PREVIOUS PAGE

Chapter 5. SUPPORT menu

What you will learn from this chapter

This chapter will introduce you to routines meant to supplement or support the data analyses presented in the previous chapter.

Simulation of length-frequency samples

This routine applies the Monte Carlo technique to simulate the dynamics of a fish stock and a random sampling procedure, taking into account the various stochastic elements of the biological system when generating length-frequency samples. The file(s) output by this simulation routine may be used in various ways such as for assessing the applicability of a model to data with known characteristics or estimating population parameters by changing them iteratively until the length frequencies that are generated come very close to those observed.

This routine includes options to generate length frequencies through random sampling in a "closed habitat" and length frequencies accounting for migrations.

Required file None

Input parameters Except for one element, the migration route for migratory stocks, the required inputs are the same for both options. These inputs are summarized in Tables 5.1 to 5.3.

Functions The sequence of probability functions used are summarized in Table 5.4. These are used for simulating the life (growth, migration) of one individual fish at a time, from one sampling period to the next, until it dies due to M or F.

Table 5.1. Required single field inputs for simulating length-frequency data.

Field name	Type	Limits	Remarks
Number of areas	N	1 to 5	The number of hypothetical areas between which the stock will migrate (for migratory stocks only).
Sample type	Ch	-	Three sample types are available; (1) representing population, (2) representing catch, and (3) double sampling, representing both population and catch.
Number of fish sampled	N	1 to10^6	Total number of specimens in a simulated sample.
Number of age groups	N	1 to 10	Number of age groups assumed to occur in the sample.
Number of length groups	N	2 to 100	Number of length groups in the simulated samples.
L_∞	N	1 to 10^5	Asymptotic length.
CV of L_∞	N	0 to 99	A measure of the assumed variability of L_∞, i.e. $CV = \sigma(L_\infty) \cdot 100/L_\infty$.
K	N	0.1 to 20	Curvature parameter of the VBGF.
CV of K	N	0 to 99	A measure of the assumed variability of K, i.e. $\sigma(K) \cdot 100/K$.
C	N	0 to 1	The amplitude of the seasonal oscillations of the growth curve. An input of zero will automatically set the Winter Point (WP) to zero.

Table 5.1 (cont). Required single field inputs for simulating length-frequency data.

Field name	Type	Limits	Remarks
CV of C	N	0 to 99	A measure of the assumed variability of C, i.e. σ(C)·100/C
WP	N	0 to 1	Time of the year when growth is slowest.
CV of WP	N	0 to 99	A measure of the assumed variability of WP, i.e. σ(WP)·100/WP.
L50*	N	0 to 10^6	50% retention length (left hand selection and/or recruitment).
L75*	N	0 to 10^6	75% retention length (left hand selection and/or recruitment).
R50*	N	0 to 10^6	50% retention length (right hand selection or de-recruitment).
R75*	N	0 to10^6	75% retention length (right hand selection or de-recruitment).
F maximum*	N	0 to 99	The maximum fishing mortality over age group that will be applied to the stock.

*In migratory stock, these fields are area-specific, i.e. values are defined for each area the fish migrates to.

Table 5.2. Other required inputs when running a simulation routine (Options 1 and 2).

Field name	Type	Limits	Remarks
Seed value for randomization	N	0 to 100	Use the same seed value to obtain exactly the same values as in a previous run.
No. of samples	N	0 to 50	This refers to the number of sampling months to simulate. Note that as more simulations are required, computing time increases exponentially.
No. of months between samples	N	1 to 11	Number of months separating simulated samples.
Run time identifier	C	9 char.	This will be recorded, when stored to a FiSAT file in OTHER FILE IDENTIFIERS. Provide inputs to this field that will clearly identify the simulation run.
Recruitment strength	N	0 to 100	The inputs for this table are in relative terms, i.e. the strength of recruitment in a given month *vis-à-vis* other months. FiSAT will proportionally adjust all values such that the largest entry will be equal to 1.
Relative strength	N	0 to 100	Relative strength of each age group; as with the previous table entry, FiSAT will proportionally adjust all values such that the largest entry will be equal to 1.
Natural mortality	N	0.01 to 20	The natural mortality affecting each age group.

Table 5.3. Additional inputs for running a simulation routine incorporating migrations.

Field name	Type	Limits	Remarks
L50 when migration starts	N	0 to 10^6	50% retention length (left-hand selection) at the start of migration out of the nursery area (Area 1).
L75 when migration starts	N	0 to 10^6	75% retention length (left-hand selection) at the start of migration out of the nursery area (Area 1).
Where to go from Area 1	N	2 to 5	Destination (Area 1+i) at the start of migration out of Area 1.
Stay in Area 1+i	N	1 to10^5	Duration of stay in Area 1+i (in months).

Following the above inputs, FiSAT will prompt the user to identify the subsequent areas of migration (2 to 5) and durations in the specified area (1 to 10^5).

Table 5.4. Summary and sequence of procedures which defines a Monte Carlo simulation to generate length-frequency samples.

Probability distribution	Input Parameters	Probability of occurrence	Output
Recruitment	no. of age groups (t_n) and year class strength (Cy_i); if year class strength is not specified, class strength is assumed equal for all year classes	$Cy_i/\Sigma Cy_i$	the age grps. where the fish should be placed
Month of birth	relative monthly recruitment (MR_i)	$MR_i/\Sigma MR_i$	day is assumed to be the 15th of the month and birthdate (tz) is defined

Table 5.4 (Cont.). Summary and sequence of procedures which defines a Monte Carlo simulation to generate length-frequency samples.

Probability distribution	**Input Parameters**	**Probability of occurrence**	**Output**
Growth parameters	growth parameters and their corresponding standard deviations σ(x)	1/(x+2·σ(x))	defines the growth curve of a fish
Migration	the ages at which the fish is expected to stay in the fishing ground	(n.a.)	checks if the fish has left or arrived at the fishing ground
Mortality	Natural mortality (M_t) and selection data SEL_t at age t, and the maximum fishing mortality the sample is exposed to during its life (F_{max})	e^{-Z}, where $Z=\Sigma((F_{max}\cdot P_t)+M_t)$	checks if the fish survived to that age or died due to fishing or natural mortality
Gear selection	Probability of capture (i.e. selection and recruitment curve) by length or age groups (P_t)	P_t	checks if the fish was caught by the gear or not

Outputs — Both options of this routine can generate time series of length frequencies that are saved automatically.

User interface — The user interface of this routine contains a series of tabs (Fig. 5.1) to encode the parameters. Default values are provided by FiSAT II that can be modified. The resulting length frequencies are automatically saved for use in various routines of FiSAT II.

Remarks The time required to run this simulation routine depends on the inputs provided, and may range from a few minutes to several days. However, it is possible to interrupt any simulation by pressing any key (warning: intermediate results are not saved, and the simulation must be restarted from scratch if interrupted).

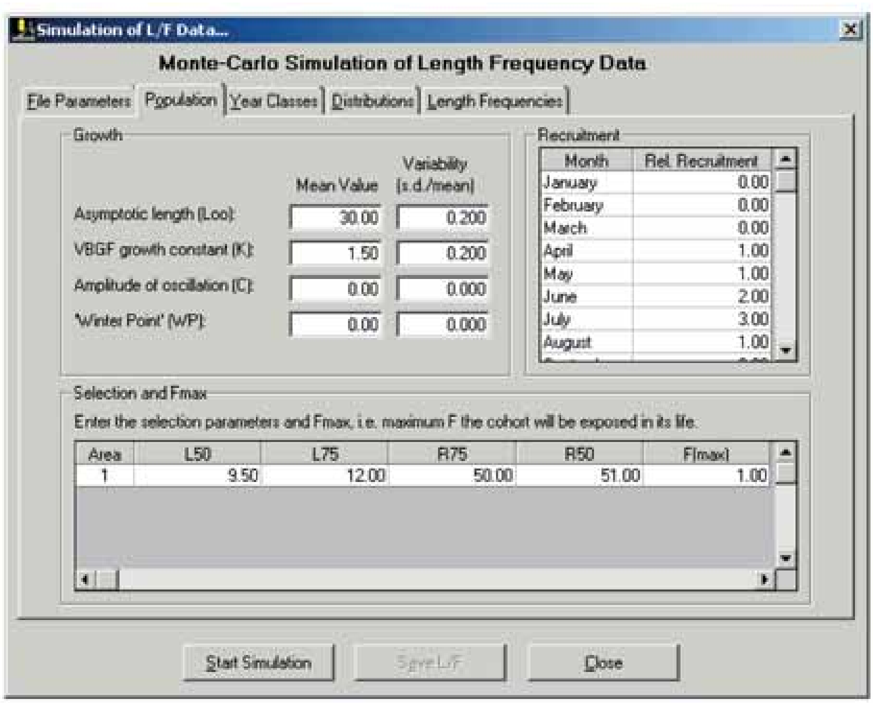

Fig. 5.1. User interface when executing the simulation routine to generate length frequencies.

Sample weight estimation

This routine allows users to estimate sample weights as required to estimate raising factors, or for other purposes.

Required file	Length frequencies with constant class size.
Input parameters	a and b coefficients of the length-weight relationship.

Functions

The mean weight of the sample ($\overline{W}s$) is computed from

$$\overline{W}s = \sum_i \overline{w}_i \cdot N_i / \sum_i N_i$$

where

N_i is the frequency count, and $\overline{w}_i$ is the mean weight of the fish in class i computed from

$$\overline{w}_i = \left(\frac{1}{L_{i+1} - L_i}\right) \cdot \left(\frac{a}{b+1}\right) \cdot \left(L_{i+1}^{\ b+1} - L_i^{\ b+1}\right)$$

where a and b are the coefficients of the length-weight relationship and L_i and L_{i+1} are the lower limit and upper limit of length class i, respectively;

Outputs

A table of computed weights for each length class and the weight of the sample.

User interface

The user interface contains two tabs (Fig. 5.2 and Fig. 5.3). The "General" tab (Fig. 5.2) identifies the file and provides the fields to enter the 'a' and 'b' coefficients of the length-weight relationship.

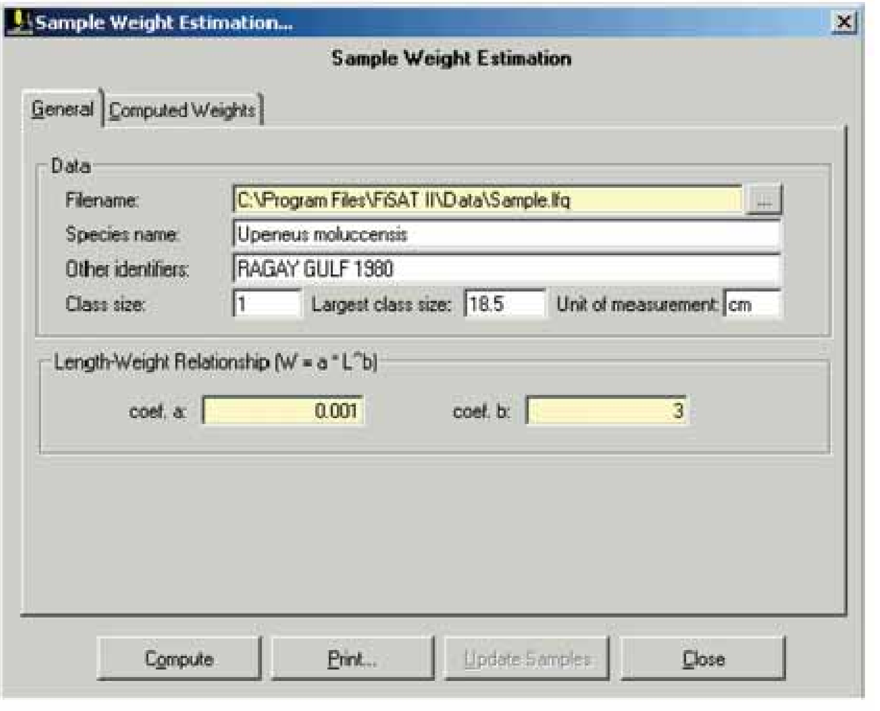

Fig. 5.2. User interface to encode inputs for sample weight estimation routine.

The second tab (Fig. 5.3) is the results of the analysis. Note the presence of the "Compute" command button. After file identification and encoding the required coefficients, clicking this button will commence the calculations.

Also, note the presence of the "Update Samples" command button. Clicking this command button will update the sub-header of the length frequency file, replacing whatever value is stored. This function should, therefore, be used with caution.

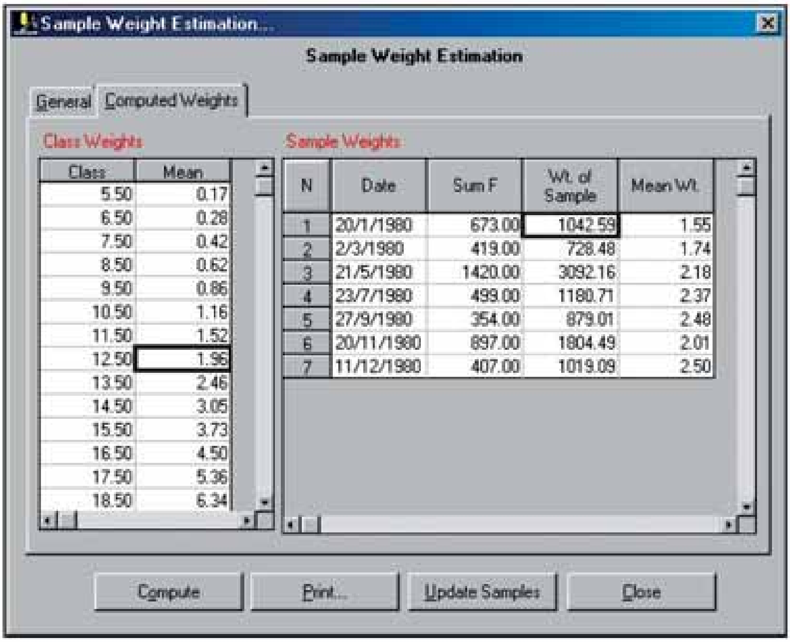

Fig. 5.3. Outputs of the sample weight estimation routine. Note that the sample sub-header can be automatically updated using the computed sample weights.

Remarks The unit for the computed weights is determined by the coefficient a, provided as input to the routine.

[The above equation provides unbiased estimates of $\overline{w}$; estimating $\overline{w}$, as the weight corresponds to $\overline{L}$, leads to bias].

Reading Beyer (1987)

VBGF and L/F plot

This routine provides the option to view length- or weight-frequency data as a 2-dimensional plot (Fig 5.4).

Required file Length or weight frequencies with constant class size.

Input parameter	None
Function	None
Outputs	A plot of the histogram in two dimensions.
User interface	The user interface for this routine contains two tabs (as in the previous routine) (Fig. 5.4). The first tab identifies the length frequency file to plot and text boxes to encode the growth parameters to use in plotting the VBGF curve (if applicable). There are several options that the user may invoke in plotting the length frequency histograms and the growth curve. An option is provided to plot the restructured data (see Chapter 4 on data restructuring as employed in ELEFAN I). However, the option to plot using "Solid Bar Graphs" will be disabled if restructured data are to be plotted.

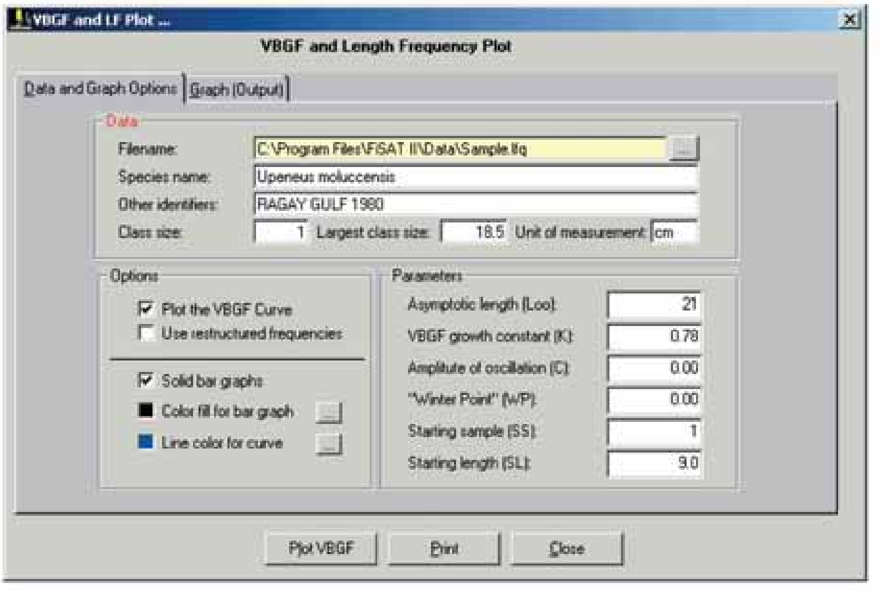

Fig. 5.4. User interface for encoding parameters for the VBGF plot and selecting plotting options.

The resulting graph (Fig. 5.5) may be printed or saved to file (from the Print command). The checkbox in the lower left corner of the graph, "Display all" is enabled only if more than one year of data has been detected. In this case, users may use the scroll bar to view other parts of the resulting plot or view the complete file in one screen by checking the "Display all" checkbox.

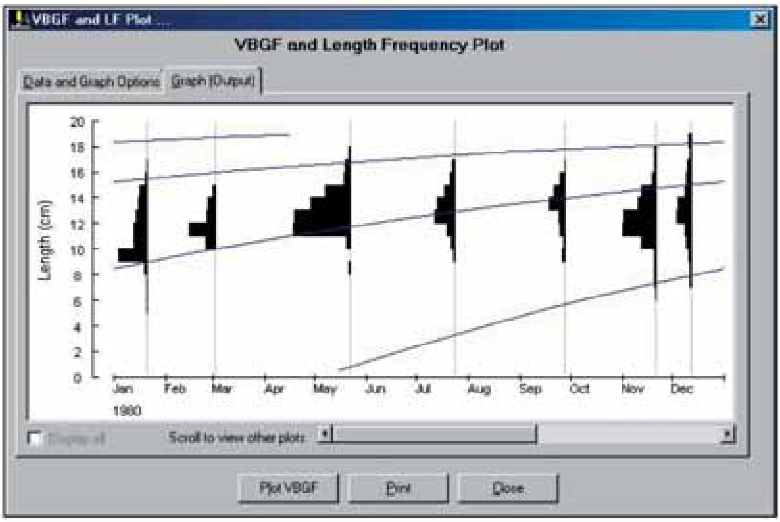

Fig. 5.5. Resulting VBGF plot overlaid by the length frequency histograms.

Remarks	Users should rely on this routine to assess visually the progression of modes in a series of samples before attempting to estimate growth parameters from such series.

Maximum length estimation

This routine estimates the (un-sampled) maximum length of fish (L_{max}) in a population, based on the assumption that the observed maximum length of a time series of samples does not refer to a fixed quantity but rather, represents a random variable which follows a probabilistic law.

Required file	Time series of length frequencies with constant class size (the routine only uses the extreme length of each sample).
Input parameter	None

Functions

L'_{max} is estimated from a set of n extreme values (L*, the largest specimen in each sample of a file) using the (Type I) regression:

$$L^* = a + 1/\alpha \cdot P$$

where P is the probability associated with the occurrence of an extreme value, $1/\alpha$ a measure of dispersion, and L'_{max} is the intercept of the regression line with the probability associated with the n^{th} observation (note that the scale used for P is non-linear, i.e. corresponds to that used for extreme value probability paper).

P is computed for any extreme value from P = m/(n+1) (Gumbel 1954) where m is the position of the value, ranked in ascending order and n is the number of L* values.

Output

Predicted L'_{max} for a given sample size n, and its confidence limits (here for 95% probability).

User interface

The user interface of this routine contains three tabs (Fig. 5.6 and Fig. 5.7). The first tab identifies the file to use in the analysis and summary of the results. The second tab displays the probability plot with the corresponding confidence region. The third tab summarizes the result in table format.

Remarks This routine may also be invoked to estimate L'_{max} for inputs to routines described earlier (e.g. Ault and Ehrhardt's model) or as an initial estimate of L_∞.

Readings Formacion *et al.* (1991)

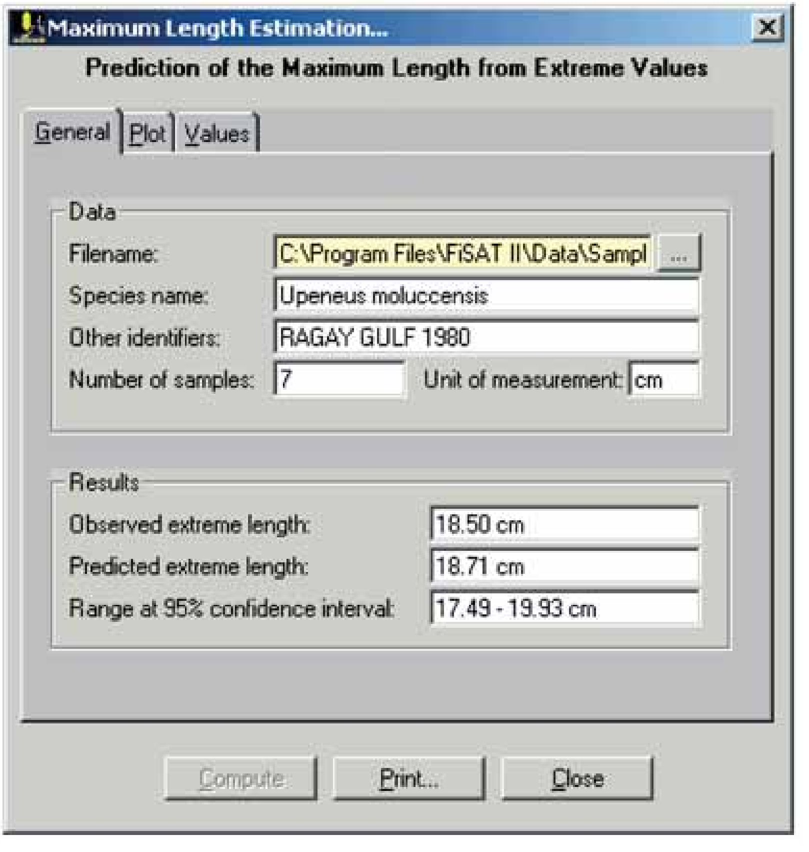

Fig. 5.6. User interface used for the prediction of the maximum length from extreme values. This tab identifies the file and summarizes the results.

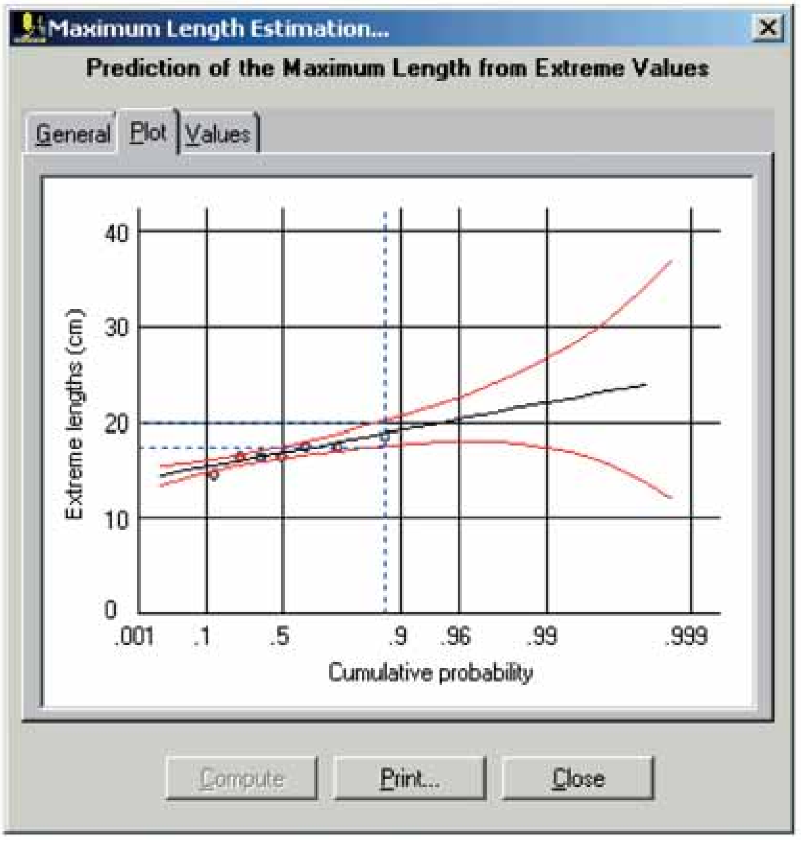

Fig. 5.7. Facsimile representation of the resulting analysis of extreme values.

Growth performance indices

This utility provides the facility to rapidly compute the growth performance index (1) ø (if asymptotic weight is given) or (2) ø' (if asymptotic length is given).

Required file None

*Input parameter*s **Option 1**: ø

Growth parameters W_∞ (asymptotic weight; g) and K (VBGF curvature parameter; $year^{-1}$)

Option 2: ø'

Growth parameters L_∞ (asymptotic length in cm) and K (VBGF curvature parameter; $year^{-1}$)

Functions

Option 1: ø

$ø = \log_{10}(K) + 2/3 \cdot \log_{10}(W_\infty)$

Option 2: ø'

$ø' = \log_{10}(K) + 2 \cdot \log_{10}(L_\infty)$

Outputs

ø and/or ø' values.

User interface

The user interface of this routine (Fig. 5.8) provides fields for the user to encode known parameters. Depending on what is available, the other parameters will be computed. For example, if L_∞ and the growth constant K are given, phi prime (ø') will be computed. If L_∞ and phi prime are given, the growth constant K will be computed. The same is true with regards to the relation of phi, K and W_∞.

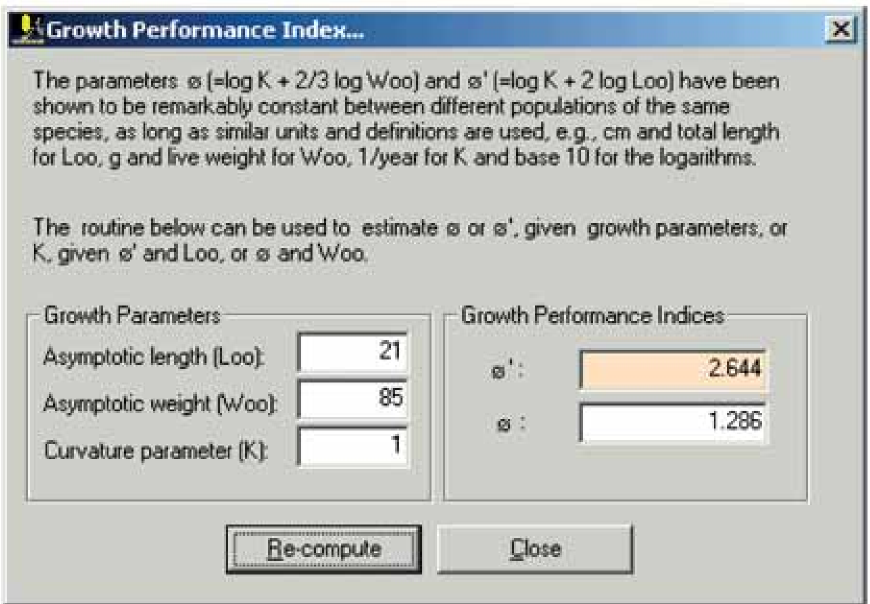

Fig. 5.8. User interface in the calculation of growth indices.

Remarks None

Readings Munro and Pauly (1983)
Pauly (1979)
Pauly (1981)
Pauly and Munro (1984)

Regression analysis

FiSAT II provides a routine to perform linear regression analyses as commonly used in fisheries stock assessment. Several options are provided;

(1) $Y = a + b \cdot X$ (Type I, or AM regression)
(2) $Y = a' + b' \cdot X$ (Type II, GM regression)
(3) $\log(Y) = a + b \cdot \log(X)$
(4) $\ln(Y) = a + b \cdot X$
(5) $Y = a + b \cdot \ln(X)$
(6) $Y/X = a + b \cdot X$
(7) $\ln((1-Y)/C) = a + b \cdot X$

(8) $Y^C = a + b \cdot X$
(9) $Y = a + b \cdot X^C$

Required file — Two-column regression file with at least three pairs of data.

Input parameter — **Options 1 to 6** : None

Options 7 to 9 : A constant C (>0 to 999).

Functions — As defined by the option labels, where a is the Y-intercept, b is the slope, and C is a constant.

Outputs — An XY-plot of the points, and the regression line (Fig. 5.9).

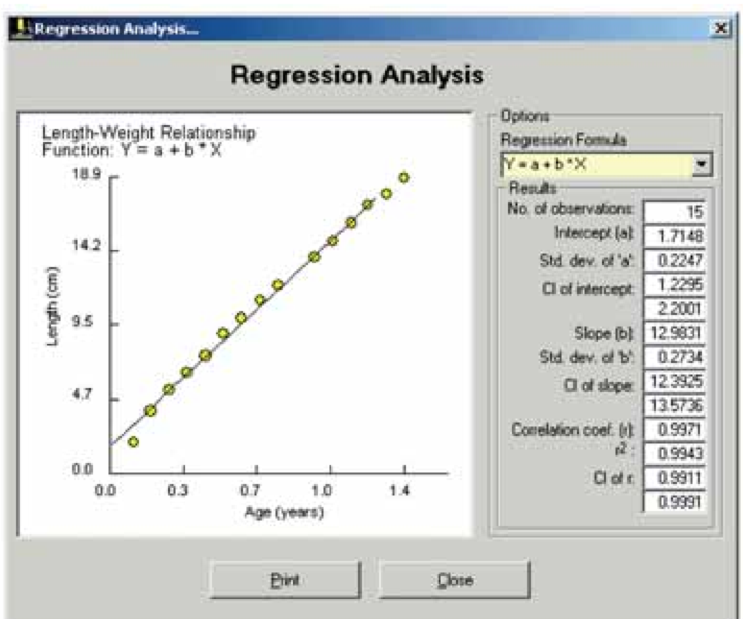

Fig. 5.9. User interface in regression analysis of a XY file.

User interface — This routine requires an active XY Regression file (*.xyf). The options presented above can be accessed from the dropdown list. The results (standard regression statistics) are given on the right hand side of the interface.

Remarks

The options available in this routine may be applied to various scenarios. **Option 3**, for example, may be used to establish the length-weight relationship of fish; **Option 4** can be used for catch curve analysis, where ln(N) is plotted against absolute or relative age; **Option 6** is typically used for surplus production models whose parameters are often estimated through a plot of catch per unit effort (C/f) against effort (f); **Option 7** may be used to linearize complex functions, such as the VBGF in which case, $Y = L_t$, $C = L_\infty$ and $X = t$.

NEXT PAGE