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REPORT OF THE

WORKSHOP ON STANDARD ASSESSMENT TOOLS FOR WORKING GROUPS

Aberdeen, United Kingdom
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1 INTRODUCTION

1.1 Participants

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1.2 Terms of Reference

In the report of its October 1998 meeting (ICES CM 1999/ACFM:9), the Study Group on Future Requirements for Fisheries Assessment Data and Software recommended that a Workshop on standard assessment tools for working groups (Chair: Mr S. Reeves, UK) will meet at Aberdeen, UK on dates to be decided in 1999, at national expense to:

a) Prepare a preliminary list of analytical software to be used by assessment working groups which will replace the analysis tools currently performed by IFAP.
b) Identify any additional software, currently in use, which might be usefully included in the standard set.
c) Document the files to be used by these programs to exchange data.
d) Agree a set of programming guidelines for assessment software developers and acceptance protocol for such programs to be included in an ICES assessment software library.

The workshop took place at Aberdeen on 3-5 March 1999.

1.3 Background

For around seven years, the ICES Fisheries Assessment Package (IFAP) has provided the major assessment tools used for the majority of ICES assessments. However the Study Group on Future Requirements for Fisheries Assessment Data and Software (SGFADS; ICES 1998/ACFM:9) reviewed existing ICES software and concluded that the speed of development of assessment methodology has been such that it has always outstripped the speed with which new techniques can be incorporated into IFAP. In order to provide a more flexible set of assessment tools, SGFADS proposed moving to a PC based system. This would consist of a set of standard programs together with defined file formats for exchange of information between these programs. To ensure a degree of quality control and efficiency, programs would not be incorporated into the standard set unless they conformed to defined minimum standards of programming practice and documentation. Some progress was made in these areas by inter-sessional work, but nonetheless at the second meeting of SGFADS (ICES CM 1999/ACFM:9) it became apparent that a specific workshop would be required to finalise this work. This led to the current workshop with the terms of reference as given above.

2 ASSESSMENT TOOLS

To address Terms of Reference a and b the approach used was first to identify the principle assessment tasks, then identify the programs available to perform these tasks. These programs were then judged against a number of criteria to gauge their suitability for inclusion in a ‘standard set' of assessment software. The principle assessment tasks identified were:

- Catch-at-age analysis
- Recruitment prediction/Short-term catch forecast
- Long-term forecast/Yield-per-recruit

In addition, although they are not implemented within IFAP, the following tasks were also considered:

- Medium-term projections
- Estimation of reference points

The criteria used to judge the suitability of the programs were:

- Whether the method implemented had been published in a peer-reviewed publication
- Whether user documentation (i.e., documentation of how to use the program) is available
- Whether technical documentation (i.e., documentation of the specific methods and algorithms used) is available
- Whether the program is currently used by Assessment Working Groups
- Whether assessments using the program have been used as the basis of ACFM advice

By listing all candidate programs against these criteria, the intention was to highlight areas where in particular the documentation of existing programs could be improved in line with that available for programs accepted into the standard software library. In addition to identifying the main candidate programs and categorising them against the above criteria, other programs which could potentially be used were also identified but not categorised.

2.1 Catch at age analysis

The candidate programs for this assessment task were the Lowestoft VPA suite (Darby & Flatman, 1994), ICA (Patterson & Melvin, 1996), ADAPT (Gavaris, 1988), Time-series Analysis (Gudmunsson 1994; Fryer *et al,* 1998); ASPIC (Prager, 1995); CEDA (MRAG,1992), SXSA (Skagen, 1993) and RCSEP (Cook *et al*, 1991). These are tabulated in Table 2.1. Of these programs, the Lowestoft VPA and ICA are widely used by ICES Working Groups, and are currently implemented within IFAP. In addition the documentation for both of these packages covers all the detail required, so it is clearly appropriate that they should form part of the standard software library. In addition, although less widely used by Working Groups, CEDA is also considered sufficiently well documented to form part of the standard set.

The other catch-at-age analysis programs considered fail to meet the criteria on one or more count. Many of these latter programs have been developed as tools for specialised rather than general application and while their use will remain appropriate for these limited cases, they are not at present considered appropriate for the more general use which addition to the standard software library would imply. Thus these techniques should only be used where no standard tool is available to address the problem.

2.2 Short-term Prediction

The candidate programs for short-term catch prediction were WGFRAN4 (Reeves & Cook, 1994), the IFAP prediction program, and the multi-fleet prediction program MSFPMO (which is the basis of the IFAP prediction program). The recruitment calibration program RCT3 (Shepherd 1997) was also considered in this category, as were a number of stock-specific spreadsheets. These are summarised in Table 2.2.

Of the programs considered, RCT3 and the IFAP prediction program were considered to meet the standards of documentation and established usage required, and are thus regarded as standard assessment tools. The other programs considered did not meet these standards. While it is recognised that *ad hoc* spreadsheet-based predictions allow flexibility to address specific problems with individual stocks, this approach is notoriously error prone, and it is desirable that such spreadsheets be replaced with fully tested and documented programs.

Of the candidate forecast programs considered, only the existing IFAP program was considered to meet the standards required. As the intention is to move away from programs implemented within IFAP, this presents a problem. There is a clear need for a stand-alone forecast program to be developed to fill this gap. A specification for this program is given in Section 2.6. As an interim measure, the program WGFRAN4 (and by association the file preparation program INSENS), or MSFPMO could be used, although it is necessary to improve the user interface, robustness and documentation of these programs.

2.3 Yield per recruit and estimation of reference points

These two categories were considered together as reference points calculated from yield-per-recruit analysis represent a subset of the reference points which are routinely estimated for the purpose of current assessments.

For routine yield per recruit analysis the main programs available are the IFAP implementation (which is based on the stand-alone program MSFY) and the program 'Refpoint' developed at the Marine Laboratory, Aberdeen. Only the former met the criteria for acceptance (Table 2.3), so as with the short-term prediction program, there is a need for a stand-alone program to be developed for this purpose. The specification for such a program is given in Section 2.7. The

Excel Add-in ‘PASoft’ (see below) includes yield-per-recruit functions and it is possible that these could provide the basis of a stand-alone program for this purpose.

The programs considered for the purpose of reference point estimation were the Excel add-in ‘PA-soft’ developed at CEFAS Lowestoft’; the program GlossC which estimates G_{loss} (Cook, 1998); The stochastic equilibrium model ‘Stokpred’ developed by Dankert Skagen (IMR, Bergen) and the non-equilibrium production model ‘ASPIC’ (Prager, 1995). Of these the PA-soft application was considered to meet most of the criteria (Table 2.3), although workshop participants were not completely familiar with the attributes of StokPred and ASPIC.

From the various candidate programs considered, the PA-soft Excel add-in is considered suitable for inclusion in the standard set. Pending the development of a stand-alone yield-per-recruit program, ‘Refpoint’ or ‘MSFY’ could be used as a short-term stopgap, although improvements to these programs and their documentation are desirable.

2.4 Medium-term projections and stock-recruitment analysis

Medium-term projections have not been incorporated into IFAP, and they represent an area which is currently the focus of much development work. Thus methods in use are likely to change in the near future. Nonetheless it is still appropriate to consider those programs currently in use. Table 2.4 shows the programs considered. The candidate programs were ICP, the projection add-on to ICA (Patterson & Melvin, 1996); the medium-term projection program WGMTERMA and its associated stock-recruitment fitting program ‘Recruit’ (Reeves & Cook, 1994); and the spreadsheet template developed by Gunnar Stefansson (IMR, Reykjavik).

Of the programs considered, only ICP met all of the criteria and has thus been added to the standard set. However, this program can only be used where the base assessment has been done using ICA. Where XSA has been used for the catch-at-age analysis, it will be necessary to use the combination of WGMTERMA and Recruit if medium-term projections are required Hence it is desirable that the documentation, user interface and robustness of these programs is improved.

2.5 Standard Assessment Tools - Summary

On the basis of the considerations outlined above, it is proposed that the following programs form the initial standard set of assessment tools:

Program	**Function**
Lowestoft VPA suite	Catch-at-Age analysis
ICA	Catch-at-Age analysis
CEDA	Catch/Effort data analysis -Production model fitting
RCT3	Recruitment calibration
PA-soft	Estimation of reference points
ICP	Medium-term projection, ICA base assessment.

In addition, pending the development of programs which conform to the required standards, the following are suggested for interim use:

Program	**Function**
WGFRAN4 (+Insens)	Short-term forecast
MSFPMO	Short-term forecast
Refpoint (+Insens)	Yield-per-recruit
MSFY	Yield-per-recruit
WGMTERMA+Recruit (+Insens)	Medium-term projection, XSA base assessment

Most of the above programs have been developed by scientists from within the ICES community. In addition, it is envisaged that there will also be standard programs to pick-up output from these programs and produce standard tables and plots for inclusion in Working Group and ACFM reports. However, as these would be presentation rather than analysis tools it would be appropriate that such programs are developed by the ICES secretariat.

2.6 Specification for a short-term forecast program.

2.6.1 Input data

The basic data required for a short-term catch prediction are starting population numbers, and fishing mortalities which can be derived from catch-at-age analysis; estimates of weights at age, natural mortality, maturity at age etc. which can be derived from the input data to the catch-at-age analysis, and estimates of recruitment during the prediction period, which may be available externally (e.g from RCT3). In addition, information on catch at age and weight at age by fleet/category will be necessary if the forecast is to be fleet disaggregated.

Most of the requisite data would thus be available in existing Lowestoft format files, either as input to or output from the catch-at-age analysis. The exception is the information on catch numbers & weights at age by fleet/category. The format specified for this data is given in Section 3.3. The file formats used by RCT3 are not compatible with those used by other programs so it is envisaged that recruitment estimates will continue to be entered manually.

To access the input data the program could read directly from these files, or an intermediate program could read these files and create a file containing the prediction inputs. This latter approach has the advantage that options such as year ranges for mean weights at age and recruitment estimates for recent years need only be entered once, making it very simple to re-run predictions. Such an input file could also be used as input to subsequent steps such as medium-term projections and yield-per-recruit analysis. This approach is used by the existing program 'Insens'.

2.6.2 Program Functionality

Catch predictions for some stocks, notably the North Sea Herring, involve a high degree of complexity, e.g., with different catch constraints applied to different fleets. It is not the intention to specify a program to cover all such eventualities; for cases such as this it would be desirable to develop a program specifically for that stock. In addition, developments in the area of multi-annual management may require predictions over a longer period than is currently conventional. Such considerations are beyond the scope of this specification. Instead, the program to be specified here would be of more general application so some limitations on its functionality can be accepted. Nonetheless a certain minimum specification is desirable. This can be specified as follows:

- Forecast can be disaggregated for a minimum of three fleets either independent (i.e., subject to different effort multipliers) or combined (i.e discards and landings from the same fleet)
- The prediction should run for at least one year ahead, with or without a TAC constraint, on the basis of a single option prediction for the intermediate year, followed by a range of options for the prediction year, and the resultant estimates of SSB.

2.6.3 Program outputs

The primary outputs from the forecast program will be two output files; a file containing the prediction results and a log file. The log file should conform to the general standards given in Section 3.6. The key information to be contained in the results file is the information to be summarised in the management options table (with sufficient effort-multipliers to ensure that the results can readily be plotted), and this information should be given in the format specified in Section 3.4. Information on the detailed output from the prediction (i.e catches at age as well as aggregate weights) for one catch option (e.g status quo) should also be available in the program output, but as the main use of this information is as a diagnostic, it is less essential that this information is held in a formally described format. The management option information needs to be available for subsequent plotting, and also for formatting in a tidy format for inclusion in e.g the ACFM report. While it is desirable that any catch prediction program which is developed to follow these guidelines also produces a comprehensible management option table, this is a non-trivial task, and it should be considered optional provided an external program is available to pick-up the results file and turn that into formatted output. As noted in Section 2.5, it would be most appropriate for the ICES secretariat to develop such a program.

2.7 Specification for a Yield-per-Recruit Program.

The considerations in specifying a yield-per-recruit problem are very similar to those for a short-term forecast program and many of the required inputs are essentially the same. Thus a yield-per-recruit program should also conform to the specifications given in Section 2.6 where these are applicable. In particular, the program should be able to handle a minimum of three categories/fleets, and values should be calculated for a wide range of effort multipliers, with a small enough interval between them to facilitate straightforward plotting of the results. The program should output the results in the format specified in Section 3.5, and should also provide a log file (Section 3.6).

3 FILE FORMATS

Current catch-at-age analysis methods use data aggregated to total international, annual catches. Whilst it would be desirable to move towards using data at a greater level of disaggregation, (e.g., by fleet and season) such considerations are not addressed here. For total international catch data as input to catch-at-age analysis, standard file formats are already defined and in routine use. These are the file formats specified by Darby and Flatman (1994) for use in the Lowestoft VPA suite. These file formats are also used as input to ICA (Patterson and Melvin, 1996).

While file formats for input to catch at age analysis are well standardised, no formats have been specified for catch-at-age outputs. In order to make the results of catch-at-age analysis more readily available to other programs, the following output formats have been specified. In all cases example files are given. These are based on a recent assessment of North Sea Haddock (ICES CM 1999/ACFM:8).

3.1 Catch-at-age Outputs - Population numbers and fishing mortalities at age.

To allow compatibility with existing data structures and data entry routines, these should be stored in the Lowestoft data format as ASCII files with space or comma separation.

Title.

Sex ID,	Index No
First Year,	Last Year
First age,	Last age
DFI	
N/F ⇒ by age	
⇓	
by year	

The title information should include the stock, and a unique run identifier. The sex identifier has been retained for future development, it would usually be set to 1 for a combined sex analysis. The Index No. is a reference for file identification. To be consistent with the current Lowestoft format, suggested values are 12 for fishing mortalities at age and 13 for population numbers. The first age, last age and first and last years should be integers with years as four digits. The last age is the plus group. The Lowestoft format uses a data format identifier (DFI) to identify the data structure contained within a file, in both files this should be set to 1, i.e., a two dimensional array.

The use of this file format for output data results in a couple of minor complications. In particular the input files will often contain the full age-range of data (e.g., 0–15+), where as this may be truncated prior to the catch-at-age analysis (e.g to 0–10+), so the data files will only contain estimates for this reduced age range. For subsequent analyses, such as the catch prediction, the program may need to identify whether or not the oldest age in the output files is a plus-group. The population numbers should be given in thousands to avoid any possible confusion over units. In addition, the population numbers file should include estimates of survivors so will have information for an additional year. Example files are given in Tables 3.1.1 and 3.1.2. Note that as recruit calibration is not yet integrated into XSA, there is no estimate for recruitment in 1998, hence this is given as a missing value (i.e., a negative number) in the file (Table 3.1.2).

3.2 Catch-at-age Outputs - Stock Summary Information

A file containing stock summary information is required for ease of plotting and tabulating this information, and also as a means of using this information in e.g., stock-recruitment analysis. A file format for this information already exists (the SUM file produced by the program ‘Insens’), and this is proposed as the standard file format for this information. This file format allows for catches and mean Fs disaggregated into up to three categories. Where the number of categories is less than this, columns of zeros will be needed. An example file, with comments in square brackets, is given in Table 3.2. It should be noted that both the number of columns, and the order in which they appear in the file, is fixed. The header information ensures that each column can be labelled and interpreted correctly.

3.3 Fleet disaggregated catch data

Catch and weight-at-age information disaggregated by fleet/category is necessary if catch predictions are to be disaggregated on this basis. This requires that these data are available in a specified file format. It is suggested that these data should be stored as two separate files for each fleet, a catch numbers at age file and a catch weight at age file. In order to reduce user errors at the keyboard, the names and location of the files would preferably be accessed using an index file. The ASCII files should be space or comma separated and use a structure similar to the example for catch numbers at age given below. The format would be repeated in a corresponding file for the catch weights where the "total" weights would be the catch weighted average values. In each category the data format identifier (DFI) is used to identify the format of the following data structure (row vector or array). Missing values would be indicated by negative numbers.

Stock/file title.

Sex ID, File ID (e.g., catch numbers-at-age 2, catch weights-at-age 3)
Number of categories (no more than 2 per fleet, i.e., landings & discards)

Total catch title

First Year, Last Year
First age, Last age

DFI

Total catch numbers ⇒ by age
⇓
by year

Landings title

First Year, Last Year
First age, Last age
DFI

Landings catch numbers ⇒ by age
⇓
by year

Discards title

First Year, Last Year
First age, Last age
DFI

Discard catch numbers ⇒ by age
⇓
by year

An example file is given in Table 3.3. Note that in the example given, (North Sea Haddock), there would also need to be a corresponding catch numbers file for the industrial fleet, as well as weight-at-age files for both fleets.

3.4 Short term catch forecast results

The specification for the short term forecast program (Section 2.6) considered that the complexity required for some stocks, notably the North Sea herring, would probably require a specific implementation. Also the development of multi-annual management strategies requiring predictions over more than 1 year ahead would be outwith the current specification. Nonetheless it would be desirable if the basic output format could be flexible to handle the extra fleets and years which the above extensions to the specification would require.

The minimum specification is that the forecast can be disaggregated to consider a minimum of three fleets representing the categories of human consumption landings, discards and industrial landings. These 3 categories might be subject to combined F multipliers (i.e., human consumption and discards) or different F multipliers (i.e., industrial fisheries or fisheries targeted at another stock but with a substantial by-catch).

The output should as minimum provide details of F and yields (catches in weight) for a single option in the intermediate year, which could be managed on the basis of F multiplier or through a catch constraint, followed by a range of F multiplier options for the projection year. Spawning stock biomass estimates, at the time of spawning, should be provided for the interim year, the projection year and the subsequent year.

While a conventional catch forecast will typically consist of a single multiplier applied to all fleets in the interim year, followed by a range of multipliers applied to the principal fleet in the prediction year, it is possible to envisage more complex scenarios. To allow for increased flexibility in this respect, the results of the catch forecast will be presented as individually numbered scenarios. Thus for a prediction involving *I* fleets over *J* years, each scenario can be described as a combination of *I* x *J* effort multipliers, $\alpha_{i,j,}$ where $\alpha_{i,j}$ is the effort multiplier to be applied to fleet *i* in year *j*. For the 'typical' situation described above, and assuming status quo F in the interim year and two fleets, with the second to be held constant in all catch options, all scenarios would have $\alpha_{1,1} = \alpha_{2,1} = \alpha_{2,2} = 1$, but $\alpha_{1,2}$ would take a range of values. A prediction would need to conform to this model if the results are to be plotted. This would also require that a minimum of seven effort multipliers are used in the prediction year in order that sufficient points were available for a smooth plot.

In order that the output format can allow for multiple fleets/categories, it is assumed that catches by all fleets can be either landed or discarded. In addition, the first fleet will be regarded as the reference fleet. Typically this will be the fleet which accounts for the highest proportion of the catches, and which is likely to be subject to management action.

Taking account of these requirements the format below was specified as the basis for a standard output although it was recognised that during program development some minor alterations might be required.

The top of the file will consist of four lines giving the following information:

Header	(Run specific includes: date and software version)
I	(No. Fleets)
J	(No. Years)
K	(No. Scenarios)

This will then be followed by *J* blocks of information; one per year. The first *J-1* of these will consist of the year followed by a separate block of information for each fleet, with SSB estimates given along with the reference fleet data. The final block will give only SSB estimates in the final year corresponding to each scenario.

For each fleet, the block would consist of a header:

Name(i)
$\mathrm{Fbar}_{land,i}$ $\mathrm{Fbar}_{disc,i}$ age(1,*i*) age(2,*i*)

i.e name of fleet *i* followed by the landings and discards reference Fs for that fleet and the age range used to calculate the reference F.

This would then be followed by *K* rows as follows

k $\alpha_{i,j,k}$ $\mathrm{Land}_{i,j,k}$ $\mathrm{Disc}_{i,j,k}$ [$\mathrm{SSB}_{j,k}$]

where *k* is the scenario number, $\alpha_{i,j,k}$ is the effort multiplier applied to fleet *i* in year *j* under scenario *k*, $\mathrm{Land}_{i,j,k}$ and $\mathrm{Disc}_{i,j,k}$ are the landings and discards by fleet *i* in year *j* resulting from scenario *k,* and $\mathrm{SSB}_{j,k}$ is the SSB at spawning time in year *j* resulting from scenario *k*. This will only be given with the reference fleet data, i.e., when *i* = 1.

For the last prediction year, $j = J$, the block will be as follows:

Year *J*
K rows: *k* $\mathrm{SSB}_{J,k}$

To summarise, the prediction results format can be specified:

Header
I
J
K
Year1
Block for fleet 1 (inc SSBs)
Block for fleet 2

Block for fleet *I*
Year2
Block for fleet 1 (inc SSBs)
...
Block for fleet *I*

Year(*J-1*)
Block for fleet 1 (inc SSBs)

Block for fleet *I*
Year(*J*)
Block of SSBs only

An example file, based on a recent prediction for Haddock in the North Sea and Skagerrak (ICES CM 1999/ACFM:8) is given in Table 3.4.

The short-term prediction program should also produce a file giving the detailed (i.e., age-structured) summary for a single option projection. The format for this is not specified here as the function of this information is largely diagnostic. However, the format given above could be adapted by assuming only one scenario but giving age information within the blocks. A log file should also be produced. The format of this is left to the discretion of the programmer, but general considerations are given in Section 3.6.

3.5 Yield-per-Recruit Results

The file format proposed for yield-per-recruit results is essentially a simplified version of that proposed for short-term catch forecast results. It can be simplified as there is no need for a year dimension, and only a limited range of scenarios are applicable. The format proposed is:

Header Run specific includes: date and software version
I (No. Fleets)
1 (No. Years - retained for consistency with short-term forecast output)
K (No. Scenarios)

This will then be followed by *I* blocks of information; one per fleet. As with catch forecast output, the first fleet will be identified as the reference fleet, and the output will include SSB-per-recruit figures.

For each fleet, the block would consist of a header:

Name(i)
$Fbar_{land,i}$ $Fbar_{disc,i}$ age(1,*i*) age(2,*i*)

i.e., name of fleet *i* followed by the landings and discards reference Fs for that fleet and the age range used to calculate the reference F. This would then be followed by *K* rows as follows:

k $\alpha_{i,k}$ $YPRL_{i,k}$ $YPRD_{i,k}$ [$SSBR_k$ $TSBR_k$]

where k is the scenario number, $\alpha_{i,k}$ is the effort multiplier applied to fleet i under scenario k; $YPRL_{i,k}$ and $YPRD_{i,k}$ are respectively the landings and discards yield per recruit for fleet i under scenario k and $SSBR_k$ and $TSBR_k$ are respectively the spawning and total biomass per recruit resulting from scenario k. These would only be included in the reference fleet block.

3.6 Program log Files; general considerations

The essential requirement of a log file is that it should completely document a program run and thus enable it to be reconstructed subsequently. For this reason, the following requirements are suggested:

- The program should create a unique run identifier, including the program name and version numbers, and probably also the time and date of the run. This should be given in the header of all output files including the log file.
- The log file should include full filenames (i.e., including path names) for all input datafiles and the datafiles themselves should also be reproduced in the log file.
- The log file should record all options chosen while running the program
- Full filenames should be given for all output files, and the essential components of the output (e.g Ns, Fs and stock summary information in the case of a catch-at-age analysis) should be given.

4 PROGRAMMING GUIDELINES AND ACCEPTANCE PROTOCOL

4.1 Introduction

Most analytical software used by ICES assessment working groups is developed by stock assessment scientists using their own preferred programming environment and software tools. This environment may be dictated by many factors, not least the computing policy of their host institute. In these circumstances, it is unrealistic to expect to set a formal programming environment where, platforms, software environment and system design are agreed across the ICES community, however desirable this may be. The purpose of these guidelines is not to lay down restrictive rules but to try to identify a framework in which sufficient freedom is allowed to the program developer while addressing issues of quality control and efficiency of operation. Where such guidelines can be taken into account at the outset when programming begins, the extra overhead in development can be small but enhance the value of the software considerably.

Most assessment software tools, to some degree, make use of similar input data and produce output information of a similar type. A typical catch-at-age analysis program will, for example, require inputs of catch-at-age, weight-at-age, maturity etc. and will output estimates of numbers-at-age, F-at-age and spawning stock biomass. It makes sense in this situation to ensure that input data files are of a standard format and similarly for outputs. With agreed standards it should then be possible to use any appropriate analytical tool to carry out each stage of the stock assessment without having to edit data files. This improves efficiency and minimises potential errors. It also means that the analytical tools are not tied to any particular operating environment provided the data are available on file in an agreed format.

4.2 Programming languages and tools

At present the great majority of ICES working group members use PCs running Windows of some form. As a minimum, therefore, assessment programs should run in this environment. However, most programming languages, will run on other platforms so it is unlikely that programming in a common high level language such as C++ or Fortran will cause problems. However, it is important to try to avoid proprietary software packages which are not in common usage or are likely to require potential users to have to buy them. This acts as a barrier to wide usage and also makes software tools vulnerable to commercial upgrades or discontinued support. Assessment programs should be stand-alone and able to read from ASCII data files and write ASCII output files without the mediation of a secondary commercial package.

4.3 Programming standards

The over-riding principles to follow in program development are to make use of standard file formats as far as possible, and to ensure quality control. It is not intended that the guidelines suggested here lay down rules for program design, which is a matter for the developer. Given that file formats are specified by mutual agreement then the following rules should be adhered to as far as possible.

4.3.1 File handling

- File opening and reading errors should be trapped and the user offered sensible recovery options.
- When output is written to file, warnings should be given to prevent over-writing existing files.
- All program runs should be identified by a unique identifier (consisting e.g of the date and time when the program was started, the program name and version number) which should be included in the header of all output files.

Output files should include a log file which gives all the information which completely specifies the run both in terms of input data and user specified options at run time. See Section 3.6 for more details.

4.3.2 Program robustness and user interface

It is essential that any program intended for routine use by assessment Working Groups is robust and relatively straightforward to use. To reduce the risk of the program crashing, it should routinely check input values to ensure that e.g., year and age ranges are consistent and sensible. In addition, any resultant error messages should be clear and concise to enable users to trace and correct any problems in the data. Similarly all user prompts should be self-explanatory, i.e., it should be clear which file-type is expected at any given stage.

4.3.3 Testing

Before programs can be accepted as part of the agreed ICES suite of assessment programs it will be necessary to ensure that programs are adequately tested. Most developers will undertake their own testing but evidence of adequate performance will be required. For certain programs which perform well known calculations, the Secretariat will use standard data sets to verify that the program delivers the appropriate results. For other programs, the developer will need to supply appropriate test data sets so that performance can be independently verified. For novel methods of catch-at-age analysis it is desirable that the testing includes some form of Monte Carlo testing, e.g., using simulated data with a known error distribution to verify that the program returns unbiassed estimates of the population parameters. It is particularly important that before software tools are used in working groups, testing is undertaken by an independent user. Not only does this verify that the program does what it is supposed to do, but it can often reveal unforseen weaknesses in the original program. Testing of this type needs to be done well before the working group meeting.

4.3.4 Documentation

Most assessment program developers are not professional programmers and their software is written as part of their research duties. It would be a barrier to the rapid implementation of new and more efficient methods if substantial documentation was a pre-requisite to wider usage by the ICES community. However, certain minimum documentation will be necessary. This includes;

- A complete description of the analytical method should be given. This should include implementation specific details, i.e., the precise algorithms used within the program.
- All new data file structures, either input or output should be fully described so that other programmers can make use of them, and example data sets and specified runs should also be supplied to allow users to replicate the results.
- Comprehensive information should be given to enable the user to run the program and interpret the output.
- The source code, which should include extensive comments, should be made available in the ICES Secretariat, although the copyright should remain with the developer and his or her home institute. Hence the source code will not normally be available outside ICES.

4.3.5 Technical support

The developer should take all reasonable steps to support software implemented by ICES working groups. The most important issues to address are:

- Ensuring that the Secretariat has the most up-to-date accepted version, and that version control is exercised and that the documentation also details the version changes
- A contact point for technical queries is given

4.3.6 Copyright and commerce

While some commercial assessment software is purchased and used by ICES, the majority of assessment tools are authored by ICES community scientists. It is expected that programs written specifically for use by the ICES assessment working groups are done so for mutual benefit and that no commercial charge will be made for the software. There may, of course, be commercial packages used by developers, such as NAG routines, which necessitates users paying a charge to use the software. These should be kept to a minimum. Copyright will always remain with the host institute or author.

4.3.7 Useful additions

Assessment working groups operate in a "production line" mode. That is to say the results of their work needs to be produced efficiently, with minimal errors for direct incorporation into a report. The reports are often needed rapidly for review by ACFM ready for their tasks soon afterwards. The need for speed and accuracy can be greatly enhanced if the output from analytical software, which is required for the report, is produced in a form which is suitable for the report without the need for user intervention. It is undesirable for tables to be edited or reformatted manually in a word processor or spreadsheet since this can introduce errors. There are broadly two ways of dealing with this issue. Either,

(a) the analytical software itself can produce formatted output ready for the report

and/or

(b) a utility can be written which picks up the output and automatically formats tables or plot figures.

In some respects (b) is to be preferred because this allows the analytical software to produce flat file output ready for a variety of other programs and secondly, it increases flexibility by allowing a variety of other formatting utilities to be produced. Furthermore, assessment scientist programmers are better employed writing the analytical software and leaving the report preparation software to the ICES Secretariat. However, it is useful to bear in mind the need to produce report standard tables and figures and if appropriate formatting/plotting utilities can be easily written, these are most welcome.

4.4 Acceptance Protocol

It is proposed that the Secretariat creates a library of "standard" software which has passed a set of acceptance criteria. These programs would be the preferred tools to be used by assessment working groups. Other tools would only be used if the standard library did not provide the necessary method and working groups would need a strong justification for using such tools. As a minimum, any non-standard method should be used in addition to one of the standard tools so that results could be compared.

In order for a program to be accepted as part of the standard it would need to go through the following process:

The Secretariat must be provided with:

- Documentation of the analytical method which gives a complete description of the approach.
- Documentation of the program which gives sufficient information on how to install and run the program, and how to interpret the output
- Documentation of the input and output files
- The program source code
- Example data sets to check that the program is running correctly.

The Secretariat will check that the program installs and runs correctly on the ICES system. It will also check that the program conforms to the programming guidelines (see Section 4.3).

ACFM will be required to endorse the proposed method to ensure scientific quality.

The role of ACFM needs some further explanation. Given that assessment tools vary considerably in sophistication, it will be necessary for ACFM to identify the appropriate body to ensure scientific quality. For new sophisticated analytical methods, it would be expected that ACFM would refer the task of scientific endorsement to a working group such as the Methods Working Group which possesses the appropriate expertise. Such a group would undertake detailed testing of the method to ensure that the program gives the correct results and also recommend the context in which the method should be appropriately applied. For simpler tools, such a program to perform a standard catch forecast, ACFM may feel satisfied to test the program themselves, or delegate the task to the Secretariat. In all cases, ACFM will need to be satisfied that the program developer has undertaken adequate testing of the program and might expect documentation from the developer outlining the testing which has been undertaken.

It has to be appreciated that the above process cannot guarantee that every program is free of bugs. For this reason it is expected that the program source code will be available at the Secretariat. This will enable working groups to check any problems against the source code. However, it is understood that the copyright of source code will remain with the developer and cannot be distributed.

After implementation it is likely that programs will need some support, particularly where bugs need to be fixed. Where a bug comes to light and is corrected by the developer, this will need to be recorded in the program documentation at the Secretariat and a new version of the program identified in the standard library.

Where a substantial revision or update to a program it will be necessary for the new revision to undergo the same acceptance protocol as the original program. However, depending on the nature of the change, ACFM may identify a simpler endorsement procedure than that originally carried out.

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Table 2.1
Catch-at-Age Analysis and related methods

	Lowestoft VPA	ICA	ADAPT	Time-Series	ASPIC	CEDA	SXSA	RCSEP
Published method ?	x	x	x	x	x	x	x	x
User documentation ?	x	x	x		x	x	x	
Technical Documentation ?	x	x			?	x		
WG usage ?	x	x	(x)	(x)	(x)	(x)	(x)	(x)
Basis of ACFM advice ?	x	x	?	x	x	?	(x)	?

Other methods identified :

MULTIFAN	Stock Synthesis
Jones LCA	Fleksibest
CASA	CAGEAN
LFDA	FAO stock-production spreadsheet
FISAT	Other length decomposition methods

Table 2.2
Recruitment prediction and short-term forecast

	RCT3	WGFRAN4	IFAP	MSFPMO	NS Herring spreadsheet	NE Arctic Cod s/sheet	Capelin spreadsheet
Published method ?	x	x	x	(x)	(x)	(x)	(x)
User documentation ?	x		x	(x)			?
Technical Documentation ?	x						?
WG usage ?	x	x	x		(x)	(x)	(x)
Basis of ACFM advice ?	x	x	x		(x)	(x)	(x)

Other methods identified :

CEDA Forecast
ASPIC Forecast
Time-series Forecast
SHOT

Table 2.3
Yield per Recruit and estimation of reference points

	IFAP	MSFY	Refpoint	PA-soft	GlossC	StokPred	ASPIC
Published method ?	x	x	x	x	x	?	x
User documentation ?	x	x		x			x
Technical Documentation ?				[x]			?
WG usage ?	x		x	x	x	(x)	(x)
Basis of ACFM advice ?	x		x	x	x	(x)	?

Other methods identified :

CEDA
ConCur

Table 2.4
Medium-term projections and stock-recruitment analysis

	ICP	WGMTERMA	Recruit	Steffanson spreadsheet
Published method ?	(x)	(x)	x	(x)
User documentation ?	x	(x)	(x)	?
Technical Documentation ?	x			?
WG usage ?	x	x	x	x
Basis of ACFM advice ?	x	x	x	x

Other methods identified :

Bayesian ADAPT	FishLab
Monte Carlo ADAPT	ASPIC (?)
CEDA	Ad hoc spreadsheets
Time-series	

Table 3.1.1
Example data file for catch-at-age analysis results - Fishing Mortalities at age.

Haddock in IV+IIIa; VPA3.1 RUN XSASAR01 Fs at age XSAV3.1, 23.10, 10/10/98

1	12									
1963	1997									
0	10									
1										
0.0016	0.1241	0.8053	0.6704	0.7614	0.8802	0.5085	0.8268	0.7773	0.7582	0.7582
0.0435	0.0581	0.4545	1.1746	0.7560	0.8843	1.2628	0.6215	0.8385	0.8819	0.8819
0.0716	1.3627	0.4164	0.5093	0.9848	1.2993	1.0212	0.8722	0.4982	0.9455	0.9455
0.0699	1.3029	0.8308	0.3602	0.7794	1.2403	1.3097	1.0825	0.9695	1.0890	1.0890
0.0022	0.2626	1.0805	0.4148	0.3720	1.0137	1.3260	1.1388	1.9446	1.1731	1.1731
0.0018	0.0516	0.5778	0.8979	0.3069	0.5076	0.8082	0.5968	0.6586	0.5805	0.5805
0.0167	0.0215	0.6553	1.3759	1.2867	0.8141	1.6261	1.0000	0.9509	1.1493	1.1493
0.0298	0.5004	1.0385	1.1499	1.2693	0.7114	1.4369	0.7088	1.0592	1.0491	1.0491
0.0119	0.4743	0.6590	0.7977	0.8706	0.8645	0.6864	1.0169	1.2854	0.9552	0.9552
0.0321	0.1692	0.7932	1.3394	1.2012	1.1583	0.8587	0.6843	0.4712	0.8841	0.8841
0.0023	0.3736	0.5649	1.1582	0.8019	0.9500	1.0978	0.8819	1.1459	0.9865	0.9865
0.0129	0.3532	0.9334	0.9499	1.0028	0.6280	0.8804	1.1249	0.4048	0.8165	0.8165
0.0113	0.3351	0.9691	1.2536	1.0991	0.9922	0.8201	1.5674	0.9978	1.1083	1.1083
0.0299	0.3077	0.8145	1.3710	0.7813	1.2713	1.0639	0.3934	0.8395	0.8792	0.8792
0.0132	0.3381	1.0051	1.0375	1.2621	1.0313	0.9889	0.9242	0.4875	0.9492	0.9492
0.0217	0.3905	1.0116	1.1281	1.1235	1.1628	1.0363	1.1463	0.8534	1.0769	1.0769
0.0347	0.1755	0.8822	1.1414	1.0619	1.0234	1.1708	0.6171	0.9416	0.9737	0.9737
0.0738	0.1894	0.7074	1.2096	1.1849	0.9369	0.9855	1.2960	0.6567	1.0236	1.0236
0.0571	0.1790	0.4501	0.9456	0.9932	0.8030	0.6102	1.0081	1.1157	0.9159	0.9159
0.0384	0.1735	0.4308	0.8157	0.8798	0.6468	0.7498	0.9822	1.1053	0.8821	0.8821
0.0270	0.1514	0.6601	1.0205	1.1611	1.2122	0.8139	0.8396	0.5776	0.9310	0.9310
0.0155	0.1250	0.6686	0.9966	1.1413	1.2207	1.0876	0.7671	0.5766	0.9694	0.9694
0.0163	0.2064	0.6139	0.9573	1.1030	1.0253	1.0710	0.9465	0.6813	0.9763	0.9763
0.0032	0.1280	1.0180	1.2402	1.2895	1.0570	0.7116	0.8594	0.6752	0.9286	0.9286
0.0089	0.1187	0.9027	1.0467	1.0828	0.8362	1.1422	0.8167	1.2616	1.0398	1.0398
0.0055	0.1367	0.7961	1.3043	1.1148	1.1074	0.7708	0.8647	0.6188	0.8550	0.8550
0.0039	0.1060	0.6549	0.9868	1.1843	0.7004	0.7779	0.6009	0.7508	0.7610	0.7610
0.0057	0.1953	1.1202	1.1584	1.1511	0.9484	0.5469	0.6711	0.5215	0.7850	0.7850
0.0125	0.1559	0.7803	1.0319	0.8573	0.8827	0.6594	0.5072	0.7439	0.8782	0.8782
0.0182	0.1461	0.7360	1.1374	1.0645	0.7903	1.1142	0.7559	0.9206	1.0204	1.0204
0.0309	0.1686	0.7957	1.0336	0.9039	0.9584	0.7538	0.8803	0.5810	1.0098	1.0098
0.0044	0.1511	0.5479	1.0317	1.0081	0.6873	1.0863	0.8753	1.4749	1.4400	1.4400
0.0457	0.1039	0.5000	0.8462	0.9091	0.8273	0.3875	0.7582	0.5154	0.6961	0.6961
0.0437	0.0754	0.4443	0.8990	0.8264	0.8364	0.9588	1.9267	0.8279	0.8316	0.8316
0.0105	0.1044	0.4272	0.6182	0.7420	0.6334	0.7305	0.5747	0.8859	0.6051	0.6051

Table 3.1.2
Example data file for catch-at-age analysis results - Population numbers at age.

Haddock in IV+IIIa; VPA3.1 RUN XSASAR01 Ns at age (thousands), XSAV3.1, 23.10, 10/10/98

1	13									
1963	1998									
0	10									
1										
2338300	25564000	740100	48600	27700	10900	1400	1300	1200	100	0
9172100	300500	4336700	221700	19400	10100	3700	700	500	400	0
26336300	1130400	54500	1845300	53400	7100	3400	900	300	200	100
68992300	3156300	55600	24100	863600	15500	1600	1000	300	100	0
3.88E+08	8282100	164700	16200	13100	308500	3700	300	300	100	100
17102500	49853800	1223300	37500	8300	7000	91700	800	100	0	0
12195500	2197700	9092900	460100	11900	4800	3500	33400	400	0	0
87763900	1543900	413100	3165200	90500	2600	1700	600	10100	100	100
78284800	10966100	179800	98000	780600	19800	1000	300	200	2900	300
21539200	9958400	1310600	62300	34400	254500	6800	400	100	100	800
72898300	2685300	1614900	397500	12700	8100	65400	2400	200	100	300
1.33E+08	9362800	354900	615300	97200	4400	2600	17900	800	0	100
11542300	16964600	1263100	93600	185300	27800	1900	900	4800	400	100
16483500	1469300	2330300	321300	20800	48100	8400	700	100	1400	100
25751400	2059500	207400	691800	63500	7400	11000	2400	400	100	400
39549000	3271800	282100	50900	190900	14000	2200	3400	800	200	200
72154800	4981900	425200	68800	12800	48300	3600	600	900	300	100
15653800	8972500	802700	118000	17100	3500	14200	900	300	300	200
32479800	1871900	1425800	265200	27400	4100	1100	4300	200	100	100
20614600	3949400	300600	609400	80200	7900	1500	500	1300	100	0
66976400	2553800	637700	131000	209900	25900	3400	600	200	400	100
17269000	8392600	421500	220900	36800	51200	6300	1200	200	100	200
24047300	2188900	1422400	144800	63500	9100	12400	1700	500	100	200
49887000	3045600	342000	516000	43300	16400	2700	3500	600	200	200
4205000	6401900	514600	82800	116300	9300	4700	1100	1200	200	300
8444300	536500	1091900	139900	22600	30700	3300	1200	400	300	200
8709000	1081100	89900	330100	29600	5800	8300	1200	400	200	100
28231300	1116800	186800	31300	95800	7000	2400	3100	600	200	100
27721300	3613700	176400	40800	7700	23600	2200	1100	1300	300	100
41892200	3524200	593800	54200	11300	2500	8000	900	500	500	300
12945800	5297800	584900	190700	13500	3000	900	2100	400	200	400
54510800	1615900	859700	177200	53000	4300	1000	400	700	200	100
13058300	6986600	266800	333000	49300	15100	1800	300	100	100	100
22543000	1582900	1209500	108500	111500	15600	5500	1000	100	100	100
10607400	2778000	281900	520000	34400	38000	5500	1700	100	0	100
-1	1351200	480600	123300	218200	12800	16500	2200	800	0	0

Table 3.2; Example Stock Summary File ***Italics indicate comments***

Stock summary, Haddock ,North Sea + Skagerrak,17:10 5/10/98	*Header*
12	*No. Columns (fixed at 12)*
1 1 1	*Category usage (Hcons, disc, Ind BC all used here)*
Year	*Label for column 1*
1963 1997	*Year range*
Recruits, age 0, (millions)	*Label for column 2*
0 100000	*age at recruitment & units*
SSB, ('000 t)	*Label for column 3*
1000	*Units (i.e '000t)*
TSB, ('000 t)	*Label for column 4*
1000	*Units (i.e '000t)*
Catch, Total ('000 t)	*Label for column 5*
1000	*Units (i.e '000t)*
Catch, H.cons ('000 t)	*(etc…)*
1000	
Catch, Disc ('000 t)	*NB label required but column all zeros if no data*
1000	
Catch, Ind BC ('000 t)	
1000	
Mean F, Total	
2 6	*Age range for Mean F*
Mean F, H.cons	
2 6	
Mean F, Disc	
2 6	
Mean F, Ind BC	*Columns below are in order of labels above*
0 3	

1963	2338	137.2	3387.1	271.5	68.8	189	13.8	0.725	0.579	0.125	0.026
1964	9172	420	1187.9	380.2	130.9	160.3	88.9	0.906	0.699	0.073	0.131
1965	26336	526.1	812.4	299.5	162.3	62.2	74.9	0.846	0.647	0.067	0.343
1966	68992	432.2	779.6	346.7	226.3	73.6	46.8	0.904	0.715	0.104	0.263
1967	388112	229.1	1216.5	246.6	147.8	78.1	20.8	0.841	0.678	0.142	0.052
1968	17103	264.6	6700.5	302	105.8	161.9	34.3	0.62	0.485	0.089	0.056
1969	12196	815.8	2344.1	930.5	331.4	260.2	338.9	1.152	0.843	0.093	0.198
1970	87764	899.5	1405.4	806.7	525.3	101.4	180	1.121	0.804	0.123	0.266
1971	78285	417.8	1672.1	446.6	237.3	177.5	31.8	0.776	0.629	0.108	0.078
1972	21539	301	1677.3	353.6	195.5	128.1	30	1.07	0.9	0.145	0.051
1973	72898	294.5	899.9	307.7	181.5	114.7	11.5	0.915	0.777	0.126	0.034
1974	133493	258.4	1567.7	368.8	153.1	166.8	48.9	0.879	0.639	0.14	0.101
1975	11542	238.1	2162.8	454.5	151.4	260.4	42.7	1.027	0.763	0.203	0.086
1976	16484	307.8	884.8	377.1	172.6	154.3	50.2	1.06	0.812	0.153	0.125
1977	25751	238.6	567.2	226.4	145.1	44.3	37	1.065	0.807	0.127	0.173
1978	39549	132.3	664.9	180.1	91.7	76.9	11.6	1.092	0.879	0.185	0.062
1979	72155	109.2	673.1	146	87.1	41.7	17.2	1.056	0.939	0.085	0.056
1980	15654	153	1249.8	223.6	105.1	94.7	23.8	1.005	0.847	0.08	0.088
1981	32480	240.2	670.8	217.2	138.7	60.1	18.3	0.76	0.654	0.086	0.064
1982	20614	299.7	840.3	237.8	176.6	40.5	20.7	0.705	0.588	0.067	0.066
1983	66978	253	759.1	253.6	167.4	65.9	20.3	0.974	0.802	0.145	0.049
1984	17269	198.9	1493	222.6	134.5	75.3	12.8	1.023	0.907	0.091	0.032
1985	24047	240.9	859.7	258.1	165.7	85.4	7	0.954	0.855	0.078	0.018
1986	49887	221.7	715.5	225.7	169.2	52.2	4.3	1.063	0.881	0.178	0.012
1987	4205	157.3	1068.2	176.9	111.8	59.2	5.9	1.002	0.855	0.142	0.019
1988	8444	159	427.6	175.5	108	62.1	5.5	1.019	0.843	0.147	0.026
1989	8709	129	396.4	108.8	80.3	25.7	2.8	0.86	0.705	0.132	0.016
1990	28243	81.3	342.9	92.7	55.6	32.6	4.6	0.985	0.702	0.233	0.026
1991	27738	63.3	742.2	97	48.7	40.3	8	0.842	0.762	0.065	0.023
1992	41907	101.2	607.2	138	74.6	48	15.4	0.968	0.858	0.099	0.032
1993	12946	134.8	875.4	174.3	81.5	79.6	13.2	0.888	0.731	0.14	0.04
1994	54511	158.2	515.7	153.9	82.7	65.4	5.7	0.87	0.688	0.175	0.014
1995	13058	157.7	956.5	144.8	77.5	57.4	9.9	0.69	0.548	0.138	0.029
1996	22543	192.7	621	159.7	79.2	72.5	8	0.793	0.625	0.146	0.03
1997	14613	210.9	709	141.9	82.5	52.1	7.3	0.63	0.454	0.116	0.019

Table 3.3; Example Fleet-disaggregated data file

Haddock in the North Sea/Skagerrak, human consumption fleet, catch numbers

1	2									
2										
Hcons_total										
1988	1997									
0	10									
1										
1527.899	26111.67	471662.3	86608.546	12811.931	18376.501	1602	639	163	145	51
1790.228	44729.97	33346.02	179541.96	17576.408	2593.917	3957.935	498	200.458	83	30.458
52476.84	74117.55	99526.98	18314.512	55204.77	3504.046	852.384	1242	198	80	42
7001.151	201643.6	74843.6	22565.835	3838.778	12481.538	976	401	620	144	53
29056.18	113847.9	241913.6	32126.46	6523.005	1247	4844.467	454	298	294	124
16714.73	237611.3	248614.1	105181.29	7023.529	1688.631	450	1119.753	145	103	145
16058.61	82500.24	286994.5	99453.86	29448.616	1912.616	572.386	191	509	115	32
3227.784	193677.4	83625.26	166913.28	25810.031	7644.145	511	127	45	62	19
3967.986	36081.76	350488.7	53555.38	55040.134	7502.911198	3052	756	52	31	25
7161.603	86995.49	74916.56	208838.44	15088.773	15388.8966	1892	679	62	15	12
Hcons_land										
1988	1997									
0	10									
1										
0	1524	146403	76925	12024	18310	1602	639	163	145	51
0	4519	16387	128051	16762	2574	3916	498	200	83	30
0	5493	43168	14338	45015	3269	775	1242	198	80	42
0	19482	46902	21841	3812	12337	976	401	620	144	53
0	2853	117953	28828	6485	1247	4779	454	298	294	124
0	2488	77820	86806	6976	1686	450	1119	145	103	145
0	467	69457	70354	27587	1860	524	191	509	115	32
0	1870	29177	101663	24715	7565	511	127	45	62	19
0	742	74892	36685	47168	7501	3052	756	52	31	25
0	1409	23942	123176	14028	15207	1892	679	62	15	12
Hcons_disc										
1988	1997									
0	10									
1										
1527.899	24587.67	325259.3	9683.546	787.931	66.501	0	0	0	0	0
1790.228	40210.97	16959.02	51490.96	814.408	19.917	41.935	0	0.458	0	0.458
52476.84	68624.55	56358.98	3976.512	10189.77	235.046	77.384	0	0	0	0
7001.151	182161.6	27941.6	724.835	26.778	144.538	0	0	0	0	0
29056.18	110994.9	123960.6	3298.46	38.005	0	65.467	0	0	0	0
16714.73	235123.3	170794.1	18375.29	47.529	2.631	0	0.753	0	0	0
16058.61	82033.24	217537.5	29099.86	1861.616	52.616	48.386	0	0	0	0
3227.784	191807.4	54448.26	65250.28	1095.031	79.145	0	0	0	0	0
3967.986	35339.76	275596.7	16870.38	7872.134	1.911198	0	0	0	0	0
7161.603	85586.49	50974.56	85662.44	1060.773	181.8966	0	0	0	0	0

Table 3.4; Example Short-term forecast output file *Italics indicate comments*

Haddock in North Sea & IIIa - newpredprog v1.1 - 03:15, 32/10/98					*Header*
2					*No. fleets*
3					*No. years*
8					*No. scenarios*
1998					*Year 1*
Hcons_all					*Reference fleet name*
0.5414	0.1342	2	6		*Landings mean F, discard mean F, F age range*
1	1	102098	41577	212684	*Scenario No, Fmult, Land, Disc, SSB*
2	1	102098	41577	212684	*--"--------------------"*
3	1	102098	41577	212684	*--"--------------------"*
4	1	102098	41577	212684	*--"--------------------"*
5	1	102098	41577	212684	*--"--------------------"*
6	1	102098	41577	212684	*--"--------------------"*
7	1	102098	41577	212684	*--"--------------------"*
8	1	102098	41577	212684	*--"--------------------"*
Ind_all					*Fleet 2 name*
0.0258	0	0	3		*Landings mean F, discard mean F, F age range*
1	1	6311	0		*Scenario No, Fmult, Land, Disc*
2	1	6311	0		*------"--------------------"------*
3	1	6311	0		*------"--------------------"------*
4	1	6311	0		*------"--------------------"------*
5	1	6311	0		*------"--------------------"------*
6	1	6311	0		*------"--------------------"------*
7	1	6311	0		*------"--------------------"------*
8	1	6311	0		*------"--------------------"------*
1999					*Year 2*
Hcons_all					*Reference fleet name*
0.5414	0.1342	2	6		*Landings mean F, discard mean F, F age range*
1	0	0	0	170804	*Scenario No, Fmult, Land, Disc, SSB*
2	0.2	21044	7709	170804	*--"--------------------"*
3	0.4	39331	14723	170804	*--"--------------------"*
4	0.6	55241	21120	170804	*--"--------------------"*
5	0.8	69103	26969	170804	*--"--------------------"*
6	1	81196	32331	170804	*--"--------------------"*
7	1.2	91761	37258	170804	*--"--------------------"*
8	1.4	101006	41798	170804	*--"--------------------"*
Ind_all					*Fleet 2 name*
0.0258	0	0	3		*Landings mean F, discard mean F, F age range*
1	1	9407	0		*Scenario No, Fmult, Land, Disc*
2	1	9183	0		*------"--------------------"------*
3	1	8977	0		*------"--------------------"------*
4	1	8790	0		*------"--------------------"------*
5	1	8617	0		*------"--------------------"------*
6	1	8459	0		*------"--------------------"------*
7	1	8313	0		*------"--------------------"------*
8	1	8179	0		*------"--------------------"------*
2000					*Year 3*
1	250230				*Scenario number, SSB*
2	220475				*----"--------------------"----*
3	194714				*----"--------------------"----*
4	172388				*----"--------------------"----*
5	153017				*----"--------------------"----*
6	136193				*----"--------------------"----*
7	121563				*----"--------------------"----*
8	108826				*----"--------------------"----*

Table 3.5; Example Yield-per-Recruit output file *Italics indicate comments*

Haddock in North Sea & IIIa - newYPRprog v1.1 - 03:61, 32/10/98

2						
1						
20						
Hcons_all						*Fleet name - reference fleet*
0.5414	0.1342	2	6			*Land Fbar, Disc Fbar, Age range for Fbar*
1	0	0	0	0.0811	0.0911	*No, Fmult, Land YPR, Disc YPR, SSB/R, TSB/R*
2	0.05	0.00206	0.00016	0.06234	0.07249	----" ---------------------------"--------
3	0.1	0.00322	0.00031	0.04948	0.05978	----" ---------------------------"--------
4	0.15	0.00386	0.00046	0.04032	0.05077	----" ---------------------------"--------
5	0.2	0.00422	0.0006	0.03357	0.04417	*etc….*
6	0.25	0.00439	0.00073	0.02848	0.03923	
7	0.3	0.00446	0.00086	0.02454	0.03544	
8	0.35	0.00446	0.00098	0.02145	0.0325	
9	0.4	0.00442	0.00109	0.01897	0.03017	
10	0.45	0.00436	0.0012	0.01696	0.02831	
11	0.5	0.00428	0.00131	0.0153	0.0268	
12	0.55	0.0042	0.00141	0.01392	0.02557	
13	0.6	0.00411	0.0015	0.01275	0.02455	
14	0.65	0.00403	0.0016	0.01176	0.02371	
15	0.7	0.00395	0.00168	0.01091	0.02301	
16	0.75	0.00387	0.00177	0.01017	0.02242	
17	0.8	0.00379	0.00185	0.00953	0.02193	
18	0.85	0.00372	0.00193	0.00896	0.02151	
19	0.9	0.00365	0.00201	0.00846	0.02116	
20	0.95	0.00358	0.00208	0.00801	0.02086	
Ind_all						*Fleet name - fleet 2*
0.0258	0	0	3			*Land Fbar, Disc Fbar, Age range for Fbar*
1	1	0.00085	0			*No, Fmult, Land YPR, Disc YPR*
2	1	0.00079	0			----" ---------------------------"--------
3	1	0.00075	0			----" ---------------------------"--------
4	1	0.0007	0			----" ---------------------------"--------
5	1	0.00067	0			*etc….*
6	1	0.00063	0			
7	1	0.00061	0			
8	1	0.00058	0			
9	1	0.00056	0			
10	1	0.00054	0			
11	1	0.00052	0			
12	1	0.0005	0			
13	1	0.00049	0			
14	1	0.00047	0			
15	1	0.00046	0			
16	1	0.00045	0			
17	1	0.00044	0			
18	1	0.00043	0			
19	1	0.00042	0			
20	1	0.00042	0			