

BIOMASS MODELLING REPORT

Proposed Little Cumbrae Finfish Pen Site, Clyde Estuary

Prepared for

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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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CONTENTS

1. Summary.....	3
2. Introduction.....	3
3. Little Cumbrae site information.....	4
4. Hydrographic data.....	4
5. AutoDEPOMOD.....	5
5.1 Site set-up.....	5
5.2 Model grid generation.....	6
5.3 Benthic modelling.....	6
6. Transects and sample stations.....	7
APPENDIX 1.....	10

List of Figures

Figure 1. Plot of AutoDEPOMOD benthic model Run 8.....	8
Figure 2. Depth measurement locations.....	8
Figure 3. Plot showing primary and spare transect positions and the respective sample stations.....	10
Figure 4. Cross sections of the primary and spare transects.....	10

List of Tables

Table 1. Spring and neap tides.....	6
Table 2. Intermediate spring and intermediate neap tides.....	6
Table 3. Current meter data summary.....	6
Table 4. Details and position of the three selected sample stations along the primary transect.....	9
Table 5. Details and position of the three selected sample stations along the spare transect.....	9

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 Little 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 2243.8 tonnes.

Benthic Pass = 2243.8 T₃

Stocking Density = 14.0 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 Little 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. Little Cumbrae site information

Site details

Site name: Little Cumbrae
Location: Clyde Estuary

Pen group details

Group centre position: 214484.1 E, 652622.4 N
SE pen centre position: 214641.5 E, 652669.9 N
Number of pens: 10
Reported pen group configuration: 2 x 5
Pen dimensions: 120 m circumference circles
Net depth: 14.0 m
Grid size (x by y): 80 m x 75 m
Pen group orientation: 240.0°

Hydrographic data

Current meter position: 214627.3 E, 652653.2 N
(146.4 m from group centre)
Deployment depth: 32.1 mCD
Sub surface cell: 26.92 m above seabed
Selected pen bottom cell: 17.92 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 (12/10/17 21:19 to 27/10/17 21:19 GMT)

Additional data

Correction from Magnetic to Grid N: -0.33°
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	21/10/2017	00:42	3.5 m
Neap	HW	28/10/2017	05:19	2.9 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	17/10/2017	11:59	111
Predicted intermediate-neap	24/10/2017	11:59	279

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 0.33° 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)
12/10/17 21:19 to 27/10/17 21:19 GMT	Sub surface	0.097	0.036	79.0
	Pen bottom	0.081	0.029	68.6
	Near bed	0.062	0.014	82.6

5. AutoDEPOMOD

5.1 Site set-up

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

Little_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 213990 E to 214990 E and 652080 N to 653080 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.

2038 depth measurements fall within the modelled grid (figure 2). These along with 516 depths bounding the grid and chart contours were used to create the Little_Cumbrae_2018v1 -M.csv file. The recorded depths and their conversion to Chart Datum are provided in Little_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 = 15.5833 kg/m³
Pen Volume Adjustment = 1

A maximum biomass of 2500.0 tonnes was specified for the modelling by setting the stocking density to 15.5833 kg/m³. The model iterated to a PASS prediction of 2243.8 tonnes for the neap-spring and spring-neap runs respectively (Runs 7 and 8). The run with the smallest area of impact at the 30 ITI EQS was Run 8 (spring-neap).

The maximum feed input for Run 8 (figure 1) was defined by the model as 15706.2 kg/day. The 80% solids area was predicted as 77199 m² with a flux in the area of 1561 g/m²/yr.

At the 2243.8 tonnes biomass, the pen area equivalent contour flux was 8862 g/m²/yr, at a mean ITI of 3.2 with a pen area of 40547 m². The benthic sampling area, where the ITI = 30.0, showed a flux of 191.8 g/m²/yr inside an area of 105917 m². A summary of the results can be found in the Little_Cumbrae_2018v1 -M_marine_sum_v3.xls Benthic Worksheet in appendix 1.

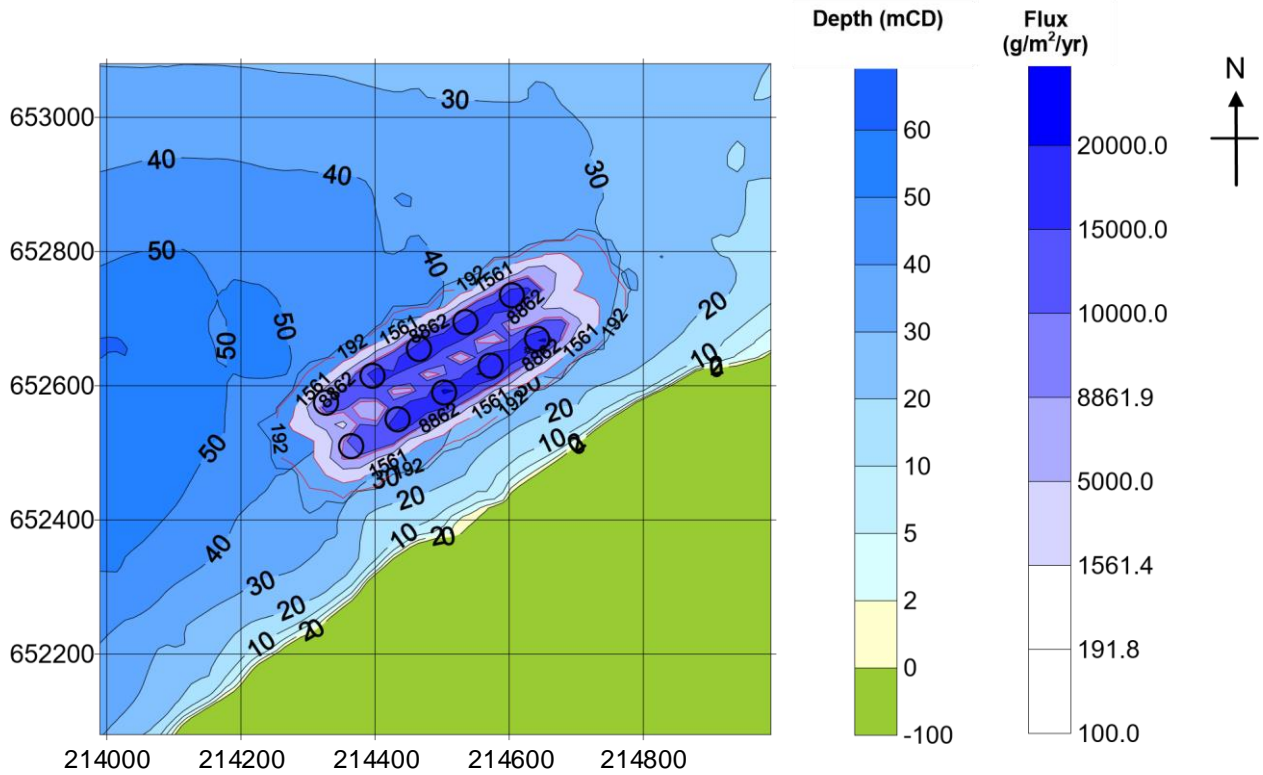


Figure 1. Plot of AutoDEPOMOD benthic model Run 8

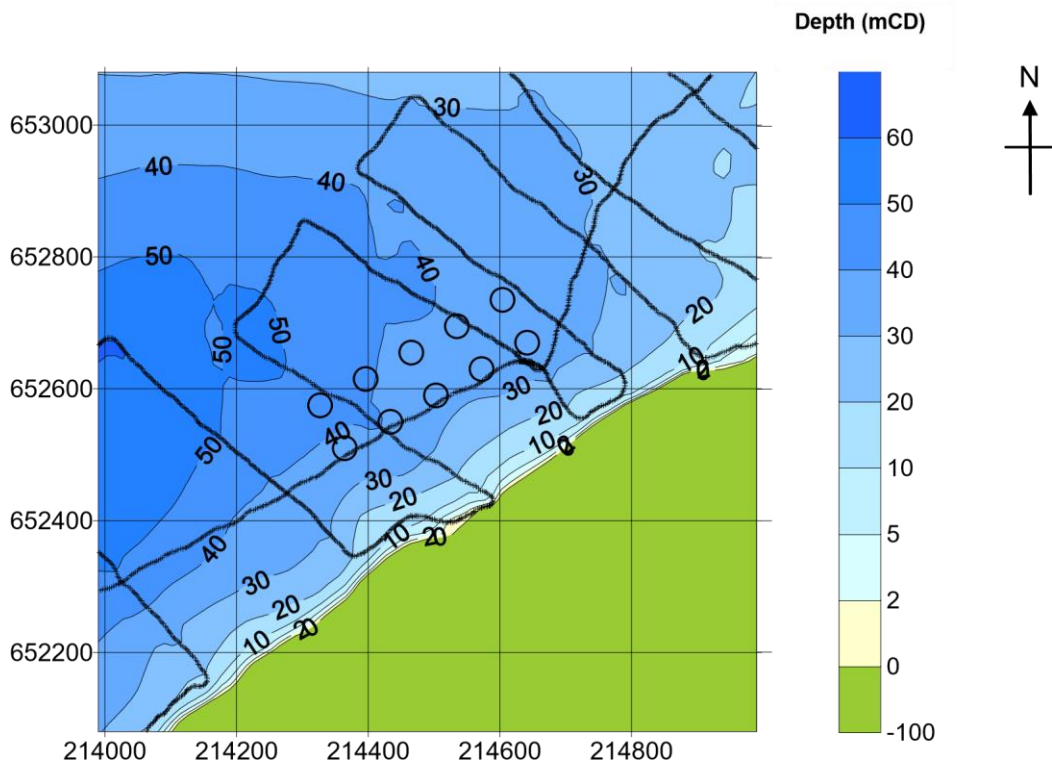


Figure 2. Depth measurement locations
 6. Transects and sample stations

Primary and spare sampling transects were created for the site (tables 4 and 5) using Benthic Run 8.

Details of the primary transect:

Transect start co-ordinates (PE) 214619.8 E 652746.3 N
 55 43.9519 N 04 57.2369 W
 Transect bearing and length 60.0° Grid North and 200.0 m
 Depth (PE) 34.0 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	214726.9	214735.5	214744.2
NGR Northing	652808.1	652813.1	652818.1
Latitude	55 43.9877	55 43.9906	55 43.9935
Longitude	04 57.1372	04 57.1292	04 57.1211
Distance from PE (m)	123.6	133.6	143.6
Depth (mCD)	30.2	30.1	30.0
Modelled ITI	24.5	30.0	36.3

Details of the spare transect:

Transect start co-ordinates (PE) 214656.4 E 652682.7 N
 55 43.9185 N 04 57.1994 W
 Transect bearing and length 60.0° Grid North and 200.0 m
 Depth (PE) 32.0 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	214763.3	214771.9	214780.6
NGR Northing	652744.4	652749.4	652754.4
Latitude	55 43.9542	55 43.9571	55 43.9600
Longitude	04 57.0999	04 57.0919	04 57.0838

Distance from PE (m)	123.3	133.3	143.3
Depth (mCD)	30.0	30.0	30.0
Modelled ITI	23.7	30.0	36.4

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.

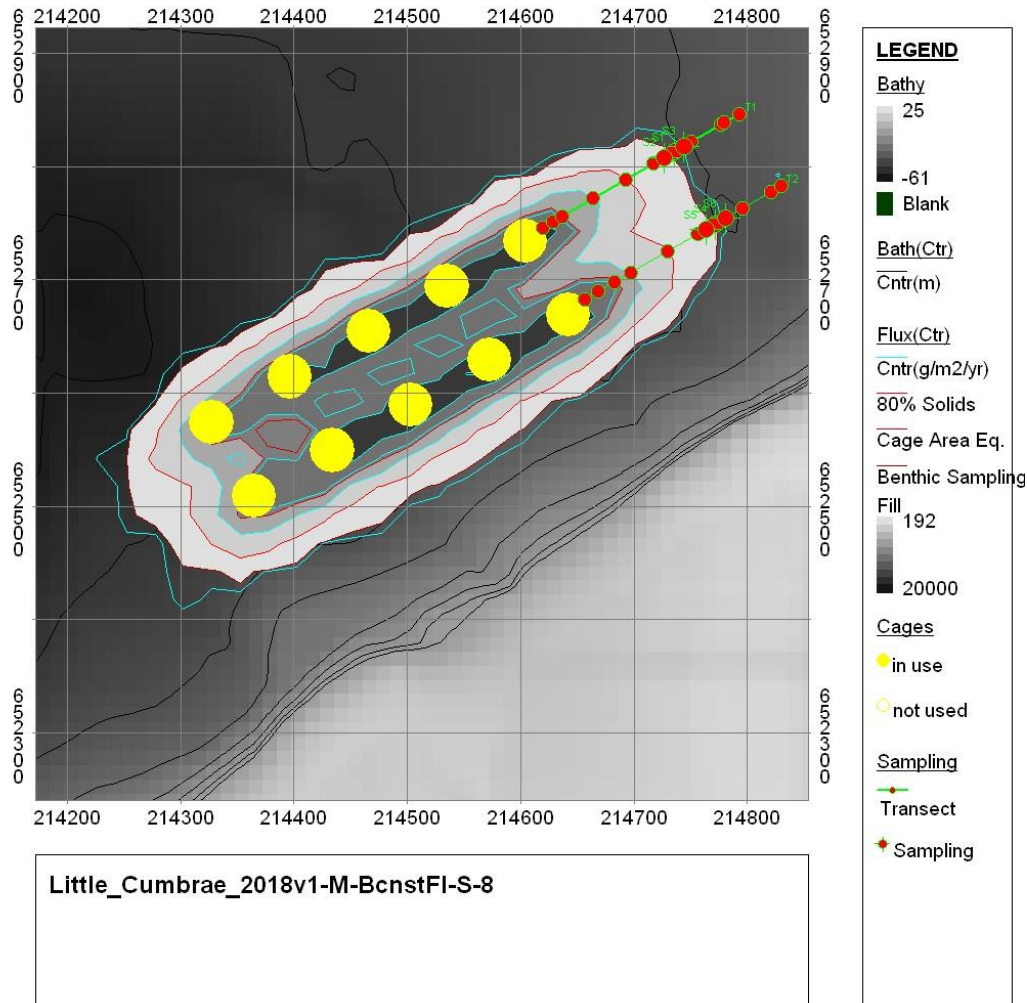
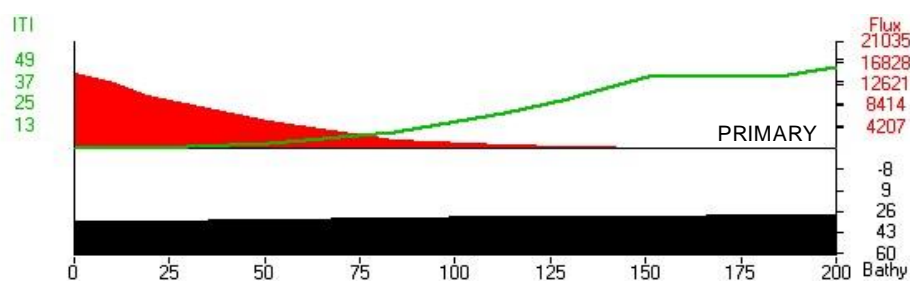


Figure 3. Plot showing primary and spare transect positions and the respective sample stations



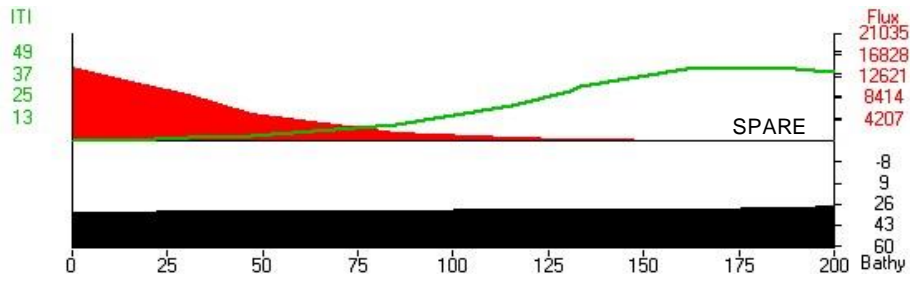


Figure 4. Cross sections of the primary and spare transects

The benthic sampling has been packaged in Little_Cumbrae_2018v1M\depomod\mapping\XLS\Little_Cumbrae_2018v1-M-BcnstFI-S-8_000.xls.

APPENDIX 1

Little_Cumbrae_2018v1-M_marine_sum_v3.xls (Version 3.13) Benthic Worksheet

Fish farm site at :	Little 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	0.097	57%	055	2.40	0.036	079	0.025 m/s at 75 degrees
Cage-bottom	0.08	69%	050	2.52	0.030	069	
Near-bed	0.06	81%	070	2.19	0.010	083	
Cage group corners				NGR			
		Easting	Northing				
Corner position #1:		214604 m	652735 m	These are corner pen centre positions			
Corner position #2:		214641 m	652670 m				
Corner position #3:		214364 m	652510 m				
Corner position #4:		214327 m	652575 m				
Organic waste				Flux [g/m ² /y]	ITI	Area [m ²]	
Peak biomass :	2243.8 t	80% solids		1561	10	77199	
Modelled biomass :	2243.8 tonnes	Cage Area Equivalent		8862	3	40547	
Cage depth :	14.0 m	Benthic Sampling area		192	30	105917	
Stocking density :	14.0 kg/m ³						
Release of solids :	916,181 kg/yr						
Mass balance :	720,088 kg	Affected area :		1.0 km ²			
Export :	196,093 kg/yr						
Receiving area :	10.0 km ²						
Site Specific Sampling - 1				<i>Important note</i>			
	Cage edge station	Transect start	AZE-10m	AZE	AZE+10m		
NGR Easting:	214620 m	214620 m	214727 m	214736 m	214744 m		
NGR Northing:	652746 m	652746 m	652808 m	652813 m	652818 m		
transect direction/distance:	57.6 degT	60.0 degG	124 m	134 m	144 m		
depth (CD):	34.0 m	34.0 m	30.2 m	30.1 m	30.0 m		
		modelled ITI:	24.5	30.0	36.3		
Site Specific Sampling - 2							
	Cage edge station	Transect start	AZE-10m	AZE	AZE+10m		
NGR Easting:	214656 m	214656 m	214763 m	214772 m	214781 m		
NGR Northing:	652683 m	652683 m	652744 m	652749 m	652754 m		
transect direction/distance:	57.6 degT	60.0 degG	123 m	133 m	143 m		
depth (CD):	32.0 m	32.0 m	30.0 m	30.0 m	30.0 m		
		modelled ITI:	23.7	30.0	36.4		
Modelled by :	Garret Macfarlane	date :	15/12/2018	Not Yet Approved by SEPA			
SEPA (MS:H-M) Approved by :		date :					
SEPA (MS:M-Eco) Approved by :		date :					

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