

Fig. 4.20. The length-converted catch curve user interface in FiSAT II.

The growth parameters are required to compute the data points presented in the second tab.

If the required inputs are encoded, clicking the “Compute Data Points” will plot the results presented in the second tab (Fig. 4.21).

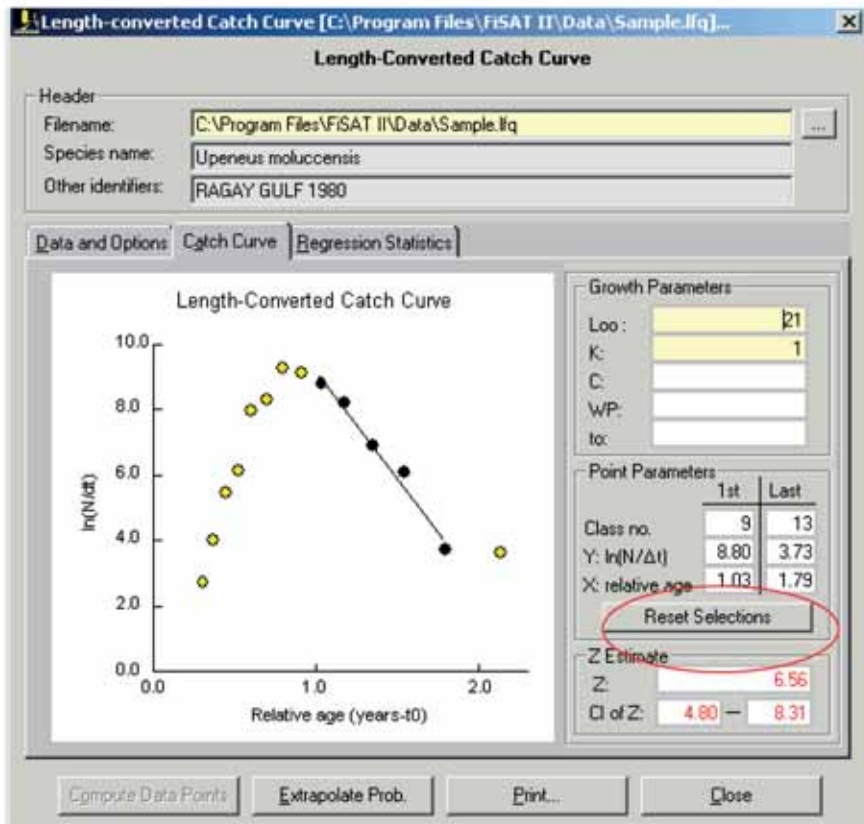


Fig. 4.21. Length-converted catch curve based on the growth parameters entered in the first tab of the user interface.

The first and last data points to be included in the regression analysis are computed automatically but users have the option to change the default points by clicking on the “Reset Selections” command button. The first and last data points may be selected or deselected using the mouse.

The statistical results of the regression analysis are presented in the third tab. When C is not given or set to zero, the regression line can be extrapolated to approximate the probability of capture given natural mortality. FiSAT II

provides the option to estimate this value using Pauly's empirical equation (Fig. 4.22).

The screenshot shows a dialog box titled "Mortalities...". The text inside reads: "The total and natural mortalities are required to extrapolate the probability of capture from the length-converted catch curve." Below this are several input fields:

- "Total mortality (Z) from catch curve:" with a text box containing "6.050".
- "Total mortality (Z) to use:" with a highlighted text box containing "6.050".
- "Mean annual habitat temperature:" with a text box containing "27".
- "Natural mortality (M) from Pauly's empirical formula:" with an empty text box.
- "Natural mortality (M) to use:" with a highlighted empty text box.

At the bottom, there is a note: "* Required to estimate M given Loo (in cm) and K (/year)." and two buttons: "Proceed" and "Cancel".

Fig. 4.22. User interface to compute natural mortality (M) from Pauly's empirical equation. Users may encode the value of M directly that will be used in extrapolating points of the catch curve (Fig. 4.23)

The extrapolated points (Fig. 4.23) will be used to approximate the probability of capture. To estimate the selection parameters based on the extrapolated points, click the command button "Show Prob." that replaced the command button "Extrapolate Prob."

The probability of capture for each length group will be plotted and users have options to use either the logits plot or simply using the running average technique to estimate selection parameters (see below for detailed discussion on how to use the user interface in estimating the selection parameters).

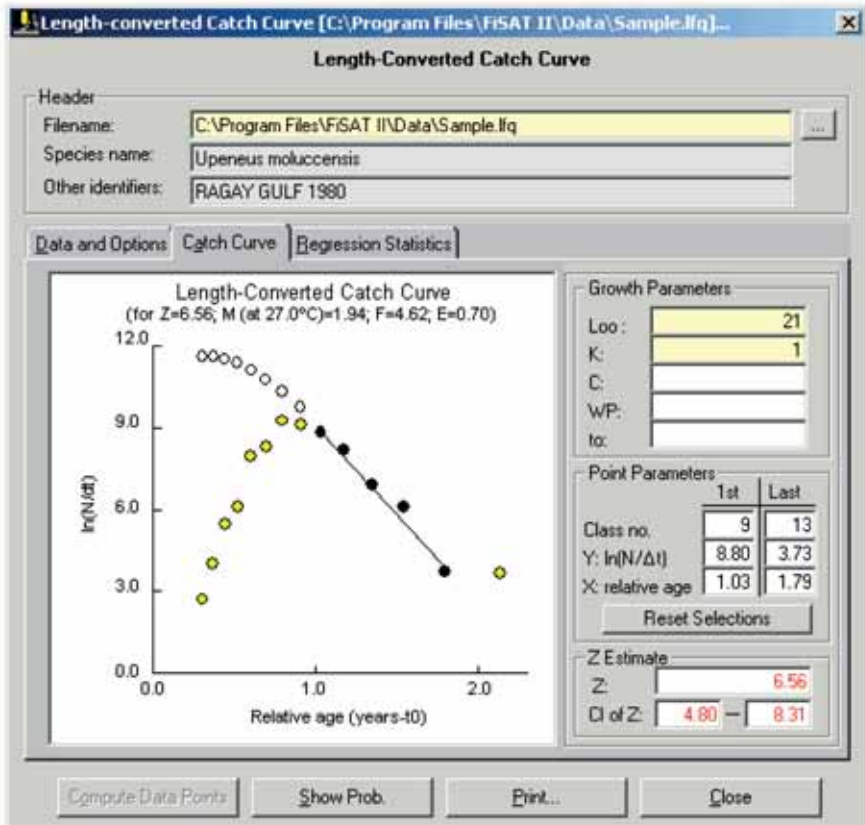


Fig. 4.23. Length-converted catch curve with extrapolated data points. Clicking “Show Prob.” will open the dialog box to estimate the selection parameters (see further below for details).

Remarks

In both options, defaults for the points to be included in the regression analysis are proposed by FiSAT II; use these only if no better sequence of points can be identified by visual inspection of the catch curve.

Option 1 provides the facility to proceed to the estimation of L_{25} , L_{50} and L_{75} . This routine is discussed further below.

Readings

Pauly (1984a; 1984b; 1990)

Jones/van Zalinge plot

The cumulative plot of Jones and van Zalinge is an early form of length-converted catch curve and these two methods thus share many common assumptions.

Required file Length-frequency data with constant class interval.

Input parameters L_{∞} and K (or 1 if K is unknown), with graphical selection of the points to be used in the regression analysis.

Function $\ln(C_{L_i, \infty}) = a + b \cdot \ln(L_{\infty} - L_i)$

where

$C_{L_i, \infty}$ is the cumulative catch (computed from the highest length class with non-zero catch) corresponding to length class i ,

and

L_i is the lower limit of length class i .
The slope b , is an estimate of Z/K .

Outputs Z or Z/K if 1 was entered instead of K .

User interface The first tab of this user interface identifies the file and provides options (see Fig. 4.5) for temporary data transformation.

The data points will be plotted after encoding the growth parameters to be used in the analysis. Points to be included in the regression analysis are not automatically identified by FiSAT

II as in the case of the length-converted catch curve routine. The user will be required to identify the first and last points to be included using the mouse (Fig. 4.24).

The details of the regression analysis are given in the third tab.

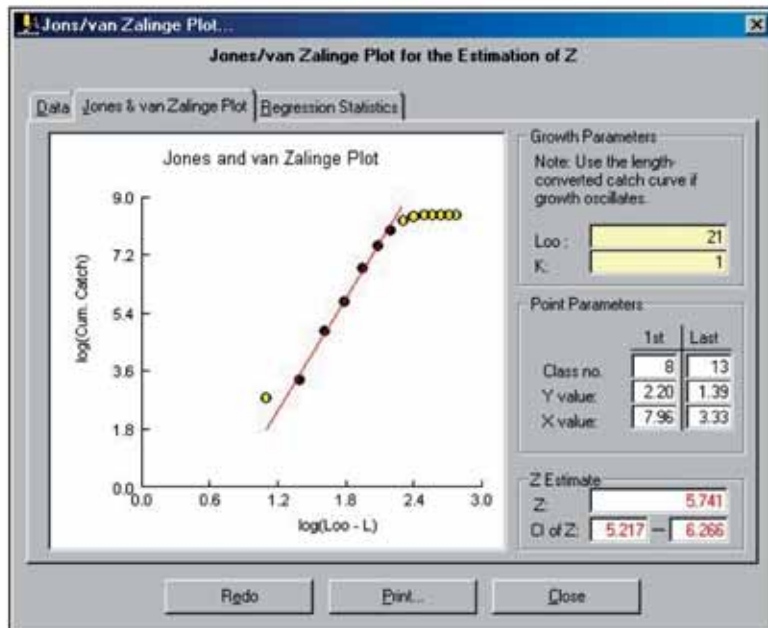


Fig. 4.24. User interface of the Jones and van Zalinge plot to estimate total mortality.

Remarks

This routine was included in FiSAT II mainly for comparison, as it lacks many of the advantages of length-converted catch curves (independence of the data points, ability to deal with seasonal growth oscillations, etc.), without offering any distinct advantage over catch curves.

Readings

Jones (1984)
Jones and van Zalinge (1981)

Z from mean length

Two routines are available in FiSAT II which derive estimates of Z from mean lengths:

Beverton and Holt model

This model, a classic developed by Beverton and Holt (1956), assumes that growth follows the VBGF, that mortality can be represented by negative exponential decay, and that L is estimated from a sample representing a steady-state population.

<i>Required file</i>	None
<i>Input parameters</i>	Growth parameters L_{∞} and K, cut-off length (L') and mean length (\bar{L}) above L'.
<i>Function</i>	$Z = K \cdot (L_{\infty} - \bar{L}) / (L_{\infty} - L')$
<i>Output</i>	Estimate of Z
<i>User interface</i>	This routine will require only the inputs to the growth parameters (L and K), mean length and the cut-off length to estimate the total mortality. Note that if K is unknown and set to 1, the result should be read as Z/K. If a value is altered, clicking the "Compute" command button will re-compute the Z estimate (Fig. 4.25).

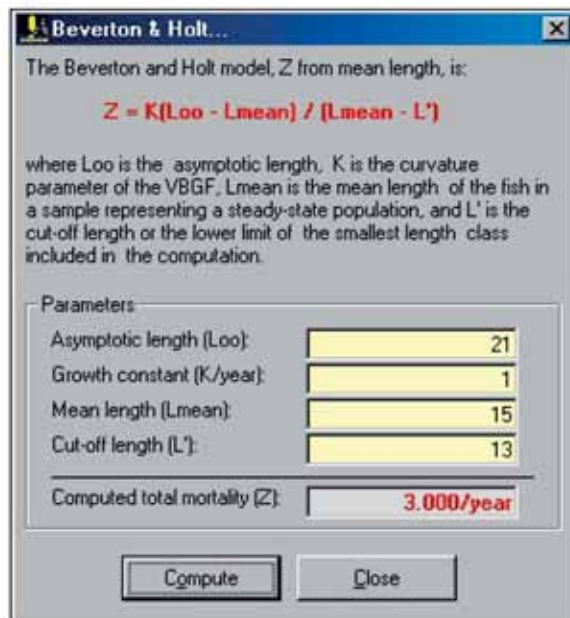


Fig. 4.25. User interface in estimating the total mortality using the Beverton and Holt model.

Remarks This routine is presented along with the model of Ault and Ehrhardt (see below) because the inputs are similar. This model is best applied to long living and slow growing species.

Reading Beverton and Holt (1956)

Ault and Ehrhardt method

Unlike the Beverton and Holt Z equation (above), this model does not assume an infinite life span for the fish of the stock being analysed and thus is applicable to short-lived tropical species.

Required file None

Input parameters Growth parameters L_{∞} and K, the cut-off length (L'), the mean length (\bar{L}) and the maximum length (L_{\max})

Functions

$$\left(\frac{L_{\infty} - L_{\max}}{\bar{L} - L'} \right)^{Z/K} = \left(\frac{A(L')}{A(L_{\max})} \right)$$

where

$$A(L') = Z(L' - \bar{L}) + K(L_{\infty} - \bar{L}), \text{ and}$$

$$A(L_{\max}) = Z(L_{\max} - \bar{L}) + K(L_{\infty} - \bar{L})$$

Outputs Estimate of Z

User interface As with the previous routines, the total mortality will be estimated only after the required inputs are given (Fig.4.26).

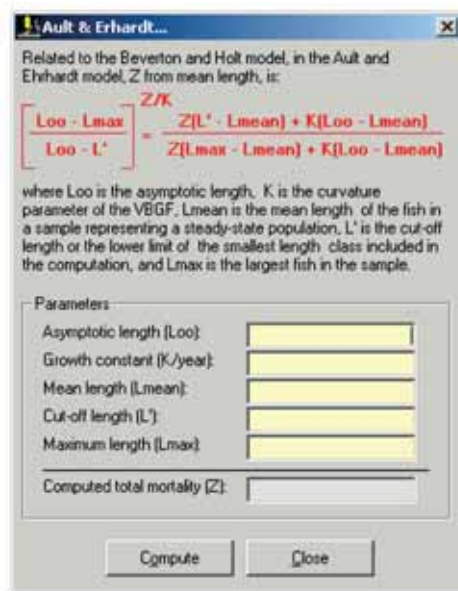


Fig. 4.26. User interface to estimate the total mortality using the Ault and Ehrhardt model in FISAT II.

Remarks The function is solved iteratively. The value of L_{\max} required here may be the largest specimen in a set of samples, or L'_{\max} as estimated via the extreme value theorem (see Chapter 5). The required \bar{L} and L' can be obtained as for the Beverton and Holt model (see above).

Readings Ault and Ehrhardt (1991)
Ehrhardt and Ault (1992)

Hoening's model

The method below relates t_{\max} (i.e. the longevity of fish) and mortality.

Required file None

Input parameters t_{\max} (maximum age in years) observed in a given stock and as an option, t_c (mean age at first capture) and the sample size, N from which t_{\max} was estimated.

Functions When t_c and N are not available, Z is computed from the empirical model

$$\ln(Z) = 1.44 - 0.984 \cdot \ln(t_{\max})$$

When t_c and N are available, total mortality is estimated from

$$Z = 1 / (c_1 \cdot (t_{\max} - t_c))$$

and the standard error (s.e.) of the estimated Z is from the relationship:

$$\text{s.e.}(Z) = (c_2 \cdot Z^2)^{1/2}$$

where c_1 and c_2 are table values and a function of N (these table values are pre-programmed in FiSAT II).

Output

Estimate of Z

User interface

The user interface of this routine provides the user with options on what model to use as presented by the author of the model. Note that the text boxes for N and t_c will be enabled only if the checkbox for Model 2 is checked using the mouse (Fig. 4.27).

Remarks

The estimates of Z obtained by these models (particularly the first) are rather approximate, and should be validated using other methods.

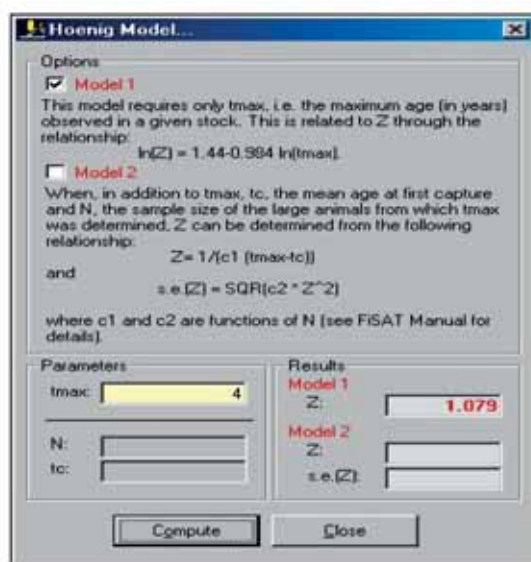


Fig. 4.27. User interface of Hoenig's model as implemented in FiSAT II. Note that the estimates using the two models can be calculated simultaneously.

Tabulated values of c_1 and c_2 may be found in Hoenig and Lawing (1982) and Pauly (1984a).

Readings Hoenig (1982)
 Hoenig and Lawing (1982)
 Pauly (1984a)

Natural mortality

In fish stock assessment, natural mortality is the most difficult parameter to estimate. The following models, two empirical and one analytical, may be useful to approximate M.

Rikhter and Efanov's method

A variant of the Beverton and Holt (1956) equation which relates longevity (t_{\max}) with the $L_{\text{mass}}/L_{\infty}$ ratio (where L_{mass} is the mean length at first maturity), this model relates natural mortality (M) to the age at which 50% of the stock reaches the age of "massive spawning" (t_{mass}).

Required file None

Input parameter t_{mass} (\approx age at first maturity)

Function $M = ((1.52/t_{\text{mass}}) \cdot 0.72) - 0.16$

Output Estimate of M

User interface The dialog box for this routine will require only the input of the age at massive maturation to estimate the natural mortality (Fig. 4.28).

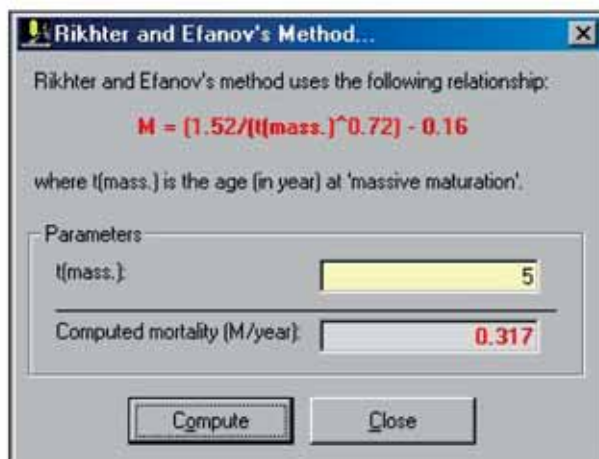


Fig. 4.28. User interface to estimate natural mortality using Rikhter and Efanov's empirical model.

Remarks The derivation of the model was based largely on data from boreal/temperate stocks and should not be used for tropical stocks without prior comparison with the results of other models.

Reading Rikhter and Efanov (1976)

Pauly's M equation

These equations were derived from 175 independent sets of estimates of M and predictor variables for most tropical species. Two options are provided; (1) for cases when L_{∞} is available and (2) for cases when W_{∞} is available.

Required file None

Input parameters Growth parameters L_{∞} , (in cm) or W_{∞} (in g) and K (year^{-1}) and T [mean annual habitat temperature (in $^{\circ}\text{C}$)]. The values of L_{∞} to be used should refer to or approximate total length.

*Functions***Option 1:** L_{∞} is given

$$\ln(M) = -0.0152 - 0.279 \ln(L_{\infty}) + 0.6543 \ln(K) + 0.463 \ln(T),$$

and

Option 2: W_{∞} is given

$$\ln(M) = -0.4851 - 0.0824 \ln(W_{\infty}) + 0.6757 \ln(K) + 0.4687 \ln(T)$$

Output

Estimate of M

User interface

The user interface of this routine provides the users with the two options to estimate natural mortality (M) based on Pauly's M empirical equations. Option 1 is the default model. Clicking on the second option (red circle in Fig. 4.29) will change the labels of the function and input fields.

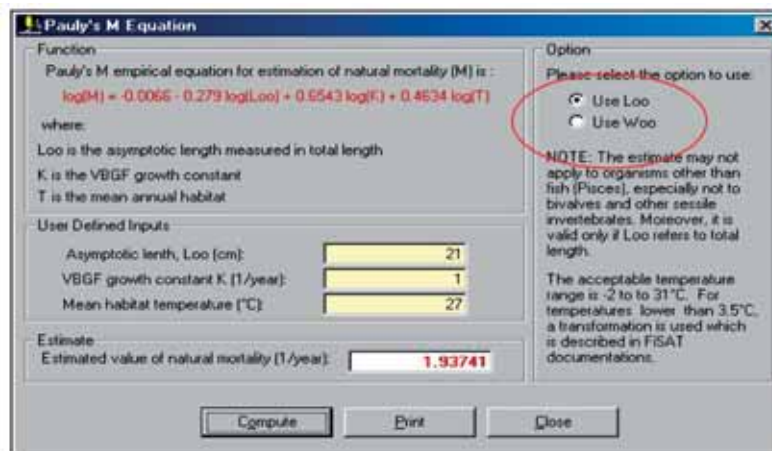


Fig. 4.29. User interface to estimate the natural mortality using Pauly's M empirical equations.