Pauly, D. 1985. The ICLARM/KISR conference on the "theory and application of length-based stock assessments." Fishbyte 3(1):5-12

THE ICLARM/KISR CONFERENCE ON THE THEORY AND APPLICATION OF LENGTH-BASED STOCK ASSESSMENTS

by

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The international conference on the "Theory and Application of Length-based Stock Assessments" took place from 11-16 February, 1985 at the Instituto di Technologia della Pesca e del Pescato (ITPP) at Mazara del Vallo, Sicily, Italy, as announced in the previous issue of Fishbyte. We had great hopes for this conference. All of them were met, and in many ways, the conference went beyond what we had hoped it would achieve.

Specific aims of the conference were:

- to identify the basic features of sampling schemes for representative length-frequency data,
- to review length-based methodologies for fish stock assessments, with particular reference to their precision and accuracy,
- to examine the interrelationships between length-based and age-based methods, and possible approaches for combining the two, and finally,
- to review and test computer programs implementing length-based methods.

The conference, the planning of which was initially in the hands of Dr. J.L. Munro, ICLARM, was organized by this author, acting as conference secretary and Dr. G. Morgan of the Kuwait Institute of Scientific Research. It had the active support of the Division of Marine Resources, FAO and of the Consiglo Nazionale delle Ricerche, through ITPP, the host institution.

Both the host, ITPP Director Dr. Dino Levi and the conference Chairman Dr. J.A. Gulland contributed to the smooth running of the conference, which began with a two-day presentation of the 22 contributed papers (see Appendix for their title, authors and abstracts). The conference participants and six observers (three from KISR and three from ITPP) then split into four working groups, each of which looked at one of the following areas:

- sampling of length-frequency data,
- review of existing length-based models,
- sensitivity, precision and bias of various models,
- review and testing of relevant computer programs.

A report for inclusion in the conference proceedings was prepared by each of the groups, to which will be added a report, presently being written by Dr. J.A. Gulland, on the conference as a whole.

Although it is Dr. Gulland's report which will contain the finer points of the conference, three areas of concensus emerged clearly enough for them to be mentioned here:

i) Although length-frequency data can be obtained relatively cheaply, they must be obtained through well-designed sampling schemes if they are to form the backbone of stock assessments. Particularly, attention must be given to appropriate sampling of young stages,

ii) There are a vast number of methods for estimation of growth, mortality and recruitment patterns and for deriving other information from length-frequency data. It is therefore possible to select the method best suited to the structure of the data set. However, when applying such methods, care must be taken to assess the likely errors involved, and to take remedial measures where appropriate.

iii) The precision and accuracy of length-based methods generally improves considerably when growth information (e.g. as obtained by reading ages from a few otoliths) is incorporated into an analysis based predominantly on length-composition data. This suggests that the most cost-effective methods for stock assessments, both in developed temperate and in tropical developing countries should be "hybrid methods", combining lots of length-frequency data with some age information from hard parts (e.g. daily rings; see Fishbyte 2(3)).

The proceedings of the conference, will be edited by this author and Dr. Gary Morgan and will be published in two volumes in the ICLARM Conference Proceedings Series. The first volume will contain the 22 contributions listed below, the four group reports and the Chairman's report. The second volume will include user's instruction, listings, test runs and test data for a number of the computer and calculator programs presented and tested at the conference (excluding the ELEFAN programs, which will be published separately). These programs will not be standardised to a common language, however, and thus will include listings in FORTRAN, various dialects of BASIC, as well as routines in HP's Reverse Polish Notation.

The ELEFAN program whose review and detailed examination made up about 1/4 of the conference contributions have "survived" the very critical tests to which they were put, in the sense that the conditions could be defined under which they can be expected to provide reasonable answers.

It will thus be possible, when the ELEFAN programs are prepared for publication to state these conditions explicitly - as well as to incorporate the suggestions for improvements that were made during the conference.

Altogether, the conference was a resounding success. This was best summarised in a letter just received from one of the participants which concluded with "...good science, good people, good food. What more could one ask for a conference?"

Abstracts of papers presented at the conference

METHODS OF SIZE FREQUENCY ANALYSIS AND THEIR INCORPORATION IN PROGRAMMES FOR FISH STOCK ASSESSMENT IN DEVELOPING COUNTRIES: FAO INTEREST IN RECEIVING ADVICE

J. Csirke, J.F. Caddy* and S. Garcia*
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Abstract: FAO's task requires the adaptation of conventional methodologies developed in high latitudes for use in tropical situations and the development and further refinement of length-based methodologies. However, a number of problems need to be resolved before these methods can be applied on a grand scale. Questions for which FAO requires detailed answers from this conference relate among other things to the following items: "quick and dirty" vs elaborate approaches, problems with cohort separation, bias due to selectivity and heterogenous fishing effort, departures from steady state, sampling problems in multispecies, multigear fisheries, problems with very short-lived animals, appropriate trawl survey stratification for sampling length frequency data, effects of sampling errors and biases on mortality and growth estimates from different methods, use of mean size statistics and translation of results from length based models into management advice.

[Answers to most of these questions will be found in the 21 other contributions presented at the conference. D.P.]

A REVIEW OF THE ELEFAN SYSTEM FOR ANALYSIS OF LENGTH-FREQUENCY DATA IN FISH AND AQUATIC INVERTEBRATES

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Abstract: Some aspects of the history and present role of length-based methods for the study of the growth, mortality and recruitment of fish and invertebrate stocks are reviewed. The recently deve-

loped ELEFAN (Electronic LEngth Frequency ANalysis) system of BASIC microcomputer programs is presented and some of its key features are discussed in detail.

Examples of the use of the ELEFAN system are provided; these examples are used to illustrate the need for further research on length-based systems in general and to emphasize the need for adequate sampling.

ESTIMATING GROWTH AND SURVIVAL PARAMETERS BY NONLINEAR REGRESSION USING AVERAGE SIZE IN CATCHES

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Abstract: When recruitment is periodic, average size in samples is smallest in the month of recruitment and largest in the month just before recruitment. The change in average size during a year is a function of growth and survival parameters, which can be estimated by an iterative nonlinear regression technique using average size as the dependent variable and time since recruitment as the independent variable. The model that is presented uses a constant rate of survival and the Richards function to model growth. Four parameters can be estimated: Z, the mortality constant; K, the growth rate constant; S_∞, asymptotic size; and, n, the shape parameters. Two examples are presented to illustrate applications of the method.

SOME MODIFICATIONS OF EBERT'S METHOD TO CALCULATE GROWTH AND MORTALITY PARAMETERS FROM AVERAGE LENGTHS IN A POPULATION

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Abstract: Ebert's method for the analysis of average sizes in a population is discussed and its similarity to certain methods for fitting a von Bertalanffy growth curve is pointed out. A simple fitting method is proposed. It is shown how this method can be applied to the special case of two recruitments per year; the robustness of this approach is discussed. A BASIC program is given which can fit the relevant function to a given set of data.

ESTIMATING GROWTH AND MORTALITY IN STEADY STATE FISH STOCKS FROM LENGTH-FREQUENCY DATA

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Abstract: Methods of using length-frequency statistics to estimate L_∞ and the ratio Z/K in steady state fish stocks with von Bertalanffy growth and exponential mortality are studied. Several standard procedures applicable when mortality is constant are reviewed, and new methods are introduced which have superior performance. The various methods are evaluated using Monte Carlo techniques. Problems of systematic bias are discussed, and remedial measures are suggested. Finally, a method is developed (but not yet evaluated) to estimate length-specific mortality rates under the steady state model.

A METHOD FOR ESTIMATION OF GROWTH, MORTALITY AND GEAR SELECTION/RECRUITMENT PARAMETERS FROM MULTIPLE C.P.U.E. LENGTH FREQUENCY DATA.

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Abstract: This paper describes a method and a program for the estimation of von Bertalanffy growth parameters, total mortality rates and gear selection/recruitment parameters from multiple length frequency samples in the form of C.P.U.E. (e.g. numbers caught per hour by length group each quarter of the year). The length frequencies are separated into normally distributed components, each of which represents a brood.

The method is constructed to allow for continuous (although seasonally variable) recruitment all year round and is intended to be used especially for tropical fish stocks with such a recruitment pattern.

The program is implemented in FORTRAN 77 for VAX 11/750.

TWO METHODS FOR SIMULTANEOUSLY ESTIMATING GROWTH, MORTALITY AND COHORT SIZE PARAMETERS FROM TIME SERIES OF CATCH AT LENGTH DATA FROM RESEARCH VESSEL SURVEYS.

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Abstract: Two methods for estimating growth, mortality and cohort size parameters from time series of groundfish survey catch at length data are described. Examples of their use are given based on North Sea cod data from English groundfish surveys.

A WEAKLY PARAMETRIC METHOD FOR THE ANALYSIS OF LENGTH COMPOSITION DATA

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Abstract: A new and robust method for the analysis of length compositions in terms of the parameters of a specified growth curve (e.g. von Bertalanffy) was developed. It does not require the number or width of modes to be specified, and is insensitive to sampling noise of the larger length groups. A goodness-of-fit measure is mapped as a function of growth parameters, which avoids problems caused by multiple maxima, and enables the size and shape of approximate confidence regions to be estimated. Once growth parameters have been selected, these may be used to 'slice' the length composition into age groups. However, it is probable that further analysis of length data directly is preferable to methods relying on such a decomposition.

ESTIMATION OF GROWTH AND MORTALITY PARAMETERS FOR USE IN LENGTH-STRUCTURED STOCK PRODUCTION MODELS

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Abstract: The suggestion by Vaughan and Kanciruk that linear methods of fitting von Bertalanffy growth curves should be abandoned in favour of non-linear estimation appears premature, because the direction of the bias is explainable by the use of an ordinary predictive regression line in their simulation study instead of a functional regression. An estimator for the total mortality, Z, based on mean length is derived for use when reproduction occurs periodically instead of continuously. Production models employing mortality rate or Z/K as the independent variable, as suggested by Csirke and Caddy, may appear tilted to the left if natural mortality rate is compensatory. If data are limited to a small portion of the production curve, attempts at curve fitting may give unreasonable results. In this case, one can constrain a parameter to equal an independent estimate so that the other estimates become more reasonable.

ESTIMATING MORTALITIES FROM LENGTH (OR AGE) SPECIFIC RATIOS

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Abstract: Methods are presented for estimating F's and M's from the proportions by length (or age) of each sex in the catch; and knowledge of the total mortality coefficient and age at first capture for each sex. When dealing with seasonal fisheries, the additional information required are the ages at the end of the first fishing season, and the fishing season duration. The methods are supported by the provision of programmes suitable for Hewlett Packard 67/97 calculators and worked examples.