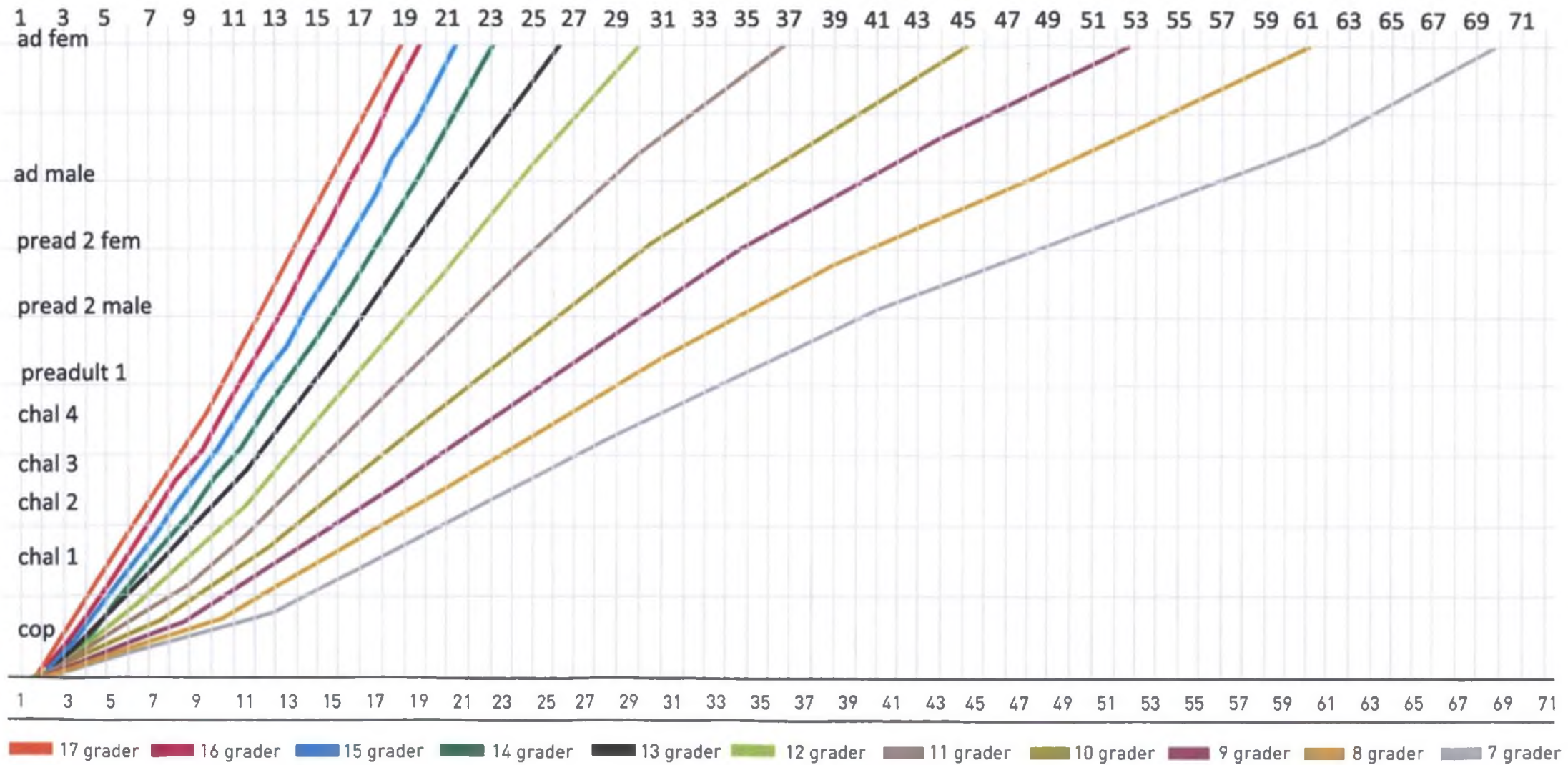


319. maí

Alpingi
Erindi nr. P 143/1785
komudagur 6.5.2014

Ewos plansje

Approximate developmental rate for L. salmonis (days)





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Reykjavík

26. febrúar, 2001

Heill og sæll,

Hjálagðar eru upplýsingar um reiknilíkan á umhverfispóli fyrir laxeldi í sjó.

Eftirgrennslan okkar sýnir að ekkert virðist hafa verið gert hér á landi til að nálgast slíkt reiknilíkan. Hvernig væri að ráðuneytið beiti sér fyrir því að það verði gert og að hagsmunaaðilum og almenningi verði kynnt niðurstaðan?

Bestu kveðjur,



Orri Vigfússon

afrit fá:

Óðinn Sigbórsson, Landssambandi veiðifélaga
Ragnar Þór Hólm, Landssambandi stangaveiðifélaga
Gunnar Steinn Jónsson, Hollustuvernd.



Ancylus MOM 2.0 – Manual

<http://www.ancylus.net>

Preface.

MOM version 2.0 is software to compute the holding capacity of a locality with respect to fish farming. MOM is so far adapted to Atlantic salmon and Sea Trout and should be applicable in all kinds of natural aquatic environments. The holding capacity is computed from the following user-determined conditions: 1) A certain minimum oxygen concentration in the cages, 2) a certain maximum ammonium concentration in the cages and 3) reasonably good oxygen conditions for benthic animals beneath the farm.

The manual is arranged as follows. Chapter 1 describes how to handle the program technically. In chapter 2, Data Cards for input and results (output) are described. The foundations for the computations may be found in reports and other publications mentioned in chapter 3. Finally, in chapter 4 it is shown how one may extract information relevant to the computations in MOM from current measurements at a location.

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1. How to use the MOM program – A technical description.

To do the computations in the MOM program, data about both the fish farm and the natural environment surrounding the farm are needed. Before the computations are done, one has to look after that all the information fields in three data cards for input are filled.

Results from the computations are presented in two data cards for output.

All data cards are discussed in chapter 2 below.

In the program, one may open old and new "cases" and store (file) data from particularly interesting cases. One may also print out the Data Cards from a model run on a printer as described below.

1.1 About case handling in the program.

The user establishes different "Case" to simulate different cases and localities. Each case may be stored in a database (mom2.mdb), compatible with Access, that may be found in the program



catalogue together with e.g. the program file (mom2.exe). Below is a description of how to handle the Case function.

Establish a new Case.

Choose "Case" from the column of tools, to the left in the main window. When the window to administrate Case is opened, press "New Case". Then a window is opened in which a new Case may be established, type the name of the case and possibly also a note describing the Case. This window may also be reached from the menu "Archive" at the top of the main window by choosing "New Case".

Remove Case.

Choose "Case" from the toolbar to the left in the main window. When the window to administrate Case is opened, press "Remove Case". Then a text box is shown. Type the number of the Case that shall be removed and thereafter press "Ok" to remove the chosen case. The number of the Case is visible in the grid on the administrative window.

Save Case.

Press "Save Case" in the column of tools to the left in the main window. The case number is visible in the list on the administrative window. The particular case that is active for the moment may be seen in the name list at the top of the main window.

1.2 About data input.

Input of data goes through tables that are placed on data cards with tabs. The first three (leftmost) data cards are dedicated for input while the two last (rightmost) data cards show results after running the program. The data cards are opened by pressing the icon "Data Input" in the column of tools to the left in the main menu or from the "Data" menu at the top of the main window.

Type all data asked for in the first three data cards and press thereafter "Compute Results". The program runs and the results are printed on the two data cards to the right.

On the first data card there is a so-called "drop-down list" with localities (only from Norway so far). Choose a location close to the location you are investigating and thereafter press "Read Data" to get temperature data into the text boxes, one for each month. If you are considering a location outside Norway, you have to type the monthly mean temperatures into the text boxes.

1.3 About reports.

The report shows data input and results for the active case. Which case that is active can be seen in the name list at the top of the main window. The Report function can be reached from either the column of tools, to the left in the main window, or the menu at the top of the main window. The report can be previewed on the screen and may be printed out if a printer is installed. The report may also be exported in html or text format.



2. Description of Data Cards for Input and Results.

Input data to the model are given in three data cards. The user of MOM has to collect this information but default values are given in the model.

Output data (results) are given in the two rightmost data cards.

Data Card 1. "Location and temperature".

Selected locations along the Norwegian coast from which monthly mean temperatures are stored in the program. Choose a location and press "Read data". The temperatures are shown below.

1. Ferder
2. Torungen
3. Lindesnes
4. Jæren
5. Sletta
6. Korsfjorden
7. Sognesjøen
8. Stadt
9. Breisundet
10. Hustadvika
11. Smøla
12. Kjeungskjær
13. Folla
14. Ylvingen
15. Hestmanøy
16. Vestfjorden
17. Andfjorden
18. Vågsfjorden
19. Malangen
20. LoppHAVet
21. Revsbotn
22. Nordkyn
23. Vardø
24. Varangerfjorden

Monthly mean temperatures at the chosen location. If you are considering a location outside Norway, you have to type the actual monthly mean temperatures into the table.

Jan	Apr	July	Oct
Feb	May	Aug	Nov
Mar	June	Sept	Dec



Data Card 2. "Location data and critical concentrations"

Locality data and data specific for the farm. The user must bring forward the data. For the computations, it is assumed that the cages of the farm are arranged in R rows (1, 2 or 3) ("standard farm"). The cages are quadratic and of equal size, with side length L and depth D so the horizontal area is L^2 and the cage volume L^2D . The distance (separation) between cages is S. The total cage area in the farm is $AC=N \cdot L^2$ where N is the number of cages.

Water depth at the farm site (m)
 Sigma - current std dev (cm/s)
 Salinity, typical in summer (o/oo)
 Oxygen conc., bottom layer (mg/l)
 Total area of cages (sqm)
 Side-length of cages (m)
 Depth of cages (m)
 Distance between cages (m)
 Reduction factor for through-flow (0-1) default 0.7
 Food factor, real
 Ammonium conc. in environment (mg/l)
 Dimensioning current, surface layer (cm/s)
 Dimensioning current, bottom layer (cm/s)
 Number of cage-rows (1, 2 or 3)

"Sigma - Current std dev" (standard deviation), "Dimensioning current, surface layer" and "Dimensioning current, bottom layer" may be estimated from current measurements as described in chapter 4 below. "Reduction factor for through flow" may tentatively be taken equal to 0.7 if not estimated from current measurements.

Critical concentrations etc.

Lowest acceptable oxygen conc. in cages (mg/l) default 5
 Highest acceptable ammonium conc. in cages (mg/l) default 0.5
 Lowest acceptable oxygen conc. at the bottom (mg/l) default 3

Data Card 3. "Fish and food data".

Food data

Protein content (0-1) default 0.45
 Fat content (0-1) default 0.3
 Carbohydrate content (0-1) default 0.10
 Ash content (0-1) default 0.07
 Sinking speed (cm/s) default 15

NB! Water makes up for the missing food content.

Fish data

Start weight (g) default 60
 End weight (g) default 4000
 Protein content (0-1) default 0.18
 Fat content (0-1) default 0.18
 Sinking speed of faeces (cm/s) default 3



Data Card 4. "Results I".

Some results computed by the model.

- Theoretical food factor
- Energy content of food OE (kJ/kg)
- Time to reach final weight (days)
- Median weight of fish (g)
- Maximal carbon flux to the sediment (gC/sqm/year) *)

Outlets per 1 tonne fish production

To cages (dissolved)

- Nitrogen (kg)
- Phosphorus (kg)

To the sediment (in particulate matter)

- Nitrogen (kg)
- Phosphorus (kg) **)
- Faeces (kg)
- Wasted food (kg)

*) If Sigma is greater than 10 cm/s it is assumed that possible deposits on the bottom are flushed by intermittent strong currents. Maximal carbon flux to the sediment is then set to zero.

**) May be greater if the food contains grained fish bones. This is the case if the declared P content is greater than the (protein content)/36

Data Card 5. " Results II"

Maximal production (tonnes/month) in different months according to the three different criteria to compute holding capacity of a locality (row 1, 2, 3). That means based on either a certain minimum oxygen concentration in cages (row 1), or a certain maximum ammonium concentration in cages (row 2) or on reasonably good benthic oxygen conditions (row 3). The lowest of these estimates of maximal production determines the holding capacity of the farm. The biomass needed to reach the production numbers in rows 1-3 is estimated using the temperatures in Data Card 2 and the median weight of the fish during its stay in the farm (Data Card 4) (row 4, 5, 6). The theoretical maximal annual production is obtained by summation of the minimum values (in rows 1,2 or 3) for all months.

Month		Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Oxy - cage	Tons/month												
Amm- cage	Tons/month												
Oxy- bent*	Tons/month												
Oxy - cage Biomass	Tons												
Amm- cage Biomass	Tons												
Oxy - bent Biomass	Tons												



*) If Sigma is greater than 10 cm/s it is assumed that possible deposits on the bottom are flushed by intermittent strong currents. The production based on benthic conditions is then very great (infinite) which in the Table is symbolised by the figure 1000 tons/month.

NB! It is usually not possible to obtain the theoretical maximal annual production if this requires larger increases in biomass than predicted by the production.

3. The foundations for the computations in the MOM program

In MOM different models for hydrodynamic and benthic processes active in fish farms are used. The processes and models are described in reports and scientific journals as mentioned below.

3.1 Fish model

The fish model computes the turnover of energy and matter, i.e. protein, fat and carbohydrates. The turnover is dependent on the weight of the fish and the temperature of water, which give the fish growth. With a given food composition the model computes among other things, consumption of food and oxygen, production of faeces and excretion of ammonium. The waste-rate of food is computed from the difference between real food factor (Data Card 2) and theoretical (from the model) food factor (Data Card 4). The fish model is described in:

I. Stigebrandt, A.: MOM. Turnover of energy and matter by fish – a general model with application to Salmon. *Fisken & Havet* Nr. 5 – 1999.

3.2 Dispersion model and the benthic model

The fish farm emits particular organic matter in the forms of wasted food and faeces. This matter will be spread by the time-varying current flushing the farm. The dispersion model used in MOM 2.0 is described in the Appendix to the report listed below. This report also describes a model for oxygen supply to the bottom, a prerequisite for the respiration of benthic animals. The oxygen transport towards the bottom depends on the current velocity in the bottom layer. MOM 2.0 computes how great the supply of organic matter to the bottom may be without killing the benthic animals.

II. Stigebrandt, A. & J. Aure: Model for critical organic loading under fish farms. *Fisken & Havet* No. 26 – 1995 + Appendix. (In Norwegian - Abstract and Figure Captions in English).

3.3 Water quality model plus the MOM software as an entity.

The fish in the cages must have sufficiently high oxygen concentrations and sufficiently low ammonium concentrations. From a given lowest current speed in the surface layer (Data Card 2), MOM computes maximum fish biomass and fish production for each month under the prerequisite of good oxygen and ammonium conditions in the cages. The critical concentrations of oxygen and ammonium are given in Data Card 2, see chapter 2 above. These computations are described in the paper below. That paper also gives a summary of all processes and models used in the MOM software.

III. Stigebrandt, A., Aure, J. Ervik, A., Kupka-Hansen, P., +??: MOM Report No. III. A model to estimate the carrying capacity of a locality for intensive marine fish farming. (Manuscript, to be submitted to *Aquaculture*)



4 Estimation of current characteristics from current measurements

The current conditions in a farm are crucial for both the farmed fish and for the benthic animals at the site. However, different current characteristics are decisive for water quality in the cages and water quality at the bottom, respectively. The worst water quality for the fish is determined by the longest flushing time of the cages. The water quality at the bottom is dependent both on the variability of currents, that determines the dispersion of particulate matter, and on the minimum current in the bottom layer that supplies oxygen to the benthic animals. How these entities are extracted from current measurements is discussed below.

Ideally, current measurements should be done at least at three levels – in the surface layer, at intermediate depths (halfway between the sea surface and the bottom) and in the bottom layer. In cases when rotor instruments are used in environments with weak currents, one has to replace the recorded zero's due to the current meter threshold with currents extracted randomly from the statistical distribution of weak currents. This was done in e.g. paper II (see Chapter 3.2 above) where it was shown that the currents in two Norwegian fjords were approximately normally distributed. Before computations are performed according to the descriptions below, the current record should thus first be "corrected" for possible threshold effects. (Later, unpublished, investigations show that currents often are normally distributed).

4.1. Sigma – current standard deviation

The dispersion of particulate matter is determined by the fluctuating component of the current. A measure of this is the standard deviation (std dev= σ "sigma") which is estimated from the variance sigma (σ^2). If a current record is composed of M current registrations u_i ($i=1..M$) and the mean current of the record is u_0 , then σ is defined by

$$\sigma = \sqrt{\frac{1}{M} \sum_{i=1}^M (u_i - u)^2} \quad (1)$$

Current measurements obtained at mid-depth should be used for the estimate of σ . Furthermore, the current component perpendicular to the main axis of the farm should be used.

4.2 Dimensioning current, surface layer

The dimensioning current in the surface layer is determined in the following way from a record obtained in the surface layer. The current component perpendicular to the main axis of the farm should be used. The flushing time of the cages $\tau = n \cdot dt$ may then be estimated from the series of the perpendicular current component u_i using the following relationship

$$\tau = \sum_t^{t+n} u_i \cdot dt = R(L+S) \quad (2)$$

Here the summation starts at time t and encompasses n consecutive records and dt is the length of the interval between recordings. The maximum time it takes to flush the farm is given by $T = \max(\tau)$. The dimensioning current is then taken as $U = R(L+S)/T$. Note that in Data Card 2, U should be expressed in cm/s. L, R and S are defined in chapter 2 (see head of Data Card 2).

4.3 Dimensioning current, bottom layer

The dimensioning current in the bottom layer is taken as the minimum mean speed during two hours long periods as determined from the corrected record. In this case, one should use the length of the current vector, i.e. the speed of the current irrespective of the direction. The reason for taking mean values over a certain time (two hours in this case) is that some benthic animals will survive shorter



periods of low oxygen concentrations. Thus

$$U = \min\left(\frac{1}{k} \sum_{t}^{t+k} u_t\right) \quad (3)$$

Here the summation starts at time t and encompasses k values where $k \cdot dt = 2$ hours.

5. Error handling and support

This chapter describes how to track down errors that may occur when running the MOM 2.0 software.

When an error occurs, two things will happen in order to inform the user. First, the user will be prompted an easy-to-understand error message with no technical terms included. Thereafter, a technical error message raised by the operative system will be written to a text file called "err.log". The file err.log resides in the Mom2-folder. Open this file with the notepad program to view the actual error message along with what part of the Mom software that encountered the error and the date and time. The error message will look somewhat like shown below for each row. One row represents one error.

"Part of Mom:" "Error message" "Date and time"

Before contacting Ancylus for support, use the error message to try to understand the cause of the error. If you cannot figure out the cause of the error, contact Ancylus for technical support. Please send an email with a description of the problem to support@ancylus.net. Normally, you will be answered within a few days, and always within one week.