## Editorial

This issue of *Fishbyte*, while also presenting empirical data from studies in Costa Rica and Brazil, emphasizes software that support management-oriented fisheries research.

Furthermore, these software themselves cover a wide range of approaches, from the sophisticated database system developed by J. Kolding to the neural network of A. Jarre-Teichmann et al., and from M. King's fisheries simulation package to a new twist in length-based assessment saga, by yours truly and "Paco" Arreguín-Sánchez.

This last item, incidentally, illustrates a point which I believe cannot be overemphasized: that our present methods, sophisticated as they may seem at first sight, all have weak points, and, more importantly, that these weak points can be identified and overcome if the right questions are asked.

Further development of the methods used by the community of scientists working on tropical fisheries is crucial: only through such development will we get, in the long term a toolkit appropriate to our needs, and in the process contribute as well to the development of fisheries science as a whole.

I'll emphasize this point in 1996 - most probably my last as *Fishbyte* editor. Your feedback on this is welcome. ***D. Pauly***

# Improving Shepherd's Length Composition Analysis (SLCA) Method for Growth Parameter Estimations

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## Abstract

Shepherd's "weakly parametric" method for estimating the parameter $L_\infty$ and K of the von Bertalanffy growth function from length-frequency data often fails to converge, and usually overestimates K. It is shown that this is due to overcounting of the frequencies associated with large, slow growing fish, and that both of these problems can be completely overcome by a simple change in the way the scoring function is formulated.

### Box 1. How to obtain FiSAT and SLCA

Following a four-month debugging process, involving Dr. M.L. "Deng" Palomares, F. Torres, Jr. and Senior Programmer F.C. "Nonong" Gayanilo, version 1.01 of FiSAT was handed over to FAO in September 1995 for duplication and dissemination, thus fulfilling the commitment expressed, somewhat optimistically, in Pauly and Garcia (1994).

Printed versions of the FiSAT user's guide (Gayanilo et al. 1995), distributed jointly with three original FiSAT diskettes (including the original SLCA routine) can be obtained through FAO outlets.

A diskette is available from ICLARM which includes a file that modifies the SLCA routine of FiSAT to its new version, as described in this contribution. This diskette will also include any update of the FiSAT README file, pending the next release of FiSAT. The file can also be downloaded from ICLARM's forthcoming homepage on the WWW.

Write to Felimon Gayanilo, Jr., ICLARM (f.gayanilo@cgnet.com) for details. ***D. Pauly and F.C. Gayanilo, Jr.***

## Introduction

Applying to a given dataset different methods of analysis, yet obtaining the same or similar results is one of the ways to reduce the probability of blunderous interpretations.

This is why the recently released FiSAT software (Box 1) contains several approaches for estimating growth parameters from length-frequency data:

1) Bhattacharya's method (or NORMSEP) for decomposition of mixture of distribution plus modal progression analysis;
2) the procedure known as ELEFAN I (Pauly 1987);
3) the method of Shepherd (1987) for length composition analysis or SLCA.

All three of these methods have their advantages and disadvantages. In the case of SLCA, however, the latter tends to be predominant.

Thus, while SLCA is rather ingenious in its design, and runs fast on any computer, it has the following disadvantages:

i) theoretical background is not easily understood by many potential users;
ii) it does not incorporate seasonal oscillations;
iii) its score function does not have obvious maxima and minima, for best and worst possible fits, respectively;
iv) it usually does not converge, i.e., the highest value of the score function does not correspond to the best combination of $L_\infty$, K values (which are usually identified by a *local* optimum).

We shall deal elsewhere with items (i) to (iii) (Arreguín-Sánchez and Pauly, unpubl.), and shall thus concentrate here only on (iv) which turned out to be very easy to remedy.

## Addressing a Problem of SLCA

The problem in (iv), not addressed by Shepherd (1987) is illustrated in Fig. 1: the scoring function of SLCA tends to increase without bounds as K increases, and the optimum value of K is identified - at best - by a *local* optimum. Moreau et al. (1995) present applications of SLCA to 56 length-frequency datasets pertaining to African freshwater fishes (and included in the report in question); the scoring function had its maximum at K = 10 year$^{-1}$ in 29 of these cases, and K was overestimated in nearly all cases.

The reason for these features of SLCA is that the score function of SLCA gives the same weight to length classes pertaining to small (young) fishes, of which there are several in one age group, as to length classes pertaining to large (old) fishes, consisting of the fish of several cohorts.

Countering this is surprisingly simple: it is sufficient to give adequate weights to the different frequencies to be analyzed (see Fig. 2) to divide each frequency associated with a given length class by Δt, the time needed by the fishes to grow from the lower limit (L1) to the upper limit (L2) of that length class; this should be done right after tracing the oscillatory curve, and before counting the "scores".

To estimate Δt, one uses

$$\Delta t_{1,2} = \frac{-1}{K} \ln \left( \frac{L_\infty - L_2}{L_\infty - L_1} \right) \qquad ...(1)$$

where $L_\infty$ and K are the growth parameters being evaluated by the scoring function. It will be noted that in length-converted catch curves, the same equation is used to correct for the piling-up of old, large fish at the tail end of the length-frequency distributions, which otherwise leads to underestimation of Z (Pauly et al. 1995).

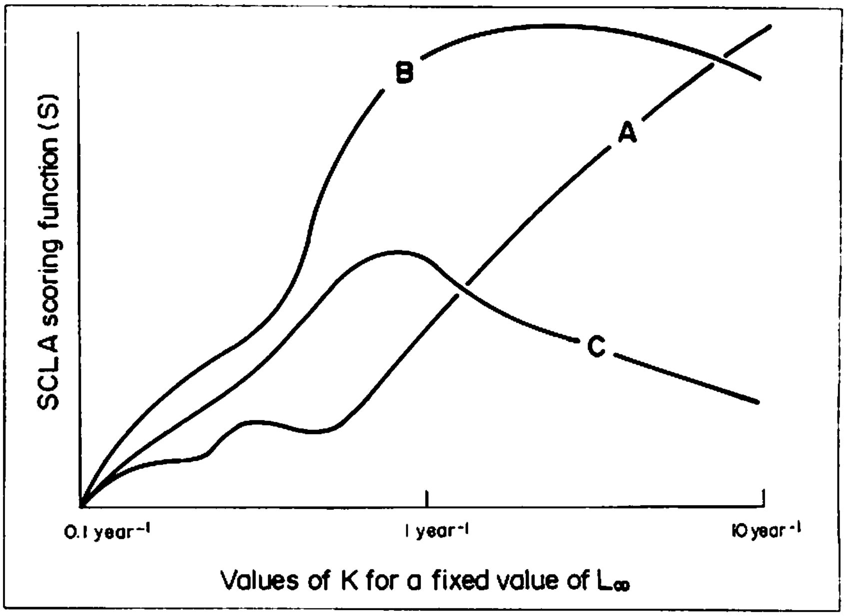

*Fig. 1. Illustrating the key problem of the SLCA method: at high values of K, the scoring function (S) takes very high values, leading to overestimates of K (given $L_\infty$) when it can be estimated at all.*
- *A: the most frequent case, with S growing without bounds as K increases, preventing evaluation of K;*
- *B: a common case: S peaks, then decreases slowly with K, which is overestimated;*
- *C: the rarer case: K is relatively well identified, but may still be overestimated, given the effects in A and B (see also text).*

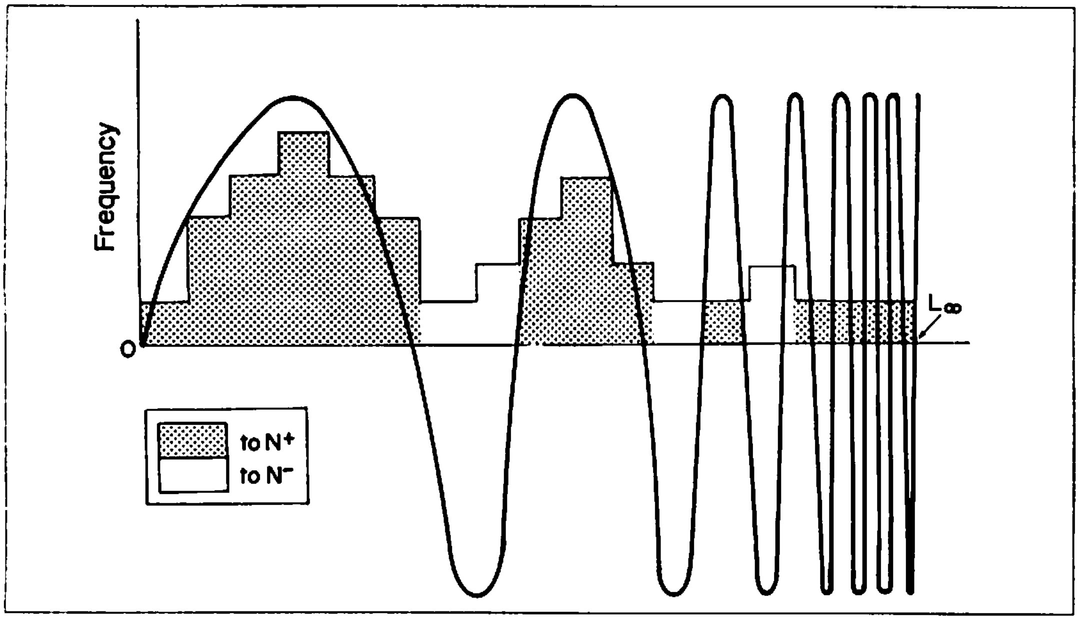

*Fig. 2. The SLCA method estimates $L_\infty$ and K by reexpressing the VBGF as an oscillating line whose limit is ($L_\infty$) and whose frequency of oscillation is determined by K. The frequencies comprised between the positive parts of oscillations are multiplied with the value of the corresponding section of the oscillatory curve, then added to a positive counter (N+), while the corresponding products for the negative parts are added to a negative (counter N-). The scoring function is then S = N++ N-. The problem is that the number of cohorts represented by each length class is not taken into account. This can be achieved, however, by division of each frequency by the corresponding Δt value.*

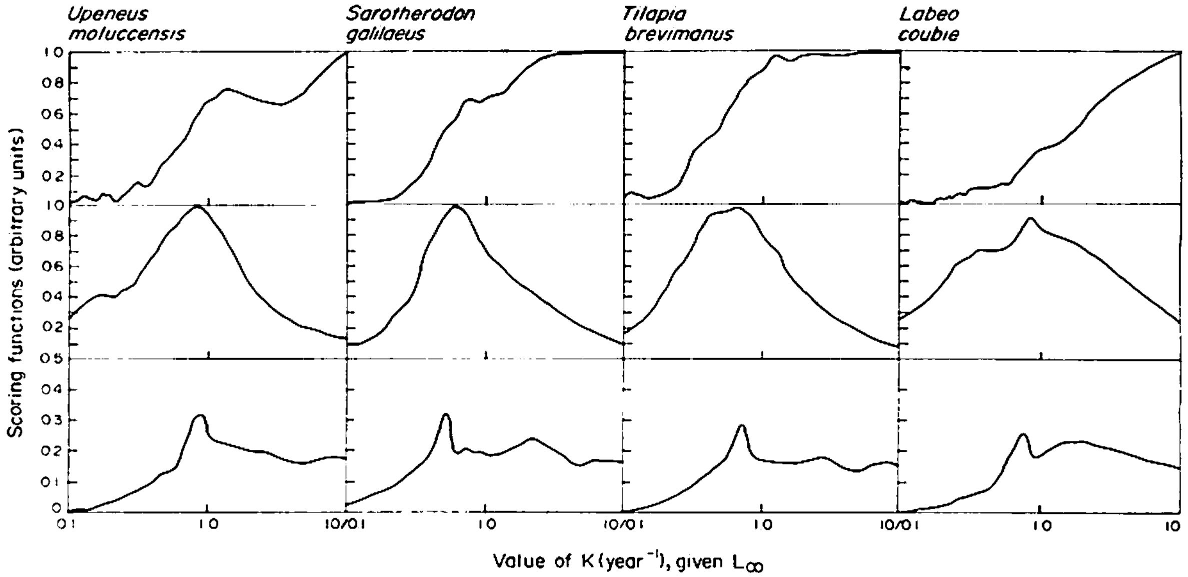

*Fig. 3. Four examples of the differences and similarities between the old version of SLCA (top row), the new version of SLCA (NSLCA; middle row), and the ELEFAN I routine (bottom row). [Files other than MUMORG are from Moreau et al. 1995].*

- **Upeneus moluccensis:** *based on MUMORG file, and $L_\infty = 20$; the old SLCA overestimates K; NSLCA and ELEFAN I estimate K = 0,84 and 0.87 year$^{1}$, respectively;*
- **Sarotherodon galilaeus:** *the old SLCA does not allow estimation of K; NSLCA leads to K = 0.58; for ELEFAN I, K = 0.51 year$^{1}$;*
- **Tilapia brevimanus** *($L_\infty$ = 19.6 cm): the old SLCA does not allow estimation of K; NSLCA leads to K = 0.65, ELEFAN I to K = 0.69 year$^{1}$;*
- **Labeo coubie** *($L_\infty$ = 37 cm): the old SLCA does not allow estimation of K; NSLCA does (K = 0.84 and so ELEFAN I: K = 0.75 year-1).*

## Results and Discussion

Since a picture is reportedly better than a thousand words, we present in Fig. 3 a panel with four examples comparing the "old" and the new version of SLCA and of ELEFAN I.

As might be seen, the increase with K of the scoring function is suppressed in the new version of SLCA , and the optima shifted to the left, largely countering its tendency to overestimate K. Indeed, when seasonal growth oscillations are not considered, the results obtained with the new SLCA are virtually the same as obtained with ELEFAN I, as should be expected if both methods work as they should.

We will deal elsewhere with the incorporation of seasonal growth oscillations into SCLA, and cases (pertaining to very small, fast growing species) where the adjustment proposed here may not suffice to completely resolve the problem addressed here.

## Acknowledgements

We thank F.C. Gayanilo, Jr. for incorporating equation (1) at the right place in the SLCA routine, and for preparing and agreeing to maintain a complementary diskette to FiSAT, and Mr. F. Torres, Jr. for his help with preparing Figs. 1-3.

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