2022 Scapa Deep Water Quay Habitat Mapping Survey

Survey Report

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1 INTRODUCTION

1.1 Background

In 2020, the Orkney Island Council Harbour Authority (OICHA) unveiled the Orkney Harbour Masterplan Phase I. The Masterplan proposed a £230 million investment in a range of harbour infrastructure enhancements to be completed over a 20-year period. Phase I of the Masterplan considers five locations on the Orkney mainland, namely:

- Scapa Deep Water Quay;
- Hatston Pier and Harbour;
- Scapa Pier;
- Kirkwall Pier and Harbour; and
- Stromness.

Phase II of the Masterplan will include the development and expansion of smaller harbours and piers across the wider Orkney Islands.

Seastar Survey Ltd. (hereafter Seastar) and Physalia Associates Ltd. (hereafter Physalia) were commissioned by Envirocentre to undertake a broadscale habitat assessment of the intertidal and subtidal habitats at and in the vicinity of the proposed Scapa Deep Water Quay expansion project. The data obtained will inform the Environmental Impact Assessment (EIA) that will be submitted with the project planning permission application by the Orkney Island Council Harbour Authority (OICHA). If planning permission is granted, a full baseline survey of the area will be conducted, which, when combined with a suitable monitoring scheme, will enable potential future changes to the local habitats and biological communities to be detected and quantified.

1.2 The existing site

The site selected for the proposed Scapa Deep Water Quay is in the area known as the Bay of Deepdale, located approximately 4.5 km south of the existing Scapa Pier and approximately 3.5 km northwest of the village of St Mary's. The shoreline at and in the vicinity of the proposed development comprises a mix of substrate types, including cobbles, boulders and bedrock leading to sand-dominated subtidal substrate. The upper shore is separated from the adjacent pasture fields by a rock cliff or a steep, rocky embankment, approximately 3 m in height.

Between 1974 and 1990, annual surveys of rocky shores in Orkney were conducted (e.g. Baxter, Jones and Simpson, 1985), which included a transect located in the vicinity of the current survey area ('Quoy Ribs'). However, as the associated data were not made available during the planning process, the transect was not incorporated into the current survey. Furthermore, as the associated data are not recent (predating the current survey by more than 30 years), their use in informing the current survey has been deemed to be limited.

1.3 Proposed development summary

The Scapa Deep Water Quay is to be developed as part of the Orkney Harbour Masterplan Phase I. As no existing dock facilities are currently available at the site, this would constitute a new development. It is proposed that the development be constructed in three phases and, upon completion, will comprise the following: an approximately 597 m long main quayside

berth with a water depth of ~15 m below chart datum (CD), incorporating a 135 m quayside pocket with a water depth of ~20 m below CD; a tug and pilot boat berth approximately 180 m in length with a water depth of 6-9 m below CD; and 22.85 ha of laydown area directly behind the quay face.

The construction of the Scapa Deep Water Quay will necessitate the reclamation of 10.455 ha (Phase 1: 5.185 ha; Phase 2: 5.27 ha) of marine habitat (intertidal and subtidal) and the dredging of a total of 51,800 m^2 (Phase 1: 21,500 m^2; Phase 2: 16,500 m^2; Phase 3: 13,800 m^2) of marine benthic habitat. In addition, it is likely that maintenance dredging will be required to retain the required water depths during the operational phase of the proposed development.

Both land reclamation and capital dredging will result in the direct loss of both intertidal and subtidal habitats and the associated biotic communities. Maintenance dredging activities will also cause additional direct habitat loss and disturbance. Both maintenance dredging and construction activities also have the potential to cause indirect impacts on the environment due to dissemination of disturbed particulate substrate, including modification of habitat conditions and habitat smothering.

Details of the proposed Scapa Deep Water Quay and Harbour development and design drawings are presented in the project's EIA Scoping Report (see EnviroCentre, 2022).

1.4 Survey aims and objectives

Due to the timescales associated with the submission of the planning permission, there was a requirement to undertake both the intertidal and subtidal surveys in early winter 2022 on a single mobilisation. Winter is generally not considered an ideal time to conduct ecological surveys in the intertidal (and, to a lesser degree, the shallow subtidal), due both to logistical (see section 2.1.2) and ecological (see section 4.3) concerns. The decision was therefore taken ahead of the survey being conducted to reduce the scope of the intertidal surveys to only include rapid broadscale habitat identification and mapping (i.e. Phase I survey), rather than attempting to also collect quantitative and statistically robust species data, i.e. Phase II survey, which is best undertaken on a spring tide when algal growth is at maximum (generally in the summer months).

Despite the reduction in scope, the survey approach was considered to be appropriate for the project. Where there are little to no habitat data available for an area (as in this case) it is considered acceptable practice to conduct Phase I surveys prior to undertaking more focused characterisation and/or baseline surveys in order to gain a better understanding of the habitats and taxa present. The broadscale habitat data acquired during the Phase I surveys can then be used to inform and better plan subsequent quantitative data collection. In addition, the data collected as part of the Phase I surveys undertaken was considered to be of sufficient resolution to gain a good understanding of the habitats and dominant taxa present and therefore adequately inform assessments of the likely significant effects (LSE) of the proposed development, detailed in the EIA.

The overall aim of the survey was to conduct a broadscale habitat mapping survey, i.e. to identify and map the extent and distribution of the range of habitats and biotopes present at and in the vicinity of the proposed Scapa Deep Water Quay development. The objectives of the survey were to;

- conduct a Phase I survey of the intertidal habitats at a series of belt transects within the survey area;
- identify and map the extent and distribution of intertidal habitats at each transect;
- identify and map the extent and distribution of the littoral biotopes present;
- characterise the habitats observed by providing semi-quantitative data on species composition of representative intertidal habitats and biotopes;
- conduct a drop-down camera and benthic grab sampling survey of the subtidal benthic habitats within the survey area;
- identify and determine the extent and distribution of subtidal habitats within the survey area;
- identify and determine the extent and distribution of the sublittoral biotopes present;
- identify any protected species and/or communities including habitats of conservation or ecological importance such as Priority Marine Features (PMFs) and Annex I habitats;
- produce habitat data of sufficient resolution to enable an assessment of the LSE of the proposed development as part of the EIA.

2 METHODS

2.1 Intertidal survey

The aim of the Phase I intertidal survey was to determine the range, distribution and extent of the habitats present by assigning biotopes *in situ* on vertical (i.e. running from high to low shore) transects, in accordance with best practice guidance. The collection and analysis of the data was completed in accordance with Common Standards Monitoring guidance (JNCC, 2004) and procedural guidelines outlined in the Marine Monitoring Handbook (Davies *et al*., 2001) and the CCW Handbook for Marine Intertidal Phase I Survey and Mapping (Wyn, *et al*., 2006).

2.1.1 Transect locations

Prior to the survey, target locations for four intertidal 'belt' transects were selected. No aerial photography data for the survey area were available in which the intertidal zone was visible, and no previous habitat mapping data were available. Therefore, in order to achieve good geographical spread, and in an attempt to sample a range of habitat types, four transects were placed within the survey area. To the north of the proposed development area, the shore was deemed to be inaccessible due to the presence of steep cliffs (this was also confirmed in the field); three transects were therefore planned within the consent boundary with a fourth transect (SB_4) planned just to the south of the consent boundary. Start of line (SOL) and end of line (EOL) positions for each transect were input into a Garmin GPSMAP 276Cx portable chartplotter. These included a central transect line and two parallel 'boundary' lines, one 30 m either side of the central transect line.

Once in the field, the appropriateness of the planned transect sites was reassessed and, where necessary, locations were changed due to impediments to access. This included changes to the locations of both SB_3 and SB_4, which were both moved north along the shore due to the difficulties encountered when traversing southwards around the rocky outcrop/headland known as the Tongue of Gangsta.

The transect locations used for the Scapa intertidal survey are presented in Table 2.1 and illustrated in Figure 2.1.

Table 2.1: Start of line (SOL) and end of line (EOL) positions of the centre line of each of the four belt transects surveyed during the 2022 Scapa Deep Water Quay Phase I intertidal survey. Positions are WGS84 (DD MM.MMMM); negative longitudes are west.

Transect Name	Transect Number	SOL Position WGS84		EOL Position WGS84		Bearing to EOL
		Latitude	Longitude	Latitude	Longitude	
Scapa	**SB_1**	58 55.3519	-002 57.2125	58 55.3368	-002 57.2465	245
Scapa	**SB_2**	58 55.1976	-002 57.0979	58 55.1899	-002 57.1314	244
Scapa	**SB_3**	58 55.1124	002 57.0421	58 55.1122	-002 57.0885	270
Scapa	**SB_4**	58 55.0467	-002 57.0731	58 55.0361	-002 57.1011	250

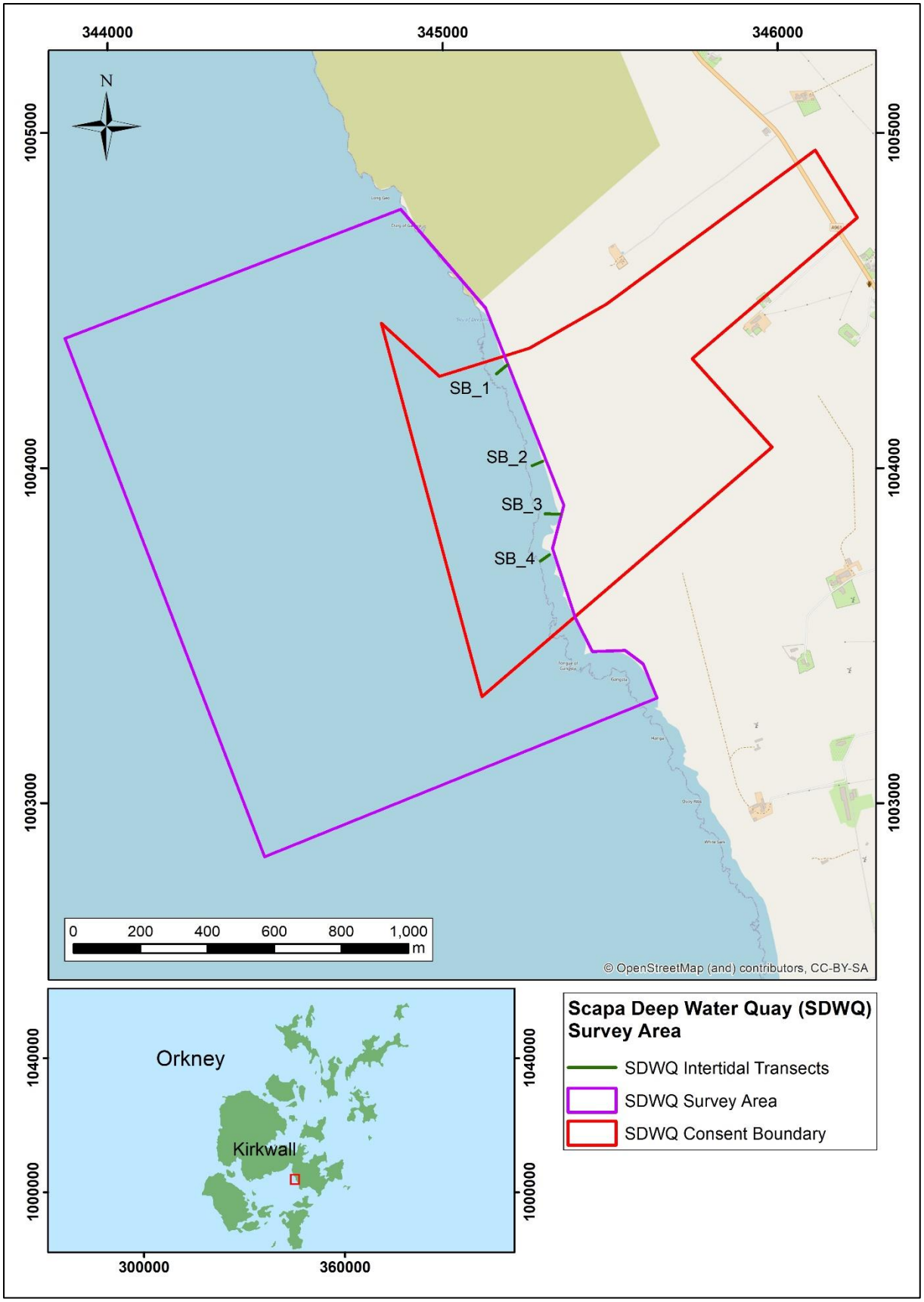

Figure 2.1: Locations of the four intertidal belt transects (centre lines only) surveyed during the 2022 Scapa Deep Water Quay Phase I intertidal survey.

2.1.2 Survey dates and tide times

Due to the requirement to undertake the survey in early winter 2022, it was not possible to undertake the survey at low tide on a spring tide as these coincided with hours of darkness. Instead, the best available low tides were utilised, maximising the tidal range (i.e. the amount of beach exposed) whilst ensuring work could be undertaken in daylight hours. The intertidal survey work at the Scapa Deep Water Quay site was completed on 3rd and 4th December 2022. Details of the tide times are provided in Table 2.2. The surveys were undertaken during the period two hours before and after low water.

Table 2.2: Tide times (UTC) and heights relative to Chart Datum during the Scapa Deep Water Quay Phase I intertidal survey.

Survey Day	High Water 1		Low Water		High Water 2	
	Time	Height (m)	Time	Height (m)	Time	Height (m)
Saturday 03/12/2022	06.02	2.82	11:57	1.48	17:59	3.03
Sunday 04/12/2022	06:57	0.91	12:49	1.33	18.58	3.09

2.1.3 Access

Access to the foreshore at Scapa was arranged by EnviroCentre. The foreshore was accessed from the A961 via a farm track leading to the mouth of the Burn of Deepdale at the northern end of the survey area. Permission was granted by the landowner to use the access route on the days of survey only.

2.1.4 Transect assessment

At each transect, all habitat types present within the 60 m wide 'belt' were recorded and assigned a biotope as per the latest iteration of the MNCR Marine Habitat Classification for Britain and Ireland (JNCC, 2022), incorporating information regarding species composition and abundance, shore height, exposure of the shore and substrate type. The vertical width (high-low shore) of each habitat was recorded and GPS positions were taken at the habitat boundaries along the central transect line using the GPSMAP portable chartplotter (which used both GPS and GLONASS sensors for improved positional accuracy). The distribution of biotopes 30 m either side of the central line was recorded using wireframe map annotations. In addition, the track function in the GPS was used to map each biotope boundary.

For each identified biotope, a detailed habitat description was recorded using modified MNCR field forms (see Appendix I), including information regarding shore position, substrate type and percentage cover, rock type, surface relief, texture and stability, modifiers such as scour, silt and macroalgal mats, and any anthropogenic influences present. In addition, for each identified habitat a list of the dominant/conspicuous biota present was produced with taxa enumerated using the semi-quantitative SACFOR[1] scale (see Appendix II). Any additional relevant metadata, including time, state of tide, weather etc., were also recorded.

[1] **S**uper-abundant, **A**bundant, **C**ommon, **F**requent, **O**ccasional, **R**are.

Photographs documenting the zonation patterns present were taken at three locations (high, mid and low shore) along the central transect line. Where images could not be taken in the low shore due to tidal timings (see section 2.1.2), 'low shore' images were taken as far down the shore as possible. At each location, the GPS position was recorded and photographs were taken up-shore, down-shore, and along-shore in both directions.

2.1.5 Additional observations

When transiting on foot to, from and between transects, any non-indigenous species (NIS), freshwater outflows, litter or other anthropogenic influences were documented. In each instance, the position was recorded from the GPS and a photograph was taken. Where anthropogenic influences were clearly impacting the surrounding environment, details of this were recorded. Where NIS were encountered, abundance was recorded using the semi-quantitative SACFOR scale.

2.1.6 Analysis

All field notes, including field sketches, were digitised post-survey and photographic records were reviewed by a senior marine ecologist to confirm the assigned biotopes and taxon identifications. Species lists were created for each Phase I habitat ensuring that all taxa were recorded in accordance with the World Register of Marine Species (WoRMS Editorial Board, 2023) and assigned an MCS alphanumeric bio-code according to Howson and Picton (1997), where applicable, to avoid problems in species nomenclature. Biotopes were assigned to each habitat according to the Marine Habitat Classification for Britain and Ireland (JNCC, 2022) following the guidance provided in Parry (2019).

2.1.7 GIS

Data obtained during the Phase I survey, included all GPS trackplots and relevant point data, were imported into ArcGIS. Utilising these data together with the wireframe map field sketches created during the Phase I surveys, polygons were created within the GIS in order to map the location of the different biotopes identified within each of the four belt transects.

2.2 Subtidal survey

The subtidal survey work comprised a drop-down camera survey for the acquisition of high-definition video and high-resolution still images and a grab sampling survey to acquire samples for macrobenthic invertebrate assessment and particle size analysis (PSA). The survey work was undertaken from *MV Uskmoor*, a local survey vessel suited to the work and equipped with a winch, A-frame, and crane. For the Scapa Deep Water Quay subtidal survey, the vessel was mobilised from Scrabster harbour.

The Scapa Deep Water Quay drop-down camera survey was undertaken on 7th December 2022, with grab sampling taking place on 8th December 2022.

2.2.1 Drop-down camera survey

The underwater imagery survey work was conducted in accordance with operational guidelines issued by the NMBAQC scheme for drop-down camera systems (Hitchin *et al*., 2015).

Prior to the survey, a total of 15 drop-down targets were selected for investigation, aiming to achieve good geographical spread at a range of depths. The plan was to run a 10-minute transect across each of the targets against the direction of the tide at the time of survey. However, in order to save time and reduce the number of deployments, multiple targets were surveyed on a single camera deployment resulting in deployments of approximately 20 – 30 minutes in duration.

The following equipment was used during the camera survey:

- Leica GX1230 RTK GPS;
- Hypack survey management software;
- SubC Rayfin camera system;
- SubC Aquorea LED Flash;
- Four CT4011 LED lights;
- NETMC digital video recorder with video overlay.

Survey navigation was achieved using a Leica GX1230 RTK GPS. The GPS antenna was mounted inboard and offsets between the antenna and vessel's A-frame measured and entered into Hypack prior to the survey.

The GPS was used in full RTK mode; within the GPS, satellite derived positions (WGS84 latitude and longitude) were updated in real-time with pseudo-range corrections from Leica Smartnet, via a GSM receiver. Used in full RTK mode, GPS positions were accurate to ± 0.03 m in three dimensions. During the survey, positional data were recorded using Hypack survey management software and converted to OSGB36 National Grid coordinates in real time using the OSTN15 model within Hypack. Navigation checks of the Leica GX1230 RTK GPS system were carried out against a known location at the start and end of the survey day.

Positioning of the camera frame was achieved by calculating a layback within the survey management software, and was based on the vessel's known position, vessel heading, vessel speed, water depth, height of the A-frame, and the amount of winch wire out.

A SubC Rayfin camera system was used which included a full colour HD video camera and a high-resolution stills camera with manual focus. The camera was mounted at an oblique angle on the camera frame (facing the direction of travel), with the external flash gun and LED video lights mounted on the frame so as to minimise backscatter, deliver bright and even illumination, and maximise image quality. The camera, flash, video lights, and lasers were connected to the surface using a 200 m multifunction soft umbilical, which allowed the LED lights, flash, and camera settings to be adjusted from the topside unit.

The HD video feed was viewed in real time and recorded to a hard drive using the digital video recorder with video overlay. The video overlay included date, time, sample number and height of camera above seabed. The still photographs were recorded sub-sea and uploaded at the

end of the survey day. Before each deployment a new folder was created with a unique sample number and the video and stills data were saved to this folder using unique filenames.

The clocks associated with all equipment were synchronised with the GPS time at the start of each survey day, and all survey log entries were made with a record of the GPS time. The times (to the second) of the start and end of each deployment were recorded as were the times that each photograph was taken in order to enable the position of each video transect and photograph to be extracted from the navigation data following the survey.

Prior to camera deployment the skipper steered the vessel into the prevailing conditions (current and wind) and set up on a bearing toward the selected target. The camera was lowered to the seabed whilst the vessel moved toward the initial selected target. When the camera frame reached approximately 1 m above the seabed (as observed using the topside unit) the camera operator started logging navigation data and then started recording the HD video.

During each deployment the height of the camera system above the seabed was controlled by a winch operator on deck, who was in constant communication with the camera operator. The camera was flown just above the seabed to reduce impact on the environment and then landed to take still images at regular intervals (approximately every one minute). Vessel speeds over the ground were maintained at approximately 0.5 knots throughout each deployment.

At the end of each survey day, all survey navigation data, still photographs, and HD video recordings were backed-up onto an external hard drive, which was removed from the vessel.

2.2.2 Benthic grab sampling

Grab sampling locations were selected following completion of the drop-down camera survey and were based on an initial review of the video footage. A total of eight sampling locations were selected, spread geographically throughout the survey area and at a range of depths with the aim of sampling areas of different types of soft sediment.

At each sampling location the vessel set up on the proposed position and a 0.1 m^2 Day grab sampler was deployed over the side of the vessel. A ‘fix’ of GPS position and time was recorded in Hypack and manually logged in the logbook when the grab was determined to be on the seabed. The grab was recovered to deck and the sample inspected for quality.

Samples were to be rejected on the grounds of poor quality for the following reasons:

- Uneven surface indicative of striking the seabed at an angle;
- Washed out sample;
- Disturbed surface sediment;
- Contamination of the sediment (e.g. hagfish, paint chips, oil etc.);
- Sample touching the top of the grab;
- Sample <50 % of the grab’s capacity.

If the sample was not acceptable the vessel was repositioned on the sample location and the grab was redeployed. If after three attempts at a location a successful grab was not collected

a new location was chosen close to the original station. If the sample was acceptable a brief description of the sediment was recorded (including appearance, texture, odour, etc.) and a labelled photograph taken.

A sub-sample for PSA was collected from each acceptable grab sample following the NMBAQC's Best Practice Guidance for PSA to support biological analysis (Mason, 2016). The PSA sub-sample was collected using a metal scoop to remove a 5 cm deep core from the grab sample, ensuring that at least 100 ml of sediment was collected. Any conspicuous biota was noted in the logbook and removed from the sub-sample before storing the sediment in labelled plastic bags.

Following sub-sampling for PSA the rest of the grab sample was processed for macrobenthic invertebrate analysis. The sediment in the grab was transferred to a dump tray and washed gently over a 0.5 mm field sieve. The sediment retained in the sieve was photographed before being transferred to a labelled plastic bucket and fixed using a 4 % buffered formaldehyde-seawater solution for subsequent laboratory analysis.

2.2.3 Laboratory methods

2.2.3.1 Particle size analysis

Particle size analysis (PSA) was carried out using wet and dry sieving at one phi intervals. Samples were visually assessed and all marine biota (>1 mm) that was alive at the time of sampling were removed. A brief sediment description was noted in the PSA log, together with details of any biota removed, and any other pertinent sediment characteristics (e.g. presence worm tubes, shell fragments).

The results were analysed to determine the proportions of gravel, sand, and mud within the samples and sediment names were assigned as per the modified Folk classification (1954).

2.2.3.2 Macrobenthic invertebrate analysis

In the laboratory, the macrobenthic invertebrate samples were washed through a 0.5 mm sieve in order to remove the fixative and any mud remaining in the sample. The sample retained on the sieve was then transferred to petri dishes and was sorted by experienced personnel using low magnification microscopes. The picked taxa were split by phyla and stored in glass vials in 80 % industrial methylated spirit (IMS) ready for identification.

Taxa were identified to the lowest practical taxonomic level with reference to WoRMS (WoRMS Editorial Board, 2023) for species nomenclature. Epifauna were identified and recorded when clearly attached to substrate.

Identified taxa were separated by major taxonomic group and preserved in 80 % IMS before being analysed for biomass by major taxonomic group. Taxa were removed from their sample vials and blotted dry to remove excess IMS before being weighed using a calibrated balance accurate to 5 decimal places. A reference collection, consisting of examples of each identified taxon, was also created.

2.2.4 Data analyses

2.2.4.1 Video analysis

The video analysis was conducted using software that enabled slow-motion, freeze frame and standard play analysis. During the first review, video footage was viewed at 2x - 4x normal speed in order to divide the footage into segments of different habitat types; any segments of video showing camera deployment and recovery were discounted from further review. Brief changes in habitat type, considered to be less than 5 m distance, were treated as incidental patches and not recorded as separate segments, however the presence of these habitats was recorded as part of the habitat description. The distance travelled by the camera was estimated based on the navigation data.

The start and end time and position of each segment was recorded, and each segment was then analysed in more detail. For each segment, all observations were recorded in a pro forma spreadsheet. Each video segment was assessed for quality, according to NMBAQC scheme guidelines (Turner *et al*., 2016). A description of the observed habitat and a broadscale habitat (BSH) type was assigned to each video segment, and the presence of any visible impacts or modifiers (e.g., trawl marks, litter, evidence of strong currents etc.) was also recorded.

A list of the encountered taxa was produced for each video segment, using species reference numbers as cited in the Marine Conservation Society Species Directory (Howson and Picton, 1997) with additional reference to the World Register of Marine Species (WoRMS Editorial Board, 2023) to avoid problems in species nomenclature. Taxa were identified to the lowest (i.e. most detailed) practical taxonomic level. Identification of taxa was only attempted where biota was considered to be large and conspicuous enough to be confidently and reliably identified. Where lifeforms could not be identified to a specific taxonomic group a brief description was used (e.g. mixed faunal turf). Sponge morphologies were divided into appropriate pre-defined categories after Berman *et al*. (2013). Where sponge species showed plasticity, separate records were made for each morphology type.

Assignment of biotopes

Following analysis of the video segments, the information recorded was reviewed and used to determine the most appropriate MNCR biotope according to JNCC (2022), following guidance outlined in Turner *et al*. (2016) and Parry (2019). Wherever possible biotopes were assigned at the biotope (level 5) or sub-biotope (level 6) level. However, where biological information was lacking (e.g., barren soft sediments with very little epifauna), biotopes were recorded at the biotope complex level (level 4). Where the seabed comprised a mosaic of more than one substrate type (e.g., <5 m alternating bands of exposed bedrock and coarse sediment) it was considered appropriate to assign more than one biotope to the same video segment. In these cases, the most dominant biotope was assigned as the ‘primary’ biotope and the other assigned as secondary.

Assignment of priority marine features

Following identification of biota and assignment of biotope(s) to each video segment, priority marine features (PMFs), as per Tyler-Walters *et al*. (2016), were assigned. If PMF components were found to be present within a video segment (i.e. if a relevant biotope had been assigned, or if a component species had been identified) the PMF was assigned. If two

component biotopes had been assigned to one video segment (see above), two PMFs were assigned.

Where maerl was present, the NatureScot evolving definition was used as a guide to assignment of the PMF 'maerl beds.' A substrate consisting of a minimum of 20 % maerl that was clearly identifiable as either twiglets, medallions, or hedgehog stones (>1 cm in size) qualified as a maerl bed, irrespective of whether the rhodoliths were alive or dead. An exception to this is where the substrate underlying the fully formed maerl rhodoliths was comminuted maerl gravel; in this case a 5 % cover of maerl (dead or alive, fully formed rhodoliths > 1 cm) was sufficient to qualify a habitat as maerl bed. It should be noted, however, that areas conforming to this exception are considered to reflect degradation of previously healthy maerl bed habitat, as it can be assumed that fully formed maerl rhodoliths were once much more prolific to have created the maerl gravel substrate.

Assignment of Annex I habitats

The presence of any Annex I habitats and associated sub-features, including reef sub-features, was also recorded for each video segment. Reef features were determined using criteria outlined in Irving (2009), with a minimum of 10 % hard substrate (i.e. bedrock, boulders or cobbles) required for assignment of Annex I habitat. Due to difficulties inherent in estimating elevation from video footage, the assessment of 'reefiness' of stony reef habitats (Table 2.3) was primarily based on seabed composition, i.e. percentage coverage of hard substrate.

Table 2.3: The main characterising features of a stony reef, after Irving (2009).

Characteristic	Not a reef	Resemblance to being a stony reef		
		Low	Medium	High
Composition	< 10 %	10 - 40 %	40 - 95 %	> 95 %
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 epifauna

2.2.4.2 Still image analysis

The still image analysis was undertaken following analysis of the video. Each still image was assessed for quality, according to NMBAQC scheme guidelines (Turner *et al*., 2016), and a brief description of the habitat and characterising biota present in each image recorded. All observations were recorded in a pro forma spreadsheet. A BSH was recorded based on the substrate type present.

Epibiota were identified, with taxa recorded to the best practical taxonomic level. A list of the encountered taxa was produced for each image, using species reference numbers as cited in the Marine Conservation Society Species Directory (Howson and Picton, 1997) with additional reference to the World Register of Marine Species (WoRMS Editorial Board, 2023) to avoid problems in species nomenclature. For each image, all biota was identified and enumerated.

Taxon abundance data was recorded using the semi-quantitative SACFOR scale, with counts or percentage cover recorded where appropriate. The most appropriate MNCR biotope (JNCC, 2022) was assigned to each still image with reference to the parent video segment, following guidance outlined in Turner *et al*. (2016) and Parry (2019).

2.2.4.3 GIS

Data obtained during the drop-down camera and grab survey were imported into ArcGIS. These included all GPS video trackplots and relevant target ('fix') locations. These data were presented as annotated maps identifying the locations of the biotopes and benthic community types identified during the study.

3 RESULTS

3.1 Intertidal survey

Representative field photographs documenting the zonation at each of the transects are provided in Appendix III and the logs detailing the results of the Phase I survey are provided in Appendix IV. Full species lists for each habitat zone at each transect are provided in Appendix V, and a glossary of the biotopes assigned is provided in Appendix VI. Note that in the descriptive text below, the abundance (according to SACFOR), is provided in parentheses following the taxon name and refers to the abundance within the respective habitat zone.

3.1.1 Scapa Transect 1 (SB_1; Plates 1a – 1d)

Transect 1 was located approximately 160 m south of the mouth of the Burn of Deepdale (see Figure 2.1). The central transect line extended 27 m from the upper shore cliff to the low water mark on the day of the survey (low water was 1.33 m above CD).

The upper littoral zone was backed by a steeply sloping cliff of 7 – 8 m in height (see Appendix III). The upper half of the cliff face was colonised by a turf of coarse terrestrial grass species. The exposed rock of the cliff face at the northern edge of the transect was characterised by sporadic lichen growth, including *Orchrollechia parella*, *Caloplaca* sp. and *Ramalina siliquosa* (sea ivory). Adjacent to the centre line of the transect was a small freshwater seep that emanated from the pasture fields above the shore. The seep was characterised by the occurrence of an unidentified moss species and brown algal biofilm. Below the cliffs, five habitat zones were identified. The distribution of the biotopes identified at Transect 1 are shown in Figure 3.1.

SB_1 Zone 1. The upper foreshore adjacent to the cliff was composed of barren shingle (**LS.LCS.Sh.BarSh**; 'Barren littoral shingle') which extended approximately 8 m from the cliff base. Within the barren shingle zone were aggregations of overlying phytodetritus (**LS.LSa.St**; 'Strandline') primarily comprising detached kelp and fucoid fronds. No invertebrate taxa were recorded in this zone.

SB_1 Zone 2. The substrate in Zone 2 was more coarse than that present in Zone 1, with cobbles overlying the shingle. Beneath the cobbles, low densities of gammarid amphipods (occasional) were recorded. Sparse individuals of the small periwinkle *Melarhaphe neritoides* (rare) were also observed on the cobble surfaces. However, as no other taxa were recorded, this zone was also assigned the biotope **LS.LCS.Sh.BarSh**.

SB_1 Zone 3. Zone 3 consisted of a series of slightly raised bedrock 'fingers' which zig-zagged along the shore approximately parallel with the cliffs. As a result, this zone was somewhat variable in width, ranging from approximately 1 – 4 m. The rock was covered with dense *Fucus spiralis* (abundant) together with much lower densities of *Pelvetia canaliculata* (rare). Beneath the canopy, patches of red encrusting algae were present (rare to occasional) on the rock surface. Faunal taxa were also present amongst the *F. spiralis* and in rock cervices, including the periwinkles *Littorina littorea* (common), *L. saxatilis* (frequent) and *L. obtusata* (occasional), the common limpet *Patella vulgata* (common) and the beadlet anemone *Actinia equina* (frequent). Due to the dominance of *F. spiralis*, the biotope **LR.LLR.F.Fspi.FS** ('*Fucus spiralis* on full salinity sheltered upper eulittoral rock') was assigned to this zone.

SB_1 Zone 4. Zone 4 was characterised by dense *Fucus vesiculosus* (super-abundant) on uneven bedrock with *Osmundea pinnatifida* (super-abundant). In addition, low quantities of *Corallina officinalis* (rare) and *Fucus serratus* (rare) were present in crevices. Fauna present in this zone included *P. vulgata* (common), *L. obtusata* (common), *A. equina* (frequent), *L. littorea* (rare), the dogwhelk *Nucella lapillus* (occasional) and *Steromphala umbilicalis* (present). Despite the prevalence of *O. pinnatifida*, the very high abundance of *F. vesiculosus* meant that the biotope **LR.LLR.F.Fves.FS** ('*Fucus vesiculosus* on full salinity moderately exposed to sheltered mid eulittoral rock') was assigned to this habitat.

Zone 4 was variable in width, ranging from approximately 1 m in the centre of the transect to approximately 12 m at the north and south edges of the transect. This habitat also extended down the shore into Zone 5 where it occurred around the raised bedrock ridges.

SB_1 Zone 5. Zone 5 comprised a series of bedrock ridges and gullies on the lower shore. The ridges ran perpendicular to the coastline and rose to approximately 2 – 3 m above the gully bases. The zone was approximately 12 m wide at the centre of the transect and, at the time of survey, could be seen to extend for up to a further 10 m below the water line.

The biological communities present in this zone were variable, with vertical zonation apparent on the individual bedrock ridges and gullies. On the tops of the ridges, egg wrack, *Ascophyllum nodosum*, (rare) was dominant. Below this, and covering the majority of the rock, was the same biological community observed in zone 4, with dense *F. vesiculosus* (abundant) and *O. pinnatifida* (common) present together with *P. vulgata* (abundant) and the barnacle *Semibalanus balanoides* (frequent). Other faunal taxa recorded in this zone included *N. lapillus* (common), *L. obtusata* (common), *L. littorea* (rare), *S. umbilicalis* (rare) and *A. equina* (occasional). In the gullies, *F. serratus* (abundant) was the dominant taxa, with encrusting red algae (rare to occasional) present on the rock beneath.

The abundances of the taxa *F. vesiculosus, O. pinnatifida* and *S. balanoides* recorded are highly indicative of the biotope **LR.MLR.BF.FvesB** ('*Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock'). While this community was the dominant one within zone 5 and was therefore assigned to the observed habitat, the presence of *F. serratus* in gullies may suggest that this zone could be best described as a mosaic habitat together with **LR.LLR.F.Fserr.FS** ('*Fucus serratus* on full salinity sheltered lower eulittoral rock').

Below zone 5, below the water, kelp (*Laminaria* sp. indet.) was observed, likely indicating the presence of an infralittoral kelp biotope.

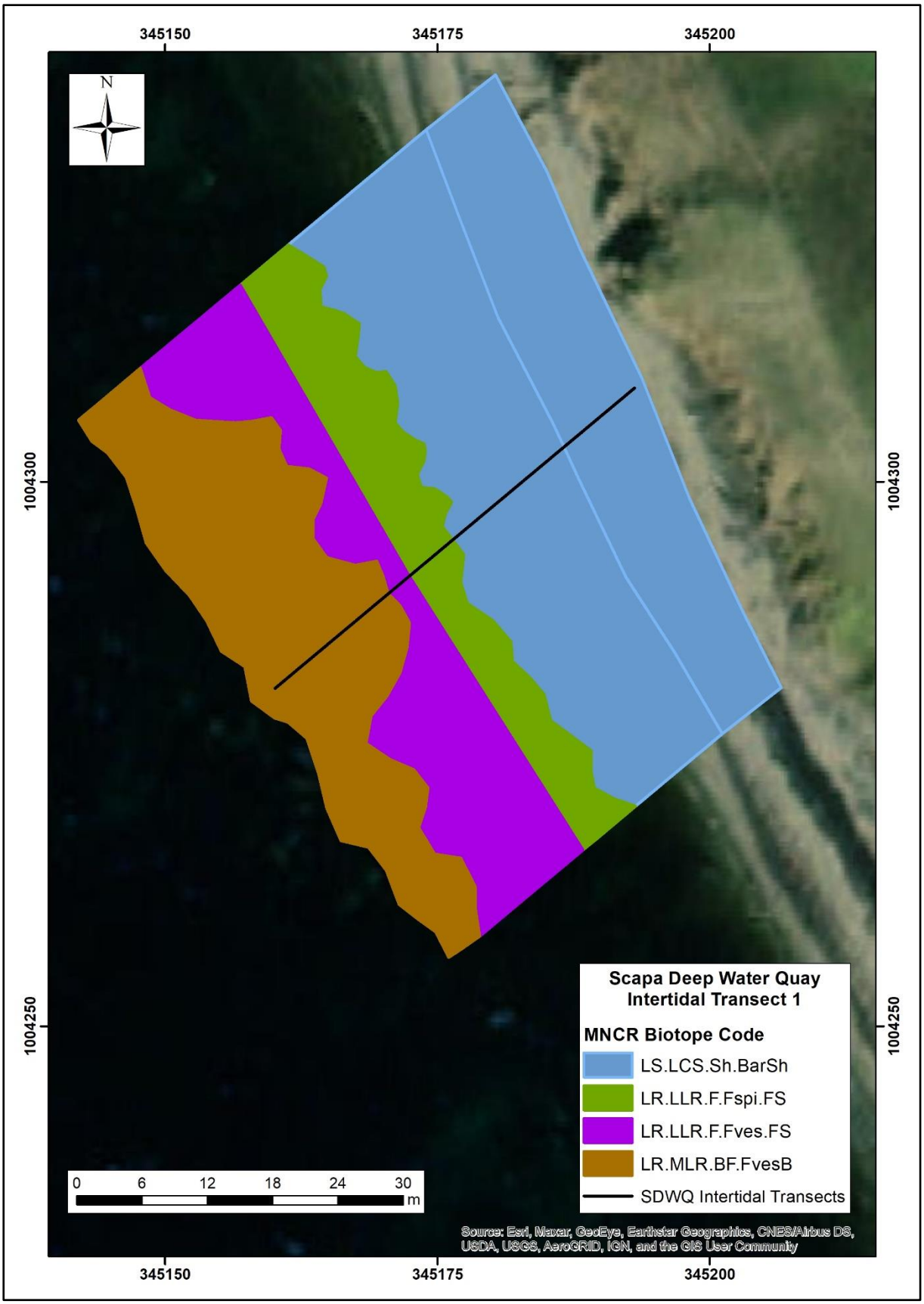

Figure 3.1: Distribution of MNCR biotopes (JNCC, 2022) at Transect 1 (SB_1), surveyed as part of the 2022 Scapa Deep Water Quay Phase I intertidal survey.

3.1.2 Scapa Transect 2 (SB_2; Plates 2a – 2d)

Transect 2 was located approximately 470 m south of the Burn of Deepdale. The upper shore was backed by a steeply sloping cliff approximately 8 m in height. The top of the cliff supported a thin soil strata and coarse terrestrial grasses. Occasional clumps of grasses occurred in the crevices of the main rock face (see Appendix III). The rock surface supported the lichens *Hydropunctaria maura* (previously *Verrucaria maura*), *O. parella*, *Caloplaca* sp. and *R. siliquosa*. Freshwater was observed percolating from the soil at the top of the cliff causing an area of cliff rock at the centre of the transect to support a brown algal biofilm.

Below the cliff, six habitat zones were identified. The distribution of the biotopes identified at Transect 2 is shown in Figure 3.2.

SB_2 Zone 1. The upper shore directly under the cliff was characterised by barren shingle and cobbles with outcrops of bedrock. This habitat was variable in width and extended up to 4 m from the base of the cliff. The bedrock and more stable cobbles supported the black lichen *H. maura* (common), with *O. parella* (occasional) and *Caloplaca* sp. (occasional) occurring in lower abundances. The biotope **LR.FLR.Lic.Ver.Ver** ('*Verrucaria maura* on very exposed to very sheltered upper littoral fringe rock') was therefore assigned to this zone.

In addition to the lichens, a range of fauna was present in this zone. On the rock surface, *L. saxatilis* (occasional), *L. littorea* (rare) and *P. vulgata* (rare) were all observed, while underneath the less stable cobbles highly abundant talitrid amphipods (abundant) and the sea slater *Ligia oceanica* (frequent) were also recorded.

SB_2 Zone 2. The substrate in Zone 2 was similar to that present in Zone 1, and comprised a mixture of shingle, cobbles and exposed bedrock with occasional boulders. The rock was characterised by a 6 m wide band of dense *P. canaliculata* (super-abundant) and *F. spiralis* (abundant). The fauna was dominated by the winkles *L. saxatilis* (abundant) and *M. neritoides* (common), with *L. littorea* (occasional) and *P. vulgata* (rare) also present. Gammarid amphipods (occasional) were also recorded under cobbles and in patches of standing water.

Due to the high abundance of the characterising species *P. canaliculata*, the biotope **LR.LLR.F.Pel** ('*Pelvetia canaliculata* on sheltered littoral fringe rock') was assigned to this zone.

SB_2 Zone 3. Zone 3 was similar to Zone 2 in terms of substrate, however here the dominant seaweed was *F. spiralis* (abundant), with lower quantities of *P. canaliculata* (occasional) and *A. nodosum* (common) also present. Other algal taxa recorded in this zone included *Cladophora* sp. (occasional), red filamentous algae (rare), red calcareous encrusting algae (rare) and fucoid sporlings (rare). In the rock crevices and underneath the seaweeds fauna was relatively abundant and included *L. saxatilis* (abundant), *L. littorea* (common), *P. vulgata* (frequent), *A. equina* (frequent) and *N. lapillus* (rare), with gammarid shrimp (occasional) observed on the undersides of cobbles.

Due to the high abundance of the characterising species *F. spiralis*, and the relatively low abundance of both *P. canaliculata* and *A. nodosum*, the biotope **LR.LLR.F.Fspi.FS** was assigned to this zone.

SB_2 Zone 4. In the mid-shore, the substrate consisted of boulders and cobbles with gravel and sand infill. In the upper 7 m of this habitat the biological community was dominated by *F. vesiculosus* (common) with *A. nodosum* (occasional) also present, particularly in the upper parts of this zone. Faunal taxa recorded in this zone included *L. littorea* (common), *L. saxatilis* (frequent), *L. obtusata* (rare), *N. lapillus* (frequent) and *P. vulgata* (occasional), with gammarid amphipods (occasional) also observed under cobbles.

Due to the dominance of *F. vesiculosus*, the biotope **LR.LLR.F.Fves.X** ('*Fucus vesiculosus* on mid eulittoral mixed substrata') was assigned to this zone.

SB_2 Zone 5. Zone 5 was very similar to Zone 4, however much higher densities of the characterising seaweeds *F. vesiculosus* (super-abundant) and *A. nodosum* (abundant) were recorded. While the change in abundance of the characterising species necessitated classification of a separate habitat zone, the same biotope recorded for Zone 4 (**LR.LLR.F.Fves.X**) was also assigned here. In addition to *F. vesiculosus* and *A. nodosum*, *F. serratus* (occasional) and filamentous red seaweeds (occasional) were present as small patches. On the rock beneath the algal canopy, calcareous red algal crusts (frequent) were present together with relatively dense faunal taxa including *P. vulgata* (abundant), *L. littorea* (abundant), *N. lapillus* (common), *A. equina* (frequent), *S. umbilicalis* (rare), hermit crabs (occasional) and the shore crab *Carcinus maenas* (rare). Encrusting taxa including spirorbid worms (occasional), *S. balanoides* (rare) and *H. maura* (frequent) were also recorded in this zone.

SB_2 Zone 6. The parts of the low shore that were observable during the survey were primarily composed of bedrock protrusions with occasional cobbles and sand infill. The bedrock was uneven, forming ~0.3 m high ridges with gullies in between. The ridges were characterised by a mixture of *F. serratus* (abundant) and *F. vesiculosus* (common), while the lower rock surfaces, gullies and crevices were dominated by a mixture of *O. pinnatifida* (super-abundant) and *F. serratus*. Red seaweeds including *C. officinalis* (occasional) and *Chondrus crispus* (occasional) were also present in the gullies, with calcareous red algal crusts (frequent) also recorded. Fauna present in this zone included *P. vulgata* (common), *L. littorea* (common) and *N. lapillus* (frequent), *L. obtusata* (rare) and the topshells *S. umbilicalis* (rare) and *S. cineraria* (rare).

Due to the prevalence of *F. serratus* in this zone, together with the presence of various red seaweeds, the biotope **LR.MLR.BF.Fser.R** ('*Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock') was assigned to this zone.

As at Transect 1, kelp (*Laminaria* sp. indet.) was observed in the surf zone below low water, indicating the presence of an infralittoral kelp biotope in the shallow subtidal.

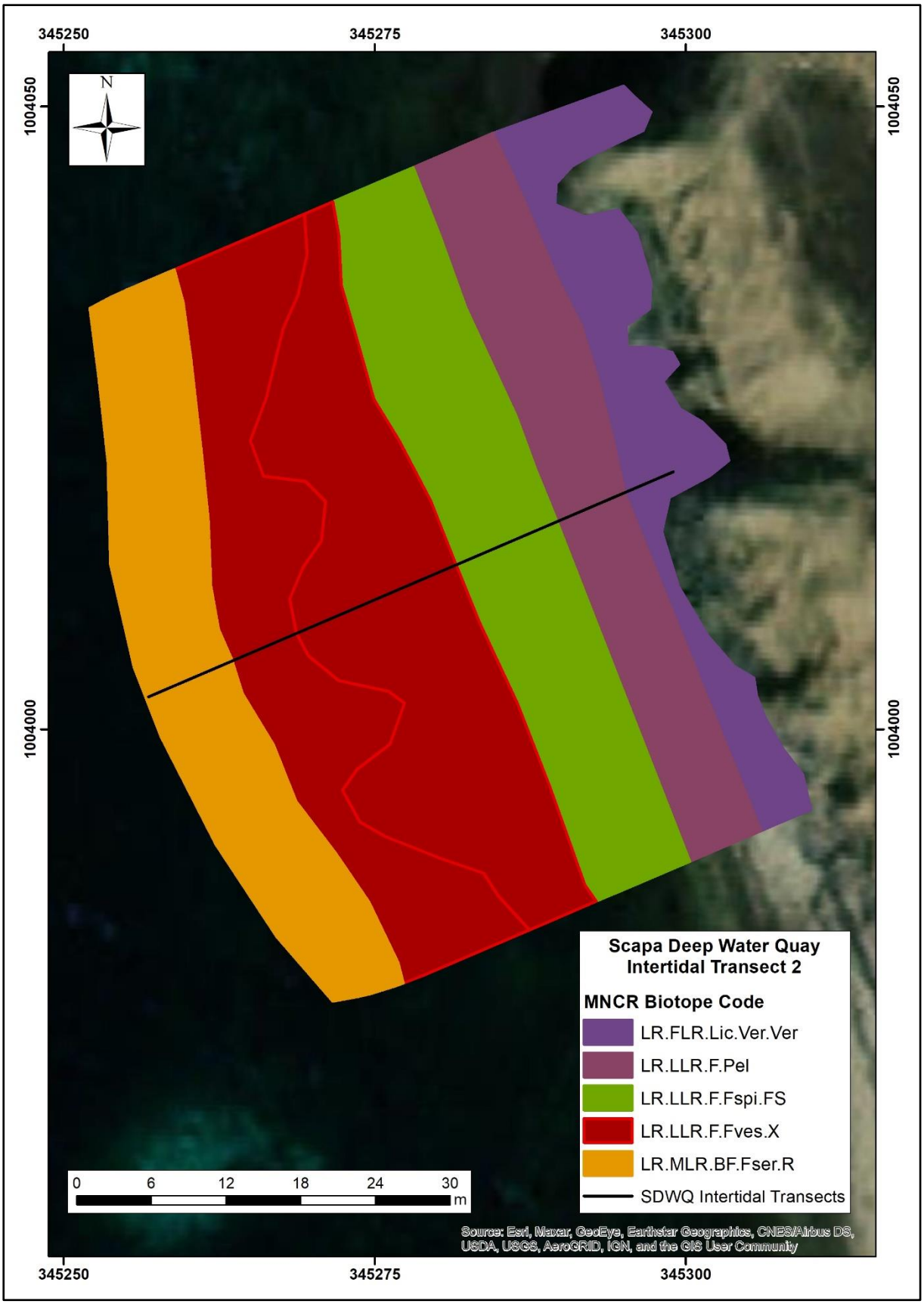

Figure 3.2: Distribution of MNCR biotopes (JNCC, 2022) at Transect 2 (SB_2), surveyed as part of the 2022 Scapa Deep Water Quay Phase I intertidal survey.

3.1.3 Scapa Transect 3 (SB_3; Plates 3a – 3d)

Transect 2 was located approximately 650 m south of the Burn of Deepdale, immediately north of a rocky outcrop/headland known as the Tongue of Gangsta. The cliff that separated the upper intertidal zone from the adjacent field was not as sheer as at Transects 1 and 2 and was largely covered with terrestrial plants and grasses with only a few sections of exposed rock (see Appendix III). Below the cliff the shore was divided into six distinct habitat zones running parallel to the coastline. The distribution of biotopes at this transect is shown in Figure 3.3.

SB_3 Zone 1. Adjacent to the cliff was a 4 m band of gravel, pebbles and cobbles with some small patches (<0.25 m^2) of exposed bedrock. No taxa were recorded; the biotope **LS.LCS.Sh.BarSh** was therefore assigned to this zone.

SB_3 Zone 2. Below Zone 1 was a 9 m band of cobbles and boulders overlying gravel. The only macroalgae recorded was *P. canaliculata* (rare), however low numbers of *L. saxatilis* (occasional) were present on the more stable cobbles together with a thin and patchy green biofilm (common). Beneath the larger cobbles and boulders were high numbers of talitrid (abundant) and gammarid (frequent) amphipods.

Given the abundance of talitrids, the biotope **LS.LSa.St.Tal** ('Talitrids on the upper shore and strand-line') was assigned to this habitat. Whilst this zone did not possess the accumulations of decomposing seaweed detritus that are usually associated with this biotope, the occurrence of talitrids in large numbers indicated that such material does occur in this location, but may be transient and dependent on the sea conditions.

SB_3 Zone 3. The mid-shore substrate at Transect 3 was primarily composed of cobbles and small boulders with gravel and pebble infill and patches of exposed bedrock. The upper 5 m of this habitat was characterised by *F. spiralis* (abundant) and *A. nodosum* (occasional), with small dense patches of *P. canaliculata* (abundant) also present, particularly at the upper edge of the zone in the southern half of the transect. However, due to the patchy nature of the *P. canaliculata* present, these areas were not considered sufficient to justify the inclusion of a separate habitat zone or biotope allocation. Zone 3 was therefore classified as **LR.LLR.F.Fspi.X** ('*Fucus spiralis* on full salinity upper eulittoral mixed substrata').

A range of faunal taxa were recorded in this zone, including *M. neritoides* (abundant), *L. saxatilis* (common), *L. littorea* (rare), *P. vulgata* (occasional), *C. maenas* (occasional), *A. equina* (rare) and *S. balanoides* (rare). In addition, gammarid amphipods (frequent) were observed beneath cobbles. It was noted that faunal abundance and diversity in this zone was greater on the undersides of cobbles and boulders, particularly adjacent to standing water. The zone may therefore constitute an "underboulder-like" habitat.

SB_3 Zone 4. Below Zone 3 was a 7 m wide band dominated by *A. nodosum* (super-abundant) and *F. vesiculosus* (common). Beneath the macroalgae, fauna present included *P. vulgata* (abundant), *A. equina* (frequent) and the periwinkles *L. littorea* (common), *L. obtusata* (occasional), *L. saxatilis* (occasional) and *M. neritoides* (occasional). Beneath the cobbles and boulders gammarid amphipods (occasional) and *C. maenas* (occasional) were recorded in low numbers.

Due to the overall dominance of *A. nodosum*, the biotope **LR.LLR.F.Asc.X** ('*Ascophyllum nodosum* on full salinity mid eulittoral mixed substrata') was assigned to this zone.

SB_3 Zone 5. Below Zone 4, and continuing on the same substrate type as the previous zone, was a 7 m wide band characterised by *F. vesiculosus* (abundant) with *O. pinnatifida* (frequent) occurring beneath the wrack canopy and between boulders. Other, less abundant algal taxa recorded in this zone included *Mastocarpus stellatus* (occasional), which occurred in standing water between the boulders.

Faunal taxa recorded in this zone were broadly similar to those occurring in previous zones and included *L. littorea* (abundant), *L. obtusata* (occasional), *L. saxatilis* (occasional), *P. vulgata* (common), *N. lapillus* (frequent), *A. equina* (occasional) and very low numbers of barnacles (present). Under the cobbles and boulders gammarid amphipods (common) and *C. maenas* (frequent) were also often observed.

Due to the presence of dense *F. vesiculosus* together with low quantities of red seaweeds, the biotope **LR.LLR.F.Fves.X** was assigned to this habitat.

SB_3 Zone 6. In contrast to the mid shore zones, the lower 10 m of exposed shore at Transect 3 was composed of bedrock and large boulders. However, the biological community present was similar to that observed in Zone 5, with *F. vesiculosus* (abundant) and *O. pinnatifida* (common) dominating the rock surface with low quantities of *F. serratus* (occasional) and *C. crispus* (rare) also present. Very high numbers of *L. littorea* (super-abundant) were present on the rock surface, together with *P. vulgata* (common), *N. lapillus* (frequent), *A. equina* (frequent).

While the community present was very similar to the preceding zone, due to the change in substrate type this zone was assigned the biotope **LR.LLR.F.Fves.FS**.

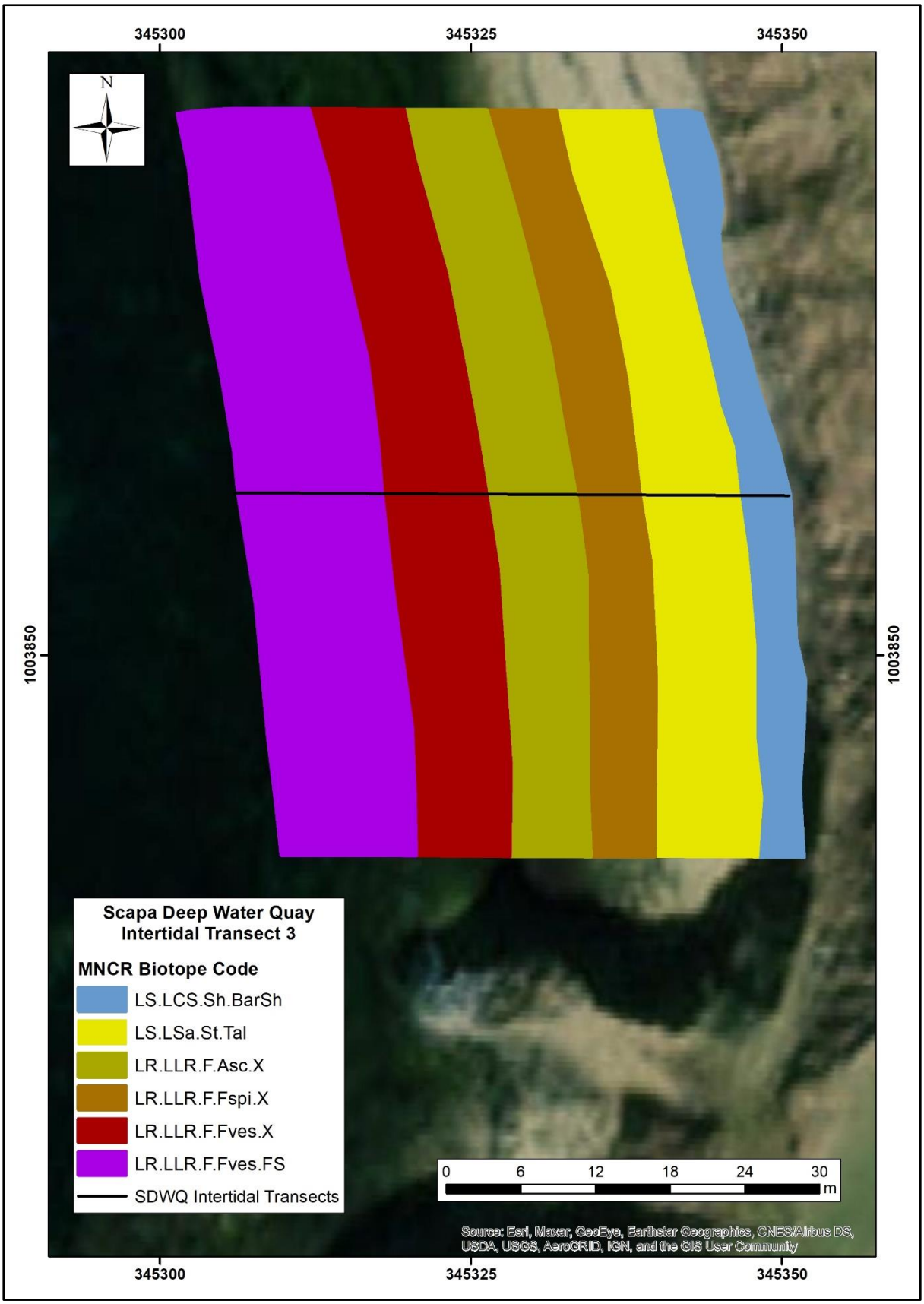

Figure 3.3: Distribution of MNCR biotopes (JNCC, 2022) at Transect 3 (SB_3), surveyed as part of the 2022 Scapa Deep Water Quay Phase I intertidal survey.

3.1.4 Scapa Transect 4 (SB_4; Plates 4a – 4d)

Transect 4 was located on the Tongue of Gangsta, approximately 740 m south of the mouth of the Burn of Deepdale. The shore at this location was separated from the adjacent fields by a high (7 – 8 m), uneven, steep bedrock embankment (~45° slope) (see Appendix III). The upper levels of the embankment had a thin soil layer and terrestrial grass cover, while the lower rocks supported a range of lichens including *H. maura* (common), *O. parella* (occasional), *R. siliquosa* (frequent) and *Caloplaca* sp. (frequent). At the very base of the rocky embankment, a few fucoid sporelings were observed, however, as no mature specimens were recorded, it is unlikely that these represented a viable population. Below the embankment, four habitat zones were identified. The distribution of the biotopes identified at Transect 4 is shown in Figure 3.4.

SB_4 Zone 1. At the base of the bedrock embankment the shore comprised cobbles overlying gravel. This material infilled the crevices between the protrusions of rock strata (see Appendix III) and extended up to 4 m from the embankment base.

The lichen *H. maura* (occasional) was present as small patches while algae was restricted to small patches of *P. canaliculata* (rare). Despite the lack of algal growth, the cobbles supported a range of molluscan taxa including *L. saxatilis* (common), *L. littorea* (occasional), *M. neritoides* (frequent) and *P. vulgata* (rare). In addition, *C. maenas* (rare) was also observed in low numbers on the undersides of cobbles.

Due to the paucity of characterising taxa; this zone was recorded as the biotope **LS.LCS.Sh.BarSh**.

SB_4 Zone 2. Zone 2 consisted of a 7 m band of boulders and cobbles overlying bedrock, with pebble and gravel infill. A mixture of *F. spiralis* (common) and *F. vesiculosus* (common) was present throughout the zone. Other seaweed species present included small quantities of *P. canaliculata* (rare) and *Cladophora* sp. (rare).

Faunal taxa present in this zone included *P. vulgata* (common), *L. littorea* (frequent), *A. equina* (frequent), *N. lapillus* (occasional) and *S. balanoides* (rare). In addition, high numbers of gammarid shrimps (common) and a single *C. maenas* (rare) were observed underneath boulders.

No biotope was found to be a good fit for the communities observed. If *F. spiralis* or *F. vesiculosus* had been dominant, it is probable that either **LR.LLR.F.Fspi** or **LR.LLR.F.Fves** would have been assigned. However, due to the mix of fucoid species present, the biotope complex **LR.LLR.F** ('Fucoids on sheltered marine shores') was assigned to this zone.

SB_4 Zone 3. Below the somewhat mixed Zone 2 was a 6 m band of bedrock with overlying boulders dominated by *F. vesiculosus* (abundant) with *O. pinnatifida* (abundant) present in the areas between the boulders and in rock crevices. In addition, *C. officinalis* (frequent) and calcareous red algal crusts (frequent) were also conspicuous in this zone. Fauna recorded included *P. vulgata* (common), *N. lapillus* (common), *A. equina* (frequent) and low numbers of *Littorina* spp. (rare).

Due to dominance of *F. vesiculosus*, the biotope **LR.LLR.F.Fves.FS** was assigned to this zone.

SB_4 Zone 4. In the low shore, the beach was composed of exposed bedrock with occasional boulders. The rock was characterised by dense *F. serratus* (abundant) and red seaweeds including *O. pinnatifida* (common), *C. officinalis* (frequent) and *C. crispus* (occasional). The range of faunal taxa recorded was very similar to that observed in Zone 3, however most taxa were more abundant than previously. Taxa recorded included *P. vulgata* (abundant), *A. equina* (common), *N. lapillus* (common) and *L. littorea* (occasional).

Zone 4 extended 7 m to the low water mark on the day of survey, however the same habitat could be seen to extend a further ~10 m into the surf zone and would likely be exposed on a spring tide. The width of the Zone 4 was therefore recorded as 17 m.

Due to the prevalence of *F. serratus*, combined with the presence and abundance of a variety of red macroalgal taxa, the biotope **LR.MLR.BF.Fser.R** was assigned to this zone.

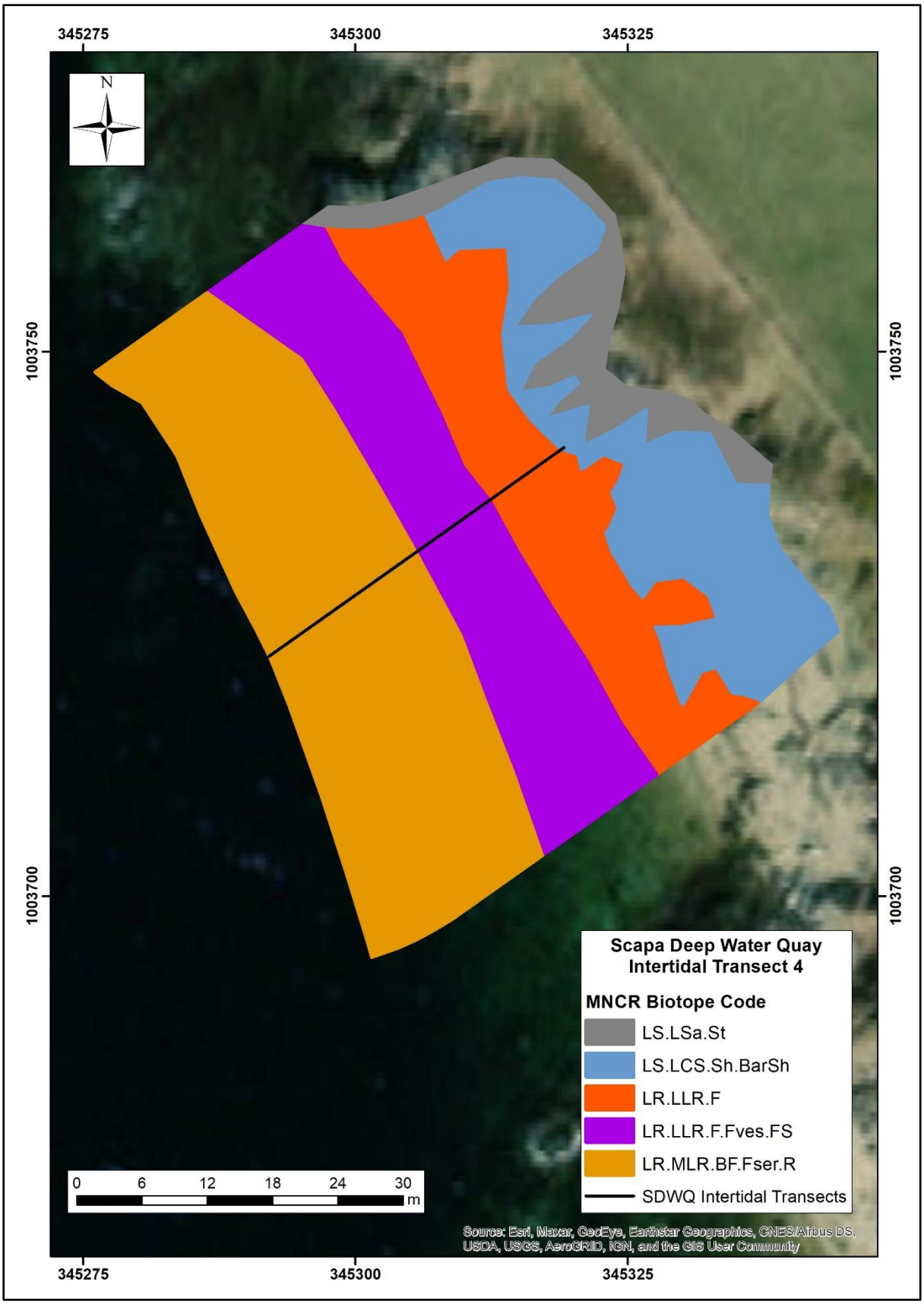

Figure 3.4: Distribution of MNCR biotopes (JNCC, 2022) at Transect 4 (SB_4), surveyed as part of the 2022 Scapa Deep Water Quay Phase I intertidal survey.

3.1.5 Additional observations

Between Transects 1 and 2, multiple small freshwater streams, apparently natural in origin, were observed flowing over the cliffs. These presumably comprised primarily surface run-off but may have had a groundwater component. The freshwater input did not appear to have a widespread effect on the intertidal communities. The only visible effect was an increase in the abundance and density of green epilithic algae, comprising *Ulva* spp. and filamentous algae, in the immediate vicinity of the stream path at the mid and upper foreshore. This conformed to the littoral rock feature **LR.FLR.Eph.Ulv** ('*Ulva* spp. on freshwater-influenced and/or unstable upper eulittoral rock').

3.2 Underwater imagery analysis

The 15 target sites selected for investigation were surveyed using a total of 8 camera deployments. A total of 192 still images were taken, with 176 of these deemed suitable for analysis. A summary of the logs for each camera deployment are provided in Appendix VII.

The survey area was found to be characterised primarily by soft sediment habitats, although areas of hard substrate, consisting variously of bedrock, boulders and cobbles, were also recorded. A total of seven different biotopes, biotope complexes and habitat complexes were identified. A summary of the habitats observed is given in Appendix VIII and the distribution of biotopes assigned to the video records is shown in Figure 3.5 (see Appendix VI for the biotope glossary).

The vast majority of the survey area was found to comprise sandy mixed sediments with a significant shell and/or gravel fraction. Where epibiota was sparse, the biotope complex **SS.SMx.IMx** ('Infralittoral mixed sediment') was assigned to imagery records. However, the mixed sediments were often overlain with loose-lying mats of red seaweed (likely *Phyllophora crispa*). The abundance of these mats was somewhat variable, ranging from very patchy (occasional to frequent) to very dense (abundant to super-abundant). Where the abundance of the seaweed was estimated at greater than 5 % (i.e. frequent or higher) the biotope **SS.SMp.KSwSS.Pcri** ('Loose-lying mats of *Phyllophora crispa* on infralittoral muddy sediment') was assigned. This biotope was found to be present on seven of the eight transects surveyed, being absent only from transect SBC5, located in the northern section of the consent boundary. On transect SBC2 the mats of red seaweed were present together with the kelp *Saccharina latissima*; this area was therefore assigned the biotope **SS.SMp.KSwSS.SlatR** ('*Saccharina latissima* and red seaweeds on infralittoral sediments'). Both of the SS.SMp.KSwSS biotopes identified are listed as components of the PMF 'kelp and seaweed communities on sublittoral sediment.' This PMF was therefore assigned to all associated imagery records.

Areas of hard substrate comprising a mixture of bedrock, boulders and cobbles were observed on a total of three transects (SBC1, SBC4 and SBC5), all located in the inshore of the survey area, within the consent boundary. Both rocky reef, present as 'stepped' bedrock, and stony reef, comprising cobbles and boulders overlying coarse sediment, were observed on all three transects. The observed hard substrate was generally heavily sediment-influenced, being present adjacent to coarse sands and gravels, and exhibited signs of scour. In addition, the hard substrate generally had the appearance of being heavily grazed, with the most conspicuous biota present being calcareous red algal crusts (corallinaceae) and the urchin *Echinus esculentus*. Where the biota was particularly sparse, the habitat complex **IR.LIR**

('Low energy infralittoral rock') was assigned (often together with **SS.SCS.ICS**, 'Infralittoral coarse sediment'). There were however some areas of hard substrate where sparse kelps were recorded. On transect SBC4 (S7), *S. latissima* was observed on an area of stepped bedrock, with the biotope **IR.LIR.K.Slat.Gz** ('Grazed *Saccharina latissima* with *Echinus*, brittlestars and coralline crusts on sheltered infralittoral rock') therefore assigned. On transect SBC5 (S3) an area of mixed kelps was observed and the biotope **IR.LIR.K.LhypSlat.Gz** ('Grazed, mixed *Laminaria hyperborea* and *Saccharina latissima* on sheltered infralittoral rock') was recorded. It should be noted, however, that this biotope was only tentatively assigned due to difficulties encountered in identifying the kelps present to species level. In both cases, due to the low abundance of the characterising taxa present, the communities observed likely represented an extremely impoverished version of the biotopes assigned.

Maerl was recorded on a total of four transects (SBC1, 2, 4 and 5), all in the inshore section of the survey area (i.e. inshore of the westward consent boundary). All observations were of so-called 'hedgehog stones,' maerl growing as a series of 'spikes' over hard substrate such as pebbles and cobbles. No free-living maerl or maerl gravel was observed. In all cases, the quantity of maerl present was very low, ranging from <1 % cover to a maximum of 2 % cover. The PMF 'maerl beds' was therefore not assigned to any video segment.

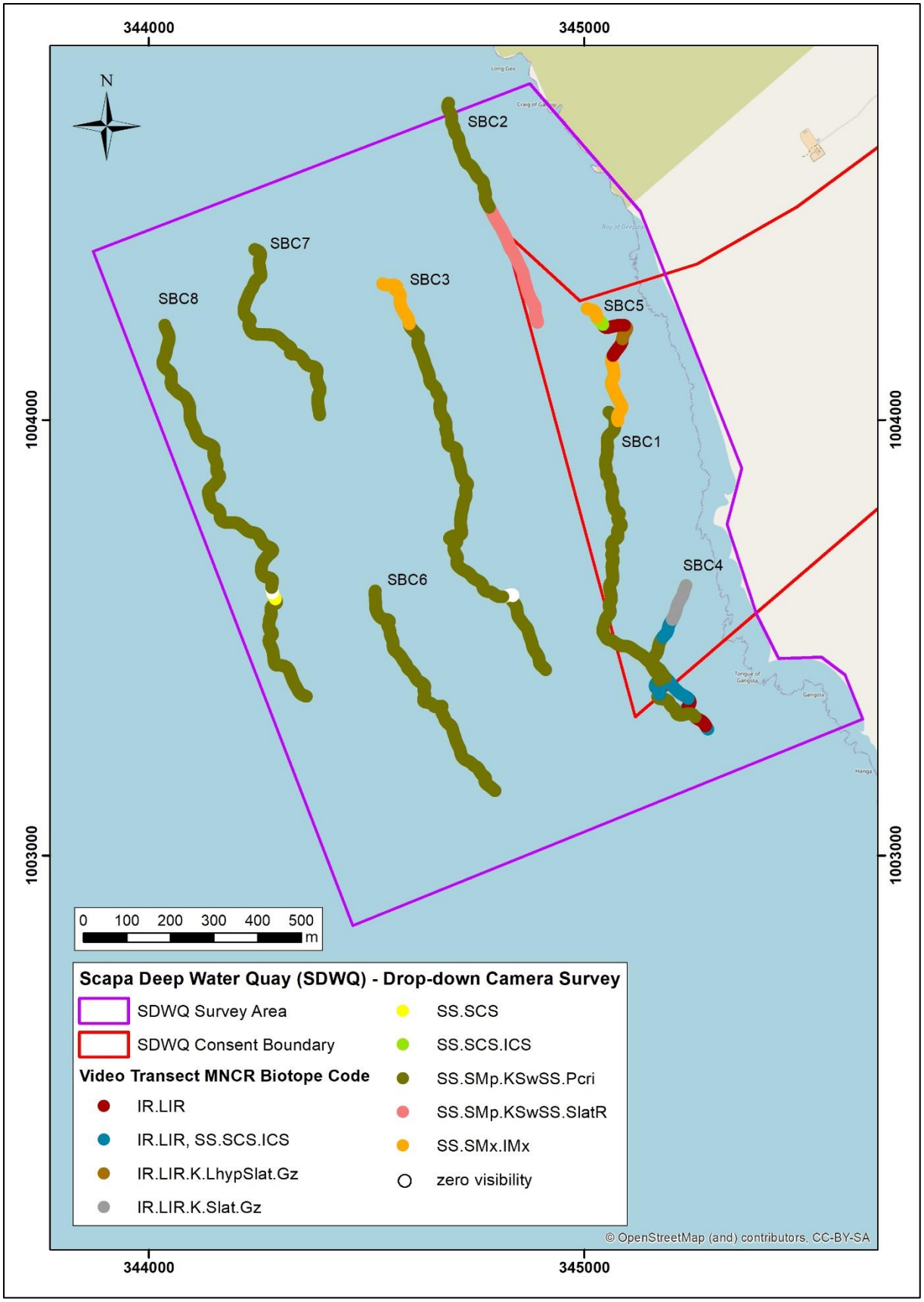

Figure 3.5: MNCR biotopes (JNCC, 2022) assigned to video segments following analysis of underwater imagery collected as part of the 2022 Scapa Deep Water Quay broadscale habitat mapping survey.

3.3 Benthic grab sample analyses

Eight grab samples were successfully collected from the survey area. The survey logs are provided in Appendix IX.

3.3.1 Sediment particle size analysis

A summary of the results of the PSA is given in Table 3.1. Full results are provided in Appendix X. The distribution of sediment types identified is shown in Figure 3.6.

Table 3.1: Summary of the particle size analysis results of grab samples collected as part of the 2022 Scapa Deep Water Quay broadscale habitat mapping survey.

Sample no.	Grab no.	Gravel	Sand	Mud	Classification	Abbreviation
568#09	SBG1	3.45	74.17	22.35	Slightly gravelly muddy sand	(g)mS
568#10	SBG2	9.08	71.23	19.71	Gravelly muddy sand	gmS
568#11	SBG3	6.42	72.03	21.50	Gravelly muddy sand	gmS
568#12	SBG4	0.33	86.78	12.89	Muddy sand	mS
568#13	SBG5	3.90	72.69	23.39	Slightly gravelly muddy sand	(g)mS
568#14	SBG6	19.43	57.94	22.68	Gravelly muddy sand	gmS
568#15	SBG7	9.94	71.50	18.51	Gravelly muddy sand	gmS
568#16	SBG8	9.36	74.79	15.90	Gravelly muddy sand	gmS

The soft sediments across the survey area was found to be fairly homogeneous, with seven of the eight samples found to be composed of mixed gravelly muddy sands. The final sample (SBG4), located in the approximate centre of the survey area, was less coarse, however, with a gravel fraction of < 1 %, and was therefore classified as muddy sand. Despite this, the fraction of mud present in the samples was fairly consistent throughout the survey area (13 – 23 %).

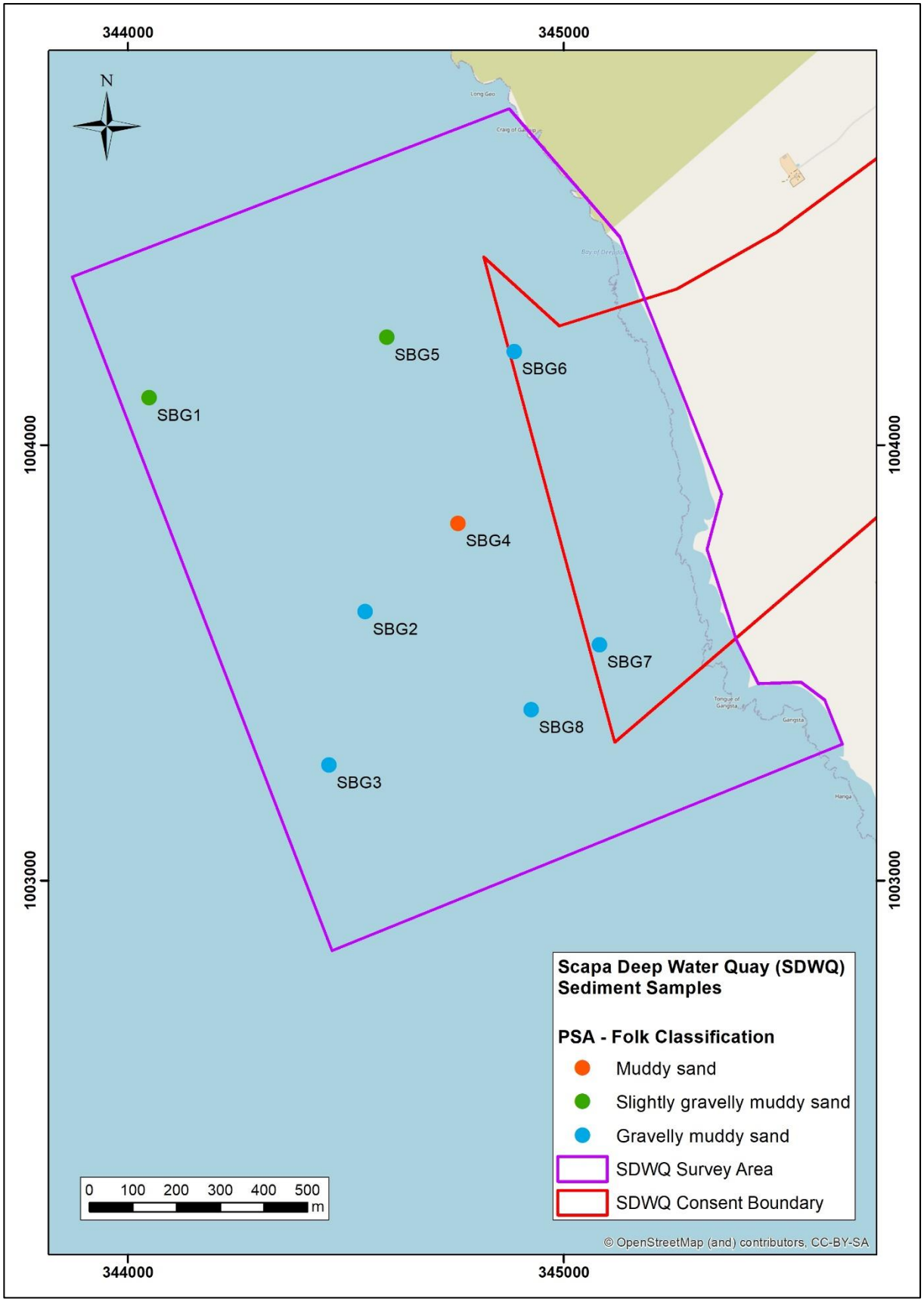

Figure 3.6: Sediment types assigned following particle size analysis of grab samples collected as part of the 2022 Scapa Deep Water Quay broadscale habitat mapping survey.

3.3.2 Macrobenthic invertebrate analysis

The macrofaunal analysis identified a total of 5172 individuals and 214 taxa (excluding unquantifiable meiofauna and epifauna). The full results of the macrobenthic invertebrate analysis are provided in Appendix XI. The total numbers of individuals (N) and taxa (S) for each sample are given in Table 3.2.

Table 3.2: Summary of the total numbers of individuals (N) and taxa (S) identified in grab samples collected as part of the 2022 Scapa Deep Water Quay broadscale habitat mapping survey.

Grab no.	Target no.	N	S
SBG1	SB_C15	396	101
SBG2	SB_C10	640	92
SBG3	SB_C13	505	84
SBG4	SB_C07	937	91
SBG5	SB_C08	766	104
SBG6	SB_C04	554	125
SBG7	SB_C02	550	124
SBG8	SB_C06	824	97

The total numbers of individuals at each station ranged from 396 to 937 individuals per sample. The total number of taxa (S) was however more consistent throughout the survey area, ranging from 84 to 125 per sample. Overall, the macrofauna was dominated by Annelida (60.2 %) followed by Crustacea (16.3%) and Mollusca (11.1 %) and Phoronida (7.7 %). The remaining 4.7 % of individuals comprised Nematoda (1.3 %), Nemertea (1.2 %), Cnidaria, Echinodermata, Foraminifera, Hemichordata, Platyhelminthes, Pycnogonida and Chaetognatha (all < 1 %). A summary of the most abundant taxa present in the samples is given in Table 3.3.

Table 3.3: Total abundance of the macrofaunal taxa identified in grab samples collected as part of the 2022 Scapa Deep Water Quay broadscale habitat mapping survey. Taxa shown comprise 70 % of total individuals identified.

Taxon	Qualifier	Abundance (total no. in all samples)
Lumbrineris	nr. cingulata	686
Phoronis	sp. indet.	396
Prionospio fallax		385
Thyasira flexuosa		349
Ampelisca	juvenile	234
Nephtys	juvenile	154
Tanaissus danica		130
Notomastus	sp. indet.	121
Ampelisca provincialis		112
Pseudopolydora paucibranchiata		107
Scoloplos armiger		93

Taxon	Qualifier	Abundance (total no. in all samples)
Mediomastus fragilis		80
Anobothrus gracilis		74
Turritellinella tricarinata		74
Dipolydora flava		71
Magelona alleni		70
Nematoda		69
Aurospio banyulensis		67
Myodocopida		66
Nemertea		64
Amphicteis gunneri		62
Verruca stroemia		61
Scalibregma celticum		60
Jasmineira caudata		57

Generally, the samples exhibited very similar macrofaunal assemblages, with only the relative abundance of the dominant species varying from sample to sample. The most abundant taxa present included a range of polychaetes, including *Prionospio fallax*, *Notomastus* sp. indet., *Pseudopolydora paucibranchiata*, *Scoloplos armiger* and *Mediomastus fragilis*. The errant polychaetes *Lumbrineris* sp. (nr. cingulata) and *Nephtys* spp. were also particularly abundant in all eight of the samples. The bivalve *Thyasira flexuosa*, the amphipod *Ampelisca* spp. and the horseshoe worm *Phoronis* sp. indet. were also among the most abundant taxa, also being present in all samples.

The dominant fauna present were generally characteristic of shallow mixed sediments. The best fit for the recorded assemblage was found to be the biotope **SS.SMx.CMx.KurThyMx** ('*Kurtiella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment'). However, whilst *T. flexuosa* was present in high numbers, and other characterising taxa were also present throughout the survey area, the bivalve *Kurtiella bidentata* was only present in low numbers (n = 2 - 4) in 4 of the 8 samples. It is possible therefore that the recorded community is a variant of the described biotope.

While the PSA results indicated that the sediments at SBG4 were composed of muddy sands (and therefore not mixed sediment), the biotope **SS.SMx.CMx.KurThyMx** was also assigned to this sample due to high numbers of *T. flexuosa* (n = 128) and other taxa characteristic of this biotope (including *P. fallax*, *S. armiger*, *Ampelisca* spp. and *Lumbrineris* sp.) present.

4 SUMMARY

4.1 Intertidal survey

The habitats and associated biological communities recorded in the Scapa Deep Water Quay intertidal survey area were typical of low energy, sheltered, rocky and mixed substrate coastlines in the north of Scotland. The patterns of vertical zonation observed on the four representative transects were similar to those described for the Hatston Pier site (O'Dell *et al.*, 2023), and reflected the exposure tolerances of the seaweed and animal communities, ranging from the barren or lichen-dominated upper shore (supra-littoral zone) to the lower littoral fringe and infralittoral habitats.

Table 4.1 provides a summary of the biotopes recorded at each transect. None of the biotopes identified are considered of national or international importance or of special interest (see Annex I, Brazier *et al.* (2019)) and no PMF habitats or species (Tyler-Walters *et al.*, 2016) were observed.

Table 4.1: A summary of the biotopes identified at each transect surveyed as part of 2022 Scapa Deep Water Quay intertidal survey.

Biotope Code	SB_1	SB _2	SB _3	SB _4
LR.MLR.BF.FvesB	●			
LR.MLR.BF.Fser.R		●		●
LR.LLR.F				●
LR.LLR.F.Pel		●		
LR.LLR.F.Fspi.FS	●	●		
LR.LLR.F.Fspi.X			●	
LR.LLR.F.Fves.FS	●		●	●
LR.LLR.F.Fves.X		●	●	
LR.LLR.F.Asc.X			●	
LR.LLR.F.Fserr.FS	●			
LR.FLR.Lic.Ver.Ver		●		
LS.LCS.Sh.BarSh	●		●	●
LS.LSa.St		●		●
LS.LSa.St.Tal			●	

The dog whelk, *N. lapillus*, occurred at varying abundances on all four transects. This species was included on the OSPAR List of threatened and/or declining species and habitats in 2003 (OSPAR, 2009). The decline in the *N. lapillus* populations has been linked with contamination effects of tributyltin (TBT) compounds used in boat and ship antifouling paints. Even at low concentrations, these cause a condition known as imposex, where female *N. lapillus* develop male characteristics (the formation of a vas deferens and growth of a penis) and become sterile. Whilst recovery of *N. lapillus* populations has been demonstrated at some locations

that were previously denuded of this species, *N. lapillus* still remains on the OSPAR list (OSPAR, 2018).

4.2 Subtidal survey

The results of the grab survey indicate that the soft-sediment infaunal communities in the survey area are fairly consistent, with only one biotope (**SS.SMx.CMx.KurThyMx**) assigned to all the grab samples. Similarly, the results of the underwater imagery analysis indicate that the epibiotic communities present are also fairly consistent within the survey area, with only seven biotopes (including habitat complexes and biotope complexes) assigned to the imagery records. A summary of the biotopes identified on each video transect is given in Table 4.2.

Table 4.2: A summary of the biotopes identified at each transect surveyed as part of 2022 Scapa Deep Water Quay subtidal drop-down camera survey.

Biotope code	SBC1	SBC2	SBC3	SBC4	SBC5	SBC6	SBC7	SBC8
IR.LIR	●			●	●			
IR.LIR.K.LhypSlat.Gz					●			
IR.LIR.K.Slat.Gz				●	○			
SS.SCS.ICS				○	●			●
SS.SMx.IMx			●		●	○	○	○
SS.SMp.KSwSS.SlatR*		●						
SS.SMp.KSwSS.Pcri*	●	●	●	●		●	●	●

● = Identified from video footage

○ = Identified from still images only (and therefore unlikely to represent an actual biotope)

* associated with PMF habitats

One PMF habitat was identified in the subtidal survey area. The PMF habitat 'kelp and seaweed communities on sublittoral sediment' was identified on a total of seven transects (all excepting SBC5), and was recorded within the proposed development consent boundary.

Maerl, whilst present in the survey area, was only observed as scattered/isolated 'hedgehog stones' in very low abundances (up to 2 % coverage in any given still image in which it occurred, and < 1% in any of the video records). The PMF 'maerl beds' was therefore not assigned to any of the imagery records.

While kelp communities were observed, these were typical of low-energy, highly sediment-influenced environments and were heavily grazed. The PMF 'kelp beds' has several biotope components (Tyler-Walters *et al*., 2016), however these are all high- and moderate-energy biotopes not recorded in the present survey. The PMF 'kelp beds' was therefore not assigned to any of the imagery records.

4.3 Limitations

Due to the timings associated with the submission of the planning permission, there was a requirement to undertake the surveys in early winter 2022. In addition to the issues with the

intertidal survey, caused due to spring low tide times coinciding with hours of darkness (see section 2.1.2), this is likely to have impacted the biological communities observed. This particularly pertains to the macroalgal-dominated habitats in the intertidal and the kelp communities observed in the shallow subtidal, as a significant amount of autumn/winter 'die-back' is likely to have occurred prior to the survey being conducted. It is possible that the communities and biotopes recorded would change significantly if the survey was conducted in the summer.

4.4 Report summary and recommendations

The survey detailed in this report achieved all of the stated objectives, and the data collected were deemed to be sufficient for the purpose of informing the EIA and enabling assessments of the LSE associated with the proposed development. Despite the reduction in scope (see section 1.4), the survey approach was deemed appropriate for the project, as the data acquired were of sufficient resolution to gain a good understanding of the range and distribution of habitats, biotopes and dominant taxa at and in the vicinity of the proposed development. Furthermore, the data acquired can be used to inform subsequent surveys, including baseline and monitoring surveys.

It is strongly recommended that a full baseline survey is carried out prior to commencement of the proposed development. The data collected should be of sufficient quality and resolution to be suitable in supporting future assessments of feature condition and of measuring the magnitude and direction of any potential change related to the proposed development. A marine monitoring plan (MMP) should be developed by personnel familiar with such surveys in conjunction with the regulators and with relevant local stakeholder groups and specialists, where available.

It is recommended that baseline surveys should include Phase II intertidal surveys to collect quantitative, statistically robust species data and to investigate those low-shore habitats which could not be covered by the present Phase I survey, thereby resolving any data gaps. It is strongly recommended that these surveys are conducted in late summer (ideally August) when macroalgal growth is at maximum and spring low tides can be utilised for intertidal survey.

The lack of available acoustic (bathymetry and sidescan sonar) data in the subtidal region of the survey area meant that predictive broadscale habitat maps could not be produced using the present data. While the subtidal sediments and infaunal communities identified within the survey area were relatively homogenous, it is recommended that bathymetry and sidescan sonar surveys be conducted as part of the baseline survey in conjunction with additional drop-down camera and grab sample surveys in order to enable the creation of high-resolution predictive habitat maps. Given the prevalence of shallow subtidal macroalgal communities in the survey area, it is recommended that drop-down camera work be carried out during the summer months when macroalgal diversity is likely to be highest. A grab sampling survey should be conducted to provide additional macrobenthic invertebrate data, although it is also recommended that grab samples are taken for analysis of sediment chemistry. Sampling for marine water quality parameters may also be required. Both the drop-down camera and grab surveys should have a greater level of replication than in the present survey in order to provide statistically robust data against which potential future changes can be measured.

All baseline surveys should be conducted with reference to the broadscale habitat identification surveys described in this report and should aim to build upon the data collected

using readily comparable methodologies. Suitable intertidal and subtidal control sites should also be identified, and a suitable monitoring programme developed.

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6 APPENDICES

Appendix I: Modified MNCR field form used as part of the Phase I intertidal surveys conducted as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

Intertidal Ecological Surveys - Phase I recording form (one per habitat per transect)

1) Site information

Date:				
Time/weather/state of tide/other data				
Transect no.:				
Habitat no.				
Shore position (circle appropriate):	**Strandline**	**High**	**Mid**	**Low**
Position (centre point of habitat):		**N**		**W**

2) Photo Taken (tick as appropriate):	Up-shore ☐ Down-shore ☐ Right ☐ Left ☐

3) Site Description (tick appropriate score):		**1**	**2**	**3**	**4**	**5**
Surface relief (even-rugged)						
Texture (smooth-pitted)						
Stability (stable-mobile)						
Scour (none-scoured)						
Silt (none-silted)						
Fissures > 10mm (none-many)						
Crevices < 10mm (none-many)						
Boulder/cobble/pebble shape (rounded-angular)						
Rockpools (none-all)						

4) Note if the following are present:	**Tick as appropriate**
Burrows / holes	
Tubes	
Algal mat	
Drainage channels / creeks / freshwater runoff	
Standing water	
Sediment veneer	
Sabellaria alveolata (detail below)	
Macroalgae (detail below)	
Anthropgenic feature (detail below)	
Other (please specify)	

Substrate Type	**% cover (approx.)**
Bedrock	
Boulders (S/L/XL)	
Cobbles	
Pebbles	
Gravel (stone/shell)	
Sand	
Mud	
Biogenic (specify below)	
Artificial (specify below)	
Peat	

5) MNCR Biotope code / notes (e.g. variant)

6) Major taxa present (Please note species below with SACFOR abundance)

7) Additional notes (rock type, anthropogenic features etc.)

Appendix II: MNCR SACFOR abundance scale.

The MNCR cover/density scales adopted from 1990 onwards (see Hiscock, 1996) provide a unified system for recording the abundance of marine benthic taxa in intertidal and subtidal marine surveys. The scales are given below.

MNCR SACFOR abundance scales

S = Superabundant, A = Abundant, C = Common, F = Frequent, O = Occasional, R = Rare

GROWTH FORM			SIZE OF INDIVIDUALS / COLONIES				
% COVER	CRUST / MEADOW	MASSIVE / TURF	<1 cm	1-3 cm	3-15 cm	>15 cm	DENSITY
>80%	S		S				>1 / 0.0001 m^2 (1x1 cm) >10,000/ m^2
40-79%	A	S	A	S			1-9 / 0.001 m^2 (3.16x3.16 cm) 1000-9999 / m^2
20-39%	C	A	C	A	S		1-9 / 0.01 m^2 (10x10 cm) 100-999 / m^2
10-19%	F	C	F	C	A	S	1-9 / 0.1 m^2 10-99 / m^2
5-9%	O	F	O	F	C	A	1-9 / m^2
1-5% or density	R	O	R	O	F	C	1-9 / 10 m^2 (3.16x3.16 m)
<1% or density		R		R	O	F	1-9 / 100 m^2 (10x10 m)
					R	O	1-9 / 1000 m^2 (31.6x31.6 m)
						R	>1 / 10,000 m^2 (100x100 m) <1 / 1000 m^2

PORIFERA	Crusts *Halichondria*	Massive spp. *Pachymatisma*		Small solitary *Grantia*	Large solitary *Stelligera*	
HYDROZOA		Turf species *Tubularia Abietinaria*		Small clumps *Sarzia Aglaophenia*	Solitary *Corymorpha Nemertesia*	
ANTHOZOA	*Corynactis*	*Alcyonium*		Small solitary *Epizoanthus Caryophyllia*	Med. Solitary *Virgularia Cerianthus Urticina*	Large solitary *Eunicella Funiculina Pachycerianthus*
ANNELIDA	*Sabellaria spinulosa*	*Sabellaria alveolata*	*Spirorbis*	Scale worms *Nephtys Pomatoceros*	*Chaetopterus Arenicola Sabella*	
CRUSTACEA	Barnacles Tubiculous amphipods		*Semibalanus* Amphipods	*B. balanus Anapagurus Pisidia*	*Pagurus Galathea* Small crabs	*Homarus Nephrops Hyas araneus*
MOLLUSCA	*Mytilus Modiolus*		Small gastropod *L. neritoides* Small bivalves *Nucula*	Chitons Med. gastropod *L. littorea Patella* Med. bivalves *Mytilus Pododesmus*	Large gastropod *Buccinum* Lge bivalves *Mya, Pecten Arctica*	
BRACHIOPODA				*Neocrania*		
BRYOZOA	Crusts	*Pentapora Bugula Flustra*			*Alcyonidium Porella*	
ECHINO-DERMATA				*Echinocyamus Ocnus*	*Antedon* Small starfish Brittlestars *Echinocardium Asilia, Thyone*	Large starfish *Echinus Holothuria*
ASCIDIACEA	Colonial *Dendrodoa*			Small solitary *Dendrodoa*	Large solitary *Ascidia, Ciona*	*Diazona*
PISCES					Gobies Blennies	Dog fish Wrasse
PLANTS	Crusts, Maerl *Audouinella* Fucoids, Kelp *Desmarestia*	Foliose Filamentous			*Zostera*	Kelp *Halidrys Chorda Himanthalia*

Examples of groups or species for each category

Appendix III: Transect and habitat photographs taken during the Phase I intertidal survey conducted as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

Field photographs captured on the centre line at each intertidal belt transect in the upper shore. Photographs were taken up-shore, down-shore and along-shore in both directions and have been displayed in this order. Note that, due to the timing of the survey relative to the spring tide, the low shore was not always visible, however the label 'low shore' has been retained for simplicity.

Plate 1a. Scapa Deep Water Quay intertidal survey Transect 1 (SB_1), upper shore.

Plate 1b. Scapa Deep Water Quay intertidal survey Transect 1 (SB_1), mid and lower shore.

Plate 1c. Scapa Deep Water Quay intertidal survey Transect 1 (SB_1), view north from upper shore.

Plate 1d. Scapa Deep Water Quay intertidal survey Transect 1 (SB_1), view south from the upper shore.

Plate 2a. Scapa Deep Water Quay intertidal survey Transect 2 (SB_2), upper shore.

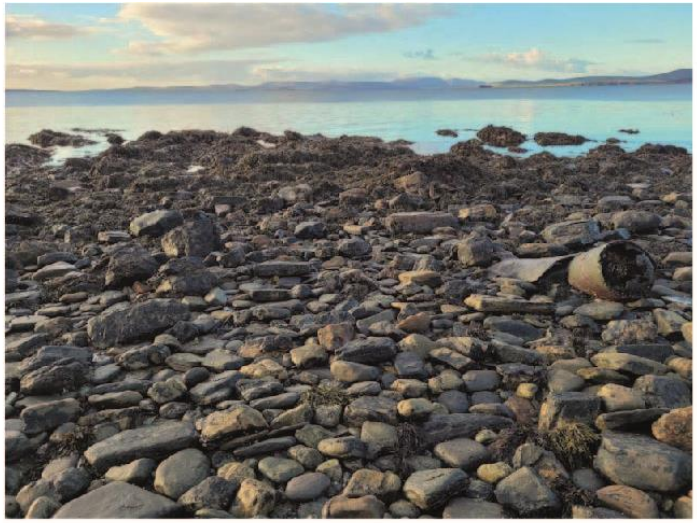

Plate 2b. Scapa Deep Water Quay intertidal survey Transect 2 (SB_2), mid and lower shore.

Plate 2c. Scapa Deep Water Quay intertidal survey Transect 2 (SB_2), view north from upper shore.

Plate 2d. Scapa Deep Water Quay intertidal survey Transect 2 (SB_2), view south from the upper shore.

Plate 3a. Scapa Deep Water Quay intertidal survey Transect 3 (SB_3), mid and upper shore.

Plate 3b. Scapa Deep Water Quay intertidal survey Transect 3 (SB_3), lower shore.

Plate 3c. Scapa Deep Water Quay intertidal survey Transect 3 (SB_3), view north from mid shore.

Plate 3d. Scapa Deep Water Quay intertidal survey Transect 3 (SB_3), view south from the upper shore.

Plate 4a. Scapa Deep Water Quay intertidal survey Transect 4 (SB_4), upper shore.

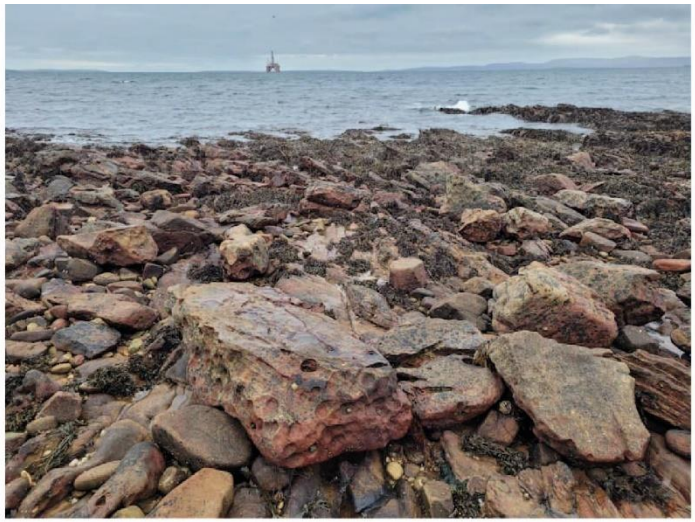

Plate 4b. Scapa Deep Water Quay intertidal survey Transect 4 (SB_4), mid and lower shore.

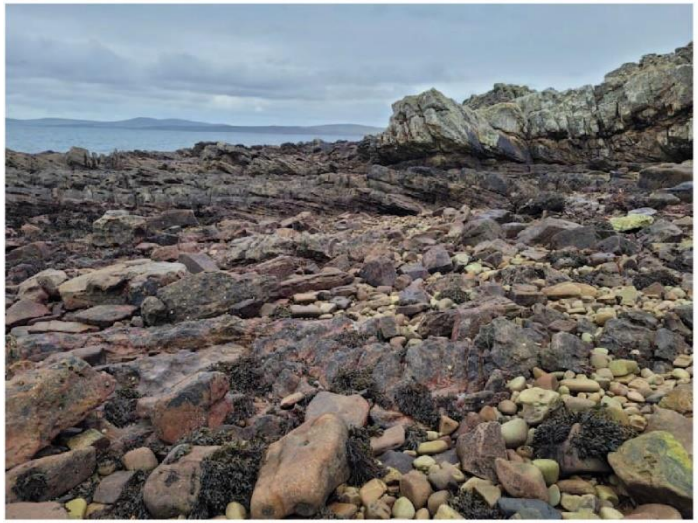

Plate 4c. Scapa Deep Water Quay intertidal survey Transect 4 (SB_4), view north from upper shore.

Plate 4d. Scapa Deep Water Quay intertidal survey Transect 4 (SB_4), view south from the upper shore.

Appendix IV: Phase I intertidal survey logs for work conducted as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

All positions represent the lower boundary of the habitat as recorded on the central transect line and are given in WGS84 latitude and longitude (DD MM.MMMM; negative longitudes are west).

Transect No.	Habitat No.	Shore Position	Date	Time (BST)	Latitude	Longitude	Habitat width (m)	Habitat Description	MNCR Biotope Code
SB_1	1	High	04/12/2022	12:58	58 55.3523	-002 57.2114	8	Barren shingle.	LS.LCS.Sh.BarSh
SB_1	2	High	04/12/2022	13:01	58 55.3497	-002 57.2222	11	Barren shingle with sparse Gammaridae under cobbles.	LS.LCS.Sh.BarSh
SB_1	3	Mid	04/12/2022	13:08	58 55.3482	-002 57.2241	4	Dense *Fucus spiralis* on exposed bedrock.	LR.LLR.F.Fspi.FS
SB_1	4	Low	04/12/2022	13:16	[Not recorded - habitat width narrower than GPS error]		1	Dense *Fucus vesiculosus* on bedrock with *Osmundea pinnatifida*.	LR.LLR.F.Fves.FS
SB_1	5	Low	04/12/2022	13:22	58 55.3368	-002 57.2465	16	Mosaic of *Semibalanus balanoides* and *Fucus vesiculosus* on bedrock with *Fucus serratus* in gullies.	LR.MLR.BF.FvesB
SB_2	1	Strandline	04/12/2022	11:15	58 55.1976	-002 57.0979	0	Near-vertical cliff face with moss and lichens, freshwater input with associated brown algal biofilm.	LS.LSa.St
SB_2	2	High	04/12/2022	11:20	58 55.1962	-002 57.0995	4	Bedrock with *Verrucaria maura* with barren shingle.	LR.FLR.Lic.Ver.Ver
SB_2	3	High	04/12/2022	11:30	58 55.1968	-002 57.1047	6	*Pelvetia canaliculata* and *Fucus spiralis* on bedrock with cobbles and pebbles.	LR.LLR.F.Pel
SB_2	4	Mid	04/12/2022	11:45	58 55.1964	-002 57.1083	5	*Fucus spiralis* on bedrock with cobbles and pebbles.	LR.LLR.F.Fspi.FS

Transect No.	Habitat No.	Shore Position	Date	Time (BST)	Latitude	Longitude	Habitat width (m)	Habitat Description	MNCR Biotope Code
SB_2	5	Mid	04/12/2022	11:58	58 55.1953	-002 57.1134	7	*Fucus vesiculosus* and *Ascophyllum nodosum* on cobbles and boulders with coarse sediment infill.	LR.LLR.F.Fves.X
SB_2	6	Low	04/12/2022	12:12	58 55.1906	-002 57.1271	15	*Fucus vesiculosus* on cobbles and boulders.	LR.LLR.F.Fves.X
SB_2	7	Low	04/12/2022	12:25	58 55.1899	-002 57.1314	5	*Fucus serratus* and red seaweeds on bedrock with occasional cobbles and sand infill.	LR.MLR.BF.Fser.R
SB_3	1	Strandline	03/12/2022	12:45	58 55.1124	-002 57.0463	4	Barren shingle.	LS.LCS.Sh.BarSh
SB_3	2	High	03/12/2022	12:38	58 55.1123	-002 57.0546	9	Mixed coarse sediment with talitridae and gammaridae between/beneath larger cobbles and boulders.	LS.LSa.St.Tal
SB_3	3	Mid	03/12/2022	12:26	58 55.1123	-002 57.0599	5	*Fucus spiralis* on cobbles and small boulders with *Pelvetia canaliculata* and *Melarhaphe neritoides*.	LR.LLR.F.Fspi.X
SB_3	4	Mid	03/12/2022	12:11	58 55.1124	-002 57.0674	7	*Ascophyllum nodosum* on cobbles and small boulders with *Patella vulgata*.	LR.LLR.F.Asc.X
SB_3	5	Mid	03/12/2022	11:57	58 55.1122	-002 57.0761	7	*Fucus vesiculosus* on cobbles and boulders overlying bedrock .	LR.LLR.F.Fves.X
SB_3	6	Low	03/12/2022	11:42	58 55.1122	-002 57.0885	10	*Fucus vesiculosus* on bedrock and boulders with *Osmundea pinnatifida*.	LR.LLR.F.Fves.FS
SB_4	1	Strandline	03/12/2022	10:31	58 55.0468	-002 57.0711	0	Bedrock cliffs with lichen.	LS.LSa.St

Transect No.	Habitat No.	Shore Position	Date	Time (BST)	Latitude	Longitude	Habitat width (m)	Habitat Description	MNCR Biotope Code
SB_4	2	High	03/12/2022	10:39	58 55.0465	-002 57.0735	4	Bare cobbles overlying gravel with periwinkles.	LS.LCS.Sh.BarSh
SB_4	3	Mid	03/12/2022	10:50	58 55.0440	-002 57.0801	7	*Fucus vesiculosus* and *Fucus spiralis* on boulders and bedrock with *Patella vulgata* and *Littorina* spp..	LR.LLR.F
SB_4	4	Low	03/12/2022	10:58	58 55.0414	-002 57.0871	6	*Fucus vesiculosus* on bedrock and occasional boulders with *Osmundea pinnatifida* and *Nucella lapillus*.	LR.LLR.F.Fves.FS
SB_4	5	Low	03/12/2022	11:10	58 55.0361	-002 57.1011	17	*Fucus serratus* and red seaweeds on bedrock with occasional boulders.	LR.MLR.BF.Fser.R

Appendix V: Species lists for each habitat at each intertidal transect surveyed as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

Transect no.	SB_1	SB_1	SB_1	SB_1
Habitat no.	1	2	3	4
Shore position	High	High	Mid	Low

Taxon	Qualifier	SACFOR class				
Biofilm	brown	massive/turf				
Biofilm	green	massive/turf				
Plantago	sp.	crust/meadow	R			
Hydropunctaria maura		crust/meadow			O	R
Ochrolechia parella		crust/meadow	R		R	
Caloplaca	sp.	crust/meadow	R			
Ramalina siliquosa		crust/meadow	R			
Actinia equina		1 - 3 cm				F
Spirorbinae		crust/meadow				
Chthamalus	sp.	crust/meadow				
Semibalanus balanoides		crust/meadow			R	
Talitridae		<1 cm				
Gammaridae		<1 cm		O	O	
Ligia	sp.	<1 cm				
Paguridae		3 - 15 cm				
Carcinus	sp.	3 - 15 cm				
Carcinus maenas		3 - 15 cm			P	
Steromphala cineraria		1 - 3 cm				
Steromphala umbilicalis		1 - 3 cm				P
Patella vulgata		3 - 15 cm			C	C
Littorina littorea		1 - 3 cm			C	R
Littorina obtusata		1 - 3 cm			O	C
Littorina saxatilis		1 - 3 cm			F	
Melarhaphe neritoides		<1 cm		R		
Nucella lapillus		1 - 3 cm				O
Rhodophyta	dark red crusts	crust/meadow			O	R
Rhodophyta	rust red crusts	crust/meadow				
Rhodophyta	filamentous red	massive/turf				R
Corallinaceae		crust/meadow			R	O
Corallina officinalis		massive/turf				R
Chondrus crispus		massive/turf				
Mastocarpus stellatus		massive/turf				
Osmundea pinnatifida		massive/turf				S
Laminaria digitata		crust/meadow				
Fucales	sporelings	crust/meadow				
Halidrys siliquosa		crust/meadow				
Ascophyllum nodosum		crust/meadow				
Fucus spiralis		crust/meadow			A	
Fucus vesiculosus		crust/meadow				S
Pelvetia canaliculata		crust/meadow			R	
Fucus serratus		crust/meadow				R
Ulva	spp. indet	massive/turf				
Cladophora	sp.	massive/turf			R	

Transect no.	SB_1	SB_2	SB_2	SB_2
Habitat no.	5	1	2	3
Shore position	Low	Strandline	High	High

Taxon	Qualifier	SACFOR class				
Biofilm	brown	massive/turf		R	R	
Biofilm	green	massive/turf				O
Plantago	sp.	crust/meadow		C		
Hydropunctaria maura		crust/meadow	R	C	C	C
Ochrolechia parella		crust/meadow		R	O	R
Caloplaca	sp.	crust/meadow		O	O	
Ramalina siliquosa		crust/meadow				
Actinia equina		1 - 3 cm	O			
Spirorbinae		crust/meadow	R			
Chthamalus	sp.	crust/meadow				
Semibalanus balanoides		crust/meadow	F			R
Talitridae		<1 cm			A	
Gammaridae		<1 cm				O
Ligia	sp.	<1 cm			F	
Paguridae		3 - 15 cm	R			
Carcinus	sp.	3 - 15 cm				
Carcinus maenas		3 - 15 cm				
Steromphala cineraria		1 - 3 cm				
Steromphala umbilicalis		1 - 3 cm	R			
Patella vulgata		3 - 15 cm	A		R	R
Littorina littorea		1 - 3 cm	R			O
Littorina obtusata		1 - 3 cm	C		R	
Littorina saxatilis		1 - 3 cm			O	A
Melarhaphe neritoides		<1 cm				C
Nucella lapillus		1 - 3 cm	C			
Rhodophyta	dark red crusts	crust/meadow	R			R
Rhodophyta	rust red crusts	crust/meadow				
Rhodophyta	filamentous red	massive/turf	R			
Corallinaceae		crust/meadow	O			
Corallina officinalis		massive/turf				
Chondrus crispus		massive/turf				
Mastocarpus stellatus		massive/turf				
Osmundea pinnatifida		massive/turf	C			
Laminaria digitata		crust/meadow				
Fucales	sporelings	crust/meadow				R
Halidrys siliquosa		crust/meadow	R			
Ascophyllum nodosum		crust/meadow	R			
Fucus spiralis		crust/meadow				A
Fucus vesiculosus		crust/meadow	A			
Pelvetia canaliculata		crust/meadow				S
Fucus serratus		crust/meadow	A			
Ulva	spp. indet	massive/turf			O	
Cladophora	sp.	massive/turf				

Transect no.	SB_2	SB_2	SB_2	SB_2
Habitat no.	4	5	6	7
Shore position	Mid	Mid	Low	Low

Taxon	Qualifier	SACFOR class				
Biofilm	brown	massive/turf				
Biofilm	green	massive/turf				
Plantago	sp.	crust/meadow				
Hydropunctaria maura		crust/meadow	O	C	F	O
Ochrolechia parella		crust/meadow				
Caloplaca	sp.	crust/meadow				
Ramalina siliquosa		crust/meadow				
Actinia equina		1 - 3 cm	F	C	F	O
Spirorbinae		crust/meadow			O	R
Chthamalus	sp.	crust/meadow	R			
Semibalanus balanoides		crust/meadow	R	O	R	R
Talitridae		<1 cm				
Gammaridae		<1 cm	O	O		
Ligia	sp.	<1 cm				
Paguridae		3 - 15 cm			O	
Carcinus	sp.	3 - 15 cm				
Carcinus maenas		3 - 15 cm			R	
Steromphala cineraria		1 - 3 cm				R
Steromphala umbilicalis		1 - 3 cm			R	R
Patella vulgata		3 - 15 cm	F	O	A	C
Littorina littorea		1 - 3 cm	C	C	A	C
Littorina obtusata		1 - 3 cm		R		R
Littorina saxatilis		1 - 3 cm	A	F		
Melarhaphe neritoides		<1 cm				
Nucella lapillus		1 - 3 cm	R	F	C	F
Rhodophyta	dark red crusts	crust/meadow				
Rhodophyta	rust red crusts	crust/meadow				
Rhodophyta	filamentous red	massive/turf	R		O	
Corallinaceae		crust/meadow	R	O	F	F
Corallina officinalis		massive/turf				O
Chondrus crispus		massive/turf				O
Mastocarpus stellatus		massive/turf				
Osmundea pinnatifida		massive/turf			A	S
Laminaria digitata		crust/meadow				
Fucales	sporelings	crust/meadow	R			
Halidrys siliquosa		crust/meadow				
Ascophyllum nodosum		crust/meadow	C	O		
Fucus spiralis		crust/meadow	A			
Fucus vesiculosus		crust/meadow		C	S	C
Pelvetia canaliculata		crust/meadow	O			
Fucus serratus		crust/meadow			O	A
Ulva	spp. indet	massive/turf				
Cladophora	sp.	massive/turf	O			

Transect no.	SB_3	SB_3	SB_3	SB_3
Habitat no.	1	2	3	4
Shore position	Strandline	High	Mid	Mid

Taxon	Qualifier	SACFOR class				
Biofilm	brown	massive/turf				
Biofilm	green	massive/turf		C	O	
Plantago	sp.	crust/meadow				
Hydropunctaria maura		crust/meadow			F	R
Ochrolechia parella		crust/meadow		O		
Caloplaca	sp.	crust/meadow				
Ramalina siliquosa		crust/meadow				
Actinia equina		1 - 3 cm			R	F
Spirorbinae		crust/meadow				
Chthamalus	sp.	crust/meadow			R	R
Semibalanus balanoides		crust/meadow			R	R
Talitridae		<1 cm		A		
Gammaridae		<1 cm			F	O
Ligia	sp.	<1 cm				
Paguridae		3 - 15 cm				R
Carcinus	sp.	3 - 15 cm				
Carcinus maenas		3 - 15 cm		O	O	O
Steromphala cineraria		1 - 3 cm				
Steromphala umbilicalis		1 - 3 cm				
Patella vulgata		3 - 15 cm			O	A
Littorina littorea		1 - 3 cm			R	C
Littorina obtusata		1 - 3 cm				O
Littorina saxatilis		1 - 3 cm		O	C	O
Melarhaphe neritoides		<1 cm			A	O
Nucella lapillus		1 - 3 cm				
Rhodophyta	dark red crusts	crust/meadow				
Rhodophyta	rust red crusts	crust/meadow			R	
Rhodophyta	filamentous red	massive/turf				
Corallinaceae		crust/meadow				R
Corallina officinalis		massive/turf				
Chondrus crispus		massive/turf				
Mastocarpus stellatus		massive/turf				
Osmundea pinnatifida		massive/turf				
Laminaria digitata		crust/meadow				
Fucales	sporelings	crust/meadow			R	R
Halidrys siliquosa		crust/meadow				
Ascophyllum nodosum		crust/meadow			O	S
Fucus spiralis		crust/meadow			A	O
Fucus vesiculosus		crust/meadow				C
Pelvetia canaliculata		crust/meadow		R	F	
Fucus serratus		crust/meadow				
Ulva	spp. indet	massive/turf				
Cladophora	sp.	massive/turf				O

Transect no.	SB_3	SB_3	SB_4	SB_4
Habitat no.	5	6	1	2
Shore position	Mid	Low	Strandline	High

Taxon	Qualifier	SACFOR class				
Biofilm	brown	massive/turf				
Biofilm	green	massive/turf				
Plantago	sp.	crust/meadow				
Hydropunctaria maura		crust/meadow	R	R	C	O
Ochrolechia parella		crust/meadow				
Caloplaca	sp.	crust/meadow			F	
Ramalina siliquosa		crust/meadow			F	
Actinia equina		1 - 3 cm	O	F		
Spirorbinae		crust/meadow		R		
Chthamalus	sp.	crust/meadow	R			
Semibalanus balanoides		crust/meadow	R	R		
Talitridae		<1 cm				
Gammaridae		<1 cm	C	A		
Ligia	sp.	<1 cm				
Paguridae		3 - 15 cm		R		
Carcinus	sp.	3 - 15 cm	O			
Carcinus maenas		3 - 15 cm	F	F		R
Steromphala cineraria		1 - 3 cm		R		
Steromphala umbilicalis		1 - 3 cm				
Patella vulgata		3 - 15 cm	C	C		R
Littorina littorea		1 - 3 cm	A	S		O
Littorina obtusata		1 - 3 cm	O	O		
Littorina saxatilis		1 - 3 cm	O	R		C
Melarhaphe neritoides		<1 cm				F
Nucella lapillus		1 - 3 cm	F	F		
Rhodophyta	dark red crusts	crust/meadow				
Rhodophyta	rust red crusts	crust/meadow				
Rhodophyta	filamentous red	massive/turf				
Corallinaceae		crust/meadow	R	F		
Corallina officinalis		massive/turf				
Chondrus crispus		massive/turf		R		
Mastocarpus stellatus		massive/turf	O			
Osmundea pinnatifida		massive/turf	F	C		
Laminaria digitata		crust/meadow				
Fucales	sporelings	crust/meadow			R	
Halidrys siliquosa		crust/meadow				
Ascophyllum nodosum		crust/meadow	O			
Fucus spiralis		crust/meadow				R
Fucus vesiculosus		crust/meadow	A	A		
Pelvetia canaliculata		crust/meadow			R	
Fucus serratus		crust/meadow		O		
Ulva	spp. indet	massive/turf				
Cladophora	sp.	massive/turf	O			

Transect no.	SB_4	SB_4	SB_4
Habitat no.	3	4	5
Shore position	Mid	Low	Low

Taxon	Qualifier	SACFOR class			
Biofilm	brown	massive/turf			
Biofilm	green	massive/turf			
Plantago	sp.	crust/meadow			
Hydropunctaria maura		crust/meadow		F	R
Ochrolechia parella		crust/meadow			
Caloplaca	sp.	crust/meadow			
Ramalina siliquosa		crust/meadow			
Actinia equina		1 - 3 cm	F	F	C
Spirorbinae		crust/meadow			R
Chthamalus	sp.	crust/meadow			
Semibalanus balanoides		crust/meadow	R	R	
Talitridae		<1 cm			
Gammaridae		<1 cm	C	F	
Ligia	sp.	<1 cm			
Paguridae		3 - 15 cm			
Carcinus	sp.	3 - 15 cm			
Carcinus maenas		3 - 15 cm	R		
Steromphala cineraria		1 - 3 cm			R
Steromphala umbilicalis		1 - 3 cm			
Patella vulgata		3 - 15 cm	C	C	A
Littorina littorea		1 - 3 cm	F	R	O
Littorina obtusata		1 - 3 cm		R	R
Littorina saxatilis		1 - 3 cm	R		
Melarhaphe neritoides		<1 cm			
Nucella lapillus		1 - 3 cm	O	C	C
Rhodophyta	dark red crusts	crust/meadow	R		
Rhodophyta	rust red crusts	crust/meadow			
Rhodophyta	filamentous red	massive/turf			R
Corallinaceae		crust/meadow	R	F	R
Corallina officinalis		massive/turf		F	F
Chondrus crispus		massive/turf			O
Mastocarpus stellatus		massive/turf			
Osmundea pinnatifida		massive/turf		A	C
Laminaria digitata		crust/meadow			R
Fucales	sporelings	crust/meadow			
Halidrys siliquosa		crust/meadow			
Ascophyllum nodosum		crust/meadow			
Fucus spiralis		crust/meadow	C		
Fucus vesiculosus		crust/meadow	C	A	O
Pelvetia canaliculata		crust/meadow	R		
Fucus serratus		crust/meadow			A
Ulva	spp. indet	massive/turf			
Cladophora	sp.	massive/turf	R	R	O

Appendix VI: Glossary of biotopes assigned to habitats and samples assessed as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

Biotope code	Biotope name
LR.MLR.BF.FvesB	*Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock
LR.MLR.BF.Fser.R	*Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock
LR.LLR.F	Fucoids on sheltered marine shores
LR.LLR.F.Pel	*Pelvetia canaliculata* on sheltered littoral fringe rock
LR.LLR.F.Fspi.FS	*Fucus spiralis* on full salinity sheltered upper eulittoral rock
LR.LLR.F.Fspi.X	*Fucus spiralis* on full salinity upper eulittoral mixed substrata
LR.LLR.F.Fves.FS	*Fucus vesiculosus* on full salinity moderately exposed to sheltered mid eulittoral rock
LR.LLR.F.Fves.X	*Fucus vesiculosus* on mid eulittoral mixed substrata
LR.LLR.F.Asc.X	*Ascophyllum nodosum* on full salinity mid eulittoral mixed substrata
LR.LLR.F.Fserr.FS	*Fucus serratus* on full salinity sheltered lower eulittoral rock
LR.FLR.Lic.Ver.Ver	*Verrucaria maura* on very exposed to very sheltered upper littoral fringe rock
LS.LCS.Sh.BarSh	Barren littoral shingle
LS.LSa.St	Strandline
LS.LSa.St.Tal	Talitrids on the upper shore and strand-line
IR.LIR	Low energy infralittoral rock
IR.LIR.K.LhypSlat.Gz	Grazed, mixed *Laminaria hyperborea* and *Saccharina latissima* on sheltered infralittoral rock
IR.LIR.K.Slat.Gz	Grazed *Saccharina latissima* with *Echinus*, brittlestars and coralline crusts on sheltered infralittoral rock
SS.SCS.ICS	Infralittoral coarse sediment
SS.SMx.IMx	Infralittoral mixed sediment
SS.SMx.CMx.KurThyMx	*Kurtiella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment
SS.SMp.KSwSS.SlatR	*Saccharina latissima* and red seaweeds on infralittoral sediments
SS.SMp.KSwSS.Pcri	Loose-lying mats of *Phyllophora crispa* on infralittoral muddy sediment

Appendix VII: Underwater imagery logs for the drop-down camera survey conducted as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

Positions are given in OSGB36 Easting and Northing (m).

Sample no.	Transect No.	Date	Start time (UTC)	Start of line position		End time (UTC)	End of line position		Video duration	No. stills
				Easting	Northing		Easting	Northing		
568#01	SBC1	7th Dec 2022	09:39:39	345226.74	1003322.33	10:12:34	345046.27	1004028.27	00:32:55	37
568#02	SBC2	7th Dec 2022	10:32:20	344893.67	1004223.21	10:52:55	344691.38	1004731.78	00:20:35	20
568#03	SBC3	7th Dec 2022	11:09:59	344919.43	1003399.63	11:58:20	344535.99	1004321.61	00:48:21	40
568#04	SBC4	7th Dec 2022	12:14:08	345282.55	1003292.35	12:32:01	345234.37	1003621.48	00:17:53	15
568#05	SBC5	7th Dec 2022	12:42:55	345078.48	1003987.73	12:55:07	345005.48	1004260.52	00:12:12	10
568#06	SBC6	7th Dec 2022	13:13:50	344799.42	1003133.61	13:41:05	344525.28	1003620.77	00:27:15	25
568#07	SBC7	7th Dec 2022	13:54:50	344389.09	1004002.48	14:12:04	344235.43	1004395.70	00:17:14	15
568#08	SBC8	7th Dec 2022	14:28:26	344362.91	1003365.17	15:01:56	344037.55	1004228.51	00:33:30	30

Appendix VIII: Summary of the results of the analysis of underwater imagery captured during the drop-down camera survey conducted as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

NB. Video segments with zero visibility have not been included.

Transect no.	Section no.	Habitat description	MNCR biotope code(s) assigned	PMF(s) present	Annex I habitats present
SBC1	S1	Coralline crusts on cobbles and boulders overlying gravel.	IR.LIR SS.SCS.ICS		Reefs
SBC1	S2	Coralline crusts and *Echinus esculentus* on bedrock outcrop with vertical face.	IR.LIR		Reefs
SBC1	S3	Pebbles, cobbles and boulders overlying gravel.	IR.LIR SS.SCS.ICS		Reefs
SBC1	S4	Shelly mixed sediment with loose-lying mats of red seaweed.	SS.SMp.KSwSS.Pcri	Kelp and seaweed communities on sublittoral sediment	
SBC2	S1	*Saccharina latissima* and loose-lying mats of red seaweeds on shelly mixed sediment.	SS.SMp.KSwSS.SlatR SS.SMp.KSwSS.Pcri	Kelp and seaweed communities on sublittoral sediment	
SBC2	S2	Loose-lying mats of red seaweed on gravelly mixed sediment with sparse *Saccharina latissima*.	SS.SMp.KSwSS.Pcri	Kelp and seaweed communities on sublittoral sediment	
SBC3	S1	Loose-lying mats of red seaweed on mixed sediment.	SS.SMp.KSwSS.Pcri SS.SMx.IMx	Kelp and seaweed communities on sublittoral sediment	
SBC3	S3	Patchy loose-lying mats of red seaweed on sandy mixed sediment with simple burrows.	SS.SMp.KSwSS.Pcri SS.SMx.IMx	Kelp and seaweed communities on sublittoral sediment	
SBC3	S4	Sandy mixed sediment with sparse biota.	SS.SMx.IMx		
SBC4	S1	Coralline crusts on cobbles and boulders overlying gravel.	IR.LIR SS.SCS.ICS		Reefs
SBC4	S2	Coralline crusts on stepped bedrock with gravel infill.	IR.LIR		Reefs
SBC4	S3	Patchy loose-lying mats of red seaweed on shelly mixed sediment with small quantities of maerl.	SS.SMp.KSwSS.Pcri	Kelp and seaweed communities on sublittoral sediment	
SBC4	S4	Sparse biota on stepped bedrock with gravel infill.	IR.LIR SS.SCS.ICS SS.SMp.KSwSS.Pcri		Reefs
SBC4	S5	Patchy loose-lying mats of red seaweed on shelly mixed sediment with small quantities of maerl.	SS.SMp.KSwSS.Pcri	Kelp and seaweed communities on sublittoral sediment	

Transect no.	Section no.	Habitat description	MNCR biotope code(s) assigned	PMF(s) present	Annex I habitats present
SBC4	S6	Coralline crusts on pebbles, cobbles and boulders with sand and gravel infill.	IR.LIR SS.SCS.ICS		Reefs
SBC4	S7	Coralline crusts on stepped bedrock with sparse kelps.	IR.LIR.K.Slat.Gz		Reefs
SBC5	S1	Sparse red seaweeds on shelly mixed sediment.	SS.SMx.IMx		
SBC5	S2	Coralline crusts on pebbles, cobbles and boulders with *Echinus esculentus*.	IR.LIR SS.SCS.ICS		Reefs
SBC5	S3	Sparse kelps on stepped bedrock with coralline crusts.	IR.LIR.K.LhypSlat.Gz		Reefs
SBC5	S4	Patchy coralline crusts on bedrock, boulders and cobbles with gravel infill.	IR.LIR		Reefs
SBC5	S5	Sand and gravel with occasional bedrock outcrops.	SS.SCS.ICS		
SBC5	S6	Shelly mixed sediment with sparse red seaweeds.	SS.SMx.IMx		
SBC6	S1	Patchy loose-lying mats of red seaweed on gravelly mixed sediment with burrows.	SS.SMp.KSwSS.Pcri SS.SMx.IMx	Kelp and seaweed communities on sublittoral sediment	
SBC7	S1	Patchy loose-lying mats of red seaweed on sandy mixed sediment with burrows.	SS.SMp.KSwSS.Pcri SS.SMx.IMx	Kelp and seaweed communities on sublittoral sediment	
SBC8	S1	Loose-lying mats of red seaweed on gravelly mixed sediment with burrows.	SS.SMp.KSwSS.Pcri SS.SMx.IMx	Kelp and seaweed communities on sublittoral sediment	
SBC8	S2	Rock debris overlying mixed sediment.	SS.SCS		
SBC8	S4	Patchy loose-lying mats of red seaweed on gravelly mixed sediment with burrows.	SS.SMp.KSwSS.Pcri SS.SMx.IMx	Kelp and seaweed communities on sublittoral sediment	

Appendix IX: Benthic grab logs for samples collected as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

Positions are given in OSGB36 Easting and Northing (m).

Sample no.	Grab no.	Date	Time (UTC)	Easting	Northing
568#09	SBG1	8th Dec 2022	10:00	344048.89	1004108.33
568#10	SBG2	8th Dec 2022	10:24	344544.43	1003617.64
568#11	SBG3	8th Dec 2022	10:44	344461.88	1003265.39
568#12	SBG4	8th Dec 2022	11:03	344757.72	1003819.71
568#13	SBG5	8th Dec 2022	11:25	344594.51	1004247.62
568#14	SBG6	8th Dec 2022	11:45	344886.79	1004214.84
568#15	SBG7	8th Dec 2022	12:07	345082.34	1003541.48
568#16	SBG8	8th Dec 2022	12:22	344926.76	1003396.67

Appendix X: Results of the particle size analysis of grab samples collected as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

Percentage of sediment retained at each phi interval for each grab sample collected as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

Sieve mesh size	SBG1	SBG2	SBG3	SBG4	SBG5	SBG6	SBG7	SBG8
16 mm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8 mm	0.00	0.10	0.36	0.00	0.00	3.07	0.00	2.54
4 mm	0.88	2.75	1.89	0.07	1.09	7.67	1.82	1.07
2 mm	2.58	6.23	4.17	0.26	2.81	8.69	8.12	5.74
1 mm	4.59	9.36	4.92	1.03	4.21	7.98	10.42	10.88
500 µm	5.14	5.85	5.59	3.79	3.47	3.80	5.37	7.62
250 µm	11.14	12.88	10.77	19.31	14.00	4.07	7.83	10.98
125 µm	23.58	23.85	26.19	42.49	29.55	18.61	27.72	22.63
63 µm	29.73	19.27	24.59	20.16	21.47	23.46	20.19	22.65
< 63 µm	22.35	19.71	21.51	12.89	23.39	22.67	18.52	15.89

Appendix XI: Results of the macrobenthic invertebrate analysis of grab samples collected as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

Taxon	Qualifier	SBG1	SBG2	SBG3	SBG4	SBG5	SBG6	SBG7	SBG8
Lagotia viridis		P	P	P		P	P		
Astrorhiza	indet.	1	1	1	2				1
Porifera		P	P	P	P		P	P	
Cliona	indet.	P		P			P	P	
Sycon ciliatum		1						3	
Campanulariidae				P					
Bougainvilliidae		P		P					
Actiniaria				1		1			
Cerianthus lloydii			2			2		1	3
Edwardsiidae		3	4	4	3	4	3	7	9
Nemertea		7	5	11	9	6	10	6	10
Nematoda		1	5	1	13	6	1	14	28
Platyhelminthes						1	2	1	
Sipuncula	bits							FRAG	
Sipuncula	juvenile							1	3
Golfingia (Golfingia) elongata			4	1		2			2
Golfingia (Golfingia) vulgaris vulgaris		1	1			1	1		
Phascolion (Phascolion) strombus strombus					2				
Thysanocardia procera		1	3	1	2	2	1	1	5
Chaetognatha								1	
Annelida	bits	FRAG	FRAG	FRAG	FRAG	FRAG	FRAG	FRAG	FRAG
Harmothoe	indet.	2	3	1	1	2	3	3	1
Harmothoe extenuata							4	1	
Harmothoe impar								1	
Malmgrenia	indet.		2			1			
Malmgrenia arenicolae			3		1	3	1		
Malmgrenia ljungmani							1	1	
Pholoe baltica			5	3	1	4	2		5
Pholoe inornata		2	4		1		7	10	4
Sigalionidae	juvenile						1		

Taxon	Qualifier	SBG1	SBG2	SBG3	SBG4	SBG5	SBG6	SBG7	SBG8
Sthenelais limicola		2			2	1			
Eteone longa	agg.			1	3		4	4	1
Pseudomystides limbata		1	2	1					1
Eumida	indet.		4	1	2	1	9	4	1
Eumida bahusiensis		1	3		2	3	2	2	1
Eumida sanguinea			4				3	3	
Hesiospina aurantiaca							2	1	
Nereimyra punctata							2		
Oxydromus flexuosus					1	3			
Oxydromus	indet.	1	6	4		2	21	11	9
Podarkeopsis capensis		1	5	1	4	4	4	2	3
Psamathe fusca			1				6	1	1
Syllidia armata		1	2			1	5	6	1
Autolytinae		1							
Eusyllis blomstrandi							1		
Odontosyllis gibba							4		
Syllides benedicti			1						1
Exogoninae	epitoke					1			
Parexogone hebes			5	2	22	6	2	10	5
Exogone naidina		1					2	2	
Sphaerosyllis taylori					1		1		
Scoloplos armiger		6	1	10	11	6	20	24	15
Sphaerodorum gracilis							1		
Glycera	juvenile	3	9	3	2	4	2		2
Glycera alba		1	2	1		5		1	3
Glycera lapidum	agg.						2	3	2
Goniadidae	juvenile	2	2	4	4				
Glycinde nordmanni						3	1	2	3
Goniada maculata		4			2	4	1		5
Eunereis longissima						2	1		

Taxon	Qualifier	SBG1	SBG2	SBG3	SBG4	SBG5	SBG6	SBG7	SBG8
Platynereis	indet.	6	1			1	5	13	
Nephtys	juvenile	20	30	29	11	13	14	14	23
Nephtys hombergii		1			5		1		
Nephtys kersivalensis		1	4	3			2	7	3
Magelona alleni		8	7	16	19	13		2	5
Magelona filiformis		1	3	1	1	5		2	1
Poecilochaetus serpens			1	1	3	5			
Protodorvillea kefersteini								1	
Ophryotrocha	indet.				7	3	1		
Notocirrus scoticus			1						
Lumbrineris	nr. cingulata	94	121	94	61	108	68	32	108
Paradoneis lyra					17	4	5	11	
Aurospio banyulensis		11	11	3	10	6	4	6	16
Spio decorata					2			1	1
Spio symphyta					6			1	6
Prionospio cirrifera		1				1		4	5
Prionospio fallax		11	3		311	39		2	19
Spiophanes bombyx			1		1				
Spiophanes kroyeri		1					1	2	
Dipolydora flava		6	16	9	9	10	1	13	7
Pseudopolydora paucibranchiata		7	8	8	12	18	10	15	29
Pseudopolydora pulchra						2		2	
Chaetozone setosa		1	2	2	9	11	1	1	
Chaetozone zetlandica		1	5	1					
Cirratulus	juvenile							1	
Cirratulus cirratus					1				
Tharyx killariensis			1	3	1	1		1	1
Ophelina acuminata				1			1		
Polyophthalmus pictus								2	
Diplocirrus glaucus		1	4	5	9	3		4	1

Taxon	Qualifier	SBG1	SBG2	SBG3	SBG4	SBG5	SBG6	SBG7	SBG8
Scalibregma celticum			16	6		3	9	5	21
Scalibregma inflatum			16	2		10	1	2	10
Notomastus	indet.	2	42	8	2	43	7	2	15
Mediomastus fragilis		3	6	8		32	6	10	15
Leiochone	indet.	6					1		
Praxillella affinis		2		1	1		6		
Euclymene oerstedii		6	4	11	4	5	5	1	7
Euclymene lombricoides				1					
Micromaldane ornithochaeta								1	
Galathowenia oculata				7					
Owenia	indet.	8	3	9	4	6	2		2
Amphictene auricoma		3		1		3	9	3	6
Ampharetidae	juvenile	2		2	3	3	1		1
Ampharete lindstroemi		4	1		2	2	3	4	4
Amphicteis gunneri		4	6	10	4	19		5	14
Anobothrus gracilis		10	3	5	6	12	12	6	20
Terebellidae	indet.	1	1		1		1		
Pista	juvenile			1			1	2	2
Pista mediterranea							2	1	
Amphitritides gracilis			1			2			
Polycirrini		4	4		6	4	1	3	2
Polycirrus plumosus						1			
Streblosoma intestinale				1		1			
Terebellides	indet.	2	1	1		2	1	2	2
Trichobranchus roseus		3	4	1	1	5		1	
Serpulidae	indet.						1	3	
Hydroides norvegica							1		
Spirobranchus lamarcki						1	4	16	
Sabellidae	indet.				1			2	
Euchone rubrocincta		1	1	6	3	2	7	11	4

Taxon	Qualifier	SBG1	SBG2	SBG3	SBG4	SBG5	SBG6	SBG7	SBG8
Jasmineira caudata		12	7	8	4	9	4	6	7
Anoplodactylus petiolatus						1			
Sessilia	juvenile	1							
Balanus balanus				1					
Verruca stroemia		36		23		1	1		
Copepoda					4	2	3	8	3
Myodocopida		2	18	1			25	18	2
Podocopida								1	
Phtisica marina		3	3		1	2	3	3	
Lysianassa plumosa							3	5	
Socarnes erythrophthalmus							1		
Acidostoma obesum			2		1				1
Apolochus neapolitanus									1
Gitana sarsi									1
Metaphoxus fultoni				1			5	13	4
Westwoodilla caecula				2		4			
Leucothoe lilljeborgi				1	2	1			
Ampelisca	juvenile	7	13	54	24	44	4	11	77
Ampelisca diadema					2				
Ampelisca provincialis		10	5	22	5	7	19	12	32
Aoridae	female	1					3	3	
Microdeutopus anomalus							1		
Othomaera othonis							1		
Cheirocratus	female	1	1			4	4	7	4
Cheirocratus intermedius								2	1
Gammaropsis maculata			1		1	1		1	
Photis longicaudata		3							12
Megamphopus cornutus					2				5
Corophiidae	sp. indet		1			1	6	5	1
Monocorophium sextonae							7	1	

Taxon	Qualifier	SBG1	SBG2	SBG3	SBG4	SBG5	SBG6	SBG7	SBG8
Leptocheirus pectinatus								1	
Dexamine spinosa							1	2	
Nototropis vedlomensis									1
Eurydice pulchra									1
Pseudoparatanais batei							4	3	1
Tanaissus danica		2	15	3	36	24	6	24	20
Iphinoe trispinosa						1			
Eudorella truncatula				9			2	7	3
Paguridae	juvenile	2	1	1		1			
Pagurus cuanensis						2			
Axiidea	juvenile								1
Galathea intermedia		2					12	1	
Caridea	indet.	2							
Eualus cranchii		2					1		
Processa nouveli holthuisi				1					
Crangonidae	indet.					1			
Philocheras bispinosus bispinosus									1
Liocarcinus	sp. juv							1	
Liocarcinus marmoreus	juvenile		1						
Hyas araneus		1							
Sepiola atlantica						1			
Chaetoderma nitidulum		3	2	1	1	1			
Polyplacophora	juvenile						3	3	1
Leptochiton asellus							2		
Leptochiton cancellatus							1	1	
Callochiton septemvalvis								2	
Cylichna cylindracea					1				
Laona quadrata					2		1		1
Testudinalia testudinalis							4	1	
Euspira nitida			1						

Taxon	Qualifier	SBG1	SBG2	SBG3	SBG4	SBG5	SBG6	SBG7	SBG8
Lacuna pallidula							1		
Turritellinella tricarinata		6	3	8	50	5			2
Brachystomia eulimoides					1				
Onoba semicostata			1						
Buccinum undatum	juvenile				1				
Nucula nucleus		1	5	5		2	2		2
Anomiidae	juvenile	1		1	1	4	21	1	
Mytilidae	juvenile	1					1		
Limaria loscombi								2	
Aequipecten opercularis						1	1		
Parvicardium pinnulatum								1	
Parvicardium scabrum					1	7	1	2	3
Thyasira flexuosa		4	13	28	128	42	36	40	58
Kurtiella bidentata			2		3	3			4
Abra alba						3			
Abra nitida		1		1	1	1			
Lucinoma borealis			1			3			
Lucinoma borealis	juvenile		1	2	1	1	1		1
Timoclea ovata									1
Chamelea striatula			1						
Chamelea striatula	juvenile				1	1			
Dosinia	juvenile				1				
Polititapes rhomboides	juvenile						1		
Mya arenaria								1	
Saxicavella jeffreysi								1	
Phaxas pellucidus					1				1
Phaxas pellucidus	juvenile					2			
Hiatella arctica									1
Thraciidae	juvenile					1			3
Thracia phaseolina								1	

Taxon	Qualifier	SBG1	SBG2	SBG3	SBG4	SBG5	SBG6	SBG7	SBG8
Phoronis	indet.	9	123	21	29	102	21	5	86
Hippothoa divaricata		P							
Hippothoa flagellum		P							
Aetea truncata		P					P	P	
Escharella immersa		P					P	P	
Escharoides coccinea		P					P		
Chorizopora brongniartii		P							
Fenestrulina malusii		P				P	P		
Microporella ciliata			P				P		
Bugulina fulva							P	P	
Disporella hispida		P	P						
Electra pilosa			P						
Crisia	indet.	P		P					
Crisidia cornuta								P	
Asterias rubens	juvenile	1						2	
Luidia sarsii	juvenile								1
Ophiuroidea		FRAG		FRAG	FRAG				
Ophiuroidea	juvenile				3				
Amphiura filiformis		2			1				
Amphipholis squamata		2					7	6	
Ophiothrix fragilis	juvenile				1				
Spatangoida	juvenile		2	2	3				1
Psammechinus miliaris	juvenile	1					5	2	
Cucumariidae	juvenile	1						FRAG	
Didemnidae				P					
Hemichordata							1		4
Chlorophyta					P				
Chlorophyta	Filamentous greens	P		P	P	P	P	P	P
Corallinaceae		P	P			P	P	P	
Corallina	indet.							P	

Taxon	Qualifier	SBG1	SBG2	SBG3	SBG4	SBG5	SBG6	SBG7	SBG8
Rhodophyta							P		
Rhodophyta	Encrusting red						P	P	P
Rhodophyta	Feathery reds							P	
Ochrophyta	Encrusting brown	P	P	P	P	P	P	P	P
Ochrophyta	Filamentous browns		P				P		
Ochrophyta	Foliaceous brown							P	

Plastics	P							
Plastic fibres	P		P			P		P
Paint chips		P				P		P
Ceramic bead			1					