Ocean Ecology

Marine Surveys, Analysis & Consultancy

Beinn Reithe Fish Farm

Benthic Baseline Survey Report

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ADCP	Acoustic Doppler Current Profiler
AIS	Automatic Identification System
AMBI	AZTI Marine Biotic Index
AMSL	Anderson Marine Supplies Ltd.
BBS	Benthic Baseline Survey
BGS	British Geological Survey
BSH	Broadscale Habitat
CAR	Controlled Activities Regulations
DDV	Drop Down Video
EIA	Environmental Impact Assessment
EMODnet	European Marine Observation and Data Network
ES	Ecological Status
EUNIS	European Nature Information System
GPS	Global Positioning System
HA	Habitat Assessment
HOCI	Habitats of Conservation Interest
IDA	Industrial Dentatured Alcohol
IQI	Infaunal Quality Index
JNCC	Joint Nature Conservation Committee
LLS	Loch Long Salmon
MPB	Maximum Proposed Biomass
MACS	Measurement Assurance and Certification Scotland
MBES	Multibeam Echosounder
MLWS	Mean Low Water Springs
MNCR	Marine Nature Conservation Review (Marine Habitat Classification for Britain and Ireland)
MT	Metric Tonnes
NMBAQC	NE Atlantic Marine Biological Analytical Quality Control
nMDS	Non-metric Multidimensional Scaling
OEL	Ocean Ecology Limited
PMF	Priority Marine Feature
PRP	Processing Requirement Protocol
PSA	Particle Size Analysis
PSD	Particle Size Distribution
QMS	Quality Management System
SAC	Special Area of Conservation
SE	Standard Error
SEPA	Scottish Environment Protection Agency
SIMPER	Similarity Percentages Analysis

SIMPROF	Similarity Profile Routine
SOP	Standard Operating Procedure
TOC	Total Organic Carbon
TOM	Total Organic Matter
UKHO	UK Hydrographic Office

1. Non-Technical Summary

This report sets out the benthic baseline conditions for the proposed Beinn Reithe fish farm to be installed and operated Loch Long Salmon (LLS). It acts to inform the Scottish Environment Protection Agency (SEPA) of the benthic conditions at the site prior to installation as well as providing a robust dataset for future comparison if required.

Introduction

Ocean Ecology Limited (OEL) were commissioned by LLS to conduct a Benthic Baseline Survey (BBS) of the proposed fish farm and its environs. The project area is situated off the west shore of Upper Loch Long within the Firth of Clyde loch systems and will comprise four 45 m diameter enclosures constituting a Maximum Proposed Biomass (MPB) of 3,452 tonnes (MT) for the site. The enclosures will be in water depths ranging from approximately 40m at the northern enclosure to -53m at the southern enclosure.

Survey Strategy

A total of 10 survey stations were proposed across the baseline survey area. In line with MACS FFA 01 performance standards (SEPA 2019a), a semi-probabilistic sampling approach was employed resulting in the placement of 5 randomised sampling stations positioned in the two key habitats (A5.36 and A5.442) found across the survey area. These 10 sampling stations were sampled in triplicate using a 0.1m^2 Van Veen grab on 15th June 2021 aboard the multi role vessel Mary M and subsequently underwent Particle Size Distribution (PSD), macrobenthic and Total Organic Carbon (TOC) analysis.

Sediments

Most samples were comprised of mud and sand representing European Nature Information System (EUNIS) Broadscale Habitat (BSH) A5.3 (Mud and Sandy Mud), while three stations were classified as EUNIS BSH A5.4 (Mixed sediment).

Total Organic Carbon (TOC) concentrations ranged from 0.47 % at station 2 to 4.58 % at station 4, with an average value (± SE) of 2.76 ± 0.6 % across the survey area. In general, the highest TOC content (> 3%) in the sediment was found at stations with the highest mud content (>20 %).

Macrobenthos

A diverse macrobenthic assemblage was identified across the survey area, with a total of 3,789 individuals and 96 taxa recorded. Most stations were characterised by the presence of the polychaete *Mediomastus fragilis* accounting for 33.3 % of all individuals recorded.

One Macrobenthic Group and 4 distinct stations were identified across the survey area based on similarities in the composition of macrobenthic assemblages between sampling stations. A

clear distinction was evident between stations located in the middle of the loch, in proximity of the proposed enclosure locations (Macrobenthic Group A), and the other stations located along the coast, the former characterised by high abundances of *M. fragilis, Chaetozone* (Species A) and *Chaetozone zetlandica*.

The main biotope identified across the survey area at which grab samples were obtained was identified as EUNIS A5.355 '*Lagis koreni* and *Phaxas pellucidus* in circalittoral sandy mud'. Stations located along the coast that did not fall in a specific macrobenthic group based on their assemblage composition were only assigned EUNIS level 4 (biotope complex) classifications A5.44 'Circalittoral mixed sediments' and A5.35 'Circalittoral sandy mud'.

The Infaunal Quality Index (IQI) assessment that incorporated both the macrobenthic and sediment data collected across the survey area reported good Ecological Status (ES) for the survey area as a whole. This metric will be useful as a means of comparison in the future to monitor the ES following the installation of the fish farm for assessing compliance with any Controlled Activities Regulations (CAR) licence consented for the site.

2. Introduction

2.1. Project Overview

Loch Long Salmon Ltd. (LLS) is a new salmon farming company established in 2019 that plans to build, install, and operate several semi-closed system salmon farms in Scotland. The first site at Beinn Reithe in Loch Long has a Lease Option Agreement from Crown Estate Scotland and has completed the Scottish Environment Protection Agency (SEPA) pre-screening process.

LLS will subsequently be submitting a Controlled Activities Regulations (CAR) licence application to the SEPA in 2021 alongside undertaking a full Environmental Impact Assessment (EIA) as part of the planning application process.

This document reports on the findings of the baseline benthic survey conducted in June 2021, which will further inform the CAR process.

2.2. Project Background

The Beinn Reithe site is located off the west bank of Upper Loch Long within the Firth of Clyde loch system and will comprise four 45 m diameter enclosures constituting a maximum Proposed Biomass (MPB) of 3,452 tonnes (MT) for the site (Table 1) The enclosures will be located in water depths ranging from approximately 40-50 m (Figure 1).

Table 1. Proposed site details for the Beinn Reithe fish farm.

Site details	Description
Site name	Beinn Reithe
Location (group centre)	NS 25514 99249
Site address	Loch Long, Argyll and Bute, Scotland
Maximum proposed biomass	3,452 tonnes
Proposed no. of enclosures and size	4 enclosures, each with 45 m diameter 140 m circumference
Emamectin benzoate	0g (MTQ); 0g (TAQ)
Azamethiphos	0g
Deltamethrin	0g
Cypermethrin	0g

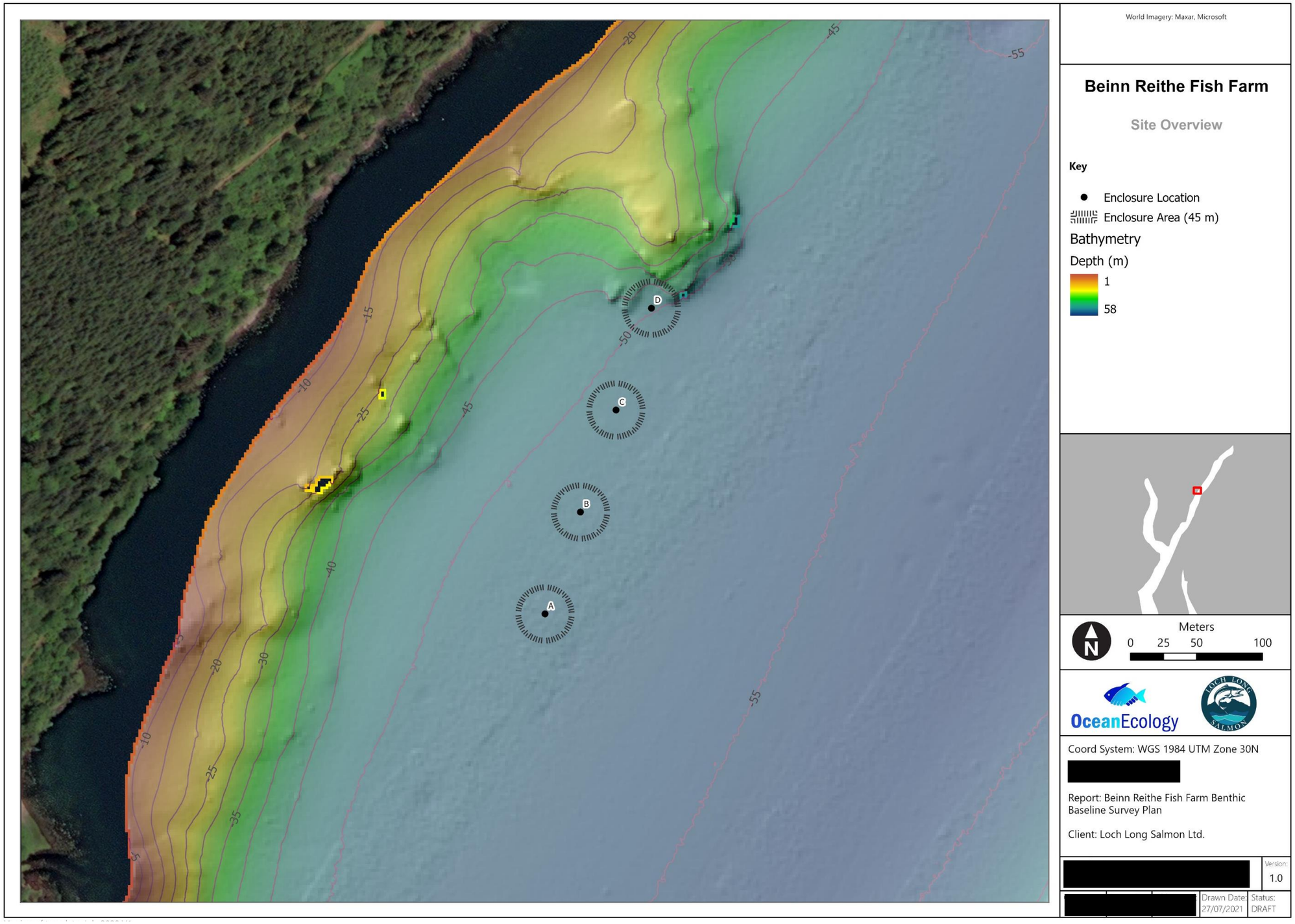

Figure 1. Proposed enclosures locations for Beinn Reithe Fish Farm.

Ocean Ecology Limited (OEL) was commissioned by LLS to undertake the Benthic Baseline Survey (BBS) of the proposed Beinn Reithe fish farm site. The data collected during the survey was intended to:

- characterise the seabed in and around the proposed farm's predicted area of impact;
- identify any protected habitats or species within the predicted area of impact;
- provide an assessment of the existing environmental status of the seabed by means of calculating the Infaunal Quality Index (IQI), including existing impacts;
- address any potential risks identified in the wider area.

2.3. Report Scope

This report presents the results of the macrobenthic, Particle Size Distribution (PSD) and Total Organic Carbon (TOC) analysis conducted on the sediment samples collected across the survey area. The resulting datasets have undergone detailed statistical analysis to provide a comprehensive account of the biological and physical status of the seabed.

3. Review of Existing Data

3.1. Survey Data

3.1.1. Bathymetry Data

Full coverage multibeam echosounder (MBES) bathymetry data is available for the Beinn Reithe site and majority of the proposed survey area at 2 m resolution. The data was collected by the British Geological Survey (BGS) and is available via the UK Hydrographic Office (UKHO) ADMIRALTY Marine Data Portal[1] and the Marine Environment Data Network (MEDIN)[2]. Wider coverage bathymetry data is also available for the whole of Loch Long (OceanWise Marine Themes DEM[3]) although a licence for this dataset was not available at the time of preparing this document.

3.1.2. NatureScot Survey 2010

In 2010 NatureScot performed a drop-down camera survey throughout the Clyde Sea Area to validate the presence of Priority Marine Features (PMFs) and supplement existing species and habitat records (Allen et al. 2013). This survey included data collection throughout Loch Long however limited sampling was conducted in the local vicinity of the proposed Beinn Reithe site.

The survey found that the PMF 'Burrowed Mud' (Tyler-Walters et al. 2016) was extensive throughout the wider Loch Long area, where in the upper reaches the PMF component biotopes '*Seapens and burrowing megafauna in circalittoral fine mud*' (EUNIS: A5.361 / JNCC: SS.SMu.CFiMu.SpnMeg) and '*Burrowing megafauna and Maxmuelleria lankesteri in circalittoral mud*' (EUNIS: A5.362 / JNCC: SS.SMu.CFiMu.MegMax) were occasionally observed in close proximity to each other. Populations of firework anemone *Pachycerianthus multiplicatus* were observed in mud to sandy mud sediment often near to sea pens or macrofaunal burrows associated with the A5.361 / SS.SMu.CFiMu.SpnMeg biotope.

3.1.3. Benthic Video Survey Beinn Reithe 2020

A drop-down video (DDV) benthic survey was undertaken on the 19th September 2020 by Anderson Marine Surveys Ltd (AMSL) (Aquatera 2020) with the aim to investigate seabed species and habitats within the Beinn Reithe site. This involved collection of seabed imagery using a drop-down camera along 4 pre-determined transects to allow representative coverage of benthic habitats across the Beinn Reithe area and its immediate environs. The survey area was dominated by soft sediments, with muddy sand observed toward the middle of the loch and fine mud, easily prone to resuspension, along northwest transects. Patches of stone or shell

[1] https://datahub.admiralty.co.uk/portal/apps/sites/#/marine-data-portal
[2] https://www.medin.org.uk/
[3] http://marine.gov.scot/maps/1640

gravel overlain with fine sediment were additionally observed at around 20 – 30 m depth along the northwest extent of the survey area.

Scarce fauna observed on stone or shell gravels in shallower regions included the sealoch anemone *Protanthea simplex*, crabs and individual sightings of the sea urchin *Echinus esculentus*. Elsewhere, numerous crustacean faunal burrows were observed in soft sediments within the survey area. The Norway lobster *Nephrops norvegicus* was also occasionally observed at the entrance of burrows. There was frequent *P. simplex* on sediments throughout this area, as well as locally abundant on occasional boulders and outcrops where brittle stars and sea squirts (possible *Ciona intestinalis*) and sabellid worms were observed in association. Low numbers of the burrowing anemone *Cerianthus lloydii* and firework anemone *Pachycerianthus multiplicatus* were observed in this area of seabed. Sparse crustaceans observed along northwest transects included occasional crabs (possible *Liocarcinus* spp.), hermit crabs (*Pagurus bernhardus*) and lesser numbers of squat lobsters (*Munida rugosa*). Feather stars (possible *Antedon petasus*) were also observed on rare occasions.

Throughout deeper parts of the survey area, there were widespread observations of small projections from sediments indicative of the arms of burrowing brittle stars (possible *Amphiura* spp.). Other brittle stars (possible *Ophiura* sp.) were frequently observed on the sediment surface. Flat burrow holes throughout deeper areas of seabed appeared to more likely belong to the frequently observed *C. lloydii*. *P. simplex* was occasionally observed on muddy sands with rare sightings of the plumose anemone *Metridium dianthus*. Sparse and scattered epifauna predominantly consisted of echinoderms (brittle stars, occasional common starfish *Asterias rubens*), crabs (possible *Liocarcinus* spp), and *P. bernhardus*. There were additional occasional sightings of common whelk *Buccinum undatum*, mud shrimp (possible *Calocaris macandreae*) and rare observations of hydroids. A small number of flatfish were observed.

3.1.4 Acoustic Doppler Current Profiler data and NewDepoMod output

The recently updated requirements for seabed impacts for aquaculture state that the mean deposited mass within the 250g/m^2 impact area (equivalent to IQI 0.64) should not exceed a certain limit that depends on the wave exposure of the location and that the total area (m^2) with a mean deposited mass more than 250g/m^2 should not exceed the allowable mixing zone[4] area (m^2). Both environmental quality criteria are judged using the average seabed impact calculated over the final 90-day model (NewDepoMod) period.

The likely deposition resulting from discharges from the proposed 'Beinn Reithe' site has been predicted using NewDepoMod model based on acoustic doppler current profiler (ADCP) derived current data collected in 2020[5]. This established that the total area (m^2) with a mean

[4] The maximum allowable area of impact from a fish farm, calculated by applying a 100 metre radius around each enclosure. Its shape is based upon the farm's modelled impact area.

[5] Note that this modelling did not incorporate recent bathymetric survey data and therefore assumed a flat seabed of 50 m depth across the whole site.

deposited mass more than 250g/m^2 will be 95,637 m^2 equating to 90.2% of the allowable mixing zone (106,025 m^2).

3.2. Existing Mapping

3.2.1. EMODnet

Medium scale habitat mapping is available for the proposed Beinn Reithe site from the European Marine Observation and Data Network (EMODnet) mapping portal[6] (Figure 2). This indicates that the site straddles areas of *'Circalittoral soft muds'* (EUNIS: A5.36) and '*Sparse Modiolus modiolus*, dense *Cerianthus lloydii and burrowing holothurians on sheltered circalittoral stones and mixed sediment*' (EUNIS: A5.442). It also indicates that an area of '*Seapens and burrowing megafauna in circalittoral fine mud*' (A5.361) is located approximately 5 km to the south of the southern enclosure location. The mapping also shows that the western extent of the proposed site is fringed by subtidal rocky reef habitat representative of Annex I bedrock reef grading into '*Fucoids on sheltered marine shores*' (EUNIS: A1.31) in the intertidal area. An area of '*Neocrania anomala and Protanthea simplex on very wave-sheltered circalittoral rock*' A4.3141 is also thought to occur 800 m east of the northern enclosure location.

3.2.2. Priority Marine Features

Figure 2 shows the distribution of PMF habitats and records of their component biotopes and species across the Beinn Reithe site and its environs based on all available survey data.

Existing mapping from EMODnet demonstrates that much of the Beinn Reithe site and surrounding areas are characterised by *'Circalittoral soft muds'* (EUNIS: A5.36) with an area of '*Seapens and burrowing megafauna in circalittoral fine mud*' (A5.361 / JNCC: SS.SMu.CFiMu.SpnMeg) located approximately 5 km to the south of the southern enclosure location that represents a component biotope of the 'Burrowed Mud' broad habitat that is a PMF in Scotland's seas (Tyler-Walters et al. 2016) as well as representing the 'Sea-pen and Burrowing Megafauna' habitat included on the OPSAR List of Threatened and/or Declining Species an Habitats (OSPAR 2008).

Based on the existing EMODnet mapping, the EUNIS biotope '*Modiolus modiolus* beds with fine hydroids and large solitary ascidians on very sheltered circalittoral mixed substrata' (A5.623) was also observed to the east of the enclosure area which represents one of the component biotopes of the PMF 'Horse mussel beds'.

The most recent survey of the area undertaken in 2020 (Aquatera 2020) indicated that a low-quality example of the 'Burrowed Muds' PMF was also observed across the proposed Beinn Reithe site and its environs after observing the '*Seapens and burrowing megafauna in circalittoral fine mud*' (EUNIS: A5.361 / JNCC: SS.SMu.CFiMu.SpnMeg) component biotope as

[6] https://www.emodnet-seabedhabitats.eu/access-data/launch-map-viewer/

well as occasional examples of the component species *P. multiplicatus*. No observations of the other component species characteristic of the other component biotope ('*Burrowing megafauna and Maxmuelleria lankesteri in circalittoral mud*' (EUNIS: A5.362 / JNCC: SS.SMu.CFiMu.MegMax)) of the 'Burrow Mud' PMF were made however the presence / absence of the characteristic infauna species of this biotope could not be confirmed by the visual survey which would have required the collection of sediment samples to undergo benthic infaunal analysis.

3.2.3. Habitats Directive (Annex I Habitats)

Existing mapping from EMODnet demonstrates that the western extent of the proposed site is fringed by rocky reef habitat representative of Annex I reef habitat (Figure 2) that is afforded protection under the EC Habitats Directive when designated as a feature of Special Areas of Conservation (SAC). Coverage across this area was not achieved during the most recent survey of the area undertaken in 2020 (Aquatera 2020) and therefore the presence/absence of this habitat and any associated PMFs (e.g. 'Kelp Beds') cannot be confirmed.

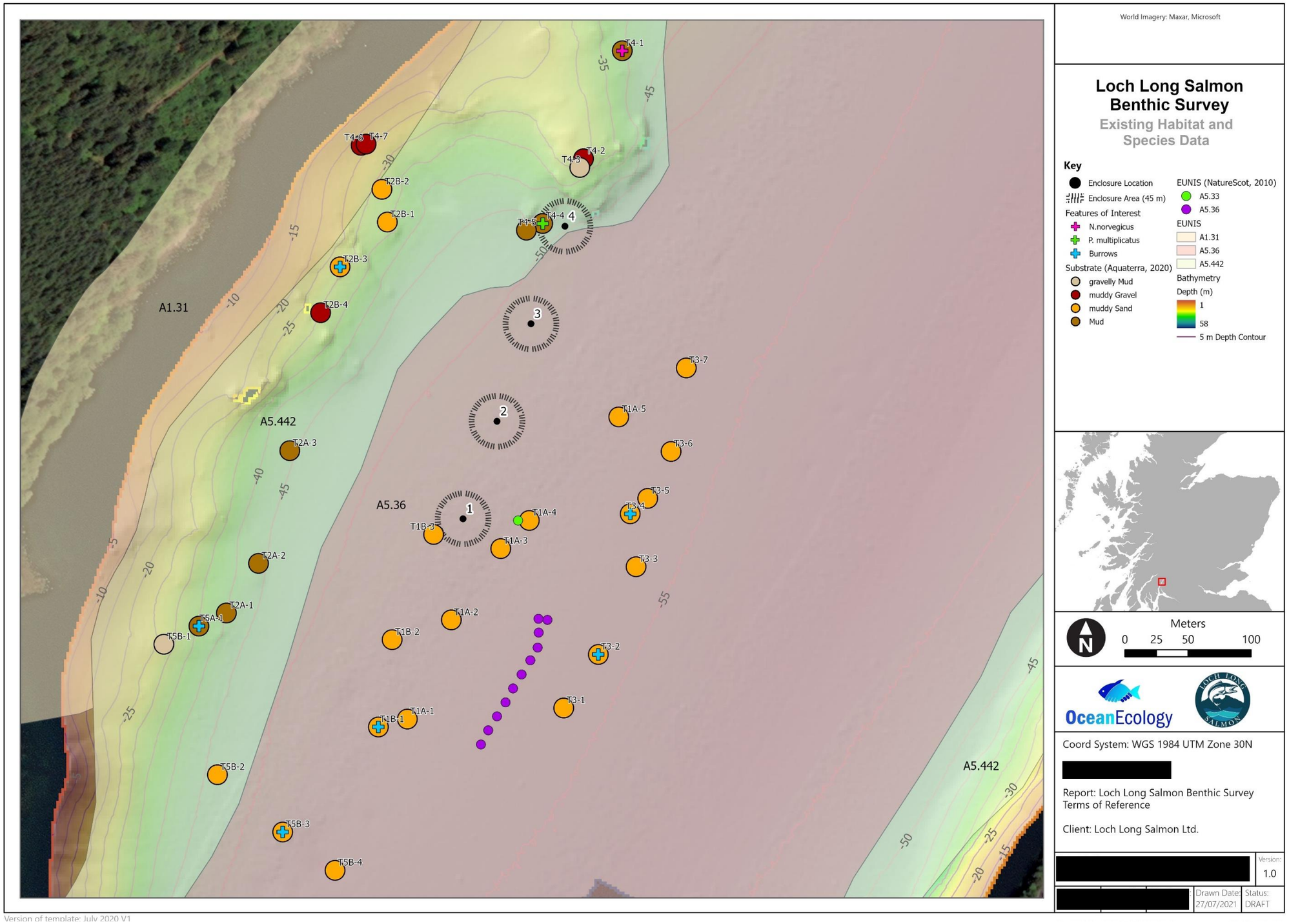

Figure 2. Existing habitat mapping across the Beinn Reithe site and its environs overlain with records of habitats and features of conservation importance.

4. Survey Design

4.1. Identification of Baseline Survey Area

The 'Measurement Assurance and Certification Scotland - Baseline survey & seabed and water quality monitoring plan design' (MACS FFA 01) (SEPA 2019a) states that the minimum baseline survey area required must be identified by extending the allowable mixing zone along its major and minor axes by 50 metres in all directions, or to a distance of 150 metres from the enclosure edge - whichever is the greater; and enclosing this extended area. Figure 3 presents the mapping undertaken to establish the enclosed survey area for the Beinn Reithe benthic baseline survey covering an area of 534,276 m^2.

4.2. Seabed Assessment

The MACS FFA 01 (SEPA 2019a) state that '*…within the identified survey area, an initial visual assessment of the seabed must be performed prior to any detailed baseline survey design taking place. The extent of this assessment must be sufficient to identify the broad habitat types found within the survey area, and the boundaries between those habitats*'.

The results of the visual assessment undertaken of the Beinn Reithe site undertaken in September 2020 are discussed in Section 3.1.3.

4.3. Survey Design

The MACS FFA 01 (SEPA 2019a) state that '*…sampling effort must be sufficient to provide an assessment of the status of each habitat type with the baseline survey area. By using a targeted approach, required sampling effort will be less where the seabed is homogenous than in a heterogeneous environment. Within each soft sediment habitat identified during seabed assessment, a sufficient number of sampling stations must be randomly distributed within that area. In order to allow for reasonable characterisation, a minimum of five sampling stations must be located within each habitat*'.

In line with MACS FFA 01 (SEPA 2019a) a semi-probabilistic sampling approach was employed resulting in the placement of 5 randomised sampling stations positioned in the two key habitats (A5.36 and A5.442) known to occur across the survey area (10 stations in total) (Figure 3). A rationale for the placement of each sampling station is provided in Table 2.

Table 2. Details and rationale for the Beinn Reithe benthic baseline survey (WGS84).

Station Number	Latitude	Longitude	Rationale	Type	Predicted EUNIS Classification
1	56.15594	-4.807	Survey area boundary NE aspect on predicted A5.36 habitat	GRAB	A5.36
2	56.15602	-4.81112	Within the enclosure area on predicted A5.442 biotope	GRAB	A5.442
3	56.15494	-4.8088	Boundary of deposition footprint (including buffer) NE aspect	GRAB	A5.36
4	56.15388	-4.81097	Centralised area beneath proposed salmon enclosure where DDV was not possible in 2020	GRAB	A5.36
5	56.15364	-4.81248	Boundary between two EUNIS habitat types and within the deposition footprint and west of proposed salmon enclosure	GRAB	A5.442
6	56.15327	-4.81525	Boundary of biotope A5.442 to the west and within the deposition footprint	GRAB	A5.442
7	56.15031	-4.81135	Area of predicted habitat A5.36 lacking characterising data	GRAB	A5.36
8	56.14995	-4.81568	Area of predicted biotope A5.442 lacking characterising data	GRAB	A5.442
9	56.14895	-4.81628	Most southerly extent of biotope of predicted biotope A5.442 lacking characterising data	GRAB	A5.442
10	56.14816	-4.81203	Deep area in the south of the survey area lacking characterising data	GRAB	A5.36

4.1 Sampling Requirements & Timing

As per the 'Measurement Assurance and Certification Scotland Sampling of soft substrate' (MACS-FFA-02) (SEPA 2019b) grab samples were collected at each soft sediment sampling station to assess for benthic invertebrates, Particle Size Analysis (PSA) and Total Organic Carbon (TOC). It is understood that the Beinn Reithe site is proposed in an area within which there has not been previous use of in-feed medicine. As such, chemical residue samples were not collected. The survey was undertaken on 15th June 2021. The proposed sampling array was submitted in the form of a Benthic Baseline Survey Plan (Ocean Ecology Limited 2021) submitted to SEPA for approval in April 2021 (provided as Appendix VIII).

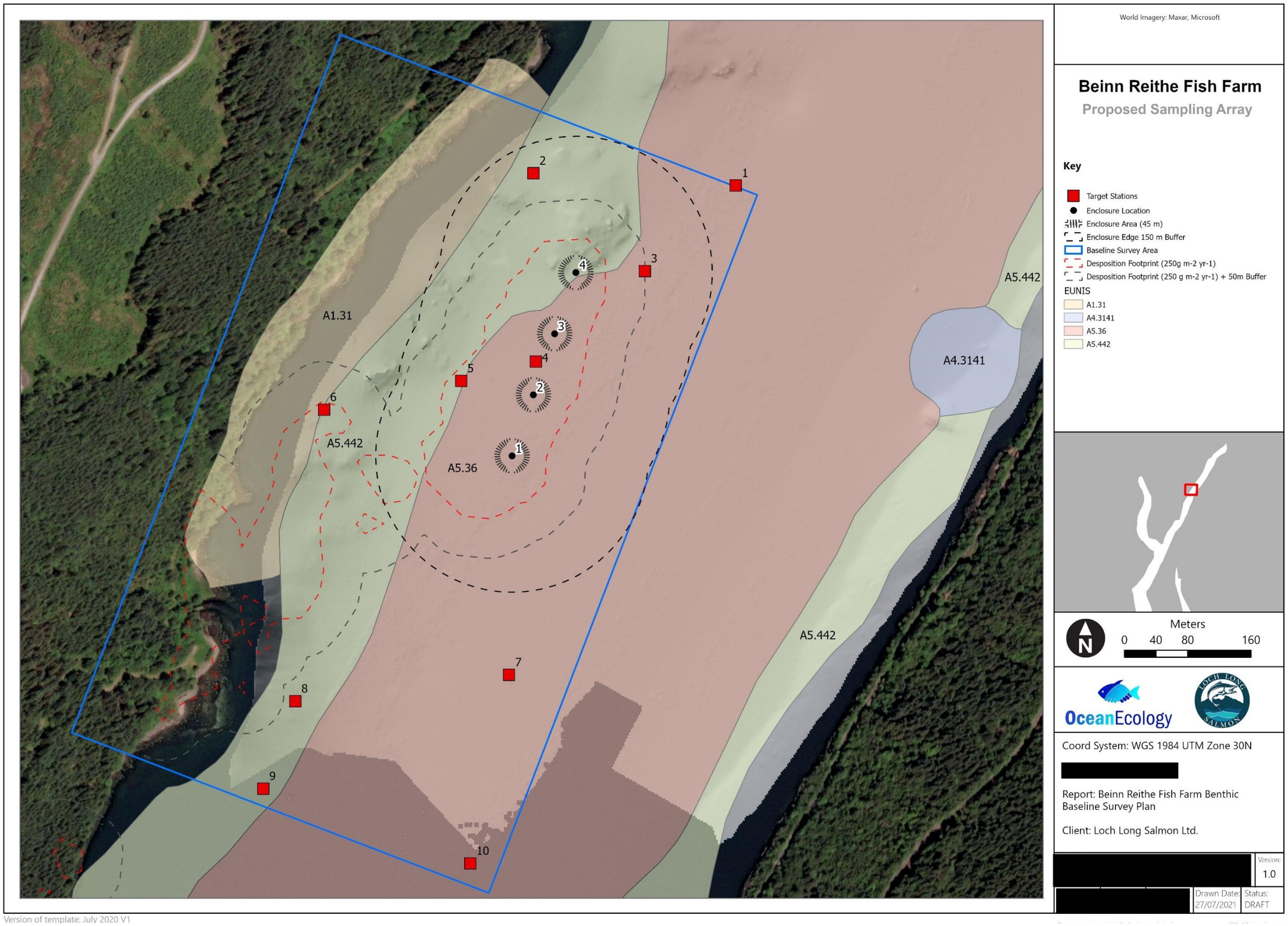

Figure 3. Proposed benthic baseline sampling stations across the Beinn Reithe survey area.

5. Methods

5.1. Survey Vessel - MRV Mary M

Mary M is one of 4 MRVs (Multi Role Vessels) operated by GSS Plant from their base at Rosneath, Argyll and Bute. Mary M is a 16m x 7.5m beam multi cat, coded to Category 2 for operations within 60 miles of safe haven, with stability book. She is fitted with twin 250 hp engines for accurate position holding. She has a 12 tonne capacity deck crane, 10 tonne deck winch and a 95 m^2 working deck space.

Sampling aboard Mary M was undertaken using OEL's 0.1m^2 Van Veen Grab deployed from the vessel's crane arm by GSS's and OEL's field personnel. The vessel was equipped with a Hemisphere V104s GPS Compass system that provided a accurate offset position of the sampling equipment when deployed from the stern. This provided a GPS feed to a dedicated survey navigation PC operating EIVA NaviPac survey navigation software.

Plate 1. GSS MRV Mary M.

5.2. Benthic Grab Sampling

A 0.1m^2 Van Veen Grab was used to obtain two sediment samples at each of the sampling stations. Grab sampling was undertaken in line with MACS FFA-02 for the sampling of soft-substrate (SEPA 2019b).

5.2.1. Method of Sample Collection

One grab sample was collected exclusively for the macrobenthic analysis, and one was collected and subsampled for the analysis of particle size distribution (PSD) and total organic carbon (TOC). Note that it was not deemed that chemical residue subsamples would be required due to the Beinn Reithe site not being located within a waterbody or wider area within which in-feed medicine has previously been used.

The grab was deployed from the hydraulic crane on the deck of Mary M and lowered to the seabed. Detailed field notes were taken including station number, fix number, number of attempts, sample volume, sediment type, conspicuous fauna, any sign of protected features and water depth.

To ensure consistency in sampling, grab samples were screened by the lead marine ecologist and considered unacceptable if:

- The sample was less than 5L. i.e., the sample represented less than half the 10L capacity of the grab used.
- The jaws failed to close completely or were jammed open by an obstruction, allowing fines to pass through (washout or partial washout).
- The sample was taken at an unacceptable distance from the target location (beyond 20 m).
- There was obvious contamination of the sample from survey equipment, paint chips etc.

Where a suitable sample could not be collected after three attempts, the sample location was moved up to 50 m away. Where samples of less than 5L are continually achieved, these samples were assessed on-site to establish if the sample volume were acceptable to allow subsequent analysis. No pooling of samples took place.

5.2.2. Sample Processing

Initial grab sample processing was undertaken onboard the survey vessel in line with the following methodology:

- **Sample 1 – Macrobenthic Analysis**
    - Initial visual assessment of sample size and acceptability were made
    - Photograph of sample with station details and scale bar was taken (Appendix I).
    - Sample emptied onto 1.0 mm sieve net laid over 4.0 mm sieve table and washed through using gentle rinsing with seawater hose.
    - The remaining sample for faunal sorting and identification backwashed into a suitable sized sample container and diluted 10% formalin solution added to fix the sample prior to laboratory analysis.

Sample containers were clearly labelled internally and externally with the project name, sample ID and sample type (Appendix I).

- **Sample 2 – PSD and TOC Analysis**
    - Initial visual assessment of sample size and acceptability made.
    - Photograph of the sample with station details and scale bar were taken (Appendix I).
    - 10% of the sample removed for PSD/TOC Analysis and transferred to a labelled tray.
    - Sample containers were clearly labelled externally with the project name, sample ID and sample type.

5.2.3. Use of Chemicals

Sieved sample residues were retained and fixed in 4% formaldehyde solution in a sealed watertight container and returned to OEL's NE Atlantic Marine Biological Analytical Quality Control (NMBAQC) scheme participating laboratory for further analysis.

6. Laboratory and Analytical Methods

On arrival to the laboratory, all samples were logged in and entered into the project database created in OEL's web-based data management application ABACUS in line with in-house Standard Operating Procedures (SOPs) and OEL's Quality Management System (QMS).

6.1. Particle Size Distribution (PSD) Analysis

Particle Size Distribution (PSD) analysis of sediment samples was undertaken by in-house laboratory technicians at OEL's NMBAQC scheme participating laboratory, in line with NMBAQC best practice guidance (Mason 2016).

6.1.1. Sample Preparation

Frozen sediment samples were first transferred to a drying oven and thawed at 80°C for at least six hours prior to visual assessment of sediment type. Before any further processing (e.g. sieving or sub-sample removal), samples were mixed thoroughly with a spatula and all conspicuous fauna (>1 mm) which appeared to have been alive at the time of sampling removed from the sample. A representative sub-sample of the whole sample was then removed for laser diffraction analysis before the remaining sample screened over a 1mm sieve to sort coarse and fine fractions.

6.1.2. Dry Sieving

The >1mm fraction was then returned to a drying oven and dried at 80°C for at least 24 hours prior to dry sieving. Once dry, the sediment sample was run through a series of Endecott BS 410 test sieves (nested at 0.5 φ intervals) using a Retsch AS200 sieve shaker to fractionate the samples into particle size classes. The dry sieve mesh apertures used are given in Table 3.

Table 3. Sieve series employed for Particle Size Distribution (PSD) analysis by dry sieving (mesh size in mm).

Sieve aperture (mm)												
63	45	32	22.5	16	11.2	8	5.6	4	2.8	2	1.4	1

The sample was then transferred onto the coarsest sieve (63 mm) at the top of the sieve stack and shaken for a standardised period of 20 minutes. The sieve stack was checked to ensure the components of the sample had been fractioned as far down the sieve stack as their diameter would allow. A further 10 minutes of shaking was undertaken if there was evidence that particles had not been properly sorted.

6.1.3. Laser Diffraction

The fine fraction residue (<1mm sediments) was transferred to a suitable container and allowed to settle for 24 hours before excess water syphoned from above the sediment surface until a paste texture was achieved. The fine fraction was then analysed by laser diffraction using a Beckman Coulter LS13 320. For silty sediments, ultrasound was used to agitate particles and prevent aggregation of fines.

6.1.4. Data Merging

The dry sieve and laser data were then merged for each sample with the results expressed as a percentage of the whole sample. Once data was merged, PSD statistics and sediment classifications were generated from the percentages of the sediment determined for each sediment fraction using Gradistat v8 software.

Sediment were described by their size class based on the Wentworth classification system (Wentworth 1922) (Table 4). Statistics such as mean and median grain size, sorting coefficient, skewness and bulk sediment classes (percentage silt, sand and gravel) were also derived in accordance with the Folk classification (Folk 1954).

Table 4. Classification used for defining sediment type based on the Wentworth Classification System (Wentworth 1922).

Wentworth Scale	Phi Units (φ)	Sediment Types
>64000 µm	<-6	Cobble and boulders
32000 – 64000 µm	-5 to -6	Pebble
16000 – 32000 µm	-4 to -5	Pebble
8000 – 16000 µm	-3 to -4	Pebble
4000 - 8000 µm	-3 to -2	Pebble
2000 - 4000 µm	-2 to -1	Granule
1000 - 2000 µm	-1 to 0	Very coarse sand
500 - 1000 µm	0 to 1	Coarse sand
250 - 500 µm	1 to 2	Medium sand
125 - 250 µm	2 to 3	Fine sand
63 - 125 µm	3 to 4	Very fine sand
31.25 – 63 µm	4 to 5	Very coarse silt
15.63 – 31.25 µm	5 to 6	Coarse silt
7.813 – 15.63 µm	6 to 7	Medium silt
3.91 – 7.81 µm	7 to 8	Fine silt
1.95 – 3.91 µm	8 to 9	Very fine silt
<1.95 µm	<9	Clay

6.2. Total Organic Carbon (TOC)

After the removal of any inorganic carbon species, TOC of dry sediment was determined by combustion at 1600 ºC in an oxygen atmosphere; the combustion gases were then measured for carbon concentration. The analysis was undertaken on subsamples from the <1 mm fraction of each sample.

6.3. Macrobenthic Analysis

All elutriation, extraction, identification and enumeration of the grab samples was undertaken at OEL's NMBAQC scheme participating laboratory in line with the NMBAQC Processing Requirement Protocol (PRP) (Worsfold & Hall 2010). All processing information and macrobenthic records were recorded using OEL's cloud-based data management application 'ABACUS' that employs MEDIN[7] validated controlled vocabularies ensuring all sample information, nomenclature, qualifiers and metadata are recorded in line with international data standards.

For each macrobenthic sample, the excess formalin was drained off into a labelled container over a 1 mm mesh sieve in a well-ventilated area. The samples were then re-sieved over a 1 mm mesh sieve to remove all remaining fine sediment and fixative. The low-density fauna was then separated by elutriation with fresh water, poured over a 1 mm mesh sieve, transferred into a Nalgene and preserved in 70 % Industrial Denatured Alcohol (IDA). The remaining sediment from each sample was subsequently separated into 1 mm, 2 mm and 4 mm fractions and sorted under a stereomicroscope to extract any remaining fauna (e.g. high-density bivalves not 'floated' off during elutriation). All macrobenthos present was identified to species level, where possible, and enumerated by trained benthic taxonomists using the most up to date taxonomic literature and checks against existing reference collections. Nomenclature utilised the live link within ABACUS to the WoRMS[8] REST webservice (World Register of Marine Species), to ensure the most up to date taxonomic classifications were recorded. Colonial fauna (e.g. hydroids and bryozoans) were recorded as present (P). For the purposes of subsequent data analysis, taxa recorded as P were given the numerical value of 1.

Following identification, all specimens from each sample were pooled into five major groups (Annelida, Crustacea, Mollusca, Echinodermata and Miscellaneous taxa) in order to measure blotted wet weight major group biomass to 0.0001g. As a standard, the conventional conversion factors as defined by Eleftheriou & Basford (1989) were applied to biomass data to provide equivalent dry weight biomass (Ash Free Dry Weight, AFDW). The conversion factors applied are as follows:

- Annelida = 15.5 %
- Crustacea = 22.5 %

[7] Marine Environmental Data and Information Network
[8] http://www.marinespecies.org

- Mollusca = 8.5 %
- Echinodermata = 8.0 %
- Miscellaneous = 15.5 %

6.4. Data Analysis

6.4.1. Data Truncation and Standardisation

The macrobenthic species list was checked using the R package '*worms*' (Holstein 2018) to check against WoRMS taxon lists and standardise species nomenclature. Once the species nomenclature was standardised in accordance with WoRMS accepted species names, the species list was examined carefully by a senior taxonomist to truncate the data, combining species records where differences in taxonomic resolution were identified.

The data used specifically for calculation of the IQI (see Section XX) underwent a

6.4.2. Pre-Analysis Data Treatment

All data were collated in excel spreadsheets and made suitable for statistical analysis. All data processing and statistical analysis was undertaken using R v 1.2 1335 (R Core Team 2020) and PRIMER v7 (Clarke & Gorley 2015) software packages. To note that no replicate samples were available for macrobenthic analysis thus no mean values could be calculated per sampling station.

The data used specifically for calculation of the IQI (see Section XX) underwent a limited pre-treatment process that first involved the removal of records represented by quantifiable taxa qualified as a fragment (e.g. *Nephtys fragment*) and as eggs. The IQI tool automatically truncates these taxa. Other qualifiers were removed from all records except taxonomic qualifiers (i.e. those which related to the identification of the taxon e.g. species *H. longa/flava* etc.).

6.4.3. Multivariate Statistics

Prior to multivariate analyses, data were displayed as a shade plot with linear grey-scale intensity proportional to macrobenthic abundance (Clarke et al. 2014) to determine the most efficient pre-treatment (transformation) method. Macrobenthic abundance data from grab samples was square root transformed to prevent taxa with intermediate abundances from being discounted from the analysis, whilst allowing the underlying community structure to be assessed.

The PRIMER v7 software package (Clarke & Gorley 2015) was utilised to undertake the multivariate statistical analysis on the biotic macrobenthic dataset. To fully investigate the multivariate patterns in the biotic data, macrobenthic assemblages were characterised based on their community composition, with hierarchical clustering and non-metric multidimensional scaling (nMDS) used to identify groupings of sampling stations that could

be grouped together as a habitat type or community. SIMPER (similarities-percentage) analysis was then applied to identify which taxa contributed most to the similarity within that habitat type or community. A detailed description of analytical routines is provided in Appendix III.

6.5. Determining EUNIS Classifications

Macrobenthic assemblages were characterised based on their community composition, with hierarchical clustering used to identify groupings of sampling stations that could be grouped together as a habitat type or community. Setting these groupings as factors within PRIMER, SIMPER analysis was then applied to identify which taxa contributed the most to the similarity within that community. EUNIS classifications were then assigned based on the latest JNCC guidance (Parry 2019).

6.6. Infaunal Quality Index

The IQI is a multimetric index that expresses the ecological health of benthic macroinvertebrate (infauna) assemblages in accordance with the normative definitions of the Water Framework Directive (WFD) as an Ecological Quality Ratio (EQR). The index incorporates taxa number, the AZTI Marine Biotic Index (AMBI, a measure of sensitivity to disturbance) (Borja et al., 2000) and Simpson's evenness (a measure of the distribution of individuals across the different taxa). To fulfil the requirements of the WFD, the IQI also incorporates each metric as a ratio of the observed value to that expected under reference conditions.

As a means of establishing the ecological status of the infaunal assemblages of the survey area, the IQI was calculated for all 10 samples. The IQI requires that all taxa are standardised to a common list within which AZTI AMBI groups (Borja et al., 2000) are assigned to all taxa listed. A separate data standardisation process was required to ensure all taxa listed in the final dataset aligned with the common list used for calculation of the IQI. This involved cross-checking the taxon list against AMBI group information contained within the IQI Workbook template and held in MSBIAS/WoRMS and assigning missing AMBI groups, truncation scores and ecological group multipliers to taxa and/or corresponding synonyms (where possible/reasonable).

7. Results

7.1. Particle Size Distribution Data

The composition of sediment data at each sampling station across the survey area is mapped in Figure 4. Benthic grab sample photos and sampling logs are provided in Appendix I and Appendix IV respectively with the full PSD data provided in Appendix V.

7.1.1. Sediment Type

Sediment types at each sampling station as by the Folk (1954) classification are summarised in Appendix VI and illustrated in Figure 5. Despite some variation in sediment type between stations, the majority of stations were dominated by mud and sand. Gravel content was highest close to land and towards the south of the survey area. The majority of samples were comprised of mud and sand representing EUNIS BSH A5.3 (Mud and sandy mud), while three stations were classified as Gravelly Muddy Sand (gmS) and Gravelly Mud (gM) representing EUNIS BSH A5.4 (Mixed Sediments). These sublittoral sediment types could represent 'subtidal mixed muddy sediments' listed as habitats of principal importance under Section 2(4) of the Nature Conservation (Scotland) Act 2004. To note that these habitats are among the most common habitats found below Mean Low Water Springs (MLWS) around the coast of the UK.

Most of the sediments recorded were classified as poorly to very poorly sorted as a result of the mixed composition of different size fractions of all three principal sediment types (gravel, sand and mud).

7.1.2. Sediment Composition

The percentage contribution of gravels (> 2 mm), sands (0.63 mm to 2 mm) and fines (< 63 µm) at each station are presented in Figure 6. Mud and sand were the main sediment fractions present. The mean proportion (± Standard Error, SE) of mud across all stations was 46.29 % (± 0.05) while that of sand was 46.23 % (± 0.04); mean (±SE) gravel content across the survey area was 7.45 (± 0.04). Mud content was greatest at stations 3, 5, 7, 9, 10, while sand content was greatest at stations 1, 2, 4, 6 and 8. The mean grain size at sampling stations ranged from 18.71 µm at Station 10 to 283.0 µm at Station 8 (Figure 7).

7.1.3. Total Organic Carbon (TOC)

TOC concentrations ranged from 0.47 % at station 2 to 4.58 % at station 4 with an average value (± SE) of 2.76 ± 0.6 % across the survey area as a whole (Figure 8). Values were generally low (< 1 %) close to land (Stations 2, 6, 8 and 9) while were around 3 -4 % toward the proposed enclosure locations (Stations 1, 3, 4, 5, 7 and 10).

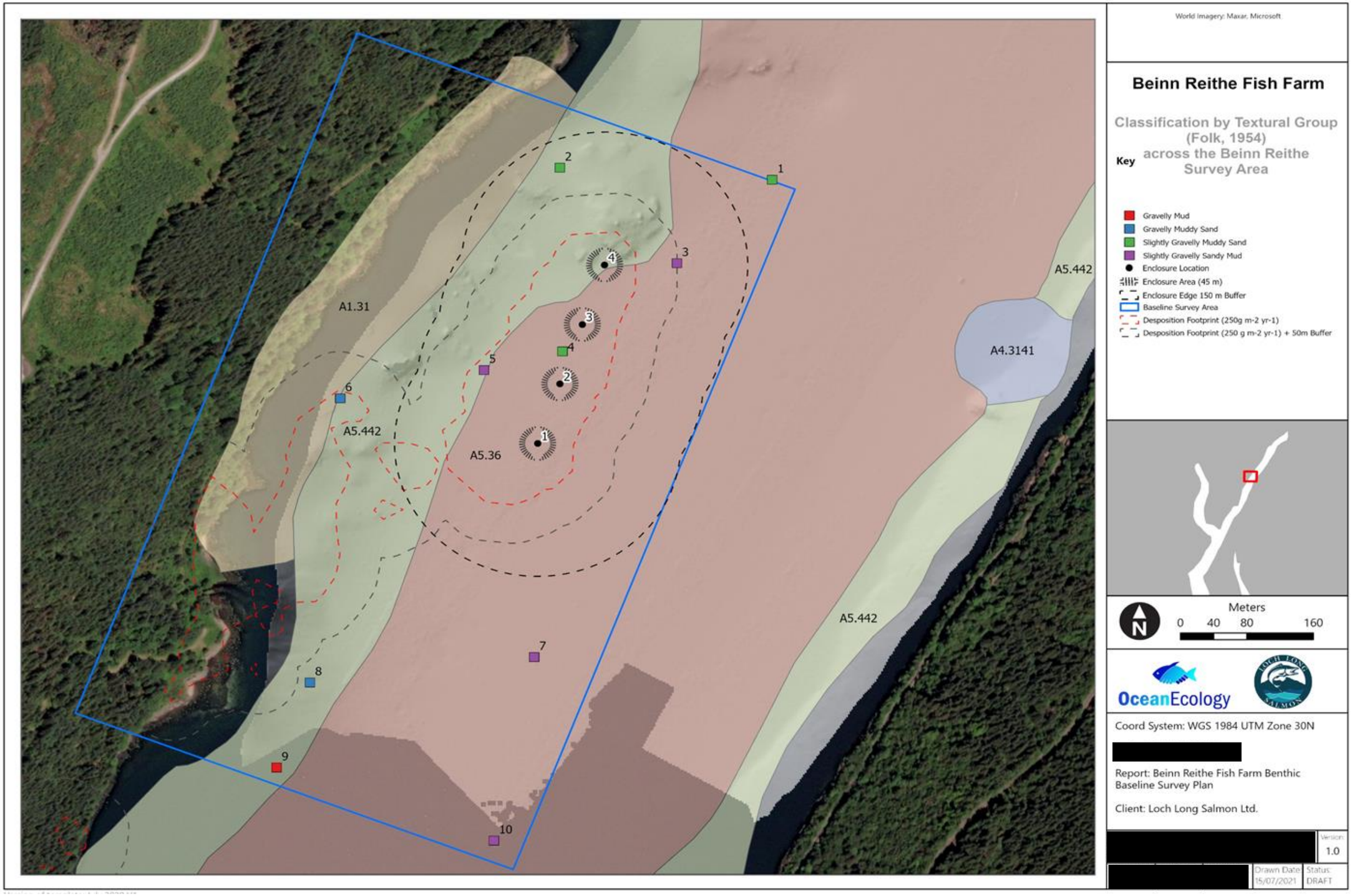

Figure 4. Folk (1954) sediment types as determined from PSD analysis of samples acquired across the Beinn Reithe survey area.

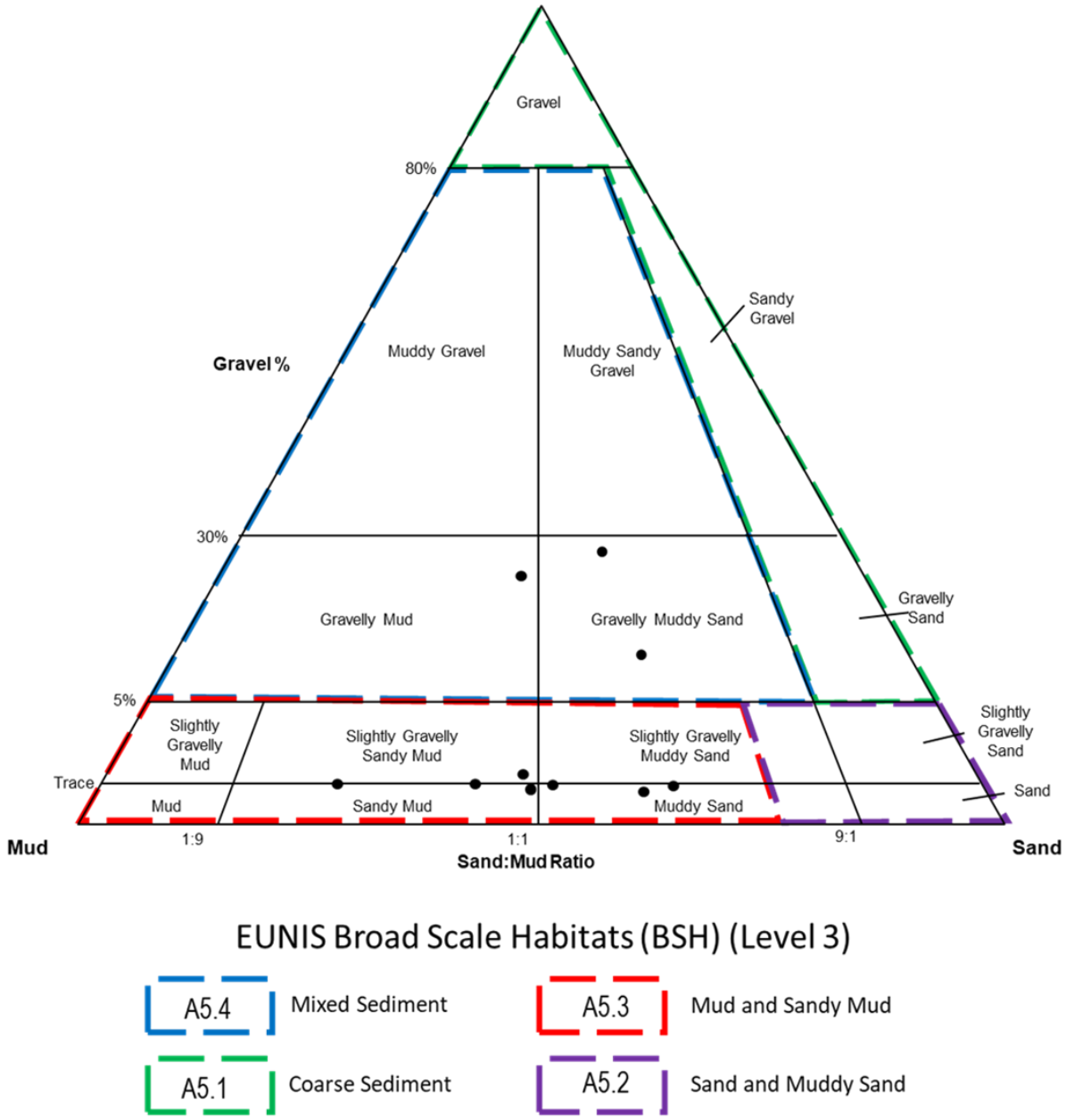

Figure 5. The Folk (1954) triangle classifications of sediment gravel percentage and sand to mud ratio of samples collected across the Beinn Reithe survey area, overlain by the modified Folk triangle for determination of mobile sediment BSHs under the EUNIS habitat classification system (adapted from (Long 2006)).

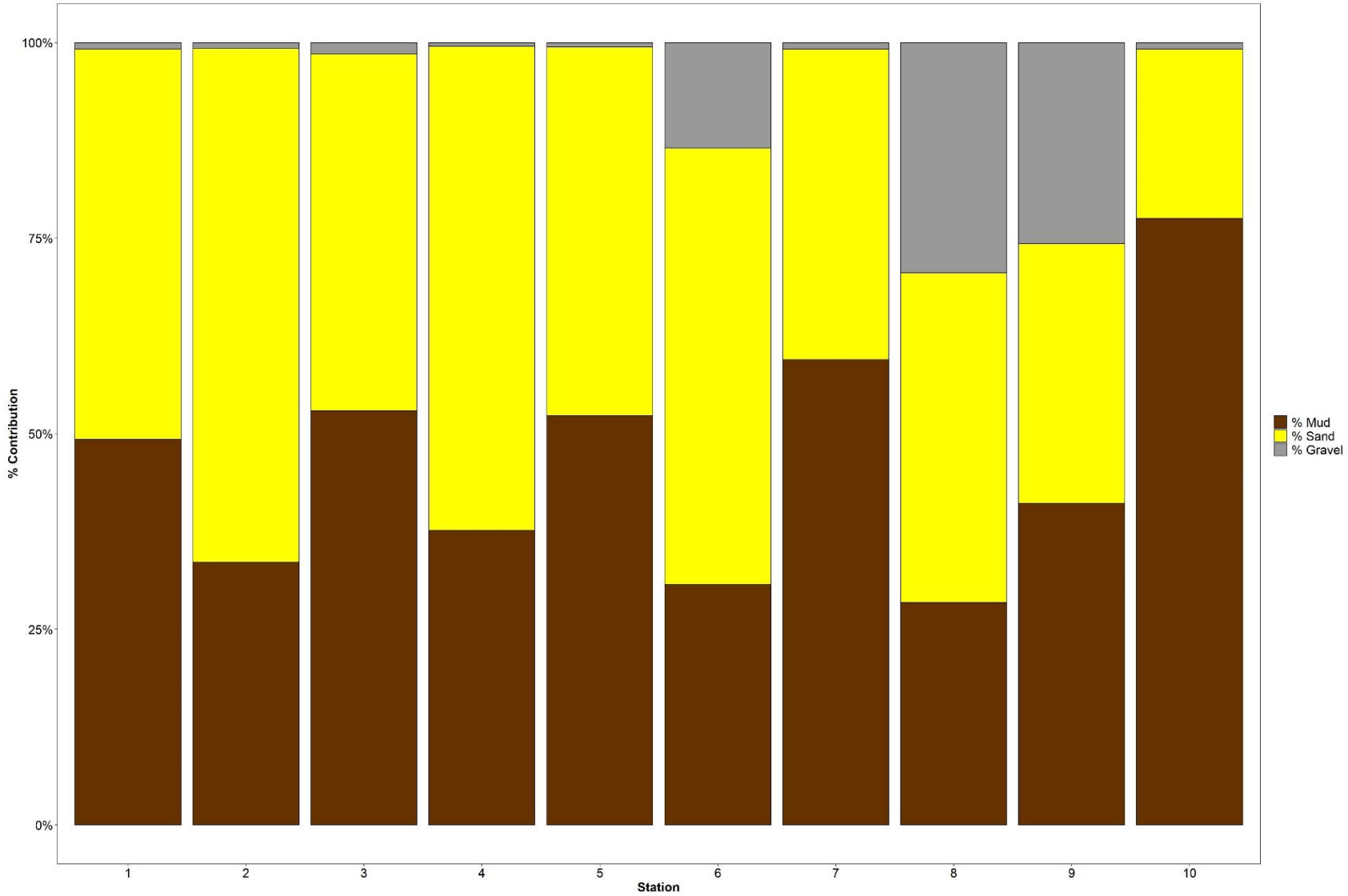

Figure 6. Principal sediment components (Gravel, Sand, Mud) as determined from PSD analysis of stations sampled across the Beinn Reithe survey area.

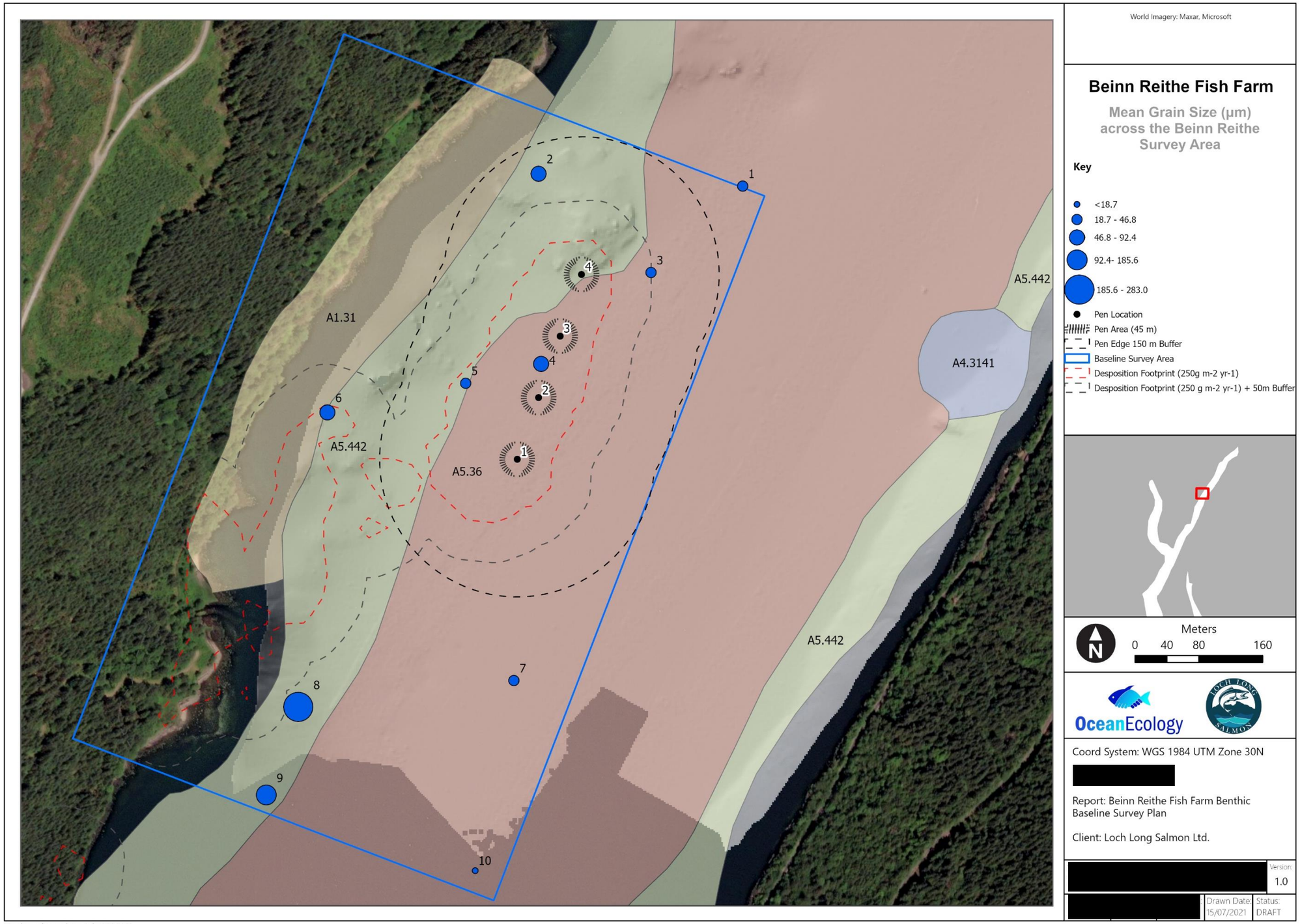

Figure 7. Comparison of mean sediment grain size (µm) of sediment samples collected across the Beinn Reithe survey area.

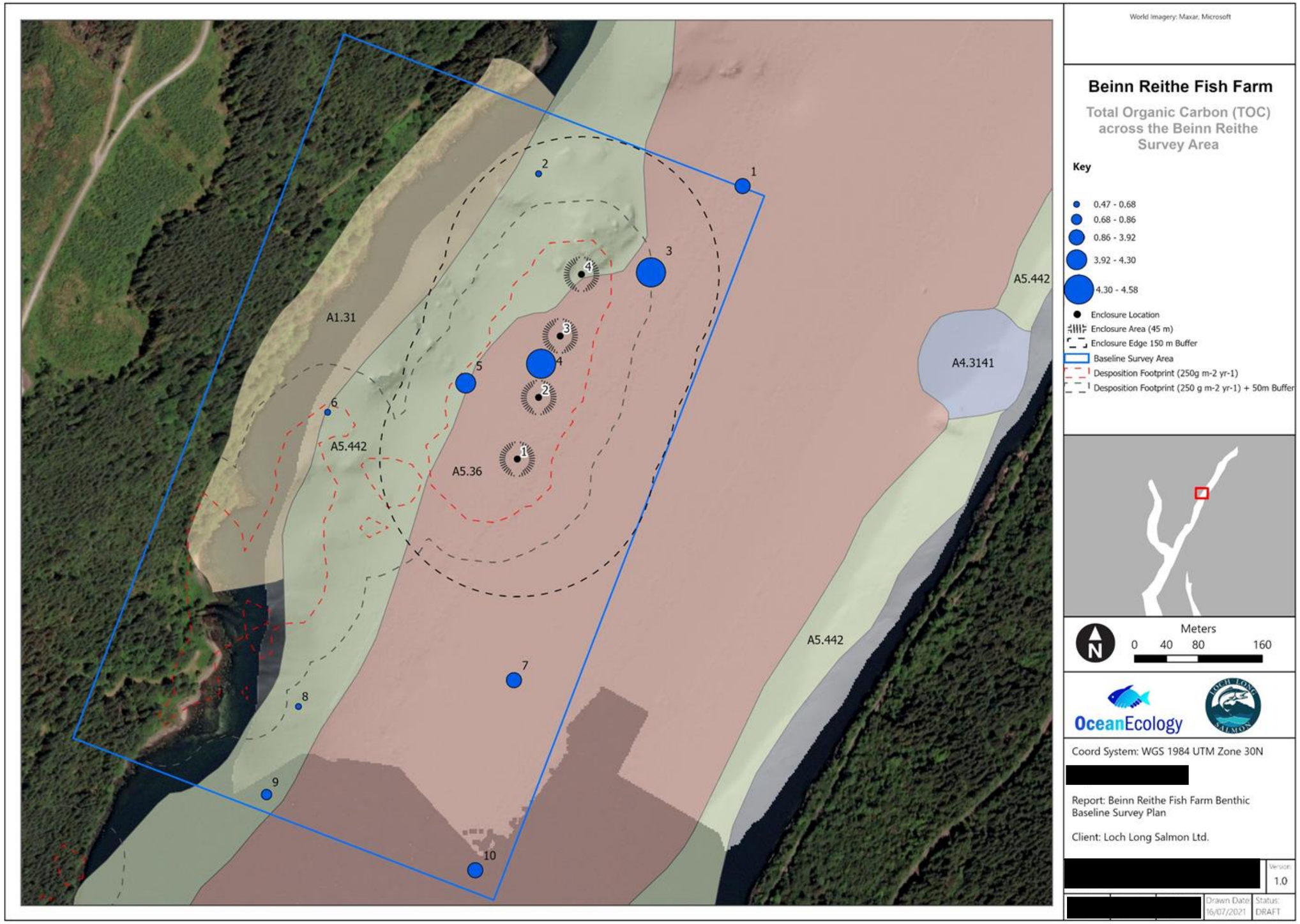

Figure 8. Total Organic Carbon (TOC) in the sediment samples collected across the Beinn Reithe survey area.

7.2. Macrobenthos

7.2.1. Macrobenthic Composition

The full macrobenthic abundance matrix is provided in Appendix VII. The biomass (gAFDW) of each major taxonomic group (Annelida, Crustacea, Mollusca, Echinodermata and Miscellaneous) in each sample collected is presented in Appendix VIII.

A diverse macrobenthic assemblage was identified across the Beinn Reithe survey area from the grab samples, with a total of 3,789 individuals and 96 taxa recorded. The mean (± SE) number of taxa was 28 ± 2.24 per station. Mean (± SE) abundance per station was 378.81 ± 73.4 with a mean (± SE) biomass per station of 0.8 ± 0.2 gAFDW.

As shown in Figure 9, the polychaete *Mediomastus fragilis* was the most abundant species sampled accounting for 33.3 % of all individuals recorded. It also accounted for the maximum abundance in a single sample and greatest average density per sample (Figure 9c and Figure 9d). Other key taxa were the bivalves *Thyasira flexuosa* and *Nucula nitidosa*, the roundworms Nematoda and the polychaete *Chaetozone* (Species A), which were recorded in all the sampling stations (Figure 9b).

The sampling stations with the highest abundance were stations 1, 10 and 5 (Figure 11) and were all dominated by the polychaete *M. fragilis*. Sampling stations with the highest richness (S, number of species/taxa) were stations 9, 2 and 8 with specimens belonging to 43, 33 and 30 different taxa, respectively (Figure 12).

Biomass ranged between 0.12 and 1.8 gAFDW per sample, with the highest value found at Station 4 due to high mollusc biomass (Figure 13). Across the entire survey area, most of the biomass was accounted for by the group Mollusca. Figure 10 illustrates the relative contributions to total abundance, diversity, and biomass of the major taxonomic groups in the macrobenthic community sampled across the Beinn Reithe survey area.

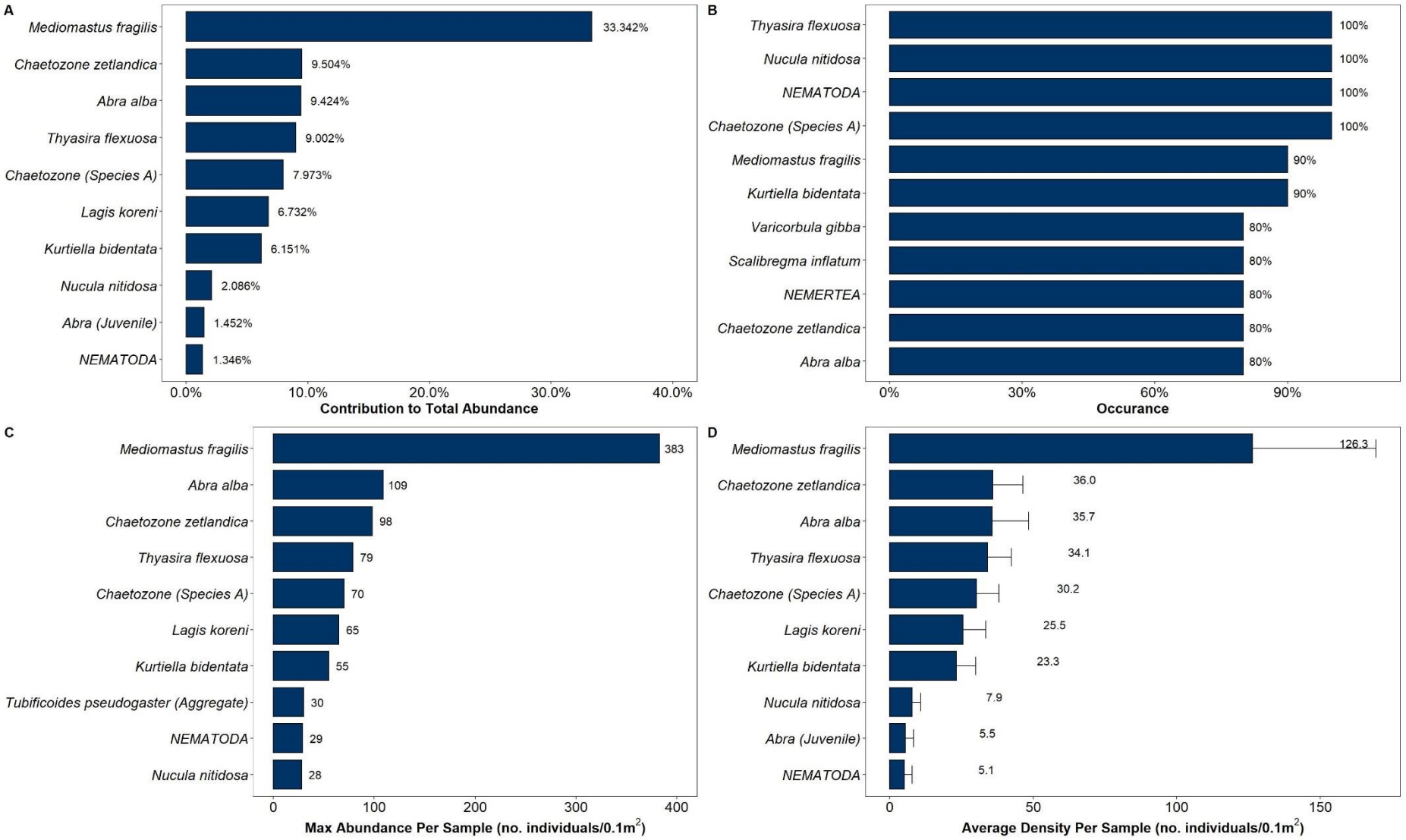

Figure 9. Percentage contributions of the top 10 macrobenthic taxa to total abundance (a) and occurrence (b) from samples collected across the Beinn Reithe survey area. Also shown are the maximum densities of the top 10 taxa per sample (c) and average densities of the top 10 taxa per sample (d).

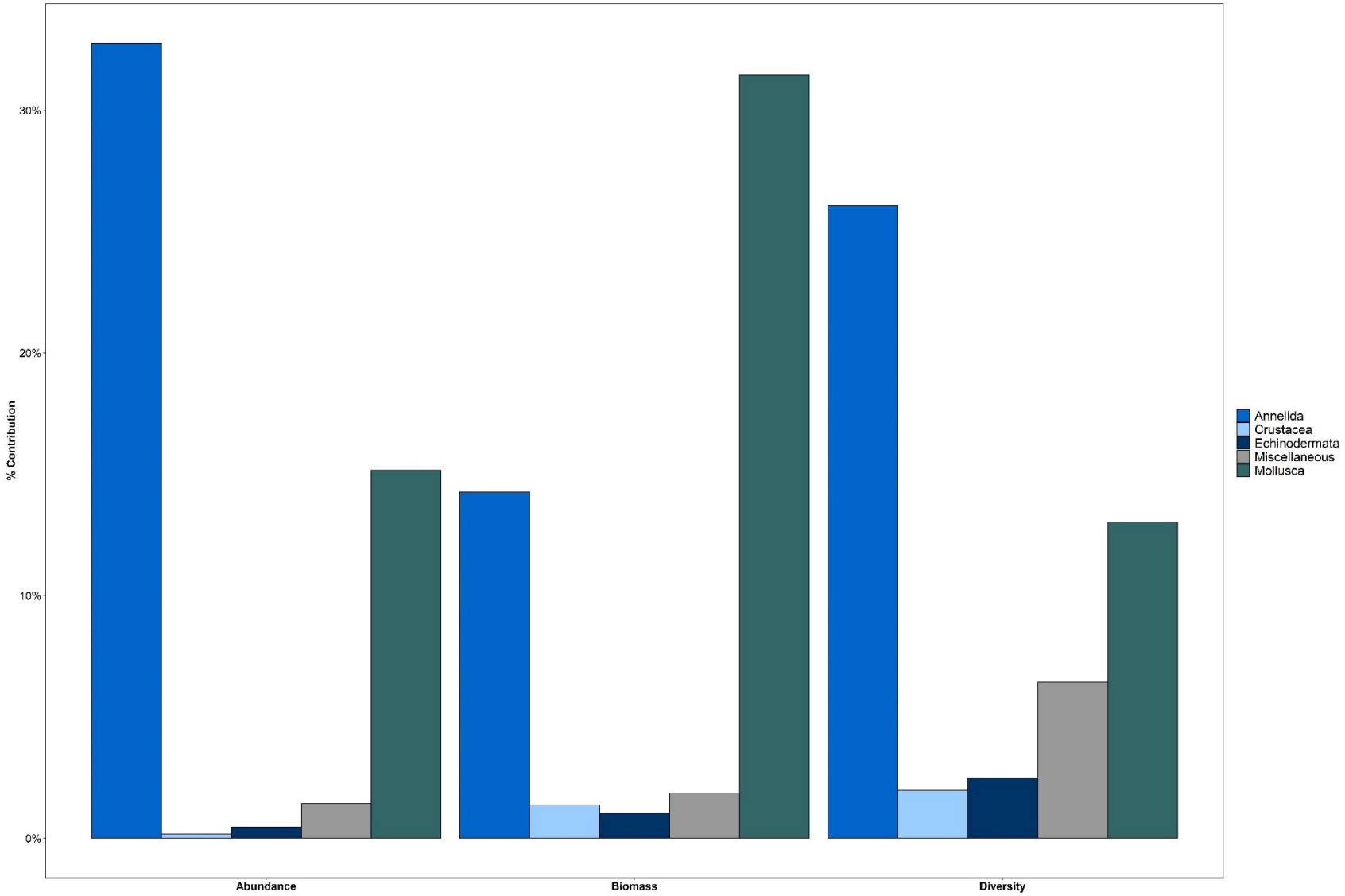

Figure 10. Relative contribution of the major taxonomic groups to the total abundance, diversity and biomass of the macrobenthos sampled across the Beinn Reithe survey area.

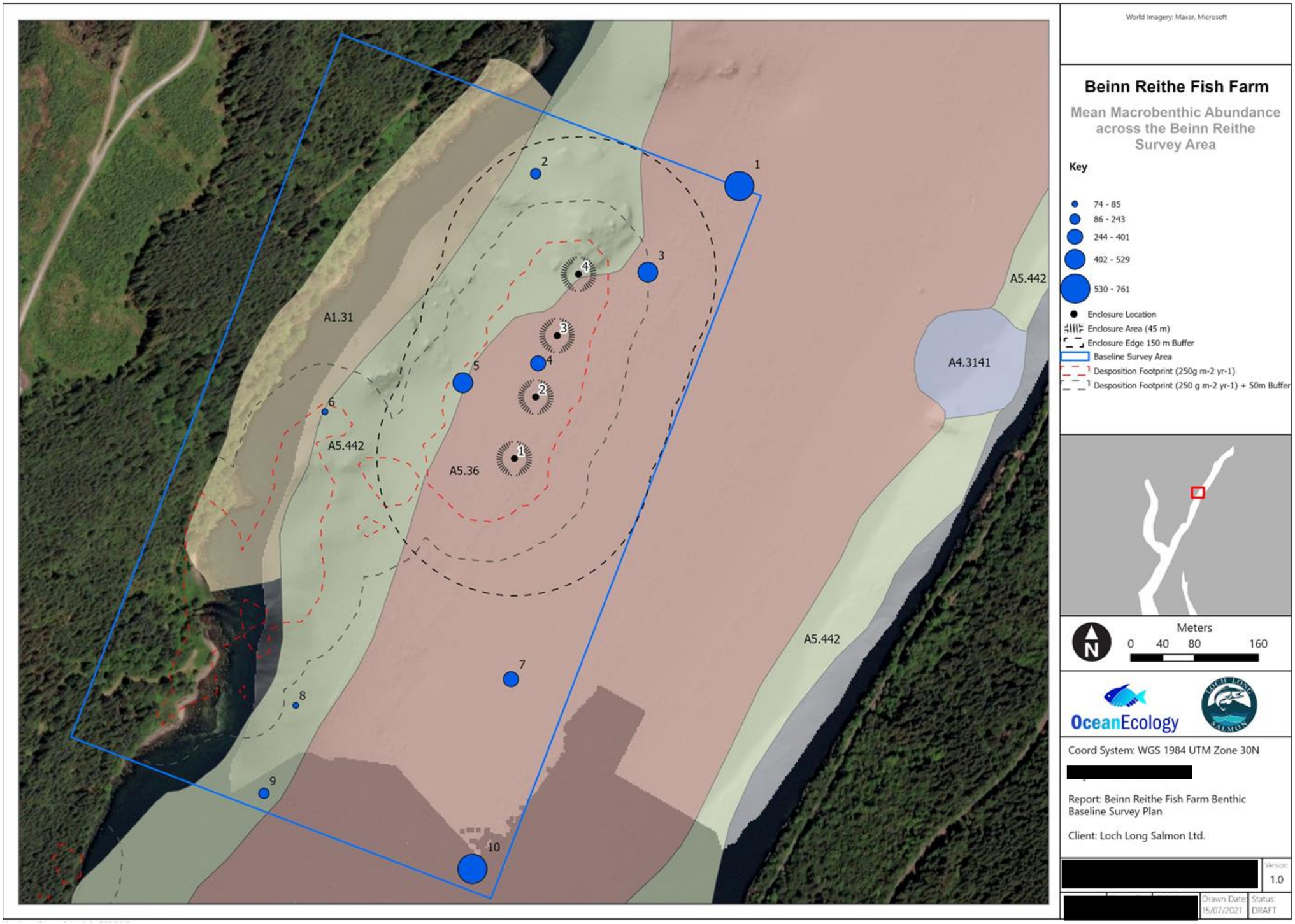

Figure 11. Mean macrobenthic abundance per station samples across the Beinn Reithe survey area.

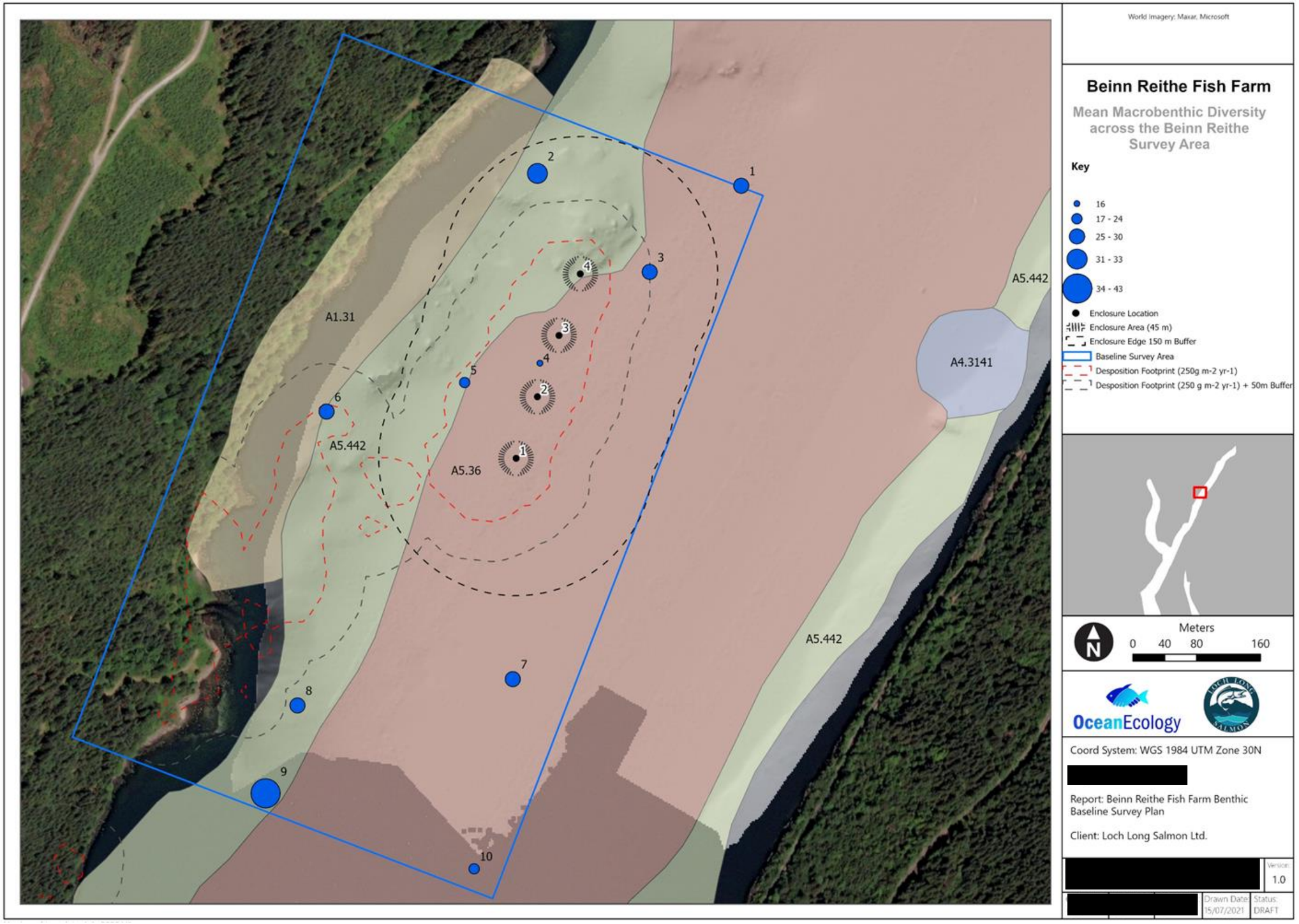

Figure 12. Mean macrobenthic diversity per station samples across the Beinn Reithe survey area.

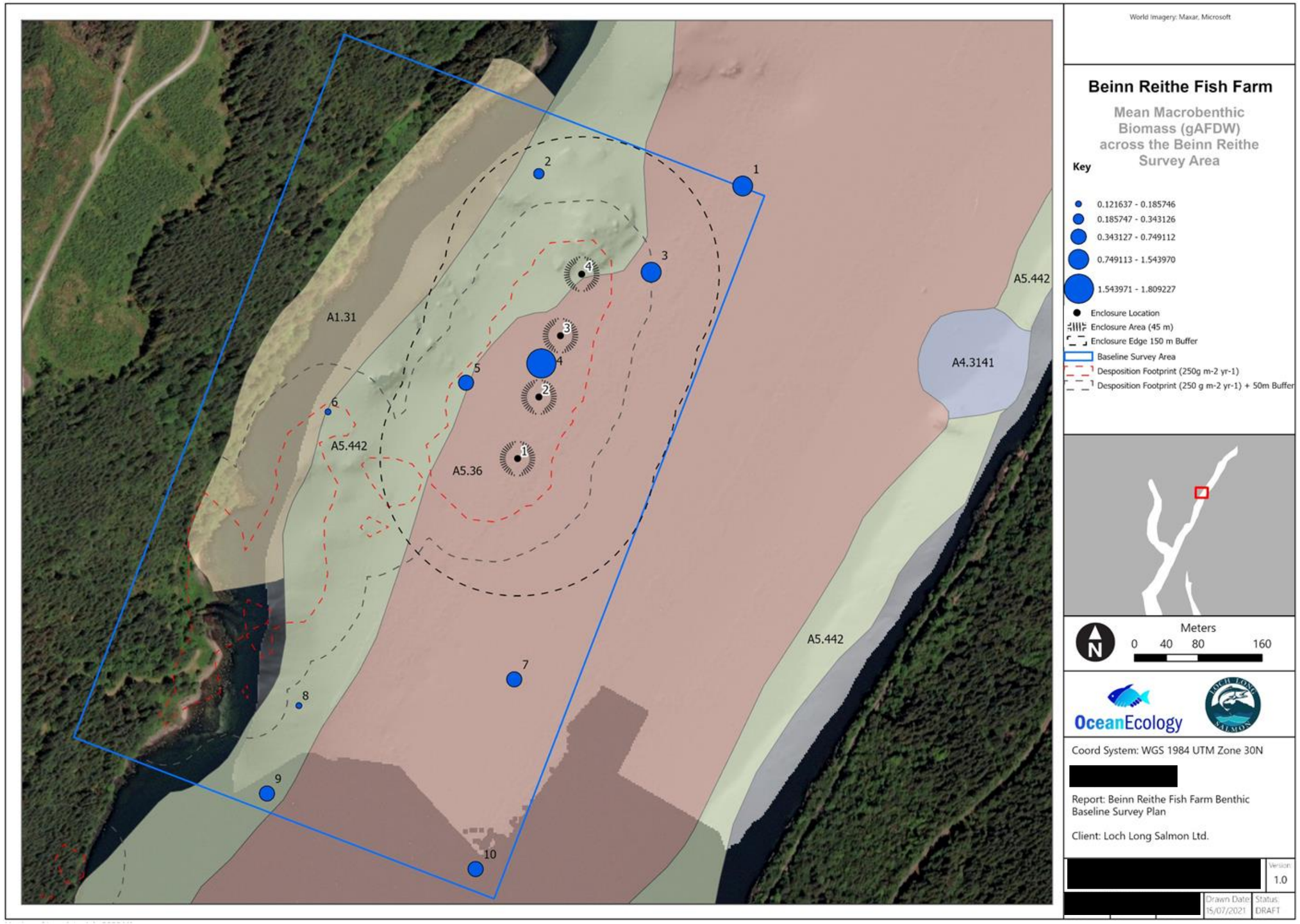

Figure 13. Mean macrobenthic biomass (gAFDW) per station samples across the Beinn Reithe survey area.

7.3. Macrobenthic Faunal Groupings

Multivariate analysis was undertaken on the square root transformed macrobenthic grab abundance data, to identify spatial distribution patterns in faunal assemblages across the Beinn Reithe survey area and identify characterising taxa present.

Cluster analysis of the macrobenthic data was performed on a Bray-Curtis similarity matrix to analyse the spatial similarities in macrobenthic communities recorded across all sampled stations. The dendrogram resulting from the cluster analysis and associated Type 1 SIMPROF (similarity profile routine) permutation test of all nodes within the dendrogram, identified 5 statistically significantly similar groups ($p > 0.05$), which included 4 stations constituting a group on their own, namely stations 2, 6, 8 and 9 (Figure 14).

To visualise the relationships between the sampled macrobenthic assemblages, a non-metric multi-dimensional scaling (nMDS) ordination plot was generated on the community abundance data (Figure 14). The nMDS represents the relationships between the communities sampled, based on the distance between sample (station) points. The stress value of the nMDS ordination plot (0.04) indicates that the two-dimensional plot provides an excellent representation of the similarity between stations. The degree of clustering of intra-group sample points demonstrates the level of within group similarity, whilst the lack of overlap/interspersion of inter-group sample points is indicative of the level of dissimilarity between different macrobenthic groups.

The spatial distribution of the 5 macrobenthic groups is mapped in Figure 15. SIMPER (similarity percentage analysis) was used to identify the key taxa contributing to the within group similarity (see Appendix IX for SIMPER results).

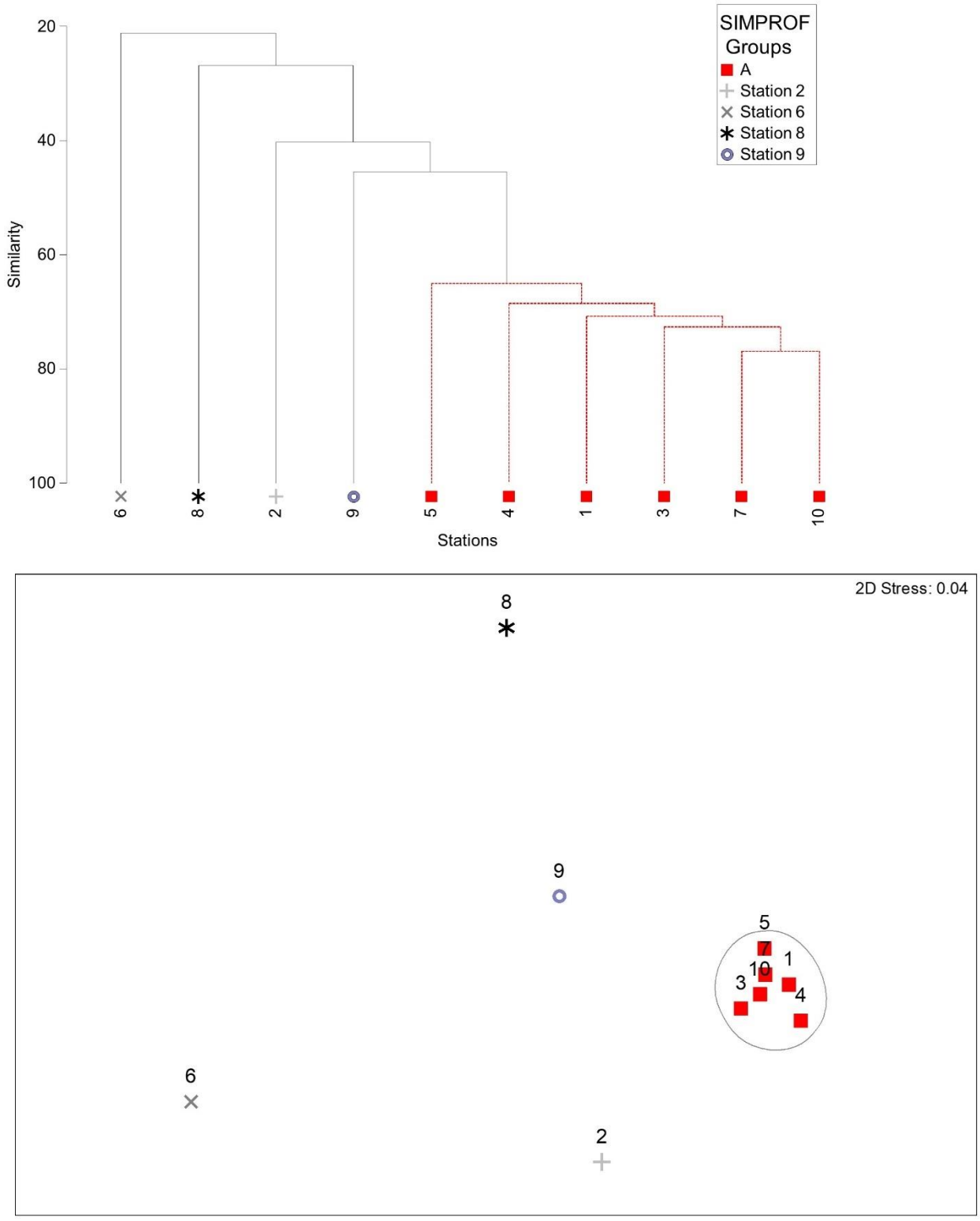

Figure 14 Top: Dendrogram resulting from the cluster analysis and associated SIMPROF test on a Bray-Curtis similarity matrix derived from square-root transformed macrobenthic abundance data. Bottom: Two-dimensional nMDS ordination of macrobenthic communities sampled across the Beinn Reithe survey area based on square root transformed and Bray-Curtis similarity abundance data. Macrobenthic Groups were identified based on the SIMPORF routine.

Macrobenthic Group A (6 stations) – This was the only group identified based on the SIMPROF routine that included more than one station (Figure 14). Taxa contributing the most to the similarity within this group (average similarity 68.93) were the polychaetes *M. fragilis, Chaetozone* (Species A) and *Chaetozone zetlandica* together accounting for over 40 % of the group total average similarity. Other key species within this group were the bivalves *T. flexuosa* and *Abra alba,* and the trumpet worm *Lagis koreni*.

Station 2 – was dominated by the presence in high numbers of the bivalves *T. flexuosa, Kurtiella bidentata* and *A. alba* together accounting for 58 % of the total assemblage at this station.

Station 6 and **Station 8** were overall characterised by low abundance of macrofauna with **Station 6** dominated by Nematoda accounting for 32 % of the total assemblage and **Station 8** characterised by the presence of *C. zetlandica,* the ribbon worms Nemertea, the polychaete of the genus *Aphelochaeta* and the brittle star *Ophiura albida* altogether accounting for 45 % of the total assemblage.

Station 9 – had an assemblage characterised by relatively high numbers of *M. fragilis*, accounting for 19 % of the total assemblage at this station, as well as other taxa including *T. flexuosa, A. alba, K. bidentata, Chaetozone* (Species A) and the polychaete *Prionospio fallax*.

7.4. Biotope Assignment

For **Macrobenthic Group A**, the only group made up of several stations, a biotope was assigned according in consideration of the latest JNCC guidance (Parry 2019) based upon its faunal and physical characteristics. Correlation of EUNIS/MNCR (Marine Nature Conservation Review) biotopes was undertaken using the JNCC correlation table (JNCC 2018).

Macrobenthic Group A - the biotope that most closely align with the community observed in this group was "A5.355 *Lagis koreni* and *Phaxas pellucidus* in circalittoral sandy mud", which is consistent with the high mud content observed at these stations and its macrobenthic assemblage.

All other macrobenthic groups were made up of only one station each and two out of four (Stations 6 and 8) had low abundances of characterising species which further hindered the allocation of a specific biotope to these stations. For these reasons, these stations were assigned a level 4 biotope complex based on their physical characteristic which corresponds to EUNIS biotope A5.44 'Circalittoral mixed sediments' for Stations 6, 8, and 9 and to EUNIS biotope A5.35 'Circalittoral sandy mud' for Station 2.

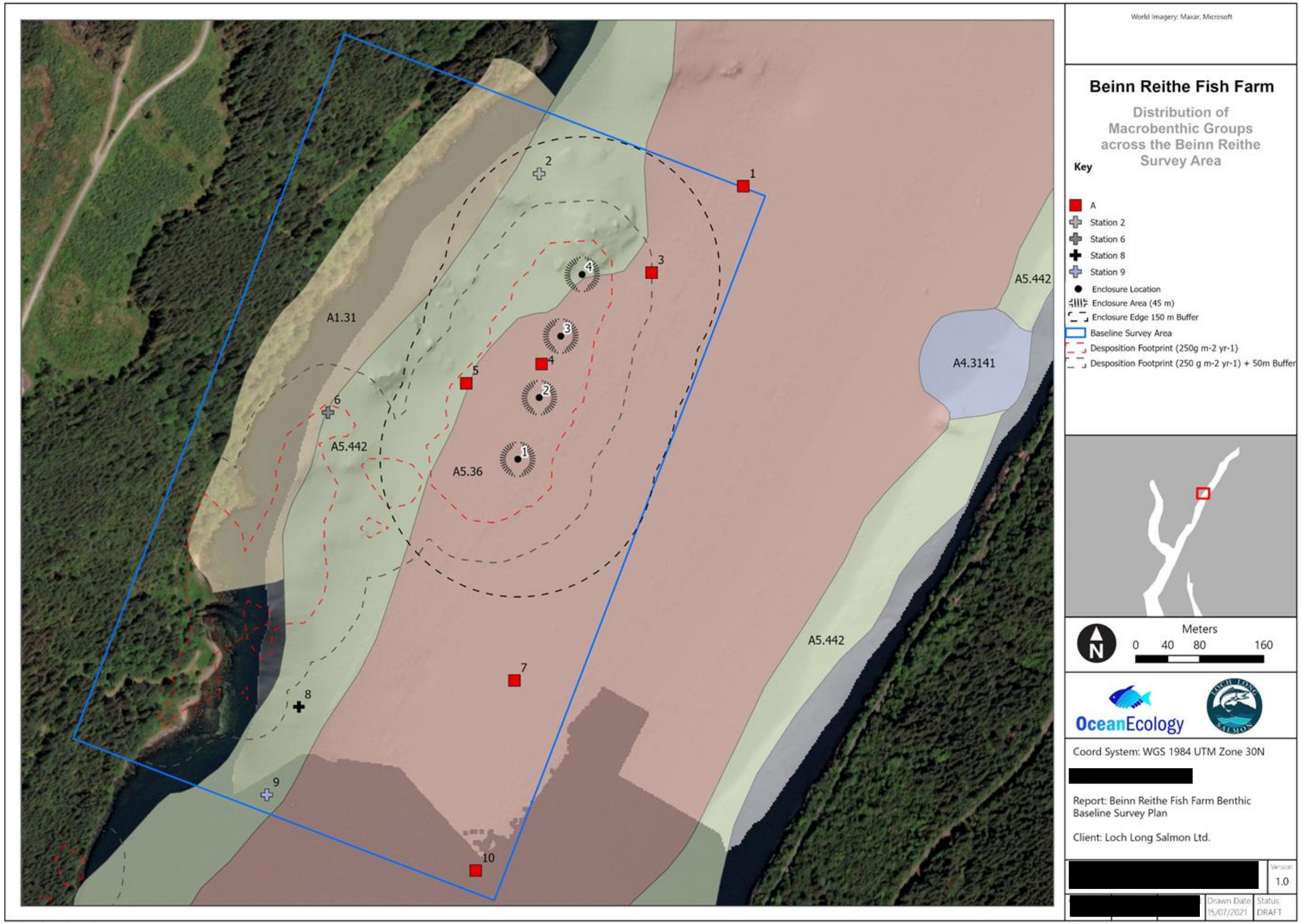

Figure 15. Distribution of macrobenthic groups across the Beinn Reithe survey area.

7.5. Infaunal Quality Index and AMBI Species

As a means of assessing the Ecological Status (ES) across the survey area, the IQI was calculated for all stations based on infaunal and sediment data collected across the Beinn Reithe survey area (Table 5). The survey area was found in overall "good" ES, with a mean IQI value (± SE) of 0.73 ± 0.03 (Figure 16). Some individual samples were classified as "high" ES, namely stations 2, 3 and 6 (Figure 17); however, when IQI values were averaged across the survey area they indicated an overall "good" ES.

Table 5. IQI values at each station sampled across the Beinn Reithe survey area. Cells are colour coded based on ES classification. Green = GOOD (0.64 – 0.75) and Blue = HIGH (>0.75).

Station	1	2	3	4	5	6	7	8	9	10
IQI	0.72	0.89	0.76	0.64	0.67	0.86	0.73	0.65	0.65	0.67

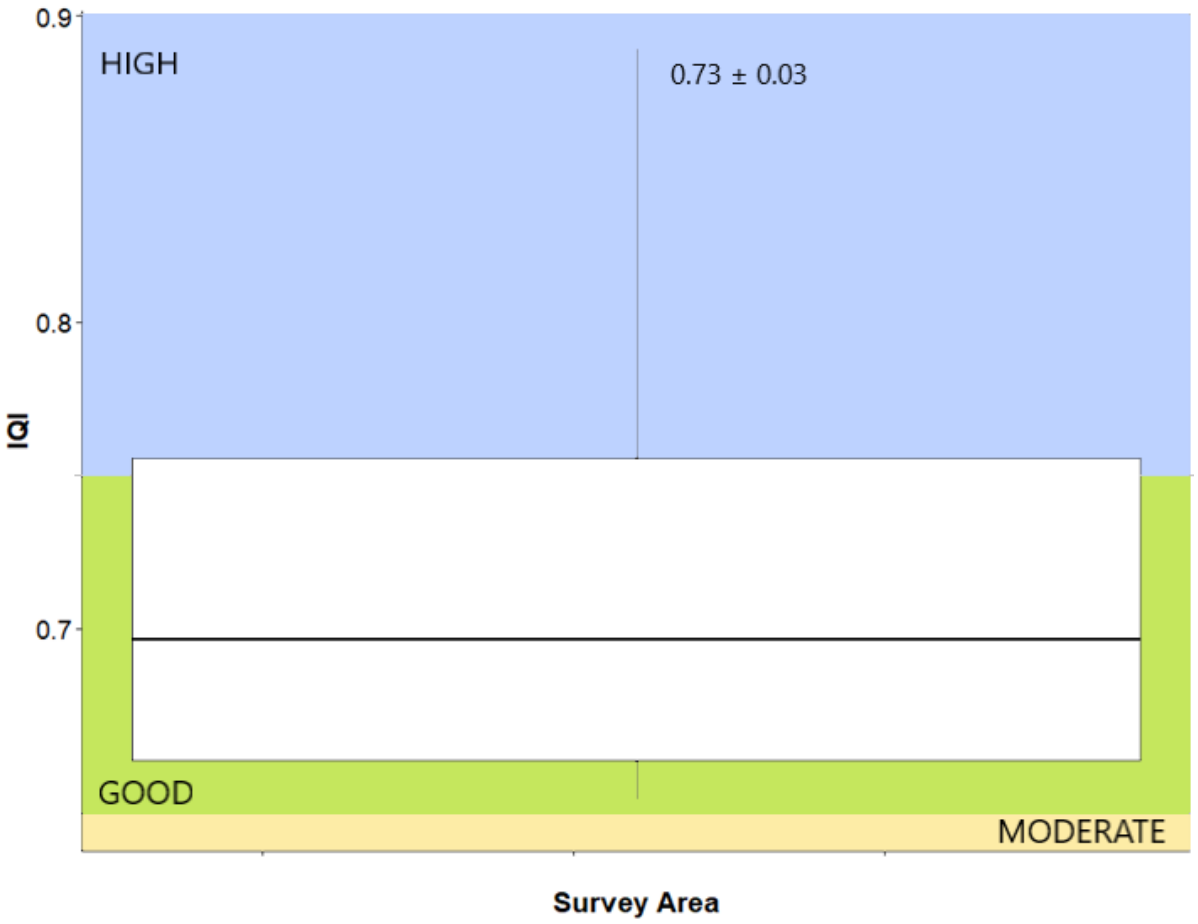

Figure 16. Box plot of IQI values for the Beinn Reithe survey area. Box plot shows the interquartile range and median values whilst the maximum and minimum observed values are represented by the whiskers. Colours illustrate the Ecological Status classification boundaries. Yellow = MODERATE (0.44 – 0.64), Green = GOOD (0.64 – 0.75) and Blue = HIGH (>0.75).

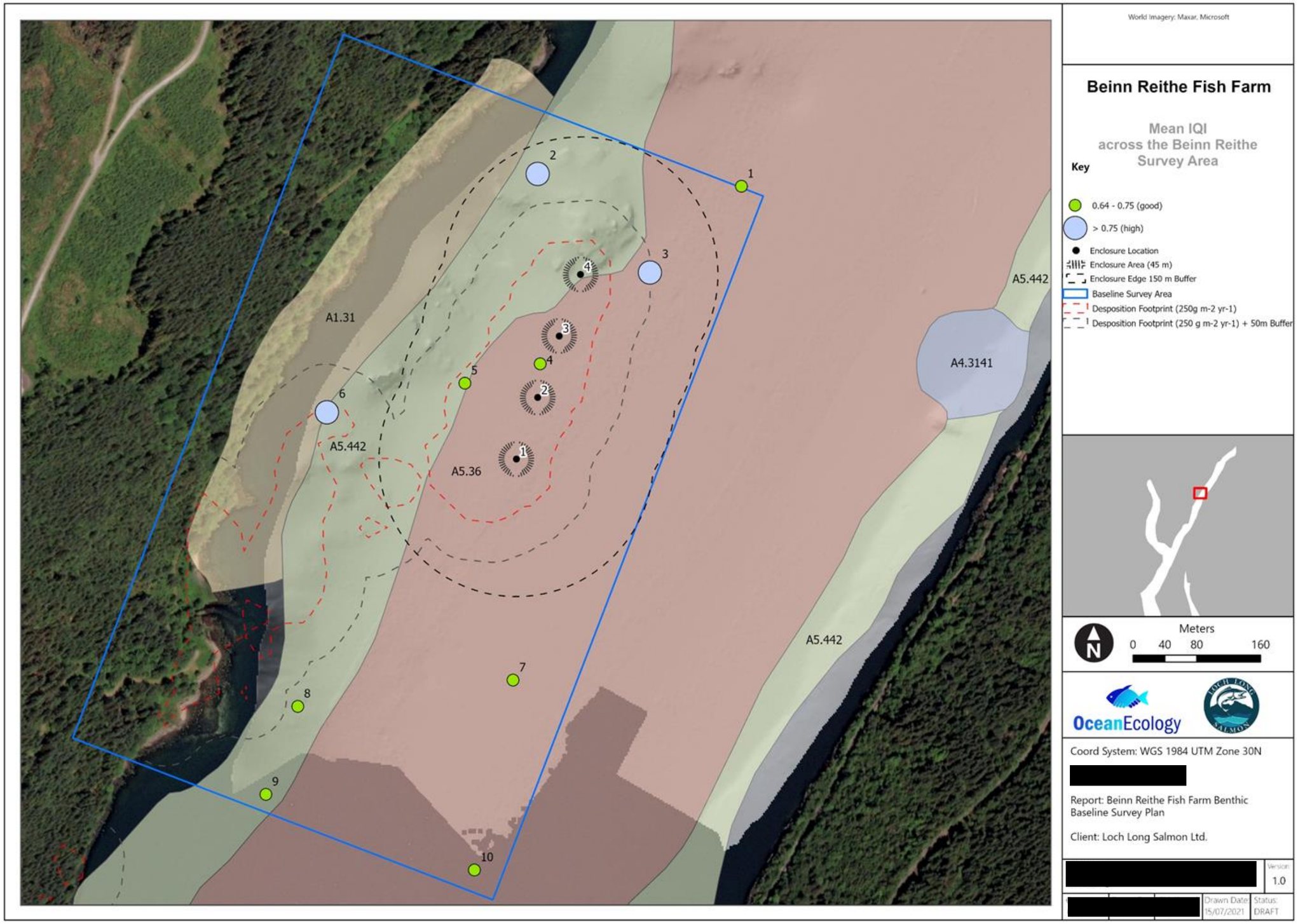

Figure 17. IQI at each station sampled across the Beinn Reithe survey area. Colours illustrate the Ecological Status (ES) classification boundaries. Green = GOOD (0.64 – 0.75) and Blue = HIGH (>0.75).

7.6. Notable Taxa

One species of conservation interest was identified from the 10 grab samples collected across the Beinn Reithe survey area (Table 6). This was the ocean quahog *Arctica islandica* which is a designated species under the OSPAR List of Threatened and/or Declining Species and Habitats (2008) and listed as a PMF in Scotland (Tyler-Walters et al. 2016). Only two juvenile specimens were found in total across the survey area, one at Station 1 and the other at Station 2.

Table 6. Notable taxa found across the Beinn Reithe survey area.

Taxon	Major Group	Designation	N of individuals
Arctica islandica	Mollusca	OSPAR List of Threatened and/or Declining Species and Habitats	2

8. Discussion

This report sets out the benthic baseline conditions for the proposed Beinn Reithe fish farm to be installed and operated Long Long Salmon (LLS). It acts to inform the Scottish Environment Protection Agency (SEPA) of the benthic conditions at the site prior to installation as well as providing a robust dataset for future comparison if required

8.1. Sediments

Despite some variation in sediment type between stations, most stations were dominated by mud and sand with an overall low gravel content except for Stations 6, 8 and 9 (Figure 6). Of the ten stations sampled, EUNIS BSH A5.3 'Mud and sandy Mud' was the most common occurring at 7 stations, followed by EUNIS BSH A5.4 'Mixed Sediments' (n=3). These types of sediment are among the most common habitats found in subtidal settings across the UK coast and fall in the list of habitats of principal importance under Section 2(4) of the Nature Conservation (Scotland) Act 2004.

In general, stations rich in mud (> 20 %) were also the stations with the highest TOC content (> 3%). Studies based on the coastal ocean and marine environment have found a positive relationship between organic carbon content and proportions of finer sediment grain size (Winterwerp & van Kesteren 2004, McBreen et al. 2008, Hunt et al. 2020) which is reflected in this broad scale pattern observed across the survey area (Figure 6 and Figure 8Figure 8). On average TOC (2.76 ± 0.6 %) measured across the survey area compares well with global sediment average TOC content for marginal seas (2 %) (Seiter et al. 2004).

8.2. Macrobenthos

A diverse macrobenthic community was identified across the survey area with a total of 3,789 individuals and 96 taxa recorded. However, most stations were characterised by the presence of the polychaete *M. fragilis* which occurred in 33.3 % of the samples. Other key taxa were the bivalves *T. flexuosa* and *N. nitidosa*, the roundworms Nematoda and the polychaete *Chaetozone* (Species A), which were recorded in all the sampling stations (Figure 9).

Macrobenthic communities can be highly heterogenous as they are heavily influenced by ambient environmental conditions such as sediment composition (Cooper et al. 2011), hydrodynamic forces and physical disturbance (Hall 1994), depth (Ellingsen 2002) and salinity (Thorson 1966). Macrobenthic abundance (N) and richness (S) varied across the Beinn Reithe survey area with high N values and relatively low S values toward the middle of the loch, in proximity of the proposed enclosure locations, while the opposite pattern was observed at the stations closer to land (Figure 11 and Figure 12). The Macrobenthic Groups identified by the multivariate cluster analysis did reflect this pattern with stations located in the middle of the loch belonging to the same group, Macrobenthic Group A, while the remaining 4 stations formed individual groups on their own. Sediment composition is a key factor in determining

macrobenthic community structure (Hall 1994, Cooper et al. 2011), itself defined by ambient conditions. This was clearly reflected in the Macrobenthic Groups detected across the Beinn Reithe survey area with Macrobenthic Group A characterised by the dominance of *L. koreni* and other polychaetes indicating an affinity for muddier substrates compared to the other stations which had a higher content of sand (Station 2) and gravel (Station 6, 8 and 9) (Figure 6).

The IQI assessment carried out based on macrobenthic and sediment data obtained across the Beinn Reithe survey area indicated a "good" ES across the area as a whole (Figure 16), with Stations 2, 3 and 6 reporting a "high" ES (Figure 17). This metric will be useful as a means of comparison in the future to monitor the ES following the installation of the fish farm for assessing compliance with any Controlled Activities Regulations (CAR) licence consented for the site.

One species of conservation interest was identified from the 10 grab samples. This was the ocean quahog *Arctica islandica* which is a designated species under the OSPAR List of Threatened and/or Declining Species and Habitats (2008) and listed as a limited mobility PMF species in Scotland (Tyler-Walters et al. 2016). Only two juvenile specimens were found in total across the survey area indicating that it is unlikely that a significant aggregation of this species occurs across the site.

8.3. EUNIS Habitats/Biotopes

The main habitat identified across the survey area at which grab samples were obtained was EUNIS biotope A5.355 '*Lagis koreni* and *Phaxas pellucidus* in circalittoral sandy mud' mostly encompassing stations located in proximity of the proposed enclosure locations (middle of the loch). Station located closer to land were characterised as level 4 EUNIS classifications A5.44 'Circalittoral mixed sediments' and EUNIS biotope A5.35 'Circalittoral sandy mud'.

Overall, the habitat identified across the Beinn Reithe survey area using a combination of sediment and macrofauna samples for ground truthing reflect the existing EMODnet broad scale habitat mapping while providing a more refined assessment of the habitats and biotopes present across the survey area, including key features and designated habitats.

9. References

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