ICES WKAFAT Report 2006

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

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ICES Headquarters

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

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Executive summary

This was the third consecutive advanced course in fish stock assessment techniques. As in 2004 and 2005, the course was a combination of lectures, presented as power point slides, and exercises on spreadsheets with artificial data. There were 28 participants.

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. The backbone of the practical analysis material was a set of excel spreadsheet, which included a data simulator, analysis programs and presentation facilities. The exercises included simple analysis of input data, construction of data simulator and age structured assessment models, estimation of uncertainty (bootstrap), influence of data and parameters on assessment, predictions and yield per recruit analysis.

While the course originally was intended as a supplementary course for experienced assessment analysts, most of the participants were people on their way into assessment work. For the future, courses specifically directed towards this kind of audience should be considered, supplemented with more advanced courses. ICES needs to ensure that scientists doing assessments have a good insight in the field, and it is recommended that ICES develops a clear strategy for teaching. The report has more detailed recommendations for elements in such a strategy.

1 Workshop summary

1.1 Terms of Reference

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

Supporting information

Priority:	In order to maintain and improve the quality of ICES advice, continual education in new and modern modelling tools that take into account new scientific ideas is necessary. The training undertaken in this Workshop is essential for ICES to assure the quality of the ICES advisory function and of its fish stock assessments in the longer term.
Scientific Justification and Relation to Action Plan:	This series of courses started in 2002 as WKCFAT, with teaching principles and practise of XSA and ICA, which are the main assessment softwares 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. To cover the needs for expertise in the ICES community, it is still considered necessary to have a range of courses at different levels. The WKAFAT covers the intermediate level in this range.
	The workshop as it was conducted in 2004 and 2005, and again is proposed for 2006, intends to outline principles and practise of analytical stock assessment. It will concentrate on general principles rather than on specific computer programs. It should convey insight in the information that is embedded in the data, the various types of analytic approaches (VPAs, Separable and other statistical catch at age models, as well as method not dependent on detailed age disaggregated data. Emphasis will be on similarities and differences between models, understanding of how the data and model assumptions influence the results, diagnostics and evaluation of uncertainty. The course will also outline how predictions are made, and briefly, how harvest control rules can be evaluated by simulation. The course will be a given as a combination of lectures and practical exercises using spreadsheets.
	The course will require some previous insight in fish stock assessment, e.g. through experience from assessment working groups, and intends to give the participants a broader and deeper insight in the field. For the practical excercises, some experience with EXCEL is necessary. The course is not intended as a first introduction to analytical assessment.
	In general, the remit of this group addresses Action Numbers 4.10 and 6.7.3.

1.2 Background

This was the third 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 from 2004 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.

1.3   The workshop

As in 2004 and 2005, 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 input data, construction of data simulator and age structured assessment models, estimation of uncertainty (bootstrap), influence of data and parameters on assessment, predictions and yield per recruit analysis.

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, unaccounted mortality, as well as the effect of other model violations (e.g. catchability creep in surveys) could be made relatively easily. The standard output of results and diagnostics provided the group a uniform platform as a basis for discussions.

One synthetic set of input data was provided to the group for the analysis throughout the course. The data were a single fixed exploitation catch-at-age matrix, with a plus group, and two sets of age based tuning fleet indices. Further analysis of varying complexity were done by the group and by individuals using the simulator.

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/2006/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 population simulation	Analysis of input data (catch curves, log-ratio). Handout of simulator.
2	Building blocks of an assessment model: Parametric population model, observation model, objective functions and optimization. Contrast of catch at age models and the VPA.	Building a statistical catch at age model from scratch in Excel. Example of VPA setup.
3	Sources of error, model misspecification, random walk, influence of data, diagnostics, uncertainty, bootstrap.	Violation of model assumptions, visualization and interpretation of diagnostics, perturbation exercises, examples of random walk..
4	Day off (Sunday)	Ad libitum
5	Estimation and modelling of uncertainty (bootstrap), Predictions, Y/R, Introduction to HCR and management strategies, Simple models (production, diff-delay etc). Predictions and evaluation of management strategies.	Practical exercise in bootstrap and predictions, demonstration of Y/R model.
6	Brief introduction on alternative methods (stock production, Catch-Survey analysis, Delay-difference models), summary of structural assumptions in commonly used software, introduction to some non-ICES off-the-shelf software. Discussion of course outcome and future directions.	Demonstration of software: NOOA toolbox software.

2   Experiences

This year, participants had very broad range of experience in assessment work. The course
may thus have been more ambitious for some students but at the same time too elementary for
others. 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. It was concluded that a fair compromise was reached.

Within **the present course framework** following points were raised in the final plenary in
regards to improvement of the courses:

- In addition to providing the course material from last year, provide a broad summary, specifying the main outline of the course.
- Give a 1 day pre-session on the basics, addressing the needs of those just entering the field.
- Increase emphasis of practical exercises to better convey the theoretical points raised in the lectures.
- More assessment exercises on data sets mimicking present problems facing the WG.

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 use 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. Like-wise, 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 in some cases.

3 Future teaching of fish stock assessment in ICES

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, parameterisation), 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 in the last two 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 also be considered again since there is evidence of sufficient interest in such a course.

4 Recommendations

1) WKAFAT recommends that an introductory course on fish stock assessments and predictions be held early 2007. The target group for this course should be scientists preparing to enter assessment work and scientists with limited experience in such work. The main purpose of the course is to ensure that scientists taking part in assessments in ICES have the skill and understanding to provide sound and consistent assessments of ICES stocks. The course should cover the general approach to analysing catch and survey data, the information in such data, the use of assessment tools commonly used in ICES, interpretation of results and diagnostics. The course should also cover uncertainty in the assessment, procedures for predictions in the short and medium term, and long term equilibria, as well as ICES standards for establishing target and precautionary reference point.

2) WKAFAT recommends that the present advance course, amended and extended as appropriate, be held again once a sufficient number of participants is

identified. The participants in this course should have a considerable documented experience in assessment work. The purpose of this course should be to give the participants a broad and in depth understanding of assessment methods, beyond what one can achieve by doing routine assessments.

3) WKAFAT recommends that ICES should arrange courses or seminars on selected topics related to assessment and management advise, to distribute new and important insight in the community. Some examples of topics include:

- Evaluation of management procedures

- Management advise in data poor situations

- Estimation of uncertainty and incorporating uncertainty into management advise

- Incorporating ecosystem insight into assessment, predictions and advise

- Advise on mixed fisheries

- Implications of multispecies interactions

- Technical/methodological issues like retrospective bias and handling of incomplete data on discards and misreporting.

Many of these issues are dealt with by Expert Groups like WGFS, SGMAS, WGMG and others, and the teaching outlined here should be developed in cooperation with these groups and serve as a way of communicating the progress made by these groups to relevant parts of ICES.

Annex 1: List of participants

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