Offshore Wind Power Limited

West of Orkney Windfarm Offshore EIA Report

Volume 2, Supporting Study 4: Benthic Subtidal and Intertidal Baseline Report

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CONTENTS

1 INTRODUCTION

The Applicant, Offshore Wind Power Limited (OWPL) is proposing the development of the West of Orkney Windfarm ('the Project'), an Offshore Wind Farm (OWF), located approximately 23 kilometres (km) from the north coast of Scotland and 28 km from the west coast of Hoy, Orkney. Crown Estate Scotland awarded OWPL the Option Agreement Area (OAA) in January 2022 for the development of the proposed Project following the ScotWind leasing round which began in June 2020.

The OAA lies wholly within the "N1" Plan Option (PO), which is one of 15 PO areas around Scotland which the Scottish Government considered suitable for the development of commercial scale OWFs. The Scottish Government published the Sectoral Marine Plan for Offshore Wind Energy in October 2020 following over two years of extensive analysis, consideration and engagement with a wide range of stakeholders.

The purpose of this Benthic Subtidal and Intertidal Ecology Baseline Report ('this Report') is to provide a detailed review of publicly available data sources and site specific survey data for the offshore Project[1]. This Report feeds into the Offshore Environmental Impact Assessment (EIA) Report chapter 10: Benthic subtidal and intertidal ecology.

[1] *The 'offshore Project' encompasses all offshore components seaward of Mean High Water springs (MHWS) (Wind Turbine Generators (WTG), cables, foundations, Offshore Substation Platforms (OSPs) and all other associated infrastructure) and all Project stages from development to decommissioning.*

2 STUDY AREA

The study area, as shown in Figure 2-1, has been defined by:

- The offshore Project area - the area that will encompass the offshore infrastructure, including Wind Turbine Generators (WTGs) and associated foundations and substructures, the Offshore Substation Platforms (OSPs) and associated foundations, the inter-array cables and interconnector cables all within the OAA, and offshore export cables within the offshore Export Cable Corridor (ECC); and
- A larger area established using a 10 km buffer around the OAA and a 15 km buffer around the offshore ECC to take into account areas adjacent to the offshore Project area that may be affected by indirect impacts, such as sediment suspension and resettlement.

The buffers around the offshore Project area are based on the mean spring tidal excursion distance from the United Kingdom (UK) Atlas of Marine Renewable Energy Resources meso-scale model (ABPmer, 2008). Different buffer distances have been applied to the OAA and offshore ECC to account for the variation in the tidal excursion distance between the OAA and the offshore ECC. The proximity of the offshore ECC to faster and stronger flows through the Pentland Firth between the Scottish mainland and Orkney Islands accounts for the larger excursion distance for the offshore ECC.

The OAA encompasses two banks, Stormy Bank and Whitten Head Bank with a deeper channel between the two. The study area also includes the intertidal area along the Caithness coast which takes into account the offshore export cables landfall areas at Greeny Geo and Crosskirk where intertidal habitat assessments have been undertaken.

Where appropriate, a larger impact area has been considered, for example, in relation to the potential introduction of Invasive Non-native Species (INNS).

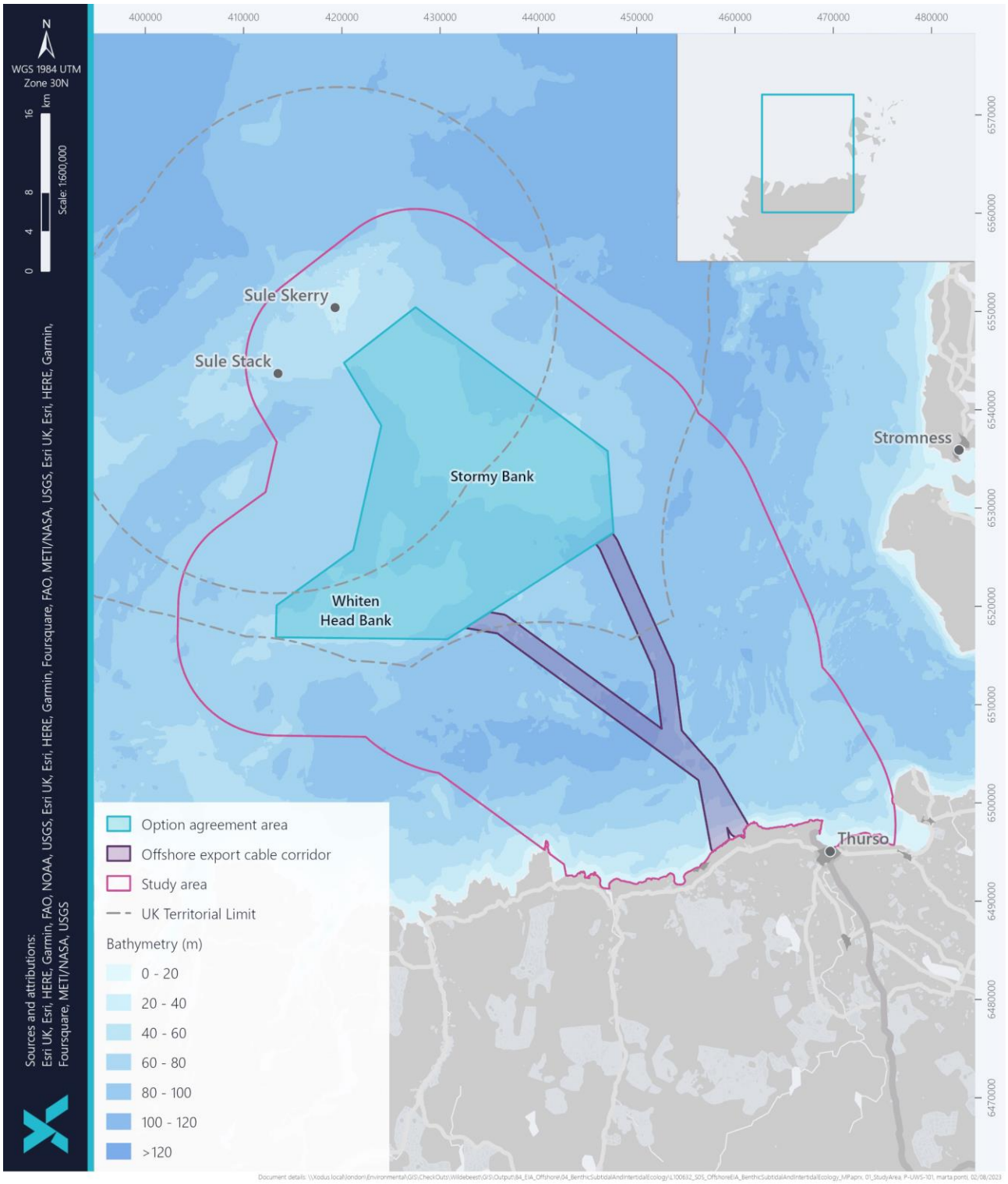


Figure 2-1 Benthic subtidal and intertidal ecology offshore study area

3 CONSULTATION

A number of benthic subtidal and intertidal ecology consultation meetings have taken place to inform the relevant key stakeholders on the approach to the benthic ecology surveys and results. The consultation meetings are detailed in Table 3-1.

Table 3-1 Summary of relevant consultation meetings

CONSULTATION MEETING	DATE HELD	KEY POINTS OF DISCUSSION
NatureScot and Marine Planning and Marine, OIC	29th June 2022	Details were provided of the geotechnical, geophysical and benthic surveys that had already been undertaken, together with the plans and approaches for further surveys.
NatureScot	7th February 2023	The aims of this meeting were to: • Present findings of the benthic survey; and • Present how areas of potential Annex I Stony reef have been qualified, the analysis approach, and next steps. As agreed, written questions were sent to NatureScot on 7th February following the meeting, and NatureScot responded on 28th February.
NatureScot	24th May 2023	An overview of the assessment of effects on Annex I habitats was provided, focussing on impacts to the seabed such as temporary habitats loss / disturbance, sediment deposition and long-term loss or damage to benthic habitats and species.

4 LEGISLATION AND POLICY

4.1 Legislation

- Marine (Scotland) Act 2010 and Marine and Coastal Access Act 2009: The Marine (Scotland) Act 2010, which applies to Scottish Territorial Waters (between 0 and 12 nautical miles (nm) from Mean High Water Springs (MHWS)) and the Marine and Coastal Access Act 2009, which applies between the 12 and 200 nm limit, provides provisions around marine planning, marine licensing and marine protection and enhancement. Under the two acts, a Marine Licence is required to construct, alter or improve any works, or deposit any object in or over the sea, or on or under the seabed. As the offshore Project is both within and beyond the 12 nm limit, a Marine Licence under both sets of legislation will be required to deposit project components in/on the seabed. It defines powers to designate Nature Conservation Marine Protected Areas (NCMPAs) for marine flora, fauna, and marine habitats.
- Nature Conservation (Scotland) Act 2004 (as amended): Ensures public bodies in Scotland have a duty to further the conservation of biodiversity.
- The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended): Implements species protection requirements of the European Union (EU) Habitats Directive (as detailed in chapter 3: Planning policy and legislative context of the Offshore EIA Report) in Scotland, on land and inshore waters up to the 12 nm limit).
- The Offshore Marine Conservation (Natural Habitats &c) Regulations 2017 (as amended): Implements the requirements of the EU Habitats Directive in the UK offshore marine area (beyond the 12 nm limit).
- The Conservation of Habitats and Species Regulations 2017: Transpose the requirements of EU Directive 92/43/EEC (the Habitats Directive) and Directive 2009/147/EC (the Birds Directive) for developments in Scotland.
- The International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Management Convention) 2004: Aims to prevent the spread of harmful aquatic organisms from one region to another, by establishing standards and procedures for the management and control of ships' ballast water and sediments.
- The Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR Convention): The relevant annexes to benthic subtidal and intertidal ecology include Annex III: Prevention and elimination of pollution from offshore sources, Annex IV: Assessment of the quality of the marine environment, and Annex V: On the protection and conservation of the ecosystems and biological diversity of the maritime area.

4.2 Policy

- Sectoral Marine Plan for Offshore Wind Energy (Scottish Government, 2020): The Plan was published in October 2020 and builds on the work of earlier sectoral planning and incorporates recent technological, policy, regulatory, and market developments to develop a new strategic planning process. The Plan will be revised following the 2021 review and the Iterative Plan Review (IPR) process of the Plan for Offshore Wind Energy will take place in 2023.
- UK Biodiversity Action Plan (UKBAP): The UK Government's response to the Convention on Biological Diversity, which called for the development and enforcement of national strategies and associated action plans to identify, conserve, and protect existing biological diversity and enhance it wherever possible.
- Priority Marine Features (PMFs): Scotland adopted a list of 81 PMFs in 2014, representing species and habitats on existing conservation lists that were assessed against a set of criteria, including the abundance of the feature in

Scottish seas, the conservation status and the functional role played by the feature. Several benthic species are listed as PMFs.

- Scotland's National Marine Plan (Scottish Government, 2015a): Sets out policies and objectives requiring marine planners and decision-makers to consider the potential impacts of development on benthic subtidal and intertidal ecology and is useful to identify some of the key concerns and issues that should be addressed in any impact assessment. Policies under General Policies (GEN) 9 and GEN 10 are considered relevant to benthic subtidal and intertidal ecology:
  - GEN 9 Natural heritage: Development and use of the marine environment must: (a) Comply with legal requirements for protected areas and protected species; (b) Not result in significant impact on the national status of PMFs; and (c) Protect and, where appropriate, enhance the health of the marine area; and
  - GEN 10 Invasive non-native species: Opportunities to reduce the introduction of invasive non-native species to a minimum or proactively improve the practice of existing activity should be taken when decisions are being made.
- The National Islands Plan (Scottish Government, 2019): The Plan sets out 13 objectives to address crucial sectors within island communities. Under Strategic Objective 8: To improve and promote environmental wellbeing and deal with biosecurity, there is a commitment to protect island biodiversity and to address biosecurity issues.
- Orkney Islands Regional Marine Plan: Consultation Draft (Orkney Islands Council, 2022): This plan is currently being reviewed by Scottish Ministers. The plan will be an integrated guide to marine development and activities within the Orkney Islands marine region to assist public authorities, including regulators, decision makers and planners.
- Pilot Pentland Firth and Orkney Waters Marine Spatial Plan (Scottish Government, 2016): This non-statutory plan sets out an integrated planning policy framework to guide marine development, activities, and management decisions, whilst ensuring the quality of the marine environment is protected.

4.3 Guidance

- Scotland's Biodiversity Strategy (Scottish Government, 2015b): A route map to 2020; and
- Guidelines for Ecological Impact Assessment in the UK and Ireland (CIEEM, 2019): Combines the Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal, 2nd edition (2016) and the Guidelines for Ecological Impact Assessment in Britain and Ireland: Marine and Coastal (2010).

5 SITE CHARACTERISTICS

Offshore EIA Report, Supporting Study (SS) 3: Marine physical and coastal processes supporting study and chapter 8: Marine physical and coastal processes provide baseline information on the physical environment of the offshore Project area including geology, bathymetry, seabed morphology sediment transport and coastal morphology. Key features of the offshore Project area which provides useful context for the benthic baseline include:

- The OAA is situated on two large bedform features which represent banks. Whiten Head Bank is located in the south of the OAA, close to the southeastern boundary where the western offshore ECC begins. Stormy Bank is located in the north of the OAA; and
- Water depths within the OAA range approximately from a minimum of 45 mLAT on the Stormy Bank to a maximum of 99 m LAT in the far east of the OAA. The bank features are separated from one another by a deeper area in the centre of the OAA which reaches varying depths of 60-70 m; see SS5: Benthic environmental baseline report);
- The maximum depth along the eastern offshore ECC, as surveyed, is approximately 100 m LAT; and
- The maximum depth along the western ECC, as surveyed, is approximately 110 m LAT (Figure 6-1).

6 BENTHIC ECOLOGY BASELINE (DESK-BASED)

This section outlines the information on the OAA and offshore ECC found during desk based study using the data sources detailed in Table 6-1.

Table 6-1 Summary of key datasets and reports

SOURCE AND DATA	DESCRIPTION & KEY USE IN EIA	ACCESSIBILITY
EMODnet (2021)	EMODnet Broad-scale Seabed habitat map for Europe (EUSeaMap).	Publicly available via EMODnet Seabed Habitats – EUSeaMap broad-scale maps (emodnet-seabedhabitats.eu).
Marine Scotland (2023)	The Marine Scotland National Marine Plan Interactive (NMPi) maps show spatial data relating to benthic ecology on National Marine Plan Interactive: • NatureScot (2018). Ocean Quahog (*Arctica islandica*); and • Mapping European Seabed Habitat (MESH) project data.	Publicly available via Marine Scotland – National Marine Plan Interactive (atkinsgeospatial.com).
Scottish National Heritage (SNH) (now NatureScot) (2016)	Descriptions of Scottish Priority Marine Features (PMFs).	Available via https://www.nature.scot/professional-advice/protected-areas-and-species/priority-marine-features-scotlands-seas.
NatureScot (2023)	Sitelink NatureScot.	Available via https://sitelink.nature.scot/home.
Department of Energy and Climate Change (DECC) (now Department for Energy Security and Net Zero) (2004)	Synthesis of Information on Benthos of Area SEA 5.	Available via https://www.gov.uk/government/publications/strategic-environmental-assessment-5-supporting-documents.
The Department for Business, Energy and Industrial Strategy (BEIS) (now Department for Energy Security and Net Zero) (2022)	UK Offshore Energy Strategic Environmental Assessment 4 (OESEA 4).	Available via https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1061670/OESEA4_Environmental_Report.pdf.
Wilding *et al.* (2005)	The Benthic Environment of the North and West of Scotland and Northern and Western Isles: Sources of information and overview.	Available via https://tethys.pnnl.gov/sites/default/files/publications/Wilding_et_al_2005.pdf.
JNCC (2017)	North-West Orkney NCMPA.	Available via https://jncc.gov.uk/our-work/north-west-orkney-mpa/.

SOURCE AND DATA	DESCRIPTION & KEY USE IN EIA	ACCESSIBILITY
NatureScot (2022)	Designated sites.	Available via https://gateway.snh.gov.uk/natural-spaces/inspire_download.atom.xml.
Marine Life Information Network (MarLIN) (2023)	The Marine Life Information Network.	Available via https://www.marlin.ac.uk/.

6.1 Subtidal seabed features and sediments

Shelf banks and mounds are formed by the action of strong currents on mobile sediments (usually coarse sands and gravels) and rise with a slope greater than 2% from the seafloor. The OAA is situated on two large bedform features which represent banks. Whiten Head Bank is located in the south of the OAA, close to the southeastern boundary where the western offshore ECC begins. Stormy Bank is located in the north of the OAA (see Figure 2-1).

The four predominant types of seabed sediment within the study area are classified (as per British Geological Survey Web Map Service (BGS WMS)) as gravelly sand, slightly gravelly sand, sandy gravel, and sand (NMPi; Marine Scotland, 2023). Gravelly sand is present across much of the central and western OAA. Sand is present particularly in the eastern side, whereas coarser sandy gravel is prevalent in areas to the east and north. Slightly gravelly sand is present in patches throughout the OAA. The wider study area consists of much of the same sediment types, aside from the rock outcrops around Sule Skerry and Sule Stack. The predicted European Nature Information System (EUNIS) habitat classification within the OAA is dominated by A5.15/MD52: Atlantic offshore deep circalittoral sand, A5.14/MD32 circalittoral coarse sediment or MC32: circalittoral coarse sediment (Figure 6-1).

Within the offshore ECC, slightly gravelly sand is present across much of the area, with gravelly sand found in discrete areas. The predicted EUNIS classification for the offshore ECC is predominantly MD52: circalittoral sand or circalittoral coarse sediment, with areas of MC32: Atlantic circalittoral coarse sediment and MB32: Atlantic moderate energy infralittoral rock as it approaches the Caithness coastline (EMODnet, 2021). The predicted habitat classification of the potential landfall sites is MB52: Atlantic infralittoral sand with substrate varying between sand and rock or other hard substrata. To the immediate west of the offshore ECC, areas of circalittoral fine sand and circalittoral muddy sand are found (A5.25 and A5.26).

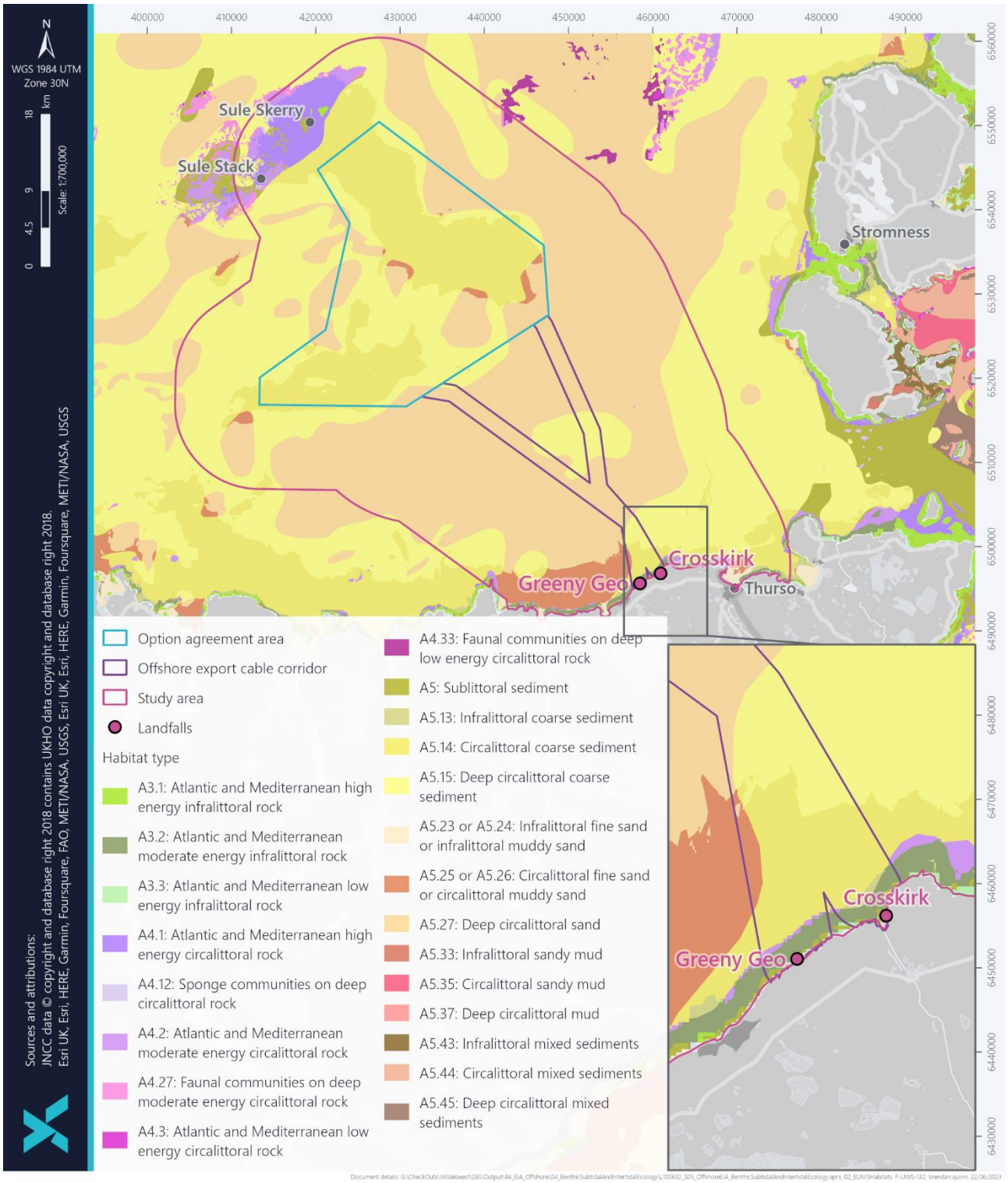


Figure 6-1 Predicted EUNIS Habitats from the UKSeaMap

6.2 Subtidal benthic communities

The predicted habitats in the OAA, described in section 6.1, are predominantly comprised of coarse sands and gravels which cover much of the region to the west of Orkney. Therefore, the corresponding benthic communities in the OAA are expected to resemble those associated with offshore coarse sands and gravels. Although there is limited published quantitative data on the benthic communities of these habitats, they are expected to be characterised by robust infaunal polychaetes and mobile crustacea and bivalve species (JNCC, 2023a). Characterising taxa include predatory polychaetes such as *Glycera alba* and *Protodorvillea kefersteini*, tube worms including *Spirobranchus triqueter*, ribbon worms (Nemertea), the bivale *Abra alba*, amphipods such as *Ampelisca spinipes* and echinoderms such as the seastar *Asterias rubens*, brittlestar *Ophiura albida* and, in particular, the burrowing sea cucumber *Neopendactyla mixta* (JNCC, 2023a).

This area is characterised by sand within areas of coarse sediment, which makes it an ideal habitat for sandeels (refer to SS7: Fish and shellfish ecology baseline report). Newly hatched sandeel larvae from this region are exported to sandeel grounds around Shetland and south of the Moray Firth (JNCC, 2017). There are also benthic species that are important to commercial fisheries (refer to SS7: Fish and shellfish ecology baseline report), such as brown crab, common lobster, and scallops.

The seabed in the nearshore waters off the north coast of Caithness, which the offshore ECC crosses, is dominated by rippled fine sand with a sparse epifauna. Empty shells of the PMF ocean quahog (*Arctica islandica)* appear to be common in deeper water (>70 m). Sand waves of coarser materials are widely distributed; rocky reef habitats of boulders and cobbles are predominantly in shallower depth of water (<45 m) (BEIS, 2022). Hard substrata (boulder and bedrock) continue into the sublittoral zone with steep cliffs, caves, and overhangs. A kelp forest of *Laminaria hyperborean* grows on the hard substrate at depths of approximately 20 m. On steep cliffs, sponges *Pachymatisma johnstoni* and *Clathrina coriacea*, soft coral *Alcyonium digitatum*, and the colonial ascidian *Botryllus schlosseri* are all present. The Caithness nearshore waters are also known to host a range of brown algae and common encrusting forms, blue-green algae and many Lusitanian species such as the red alga *Porphyra umbilicalis*, the limpet *Patella ulyssiponensis siculosus* brown algae such as *Fucus vesiculosus*, *F. linearis* and *Himanthalia analicu* on the exposed rocky shore (Eleftheriou 2003; Wilding *et al*., 2005)

6.3 Intertidal areas

The Caithness shoreline is predominantly rocky with small bays of sediment beaches. The beaches along the northern coast of Caithness are generally formed of offshore glacial deposits and alluvial material. Boulder, pebble and shingle beaches are predominant in the more exposed areas of the coast, while narrow inlets and small bays have mixed sediments, such as sand and mud, in more sheltered areas (BEIS, 2004). There is a diverse range of brown algae and common encrusting forms with the addition of blue-green algae and many Lusitanian species, such as the red alga *Porphyra umbilicalis*, the limpet *Patella ulyssiponensis siculosus*, and brown algae *Fucus vesiculosus*, *F. linearis* and *Himanthalia elongata* that colonise the exposed rocky shores of Caithness. The barnacle *Chthamalus montagui*, the gastropod *Littorina neritoides* and the top-shell *Gibbula umbilicalis* are also characteristic of the area (Wilding *et al.*, 2005).

6.4 Annex I habitats

The desktop study identified no potential Annex I habitat within the OAA. However, Annex I potential reef habitat was expected at the Caithness landfall and intertidal areas within the offshore ECC.

During the site specific survey (outlined in section 7), Annex I habitats were identified.

6.5 PMFs

The desk based study identified one existing record of the PMF species, ocean quahog, present within the OAA and 16 existing records within the offshore ECC (Marine Scotland, 2023). *Parazoanthus anguicomus*, ocean quahog and kelp beds are present within Offshore Project Area. Table 6-2 shows all PMFs potentially present in the OAA and offshore ECC. Ocean quahog is also listed as an OSPAR Threatened and/or Declining Species.

Table 6-2 PMFs Present within the study area

PRIORITY MARINE FEATURE	COMPONENT BIOTOPES/ SPECIES	OFFSHORE PROJECT AREA
Ocean quahog	N/A	✓
Parazoanthus anguicomus	N/A	✓
Kelp beds	*Laminaria hyperborean* park and foltose red seaweeds on moderately exposed lower infralittoral rock	✓
	L. hyperborean forest with a faunal cushion (sponges and polyclinids) and foliose red seaweeds on very exposed upper infralittoral rock	✓
	L. hyperborean with dense foliose red seaweeds on exposed infralittoral rock	✓
	Grazed *L. hyperborean* park with coraline crusts on lower infralittoral rock	✓

6.6 Designated sites

The nearest marine designated site is the North-West Orkney NCMPA located approximately 11.5 km to the northeast of the OAA (Figure 6-2). The NCMPA is designated for its importance to biodiversity (sandeels) and geodiversity (marine geomorphology of the Scottish Shelf Seabed including sandbanks and sand and sediment wave fields) (JNCC, 2017). Sandeels spend the majority of their life in the sandy substrate of the seabed on which they depend, except when feeding and spawning, and are therefore vulnerable to disturbance and habitat loss. They are a key food source for a range of marine wildlife, including many types of larger fish and seabirds along with being commercially

important to the UK and EU nations (e.g. Denmark). The NCMPA also includes protection for geomorphological features, such as sediment wave fields, sand waves, and sandbanks, that are maintained under a specific range of tidal current conditions (JNCC, 2017).

The Solan Bank Reef SAC is located approximately 25 km to the west of the OAA (Figure 6-2). The site is designated for two types of Annex I reef habitat, bedrock and stony reef. The reef is situated on a geological feature known as 'Solan Bank High', and the bedrock provides an underwater landscape of sea cliffs reaching approximately 10 m in height (JNCC, 2023b).

The Ushat Head SSSI is located on the north Caithness coasts and is immediately adjacent to a potential landfall. It is designated for maritime cliffs. Other SSSI are located within the wider study area (Strathy Coast, Red Point Coast, Sandside Bay, Holborn Head and Pennylands) and are designated for maritime cliffs, saltmarsh and/or other terrestrial features (NatureScot, 2020).

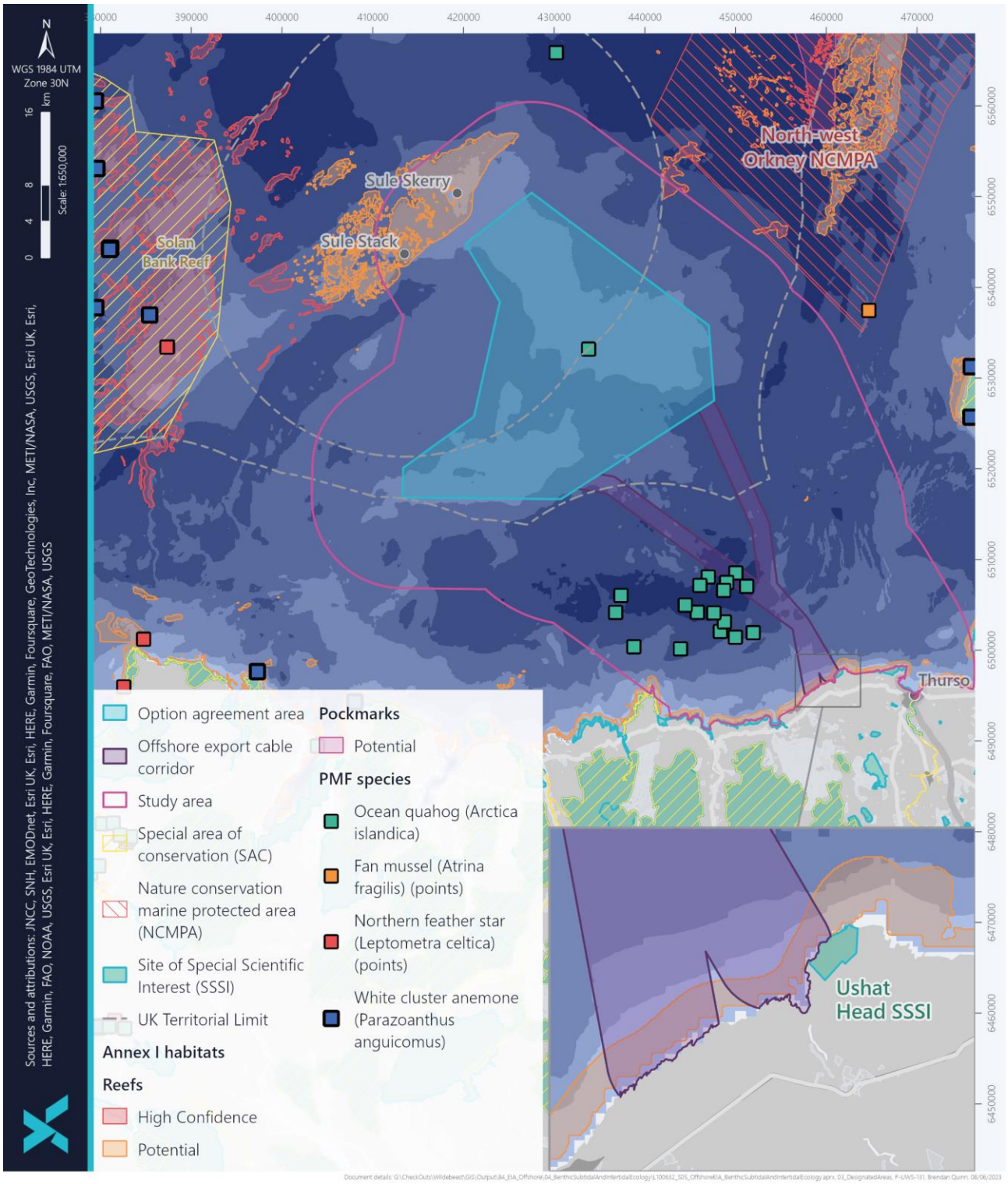


Figure 6-2 Designated sites, habitats and species

6.7 Blue carbon

Blue carbon refers to the ability of coastal or marine habitats to capture and store atmospheric carbon dioxide. Plants, calcifying organisms, and sediments can sequester and store carbon, in both the short term (i.e. plants) and long term (i.e. reefs and deep-sea sediments). The principal threat to long-term carbon storage is any process or work that disturbs the top layers of sediment (for example including activities relating to the placement of sub-sea cables or piling of WTG foundations). The key habitats that support blue carbon storage and sequestration include:

- Kelp forest;
- Intertidal macroalgae;
- Subcanopy algae;
- Maerl beds;
- Burrowed mud;
- Seagrass beds;
- Saltmarshes;
- Horse mussels (*Modiolus modiolus*);
- Flame shell (*Lamaria hians*);
- Sabellaria reefs;
- *Lophelia pertusa* reefs;
- Tubeworm (*Serpula vermicularis*) reef;
- Brittlestar beds; and
- Blue mussel (*Mytilus edulis*).

Of the above habitats, kelp beds, intertidal macroalgae, subcanopy algae and blue mussel have been identified as most likely to be present within the study area.

7 BENTHIC ECOLOGY BASELINE (SITE SPECIFIC SURVEYS)

This section outlines the key findings of the Project site-specific surveys undertaken within the OAA and offshore ECC. The surveys are outlined in Table 7-1. This section is informed by the offshore environmental baseline survey and habitat assessment report (SS5: Benthic environmental baseline report), and the intertidal habitat assessment report (SS6: Intertidal survey habitat assessment).

Table 7-1 Project survey reports used to inform this report

SURVEY	DETAILS
Key environmental surveys used to inform this report	
Benthic Environmental Baseline Survey (see SS5: Benthic environmental baseline report)	A total of 73 grab stations across the OAA and cable corridors were sampled and analysed for macrofauna, sediment particle size, and sediment chemistry and contaminants. For the offshore survey, the primary grab sampler was a dual van Veen grab (2 x 0.1 m^2) and the secondary grab sampler, used in areas of coarser sediment, was a Hamon grab (0.1 m^2). For the nearshore survey, an additional four samples were taken. Of these three were successfully sampled for particle size, chemistry, and fauna. Macrofaunal samples were obtained with a Hamon grab (0.1 m^2) and a Shipek grab (0.05 m^2) was used to obtain samples for sediment analysis. Stills and video footage at the grab stations were also used to help characterise the habitats present. The survey took place between 15th August and 21st September 2022.
Intertidal habitat assessment survey (see SS6: Intertidal survey habitat assessment)	Unmanned Aerial Vehicles (UAV) habitat mapping and a Phase I Walkover survey was undertaken at the two proposed landfall locations in Caithness between the 24th and 26th October 2022.
Supporting geophysical surveys	
Offshore geophysical survey (Ocean Infinity, 2023a,b,c)	The offshore geophysical survey took place from April – September 2022. The survey focused on the OAA and offshore ECC. The results from this survey ascertained the seabed characteristics to determine the cable route options and turbine foundations and also informed the environmental sampling and habitat assessment.
Nearshore surveys 2021 (see SS5: Benthic environmental baseline report)	Nearshore surveys were carried out from August 2021-October 2021 to cover the cable landfall options in north Caithness and in Orkney (north coasts of Hoy, and Scapa Flow[2]).

[2] *North coast of Hoy and Scapa Flow cable landfall options are not being considered in for the Offshore EIA Report.*

SURVEY	DETAILS
Nearshore geophysical survey (Spectrum, 2023)	Another nearshore geophysical survey was undertaken in 2022 in north Caithness for the two preferred landfall options, Greeny Geo and Crosskirk.

7.1 Offshore and nearshore environmental survey

7.1.1 Bathymetry overview

Water depths within the OAA range approximately from a minimum of 45 mLAT on the Stormy Bank to a maximum of 99 mLAT in the far east of the OAA. The bank features are separated from one another by a deeper area in the centre of the OAA which reaches varying depths of 60-70 m; Ocean Infinity, 2023a). The maximum depth along the eastern offshore ECC, as surveyed, is approximately 99 m LAT. The maximum depth along the western offshore ECC, as surveyed, is approximately 111 mLAT (Figure 6-1).

7.1.2 Environmental survey coverage

Figure 7-1 outlines the sample locations undertaken for grab sampling and camera transects across the OAA and offshore ECC for the offshore and nearshore surveys. The environmental sampling locations were selected based on depth variation, sediment and habitat changes as delineated during the geophysical survey, to provide benthic data for all habitats interpreted across the survey area. A total of 95 locations (82 for grab sampling and 13 for standalone video transects) were selected for sampling (see SS5: Benthic environmental baseline report). Grab samples were taken at only 73 of the planned 82 grab sample stations.

For the nearshore survey nine DDV transects were planned and were conducted prior to grab sampling, with a minimum of six images with continuous video acquired per transect. Out of the nine planned DDV stations, all were successfully investigated. Following the completion of the DDV scope, four of the proposed grab sample stations were deemed suitable for sampling and three were successfully sampled for particle size, chemistry, and fauna (SS5: Benthic environmental baseline report).

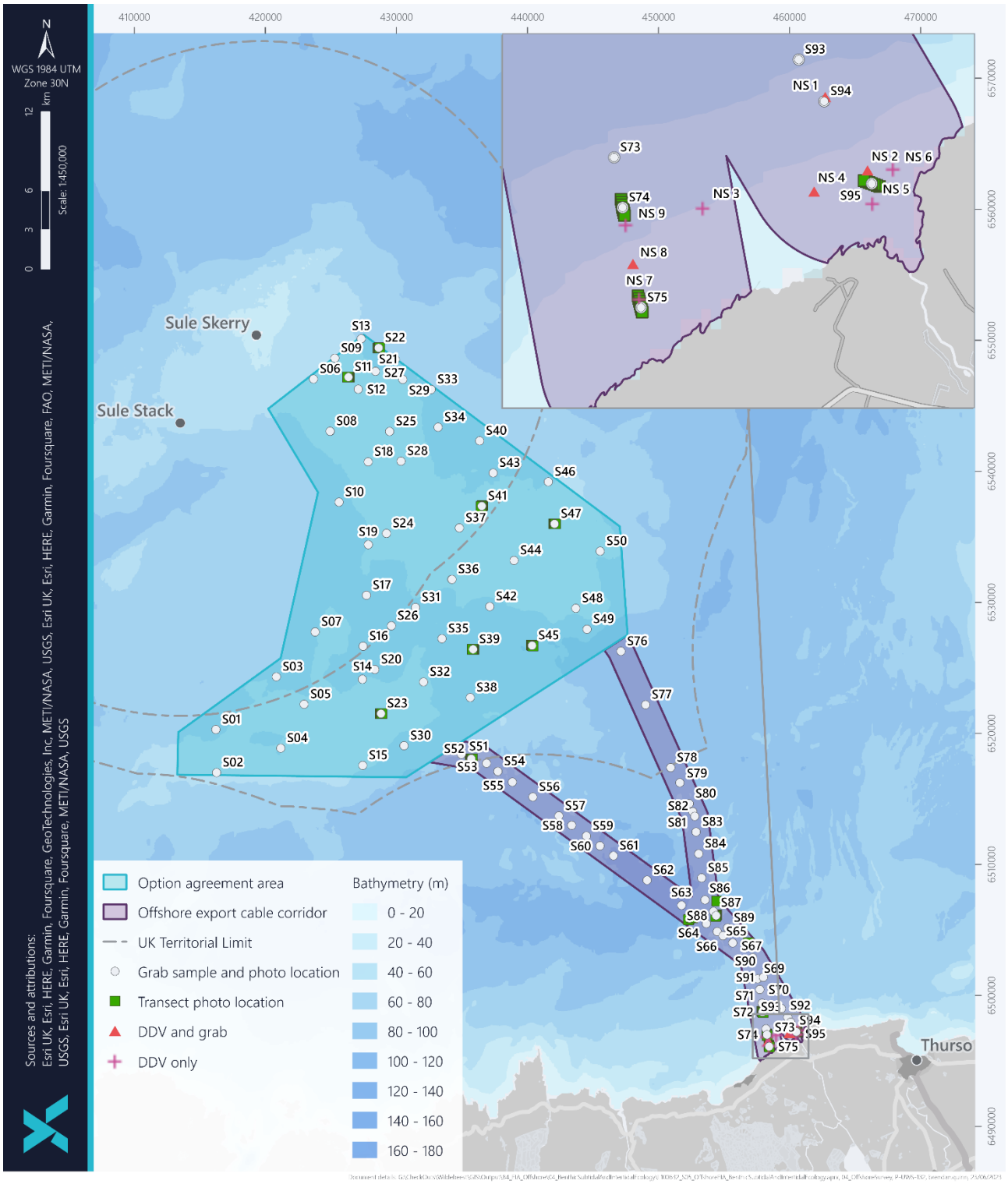


Figure 7-1 Overview of environmental sampling undertaken (see SS5: Benthic environmental baseline report)

7.1.3 Sediment analysis

The sediment grabs were sub-sampled for physical (particle size distribution) and chemical analyses.

Particle size distribution

Of the total 86 selected grab sampling locations in the whole survey area (offshore and nearshore), Particle Size Analysis (PSA) samples were successfully acquired from 70 stations.

The OAA primarily comprised sand and gravel with varying ratios, and the offshore ECC was dominated by sand as shown in Figure 7-2 (SS5: Benthic environmental baseline report). The most prominent sediment types were described as 'sand', 'gravelly sand' and 'sandy gravel'. The amount of fine particles (mud, consisting of clay and silt) was generally low over the survey area, ranging from 0% to 8.2% (mean 1.5%) (Figure 7-2).

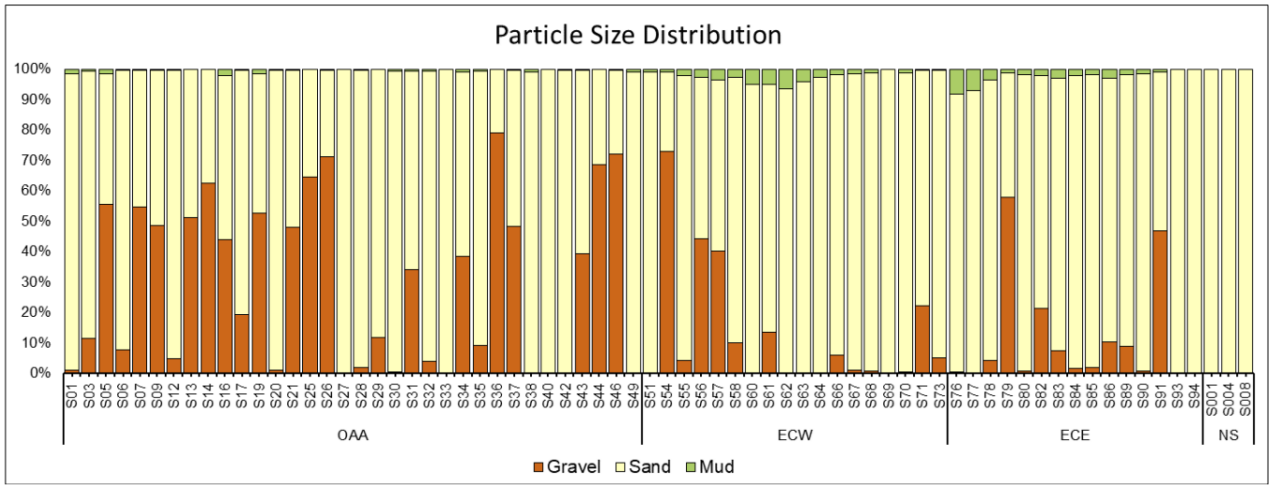


Figure 7-2 Summary of particle size distribution across all stations sampled (Ocean Infinity, 2023d)

Sediment chemistry

Across the entire survey area (offshore and nearshore), a total of 86 sampling stations were selected for sediment chemistry and contaminant analysis. Samples were successfully acquired at 60 stations, with one station (OAA_S09) not having samples acquired for metal and organics analyses. Out of the 86 stations, 35 were selected for additional analyses of pesticide and flame-retardants, of which 29 were successfully sampled (SS5: Benthic environmental baseline report).

The results of the sediment chemistry and contaminant analysis are summarised in Table 7-2 (also see SS5: Benthic environmental baseline report).

Table 7-2 Sediment chemistry and contaminant analysis summary (SS5: Benthic environmental baseline report)

CHEMICAL GROUP	SUMMARY	NUMBER OF LOCATIONS SAMPLED
Metals	• Overall, low across the OAA and offshore ECC;	82
	• Arsenic concentration was recorded above the CCME ISQG*1 threshold value at seven stations; and • One of these stations also slightly exceeded the arsenic lower threshold of the NEA class 2 Good*2 (15 mg/kg), thereby exceeding the expected natural background levels.	
	• Nickel concentration was recorded above CEFAS AL1*3 threshold (>20 mg/kg) at 8 stations; and • Two of these samples slightly exceeded the threshold for NEA class 2 Good (30 mg/kg), thereby exceeding the expected natural background levels.	
	• Metal concentrations were generally of no environmental concern.	
Organics	• Total Organic Matter (TOM) and Total Organic Carbon (TOC) was generally low; and • These varied throughout the survey area, with a mean content of 1.5 % (SD=0.4) and 0.20 % (SD=0.10) respectively.	82
Hydrocarbons	• Total Hydrocarbon Content (THC) was low but variable throughout the survey area; and • Polycyclic Aromatic Hydrocarbon (PAH) concentrations were variable and notably higher in the nearshore area.	82
Polychlorinated Biphenyls (PCB)	• Low throughout the survey area; and • Concentrations exceeded the NEA class 2 Good*1 threshold at seven stations.	82
Organochlorine Pesticides (OCP)	• Low throughout the survey area with no threshold values being exceeded.	29
Brominated Flame Retardants (PBDE)	• Overall low throughout the survey area; and • 16 sampling stations were above the OSPAR Background Assessment Concentration (BAC).	26

***1 – CCME (Canadian Council of Ministers of the Environment) ISQG – threshold levels above which adverse effects occur occasionally.**
***2 – NEA (Norwegian Environment Agency) Class 2 Good – contaminant levels considered higher than background levels (Class 1 – Background).**
***3 – CEFAS Action Level 1 (AL1) indicates that contaminant levels are of no concern.**

7.1.4 Macrofaunal analysis

Macrofaunal grab samples were taken from 73 stations during the offshore survey and a further three stations during the nearshore survey. Of these, nine were deemed to have insufficient sample material and were excluded from the statistical analyses. The majority of offshore grab samples were obtained using a dual van Veen grab, with the remainder (approximately 23%) and all of the nearshore samples obtained using a Hamon grab. A single 0.1 m^2 sample was analysed from each station and sieved over a 0.5 mm mesh.

The faunal analysis was undertaken separately for non-colonial and colonial fauna[3] (see SS5: Benthic environmental baseline report). Full quantitative analysis of abundance and biomass, employing a range of univariate and multivariate techniques, was conducted for the non-colonial macrofauna, which consisted of infaunal and epifaunal species. The colonial macrofauna obtained in the grab samples were all epifaunal and were recorded as present only.

A resemblance to sandy mud communities was identified in reference to the biotope *Lagis koreni* and *Phaxas pellucidus* in Atlantic circalittoral sandy mud. The particle size distribution results mainly grouped the stations based on the gravel-to-sand ratio, and to a lesser extent on mud content, across the offshore Project area.

Non-colonial macrofauna

The non-colonial fauna were dominated by polychaete annelids in terms of abundance (53%) and species diversity (47%). The second most prominent phyla were the arthropods (13% abundance, 29% diversity) and molluscs (12% abundance and 18% diversity), respectively (Figure 7-3).

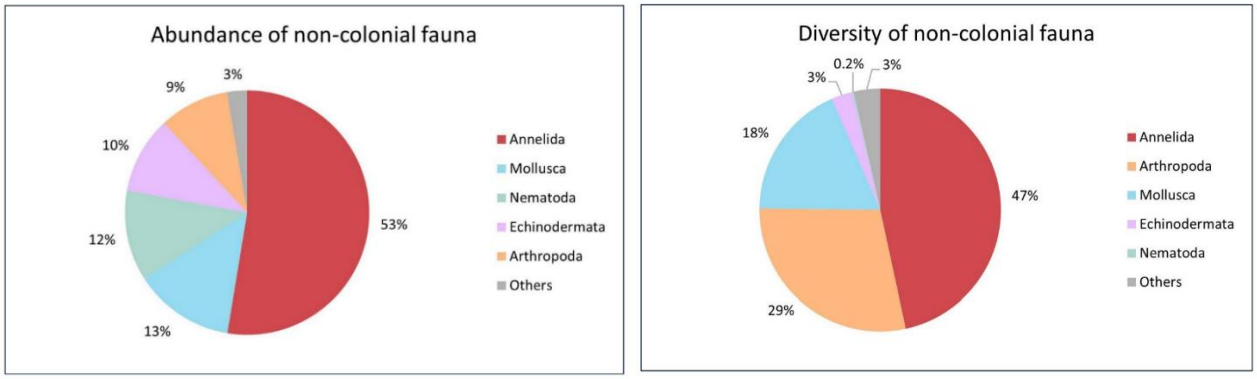


Figure 7-3 Non colonial fauna abundance (left) and diversity (right) (Ocean Infinity, 2023d)

The most abundant taxon recorded was the polychaete *Owenia* spp., which forms tubes in sandy sediments; this taxon was also widespread, occurring in 77% of the grab samples. The most frequently occurring taxon was the pea urchin *Echinocyamus pusillus*, which is found buried in coarse sands and gravels; this taxon occurred in 95% of all grab samples and was also the third most abundant taxon recorded.

The number of taxa was highly variable between stations, ranging from nine at two of the nearshore stations to 99 at station OAA-S16. The Shannon-Wiener diversity index also varied considerably, ranging from 0.67 at three stations to 4.09 at station OAA-S16. Examination of the dominance measures indicates that the lower diversity exhibited at some stations was due principally to the presence of relatively few species, rather than to enhanced dominance by the most abundant species that may occur in disturbed or polluted sediments. Cluster analysis was conducted on the

[3] *Non-colonial fauna are individual animals and colonial fauna are colonial forms such as hydroids, corals and seapens.*

species-abundance data using the program SIMPROF[4]. The resulting dendrogram revealed a total of 21 macro-benthic assemblages across 15 EUNIS habitats/habitat complexes (Figure 7-4).

A description of all the EUNIS biotopes characterised from the macrofaunal analysis is provided in Table 7-4. It is worth noting that in seven cases, the community was only represented at a single station. Statistically, there was a strong correlation between macrofaunal community structure and the combined variables of depth, % medium sand and % clay, indicating that water depth and substrate type are likely to be the main factors influencing the distribution of the faunal assemblages. The large number of groups seen in the SIMPROF analysis is reflective of the range of depths and the varied and complex seabed in the offshore Project area.

It can be seen in the Multidimensional Scaling (MDS)[5] plot in Figure 7-5 that the macrofaunal communities could be clustered into three broad groups comprising a broader cluster representing the composition across the wider OAA and offshore ECC and two outliers, 'Group T', and 'Group U'. The large cluster containing the majority of the OAA and offshore ECC stations generally had less pronounced dominant taxa with more evenness in the species composition. Key species in this group include the green urchin *Echinocyamus pusillu* and a varied polychaete assemblage including *Scoloplos armiger*, *Spiophanes bombyx*, *Peresiella clymenoides and Exogone verugera*. Group 'U' comprised of the nearshore stations NS001, NS004, NS008 Eastern offshore ECC S93 and S94 and was dominated by nematodes (34%) and the polychaete *Hesionura elongate (28%)*. Group 'T' which comprised of only two stations from the Western offshore ECC (S69 and S70), was dominated numerically by the bivalve *Asbjornsenia pygmaea (22%)*, the amphipod *Nototropis falcatus (20%)* along with the polychaetes *Sthenelais limicola (14%) and Nephtys cirrosa (14%)*. There was potentially a third outlier 'Group S' which comprised S08, S16 and S26 and included the bivalve mussel *Modiolula phaseolina* (5%) among its most abundant species.

Despite the heterogeneity of communities identified from macrofaunal analysis, almost all the biotopes were representative of subtidal sands and gravels. The exception was a resemblance to the sandy mud community MC6215: *Lagis koreni* and *Phaxas pellucidus* in Atlantic circalittoral sandy mud. Circalittoral sandy mud is generally described by JNCC as being characterised by a mud fraction of >20%. In the case here, the maximum mud fraction recorded was 8.4 % and while the macrofaunal community may have a resemblance to a sandy mud habitat, this was a confirmed as a sand dominated habitat by the PSA results and was also grouped with other sands and gravel habitats in the MDS analysis. Therefore, this EUNIS biotope was considered to be another variant of the subtidal sands and gravel communities present across the offshore Project area.

[4] *Cluster analysis is a multivariate analysis tool used to group samples together based on their faunal similarity, with the results produced in the form of a dendrogram. SIMPROF (similarity profile analysis) is used to determine which clusters of samples are statistically different.*

[5] *MDS is amultivariate analysis technique that aims to reveal the structure of a dataset by arranging sampling locations in a two-dimensional plot based on their faunal similarity.*

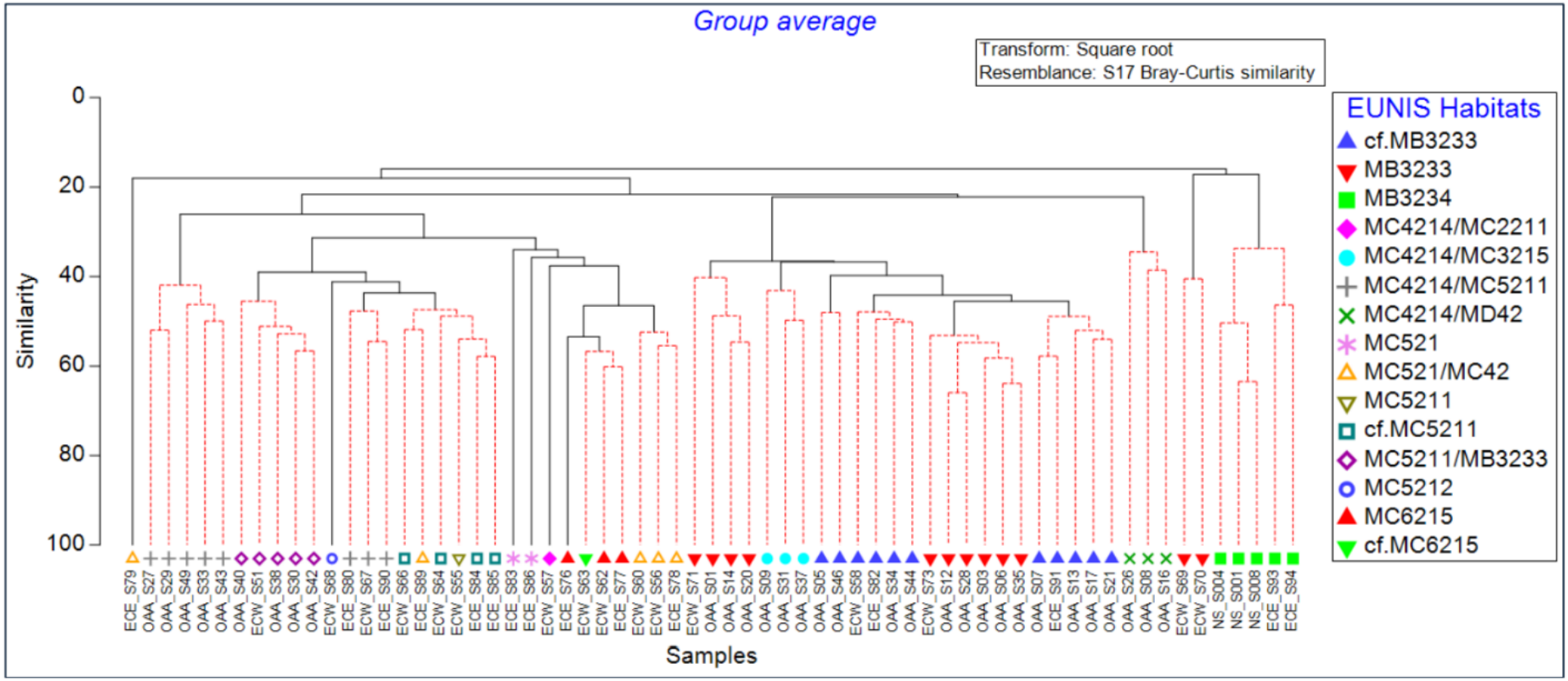


Figure 7-4 Dendrogram of non-colonial faunal composition from grab sampling with EUNIS Habitats (Ocean Infinity, 2023d)

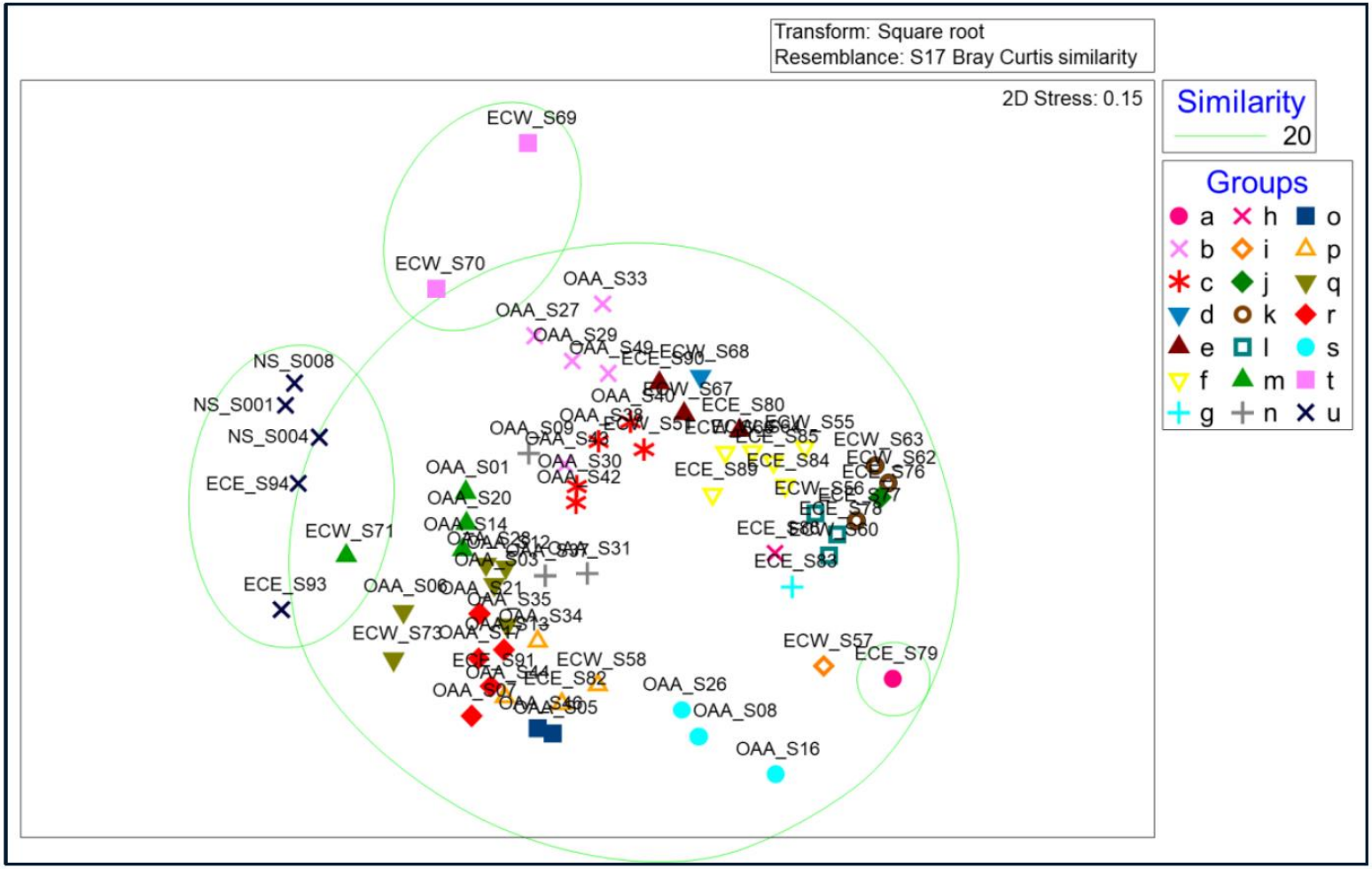


Figure 7-5 MDS plot non-colonial faunal composition from grab sampling stations based on SIMPROF analysis (Ocean Infinity, 2023d)

Colonial epifauna

While non-colonial infaunal communities dominated the majority of samples and were principally used for classifying the EUNIS biotopes, it is worth mentioning that sessile colonial epifauna also made up a portion of the benthic assemblage in collected grabs. These were dominated by bryozoans both, in terms of diversity of species (70%) and overall abundance (76%). Other important colonial epifauna included cnidarians such as the octocoral *Alcyonium digitatum* and sponges (Porifera) (Figure 7-6).

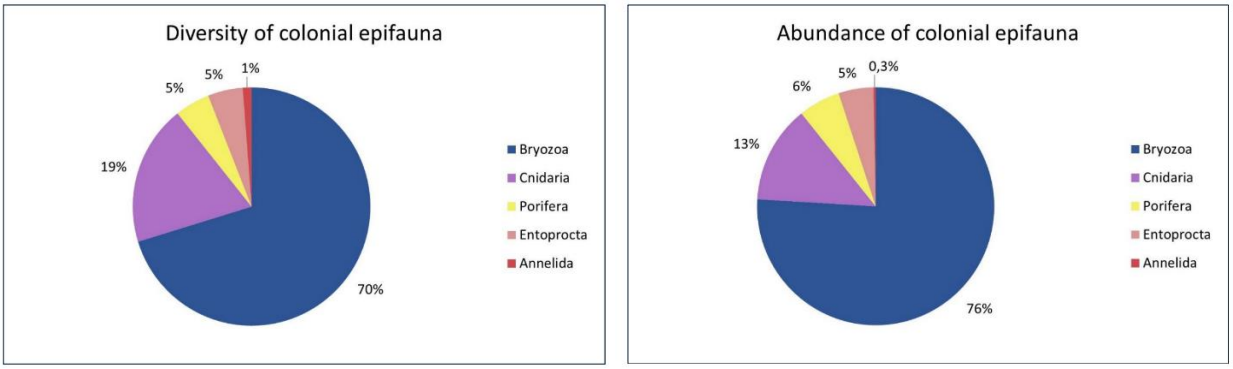


Figure 7-6 Colonial epifauna diversity (left) and abundance (right) (Ocean Infinity, 2023d)

Non-native species

One non-native taxon was identified during the survey; the polychaete *Goniadella gracilis* was identified at 23 grab sampling stations with a total of 80 individuals. The species was described from eastern North America, and the first British records are from 1970 in Liverpool Bay (Eno *et al.*, 1997; SS5: Benthic environmental baseline report).

7.1.5 Epifaunal analysis from visual survey

The epifaunal analysis survey results presented habitats generally dominated by Atlantic circalittoral mixed sediment, with visible arthropods, bryozoans and echinoderms mostly associated with the mixed substrate. Out of the 108 stations, eight had no recorded fauna and showed habitats including MC52 – Atlantic circalittoral sand, MC32 – Atlantic circalittoral coarse sediment/MC52 – Atlantic circalittoral sand, and MC42 – Atlantic circalittoral mixed sediment. The station showing the greatest diversity was S10 (Figure 7-7).

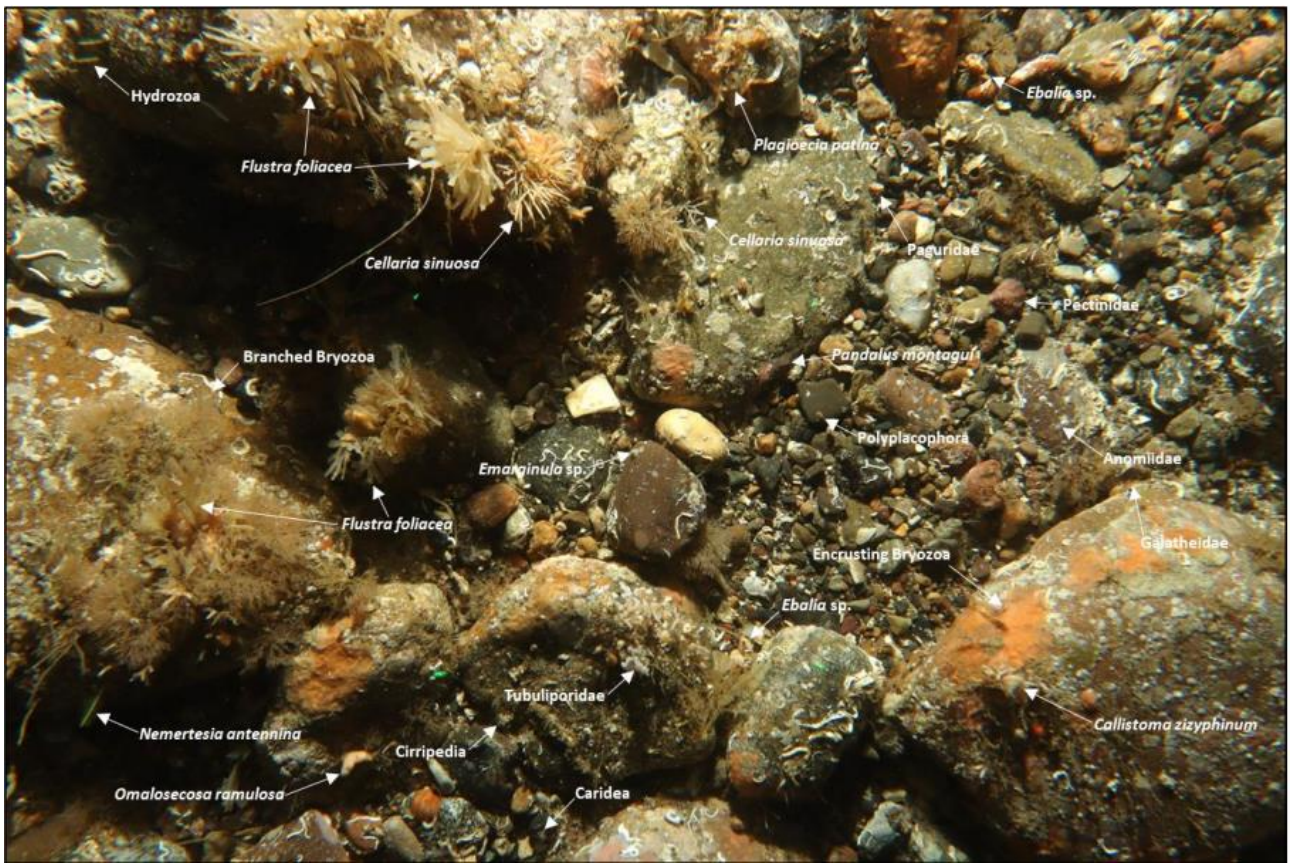


Figure 7-7 Example still photograph taken at Station OAA_S10 - the station with the greatest species diversity from the visual survey (Ocean Infinity, 2023d)

7.1.6 Habitat assessment

Seven EUNIS habitats (level 3) and two habitat complexes (level 4) were identified within the survey area during the habitat assessment DDV analysis. An overview of the distribution of these habitats and sample stations can be seen in Table 7-3, and the sampling locations are displayed in Figure 7-8, Figure 7-9 and Figure 7-10.

The broad habitats across the offshore Project area can be described as follows:

- The Whiten Head Bank area in the southern portion of the OAA is predominantly mixed and rocky sediment characterised by cobbles and boulders. This area also has rippled scour depressions of coarse sediment (MC32);
- The Stormy Bank to the north of the OAA is comprised predominantly mixed sediments (MC42) and circalittoral coarse sediment associated with scour depressions;
- Circalittoral sand (MC52) is also found in deeper areas to the south and southeast of the OAA;
- Western offshore ECC was comprised Atlantic circalittoral sand along entire length with increased presence southwards. This route also had areas of circalittoral rock in in northern section where density of boulders is higher;
- Eastern offshore ECC had prominent areas of circalittoral sand especially in north. The sand component decreases toward the south where the sediment is characterised by alternating coarse and mixed sediments; and

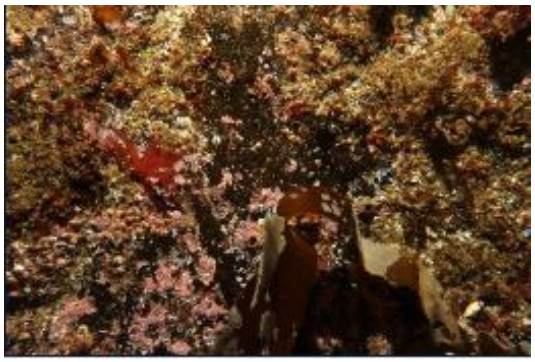
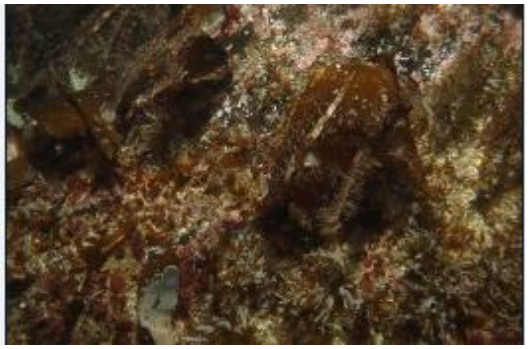
- In the nearshore into the lower subtidal, there was bedrock reef supporting stands of kelp, represent the PMF Kelp beds.

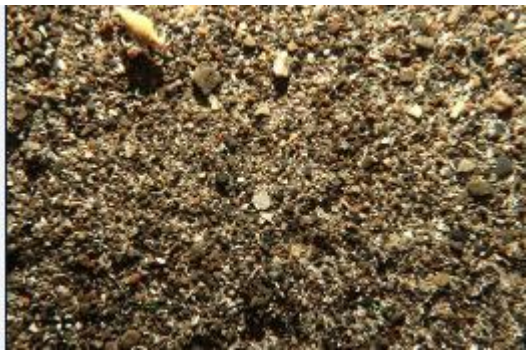
The habitats outlined in Table 7-4 are based on the analysis of benthic grab samples within the offshore and nearshore survey areas and provide more refinement (EUNIS Level 4/5) over the seven broadscale EUNIS habitats delineated from the camera based habitat assessment (see SS5: Benthic environmental baseline report). These assigned EUNIS habitats generally reflect the sand, gravelly sand, mixed and coarse sediments that were identified from the assignment to the Level 3 habitats.

It should be noted that in the more detailed habitats listed in Table 7-4, there were 'infralittoral' EUNIS habitats assigned which were actually in the circalittoral zone. This was due to a differing approach based on assigning the infralittoral category to benthic communities that were adapted to sediment mobility in waters deeper than the photic zone. However, for the purposes of the impact assessment, the distinction between the infralittoral and circalittoral sediment habitats will not be of significant concern.

It is also noteworthy that at four stations, the benthic composition was observed to resemble the sandy mud habitat MC6215 *(Lagis koreni* and *Phaxas pellucidus* in Atlantic circalittoral sandy mud). However, particle size analysis (section 7.1.3) has confirmed that the sand fraction was >90 % (mud <10%) at these stations and therefore the habitats present are considered to be sand.

Table 7-3 Identified habitat within the offshore and nearshore survey areas (Ocean Infinity 2023d; SS5: Benthic environmental baseline report)

HABITAT IMAGE	EUNIS HABITAT CODE	HABITAT CLASSIFICATION	SITE SAMPLE POINT ID
	MB12	Atlantic infralittoral rock	T74, T75 and T95 NS_T005, NS_T006, NS_T007 and NS_T009
	MB121	Kelp and seaweed communities on Atlantic infralittoral rock	T75 NS_T005 and NS_T006

HABITAT IMAGE	EUNIS HABITAT CODE	HABITAT CLASSIFICATION	SITE SAMPLE POINT ID
	MC12	Atlantic circalittoral rock	S02, S05, S10, S15, S32, S48, S53, S65 and S84 T23, T45, T47, T52, T72, T88, T96, T97 and T98 NS_T003
	MC128	Sabellaria on Atlantic circalittoral rock	S53 and S54 T52
	MC32	Atlantic circalittoral coarse sediment	S07, S13, S17, S19, S21, S30, S31, S33, S34, S35, S44, S46, S58, S79, S82, S84 and S92 T22 and T72
	MC32/ MC52	Atlantic circalittoral coarse sediment/ Atlantic circalittoral sand	S01, S03, S06, S09, S12, S14, S19, S28, S33, S55, S56, S58, S73, S80, S86, S91 and S93 T22

HABITAT IMAGE	EUNIS HABITAT CODE	HABITAT CLASSIFICATION	SITE SAMPLE POINT ID
	MC42	Atlantic circalittoral mixed sediment	S04, S08, S16, S18, S19, S24, S25, S26, S29, S36, S37, S43, S50, S54, S57, S59, S61, S65, S68, S78, S81, S83, S84, S85, S87 and S89 T11, T22, T39, T41, T97 and T99
	MC52	Atlantic circalittoral sand	S20, S27, S30, S38, S40, S42, S49, S51, S60, S62, S63, S64, S66, S67, S68, S69, S70, S71, S76, S77, S90 and S94 T72 and T99 NS_S001, NS_S002, NS_S004, NS_T007 and NS_S008
	MC52/ MC12	Atlantic circalittoral sand/ Atlantic circalittoral rock	NS_S004

Table 7-4 Sample-specific habitats within the surveyed area (SS5: Benthic environmental baseline report)

HABITAT CLASSIFICATION	EUNIS HABITAT CODE	SAMPLE ID
Moerella spp. **with venerid bivalves in Atlantic infralittoral gravelly sand**	MB3233	S01, S03, S06, S12, S14, S20, S28, S35, S69, S70, S71 and S73 Potentially S05, S07, S13, S17, S21, S34, S44, S46, S58, S82 and S91
Hesionura elongata **and** ***Microphthalmus similis*** **with other interstitial polychaetes in Atlantic infralittoral mobile coarse sand**	MB3234	S93, S94, NS_S001, NS_S004 and NS_S008

HABITAT CLASSIFICATION	EUNIS HABITAT CODE	SAMPLE ID
Flustra foliacea and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment/ *Sabellaria spinulosa* on stable Atlantic circalittoral mixed sediment	MC4214/MC2211	S57 and S59
Flustra foliacea and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment/ *Branchiostoma lanceolatum* in Atlantic circalittoral coarse sand with shell gravel	MC4214/MC3215	S09, S24, S31 and S37
Flustra foliacea and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment/ *Echinocyamus pusillus, Ophelia borealis* and *Abra prismatica* in circalittoral fine sand	MC4214/MC5211	S27, S29, S33, S43, S49, S67, S80 and S90
Flustra foliacea and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment/ Atlantic offshore circalittoral mixed sediment	MC4214/MD42	S08, S16 and S26
Faunal communities of Atlantic circalittoral sand	MC521	S83 and S86
Faunal communities of Atlantic circalittoral sand/ Atlantic offshore circalittoral mixed sediment	MC521/MC42	S56, S60, S78, S79, S81, S89 and S87
Echinocyamus pusillus, Ophelia borealis and *Abra rismatica* in circalittoral fine sand	MC5211	S55, potentially S64, S66, S84 and S85
Echinocyamus pusillus, Ophelia borealis and *Abra prismatica* in circalittoral fine sand/ *Moerella spp*. with venerid bivalves in Atlantic infralittoral gravelly sand	MC5211/MB3233	S30, S38, S40, S42 and S51
Abra prismatica, Bathyporeia elegans and polychaetes in circalittoral fine sand	MC5212	S68
Lagis koreni and *Phaxas pellucidus* in Atlantic circalittoral sandy mud	MC6215	S62, S76 and S77, potentially S63

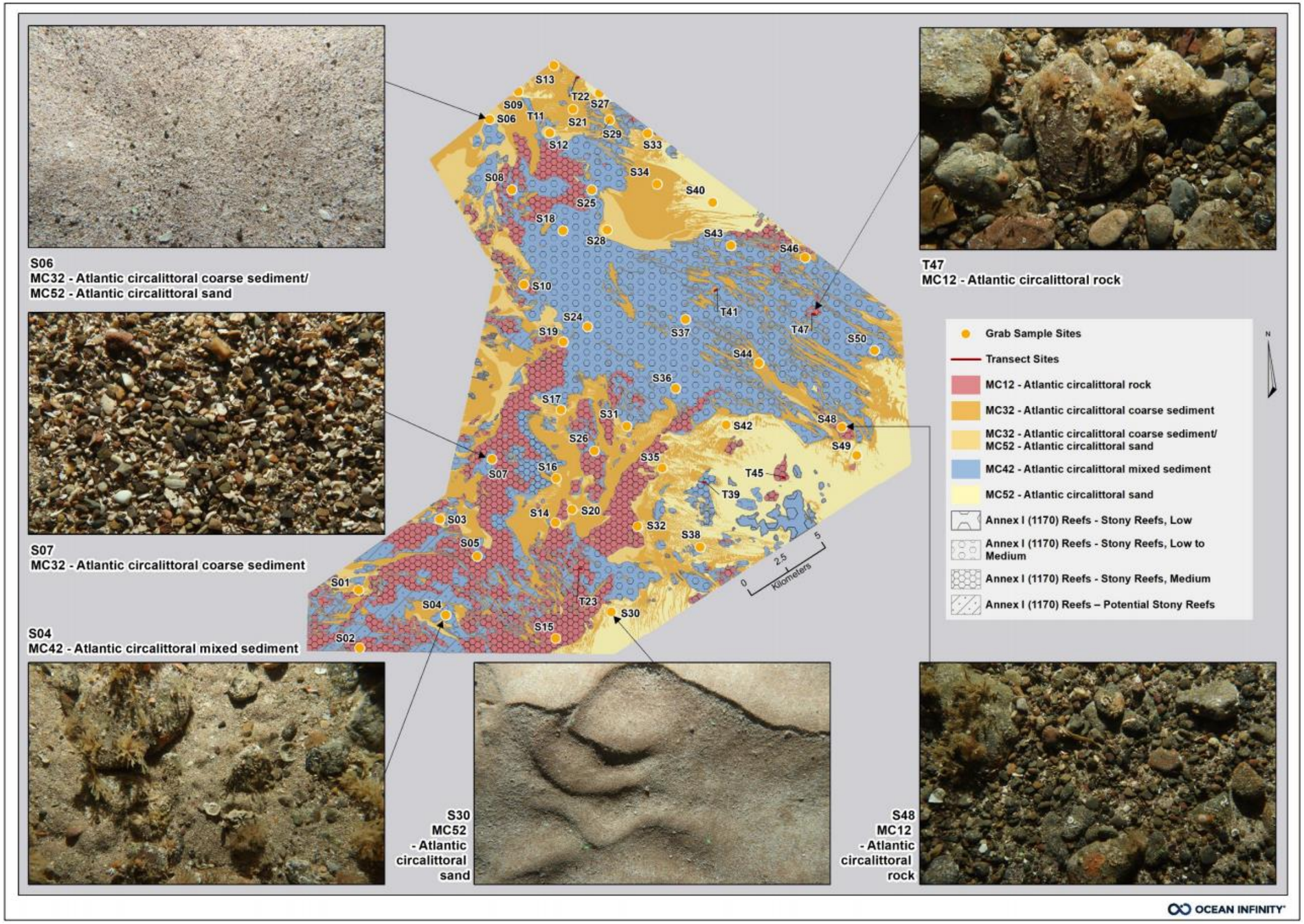


Figure 7-8 Grab sampling locations and distribution of habitats within the OAA (Ocean Infinity, 2023d)

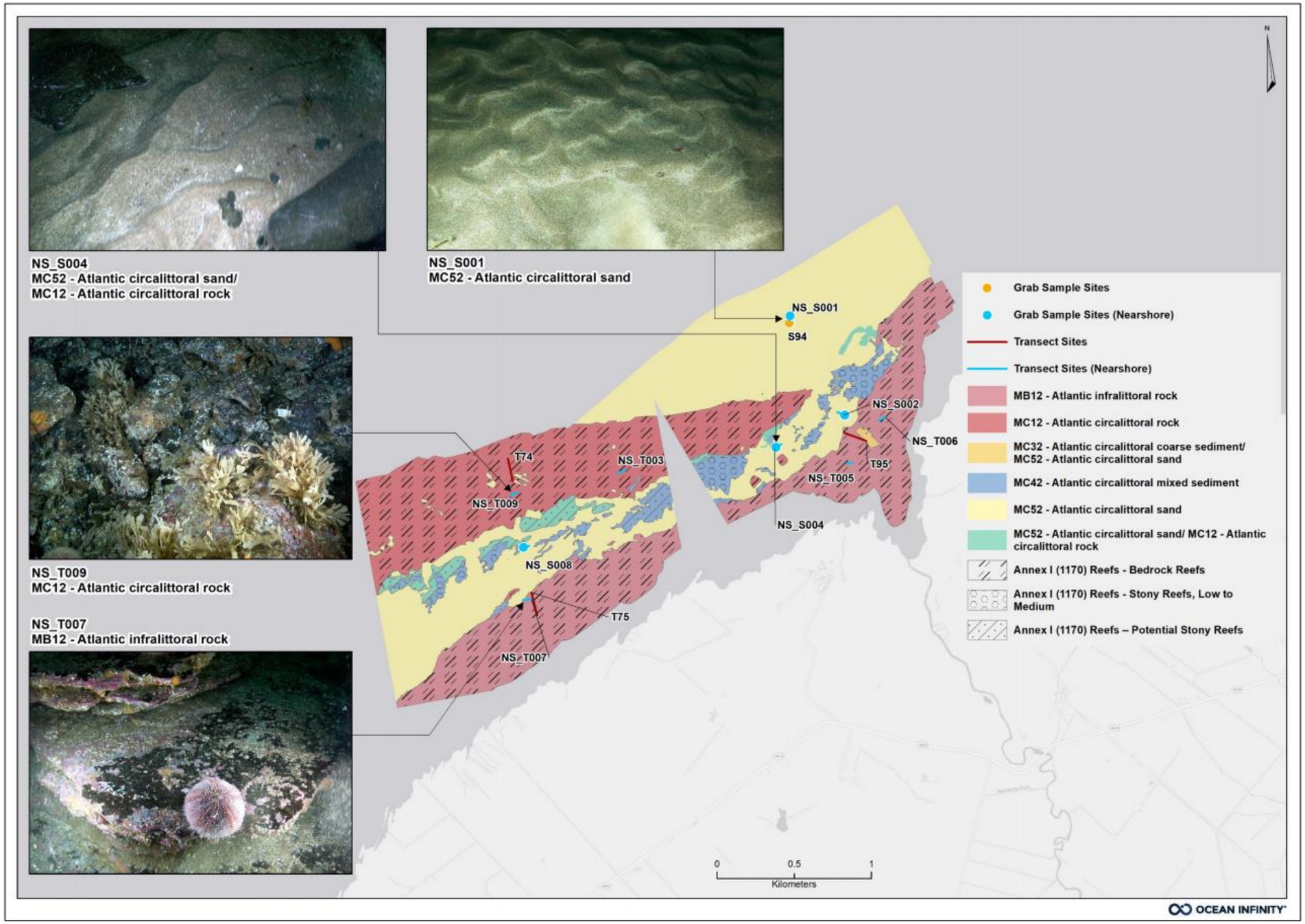


Figure 7-9 Grab sampling locations and distribution of habitats within the nearshore survey area (Ocean Infinity, 2023d)

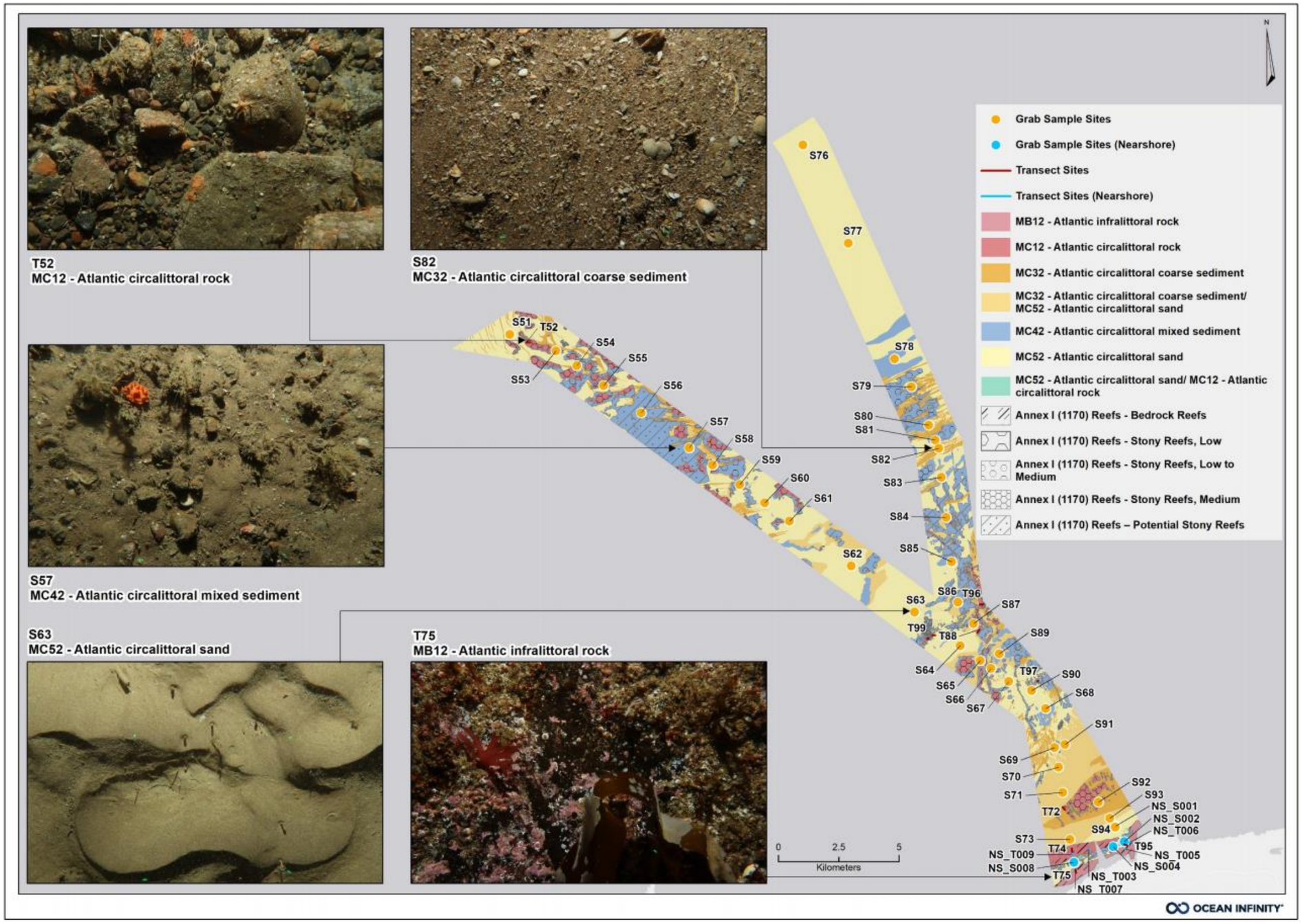


Figure 7-10 Grab sampling locations and distribution of habitats within the offshore ECC (Ocean Infinity, 2023d)

Habitats and species of conservation importance

The habitats and species identified during the survey that correspond to those defined in the European Commission (EC)'s Habitats Directive, the OSPAR List of Threatened and/or Declining Species and Habitats, Scottish PMF, and Scottish Biodiversity List (SBL) are listed in Table 7-5. Notable benthic species included ocean quahog (adults and juveniles) recorded at 19 stations, together with the supporting habitat of sands and gravel, and two benthic invertebrates: the colonial hydroid *Tamarisca tamarisca* recorded at four stations, and the marine gastropod *Ceratia proxima,* which was recorded at a single station. Juvenile ocean quahog were recorded across the OAA and offshore ECC and two adult specimens were recorded in the offshore ECC (Figure 7-11). The most prominent habitat of conservation significance was the potential Annex I rocky habitats for which an assessment on 'reefiness' was carried out. Octocorallia (also a SBL taxa) were widely represented and associated with the rocky substrata (Table 7-5).

It is also worth noting that sandeels (*Ammodytes* spp.*)* (both a PMF and SBL) were identified at ten sample locations and the supporting sands and gravels habitat was present in the Project area. Sandeels as well as the other fish species including cod, common skate, ling, thornback ray, angler, whiting and Norway pout were also identified during the survey and are covered in more detail in the SS7: Fish and shellfish ecology baseline report).

Sabellaria spinulosa was identified during the survey, but aggregations did not occur in any sufficient quantity to merit undertaking a detailed *Sabelleria* reef assessment. It can therefore be stated that *Sabellaria* biogenic reefs are not a feature of the offshore Project area. However, as mentioned above, reefs of a geogenic nature were subject to further assessment as stated in Table 7-5.

Table 7-5 Protected habitats and benthic species (SS5: Benthic environmental baseline report)

SPECIES/HABITAT	PROTECTION	SITE SAMPLE POINT ID
Ocean quahog	OSPAR and PMF taxon	S01, S20, S27, S30, S31, S33, S38, S40, S42, S49, S51, S54, S60, S62, S63, S76, S77, S81 and S84
Octocorallia	SBL taxa	S02, S04, S05, S08, S15, S16, S18, S24, S25, S29, S32, S36, S37, S43, S44, S48, S50, S59, S65, S78, S85, S86, S87, S89 and S92 T11, T22, T39, T41, T45, T47, T52, T72, T74, T75, T88, T95, T96, T97, T98 and T99 NS_T003, NS_T007 and NS_T009
Annex I (1170) Bedrock Reefs	Habitats Directive	T74, T75 and T95
Annex I (1170) Stony Reefs Low	Habitats Directive	S16
Annex I (1170) Stony Reefs Low to Medium	Habitats Directive	S04, S08, S18, S19, S24, S25, S26, S29, S36, S37, S43, S50, S54, S59 and S61 T11, T22, T41, T97 and T98
Annex I (1170) Stony Reefs Medium	Habitats Directive	S02, S05, S10, S15, S32, S48, S53, S65 and S84 T23, T39, T45, T47, T52, T72, T88, T96 and T97
Annex I (1170) Potential Stony Reefs	Habitats Directive	S57 and S84 T99

SPECIES/HABITAT	PROTECTION	SITE SAMPLE POINT ID
Offshore Subtidal Sands and Gravels	PMF SBL habitat	S01, S03, S06, S07, S09, S12, S13, S14, S17, S19, S20, S21, S27, S28, S30, S31, S33, S34, S35, S38, S40, S42, S44, S46, S49, S51, S55, S56, S58, S60, S62, S63, S64, S66, S67, S68, S69, S70, S71, S73, S76, S77, S79, S80, S82, S86, S90. S91, S92, S93 and S94 T22, T72 and T99 NS_S001, NS_S002, NS_S004, NS_S008
Kelp Beds	PMF habitat	T75 NS_T005, NS_T006
Tamarisca tamarisca	SBL taxon	S08, S16, S57 and S81
Ceratia proxima	SBL taxon	S76

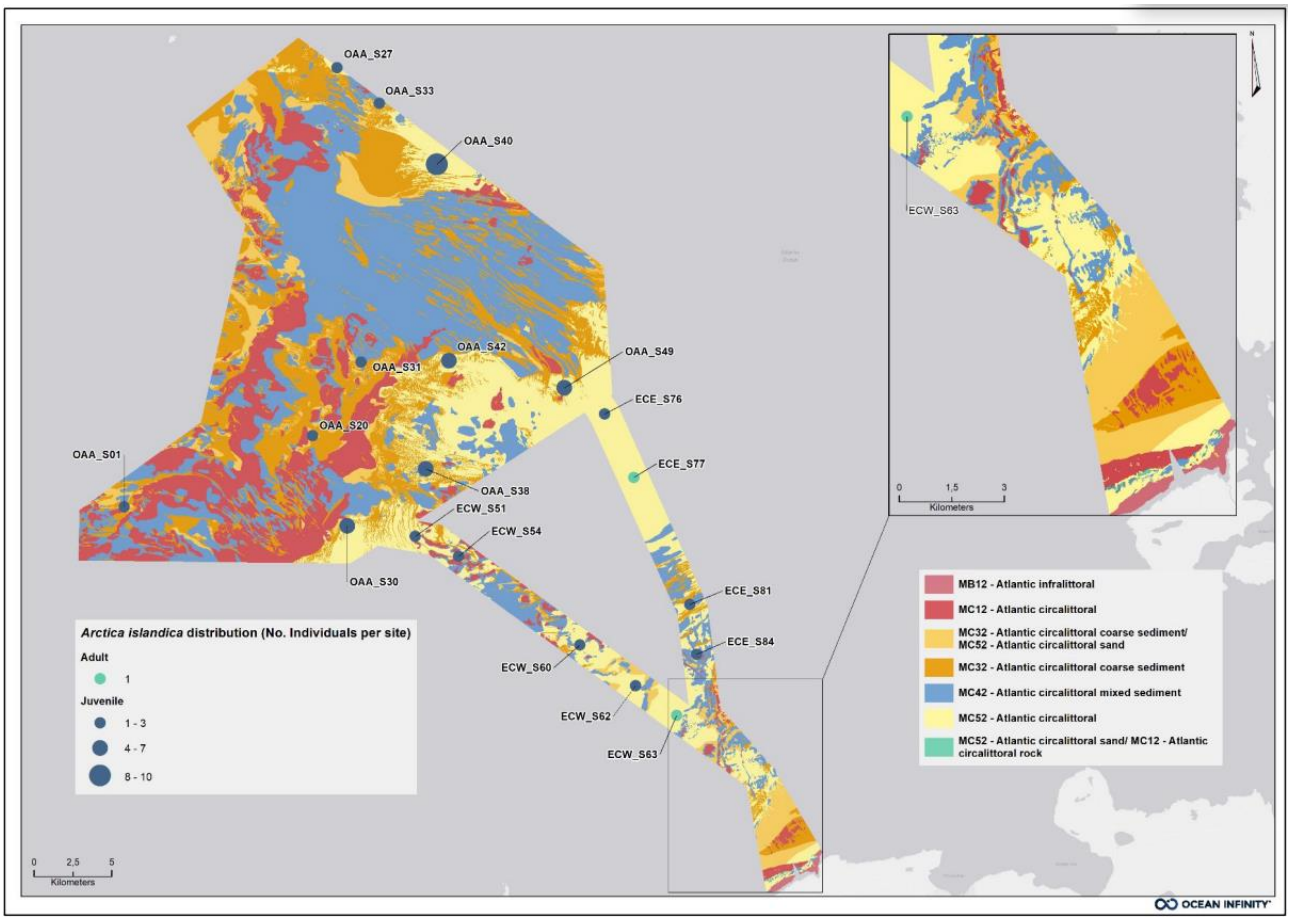


Figure 7-11 Delineated broad habitat types identified across the OAA and offshore ECC showing recorded specimens of ocean quahog (Arctica islandica) (Ocean Infinity, 2023d)

Annex I stony reef assessment

The stony reef areas were assessed in accordance with the criteria as outlined in JNCC Report No.432 (Irving, 2009) and JNCC Report No.656 by Golding *et al.* (2020). The guidelines used are detailed in Table 7-6 and Table 7-7.

Table 7-6 Stony reef assessment criteria (from Irving, 2009)

MEASURE OF 'REEFINESS'	NOT A STONY REEF	LOW	MEDIUM	HIGH
Notes: Diameter of cobbles / boulders being greater than 64 mm. Percentage cover relates to a minimum area of 25 m2. This 'composition' characteristic also includes 'patchiness'.				
Elevation	Flat Seabed	<0.064 m	0.064 m – 5 m	>5m
Notes: Minimum height (64 mm) relates to minimum size of constituent cobbles. This characteristic could also include 'distinctness' from the surrounding seabed.				
Extent	<25 m^2		>25m^2	
Biota	Dominated by infaunal species			>80 % of species present composed of epifaunal species

Table 7-7 Low reef assessment criteria (from Golding et al. 2020)

	KEY SPECIES COUNT	REEF SPECIES COUNT
Reef	>3	>20
Possible Reef	>1 and <3	>5 and <20
Not a Reef	0	<5

Overall, stony reefs were identified across the entire survey area, OAA as well as the western and eastern offshore ECCs. The majority of the "Low to Medium Reefs" are located within the northern section of the OAA overlapping the Stormy Bank whereas the "Medium Reefs" are predominantly in the southern section of the OAA overlapping the Whiten Head Bank. "Potential Reefs" are mainly located in the offshore ECCs and the western section of the OAA.

A total of ten transects (T23, T39, T41, T45, T47, T52, T72, T74, T96 and T97) and ten grab samples stations (S02, S05, S10, S15, S32, S43, S48, S50, S65 and S84) were assessed to qualify as Annex I (1170) Reefs – Stony Reefs, medium resemblance as shown in Table 7-8.

Table 7-8 Annex I Reef resemblance (SS5: Benthic environmental baseline report)

SITE	ELEVATION				COMPOSITION (%)				
	Not Reef	Low	Medium	High	0-9 Not a reef	10-39 Low	40-94 Medium	95-100 High	Final resemblance
T23			X			X	X		Medium
T39	X		X		X	X	X		Medium
T41			X			X	X		Medium
T45			X			X	X		Medium
T47		X	X			X	X	X	Medium
T52			X			X	X		Medium
T72	X		X		X		X	X	Medium
T74			X				X	X	Medium
T96	X		X		X		X		Medium
T97		X	X			X	X		Medium
S02			X			X	X		Medium
S05		X	X			X	X		Medium
S10			X				X		Medium
S15		X	X			X	X		Medium
S32	X	X	X		X	X	X		Medium
S43	X	X	X		X	X	X		Medium

Table 7-9 Summary of Annex I coverage across the OAA (SS5: Benthic environmental baseline report)

ANNEX I (FROM PROJECT-SPECIFIC SURVEY DATA)	AREA WITHIN OAA (KM^2)	% OF OAA	AREA WITHIN OFFSHORE ECC (KM^2)	% OF OFFSHORE ECC	TOTAL OAA & OFFSHORE ECC (KM^2)	% OF TOTAL AREA
Annex I (1170) reefs – bedrock reefs	0.00	0.00	2.60	2.09	2.60	0.33
Annex I (1170) reefs – potential stony reefs	29.87	4.55	12.55	10.07	42.42	5.43
Annex I (1170) reefs – stony reefs, low	6.29	0.96	0.31	0.25	6.61	0.85
Annex I (1170) reefs – stony reefs, low to medium*	116.75	17.77	8.90	7.14	125.65	16.06
Annex I (1170) reefs – stony reefs, medium	126.91	19.34	7.37	5.91	134.28	17.17
Total	279.82	42.62	31.74	25.46	311.56	39.8

ANNEX I (FROM PROJECT-SPECIFIC SURVEY DATA)	AREA WITHIN OAA (KM^2)	% OF OAA	AREA WITHIN OFFSHORE ECC (KM^2)	% OF OFFSHORE ECC	TOTAL OAA & OFFSHORE ECC (KM^2)	% OF TOTAL AREA

* Subject to Rugosity study described below.

A spatial analysis of the delineated Annex I reef areas indicate that approximately 42.6% of the OAA (279.9 km^2) is comprised of Annex I reef habitat (Table 7-9). It was interpreted that the proportion of medium reef to occur across the entire offshore Project area was ~17% (19% of OAA), which was concentrated mainly in the southern part of the OAA in the vicinity of Whiten Head Bank. A further 16.06 % of the offshore Project area was categorised stony reef 'low to medium', which was predominantly concentrated, in the northern part of the OAA, in the approximate location of the Stormy Bank. It should be noted that these areas of low to medium reef were particularly patchy and interspersed with sediment habitats. Therefore, the original estimated area coverage for the 'low to medium' stony reef (194.59 $km^{2)}$ was considered likely to be an overestimate. To get a better understanding of the extent of likely low to medium stony reef, a rugosity study was carried out across a large patch of stony reef 'low to medium' within the OAA which is summarised below. The results of this assessment were used to refine the estimated 'low to medium' stony reef area from 194.59 km^2 down to 116.75 km^2. Further information on the rugosity model that was used to do this is summarised below.

Annex I 'low to medium' reef rugosity model

In order to provide further information on the characteristics and patchiness of the "Low to Medium" resemblance stony reefs within the OAA, a Vector Ruggedness Measure (VRM) was utilised to create a seabed roughness model, termed Rugosity.

The model, created in ArcGIS, provides indicative trends with regard to seabed variability and was used to model the variability within the delineated area of the "Low to Medium" polygon. The approach aimed at quantifying and further differentiating between areas of "Reef Features Likely Present" and "Reef Features Likely Absent". The interval values presented are based on the ground-truthing imagery data and grab samples acquired during the survey. The value intervals have been divided into three categories of interpretation; Category I represents the Reef Features Likely Absent whereas Categories II and III represent Reef Features Likely Present (Table 7-10).

Table 7-10 VRM model intervals

VRM VALUES (UNITLESS)	ID	% OF OAA	CATEGORY
0.000001073 – 0.000045		Reef Features Likely Absent	I
0.000045 – 0.00023		Reef Features Likely Present	II
0.00023 – 0.0027		Reef Features Likely Present	III

The produced model indicates that variability can be tied to stony reefs, to an extent. While it is not possible to delineate between the low and medium resemblance, mainly due to patchiness being a natural progression, the VRM indicates that the flattest areas i.e., lowest variability, Category I (blue), are unlikely reefs. Category II (yellow) are areas interpreted as likely to be associated with reefs. Category III (red) also likely to be associated with reefs, is interpreted

to represent mottled seabed features, as noted in the SSS, and where rapid variations on a small scale were further noted in the MBES data (see SS5: Benthic environmental baseline report).

The rugosity study illustrates the high degree of variability across this area and helps put into context the likely extent of 'low to medium' reef. Of particular note, there was a relatively high extent of the Category I (blue) representing low variability and low reef potential.

The extrapolated and delineated seabed surface assessed as low and medium stony reefs resemblance covered an area of approximately 156 km^2. The reef features within this area are patchy a delineation on that level was not feasible. The rugosity, and the inherent variability interpreted to be associated with the ground-truthed stony reefs, indicates that the likely coverage of stony reefs within this area covers an area of approximately 93 km^2, 60 % of the area.

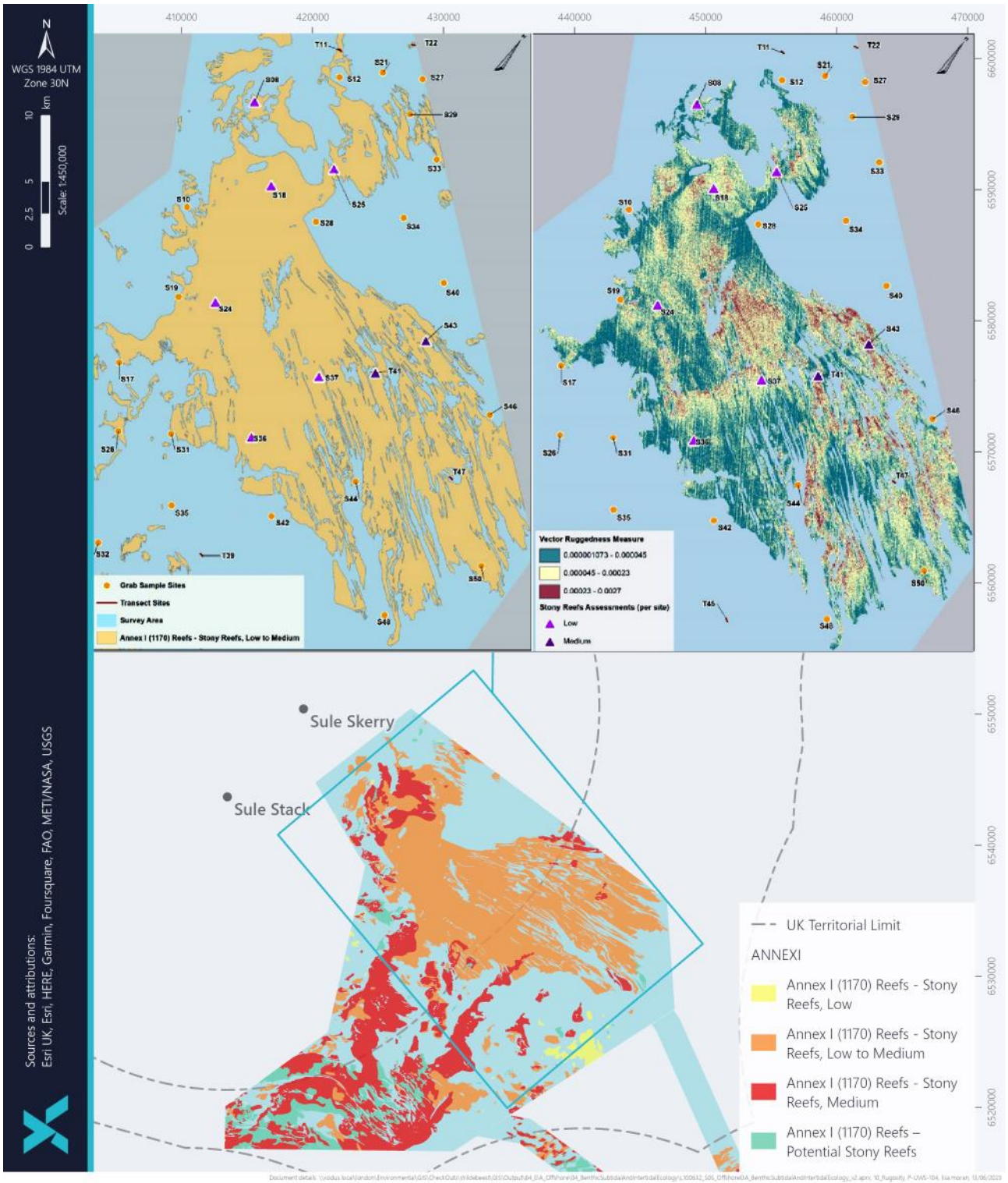


Figure 7-12 VRM Rugosity model superimposed on classified habitats in the OAA (Ocean Infinity, 2023d)

7.2 Intertidal survey

For the intertidal surveys, UAV habitat mapping and the Phase I Walkover survey was undertaken at the two proposed landfall locations in Caithness between the 24th and 26th October 2022.

The key EUNIS habitats identified in the walkover surveys are outlined for Greeny Geo (Table 7-11 and Figure 7-13 and for Crosskirk in Table 7-12 and Figure 7-13 (see SS6: Intertidal survey habitat assessment).

Both survey areas were found to be dominated by high energy rocky habitats (A1.1) supporting a variety of marine invertebrates, fucoids and seaweed. An intricate mosaic of rocky habitats of different energies (A1.1, A1.2, and A13) was present across both survey areas, while soft sediments, mostly coarse sediment, gravel and shingle, were limited to the most sheltered areas across both areas.

The central part of the Crosskirk landfall area included littoral coarse sand and muddy sand and a strandline in the upper shore giving way in the mid shore to low energy littoral rock supporting a variety of fucoids followed by moderate to high energy rock habitats in the lower shore supporting marine invertebrates as well as fucoids. No sediments were observed in the eastern reaches of the Crosskirk site while some 'pockets' of coarse sediments were observed in the upper shore on the western portion of the Crosskirk survey area.

High energy rock habitats with large areas covered in *F. distichus* and *F. spiralis* dominated throughout the Greeny Geo site with a more intricate complex of habitats and biotopes occurring to the east and west of the site. To the east littoral rockpools supporting coralline algae and green seaweeds populated the upper shore, while gravel and shingle were observed in a sheltered embayment to the west of the rockpools.

7.2.1 Intertidal features of conservation importance

All EUNIS rock classifications observed at both Crosskirk and Greeny Geo were located in the intertidal area (Table 7-11; Table 7-12). Available data from EMODnet indicated the presence of subtidal Annex I rocky reefs in areas adjacent to those surveyed for this assessment suggesting that the observed intertidal rock classifications extended to the subtidal zone and as such qualified as Annex I reefs.

The EUNIS biotope 'A1.445 *Verrucaria mucosa* and/or *Hildenbrandia rubra* on upper to mid shore cave walls' was identified at both survey areas and could potentially classify as Annex I habitat 'submerged or partially submerged sea caves' (Table 7-11; Table 7-12). During the walkover survey, several overhanging areas and a few archways were observed, however none of these features were deemed to be a partially submerged sea cave. Nevertheless, the presence of sea caves cannot be completely ruled out as there were areas of the coastline that were not accessible and could lend themselves to sea caves, although no partially submerged sea caves were observed.

Kelp was observed in both the UAV imagery and target notes. It is likely that PMFs 'kelp beds' and 'kelp and seaweed communities on sublittoral sediment' designated in Scottish waters were present.

7.2.2 Blue carbon habitats

Of the blue carbon habitats discussed section 6.7, only kelp forest and intertidal macroalgae were observed during the surveys (see SS5: Benthic environmental baseline report and SS6: Intertidal survey habitat assessment). The Projects blue carbon assessment can be found in SS1: Climate and carbon assessment.

Table 7-11 Key EUNIS classifications recorded at Greeny Geo (SS6: Intertidal survey habitat assessment)

EUNIS BROADSCALE HABITAT	EUNIS CODE	EUNIS DESCRIPTION
A1.1 – High energy Littoral Rock	A1.11	Mussel and/or barnacle communities
	A1.111	*Mytilus edulis* and barnacles on very exposed eulittoral rock
	A1.113	*Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock
	A1.1131	*Semibalanus balanoides*, *Patella vulgata* and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock
	A1.121	*Fucus distichus* and *Fucus spiralis f. nana* on extremely exposed upper eulittoral rock
A1.2 – Moderate energy littoral rock	A1.21	Barnacles and fucoids on moderately exposed shores
	A1.211	*Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock
	A1.212	*Fucus spiralis* on full salinity exposed to moderately exposed upper eulittoral rock
	A1.214	*Fucus serratus* on moderately exposed lower eulittoral rock
	A1.2141	*Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock
A1.3 – Low energy littoral rock	A1.311	*Pelvetia canaliculata* on sheltered littoral fringe rock
	A1.321	*Pelvetia canaliculata* on sheltered variable salinity littoral fringe rock
	A1.322	*Fucus spiralis* on sheltered variable salinity upper eulittoral rock
A1.4 – Features of littoral rock	A1.41	Communities of littoral rockpools
	A1.411	Coralline crust-dominated shallow eulittoral rockpools
	A1.4111	Coralline crusts and Corallina officinalis in shallow eulittoral rockpools
	A1.412	Fucoids and kelp in deep eulittoral rockpools
	A1.421	Green seaweeds (*Enteromorpha* spp. and *Cladophora* spp.) in shallow upper shore rockpools
	A1.44	Communities of littoral caves and overhangs
	A1.445	*Verrucaria mucosa* and/or *Hildenbrandia rubra* on upper to mid shore cave walls
	A1.45	Ephemeral green or red seaweeds (freshwater or sand-influenced) on non-mobile substrata
A2.1 – Littoral coarse sediment	A2.11	Shingle (pebble) and gravel shores

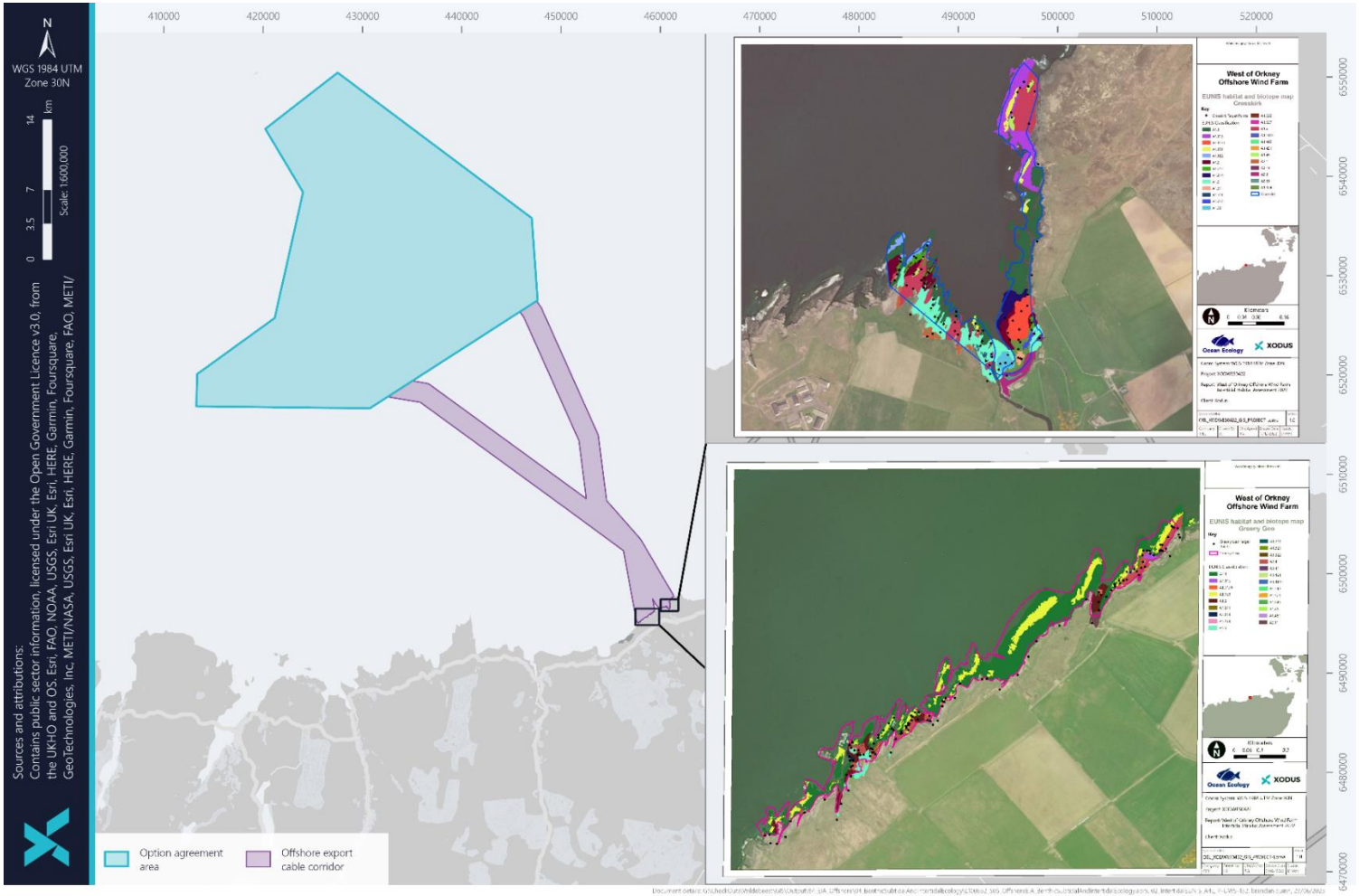


Figure 7-13 Intertidal survey EUNIS habitat and biotope map for the Greeny Geo and Crosskrik landfalls (Ocean Ecology, 2022)

Table 7-12 Key EUNIS classifications recorded at Crosskirk (SS6: Intertidal survey habitat assessment)

EUNIS BROADSCALE HABITAT	EUNIS CODE	EUNIS DESCRIPTION
A1.1 – High energy Littoral Rock	A1.113	*Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock
	A1.1131	*Semibalanus balanoides, Patella vulgata* and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock
	A1.121	*Fucus distichus* and *Fucus spiralis f. nana* on extremely exposed upper eulittoral rock
	A1.122	*Corallina officinalis* on exposed to moderately exposed lower eulittoral rock
A1.2 – Moderate energy littoral rock	A1.212	Fucus spiralis on full salinity exposed to moderately exposed upper eulittoral rock
	A1.213	Fucus vesiculosus and barnacle mosaics on moderately exposed mid eulittoral rock
	A1.214	Fucus serratus on moderately exposed lower eulittoral rock
A1.3 – Low energy littoral rock	A1.311	*Pelvetia canaliculata* on sheltered littoral fringe rock
	A1.312	*Fucus spiralis* on sheltered upper eulittoral rock
	A1.314	*Ascophyllum nodosum* on very sheltered mid eulittoral rock
	A1.322	*Fucus spiralis* on sheltered variable salinity upper eulittoral rock
	A1.323	*Fucus vesiculosus* on variable salinity mid eulittoral boulders and stable mixed substrata
	A1.324	*Ascophyllum nodosum* and *Fucus vesiculosus* on variable salinity mid eulittoral rock
	A1.327	*Fucus ceranoides* on reduced salinity eulittoral rock
A1.4 – Features of littoral rock	A1.4111	Coralline crusts and Corallina officinalis in shallow eulittoral rockpools
	A1.412	Fucoids and kelp in deep eulittoral rockpools
	A1.421	Green seaweeds (*Enteromorpha* spp. and *Cladophora* spp.) in shallow upper shore rockpools
	A1.445	*Verrucaria mucosa* and/or *Hildenbrandia rubra* on upper to mid shore cave walls
	A1.45	Ephemeral green or red seaweeds (freshwater or sand-influenced) on non-mobile substrata
	A1.451	*Enteromorpha* spp. on freshwater-influenced and/or unstable upper eulittoral rock
A2.1 – Littoral coarse sediment	A2.11	Shingle (pebble) and gravel shores
A2.2 – Littoral sand and muddy sand	A2.21	Strandline

8 DISCUSSION AND CONCLUSIONS

8.1 Comparison of desk-based and 'site-specific data

It can be seen from Figure 8-1 that there are similarities and key differences between the predicted EUNIS biotopes from the 2018 UK SEA Map data and the 2023 West of Orkney Environmental baseline report (SS5: Benthic environmental baseline report) . In particular, the circalittoral coarse sediments that were predicted to occur throughout the majority of the OAA were interpreted from survey data to be made up of a patchwork of mixed and coarse sediments with extensive areas of boulders and cobbles in the south west of the OAA in the Whiten Head Bank location. These rocky sediments have sedimentary and rocky components and are considered to represent 'medium' resemblance stony reef.

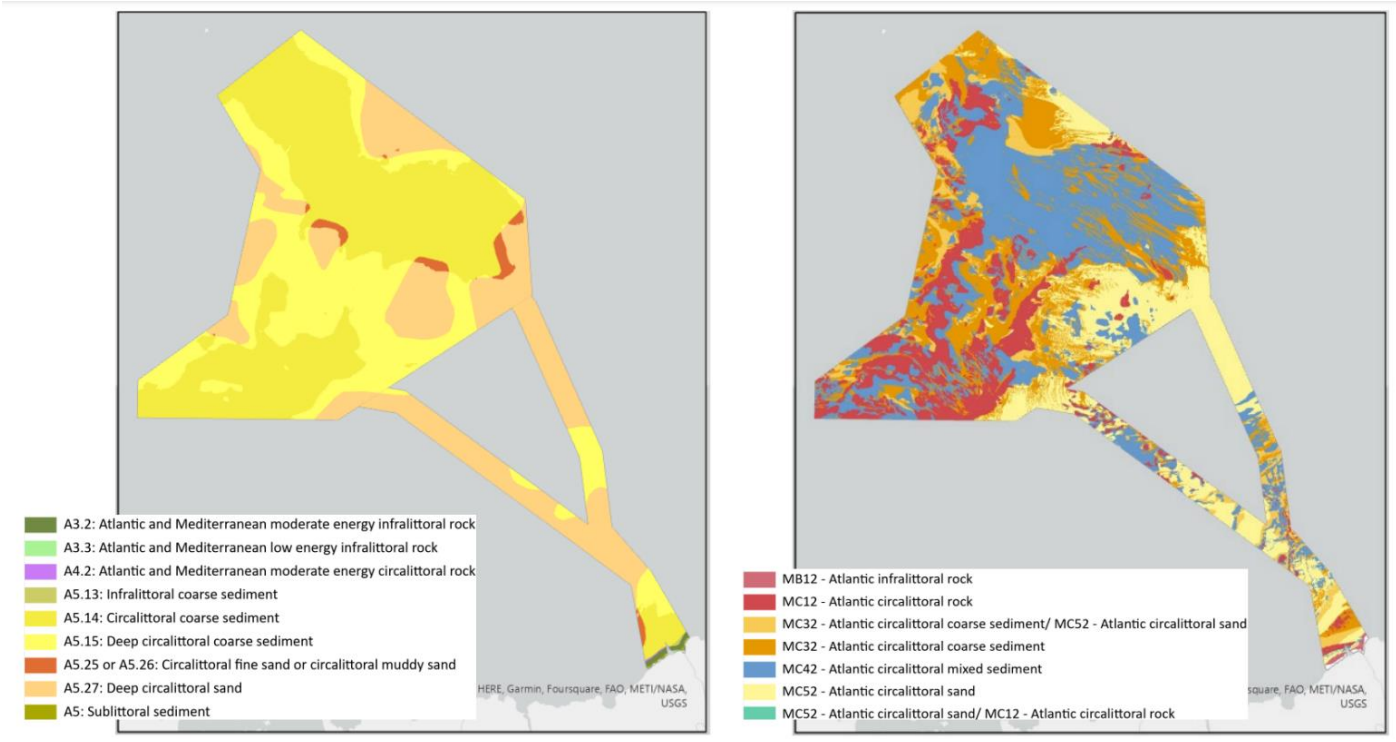


Figure 8-1 Comparison of UKSEAMAP 2018 data (left) and 2023 Environmental baseline report (SS5: Benthic environmental baseline report (right) biotope maps

As was predicted from the desk based study, the gravelly sand and low fines content of the sediment habitats across the offshore Project area have been demonstrated to support sandeels and, while generally of a coarser nature (See SS7: Fish and shellfish ecology baseline report for further details), had some resemblance to the sediment habitats within the North-West Orkney NCMPA further to the north.

The areas of cobbles and boulders interpreted as stony reef were not predicted to be present based on the information in the desk based study. However the environmental surveys revealed some similarities to the stony reef habitat which occurs in the Solan Bank Reef SAC. One of the key differences is the lack of prominent offshore bedrock and encrusting fauna reef which are a key feature of the Solan Bank.

The areas of circalittoral sand are very consistent between the desk-based and survey data sets, particularly along the cable corridors, as are the predicted areas of bedrock close to the landfall areas at Caithness. The bedrock reef at the nearshore/landfall area was also associated with the PMF kelp beds. The kelp beds and other macroalgae dominated bedrock habitats in this intertidal/nearshore area were the only blue carbon habitats that was observed to occur in the site specific survey.

The intertidal survey also identified potential Annex I habitat 'submerged or partially submerged sea caves', although no partially submerge sea caves were observed. One other PMF that was predicted to be present from the desk top study and confirmed in the survey results was the presence of ocean quahog which is supported by the sands and gravel habitat present across the site.

8.2 Sediment characterisation

Sediment analysis confirmed the dominant fractions of sands (mean 78%) and gravels (mean 20%), indicative of the sand, coarse and mixed habitats identified. The mud content was consistently low across the survey area with a mean of 1.5%, and a maximum of 8.2%.

The low fines content also likely influenced the relatively low contaminants levels across the site. Overall, the contaminants analysed heavy metals, hydrocarbon concentrations, PCBs, OCPs and flame retardants (PBDEs) were considered to be at concentrations of no concern. Metal concentrations were generally low across the offshore Project area, with grab samples exceeding some threshold values for arsenic and/or nickel at 13 grab sample sites.

8.3 Summary of benthic habitats present

8.3.1 Offshore and nearshore habitats

Analysis of geophysical data and DDV identified five EUNIS (Level 3) habitats across the offshore and nearshore area and two EUNIS level 4 habitat complexes as follows:

- Atlantic infralittoral rock (MB12):
  - Habitat complex- Kelp and seaweed communities on Atlantic infralittoral rock (MB121);
- Atlantic circalittoral rock (MC12):
  - Habitat complex – Sabellaria on Atlantic circalittoral rock (MC128);
- Atlantic circalittoral coarse sediment (MC32);
- Atlantic circalittoral sand (MC52); and
- Atlantic circalittoral mixed sediment (MC42).

Further refinement assigned sediment EUNIS habitats based on the grab sampling results. This process identified ~16 EUNIS habitats which are associated with the infaunal and epifaunal assemblages identified from the benthic taxonomy. These were reflective of the broad habitats identified from the initial camera based habitats assessment.

8.3.2 Intertidal habitats

A summary of the intertidal habitats present at the Greeny Geo and Crosskirk landfall areas is as follows:

- Littoral rock was the dominant intertidal habitat;
- A variety of littoral rock EUNIS biotopes were assigned based on the level of wave exposure (ranging from low to high) and zonation along the shore from low spring tide to the strand line;
- The biotopes indicated full range of rocky shore macroalgae zonation;
- Greeny Geo had the most exposed, high energy area; and
- Limited littoral course sediment (shingle and gravel shores) which were restricted to sheltered areas, especially inlet at Crosskirk survey area.

8.3.3 Protected habitats and species

Protected Habitats under Annex I of the EU habitats Directive include:

- Annex I stony reef comprising a matrix of coarse sediment, cobbles and boulder. These covered an extent of up to approximately 17.8% of the OAA, with the majority of 'moderate' reef resemblance in the Whiten Head Bank area to the south;
- Annex I bedrock reef was present in a narrow strip across most of the shallow subtidal area of the offshore ECC and extending into the intertidal; and
- Potential Annex I 'submerged or partially submerged sea caves' along the Greeny Geo intertidal landfall survey area, noting that none were observed during the intertidal surveys.

PMF, SBL and OSPAR Species/Habitats present in the development area include:

- Ocean quahog (PMF, OSPAR threatened or declining species);
- Offshore Subtidal Sands and Gravels (PMF, SBL habitat);
- Kelp beds (PMF);
- Octocorallia (e.g. *Alcyonium digitatum*) (SBL);
- Hydroid, *Tamarisca tamarisca* (SBL taxon);
- Gastropod, *Ceratia proxima* (SBL Taxon); and
- Fish PMF species, including sandeels, were also identified in the survey; these are covered in more detail in the SS7: Fish and shellfish ecology baseline report.

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10 ABBREVIATIONS

TERM	DEFINITION
BAC	Background Assessment Concentration
BEIS	Department for Business, Energy and Industrial Strategy
BGS	British Geological Survey
DECC	Department of Energy & Climate Change
EC	European Commission
ECC	Export Cable Corridor
EIA	Environmental Impact Assessment
EU	European Union
EUNIS	European Nature Information System
GEN	General Policy
INNS	Invasive Non-native Species
IPR	Iterative Plan Review
JNCC	Joint Nature Conservation Committee
km	kilometres
MarLIN	The Marine Life Information Network
MDS	Multidimensional Scaling
MESH	Mapping European Seabed Habitat
MHWS	Mean High-Water Springs
NCMPA	Nature Conservation Marine Protected Area
NMPi	National Marine Plan Interactive
nm	nautical miles
OAA	Option Agreement Area
OCP	Organochlorine Pesticides
OESEA4	Offshore Energy Strategic Environmental Assessment 4
OIC	Orkney Islands Council
OSP	Offshore Substation Platform
OSPAR Convention	Convention for the Protection of the Marine Environment of the North East Atlantic
OWF	Offshore Wind Farm
OWPL	Offshore Wind Power Limited
PAH	Polycyclic Aromatic Hydrocarbon
PBDE	Brominated Flame Retardants

TERM	DEFINITION
PCB	Polychlorinated Biphenyls
PMF	Priority Marine Features
PO	Plan Option
PSA	Particle Size Analysis
SBL	Scottish Biodiversity List
SNH	Scottish National Heritage (now known as NatureScot)
TOM	Total Organic Matter
TOC	Total Organic Carbon
THC	Total Hydrocarbon Content
UAV	Unmanned Aerial Vehicles
UK	United Kingdom
UKBAP	UK Biodiversity Action Plan
VRM	Vector Ruggedness Measure
WMS	Web Map Service
WTG	Wind Turbine Generator