

# The Growth of ELEFAN

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No, this is not a misprint; this article deals with a fish stock assessment method called Electronic Length Frequency Analysis, first presented in 1980 in the ICLARM Newsletter<sup>1</sup>, the predecessor of *Naga*, and which has since grown in scope and is now in use throughout the world.

Initially, ELEFAN was a relatively simple computer program, implemented on a narrow-minded (16 K!), steam-engined microcomputer fed via cassette tapes. Still, this program represented an improvement: it allowed estimation of growth parameters from length-frequency data, i.e., from length-frequency measurements such as can be obtained, rather cost-effectively<sup>2</sup>, from landing places. Fish growth parameters are needed for the formulation of management advice in various tropical and other fisheries.

The ELEFAN I program caught on for a number of reasons:

- it was straightforward and easy to understand;
- although not perfect, it was better than the subjective paper-and-pencil methods then predominantly used;
- it requires length-frequency data, of which immense quantities had been gathered for decades in most laboratories of the world, especially in the tropics for which ELEFAN I had been developed (Fig. 1).

The adoption of ELEFAN I, and its gradual transition into a standard method, did not proceed smoothly. Many colleagues involved, e.g., in teaching fishery biology, had to be convinced that this approach would not mislead its users.

A major step in overcoming these fears was an international conference co-sponsored by ICLARM, the Kuwait Institute for Scientific Research (KISR), the Food and Agriculture Organization of the United Nations (FAO) and the Italian Consiglio Nazionale delle Ricerche, held in February 1985 in Mazarra del Vallo, Sicily. Several contributions presented at this conference, and subsequently included in the proceedings<sup>3</sup>, dealt explicitly with the ELEFAN I program. These contributions helped define the conditions under which ELEFAN I can be expected to produce

reliable results and conversely, to identify datasets to which the method should not be applied, thus reducing the risk of misuse.

Also, a number of approaches for preliminary data treatment and supporting routines were identified which improved the estimation of parameters using ELEFAN I, e.g, the Wetherall plot for the independent estimation of the

asymptotic length of fishes (Fig. 2). Following this conference, two software packages were developed which incorporated these findings:

- the one-diskette "Kiel version" of ELEFAN, for either Apple II

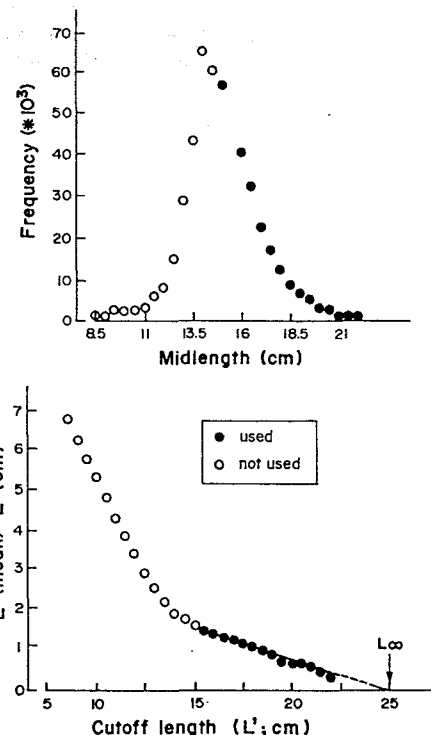
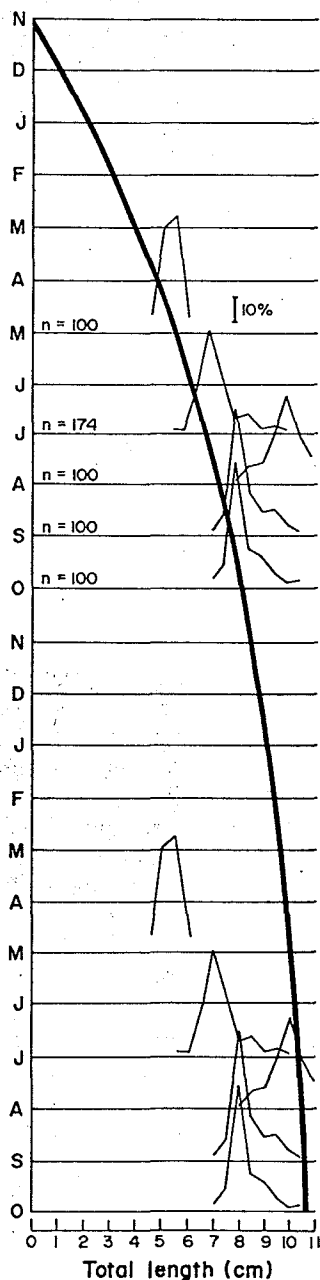


Fig. 2. Plots for independent estimation of asymptotic length ( $L_{\infty}$ ) and related parameters from length-frequency data. Above: Cumulative frequencies by length of roundscale *Decapterus macrossoma* from the Java Sea, as used to identify points not affected by selection effects, and which hence can be used for regression analysis. Below: Modified Wetherall plot, as used to estimate  $L_{\infty}$  and  $Z/K$ . Redrawn from a printout of the Compleat ELEFAN (from Suherman Banon Atmadja. 1988. *FAO Fish. Rep.* 389: 324-345). The Wetherall plot and its modification were originally published in *Fishbyte* 4(1):12-14.

Fig. 1. The first published graph illustrating the ELEFAN program<sup>1</sup>. It shows a set of length-frequency samples sequentially arranged in time, with growth curve fitted by the program. Note that the distance between the bases of the samples and the time period between the sampling dates are proportional, and that the set of samples is "repeated" one year later, to allow for the forward projection of the growth curve. The curve has the parameters  $L_{\infty} = 12.2$  cm and  $K = 1.3$  year, with a goodness of fit index called ESP/ASP = 0.804. It must be emphasized that the curve was *not* fitted by eye, and that *no* inputs were made as to expected ages of the various peaks, which of the peaks should be interconnected, etc. The data, which pertain to slipmouths (*Leiognathus bindus*) caught off Calicut, India, in 1958, were originally published in Balan, V. 1967. *Indian J. Fish* 10(1):118-134.

(CP/M) or IBM PC and their compatibles<sup>4</sup>

- the 12-diskette Compleat ELEFAN for IBM XT and their compatibles<sup>5</sup>

[Earlier versions of ELEFAN for Radio Shack TRS-80, HP 85/87 and other obsolete microcomputers are no longer supported by ICLARM.]

Both the "Kiel version" and Compleat ELEFAN are rather popular throughout the world, (Fig. 3) with, to date, over 150 sets (diskette(s) and manual) distributed of the former package, and close to 300 sets of the latter, not accounting for the unregistered copies. The reasons are probably: (i) the fact that the programs are user-friendly, and that (ii) they do not only lead to the estimation of growth parameters, but also allow, once the growth analysis is complete, to "dig deeper" into the available length-frequency data, and to estimate from them parameter values for a number of processes (e.g., seasonal growth oscillations production/ biomass ratios) in which fishery biologists and aquatic ecologists are interested, but more often than not, did not know how to quantify (Fig. 4).

These two points are particularly true in the case of the Compleat ELEFAN, whose high resolution screen graphics (which can be plotted using a printer and/or a plotter) are particularly vivid (Fig. 5) and which includes rather sophisticated routines for estimating total natural and fishing mortalities, gear selection parameters, the parameters of seasonal recruitment pulses, as well as for performing standard and nonstandard stock assessments such as yield-per-

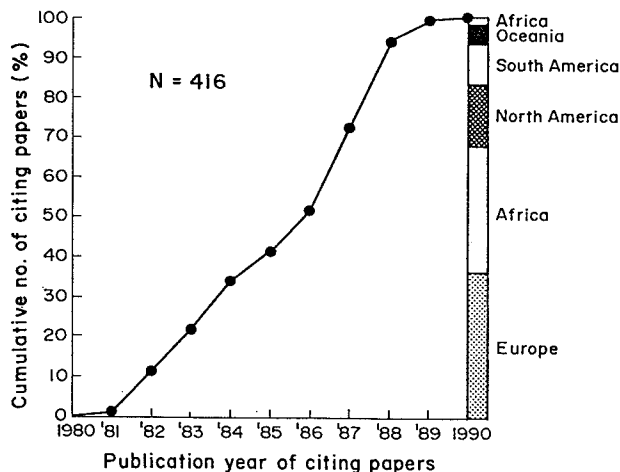


Fig. 3. To date, ICLARM publications referring to the ELEFAN programs have been cited at least 846 times in at least 416 citing papers, reports, theses, etc. This impact is illustrated here as a temporal trend, and by major regions of the world.

recruit analyses, or age- and length-structured virtual population analyses (Fig. 4, 5).

The Food and Agriculture Organization of the United Nations (FAO) in the courses of its FAO/DANIDA Training Courses in Tropical Fish Stock Assessment Project also developed a software package for fish stock assessment from length-frequency data, the LFSa package<sup>5</sup>. The participants of various courses held in Asia, Africa, South America and Europe were introduced to both LFSa and the Compleat ELEFAN, although they overlapped in well over half of their routines.

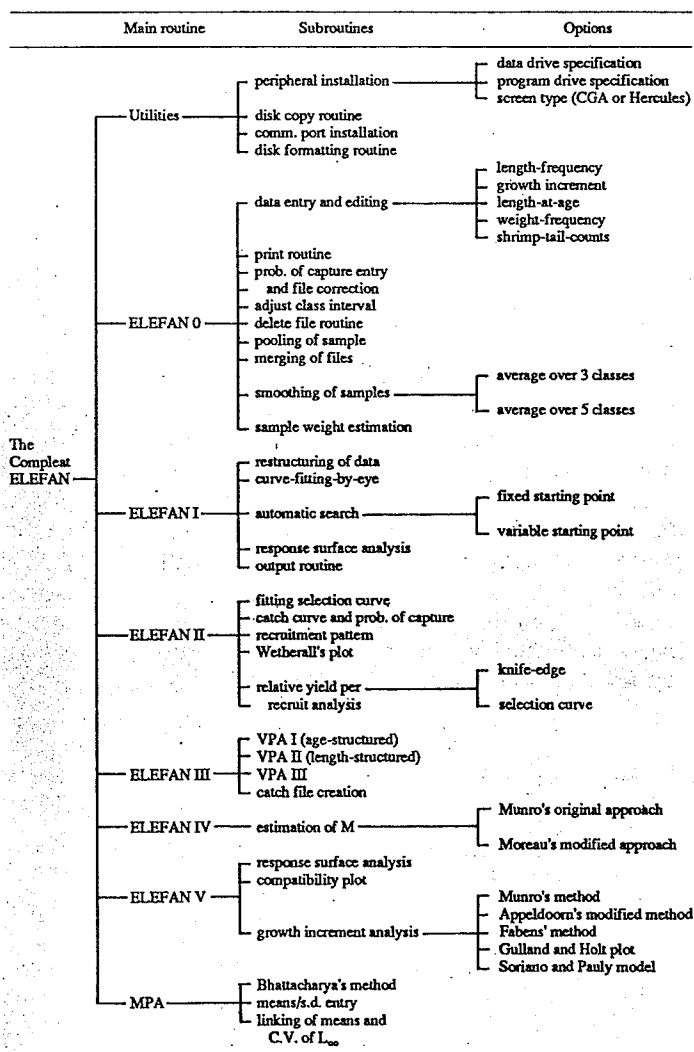
In 1989, a reassessment of this approach led the Marine Resource Services of FAO and ICLARM signing a Letter of Agreement involving the

merging of these two software, and thereby the creation of a still unnamed new package that will be distributed by both FAO and ICLARM, and whose documentation will eventually be translated into French and Spanish (Fig. 6).

Although the ELEFAN I routine for estimation of growth parameters will be incorporated into the joint product, this development will mean the eventual discontinuation of ELEFAN as an integrated software package.

The new software, partly under development and of which a test version will be available in 1991, will however keep the "feel" of the Compleat ELEFAN, i.e., include high-resolution interactive graphics, text-rich self-documenting menus and the optional use of a mouse.

Fig. 4. Main routines, subroutines and options of Version 1.10 of the Compleat ELEFAN (from Gayanilo and Pauly 1989, Fishbyte 7(2): 20-21).



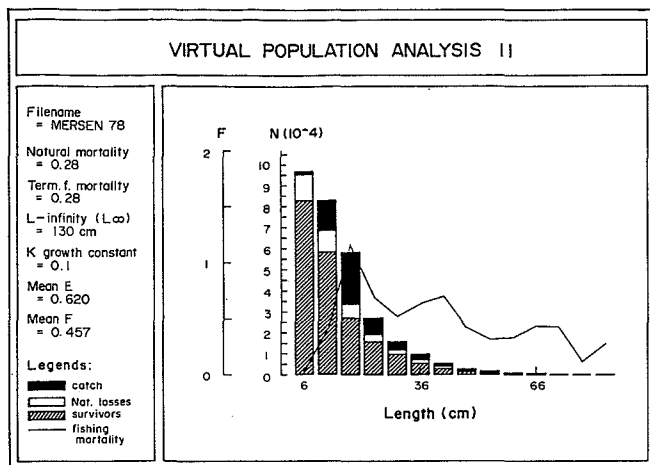


Fig. 5. Facsimile of a plotter output generated by the ELEFAN III program of the Compleat ELEFAN package, and representing a form of Virtual Population Analysis analogous to R. Jones' length-cohort analysis. The data used pertain to a West African stock of hake (*Merluccius merluccius*) and all rates are annual<sup>3</sup>.

This process is documented in successive issues of Fishbyte, the newsletter of ICLARM Network of Tropical Fisheries Scientists. Also, the authors will be pleased to provide details directly to any interested reader.

#### Further Reading

<sup>1</sup>Pauly, D. and N. David. 1980. An objective method for determining fish growth from

length-frequency data. ICLARM Newsl. 3(3): 13-15.

<sup>2</sup>Morgan, G.R. 1983. Application of length-based stock assessment to Kuwait's fish stock. ICLARM Newsl. 6(4): 3-4.

<sup>3</sup>Pauly, D. and G.R. Morgan, editors. 1987. Length-based methods in fisheries research. ICLARM Conference Proceedings 13, 468 p. ICLARM, Manila, Philippines and Kuwait Institute for Scientific Research, Safat, Kuwait.

<sup>4</sup>Brey, T., M. Soriano and D. Pauly. 1987. Electronic length-frequency analysis: a revised and expanded user's guide to ELEFAN 0, 1 and 2 (Second Edition). Berichte des Instituts

für Meereskunde an der Universität Kiel No. 177. 31 p.

<sup>5</sup>Gayanilo, F., Jr., M. Soriano and D. Pauly. 1987. A draft guide to the Compleat ELEFAN. ICLARM Software 2, 65 p.

<sup>6</sup>Sparre, P. 1987. Computer programs for fish stock assessment: length-based fish stock assessment for Apple II computers. FAO Fish. Tech. Pap. 101. Suppl. 2, Rome. 218 p. [Note that the LFSA package, as presently maintained and distributed by FAO, is only for IBM and compatible microcomputers, notwithstanding the title of the documentation.]

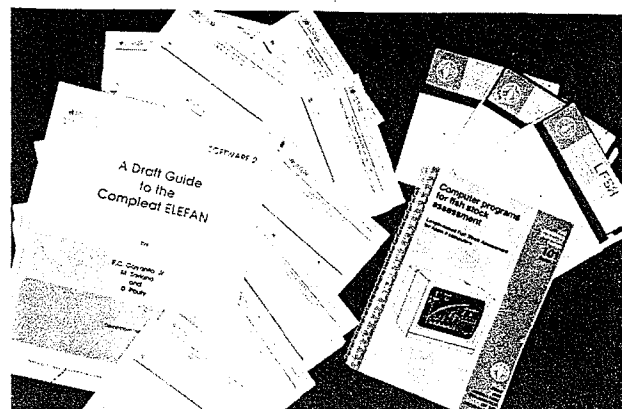


Fig. 6. Photo of manual and diskettes of ELEFAN + LFSA. The Compleat ELEFAN (Electronic Length Frequency Analysis) and LFSA (Length-based Fish Stock Assessment) software packages of ICLARM and FAO, respectively, are extremely useful to fishery scientists in developing countries. Rewriting these programs into a single, optimized software package will facilitate the training activities of both FAO and ICLARM.

#### The ICLARM Software Project

The ICLARM Software Project was initiated in early 1987. It involves the dissemination of software for calculators and microcomputers, along with their supporting documentation (e.g., manuals or scientific paper).

The material now available for distribution presently consists of software produced at ICLARM (see below), but will in the near future include *public domain programs*, as well as software made available by their authors to ICLARM for free worldwide distribution.

This software will include the areas of fish population dynamics, fisheries and aquaculture economics, fish genetics and other fields covering ICLARM's areas of interest.

All software will be made available at cost, i.e., including only material, mailing and handling costs. Copyrighted material will not be distributed. Authors and potential contributors to this scheme are invited to write to the Director, Capture Fisheries Management Program, International Center for Living Aquatic

Resources Management, (ICLARM), MC P.O. Box 1501, Makati, Metro Manila, Philippines. Interested readers can write to The ICLARM Software Project, ICLARM.

Payment (payable to ICLARM) should be in US\$ by international money order, bankdraft or UNESCO coupons. We can accept US\$ checks only if from a US-based bank due to high clearance fees of other banks.



#### Titles in the ICLARM Software Series

- User's manual for the fish population dynamics plug-in module for HP41CV calculators. M.L. Palomares and D. Pauly. 1987. ICLARM Software 1, 5 p. Distributed with a custom-made plug-in module for HP41CV calculators for US\$150 (airmail).
- A draft guide to the Compleat ELEFAN. F.C. Gayanilo, Jr., M. Soriano and D. Pauly. 1988. ICLARM Software 2, 65 p. Distributed with a 10-diskette (5-1/4") Compleat ELEFAN package for US\$75 (airmail).

- Estimation and comparison of fish growth parameters from pond experiments: a spreadsheet solution. J.M. Vakil. 1988. ICLARM Software 3, 12 p. Distributed with one 5-1/4" diskette for US\$15 (airmail).
- MAXIMS: A computer program for estimating the food consumption of fishes from diet stomach contents data and population parameters. A. Jarre, M.L. Palomares, M.L. Soriano, V.C. Sambalay, Jr. and D. Pauly. ICLARM Software 4. Distributed with two 5-1/4" diskettes for US\$20.

- CDS ASSISTANT. F.C. Gayanilo, Jr. 1990. ICLARM Software 5, 19 p. Distributed with one 5-1/4" diskette for US\$15 (airmail).
- A draft guide to the ECOPATH II program (ver 1.0). 1990. ICLARM Software 6, 22 p. Distributed with one 5-1/4" MS-DOS diskette for US\$20 (airmail). Software 6 is available free of cost for cooperators of the ICLARM project "Global Comparisons of Multispecies Trophic Models". Please contact V. Christensen for further details.