TotalEnergies E&P North Sea UK Ltd

Culzean - Floating Offshore Wind Turbine Pilot Project

Appendix C: Habitat Assessment Survey Report (2023)

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Habitat Assessment Report

Culzean WT Site Survey

Benthic and Environmental Survey

Geophysical, Geotechnical and Environmental Survey

Culzean Field, Central North Sea

CLIENT
TotalEnergies E&P North Sea UK Ltd

DATE
2nd June 2023

CREATED BY
Iris Duranović

OI DOC NO.
104728-TOT-OI-SUR-REP-HABASRE

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03

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Abbreviations and Definitions

CPF	Central Processing Platform
CPT	Cone Penetration Test
CTD	Conductivity, Temperature and Depth
DBT	Dibutyltin
DDV	Drop Down Video
DNA	Deoxyribonucleic Acid
DPR	Daily Progress Report
DVV	Dual Van Veen grab
EC	European Commission
ED50	European Datum 1950
eDNA	Environmental DNA
EUNIS	European Nature Information System
GIS	Geographic Information System
HG	Hamon Grab
IMR	Inspection. Maintenance, and Report
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
KP	Kilometer Post
LAT	Lowest Astronomical Tide (vertical datum)
MAC	Mobilisation and Calibration
MAG	Magnetometer
MBT	Monobutyltin
MBES	Multibeam Echo Sounder
M/V	Motor Vessel
OI	Ocean Infinity Group Holding AB
OSPAR	The Oslo and Paris Conventions for the protection of the marine environment of the North-East Atlantic
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PMF	Priority Marine Feature
PPS	Pulser Per Second
PSA	Particle Size Analysis
ROV	Remotely Operated Vehicle
SBL	Scottish Biodiversity List
SBP	Sub-bottom Profiler
SOW	Scope of Work
SSIV	Sub-Sea Underwater Intervention Valve
SSS	Side Scan Sonar
TBT	Tributyltin

THC.....Total Hydrocarbons
TOC.....Total Organic Carbon
TOM .....Total Organic Matter
UK.....United Kingdom
ULQ .....Utilities and Living Quarters
UTC.....Coordinated Universal Time
UTM .....Universal Transverse Mercator
VORF.....Vertical Offshore Reference Frame
WGS84 .....World Geodetic System 1984

Executive Summary

This report details the results of the Environmental Habitat Assessment for the Culzean floating wind turbine survey located approximately 230 kilometres off the coast of Aberdeen, Scotland in the Central North Sea.

The benthic and environmental survey data acquisition included sediment sampling and imagery, with continuous video, and water sampling for eDNA profiling to establish a baseline for the habitats and faunal communities within the survey area. The benthic and environmental survey was carried out from the survey vessel M/V Deep Helder between the 21st of March and the 10th of April 2023.

Seabed imagery and grab samples were acquired at all of the 8 planned grab sample sites. All of the 8 planned water sample sites were completed.

Geophysical data were used to determine water depths, surficial geology, seabed features, shallow geology, and objects present within the survey area. Equipment used during the geophysical survey included Multibeam Echo Sounder, Side Scan Sonar, Sub-Bottom Profiler, Sparker and a single Magnetometer.

The geophysical interpretation combined with the environmental data was used as the basis for the EUNIS habitat classifications and assessments of potential areas and species of conservation importance.

A total of five EUNIS habitats including three habitat complexes, as well as one artificial habitat, were identified within the survey area.

The OSPAR habitat Sea-Pen & Burrowing Megafauna Communities was identified both within the site survey area and the cable route corridor. Habitat Sea-Pen & Burrowing Megafauna Communities is a component of the Priority Marine Feature Burrowed Mud. Sandy Ray, *Leucoraja circularis,* listed as a Priority Marine Feature and in the Scottish Biodiversity List, was identified within the site survey area.

No habitats listed in the Annex I of the Habitats Directive were identified within the site survey area or within the route cable corridor.

1. Introduction

1.1 Project Information

Ocean Infinity (OI) has been contracted by TotalEnergies E&P North Sea UK Ltd (TotalEnergies) to perform a geophysical, benthic and environmental, and geotechnical survey for a floating wind turbine in the Culzean Field (UKCS 22/25a).

The Culzean field is located approximately 230 kilometres off the coast of Aberdeen, Scotland in the Central North Sea (Figure 1).

The site survey area covers a 2 km by 2 km area and encompasses the proposed location for a floating wind turbine and its associated moorings. The centre of the main survey area is 2.1 km west of the Culzean ULQ (Utilities and Living Quarters) platform. A 2.3 km long power cable will connect the floating wind turbine to the Culzean CPF (Central Processing Platform) platform.

Project details are stated in Table 1.

Table 1 Project details.

Client	TotalEnergies
Project	Culzean WT Site Survey
Ocean Infinity (OI) Project Number	104728
Survey Type	Geophysical, Geotechnical and Environmental Survey
Area	Central North Sea
Survey period	March/April 2023
Survey Vessels	M/V Deep Helder
OI Project Manager	Edward Lloyd Rich
Client Project Manager	Mark Grove Smith

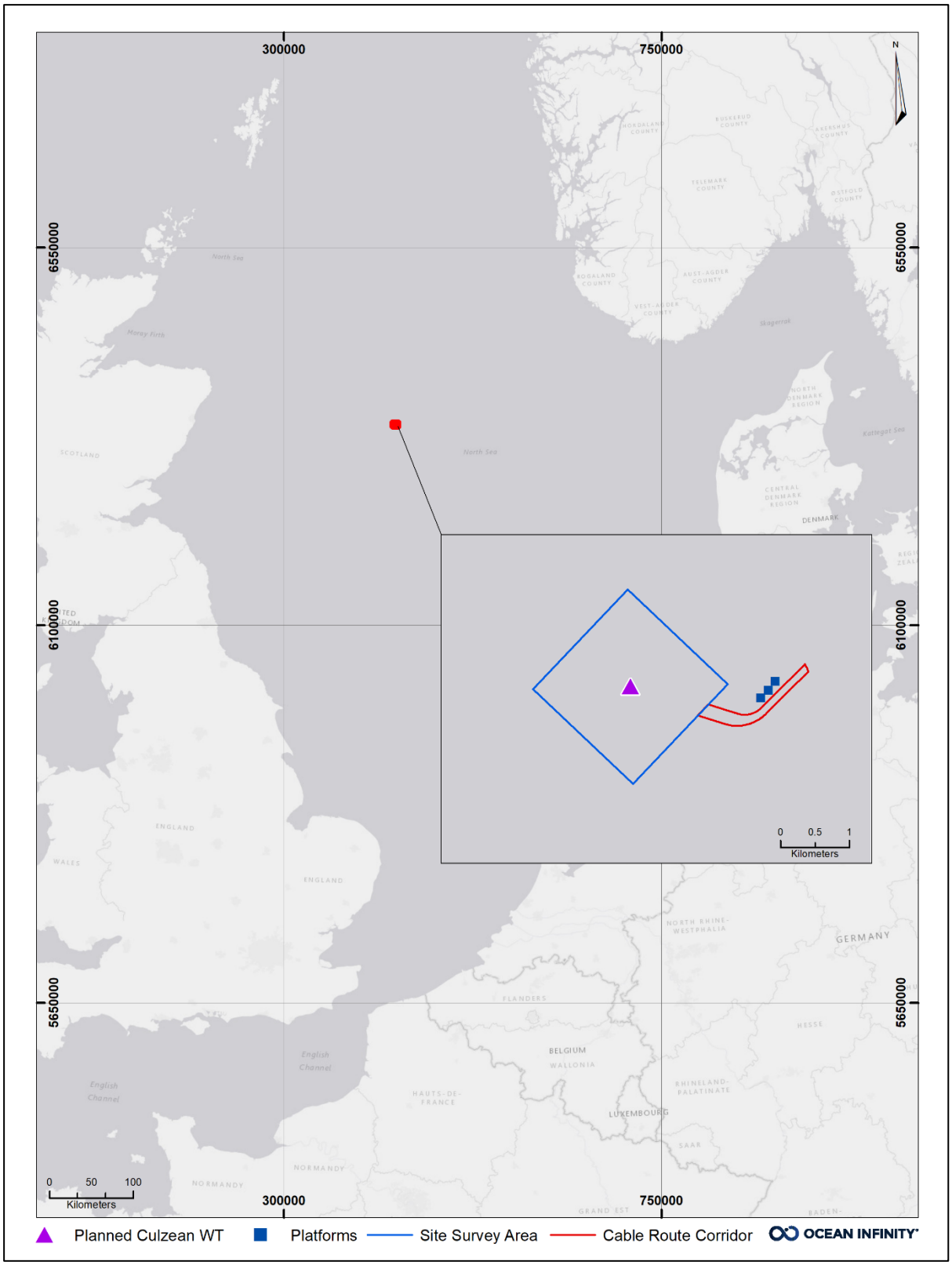


Figure 1 Overview of the survey area.

1.2 Scope of Work – Benthic and Environmental Survey

The aim of the Benthic and Environmental Survey was to collect data for Habitat Assessment and to provide an Environmental Baseline to allow for future determination of possible environmental impacts as a result of site developments.

The objectives of the Benthic and Environmental sampling and photography were to characterise the area and obtain baseline data that will:

- Support environmental applications
- Recognise any contamination or sensitive habitats already present in the area
- Provide a baseline set of observations that will allow any cumulative impact to be monitored by future surveys

The following summarises the Environmental Survey Scope of Work:

- Drop down video (DDV) for identifying epifauna and habitat
- Grab sampling for faunal taxonomy, biomass, particle size analysis (PSA) and contaminants
- Grab sampling for Environmental DNA (eDNA)
- Water sampling for contaminants and eDNA

1.2.1 Scope of Work – Geophysical Survey

The aim of the Geophysical Survey was to acquire data to evaluate the seabed and sub-seabed conditions, including potential associated hazards (geohazards or man-made hazards), affecting the future installation of a floating wind turbine and subsea cable.

The Geophysical Survey scope included the acquisition of multibeam echo sounder (MBES), side scan sonar (SSS), magnetometer (MAG), sub-bottom profiler (SBP) and Sparker data. The SBP was used to map variations in the top 3 to 5 m of sediment and the lower frequency Sparker system was used for detailed geological mapping of the uppermost 50 m of the seabed sediments.

1.2.2 Scope of Work – Geotechnical Survey

The shallow geotechnical survey included vibrocore (VC) and CPT investigations at the 3 planned mooring locations and at 500 m intervals along the proposed cable route to the Culzean CPF platform.

1.3 Purpose of Document

The purpose of this Report is to present the Habitat Assessment methodology and results within the survey areas. This report, together with overview charts and Geographic Information System (GIS) database, presents the environmental conditions from the Culzean WT Site Survey.

All existing OI data from the Geophysical and Benthic and Environmental Survey are correlated to each other and compared against the existing background information and the publicly available environmental data, to strengthen the accuracy of the interpretations.

NOTE: The Habitat Assessment presented in this report is based on video and still images along with field descriptions and PSA results of the grab samples. The grab sample laboratory test results were not available at the time of writing but will be included in the Environmental Baseline Report (104728-TOT-OI-SUR-REP-ENVBASRE).

2. Survey Parameters

2.1 Geodetic Datum and Grid Coordinate System

2.1.1 Geodetic Datum

Acquisition

Details of the geodetic datum used during acquisition are presented in Table 2. The survey data acquisition software QINSy had transformation parameters (Table 4) implemented to transform the online positions from WGS84 to the survey datum ED50.

The projection parameters will also be used in QINSy (Table 6).

Table 2 Geodetic datum parameters used during acquisition.

Horizontal Datum: WGS 84 (EPSG: 4326)	
Datum	World Geodetic System 1984 (6326)
Ellipsoid	World Geodetic System 1984 (7030)
Prime Meridian	Greenwich (8901)
Semi-major axis	6 378 137.000 m
Semi-minor axis	6 356 752.3142 m
Inverse Flattening (1/f)	298.257223563
Unit	International metre

Processing

The geodetic datum used during processing and reporting is presented in Table 3.

Table 3 Geodetic parameters used during processing.

Horizontal Datum: ED50	
Datum	ED50 (6230)
Ellipsoid	International 1924 (7022)
Prime Meridian	Greenwich (8901)
Semi-major Axis	6 378 388.000 m
Semi-minor Axis	6 356 911.946 m
Inverse Flattening (1/f)	297
Unit	International metre

2.1.2 Transformation Parameters

The transformation parameters used during the project are presented in Table 4. The transformation was used in the survey data acquisition software QINSy, although raw outputs from QINSy are in the WGS84 datum. Test coordinates for the transformation are presented in Table 5.

Table 4 Transformation parameters.

Datum Shift Parameters: From WGS84 To ED50 (Reversed EPSG 1311)	
Shift dX (m)	+89.5 m
Shift dY (m)	+93.8 m
Shift dZ (m)	+123.1 m
Rotation rX (“)	0 sec
Rotation rY (“)	0 sec
Rotation rZ (“)	0.156 sec
Scale Factor (ppm)	-1.2 ppm

Table 5 Test coordinate for datum shift.

UTM Zone	Datum	Easting (M)	Northing (M)	Latitude	Longitude
31N	WGS 84			55° 43' 17.274” N	004° 48' 06.789” E
	ED50	613272.04	6176763.30	55° 43' 19.677” N	004° 48' 11.870” E

2.1.3 Projection Parameters

The projection parameters used during survey are presented in Table 6.

Table 6 Projection parameters.

Projection Parameters	
Projection	UTM
Zone	31 N
Central Meridian	03° 00’ 00’’ E
Latitude origin	0
False Northing	0 m
False Easting	500 000 m
Central Scale Factor	0.9996
Units	metres

2.2 Vertical Datum

The vertical reference parameters used during survey are presented in Table 7.

Table 7 Vertical reference parameters.

Vertical Reference Parameters	
Vertical Reference	LAT
Height Model	VORF

Global Navigation Satellite System (GNSS) tide was used to correct the bathymetry data to LAT, the defined vertical reference model (Figure 2). The GNSS tide was generated from post-processing of the GNSS data collected by the Applanix PosMV 320 system.

The GNSS data was post-processed using the Applanix software POSPac MMS. POSPac MMS outputs ellipsoidal heights with an accuracy of 0.05 m RMS, corrected for motion and referenced to the MBES reference point. All heights were referenced to the same vertical height model by incorporating the model of the defined vertical datum into the process. Comparisons with the closest water level station were performed to ensure that the data was levelled correctly.

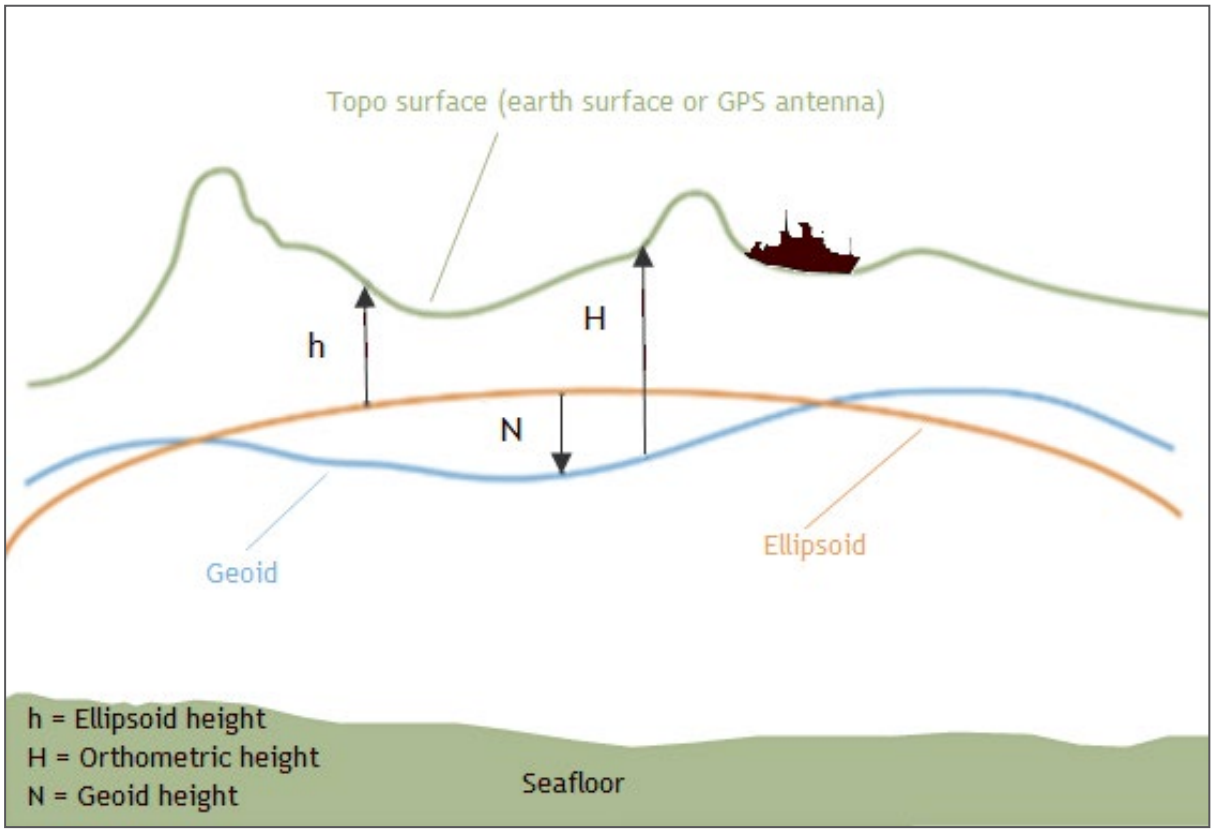


Figure 2 Overview of the relation between different vertical references.

The tidal reduction methodology encompasses all vertical movement of the vessel, including tidal effect and vessel movement due to waves and currents. The short variations in height are identified as heave and the long variations as tide.

This methodology is very robust, since it is not limited by the filter settings defined online and provides very good results in complicated wave and swell patterns as well as accounts for any changes in height caused by changes in atmospheric pressure, storm surge, squat, loading or any other effect not accounted for in a tidal prediction. The vessel navigation is exported into a post-processed format, SBET (Smoothed Best Estimated Trajectory), and applied to the MBES data.

2.3 Time Datum

Coordinated universal time (UTC) is used on all survey systems on board the vessel. The synchronisation of the vessel's onboard system is governed by the pulse per second (PPS) issued by the primary positioning system. All displays, overlays and logbooks are annotated in UTC as well as the daily progress report (DPR) that is referred to UTC.

3. Survey Vessel and Equipment

A summary of the survey tasks performed is presented in Table 8, and the tasks are described in the following sections.

Table 8 Survey tasks – M/V Deep Helder.

Task	Date	Description
Mobilisation	2023-03-21 2023-03-27	Mobilisation of equipment onto the vessel and alongside verifications
Calibrations and verifications	2023-03-28 2023-03-29	Offshore equipment verifications and calibration checks
Environmental	2023-04-03 2023-04-08	Environmental survey with SeaSpyder, Grab Sampler, Water Sampler
De-mobilisation	2023-04-09 2023-04-10	Geotechnical and Environmental de-mobilisation

Mobilisation of M/V Deep Helder commenced on the 22nd of March 2023 in Den Helder, North Holland. All necessary mobilisation of equipment and alongside tests were completed in Den Helder by the afternoon of the 25th of March 2023.

Offshore calibration and verification tests were performed over a 22” Gas Export mid-line spool, a location that was decided together with the onboard Client Representatives. The site was chosen due to its proximity to the site and known verifiable features at the location.

For a detailed description of the calibration performance and results please refer to the MAC report 104728-TOT-OI-MAC-REP-DEEPHELD. Further information about the equipment set-up and performance can be found in the Field and Operations Report 104728-TOT-OI-SUR-REP-FIELDOPS.

3.1 Survey Vessel

M/V Deep Helder

The M/V Deep Helder (Figure 3) is a Multi-Purpose Survey, Inspection, Maintenance and Repair (IMR) and Intervention Vessel, built in 2014. The vessel is equipped with a Dynamic Positioning 2 (DP2) system, an offshore crane, survey and Remotely Operated Vehicle (ROV) systems. Deployment of equipment can be done via a moon pool or an A-frame.

Figure 3 M/V Deep Helder.

3.2 Environmental Sampling Equipment

The Environmental Survey work at the Culzean WT site was carried out between the 3rd and 8th of April 2023 using the environmental sampling equipment listed in Table 9.

Table 9 M/V Deep Helder Benthic survey equipment.

Equipment	Name
Benthic Grabs	Dual Van Veen (2*0.1 m^2), Hamon Grab (0.1 m^2)
Drop Down Video (DDV) System	STR SeaSpyder
Sieve Table	0.5 mm and 5 mm Sieves and Sampling Table
Water Sampler	Rosette with Niskin Bottles (5*5L)
eDNA Sampler (water)	Vampire Sampler

Further information about the vessel, equipment set-up and performance can be found in the Operations Report 104728-TOT-OI-SUR-REP-FIELDOPS. Detailed information about the equipment calibrations and verifications can be found in the Mobilisation and Calibration (MAC) Report 104728-TOT-OI-MAC-REP-DEEPHELD.

4. Methodology

4.1 Field Methods

4.1.1 Survey Design

The final number and location of environmental sample sites were provided to OI by TotalEnergies prior to the start of the survey (Figure 4).

A Senior Benthic Ecologist reviewed the pre-selected sites based on the acquired geophysical data and preliminary geological interpretations, ensuring that the different habitats as interpreted from the Side Scan Sonar (SSS), Multibeam Echo Sounder (MBES), including normalised backscatter values, were ground-truthed. Final sampling sites were agreed upon in consultation with the Client prior to the commencement of the sample collection.

Before conducting grab sampling the Drop Down Video camera system (DDV) was deployed at each grab sample site. A minimum of 5 still images, with continuous video, were acquired at each grab sample site to collate information on epifaunal and faunal assemblage.

Grab sampling was planned at a total of eight (8) sites. At each of the eight (8) sites, three (3) replicate samples were to be allocated for taxonomic and biomass analyses, one (1) sample for Particle Size Analysis (PSA) and contaminants analyses. Additionally, a sub-sample for eDNA was to be collected from the third faunal replicate at each site.

Water sampling was planned at a total of eight (8) sites and was to be co-located with the planned grab sample sites. Water samples were to be collected at two (2) depths, close to the seabed and close to the surface, at each site. Samples were collected for both contaminants and eDNA analyses. All water samples were to be acquired on the up cast of the water sampler rosette.

A detailed account of selected sites and positions is presented in Appendix A.

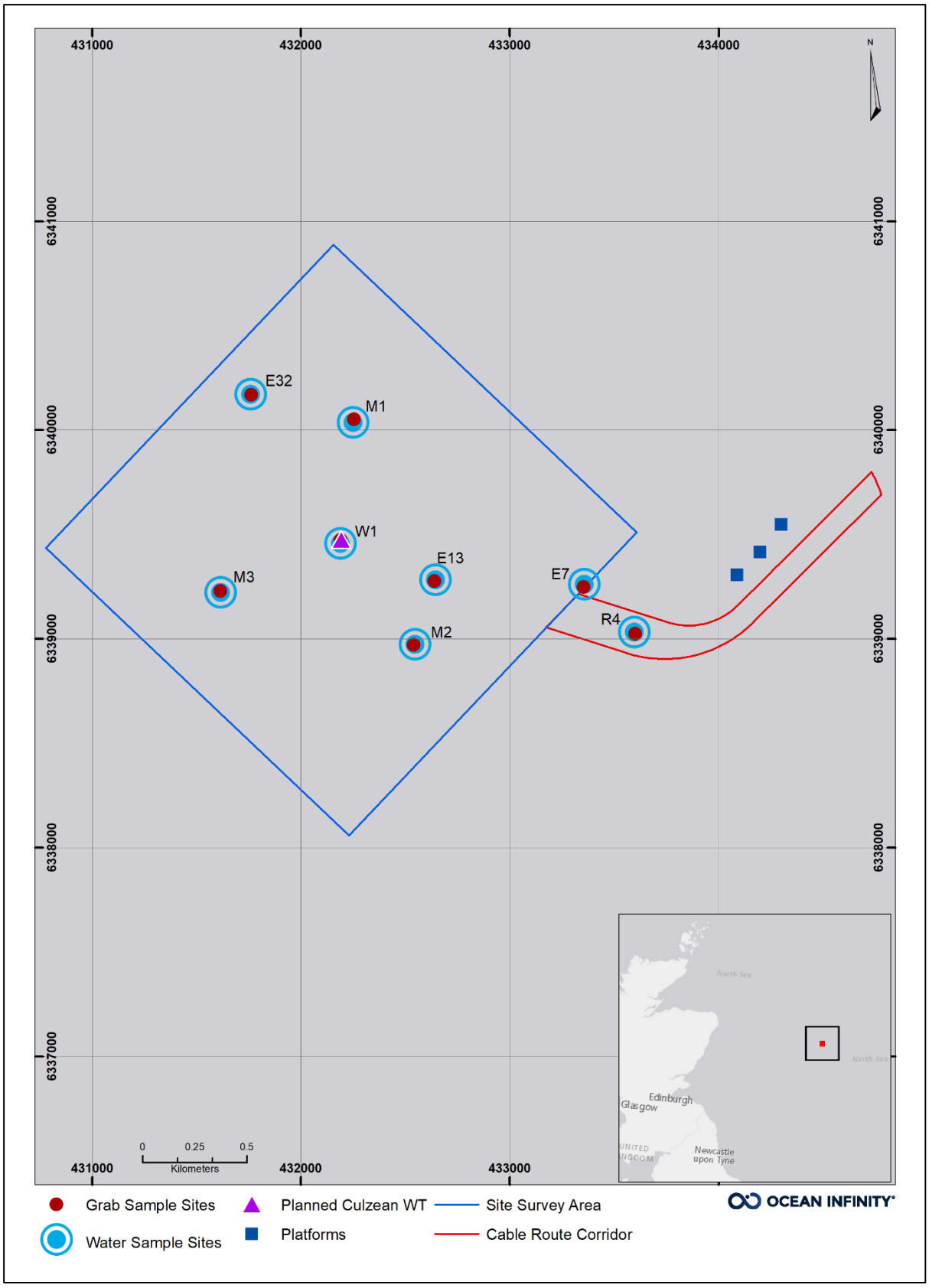


Figure 4 Overview of the proposed sampling design.

4.1.2 Drop Down Video

A SeaSpyder DDV system from STR (Figure 5 and Figure 6) was used to acquire still and video imagery at each sample site.

Figure 5 SeaSpyder DDV System.

Figure 6 SeaSpyder DDV example still photo.

Video transects of length 100 m were planned at each sampling, covering the centre location of the proposed grab sample site. Still photos were acquired every 25 m along the 100 m transects at positions +50 m, +25 m, 0 m, -25 m, and -50 m from the centre of the grab sample site. In total, a minimum of five (5) still photos were taken and more frequently if the seabed exhibited features of interest i.e., reefs and/or evidence of increased diversity.

The camera was positioned as close as possible to the pre-selected starting point using the vessel's dynamic positioning system during the survey. The camera frame was lowered onto the seabed to adjust the camera focus. When the camera focus was set, an initial photo was taken, before the video recording was initiated.

The camera frame was eased off the seabed and towed slowly at approximately 0.2 - 0.5 knots. It was positioned as close to the seabed as possible with an approximate altitude of 0.5 - 1 m. Altitude was determined by seabed topography and weather conditions.

A field log was maintained during photo and video collection at each site to provide each grab sample site with a preliminary description of findings. This included the drop number, position in relation to the proposed location, duration and a summary of the sediment type and conspicuous fauna observed. Anthropogenic impacts that were visible were also recorded including evidence of fishing activity, existing infrastructure, and marine debris.

Prior to grab sampling, an experienced Benthic Ecologist reviewed all video transect data onboard to confirm the presence/absence of any potentially sensitive habitats or features of conservation interest.

4.1.3 Faunal Grab Sampling and Sample Preservation

At each grab sample site, four (4) grab samples were acquired: three (3) samples for benthic faunal analyses and one (1) sample that was subsampled for Particle Size Analysis (PSA) and contaminant analyses. A sub-sample for eDNA was collected from the third faunal sample at each grab site.

Upon retrieval, samples were checked for adequate sample volume and samples covering less than 0.1 m^2 of bottom surface sediment were deemed unacceptable. No samples of less than 5 cm (7 cm in fine sediments) for the Dual Van Veen (DVV) or 7 litres for the Hamon grab (HG) were considered acceptable samples (Worsfold, Hall, & O'Reilly, 2010; Davies, et al., 2001). Samples that were not accepted were not included in any statistical analyses. During survey, only the DVV was deployed due to the nature of the seabed and lack of coarse substrates.

Sediment samples for eDNA were sampled according to the guidance specifications and materials provided by NatureMetrics.

A minimum of 40 g of sediment was collected at each site. Extreme care was taken to minimise any contamination of the samples. Each sample was stored in a sealed bag, in which the sediment was mixed to homogenise the sample.

All samples were photo-documented in-situ. Approved faunal samples were carefully sieved using seawater in a 5 mm over a 0.5 mm mesh sieve using gentle hose pressure. Sieve fractions were preserved with 96 % ethanol in separate jars, that were labelled with a unique label containing grab sample site ID and replicate number. A field log of sample positions including time, sediment type, and water depth was kept for later reference.

For further information regarding sample volume and the number of attempts see Appendix B.

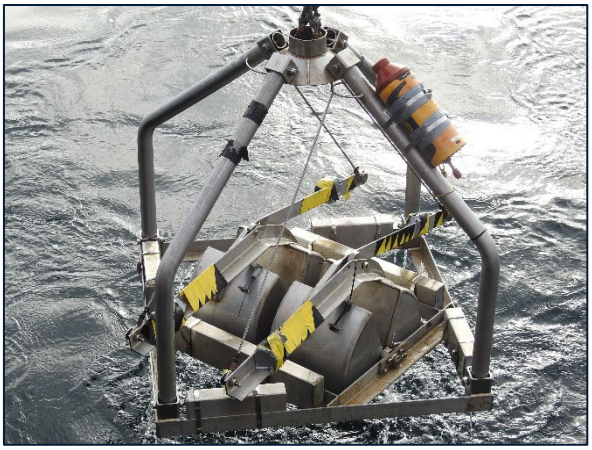


Figure 7 Dual Van Veen sampler.

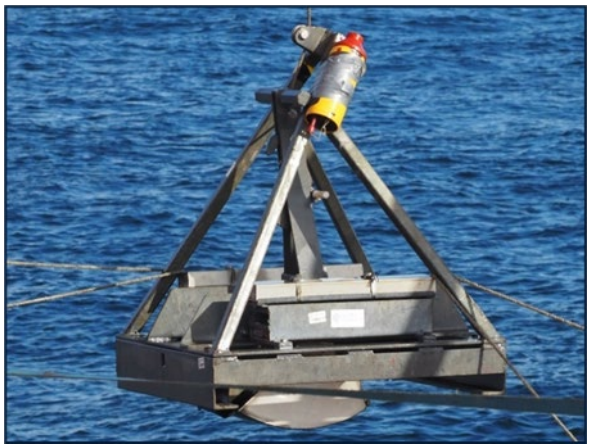


Figure 8 Hamon grab sampler.

4.1.4 Particle Size and Contaminants Grab Sampling

The primary grab sampler utilised for PSA and contaminants sampling was the Dual Van Veen (DVV) (Figure 7). The Hamon Grab (HG) was used as a secondary grab to sample PSA and fauna in areas of coarse sediment, however, the Hamon Grab could not be used for contaminants samples (Figure 8).

Upon retrieval, samples were checked for adequate sample volume and samples covering less than 0.1 m^2 of bottom surface sediment were deemed unacceptable. No samples of less than 5 cm (7 cm in fine sediments) for the DVV or 2.7 litres for HG were considered acceptable PSA samples (Worsfold, Hall, & O'Reilly, 2010; Davies, et al., 2001). During survey, only the DVV was deployed due to the nature of the seabed and lack of coarse substrates.

Samples for metals, organics (Total Organic Matter (TOM) and Total Organic Carbon (TOC)), hydrocarbons (Total Hydrocarbons (THC) and Polycyclic Aromatic Hydrocarbon (PAH)), Polychlorinated Biphenyls (PCB), organotins (Monobutyltin (MBT), Dibutyltin (DBT) and Tributyltin (TBT)), pesticides and flame-retardants were taken from an undisturbed surface. The sediments were collected with a plastic spoon for metals and a metal spoon for organics, hydrocarbons, PCB, organotins, pesticides and flame-retardant to ensure minimal contamination risk. The grab sampler was cleaned between samples and sample sites.

A one (1) litre plastic container was used for the metal samples as well as PSA samples. For the contaminant analysis of organics, hydrocarbons, PCBs, organotins, pesticides and flame-retardants, a 250 ml tin container was used for storage. The different containers ensured that there was no outside contamination of the samples.

The sample containers were labelled with a unique sample site ID. The contaminants samples were stored frozen (-21°C) according to the analysing lab's recommendations before and during shipment.

A field log of sample positions including time, sediment type, and water depth was kept for later reference. Samples were photo-documented in situ. For further information regarding sample volume and the number of attempts, see Appendix B.

4.1.5 Contaminants and eDNA Water Sampling

Water sampling was performed using 5 L Niskin bottles attached to a Rosette sampler (Figure 9). The open bottles were lowered into the water and closed at pre-assigned depths. A CTD sensor was fitted to the Rosette sampler. There were five (5) Niskin bottles attached to the Rosette, two (2) for bottom water samples, and two (2) for top water samples with one bottle collected as a redundancy. The bottles were labelled according to the depth they triggered (Bottom and Top). Samples from the two (2) depths were collected from a single cast.

As the Rosette sampler was winched down to the bottom, the CTD sensor recorded depth, temperature, conductivity/salinity in the water column. When close to the seabed, a position fix was taken, and the rosette sampler was then winched upwards for recovery. During the upcast, the bottles closed at their pre-assigned depths to collect the water samples.

Once the sampler was recovered to the vessel, water for metals, THC, PAH and Total Suspended Solids (TSS) analyses was collected from the Bottom and Top bottles into pre-labelled 1 L amber glass jars and stored in the onboard freezer at -21°C.

Retrieved samples were assigned a sample number and their UTM coordinates, date and time of collection, and water depth were documented. The data from the CTD and turbidity sensor was downloaded and saved to a hard drive separately upon recovery for each cast at each sample site.

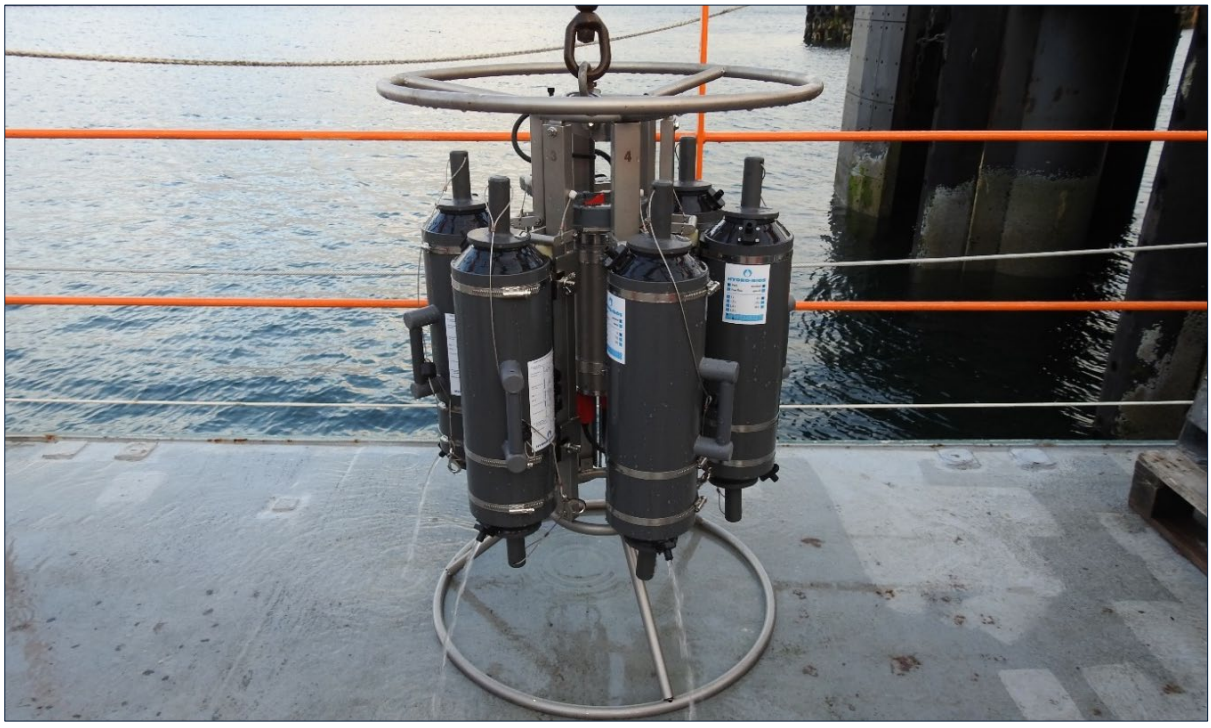


Figure 9 Rosette sampler equipped with Niskin bottles and CTD sensors.

Top and Bottom water were also filtered for eDNA using the Vampire sampling pump and following the guidance specifications provided by NatureMetrics. Water sampling for eDNA was carried out to determine the presence of fish, vertebrates, marine mammals, invertebrates and eukaryotes.

Care was taken to minimize contamination by performing the eDNA sampling in a dedicated area on the back deck. Separate eDNA sampling kits, consisting of Nitrile gloves, enclosed filters, a syringe filled with preservative solution, silicone hose, specimen bag, datasheet and disinfectant wipe were used for each sample/water body to avoid cross-contamination.

The silicone hose was inserted at the top of the Niskin with an enclosed filter (0.8 µm pore size, polyethersulfone) attached to the hose adapter. Once the entire 5 L Niskin bottle was filtered through, the filter was carefully detached from the hose.

A syringe filled with 1.5 mL DNA preservative solution was twisted onto the filter and the entire preservative solution was slowly added into the filter. The filter was then detached from the syringe and sealed with a separate Luer Lock cap.

Filters were stored in a resealable specimen bag, which was in turn placed into the eDNA kit bags alongside the datasheet noting the Sample ID and depth from which it was taken. Samples were then stored in the onboard freezer at -21°C.

4.2 Data Analysis

4.2.1 Visual Data Analysis

The stills were analysed to identify species and species densities, including seabed substrate. The video recordings were used to aid in the assessment of features and extent of habitats. Particular attention was paid to the elevation of habitats above ambient seabed level, together with their spatial extent, percentage biogenic cover, and patchiness, as these are key criteria for evaluating areas of conservation interest.

Quantitative methods were used for the identification of biota in still photographs, with all the data presented as individuals per square metre and percentage cover of colonial species. Stills were analysed in AutoCAD Map 3D, where visual epibenthic fauna was counted, and results were summarised in a log containing scientific name, position, date, time, and stills ID. Qualitative methods were used for the identification of biota in the video recordings.

4.2.2 Acoustic Data Analysis

Multibeam echo sounder (MBES) and side scan sonar (SSS) data from the geophysical survey together with the epifaunal composition from visual ground truthing data was used to determine the extent of habitats (Figure 10 and Figure 11). Video recordings, as well as field descriptions of grab samples, were also used to assign habitat classifications and delineate habitat boundaries.

The acoustic character of the SSS data has been correlated to the general seabed morphology (MBES DTM and backscatter) and used to help classify the seabed sediments. The SSS data is presented as a greyscale image mosaic where the darker grey to black colours indicate higher intensity sonar returns corresponding to coarser sediments, and lighter grey colours indicate lower intensity sonar returns corresponding to finer sediments.

Once all data has been reviewed, the different data sets are aligned, and habitat classifications are extrapolated based on textural similarity, reflectivity, and topographical features. The different datasets are combined to strengthen the accuracy of interpretations.

Extrapolating a large area based on a low number of samples may lead to a lower hierarchic biotope level for that area, compared to the actual biotope level for the samples within the habitat. If two different habitats are classified at two different sites/transects in what appears to be a similar habitat, based on the geophysical interpretation, this may lead to the assignment of a matrix of the two habitats. These compromises are reviewed individually. A smaller homogenous and distinctive area can be assigned to a higher hierarchic level compared to a larger and more variable area containing several different biotopes. The result of the habitat classification is presented in the results section and GIS charts.

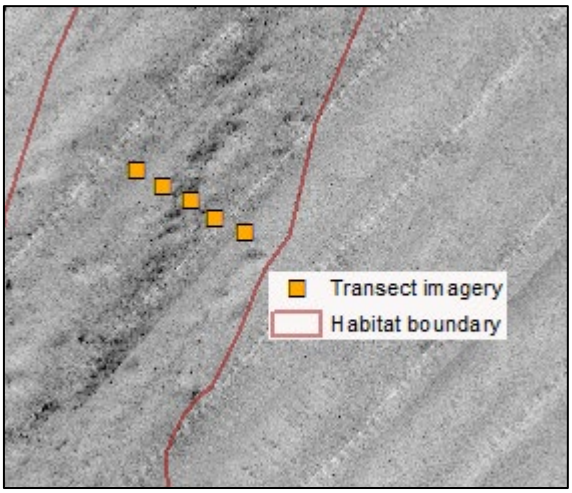


Figure 10 Example of side scan sonar image of a furrow and areas of finer sediments.

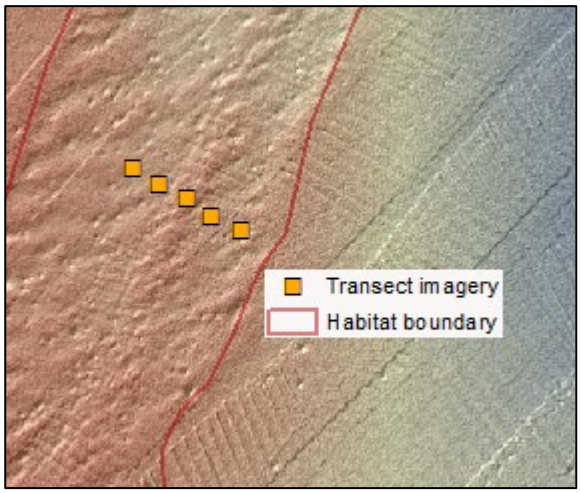


Figure 11 Corresponding bathymetric image of a furrow and areas of finer sediments.

4.2.2.1 Backscatter

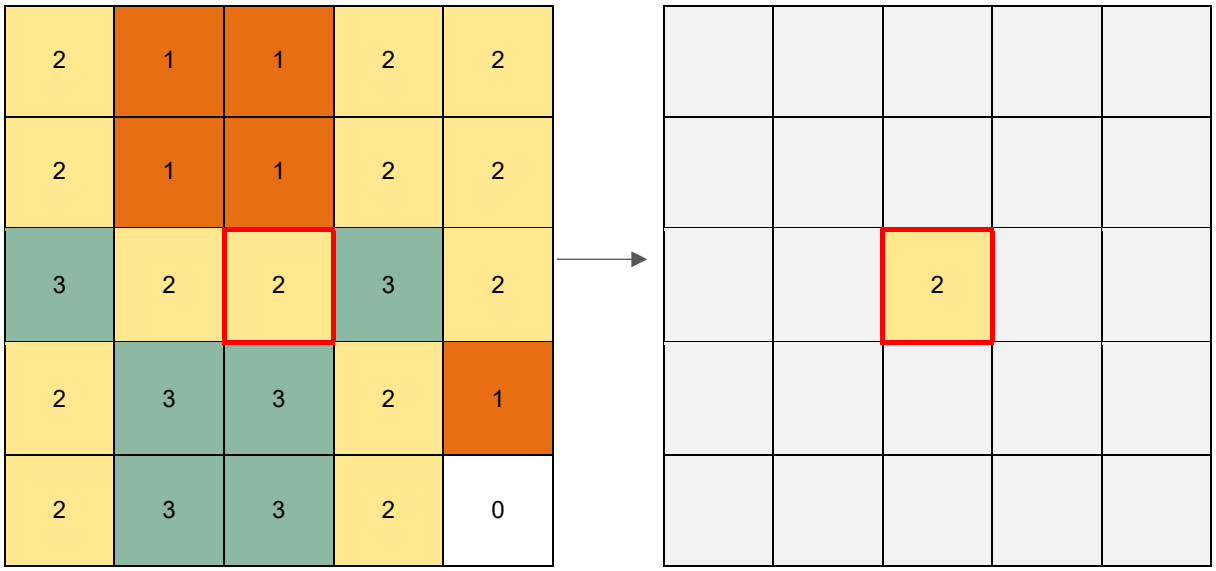
The use of backscatter data to assist habitat interpretations and mapping is a methodology under development, increasingly used in these types of analyses (Lurton and Lamarche, 2015). Backscatter Normalised Values are a measurement of the MBES echo that is scattered in the direction of the transducer. This data records the intensity, in decibels (dB), of the echo that returns to the transducer after the emitted pulse interacts with the seabed. The backscatter amplitude varies with several factors such as frequency, beam pattern, range and losses due to absorption and spreading, angle with the seabed as well as sediment type and other factors.

The raw data were processed with the Fledermaus (FMGT) software, which applied various standard normalisations to the data to compensate for how the intensity varied across the swath, producing a grayscale floating-point raster image gridded at 1 m, where each gridded cell contains a measured intensity value.

The values ranged from 9.7 to -61.5 dB, with the higher values (9.7) indicating harder/coarser seabed, and the lower values (-61.5) indicating softer/finer seabed. The raster image extent was further clipped to align with the survey boundaries to remove outlier values often associated with line turn and/ or end of the survey line. The values post-clipping ranged from -2.6 to -55.8 dB.

Backscatter values varied across a small spatial scale, making interpretations on a larger scale challenging due to the small-scale variation. To mitigate this, the Focal Statistics tool in ArcGIS was used to reduce the variation in the values. The backscatter raster data was imported into ArcGIS and a raster image was created based on the measured intensity values for each cell and plotted. Within ArcGIS, a secondary raster image was created through the calculation of the cell value with the Focal Statistics tool. The tool calculates a new value for each input cell based on the neighbouring cell values. The new value output was based on the average value of the neighbouring cells in a 10 x 10 m (10 x 10 cells) square area with the target cell included (Table 10). The new cells maintained the original cell size of 1 x 1 m.

Table 10 Focal Statistics settings.



Ground-truthing data (imagery) together with geophysical data were used to align the backscatter reflectivity intervals based on the trends interpreted, with regards to substrate and habitats (Lurton and Lamarche, 2015). However, some limitations in interpretation should be considered as the directionality of the survey lines varied and the changes in elevation and angle of the seabed affect the amount of reflected sound, resulting in the fact that overlapping lines could show different noise signatures. This was partially mitigated by using the Focal Statistics tool in ArcGIS, as the interpolation used in the tool averages out the overestimated and underestimated values from the backscatter.

Outlier values from the outermost ranges from the data sets were naturally excluded as the grouping of the intervals was set and these are detailed in Table 11.

Table 11 Backscatter Intensity colour schema for each area (intensity is presented in dB).

Datasets	Colour Bars and Classes (dB)	Outliers (dB)
RAW	-61.5 to -29.96 -29.95 to -27.45 -27.44 to -25.21 -25.2 to -22.7 -22.69 to 9.68	9.68 to - 2.6; -61.5 to -55.8
Site Survey Area and Cable Route Corridor	-29 to -25.6 -25.59 to -24.7 -24.69 to -20.8	-40 to -29; -20 to -9

4.3 Habitat Classification

Habitats were classified to the lowest hierarchic level possible and based on interpretations that combine biotope descriptions of species abundance, diversity, depth and seabed features from grab samples, video and photos acquired at each sample site.

The classification of the communities of the different habitat types was based on physical characteristics such as benthic geology, wave exposure, tidal currents, temperature, and salinity together with key species present in the area. In addition, normalized backscatter data from MBES was used to delineate habitats in areas of homogenous sediments.

4.3.1 EUNIS

Habitats within this report were classified to the lowest hierarchic level possible and based on interpretations of the combined geophysical data and ground truthing imagery. The EUNIS classification (EEA, 2022) is divided into six hierarchic levels, Figure 12.

At Level 1, the habitats are divided into marine, coastal and terrestrial habitats. The marine habitats are further divided into three separate categories: benthic, pelagic and ice-associated habitats.

At Level 2, the biological zone and presence/ absence of rock are classification criteria, and at Level 3, the classifications are separated into marine regions.

Level 4 gives references to specific taxa. For rocky substrates, the major epifauna is used, and for softer substrates, the classification relies on both zonation and physical attributes. Further, at Level 5, the classification is based on both the physical and biological characteristics of the habitats and classes are defined with both infauna and epifauna on different substrates. At the highest level, level 6, the different characterising taxa are associated with different environmental characteristics of the habitat.

If two different habitat classifications within what appears to be a similar habitat are identified, without any apparent differences in the interpreted geophysical data, a low number of samples/ transects may lead to the assignment of a matrix of two habitats. Extrapolating a large area based on a low number of samples may lead to a lower hierarchic biotope level for that area, than the actual biotope level for a singular sample within the habitat.

These compromises are reviewed individually. A smaller homogenous and distinctive area can be assigned to a higher hierarchic level compared to a larger and more variable area containing several different biotopes. The result of the habitat classification is presented in the results section and GIS charts.

L1	(M) Marine Habitats
L2	(MC4) Circalittoral mixed sediment
L3	(MC42) Atlantic circalittoral mixed sediment
L4	(MC421) Faunal communities of Atlantic circalittoral mixed sediment
L5	(MC4211) *Cerianthus lloydii* and other burrowing anemones in circalittoral muddy mixed sediment
L6	(MC42111) *Cerianthus lloydii* with *Nemertesia* spp. and other hydroids in circalittoral muddy mixed sediment

Figure 12 Example of 2022 EUNIS Hierarchy.

4.4 Habitats and Species Assessments Criteria

For the assessment and classification of potential areas and/or species of conservation importance, the following legislation and guidelines have been applied when relevant.

The European Commission (EC) Habitat Directive specifies the European nature conservation policy (EUR 28, 2013). Species and habitats of special interest for conservation are specified in the different annexes to the directive. Annex I states the habitats of special conservation interest and Annex II states the species of special conservation interest. Among the habitats specified in Annex I are the “Reefs” (code 1170). Reefs can be of biogenic, e.g. mussel beds or corals, or geogenic origin, e.g. stony areas with epifauna.

The Oslo and Paris Conventions for the protection of the marine environment of the North-East Atlantic (OSPAR), list protected species and habitats, as well as sensitive habitats and species in need of protection in the North-East Atlantic (OSPAR, 2008). This serves also as a complement to the EC Habitats Directive.

The species and habitats found in this survey were compared to the list of Scottish Priority Marine Features (PMF) (Tyler-Walters, et al., 2016) that further defines the habitats and species which are considered to be marine nature conservation priorities in Scottish waters.

In addition to the above-mentioned policies and guidelines the Scottish Biodiversity List (SBL) identifying the species and habitats which are the highest priority for biodiversity conservation in Scotland was also consulted (Scottish Biodiversity Forum, 2012).

In the Habitat Directive's interpretation manual (EUR 28, 2013) reefs are explained as follows:

"Reefs can be either biogenic concretions or of geogenic origin. They are hard compact substrates on solid and soft bottoms, which arise from the sea floor in the sublittoral and littoral zone. Reefs may support a zonation of benthic communities of algae and animal species as well as concretions and corallogenic concretions."

The distinction between what *is* and what *is not* a "reef" is not so precise and is generally referred to as "reefiness". This is particularly relevant in the case of the tube-building polychaete, *Sabellaria spinulosa* and areas of cobbles and boulders (stony reef).

If for example *S. spinulosa* or the horse mussel, *Modiolus modiolus,* is found in an area it does not automatically qualify as a "reef", Annex I habitat or a potential Annex I habitat. Therefore, a scoring/assessment system based on a series of physical, biological and spatial characteristics is used to assess the degree of "reefiness".

A method to assess 'reefiness' was presented by Gubbay (2007) and involves the quantification of three separate criteria: elevation (average tube height in cm), Area (m^2) and patchiness (percentage cover) as presented in Table 12. A similar assessment matrix for stony reefs by Irving (2009) is presented in Table 13.

Table 12 Proposed chart for Sabellaria spinulosa reef identification (Gubbay, 2007).

Characteristic	Not A Reef	"Reefiness"		
		Low	Medium	High
Elevation (cm) (average tube height)	<2	2 – 5	5 – 10	>10
Extent (m^2)	<25	25 – 10,000	10,000 – 1,000,000	>1,000,000
Patchiness (% cover)	<10	10 – 20	20 – 30	>30

Table 13 Guidelines used to categorise 'reefiness' for stony reefs (Irving, 2009).

Measure of 'reefiness'	Not a stony reef	Low	Medium	High
Composition	<10 %	10 - 40 % Matrix supported	40 - 95 %	>95 % Clast supported
Notes: Diameter of cobbles / boulders being greater than 64 mm. Percentage cover relates to a minimum area of 25 m^2. This 'composition' characteristic also includes 'patchiness'.				
Elevation	Flat Seabed	<0.064 m	0.064 m - 5 m	>5 m
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	>25 m^2		
Biota	Dominated by infaunal species			>80 % of species present composed of epifaunal species.

This scoring system indicates that stony reefs should be elevated by at least 0.064 m and with a composition of at least 10 % stones, covering an area of at least 25 m^2 and having an associated community of largely epifaunal species. For "Bedrock Reefs" no similar scoring system exists. In areas where the geophysical data cannot provide information on the degree of exposure, on bedrock, these areas will be delineated as "Potential Bedrock Reefs". The qualifying criteria for the classification "Bedrock Reefs" is the presence of bedrock that could support an epifaunal community.

5. Results

5.1 Field Operations

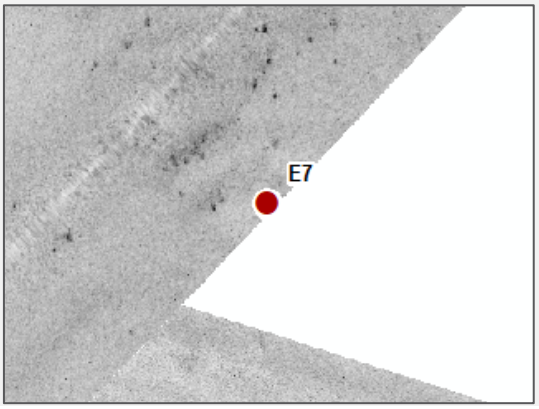
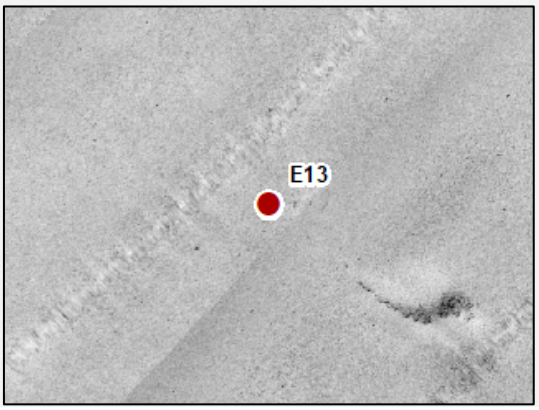
DDV transect and grab sampling as well as water sampling was undertaken at the eight (8) pre-selected sites (Table 14, Figure 13). Samples for particle size analyses, contaminants and fauna, including eDNA, were taken at all grab sample sites. Samples sites RD, M1 – M3 were offset 100 m from their planned location due to coinciding with vibrocore locations.

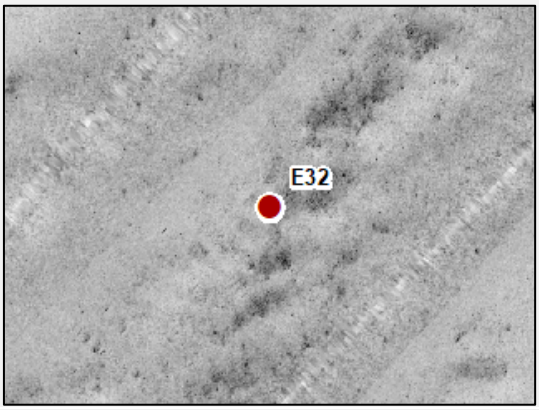
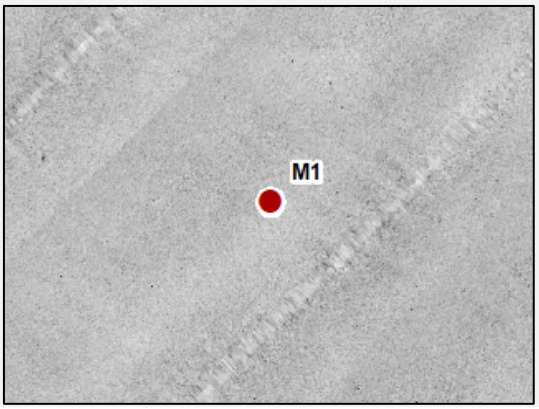
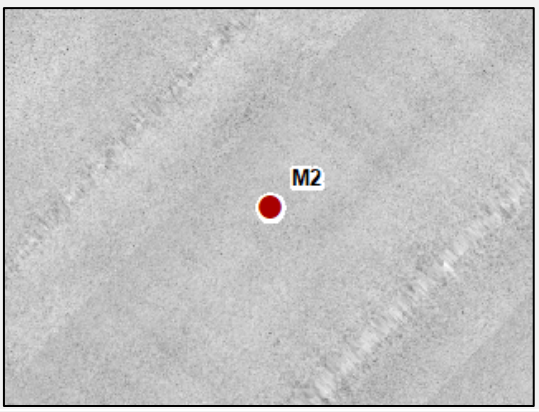
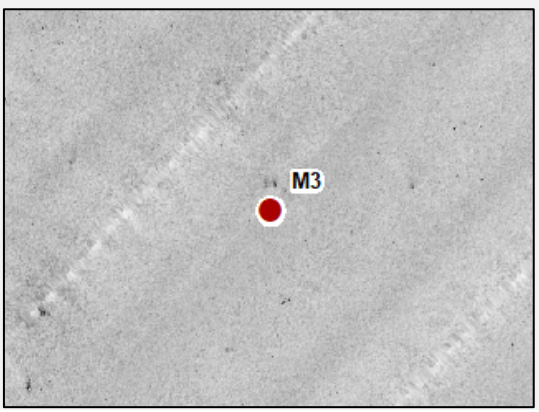
A geophysical data example of each planned grab sample site is presented in Table 14. Further information regarding sample sites is given in Appendix A.

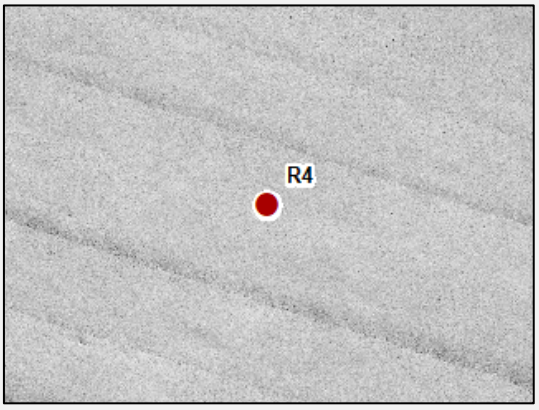
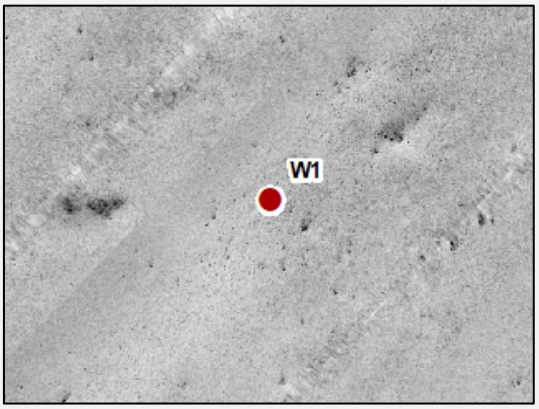
Table 14 Number of sample sites and transects.

No. of Sample Sites	Photo Transect Sites	Grab Sample Sites	PSA/Chem Sample Sites	Water/ eDNA Sample Sites
	8	8	8	8

Table 15 List of proposed grab sample sites.

Site ID	Easting	Northing	Geophysical Data Overview
E7	433355	6339248	
E13	432652	6339277	

Site ID	Easting	Northing	Geophysical Data Overview
E32	431761	6340167	
M1	432357.6	6340049.2	
M2	432609.9	6339041.5	
M3	431611	6339326.8	

Site ID	Easting	Northing	Geophysical Data Overview
R4	433682.9	6339006.7	
W1 (at Culzean WT)	432192.8	6339472.5	

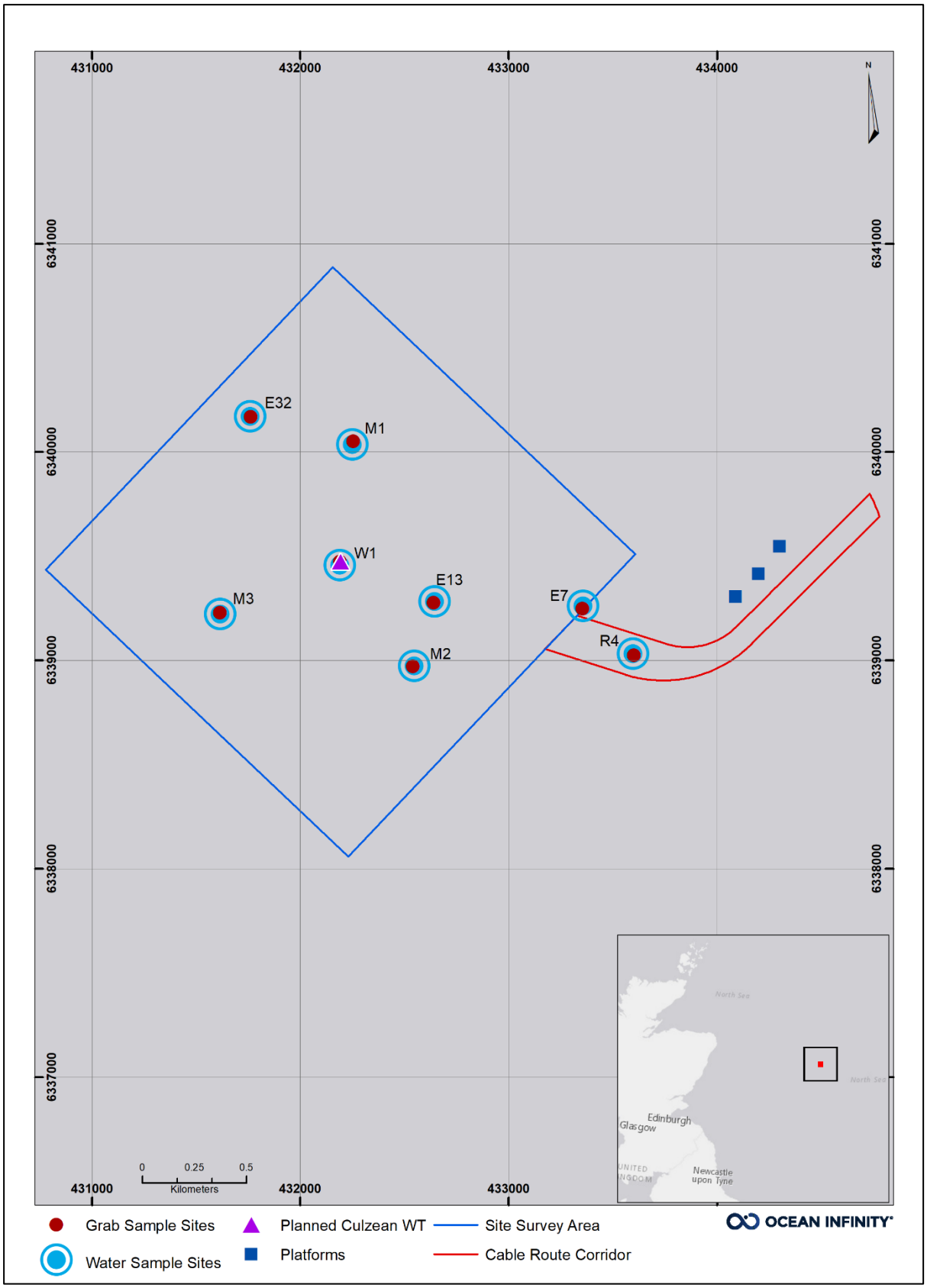


Figure 13 Overview of the conducted environmental sampling.

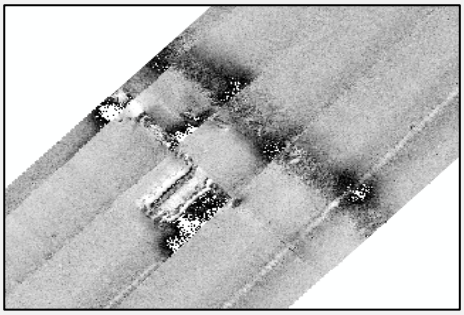
5.2 Summary of Identified Habitats

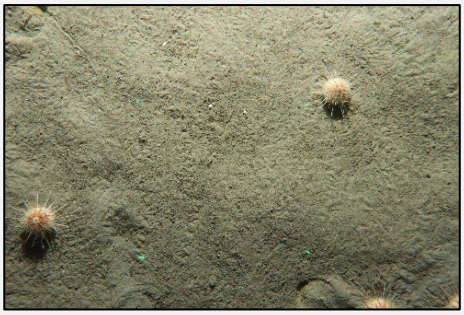
A total of five (5) EUNIS habitats including three (3) habitat complexes and one (1) artificial habitat were identified and delineated within the survey areas.

An overview of the identified habitats and sample sites is presented in Table 16 and further illustrated in Figure 16. The ID column in Table 16 defines the colour in the charts for the specific habitat type.

NOTE: The Habitat Assessment presented in this report is based on video and still images along with field descriptions and PSA results of the grab samples. The grab sample laboratory test results were not available at the time of writing but will be included in the Environmental Baseline Report (104728-TOT-OI-SUR-REP-ENVBASRE).

Table 16 Identified habitats within the surveyed area.

Habitat Image	ID	Habitat Classification	EUNIS Habitat Code	Site ID
		Constructed, industrial and other artificial habitats	J (V. 2012) *	
		Faunal communities in Atlantic offshore circalittoral sand	MD521	E7
		Faunal communities in Atlantic offshore circalittoral sand/ Seapens and burrowing megafauna in Atlantic circalittoral fine mud	MD521/ MC6216	M1, M2, E13 and R4

Habitat Image	ID	Habitat Classification	EUNIS Habitat Code	Site ID
		Faunal communities in Atlantic offshore circalittoral sand/ *Brissopsis lyrifera* and *Amphiura chiajei* in Atlantic circalittoral mud	MD521/ MC6218	E32
		Faunal communities in Atlantic offshore circalittoral sand/ *Gracilechinus acutus norvegicus* assemblage on Atlantic upper bathyal sand	MD521/ ME5213	M3, W1

**EUNIS 2012 habitat applied due to no equivalent habitat in the 2022 EUNIS classifications at the time of writing this report*

5.3 Area Descriptions

The habitat classifications within the Culzean site and route corridor were derived based on the geophysical data in combination with environmental sample sites (Figure 16). The interpreted habitats at the environmental sample sites were extrapolated to similar areas, where similarity was based on geophysical interpretations of substrate, texture, and topography.

For further details regarding results from the photo analyses see Appendix C and Section 5.4.

The depth within the Culzean site area ranges between 88.80 m to 92.35 m, and from 83.04 to 90.58 m along the cable route corridor (Figure 14). Small seabed depressions were noted scattered across both survey areas, representing the only notable features other than the jack-up spudcan depressions and existing infrastructure.

The seabed is quite homogenous within both survey areas, with some localised variations in the surface sediment composition. The backscatter intensity values exhibited limited variation with low reflectivity across a large spatial scale. Small-scale variability, where noticeable, was associated with features such as infrastructure, seabed depressions, furrows, occasional cobbles, and shell gravel (Figure 15).

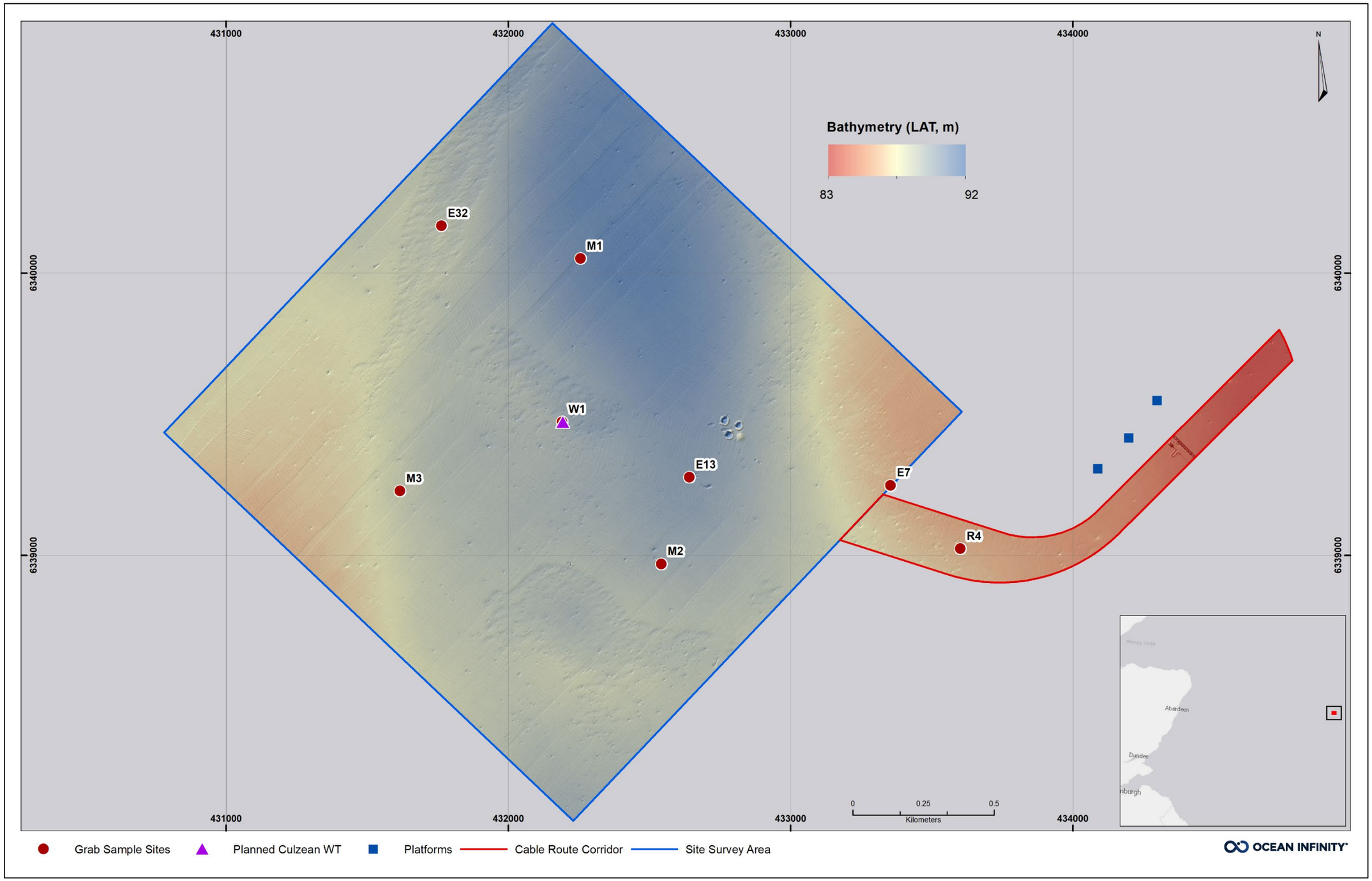


Figure 14 Bathymetric overview of the Culzean site and route corridor survey areas.

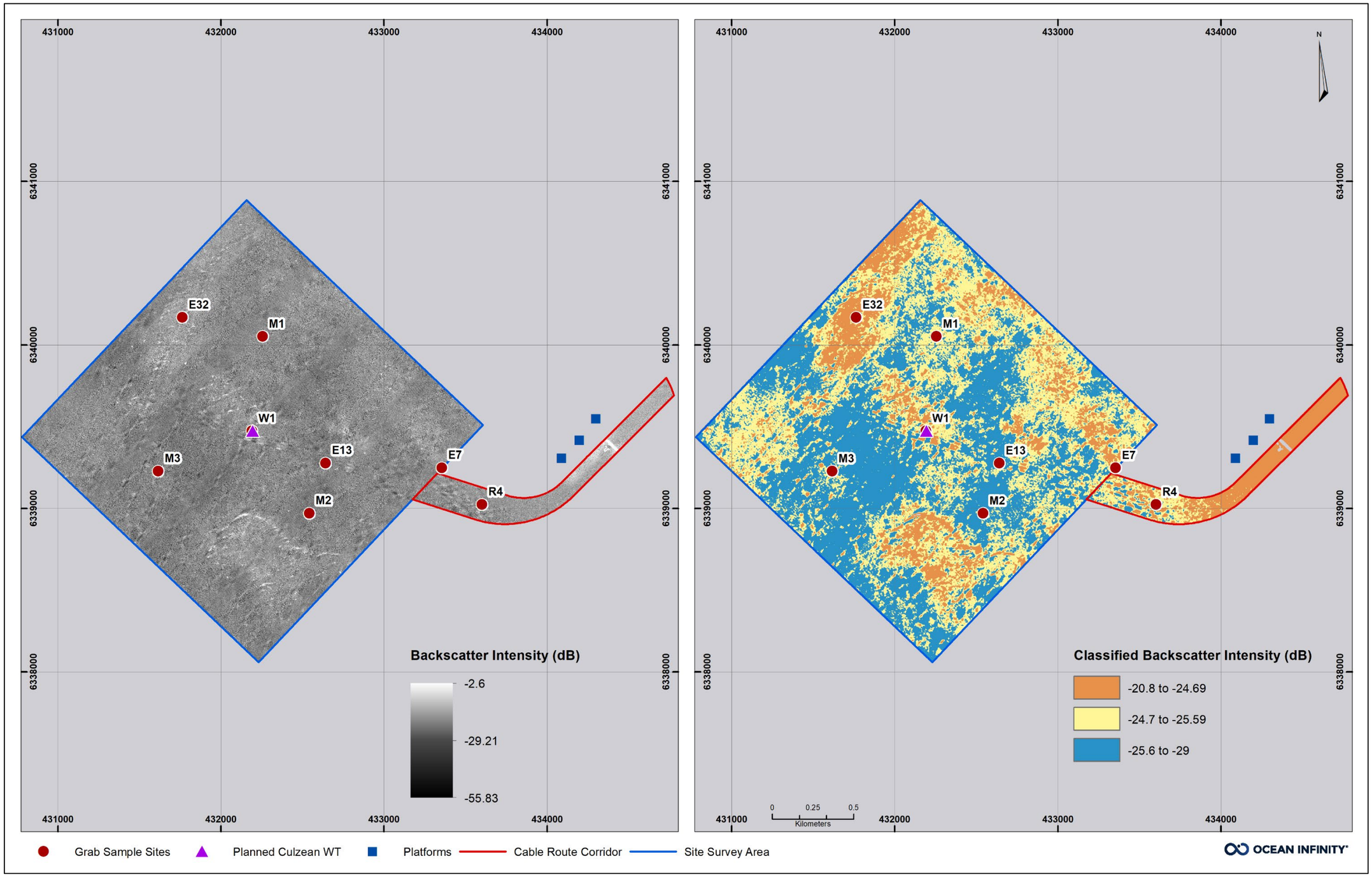


Figure 15 Overview of the raw and classified backscatter intensity within the Culzean site and route corridor survey areas.

The majority of the site area and export cable route comprises **MD521** - Faunal communities on Atlantic offshore circalittoral sand and/or muddy sand with some localised areas of coarse sediments in the north east of the Culzean site.

For the purpose of this report a number of habitat complexes have been introduced to better illustrate the small-scale substrate variation interpreted to be present.

Several of the noted taxon and the combination of these are currently only described within either the circalittoral or the upper bathyal levels of the EUNIS habitats classification. Thus, each assigned classification comprises **MD5 -** Offshore circalittoral sand as part of the complex to illustrate the depth band and substrate of the area and a more species-specific biotope to illustrate the faunal composition.

Notable taxa, as identified from the stills imagery and video acquired, were abundantly occurring sea pens *Pennatula phosphorea*, *Virgularia mirabilis*, sea urchins *Gracilechinus acutus*, *Brissopsis lyrifera* and likely a species of heart urchin, *Echinocardium chordatum* (Table 17). Further noted were rare occurrences of Ophiurida, Caridea, *Crangon* sp., Naticidae, *Hyalinoecia tubicola*, Polynoidae, Scaphopoda and *Pecten maximus*.

The majority of the site area and the western section of the route cable corridor are classified as habitat complex **MD521/MC6216** - Faunal communities on Atlantic offshore circalittoral sand/ Seapens and burrowing megafauna in Atlantic circalittoral fine mud. Occasional burrows, interpreted to be from Norway lobster *Nephrops norvegicus* were noted together with the Atlantic Hagfish *Myxine glutinosa*. The habitat complex **MD521**/**MC6216** matches the qualifying descriptors of the OSPAR habitat Sea-Pen & Burrowing Megafauna Communities.

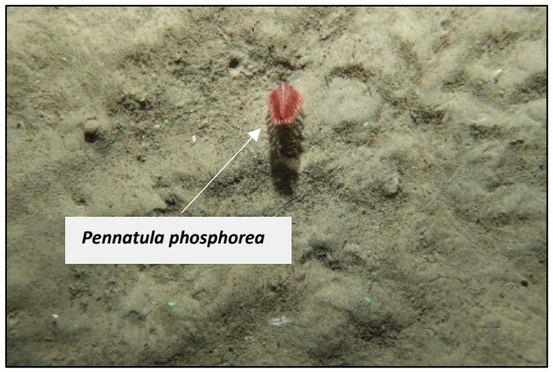
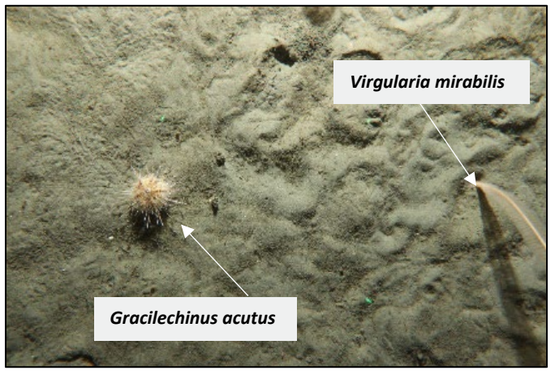
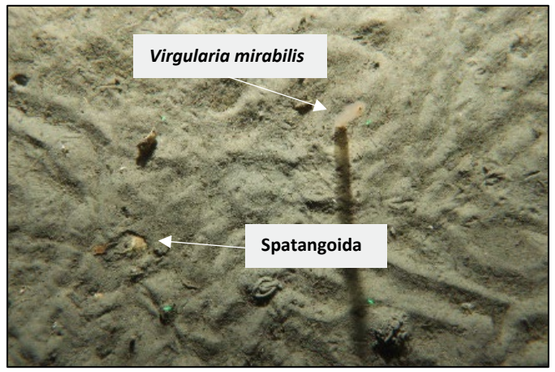
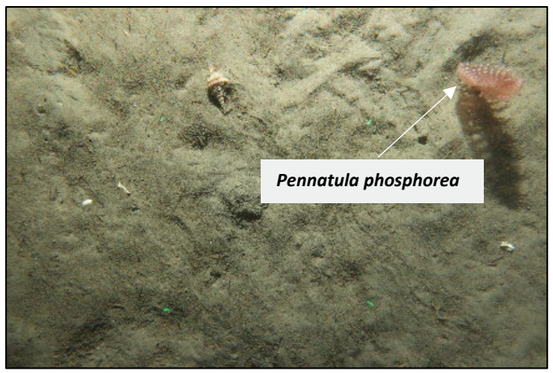
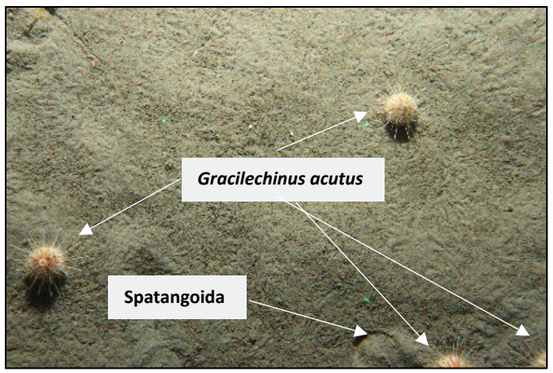
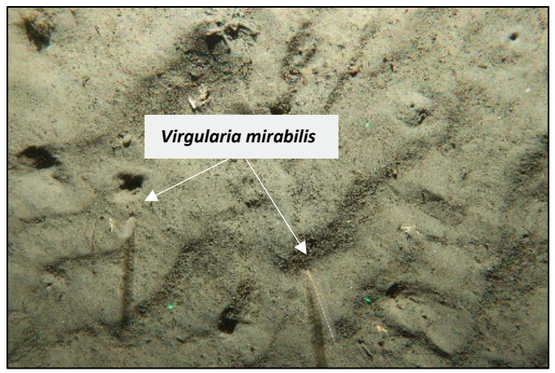
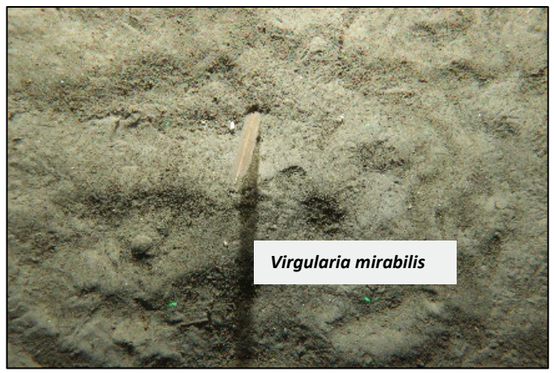
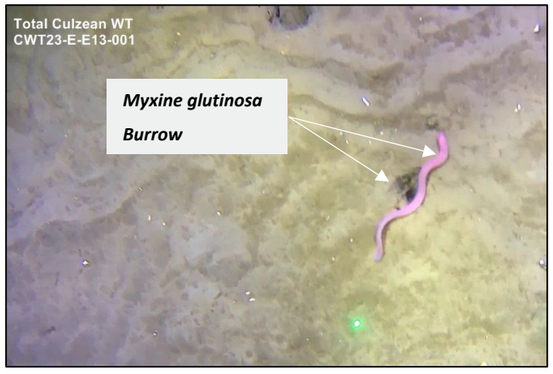
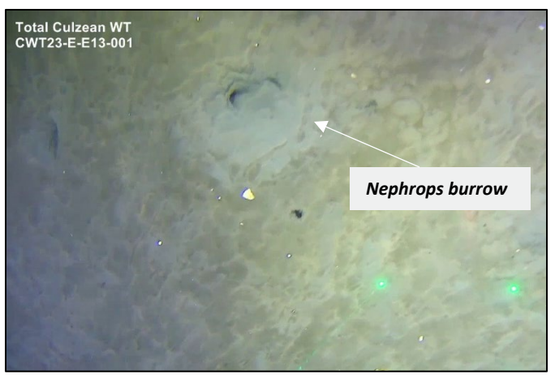
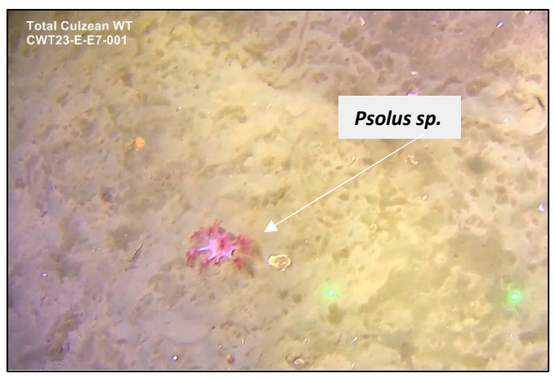
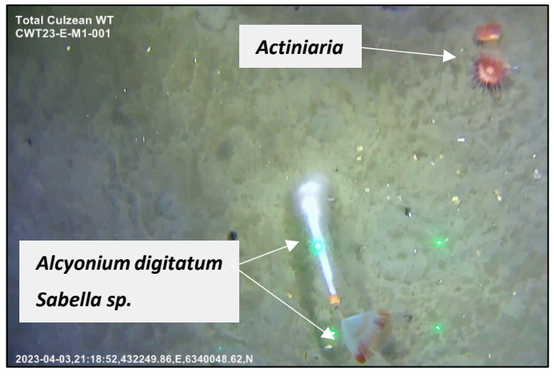
The western and central sections of the site area are characterised by a frequent occurrence of *G. acutus* and classified as habitat complex **MD521/ME5213** - Faunal communities on Atlantic offshore circalittoral sand/ *Gracilechinus acutus norvegicus* assemblage on Atlantic upper bathyal sand.

The furrows interpreted in the northernmost sections extend into the central sections of the site area and show a species composition similar to **MD521/MC6218** -Faunal communities on Atlantic offshore circalittoral sand/ *Brissopsis lyrifera* and *Amphiura chiajei* in Atlantic circalittoral mud.

The western sections of the site area were classified as **MD521** - Faunal communities on Atlantic offshore circalittoral sand, a habitat which also dominates the eastern half of the cable route corridor (Figure 16).

The underwater installation and SSIV (Sub-Sea Underwater Intervention Valve) in the cable route corridor was delineated as **J** - Constructed, industrial and other artificial habitats (EUNIS, 2012).

Table 17 Example stills acquired throughout survey area sample sites.

			
E7_SPT001	**E13_SPT001**	**E32_SPT002**	**M1_SPT005**
			
M2_SPT004	**M3_SPT005**	**R4_SPT004**	**W1_SPT003**
			
Still extracted from E13 video (E432619.01; N6339279.92)	**Still extracted from E13 video (E432631.53; N6339278.39)**	**Still extracted from E7 video (E433413.98; N6339264.47)**	**Still extracted from M1 video (E432249.86; N6340048.62)**

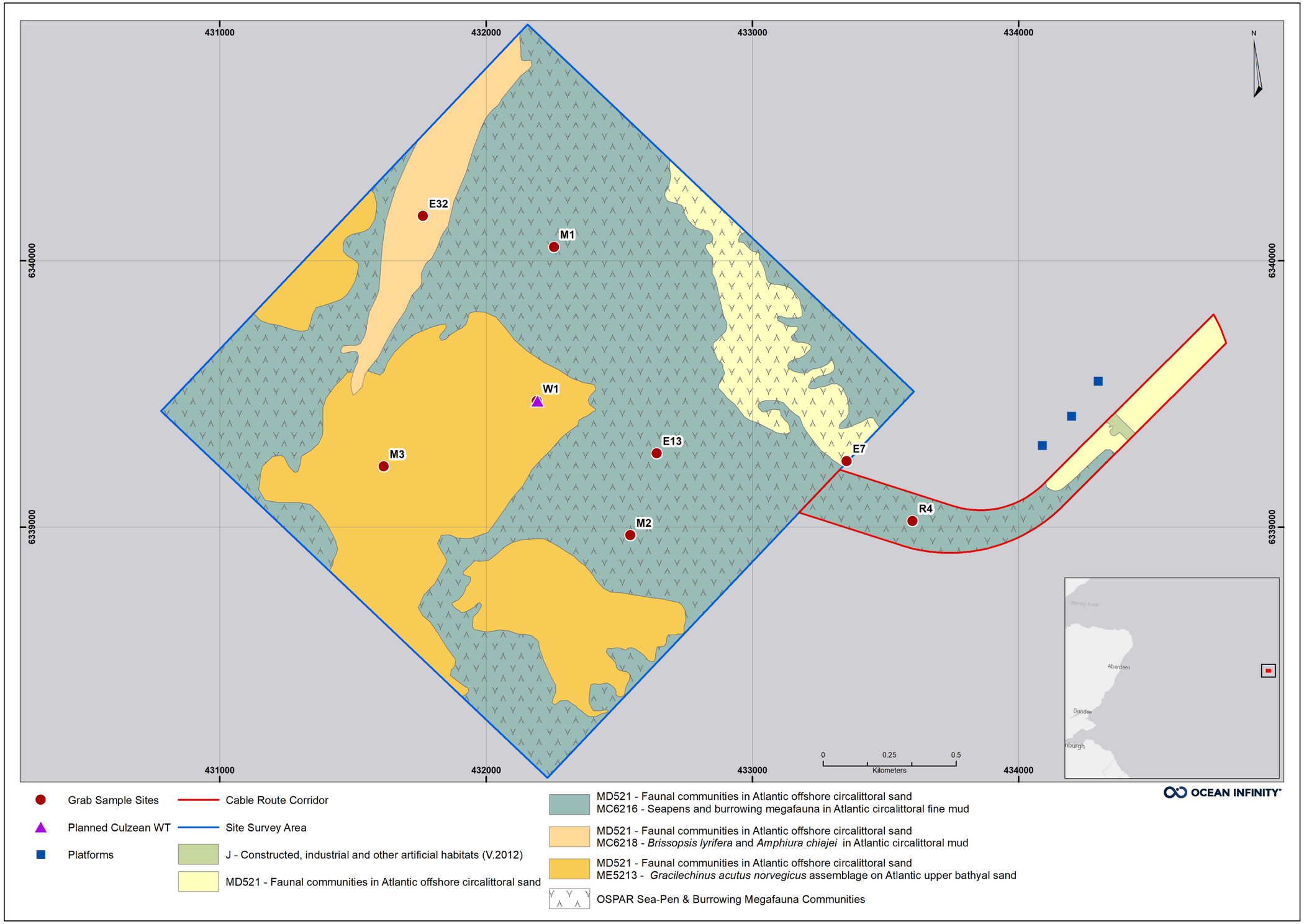


Figure 16 Overview of classified habitats within the Culzean site and route corridor survey areas.

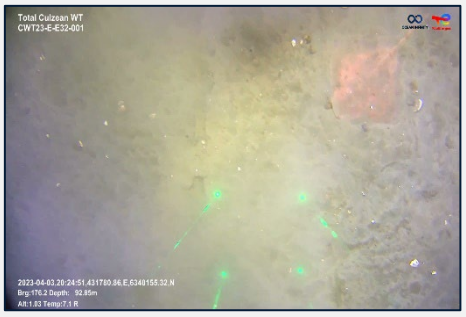
5.4 Potential Areas and Species of Interest

The habitats and species identified which correspond to those defined in the EC's Habitats Directive, the OSPAR List of Threatened and/or Declining Species and Habitats, Scottish PMF, and SBL are listed in Table 18 and Table 19.

Table 18 Potential habitats of conservation interest identified.

Image	Habitat	ANNEX I/OSPAR/PMF/SBL	Site ID
	Sea-Pen & Burrowing Megafauna Communities.	OSPAR PMF Burrowed Mud	R4, E7, E13, M2 and M1

Table 19 Potential species of conservation interest identified.

Image	Species	ANNEX I/OSPAR/PMF/SBL	Site ID
	Rajidae Possibly *Leucoraja circularis*	PMF/ SBL	E32

5.4.1 Habitats Directive

No habitats listed within the Annex I of the Habitats Directive (EEA, 2019; EUR 28, 2013) were identified within the site survey area or along the cable route corridor.

5.4.2 OSPAR and PMF

Habitat Sea pen and burrowing megafauna communities is listed by OSPAR and included in the List of Threatened and/or Declining Species and Habitats (OSPAR, 2008). It is considered under threat and/or decline in region II, the Greater North Sea (OSPAR, 2010). Sea pen and burrowing megafauna communities are a component biotope within the PMF habitat Burrowed Mud (Tyler-Walters, et al., 2016).

Sea pens and burrowing megafauna communities are characterised by a substrate comprising of fine circalittoral sand or mud, occurring in relatively sheltered areas. The bioturbation from burrowing megafauna occurring in these habitats facilitates oxygenation deep down in the sediment and allows for a great diversity of smaller organisms to survive. Prevalent features in this environment include burrowing mounds from crustaceans such as *Nephrops norvegicus, Calocaris macandreae* or *Callianassa subterranea*, as well as epifauna such as sea pens, *Virgularia mirabilis, Pennatula phosphorea*, and various types of echinoderms (OSPAR, 2010). In undisturbed areas the larger sea pen, *Funiculina quadrangularis* is more common (Tyler-Walters, et al., 2016).

The site survey area and cable route corridor comprised of sandy mud and muddy sand. Dominating species were burrowing and top gracing urchins along with sea-pens and occasional sea cucumbers. Burrows were present and observed in video on sites: E7, E13, M1, M2 and R4.

Burrows ranged from large in and exit holes and single vertical holes, presence of in fauna excrement casts was also observed, however no burrowing animals were observed. Table 17 contains example species and burrows seen in video and photos.

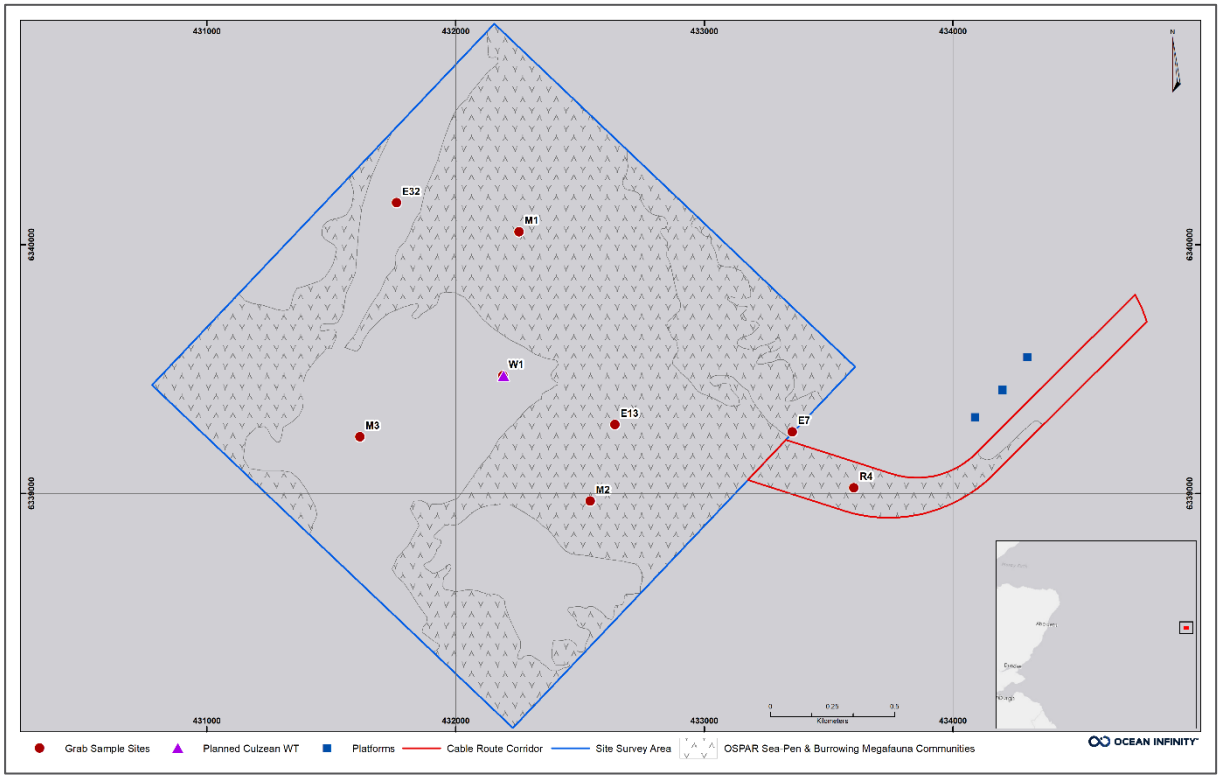
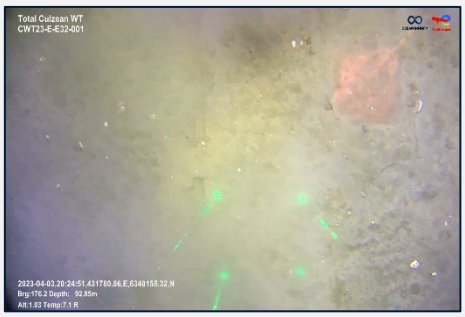


Figure 17 Survey area showing the delineation of OSPAR habitat Sea-pens and burrowing megafauna.

5.4.3 IUCN Red List

One taxon corresponding to those defined by the IUCN Red List as "Threatened" was identified in the survey area and is listed in Table 20.

Table 20 IUCN Red List taxa of concern identified within the survey areas.

Image	Description	IUCN Status	OSPAR/PMF/SBL	Site ID
	Rajidae, Possibly *Leucoraja circularis*	Endangered	PMF/ SBL	E32

Leucoraja circularis

A sandy ray, possibly *Leucoraja circularis,* was identified in the video at sample site E32. *L. circularis* belongs to the family Rajidae which is commercially designated in the United Kingdom (UK). The species *L. circularis* is considered "Endangered" according to the IUCN Red List (McCully, Ellis, Walls, & Fordham, 2015).It is also threatened by overfishing and as unwanted by-catch.

6. Conclusions

Sampling was conducted as part of the Benthic Environmental survey for TotalEnergies E&P North Sea UK Ltd (TotalEnergies) within the Culzean field, located approximately 230 kilometres off the coast of Aberdeen, Scotland in the Central North Sea.

Benthic sampling was performed at eight (8) pre-selected sites using a combination of Drop Down Video transects and grab sampling. In addition to benthic sampling, water sampling for eDNA and contaminants was conducted at the same locations.

The depth within the Culzean site area ranges between 88.80 m to 92.35 m, and from 83.04 to 90.58 m along the cable route corridor. Small seabed depressions were noted scattered across both survey areas and represent the only notable features other than the jack-up spudcan depressions within the site survey area and existing infrastructure within the route cable corridor.

The seabed within both survey areas is quite homogenous with some localised variations in the surface sediment composition. The backscatter intensity values exhibited limited variation with low reflectivity, across a large spatial scale. Small-scale variability, where noticeable, was associated with features such as infrastructure, seabed depressions, furrows, occasional cobbles and shell-gravel.

A total of five (5) EUNIS habitats including three (3) habitat complexes and one (1) artificial habitat were identified and delineated within the survey area.

The OSPAR habitat Sea-pens and burrowing megafauna was identified in the site survey area and cable route corridor. The habitat is widespread and covers more than 50 % of the surveyed area. The remaining seabed mainly comprised sea pens, heart urchins, sea urchins with minor to no burrow's present. The absence of burrows could suggest a difference in sediment composition.

From the image and video data, one species listed by IUCN Red List as "Threatened" was identified: Rajidae (possibly *Leucoraja circularis*).

7. Reservations and Recommendations

The results detailed within this report are based on the field grab sample site descriptions, and analyses of the photo and video recordings. The data has been reviewed in conjunction with the geophysical data (SSS and MBES) and interpretations. It should be noted that there is some natural limitation in the accuracy of interpretations and delineation of habitats. Where considered applicable, the sampling results have been extrapolated to surrounding areas exhibiting similarity as interpreted from the geophysical data.

The EUNIS 2022 Habitat classifications are currently under review and therefore a number of categories from the 2012 version have not yet been included. These categories include Inland waters, Wetlands, Constructed, industrial and other artificial habitats and Complexes. For the purpose of this report, infrastructure within the cable route corridor has been delineated as per the 2012 EUNIS Habitat **J** - Constructed, industrial and other artificial habitats.

NOTE: The Habitat Assessment presented in this report is based on video and still images along with field descriptions and PSA results of the grab samples. The grab sample laboratory test results were not available at the time of writing but will be included in the Environmental Baseline Report (104728-TOT-OI-SUR-REP-ENVBASRE).

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Appendix A Sample Position List

Appendix B Grab Field Protocols

Appendix C Photo Identification Results