LLŶR FLOATING OFFSHORE WIND PROJECT

Llŷr 1 Floating Offshore Wind Farm

Environmental Statement

Volume 6: Appendix 19E – Proposed Export Cable Route Benthic Characterisation Survey 2024: Habitat Assessment

August 2024

Prepared by: Llŷr Floating Wind Ltd

FLOVENTIS ENERGY

Document Status

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Prepared by	Ocean Ecology Ltd
Prepared for	Llŷr Floating Wind Limited
Approved by	Jay Hilton-Miller

Glossary of project terms

Term	Definition
The Applicant	The developer of the Project, Llŷr Floating Wind Limited.
Array	All wind turbine generators, inter array cables, mooring lines, floating sub-structures and supporting subsea infrastructure within the Array Area, as defined, when considered collectively, excluding the offshore export cable(s).
Array Area	The area within which the wind turbine generators, inter array cables, mooring lines, floating sub-structures and supporting subsea infrastructure will be located.
Floventis Energy	A joint venture company between Cierco Ltd and SBM Offshore Ltd of which Llŷr Floating Wind Limited is a wholly owned subsidiary.
Landfall	The location where the offshore export cable(s) from the Array Area, as defined, are brought onshore and connected to the onshore export cables (as defined) via the transition joint bays.
Llŷr 1	The proposed Project, for which the Applicant is applying for Section 36 and Marine Licence consents. Including all offshore and onshore infrastructure and activities, and all project phases.
Marine Licence	A licence required under the Marine and Coastal Access Act 2009 for marine works which is administered by Natural Resources Wales (NRW) Marine Licensing Team on behalf of the Welsh Ministers.
Offshore Development Area	The footprint of the offshore infrastructure and associated temporary works, comprised of the Array Area and the Offshore Export Cable Corridor, as defined, that forms the offshore boundary for the S36 Consent and Marine Licence application.
Offshore Export Cable	The cable(s) that transmit electricity produced by the WTGs to landfall.
Offshore Export Cable Corridor (OfECC)	The area within which the offshore export cable circuit(s) will be located, from the Array Area to the Landfall.
Onshore Development Area	The footprint of the onshore infrastructure and associated temporary works, comprised of the Onshore Export Cable Corridor and the Onshore Substation, as defined, and including new access routes and visibility splays, that forms the onshore boundary for the planning application.
Onshore Export Cable(s)	The cable(s) that transmit electricity from the landfall to the onshore substation.
Onshore Export Cable Corridor (OnECC)	The area within which the onshore export cable circuit(s) will be located.
proposed Project	All aspects of the Llŷr 1 development (i.e. the onshore and offshore components).
Onshore Substation	Located within the Onshore Development Area, converts high voltage generated electricity into low voltage electricity that can be used for the grid and domestic consumption.
Section 36 consent	Consent to construct and operate an offshore generating station, under Section 36 (S.36) of the Electricity Act 1989. This includes deemed planning permission for onshore works.

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Llŷr Floating Offshore Wind Farm – Proposed Export Cable Route Benthic Characterisation Survey 2024:

Habitat Assessment

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Details

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Updates

Section	Description	Page
All	Report updated to include habitat mapping and new MBES data	-

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Abbreviations

CATAMI	Collaborative and Automated Tools for the Analysis of Marine Imagery and Video
CLOC	Clear Liquid Optical Chamber
DDC	Drop-Down Camera
ECR	Export Cable Route
EIA	Environmental Impact Assessment
EPS	European Protected Species
FLO	Fisheries Liaison Officer
FOWF	Floating offshore wind farms
GPS	Global Positioning System
HD	High Definition
INNS	Invasive Non-Native Species
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
LED	Light-Emitting Diode
MBES	Multibeam Echosounder
MCA	Maritime and Coastguard Agency
MCZ	Marine Conservation Zone
MOD	Ministry of Defence
MP	Megapixel
MPA	Marine Protected Area
NRW	Natural Resources Wales
NtM	Notice to Mariners
OEL	Ocean Ecology Limited
OWF	Offshore Wind farm
SAC	Special Area of Conservation
SBAS	Satellite-Based Augmentation System
SSL	Seabed Survey Licence
SVP	Sound Velocity Profiler
TCE	The Crown Estate
UPS	Uninterruptable Power Supply
USBL	Ultra-Short Baseline
UTC	Universal Time Coordinated
UTM	Universal Transverse Mercator
VOR	Value of risk

1. Introduction

1.1. Project Overview

Llŷr 1 (the proposed Project) is a Floating offshore wind farm (FOWF) being developed by Floventis Energy Limited (Floventis). The proposed Project is located in the approaches to the Bristol Channel in the Celtic Sea, approximately 44 km from the Lundy Island shore, 62 km from the Devon coastline and 35 km from the Welsh coastline (Figure 1). The proposed Export Cable Route (ECR) is located in water depths ranging between 15 m to 60 m and will run north towards Pembroke.

1.2. Project Background

The proposed Project came forward through The Crown Estate's (TCE) Test & Demonstration leasing opportunity which was created to support the development and commercialisation of pioneering, floating wind technologies. The proposed Project is intended to test new floating platform and mooring technologies and explore innovative designs, materials, and construction approaches.

1.3. Aims and Objectives

The key aim of the drop-down camera (DDC) survey was to obtain imagery and video data to determine if the proposed nearshore cable route is viable and to subsequently inform the design of the Project.

This was achieved through the acquisition of DDC imagery to:

- Map the extent and location of habitats present in the nearshore survey area.
- Identify and assess the status of species and habitats of conservation importance, including Annex I protected species and habitats, and Annex V species[1] of the Habitats Regulations, species listed under Schedule 5 of the Wildlife & Countryside Act[2], OSPAR species and habitats[3] and designated features of the Marine Protected Area (MPA) network (e.g., Special Area of Conservation (SAC) and Marine Conservation Zone (MCZ)).

[1] https://jncc.gov.uk/our-work/article-17-habitats-directive-report-2019-species/
[2] https://www.legislation.gov.uk/ukpga/1981/69/schedule/5
[3] https://www.ospar.org/work-areas/bdc/species-habitats/list-of-threatened-declining-species-habitats

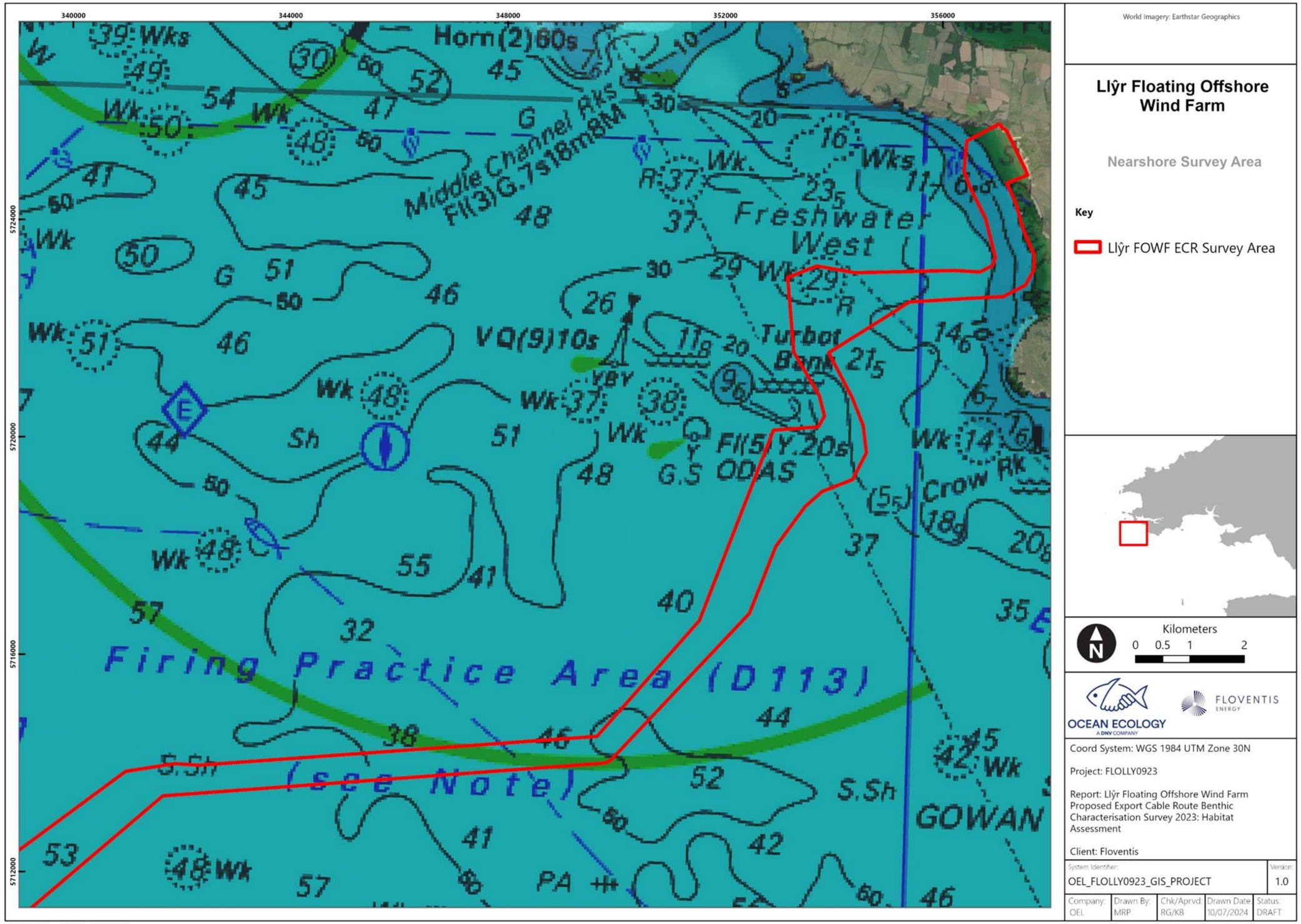

Figure 1 Survey area overview.

2. Current Understanding

2.1. Habitats and Species of Conservation Importance

European Commission Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora, commonly known as the 'Habitats Directive' ensured the conservation of a wide range of rare, threatened endemic animal and plant species as well as habitats. The EU Habitats Directive (1992) was transposed into UK law by The Conservation of Habitats and Species Regulations 2017 within 12 nautical miles (nm), and The Conservation of Offshore Marine Habitats and Species Regulations 2017 between 12 nm out to 200 nm or the UK Continental Shelf.

2.2. Designated Sites

The proposed survey area intersects and lies close to a number of MPAs as set out below and presented in Figure 2.

Pembrokeshire Marine SAC

The proposed ECR landfall location in west Wales intersects the Pembrokeshire Marine SAC which covers 1,380 km^2 in southwest Wales. This SAC is designated for the protection of the following habitats and species:

- Annex I reef
- Fragile sponge & anthozoan communities on subtidal rocky habitats
- Maerl
- *Mytilus* beds
- *Musculus discors* beds
- *Ostrea edulis* beds
- Seagrass beds

Further features designated within this SAC include:

- Estuaries
- Large shallow inlets and bays
- Reefs
- Sandbanks which are slightly covered by seawater all the time
- Mudflats and sandflats not covered by seawater at low tide
- Coastal lagoons
- Atlantic salt meadows
- Submerged or partially submerged sea caves
- Grey seal (*Halichoerus grypus*)
- Shore duck (*Rumex rupestris*)
- Sea lamprey (*Petromyzon marinus*)

- River lamprey (*Lampetra fluviatillis*)
- Allis shad (*Alosa alosa*)
- Twaite shad (*Alosa fallax*)
- Otter (*Lutra lutra*)

The proposed ECR intersects the West Wales Marine SAC which is situated off the coast of Wales extending from the Llŷn peninsula in the north, to Pembrokeshire in the southwest. The SAC has been identified as an area of importance for harbour porpoise (*Phocoena phocoena*).

Skomer, Skokholm and the Seas off Pembrokeshire SPA

The proposed ECR intersects the eastern extent of the Skomer, Skokholm and the Seas off Pembrokeshire Special Protected Area (SPA) which is classified for the protection of: European storm-petrel (*Hydrobates pelagicus*), Manx shearwater (*Puffinus puffinus*), Atlantic puffin (*Fratercula arctica*), and lesser black-backed gull (*Larus fuscus*), as well as red-billed chough (*Pyrrhocorax pyrrhocorax*), short-eared owl (*Asio flammeus*) and breeding seabird assemblage. The SPA extends beyond the 12 nautical mile boundary, lying partly in Welsh territorial waters and partly in UK offshore waters meaning Natural Resources Wales (NRW) and JNCC are responsible for providing statutory advice.

2.3. Potential Annex I Habitat within the Survey Area

Sandbanks which are slightly covered by sea water all the time

For the purposes of the European Commission (EC) Habitats Directive, the Interpretation Manual of European Union Habitats – EUR25 (C, 2013) defines Annex I 'Sandbanks slightly covered by seawater all of the time' (hereafter referred to as sandbanks) as:

'…..elevated, elongated, rounded or irregular topographic features, permanently submerged and predominantly surrounded by deeper water. They consist mainly of sandy sediments, but larger grain sizes, including boulders and cobbles, or smaller grain sizes including mud may also be present on a sandbank. Banks where sandy sediments occur in a layer over hard substrata are classed as sandbanks if the associated biota are dependent on the sand rather than on the underlying hard substrata'.[4]

Annex I sandbanks can be categorised into four sub-types: gravelly and clean sands, muddy sands, seagrass beds and free-living maerl (Corallinacea) beds (as detailed in the JNCC guidance[5].

[4] 'Slightly covered by sea water all the time' means that above a sandbank the water depth is seldom more than 20 m below chart datum. Sandbanks can, however, extend beneath 20 m below chart datum. It can, therefore, be appropriate to include in designations such areas where they are part of the feature and host its biological assemblages'.

[5] Subtidal sandbanks (Sandbanks which are slightly covered by sea water all the time) - Special Areas of Conservation (jncc.gov.uk)

The latter two sub-types are particularly distinctive and are of high conservation value because of the diversity of species they may support and their general scarcity in European waters. These habitats are typically colonised by burrowing fauna such as worms, crustaceans, bivalve molluscs and echinoderms. Mobile shrimp, gastropods, crabs and fish also inhabit these areas as well as sandeel (*Ammodytes* spp.), a key bird prey species. Where stable coarse sediments are present species of foliose algae, hydroids, bryozoans and ascidians may be present that comprise key nursery areas for various fish species. Such areas therefore often comprise key feeding grounds for numerous seabirds. Sandbanks are important areas which can be support seagrass beds and maerl, depending on their exposure to wave action and currents, sediment type, and depth.

2.4. Existing Habitat Mapping

The 2023 EUSeaMap broad-scale predictive model classifies and maps intertidal and subtidal habitats according to the European Nature Information Systems (EUNIS) classification criteria. The system is able to identify keystone species that have been evidenced to inhabit areas with certain environmental conditions and can therefore act as an indicator, allowing inferences of overall community composition. EUSeaMap mapping from within the survey area predicts A4.1 – High Energy Circalittoral Rock, A5.1 – Subtidal Coarse Sediment, and 3.1 High Energy infralittoral rock (EMODnet, 2023) (Figure 3).

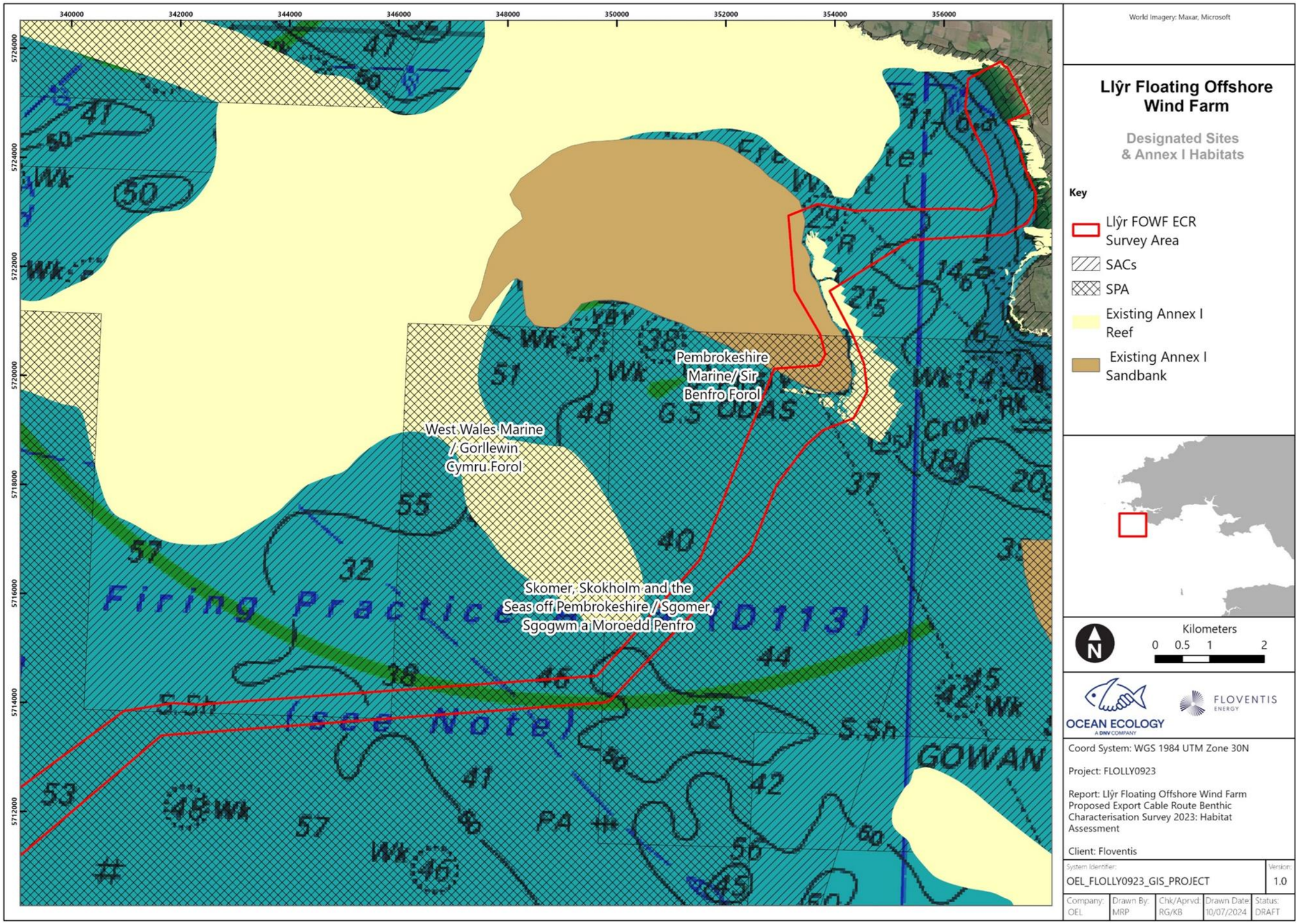

Figure 2 Designated sites and Annex I habitats within the Llyr Floating Offshore Wind Farm survey area.

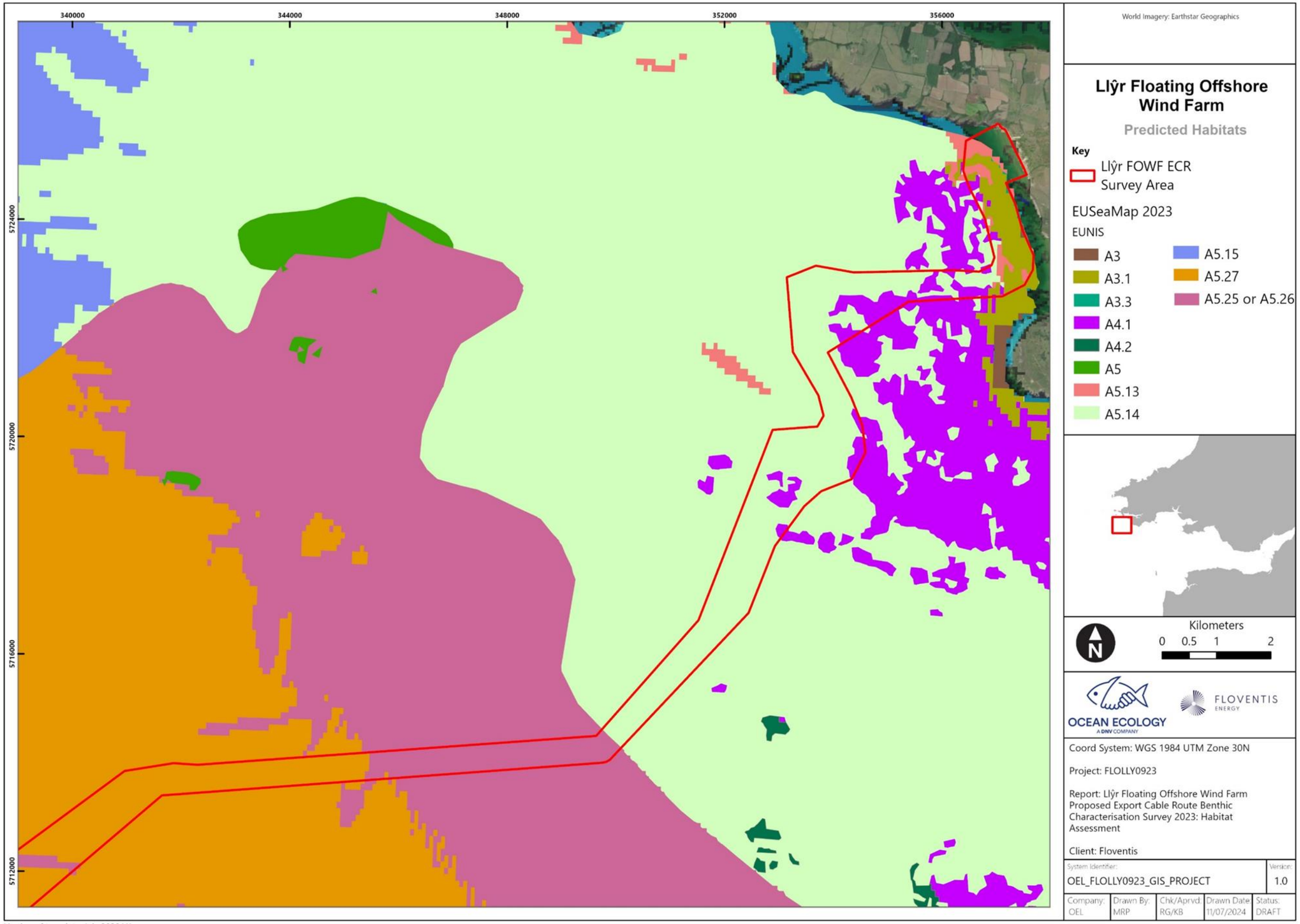

Figure 3 Predicted habitats within the Llyr Floating Offshore Wind Farm survey area (EUSeaMap 2023, obtained from EMODnet).

3. Survey Design

3.1. Sampling Design and Rationale

The sampling design was developed to provide maximum geographic coverage of the proposed survey area, whilst also ensuring that all key habitats and communities likely to be encountered across the survey area were adequately targeted. The key principles underpinning the design of this sampling plan were therefore to:

- Provide adequate spatial coverage of the proposed nearshore ECR corridor areas;
- Ensure representative visual sampling of all main sediment types was undertaken; and
- Ensure representative examples of all potential features of conservation interest (e.g., Annex I reefs) were adequately ground-truthed.

The micro-siting of transect stations was informed by a detailed review of historic multibeam echosounder (MBES) and geospatial data and in consideration of all information available in relation to surface, subsurface and subsea hazards across the entire survey area. This included all available GIS shapefiles and rasters in ESRI format including the proposed nearshore ECR corridor areas, the planned survey area, any existing infrastructure including all oil and gas surface and subsurface infrastructure within the project boundary or within proximity to it. It also included the latest relevant MPA boundaries and admiralty charts for the survey area (where available).

3.2. Sampling Approach

The following section describes the sampling approach used to undertake the seabed characterisation survey.

Transects were prioritised based on their location, position and orientation in relation to the sediment channel identified based on the interpretation of MBES and geospatial data. Transects crossing the width of the sediment channel were generally surveyed first to delineate the feature boundaries followed by perpendicular transects to ensure that cables could be laid along the channel. The sampling was heavily influenced by periods of adverse weather and access restrictions imposed by the neighbouring Ministry of Defence (MOD) Castlemartin Firing Range between February 1 and June 28, 2024. Access during this period was limited to weekends and weekdays outside of the firing exercise hours of 09:00 – 16:00 and 18:00 – 23:00, with a two-week exception around Easter.

Seventeen DDC transects were surveyed to assess the suitability of a potential sediment channel identified within the available MBES data and geospatial data (Figure 3 and Figure 4). Transect T008a was positioned along the length of the sediment channel in an east to west (EW) orientation and extended 2.8 km. A series of perpendicular north to south (NS) transects were then used to delineate the feature boundaries through the width of the channel. These included T007, T009a,

T010a, T007a, T011a, T006 and T012a. These transects measured approximately 2.4 km, 0.14 km, 0.19 km, 0.35 km, 0.2 km, 0.6 km 0.09 km in length, respectively.

A slight deviation in the channel orientation was observed at the juncture of transect T012a and T008a. Transect T015 was therefore positioned to follow the direction of the channel from this point seaward and measured approximately 1.5 km in length. A series of perpendicular NS transects were again positioned to delineate the feature boundaries across the width of the channel. These included transects T013a, T014a, and T015a which measured approximately 0.13 km, 0.15 km, and 0.4 km in length, respectively.

As the channel appeared to broaden in the MBES data, Transects T016a and T017a were positioned in a NS orientation to the south (T016a) and slightly offset to the southwest (T017a) from T015. These measured approximately 0.28 km and 0.35 km in length, respectively.

As the survey area encroached on the Turbot Bank Sandbank to the west, the remaining transects were positioned to ground-truth the presence of a channel between the sandbank and the neighbouring reef to the east. Both transects were positioned in a northwest to southeast (NWSE) orientation with T018a being positioned on the western end of the previously mentioned transects approximately 0.35 km from T017a. Transect T019a was positioned in a parallel NWSE orientation approximately 0.6 km to the south of T018a. These transects measured approximately 0.5 km and 0.2 km respectively.

A final transect, T020 was positioned at the distal end of the survey area closest to the existing order limits in an EW orientation. This measured approximately 0.3 km. This transect was not affected by the firing range restrictions and therefore allowed for the optimisation of sampling efficiencies where possible around the remaining transects.

During the survey, high resolution digital photography (stills and video footage) were acquired by a 'bed-hopping' technique to identify habitat boundaries along each transect. The camera was housed within a freshwater lens to provide optimum image clarity in the potentially turbid waters on site. Transects run in the direction of tide and current where possible to further optimise image and video quality.

A positional fix was taken each time the camera made contact with the seabed and was used as a high-level preliminary assessment of habitat. Each fix was allocated a habitat type of either 'Reef', 'Sediment' or 'Unknown'. The allocation of 'Reef' and 'Sediment' labels to the fix position reflected a preliminary assessment on the suitability of the area for cable placement. The third allocation of 'Unknown' indicated the inability of assigning the positional fix to a specific habitat type while on survey and the need of a thorough review of this assessment post-survey. Detailed survey methods for seabed imagery acquisition are presented in Section 5.1.

3.3. Timing

The survey was undertaken during periods of favourable weather between the 8th February and 26th April 2024.

4. Survey Methods

4.1. Survey vessel

The survey was conducted aboard OEL's 11.7 m MCA Category 2 survey vessel '*Argyll Explorer*' (Table 1 and Plate 1). The vessel mobilised and operated out of Neyland Marina on a 12-hour basis, operating in daylight hours only, and returning to port each day.

Table 1 Vessel details

Vessel Name	Argyll Explorer
Area of operation	Offshore
Call Sign	MWFU
IMO Number	235057487
Mobilisation Port	Neyland Marina, Milford Haven
Length	11.7 m
Beam	5.5 m
Draft	1.5 m

Plate 1 OEL's dedicated survey vessel *Argyll Explorer*.

4.2. Geodetic Parameters

4.2.1. Horizontal Datum

Table 2 Geodetic parameters

Parameter	Details
Name	World Geodetic System 1984 (WGS84)
Ellipsoid	WGS 84
Semi-Major Axis (a)	6378137.000 m
Semi-Minor Axis (b)	6356752.314 m
Inverse Flattening	298.257 223 563
Geodetic parameters EPSG Code	4326

Table 3 Projection parameters.

Projection	Transverse Mercator 6 NW
Name	UTM Zone 30 N
Longitude of Natural Origin	6° West
Latitude of Natural Origin	0°
False Easting	1 500 000.00 m
False Northing	0.00 m
Scale Factor at Natural Origin	1
Units	metres

4.2.2. Datum Transformation Parameters

All data is referenced to WGS84, UTM Zone 30 N, with no datum transformation need. No conversion or test coordinate was provided by the Client.

4.2.3. Vertical Datum

All altitude and depth data above seabed are referenced to LAT. All depth data below the seabed is referenced to LAT where available, depths may be reported as derived from ultra-short baseline (USBL) beacon.

4.2.4. Unit Format and Conversions

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

Table 4 Project unit format and convention details.

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

4.3. Survey Navigation

4.3.1. Surface Positioning

The *Argyll Explorer* was equipped with a Hemisphere V104s Global Positioning System (GPS) compass system. The Hemisphere V104s's internal GPS receiver automatically searches for and uses a minimum of 4 GPS satellites and manages the navigation information required for position to within 3 m (95% accuracy). Since there is some error in the GPS data calculations, the V104s also automatically tracks a Satellite-Based Augmentation System (SBAS) differential correction to improve its position accuracy to better than 1.0 m 95%.

The V104s has an integrated gyro and two tilt sensors to provide an accurate heading for the navigation software.

4.3.2. Subsea Positioning

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

4.3.3. Navigation Software

A vessel-based positioning system was employed utilizing EIVA NaviPac V4.6 software to ensure the accurate positioning of the vessel and subsea positioning of the sampling equipment via the USBL system as well as recording continuous track plots of the sampling equipment and recording sampling fixes. A navigation screen, displaying EIVA Helmsman Display was used at the helm position of the vessel by the Skipper as well as for the Environmental Scientist in the wheelhouse.

4.3.4. Positional Checks & Calibrations

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

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

4.4. Survey Equipment and Sampling

4.4.1. DDC System and Seabed Imagery Collection

Seabed imagery (simultaneous video and stills) was acquired at each station using OEL's SubC Rayfin PLE camera system, set up to obtain 1080p High Definition (HD) video and 20 Megapixel (MP) still images. The camera system (Plate 2) consisted of a SubC Imaging Rayfin PLE camera mounted in a Clear Liquid Optical Chamber (CLOC) (otherwise known as a 'freshwater lens') filled with fresh water to ensure imagery of suitable quality is obtained regardless of turbidity. The frame included light emitting diode (LED) strip lamps and a 10 cm point laser scaling array that is projected into the field of view and topside computer. The camera was powered with the use of an Uninterruptable Power Supply (UPS) to ensure no damage would be caused should the vessel have lost power or in the case of a power surge. A full redundancy SubC Rayfin PLE camera system was stored onboard throughout the survey but was not required.

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

All DDC stations and transects were sampled in line with the JNCC epibiota remote monitoring operational guidelines (Hitchin et al., 2015). For transects, the camera was deployed to the seabed over the target start / end transect location and slowly 'flown' just above the seabed along the transect to obtain both continuous video footage and still images. A live feed was displayed on a monitor and photographs taken continually along the transects. Whenever a photograph was taken a positional fix was taken of the USBL beacon position in the navigation software.

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

- As the vessel approached the target location, deck personnel began to prepare lifting equipment, camera, and readied the coaxial winch control.
- Deck personnel were alerted by the vessel master once on position, and the camera was raised using the A-frame and coaxial winch and lowered into the water column.
- Once the camera system was within 5 m of the seabed, video recording was started, and sampling conducted in line with the methodology set out above.
- Following the capture of the final image, the camera was lifted, video recording was stopped, and the camera was slowly brought to the surface.
- The winch operator then took the tension on the wire and once the vessel master had confirmed sea conditions were suitable, the camera system was recovered aboard and lowered onto the deck.

During the deployment, all footage underwent a preliminary review *in situ* by OEL's onboard Environmental Scientists. Each image was then assessed *in situ* and assigned one of three fix labels: 'Reef', 'Sediment' or 'Unknown' depending on the habitat type observed. Detailed notes were also taken in the logs of visible sediment conditions and seabed features, obvious fauna, and habitat-related features whilst in the field.

5. Laboratory Analysis & Interpretation

5.1. Seabed Imagery Analysis

All seabed imagery analysis collected by DDC was undertaken in consideration of the latest NMBAQC/JNCC Epibiota Quality Assurance Framework (QAF) guidance and identification protocols available on the NMBAQC website. Final datasets are presented using the latest NMBAQC/JNCC epibiota monitoring proformas available for stills and video footage and were quality assured using the QAF form check and comparison tools.

The seabed imagery analysis was undertaken in two stages using the Bio-Image Indexing and Graphical Labelling Environment (BIIGLE) annotation platform (Langenkämper et al., 2017). The first stage, "Tier 1", consisted of labels that refer to the whole image being assigned providing appropriate metadata for the image including EUNIS habitat classifications assigned in line with (Parry, 2019). The second stage, "Tier 2", was used for noting presence / absence of conspicuous epibiotal species within each image and to assign percentage cover of reef types.

A full reef HA was conducted on all DDC imagery to determine whether habitats met the definitions of Annex I reef habitats as detailed in Table 5 and Table 6 . The latest JNCC guidance on the characterisation of 'low resemblance' Annex I stony reef were also considered (Golding et al., 2020; Irving, 2009).

The annotation label tree used during analysis contained major headings for each of the reef types. Under each reef type, labels were assigned for each of the categories required to determine whether Annex I reef habitat was present (Table 5 and Table 6).

Table 5 Characteristics of stony reef (Irving 2009).

Characteristic	'Reefiness'			
	Not a Reef	Low	Medium	High
Composition (proportion of boulders/cobbles (>64 mm))	<10 %	10-40 % matrix supported	40-95 %	>95 % clast-supported
Elevation	Flat seabed	<64 mm	64 mm - 5 m	>5 m
Extent	<25 m^2	>25 m^2		
Biota	Dominated by infaunal species	>80 % of species present composed of epibiotal species		

Table 6 Characteristics of Sabellaria spinulosa reef (Gubbay 2007).

Characteristic	'Reefiness'			
	Not a Reef	Low	Medium	High
Elevation (cm)	< 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

5.1.1. Tier 1 Analysis

The first stage, "Tier 1", consisted of assigning labels that referred to the whole image, providing appropriate metadata for the image. Metadata "Image Labels" included:

- BSH type.
- Substrate type (and percentage cover in 10% intervals).
- Bedforms present.
- The presence of any Annex I habitats, Features of Conservation Importance (FOCI), Habitats of Conservation Importance (HOCI) and INNS.
- The presence of any visible impacts or other modifiers (such as discarded fishing gear or marine litter (as per the Marine Strategy Framework Directive (MSFD) categories), visible physical damage to the seabed, evidence of strong currents, non-native species, etc.).
- Image quality categories (including "Not Analysable" category).

Depending on the presence of reef, this also included:

- Extent: As it is not possible to fully determine the extent of reef habitats from a single image alone this label was used to identify areas that are highly unlikely to constitute reef habitats. An example is an image that shows a large boulder being preceded and succeeded by images of unconsolidated sandy sediments.
- Biota: Labels assigned to determine whether epifauna dominated the biological community observed.
- Elevation: Labels assigned depending on reef type. Laser points were used to assist in the assignment of categories.

5.1.2. Tier 2 Analysis

The second stage, "Tier 2", was used to assess epibiotal presence / absence data as "annotations" within each image for all visible flora and fauna. This was undertaken as follows:

- Using the BIIGLE Annotation Platform, (detailed below) presence / absence notation of all visible taxa was undertaken using point annotations.
- Identification of any INNS and species non-native to UK waters. Information was also included on species non-native to the local habitat types (e.g. hard-substrate specialists in a wider sedimentary habitat).

The substratum observed in each still image was recorded as a percentage cover of Collaborative and Automated Tools for the Analysis of Marine Imagery and Video (CATAMI) (Althaus et al., 2015) substratum types where possible. Determination of sediment type (such as coarse, mixed, sand etc.) was facilitated using the adapted Folk sediment trigon (Long, 2006) incorporated into a sediment category correlation table. Percentage cover of the different substrate types was used to determine and assign EUNIS codes and BSH.

6. Results

6.1. Survey Progress

The DDC survey was undertaken aboard the *Argyll Explorer* between 08th February and 26th April 2024.

Table 7 provides a summary of the sampling and information collection during the survey which is also displayed in Figure 5 and Figure 6.

A total of 934 digital photographic stills were collected across 102 videos. Due to a technical issue with USBL system at the time of survey, Transect T020 was re-run and renamed as T020(2). The transect position and length remained the same as T020. The positional data acquired for T020(2) was accurate and therefore the imagery data collected along this transect was used in place of that collected during T020.

Table 7 Summary of the intertidal survey and samples collected.

Sampling Summary	
Transects	17
DDC images	934
DDC videos	102

An additional hydrographic survey was undertaken between the 13th and 15th July 2024 by OEL. This survey focused on obtaining multibeam echosounder bathymetry and backscatter data from survey mainlines that ran across key areas of interest within the survey area provided in advance by Floventis (Figure 4). The hydrographic data obtained has subsequently been used to better inform the habitat assessment presented in this report. Parameters for the MBES survey included 100% bathymetric coverage, 100% backscatter coverage and 0.5m bin size, as per the methodology and sampling plan outlined in the Survey Report for the 2024 hydrographic survey (OEL, 2024).

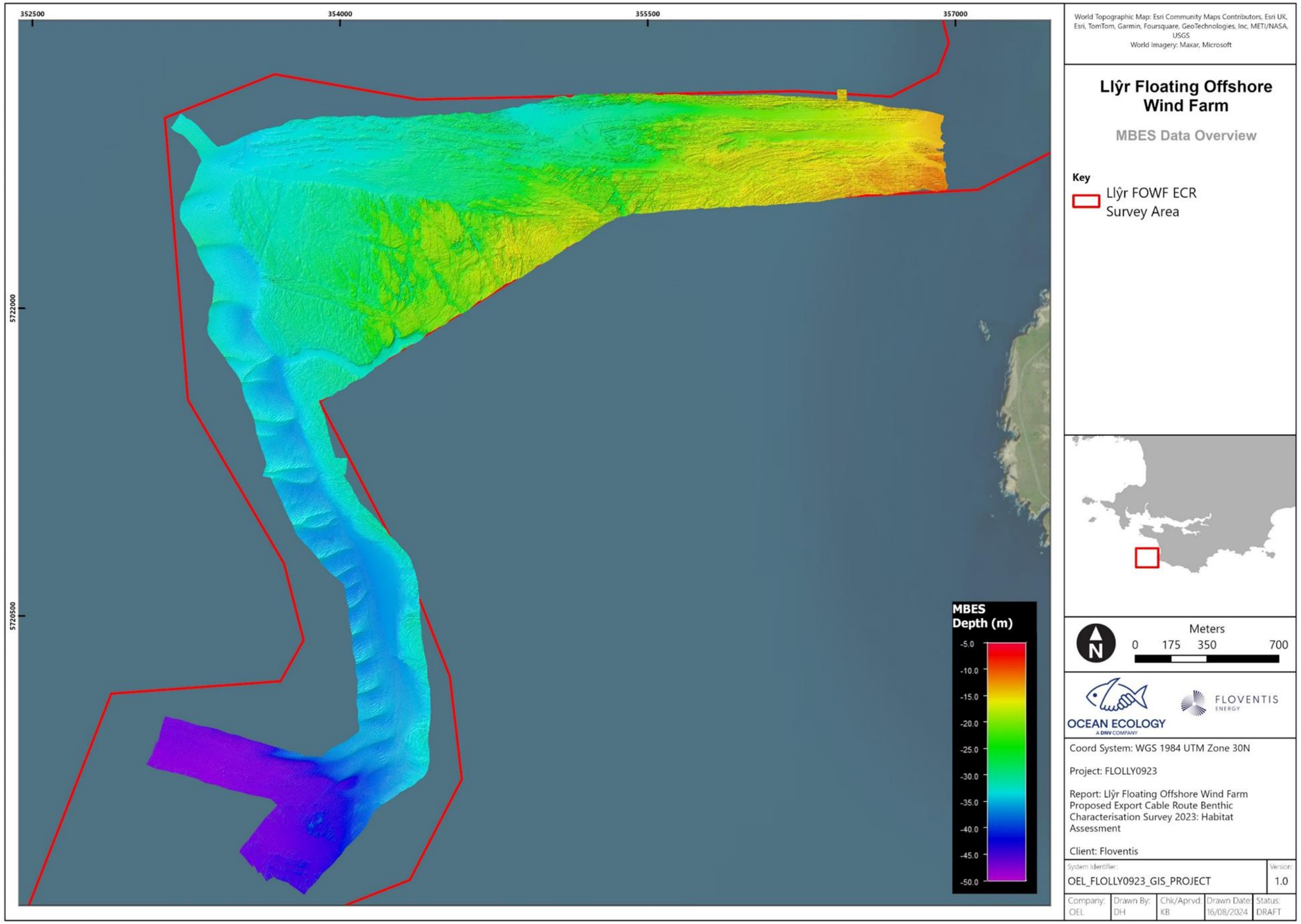

Figure 4 MBES Data Overview.

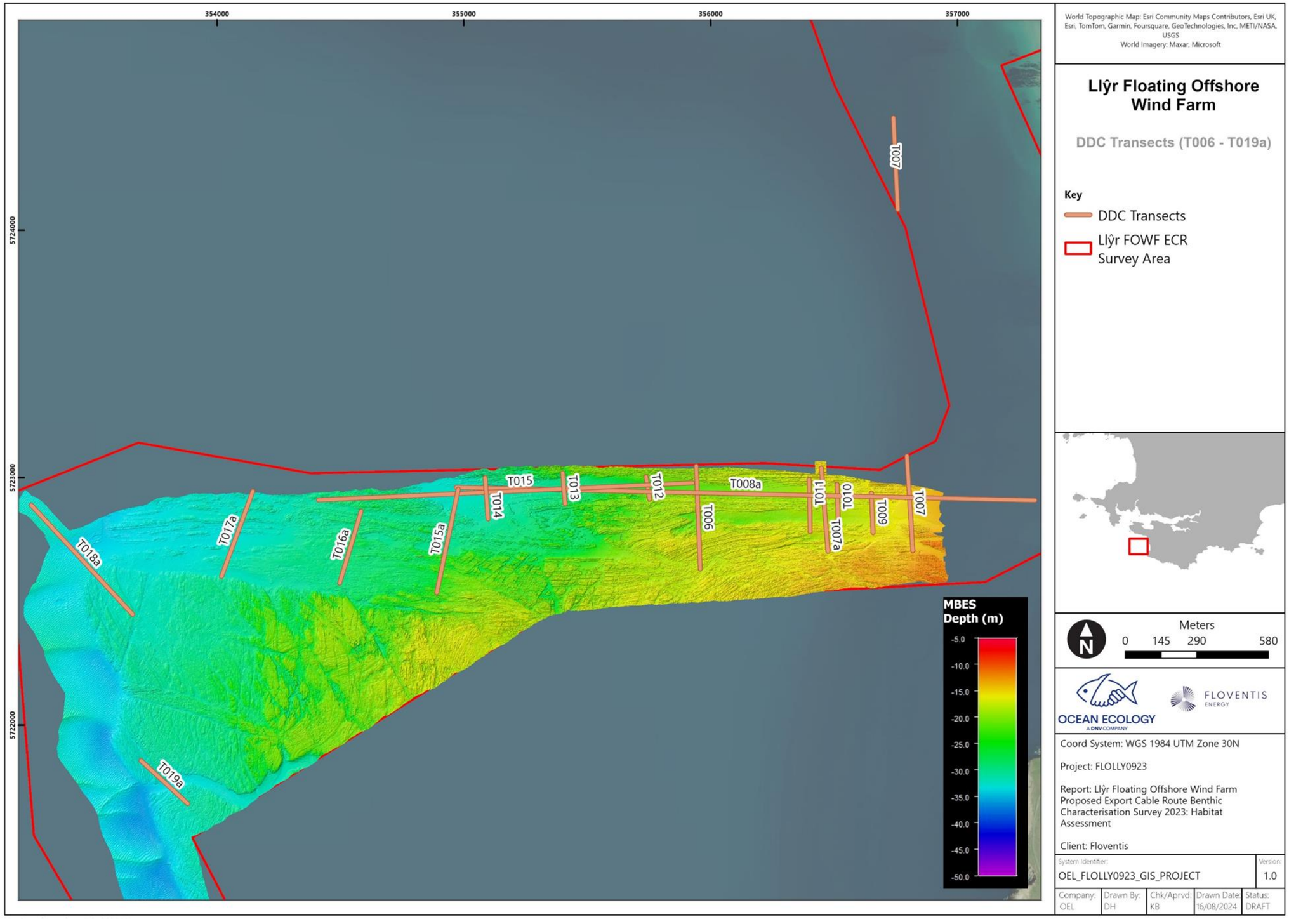

Figure 5 Target DDC transect stations within the Llyr Floating Offshore Wind Farm survey area.

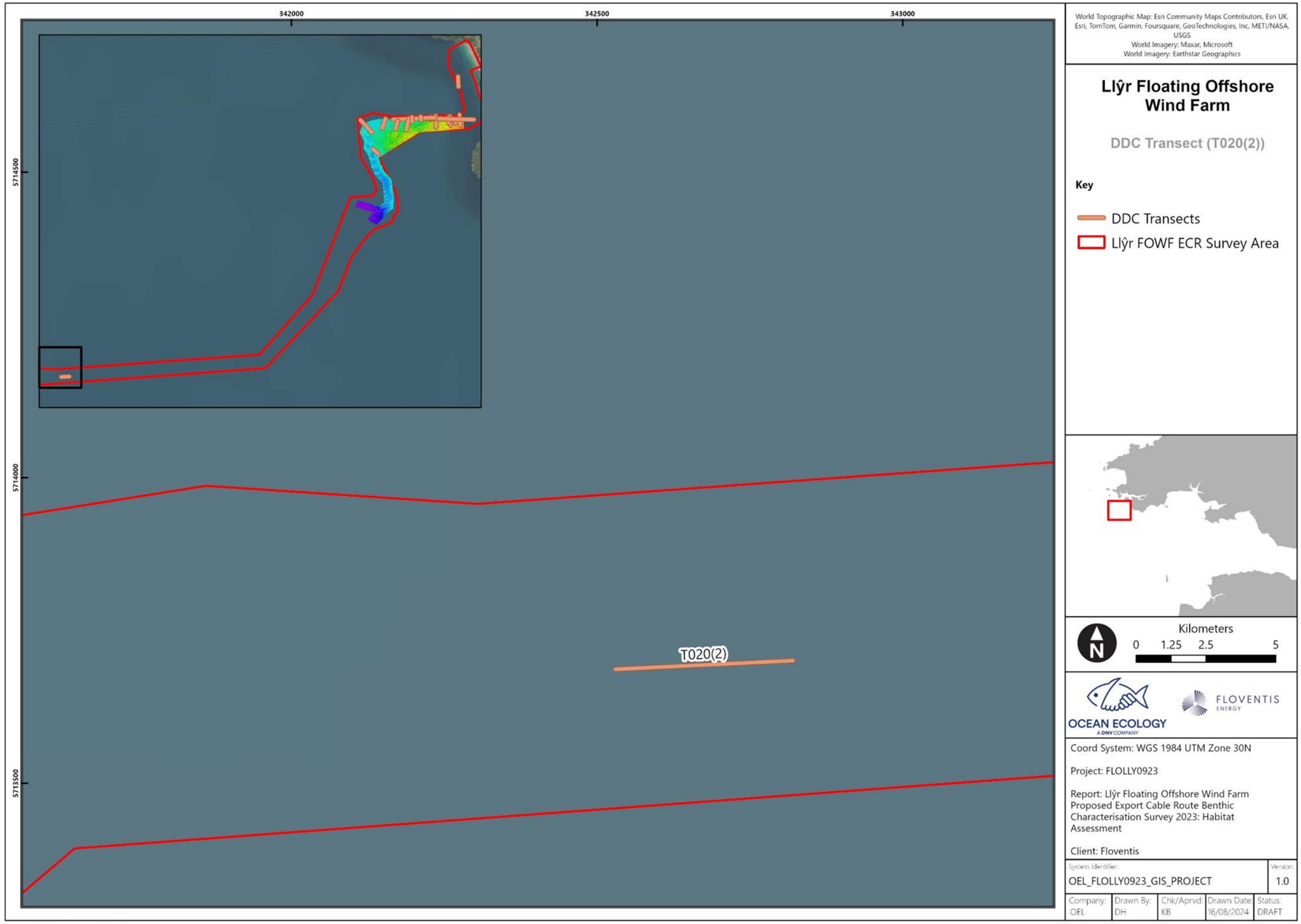

Figure 6 Target DDC transect station (T20(2)) within the Llyr Floating Offshore Wind Farm survey area.

6.2. Imagery Analysis

Seabed imagery was collected at a total of 17 transect stations resulting in the collection of 934 still images. Full sample logs are presented in Appendices I and II.

The dominant BSHs identified through the analysis of the seabed imagery were A4.1 – High Energy Circalittoral Rock, A5.1 – Subtidal Coarse Sediment, and A5.2 – Subtidal Sand.

The BSHs and biotopes identified from the imagery analysis are summarised in Table 8 and Table 9 and mapped in Figure 7**Error! Reference source not found.** to Figure 9**Error! Reference source not found.**. Example imagery of the dominant habitats and biotopes is displayed in Plate 3. Full imagery analysis is provided in Appendix III with analysis of conspicuous epifauna in Appendix IV.

Table 8 Summary of the BSH and biotopes identified from the image analysis.

BSH	Habitat/Biotope	Description
A3.1 - High energy infralittoral rock	A3.11	Kelp with cushion fauna and/or foliose red seaweeds
	A3.116	Foliose red seaweeds on exposed lower infralittoral rock
A4.1 - High energy circalittoral rock	A4.11	Very tide-swept faunal communities on circalittoral rock
	A4.116	Foliose red seaweeds on exposed lower infralittoral rock
	A4.13	Mixed faunal turf communities on circalittoral rock
	A4.131	Bryozoan turf and erect sponges on tide-swept circalittoral rock
	A4.138	*Molgula manhattensis* with a hydroid and bryozoan turf on tide-swept moderately wave-exposed circalittoral rock
A4.2 - Moderate energy circalittoral rock	A4.21	Echinoderms and crustose communities on circalittoral rock
	A4.213	*Urticina felina* and sand-tolerant fauna on sand-scoured or covered circalittoral rock
	A4.214	Faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock
	A4.241	*Mytilus edulis* beds with hydroids and ascidians on tide-swept exposed to moderately wave-exposed circalittoral rock
	A4.2511	Cushion sponges, hydroids and ascidians on turbid tide-swept sheltered circalittoral rock
A5.1 - Subtidal coarse sediment	A5.13	Infralittoral coarse sediment
	A5.14	Circalittoral coarse sediment
A5.2 - Subtidal sand	A5.23	Infralittoral fine sand
	A5.25	Circalittoral fine sand
	A5.26	Circalittoral muddy sand

BSH	Habitat/Biotope	Description
A5.3 - Subtidal Mud	A5.35	Circalittoral sandy mud
A5.4 - Subtidal mixed sediment	A5.44	Circalittoral mixed sediments

Table 9 Summary of the mosaic BSH and biotopes identified from the image analysis.

Mosaic Habitat	Habitat/Biotope Components	Description	No. of images
A3.116/A4.138	A3.116	Foliose red seaweeds on exposed lower infralittoral rock	8
	A4.138	*Molgula manhattensis* with a hydroid and bryozoan turf on tide-swept moderately wave-exposed circalittoral rock	
A3.116/A4.2511	A3.116	Foliose red seaweeds on exposed lower infralittoral rock	32
	A4.2511	Cushion sponges, hydroids and ascidians on turbid tide-swept sheltered circalittoral rock	
A4.1/A5.14	A4.1	High Energy Circalittoral Rock	2
	A5.14	Circalittoral coarse sediment	
A4.1/A5.44	A4.1	High Energy Circalittoral Rock	1
	A5.44	Circalittoral mixed sediments	
A4.1/A5.25	A4.1	High Energy Circalittoral Rock	1
	A5.25	Circalittoral fine sand	
A4.2/A5.25	A4.2	Moderate Energy Circalittoral Rock	2
	A5.25	Circalittoral fine sand	

6.3. FOCI

Two FOCIs were identified within 125 images across the survey area. Fragile sponge and anthozoan communities on subtidal rocky habitats were observed at 10 stations and tide-swept channels were observed at 5 stations.

Both FOCIs are summarised in Table 10 along with their corresponding EUNIS classifications and displayed in Figure 10 with example imagery displayed in Plate 4.

Table 10 FOCIs identified throughout the survey area with corresponding EUNIS classifications.

FOCI	EUNIS	EUNIS Description	No. of images
Fragile sponge and anthozoan communities on subtidal rocky habitats	A4.131	Bryozoan turf and erect sponges on tide-swept circalittoral rock	77
Tide-swept channels	A4.2511	Cushion sponges, hydroids and ascidians on turbid tide-swept sheltered circalittoral rock	48

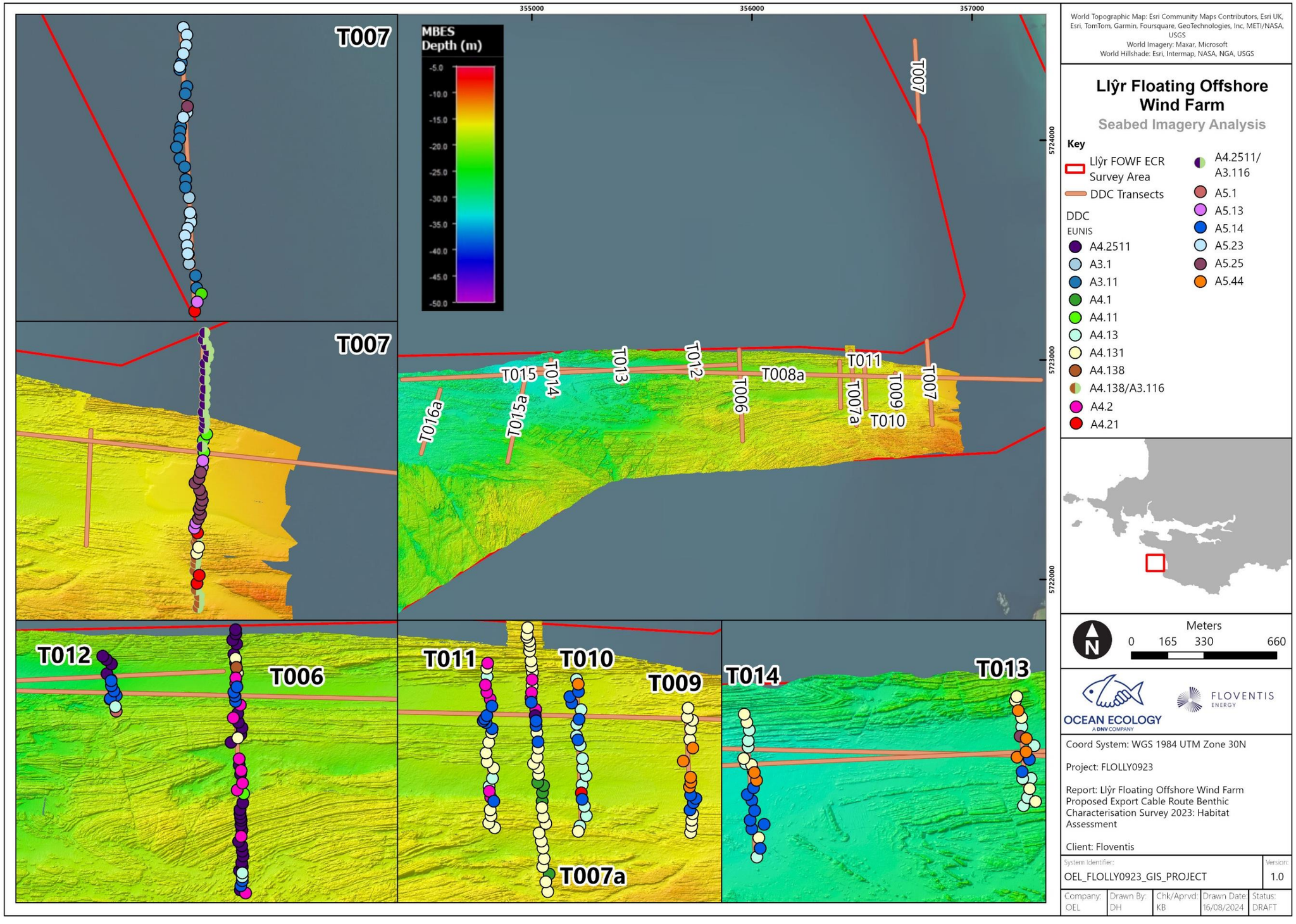

Figure 7 Drop Down Camera (DDC) assessment seabed imagery analysis (Transects T006, T007, T007a, T009, T010, T011, T012, T013 & T014) within the Llyr Floating Offshore Wind Farm survey area.

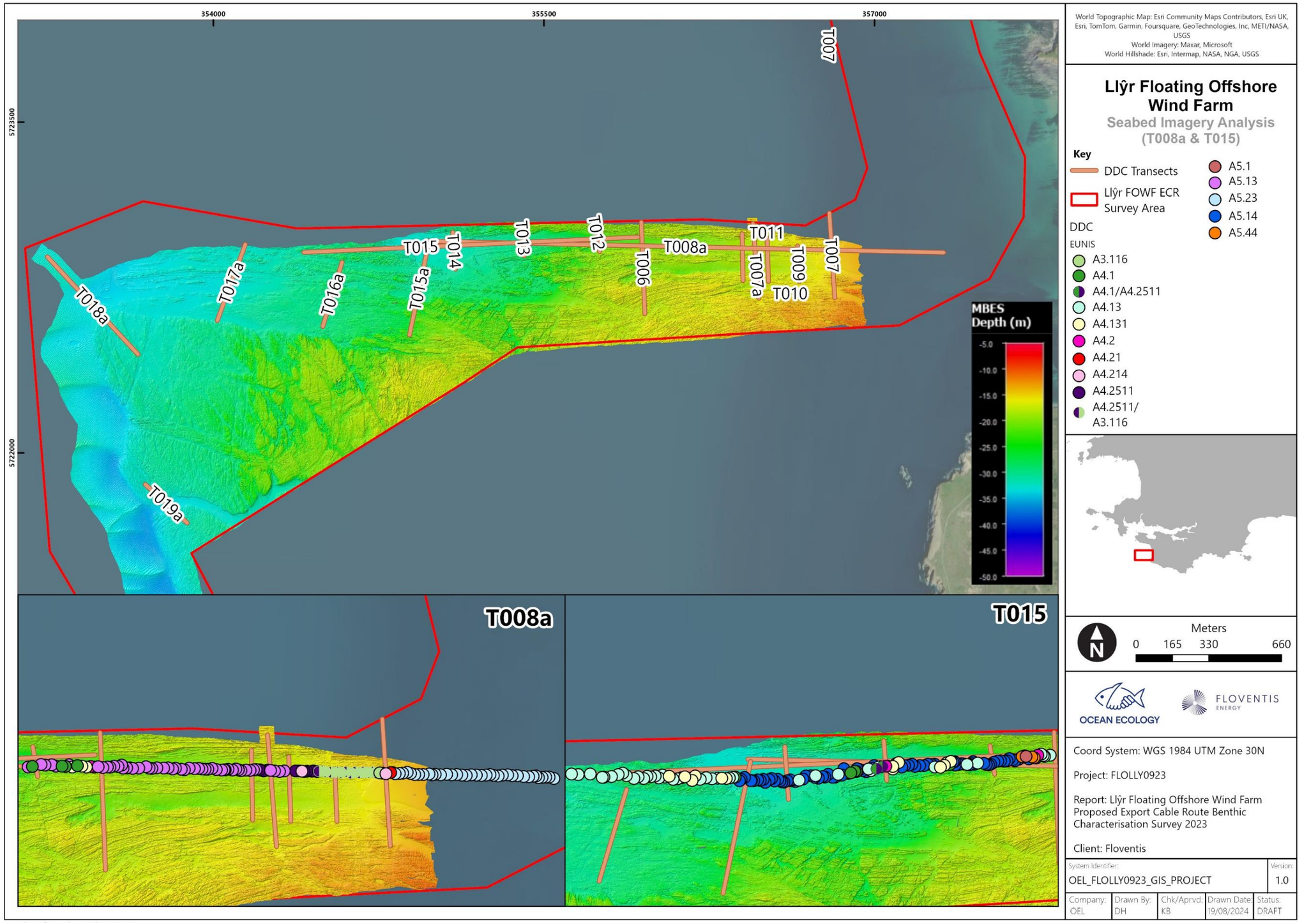

Figure 8 Drop Down Camera (DDC) assessment seabed imagery analysis (Transects T008a & T0015) within the Llyr Floating Offshore Wind Farm survey area.

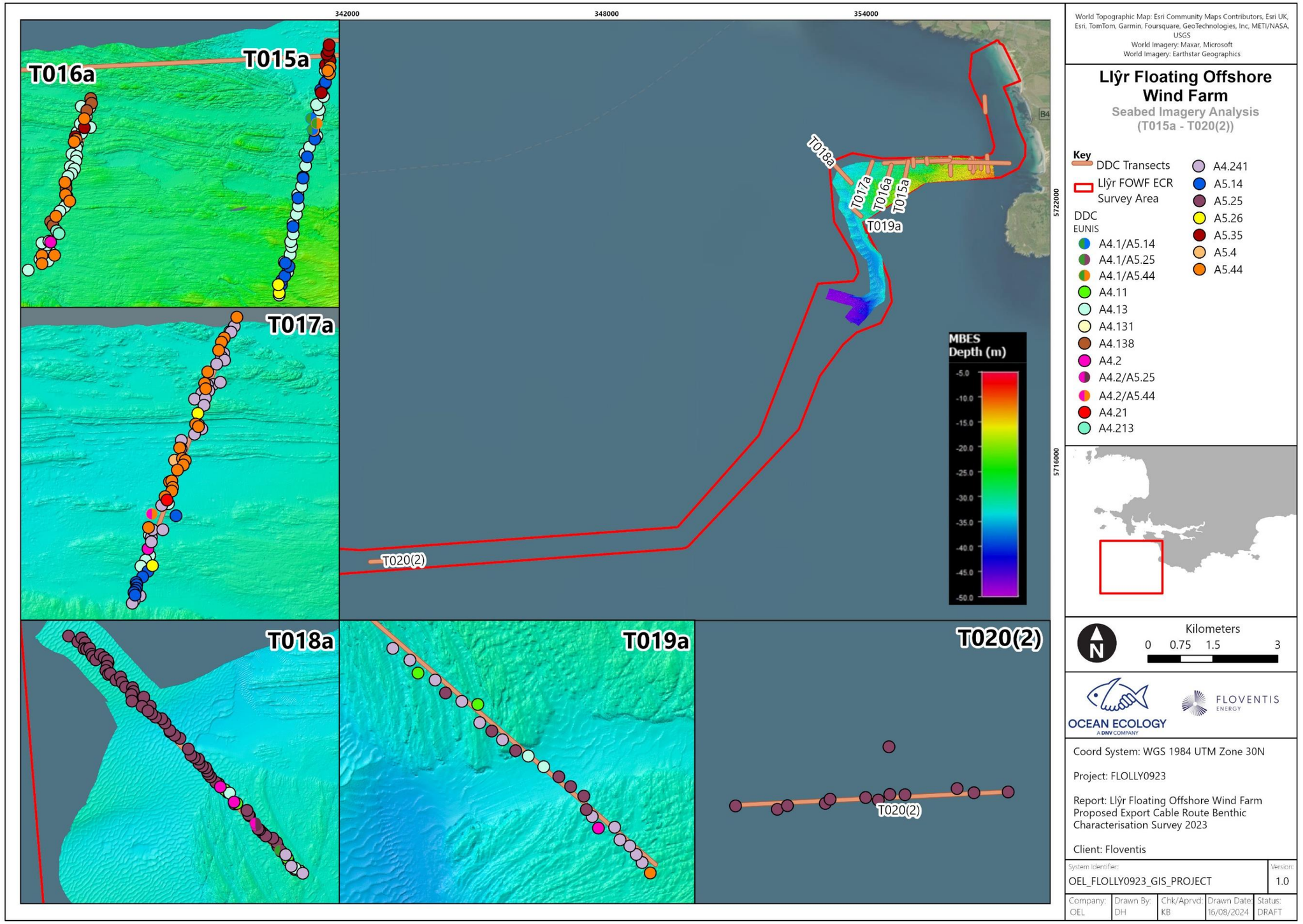

Figure 9 Drop Down Camera (DDC) assessment seabed imagery analysis (Transects T015a, T016a, T017a, T018a, T019a, & T020(2)) within the Llyr Floating Offshore Wind Farm survey area.

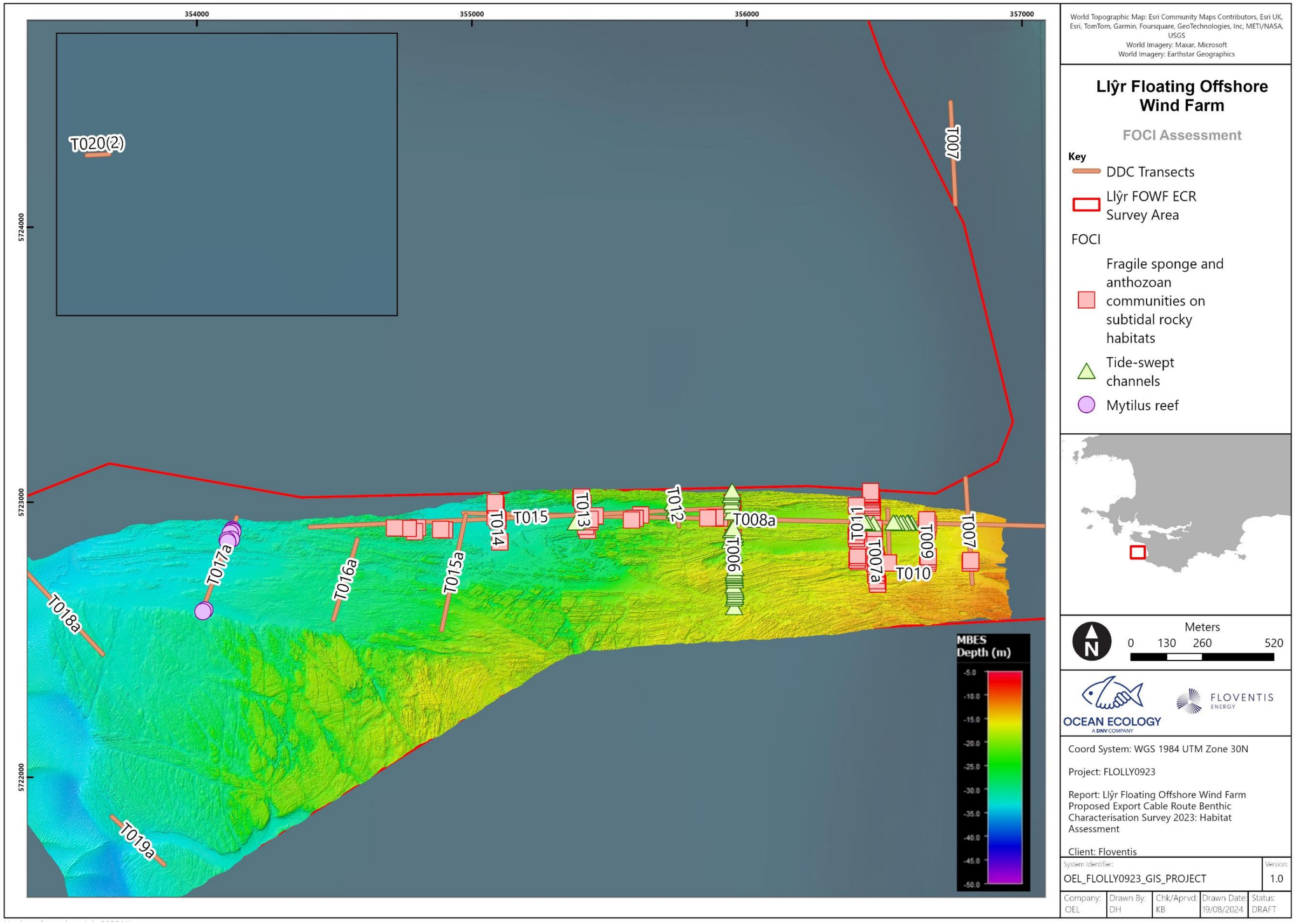

Figure 10 FOCI Assessment within the Llyr Floating Offshore Wind Farm survey area.

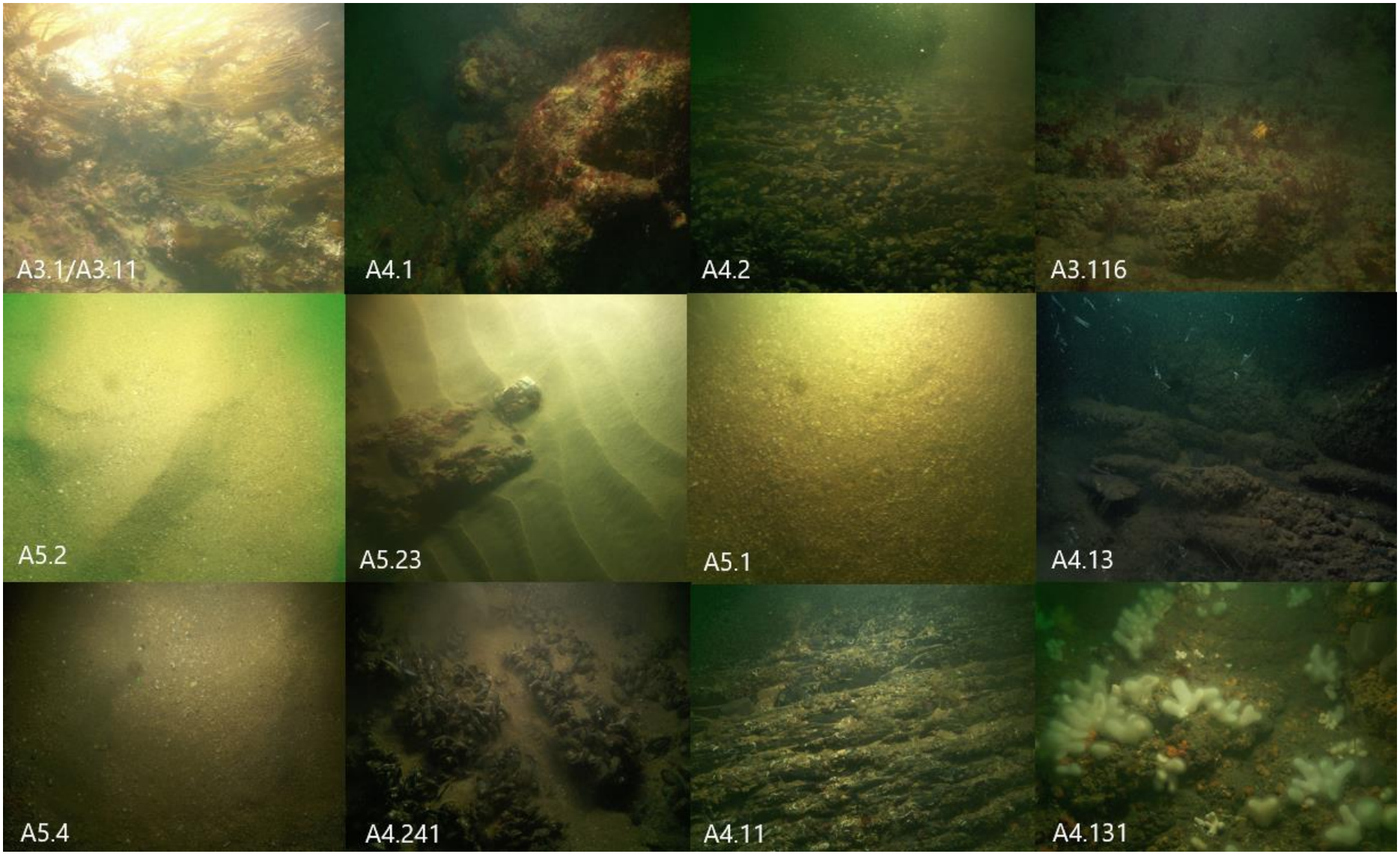

Plate 3 Example imagery of dominant EUNIS habitats identified within the Llyr Floating Offshore Wind Farm survey area.

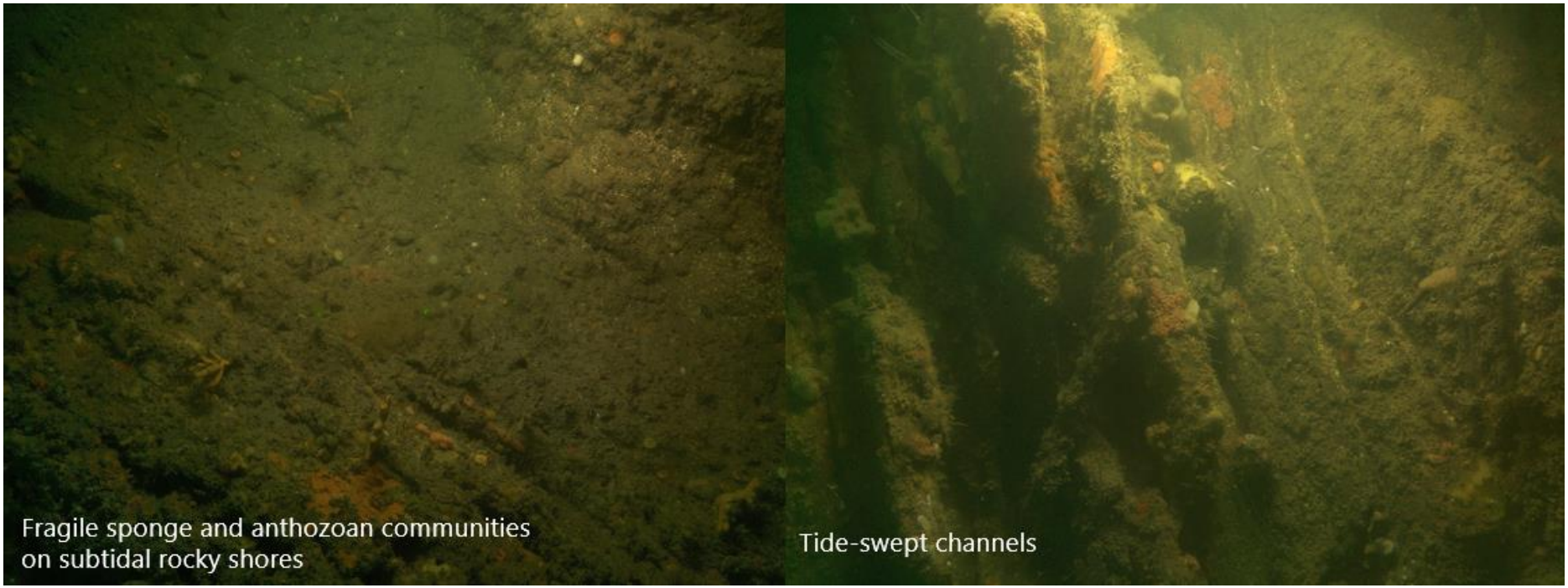

Plate 4 Example imagery of the FOCIs identified within the Llyr Floating Offshore Wind Farm survey area.

Annex I Reef Assessment

A full reef assessment was conducted on all images to determine whether habitats met the definitions of Annex I bedrock or stony reef habitats as detailed in Table 11. The full Annex I reef assessment is provided in Appendix V. Evidence of Annex I reef was identified in 434 out of the 934 images collected across the 17 transects. Annex I bedrock reef was predominant followed by Annex I medium stony reef. Bedrock and *Mytilus* reef and a mosaic of bedrock and medium stony, low stony and bedrock & low stony were also observed throughout the survey area. This is summarised in Table 11 and displayed in Figure 11 and Figure 12.

Plate 5 illustrates various types of reef habitats (and a non-reef habitat) based on percentage cover of cobble, boulders and bedrock, elevation (i.e.: low medium and high stony reef) and faunal cover. All together consolidation of substrate, energy of the environment and epifaunal community play an important role in determining the stability of a reef. Mobile substrates such as cobble, pebbles, gravel and sand do not exhibit the characteristics typically associated with a consolidated and well-established reef especially where they are barren, or infauna is dominating. In contrast a stable reef is typically colonised by faunal turf and other encrusting species as well as various epifauna both sessile and mobile. The more complex the reef community structure the more stable and diverse the reef is.

Table 11 Annex I Reef Assessment Summary.

Annex I	EUNIS	Images	Transects
Bedrock	A4.11	372	T006, T007, T007a, T008a, T009, T010, T011, T012, T013, T014, T015, T015a, T016a, T017a, T018a, T019a
	A4.111		
	A4.112		
	A4.1122		
	A4.13		
	A4.131		
	A4.138		
	4.241		
	A4.2511		
Bedrock and Low Stony	A4.1	1	T007a
	A4.131		
Bedrock & Medium Stony	A4.2	6	T006, T007a
	A4.2511		
Bedrock & Mytilus	4.2	22	T017a
	A4.241		
Low Stony	A.5.4	2	T015
	A5.44		
Medium Stony	A4.2	27	T006, T007a, T010, T012, T015
Mytilus Reef	A4.241	3	T019a
Potential Bedrock	A4.13	1	T010

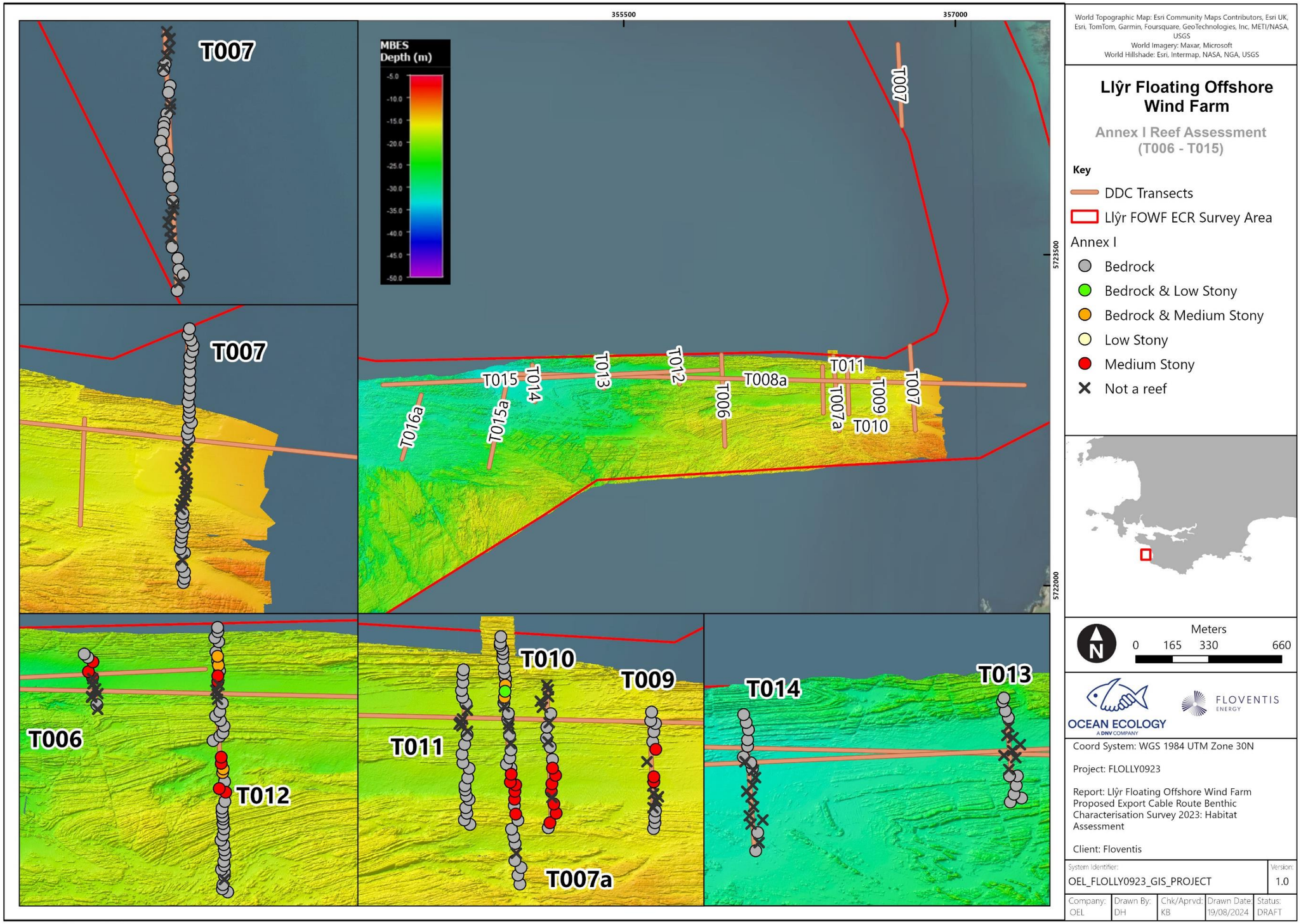

Figure 11 Annex I Reef Assessment (Transects T006, T007, T007a, T008a, T009, T010, T011, T012, T013, T014 and T015) within the Llyr Floating Offshore Wind Farm survey area.

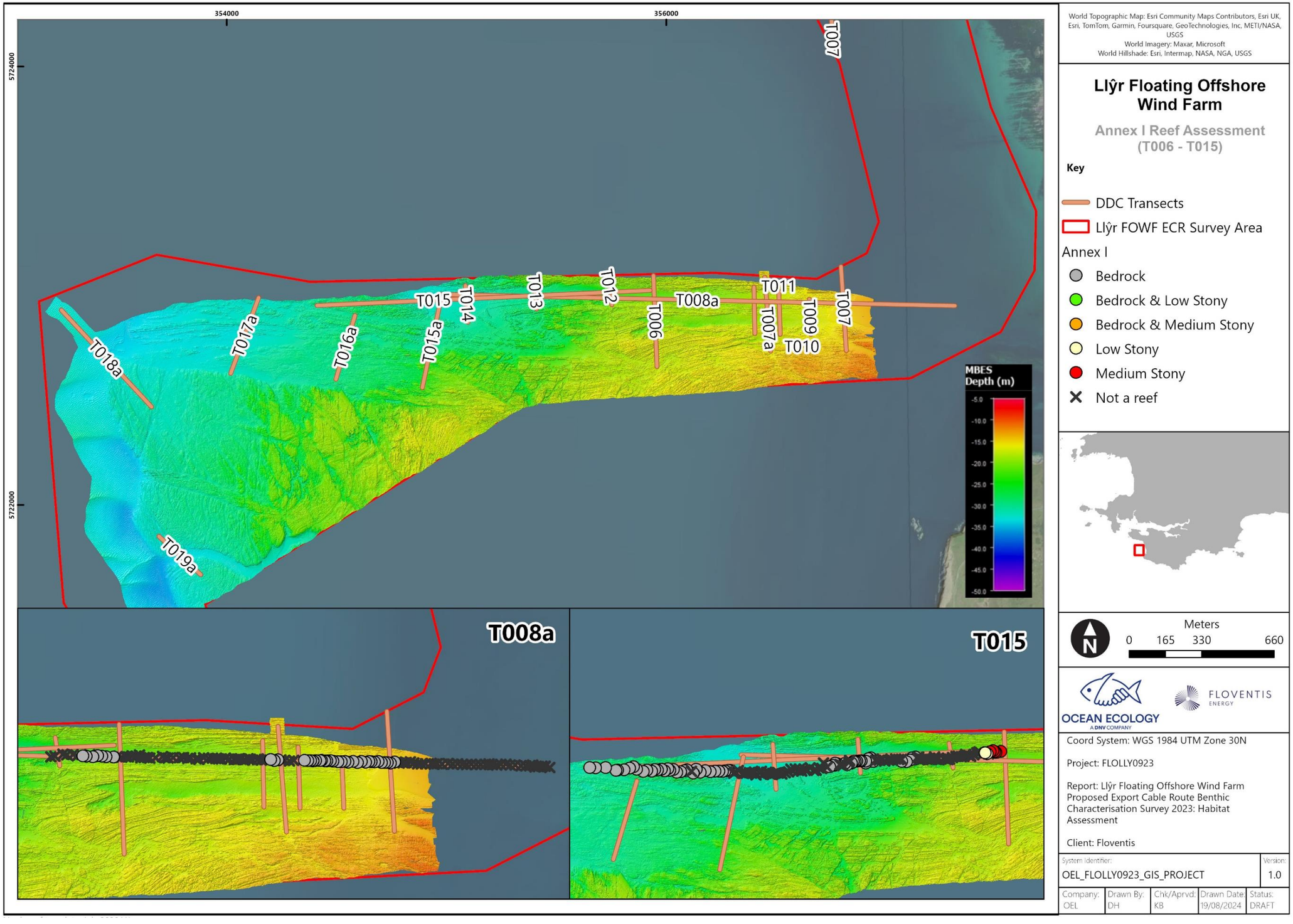

Figure 12 Annex I Reef Assessment (Transects T006, T007, T007a, T008a, T009, T010, T011, T012, T013, T014 and T015) within the Llyr Floating Offshore Wind Farm survey area.

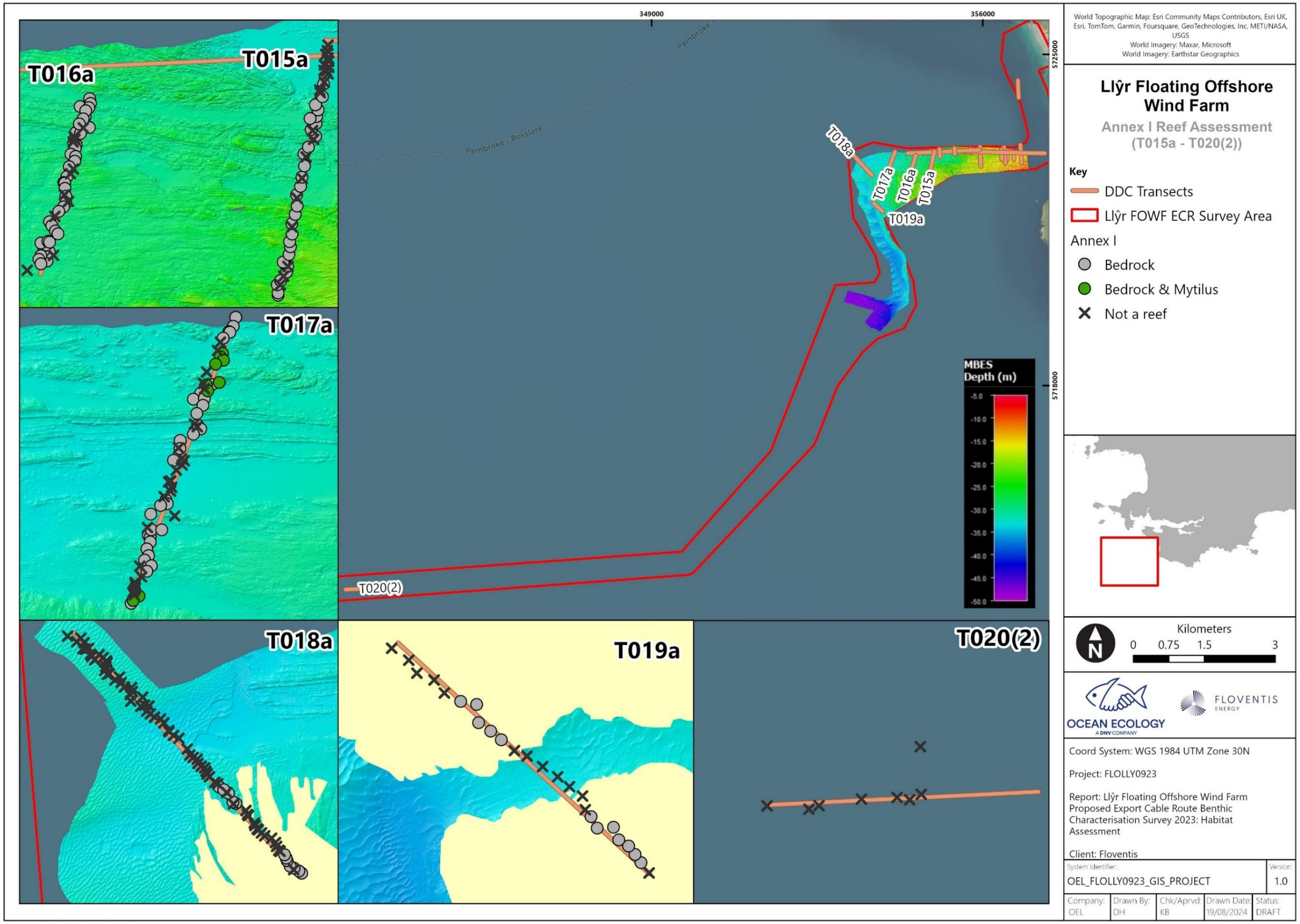

Figure 13 Annex I Reef Assessment (Transects T015a, T016a, T017a, T018a, T019a, & T020(2)) within the Llyr Floating Offshore Wind Farm survey area.

Plate 5 Example imagery of different reef types based on rock cover, elevation and epifaunal cover, and one example of a non-reef habitat**.**

6.3.1. Habitat Mapping

The survey area was dominated by stratified bedrock consisting of BSHs A4.1 and A4.2 with gullies of sediments dominated by BSH A5.1 to the northeast and A5.4 to the northwest. These gullies and sediment channels mapped in the northern section of the survey area were not continuous features but interspersed with bedrock and stony reefs (Figure 14).

A large area of sediments identified as BSH A5.2 was mapped at the west and southwest of the survey area. This area characterised by sand waves and rippled bedform is part of the Turbot Bank sandbank occurring within the Pembrokeshire Marine SAC (Figure 14).

Rock habitats across the survey area was predominantly mapped as bedrock reef with discrete areas of medium and low stony reef occurring between the bedrock and the sediments gullies in the north of the survey area. All rocky habitats mapped across the survey area fell within the boundaries of the Pembrokeshire Marine SAC and as such were afforded protection as Annex I reefs (Figure 14 and Figure 15).

Seabed imagery indicated that two FOCI habitats occurred over bedrock reef to the northeast of the survey area, namely Fragile sponge and anthozoan communities on subtidal rocky habitats and Tide-swept channels. To the northwest of the survey area the blue mussel *M. edulis* was captured in the seabed imagery over hard substrates. The combined interpretation of seabed imagery and bathymetry data revealed that mussels occurred on both bedrock and missed sediments and were therefore mapped as a combination of *M. edulis* beds over bedrock (A4.241) as well as *M. edulis* beds on sublittoral sediments with the latter representing a blue mussel bed FOCI habitat that was not originally identified based on imagery analysis alone (Figure 14).

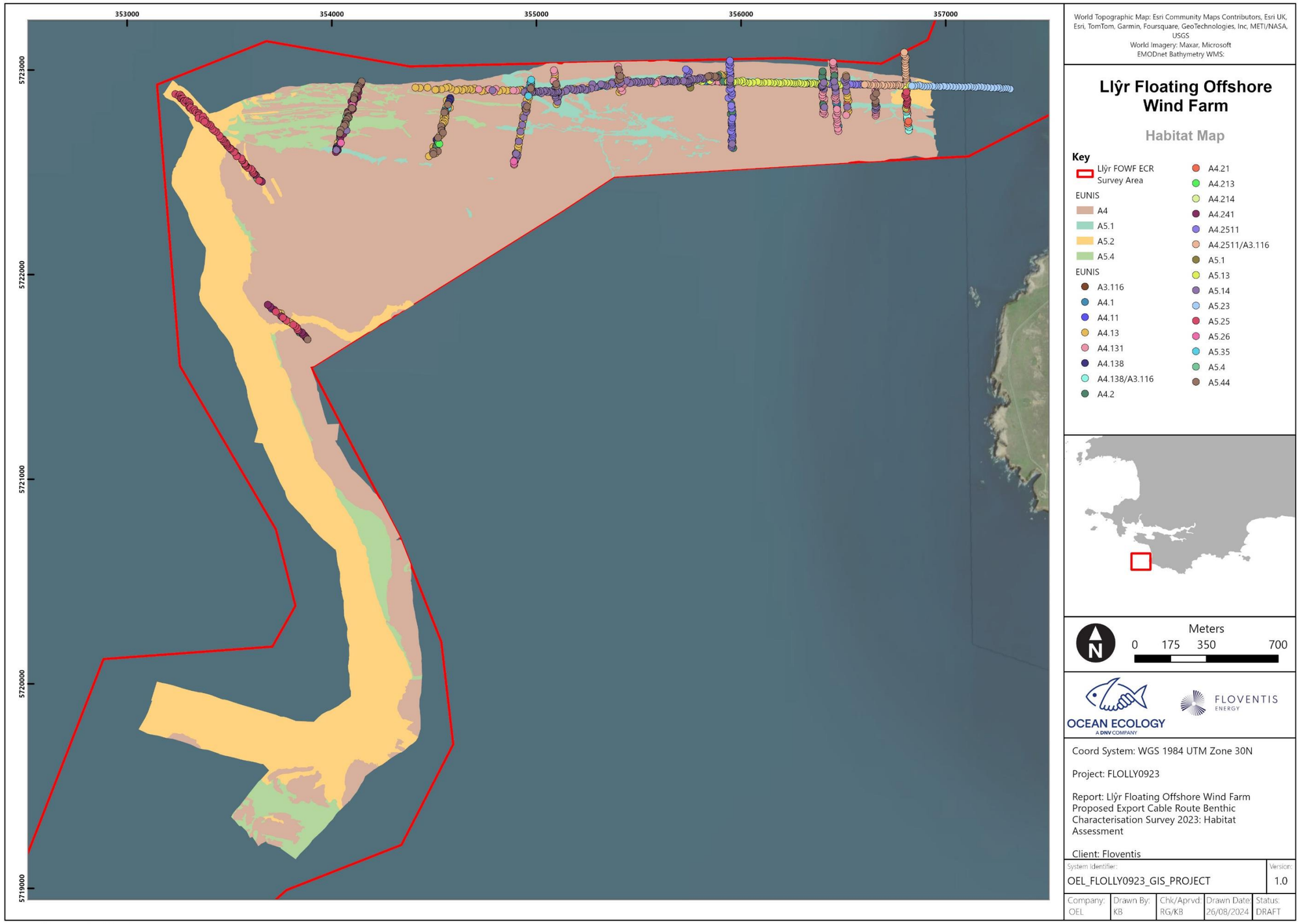

Figure 14 Broad Scale Habitat map of the Llyr survey area overlaid with EUNIS classifications from seabed imagery analysis.

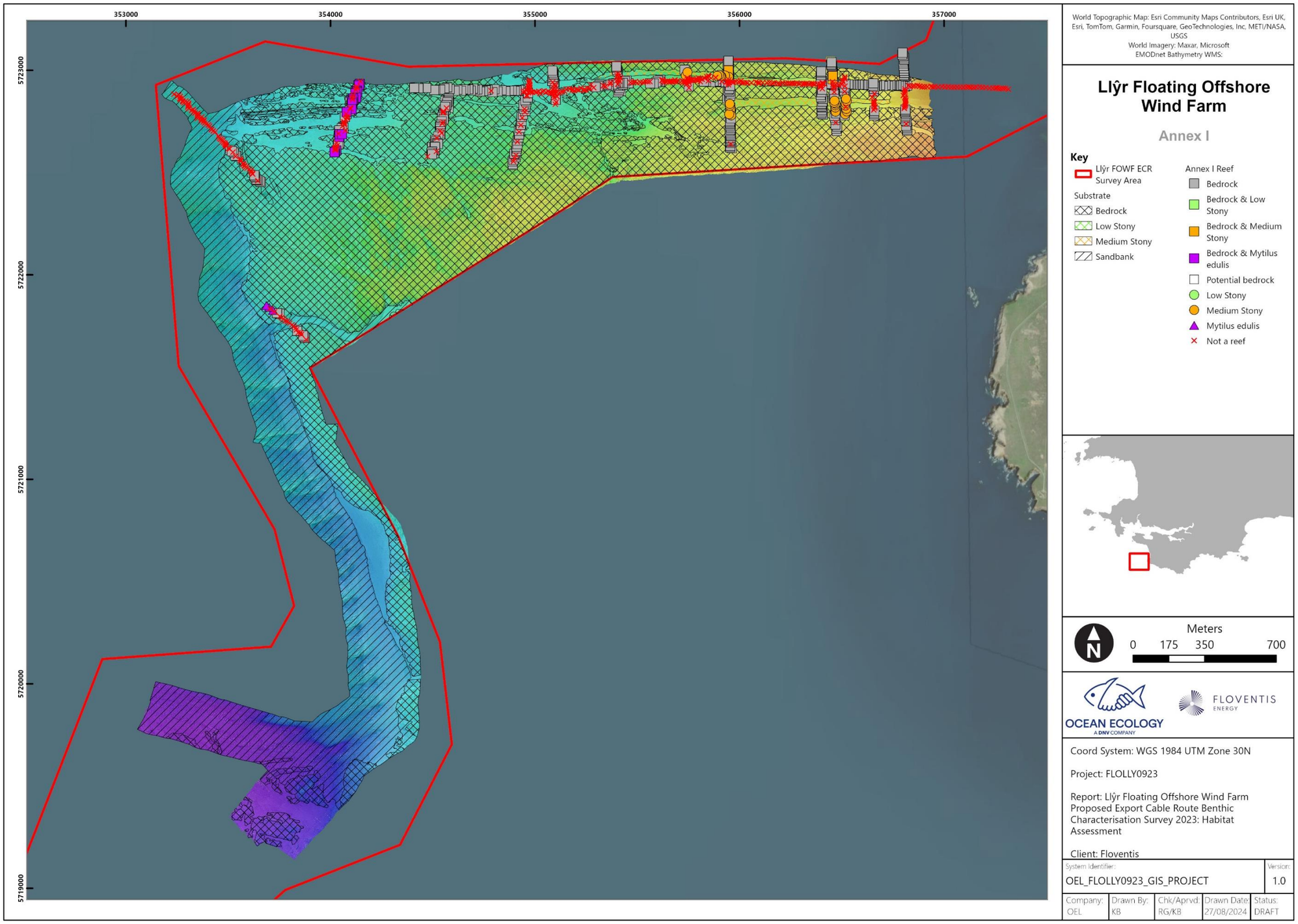

Figure 15 Substrates identified across the Llyr survey area overlaid with the Annex I reef assessment data points from the seabed imagery analysis.

7. Discussion

This report presents the habitat assessment of the subtidal survey undertaken in the Llŷr floating offshore wind farm area, located in the approaches to the Bristol Channel in the Celtic Sea. This assessment involved the collection of seabed imagery and bathymetry data and their combined interpretation has been used to assess and map the key habitats present across the survey area.

Based on MBES data it was possible to map the seabed across the survey area as a complex seabed of circalittoral rock habitats (A4) while seabed imagery analysis provided additional information on environmental energy and the community colonising these features. Most common fauna included faunal turf, bryozoans, sponges, hydroid, ascidians and seaweeds. In the shallower reaches to the east of the survey area high energy infralittoral rock (A3.1) was mapped with kelp and red seaweed. All rock habitats and biotopes qualified as Annex I reefs and are afforded protection as they are a primary reason for the designation of the Pembrokeshire marine SAC. Gullies and sediment channels cut across these rock habitats in the northern section of the survey area, mostly running east to west, with coarse sediments to the east and mixed sediments to the west. These gullies and sediment channels were assessed as not qualifying as Annex I reefs.

Two FOCIs were identified within the Llŷr survey area, namely fragile sponge and anthozoan communities on subtidal rocky habitats and tide-swept channels. These FOCIs were found to be most commonly mosaiced throughout the survey area and concentrated to the northwest where greater sampling effort was focussed. Another potential FOCI was mapped to the west of the survey area based on the combined interpretation of seabed imagery and MBES data. *Mytilus edulis* was observed occurring on both bedrock and mixed sediments with the latter potentially representing the FOCI *Mytilus edulis* beds on sublittoral sediment. More data is needed to confidently map this FOCI, hence the potential label assigned at this stage.

A large area of sand was mapped as BSH A5.2 to the west and south of the survey area and overlapped with the known sandbank Turbot Bank.

Confidence in the habitat mapping was overall high at EUNIS level 2 classification as clear boundaries between hard and soft substrate were evident in the MBES data and ground-truthed by the seabed imagery. Conversely, at BSH level the mapping was of lower confidence as there were no clear boundaries in the MBES data to distinguish between rock habitats of different energies (A4.1 vs. A4.2).

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