Resource Management Committee **ICES CM 2003/D:04**
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REPORT OF THE

Workshop Course on Fish Stock Assessment Techniques

ICES Headquarters
5–12 March 2003

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 first meeting of WKCFAT in 2002 was greatly over-subscribed, with around 20–30 individuals expressing an interest in attending who were not able to, due to resource restrictions. Given this, it seemed appropriate to plan for at least one more course. Accordingly, terms of reference and justifications for a second course were formulated (ICES 2002c).

At the 90th ICES Statutory Meeting it was decided that a **Workshop Course on Fish Stock Assessment Techniques** [WKCFAT] (Co-Chairs: C.L. Needle, UK; and C.D. Darby, UK) would be held at ICES Headquarters, from 5–12 March 2003 to:

1) present current procedures used, and apply these to case studies covering evaluation of data consistency, estimation of the state of a stock using XSA/ICA, projection of stock status, and report writing with emphasis on ACFM requirements;
2) establish the third course to be held in the spring of 2004.

Participants were each to pay a contribution of DKK 1000 towards the running expenses of the Workshop.

WKCFAT was required to report by 19th April 2002 for the attention of the Resource Management and Living Resources Committees, and ACFM.

2 WORKSHOP SUMMARY

The Workshop was intended to provide an opportunity for participants to explore assessment techniques and some of the tools available for their application. In particular the Workshop focussed on tools to perform age-structured analyses and stock abundance estimation, calculate reference points in the context of the Precautionary Approach, and carry out projections.

The Workshop examined of a wide variety of methods and datasets, in order to make the syllabus as appropriate to participants from as many different backgrounds as possible, and to ensure direct relevance to the work they will be expected to undertake in Working Groups. Model description, fitting procedures and the communication of results were covered. Discussion sessions held throughout the Workshop served to clarify technical questions on the use of the methods and common practices in stock assessment. For each method, the approach taken was to:

1. Introduce and discuss ideas and methods through lectures and reading;

2. Accustom participants to the mechanics of each method by implementation on spreadsheets; and

3. Demonstrate the use of the methods in software currently used by assessment Working Groups.

The key change from the previous year's course was the extensive use of spreadsheet template implementations of the methods presented (with the exception of ICA and XSA). This was thought to be a useful mechanism by which the underlying workings of the methods could be analysed and understood, thus enhancing the understanding of the more "black-box" implementations currently used in assessment Working Groups.

The example datasets used were as follows:

Stock	Years	Ages	Number of fleets	Source
North sea cod	1963–2001	1–11+	2	ICES (2002)
North sea herring	1960–2000	0–9+	5	ICES (2001)
North Sea whiting	1960–2000	0–12+	11	ICES (2002b)
North Sea plaice	1957–2000	1–15+	4	ICES (2002b)
North Sea sole	1957–2000	1–15+	4	ICES (2002b)
Irish Sea cod	1968–2000	1–7+	7	ICES (2002a)
West of Scotland haddock	1965–2000	1–8+	4	ICES (2002a)

3 SESSION SUMMARIES

3.1 Introduction

The basic theory of fish stock assessment was presented, in terms of justification, underlying models, and standard approximations. The evolution of VPA tuning and separable models was discussed. Spreadsheet models of weight-length relationships, age-length keys, mortality rates, and Pope's cohort approximation were used for illustration.

3.2 Separable VPA and Laurec-Shepherd tuning

The reconstruction of historical fish populations using simple cohort analysis was examined. Fixed values of terminal *F*-at-age were used for these first analyses.

The development of separable VPA models (Doubleday 1976, Pope and Shepherd 1982) was described. The method was shown to provide a useful filter for examining catch-at-age data in isolation, before tuning, as high individual residuals may indicate data anomalies. By partitioning the data (e.g. fitting the model for a specific period), the method can be used to investigate changes in the exploitation pattern over time.

The Laurec-Shepherd VPA tuning method (Pope and Shepherd 1985) is one of many *ad hoc* tuning algorithms that derive estimates of fishing mortality-at-age in the final year from an analysis of fleet disaggregated catchability at age. The algorithms have no formal statistical basis and are based on an iterative process, which relies on the convergence properties of VPA. The method provides a useful introduction to the understanding of the assessment problem and was

used as a filter for examining the catch-per-unit-effort tuning series before progressing to more complicated tuning models.

3.3 Integrated Catch-at-Age Analysis (ICA)

In Integrated Catch-at-age Analysis (ICA; Patterson and Melvin 1993) model, the last x years of the available catch-at-age matrix are fitted by a separable model. The earlier years in the data set are modelled by a conventional VPA, estimated backwards using the first year of the separable model as the starting point. ICA is widely used in ICES assessments of pelagic stocks, principally because it permits the use of non-age-structured biomass tuning indices. The theory and implementation of the ICA method was described, and the fitting of the model to an example data set (North Sea herring) was demonstrated. Participants then examined the application of ICA to their sample datasets, looking at a notional "best" assessment, and examining the effect of different model settings and parameters on outputs.

3.4 Extended Survivors Analysis (XSA)

Extended Survivor Analysis (XSA; Shepherd 1999), an extension of Survivors Analysis (Doubleday 1981), focuses on the relationship between catch-per-unit-effort (CPUE) and population abundance, allowing the use of a more complicated model for the relationship between CPUE and year-class strength at the youngest ages. XSA is widely used in ICES assessments of demersal stocks. The detailed algorithm is presented in Darby and Flatman (1994). The methodology was described and the fitting of the model to an example data set demonstrated. Participants fitted the model to their assigned data set and carried the results forward into projections and Precautionary Approach reference point estimation. Retrospective analysis was used to examine the temporal consistency of the estimates from the specified XSA model.

3.5 Short-term forecasts and yield-per-recruit

The use and estimation of short-term forecasts (for the provision of quota advice) and yield-per-recruit analyses (for long-term equilibrium modelling) was investigated. The theory of these approaches was presented and hands-on experience attained using spreadsheets, and the example datasets with ICES standard software (MFDP and MFYPR, Smith 2000a, 2000b).

3.6 Stock-recruitment modelling

The history and derivation of several of the most widely-used stock-recruitment models was presented, along with their advantages and disadvantages. Several methods of estimating parameters were compared and contrasted.

3.7 Medium-term projections

The use of medium-term (5- to 10-year) projections to frame strategic fisheries management was discussed. The current methodologies were presented, along with potential drawbacks therein and possible alternatives. Hands-on experience using a variety of standard tools was promoted.

3.8 Reference points

A key concept in implementing a precautionary approach is defining limit and target reference points. Limit reference points set boundaries which are intended to constrain harvesting within safe biological limits, whilst target reference points are intended to meet management objectives. The justification and estimation of a range of target and reference points was examined.

4 CONCLUSIONS

In order to maintain and improve the quality of scientific fisheries management advice, it is important that ICES maintains a pool of competent and experienced stock assessment scientists. The Workshop is a useful way of doing this, and would appear to be building considerable momentum as a recognised forum for the training of stock assessors for the future. In particular, the structure of the course that was given this year was seen as a considerable improvement on that for last year: the combination of spreadsheets and stand-alone assessment software was appreciated.

The future direction of the course depends largely on the use made in assessment Working Groups of different methods. For example, the XSA method is under active development to ensure its continued applicability in an era of rapidly-

changing fisheries. It is therefore likely to continue to be used for the foreseeable future, and it is relevant to retain instruction in it in the Workshop. On the other hand, a method like ICA which is not currently being updated is likely to become increasingly unsuitable, and consideration must be given to the utility of including it in the course. If ICA is developed further, then the requirement to teach it would remain for future Workshops. Interest has also been expressed in tuition in new assessment methodologies such as the Kalman filter (e.g. TSA) or survey-based analysis (e.g. SURBA), but to be feasible this must await the production and (very importantly) the certification of user-friendly and robust implementations.

5 RECOMMENDATIONS

During the course several participants requested a third Workshop meeting, as they felt that there were sufficient new members of staff at their various institutes for this to be worthwhile.

To meet this need, it is recommended that a third **Workshop Course on Fish Stock Assessment Techniques** [WKCFAT] (Co-Chairs: C.L. Needle, UK; and C.D. Darby, UK) be held at ICES Headquarters, in early spring 2004 to:

a) teach a course covering stock assessment methodology, including evaluation of data consistency, estimation of the state of a stock, and projection of stock status;
b) consider the utility of a fourth course, to be held in the spring of 2005.

WKCFAT will report by XX/XX/2004 for the attention of the Resource Management and Living Resources Committees, and ACFM.

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