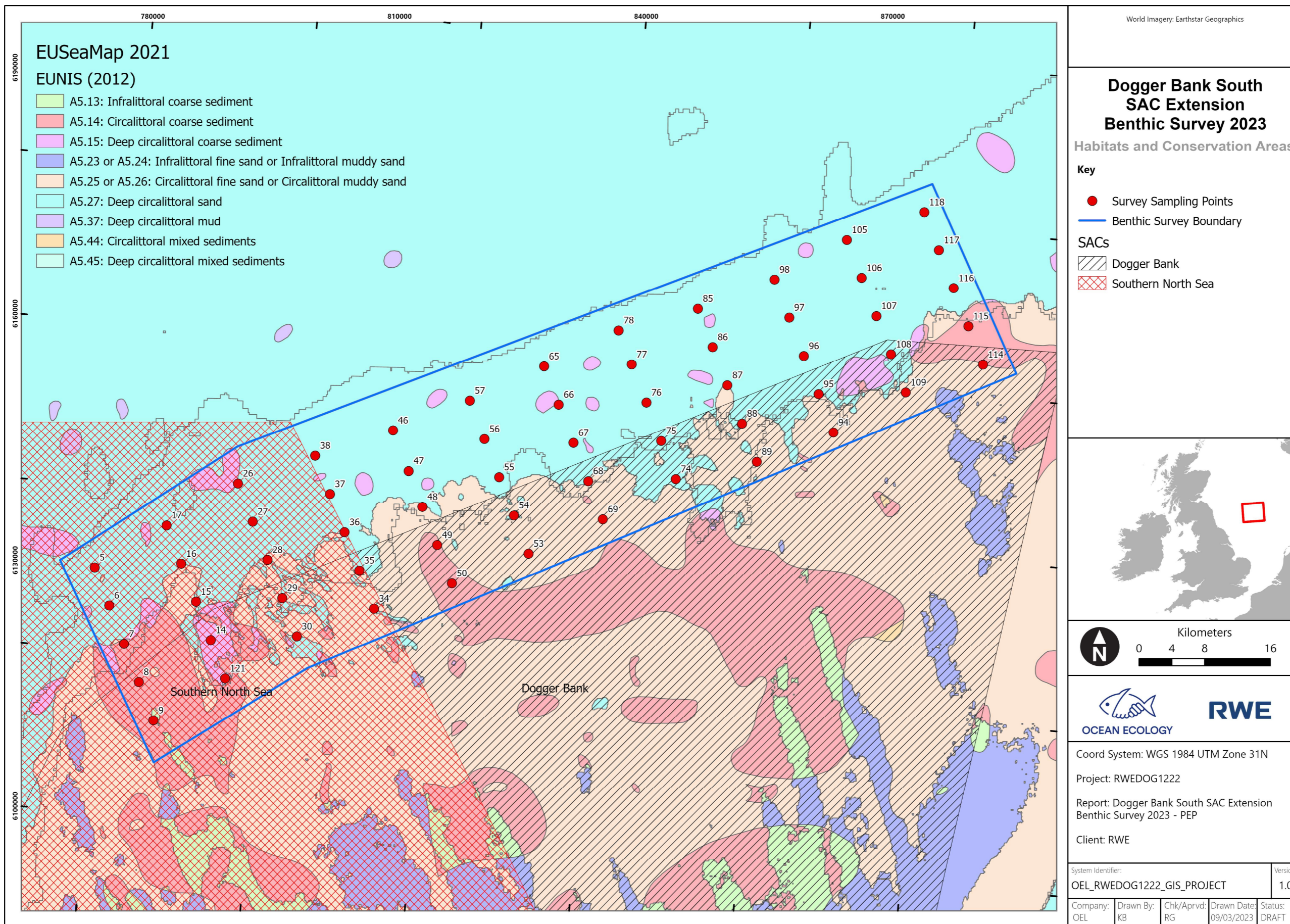


Figure 2 Designated sites and known EUNIS habitats intersecting and within the environs of the survey area.

2.4.3. Benthic Habitats of Conservation, Ecological or Economic Importance

Sandbanks which are slightly covered by seawater all the time

Sandbanks interpreted as Annex I Habitat 1110 'sandbanks which are slightly covered by seawater all the time' are described as sandy, elevated, elongated, rounded, or irregular topographical features permanently submerged and predominantly surrounded by deeper water (CEC, 2013). Sandbanks are of high conservation value, providing feeding and nursery grounds for a wide array of species including those of commercial importance. This is largely due to enhanced levels of primary and secondary productivity that occurs on and around sandbank features (Figure 3).

The sediment type of these habitats is the key driver of the diversity and type of associated communities, as well as physical, chemical, and hydrographic factors (e.g., exposure, temperature, topography, depth, turbidity, and salinity). In UK waters this feature is categorised into four sub-types: gravelly and clean sands, muddy sands, eelgrass *Zostera marina* beds and free-living maerl (Corallinacea) beds. An expansive area of Annex I sandbank habitat extends throughout The Dogger Bank SAC supporting several spatially distinct communities (Wieking & Kröncke 2003, Diesing et al. 2009).

2.4.4. Species of Conservation Interest

Arctica islandica

Arctica islandica or 'Ocean Quahog' is a large, slow growing clam with a thick round/oval shaped shell growing up to 13 cm in length. This species is believed to be one of the longest living molluscs with one individual estimated at 507 years old. They are found in subtidal sandy and muddy sediments around the UK and are sensitive to physical disturbance and habitat destruction from mobile fishing gear. There are known records of this species within the survey area (Figure 3).

Osmerus eperlanus

The European Smelt (*Osmerus eperlanus*) is a species of anadromous fish occurring in coastal and estuarine waters around the UK. They typically grow up to 18 cm long with a long slender appearance. Numbers of this species have severely declined around the UK due to overfishing, habitat destruction and barriers to migration. This species has been recorded as being present to the northwest of the survey area (Figure 3).

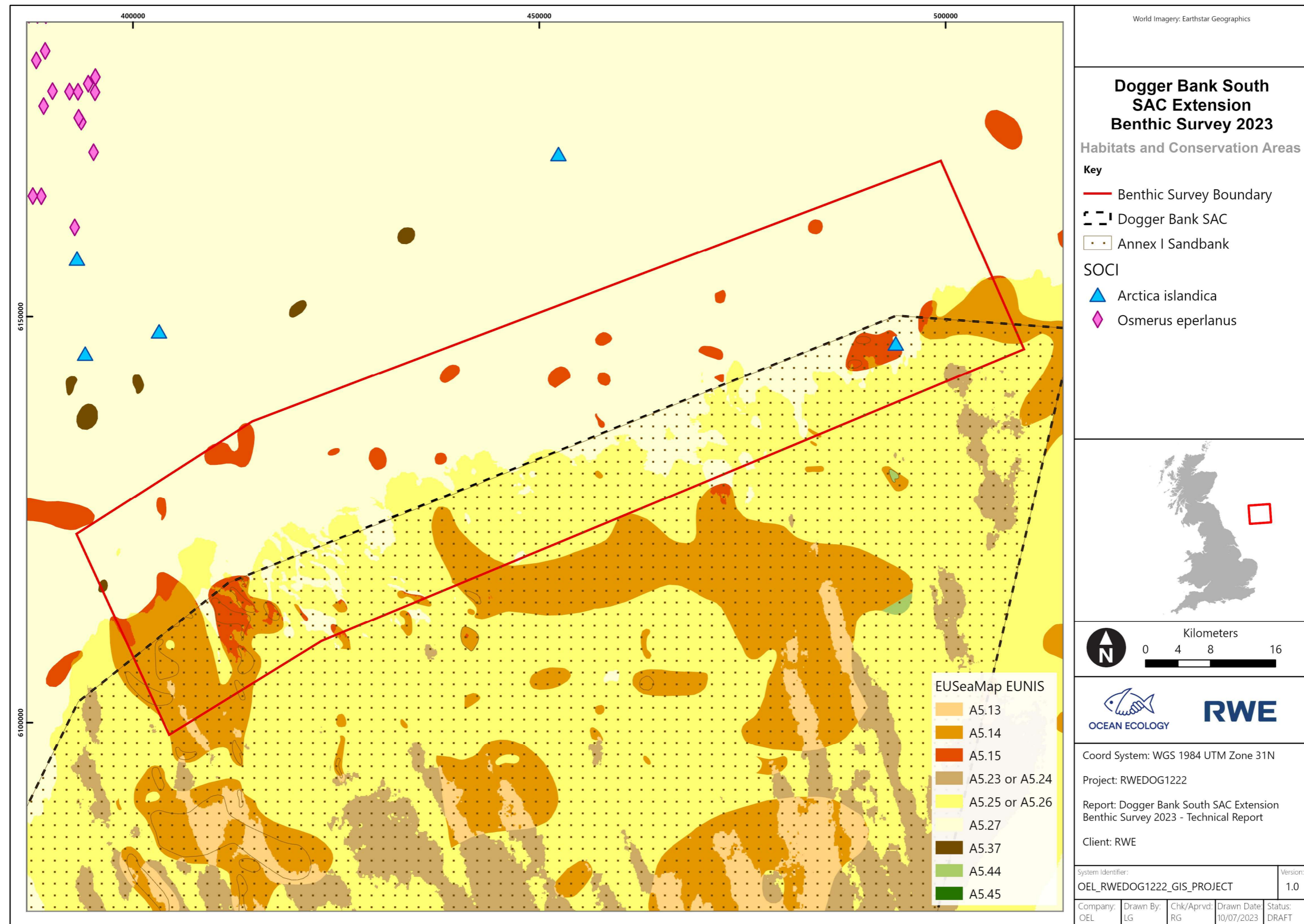


Figure 3 Species of Conservation Interest (SOCI) and Annex I habitats occurring within and in the vicinity of the survey area.

3. Sampling Plan

3.1. Rationale

The predefined sampling plan has been developed to provide adequate spatial coverage throughout the area of interest. Notably to identify whether the infaunal communities found in the area are equivalent to those described as the North-eastern community (Wieking & Kröncke 2003) and/or communities K and J (Diesing et al. 2009).

3.2. Sampling Design

The sampling array consisted of 58 predetermined sampling stations in an area located to the north and northeast of the proposed DBS East and DBS West OWF Projects (Figure 4).

The sampling stations were placed at 5 km intervals along 12 transects each separated by 10 km and orientated in a northwest to southeast arrangement. This captured the depth profile of The Dogger Bank from 50 m below lowest astronomical tide (LAT) up to within the northern aspect of the Dogger Bank SAC boundary. Primary and secondary survey transect lines were proposed as part of the original sampling array but were not sampled in order of priority during the survey due to favourable weather conditions. Stations were sampled in a systematic fashion along all survey lines in turn.

A thorough conflicts check was conducted by OEL for all sampling stations, and in consideration of the requirements detailed in Schedule 2 of the marine license. Ten stations (05, 08, 09, 16, 17, 28, 36, 49, 54, 69) lay between 250 m and 1 nautical mile of a subsea cable and / or pipeline and therefore required prior notification of the asset operator before sampling. Two stations, 14 and 121, were removed from the scope prior to the survey commencing for safety reasons due to their location within a spoil ground with poorly charted features (reducing the original scope of 60 stations to the sampled 58 stations). No other conflicts were noted.

3.3. Sampling Approach

At each sampling station, high-resolution seabed imagery (stills and video) was first collected with a DDC system to allow in situ visual inspection for confirming the absence of protected or sensitive habitats (e.g., potential Annex I Reef) and other ecological, heritage, or safety hazards prior to grab sampling. If during this pre-screening exercise the sampling stations were deemed inappropriate for grab sampling, the sampling station was to be repositioned in a nearby area of sediment and revisited with DDC prior to grab sampling.

Stations were then sampled with a 0.2m² Dual Van Veen (DVV) grab sampler, due to the presence of hard compacted sand in the area which was not favourable for a 0.1 m² mini-Hamon grab. One sample of approximately 10 L was collected at each station. From the sediments collected, a single sub-sample was taken for PSD analysis, and the remainder was sieved through a 1 mm mesh and retained for macrobenthic analysis. Grab samples were taken within 50 m of the target sampling station.

3.4. Sampling Summary

All scope operations were successfully completed within the allocated survey timeframe.

Digital photographic stills and video footage were successfully obtained at 58 DDC stations and were reviewed *in situ* to assess for the presence of protected or sensitive habitats (e.g., Annex I reef features), and general suitability for grab sampling. This resulted in the collection of 302 still images and 60 videos. No protected or sensitive habitats were noted at any of the DDC stations.

A total of 58 successful macrobenthic samples and 58 PSD samples were collected during the survey.

3.5. Timing

Sampling was undertaken from the 17th to the 20th of March 2023.

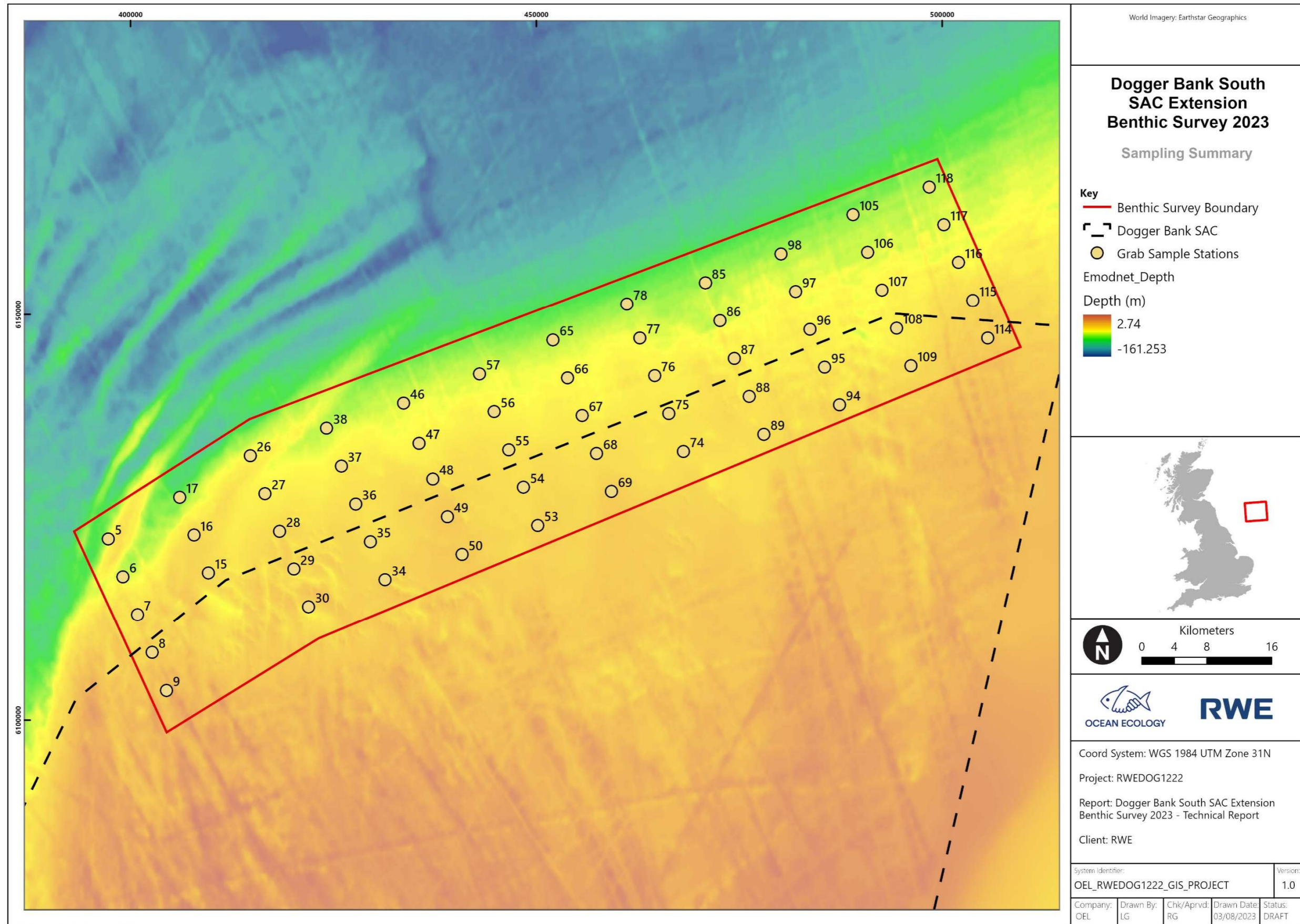


Figure 4 Grab stations sampled during the survey.

4. Survey Methods

4.1. Project Parameters

4.1.1. Horizontal Datum

All data is referenced to WGS84 UTM Zone 31N, with no datum transformation need.

Table 1 Geodetic parameters.

GPS Satellite System Geodetic Parameters	
Geodetic Datum	WGS_1984
Projection	Universal Transverse Mercator (UTM)
Zone	31 N [EPSG 32631]
Central Meridian (CM)	3.000000
Latitude of Origin	0.00000
False Easting	500000.000000
False Northing	000000
Linear Unit	Metre

4.1.2. Vertical Datum

All altitude and depth data above seabed is referenced to LAT. All depth data below the seabed is referenced to LAT where available.

4.1.3. Unit Format and Conversions

The following units were used throughout this project and have been expressed using the following conventions.

Table 2 Project unit format and convention details.

Unit Formats and Conventions	
Geographical Coordinates	Latitude N DD°MM.mmmmmm' to 6 decimal places. Longitude E/W DD°MM.mmmmmm' to 6 decimal places.
Grid Coordinates	Meters in the following format: Easting EEE EEE.eee m to 3 decimal places. Northing NNN NNN.nnn m to 3 decimal places.
Linear distances	Meters to 1 decimal places.
Offset measurement sign conventions	Meters in the following format: 'Y' is positive forward. 'X' is positive to starboard. 'Z' values are positives upwards from the waterline.
Time	UTC (GMT).

4.2. Survey Vessel

Sampling was conducted aboard the 26 m Marine and Coastal Agency (MCA) Category 1 coded survey vessel *DSV Curtis Marshall*. The vessel was mobilised from Hartlepool on the east coast of England and operations were performed on a 24-hour basis (Table 3, Plate 1).

Table 3 Vessel details

Vessel Name	DSV Curtis Marshall
Area of operation	Offshore
Call Sign	2HWN3
MMSI	235107219
Mobilisation Port	Hartlepool
Length	26 m
Beam	7.7 m
Draft	2.8 m



Plate 1 *DSV Curtis Marshall*.

4.3. Survey Navigation

4.3.1. Surface Positioning

Surface positioning aboard the *DSV Curtis Marshall* was determined using a Hemisphere V104s Global Positioning System (GPS) compass system. The Hemisphere V104s internal GPS receiver utilises a minimum of 4 GPS satellites, managing the navigation information required to obtain a position within 3 m at 95 % accuracy. The V104s automatically tracks Satellite-Based Augmentation System (SBAS) differential correction to improve position accuracy to > 1 m at 95 % accuracy. The V104s includes an integrated gyro and two tilt sensors to provide an accurate heading for navigation software.

4.3.2. Subsea Positioning

The vessel was equipped with an Easytrak Nexus 2 Lite Ultra-Short Baseline (USBL) system and 1329A Omni-directional +/- 90 ° Micro Beacons for subsea positioning of the camera and grab. The Easytrak Nexus 2 Lite is an advanced USBL positioning and tracking system that determines the position of dynamic subsea targets through the transmission and reception of acoustic signals between the submerged transceiver and a target beacon. The USBL was fully calibrated prior to survey operations using a Valeport SWiFT sound velocity profiler (SVP). Readings were obtained daily from both the up-cast and down-cast

4.3.3. Navigation Software

A vessel-based positioning system was employed utilizing EIVA NaviPac V4.6 software to ensure the accurate positioning of the vessel and subsea positioning of the sampling equipment via the USBL system as well as recording continuous track plots of the sampling equipment and recording sampling fixes. A navigation screen, displaying EIVA Helmsman Display was provided at the helm position of the vessel for the Officer on Watch.

4.3.4. Positional Checks & Calibrations

The GPS has an internal precision calculation which outputs a graphical representation of horizontal accuracy, displaying numerical precision as easting and northing. The accuracy of vessel heading, and reference systems was verified during mobilisation using reference points.

A USBL calibration was undertaken using the inbuilt Easytrak Nexus calibration software package to eliminate any alignment errors of the installation. Offsets were measured dynamically between the Easytrak Nexus Transceiver Head and the external sensors interfaced. This enabled accurate operation of the Easytrak Nexus tracking system when pole mounted onto a vessel with external VRU and gyro.

4.4. Seabed Imagery Collection

Seabed imagery (simultaneous video and stills) was acquired at each station using OEL's SubC Rayfin PLE camera system, set up to obtain 1080p High Definition (HD) video and 20 Megapixel (MP) still images. The camera system (Plate 2) consisted of a SubC Imaging Rayfin PLE camera mounted in a Clear Liquid Optical Chamber (CLOC) (otherwise known as a 'freshwater lens') filled with fresh water to ensure imagery of suitable quality was obtained regardless of turbidity (Jones et al. 2020). The frame included LED strip lamps and a 10 cm point laser scaling array that was projected into the field of view, a 300 m umbilical and topside computer. The camera was powered with the use of an Uninterruptable Power Supply (UPS) to ensure no damage would be caused should the vessel have lost power or in the event of a power surge. A full redundancy SubC Rayfin PLE camera system was stored onboard for use if required.

The CLOC was height and angle adjustable providing a variety of options for view, lighting, and focal length to maximise data quality with respect to prevailing conditions (e.g., high turbidity).

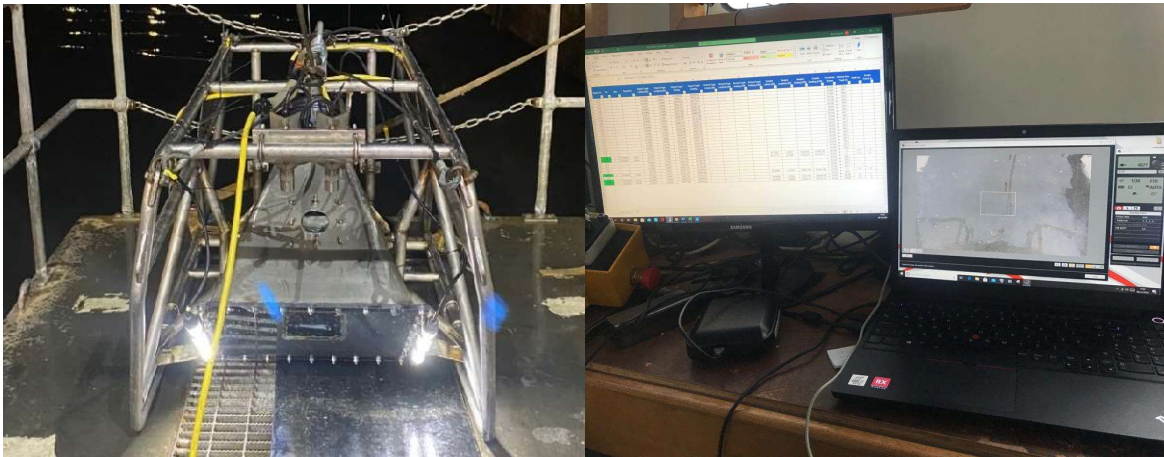


Plate 2 Left: OEL CLOC camera system. Right: The camera system topside setup.

All DDC stations were sampled in consideration of the JNCC epibiota remote monitoring operational guidelines (Hitchin et al. 2015).

The camera system was deployed from the hydraulic 'A' frame on the aft deck of the *DSV Curtis Marshall* using the following method:

- As the vessel approached the target location, deck personnel began to prepare lifting equipment, camera, and umbilical.
- Deck personnel were alerted by the vessel master once on position, and the camera was raised using the A frame winch and lowered into the water column. The umbilical was payed out by hand.
- Once the camera system was within 5m of the seabed, video recording was started, and the camera was gently lowered and landed on the seabed.
- Once any disturbed sediment/debris had cleared, still images were taken. The vessel was manoeuvred within a 50 m radius of target location, and the camera was raised from the seabed between capturing still images. This ensured broad coverage around the target location.
- Following the capture of the final image, the camera was lifted, video recording was stopped, and the camera was slowly brought to the surface.
- The winch operator then took the tension on the wire and the deck crew ensured the camera umbilical was free for recovery. The umbilical was reeled in as the camera was lifted.
- Once the vessel master had confirmed sea conditions were suitable, the camera system was recovered aboard and lowered onto the deck.

All footage underwent a preliminary review *in situ* by OEL's onboard Environmental Scientists. Videos were recorded in a digital format direct to topside hard disk drives (HDDs). Detailed notes were taken of visible sediment conditions and seabed features, obvious fauna, and habitat-related features whilst in the field.

4.5. Grab Sampling

4.5.1. Grab Samplers

Sediment samples were collected from within 50 m of the target sampling location using a 0.2 m² DVV grab sampler capable of simultaneously collecting two independent 0.1 m² samples (Plate 3). A 0.1 m² mini-Hamon grab was initially mobilised as the primary grab sampler however, due to the presence of hard compact sands within the survey area, the DVV was mobilised after multiple failed attempts with the mini-Hamon grab.

A single sample of approximately 10 L was retained at each station for macrobenthic and PSD analysis. A sub-sample of the sediment (approx. 0.5 L in volume) from each sample was removed for characterisation of the physical nature of the substrate (via PSD analysis) and the residual sample elutriated through a 1.0 mm sieve and retained for macrobenthic analysis.

The grab sampler was deployed from the port side of the *DSV Curtis Marshall* using the main deck crane.

4.5.2. Sample Collection

To ensure consistency in sampling, grab samples were screened by the lead marine ecologist and considered unacceptable if:

- The sample was less than 5 L. i.e., the sample represented less than half the 10 L capacity of the grab used.
- The jaws failed to close completely or were jammed open by an obstruction, allowing fines to pass through (washout or partial washout).
- The sample was taken at an unacceptable distance from the target location (beyond 50m).

Where three unsuccessful attempts were made within 50 m of the target locations, a fourth attempt was made approximately 100 m from the target. Following a fourth failed attempt the station would have been abandoned, however this did not occur during the survey and all stations were successfully sampled. No pooling of samples took place.

4.5.3. Grab Sample Processing (PSD and Macrobenthic)

Initial grab sample processing was undertaken onboard the survey vessel in line with the following methodology:

- An initial visual assessment was made of sample size and acceptability.
- A photograph was taken of the sample with station details and scale bar.
- 10 % of the sample was removed for PSD analysis and transferred to a labelled tray.
- The remaining sample (retained for faunal sorting and identification) was emptied onto a 1.0 mm sieve net laid over a 4.0mm sieve table and washed through using gentle rinsing with a seawater hose.

- This remaining sample was backwashed into a suitably sized sample container and diluted 10 % formalin solution was added to fix the sample prior to laboratory analysis.
- Sample containers were clearly labelled internally and externally with date, sample ID and project name.

Detailed field notes and digital photographs were taken at each station including station number, fix number, number of attempts, and water depth. Visual descriptions of sediment type were made (using the Folk classification categories) at the time of sampling, together with estimates of sample volume. Any notable or conspicuous fauna present were also recorded in the field notes.



Plate 3 Left: 0.1 m² mini Hamon grab sampler. Right: 0.2 m² DVV grab sampler.

5. Laboratory Analysis & Interpretation

5.1. Particle Size Distribution (PSD) Analysis

PSD analysis of the sediment samples was undertaken by in-house laboratory technicians at OEL's NE Atlantic Marine Biological Analytical Quality Control (NMBAQC) participating laboratory in line with NMBAQC best practice guidance (Mason 2016)

Frozen sediment samples were first transferred to a drying oven and thawed at 80 °C for at least 6 hours before visual assessment of sediment type. Before any further processing (e.g., sieving, or sub-sample removal), samples were mixed thoroughly with a spatula and all conspicuous fauna (>1 mm) which appeared to have been alive at the time of sampling were removed from the sample. A representative sub-sample was then removed for laser diffraction analysis before the remaining sample screened over a 1 mm sieve to sort coarse and fine fractions. The >1 mm fraction was then returned to a drying oven and dried at 80 °C for at least 24 hours before dry sieving. Once dry, the sediment sample were run through a series of Endecott BS 410 test sieves (nested at 0.5 ϕ intervals) using a Retsch AS200 sieve shaker to fractionate the samples into particle size classes. The dry sieve mesh apertures used are given in **Table 4**.

Table 4 Sieve series employed for PSD analysis by dry sieving.

Sieve aperture (mm)												
63	45	32	22.5	16	11.2	8	5.6	4	2.8	2	1.4	1

The samples were then transferred onto the coarsest sieve at the top of the sieve stack and shaken for a standardised period of 20 minutes. The sieve stack was then checked to ensure the components of the sample had been fractionated as far down the sieve stack as their diameter allows. A further 10 minutes of shaking was undertaken if there was evidence that particles are not properly sorted.

The sub-sample for laser diffraction was first screened over a 1 mm sieve and the fine fraction residue (<1 mm sediments) transferred to a suitable container and allowed to settle for 24 hours before excess water was syphoned from above the sediment surface until a paste texture is achieved. The fine fraction was then analysed by laser diffraction using a Beckman Coulter LS13 320. For silty sediments, ultrasound was used to agitate particles and prevent aggregation of fines.

The dry sieve and laser data was then merged for each sample with the results expressed as a percentage of the whole sample. Once data was merged, PSD statistics and sediment classifications were generated from the percentages of the sediment determined for each sediment fraction using Gradistat v9 software.

Sediment descriptions were defined by their size class based on the Wentworth classification system (Wentworth 1922) (Table 5). Statistics such as mean and median grain size, sorting

coefficient, skewness, and bulk sediment classes (percentage silt, sand, and gravel) were also derived following the Folk classification (Folk 1954).

Table 5 The classification used for defining sediment type based on the Wentworth Classification System (Wentworth 1922).

Wentworth Scale	Phi Units (ϕ)	Sediment Types
>64 mm	<-6	Cobble and boulders
32 – 64 mm	-5 to -6	Pebble
16 – 32 mm	-4 to -5	Pebble
8 – 16 mm	-3 to -4	Pebble
4 - 8 mm	-3 to -2	Pebble
2 - 4 mm	-2 to -1	Granule
1 - 2 mm	-1 to 0	Very coarse sand
0.5 - 1 mm	0 – 1	Coarse sand
250 - 500 μ m	1 – 2	Medium sand
125 - 250 μ m	2 – 3	Fine sand
63 - 125 μ m	3 – 4	Very fine sand
31.25 – 63 μ m	4 – 5	Very coarse silt
15.63 – 31.25 μ m	5 – 6	Coarse silt
7.813 – 15.63 μ m	6 – 7	Medium silt
3.91 – 7.81 μ m	7 – 8	Fine silt
1.95 – 3.91 μ m	8 – 9	Very fine silt
<1.95 μ m	<9	Clay

5.2. Macrobenthic Analysis

All elutriation, extraction, identification, and enumeration was undertaken at OEL's NMBAQC scheme participating laboratory in line with the NMBAQC Processing Requirement Protocol (Worsfold & Hall 2010). All processing information and macrobenthic records were recorded using OEL's cloud-based data management application [ABACUS](#) that employs Marine Environmental Data and Information Network (MEDIN) validated, controlled vocabularies ensuring all sample information, nomenclature, qualifiers, and metadata are recorded in line with international data standards.

For each macrobenthic sample, the excess formalin was drained off into a labelled container over a 1 mm mesh sieve in a well-ventilated area. The samples were then re-sieved over a 1 mm mesh sieve to remove all remaining fine sediment and fixative. The low-density fauna was then separated by elutriation with freshwater, poured over a 1 mm mesh sieve, transferred into a Nalgene and preserved in 70 % Industrial Denatured Alcohol (IDA). The remaining sediment from each sample was subsequently separated into 1 mm, 2 mm and 4 mm fractions and sorted under

a stereomicroscope to extract any remaining fauna (e.g., high-density bivalves not 'floated' off during elutriation).

All present fauna was identified to species level, where possible, and enumerated by trained benthic taxonomists using the most up to date taxonomic literature and checks against existing reference collections. Nomenclature will utilise the live link within ABACUS to the World Register of Marine Species ([WoRMS](#)) web services to ensure the most up to date taxonomic classifications are recorded. Colonial fauna (e.g., hydroids and bryozoans) were identified to species level where possible and recorded as present (P). For subsequent data analysis, taxa recorded as P were given the numerical value of 1. A full reference collection was retained including at least one example specimen of each taxon.

Biomass was measured as blotted wet weight in grams to at least 4 decimal places for all countable taxa (i.e., at species level where possible). As a standard, the conventional conversion factors as defined by (Eleftheriou & Basford 1989) was applied to biomass data to provide equivalent dry weight biomass (Ash Free Dry Weight (AFDW)).

The conversion factors applied are as follows:

- Annelida = 15.5%
- Crustacea = 22.5%
- Mollusca = 8.5%
- Echinodermata = 8.0%
- Miscellaneous = 15.5%

5.3. Macrobenthic Data Analysis

5.3.1. Data Truncation and Standardisation

The macrobenthic species list was checked using the R package '*worms*' (Holstein 2018) to check against WoRMS taxon lists and standardise species nomenclature. Once the species nomenclature was standardised in accordance with WoRMS accepted species names, the species list was examined carefully by a senior taxonomist to truncate the data, combining species records where differences in taxonomic resolution were identified.

5.3.2. Pre-Analysis Data Treatment

All data were collated in excel spreadsheets and made suitable for statistical analysis. All data processing and statistical analysis was undertaken using R v 4.3.1 (R Core Team 2022) and PRIMER v7 (Clarke & Gorley 2015) software packages. No replicate samples were available for macrobenthic analysis thus no mean values could be calculated per sampling station.

In accordance with the OSPAR Commission guidelines (OSPAR 2004) records of colonial, meiofaunal, parasitic, egg and pelagic taxa (e.g. epitokes and larvae) were recorded, but were excluded when calculating diversity indices and conducting multivariate analysis of community structure.

Newly settled juveniles of macrobenthic species may at times dominate the macrobenthos, however the (OSPAR 2004) guidelines suggest they should be considered an ephemeral component due to heavy post-settlement mortality and not therefore representative of prevailing bottom conditions (OSPAR 2004). OSPAR (2004) further states that "Should juveniles appear among the ten most dominant organisms in the data set, then statistical analyses should be conducted both with and without these in order to evaluate their importance". As juveniles of Amphiruridae and Tharchoidea appeared in the top ten most dominant taxa across the survey area, a 2STAGE analysis was conducted to compare the two data sets (with and without juveniles) which revealed a 93.8 % of similarity between the two and therefore juveniles were retained in the dataset for all further analyses and discussion. This was based on a p value of 0.1 and therefore if similarity was < 90 %, juveniles would have been excluded.

In accordance with NMBAQC PRP (Worsfold & Hall 2010), Nematoda were recorded during the macrobenthic analysis and included in all datasets for all further analyses and discussion.

5.3.3. Diversity Indices

In order to condense the full macrobenthic community datasets into single metrics that could be compared, a number of univariate metrics, otherwise known as diversity indices, were calculated from the macrobenthic dataset using the DIVERSE routine in PRIMER v7. These included: number of individuals (N); Shannon Wiener diversity (H'), Simpsons dominance ($1 - \lambda'$), richness (S) and evenness (J') indices were also calculated.

5.3.4. Multivariate Statistics

Prior to multivariate analyses, data were displayed as a shade plot with linear grey-scale intensity proportional to macrobenthic abundance (Clarke et al. 2014) to determine the most efficient pre-treatment (transformation) method. Macrobenthic abundance data from grab samples was square root transformed to prevent taxa with intermediate abundances from being discounted from the analysis, whilst allowing the underlying community structure to be assessed.

The PRIMER v7 software package (Clarke & Gorley 2015) was utilised to undertake the multivariate statistical analysis on the biotic macrobenthic dataset.

To fully investigate the multivariate patterns in the biotic data, macrobenthic assemblages were characterised based on their community composition, with hierarchical clustering and non-metric multidimensional scaling (nMDS) used to identify groupings of sampling stations that could be grouped together as a habitat type or community. SIMPER (similarities-percentage) analysis was then applied to identify which taxa contributed most to the similarity within that habitat type or community. A detailed description of analytical routines is provided in Appendix I.

5.3.5. Determining EUNIS Classifications

Macrobenthic assemblages were characterised based on their community composition, with hierarchical clustering used to identify groupings of sampling stations that could be grouped together as a habitat type or community. Setting these groupings as factors within PRIMER, SIMPER analysis was then applied to identify which taxa contributed the most to the similarity within that community. EUNIS classifications were then assigned based on the latest JNCC guidance (Parry 2019).

5.3.6. Seabed Imagery Analysis

Seabed imagery was obtained for the purpose of *in situ* screening of stations by completing a visual inspection for protected or sensitive habitats (e.g., potential Annex I Reef) and other ecological, heritage, or safety hazards. Subsequent analysis of the digital stills and video footage was therefore not required, however the stills and imagery obtained during the survey are provided with this report.

6. Results

Sampling at 58 grab stations across the survey area resulted in the acquisition of 58 benthic samples for macrobenthic and sediment PSD analysis. Digital photographic stills and video footage were also obtained for screening purposes at 58 DDC stations resulting in 302 still images and 60 videos. DDC logs are provided in Appendix II, with grab logs in Appendix III and grab sample images in Appendix IV.

6.1. Sediments

In total, 58 sediment samples were analysed for full particle size classification. Example images of all sampled sediment types are presented in Plate 4 with full PSD data provided in Appendix V and summary data provided in Appendix VI.

6.1.1. Sediment Type

Sediment types, as classified using the Folk triangle (Folk 1954), for each station sampled across the survey area are presented in Figure 5. Each Folk classification was converted to BSH type (EUNIS Level 3) using the adapted Folk triangle (Long 2006) (Figure 5). The majority of sediments sampled across the survey area were representative of EUNIS BSH A5.2 – Sand and Muddy Sand (n = 50). The remaining sediment samples were representative of BSH A5.1 - Coarse Sediment (n = 8). Sediments were relatively homogenous with some slight variation from Poorly Sorted Sandy Gravel (sG) to Well Sorted Sands (S). Sand content was high in all samples and mud content was generally low.

The most frequently occurring sediment type was Slightly Gravelly Sand ((g)S) recorded at 32 of the 58 sampling locations. Sand (S) was the second most commonly recorded sediment type (n = 18), followed by Gravelly Sand (gS) (n = 6) then Sandy Gravel (sG) (n = 2)

As a general spatial trend, the majority of the survey area was comprised of sands and sand with varying gravel content distributed relatively evenly throughout. The central and Northeastern region of the survey area was dominated by Slightly Gravelly Sand (g)S whilst the Southwestern region was largely Sand (S) (Figure 6). The survey area consisted largely of sediments representative of EUNIS BSH A5.2 – Sand and Muddy Sand with some stations representative of BSH A5.1 - Coarse Sediment distributed evenly across the survey area (Figure 7).

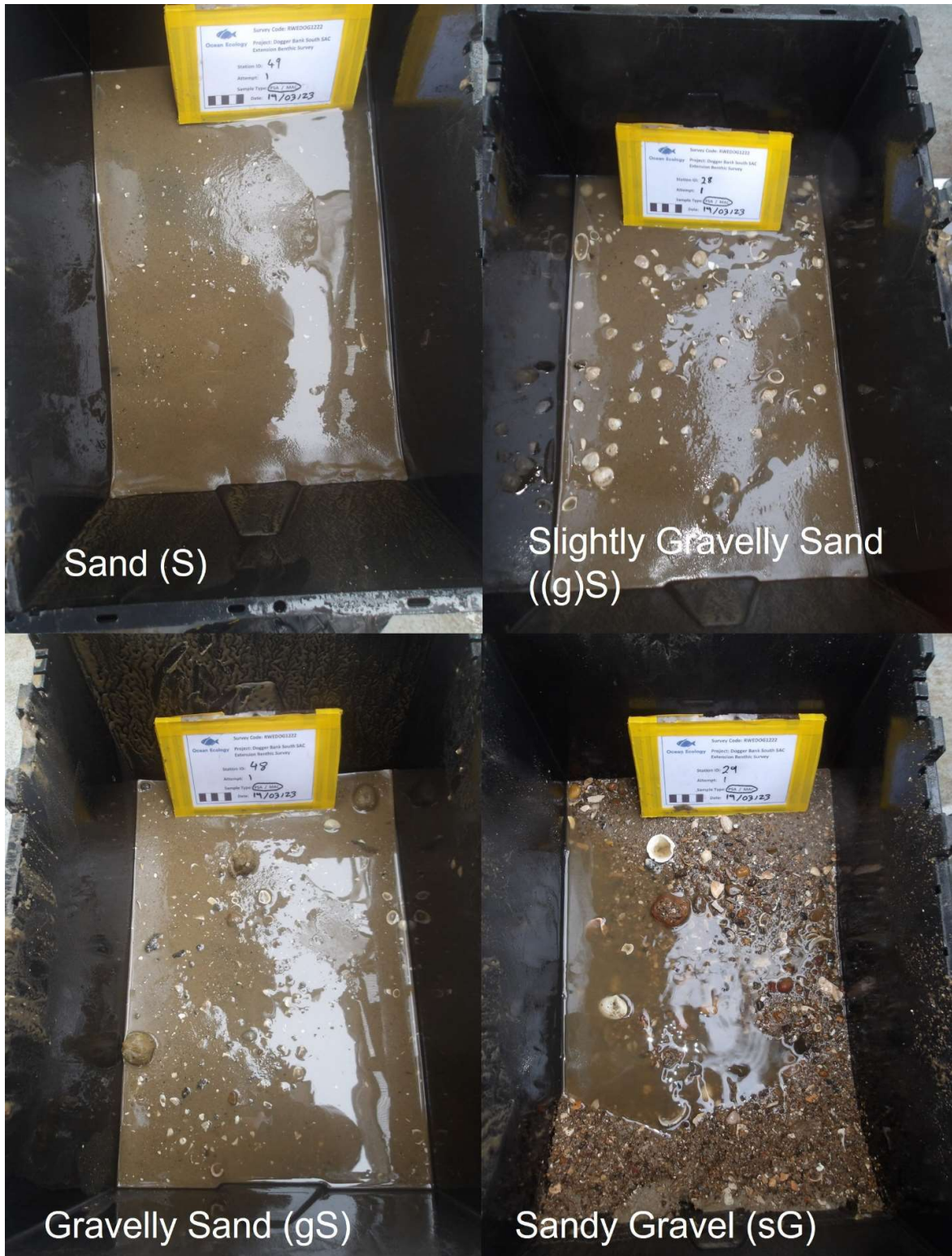
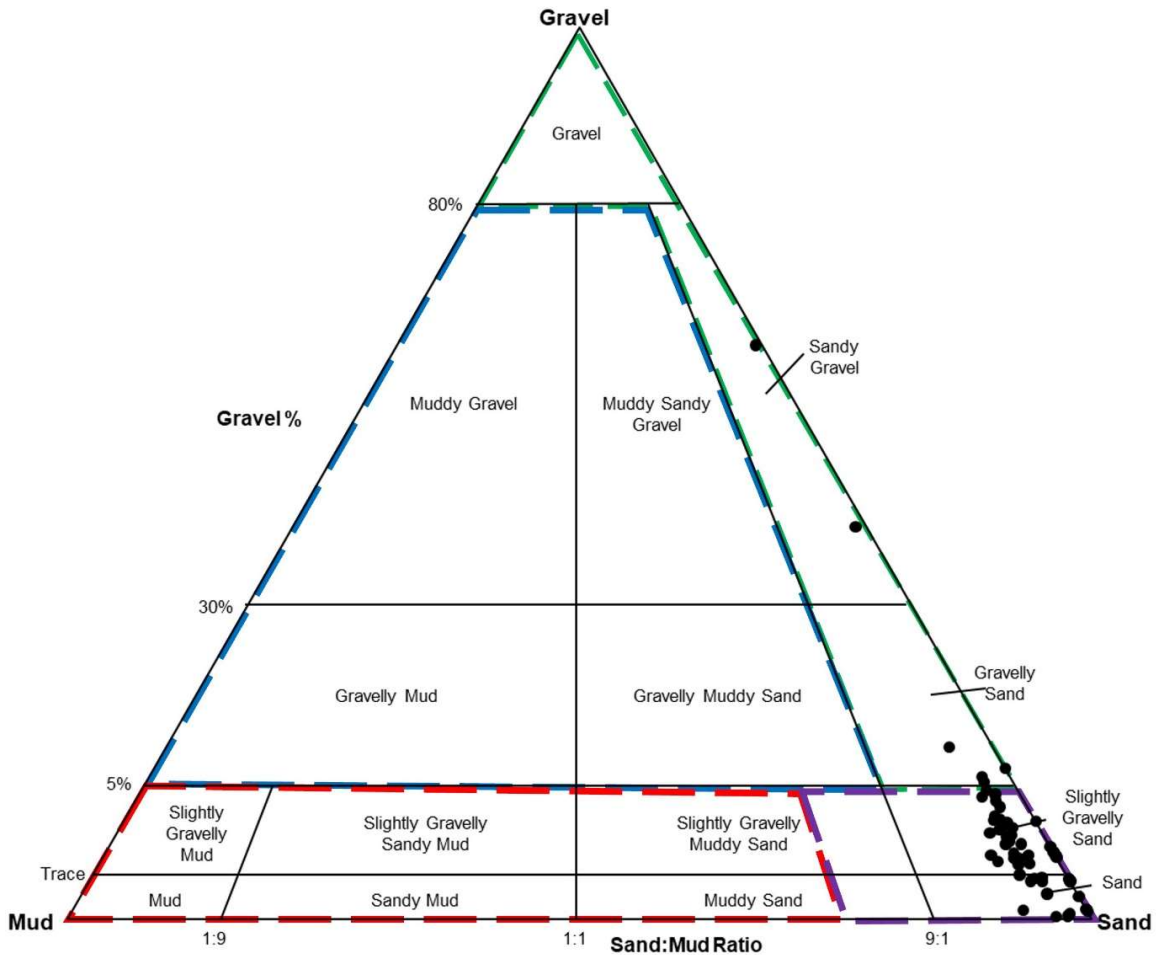


Plate 4 Example of sediments found across the survey area.



EUNIS Broad Scale Habitats (BSH) (Level 3)



Figure 5 Folk (Folk 1954) triangle classifications of sediment gravel percentage and sand to mud ratio (shown by black dots) overlain by the modified Folk triangle for determination of mobile sediment BSHs under the EUNIS habitat classification system (adapted from (Long 2006)).

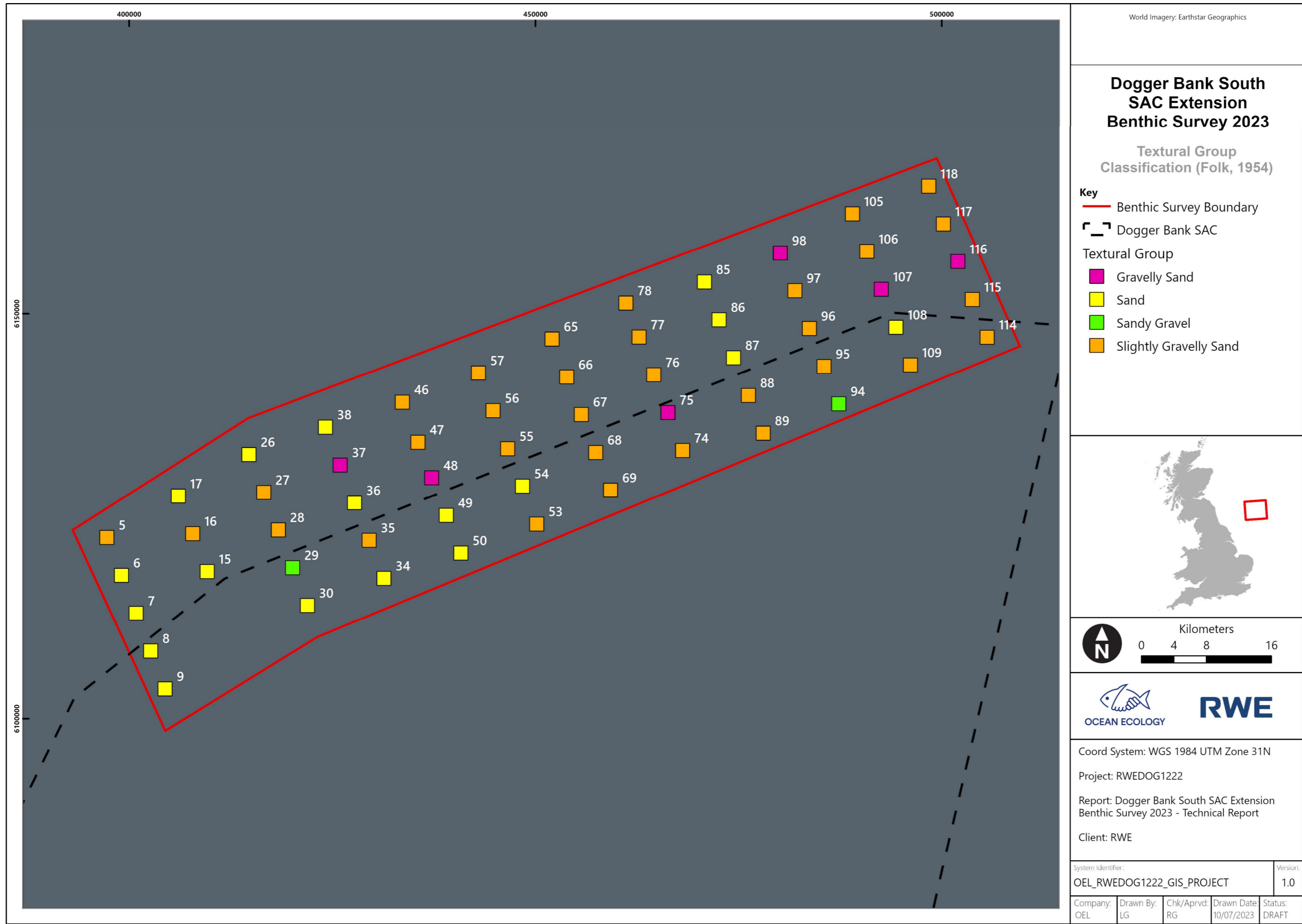


Figure 6 Folk (1954) sediment types as determined from PSD analysis of samples acquired during the survey.

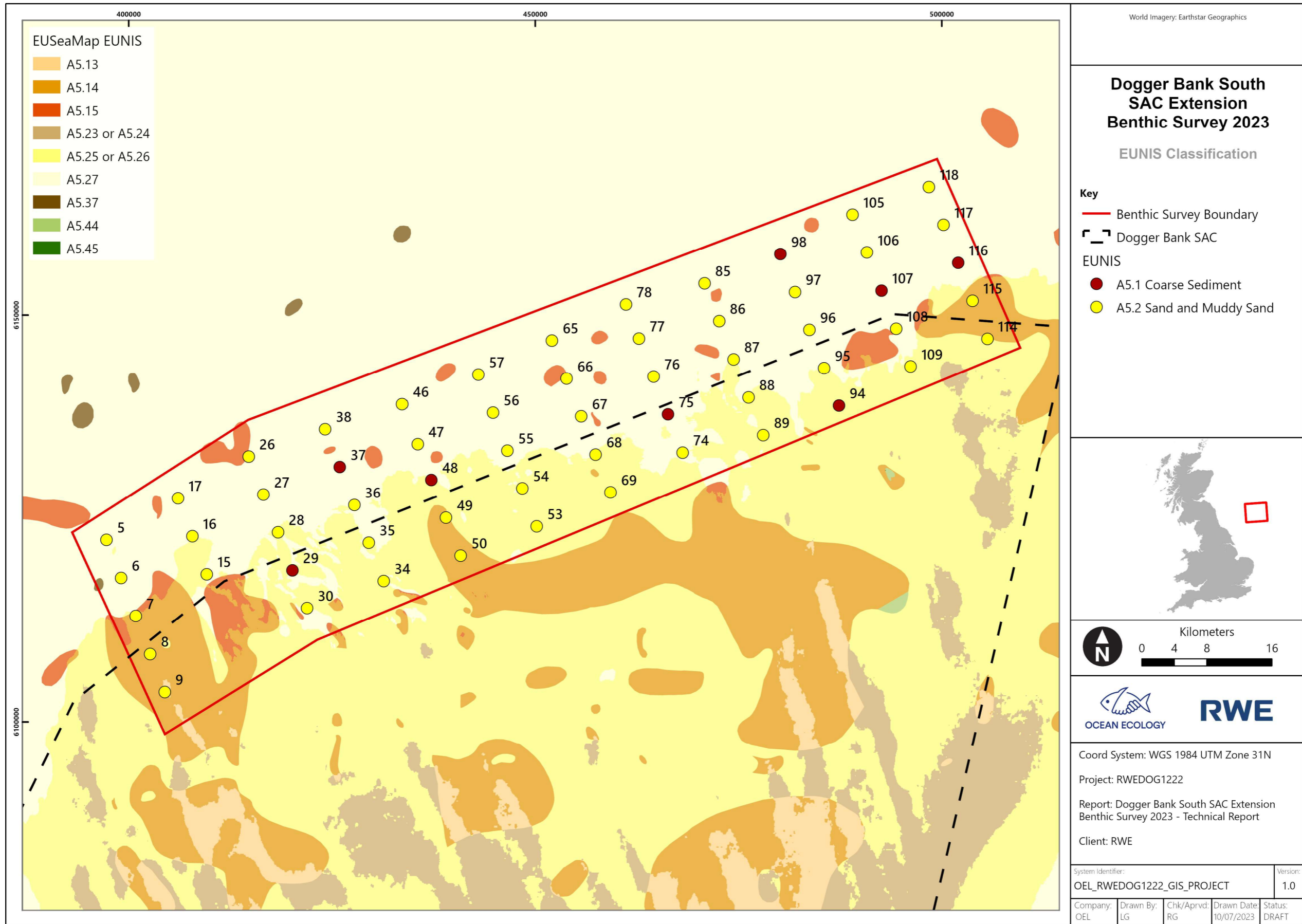


Figure 7 EUNIS habitat classification as determined from utilising the EUNIS sediment descriptions from PSD of samples collected during the survey.

6.1.2. Sediment Composition

Percentage contribution of gravels (>2 mm), sands (0.63 mm to 2 mm) and fines (<63 μm) to overall sediment composition are presented for each grab station in Figure 8 and mapped for each of the sampling stations in Figure 9.

Percentage contribution of sands to the overall sediment composition was by far the greatest across the survey area and was the principal sediment fraction at all stations but Station 94. The mean (\pm SE) proportion of sands across all stations was 93.9 ± 1.3 %, mean (\pm SE) gravel content was 4.2 ± 1.3 % and mean (\pm SE) mud content was 1.8 ± 0.2 %.

Percentage contributions of Gravel and Mud to the overall sediment composition were both very low across all stations except stations 29 and 94 which contained 41.57 % and 64.51 % Gravel respectively. These two stations are located at either end of the survey area and surrounded by stations dominated by Sand (Figure 9).

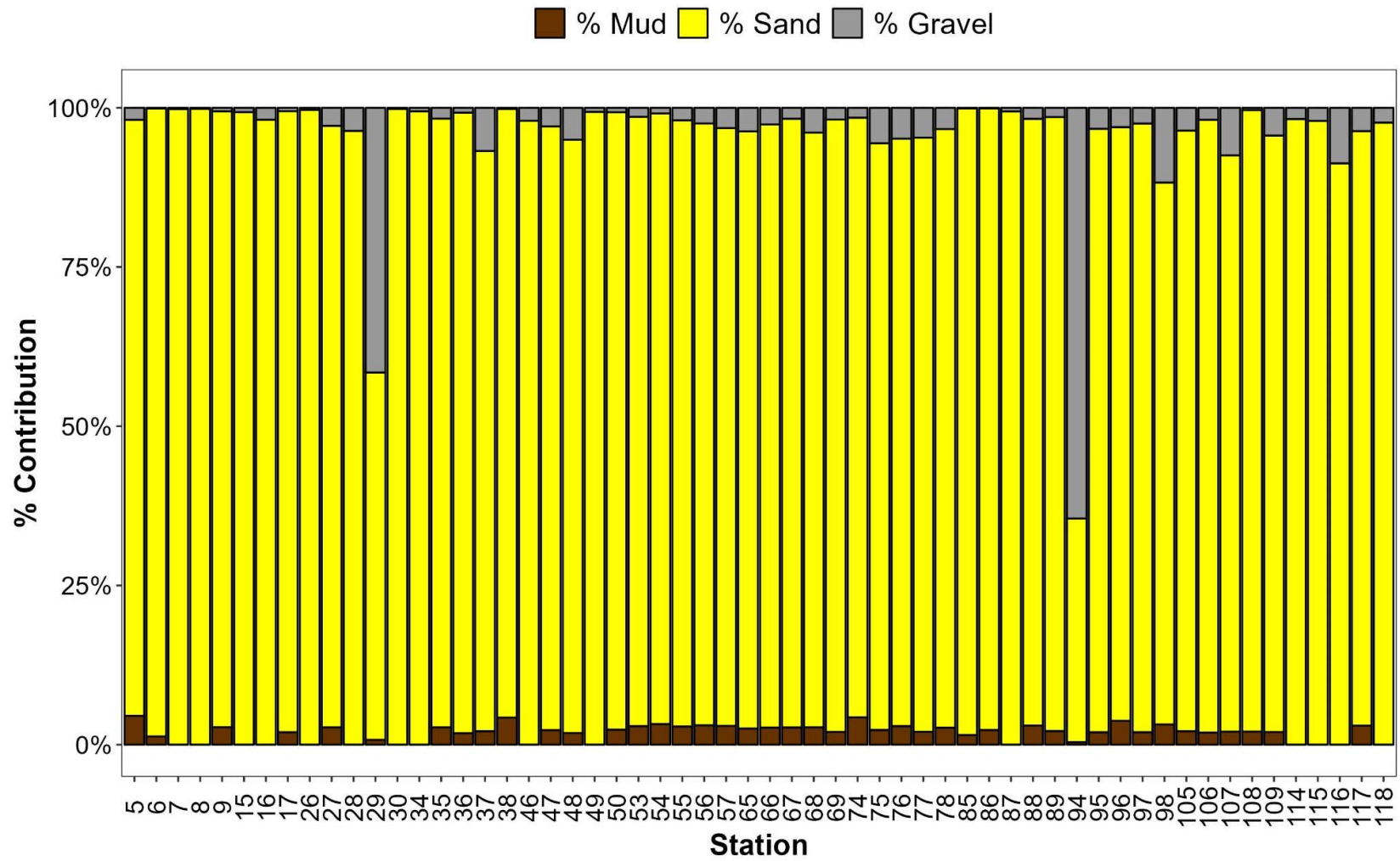


Figure 8 Principal sediment components (gravel, sand, mud) as determined from PSD analysis of samples during the survey.

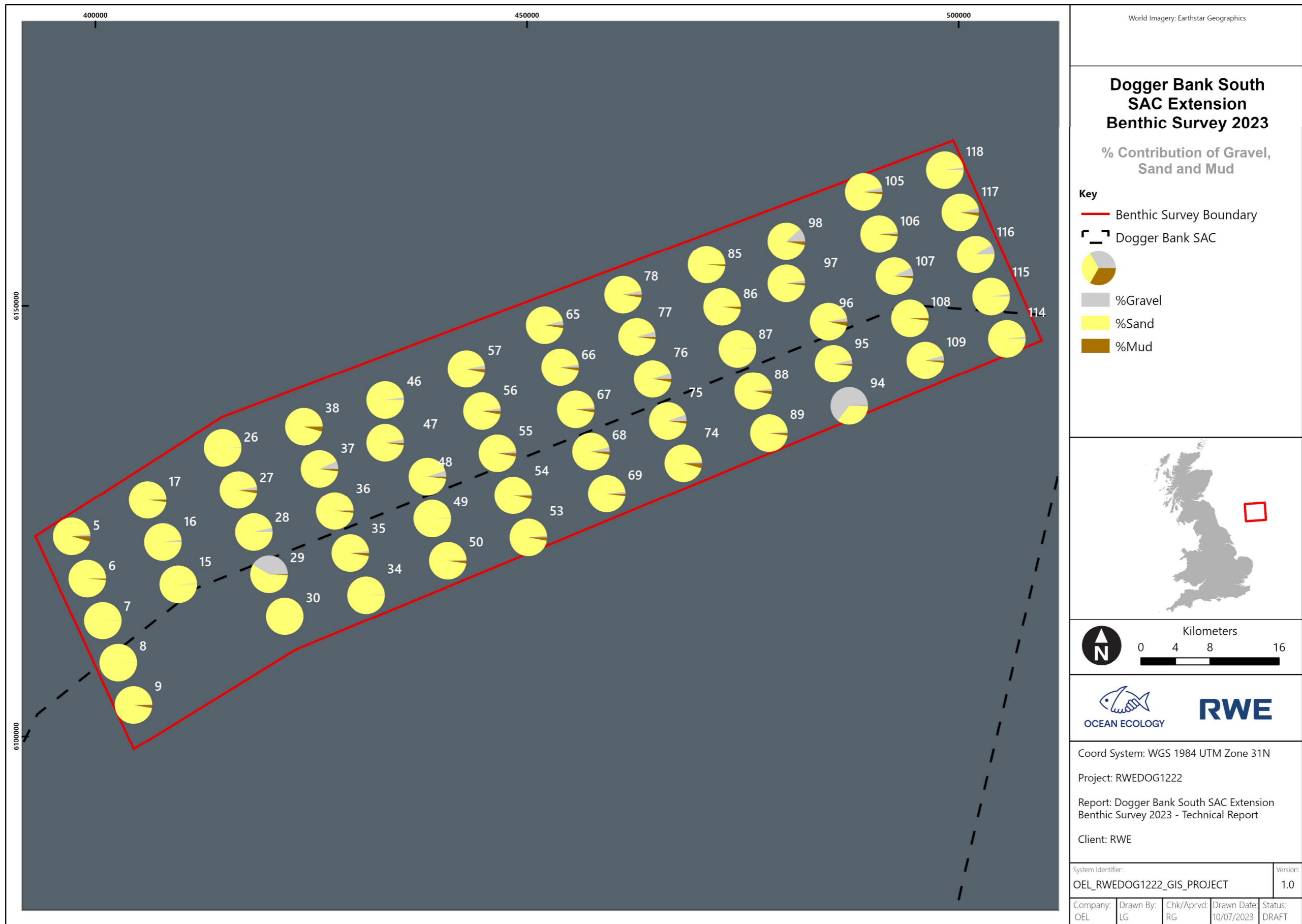


Figure 9 The principal sediment components (gravel, sand, mud) as determined from PSD analysis of samples acquired during the survey.

6.2. Macrobenthic Diversity

Fifty-eight macrobenthic samples were analysed for macrobenthic abundance, diversity and biomass. The macrobenthic assemblages of sediments sampled across the survey area constituted a mean (\pm SE) of 25 ± 1 taxa per sample. Mean (\pm SE) abundance was 58 ± 10 individuals per sample and mean (\pm SE) biomass was 1.3407 ± 0.2906 gAFDW. The full abundance and biomass matrices are provided in Appendix VII and VIII respectively, presenting the abundance of each taxon and biomass per major group (Annelida, Crustacea, Mollusca, Echinodermata and Others) in all samples collected across the survey area.

As shown in Figure 10, the polychaete *S. armiger* was the most abundant taxon sampled accounting for 6.2 % of all individuals recorded. This was closely followed by the amphipod *B. elegans* which accounted for 5.9 % of total abundance. *S. armiger* was also the most frequently occurring species appearing in 82.8 % of all samples as well as having the highest average density of 3.7 individuals per 0.1 m^2 . The polychaete *P. kefersteini* was the taxon recorded the maximum number of times in a single sample with 123 individuals recorded at station 29.

Figure 11 illustrates the relative contributions to total abundance, diversity, and biomass of the major taxonomic groups in the macrobenthic community sampled across the survey area. Annelida taxa contributed significantly to overall abundance, accounting for approximately 40 % of all individuals recorded whilst Mollusca taxa accounted for approximately 24 %. Annelida and Mollusca taxa also contributed the most to the overall diversity of the macrobenthic assemblages accounting for 32 % and 30 %, respectively. Whilst contributing the least to overall abundance (10 %), Echinodermata taxa contributed the greatest to the total biomass of macrobenthic assemblages accounting for 47 %.

The highest mean abundance was observed at station 29 ($n = 565$), followed by station 94 ($n = 321$) (Figure 12). Excluding these two stations, the mean abundance was considerably lower at $n = 44$. The highest number of taxa was also recorded at station 29 with a total of 61 different taxa identified. Biomass was greatest at station 109 with a total AFDW of 13.4323 g. This was significantly higher than the second highest biomass of 7.7919 gAFDW recorded at station 29 (Figure 12).

Figure 13, Figure 14 and Figure 15 show the distribution of the macrobenthic community abundance (N), diversity (S) and biomass sampled across the survey area. The full complement of univariate diversity indices calculated for each macrobenthic sample are presented in Appendix IX.

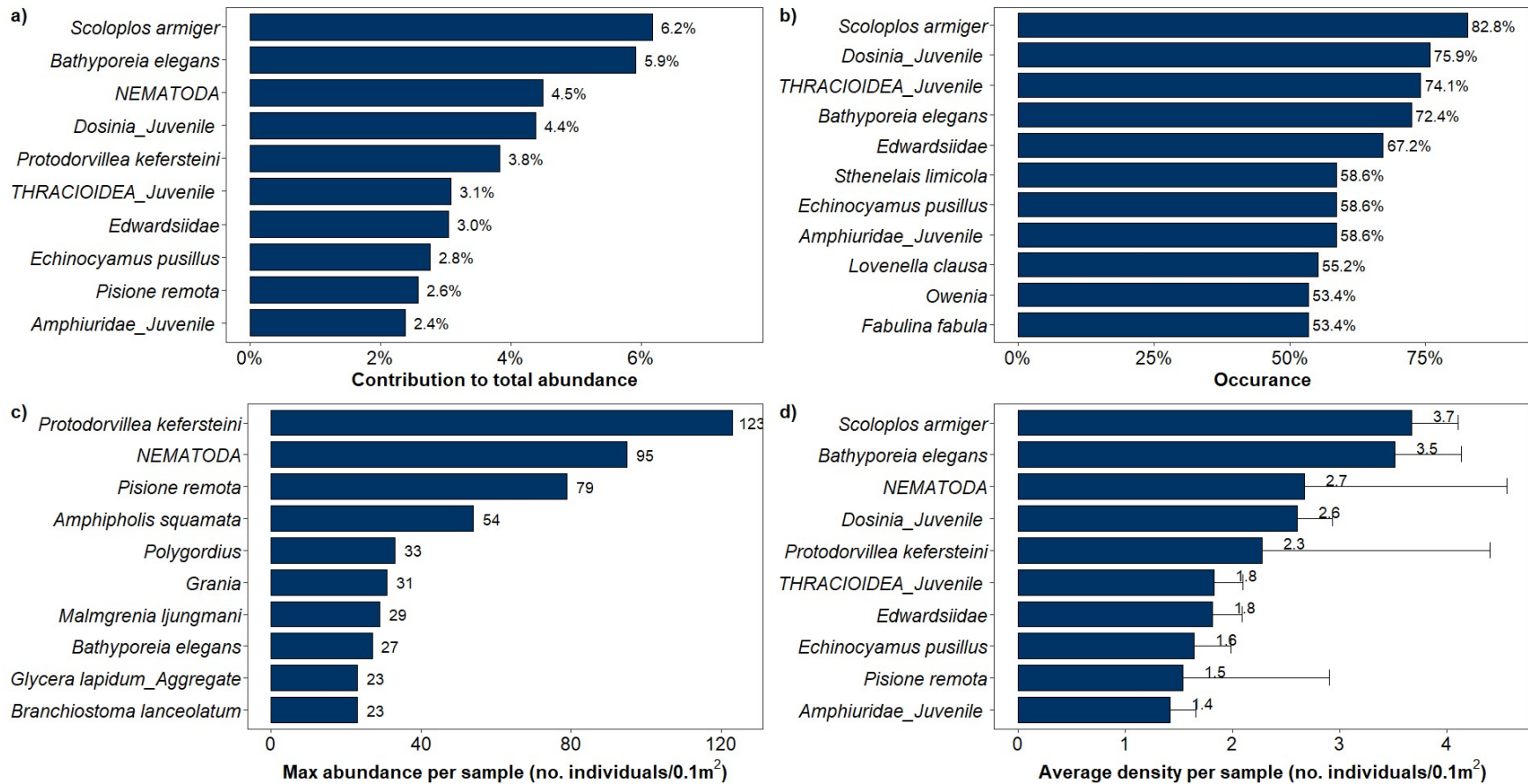


Figure 10 Percentage contributions of the top 10 macrobenthic taxa to total abundance (top left) and occurrence (top right) from samples collected during the Dogger Bank South OWF SAC Extension Benthic Survey. Also shown are the maximum densities of the top 10 taxa per sample (bottom left) and average densities of the top 10 taxa per sample (bottom right).

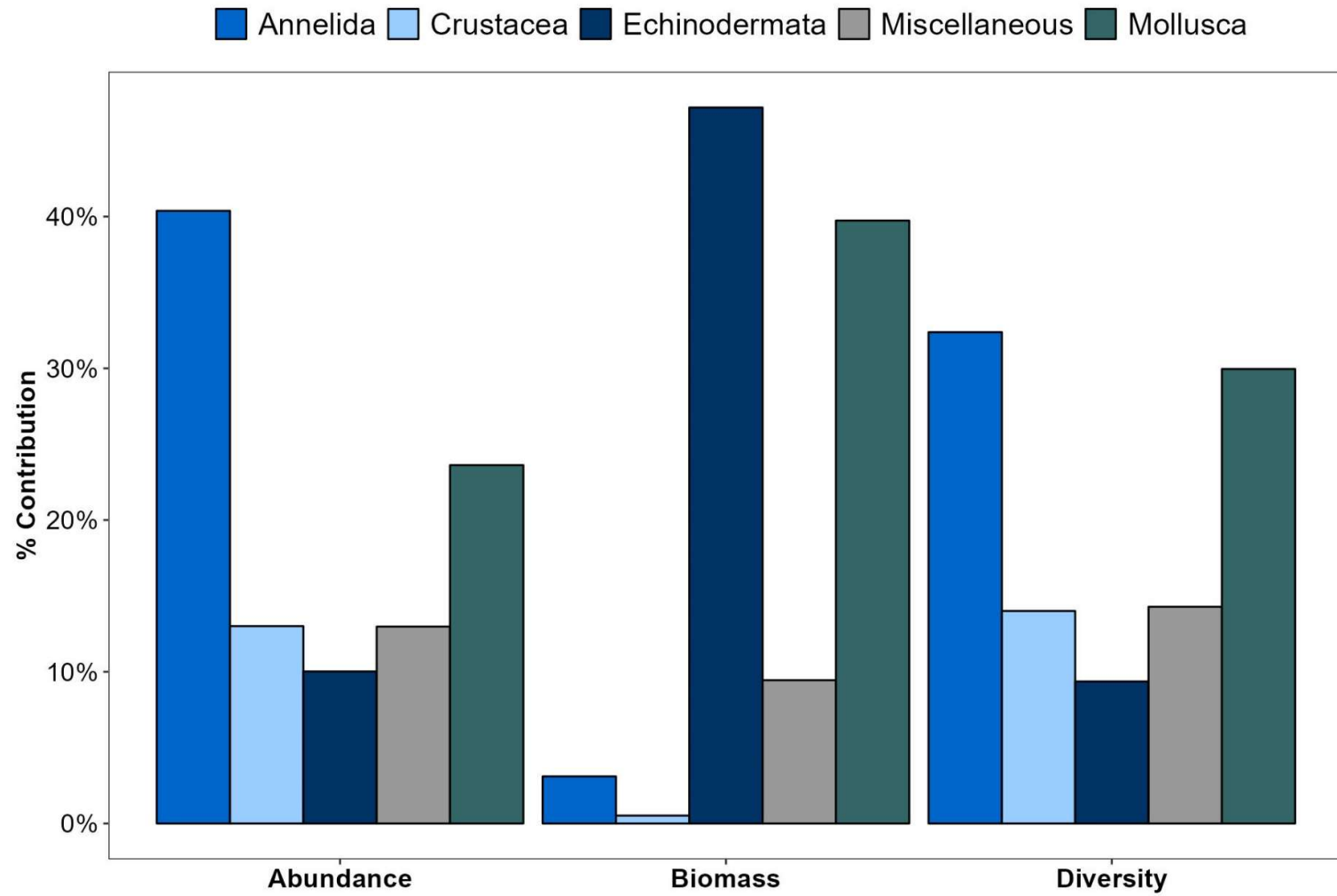


Figure 11 Relative contribution of the major taxonomic groups to the total abundance, diversity, and biomass of the macrobenthos sampled during the survey.

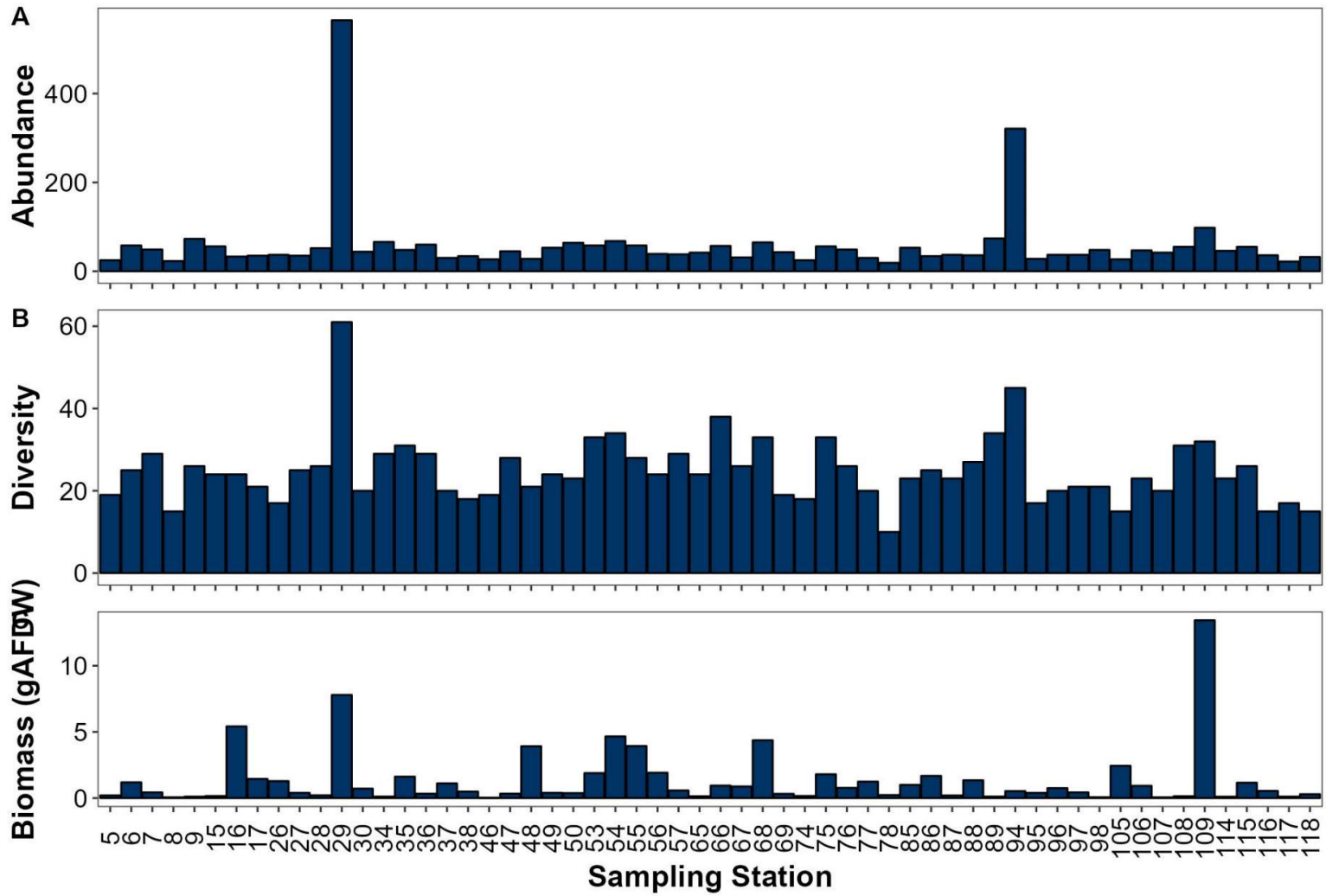


Figure 12 Abundance, diversity, and biomass (gAFDW) per station across the survey area.

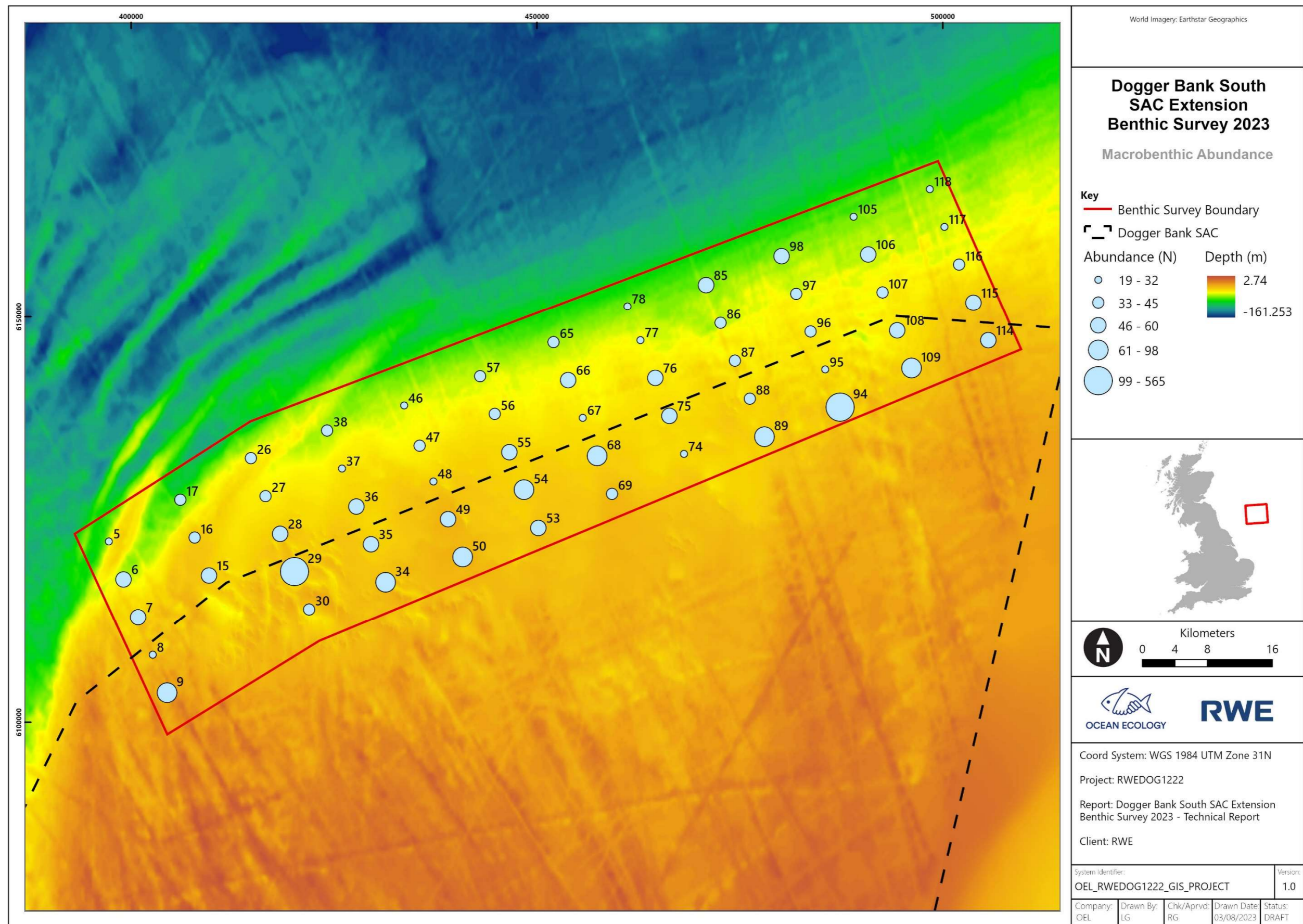


Figure 13 Macrobenthic abundance (N) per grab sampled during the survey.

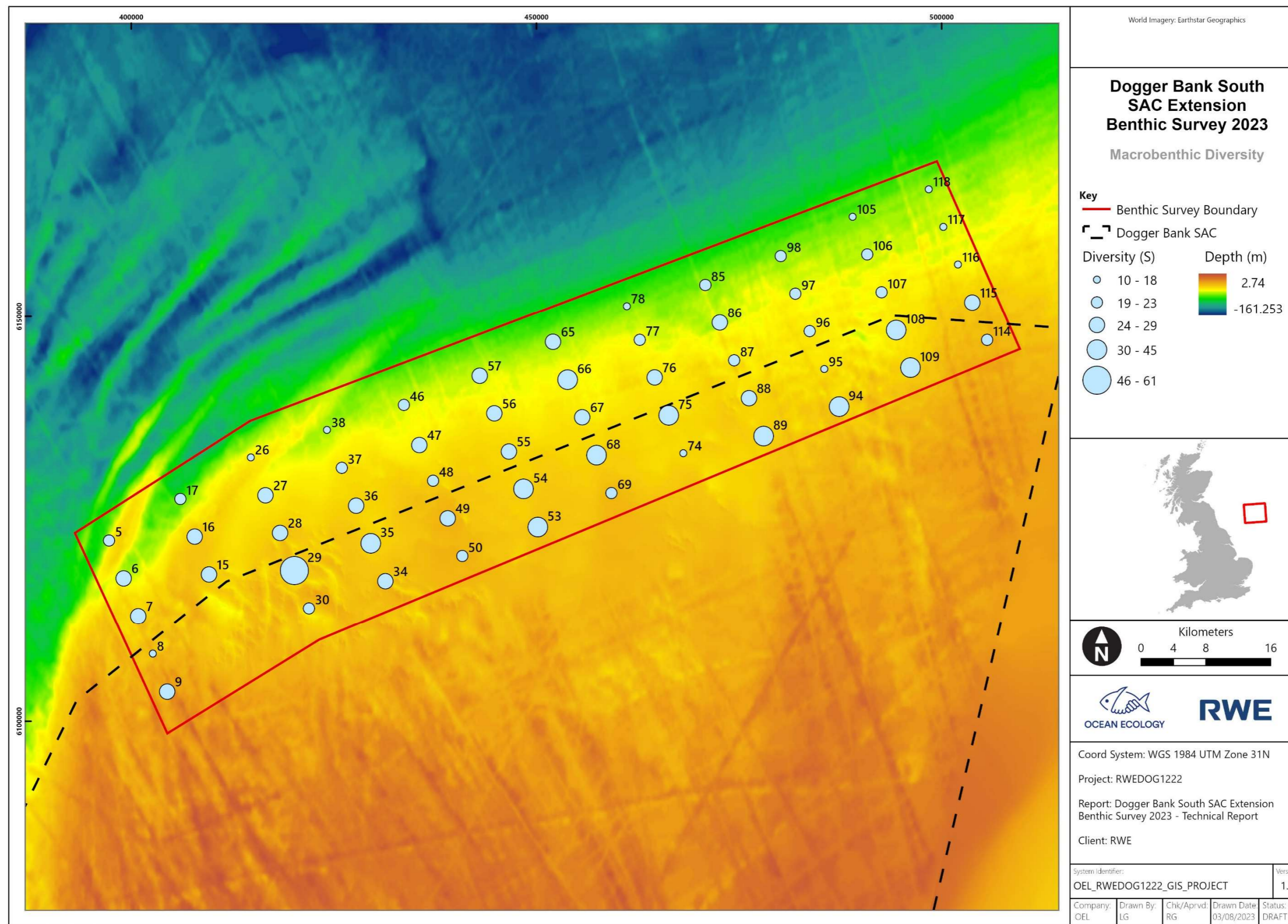


Figure 14 Macrobenthic diversity (S) per grab sampled during the survey.

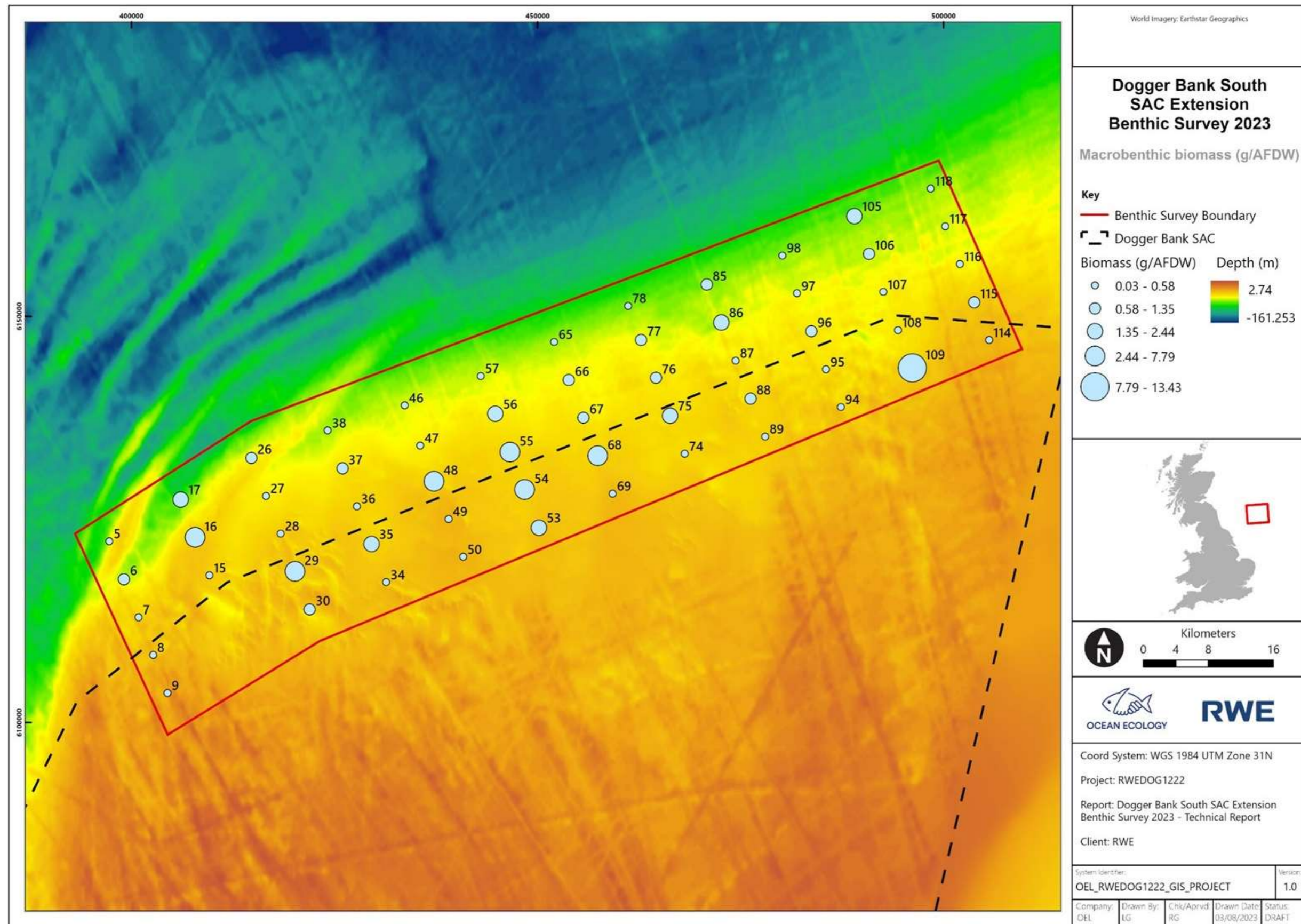


Figure 15 Macro-benthic biomass per grab sampled during the survey.

6.2.1. Macrobenthic Groupings.

Multivariate analysis was undertaken on the square-root transformed macrobenthic grab abundance data, to identify spatial distribution patterns in the macrobenthic assemblages across the survey area and identify characterising taxa present. Cluster analysis of the macrobenthic data was performed on a Bray-Curtis similarity matrix to analyse the spatial similarities in macrobenthic communities recorded across all sampled stations. The dendrogram resulting from the cluster analysis and associated Type 1 SIMPROF (similarity profile routine) permutation test of all nodes within the dendrogram, identified 7 statistically significantly similar groups ($p > 0.05$) and two outlier stations that did not belong to any group (Figure 16). The majority of samples fell within Groups F ($n = 27$) and G ($n = 14$). Groups C and B were made up of 6 and three stations respectively whilst Groups A, D and E consisted of two stations each.

To visualise the relationships between the sampled macrobenthic assemblages, an nMDS plot was generated on the community abundance data (Figure 17). The nMDS represents the relationships between the communities sampled, based on the distance between sample (station) points. The stress value of the nMDS ordination plot (0.23) indicates that the two-dimensional plot provides a reasonable representation of the similarity between stations, however caution needs to be used when interpreting patterns between and within groups. This relatively high stress value is most likely due to the presence of several groups (clusters) made only of a few stations owing to the high diversity in the macrobenthic community observed across the survey area. In general, the degree of clustering of intra-group sample points demonstrates the level of within group similarity (e.g., points within Macrobenthic Group F show distinct clustering), whilst the degree of overlap of inter-group sample points is indicative of the level of similarity between different Macrobenthic Groups (e.g., Macrobenthic Groups F and G).

Macrobenthic groups are mapped in Figure 18 to further visualise spatial trends.

SIMPER (similarity percentage analysis) was used to identify the key taxa contributing to the within group similarity of each of the 7 macrobenthic groups; the full SIMPER results are provided in Appendix X.

Macrobenthic Group A (2 stations) - Characterising taxa present at the two stations (Stations 29 and 94) in this group were species belonging to the phyla Nematoda, Annelids of the genus *Grania*, as well as the Polychaete *Glycera lapidum* (aggregate). Average similarity of samples within this group was 51.58 %.

Macrobenthic Group B (3 stations) – The taxa contributing most to similarities between the three sampling stations (Stations 8, 15 and 26) within this group (average similarity: 45.49 %) were the bivalve *Cochlodesma praetenuae*, the genus of catworm *Nephtys* (juveniles) and the sand-hopper *B. elegans*.

Macrobenthic Group C (6 stations) – Dominant taxa contributing within this group were the armoured bristleworm, *S. armiger*, and the family of sea anemone, Edwardsiidae. The within group average similarity was 37.07%.

Macrobenthic Group D (2 stations) – Characterising taxa present at the two stations (Stations 5 and 46) belonging to this group (average similarity 46.95 %) were the amphipod *Harpinia antennaria* and *S. armiger*.

Macrobenthic Group E (2 stations) – Key taxa contributing to the within group average similarity of 43.78 % were juvenile clams of the genus *Dosinia*, and juveniles belong to the superfamily of bivalves, Thracioidea. Stations 74 and 95 belonged to this group.

Macrobenthic Group F (27 stations) – Characterising taxa present at the stations belonging to this group were *S. armiger*, juvenile bivalves of the genus *Dosinia* and superfamily Thracioidea and *B. elegans*. Average similarity of this group was 40.56 %.

Macrobenthic Group G (14 stations) – The taxa contributing most to similarities between the sampling stations within this group (average similarity: 40.12 %) were *B. elegans*, juvenile clams of the genus *Dosinia*, the amphipod, *B. guilliamsoniana*, and juvenile brittlestars belonging to the family Amphiuridae.

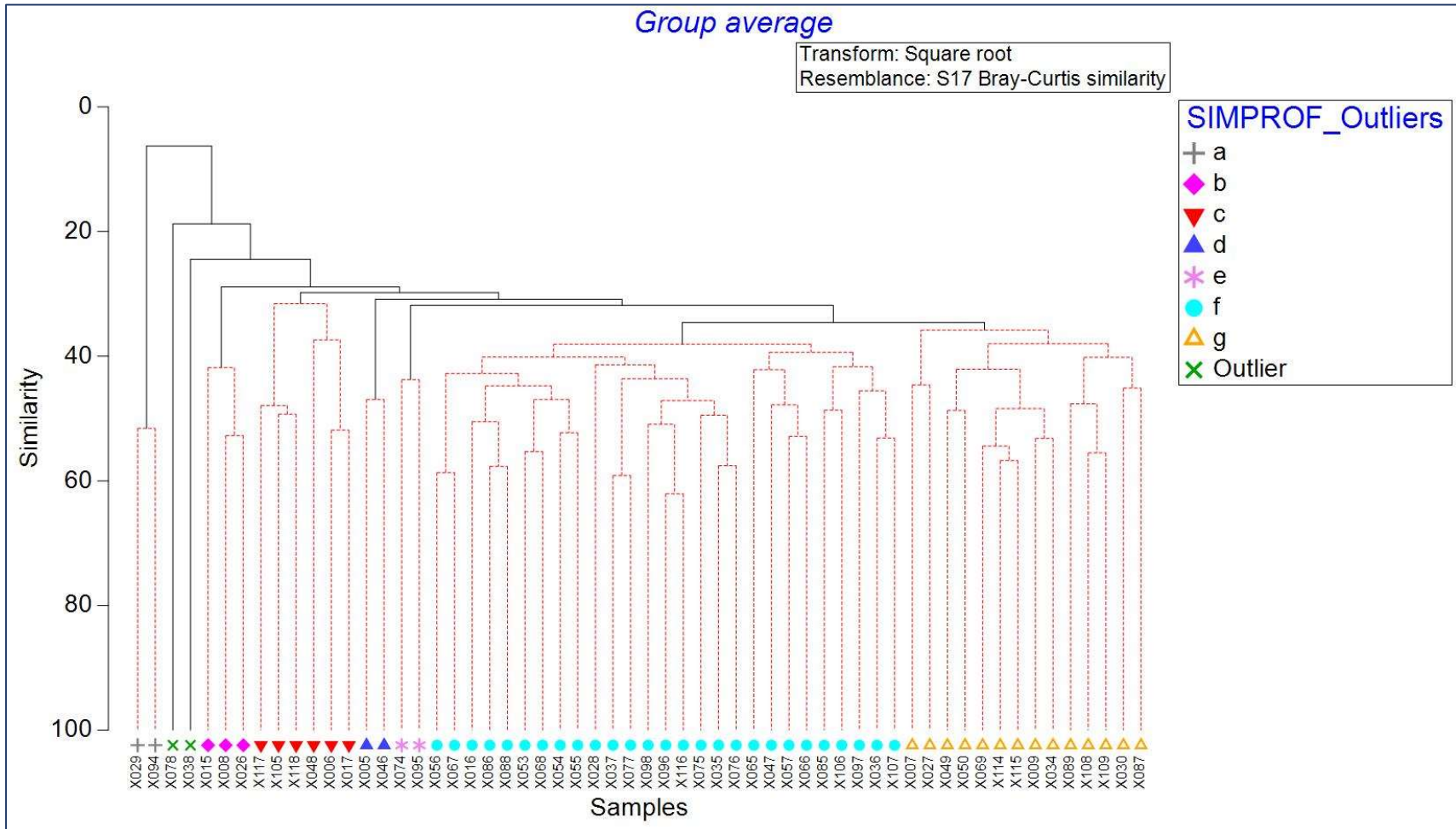


Figure 16 Dendrogram resulting from cluster analysis and associated Type 1 SIMPROF permutation analysis of macrobenthic abundance data.

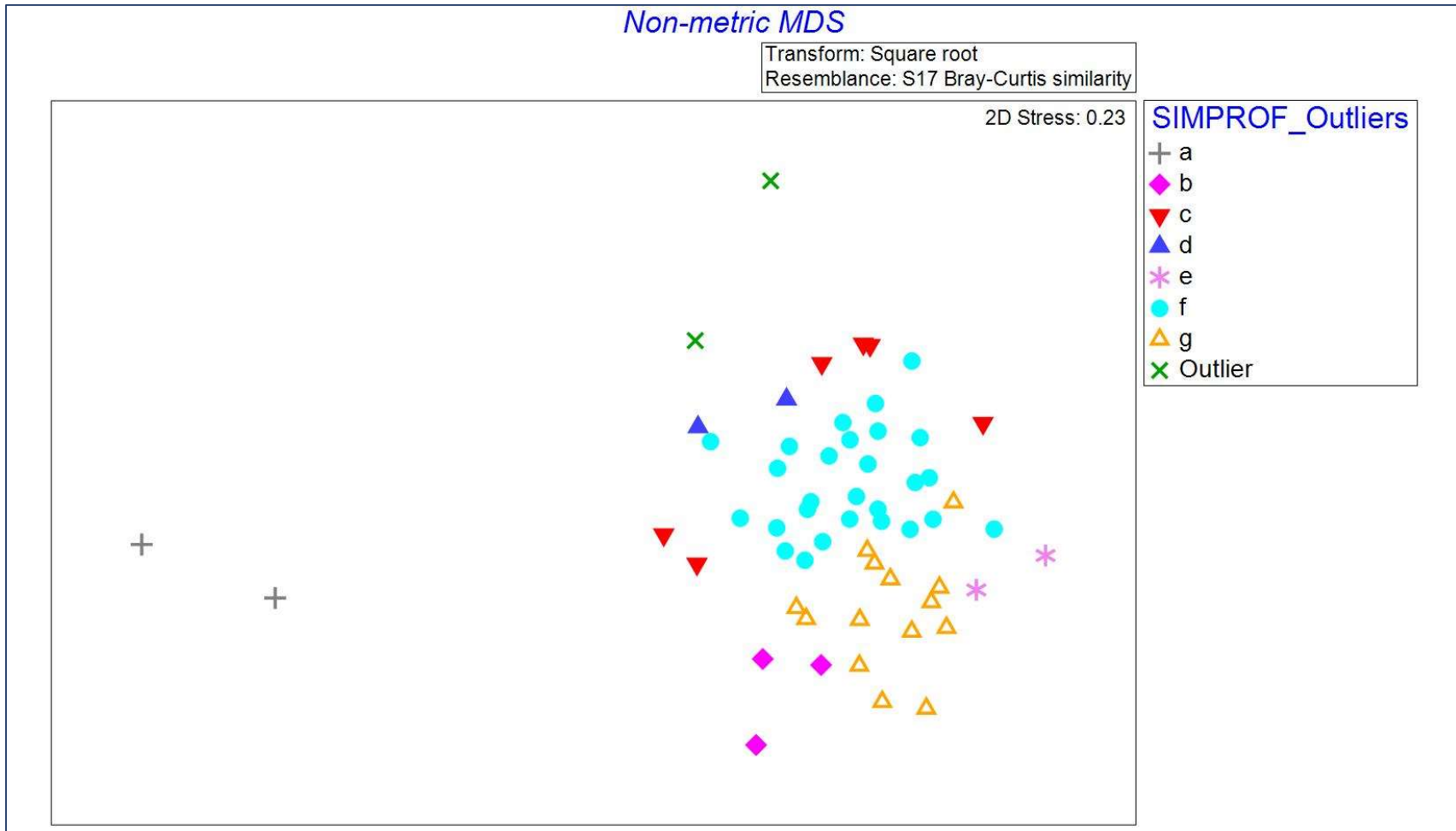


Figure 17 Non-metric MDS ordination plot of square root transformed macrobenthic data based on Bray Curtis similarity of grab samples collected during the survey.

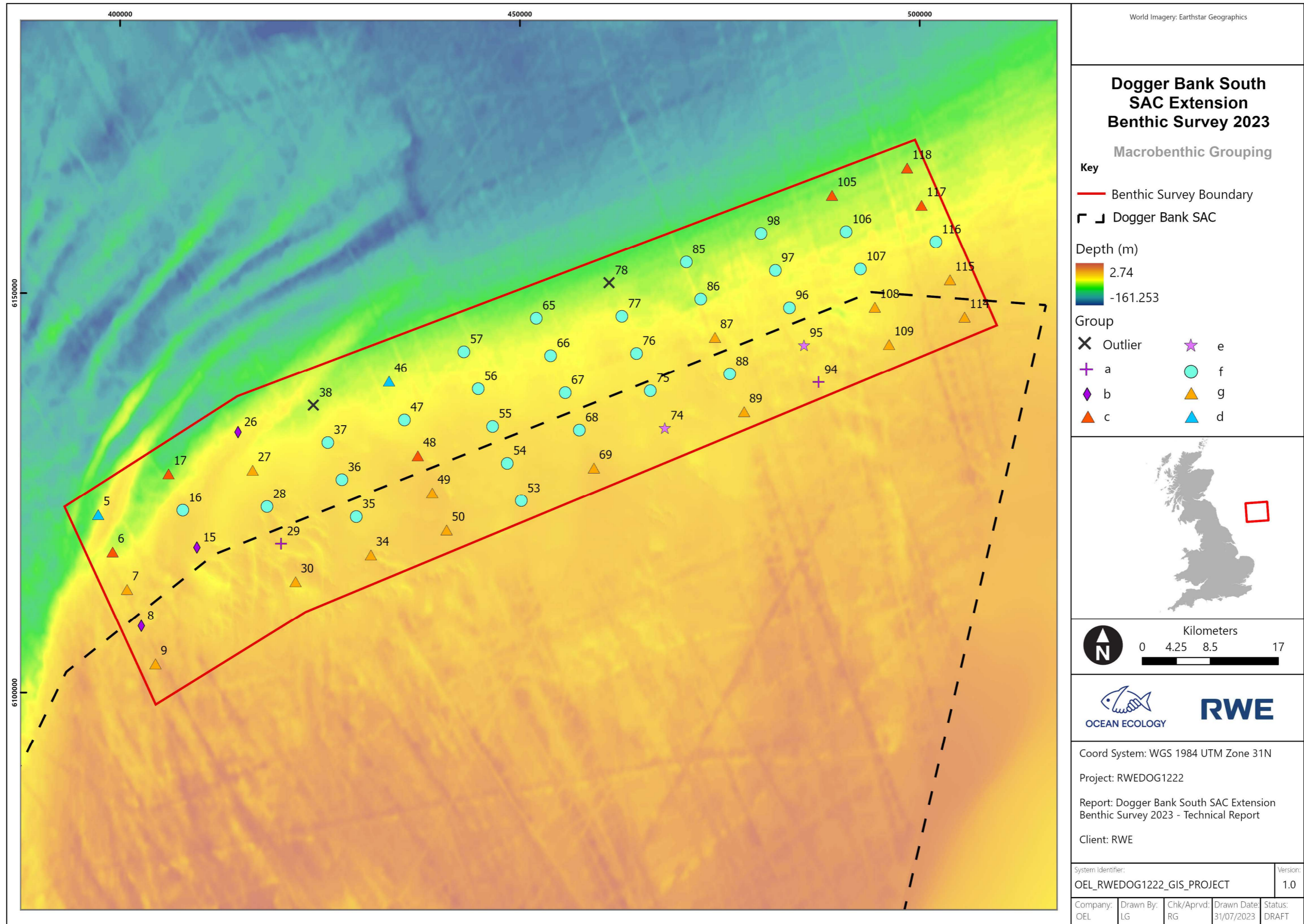


Figure 18 Macrobenthic groupings derived from cluster analysis and associated Type 1 SIMPROF permutation analysis of macrobenthic abundance data.

6.3. Biotope Assignment

For each of the Macrobenthic groups determined using cluster analysis, habitats and biotopes were assigned in considerations with JNCC guidance based upon their faunal and physical characteristics (Parry 2019). The spatial distribution of the habitat and biotopes encountered across the survey area is mapped in Figure 19.

All outlier stations were assigned to their corresponding BSH based on sediment analysis as the macrobenthic multivariate analysis did not show any pattern in the community composition that could be used to assign a biotope. Similarly, macrobenthic Groups C and E were assigned to level 4 EUNIS classifications as their macrobenthic assemblages were not dominated by any key taxa typically associated to any higher resolution biotopes. Therefore, macrobenthic Group C most closely aligned with either EUNIS level 4 habitat "A5.25 Circalittoral fine sand" or "A5.27 Deep circalittoral sand", whilst macrobenthic Group E also best aligned with EUNIS level 4 habitat "A5.27 Deep circalittoral sand".

The biotope "A5.145 *Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel" most closely aligned with the community observed in Group A. This biotope is described as typical of circalittoral coarse sand with shell gravel, aligning with EUSeaMap predicted habitats, sediment PSD data analysis and seabed imagery which clearly show coarse sand/gravel and shell fragments. Additionally, key characterising taxa of this biotope are a significant population of *B. lanceolatum* as well as *G. lapidum*, *Polygordius* and *Pisione remota*, all of which were present in samples within macrobenthic Group A.

Macrobenthic Group B most closely aligned with the biotope "A5.252 *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand". This biotope is described as circalittoral and offshore medium to fine sands between 25 m and 100 m which is consistent with sediment PSD data for this site which describes all stations within this group as "A5.2 Sand and Muddy Sand". The macrobenthic community of this biotope is characterised by the bivalve *A. prismatica* (which was present in this group although not dominant), the amphipod *B. elegans* and polychaetes such as *S. bombyx* and *Nephtys* sp. which were all driving community average similarity within this group.

The biotope most closely aligning with macrobenthic Group D was "A5.252 *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand" which is typically found in circalittoral and offshore medium to fine sands between 25 m and 100 m. This aligns with sediment PSD data but differs slightly from the predicted habitats derived from EUSea mapping which suggests these stations fall within the level 4 EUNIS classification "A5.27 Deep circalittoral sand". Whilst one of the key defining species of this biotope, *A. prismatica*, was not present in samples, *B. elegans* and *S. armiger* were among the main species driving similarity in this group and are named as key taxa in this biotope.

Macrobenthic Group F is the largest of the 7, consisting of 27 stations. PSA data suggests that the majority of the stations within this group belong to the BSH "A5.2 Sand and Muddy Sand" with 5 stations belong to the BSH "A5.1 Coarse Sediment". The biotope most closely matching this group is "A5.252 *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand". It is found in circalittoral medium to fine sands between 25 m and 100 m, and whilst one of the key characterising taxa, *A. prismatica* was not found in samples, *B. elegans* was one of the main species accounting for similarity within this group. Other taxa characteristic of this biotope were also found in samples collected from this group of stations including *S. bombyx*, *Echinocyamus pusillus*, *Chaetozone christiei*, *F. fabula* and *S. armiger*.

Macrobenthic Group G most closely aligns with the infralittoral sand biotope "A5.233 *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand". Whilst EUSea mapping suggests that stations within this group are circalittoral sands, this biotope has been recorded to at least 30 m. All stations in this group were at depths < 40 m. The key characterising taxa of this biotope are *N. cirrosa* and *Bathyporeia* spp of which two species within this genus were recorded (*B. elegans* and *B. guilliamsoniana*). *Magelona johnstoni* and *Magelona filiformis* are also characterising taxa of this biotope, both of which were found to drive similarity within this group.

6.4. Notable Taxa

Three taxa of interest were identified from the 58 grab samples collected across the survey area.

The Ross worm *S. spinulosa* is a protected species when occurring in reef form under the OSPAR list of threatened and/or declining species and habitats (2008) and as an Annex I species under the EU Habitat Directive. The latter directive has been transposed into UK law under the Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended)¹. Just two individuals were recorded at the two gravel dominated stations (Stations 29 and 94). Seabed imagery analysis showed no sign of reef forming structures at these locations (Section 6.5).

The Ocean quahog, *A. islandica*, is listed as a Species of Principal Importance in England (section 41) and Wales (section 42) under the Natural Environment and Rural Communities Act (2006) and is also protected under the OSPAR List of Threatened and/or Declining Species and Habitats (2008). One individual and 16 juveniles were recorded across the survey area.

One Mollusca taxa belonging to the family of clams Veneridae was identified and is designated as an economically important taxon. Two individuals were recorded.

No invasive or non-native species (INNS) were identified in samples collected from the survey area.

¹ The Conservation of Offshore Marine Habitats and Species Regulations 2017 have been amended by The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019 to implement the necessary changes following the UK leaving the EU.

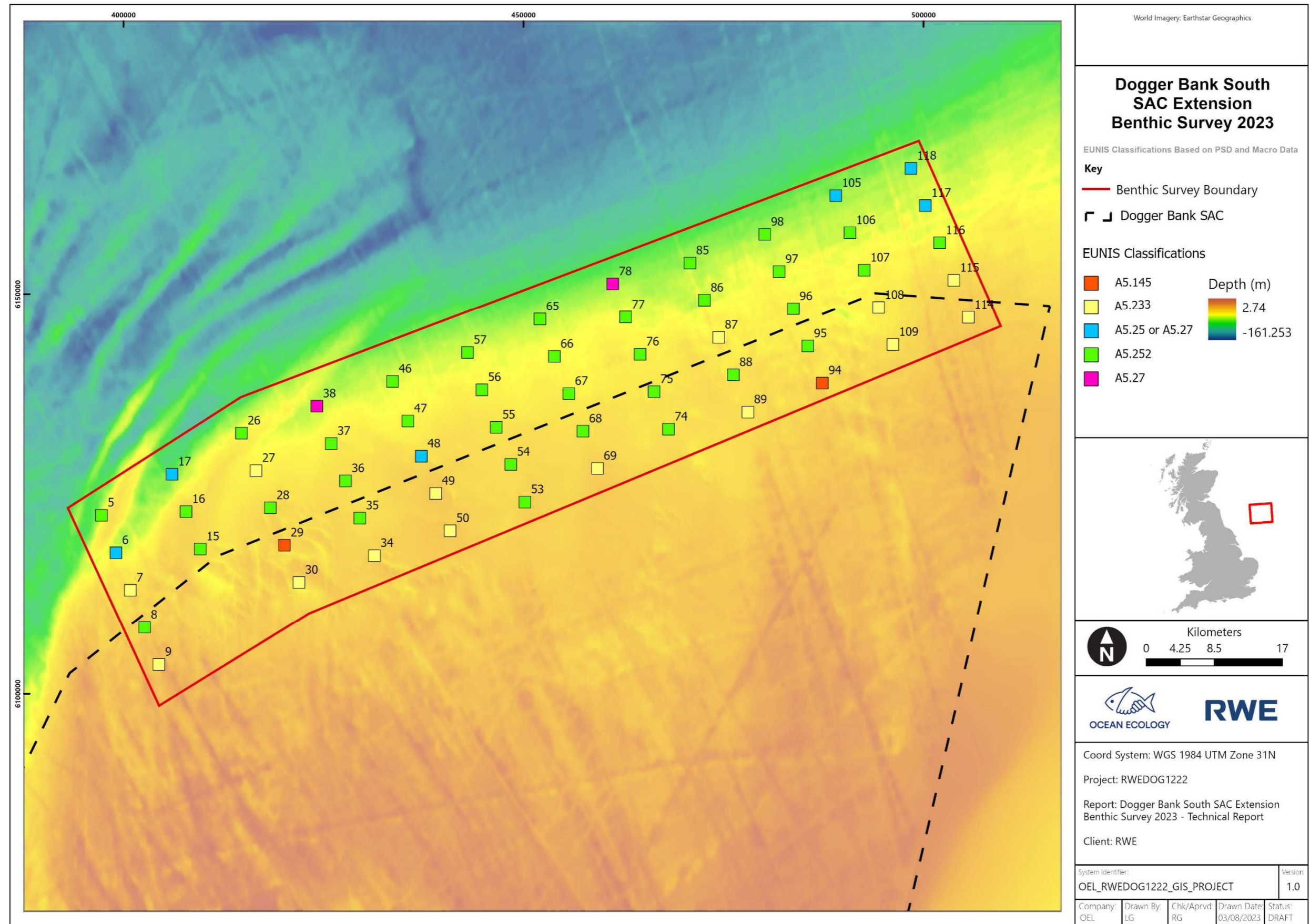


Figure 19 Spatial distribution of habitat and biotopes identified across the survey area based on macrobenthic and sediment analysis

6.5. Imagery Analysis

Seabed imagery was obtained for the purpose of *in situ* screening of stations by completing a visual inspection for protected or sensitive habitats (e.g., potential Annex I Reef) and other ecological, heritage, or safety hazards. Analysis of the digital stills and video footage was therefore not required. DDC field logs can be found in Appendix II.

7. Discussion

This report presents the interpretation of the macrobenthic and sediment data with the aim of providing information on the character of the benthos across the DBS survey area and assisting with the consenting processes for the project. The results of this study are further interrogated below to assess whether the infaunal communities identified are similar to those described by Wieking & Kröncke (2003) and Diesing et al. (2009).

7.1. Sediments

Despite some subtle variation in sediment types between stations, all but two stations (Stations 29 and 94) were dominated by sand. Mud content was very low across the survey area with no stations exceeding 5 % of the overall sediment composition. Aside from station 94 which was dominated by gravel (64.51 %) and Station 29 which also had high gravel content (41.57 %), gravel content was generally low, with no other stations exceeding 12 %. Both stations with higher gravel content were within the boundary of the Dogger Bank SAC and known area of Annex I Sandbank.

The majority of samples were comprised of sand (S) and slightly gravelly sand ((g)S) representing EUNIS BSH A5.2 Sand and Muddy Sand. Some stations were classified as Sandy Gravel (sG) or Gravelly Sand (gS) representing EUNIS BSH A5.1 (coarse sediment). Stations representative of EUNIS BSH A5.1 were distributed throughout the survey area both within and outside of the Dogger Bank SAC boundary. These sublittoral sediment types may represent 'subtidal sands and gravels' which is listed as a habitat of principal importance under Section 41 of the Natural Environment and Rural Communities Act 2006. To note that this habitat is among the most common habitats found below mean low water springs (MLWS) around the coast of the UK.

All sediments recorded as sand or slightly gravelly sand were classified as well sorted or moderately well sorted, whilst sediments classified as sandy gravel and gravelly sand were mostly all classed as poorly sorted. This is due to large variations in sediment sizes within the mixed sediments, with larger gravels mixed with finer sands (as seen in Plate 4 and Appendix IV).

7.2. Macrobenthos

A diverse macrobenthic assemblage was identified across the survey area from 58 macrobenthic samples collected, with a total of 3,383 individuals and 200 taxa recorded. The most abundant and frequent taxon sampled with the greatest average density per sample was the Bristle worm *S. armiger*. Other key taxa included the amphipod *B. elegans* which contributed to 5.9 % of the total abundance, and the polychaete *P. kefersteini* which was recorded the maximum number of times in one sample. Annelida taxa contributed the most to abundance and overall diversity of the macrobenthic assemblages, whilst Echinodermata and Mollusca taxa dominated the biomass, accounting for approximately 87 % of the total biomass.

Macrobenthic communities can be highly heterogenous as they are heavily influenced by ambient environmental conditions such as sediment composition (Cooper et al. 2011), hydrodynamic forces and physical disturbance (Hall 1994), depth (Ellingsen 2002), and salinity (Thorson 1966). Multivariate analysis on macrobenthic data identified 7 macrobenthic groups and two outlier stations across the Dogger Bank SAC Extension survey area. The majority of stations fell within macrobenthic Groups F and G accounting for 41 of the 58 macrobenthic sampling stations. This suggests that macrobenthic diversity was evenly distributed across the survey area. Macrobenthic groups G, A and E showed some distinction from other macrobenthic groups, with the majority of stations falling within the boundary of the Dogger Bank SAC and area of known Annex I Sand Bank in the shallower region of the survey area. Grouping of Stations 29 and 94 (macrobenthic Group A) was clearly reflected by the sediment composition of these two stations which both showed significantly higher gravel content than other stations. This difference in sediment type to other stations was also reflected in the macrobenthic community which was characterised by the presence of fauna such as *G. lapidum* which has previously been described as characteristic of gravelly regions of the Dogger Bank (Degraer et al. 2006, Diesing et al. 2009).

Three notable taxa were identified across the survey area. These included the OSPAR threatened and/or declining species Ross worm (*S. spinulosa*) (however there were no sign of reef forming structures observed) as well as the Ocean quahog *A. islandica*, particularly as juveniles. One Economically Important Species was also recorded: clams of Veneridae family.

7.3. EUNIS Habitats/Biotopes

PSD data clearly indicated the dominance of sandy sediments across the survey area with some areas of coarse (A5.1) sediments throughout. This was corroborated by macrobenthic data which suggested that whilst there were significant differences between macrobenthic groupings, the majority of stations closely aligned with the biotope "A5.252 *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand". The assignment of this biotope to macrobenthic Groups B, D and F further highlights the even distribution of macrobenthic diversity across the survey area. Macrobenthic Group G most closely aligned with the infralittoral sand biotope "A5.233 *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand".

Whilst EUSea mapping suggests that stations within this group belonged to the level 4 EUNIS code circalittoral fine sands, the macrobenthic community was more typical of this infralittoral biotope. This group of stations were mostly located in the shallower region of the survey area, within the boundary of the Dogger Bank SAC and areas of known Annex I Sandbank.

7.4. Comparisons to Weiking and Kroncke (2003) and Diesing et al (2009)

It is thought that macrobenthic communities within the survey area may be similar to those described as the North-Eastern community (Wieking & Kröncke 2003) and/or communities K and J (Diesing et al. 2009) within previous studies of the Dogger Bank SAC.

The North-Eastern community as described by (Wieking & Kröncke 2003) was dominated by *S. bombyx*, *B. elegans* and *S. armiger*. Both *B. elegans* and *S. armiger* were amongst the most abundant taxa recorded during the Dogger Bank SAC extension survey, accounting for 12.1 % of total abundance and occurring in the highest densities across all samples. Whilst *S. bombyx* was not amongst the most abundant taxa, 40 individuals were recorded within samples.

Similarities can be drawn between macrobenthic Group G, the Bank community as described in Wieking & Kröncke (2003) and Group K observed in Diesing et al. (2009). The two amphipod species *B. elegans* and *B. guilliamsoniana* as well as the burrowing bivalve *F. fabula* were present in all groups as well as taxa belonging to the genus *Magelona*. A key difference between these groups however was that *S. bombyx* dominated the Bank community but was not found to drive similarity within Group G of the present study.

Some similarities were also observed between macrobenthic Group F and the North-Eastern community described in Wieking & Kröncke (2003). *S. bombyx*, *B. elegans* and *S. armiger* were present in abundance in both groups along with taxa belonging to the genus of clam *Dosinia* and family of sea anemones Edwardsiidae.

No similarities were found between macrobenthic group J described in Diesing et al. (2009) and the present study. Macrobenthic group J is described as being characterised by species more commonly associated with siltier sediments such as *S. armiger*, *Galathowenia oculate*, *Goniada maculata* and the burrowing bivalves *Thyasira flexuosa* and *Lucinoma borealis*. With the exception of *S. armiger*, none of these taxa were key species in any of the present macrobenthic groups.

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