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West of Orkney Offshore EIA Report

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Marine Surveys, Analysis & Consultancy

West of Orkney Offshore Wind Farm Intertidal Habitat Assessment 2022

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Abbreviations

BSH	Broadscale Habitat
CAA	Civil Aviation Authority
DTM	Digital Terrain Model
EMODnet	European Marine Observation and Data Network
EUNIS	European Nature Information System
GPS	Global Positioning System
GSD	Ground-Sampling Distance
INNS	Invasive Non-Native Species
JNCC	Joint Nature Conservation Committee
MHWS	Mean High Water Springs
LAT	Lowest Astronomical Tide
MLWS	Mean Low Water Springs
MNCR	Marine Habitat Classification for Britain and Ireland
OEL	Ocean Ecology Ltd
OWF	Offshore Wind Farm
PfCO	Permission for Commercial Operations
RPQs	Qualified UAV Pilots
SAC	Special Area of Conservation
UAV	Unmanned Aerial Vehicle

Non-Technical Summary

This report presents the findings of the intertidal survey conducted at Caithness at two proposed landfall options for the West of Orkney Windfarm (the Project). The key aim was to characterise and map benthic habitats present across the foreshore as part of a wider programme of characterisation surveys of the export cable corridor and option agreement area.

The survey took place at Greeny Geo and Crosskirk landfall options and involved the collection of Unmanned Aerial Vehicle (UAV) aerial imagery accompanied by a Phase I walkover survey to gather detailed information on the benthic communities present for subsequent habitat / biotope mapping purposes. A comprehensive suite of images and target notes were collected across the full extent of intertidal survey area at each site between Mean Low Water Springs (MLWS) and Mean High Water Springs (MHWS). A wide range of broadscale littoral rock and sediment habitats were identified with varied associated algal and faunal communities typical of the intertidal areas along the Caithness coast. Following detailed review, the information collected during the survey was used to produce full coverage updated habitat / biotope maps for both survey areas as well as mapping for each habitat of conservation interest observed.

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

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

Kelp was observed in both the UAV imagery and target notes however without information from the adjoining subtidal areas it was not possible to confidently define the boundaries and extent of these habitats which are likely to be representative of the Priority Marine Features (PMFs) 'kelp beds' and 'kelp and seaweed communities on sublittoral sediment' designated in Scottish waters.

No invasive non-native species (INNS) were identified throughout both survey areas.

2. Introduction

2.1. Project West Orkney

Offshore Wind Power Limited (OWPL) is the developer and seabed leaseholder for the West of Orkney Windfarm ('the Project'), a proposed offshore wind farm (OWF) located approximately 23 km from the north coast of Caithness and 28 km from the west coast of Hoy, Orkney. Crown Estate Scotland (CES) awarded OWPL the Option Agreement Area (OAA) in January 2022 for the development of the proposed Project which will include both offshore and onshore infrastructures. The offshore elements of the Project (the offshore Project) will consist of:

- Up to 125 Wind Turbine Generators (WTGs) with fixed-bottom foundations (monopile, piled jacket or suction bucket jacket);
- Up to 5 High Voltage Alternating Current (HVAC) Offshore Substation Platforms (OSPs);
- Up to 150 km of OSP interconnector cables;
- Up to 500 km of inter-array cables;
- Up to 5 offshore export cable circuits to landfall options at Greeny Geo and/or Crosskirk at Caithness, with a total length of up to 320 km (an average of 64 km per offshore export cable circuit).

The offshore infrastructure is located seaward of Mean High Water Springs (MHWS). The onshore infrastructure is located landward of Mean Low Water Springs (MLWS).

2.2. Project Background

Ocean Ecology Limited (OEL) were commissioned by Xodus on behalf of OWPL to undertake an intertidal survey at Caithness to assess two landfall options: one at Greeny Geo and the other at Crosskirk. The survey involved the collection of UAV imagery (undertaken by Spectrum Geosurvey) and a Phase I walkover survey undertaken by OEL personnel to characterise and map the soft and hard substrates and associated benthic communities of the intertidal area at these two potential landfall locations (Figure 1).

This report provides a summary of the survey methodologies employed and detailed mapping of the habitats encountered during the survey. Habitats were determined through detailed interpretation of the UAV imagery, walkover site images and target notes allowing for the determination of EUNIS habitats and biotopes (where possible) and subsequent creation of full coverage mapping across the survey areas.

2.3. Aims and Objectives

The main objective of the intertidal survey was to map the distribution and extent of broadscale habitats, biotopes, biotope complexes and life forms present. A key focus was to confirm the presence/absence of any habitats and/or features of conservation interest known to occur in the vicinity of the landfall locations (e.g., reef habitats and/or seagrass beds).

2.4. Current Understanding

2.4.1. Existing Habitat Mapping

The 2021 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. The EUSeaMap data did not extend into the intertidal to completely encompass the survey area however it indicated that the habitats present in proximity of the intertidal survey area primarily consisted of sublittoral sediment (A5), Atlantic and Mediterranean high energy infralittoral rock (A3.1) and Atlantic and Mediterranean moderate energy infralittoral rock (A3.2) as mapped in Figure 2. Utilising data obtained from the Joint Nature Conservation Committee (JNCC) and the European Marine Observation and Data Network (Vasquez et al. 2021), Annex I Reefs were found in correspondence of EUNIS classifications A3.1 and A3.2 (Figure 2).

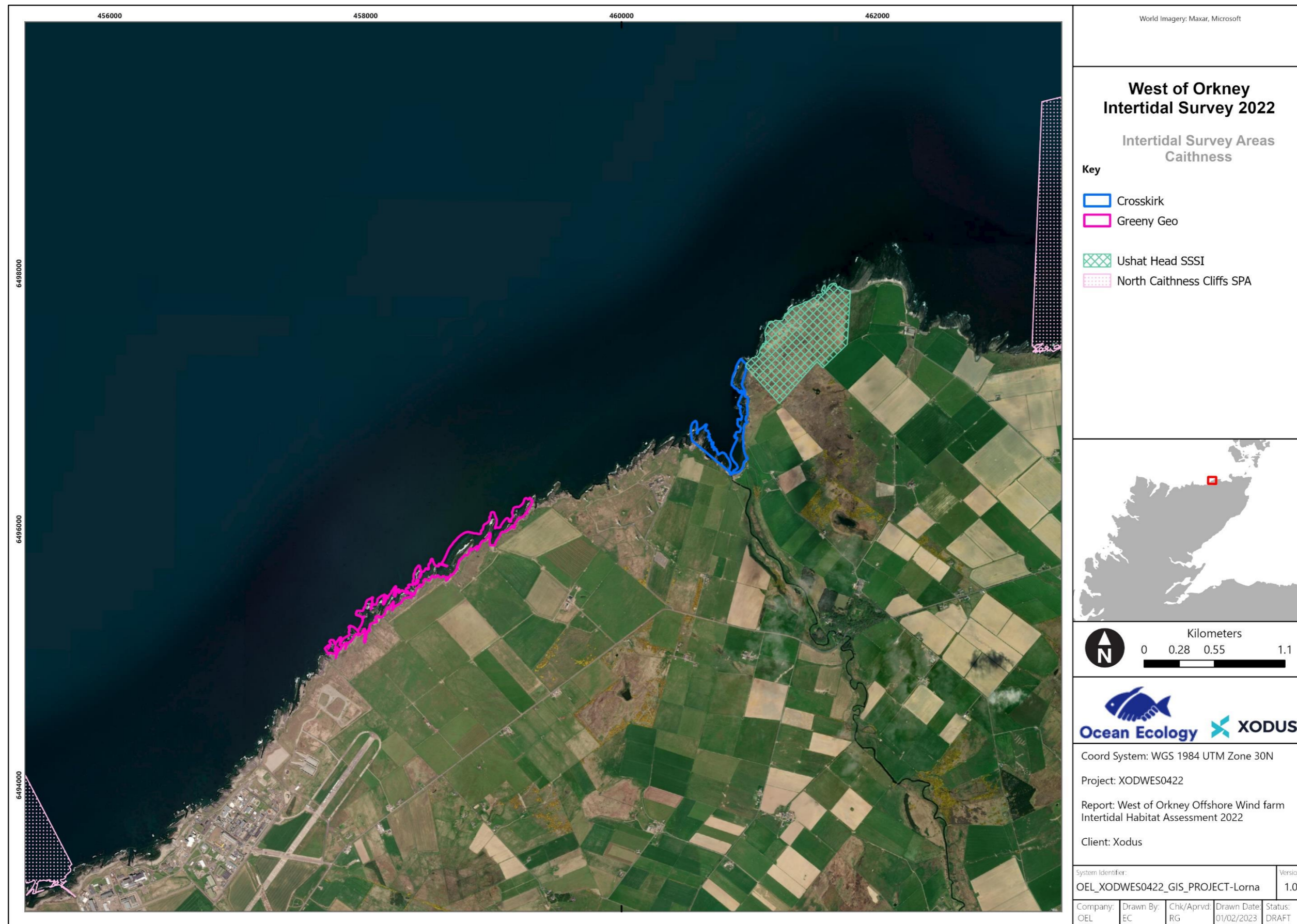


Figure 1 Intertidal survey area at Caithness; to the west is the Greeny Geo potential landfall location and to the east is the Crosskirk potential landfall location.

2.4.2. Habitats 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.

In July 2014, Scotland adopted a list of 81 priority marine features (PMFs) characteristic of the Scottish marine environment. NatureScot and JNCC worked with Marine Scotland to develop the list and assessed species and habitats on existing conservation schedules against criteria that considered:

- whether the species/habitat occurred in significant numbers in Scotland's seas
- whether the species/habitat is under threat or in decline
- the functional role that the species/habitat played

These legislations afford the protection of the designated areas and protected habitats in proximity of the Caithness intertidal survey area Figure 1.

2.4.3. Designated Sites

Ushat Head Site of Special Scientific Interest (SSSI)

Ushat Head SSSI is a low exposed headland, bordering the Crosskirk site to the northeast and approximately 9 km northwest of Thurso on the north coast of Caithness (Figure 1). It is of botanical importance for its maritime heath, which is a species rich type of heathland that is found only in Caithness, Sutherland, and Orkney. There is a good representation of species-rich maritime heath communities in a mosaic with maritime grassland. Heathers and creeping willow *Salix repens* are the main dwarf shrubs. The rare Scottish primrose (*Primula scotica*) and small-fruited yellow sedge (*Carex viridula*) are found at Ushat Head SSSI. Roseroot (*Sedum rosea*) and kidney vetch (*Anthyllis vulneraria*) are abundant, along with the maritime species, spring squill (*Scilla verna*), sea campion (*Silene uniflora*) and sea plantain (*Plantago maritima*).

North Caithness Cliffs Special Protected Area (SPA)

North Caithness Cliffs SPA is located about 2 km from both sides of the overall intertidal survey area (Figure 1). It is of special nature conservation and scientific importance within Britain and the European Community for supporting very large populations of breeding seabirds. The seaward reaches of this SPA extend approximately 2 km into the marine environment to include the seabed, water column and surface. Due to the high mobility of the species

protected under this designation, and the fact that this SPA flanks both sides of the survey area, it cannot be rule out that these breeding birds will not be present within the survey area.

2.4.4. Priority Marine Features (PMFs)

A number of PMF species have previously been identified in and around the Caithness coast. These included records of <Redacted> European spiny lobsters (*Palinurus elephas*), grey seals (*Halichoerus grypus*), <Redacted> and white-beaked dolphins (*Lagenorhynchus albirostris*). No PMFs habitats have been identified in proximity of the Caithness intertidal survey area, however, the PMF 'Offshore subtidal sand and gravels' was identified offshore along the Caithness ECC. Additionally, the PMF 'kelp bed' is likely to be found close to the MLWS in Scottish waters.

2.4.5. Geogenic Reef

Geogenic reefs are rocky marine habitats that rise from the seabed. They are generally subtidal but may extend as an unbroken transition into the intertidal zone, where they are exposed to the air at low tide. Intertidal areas qualify as Annex I geogenic reef habitats only where they are connected to subtidal reefs. EMODnet mapping indicated the presence of Annex I geogenic reefs in the subtidal area adjacent to the intertidal survey area investigated for this assessment (Figure 2), suggesting that if rock habitats were observed during the Phase I walkover survey and/or in the UAV imagery then these might qualify as Annex I geogenic reefs. Starting from the shore, rocky intertidal zones are an interface between land and sea colonised by plants and seaweeds, invertebrates, and fish during high tides. Nearshore rocky reefs are completely submerged, but still receive enough light for photosynthesis. They can be very variable in form and in the communities that they support, ranging from vertical rock walls to horizontal ledges, sloping or flat bedrock, broken rock, boulder fields, to aggregations of cobbles. Subtidal geogenic reefs are characterised by communities of attached algae, where there is sufficient light, and invertebrates, usually associated with a range of mobile animals, including invertebrates and fish.

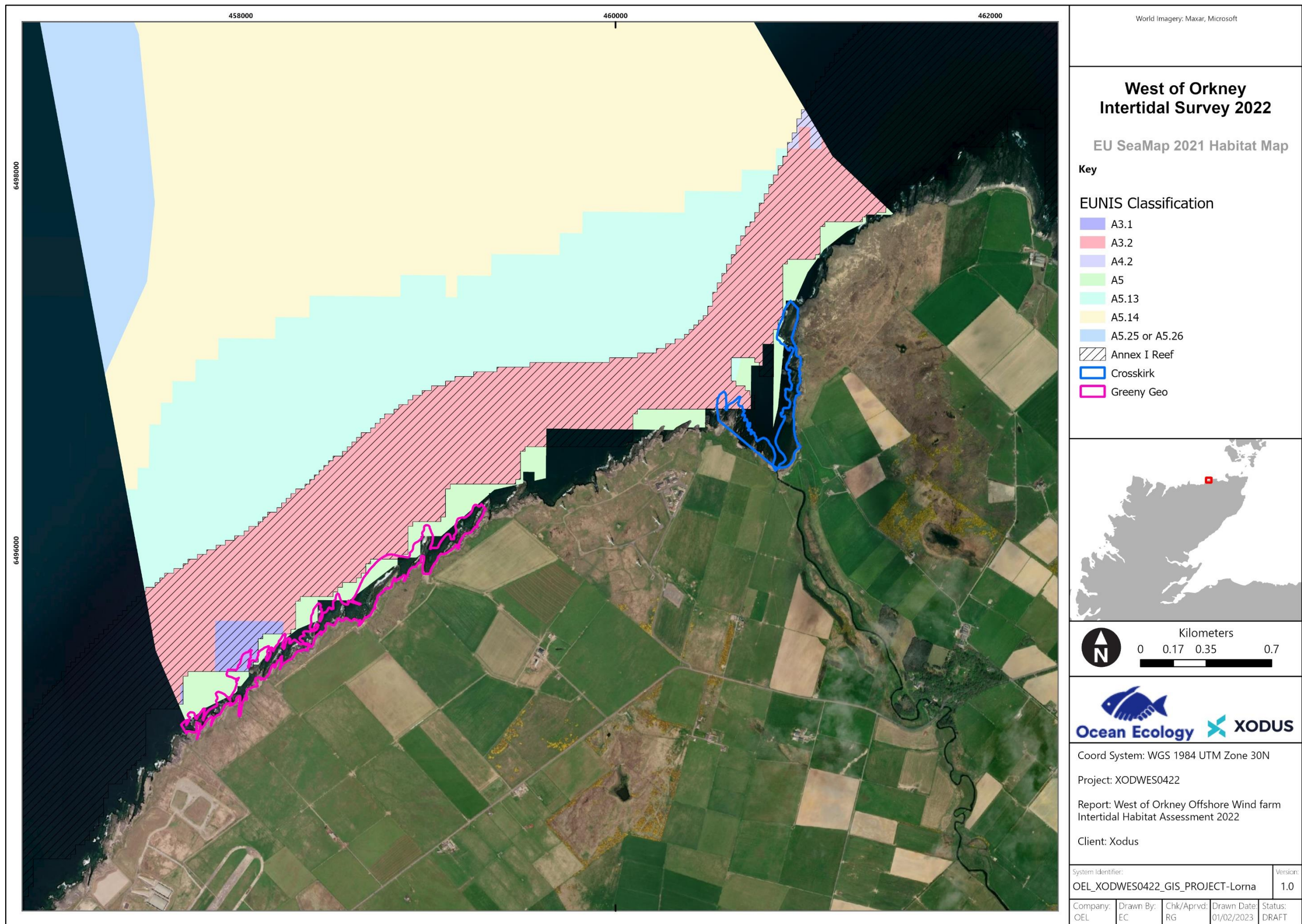


Figure 2 EUNIS classifications and Annex I habitats in proximity of the Caithness intertidal survey area (Vasquez et al. 2021).

3. Methods

3.1. Survey Design

The intertidal survey covered the two proposed landfall locations at Caithness, extending from MLWS to MHWS. An UAV survey was undertaken to collect high-resolution imagery across the survey areas at low water. Additionally, a total of 206 target points were investigated during the Phase I walkover survey to ground-truth the orthomosaic generated from the aerial imagery and subsequently inform the habitat / biotope mapping.

3.2. Survey Methods

3.2.1. Phase I walkover survey

The Phase I intertidal survey was undertaken using ESRI Field Maps app on a Bad Elf GPS & GLONASS (2.5 m accuracy) enabled tablet device in consideration of guidance in the Marine Monitoring Handbook (Davies et al. 2001), CCW Handbook for Marine Intertidal Phase I Survey and Mapping (Wyn et al. 2006) and latest guidance for characterising intertidal rocky shore and sediment habitats (NRW 2019). During the walkover survey, EUNIS classifications were assigned in consideration of the latest Joint Nature Conservation Committee (JNCC) guidance (Parry 2019a). These were correlated to the Marine Habitat Classification for Britain and Ireland (MNCR) and, where possible, boundaries of habitats / biotopes tracked as polygons in ESRI Field Maps. A detailed intertidal survey log and field notes are provided in Appendices I and II.

Representative examples of each habitat / biotope encountered were photographed. Additionally, the distribution of any features of conservation interest was recorded using photographs and GPS fixes where encountered. The presence of Invasive Non-Native Species (INNS) was also noted and their location recorded. Other information recorded included general site conditions, sediment surface features (e.g., *Lanice conchilega* tube aggregations), sediment type and characteristics, topography, and evidence of any anthropogenic pressures.

Target notes were taken at any notable change in habitat / substrate and identified the presence of any notable features (e.g., intertidal rockpools). These were accompanied by GPS fixes and close-up photographs of each feature, along with general site photographs. Aspect images to the North, East, South and West from each target location were also taken.

3.2.2. UAV Mapping

A UAV survey was undertaken by Spectrum Geosurvey to collect full coverage high-resolution imagery across the survey areas at low water.

4. Analysis

4.1.1. UAV Imagery Analysis

All images collected during the UAV mapping flights underwent processing in the DJI Terra Pro software and were 'stitched' together to generate orthomosaic and Digital Terrain Model (DTM) outputs for the intertidal survey areas. The outputs were then used as base maps in GIS to facilitate subsequent habitat / biotope mapping by visual interrogation and delineation of boundaries.

4.1.2. EUNIS Classification Mapping

EUNIS habitats and biotopes were identified in line with JNCC guidance on assigning benthic biotopes (Parry 2019b) to allow the communities to be mapped and allow comparison with existing data. All habitat / biotope determination was undertaken through consideration of the following:

- Existing habitat mapping (derived from EMODnet);
- UAV imagery interpretation;
- Review and interpretation of target field notes and quadrat imagery; and
- General site imagery.

5. Results

5.1. Survey Progress

The Phase I intertidal walk over sampling was undertaken at Crosskirk and Greeny Geo during spring tides between October 24th and 26th 2022. Table 1 provides a summary of the sampling undertaken and information collected during the surveys.

Table 1 Summary of sampling and information collected during the intertidal survey.

Sampling	Crosskirk	Greeny Geo
Target Notes	86	120
UAV imagery	1,446 images	1,662 images

5.2. UAV Survey

UAV mapping was undertaken at Caithness around low water between the 24th and 26th October 2022. Weather conditions (e.g., wind / precipitation) remained favourable for data collection throughout the survey.

The UAV flight of Crosskirk successfully captured 1,446 high-resolution nadir images across a coverage area of 0.481 km² to produce a high resolution orthomosaic model (GSD = 0.014 m/px) and DTM (GSD = 0.25 m/px) with an average accuracy level of 0.13 m.

The UAV survey of Greeny Geo successfully captured 1,662 high-resolution nadir images across a coverage area of 0.664 km² to produce a high resolution orthomosaic model (GSD = 0.013 m/px) and DTM (GSD = 0.25 m/px) with an average accuracy level of 0.11 m.

Example aerial images are provided in Plate 1.

5.3. Phase I Sampling

In total, target notes were taken at 206 locations (86 at Crosskirk and 120 at Greeny Geo) to provide localised information on habitats and features of interest present across the intertidal areas to assist in ground truthing of UAV aerial imagery (Figure 3).

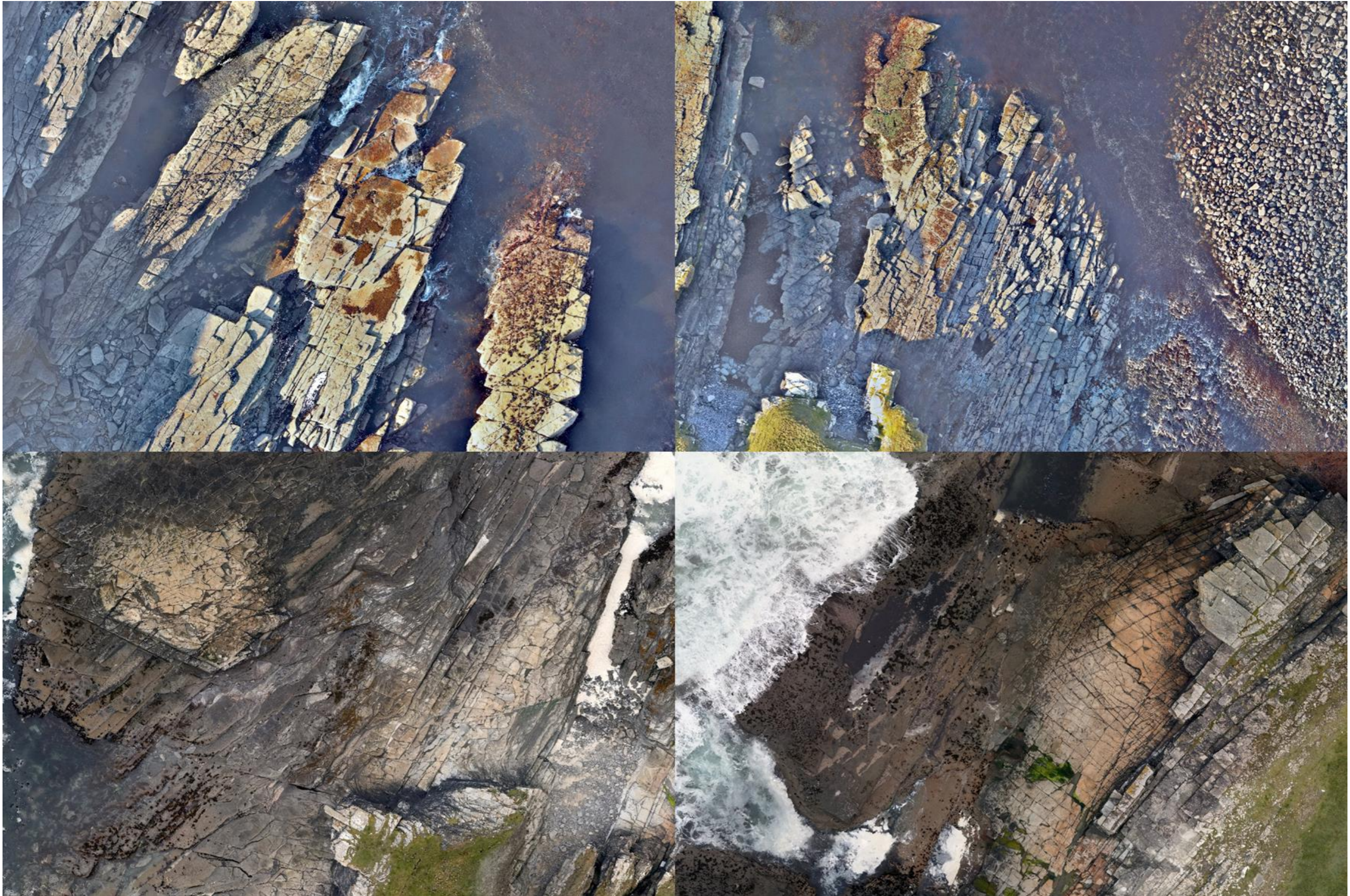


Plate 1 Example UAV imagery at Crosskirk (top) showing exposed rocky shore with algal communities and Greeny Geo (bottom) showing bare rock in the upper shore grading into soft sediment habitats in the lower shore (right).



Figure 3 Location of target notes, collected at Greeny Geo (top) and Crosskirk (bottom).

5.4. Habitat / Biotope Mapping

5.4.1. Crosskirk

There was a total of 23 unique biotopes (EUNIS level 5 or above) from 6 Broad Scale Habitats (BSH) (Table 2) observed across the Crosskirk survey area as mapped in Figure 4.

The majority of the Crosskirk site was characterised by a high energy littoral rock habitat (A1.1). On the eastern shore, this dominant habitat supported acorn barnacle *Semibalanus balanoides*, common limpet *Patella vulgata*, common periwinkle *Littorina* spp. (A1.1131) and *Fucus distichus* and *Fucus spiralis* (A1.121) in the more exposed areas, and was backed by features of littoral rock (A1.4) including ephemeral green or red seaweeds on non-mobile substrata (A1.45). On the western shore, this high energy littoral rock habitat was interspersed with other rocky habitats of different exposure (e.g., A1.2, A1.3, A1.4) at times supporting *F. spiralis* (A1.212) or *Corallina officinalis* in the more exposed areas (A1.122).

A clear zonation characterised the central part of the Crosskirk bay where the more sheltered upper shore was characterised by littoral coarse sand and muddy sand (A2.2) and a strandline (A2.21) dominated by masses of kelp and red seaweed with some fucoids. In the middle shore this graded into low energy littoral rock (A1.3) mosaiced with fucoids (A1.31, A1.311, A1.312, A1.32, A1.322, A1.327). Moderate and high energy habitats (A1.1 and A1.2) became dominant in the lower shore where they supported *S. balanoides*, *P. vulgata*, *Littorina* spp. (A1.1131) and fucoids (A1.121, A1.212, A1.214). Littoral coarse sediment was scattered along the upper shore in the central part of the Crosskirk site as well as in the western upper shore.

No notable taxa (INNS or species of commercial value) were found during the intertidal Phase 1 walkover survey at Crosskirk. However, kelp was observed in the extreme lower shore and below the waterline as well as in some of the rockpools encountered in the upper shore. Kelp beds and kelp communities on sublittoral sediments are considered a PMF in Scottish waters and protected as a features of conservation interest. Kelp habitats observed across the Crosskirk site are likely to be representative of the PMF 'kelp beds' as they occurred in rocky areas, however, without information from the adjoining subtidal areas, it was not possible to confidently define their boundaries and extent.

Table 2 Key EUNIS classifications recorded at Crosskirk.

EUNIS BSH	EUNIS Code	EUNIS Description
A1.1 - High energy Littoral Rock	A1.113	<i>Semibalanus balanoides</i> on exposed to moderately exposed or vertical sheltered eulittoral rock
	A1.1131	<i>Semibalanus balanoides</i> , <i>Patella vulgata</i> and <i>Littorina</i> spp. on exposed to moderately exposed or vertical sheltered eulittoral rock
	A1.121	<i>Fucus distichus</i> and <i>Fucus spiralis f. nana</i> on extremely exposed upper eulittoral rock
	A1.122	<i>Corallina officinalis</i> on exposed to moderately exposed lower eulittoral rock
A1.2 - Moderate energy littoral rock	A1.211	<i>Pelvetia canaliculata</i> and barnacles on moderately exposed littoral fringe rock
	A1.212	<i>Fucus spiralis</i> on full salinity exposed to moderately exposed upper eulittoral rock
	A1.214	<i>Fucus serratus</i> on moderately exposed lower eulittoral rock
	A1.2141	<i>Fucus serratus</i> and red seaweeds on moderately exposed lower eulittoral rock
A1.3 – Low energy littoral rock	A1.31	Furoids on sheltered marine shores
	A1.311	<i>Pelvetia canaliculata</i> on sheltered littoral fringe rock
	A1.312	<i>Fucus spiralis</i> on sheltered upper eulittoral rock
	A1.32	Furoids in variable salinity
	A1.321	<i>Pelvetia canaliculata</i> on sheltered variable salinity littoral fringe rock
	A1.327	<i>Fucus ceranoides</i> on reduced salinity eulittoral rock
A1.4 – Features of littoral rock	A1.41	Communities of littoral rockpools
	A1.4111	Coralline crusts and <i>Corallina officinalis</i> in shallow eulittoral rockpools
	A1.412	Furoids and kelp in deep eulittoral rockpools
	A1.421	Green seaweeds (<i>Enteromorpha</i> spp. and <i>Cladophora</i> spp.) in shallow upper shore rockpools
	A1.445	<i>Verrucaria mucosa</i> and/or <i>Hildenbrandia rubra</i> on upper to mid shore cave walls
	A1.45	Ephemeral green or red seaweeds (freshwater or sand-influenced) on non-mobile substrata
	A1.451	<i>Enteromorpha</i> spp. on freshwater-influenced and/or unstable upper eulittoral rock
A2.1 – Littoral coarse sediment	A2.11	Shingle (pebble) and gravel shores
A2.2 - Littoral sand and muddy sand	A2.21	Strandline

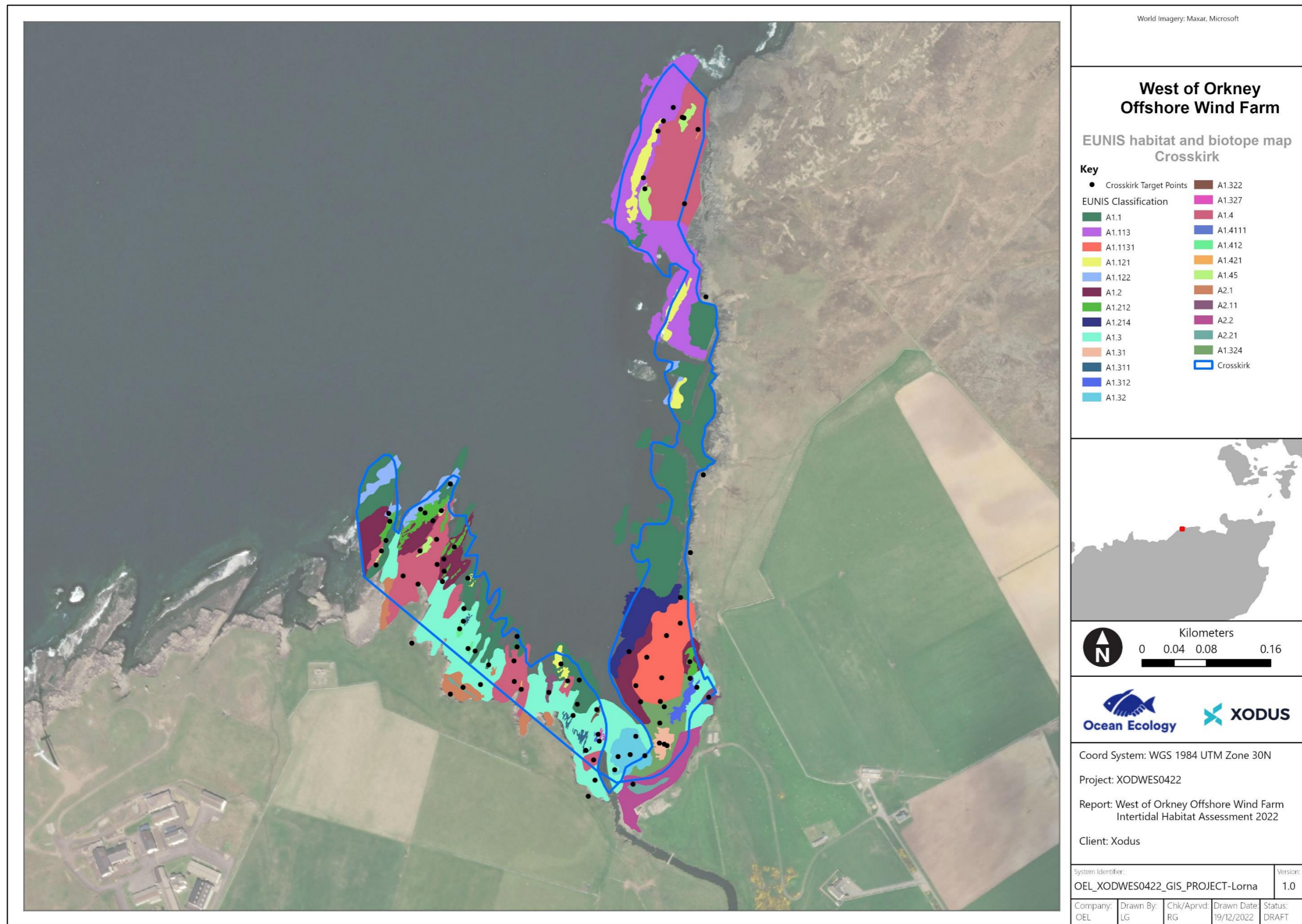


Figure 4 EUNIS habitat and biotope mapping with sampling locations visited during the intertidal survey of Crosskirk.

5.4.2. Greeny Geo

There was a total of 24 unique biotopes (EUNIS level 5 or above) from 5 BSH (Table 3) observed across the Greeny Geo survey area as mapped in Figure 5. The majority of the survey area at Greeny Geo consisted of high energy littoral rock habitat (A1.1) with large corridors of *Fucus* spp. (A1.121) captured within these high energy areas.

To the east of the site, these high energy rock habitats were backed by features of littoral rock (A1.4) including rockpools supporting coralline crusts and *C. officinalis* (A1.411 and A1.4111) and green seaweeds (A1.421). Additionally, in correspondence of a small embayment in the coastline, more sheltered conditions allowed for the presence of gravel and shingle (A2.11) in the upper shore which graded into moderate energy rock habitats seaward (A1.2) supporting *F. serratus* and seaweeds (A1.2141) and high energy rock habitats supporting *S. balanoides*, *P. vulgata* and *Littorina* spp. (A1.1131).

In the western reaches of the site, moderate and low energy littoral rock habitats (A1.2, A1.3) made up the upper shore where they were interspersed with features of littoral rock (A1.4). Some of these rock habitats supported *F. serratus* (A1.214), while rockpools were characterised by the presence of green or red seaweeds (A1.421, A1.45), *Enteromorpha* sp. (A1.451), *Verrucaria mucosa* and/or *Hildenbrandia rubra* (A1.445).

No notable taxa (INNS, species of commercial value etc.) were found within the intertidal phase 1 walkover survey at Greeny Geo. However, kelp was observed in the extreme lower shore and below the waterline likely representative of the PMF 'kelp beds' as it occurred in rocky areas. However, without information from the adjoining subtidal areas, it was not possible to confidently define boundaries and extent of these kelp habitats.

Table 3 Key EUNIS classifications recorded at Greeny Geo.

EUNIS BSH	EUNIS Code	EUNIS Description
A1.1 - High energy littoral rock	A1.113	<i>Semibalanus balanoides</i> on exposed to moderately exposed or vertical sheltered eulittoral rock
	A1.1131	<i>Semibalanus balanoides</i> , <i>Patella vulgata</i> and <i>Littorina</i> spp. on exposed to moderately exposed or vertical sheltered eulittoral rock
	A1.121	<i>Fucus distichus</i> and <i>Fucus spiralis</i> f. <i>nana</i> on extremely exposed upper eulittoral rock
	A1.211	<i>Pelvetia canaliculata</i> and barnacles on moderately exposed littoral fringe rock
	A1.212	<i>Fucus spiralis</i> on full salinity exposed to moderately exposed upper eulittoral rock
	A1.214	<i>Fucus serratus</i> on moderately exposed lower eulittoral rock
	A1.2141	<i>Fucus serratus</i> and red seaweeds on moderately exposed lower eulittoral rock
A1.3 – Low energy littoral rock	A1.31	Furoids on sheltered marine shores
	A1.311	<i>Pelvetia canaliculata</i> on sheltered littoral fringe rock
	A1.312	<i>Fucus spiralis</i> on sheltered upper eulittoral rock
	A1.32	Furoids in variable salinity
	A1.321	<i>Pelvetia canaliculata</i> on sheltered variable salinity littoral fringe rock
	A1.322	<i>Fucus spiralis</i> on sheltered variable salinity upper eulittoral rock
	A1.327	<i>Fucus ceranoides</i> on reduced salinity eulittoral rock
A1.4 – Features of littoral rock	A1.41	Communities of littoral rockpools
	A1.411	Coralline crust-dominated shallow eulittoral rockpools
	A1.4111	Coralline crusts and <i>Corallina officinalis</i> in shallow eulittoral rockpools
	A1.412	Furoids and kelp in deep eulittoral rockpools
	A1.421	Green seaweeds (<i>Enteromorpha</i> spp. and <i>Cladophora</i> spp.) in shallow upper shore rockpools
	A1.445	<i>Verrucaria mucosa</i> and/or <i>Hildenbrandia rubra</i> on upper to mid shore cave walls
	A1.45	Ephemeral green or red seaweeds (freshwater or sand-influenced) on non-mobile substrata
	A1.451	<i>Enteromorpha</i> spp. on freshwater-influenced and/or unstable upper eulittoral rock
A2.1 – Littoral coarse sediment	A2.11	Shingle (pebble) and gravel shores
A2.2 - Littoral sand and muddy sand	A2.21	Strandline

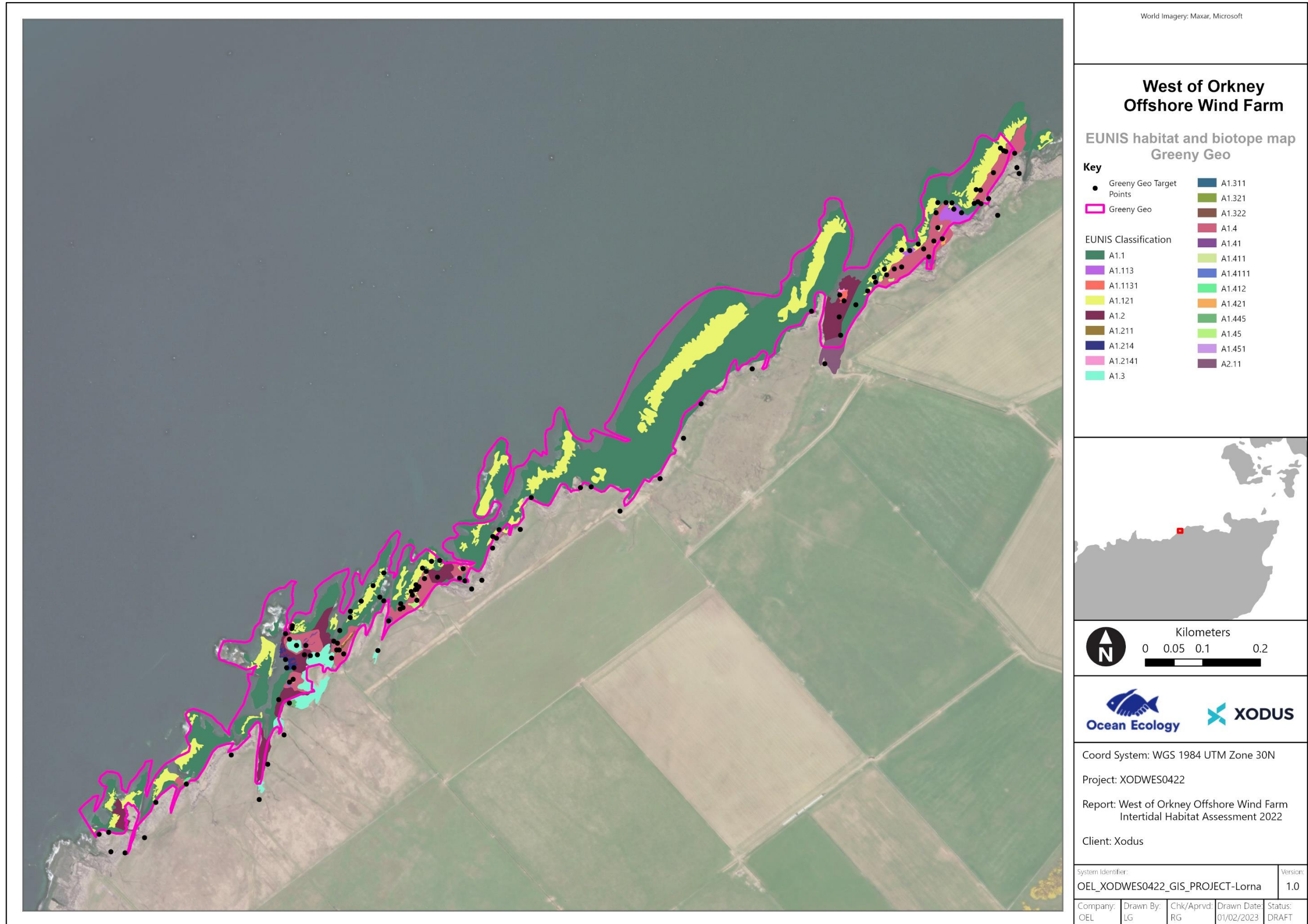


Figure 5 EUNIS habitat and biotope mapping with sampling locations visited during the intertidal survey of Greeny Geo.

5.5. Features of Interest

5.5.1. Annex I & II Habitats/Species

Crosskirk and Greeny Geo intertidal survey areas were characterised by large areas of rocky habitats comprising a mosaic of exposed bedrock, boulders, and cobbles; these were deemed to be representative of different biotopes spanning from high to low energy rock habitats with some supporting a variety of fucoids and other seaweeds.

Previously mapped areas of subtidal Annex I stony and bedrock reefs run adjacent to the lower shore section of the Crosskirk and Greeny Geo intertidal survey areas (Figure 2) and therefore it is very likely that the areas mapped as intertidal rocky habitats are connected and also qualify as Annex I reef habitat.

The EUNIS biotope 'A1.445 *Verrucaria mucosa* and/or *Hildenbrandia rubra* on upper to mid shore cave walls' was identified at both survey areas and could potentially classify as Annex I habitat 'submerged or partially submerged sea caves'. During the walkover survey, several overhanging areas and a few archways were observed however none of these features were deemed to be a partially submerged sea cave. Nevertheless, the presence of sea caves cannot be completely ruled out as there were areas of the coastline that were not accessible and could lend themselves to sea caves. Identification of these was limited by access issues however gullies running up the rock platform were backed by rock wall or boulder fields rather than opening to a partially submerged cave.

5.5.2. Kelp Beds and Kelp and seaweed communities on sublittoral sediment (PMFs)

Kelp was observed and noted at multiple target points during the Crosskirk and Greeny Geo walkover surveys as well as recorded in a number of the UAV images, especially along the extreme lower shore and below the waterline. Kelp beds and kelp communities on sublittoral sediments are PMFs in Scottish waters and protected as a features of conservation interest. Considering that most of the kelp recorded across both sites occurred on rocky areas, it is likely that it was representative of the PMF kelp beds. However, without information from the adjoining subtidal areas, these observations alone were not enough to confidently define the boundaries and extent of these kelp features (low confidence scores).

5.5.3. Other Features of Note

No INNS were recorded across the two survey areas.

6. Discussion

This report presents the findings and habitat mapping outputs of the intertidal surveys conducted across the two potential landfall locations as part of the site characterisation studies for the offshore Project. The surveys took place the landfall options at Crosskirk and Greeny Geo in Caithness and involved the collection of UAV aerial imagery accompanied by Phase I walkover survey. The key objective was to map the distribution and extent of individual or groups of broadscale habitats, biotopes, biotope complexes and life forms present with a focus on confirming the presence/absence of any habitats and/or features of conservation interest across the landfall locations (e.g., reef habitats).

A complex of habitats and biotopes characterised both Crosskirk and Greeny Geo intertidal survey areas which were dominated by rocky habitats of differing energy levels (A1.1, A1.2, A1.3), supporting a number of marine invertebrates, fucoid, and other seaweeds. A clear zonation was observed across Crosskirk, the full range of it was more evident in the central part of the site. This included littoral coarse sand and muddy sand and a strandline in the upper shore giving way in the mid shore to low energy littoral rock supporting a variety of fucoids followed by moderate to high energy rock habitats in the lower shore supporting marine invertebrates as well as fucoids. No sediments were observed in the eastern reaches of the Crosskirk site while some 'pockets' of coarse sediments were observed in the upper shore on the western portion of the Crosskirk survey area.

High energy rock habitats with large areas covered in *F. distichus* and *F. spiralis* dominated throughout the Greeny Geo site with a more intricate complex of habitats and biotopes occurring to the east and west of the site. To the east littoral rockpools supporting coralline algae and green seaweeds populated the upper shore, while gravel and shingle were observed in a sheltered embayment to the west of the rockpools. The western portion of the Greeny Geo site consisted of a mosaic of low, moderate and high energy rock habitats supporting seaweeds, fucoids and marine invertebrates with rockpools peppered all across these habitats and supporting seaweeds and lichens.

Large areas of rock habitats were mapped across both Crosskirk and Greeny Geo. To qualify as Annex I geogenic reefs, intertidal features must be connected to subtidal Annex I reefs. EMODnet classifications presented in Figure 2 indicated the presence of Annex I subtidal reefs adjacent to the rock habitats mapped in the intertidal area suggesting that these were continuous features and would therefore meet the Annex I geogenic reef criteria. Kelp was identified at Greeny Geo and Crosskirk during the Phase 1 walkover and on the UAV imagery. As most kelp occurred on rocky habitats in the extreme lower shore and below the waterline, it is likely it was representative of the PMF kelp beds. However, without information from the adjoining subtidal areas, it was not possible to confidently define the boundaries and extent of these kelp habitats.

No INNS were observed at either Crosskirk or Greeny Geo.

7. References

- Crabb M, Wright P, Hymphrey O, Johnson G, Rush S, van Rein H, Hinchin H (2019) Unmanned Aerial Vehicles for use in marine monitoring. 1–36.
- Davies J, Baxter J, Bradley M, Connor D, Khan J, Murray E, Sanderson W, Turnbull C, Vincent M (2001) Marine Monitoring Handbook March 2001.
- NRW (2019) GN030a Benthic habitat assessment guidance for marine developments and activities: A guide to characterising and monitoring intertidal rocky shore habitats and rockpools. 1–46.
- Parry ME v (2019a) Guidance on Assigning Benthic Biotores using EUNIS or the Marine Habitat Classification of Britain and Ireland (Revised 2019).
- Parry ME V (2019b) Guidance on Assigning Benthic Biotores using EUNIS or the Marine Habitat Classification of Britain and Ireland (Revised 2019).
- Vasquez M, Manca E, Inghilesi R, Martin S, Agnesi S, al Hamdanid Z, Annunziatellis A, Bekkby T, Pesch R, Askew N, Bentes L, Castle L, Doncheva V, Drakopoulou V, Gonçalves J, Laamanen L, Lillis H, Loukaidi V, McGrath F, Mo G, Monteiro P, Muresan M, O’Keeffe E, Populus J, Pinderi J, Ridgeway A, Sakellariou D, Simboura M, Teaca A, Tempera F, Todorova V, Tunesi L, Virtanen E (2021) EUSeaMap 2019. A European broad-scale seabed habitat map. D1.13 EASME/EMFF/2018/1.3.1.8/Lot2/SI2.810241– EMODnet Thematic Lot n° 2 – Seabed Habitats EUSeaMap 2021 - Technical Report.
- Wyn G, Brazier P, Birch KG, Bunker A, Cooke A, Jones M, Lough N (2006) CCW Handbook for Marine Intertidal Phase 1 Biotope Mapping Survey.