VIRTUAL POPULATION ANALYSIS - A PRACTICAL MANUAL FOR STOCK ASSESSMENT

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by

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PREPARATION OF THIS DOCUMENT

The FAO/DANIDA project GCP/INT/575/DEN “Training in Fish Stock Assessment and Fishery Research Planning” organized some 100 Training Courses and Workshops dealing with fish stock assessment from 1983 to 1998. This document is based on lecture material that was gradually developed for three high-level regional courses given in 1996 at IMARPE, in Callao, Peru for Latin America, in cooperation with the Comisión Permanente del Pacífico Sur (CPPS), in 1997 in Hillerød, Denmark for countries bordering the Baltic Sea in cooperation with the International Council for the Exploration of the Sea (ICES) and in 1998 at NATMIRC in Swakopmund, Namibia for Angola, Namibia and South Africa, in cooperation with the Nansen Programme. The material was further tested in a course held in Valparaiso, Chile in December 1999, organized under a bilateral agreement between Chile and Denmark.

The following scientists have contributed to the contents of this manual and the accompanying exercises: Ana-Maria Caramelo (FAO), Pavel Gassioukov (Russia), Renato Guevara (Peru), Eskild Kirkegaard (Denmark), Hans Lassen (ICES), Jean-Jacques Maguire (Canada), Paul Medley (UK), Christian Riise (FAO), Henrik Sparholt (ICES), Bernard Vaske (Namibia), Siebren Venema (FAO) and Alejandro Zuleta (Chile).

The lecture material underwent gradual modifications and finally a draft manual was produced by Hans Lassen in 1998. This draft was subsequently revised and expanded by Paul Medley, in close cooperation with Hans Lassen. For this work some funds were used of the FAO/Norway FISHCODE project GCP/INT/648/NOR.

ICES kindly gave permission to use selected data sets for the exercises. Use has been made of software provided by Numerical Recipes Software, Cambridge MA, USA, for which permission was requested

The document covers most of the stock assessment methods that are presently in use in countries and areas where sophisticated data collection systems provide the necessary data. It is the last, and most advanced manual in a series on fish stock assessment and data collection, developed between 1983 and 1998 by the FAO/DANIDA project GCP/INT/575/DEN.

In addition to the printed document, a compact disk is provided that contains a series of exercises and examples that should facilitate the application of these methods in countries where good data are being made available.

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Lassen, H.; Medley, P.
Virtual population analysis. A practical manual for stock assessment.
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(Includes a CD Rom containing additional examples and exercises.)

ABSTRACT

Virtual Population Analysis (VPA) is a widely used model for the analysis of fished populations. While there are very many VPA techniques, they vary in the way they use data and fit the model rather than in the form of the model itself. This manual describes the common VPA model and the assumptions on which it is based, together with descriptions of associated diagnostic procedures and common reference points. More importantly, the manual describes the numerical techniques which can be used to fit the model based on weighted least-squares, which is the basis for the ADAPT approach. The techniques are described so that they are readily implemented in a spreadsheet. General methods and specific examples are given to enable the readers to develop an approach suitable for their own data and fisheries.

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GLOSSARY AND ACRONYMS

Term	Full Name	Description	Reference
ADAPT	Adaptive framework	A general approach to fitting VPA models. ADAPT is based on minimising the sum-of-squares over any number of indices of abundance to find best-fit parameters.	Gavaris (1988)
ALK	Age-length key	A table relating ages and lengths of a fish species	
CAGEAN	Catch-at-AGE Analysis	Equivalent to ADAPT with separable VPA, but with more emphasis on the statistical rather than biological model.	Deriso *et al.* (1985)
CCAMLR	Commission for the Conservation of Antarctic Marine Living resources		
CECAF	Fishery Committee for the Eastern Central Atlantic		
CPUE	Catch per Unit of Effort		
ICA	Integrated Catch-at-age Analysis	Equivalent to ADAPT, i.e. using a least-squares fit based on VPA and auxillary data, but the standard VPA catch formulation used in ADAPT is replaced by a separable VPA.	Patterson and Melvin (1995)
ICES	International Council for the Exploration of the Sea, based in Copenhagen		
Multispecies VPA	Multispecies Virtual Population Analysis	Extends the cohort model with a model for the natural mortality that includes predator-prey relationships. Data as for VPA for all stocks, as well as stomach contents from at least one sample survey.	Sparre (1992) Magnusson (1995)
Pope's Cohort Analysis		As with VPA, but the non-linear catch equation is replaced with an approximate explicit solution.	Pope (1972)
Separable VPA	Separable Virtual Population Analysis	The fishing mortality in the normal VPA model is separated into an exploitation rate and selectivity, which multiplied together estimate the fishing mortality. This produces estimates of catches, which can be fitted to observed catches even if no indices are available.	Pope and Shepherd (1982)
SPA	Sequential Population Analysis	Equivalent to VPA. This is the more common term used in USA and Canada.	
Survivor Analysis		Analysis where the survivors are the focus of estimation rather than fishing mortality. Equivalent to VPA.	Doubleday (1976)
TAC	Total Allowable Catch	Management measure. The total amount of catch allowed to be taken from a particular stock in a particular year.	

VPA	Virtual Population Analysis	A general method to model the progression of a cohort through time. VPA became useful when the Baranov catch equation incorporating observed catches could be solved sequentially.	Gulland (1965) Fry (1949)
XSA	Extended Survivor Analysis	A VPA with no catch errors is tuned with age-specific CPUE indices. The model is fitted through a specialised robust iteration technique, rather than general least-squares. The procedure includes an iterative weighting of CPUE indices.	Shepherd (1991, 1999)