Larvae Modelling Manual

This tool is available in website: http://easyco.maretec.org/WBT
Or
http://www.project-easy.info (under "Simulations")

User Manual: http://easyco.maretec.org/wbt/tools/MOHIDfishlarvae_manual.pdf

Activity 6

EASYCO

The Atlantic Regions' Coastal Pollution Response

Responsible Partner: Instituto Superior Técnico

Objectives

The main objective of the present document is to describe the upgrades performed to the larvae model developed in Nogueira (2005). The improvements in the model consist in the generalisation of the larvae parameters, originally was developed for sardine larvae, to allow the modelling of different larvae species. In order to provide answers to the European project EASYCO, the larvae vertical migration associated to survival strategies another improvement has been implemented in the model.

In this report, the parameters needed to model the larvae biomass evolution and the larvae vertical migration, in the Mohid model (www.mohid.com), are described.

Original Larvae Model

A more complete description of the sardine larvae biomass model can be found in Nogueira (2005). The model uses the following biomass evolution equation:

$$\frac{\partial B}{\partial t} + \frac{\partial (u_1 B)}{\partial x_1} + \frac{\partial (u_2 B)}{\partial x_2} + \frac{\partial ((u_3 + u_3')B)}{\partial x_3} = k_1 k_2 (G_{ref} B) - k_3 (Z_{ref} B)$$

The coefficients **k1**, **k2** and **Gref** provide the growth dependency on food availability, temperature and individual weight. While **k3** and **Zref** are coefficients related to the mortality dependency on temperature and on individual weight. The horizontal velocities **u1** and **u2** are given by the model hydrodynamic, as well as the vertical velocity **u3**.

Larvae Model Generalisation

The parameterisation of these coefficients was made for sardine larvae by Nogueira (2005) (Table 1).

Table 1.- Parameters controlling the larvae biomass.

Parameter	Default Value	Units	Description
AWG	0.1344	--	Growth coef. dependent of larvae weight
BWG	0.0610	--	Growth coef. dependent of larvae weight
AWZ	1.0730	--	Death coef. dependent of larvae weight
BWZ	0.3530	--	Death coef. dependent of larvae weight
ATG	0.0511	--	Growth coef. dependent of temperature
BTG	0.0052	--	Growth coef. dependent of temperature
ATZ	0.0149	--	Death coef. dependent of temperature
BTZ	0.0129	--	Death coef. dependent of temperature
LSHAPE	3.78	--	Larvae Shape Factor
LDENSITY	2.95	--	Larvae Density Factor
NPHASES	1	--	Number of larvae phases (1 or 2)
INIT_AGE	5.6	Days	Larvae Initial Age
INTER_AGE	16.6	Days	Larvae Intermediate Age
FINAL_AGE	51.6	Days	Larvae Final Age
INIT_LENGTH	5.0	mm	Larvae Initial Length
INTER_LENGTH	11.0	mm	Larvae Intermediate Length
FINAL_LENGTH	36.0	mm	Larvae Final Length
FISHFOOD_REF	0.5	mgm^{-3}	Reference Food Availability
TEMPERATURE_REF	15.0	ºC	Reference temperature
AFG	0.05	--	Growth coef. dependent of available food

Diel Migration Definition

To simulate the larvae vertical migration, it was assumed that fish larvae position depends of the light radiation around the larvae. Depending of the larvae preferences it will go to or away of the light, this is parameterised using light radiation limit. It is also assumed that the fish larvae have a depth optimum interval as the larvae velocity that not allows to travel very deep, so it have to deal with being seem during some period. If the larvae are not between those positions the program add a vertical velocity (migration velocity) to the model vertical velocity to move to this depths interval. The light radiation is computed by the model taking into account the latitude, day of the year and cloud coverage by the Mohid model. Figure 1 depicts the movement for one larvae due to light availability**,** assuming that larvae moves up during the night. The parameters to define the vertical diel migration are summarised in Table 2.

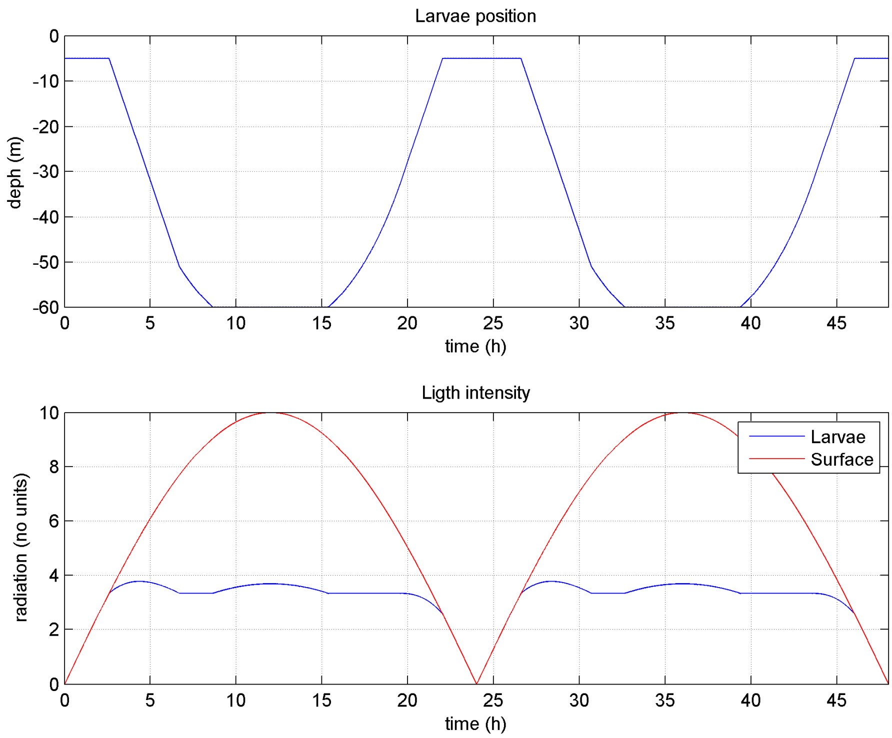

Figure 1.- Above larvae position between 5 and 60 m depth according to the light intensity.

Table 2.- Parameters controlling the larvae vertical movement.

Parameter	**Default Value**	**Units**	**Description**
VERTICAL_MIGRATION	0	--	0 Vertical migration processes OFF 1 Vertical migration processes ON
LARVAE_MIN_DEPTH	5	m	Minimum depth of the larvae
LARVAE_MAX_DEPTH	30	m	Maximum depth of the larvae
RADIATION_LIMIT	50	Wm^{-2}	Radiation Limit
LIGHT_RELATION	1	--	1 Hide from light radiation 2 Seek light radiation
COMPUTE_LARVAE_VELOCITY	0	--	0 Velocity defined by user 1 MIGRATION_TIME value
LARVAE_VELOCITY	0.001	ms^{-1}	User defined larvae velocity
MIGRATION_TIME	18000	seconds	User defined MIGRATION_TIME

Example Files

To model the larvae biological biomass a set of parameter must be defined in the waterquality module. A typical waterquality file would look as showed in Box 1.

```
LARVAE              : 1
AGE                 : 1
EXPLICIT            : 1
DTSECONDS           : 60.

! Larvae Properties

AWG                 : 0.1344
BWG                 : 0.0610
AWG                 : 1.0730
BWG                 : 0.3530
ATG                 : 0.0511
BTG                 : 0.0052
ATZ                 : 0.0149
BTZ                 : 0.0129
LSHAPE              : 3.78
LDENSITY            : 2.95
NPHASES             : 1
INIT_AGE            : 5.0
INTER_AGE           : 11.0
FINAL_AGE           : 46.0
INIT_LENGTH         : 5.0
INTER_LENGTH        : 10.0
FINAL_LENGTH        : 35.0
FISHFOOD_REF        : 0.5
TEMPERATURE_REF     : 15.
AFG                 : 0.
```

Box 1.- Waterquality input file to simulate larvae in the Mohid model with sardine parameterisation according to Santos *et al.* (2005)

To model larvae as a lagrangian property it is necessary to configure the properties larvae, age and oxygen in the lagrangian file. In order to run the waterquality module for lagrangian larvae it is mandatory to define the location of the previous waterquality file using the WQM_DATA_FILE keyword. An example of input file for the lagrangian module is found in Box 2.

```
<BeginOrigin>
ORIGIN_NAME                    :  Generic
EMISSION_SPATIAL               :  Box
EMISSION_TEMPORAL              :  Instantaneous
MOVEMENT                       :  NotRandom
ADVECTION                      :  1
BOX_NUMBER                     :  1
BOXVOLINIC                     :  10000
OLD                            :  0
WQM_DATA_FILE                  :  Location of the WaterQuality file

<<BeginProperty>>
NAME                           :  larvae
UNITS                          :  kg/m3
CONCENTRATION                  :  10e4
MIN_CONCENTRATION              :  0.0
AMBIENT_CONC                   :  0.0

VERTICAL_MIGRATION             :  1
LARVAE_MIN_DEPTH               :  5
LARVAE_MAX_DEPTH               :  15
RADIATION_LIMIT                :  100.0

COMPUTE_LARVAE_VELOCITY        :  0
LARVAE_VELOCITY                :  0.001
MIGRATION_TIME                 :  18000
<<EndProperty>>

<<BeginProperty>>
NAME                           :  age
UNITS                          :  ---
CONCENTRATION                  :  5.6
MIN_CONCENTRATION              :  0.
AMBIENT_CONC                   :  0.0
<<EndProperty>>

<<BeginProperty>>
NAME                           :  oxygen
UNITS                          :  mg/l
CONCENTRATION                  :  10.
MIN_CONCENTRATION              :  0.0
AMBIENT_CONC                   :  10.0
<<EndProperty>>
<EndOrigin>
```

Box 2.- Lagrangian input file to simulate larvae in the Mohid model.

Discussion

The vertical migration has a significant importance in the horizontal dispersion of fish larvae. It could be observed the relationship between the sardine spawning period and the typical oceanographic scenarios associated to the atmospheric dominant regimes (Santos *et al*. 2005).

Bibliography

Nogueira J (2005). Estudo numérico do recrutamento de pequenos peixes pelágicos na Costa Ibérica. MSc dissertation thesis. Technical University of Lisbon. (Portuguese)

Santos A., Nogueira J. and Martins H. (2005). Survival of Sardine Larvae off the Atlantic Portuguese Coast: A preliminary numerical study. *ICES Journal of Marine Science*, 62, 4: 634-644.