



Beinn Reithe Fish Farm
Environmental Monitoring Plan
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1. Abbreviations

ADCP	Acoustic Doppler Current Profiler
BGS	British Geological Survey
BSP	Baseline Survey Plan
CAR	Controlled Activities Regulations
DDV	Drop Down Video
EMODnet	European Marine Observation and Data Network
EMP	Environmental Monitoring Plan
IQI	Infaunal Quality Index
LLS	Loch Long Salmon Ltd
MACS	Measurement Assurance and Certification Scotland
MBES	Multi Beam Echosounder
MEDIN	Marine Environment Data Network
MT	Metric Tons
NMBAQC	North East Atlantic Marine Biological Analytical Quality Control
OEL	Ocean Ecology Limited
PMF	Priority Marine Features
PSA	Particle Size Analysis
PSD	Particle Size Distribution
SEPA	Scottish Environment Protection Agency
TOC	Total Organic Carbon
UKHO	UK Hydrographic Office



2. Introduction

2.1. Overview

This Environmental Monitoring Plan (EMP) sets out the proposed compliance monitoring protocol to be followed by Loch Long Salmon Ltd. (LLS) at the Beinn Reithe semi-closed system salmon farm site in Loch Long, Scotland. The monitoring at the site will be based on the default monitoring design as described in SEPA's latest seabed environmental standards guidance for marine finfish farms (SEPA 2021) and will be undertaken in consideration of the latest Measurement Assurance and Certification Scotland Performance Standards (SEPA 2019a b).

2.2. Site Information

The Beinn Reithe site is located off the west shore of Upper Loch Long in the Firth of Clyde loch system and will comprise four 45 m diameter enclosures constituting a maximum allowed biomass (MAB) of 3,452 metric tons (MT) for the site (Figure 1). The enclosures will be located in water depths ranging from approximately 40-50 m.

Table 1 Beinn Reithe fish farm site information.

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 45m diameter 140 m circumference
Emamectin benzoate	0g (MTQ); 0g (TAQ)
Azamethiphos	0g/24hrs
Deltamethrin	0g/3hrs
Cypermethrin	0g/3hrs

2.3. Existing Data

A notable volume of data exists for the Beinn Reithe site and its environs. This includes British Geological Survey (BGS) bathymetric survey and NatureScot monitoring data of the wider Loch Long area (Allen et al. 2013) as well as acoustic doppler current profiler (ADCP), seabed imagery and grab sample data collected during targeted surveys conducted by LLS. A full description of existing data and targeted surveys is provided in Appendix II. As a means of assessing the Ecological Status (ES) of the Beinn Reithe site, the Infaunal Quality Index (IQI) was calculated based on macrobenthic and sediment data collected during the benthic baseline survey conducted in June 2021 (Ocean Ecology Limited 2021). Overall, the site was deemed to exhibit a "good" ES, when IQI values were averaged across the survey area with a mean IQI value (\pm SE) of 0.73 ± 0.03 .

2.4. Deposition Modelling

The likely deposition resulting from discharges from the proposed Beinn Reithe site has been predicted using NewDEPDMOD model based on ADCP derived current data collected in 2020¹. This established that the total area (m²) with a mean deposited mass more than 250g/m² will be 95,637 m² equating to 90.2% of the allowable mixing zone (106,025 m²). The shape and extent of the predicted 250g/m² area shown in the modelling output (Figure 1) has been used to inform the orientation of the proposed monitoring transects presented in Figure 2 and discussed in Section 2 below.

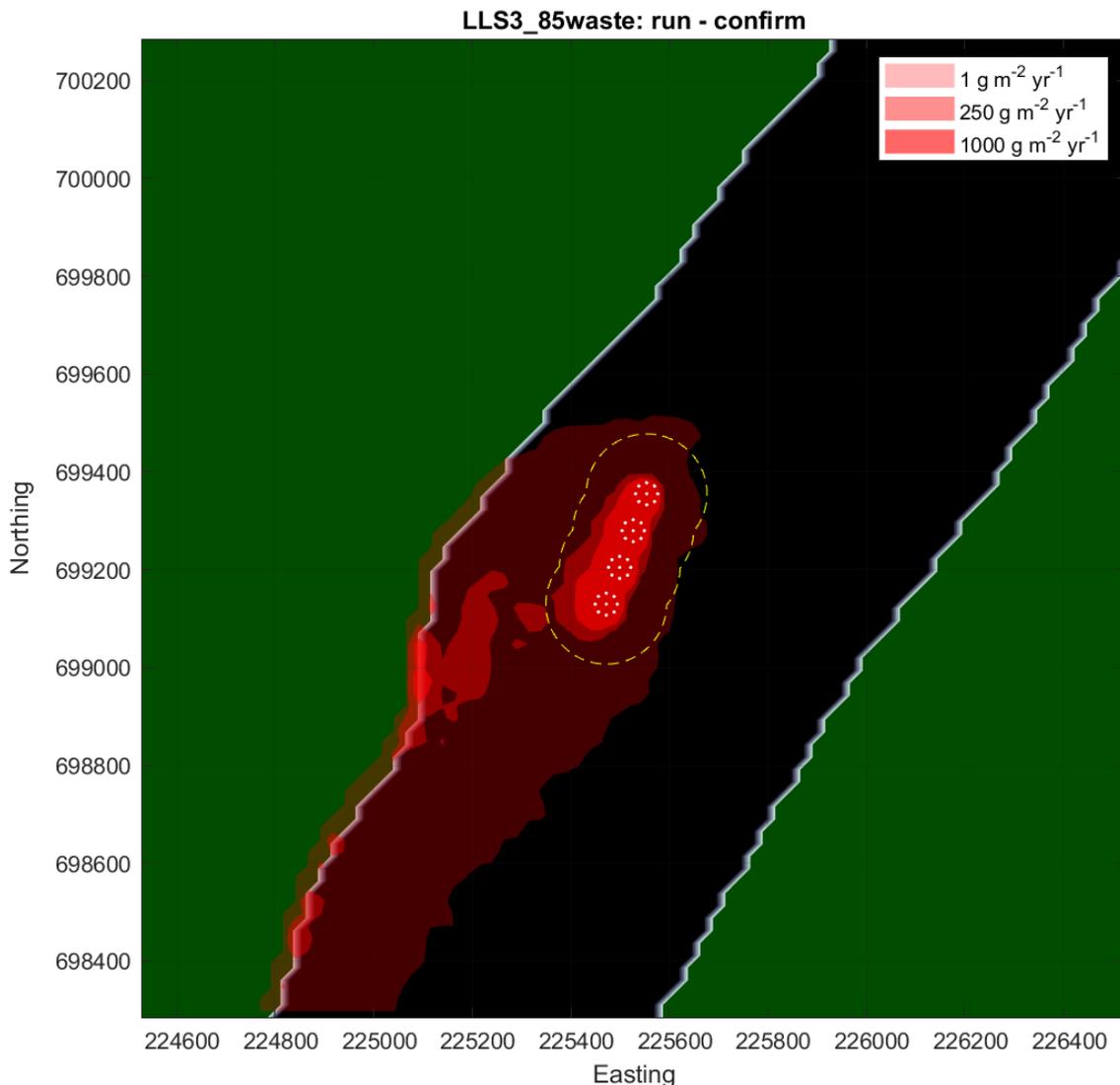


Figure 1 NewDEPDMOD model output for the Beinn Reithe site.

¹ 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.

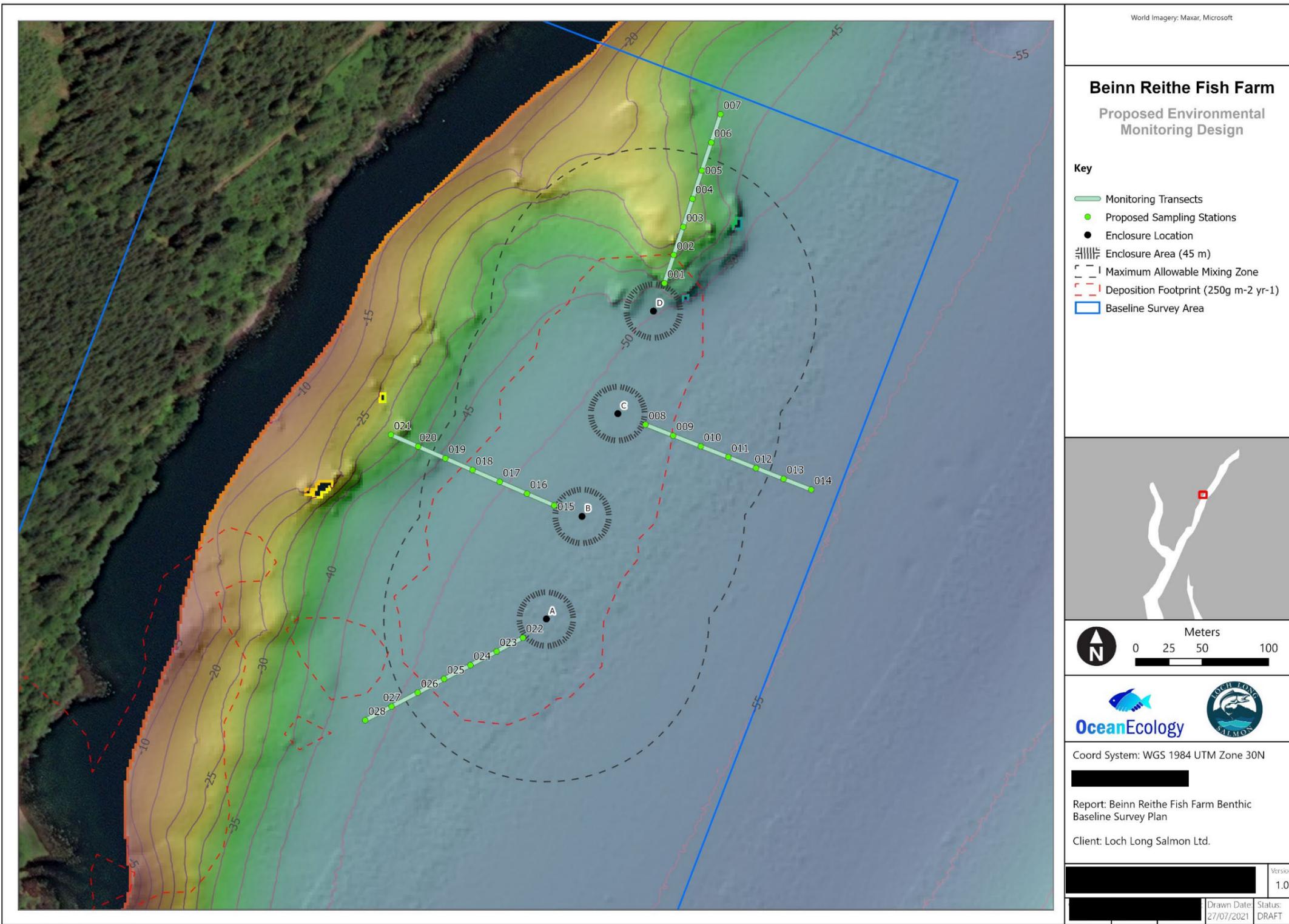


Figure 3 Bathymetric data overlain with the proposed enclosure locations, predicted deposition footprint, orthogonal transects and proposed sample stations.



3. Solid Waste Tracking

In addition to the environmental monitoring set out in Section 4, Loch Long Salmon will also be logging and reporting the mass of solid waste captured and removed from site on a monthly basis. This will be done by calculating the mass of faeces and feed by subtracting the seawater component from the volume of liquid waste removed from site. This will be cross referenced with the feed fed over the same time period and compared month to month to assess for changes in capture performance.

4. Sampling Protocol

4.1. Timing

The Beinn Reithe site will operate either of two farming models. This will include a non-typical post smolt model comprising 3 harvests each followed by short fallow periods over 2-year cycles (Figure 3) or a typical harvest model on 2-yearly cycles (Figure 4).

When farming to the post-smolt model cycle, compliance monitoring will be undertaken either 15 days before and up to 35 days after the Beinn Reithe site has reduced to 75% of the second peak biomass event and then every three peaks in biomass thereafter. LLS will liaise closely with SEPA to assess whether peaks in biomass are good representations of previous peaks within each cycle in terms of biomass and/or duration. If a peak is deemed to be unrepresentative then compliance monitoring will take place during the following peak and the monitoring programme reset at this point. SEPA will be provided with at least 14 days' notice of the start date of each proposed survey.

When employing the traditional harvesting model, compliance monitoring survey will be undertaken within a 35-day period either side of the date that fish biomass at the Beinn Reithe site has reduced to 75% of the peak biomass for the last time during that production cycle. Surveys will not however take place within 14 days of peak biomass. SEPA will be provided with at least 14 days' notice of the start date of each proposed survey.

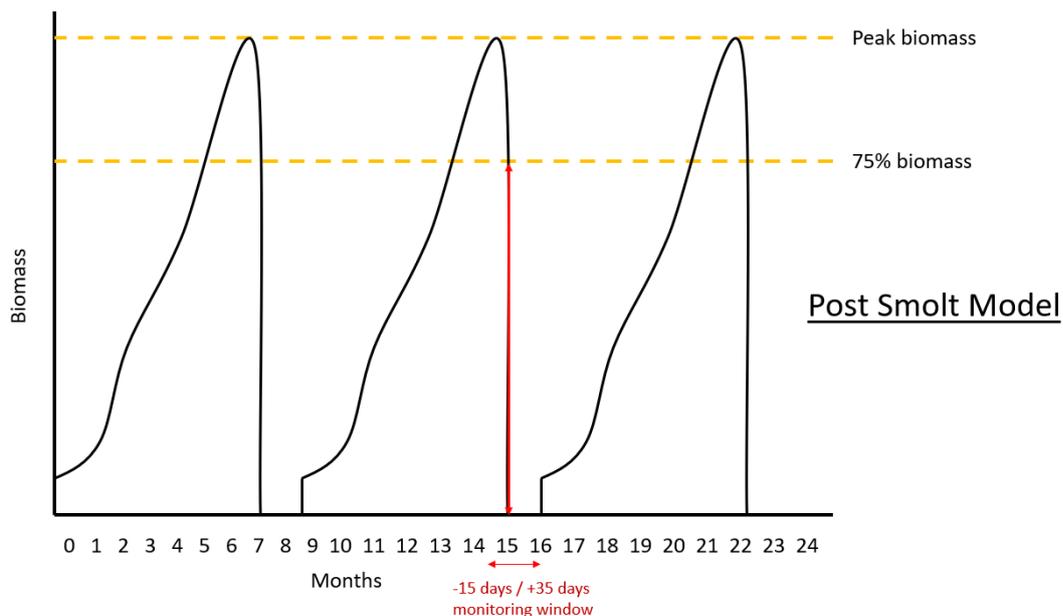


Figure 4 Compliance monitoring timings during each 2-year post smolt cycle at the Beinn Reithe site.

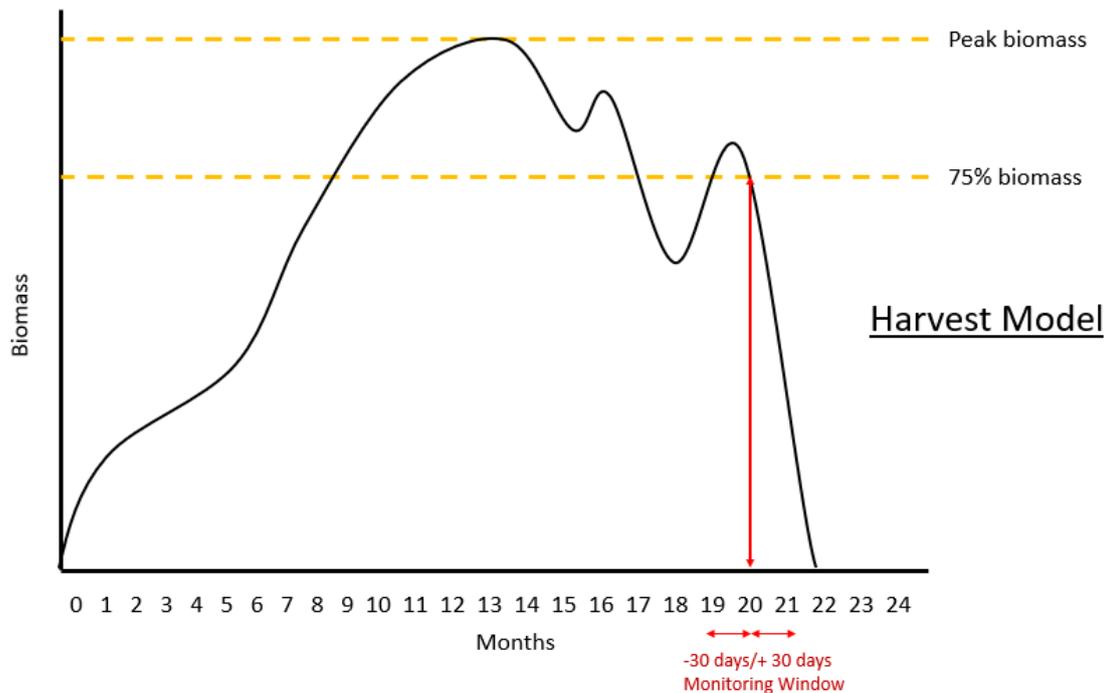


Figure 4 Compliance monitoring timings during each 2-year traditional harvest cycle at the Beinn Reithe site.

4.2. Sampling Design

Each compliance monitoring survey will involve collection of sediment samples at 7 stations along two primary transects aligned with the predominant direction of the seabed currents (as indicated by the extent of the 250g/m² deposition area shown in Figure 1 and along two transects running perpendicular to the primary transects. Each transect will begin at an enclosure edge where the first sampling station will be positioned. The remaining 6 stations on each transect will run along straight bearings each spaced at least 20 m further along the transects from the enclosure than the last. At least the final two stations on each transect will be positioned beyond the predicted impact footprint of the farm. The co-ordinates of each of the 28 proposed sampling stations are provided in Appendix 1 and mapped in Figure 2.

In practice, the exact position of the cage edge will be affected by tide and wind strengths acting to move the enclosures slightly on their anchors. Where there is a difference between modelled enclosure edge positions and the actual enclosure edge positions on the day of survey, there will be a corresponding (if minimal) offset in each of the transect station positions.

The sampling design will be reviewed by LLS in consultation with SEPA and amended as considered necessary following the first survey.



4.3. Sampling Methods

4.3.1. Personnel

Sampling and in field sample processing will be undertaken by experienced marine scientists from Ocean Ecology Limited (OEL) (or another suitably qualified company, depending on survey timing and analytical capacity). All OEL scientists hold a minimum of a degree in marine biology or related discipline, sea survival training certification and seafarers medicals.

4.3.2. Vessel

Each survey will be undertaken aboard OEL's survey vessel the 'Argyll Explorer' which is equipped with a hydraulic A-frame and winch along with dGPS and compass positioning system for providing an accurate offset position of equipment when deployed to the seabed. If required, alternative suitable vessels of similar specification may be employed to complete the sampling. Any alternative vessels used will be competently manned and have the ability to hold station, accurately fix position with dGPS and will be equipped with an A-frame / crane with winch for safe deployment/recovery of the sampling equipment.

4.3.3. Sample Collection

Grab sampling will be undertaken in line with the latest MACS performance standard for sampling soft sediments (MACS FFA 02) (SEPA 2019b). At each sampling station two sediment samples will be collected using a 0.1 m² Day or 0.1 m² Van Veen grab sampler. One grab sample will be collected exclusively for subsequent macrobenthic analysis, and one will be collected exclusively for subsequent physio-chemical analysis (Particle Size Distribution (PSD) and Total Organic Carbon (TOC)).

The grab will be deployed from the hydraulic 'A' frame on the Argyll Explorer (or alternative vessel if used) and lowered to the seabed. Upon landing on the seabed (indicated by the slackening of the winch wire) a positional fix will be taken. The sample will then be recovered to the deck at which point the grab inspection hatches will be opened and excess water will be slowly drained to allow for inspection and or approval/rejection.

To ensure consistency in sampling, grab samples will be screened by the lead marine scientist and considered unacceptable if:

- The jaws fail to close completely or are jammed open by an obstruction, allowing fines to pass through (washout or partial washout).
- A sample has an obviously uneven bite.
- Grab fullness is less than:
 - 1/2 full for muddy sediments.
 - 1/3 full for hard packed sands.
- There is obvious contamination of the sample from survey equipment, paint chips etc.

In the event of an unsuccessful grabbing attempt, several repeat attempts must be made. Where no acceptable grab is recovered within five attempts then sampling of that station will be abandoned.

Detailed field notes will be taken including:

- Station number
- Sample type (macrobenthic or physio-chemical)



- Fix number (as a record of co-ordinates)
- Time of collection (UTC)
- Water depth (m)
- Weather conditions
- Number of attempts
- Sample volume (l)
- Grab fullness (1/3, 1/2, 2/3, 3/4 full)
- Grab bit depth estimate (cm)
- Surface sediment characteristics
- Sediment type (as per Folk (1954) classification)
- Conspicuous fauna
- Any sign of protected features
- Reason/rationale of any rejected samples.

4.3.4. Sample Processing

Once accepted each grab sample will be processed in the field in line with the following methodology:

Sample 1 – Macrobenthic Sample

- Photograph of sample taken through inspection hatch with station details and scale bar shown.
- Sample emptied into container and photographed with station details and scale bar shown.
- Sample emptied onto a 1.0 mm sieve net laid over 4.0 mm sieve table and washed through using gentle rinsing with seawater hose.
- Sieved sample photographed with station details and scale bar shown.
- Remaining sample for sorting and identification backwashed into a suitable sized sample container and diluted 10% buffered formalin solution added to fix the sample.
- Sample container clearly labelled internally and externally with the survey name and sample details.

Sample 2 – Physio-Chemical Sample

- Photograph of sample taken through inspection hatch with station details and scale bar shown.
- PSD subsample taken by pushing a plastic or metal corer vertically through the sediment to the full depth of the grab.
- PSD core placed into a sealed plastic container.
- Corer thoroughly rinsed with seawater.
- TOC subsample taken by pushing a plastic or metal corer vertically through the sediment to a depth of 5 cm.
- Sample containers both clearly labelled internally and externally with the survey name and sample details.
- Both samples frozen as soon as practicable, and a least within 24 hours of collection.



4.4. Laboratory Methods

All sample analysis will be undertaken at OEL's NE Atlantic Marine Biological Quality Control (NMBAQC) scheme participating laboratory in Oban (or by an alternative laboratory, depending on survey timing and analytical capacity). Any alternative laboratories used should be able to demonstrate successful participation in the Benthic Invertebrate (BI) and Particle Size Analysis (PSA) components of the NMBAQC scheme.

4.4.1. PSD Analysis

Particle Size Distribution (PSD) analysis of sediment samples will be undertaken in line with NMBAQC best practice guidance (Mason 2016).

4.4.2. TOC Analysis

Total Organic Content (TOC) of dry sediment will be determined using Loss on Ignition (LOI) at 480°C as a surrogate. The analysis will be undertaken on subsamples from the <1 mm fraction of each sample.

4.4.3. Macrobenthic Analysis

All elutriation, extraction, identification and enumeration of the macrobenthic samples will be undertaken in line with the NMBAQC Processing Requirement Protocol (PRP) (Worsfold & Hall 2010). All processing information and macrobenthic records will be recorded using OEL's cloud-based data management application 'ABACUS' (or other laboratory databases/applications if alternative laboratories are used) that employs MEDIN2 validated controlled vocabularies ensuring all sample information, nomenclature, qualifiers and metadata are recorded in line with international data standards

All macrobenthos present will be 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 will utilise a live link within ABACUS to the WoRMS³ REST webservice (World Register of Marine Species), to ensure the most up to date taxonomic classifications are recorded. Colonial fauna (e.g. hydroids and bryozoans) will be recorded as present (P). For the purposes of subsequent data analysis, taxa recorded as P will be given the numerical value of 1.

Following identification, all specimens from each sample will be 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) will be applied to biomass data to provide equivalent dry weight biomass (Ash Free Dry Weight, AFDW). The conversion factors to be applied are as follows:

- Annelida = 15.5 %
- Crustacea = 22.5 %
- Mollusca = 8.5 %
- Echinodermata = 8.0 %

² Marine Environmental Data and Information Network

³ <http://www.marinespecies.org>



- Miscellaneous = 15.5 %

5. Reporting

Following completion of the sample analysis the results will be submitted to SEPA in the form of a technical monitoring report summarising the methods employed, the results of the analysis and conclusions. A full set of appendices will also be provided to satisfy SEPA requirements including a populated version of the most recent SEPA template for presenting compliance survey results.



6. Appendices

Appendix I. Proposed positions of compliance monitoring sampling stations for the Beinn Reithe fish farm.

Station	Transect	Bearing (T)	Distance	Latitude	Longitude
1	D	18	0m enclosure edge	56.15509	-4.81008
2	D	18	25m	56.15528	-4.80997
3	D	18	50m	56.15547	-4.80987
4	D	18	75m	56.15567	-4.80976
5	D	18	100m	56.15586	-4.80966
6	D	18	125m	56.15605	-4.80955
7	D	18	150m	56.15624	-4.80945
8	C	113	0m enclosure edge	56.15413	-4.81026
9	C	113	25m	56.15406	-4.80992
10	C	113	50m	56.15399	-4.80958
11	C	113	75m	56.15393	-4.80925
12	C	113	100m	56.15386	-4.80891
13	C	113	125m	56.15379	-4.80857
14	C	113	150m	56.15372	-4.80823
15	B	293	0m enclosure edge	56.15357	-4.81134
16	B	293	25m	56.15364	-4.81167
17	B	293	50m	56.15372	-4.81201
18	B	293	75m	56.15379	-4.81234
19	B	293	100m	56.15387	-4.81267
20	B	293	125m	56.15394	-4.81301
21	B	293	150m	56.15402	-4.81334
22	A	242	0m enclosure edge	56.15267	-4.81168
23	A	242	25m	56.15257	-4.81199
24	A	242	50m	56.15247	-4.81231
25	A	242	75m	56.15238	-4.81262
26	A	242	100m	56.15228	-4.81293
27	A	242	125m	56.15218	-4.81325
28	A	242	150m	56.15208	-4.81356



Appendix II. Existing data.

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 Portal⁴ and the Marine Environment Data Network (MEDIN)⁵. Wider coverage bathymetry data is also available for the whole of Loch Long (OceanWise Marine Themes DEM⁶) although a licence for this dataset was not available at the time of preparing this document.

NatureScot Survey 2010

In 2010 NatureScot performed a drop-down camera survey throughout the Clyde Sea Area to validate the presence of 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 burrowed muds were extensive throughout the wider Loch Long area, where in the upper reaches 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.

Existing Mapping

EMODnet

Medium scale habitat mapping is available for the proposed Beinn Reithe site from the European Marine Observation and Data Network (EMODnet) mapping portal⁷. 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 '*Furoids 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.

Priority Marine Features

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 pen location that represents a component biotope

⁴ <https://datahub.admiralty.co.uk/portal/apps/sites/#/marine-data-portal>

⁵ <https://www.medin.org.uk/>

⁶ <http://marine.gov.scot/maps/1640>

⁷ <https://www.emodnet-seabedhabitats.eu/access-data/launch-map-viewer/>



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 OSPAR List of Threatened and/or Declining Species and 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 (see below) 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 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.

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 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 see below and therefore the presence/absence of this habitat and any associated PMFs (e.g. 'Kelp Beds') cannot be confirmed.

Benthic Video Survey 2020

A drop-down video (DDV) benthic survey was undertaken in September 2020 by Anderson Marine Surveys Ltd (AMSL) (Aquatera 2020) with the aim to investigate seabed species and habitats within the Beinn Reithe application site. This involved collection of seabed imagery using a drop-down camera along four 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 gravel overlain with fine sediment were additionally observed at around 20 – 30 m depth along the northwest extent of the survey area.

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.



Benthic Baseline Survey 2021

Ocean Ecology Limited (OEL) were commissioned by LLS to conduct a Benthic Baseline Survey (BBS) of the proposed fish farm and its environs in June 2021. A semi-probabilistic sampling approach was employed which considered all existing survey data and habitat mapping discussed above. This resulted in the sampling of 5 randomised stations positioned in the two key habitats (A5.36 and A5.442) found across the survey area. These 10 sampling stations were sampled using a 0.1m² Van Veen grab on 15th June 2021 aboard the multi role vessel Mary M. The samples subsequently underwent Particle Size Distribution (PSD), macrobenthic and Total Organic Carbon (TOC) analysis.

A Infaunal Quality Index (IQI) assessment was undertaken which incorporated both the macrobenthic and sediment data collected across the survey area. The assessment reported 'good' Ecological Status (ES) for the survey area as a whole with a mean IQI value (\pm SE) of 0.73 ± 0.03 . Some of the individual samples were also classified as "high" (IQI > 0.75) as shown in the map below.

