BIOMASS MODELLING REPORT

Proposed Great Cumbrae Finfish Pen Site, Clyde Estuary

Prepared for

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Quality Assurance

The data used in this document and their input and reporting have undergone a quality assurance review which follows established TransTech Ltd procedures. The information and results presented herein constitute an accurate representation of the data collected.

TransTech is registered with SEPA for marine pen site Biomass (Ref: AMMR08v02) and Chemical discharge modelling (Ref: AMMR08v01).

Document Details

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List of Abbreviations

ADCP	Acoustic Doppler Current Profiler
ATT	Admiralty Total Tide
AZE	Allowable Zone of Effects
CD	Chart Datum
DFL	Dawnfresh Farming Ltd
EQS	Environmental Quality Standards
GMT	Greenwich Mean Time
mCD	Metres below Chart Datum
MSL	Mean Sea Level
PE	Pen Edge
SEPA	Scottish Environment Protection Agency

1. Summary

1. This report has been prepared in order to meet the specific requirements of the Scottish Environment Protection Agency (SEPA) for the assessment of applications for biomass consent for salmonids held in marine pens.

2. The predictive model, AutoDEPOMOD, was used to determine the Allowable Zone of Effects (AZE) footprint, the maximum allowable biomass at the proposed Great Cumbrae pen site in compliance with the Environmental Quality Standards (EQS) set by SEPA.

3. The mid-range speeds observed at the site during a 90 day ADCP deployment were used in the modelling. The mid-range values were used as these will be more representative of general conditions at the site. They also allow sample transects and stations to be determined for typical conditions at the site.

4. For the mid-range dataset AutoDEPOMOD predicted a benthic pass for a biomass consent of 2500.0 tonnes.

Benthic Pass = 2500.0 T 3

Stocking Density = 13.6 kg/m

2. Introduction

This report has been prepared in order to meet the specific requirements of the Scottish Environment Protection Agency for the assessment of applications for biomass consent. The biomass must comply with the EQS that is in place to protect the marine environment.

This report describes the results of predictive modelling for the AZE footprint and the maximum permissible biomass at the Great Cumbrae site.

The hydrographic data used in the modelling was provided by Dawnfresh Farming Ltd (DFL). A hydrographic report has been prepared by DFL and is understood to be submitted to SEPA along with this report.

The methods described in this report closely adhere to those set out in Annex H of the SEPA Fish Farming Manual (2005), and the results are reported to satisfy consent application requirements.

3. Great Cumbrae site information

Site details

Site name:	Great Cumbrae
Location:	Clyde Estuary

Pen group details

Group centre position:	218262.2 E, 654944.0 N
NW pen centre position:	218286.1 E, 655095.6 N
Number of pens:	10
Reported pen group configuration:	2 x 5
Pen dimensions:	120 m circumference circles
Net depth:	16.0 m
Grid size (x by y):	75 m x 65 m
Pen group orientation:	201.2°

Hydrographic data

Current meter position:	218270.2 E, 654952.9 N (12.0 m from group centre)
Minimum depth recorded by ADCP + 0.5 m for frame:	37.57 m
Sub surface cell:	32.92 m above seabed
Selected pen bottom cell:	21.92 m above seabed
Near bed cell:	2.92 m above seabed
Current meter averaging interval:	20 min
Record used for modelling (mid-range dataset):	15 days (29/10/17 09:47 to 13/11/17 09:47 GMT)

Additional data

Correction from Magnetic to Grid N:	-0.37°
Mean tidal level at site:	1.99 m (Millport)

4. Hydrographic data

The dataset used in the modelling was collected over a 15 day period which incorporated both the spring and neap components of the tidal cycle. Data were collected at 20 minute intervals and copied into the temp-20min-HGv3.xls spreadsheet to generate the .dat files required by AutoDEPOMOD. Dates and times of spring and neap high waters (table 1) were determined using the Admiralty Total Tide software (ATT). Predictions were obtained for Millport (55°45'N 4°56'W), the closest secondary port to the proposed site.

Table 1. Spring and neap tides

Tide	State	Date	Time (GMT)	Level above CD
Spring	HW	06/11/2017	01:06	3.6 m
Neap	HW	12/11/2017	06:59	2.8 m

In accordance with SEPA modelling guidelines, current meter records to be used must start at midday (GMT) on the day of the intermediate-spring and intermediate-neap tide. The date and time of the intermediate tides used in the hourly averaged records (temp-20min-HGv3.xls files) are provided in table 2.

Table 2. Intermediate spring and intermediate neap tides

Tide	Date	Time (GMT)	Hourly record
Predicted intermediate-spring	03/11/2017	12:27	123
Predicted intermediate-neap	10/11/2017	12:27	291

Admiralty Total Tide Mean Sea Level (MSL) at the site is Chart Datum + 1.99 m. The raw current meter direction data were corrected from magnetic north to grid north by subtracting 0.37˚ from the magnetic north direction data.

The current meter data is summarised below:

Table 3. Current meter data summary

Period	Cell	Mean speed (m/s)	Residual speed (m/s)	Residual direction (˚Grid N)
29/10/17 09:47 to 13/11/17 09:47 GMT	Sub surface	0.194	0.050	231.4
	Pen bottom	0.157	0.063	219.2
	Near bed	0.110	0.026	235.6

5. AutoDEPOMOD

5.1 Site set-up

A new project was created in AutoDEPOMOD (v2.0.52, 17-Aug-2005) and named

Great_Cumbrae_2018v1-M. All of the relevant bathymetric and current meter files were set up in their respective directories and the pen information was entered into the corresponding FFMTv3.0.xls file. Pen positions and orientations were then checked by looking at the AutoDEPOMOD profile to ensure that they were in the correct position.

5.2 Model grid generation

The grid limits were set to 217760 E to 218760 E and 654440 N to 655440 N.

The .csv and an appropriate .ini file was saved into the \depomod\gridgen folder, as required by AutoDEPOMOD to generate the grid over which the pens would be laid. The grid was then generated with a cell size of 25 m and is shown in figure 1.

2324 depth measurements fall within the modelled grid (figure 2). These along with 489 depths bounding the grid and chart contours were used to create the Great_Cumbrae_2018v1-M.csv file. The recorded depths and their conversion to Chart Datum are provided in Great_Cumbrae_2018v1-M/Bathymetry.

5.3 Benthic modelling

Run details used for biomass consent modelling:

No. of particles = Initial run 1 and refine at 10
Convergence value = 1 tonnes
Neap-Spring with automatically redo using Spring-Neap

Benthic Modelling Parameters:

Equally-distribute Biomass = ON
Stocking Density = 13.6354 kg/m^3
Pen Volume Adjustment = 1

A maximum biomass of 2500.0 tonnes was specified for the modelling by setting the stocking density to 13.6354 kg/m^3. The model iterated to a MAX prediction of 2500.0 tonnes for the neapspring and spring-neap runs respectively (Runs 2 and 3). The run with the smallest area of impact at the 30 ITI EQS was Run 3 (spring-neap).

The maximum feed input for Run 3 (figure 1) was defined by the model as 17500.0 kg/day. The 80% solids area was predicted as 56208 m^2 with a flux in the area of 410 g/m^2/yr.

At the 2500.0 tonnes biomass, the pen area equivalent contour flux was 1686 g/m^2/yr, at a mean ITI of 9.3 with a pen area of 34901 m^2. The benthic sampling area, where the ITI = 30.0, showed a flux of 191.8 g/m^2/yr inside an area of 62852 m^2. A summary of the results can be found in the Great_Cumbrae_2018v1-M_marine_sum_v3.xls Benthic Worksheet in appendix 1.

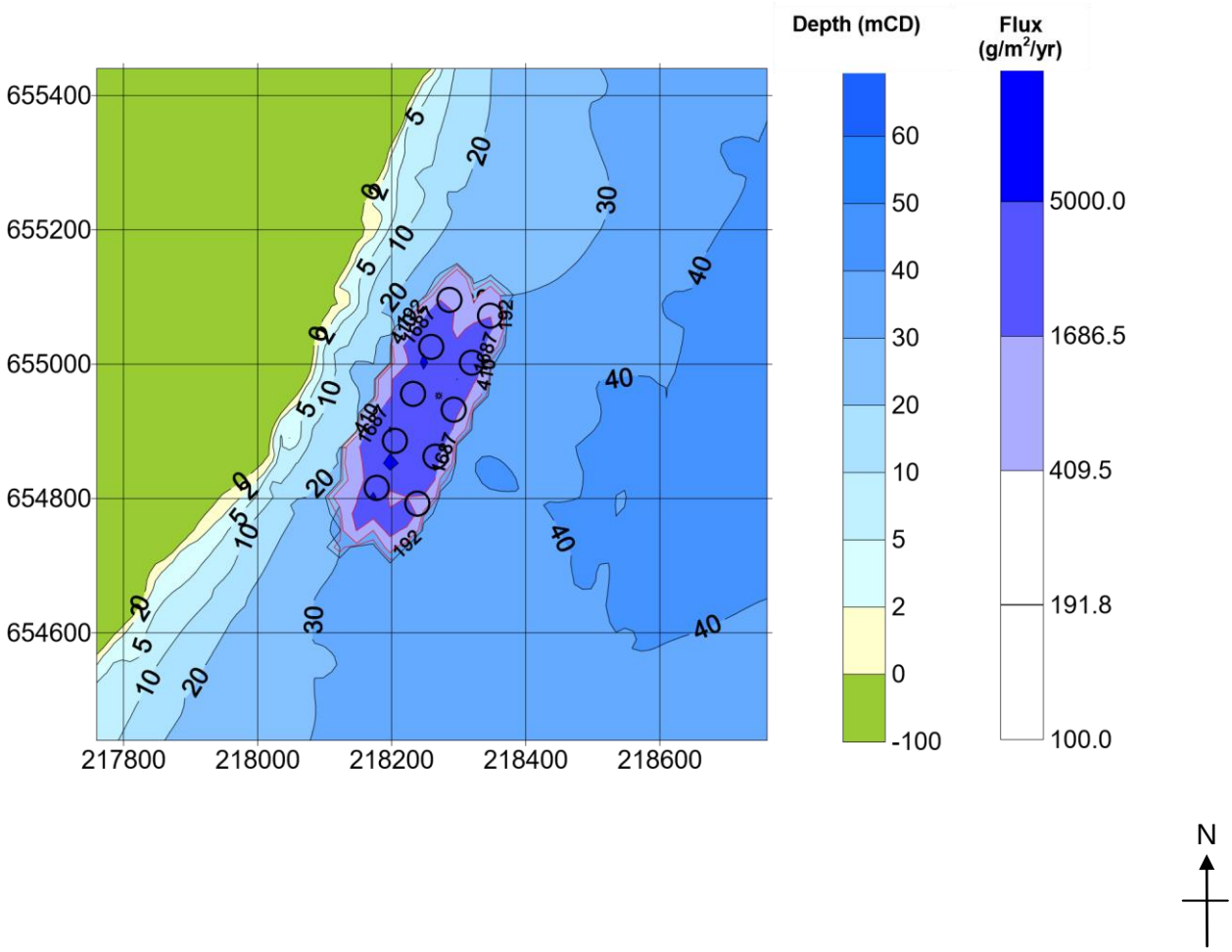

Figure 1. Plot of AutoDEPOMOD benthic model Run 3

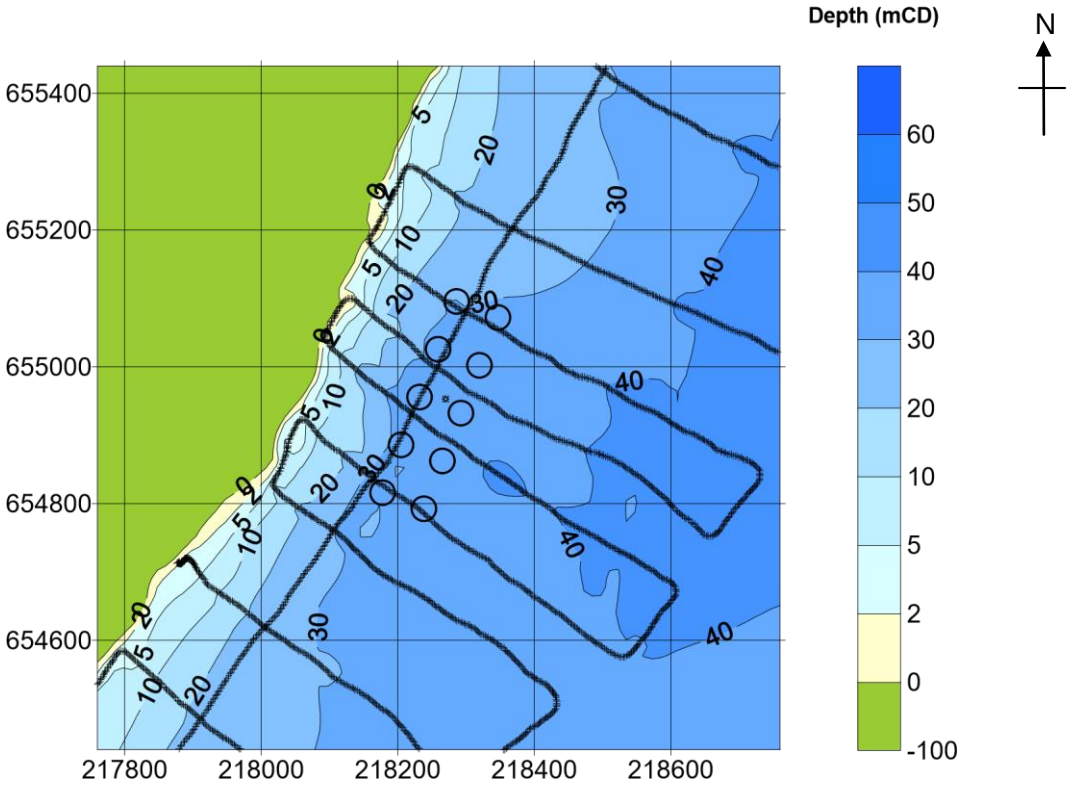

Figure 2. Depth measurement locations

6. Transects and sample stations

Primary and spare sampling transects were created for the site (tables 4 and 5) using Benthic Run 3.

Details of the primary transect:

Transect start co-ordinates (PE)	218165.8 E	654800.5 N
	55 45.1386 N	04 53.9355 W
Transect bearing and length	212.0° Grid North and 125.0 m	
Depth (PE)	30.5 mCD	

Table 4. Details and position of the three selected sample stations along the primary transect

	1st Station (EQS-10m) S2	2nd Station (EQS) S1	3rd Station (EQS+10m) S3
NGR Easting	218123.2	218117.8	218112.5
NGR Northing	654732.4	654723.9	654715.4
Latitude	55 45.1010	55 45.0963	55 45.0916
Longitude	04 53.9735	04 53.9783	04 53.9830
Distance from PE (m)	80.4	90.4	100.4

Depth (mCD)	30.6	29.6	29.3
Modelled ITI	28.3	30.0	36.2

Details of the spare transect:

Transect start co-ordinates (PE)	218228.1 E	654775.9 N
	55 45.1267 N	04 53.8751 W
Transect bearing and length	205.0° Grid North and 125.0 m	
Depth (PE)	33.3 mCD	

Table 5. Details and position of the three selected sample stations along the spare transect

	1st Station (EQS-10m) S5	**2nd Station (EQS) S4**	**3rd Station (EQS+10m) S6**
NGR Easting	218201.0	218196.8	218192.5
NGR Northing	654717.9	654708.8	654699.8
Latitude	55 45.0949	55 45.0899	55 45.0850
Longitude	04 53.8986	04 53.9023	04 53.9060
Distance from PE (m)	64.1	74.1	84.1
Depth (mCD)	31.9	32.0	32.0
Modelled ITI	24.9	30.0	40.9

The position of both the primary and spare transects and the relative sample stations in relation to the site are shown in figures 3 and 4.

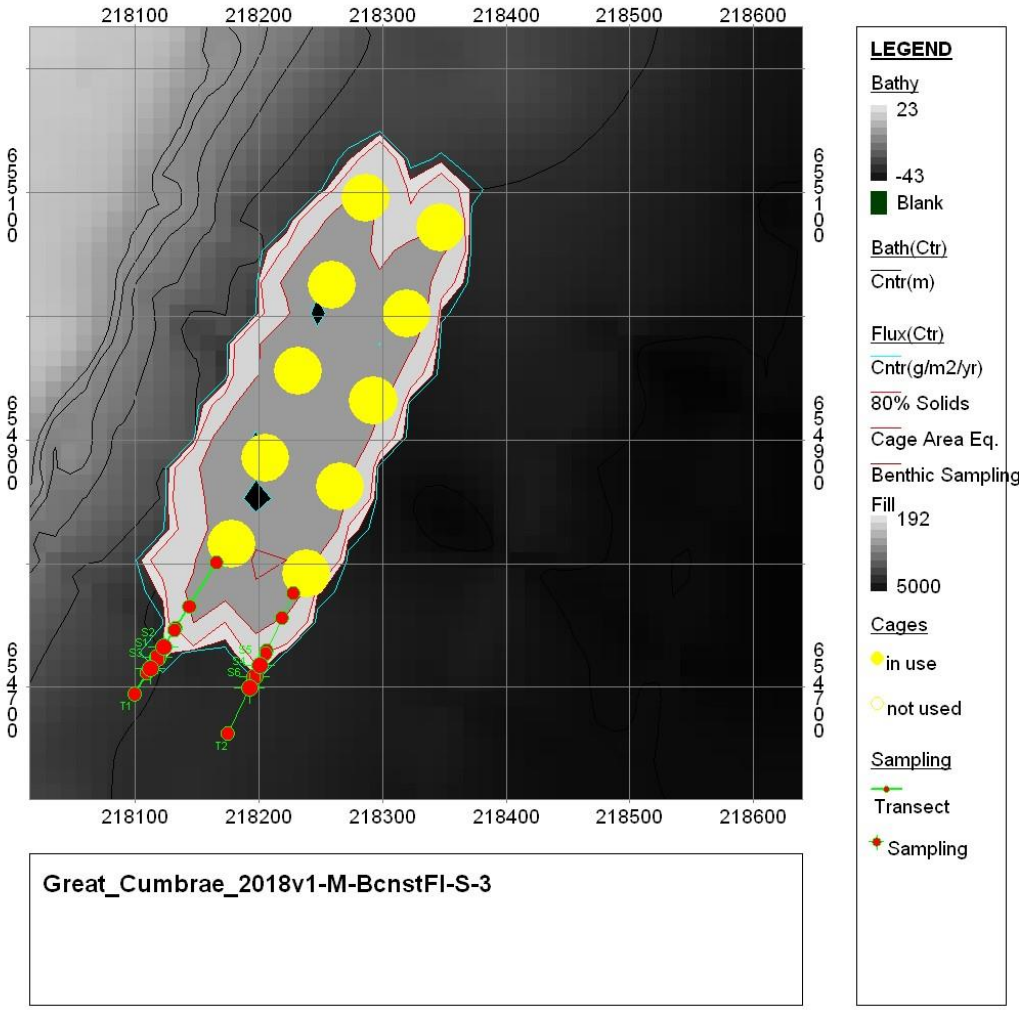

Figure 3. Plot showing primary and spare transect positions and the respective sample stations

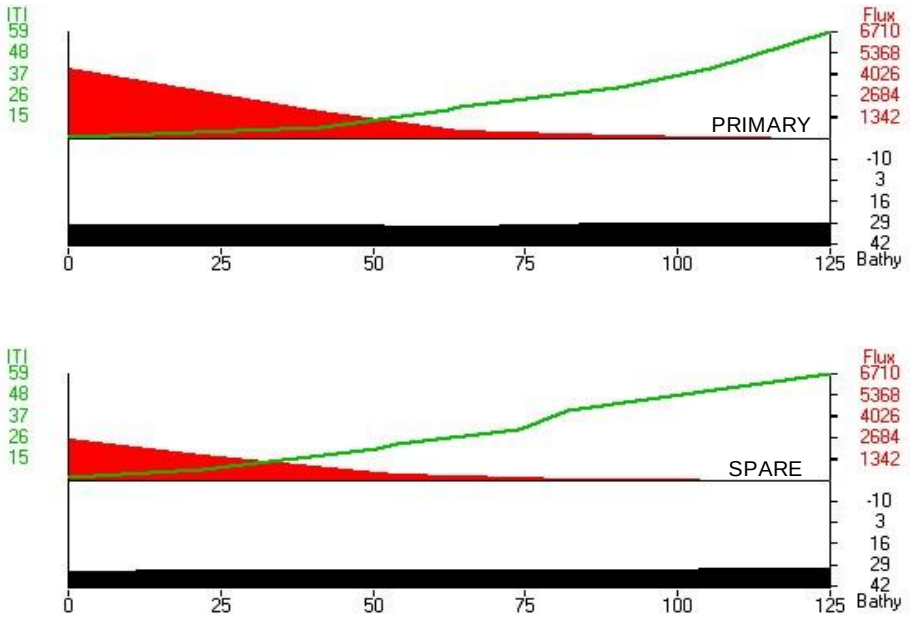

Figure 4. Cross sections of the primary and spare transects

The benthic sampling has been packaged in Great_Cumbrae_2018v1M\depomod\mapping\XLS\Great_Cumbrae_2018v1-M-BcnstFI-S-3_000.xls.

APPENDIX 1

Great_Cumbrae_2018v1-M_marine_sum_v3.xls (Version 3.13) Benthic Worksheet

Fish farm site at :	Great Cumbrae, Clyde Estuary	Receiving water :	
License No. :		Team area :	

Current data summary

LEVEL	Mean	%<=0.09 m/s	Major axis	major amp./ minor amp.	Residual speed	Residual direction	Vector av. residual
Sub-surface	0.19	21%	210	3.15	0.050	231	0.046 m/s at 226 degrees
Cage-bottom	0.16	30%	210	3.32	0.060	219	
Near-bed	0.11	50%	205	2.36	0.030	236	

Cage group corners

	NGR Easting	NGR Northing
Corner position #1:	218347 m	655072 m
Corner position #2:	218238 m	654792 m
Corner position #3:	218178 m	654816 m
Corner position #4:	218286 m	655096 m

These are corner pen centre positions

Organic waste

Peak biomass :	2500.0 t
Modelled biomass:	2500.0 tonnes
Cage depth :	16.0 m
Stocking density :	13.6 kg/m3
Release of solids :	###########
Mass balance :	130,565 kg
Export :	890,251 kg/yr
Receiving area :	10.0 km2

	Flux [g/m²/y]	ITI	Area [m²]
80% solids	410	22.9	56208
Cage Area Equivalent	1686	9	34901
Benthic Sampling area	192	30	62852

Affected area : 4.6 km2

Site Specific Sampling - 1

	Cage edge station		Transect start	AZE-10m	AZE	AZE+10m
NGR Easting:	218166 m		218166 m	218123 m	218118 m	218113 m
NGR Northing:	654801 m		654801 m	654732 m	654724 m	654715 m
transect direction/distance:		209.6 degT	212.0 degG	80 m	90 m	100 m
depth (CD):	30.5 m		30.5 m	30.6 m	29.6 m	29.3 m
			modelled ITI:	28.3	30.0	36.2

Important note

Site Specific Sampling - 2

	Cage edge station		Transect start	AZE-10m	AZE	AZE+10m
NGR Easting:	218228 m		218228 m	218201 m	218197 m	218193 m
NGR Northing:	654776 m		654776 m	654718 m	654709 m	654700 m
transect direction/distance:		202.6 degT	205.0 degG	64 m	74 m	84 m
depth (CD):	33.3 m		33.3 m	31.9 m	32.0 m	32.0 m
			modelled ITI:	24.9	30.0	40.9

Modelled by :	Garret Macfarlane	date :	29/11/2018
SEPA (MS:H-M) Approved by :		date :	
SEPA (MS:M-Eco) Approved by :		date :	

Not Yet Approved by SEPA

NB: Receiving area input at 10 km² but is significantly larger.