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Report of the Workshop on Advanced Fish Stock Assessment Techniques (WKAFAT)

24 February–1 March 2005

ICES Headquarters



International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

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1 Introduction

1.1 Participants

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1.2 Terms of reference

The terms of reference were given in the Council resolution 2D02:

A **Workshop on Advanced Fish Stock Assessment Techniques** [WKAFAT] (Co-Chairs: D. Skagen, Norway; and E. Hjörleifsson, Iceland) will be held at ICES Headquarters from 24 February to 1 March 2005 to:

- a) teach a course covering stock assessment methodology, including evaluation of data consistency, estimation of the state of a stock, projection of stock status, uncertainty evaluation and risk assessment.

WKAFAT will report by 31 March 2005 for the attention of the Resource Management and Living Resources Committees, and ACFM.

2 Workshop summary

2.1 Background

This was the second consecutive advanced course in fish stock assessment techniques. Previously, courses had been given concentrating on the standard software tools used in ICES. When the future of courses in assessment methods was discussed in the Resource Management Committee at the ASC in 2003, it was concluded that there was a need to extend and broaden the courses to take on recent developments in assessment methods into account, emphasise the importance of understanding and scrutinising the input data, and to cover the simulation methods that are developing rapidly at present. It was suggested that this would require a series of courses at different levels, both elementary courses in standard methods as an introduction to the field for newcomers, and more advanced courses to update more experienced analysts on recent developments. The courses both in 2004 and again in 2005 were designed to cover critical evaluation of data, assessment model design and model assumptions, uncertainty evaluation and risk assessment as well as projection of stock status, starting with the basic theory, but moving well beyond the elementary level in some areas.

This choice of contents reflects a concern that the current practise of standardisation may lead to uncritical application of analysis tools, without considering the adequacy of the method in sufficient depth. Therefore, the course was designed to give people with some experience in assessment work a general overview of how assessment models are designed, ways to analyse signals in the data, what kind of assumptions can be relevant and other methodological aspects of fish stock assessments. The primary purpose was to enable analysts to perform, and design if necessary, analysis of the data adapted to the properties specific for the stock and the data available, as well as to stock specific management procedures.

The justification for the course as stated in the Council Resolution 2D02 was:

The two Co-Chairs will teach a basic course, but introduce the newer model developments being employed within NWWG and the WGNPBW, for example. New developments in the field, such as statistical catch-at-age/length, data limited models, production models, CSA and delay-difference models should be in routine use within the ICES assessment toolkit, but experience with these models is currently limited. In addition, principles of error estimation such as bootstrap procedures, Bayesian methods and stock synthesis need to be disseminated more widely within ICES. The emphasis needs to be on teaching principles underlying methods rather than 'button pushing' of standard software tools as taught in previous years at the WKCFAT. The Co-Chairs will present a selection of stock assessment modelling approaches during the course.

This formulation may have created quite wide expectations, far beyond what it is possible to cover in a short course for people with variable experience in the field. Some kind of selectivity therefore was necessary. The choice was to concentrate on principles and generic properties of methods rather than on specific software. The various approaches to assessment methods were covered, with main emphasis on age-structured methods. Yield per recruit, reference points, short term predictions and medium term simulations were covered, but not very extensively.

2.2 The workshop

As in 2004, the course was a combination of lectures, presented as power point slides, and exercises on spreadsheets with artificial data. The exercises included simple analysis of data, construction of age structured assessment models (separable and tuned VPA) and construction of a data simulator. This year, more material on management strategies was included, as well as more in depth analysis of how various data influence the final results. Last year, two days were used to cover an open source framework in R, this was not repeated this year.

The aim of the lectures was to give a theoretical overview of the generic properties of various methods used to generate a historical stock and exploitation estimates. Emphasis was on classifying the various assumptions as well as strength and weaknesses of different methods. In the practical part of the course emphasis was on exploring the input data and get a hands on understanding of the families of models that assume error both in the tuning data and in the catch at age matrix, and those which take catch data as exact (VPAs). It was the intent of the instructors that the main message that participants would take home from this part of the course should be:

- The input data contain the principal information about the stock and exploitation. Thus analysis of input data should be considered an integral part of an assessment and should help in determining what type of assessment model is appropriate.
- Understand the principal assumptions that are made in different type of models.
- Understand how information in the data propagates through to the final result.
- Not to infer more from the data than they actually can tell.

The integrated Excel tools were the backbone of the practical training in the course. The tools consisted of: 1) a flexible population simulator where various types of stock and exploitation development could be simulated and observables could be generated with user controlled degree of error and amount of unaccounted mortality. 2) A statistical catch at age model and a tuned VPA with varying degree of flexibility in the assumptions made (separable model, power function, non-constant catchability, demonstration of the principal concept of random walk and bootstrap). 3) A standard set of tools displaying principal results as well as diagnostics, and 4) A tool that provided a quick graphical comparison of the known truth (from the simulator) with the estimates from the model. Since the tools were integrated, studying effect of different exploitation development, observation errors as well as the effect of unaccounted mortality could be made relatively easily. The standard output of results and diagnostics provided the group a uniform platform as a basis for discussions.

Two synthetic sets of input data were provided to the group for initial analysis, all based on the same population trajectory. The data were a single catch-at-age matrix, with a plus group, and two sets of age based tuning fleet indices.

Data set 1. Fixed exploitation pattern throughout the history.

Data set 2. Increasing exploitation of younger age groups with time

The teaching material (Power point slides, spreadsheets and some supplementary text) is attached to this report. Since this to some extent is interactive tools, it is not included in the printed report, but can be downloaded from the ICES website (www.ices.dk/reports/RMC/2005/WKAFAT).

The time schedule and the items covered are shown in the time table below.

DAY	PLENARY	PRACTICAL EXERCISES
1	Basic theory, analysis of observables, introduction to opulation simulation	Analysis of input data (catch curves, log-ratio). Handout of simulator.
2	VPA, separable models, objective functions	Building a statistical catch at age model and a tuned VPA from scratch in Excel
3	Sources of error, model misspecification, influence of data, diagnostics, uncertainty, bootstrap.	Violation of model assumptions. Handout of diagnostics in a spreadsheet, interpretation of diagnostics.
4	Day off (Sunday)	Ad libitum
5	More diagnostics, estimation and modelling of uncertainty. Random walk. Y/R Simple models (production, diff-delay etc) Predictions and evaluation of management strategies.	Practical exercise in random walk,bootstrap, influence diagnostics. Examples of harvest rules.
6	Overview of available assessment software	Demonstration of software: NOAA toolbox software, ICA, XSA, AMCI, ISVPA etc.

3 Conclusions

This year, most participants had rather limited experience in assessment work. Hence, the course may have been more ambitious than it should for that audience. The presentation was adjusted to some extent to spend more time on the very elementary theory, but a quite rapid progress was unavoidable given the field that was expected to be covered.

There was considerable interest for the course, and as last year, the number of applicants by far exceeded the maximum number of participants. Apparently, most institutes used this course to give people about to enter assessment work an introduction to the field. For future courses, alternatives aiming more directly at that kind of audience could be considered. Likewise, the field to be covered should be more restricted. This year, the amount of information that people were able to absorb in a few days was probably exceeded.

A broad syllabus specifying the main outline of the course should have been made available well in advance. This would have helped potential participants in deciding whether the course was applicable to their needs as well as help in determining the preparatory work needed.

4 Recommendations

ICES is heavily dependent on the assessment skills of Working Group participants, and both the conveners and the participants felt strongly that ICES needs to develop a clear strategy to ensure the necessary competence by those who do the assessment work. The diversity in background amongst the participants indicates a need for training at several levels. The following list of items was suggested last year, and is reiterated this year:

- A basic, introductory course, covering a basic understanding of data, the basic equations and statistical assumptions, outline of common methods, and some training in using selected assessment tools. This should bring the participants in a position where they can contribute constructively in a working group context.
- An advanced course, along the lines of the present one, but spending less time on elementary items, This should be intended for people with good control over the material covered in the basic course, and with some experience from practical assessment work. A course at this level may qualify for some authorisation by ICES

as a "Master of assessment", recognising that the quality of the assessor is as important as the quality of the software.

- Specialist courses, bringing in top expertise to cover special items in depth. Examples may be special methods (length-age based methods, Collie-Sissenwine analysis, etc.), statistical aspects (frequentist and Bayesian, weighing of alternative hypothesis, parametritation), optimisation methods or new approaches in advice (mixed fisheries approach, decision tables). This should be directed mostly at people who are in the position to develop assessment methods, be it within or outside the ICES Working Group framework.
- A course, which deals with assessment methodology within the context of management under uncertainty and evaluation of management strategies. This course should cover methods for the design and testing of management procedures (i.e. the combination of a particular stock assessment method with particular harvest control rules and their implementation) that consider uncertainty in process, measurement error, estimation, model and implementation error. The participants should be people who at least have the level of experience gained from course 1 above. Due to the advanced nature of the material the number of participants should be limited to 10–15.

The suggestion made last year that ICES should formulate a long term strategy for the continuing education of its members is reiterated. For next year, a somewhat more elementary course should be considered, which could serve as an introduction for people that are about to enter the field of assessment. A more advanced course, directed specifically at people with previous experience in assessment work should be considered again once there is evidence of sufficient interest.

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