

## **AUTODEPOMOD course notes**

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### **Background**

AUTODEPOMOD incorporates SEPA's new methodology for determining marine fish-farm biomass limits. Attendees of the workshop will learn how to use the software and test various scenarios to optimise site usage.

The DEPOMOD model and automated software AUTODEPOMOD are a result of several years of scientific research and development. Workshop participants should therefore expect that pre and post-workshop effort will be required before becoming conversant with the software and the regulatory method.

### **Workshop objective**

The objective of the workshop is:

- Familiarisation with the AUTODEPOMOD software and some scenario testing

### **Overview**

The model will be set up for the hypothetical *Eck* site, with emphasis on which data are normally site specific and which are default. Hydrographic and bathymetry data are available for this site and users may have time to set up one of their own sites with the software.

### **Workshop contents and check list**

DEPOMOD background

Regulatory method background

What information is needed to test a site

Setting up AUTODEPOMOD for a site and iterating to a solution

Scenario testing

Submitting the right information

User own data modelling

## **Workshop exercises**

Section 1 is a step by step guide to set up AUTODEPOMOD:

Before starting the exercises:

Decide on 2 different groups. Group A will set up cage layout A for Eck, group B cage layout B.

Participants that have used the model before should pair up with a non-user if necessary.

## **Scenario testing**

Objective

- To enable users to familiarise themselves with testing scenarios on cage layouts, depth and dispersive qualities of the site

The user should undertake the following to test a particular scenario:

1. Set up the model for a CONTROL scenario using either cage layout A or B (detailed in section 1). For this CONTROL scenario it is important that Autodistribute is checked ON and the default stocking density is decided upon.
2. Compare CONTROL results with the other group.
3. Now run a TEST scenario in the model to check its sensitivity and the effect on dispersion and benthic impact. Always compare consent tonnage, stocking density and cage numbers to the CONTROL run. It is important that recommended stocking densities are not exceeded.

## SECTION 1 – STEP BY STEP SET UP GUIDE

All files for the site *Eck* are supplied with course material.

Some things to watch out for:

- If the model crashes, users must make sure all instances of Excel and Surfer are closed before restarting the AUTODEPOMOD software. After a crash, click on Ctrl-Alt-Delete > Task List > Processes > Image name (to alphabetically sort) and then select Excel or Surfer and End Process
- When Surfer is newly installed on a machine, Surfer must be run once so that all the run time libraries are set up correctly before running AUTODEPOMOD
- To assist file naming and management with Windows Explorer, file extensions should be visible. In Windows Explorer, click on Tools > Folder options > View > Select Show Hidden Files and Folders. Also UNCHECK Hide Extensions for known file types.

### Exercise 1 – Grid generation

Objective – to set up the model with required information on bathymetry and cage layouts

1. Run the AUTODEPOMOD software, click on create **New Project** and enter a name (**Eck**) for the new site. The software loads a number files and stops at **FF-in-Eck.xls**. Fill in the site information in this sheet from Table 1 below and then click **Exit**.
2. The following steps are undertaken on a computer that does not have C-map installed and assumes the bathymetric data have been created by another package or from survey data. Copy previously prepared files **Eck.blm** (coastline) and **Eck.csv** (bathymetry) into the directory C:\SEPA Consent\DATA\Eck\DEPOMOD\gridgen. Annex H gives details on the formats of these files, but the user should view these files to examine their content.
3. A file called **Eck.ini** also needs to be created and the correct information entered into it. Copy **Blank.ini** to the directory C:\SEPA Consent\DATA\Eck\DEPOMOD\gridgen and rename to **Eck.ini**. This file needs to be edited to include grid origin limits only and any other information in this file is ignored by AUTODEPOMOD. Open up the **.ini** file in a text editor (e.g. notepad) and enter the information from Table 2 into the correct lines and save.
4. The main AUTODEPOMOD dialog has a **Grid and Cage set up** page which includes a panel called **C-Map files**. When the cursor is placed over the boxes the expected location is given in a hint box and also listed in Table A in the appendix. Double click on the blank box next to **Input (csv)** and a dialog appears, select the **Eck.csv** file. The **.blm** file is found automatically. Now repeat for the **Settings**

- (**ini**) file specifying **Eck.ini** in the Gridgen directory if this is not automatically found by the software (note: Eck.ini not the file SEPA-Eck.ini).
- At this point, AUTODEPOMOD highlights a **Coordinate mismatch**, as the origin limits specified in the **ini** file do not match the limits in the **Cage Layout** sheet. Click on **Edit Cages** to enter the **Cage Layout** sheet which allows the user to enter grid origins and cage layout information (maximum number of cages). **Bright yellow boxes contain information entered by the user**, green boxes contain derived information.
  - Enter the information in Table 3 into the spreadsheet carefully, using the GPS input boxes if NGR data are not available. Lat and Long data should be entered as decimal degrees into yellow boxes. The degree symbol is not necessary. e.g. enter -5.44167 into cell R10 for cage group position 1 and hit Enter. Click on **Centre on average of all group centres** at the bottom of the grid to centre cage group 1 into the middle of the grid.

#### Important notes

- Distances between cages are the distance between cage centres
- For round cages, cage size is the radius
- For cage groups not in use, check either Nx or Ny is set to zero

- The origin of the grid in the Excel sheet (shown by cells P36, P37) now has to be the same as the grid limits specified in the .INI file in step 3 (e.g. that in Table 2). Enter **x-axis** and **y-axis increment shifts** as values greater than 0. Then move the cages around the grid by clicking on the Cages up, down, left and right buttons at the corners of the grid. The aim is to move the cages around until the **Grid Origin Easting E (m)** is **192250** and the **Grid Origin Northing N (m)** is **825250**. The increment shifts may have to be changed to as low as 1 to get the exact answer. Click on **EXIT** once complete.
- As the origin in the **Cage Layouts** sheet now matches the origin in the .ini file (of the bathymetric data), the **Coordinate mismatch** error message should have disappeared.
- Now click on **Generate Grid file** (this reads **Refresh Grid Ref** if maps already exist), to create/update **Surfer** maps using all depth and cage layout information recently entered. Surfer is either shown or minimised in the task bar. The grid can be viewed by selecting the appropriate file in the **Window** menu option in Surfer. When finished viewing, minimise Surfer.
- Now click on **Generate Grid File** to create/update grids usable by DEPOMOD (this will read **ReCreate Gridgen Output** if files already exist). A message **Gridgen files exist** is now shown at the bottom of the AUTODEPOMOD dialog.
- The alternative method to view the bathymetry and cage layouts is to browse to the location C:\SEPA Consent\DATA\Eck\DEPOMOD\surfer and open the file **Eck-BENTHIC.srf**.

If bathymetry, cage layouts or locations are changed at any point, the buttons **Refresh Grid Ref** and **ReCreate Gridgen Output** should be clicked to update Surfer and DEPOMOD Gridgen files.

A later exercise will test the effect of changing cage layouts or depth, so users will come back to using this part of the software.

Table 1. Site information for Eck – All layouts.

<b>Site Data</b>	
Consent #:	
Site name:	Eck
Site NGR:	
Receiving water:	Loch Eck
Company:	
Deadline for representations:	
Bi-annual production (tonnes):	
Peak biomass (tonnes):	
Medicines applied for:	All
Current meter NGR:	
Annual feed load (tonnes):	
<b>Input Data</b>	
Distance to shore (km):	0.23
Water depth at site (m):	Depends on layout
# of cages:	10
Round/Square ?:	Circular
Diameter/Circumference/Width (m):	32 m
Working depth (m):	16 m
Treatment shallowing depth (range?) (m):	

Table 2. The origin of the bathymetric data specified in the **Eck.ini** file.

DataAreaXMin=192250  
 DataAreaXMax=193250  
 DataAreaYMin=825250  
 DataAreaYMax=826250

Table 3. Cage layout information required for the Cage Layout sheet – Cage Layout A

Input data variable	Value
Current meter RCM position	57.27818 ° -5.4413 °
Cage group 1 position (Centre of N cage)	57.27820 ° -5.44167 °
Cage group 1	10 cages (Nx) by 1 cages (Ny)
Cage orientation (from N cage)	150 degrees
Shape	Circular
Cage size-Diameter and Depth	32 m (diameter) and 16 m
Group spacing (x and y)	50 m (between cage centres)
Other groups	Zero cages in groups 2 and 3 (set either Nx or Ny to 0 for both groups)

Table 4. Cage layout information required for the Cage Layout sheet – Cage Layout B

Input data variable	Value
Current meter RCM position	
Cage group 1 position (Centre of NE cage)	
Cage group 1	5 cages (Nx) by 2 cages (Ny)
Cage orientation (from NE cage)	150 degrees
Change symmetry	Change symmetry on 1, so that cage 1 position entered above is the NE cage and the second line of cages is in shallower water
Shape	Circular
Cage size-Diameter and Depth	32 m (diameter) and 16 m
Group spacing (x and y)	50 m (between cage centres)
Other groups	Zero cages in groups 2 and 3 (set either Nx or Ny to 0 for both groups)

Table 5. Cage layout information required for the Cage Layout sheet – Cage Layout C

Input data variable	Value
Current meter RCM position	
Cage group 1 position (Centre of S cage)	
Cage group 1	5 cages (Nx) by 2 cages (Ny)
Cage orientation (from S cage)	060 degrees
Change symmetry	Change symmetry on 2, so that cage 1 position entered above is the S cage and the second line of cages is to the NW
Shape	Circular
Cage size-Diameter and Depth	32 m (diameter) and 16 m
Group spacing (x and y)	50 m (between cage centres)
Other groups	Zero cages in groups 2 and 3 (set either Nx or Ny to 0 for both groups)

## Exercise 2 – Finalising data input and iteration to a consent biomass

### Objectives

1. To enter the remaining data input required for the particle tracking model and familiarisation and checking of default settings
2. To iterate to a consent biomass value

The following data input are examined in this exercise:

- Hydrographic data - current speed and direction data in a pre-defined format
- Farm biomass/feed input data/stocking density/cage volume adjustment/biomass to feed input factor (SFR) – these data are used to determine cage numbers in the simulation and associated feed input
- Information in the *Site defaults* dialog – waste particle settling velocities and properties, EQS Benthic parameters
- Various switch boxes used during run time

This exercise also familiarises the user with the LOG file.

1. Click on **Model Parameters** to view the page. A previous presentation described the format for current speed and direction data. Copy the current meter data files (Eck-NS-s.dat, Eck-NS-m.dat, Eck-NS-b.dat) to the appropriate directory. In the **Current files** panel if the boxes next to **surface**, **middle** and **bottom** are blank, files can be loaded into AUTODEPOMOD by clicking on the blank boxes.
2. So the model iterates to a solution which is independent of where the hydrographic data record commences in the spring-neap cycle, the radio button **Tidal: Neap-Spring** should be selected and the check box **Automatically Redo using Spring-Neap** also checked.
3. In the **BENTHIC parameters** panel, check the **Feed input – constant** radio group button is selected. As the model is being run for peak biomass, a constant feed input is used in the simulation. Other options (not used in this method) allow a feed input to be set up as a time series so that feed input can be varied over a period of time as a farm increases in size.
4. To check input data on stocking density, cage volume adjustment and SFR, click on **Edit Parameters**. By switching **Auto-distribute** ON, when biomass is changed between simulations the model calculates the appropriate number of cages using **stocking density** and **CVA** (see section Annex H7.3 for additional information). Feed input is calculated from the biomass using **biomass to feed input factor (SFR)**. Although SFR varies with fish weight, an averaged value is used here. Check input data are correct using the information in Table 6 (white boxes can be edited by the user, yellow boxes cannot).

The model automatically calculates the biomass and associated feed input for the maximum number of cages defined at the grid generation stage.  
Check the maximum biomass calculation for your scenario using the formula in [Annex H eq. 3 p. 88](#).

Q. What is the feed input in terms of  $\text{kg cage}^{-1} \text{d}^{-1}$ ?

A.

5. Click on the **Cages** page tab. As Auto-distribute is switched ON, the biomass is distributed evenly between cages according to stocking density and is calculated automatically by the model. For this regulatory method, the user does not need to modify this page. Click **OK** when finished.

#### Notes

6. View default data for the site by clicking on **SITE Defaults**. Users need to familiarise themselves with all the data in these pages and check the settings are correct, using Table 6 if necessary.
7. On the **Programs** page, the default locations of the DEPOMOD executable files are specified. This is the background model to the whole AUTODEPOMOD application and is made up of grid generation, particle tracking and resuspension model components. In the absence of a CMap application, the location of Notepad is specified but this does not serve any function.
8. Under the **General** page, check the number of time steps of current data, the time step of current data and the trajectory evaluation accuracy are correct. The trajectory evaluation accuracy is the length of time used for calculation of each particle trajectory. Check dispersion coefficients are correct.
9. The **Benthic** page contains some information on refining model runs. To increase speed of runs, initial model runs are run with 1 particle and then biomass refined after initial runs with 10 particles. When refining with 10 particles, if a pass is not achieved, the initial step used in the next test is 100 tonnes.
10. The current data supplied are set up with speed and direction data in columns 5 and 6 and begin with a Neap tide. Check the **Tide sequence** settings are correct.
11. Check the feed properties are correct. These are used with feed input to calculate rates of waste feed and faecal discharge.
12. The majority of resuspension model parameters cannot be changed by the user with the exception of the consolidation time parameter of 4 days. This is the time the particle is in the benthic fluff layer and available for resuspension. The

- number of loops the model runs for should be set to 2. Neither of these parameters should be modified by the user.
13. As the DEPOMOD benthic relationship is validated using total solids (i.e. without taking into account particle decay), the G-model which is a first-order decay rate equation is switched OFF. During SLICE modelling runs, the G-model is used to model decay of the active ingredient.
  14. Check the G-model is switched OFF. Under the **Settling Vels.** page, both food and faecal settling velocity data should have normal distributions, rather than groups. Check the mean and standard deviation for both waste types are set appropriately.
  15. The EQS Benthic page contains important information on the EQS criteria used in iteration to a solution. The criteria were varied within reasonable bounds and tested for numerous sites to determine optimum criteria, as detailed in the consultation document (see points 13-18 in consultation document). Model runs are undertaken using different farm biomass until 80 % of the solids remaining in the grid are enclosed by an ITI contour of  $10 \pm 1\%$  ITI. The boundary of the AZE is taken as the 30 ITI contour, denoted **Sampling ITI**. Check settings are appropriate.
  16. Any changes made to default settings will require justification in the site methodology submitted with a consent. If any changes are made to the default data the user is asked if changes are to be saved. Defaults can be restored to original settings with **Restore Defaults**, but this is only whilst the dialog has been open. It does not restore to Global defaults.

## Notes

17. Return to the main **Model Parameters** page where several run time options are available. Check initial run settings are set to 1 particle and that refining runs are undertaken at 10 particles (see point 40, consultation document).
18. Biomass will converge to the nearest solution given by the **Convergence value** of 5 tonnes.
19. **Use Next Level of accuracy** uses the highest level of accuracy available for calculating particle mass and this is switched ON as default.
20. As random walk and resuspension are important processes in predicting the fate of particles, both switch boxes should remain unchecked.
21. Occasionally, redeposition takes place in areas at some distance from the farm and these may be real or artefacts of the model caused by the spatially homogenous hydrodynamic flows in the grid. For example, resuspended particles may intersect a coastline some distance from a farm and then redeposit in the model grid, but in reality the current would probably flow around this feature. A blanking file is used to exclude these outlying areas from AZE calculations in the immediate area of the farm. If a blanking file has been created, check **Use blanking file** (also see Annex H for further information on blanking files).

Blanking files should be used only where they are strictly necessary. In practice SEPA has found them to be of use very occasionally. In most circumstances they have been applied during Calicide assessments. If a blanking file is used then it must be clearly stated in any modelling report (see Annex H:6.3). In addition model results, without using the blanking file must be presented.

22. The **Test particles** and **Do scoping runs** features are not used in the biomass consent method.
23. Check the **Delete failed runs** box. This prevents a build up of large numbers of unwanted runs. Although the results are saved from each in a log file, the model results files created for the run are not.
24. The **Show log** button displays a log file containing important information for each run. This is an important feature of the AUTODEPOMOD software and users should have a working knowledge of its contents. On viewing the log file, the user will see it is currently blank.
25. Click on RUN MODEL.
26. Click OK to accept limit. The model discharges particles according to feed input and predicts flux at the sea bed as a result of dispersion and resuspension. From flux, a benthic impact is determined. If this impact is greater than allowable in the AZE according to EQS criteria, then the site is run with a lower biomass. Once criteria are met, the model stops and displays the log file.

#### The log file

27. On completion of the run, the log file shows the feed input and biomass of each model run. The log file can also be shown at any time by clicking on **Show Log**. The important aspects of this log file are:

**Pass or Fail** - whether the run has passed or failed at the tested biomass

**Refinement of runs** - once the model run passed, it reiterated at 10 particles and the refined the run used hydrographic data starting with a Spring tide – the run at 10 particles for a Spring tide is the FINAL SOLUTION

**Benthic testing** – area occupied by EQS criteria and any other relevant information

**Benthic cage group, Flux and trigger** – information on equivalent cage group area

**Benthic cage distribution and parameters** – number of cages used and relevant cage parameters (e.g. stocking density)

**Sampling area** – the area enclosed by the 30 ITI contour (i.e. AZE)

**Mass** – Mass released and remaining in grid

Fill in the following information for Eck log file for the final solution:

Run number and consent biomass -

Benthic testing criteria (% solids and ITI) –

Benthic under cage trigger (mean, maximum flux and equivalent area) –

AZE area and % of solids remaining in grid -

### Log file filter function

Right click on the log file and examine the options available under **Filter**, the next exercise deals with the mapping module.

By using the filter function to display the relevant information, list the run numbers and tonnages at which this site failed:

Biomass too high –

Biomass too low -

With reference to the EQS criteria and model predictions of ITI, why does a site fail?

There are also options available under right click to delete failed runs.

Table 6. Input data for the remaining stages of model set up.

Data type	Default
Feed properties – wastage (uneaten)	3 %
– digestibility	85 %
– water content	9 %
– settling velocity	Normal dist.: $\mu = 8.3 \text{ cm s}^{-1}$ , $\sigma = 1.5 \text{ cm s}^{-1}$
Faecal properties – settling velocity	Normal dist.: $\mu = 3.2 \text{ cm s}^{-1}$ , $\sigma = 1.1 \text{ cm s}^{-1}$
Dispersion coefficients (horizontal and vertical)	$k_x, k_y = 0.1 \text{ m}^2 \text{ s}^{-1}$ $k_z = 0.001 \text{ m}^2 \text{ s}^{-1}$
Resuspension model parameters	Mass Units - g Particle consolidation time - 4 days

Farm biomass	Loops – 2
Specific Feeding Rate	Calculated by model
Stocking density	0.7 %
Cage volume adjustment	17 kg m <sup>-3</sup>
Time step of velocity data	1
Number of time steps	60 mins.
Trajectory evaluation accuracy	15 days of hourly data
	1 min

#### EQS test criteria

M <sub>EQS</sub> - % of footprint particle mass enclosed by flux (g m <sup>-2</sup> yr <sup>-1</sup> ) contour	80 %
I <sub>EQS</sub> (ITI threshold) – ITI value at flux contour C	10 ITI
I <sub>EQS(tol)</sub> – Pass tolerance for I <sub>EQS</sub>	± 1% ITI
Flux trigger	10 000 g m <sup>-2</sup> yr <sup>-1</sup>
Sampling ITI	30
Transect ITI sampling values	1,4,20, 30,40
Flux contour interval for Surfer/Mapping	5000
Convergence value	5 tonnes

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## Exercise 2A – Running for a single biomass value

### Objective

- To rerun the model for *Eck* for a single biomass value

It is occasionally necessary to run the model for a set biomass rather than iterate to a solution using the EQS criteria. To undertake this, the user needs to enter a feed input to use in the simulation (the model calculates the appropriate biomass from SFR). Autodistribute also needs to be switched OFF.

1. In the AUTODEPOMOD main dialog, click on the **Edit Parameters** button.
2. Switch OFF the Auto-distribute biomass function and enter a feed input value appropriate for a biomass of **400 tonnes**. As Auto-distribute is switched off, the model is now set up to run using the maximum number of cages in the grid. Therefore, cage numbers are constant.
3. Return to the main AUTODEPOMOD dialog and **Perform Single Run**.
4. In the log file, runs undertaken with Auto-distribute switched OFF are listed as **Manual** (feed input weighted to certain cages) or **Equal** (feed input weighted equally between cages) under Benthic Cage Distribution Mode and runs with Auto-distribute switched ON are listed as **Auto**.
5. Using the log file, compare this run undertaken with 400 tonnes to a previous run of similar biomass undertaken with Auto-distribute switched on.

### Notes

### **Exercise 3 – Mapping module**

Users should explore using this feature for a run.

From the log file, right click on a run and select **Show benthic mapping for run #**

Follow the section in Annex H on the mapping module. The objective is to understand the features of the mapping module and fill out the sheet on **Recommendations on Consenting Biomass**.

Notes

## Appendix

Table A. Main input data files (root directory is C:\SEPA Consent\DATA)

File	Directory	Name
Bathymetry	.. <i>Sitename</i> \DEPOMOD\gridgen\	<i>Sitename</i> .csv
Land boundary	.. <i>Sitename</i> \DEPOMOD\gridgen\	<i>Sitename</i> .bln
Site INI file containing grid origin	.. <i>Sitename</i> \DEPOMOD\gridgen\	<i>Sitename</i> .ini
Site summary information	.. <i>Sitename</i> \	FF-in- <i>Sitename</i> .xls
Spreadsheet toolpack	.. <i>Sitename</i> \	<i>Sitename</i> -FFMTv3.0.xls
Site default settings	.. <i>Sitename</i> \	SEPA- <i>Sitename</i> .ini
Global default settings	C:\SEPA Consent\	SEPA.ini
Hydrographic data Surface Mid-water Near-bed	.. <i>Sitename</i> \DEPOMOD\partrack\current-data\	<i>Sitename</i> -NS-s.dat <i>Sitename</i> -NS-m.dat <i>Sitename</i> -NS-b.dat