Appendix 1: The Lowestoft Stock Assessment Suite

Tutorial 1

Data file input and User-defined VPA

by

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Abstract

This document is the first in a series of tutorials that provide an introduction to fitting stock assessment models within the Lowestoft VPA Suite stock assessment software package, and prediction programs that utilise the results. This tutorial takes the user through the input of data files, running a VPA with user defined fishing mortalities and the printing of data and results.

Introduction

This document takes the user through the process of entering data into the Lowestoft VPA suite program and running a "user-defined" traditional VPA (virtual population analysis) using file and keyboard input of terminal F values (the fishing mortality occurring at the oldest cohort age). The tutorial assumes that the user has installed the VPA program described in Darby and Flatman (1994), that the required data files have been placed in a directory c:\vpas\data and that the example assessment index file (Blackfin.ind) contains path names which point to the appropriate input files within that directory.

In the following text action to be taken by the user is highlighted in bold. The symbol \downarrow is used to represent the Return or Enter key on the keyboard.

Data Input

Start the VPA suite from the program file VPA95.EXE or at the windows icon.

The program should open and present the VPA suite introductory screen shown below

| C VWINNT\PROFILES\edd00\DESKT0P\VPA95 ene | |
|---|--|
| UIRTUAL POPULATION AMALYSIS Dersion : J.1 (Vindous) 20 Fleets, 25 ages, 40 years Copyright : MAFE Directorate of Pisheries Research License No. DFRUPA3IS.030 | |
| Most of the input options Will offer a default choice. To select the default, press the Kreturn> or Genter> key. | |
| Please input UpathImame of stock index file | |

If the data files were installed in the recommended directory then

Type in the directory path and index file name C:\VPAS\DATA\BLACKFIN.IND ↓

Otherwise type in the directory in which the data files were placed. The program will then present the data file entry screen.

| To 0: WINN EVPTOFFLE SVedd000DE SK TOPWPM95. exe | |
|---|--|
| You have selected: | |
| Blackfin: NAFO course 2000. Combined sex; plangroup. | |
| Data entry menu | |
| 1. Read data files listed in index file 2. Read minimum data filsz for quick run 3. Give file names interactively | |
| Your choice 7 <default =="" i="">></default> | |

The title from the index file is displayed, for reference, at the top of the screen. Three options are available for input of the data files. Selecting option (1) reads the first eight stock data files from the index file list. Option (2) only reads the catch numbers and natural mortality files from the index file list; the option is used if the other data are not readily available. Runs with this option will only calculate population numbers and fishing mortality rates. Option (3) allows the user to type the path and name of each file interactively; the defaults are taken from the appropriate file name in the index file list.

Type 3 +1

Type \dashv at each prompt and select the default data files.

Note that the program reads through the list of files provided within the index file list; each is presented so that the user can replace them with alternatives if required. Typing return at each question takes the offered default file. After selecting the data files that we wish to use in the assessment the program the prompts the user for the selection of the year and age ranges over which the assessment is to be calculated. The subset of data years used for the assessment can be selected from the complete range specified in the data files.

Type → and select the default at each of the year prompts.

| $\%_5$ C. WOINN I VPROFILE SVCdd004DE SK1 OPVVPA99, exe | XDE |
|---|-----|
| Select the year range for this analysis t | |
| First year : 4 default - 1963 >> | |
| default accepted | |
| Last year : < default = 1994 >> | |
| default accepted | |
| Select the sue range for this analysis : (lacloding the plus group if present.) | S |
| First age is already defined : 1 Plaats give latt age : < default = 18 22 | |

assessment age must be that defined in the data files. If the oldest age selected is less than the oldest defined within the data files, a plus group will be created. The plus group catch weights, stock weights and proportion mature are automatically calculated as catch number weighted means. When selecting the age range for the assessment, the only restriction imposed on the user is that the first

the oldest true age. Stock numbers for the plus group are estimated independently using the plus group catch The next question defines the use of the oldest age. The program initiates all VPA and Cohort analyses from number and the F on the oldest true age in the same year. Type ↓ and select the default oldest age.

| C \WINNT\PROFILES\cdd00\DESKTOP\VPA95 eze | - 🗆 X |
|---|-------|
| default accepted | |
| Lant year : < default = 1994 >) | - 11 |
| delault accepted | |
| Select the age range for this analysis : (Including the plus group if present.) | - 3 |
| First age is already defined : 1 | |
| Please give last age : (default : 10 >> | |
| It the last age group in the data files a plus group ? < default = ? (yes) >> | |

If the selected age was less than the number of ages in the original data files **the oldest age entered at this prompt will be a plus group**. After selecting the oldest age for the analysis, the user must then inform the program whether the oldest age defined in the data files was created as a plus group. If the oldest age selected by the user is younger than the oldest age defined in the data files, a new plus group is automatically created by summing the catch data of the selected age with the data for older ages. The new plus group catch, stock weights and other data attributes are recalculated as catch-number-weighted means. The age preceding the plus group age becomes the oldest true age for the analysis.

If the user wishes to perform a run without a plus group, the full age range defined within the header section of the original data files **must** be used. The data files should be edited to specify required age range. Data for older ages outside of the range will be ignored. During interactive input, select the default values offered for the age range (the data file values) and answer 'No' to the question asking whether the oldest age in the data files is a plus group.

In this example the original data set listed in the index file does have a plus group at age 10.

Type ↓ to take the default.

We have now completed the specification of the data structures used in the assessment.

Specification of Assessment Summary Table Means

In the next series of selections we define the range of ages used for the fishing mortality and population summary means printed in the result tables when the assessment is completed. This procedure is carried out prior to calculating assessments so that it does not have to be repeated for each assessment run.

Initially we are presented with a screen, shown below, that lists the options available for specifying the summary means.



Taking the default option (1) will calculate an unweighted arithmetic mean for each year (across ages). If the number of assessment ages selected by the user is greater than 5, the age range is (firstage +2) to (lastage -2), otherwise the average is calculated over all ages. Row means for each age (across years) are calculated as unweighted arithmetic mean with the year range: (lastyear -2) – last year.

In this example we will define two means for the annual fishing mortality. The first is an arithmetic mean F calculated over ages 3–7. The second is an average in which, at each age, the fishing mortality is weighted by the ratio of the catch numbers to the estimated population numbers.

Type 2 → To select user definition of the fishing mortality column means.

We will specify two means for each column (year) of the output summary table.

Select two means by typing 2 ↓

| C AWINNTAPP | REFILES\cdd01\DESKTOP\VPA35.cm | _ [] X |
|----------------------|---|--------|
| Please c | boase the required weighting from the mean : | |
| 1) 2) 3) 4) | Arithmetic mean weighted by catch number per recruit.(PBAR Arithmetic mean weighted by catch/population number per recruit.(FBARP) Arithmetic mean unweighted.(FBAR) Exploitation pattern weighting.(FBARS) | 65 |
| 620 6200 | s limit selected mean will be used the reference F in the loitation pattern calculation : can only be a weighting of type 1) or 3). | |
| | Your choice ? Default : < 3 >> | |

At the next screen we select the format of the first mean.

Type 3 for the arithmetic mean or just press enter for the default.

| No. Let | WINNT\PROFILES\cdd00\DESKT0P\VPA95.exe | |
|---------|---|--|
| | as the reference F in the exploitation pattern ralculation : it can only be a weighting of type 1) or 3). | |
| | Your choice ? Default $+ \in 3 >>$ | |
| | ***** default accepted ***** | |
| | Please give lower age limit for the nean : $\langle default - 3 \rangle $ | |
| | default accepted | |
| | Please give upper age limit for the nean : $\langle \text{default} = ? \rangle \rangle$ | |

Select the defaults offered for the range of ages over which the arithmetic mean is to be calculated.

This completes the specification of the unweighted arithmetic mean. We now specify the catch / population weighted mean.

| So C: VWTHIN TSP1 | RDFILES\cdd00ADESKTOP\\PA95.exe | |
|-------------------|---|--|
| Ple ¢ d | are give upper age limit for the mean : efault = $7 \rightarrow \longrightarrow 7$ | |
| | have already chosen weightingtype (3) for your zecond mean : | |
| Flease c | hoose the required weighting from the menu : | |
| 15 25 | Arithmetic mean weighted by catch number per recruit.(FDAAC) Arithmetic mean weighted by catch/population number per recruit.(FDAAR2) | |
| 1) 4) | Arithmetic man unweighted.(FDAR) Exploitation pattern weighting.(FBARS) | |
| | Your choice ? Default = < 1 > \longrightarrow _ | |

Type 2 for the catch/population weighted mean

The mean is a weighted average of the catch numbers to the population numbers calculated at each age and there is therefore no requirement to specify the age range for the calculations.

This completes the specification of the summary means and brings us to the central menu for the program.

The VPA Suite Central Menu

At the program central menu we can select assessment models and print tables of data or results. After each assessment model has been fitted to a data set, the program will return to this menu. This allows the user to undertake a series of exploratory trials and examine the results of the assessments in an editor or spreadsheet package without having to re-specify the data and summary age or year ranges.

| ∦ ₃ C-\\winn t\PROFIL | ES\edd00\DESKTOP\VPA95.exe | | |
|----------------------------------|---|----------------|--|
| ***** | LOWESIOFI UPA PROGRAM CENTRAL MENU | | |
| Assessm | ent nethods: | | |
| | User-defined UPA-Cohort an Separable UPA Ad hoc tuning Extended Survivors Analysi: | | |
| 9 11 | Print input data and result Stop | LE. | |
| ć Yau have s | • Far selected the options (| marked (= >) | |
| Please : | relect one of the options : | | |

Printing Data and Result Tables

Type 9 ↓

This screen presents a list of the tables available for printing from the program. At the current stage in the tutorial we have not run an assessment model so that there are no results available for printing. We can only print the input data sets 1-7.

| CAWINNTV | PROFILE SVcdd00/DE SKTOP/VPA95.exe | |
|-------------|---|--|
| Meno of Tab | der | |
| | Catch numbers at age Catch weights at age (kg) Stock weights at age (kg) Natural Mortality (M) at age Proportion nuture at age Proportion of M before Spawning Proportion of F before Spawning Proportion of F before Spawning Fishing nortality (F) at age Relative F at age Stock number at age (start of year) Spawning stock number at age (spawning time) Stock blomass at age (start of year) Spawning stock homass at age (spawning time) Stock blomass at age (start of year) Spawning stock blomass at age (spawning time) Stock blomass at age with SOP (start of year) Spawning stock blomass with SOP (spawning time) Summary (without SOP correction) Summary (without SOP correction) Summary (without SOP correction) Will produce result tables 8 to 19 inclusive also give tables 8 and 10.) | |

Type 1, 2, 3, 4, 5, 6, 7 ,

Type an output path followed by a file name with a .csv extension ,J

| Lable 1 | Gateli numbers at age | |
|--------------------|--|--|
| Table 2 | Catch unights at age (kg) | |
| Lable 3 | Stock weights at age (kg) | |
| Table 4 | Natural Mortality (M) at age | |
| lable 5 Lable 6 | Proportion mature at age | |
| Table 7 | Properties of A before Spawning Properties of F before Spawning | |
| Table 8 | Fishing mortality (F) at age | |
| Lable 9 | Relative F at ane | |
| Table 18 | Stock number at age (start of year) | |
| Table 11 | Spawing stock number at age (spawning time) | |
| Table 12 | Stock blomass at age (start of year) | |
| Table 13 | Spawning stock hinnass at whe (spawning time) | |
| Table 14 | Stock biomazz at age with SOP (start of year) | |
| Table 15 | Spanning stock binnars with SOP (spanning time) | |
| Table 16 | SunMary (without SOF correction) | |
| lable 17 | Summary (with SOP correction) | |
| 200E 18 | Will produce data tables 1,2,3,4,5,6,7 | |
| CODE 19 | Will produce result tables 8 to 17 inclusive | |
| CSunnarie | s also give tables 8 and 18.7 | |
| Please te | lect required tables 1.2.3.4.5.6.2 | |

After pressing return you should be back at the central menu. Note the star indicating that we have used the printing section. Examine the results file in a suitable spreadsheet or word processing package; there is no need to close the VPA program. The use of the .csv file extension produces spreadsheets that are automatically formatted when loaded into e.g. Microsoft Excel.

The VPA Suite Input Data Output File Format

Tables 1 - 7 present the Blackfin input data files that are printed as output from the VPA suite. They are:

| Table | Contents | |
|-------|-------------------------------------|--|
| 1 | Catch at age in numbers (thousands) | |
| 2 | Catch weight at age (kg) | |
| 3 | Stock weight at age (kg) | |
| 4 | Natural mortality | |
| 5 | Maturity ogive | |
| 6 | Proportion of F before spawning | |
| 7 | Proportion of M before spawning | |

Note that for this stock the catch weights have also been used for the stock weights at age. Stock weights at age are used to calculate the spawning stock biomass and ideally should be the values recorded at that time of year.

The first two lines of each output table are consistent between tables. The first line is the run title, taken from the title of the assessment data index file. It is generally used to identify the stock, year and type of data. The second line is the date and time at which the data files were printed.

Table I presents the catch numbers at age data used in the assessment model. In this instance the data have been tabulated in thousands, the unit that the program assumes for all calculations. Note however that the output table is formatted for ease of printing and the output unit, as detailed in the first line of each section, may change.

The data are tabulated in columns by year with totals presented for each column. Beneath the total numbers are the landings data time series from the first input file and a sum of products (SOP) cross check. The SOP value indicates the factor, given as a percentage, by which the sum of the products of the catch numbers and catch weights at age has to be raised to match the total landings. In Table 1 the SOP of the catch weights and catch numbers at age for 1963 is 6% lower than the landings weight. The SOP value is taken as an indication of the quality of the sampling used in the estimation of the numbers at age. In many ICES assessment working groups the catch weights are scaled, to correct for the difference, prior to the fitting of the assessment models (this is the case with this data set for recent years). However, if required the correction can be applied within the program during the printing of the results. The SOP value is also presented in Table 2: the catch weight at age data.

Analysis of the dynamics of the population and the characteristics of the fishery does not have to start with the fitting of assessment models. The structure of the catch at age data can be very informative. In the case of the Blackfin example, throughout the time series there has been a change in the peak age of the catch moving towards the youngest ages in the landings. During 1965–69 the distribution of the catch at age peaked at age 4. As the fishery has progressed there has been a gradual reduction in the dominant age towards age 3 in the late 1970's and 1980's to ages 2 and 3 in the most recent years. During the early years there were very few catches recorded at age 1, whereas more recently this age group has formed a substantial proportion of the catch. The pattern could result from high mortalities removing fish before they reach the older ages or from a change in selection by the fishery.

The catch weight at age data demonstrates trends during the available time series. During the period 1967–71 catch weight at age 5 averaged 2.2 kg; it increased during 198–84 to an average of 3.0 kg, and then decreased to less than 2.0 kg during 1987–93. The changes could be the product of the changes in selection by the fishery, such as changes in discard practices, or result from changes in growth rates.

Note that stock weights are a repeat of the catch weights for this fishery. If spawning takes place at a specific time of year catch weights from that time of year or from surveys could be used. Natural mortality is assumed constant at age and invariant through time. Maturity varies with age and is also constant in time. The proportion of fishing mortality and natural mortality that take place before spawning are set to zero so that SSB is calculated at the beginning of the year.

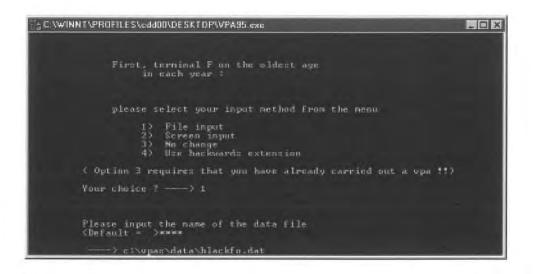
| CAWINN I VPROFI | LES\edd00\DESKTDP\VPA95.em | | |
|-----------------|---------------------------------------|----------------|--|
| ***** | LOWESTOFT UPA PROGRAM CENTRAL MENU | ***** | |
| Assess | ment methods: | | |
| | Ad hoc tuning | | |
| - y U | Print input data and read Stop | lts | |
| (You have | so far selected the option: | narked (=)) | |
| Please | sulect one of the options | 1> 1 | |

User-Defined VPA

Select Option 1 at the main menu

Four methods are available for the input of terminal fishing mortality values at the oldest age. Option 3 takes F values from a previous run of any of the assessment methods. Option 4 calculates an average of the fishing mortalities at younger ages.

Select option 1 for file input



Note the four stars in the default. This indicates that a filename was not specified in the index file and user input is required.

Type the path and file name C:\VPAS\DATA\BLACKFO.DAT →

The program reads the fishing mortality values stored in the data file and will use them to calculate population abundance for each of the cohorts terminating at the oldest age prior to the final year.

At the next menu select the "Screen Input" option and type the following values for each successive age (0.01 0.03 0.09 0.10 0.12 0.18 0.15 0.15 0.15).

| C:\WINNT\PROFILES\cdd00\DESKTOP\VPA95.exe | |
|--|--|
| Please give value for age ? < Default = .0868 > | |
| Please give value for age 8 < Default = .00000 >> 0.15 | |
| Please give value for age 9 $\langle \text{Default} =, 0000 \rangle \longrightarrow 0.15$ | |
| **** Virtual Population Analysis Menu **** | |
| Traditional upa ('exact' method) Cohort analysis (Pope's approximation) | |
| Please select your analysis (default=1)> | |

Select 1 for the Exact VPA method.

After running the VPA we return to the main menu. A star now highlights the user-defined method that we have just used.

| SC (WINNI SPHOF | NLE SNedd00NDE SK1 OPNVPA95.exe 📰 🖬 🖾 |
|--------------------|--|
| ***** | LOWESTOFT UPA PROCRAM CENTRAL MENU |
| Asseza | ment methods: |
| • 1 2 3 4 | Separable UFA Ad boc tuning |
| - ? P | |
| C You have | so far selected the options marked $\langle = \rangle$) |
| Please | select one of the options :> |

The program has now calculated a time series of population abundance and fishing mortality at each age. We can therefore print the time series of spawning and stock biomass and fishing mortalities.

Type 9 and select table 19. Specify a directory path and a file name with a .csv extension.

The VPA Suite Results Output File Format

Tables 8-17 present the output files derived from the previous run and printed using the VPA suite menu option 9.

| Table | Contents | | | | | | | |
|--------|---|--|--|--|--|--|--|--|
| 8 | Fishing mortality at age | | | | | | | |
| 8 9 | Relative fishing mortality at age | | | | | | | |
| 10 | Stock number at age, calculated at the start of the year | | | | | | | |
| 11 | Spawning stock number at age, calculated at the time of spawning | | | | | | | |
| 12 | Stock biomass at age, calculated at the start of the year, without SOP correction | | | | | | | |
| 13 | Spawning stock biomass at age, calculated at the time of spawning, without SOP correction | | | | | | | |
| 14 | Stock biomass at age, calculated at the start of the year, with SOP correction | | | | | | | |
| 15 | Spawning stock biomass at age, calculated at the start of the year, with SOP correction | | | | | | | |
| 16 | The assessment stock summary table without SOP correction | | | | | | | |
| 17 | The assessment stock summary table with SOP correction | | | | | | | |

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The first line of each table is the run title. It is taken from the title of the assessment data index file and is generally used to identify the stock, year and type of data. The second line is the date and time at which the data files were printed.

Table 8 presents the fishing mortality (F) at age matrix, calculated using the user inputs for the F in the final year, F at the oldest age from the input file, the natural mortality and the catch at age input data. The table layout is similar to the data file tabulation, with columns containing the results for a year and the rows the results for each age. Note that the plus group fishing mortality is defined to be equal to that at the oldest age.

The two fishing mortality means specified by the user are presented in the rows below the results for each age. In this instance we have defined an unweighted average F (FBAR), calculated over the age range 3-7, and a catch/population weighted average calculated across all ages (FBARP). The average values are also presented as time series in summary tables 16 and 17. The final column of the table presents an average fishing mortality for each age calculated over a user-defined range of years. As with the column means, the user can define the type of average and the year range over which it is calculated when specifying the assessment structure.

Pope (1972) has shown that the historic fishing mortality and population numbers calculated using VPA are insensitive to the values used to initiate the cohort calculations if the cumulative fishing mortality back up the cohort is greater than 1.0 (conditional on the value of M); the estimates are considered to be "converged". In Table 8 this generally holds for ages 7 and younger in the years 1963–91. Calibration models fitted to the Blackfin catch at age data set are therefore primarily estimating the level of fishing mortality and population abundance at all ages for the years 1992–94 and at ages 8 and 9 in earlier years.

Table 9 presents the relative fishing mortality at age, that is the ratio of the fishing mortality estimated at each age and the first user defined mean (Fbar 3–7). It is used to detect changes in selection at age such as the increased selection for age 2 and 3 that occurred after 1973.

Table 10 presents the population numbers at age calculated from the VPA transformation of the catch at age data with the two row (age) means. The number of means, the year range and the method of calculation are user defined. In this case the defaults were selected and they are a geometric and arithmetic mean calculated over all years except the final three.

Table 11 presents the spawning stock numbers calculated at spawning time. The populations are brought forward to spawning time using the proportions of fishing and natural mortality that take place before spawning, defined by the user within the input files.

Two tables of stock biomass at age (12, 14) and spawning stock biomass at age (13, 15) are available. The stock biomass is calculated at the beginning of the year, spawning stock biomass at spawning time. Tables 12 and 13 are the biomass without SOP correction and Table 14 and 15 present the biomasses scaled by the SOP factor which corrects for sampling error and which was discussed previously in relation to the catch data.

Two output summary tables are available. Table 16 is not SOP corrected and Table 17 has the SOP corrected biomasses. Both tables present the time series of recruitment to the first age of the assessment, total and spawning stock biomass, landings, yield (landings) / SSB which is a proxy for fishing mortality and the time series of user defined fishing mortality means specified at the start of the run.

References

DARBY, C. D. and S. FLATMAN. 1994. Virtual Population Analysis: version 3.1 (Windows/DOS) user guide. *Info. Tech. Ser.*, MAFF Direct. Fish. Res., Lowestoft, 1: 85 p.

POPE, J. G., 1972. An Investigation of the Accuracy of Virtual Population Analysis Using Cohort Analysis. *ICNAF Res. Bull.*, **9**: 65–74.

TABLE 1. The VPA suite catch numbers-at-age output table for the Blackfin example data set.

Run title : Blackfin: VPA course. Combined sex; plusgroup. At 1/02/2002 8:47

| Table 1 C | Catch numbe | ars at age | | Numb | ers*10**-3 | | | | | |
|--|--|---|---|--|--|--|---|---|---|---|
| YEAR AGE | 1963 | 1964 | | | | | | | | |
| 1 | 0 | 0 | | | | | | | | |
| 2 | 155 | 117 | | | | | | | | |
| 3 | 1483 | 2136 | | | | | | | | |
| 4 | 688 | 2340 | | | | | | | | |
| 5 | 327 | 700 | | | | | | | | |
| 6 | 215 | 339 | | | | | | | | |
| 7 | 73 | 159 | | | | | | | | |
| 8 | 149 | 42 | | | | | | | | |
| 9 | 50 | 49 | | | | | | | | |
| +gp | 49 | 93 | | | | | | | | |
| TOTALNUM | 3190 | 5975 | | | | | | | | |
| TONSLAND | 6594 | 13596 | | | | | | | | |
| SOPCOF % | 106 | 105 | | | | | | | | |
| T-bla d C | | | | N | | | | | | |
| | Catch numbe | - | 1007 | | ers*10**-3 | 4070 | 4074 | 4070 | 1070 | 4074 |
| YEAR AGE | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
| 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 57 | 350 | 897 |
| 2 | 231 | 68 | 385 | 49 | 335 | 33 | 382 | 3973 | 7753 | 3374 |
| 3 | 3327 | 2838 | 2053 | 2435 | 1983 | 2857 | 1385 | 8419 | 7665 | 6062 |
| 4 | 3060 | 4909 | 2885 | 2433 | 4618 | 2335 | 4444 | 3894 | 5251 | 2417 |
| 5 | 1757 | 1220 | 1934 | 1197 | 1498 | 1805 | 1891 | 2256 | 1946 | 2158 |
| 6 | 512 | 693 | 268 | 621 | 507 | 599 | 1085 | 456 | 883 | 617 |
| 7 | 271 | 135 | 454 | 148 | 568 | 240 | 465 | 333 | 468 | 949 |
| 8 | 92 | 39 | 91 | 126 | 106 | 196 | 362 | 160 | 336 | 925 |
| 9 | 69 | 27 | 44 | 29 | 79 | 41 | 300 | 92 | 199 | 502 |
| +gp | 137 | 48 | 75 | 58 | 71 | 122 | 238 | 162 | 472 | 869 |
| TOTALNUM | 9457 | 9977 | 8189 | 6952 | 9765 | 8228 | 10552 | 19803 | 25322 | 18769 |
| TONSLAND | 18395 | 18584 | 16034 | 12787 | 17124 | 14536 | 19863 | 29219 | 33832 | 35973 |
| SOPCOF % | 98 | 100 | 102 | 98 | 99 | 99 | 98 | 100 | 93 | 97 |
| | | | | | | | | | | |
| | | | | | | | | | | |
| Table 1 C | Catch numbe | ers at age | | Numb | ers*10**-3 | | | | | |
| Table 1 C YEAR | Catch numbe 1975 | ers at age 1976 | 1977 | Numb 1978 | ers*10**-3 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
| | | - | 1977 | | | 1980 | 1981 | 1982 | 1983 | 1984 |
| YEAR | | - | 1977 160 | | | 1980 46 | 1981 154 | 1982 43 | 1983 35 | 1984 157 |
| YEAR AGE | 1975 | 1976 | | 1978 | 1 979 | | | | | |
| YEAR AGE 1 | 1975 25 | 1976 36 | 160 | 1978 38 | 1979 10 | 46 | 154 | 43 | 35 | 157 |
| YEAR AGE 1 2 3 4 | 1975 25 2592 | 1976 36 2826 | 160 1257 | 1978 38 4452 | 1979 10 1000 | 46 1023 | 154 2490 | 43 1403 | 35 3519 | 157 3026 |
| YEAR AGE 1 2 3 | 1975 25 2592 6672 | 1976 36 2826 8274 | 160 1257 4680 | 1978 38 4452 4278 | 1979 10 1000 1836 | 46 1023 3351 | 154 2490 3932 | 43 1403 4633 | 35 3519 4761 | 157 3026 5590 |
| YEAR AGE 1 2 3 4 5 6 | 1975 2592 6672 2546 1328 873 | 1976 36 2826 8274 2782 1806 1122 | 160 1257 4680 2734 1687 743 | 1978 38 4452 4278 2362 1306 701 | 1979 10 1000 1836 1205 | 46 1023 3351 954 685 638 | 154 2490 3932 1981 | 43 1403 4633 1687 1250 574 | 35 3519 4761 2574 834 764 | 157 3026 5590 2407 880 685 |
| YEAR AGE 1 2 3 4 5 6 7 | 1975 25 2592 6672 2546 1328 873 1013 | 1976 36 2826 8274 2782 1806 1122 662 | 160 1257 4680 2734 1687 743 562 | 1978 38 4452 4278 2362 1306 701 293 | 1979 10 1000 1836 1205 1181 724 372 | 46 1023 3351 954 685 638 471 | 154 2490 3932 1981 588 410 341 | 43 1403 4633 1687 1250 574 388 | 35 3519 4761 2574 834 764 509 | 157 3026 5590 2407 880 685 302 |
| YEAR AGE 1 2 3 4 5 6 7 8 | 1975 2592 6672 2546 1328 873 1013 711 | 1976 36 2826 8274 2782 1806 1122 662 518 | 160 1257 4680 2734 1687 743 562 386 | 1978 38 4452 4278 2362 1306 701 293 244 | 1979 10 1000 1836 1205 1181 724 372 157 | 46 1023 3351 954 685 638 471 194 | 154 2490 3932 1981 588 410 341 223 | 43 1403 4633 1687 1250 574 388 247 | 35 3519 4761 2574 834 764 509 158 | 157 3026 5590 2407 880 685 302 140 |
| YEAR AGE 1 2 3 4 5 6 7 8 9 | 1975 2592 6672 2546 1328 873 1013 711 198 | 1976 36 2826 8274 2782 1806 1122 662 518 586 | 160 1257 4680 2734 1687 743 562 386 290 | 1978 38 4452 4278 2362 1306 701 293 244 163 | 1979 10 1000 1836 1205 1181 724 372 157 191 | 46 1023 3351 954 685 638 471 194 91 | 154 2490 3932 1981 588 410 341 223 154 | 43 1403 4633 1687 1250 574 388 247 136 | 35 3519 4761 2574 834 764 509 158 105 | 157 3026 5590 2407 880 685 302 140 57 |
| YEAR AGE 1 2 3 4 5 6 7 8 9 +9₽ | 1975 2592 6672 2546 1328 873 1013 711 198 343 | 1976 36 2826 8274 2782 1806 1122 662 518 586 1365 | 160 1257 4680 2734 1687 743 562 386 290 922 | 1978 38 4452 4278 2362 1306 701 293 244 163 1326 | 1979 10 1000 1836 1205 1181 724 372 157 191 757 | 46 1023 3351 954 685 638 471 194 91 817 | 154 2490 3932 1981 588 410 341 223 154 673 | 43 1403 4633 1687 1250 574 388 247 136 461 | 35 3519 4761 2574 834 764 509 158 105 506 | 157 3026 5590 2407 880 685 302 140 57 160 |
| YEAR AGE 1 2 3 4 5 6 7 8 9 +gp TOTALNUM | 1975 25 2592 6672 2546 1328 873 1013 711 198 343 16300 | 1976 36 2826 8274 2782 1806 1122 662 518 586 1365 19979 | 160 1257 4680 2734 1687 743 562 386 290 922 13421 | 1978 38 4452 4278 2362 1306 701 293 244 163 1326 15163 | 1979 10 1000 1836 1205 1181 724 372 157 191 757 7433 | 46 1023 3351 954 685 638 471 194 91 817 8270 | 154 2490 3932 1981 588 410 341 223 154 673 10947 | 43 1403 4633 1687 1250 574 388 247 136 461 10824 | 35 3519 4761 2574 834 764 509 158 105 506 13765 | 157 3026 5590 2407 880 685 302 140 57 160 13404 |
| YEAR AGE 1 2 3 4 5 6 7 8 9 *9P TOTALNUM TONSLAND | 1975 2592 6672 2546 1328 873 1013 711 198 343 16300 30800 | 1976 36 2826 8274 2782 1806 1122 662 518 586 1365 19979 41747 | 160 1257 4680 2734 1687 743 562 386 290 922 13421 27210 | 1978 38 4452 4278 2362 1306 701 293 244 163 1326 15163 31370 | 1979 10 1000 1836 1205 1181 724 372 157 191 757 7433 21604 | 46 1023 3351 954 685 638 471 194 91 817 8270 22102 | 154 2490 3932 1981 588 410 341 223 154 673 10947 23574 | 43 1403 4633 1687 1250 574 388 247 136 461 10824 23884 | 35 3519 4761 2574 834 764 509 158 105 506 13765 28890 | 157 3026 5590 2407 880 685 302 140 57 160 13404 21641 |
| YEAR AGE 1 2 3 4 5 6 7 8 9 +gp TOTALNUM | 1975 25 2592 6672 2546 1328 873 1013 711 198 343 16300 | 1976 36 2826 8274 2782 1806 1122 662 518 586 1365 19979 | 160 1257 4680 2734 1687 743 562 386 290 922 13421 | 1978 38 4452 4278 2362 1306 701 293 244 163 1326 15163 | 1979 10 1000 1836 1205 1181 724 372 157 191 757 7433 | 46 1023 3351 954 685 638 471 194 91 817 8270 | 154 2490 3932 1981 588 410 341 223 154 673 10947 | 43 1403 4633 1687 1250 574 388 247 136 461 10824 | 35 3519 4761 2574 834 764 509 158 105 506 13765 | 157 3026 5590 2407 880 685 302 140 57 160 13404 |
| YEAR AGE 1 2 3 4 5 6 7 8 9 *gp TOTALNUM TONSLAND SOPCOF % | 1975 2592 2592 2546 1328 873 1013 711 198 343 16300 30800 98 | 1976 36 2826 8274 2782 1806 1122 662 518 586 1365 19979 41747 97 | 160 1257 4680 2734 1687 743 562 386 290 922 13421 27210 | 1978 38 4452 4278 2362 1306 701 293 244 163 1326 15163 31370 97 | 1979 10 1000 1836 1205 1181 724 372 157 191 757 7433 21604 99 | 46 1023 3351 954 685 638 471 194 91 817 8270 22102 | 154 2490 3932 1981 588 410 341 223 154 673 10947 23574 | 43 1403 4633 1687 1250 574 388 247 136 461 10824 23884 | 35 3519 4761 2574 834 764 509 158 105 506 13765 28890 | 157 3026 5590 2407 880 685 302 140 57 160 13404 21641 |
| YEAR AGE 1 2 3 4 5 6 7 8 9 +gp TOTALNUM TONSLAND SOPCOF % Table 1 C | 1975 25 2592 2546 1328 873 1013 711 198 343 16300 30800 98 Catch numbe | 1976 36 2826 8274 2782 1806 1122 662 518 586 1365 19979 41747 97 ers at age | 160 1257 4680 2734 1687 743 562 386 290 922 13421 27210 96 | 1978 38 4452 4278 2362 1306 701 293 244 163 1326 15163 31370 97 Numbe | 1979 10 1000 1836 1205 1181 724 372 157 191 757 7433 21604 99 ers*10**-3 | 46 1023 3351 954 638 471 194 91 817 8270 22102 100 | 154 2490 3932 1981 588 410 341 223 154 673 10947 23574 98 | 43 1403 4633 1687 1250 574 388 247 136 461 10824 23884 99 | 35 3519 4761 2574 834 764 509 158 105 506 13765 28890 102 | 157 3026 5590 2407 880 685 302 140 57 160 13404 21641 99 |
| YEAR AGE 1 2 3 4 5 6 7 8 9 +gp TOTALNUM TONSLAND SOPCOF % Table 1 YEAR | 1975 2592 2592 2546 1328 873 1013 711 198 343 16300 30800 98 | 1976 36 2826 8274 2782 1806 1122 662 518 586 1365 19979 41747 97 | 160 1257 4680 2734 1687 743 562 386 290 922 13421 27210 | 1978 38 4452 4278 2362 1306 701 293 244 163 1326 15163 31370 97 | 1979 10 1000 1836 1205 1181 724 372 157 191 757 7433 21604 99 | 46 1023 3351 954 685 638 471 194 91 817 8270 22102 | 154 2490 3932 1981 588 410 341 223 154 673 10947 23574 | 43 1403 4633 1687 1250 574 388 247 136 461 10824 23884 | 35 3519 4761 2574 834 764 509 158 105 506 13765 28890 | 157 3026 5590 2407 880 685 302 140 57 160 13404 21641 |
| YEAR AGE 1 2 3 4 5 6 7 8 9 *gp TOTALNUM TONSLAND SOPCOF % Table 1 C YEAR AGE | 1975 25 2592 6672 2546 1328 873 1013 711 198 343 16300 30800 98 Catch number 1985 | 1976 36 2826 8274 2782 1806 1122 662 518 586 1365 19979 41747 97 ers at age 1986 | 160 1257 4680 2734 1687 743 562 386 290 922 13421 27210 96 1987 | 1978 38 4452 2362 1306 701 293 244 163 1326 15163 31370 97 Numb- 1988 | 1979 10 1000 1836 1205 1181 724 372 157 191 757 7433 21604 99 ers*10**-3 1989 | 46 1023 3351 954 685 638 471 194 91 817 8270 22102 100 1990 | 154 2490 3932 1981 588 410 341 223 154 673 10947 23574 98 | 43 1403 4633 1687 1250 574 388 247 136 461 10824 23884 99 | 35 3519 4761 2574 834 764 509 158 105 506 13765 28890 102 1993 | 157 3026 5590 2407 880 685 302 140 57 160 13404 21641 99 |
| YEAR AGE 1 2 3 4 5 6 7 8 9 +gp TOTALNUM TONSLAND SOPCOF % Table 1 CYEAR AGE 1 | 1975 25 2592 6672 2546 1328 873 1013 711 198 343 16300 30800 98 Catch numbe 1985 6 | 1976 36 2826 8274 2782 1806 1122 662 518 586 1365 19979 41747 97 ers at age 1986 232 | 160 1257 4680 2734 1687 743 562 386 290 922 13421 27210 96 1987 | 1978 38 4452 2362 1306 701 293 244 163 1326 15163 31370 97 Numbe 1988 21 | 1979 10 1000 1836 1205 1181 724 372 157 191 757 7433 21604 99 ers*10**-3 1989 22 | 46 1023 3351 954 685 638 471 194 91 817 8270 22102 100 1990 58 | 154 2490 3932 1981 588 410 341 223 154 673 10947 23574 98 1991 153 | 43 1403 4633 1687 1250 574 388 247 136 461 10824 23884 99 1992 28 | 35 3519 4761 2574 834 764 509 158 105 506 13765 28890 102 1993 15 | 157 3026 5590 2407 880 685 302 140 57 160 13404 21641 99 1994 3 |
| YEAR AGE 1 2 3 4 5 6 7 8 9 +gp TOTALNUM TONSLAND SOPCOF % Table 1 YEAR AGE 1 2 | 1975 25 2592 6672 2546 1328 873 1013 711 198 343 16300 30800 98 Catch numbe 1985 6 2288 | 1976 36 2826 8274 2782 1806 1122 662 518 586 1365 19979 41747 97 ers at age 1986 232 773 | 160 1257 4680 2734 1687 743 562 386 290 922 13421 27210 96 1987 1 | 1978 38 4452 4278 2362 1306 701 293 244 163 1326 15163 31370 97 Numb 1988 21 3591 | 1979 10 1000 1836 1205 1181 724 372 157 191 757 7433 21604 99 ers*10**-3 1989 22 759 | 46 1023 3351 954 685 638 471 194 91 817 8270 22102 100 1990 58 1485 | 154 2490 3932 1981 588 410 341 223 154 673 10947 23574 98 1991 153 1243 | 43 1403 4633 1687 1250 574 388 247 136 461 10824 23884 99 1992 28 861 | 35 3519 4761 2574 834 764 509 158 105 506 13765 28890 102 1993 15 2511 | 157 3026 5590 2407 880 685 302 140 57 160 13404 21641 99 1994 3 2408 |
| YEAR AGE 1 2 3 4 5 6 7 8 9 +9P TOTALNUM TONSLAND SOPCOF % Table 1 YEAR AGE 1 2 3 | 1975 25 2592 6672 2546 1328 873 1013 711 198 343 16300 30800 98 Catch number 1985 6 2288 5122 | 1976 36 2826 8274 2782 1806 1122 662 518 586 1365 19979 41747 97 ers at age 1986 232 773 7101 | 160 1257 4680 2734 1687 743 562 386 290 922 13421 27210 96 1987 1 1698 2194 | 1978 38 4452 4278 2362 1306 701 293 244 163 1326 15163 31370 97 Numb 1988 21 3591 5702 | 1979 10 1000 1836 1205 1181 724 372 157 191 757 7433 21604 99 ers*10**-3 1989 22 759 7291 | 46 1023 3351 954 685 638 471 194 91 817 8270 22102 100 1990 58 1485 5595 | 154 2490 3932 1981 588 410 341 223 154 673 10947 23574 98 1991 153 1243 3594 | 43 1403 4633 1687 1250 574 388 247 136 461 10824 23884 99 1992 28 861 1773 | 35 3519 4761 2574 834 764 509 158 105 506 13765 28890 102 1993 15 2511 2668 | 157 3026 5590 2407 880 685 302 140 57 160 13404 21641 99 1994 3 2408 2029 |
| YEAR AGE 1 2 3 4 5 6 7 8 9 • tgp TOTALNUM TONSLAND SOPCOF % Table 1 SOPCOF % Table 1 YEAR AGE 1 2 3 4 | 1975 2592 2592 2546 1328 873 1013 711 198 343 16300 30800 98 Catch number 1985 6 2288 5122 3051 | 1976 36 2826 8274 2782 1806 1122 662 518 586 1365 19979 41747 97 97 97 97 97 97 97 97 97 97 97 97 97 | 160 1257 4680 2734 1687 743 562 386 290 922 13421 27210 96 1987 1 1698 2194 6967 | 1978 38 4452 4278 2362 1306 701 293 244 163 1326 15163 31370 97 Numb 1988 21 3591 5702 3518 | 1979 10 1000 1836 1205 1181 724 372 157 191 757 7433 21604 99 ers*10**-3 1989 22 759 7291 5703 | 46 1023 3351 954 638 471 194 91 817 8270 22102 100 1990 58 1485 5595 3729 | 154 2490 3932 1981 588 410 341 223 154 673 10947 23574 98 1991 153 1243 3594 2946 | 43 1403 4633 1687 1250 574 388 247 136 461 10824 23884 99 1992 28 861 1773 3093 | 35 3519 4761 2574 834 764 509 158 105 506 13765 28890 102 1993 15 2611 2668 2827 | 157 3026 5590 2407 880 685 302 140 57 160 13404 21641 99 1994 3 2408 2029 1080 |
| YEAR AGE 1 2 3 4 5 6 7 8 9 +gp TOTALNUM TONSLAND SOPCOF % Table 1 YEAR AGE 1 2 3 4 5 | 1975 25 2592 6672 2546 1328 873 1013 711 198 343 16300 30800 98 Catch number 1985 6 2288 5122 3051 1459 | 1976 36 2826 8274 2782 1806 1122 662 518 586 1365 19979 41747 97 ers at age 1986 232 773 7101 8441 3787 | 160 1257 4680 2734 1687 743 562 386 290 922 13421 27210 96 1987 1987 1 1698 2194 6967 1928 | 1978 38 4452 4278 2362 1306 701 293 244 163 1326 15163 31370 97 Number 1988 21 3591 5702 3518 2627 | 1979 10 1000 1836 1205 1181 724 372 157 191 757 7433 21604 99 ers*10**-3 1989 22 759 7291 5703 2255 | 46 1023 3351 954 685 638 471 194 91 817 8270 22102 100 22102 100 1990 58 1485 5595 3729 1194 | 154 2490 3932 1981 588 410 341 223 154 673 10947 23574 98 1991 153 1243 3594 2946 1175 | 43 1403 4633 1687 1250 574 388 247 136 461 10824 23884 99 1992 28 861 1773 3093 968 | 35 3519 4761 2574 834 764 509 158 105 506 13765 28890 102 1993 15 2511 2668 2827 1185 | 157 3026 5590 2407 880 685 302 140 57 160 13404 21641 99 1994 3 2408 2029 1080 492 |
| YEAR AGE 1 2 3 4 5 6 7 8 9 *gp TOTALNUM TONSLAND SOPCOF % Table 1 YEAR AGE 1 2 3 4 5 6 | 1975 25 2592 6672 2546 1328 873 1013 711 198 343 16300 30800 98 Catch number 1985 6 2288 5122 3051 1459 1230 | 1976 36 2826 8274 2782 1806 1122 662 518 586 1365 19979 41747 97 97 97 97 97 97 97 97 97 9 | 160 1257 4680 2734 1687 743 562 386 290 922 13421 27210 96 1987 1 1698 2194 6967 1928 1359 | 1978 38 4452 4278 2362 1306 701 293 244 163 1326 15163 31370 97 Numbu 1988 21 3591 5702 3518 2627 1051 | 1979 10 1000 1836 1205 1181 724 372 157 7433 21604 99 ers*10**-3 1989 22 759 7291 5703 2255 1400 | 46 1023 3351 954 685 638 471 194 91 817 8270 22102 100 22102 100 1990 58 1485 5595 3729 1194 786 | 154 2490 3932 1981 588 410 341 223 154 673 10947 23574 98 1991 153 1243 3594 2946 1175 607 | 43 1403 4633 1687 1250 574 388 247 136 461 10824 23884 99 1992 28 861 1773 3093 968 354 | 35 3519 4761 2574 834 764 509 158 105 506 13765 28890 102 1993 15 2511 2668 2827 1185 270 | 157 3026 5590 2407 880 685 302 140 57 160 13404 21641 99 1994 3 2408 2408 2408 2408 2408 2408 2408 |
| YEAR AGE 1 2 3 4 5 6 7 8 9 +9P TOTALNUM TONSLAND SOPCOF % Table 1 C YEAR AGE 1 2 3 4 5 6 7 | 1975 25 2592 6672 2546 1328 873 1013 711 198 343 16300 30800 98 Catch numbe 1985 6 2288 5122 3051 1459 1230 610 | 1976 36 2826 8274 2782 1806 1122 662 518 586 1365 19979 41747 97 ers at age 1986 232 773 7101 8441 3787 1399 1056 | 160 1257 4680 2734 1687 743 562 386 290 922 13421 27210 96 1987 1 1698 2194 6967 1928 1359 779 | 1978 38 4452 4278 2362 1306 701 293 244 163 1326 15163 31370 97 Number 1988 21 3591 5702 3518 2627 1051 892 | 1979 10 1000 1836 1205 1181 724 372 157 7433 21604 99 ers*10**-3 1989 22 759 7291 5703 2255 1400 376 | 46 1023 3351 954 685 638 471 194 91 817 8270 22102 100 22102 100 1990 58 1485 5595 3729 1194 786 525 | 154 2490 3932 1981 588 410 341 223 154 673 10947 23574 98 1991 153 1243 3594 2946 1175 607 424 | 43 1403 4633 1687 1250 574 388 247 136 461 10824 23884 99 1992 28 861 1773 3093 968 354 107 | 35 3519 4761 2574 834 764 509 158 105 506 13765 28890 102 1993 15 2511 2668 2827 1185 270 112 | 157 3026 5590 2407 880 685 302 140 57 160 13404 21641 99 1994 3 2408 2029 1080 492 280 109 |
| YEAR AGE 1 2 3 4 5 6 7 8 9 *gp TOTALNUM TONSLAND SOPCOF % Table 1 YEAR AGE 1 2 3 4 5 6 | 1975 25 2592 6672 2546 1328 873 1013 711 198 343 16300 30800 98 Catch numbe 1985 6 2288 5122 3051 1459 1230 610 187 | 1976 36 2826 8274 2782 1806 1122 662 518 586 1365 19979 41747 97 ers at age 1986 232 773 7101 8441 3787 1399 1056 470 | 160 1257 4680 2734 1687 743 562 386 290 922 13421 27210 96 1987 1 1698 2194 6967 1928 1359 779 454 | 1978 38 4452 4278 2362 1306 701 293 244 163 1326 15163 31370 97 Numb- 1988 21 3591 5702 3518 2627 1051 892 698 | 1979 10 1000 1836 1205 1181 724 372 157 7433 21604 99 ers*10**-3 1989 22 759 7291 5703 2255 1400 376 258 | 46 1023 3351 954 685 638 471 194 91 817 8270 22102 100 1990 58 1485 5595 3729 1194 786 525 245 | 154 2490 3932 1981 588 410 341 223 154 673 10947 23574 98 1991 153 1243 3594 2946 1175 607 424 235 | 43 1403 4633 1687 1250 574 388 247 136 461 10824 23884 99 1992 28 861 1773 3093 968 354 | 35 3519 4761 2574 834 764 509 158 105 506 13765 28890 102 1993 15 2511 2668 2827 1185 270 112 56 | 157 3026 5590 2407 880 685 302 140 57 160 13404 21641 99 1994 3 2408 2029 1080 492 280 109 65 |
| YEAR AGE 1 2 3 4 5 6 7 8 9 • 9 • 10 TALNUM TONSLAND SOPCOF % Table 1 CYEAR AGE 1 2 3 4 5 6 7 8 9 • 1 2 3 4 5 5 6 7 8 9 • 1 2 7 8 9 • 1 1 2 7 8 9 • 1 1 2 3 4 5 5 6 7 8 9 • 10 7 8 9 • 10 7 10 10 10 10 10 10 10 10 10 10 10 10 10 | 1975 25 2592 6672 2546 1328 873 1013 711 198 343 16300 30800 98 Catch number 1985 6 2288 5122 3051 1459 1230 610 187 105 | 1976 36 2826 8274 2782 1806 1122 662 518 586 1365 19979 41747 97 ers at age 1986 232 773 7101 8441 3787 1399 1056 470 186 | 160 1257 4680 2734 1687 743 562 386 290 922 13421 27210 96 1987 1 1698 2194 6967 1928 1359 779 454 261 | 1978 38 4452 4278 2362 1306 701 293 244 163 1326 15163 31370 97 Numb 1988 21 3591 5702 3518 2627 1051 892 698 330 | 1979 10 1000 1836 1205 1181 724 372 157 7433 21604 99 ers*10**-3 1989 22 759 7291 5703 2255 1400 376 258 157 | 46 1023 3351 954 685 638 471 194 91 817 8270 22102 100 1990 58 1485 5595 3729 1194 786 525 245 132 | 154 2490 3932 1981 588 410 341 223 154 673 10947 23574 98 1991 153 1243 3594 2946 1175 607 424 235 96 | 43 1403 4633 1687 1250 574 388 247 136 461 10824 23884 99 1992 28 861 1773 3093 968 354 107 61 54 | 35 3519 4761 2574 834 764 509 158 105 506 13765 28890 102 1993 15 2511 2668 2827 1185 270 112 56 43 | 157 3026 5590 2407 880 685 302 140 57 160 13404 21641 99 1994 3 2408 2029 1080 492 280 109 65 50 |
| YEAR AGE 1 2 3 4 5 6 7 8 9 +gp TOTALNUM TONSLAND SOPCOF % Table 1 YEAR AGE 1 2 3 4 5 6 7 8 9 1 7 8 9 1 7 8 9 1 7 8 9 1 7 8 9 1 1 7 8 9 1 7 8 9 1 7 8 9 1 7 8 9 1 7 8 9 1 7 8 9 1 7 8 9 1 7 8 9 1 7 8 9 1 7 8 9 1 7 8 9 1 7 8 9 1 7 8 9 1 7 8 9 1 7 8 9 1 7 8 9 1 7 8 9 1 7 8 9 1 7 8 9 1 7 8 8 9 1 7 8 8 9 1 7 8 8 9 1 7 8 8 9 1 7 8 8 9 1 7 8 8 9 1 7 8 8 9 1 7 8 8 9 1 7 8 8 9 1 7 8 8 9 1 7 8 8 9 1 7 8 8 9 1 7 8 8 9 1 7 8 8 9 1 7 8 8 9 1 7 8 8 9 1 7 8 8 9 1 8 9 1 7 8 8 9 1 7 8 8 9 1 7 8 8 9 1 7 8 8 9 1 7 8 8 9 1 7 8 8 9 1 7 8 9 1 7 8 1 8 9 1 7 8 8 9 1 7 8 8 1 8 9 1 8 1 8 9 1 7 8 1 8 9 1 7 8 1 8 1 8 1 8 1 8 1 8 1 8 1 8 1 8 1 | 1975 25 2592 6672 2546 1328 873 1013 711 198 343 16300 30800 98 Catch number 1985 6 2288 5122 3051 1459 1230 610 187 105 225 | 1976 36 2826 8274 2782 1806 1122 662 518 586 1365 19979 41747 97 ers at age 1986 232 773 7101 8441 3787 1399 1056 470 186 347 | 160 1257 4680 2734 1687 743 562 386 290 922 13421 27210 96 1987 1 1698 2194 6967 1928 1359 779 454 261 210 | 1978 38 4452 4278 2362 1306 701 293 244 163 15163 31370 97 Numb 1988 21 3591 5702 3518 2627 1051 892 698 330 329 | 1979 10 1000 1836 1205 1181 724 372 157 191 757 7433 21604 99 ers*10**-3 1989 22 759 7291 5703 2255 1400 376 258 157 184 | 46 1023 3351 954 685 638 471 194 91 817 8270 22102 100 1990 58 1485 5595 3729 1194 786 525 245 | 154 2490 3932 1981 588 410 341 223 154 673 10947 23574 98 1991 153 1243 3594 2946 1175 607 424 235 96 223 | 43 1403 4633 1687 1250 574 388 247 136 461 10824 23884 99 1992 28 861 1773 3093 968 354 107 61 54 93 | 35 3519 4761 2574 834 764 509 158 105 506 13765 28690 102 1993 15 2511 2668 2827 1185 270 112 566 270 112 566 | 157 3026 5590 2407 880 685 302 140 57 160 13404 21641 99 1994 3 2408 2029 1080 492 280 109 65 50 110 |
| YEAR AGE 1 2 3 4 5 6 7 8 9 +gp TOTALNUM TONSLAND SOPCOF % Table 1 CYEAR AGE 1 2 3 4 5 6 7 8 9 9 +gp | 1975 25 2592 6672 2546 1328 873 1013 711 198 343 16300 30800 98 Catch number 1985 6 2288 5122 3051 1459 1230 610 187 105 | 1976 36 2826 8274 2782 1806 1122 662 518 586 1365 19979 41747 97 ers at age 1986 232 773 7101 8441 3787 1399 1056 470 186 347 23792 | 160 1257 4680 2734 1687 743 562 386 290 922 13421 27210 96 1987 1 1698 2194 6967 1928 1359 779 454 261 | 1978 38 4452 4278 2362 1306 701 293 244 163 1326 15163 31370 97 Numb 1988 21 3591 5702 3518 2627 1051 892 698 330 | 1979 10 1000 1836 1205 1181 724 372 157 7433 21604 99 ers*10**-3 1989 22 759 7291 5703 2255 1400 376 258 157 | 46 1023 3351 954 685 638 471 194 91 817 8270 22102 100 1990 58 1485 5595 3729 1194 786 525 245 132 157 13906 | 154 2490 3932 1981 588 410 341 223 154 673 10947 23574 98 1991 153 1243 3594 2946 1175 607 424 235 96 | 43 1403 4633 1687 1250 574 388 247 136 461 10824 23884 99 1992 28 861 1773 3093 968 354 107 61 54 | 35 3519 4761 2574 834 764 509 158 105 506 13765 28890 102 1993 15 2511 2668 2827 1185 270 112 56 43 | 157 3026 5590 2407 880 685 302 140 57 160 13404 21641 99 1994 3 2408 2029 1080 492 280 109 65 50 |
| YEAR AGE 1 2 3 4 5 6 7 8 9 • 9 • 1 0 5 0 7 8 9 • 9 • 9 • 1 2 3 4 5 6 7 8 9 • 1 2 3 4 5 6 7 7 8 9 9 • 1 2 3 4 5 5 6 7 7 8 9 9 • 1 0 1 0 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1 | 1975 25 2592 6672 2546 1328 873 1013 711 198 343 16300 30800 98 Catch number 1985 6 2288 5122 3051 1459 1230 610 187 105 225 14283 | 1976 36 2826 8274 2782 1806 1122 662 518 586 1365 19979 41747 97 ers at age 1986 232 773 7101 8441 3787 1399 1056 470 186 347 | 160 1257 4680 2734 1687 743 562 386 290 922 13421 27210 96 1987 1987 1987 1987 1987 1987 1988 1359 779 454 261 210 15850 | 1978 38 4452 4278 2362 1306 701 293 244 163 1326 15163 31370 97 Numb. 1988 21 3591 5702 3518 2627 1051 892 698 330 329 18759 | 1979 10 1000 1836 1205 1181 724 372 157 191 757 7433 21604 99 ers*10**-3 1989 22 759 7291 5703 2255 1400 376 258 157 184 18406 | 46 1023 3351 954 685 638 471 194 91 817 8270 22102 100 1990 58 1485 5595 3729 1194 786 525 245 132 157 | 154 2490 3932 1981 588 410 341 223 154 673 10947 23574 98 1991 153 1243 3594 2946 1175 607 424 235 96 223 10697 | 43 1403 4633 1687 1250 574 388 247 136 461 10824 23884 99 1992 28 861 1773 3093 968 354 107 61 54 93 7392 | 35 3519 4761 2574 834 764 509 158 105 506 13765 28890 102 1993 15 2611 2668 2827 1185 270 112 566 43 83 9768 | 157 3026 5590 2407 880 685 302 140 57 160 13404 21641 99 1994 3 2408 2029 1080 492 280 109 65 50 110 6627 |

TABLE 2. The VPA suite catch weights-at-age output table for the Blackfin example data set.

Run title : Blackfin: VPA course. Combined sex; plusgroup.

At 1/02/2002 8:47

| AGE | | |
|----------|--------|--------|
| 1 | 0 | 0 |
| 2 | 0.92 | 0.8 |
| 3 | 1.3 | 1.45 |
| 4 | 1.769 | 2.01 |
| 5 | 2.35 | 2.76 |
| 6 | 3.21 | 3.76 |
| 7 | 4.17 | 4.27 |
| 8 | 3.759 | 5.06 |
| 9 | 5.309 | 6.26 |
| +gp | 7.542 | 7.297 |
| SOPCOFAC | 1.0558 | 1.0476 |

| YEAR 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 AGE 1 0 0 0 0.48 0 0 0 0.506 0.31 0.309 2 0.74 0.65 1.07 0.63 0.78 0.66 0.65 0.749 0.62 0.599 3 1.16 1.09 1.19 1.19 1.04 1.080 1.79 2.474 2.47 1.716 5 2.47 2.74 2.24 2.19 2.28 1.80 1.79 2.474 2.521 3.522 7 4.48 4.62 3.761 4.05 3.511 3.67 3.51 2.906 3.605 4.595 9 6.701 6.549 5.951 5.28 6.778 7.158 7.344 8.088 8.105 8.276 SOPCOFAC 0.9839 0.9952 1.023 0.3861 0.951 0.415 0.399 < | Table 2 | Catch weigh | | | 4000 | 4000 | 4070 | 4074 | 4070 | 4070 | 4074 |
|--|------------|-------------|----------------|--------|---------|---------|--------|--------|--------|--------|--------|
| 1 0 0 0.448 0 0 0 0.568 0.311 0.399 2 0.74 0.65 1.07 0.63 0.78 0.66 0.655 0.744 0.62 0.589 3 1.16 1.09 1.19 1.19 1.04 1.08 0.955 1.082 1.089 0.973 4 1.68 1.74 1.781 1.716 1.778 1.771 2.474 2.487 1.716 1.778 2.511 3.025 3.522 7 4.44 4.62 3.761 4.05 3.511 3.67 3.51 2.904 2.74 4.889 4.736 4.985 9 6.791 6.549 5.515 5.28 6.737 6.259 5.28 6.014 6.641 6.612 2.976 SOPCOFAC 0.9899 0.952 1.023 0.9871 0.9871 0.9842 1.0037 0.9289 0.9715 Table 2 Catch weights at age (kg) 1.977 | TEAR | 1900 | 1900 | 1907 | 1900 | 1909 | 1970 | 1971 | 19/2 | 1973 | 1974 |
| 1 0 0 0 0.48 0 0 0 0.568 0.531 0.392 2 0.74 0.65 1.07 0.63 0.78 0.6 0.65 0.744 0.62 0.589 3 1.16 1.09 1.19 1.19 1.04 1.08 0.95 1.082 1.089 0.973 4 1.68 1.74 1.581 1.66 1.43 1.419 1.26 1.778 1.778 1.742 2.477 1.448 4.62 3.761 4.05 3.511 3.67 3.61 2.989 2.95 2.949 2.74 4.889 4.736 4.985 9 6.791 6.549 5.561 5.22 5.73 6.259 5.28 6.014 6.681 6.012 +gp 7.504 8.069 7.233 7.366 7.578 7.158 7.344 8.088 8.105 8.276 SOPCOFAC 0.9899 0.9952 1.022 0.9871 0. | ACE | | | | | | | | | | |
| 2 0.74 0.65 1.07 0.63 0.78 0.66 0.66 0.748 0.62 0.589 3 1.16 1.09 1.19 1.14 1.41 1.26 1.708 1.369 0.973 4 1.68 1.74 1.51 1.68 1.43 1.419 1.26 1.708 1.374 1.607 5 2.47 2.74 2.247 2.74 2.247 2.747 2.247 1.716 6 3.85 3.299 2.999 2.95 2.949 2.74 2.521 3.025 3.522 7 4.48 4.62 3.761 4.05 3.511 3.67 3.673 6.259 5.28 6.014 6.681 6.012 +gp 7.504 8.069 7.233 7.386 7.578 7.158 7.344 8.088 8.105 8.276 SOPCOFAC 0.9839 0.9952 1.0223 0.9841 0.9871 0.9842 1.0037 0.3289 0.47 | | n | 0 | 0 | 0.48 | ń | ٥ | ń | 0 508 | 0.31 | 0 309 |
| 3 1.16 1.09 1.19 1.19 1.04 1.08 0.973 1.089 0.973 4 1.68 1.74 1.581 1.68 1.43 1.419 1.26 1.708 1.374 1.607 5 2.47 2.74 2.24 2.19 2.28 1.98 1.71 2.474 2.467 1.716 6 3.85 3.223 3.53 2.969 2.95 2.949 2.74 2.521 3.025 3.5522 7 4.48 4.62 3.761 4.055 3.511 3.67 3.572 5.28 6.73 6.259 5.28 6.014 6.681 6.012 9 6.761 6.549 5.951 5.28 5.73 6.259 5.28 6.014 6.686 6.012 SOPCOFAC 0.9639 0.952 1.0223 0.9841 0.9873 0.9871 0.9842 1.0037 0.9289 0.9715 Table 2 Catch weights at age (kg) 1.977 1978 1979 1980 1981 1982 1.63 1.941 0.726< | | | | | | | | | | | |
| 4 1.68 1.74 1.581 1.68 1.43 1.419 1.79 2.474 2.467 1.716 5 2.47 2.74 2.24 2.19 2.28 1.98 1.79 2.474 2.467 1.716 6 3.85 3.229 3.53 2.999 2.95 2.949 2.74 2.521 3.025 3.552 4.75 4.889 4.736 4.985 4.736 4.985 4.736 4.985 4.736 4.985 4.736 4.985 4.736 4.985 5.28 6.014 6.681 6.012 5.97 5.28 6.014 6.681 6.012 5.97 | | | | | | | | | | | |
| 5 2.47 2.74 2.24 2.19 2.28 1.96 1.79 2.474 2.247 1.716 6 3.85 3.229 3.53 2.989 2.95 2.949 2.74 2.521 3.025 3.522 7 4.48 4.62 3.761 4.05 3.511 3.67 3.51 2.908 3.605 4.519 8 5.431 5.51 5.28 6.73 6.259 5.28 6.014 6.681 6.012 +gp 7.504 8.069 7.233 7.386 7.578 7.158 7.344 8.088 8.105 8.276 SOPCOFAC 0.9839 0.9952 1.0223 0.9841 0.9873 0.9871 0.9842 1.0037 0.9289 0.9715 Table 2 Catch weights at age (kg) YEAR 1975 1976 1977 1978 1979 1980 1981 1962 1963 1964 A 0.451 0.9871 0.9842 1.0039 0.432 0.38 0.471 1.076 1.0415 0.399< | | | | | | | | | | | |
| 6 3.85 3.229 3.53 2.989 2.949 2.74 2.521 3.025 3.522 7 4.48 4.62 3.761 4.05 3.511 3.67 3.51 2.908 3.605 4.519 9 6.791 6.549 5.951 5.28 6.73 6.259 5.28 6.014 6.681 6.012 rgp 7.504 7.158 7.158 7.158 7.158 7.158 7.158 7.158 7.158 7.158 7.346 8.088 8.015 8.276 SOPCOFAC 0.9839 0.9952 1.0223 0.9841 0.9873 0.9871 0.9842 1.0037 0.9289 0.9715 Table 2 Catch weights at age (kg) YEAR 1975 1976 1977 1978 1979 1980 1981 1962 1.983 1984 AGE 1 0.463 0.444 0.459 0.481 0.51 0.415 0.399 0.432 0.38 0.471 2 0.736 0.666 0.659 0.502 0.697 0.655 0.67 | | | | | | | | | | | |
| 7 4.48 4.62 3.761 4.05 3.511 3.67 3.51 2.908 3.605 4.579 9 6.731 6.549 5.28 6.73 6.259 5.28 6.014 6.661 6.012 *gp 7.504 8.069 7.233 7.386 7.578 7.158 7.344 8.088 8.105 8.276 SOPCOFAC 0.9839 0.9952 1.0223 0.9841 0.9873 0.9842 1.0037 0.9289 0.9715 Table 2 Catch weights at age (kg) ************************************ | | | | | | | | | | | |
| 8 5.431 5.81 5.26 4.47 4.931 4.879 4.701 4.889 4.736 4.985 *gp 6.791 6.549 5.951 5.28 5.73 6.259 5.28 6.014 6.681 6.012 SOPCOFAC 0.9839 0.9952 1.0223 0.9841 0.9873 0.9871 0.9842 1.0037 0.9289 0.9715 Table 2 Catch weights at age (kg) YEAR 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 AGE | | | | | | | | | | | |
| 9 6.791 6.549 5.951 5.28 5.73 6.259 5.28 6.014 6.681 6.012 *gp 7.504 8.069 7.233 7.386 7.578 7.158 7.344 8.088 8.105 8.276 SOPCOFAC 0.9839 0.9852 1.0223 0.9841 0.9873 0.9871 0.9842 1.0037 0.9289 0.9715 Table 2 Catch weights at age (kg) 7 1976 1977 1978 1979 1980 1981 1982 1983 1984 AGE 1 0.463 0.444 0.459 0.687 0.415 0.399 0.432 0.38 0.471 2 0.736 0.868 0.659 0.602 0.697 0.415 0.399 0.432 0.38 0.471 3 0.928 1.019 0.844 1.129 1.318 1.165 1.107 1.251 1.108 4 1.491 1.458 1.396 1.697 1.974 | | | | | | | | | | | |
| +gp 7.504 8.069 7.233 7.386 7.578 7.158 7.344 8.088 8.105 8.276 SOPCOFAC 0.9839 0.9952 1.0223 0.9841 0.9873 0.9871 0.9842 1.0037 0.9289 0.9715 Table 2 Catch weights at age (kg) YEAR 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 AGE 1 0.463 0.444 0.459 0.481 0.51 0.415 0.399 0.432 0.38 0.471 2 0.736 0.666 0.659 0.502 0.697 0.65 0.677 0.714 0.674 0.726 3 0.928 1.019 0.844 1.129 1.318 1.165 1.107 1.251 1.108 4 1.491 1.458 1.394 4.555 5.182 5.29 5.04 4.743 5.587 5.038 5.132 5.48 5.784 5.535 | | | | | | | | | | | |
| SOPCOFAC 0.9839 0.9952 1.0223 0.9841 0.9873 0.9871 0.9842 1.0037 0.9289 0.9715 Table 2 Catch weights at age (kg) YEAR 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 AGE 1 0.463 0.444 0.459 0.481 0.51 0.415 0.399 0.432 0.38 0.471 2 0.736 0.666 0.659 0.502 0.697 0.65 0.677 0.714 0.674 0.726 3 0.928 1.019 0.844 1.129 1.318 1.165 1.005 1.07 1.251 1.108 4 1.491 1.458 1.396 1.697 1.974 1.928 1.717 1.768 1.841 1.791 5 2.573 2.786 2.252 2.639 2.391 2.645 2.997 2.722 3.089 3.527 7 4.774 4.264 4.33 | | | | | | | | | | | |
| Table 2 YEAR Catch weights at age (kg) 1975 1976 1977 1978 1979 1980 1981 1962 1963 1984 AGE 1 0.463 0.444 0.459 0.481 0.51 0.415 0.399 0.432 0.38 0.4711 2 0.736 0.686 0.659 0.502 0.697 0.65 0.677 0.714 0.674 0.726 3 0.928 1.019 0.844 1.129 1.318 1.165 1.105 1.07 1.251 1.108 4 1.491 1.458 1.396 1.697 1.974 1.928 1.717 1.768 1.841 1.791 5 2.573 2.786 2.252 2.639 2.391 2.645 2.997 2.722 3.089 2.671 6 3.433 3.595 5.946 6.137 6.955 5.182 5.29 5.04 4.743 8 5.587 5.038 5.132 5.48 5.745 5.33 | | | | | | | | | | | |
| YEAR 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 AGE 1 0.463 0.444 0.459 0.481 0.51 0.415 0.399 0.432 0.38 0.471 2 0.736 0.686 0.659 0.697 0.65 0.677 0.714 0.674 0.726 3 0.928 1.019 0.844 1.129 1.318 1.165 1.105 1.07 1.251 1.108 4 1.491 1.458 1.396 1.697 1.974 1.928 1.717 1.768 1.841 1.791 5 2.573 2.786 2.252 2.639 2.391 2.645 2.997 2.722 3.089 2.671 6 3.483 3.296 3.259 3.891 3.341 3.552 4.095 3.874 3.656 3.522 7 4.774 4.284 4.339 4.816 4.583 4.553 6.3 | 001 001110 | 0,0000 | 0.0002 | TICLEO | 0,00,11 | 0.007.0 | | 0.00 | | | |
| YEAR 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 AGE 1 0.463 0.444 0.459 0.481 0.51 0.415 0.399 0.432 0.38 0.471 2 0.736 0.686 0.659 0.697 0.65 0.677 0.714 0.674 0.726 3 0.928 1.019 0.844 1.129 1.318 1.165 1.105 1.07 1.251 1.108 4 1.491 1.458 1.396 1.697 1.974 1.928 1.717 1.768 1.841 1.791 5 2.573 2.786 2.252 2.639 2.391 2.645 2.997 2.722 3.089 2.671 6 3.483 3.296 3.259 3.891 3.341 3.552 4.095 3.874 3.656 3.522 7 4.774 4.284 4.339 4.816 4.583 4.553 6.3 | | | | | | | | | | | |
| AGE 1 0.463 0.444 0.459 0.481 0.51 0.415 0.399 0.432 0.38 0.471 2 0.736 0.686 0.659 0.502 0.697 0.65 0.677 0.714 0.674 0.726 3 0.928 1.019 0.844 1.129 1.318 1.165 1.105 1.07 1.251 1.108 4 1.491 1.458 1.396 1.697 1.974 1.928 1.717 1.768 1.841 1.791 5 2.573 2.766 2.252 2.639 2.391 2.645 2.997 2.722 3.089 2.671 6 3.483 3.298 3.259 3.891 3.341 3.552 4.095 3.874 3.656 3.522 7 4.774 4.264 4.339 4.816 4.583 4.555 5.182 5.29 5.04 4.743 8 5.587 5.038 5.132 5.48 5.784 5.533 6.362 6.143 6.315 5.837 9 6.533 5.905 5.946 6.137 6.951 6.552 7.353 7.752 6.985 7.672 +gp 8.554 7.915 7.907 8.572 9.326 9.652 9.944 10.679 10.867 10.877 SOPCOFAC 0.981 0.9737 0.9607 0.9688 0.9936 0.9955 0.9643 0.9895 1.023 0.9853 Table 2 Catch weights at age (kg) YEAR 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 AGE 1 0.403 0.671 0.453 0.56 0.5 0.55 0.564 0.524 0.615 0.632 2 0.702 0.736 0.608 0.7 0.74 0.747 0.865 0.791 0.8652 0.939 3 1.047 0.866 0.955 1.034 0.929 0.881 0.969 1.123 1.102 1.168 4 1.67 1.333 1.184 1.344 1.159 1.229 1.235 1.34 1.434 1.612 5 2.61 2.199 1.985 1.706 1.5977 2.618 2.366 2.717 2.283 2.998 7 4.301 4.112 4.421 4.414 4.387 3.771 3.249 4.164 3.888 4.377 8 5.979 5.148 5.65 5.545 5.665 5.696 4.64 5.043 4.937 5.381 9 7.352 6.368 7.236 7.176 6.946 6.952 6.596 6.717 3.249 4.164 3.888 4.377 8 5.979 5.148 5.65 5.545 5.545 5.666 5.696 4.64 5.043 4.937 5.381 9 7.352 6.368 7.236 7.176 6.946 6.952 6.536 6.599 6.372 6.397 + gp 11.052 9.469 10.973 9.959 8.75 8.864 8.705 9.744 8.547 8.861 | Table 2 | Catch weigh | its at age (kj | g) | | | | | | | |
| 1 0.463 0.444 0.459 0.481 0.51 0.415 0.399 0.432 0.38 0.471 2 0.736 0.666 0.659 0.502 0.697 0.65 0.677 0.714 0.674 0.726 3 0.928 1.019 0.844 1.129 1.318 1.165 1.105 1.07 1.251 1.108 4 1.491 1.458 1.396 1.697 1.974 1.928 1.717 1.768 1.841 1.791 5 2.573 2.786 2.252 2.639 2.391 2.645 2.997 2.722 3.089 2.671 6 3.483 3.298 3.259 3.891 3.341 3.552 4.095 3.874 3.656 3.522 7 4.774 4.264 4.339 4.816 4.583 4.553 6.622 7.353 7.752 6.985 7.672 9 6.533 5.905 5.946 6.137 6.951 6.525 7.353 7.752 6.985 7.672 9.9 8.554 | YEAR | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
| 1 0.463 0.444 0.459 0.481 0.51 0.415 0.399 0.432 0.38 0.471 2 0.736 0.666 0.659 0.502 0.697 0.65 0.677 0.714 0.674 0.726 3 0.928 1.019 0.844 1.129 1.318 1.165 1.105 1.07 1.251 1.108 4 1.491 1.458 1.396 1.697 1.974 1.928 1.717 1.768 1.841 1.791 5 2.573 2.786 2.252 2.639 2.391 2.645 2.997 2.722 3.089 2.671 6 3.483 3.298 3.259 3.891 3.341 3.552 4.095 3.874 3.656 3.522 7 4.774 4.264 4.339 4.816 4.583 4.553 6.622 7.353 7.752 6.985 7.672 9 6.533 5.905 5.946 6.137 6.951 6.525 7.353 7.752 6.985 7.672 9.9 8.554 | | | | | | | | | | | |
| 2 0.736 0.686 0.659 0.502 0.697 0.65 0.677 0.714 0.674 0.726 3 0.928 1.019 0.844 1.129 1.318 1.165 1.105 1.07 1.251 1.108 4 1.491 1.458 1.396 1.697 1.974 1.928 1.717 1.768 1.841 1.791 5 2.573 2.786 2.252 2.639 2.911 2.645 2.997 2.722 3.089 2.671 6 3.483 3.298 3.259 3.891 3.341 3.552 4.095 3.874 3.656 3.522 7 4.774 4.264 4.339 4.816 4.583 4.555 5.182 5.29 5.04 4.743 8 5.587 5.038 5.946 6.137 6.951 6.525 7.353 7.752 6.985 7.672 +gp 8.554 7.915 7.907 8.572 9.326 9.652 9.944 10.679 10.867 10.23 0.9853 YEAR 1985< | | | | | | | | | | | |
| 3 0.928 1.019 0.844 1.129 1.318 1.165 1.105 1.07 1.251 1.108 4 1.491 1.458 1.396 1.697 1.974 1.928 1.717 1.768 1.841 1.791 5 2.573 2.786 2.252 2.639 2.391 2.645 2.997 2.722 3.089 2.671 6 3.483 3.298 3.259 3.891 3.341 3.552 4.995 3.874 3.656 3.522 7 4.774 4.264 4.339 4.816 4.583 4.555 5.182 5.29 5.04 4.743 8 5.587 5.038 5.132 5.48 5.784 5.533 6.362 6.143 6.315 5.837 9 6.533 5.905 5.946 6.137 6.951 6.525 7.353 7.752 6.985 7.672 9 8.554 7.915 7.907 8.572 9.944 10.679 10.867 10.877 SOPCOFAC 0.981 1.987 1988 1989 | | | | | | | | | | | |
| 4 1.491 1.458 1.396 1.697 1.974 1.928 1.717 1.768 1.841 1.791 5 2.573 2.786 2.252 2.639 2.391 2.645 2.997 2.722 3.089 2.671 6 3.483 3.298 3.259 3.891 3.341 3.552 4.095 3.874 3.656 3.522 7 4.774 4.264 4.339 4.816 4.583 4.555 5.182 5.29 5.04 4.743 8 5.587 5.038 5.132 5.48 5.533 6.362 6.143 6.315 5.837 9 6.533 5.905 5.946 6.137 6.951 6.525 7.353 7.752 6.965 7.672 +gp 8.554 7.915 7.907 8.572 9.326 9.955 0.9843 0.9895 1.023 0.9853 SOPCOFAC 0.981 0.9737 0.9607 0.9688 0.9955 0.9843 0.9895 1.023 0.9853 4GE 1 0.403 0.671 | | 0.736 | | 0.659 | | 0.697 | | 0.677 | | | |
| 5 2.573 2.786 2.252 2.639 2.391 2.645 2.997 2.722 3.089 2.671 6 3.483 3.298 3.259 3.891 3.341 3.552 4.095 3.874 3.656 3.522 7 4.774 4.264 4.339 4.816 4.583 4.555 5.182 5.29 5.04 4.743 8 5.587 5.038 5.132 5.48 5.784 5.533 6.362 6.143 6.315 5.837 9 6.533 5.905 5.946 6.137 6.951 6.525 7.953 7.752 6.985 7.672 +gp 8.554 7.915 7.907 8.572 9.326 9.955 0.9843 0.9895 10.867 10.877 SOPCOFAC 0.981 0.9737 0.9607 0.9688 0.9936 0.9955 0.9843 0.9895 1.023 0.9853 YEAR 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 AGE | | | 1.019 | | | | | | | | |
| 6 3.483 3.298 3.259 3.891 3.341 3.552 4.095 3.874 3.656 3.522 7 4.774 4.264 4.339 4.816 4.583 4.555 5.182 5.29 5.04 4.743 8 5.587 5.038 5.132 5.48 5.784 5.533 6.362 6.143 6.315 5.837 9 6.533 5.905 5.946 6.137 6.951 6.525 7.353 7.752 6.985 7.672 9 8.554 7.915 7.907 8.572 9.326 9.652 9.944 10.679 10.867 10.877 SOPCOFAC 0.981 0.9737 0.9607 0.9688 0.9955 0.9843 0.9895 1.023 0.9853 YEAR 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 AGE | | | | | | | | | | | |
| 7 4.774 4.264 4.339 4.816 4.583 4.555 5.182 5.29 5.04 4.743 8 5.587 5.038 5.132 5.48 5.784 5.533 6.362 6.143 6.315 5.837 9 6.533 5.905 5.946 6.137 6.951 6.525 7.353 7.752 6.985 7.672 +gp 8.554 7.915 7.907 8.572 9.326 9.652 9.944 10.679 10.867 10.877 SOPCOFAC 0.981 0.9737 0.9607 0.9688 0.9936 0.9955 0.9843 0.9895 1.023 0.9853 Table 2 Catch weights at age (kg) YEAR 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 AGE 1 0.403 0.671 0.453 0.56 0.55 0.564 0.524 0.615 0.632 2 0.702 0.736 0.608 0.7 0.74 0.747 0.865 0.791 0.852 | | | | | | | | | | | |
| 8 5.587 5.038 5.132 5.48 5.784 5.533 6.362 6.143 6.315 5.837 9 6.533 5.905 5.946 6.137 6.951 6.525 7.353 7.752 6.985 7.672 +gp 8.554 7.915 7.907 8.572 9.326 9.652 9.944 10.679 10.867 10.877 SOPCOFAC 0.981 0.9737 0.9607 0.9688 0.9936 0.9955 0.9843 0.9895 1.023 0.9853 YEAR 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 AGE | | | | | | | | | | | |
| 9 6.533 5.905 5.946 6.137 6.951 6.525 7.353 7.752 6.985 7.672 +gp 8.554 7.915 7.907 8.572 9.326 9.652 9.944 10.679 10.867 10.877 SOPCOFAC 0.981 0.9737 0.9607 0.9688 0.9936 0.9955 0.9843 0.9895 1.023 0.9853 Table 2 Catch weights at age (kg) 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 AGE | | | | | | | | | | | |
| +gp 8.554 7.915 7.907 8.572 9.326 9.652 9.944 10.679 10.867 10.877 SOPCOFAC 0.981 0.9737 0.9607 0.9688 0.9936 0.9955 0.9843 0.9895 1.023 0.9853 Table 2 Catch weights at age (kg) 1986 1987 1988 1989 1990 1991 1992 1993 1994 AGE 1 0.403 0.671 0.453 0.566 0.5 0.555 0.564 0.524 0.615 0.632 2 0.702 0.736 0.6608 0.7 0.74 0.747 0.865 0.791 0.852 0.939 3 1.047 0.866 0.955 1.034 0.929 0.891 0.969 1.123 1.102 1.168 4 1.67 1.333 1.184 1.344 1.159 1.229 1.235 1.34 1.434 1.612 5 2.61 2.199 1.985 1.706 1.597 1.849 1.797 2.04 1.974 2.322 <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<> | | | | | | | | | | | |
| SOPCOFAC 0.981 0.9737 0.9607 0.9688 0.9936 0.9955 0.9843 0.9895 1.023 0.9853 Table 2 Catch weights at age (kg) YEAR 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 AGE 1 0.403 0.671 0.453 0.56 0.5 0.55 0.564 0.524 0.615 0.632 2 0.702 0.736 0.608 0.7 0.74 0.747 0.865 0.791 0.852 0.939 3 1.047 0.8666 0.955 1.034 0.929 0.891 0.969 1.123 1.102 1.168 4 1.67 1.333 1.184 1.344 1.159 1.229 1.235 1.34 1.434 1.612 5 2.61 2.199 1.985 1.706 1.597 1.849 1.797 2.04 1.974 2.322 6 3.23 3.14 3.054 | | | | | | | | | | | |
| Table 2 Catch weights at age (kg) YEAR 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 AGE 1 0.403 0.671 0.453 0.56 0.5 0.55 0.564 0.524 0.615 0.632 2 0.702 0.736 0.608 0.7 0.74 0.747 0.865 0.791 0.852 0.939 3 1.047 0.866 0.955 1.034 0.929 0.891 0.969 1.123 1.102 1.168 4 1.67 1.333 1.184 1.344 1.159 1.229 1.235 1.34 1.434 1.612 5 2.61 2.199 1.985 1.706 1.597 1.849 1.797 2.04 1.974 2.322 6 3.23 3.14 3.054 3.21 2.577 2.618 2.366 2.717 2.893 2.998 7 4.301 4.112 4.421 4.414 <td></td> | | | | | | | | | | | |
| YEAR 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 AGE 1 0.403 0.671 0.453 0.56 0.5 0.55 0.564 0.524 0.615 0.632 2 0.702 0.736 0.608 0.7 0.744 0.747 0.865 0.791 0.852 0.939 3 1.047 0.866 0.955 1.034 0.929 0.891 0.969 1.123 1.102 1.168 4 1.67 1.333 1.184 1.344 1.159 1.229 1.235 1.34 1.434 1.612 5 2.61 2.199 1.985 1.706 1.597 1.849 1.797 2.04 1.974 2.322 6 3.23 3.14 3.054 3.21 2.577 2.618 2.366 2.717 2.893 2.998 7 4.301 4.112 4.421 4.414 4.387 3.771 | SOPCOFAC | 0.981 | 0.9737 | 0.9607 | 0.9688 | 0.9936 | 0.9955 | 0.9843 | 0.9895 | 1.023 | 0.9853 |
| YEAR 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 AGE 1 0.403 0.671 0.453 0.56 0.5 0.55 0.564 0.524 0.615 0.632 2 0.702 0.736 0.608 0.7 0.744 0.747 0.865 0.791 0.852 0.939 3 1.047 0.866 0.955 1.034 0.929 0.891 0.969 1.123 1.102 1.168 4 1.67 1.333 1.184 1.344 1.159 1.229 1.235 1.34 1.434 1.612 5 2.61 2.199 1.985 1.706 1.597 1.849 1.797 2.04 1.974 2.322 6 3.23 3.14 3.054 3.21 2.577 2.618 2.366 2.717 2.893 2.998 7 4.301 4.112 4.421 4.414 4.387 3.771 | | | | | | | | | | | |
| YEAR 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 AGE 1 0.403 0.671 0.453 0.56 0.5 0.55 0.564 0.524 0.615 0.632 2 0.702 0.736 0.608 0.7 0.744 0.747 0.865 0.791 0.852 0.939 3 1.047 0.866 0.955 1.034 0.929 0.891 0.969 1.123 1.102 1.168 4 1.67 1.333 1.184 1.344 1.159 1.229 1.235 1.34 1.434 1.612 5 2.61 2.199 1.985 1.706 1.597 1.849 1.797 2.04 1.974 2.322 6 3.23 3.14 3.054 3.21 2.577 2.618 2.366 2.717 2.893 2.998 7 4.301 4.112 4.421 4.414 4.387 3.771 | Table 2 | Cotob woich | to ot ogo (k | -) | | | | | | | |
| AGE 1 0.403 0.671 0.453 0.56 0.5 0.55 0.564 0.524 0.615 0.632 2 0.702 0.736 0.608 0.7 0.74 0.747 0.865 0.791 0.852 0.939 3 1.047 0.866 0.955 1.034 0.929 0.891 0.969 1.123 1.102 1.168 4 1.67 1.333 1.184 1.344 1.159 1.229 1.235 1.34 1.434 1.612 5 2.61 2.199 1.985 1.706 1.597 1.849 1.797 2.04 1.974 2.322 6 3.23 3.14 3.054 3.21 2.577 2.618 2.366 2.717 2.893 2.998 7 4.301 4.112 4.421 4.414 4.387 3.771 3.249 4.164 3.888 4.377 8 5.979 5.148 5.65 5.545 5.665 5.696 4.64 5.043 4.937 5.381 9 7.352 6.368 7.236 7.176 6.946 6.952 6.536 6.509 6.372 6.397 +gp 11.052 9.469 10.973 9.959 8.75 8.864 8.705 9.744 8.547 8.861 | | | ~ | | 1088 | 1080 | 1000 | 1001 | 1002 | 1003 | 100/ |
| 1 0.403 0.671 0.453 0.56 0.5 0.55 0.564 0.524 0.615 0.632 2 0.702 0.736 0.608 0.7 0.74 0.747 0.865 0.791 0.852 0.939 3 1.047 0.866 0.955 1.034 0.929 0.891 0.969 1.123 1.102 1.168 4 1.67 1.333 1.184 1.344 1.159 1.229 1.235 1.34 1.434 1.612 5 2.61 2.199 1.985 1.706 1.597 1.849 1.797 2.04 1.974 2.322 6 3.23 3.14 3.054 3.21 2.577 2.618 2.366 2.717 2.893 2.998 7 4.301 4.112 4.421 4.4387 3.771 3.249 4.164 3.888 4.377 8 5.979 5.148 5.65 5.545 5.665 5.696 4.64 5.043 | | 1905 | 1900 | 1901 | 1900 | 1909 | 1930 | 1331 | 1332 | 1330 | 1004 |
| 1 0.403 0.671 0.453 0.56 0.5 0.55 0.564 0.524 0.615 0.632 2 0.702 0.736 0.608 0.7 0.74 0.747 0.865 0.791 0.852 0.939 3 1.047 0.866 0.955 1.034 0.929 0.891 0.969 1.123 1.102 1.168 4 1.67 1.333 1.184 1.344 1.159 1.229 1.235 1.34 1.434 1.612 5 2.61 2.199 1.985 1.706 1.597 1.849 1.797 2.04 1.974 2.322 6 3.23 3.14 3.054 3.21 2.577 2.618 2.366 2.717 2.893 2.998 7 4.301 4.112 4.421 4.4387 3.771 3.249 4.164 3.888 4.377 8 5.979 5.148 5.65 5.545 5.665 5.696 4.64 5.043 | AGE | | | | | | | | | | |
| 2 0.702 0.736 0.608 0.7 0.74 0.747 0.865 0.791 0.852 0.939 3 1.047 0.866 0.955 1.034 0.929 0.891 0.969 1.123 1.102 1.168 4 1.67 1.333 1.184 1.344 1.159 1.229 1.235 1.34 1.434 1.612 5 2.61 2.199 1.985 1.706 1.597 1.849 1.797 2.04 1.974 2.322 6 3.23 3.14 3.054 3.21 2.577 2.618 2.366 2.717 2.893 2.998 7 4.301 4.112 4.421 4.414 4.387 3.771 3.249 4.164 3.888 4.377 8 5.979 5.148 5.65 5.545 5.665 5.696 4.64 5.043 4.937 5.381 9 7.352 6.368 7.236 7.176 6.946 6.952 6. | | 0.403 | 0.671 | 0.453 | 0.56 | 0.5 | 0.55 | 0.564 | 0.524 | 0.615 | 0.632 |
| 3 1.047 0.866 0.955 1.034 0.929 0.891 0.969 1.123 1.102 1.168 4 1.67 1.333 1.184 1.344 1.159 1.229 1.235 1.34 1.434 1.612 5 2.61 2.199 1.985 1.706 1.597 1.849 1.797 2.04 1.974 2.322 6 3.23 3.14 3.054 3.21 2.577 2.618 2.366 2.717 2.893 2.998 7 4.301 4.112 4.421 4.414 4.387 3.771 3.249 4.164 3.888 4.377 8 5.979 5.148 5.65 5.545 5.665 5.696 4.64 5.043 4.937 5.381 9 7.352 6.368 7.236 7.176 6.946 6.952 6.536 6.509 6.372 6.372 +gp 11.052 9.469 10.973 9.959 8.75 8.864 | | | | | | | | | | | |
| 4 1.67 1.333 1.184 1.344 1.159 1.229 1.235 1.34 1.434 1.612 5 2.61 2.199 1.985 1.706 1.597 1.849 1.797 2.04 1.974 2.322 6 3.23 3.14 3.054 3.21 2.577 2.618 2.366 2.717 2.893 2.998 7 4.301 4.112 4.421 4.414 4.387 3.771 3.249 4.164 3.888 4.377 8 5.979 5.148 5.65 5.545 5.665 5.696 4.64 5.043 4.937 5.381 9 7.352 6.368 7.236 7.176 6.946 6.952 6.536 6.509 6.372 6.397 +gp 11.052 9.469 10.973 9.959 8.75 8.864 8.705 9.744 8.547 8.861 | | | | | | | | | | | |
| 5 2.61 2.199 1.985 1.706 1.597 1.849 1.797 2.04 1.974 2.322 6 3.23 3.14 3.054 3.21 2.577 2.618 2.366 2.717 2.893 2.998 7 4.301 4.112 4.421 4.414 4.387 3.771 3.249 4.164 3.888 4.377 8 5.979 5.148 5.65 5.545 5.665 5.696 4.64 5.043 4.937 5.381 9 7.352 6.368 7.236 7.176 6.946 6.952 6.536 6.509 6.372 6.397 +gp 11.052 9.469 10.973 9.959 8.75 8.864 8.705 9.744 8.547 8.861 | | | | | | | | | 1.34 | 1.434 | 1.612 |
| 6 3.23 3.14 3.054 3.21 2.577 2.618 2.366 2.717 2.893 2.998 7 4.301 4.112 4.421 4.414 4.387 3.771 3.249 4.164 3.888 4.377 8 5.979 5.148 5.65 5.545 5.665 5.696 4.64 5.043 4.937 5.381 9 7.352 6.368 7.236 7.176 6.946 6.952 6.536 6.509 6.372 6.397 +gp 11.052 9.469 10.973 9.959 8.75 8.864 8.705 9.744 8.547 8.861 | | | | | | | | | | | |
| 7 4.301 4.112 4.421 4.414 4.387 3.771 3.249 4.164 3.888 4.377 8 5.979 5.148 5.65 5.545 5.665 5.696 4.64 5.043 4.937 5.381 9 7.352 6.368 7.236 7.176 6.946 6.952 6.536 6.509 6.372 6.397 +gp 11.052 9.469 10.973 9.959 8.75 8.864 8.705 9.744 8.547 8.861 | | | | | | | | | | | |
| 9 7.352 6.368 7.236 7.176 6.946 6.952 6.536 6.509 6.372 6.397 +gp 11.052 9.469 10.973 9.959 8.75 8.864 8.705 9.744 8.547 8.861 | | | | | | | | 3.249 | 4.164 | 3.888 | 4.377 |
| 9 7.352 6.368 7.236 7.176 6.946 6.952 6.536 6.509 6.372 6.397 +gp 11.052 9.469 10.973 9.959 8.75 8.864 8.705 9.744 8.547 8.861 | 8 | | | | | | | 4.64 | 5.043 | 4.937 | 5.381 |
| +gp 11.052 9.469 10.973 9.959 8.75 8.864 8.705 9.744 8.547 8.861 | | | | | | | | | 6.509 | 6.372 | 6.397 |
| | +gp | | | | | | | | 9,744 | 8.547 | 8.861 |
| | SOPCOFAC | 0.9906 | 0.9478 | 1.0614 | 0.9921 | 0.9481 | 0.9613 | 1.0075 | 1.0019 | 0.9995 | 0.995 |

TABLE 3. The VPA suite weights-at-age output table for the Blackfin example data set.

Run title : Blackfin: VPA course. Combined sex; plusgroup.

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| Table 3 YEAR | Stock weights at age (kg) 1963 1964 | | | | | |
|-----------------|--|---------------|------|--|--|--|
| AGE | | | | | | |
| 1 | 0 | 0 | | | | |
| 2 | 0.92 | 0.8 | | | | |
| 3 | 1.3 | 1.45 | | | | |
| 4 | 1.769 | 2.01 | | | | |
| 5 | 2.35 | 2.76 | | | | |
| 6 | 3.21 | 3.76 | | | | |
| 7 | 4.17 | 4.27 | | | | |
| 8 | 3.759 | 5.06 | | | | |
| 9 | 5.309 | 6.26 | | | | |
| +gp | 7.542 | 7.297 | | | | |
| Table 3 | Stock wei | ghts at age (| kg) | | | |
| YEAR | 1965 | 1966 | 1967 | | | |
| AGE | | | | | | |

| Table 3 | Stock we | gnis al age | ; (Kg) | | | | | | | |
|---------|-----------|-------------|--------|-------|-------|-------|-------|--------|--------|----------------|
| YEAR | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
| | | | | | | | | | | |
| AGE | | | | | | | | | | |
| 1 | 0 | 0 | 0 | 0.48 | 0 | 0 | 0 | 0.508 | 0.31 | 0.309 |
| 2 | 0.74 | 0.65 | 1.07 | 0.63 | 0.78 | 0.6 | 0.65 | 0.748 | 0.62 | 0.589 |
| 3 | 1.16 | 1.09 | 1.19 | 1.19 | 1.04 | 1.08 | 0.95 | 1.082 | 1.089 | 0.973 |
| 4 | 1.68 | 1.74 | 1.581 | 1.68 | 1.43 | 1.419 | 1.26 | 1.708 | 1.374 | 1.607 |
| 5 | 2.47 | 2.74 | 2.24 | 2.19 | 2.28 | 1.98 | 1.79 | 2.474 | 2.487 | 1. 716 |
| 6 | 3.85 | 3.229 | 3.53 | 2.989 | 2.95 | 2.949 | 2.74 | 2.521 | 3.025 | 3.522 |
| 7 | 4.48 | 4.62 | 3.761 | 4.05 | 3.511 | 3.67 | 3.51 | 2,908 | 3.605 | 4.519 |
| 8 | 5.431 | 5.81 | 5.26 | 4.47 | 4.931 | 4.879 | 4.701 | 4.889 | 4.736 | 4.985 |
| 9 | 6.791 | 6.549 | 5.951 | 5.28 | 5.73 | 6.259 | 5.28 | 6.014 | 6.681 | 6.012 |
| +gp | 7.504 | 8.069 | 7.233 | 7.386 | 7.578 | 7.158 | 7.344 | 8.088 | 8.105 | 8.276 |
| 36 | | | | | 1.070 | 1.100 | 1.011 | 0.000 | 0.100 | 0.210 |
| | | | | | | | | | | |
| Table 3 | Stock wei | ghts at age | e (ka) | | | | | | | |
| YEAR | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
| | | | | | | | 1001 | TOOL | 1000 | |
| AGE | | | | | | | | | | |
| 1 | 0.463 | 0.444 | 0.459 | 0.481 | 0.51 | 0.415 | 0.399 | 0.432 | 0.38 | 0.471 |
| 2 | 0.736 | 0.686 | 0.659 | 0.502 | 0.697 | 0.65 | 0.677 | 0.714 | 0.674 | 0.726 |
| 3 | 0.928 | 1.019 | 0.844 | 1.129 | 1.318 | 1.165 | 1.105 | 1.07 | 1.251 | 1.108 |
| 4 | 1.491 | 1.458 | 1.396 | 1.697 | 1.974 | 1.928 | 1.717 | 1.768 | 1.841 | 1.791 |
| 5 | 2.573 | 2.786 | 2.252 | 2.639 | 2.391 | 2.645 | 2.997 | 2.722 | 3.089 | 2.671 |
| 6 | 3.483 | 3.298 | 3.259 | 3.891 | 3.341 | 3.552 | 4.095 | 3.874 | 3.656 | 3.522 |
| 7 | 4.774 | 4.264 | 4.339 | 4.816 | 4.583 | 4.555 | 5.182 | 5.29 | 5.04 | 4.743 |
| 8 | 5.587 | 5.038 | 5.132 | 5.48 | 5.784 | 5.533 | 6.362 | 6.143 | 6.315 | 5.837 |
| 9 | 6.533 | 5.905 | 5.946 | 6.137 | 6.951 | 6.525 | 7.353 | 7.752 | 6.985 | 7.672 |
| +gp | 8.554 | 7.915 | 7.907 | 8.572 | 9.326 | 9.652 | 9.944 | 10.679 | 10.867 | 10.877 |
| . Ah | 0.004 | 7,310 | 7.307 | 0.572 | 3.520 | 5.052 | 0.044 | 10.075 | 10.007 | 10.077 |
| | | | | | | | | | | |
| Table 3 | Stock wei | ghts at age | (ka) | | | | | | | |
| YEAR | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
| | | 1000 | 1001 | 1000 | 1000 | 1000 | 1001 | 1002 | 1000 | 1004 |
| AGE | | | | | | | | | | |
| 1 | 0.403 | 0.671 | 0.453 | 0.56 | 0.5 | 0.55 | 0.564 | 0.524 | 0.615 | 0.632 |
| 2 | 0.702 | 0.736 | 0.608 | 0.7 | 0.74 | 0.747 | 0.865 | 0.791 | 0.852 | 0.939 |
| 3 | 1.047 | 0.866 | 0.955 | 1.034 | 0.929 | 0.891 | 0.969 | 1.123 | 1.102 | 1.168 |
| 4 | 1.67 | 1,333 | 1.184 | 1.344 | 1.159 | 1.229 | 1.235 | 1.34 | 1.434 | 1.612 |
| 5 | 2.61 | 2.199 | 1.985 | 1.706 | 1.597 | 1.849 | 1.797 | 2.04 | 1.974 | 2.322 |
| 6 | 3.23 | 3.14 | 3.054 | 3.21 | 2.577 | 2.618 | 2.366 | 2.717 | 2.893 | 2.998 |
| 7 | 4.301 | 4.112 | 4.421 | 4.414 | 4.387 | 3.771 | 3.249 | 4.164 | 3.888 | 4.377 |
| 8 | 5.979 | 5.148 | 5.65 | 5.545 | 5.665 | 5.696 | 4.64 | 5.043 | 4.937 | 4.377 5.381 |
| 9 | 7.352 | 6.368 | 7.236 | 7.176 | 6.946 | 6.952 | 6.536 | 6.509 | 6.372 | 6.397 |
| +gp | 11.052 | 9.469 | 10.973 | 9.959 | 8.75 | 8.864 | 8.705 | 9.744 | 8.547 | 8.861 |
| '9P | 11.002 | 5.409 | 10.973 | 9,909 | 0.70 | 0.004 | 0.700 | 3./44 | 0.047 | 0.001 |

TABLE 4. The VPA suite natural mortality-at-age output table for the Blackfin example data set.

Run title : Blackfin: VPA course. Combined sex; plusgroup.

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| Table 4 YEAR | Natural Mo 1963 | ortality (M) at age 1964 |
|-----------------|--------------------|-----------------------------|
| AGE | | |
| 1 | 0.2 | 0.2 |
| 2 | 0.2 | 0.2 |
| 3 | 0.2 | 0.2 |
| 4 | 0.2 | 0.2 |
| 5 | 0.2 | 0.2 |
| 6 | 0.2 | 0.2 |
| 7 | 0.2 | 0.2 |
| 8 | 0.2 | 0.2 |
| 9 | 0.2 | 0.2 |
| +gp | 0.2 | 0.2 |

| Table 4 | Natural M | ortality (M) a | at age | | | | | | | |
|---------|-----------|----------------|--------|-------------|------|------|------|------|-------------------|------|
| YEAR | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
| | | | | | | | | | | |
| AGE | | | | | | | | | | |
| 1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 4 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 5 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 6 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 7 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 8 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 9 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| +gp | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| | | | | | | | | | | |
| Table 4 | Natural M | ortality (M) a | at ano | | | | | | | |
| YEAR | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1 98 3 | 1984 |
| 12/01 | 1010 | 1010 | 1011 | 10.0 | 1070 | .000 | | TOOL | 1000 | 1001 |
| AGE | | | | | | | | | | |
| 1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 4 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 5 6 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 6 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 7 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 8 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 9 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| +gp | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| | | | | | | | | | | |
| Table 4 | Netural M | ortality (M) a | at ano | | | | | | | |
| YEAR | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
| 1 CAN | 1000 | 1300 | 1307 | 1300 | 1303 | 1000 | 1331 | 1002 | 1000 | 1004 |
| AGE | | | | | | | | | | |
| 1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 4 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 5 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 6 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 7 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 8 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 9 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| +gp | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| . 96 | Ų.4 | Q.2 | 0.2 | U. Z | 0.2 | V.Z | 0.2 | 0.2 | 0.2 | U.2 |

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TABLE 5. The VPA suite maturity-at-age output table for the Blackfin example data set.

Run title : Blackfin: VPA course. Combined sex; plusgroup.

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| Table 5 | Proportion | mature at a | ae | | | |
|---------|------------|---------------------|------------|--------|--------|--------|
| YEAR | 1963 | 1964 | 8- | | | |
| AGE | | | | | | |
| 1 | 0 | 0 | | | | |
| 2 | ŏ | ŏ | | | | |
| 3 | ŏ | ŏ | | | | |
| 4 | ŏ | ŏ | | | | |
| 5 | 1 | 1 | | | | |
| 6 | 1 | i | | | | |
| 7 | 1 | 1 | | | | |
| 8 | 1 | 1 | | | | |
| 9 | 1 | 1 | | | | |
| +gp | 1 | 1 | | | | |
| 3F | | , | | | | |
| Table 5 | Proportion | mature at a | ge | | | |
| YEAR | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 |
| AGE | | | | | | |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 1 | 1 | 1 | 1 | 1 | 1 |
| 6 | 1 | 1 | 1 | 1 | 1 | 1 |
| 7 | 1 | 1 | 1 | 1 | 1 | 1 |
| 8 | 1 | 1 | 1 | 1 | 1 | 1 |
| 9 | 1 | 1 | 1 | 1 | 1 | 1 |
| +gp | 1 | 1 | 1 | 1 | 1 | 1 |
| Table 5 | Dressties | | | | | |
| YEAR | 1975 | mature at a 1976 | ye 1977 | 1978 | 1979 | 1980 |
| ILAN | 1913 | 1970 | 1911 | 1970 | 1979 | 1900 |
| AGE | | | | | | |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 1 | 1 | 1 | 1 | 1 | 1 |
| 6 | 1 | 1 | 1 | 1 | 1 | 1 |
| 7 | 1 | 1 | 1 | 1 | 1 | 1 |
| 8 9 | 1 1 | 1 | 1 | 1 | 1 | 1 |
| _ | 1 | 1 1 | 1 1 | 1 1 | 1 1 | 1 1 |
| +gp | I | I | 1 | I | I | I |

| Table 5 | Proportion | mature at a | age | | | | | | | |
|---------|------------|-------------|------|------|------|------|------|------|------|------|
| YEAR | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
| AGE | | | | | | | | | | |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 6 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 8 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 9 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| +gp | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

TABLE 6. The VPA suite proportion of fishing mortality before spawning output table for the Blackfin example data set.

Run title : Blackfin: VPA course. Combined sex; plusgroup.

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| Table 6 YEAR | Proportion of 1963 | M before Spa 1964 | wning |
|-----------------|-----------------------|----------------------|-------|
| AGE | | | |
| 1 | 0 | 0 | |
| 2 | 0 | 0 | |
| 3 | 0 | 0 | |
| 4 | 0 | 0 | |
| 5 | 0 | 0 | |
| 6 | 0 | 0 | |
| 7 | 0 | 0 | |
| 8 | 0 | Ū | |
| 9 | Ö | 0 | |
| +gp | 0 | 0 | |

| Table 6 | Proportion of | of M before | Spawning | | | | | | | |
|---------|---------------|-------------|---------------------|--------|------|--------|--------|--------|--------|--------|
| YEAR | 1965 | 1966 | ່ 1967 [–] | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
| | | | | | | | | | | |
| AGE | 0 | ^ | • | 0 | 0 | 0 | ~ | ^ | 0 | 0 |
| 1 | 0 0 | 0 | 0 0 | 0 0 | 0 | 0 0 | 0 0 | 0 | 0 0 | 0 0 |
| 2 3 | 0 | 0 | 0 | | 0 | 0 | | | 0 | |
| 3 4 | 0 | 0 | 0 | 0 0 | 0 | 0 | 0 | 0 0 | 0 | 0 0 |
| 4 5 | 0 | 0 | 0 | 0 | o | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ŏ | 0 |
| 7 | 0 | 0 | 0 | 0 | ŏ | 0 0 | 0 | 0 | o | 0 |
| 8 | 0 | Ö | Ö | Ő | ŏ | 0 0 | Ő | ő | ŏ | 0 |
| 9 | õ | Ö | 0 | Ő | Ő | 0 | 0 | õ | ŏ | õ |
| +gp | ŏ | Ö | 0 | ő | Ő | Ö | ő | ŏ | ŏ | ŏ |
| .95 | 0 | 0 | 0 | v | Ū | Ū | 0 | v | v | Ŭ |
| | | | | | | | | | | |
| Table 6 | Proportion of | | | | | | | | | |
| YEAR | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
| | | | | | | | | | | |
| AGE | - | _ | _ | - | _ | _ | _ | _ | | _ |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 0 | 0 | 0 |
| | 0 0 | | 0 0 | 0 | | 0 0 | 0 | | 0 0 | 0 |
| +gp | U | 0 | U | 0 | 0 | U | 0 | 0 | 0 | U |
| | | | | | | | | | | |
| Table 6 | Proportion of | of M before | Spawning | | | | | | | |
| YEAR | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
| | | | | | | | | | | |
| AGE | | | | | | | | | | |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| +gp | 0 | 0 | 0 | 0 | 0 | Û | 0 | 0 | 0 | 0 |

TABLE 7. The VPA suite proportion of natural mortality before spawning output table for the Blackfin example data set.

Run title : Blackfin: VPA course. Combined sex; plusgroup.

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Table 7Proportion of F before Spawning
1963YEAR1963AGE1020

| 3 | 0 | 0 |
|-----|---|---|
| 4 | 0 | 0 |
| 5 | 0 | 0 |
| 6 | Û | 0 |
| 7 | 0 | 0 |
| 8 | 0 | 0 |
| 9 | 0 | 0 |
| +gp | 0 | 0 |

| Table 7 YEAR | Proportion 1965 | of F before 1966 | Spawning 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
|-----------------|--------------------|---------------------|------------------|------|------|-------------------|------|------|------|-------------------|
| AGE | | | | | | | | | | |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | ō | Ō | Ō | ō | Ō | ō | Ō | Ō | Ō | Ō |
| 3 | 0 | Ō | Ō | Ō | ō | ō | Ō | Ō | Ō | Ō |
| 4 | 0 | Ő | Ō | Ō | Ő | Ō | Ō | Ō | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| +gp | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Table 7 | Proportion | of F before | Spawning | | | | | | | |
| YEAR | 1975 | 1976 | 1977 | 1978 | 1979 | 1 9 80 | 1981 | 1982 | 1983 | 1 9 84 |
| AGE | | | | | | | | | | |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | Ó | Ó | Ó | Ó | Ó | Ó | Ó | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| +gp | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Table 7 | Proportion | of F before | Spawning | | | | | | | |
| YEAR | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
| AGE | | | | | | | | | | |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| +gp | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

TABLE 8. The fishing mortality-at-age calculated for the Blackfin stock using Traditional VPA.

Run title : Blackfin: VPA course. Combined sex; plusgroup. At 1/02/2002 8:46

| Table 9 | Fishing m | ortolity (E) o | + | | | | | | | | |
|--|---|--|---|--|---|---|---|---|--|--|--|
| Table 8 YEAR | 1963 | ortality (F) a 1964 | ii age | | | | | | | | |
| AGE | 1903 | 1904 | | | | | | | | | |
| 1 | 0 | 0 | | | | | | | | | |
| 2 | 0.0133 | | | | | | | | | | |
| 23 | | 0.0052 | | | | | | | | | |
| | 0.148 | 0.2523 | | | | | | | | | |
| 4 | 0.2404 | 0.3656 | | | | | | | | | |
| 5 | 0.2208 | 0.4106 | | | | | | | | | |
| 6 | 0.3218 | 0.3742 | | | | | | | | | |
| 7 | 0.1649 | 0.4171 | | | | | | | | | |
| 8 | 0.3774 | 0.1348 | | | | | | | | | |
| 9 | 0.1582 | 0.2053 | | | | | | | | | |
| +gp | 0.1582 | 0.2053 | | | | | | | | | |
| FBAR 3-7 | 0.2192 | 0.364 | | | | | | | | | |
| FBARP | 0.1061 | 0.1395 | | | | | | | | | |
| | | | | | | | | | | | |
| Table 8 | Fishing m | ortality (F) a | it age | | | | | | | | |
| YEAR | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | |
| AGE | | | | | | | | | | | |
| 1 | 0 | 0 | 0 | 0.0001 | 0 | 0 | 0 | 0.0018 | 0.012 | 0.0299 | |
| 2 | 0.0162 | 0.0048 | 0.0167 | 0.0029 | 0.0126 | 0.0017 | 0.0133 | 0.1622 | 0.3485 | 0.1528 | |
| 3 | 0.199 | 0.2808 | 0.1965 | 0.1394 | 0.155 | 0.1414 | 0.0905 | 0.4416 | 0.5319 | 0.5061 | |
| 4 | 0.6903 | 0.5024 | 0.5124 | 0.3491 | 0.4231 | 0.2753 | 0.3391 | 0.3912 | 0.5486 | 0.3166 | |
| 5 | 0.5173 | 0.6624 | 0.3778 | 0.4151 | 0.4065 | 0.2904 | 0.3755 | 0.2883 | 0.3459 | 0.458 | |
| 6 | 0.6019 | 0.3961 | 0.293 | 0.1992 | 0.3099 | 0.2816 | 0.2843 | 0.1447 | 0.1745 | 0.175 | |
| 7 | | | | | | | | | | 0.2872 | |
| | 0.5837 | 0.3113 | 0.4908 | 0.2605 | 0.2825 | 0.2367 | 0.3682 | 0.132 | 0.2167 | | |
| 8 | 0.4553 | 0.1495 | 0.3578 | 0.2421 | 0.3007 | 0.1479 | 0.668 | 0.2079 | 0.1909 | 0.8633 | |
| 9 | 0.3433 | 0.2288 | 0.255 | 0.1842 | 0.2375 | 0.1808 | 0.3529 | 0.3525 | 0.4304 | 0.4805 | |
| +gp | 0.3433 | 0.2288 | 0.255 | 0.1842 | 0.2375 | 0.1808 | 0.3529 | 0.3525 | 0.4304 | 0.4805 | |
| FBAR 3-7 | 0.5184 | 0.4306 | 0.3741 | 0.2727 | 0.3154 | 0.2451 | 0.2915 | 0.2796 | 0.3635 | 0.3486 | |
| FBARP | 0.1665 | 0.1594 | 0.1454 | 0.1181 | 0.1319 | 0.1071 | 0.122 | 0.1816 | 0.2475 | 0.207 | |
| _ | | | | | | | | | | | |
| Table 8 | Fishing me | ortality (F) a | t age | | | | | | | | |
| | | | | | | | | | | | |
| YEAR | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | |
| YEAR AGE | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | |
| | 1975 0.0011 | 1976 0.0023 | 1977 0.0095 | 1978 0.0021 | 1979 0.0005 | 1980 0.0016 | 1981 0.0057 | 1982 0.0012 | 1983 0.001 | 1984 0.004 | |
| AGE | | | | | | | | | | | |
| AGE 1 | 0.0011 | 0.0023 | 0.0095 | 0.0021 | 0.0005 | 0.0016 | 0.0057 | 0.0012 | 0.001 | 0.004 | |
| AGE 1 2 | 0.0011 0.1131 | 0.0023 0.1653 | 0.0095 0.103 | 0.0021 0.3874 | 0.0005 0.0686 | 0.0016 0.061 | 0.0057 0.1137 | 0.0012 0.0657 | 0.001 0.1296 | 0.004 0.1062 | |
| AGE 1 2 3 4 | 0.0011 0.1131 0.505 0.4132 | 0.0023 0.1653 0.6219 0.4082 | 0.0095 0.103 0.4493 0.4295 | 0.0021 0.3874 0.5928 0.4304 | 0.0005 0.0686 0.2729 0.3279 | 0.0016 0.061 0.3412 0.2222 | 0.0057 0.1137 0.3475 0.3474 | 0.0012 0.0657 0.3186 0.2462 | 0.001 0.1296 0.3285 0.294 | 0.004 0.1062 0.3115 0.2749 | |
| AGE 1 2 3 4 5 | 0.0011 0.1131 0.505 0.4132 0.2879 | 0.0023 0.1653 0.6219 0.4082 0.5834 | 0.0095 0.103 0.4493 0.4295 0.4666 | 0.0021 0.3874 0.5928 0.4304 0.3759 | 0.0005 0.0686 0.2729 0.3279 0.3986 | 0.0016 0.061 0.3412 0.2222 0.3139 | 0.0057 0.1137 0.3475 0.3474 0.2077 | 0.0012 0.0657 0.3186 0.2462 0.3858 | 0.001 0.1296 0.3285 0.294 0.1846 | 0.004 0.1062 0.3115 0.2749 0.1543 | |
| AGE 1 2 3 4 5 6 | 0.0011 0.1131 0.505 0.4132 0.2879 0.3388 | 0.0023 0.1653 0.6219 0.4082 0.5834 0.4209 | 0.0095 0.103 0.4493 0.4295 0.4666 0.5081 | 0.0021 0.3874 0.5928 0.4304 0.3759 0.36 | 0.0005 0.0686 0.2729 0.3279 0.3986 0.3693 | 0.0016 0.061 0.3412 0.2222 0.3139 0.3905 | 0.0057 0.1137 0.3475 0.3474 0.2077 0.3144 | 0.0012 0.0657 0.3186 0.2462 0.3858 0.3211 | 0.001 0.1296 0.3285 0.294 0.1846 0.4323 | 0.004 0.1062 0.3115 0.2749 0.1543 0.2275 | |
| AGE 1 2 3 4 5 6 7 | 0.0011 0.1131 0.505 0.4132 0.2879 0.3388 0.4802 | 0.0023 0.1653 0.6219 0.4082 0.5834 0.4209 0.467 | 0.0095 0.103 0.4493 0.4295 0.4666 0.5081 0.386 | 0.0021 0.3874 0.5928 0.4304 0.3759 0.36 0.385 | 0.0005 0.0686 0.2729 0.3279 0.3986 0.3693 0.33 | 0.0016 0.061 0.3412 0.2222 0.3139 0.3905 0.4384 | 0.0057 0.1137 0.3475 0.3474 0.2077 0.3144 0.3743 | 0.0012 0.0657 0.3186 0.2462 0.3858 0.3211 0.5533 | 0.001 0.1296 0.3285 0.294 0.1846 0.4323 0.5249 | 0.004 0.1062 0.3115 0.2749 0.1543 0.2275 0.303 | |
| AGE 1 2 3 4 5 6 7 8 | 0.0011 0.1131 0.505 0.4132 0.2879 0.3388 0.4802 0.3627 | 0.0023 0.1653 0.6219 0.4082 0.5834 0.4209 0.467 0.4864 | 0.0095 0.103 0.4493 0.4295 0.4666 0.5081 0.386 0.5503 | 0.0021 0.3874 0.5928 0.4304 0.3759 0.36 0.385 0.288 | 0.0005 0.0686 0.2729 0.3279 0.3986 0.3693 0.33 0.3682 | 0.0016 0.061 0.2222 0.3139 0.3905 0.4384 0.286 | 0.0057 0.1137 0.3475 0.3474 0.2077 0.3144 0.3743 0.3837 | 0.0012 0.0657 0.3186 0.2462 0.3858 0.3211 0.5533 0.5116 | 0.001 0.1296 0.3285 0.294 0.1846 0.4323 0.5249 0.46 | 0.004 0.1062 0.3115 0.2749 0.1543 0.2275 0.303 0.2645 | |
| AGE 1 2 3 4 5 6 7 8 9 | 0.0011 0.1131 0.505 0.4132 0.2879 0.3388 0.4802 0.3627 0.4484 | 0.0023 0.1653 0.6219 0.4082 0.5834 0.4209 0.467 0.4864 0.5774 | 0.0095 0.103 0.4493 0.4295 0.4666 0.5081 0.386 0.5503 0.5585 | 0.0021 0.3874 0.5928 0.4304 0.3759 0.36 0.385 0.288 0.4746 | 0.0005 0.0686 0.2729 0.3279 0.3986 0.3693 0.33 0.3682 0.3835 | 0.0016 0.061 0.3412 0.2222 0.3139 0.3905 0.4384 0.286 0.3794 | 0.0057 0.1137 0.3475 0.3474 0.2077 0.3144 0.3743 0.3837 0.386 | 0.0012 0.0657 0.3186 0.2462 0.3858 0.3211 0.5533 0.5116 0.4291 | 0.001 0.1296 0.3285 0.294 0.1846 0.4323 0.5249 0.46 0.4267 | 0.004 0.1062 0.3115 0.2749 0.1543 0.2275 0.303 0.2645 0.2951 | |
| AGE 1 2 3 4 5 6 7 8 9 +gp | 0.0011 0.1131 0.505 0.4132 0.2879 0.3388 0.4802 0.3627 0.4484 0.4484 | 0.0023 0.1653 0.6219 0.4082 0.5834 0.4209 0.467 0.4864 0.5774 0.5774 | 0.0095 0.103 0.4493 0.4295 0.4666 0.5081 0.386 0.5503 0.5585 0.5585 | 0.0021 0.3874 0.5928 0.4304 0.3759 0.36 0.385 0.288 0.4746 0.4746 | 0.0005 0.0686 0.2729 0.3279 0.3986 0.3693 0.33 0.3682 0.3835 0.3835 | 0.0016 0.061 0.3412 0.2222 0.3139 0.3905 0.4384 0.286 0.3794 0.3794 | 0.0057 0.1137 0.3475 0.3474 0.2077 0.3144 0.3743 0.3837 0.386 0.386 | 0.0012 0.0657 0.3186 0.2462 0.3858 0.3211 0.5533 0.5116 0.4291 0.4291 | 0.001 0.1296 0.3285 0.294 0.1846 0.4323 0.5249 0.46 0.4267 0.4267 | 0.004 0.1062 0.3115 0.2749 0.1543 0.2275 0.303 0.2645 0.2951 0.2951 | |
| AGE 1 2 3 4 5 6 7 8 9 +gp FBAR 3- 7 | 0.0011 0.1131 0.505 0.4132 0.2879 0.3388 0.4802 0.3627 0.4484 0.4484 0.445 | 0.0023 0.1653 0.6219 0.4082 0.5834 0.4209 0.467 0.4864 0.5774 0.5774 0.5774 | 0.0095 0.103 0.4493 0.4295 0.4666 0.5081 0.386 0.5503 0.5585 0.5585 0.4479 | 0.0021 0.3874 0.5928 0.4304 0.3759 0.36 0.385 0.288 0.4746 0.4746 0.4746 | 0.0005 0.0686 0.2729 0.3279 0.3986 0.3693 0.3693 0.3682 0.3835 0.3835 0.3835 | 0.0016 0.061 0.3412 0.2222 0.3139 0.3905 0.4384 0.286 0.3794 0.3794 0.3794 | 0.0057 0.1137 0.3475 0.3474 0.2077 0.3144 0.3837 0.386 0.386 0.386 0.3183 | 0.0012 0.0657 0.3186 0.2462 0.3858 0.3211 0.5233 0.5116 0.4291 0.4291 0.365 | 0.001 0.1296 0.3285 0.294 0.1846 0.4323 0.5249 0.46 0.4267 0.4267 0.3528 | 0.004 0.1062 0.3115 0.2749 0.1543 0.2275 0.303 0.2645 0.2951 0.2951 0.2542 | |
| AGE 1 2 3 4 5 6 7 8 9 +gp | 0.0011 0.1131 0.505 0.4132 0.2879 0.3388 0.4802 0.3627 0.4484 0.4484 | 0.0023 0.1653 0.6219 0.4082 0.5834 0.4209 0.467 0.4864 0.5774 0.5774 | 0.0095 0.103 0.4493 0.4295 0.4666 0.5081 0.386 0.5503 0.5585 0.5585 | 0.0021 0.3874 0.5928 0.4304 0.3759 0.36 0.385 0.288 0.4746 0.4746 | 0.0005 0.0686 0.2729 0.3279 0.3986 0.3693 0.33 0.3682 0.3835 0.3835 | 0.0016 0.061 0.3412 0.2222 0.3139 0.3905 0.4384 0.286 0.3794 0.3794 | 0.0057 0.1137 0.3475 0.3474 0.2077 0.3144 0.3743 0.3837 0.386 0.386 | 0.0012 0.0657 0.3186 0.2462 0.3858 0.3211 0.5533 0.5116 0.4291 0.4291 | 0.001 0.1296 0.3285 0.294 0.1846 0.4323 0.5249 0.46 0.4267 0.4267 | 0.004 0.1062 0.3115 0.2749 0.1543 0.2275 0.303 0.2645 0.2951 0.2951 | |
| AGE 1 2 3 4 5 6 7 8 9 FBAR 3- 7 FBARP | 0.0011 0.1131 0.505 0.4132 0.2879 0.3388 0.4802 0.3627 0.4484 0.4484 0.4484 0.405 0.1922 | 0.0023 0.1653 0.6219 0.4082 0.5834 0.4209 0.467 0.4864 0.5774 0.5774 0.5774 0.5003 0.2254 | 0.0095 0.103 0.4493 0.4295 0.4666 0.5081 0.386 0.5503 0.5585 0.5585 0.4479 0.1967 | 0.0021 0.3874 0.5928 0.4304 0.3759 0.36 0.385 0.288 0.4746 0.4746 0.4746 | 0.0005 0.0686 0.2729 0.3279 0.3986 0.3693 0.3693 0.3682 0.3835 0.3835 0.3835 | 0.0016 0.061 0.3412 0.2222 0.3139 0.3905 0.4384 0.286 0.3794 0.3794 0.3794 | 0.0057 0.1137 0.3475 0.3474 0.2077 0.3144 0.3837 0.386 0.386 0.386 0.3183 | 0.0012 0.0657 0.3186 0.2462 0.3858 0.3211 0.5233 0.5116 0.4291 0.4291 0.365 | 0.001 0.1296 0.3285 0.294 0.1846 0.4323 0.5249 0.46 0.4267 0.4267 0.3528 | 0.004 0.1062 0.3115 0.2749 0.1543 0.2275 0.303 0.2645 0.2951 0.2951 0.2542 | |
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| AGE 1 2 3 4 5 6 7 8 9 +gp FBAR 3- 7 FBARP Table 8 YEAR AGE 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 1 5 6 7 7 8 9 1 1 1 1 1 1 1 1 1 1 1 1 1 | 0.0011 0.1131 0.505 0.4132 0.2879 0.3888 0.4802 0.3627 0.4484 0.405 0.1922 Fishing me 1985 0.0003 0.0745 0.2627 0.2627 0.2627 0.2627 0.2627 0.3341 0.3247 | 0.0023 0.1653 0.6219 0.4082 0.5834 0.4209 0.467 0.4864 0.5774 0.5703 0.2254 ortality (F) a 1986 0.0084 0.0484 0.3451 0.9123 0.6645 0.442 0.5356 | 0.0095 0.103 0.4493 0.4295 0.4666 0.5081 0.386 0.5503 0.5585 0.5585 0.4479 0.1967 t age 1987 0 0.0786 0.188 0.6757 0.5415 0.5354 0.4745 | 0.0021 0.3874 0.5928 0.4304 0.3759 0.36 0.385 0.288 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.5588 0.6011 0.1722 0.4059 0.5158 0.5893 0.6495 0.8315 | 0.0005 0.0686 0.2729 0.3279 0.3986 0.3693 0.33 0.3682 0.3835 0.3835 0.3835 0.3835 0.3835 0.3397 0.1542 1989 0.0011 0.0475 0.621 0.9326 0.7477 0.7365 0.5118 | 0.0016 0.3412 0.2222 0.3139 0.3905 0.4384 0.286 0.3794 0.3794 0.3794 0.3412 0.1517 1990 0.0031 0.0951 0.5696 0.7685 0.5054 0.6431 0.6916 | 0.0057 0.1137 0.3475 0.3474 0.2077 0.3144 0.3743 0.3837 0.386 0.386 0.3183 0.1664 1991 0.006 0.0835 0.3479 0.6789 0.5913 0.525 0.8954 | 0.0012 0.0657 0.3186 0.2462 0.3858 0.3211 0.5533 0.5116 0.4291 0.4291 0.365 0.1559 1992 0.0007 0.0418 0.1643 0.5722 0.4961 0.3541 0.3541 0.1615 | 0.001 0.1296 0.3285 0.294 0.46 0.4223 0.5249 0.46 0.4267 0.4267 0.3528 0.1666 1993 0.0002 0.0836 0.1758 0.425 0.4493 0.2485 0.1793 | 0.004 0.1062 0.3115 0.2749 0.1543 0.2275 0.303 0.2645 0.2951 0.2542 0.1462 1994 0.01 0.03 0.09 0.1 0.03 0.09 0.1 0.12 0.18 0.15 | 0.0036 0.0518 0.1434 0.3657 0.3551 0.2609 0.1636 |
| AGE 1 2 3 4 5 6 7 8 9 +gp FBAR 3-7 FBARP Table 8 YEAR AGE 1 2 3 4 5 6 7 8 9 +gp FBAR 3-7 FBAR 3-7 | 0.0011 0.1131 0.505 0.4132 0.2879 0.3388 0.4802 0.3627 0.4484 0.405 0.1922 Fishing me 1985 0.0003 0.0745 0.2627 0.2793 0.267 0.3341 0.3247 0.3126 | 0.0023 0.1653 0.6219 0.4082 0.5834 0.4209 0.467 0.4864 0.5774 0.5774 0.5703 0.2254 ortality (F) a 1986 0.0084 0.0084 0.3451 0.9123 0.6645 0.442 | 0.0095 0.103 0.4493 0.4295 0.4666 0.5081 0.386 0.5503 0.5585 0.4479 0.1967 t age 1987 0.0786 0.0786 0.188 0.6757 0.5415 0.5354 | 0.0021 0.3874 0.5928 0.4304 0.3759 0.36 0.385 0.288 0.4746 0.4746 0.4746 0.4288 0.2588 1988 0.0011 0.1722 0.4059 0.5158 0.5893 0.6495 | 0.0005 0.0686 0.2729 0.3279 0.3986 0.3693 0.33 0.3682 0.3835 0.3835 0.3835 0.3835 0.3835 0.3835 0.397 0.1542 1989 0.0011 0.0011 0.0475 0.621 0.9326 0.7477 0.7365 | 0.0016 0.061 0.3412 0.2222 0.3139 0.3905 0.4384 0.286 0.3794 0.3794 0.3794 0.3794 0.3794 0.3412 0.1517 1990 0.0031 0.0951 0.5696 0.7685 0.5054 0.6431 | 0.0057 0.1137 0.3475 0.3474 0.2077 0.3144 0.3743 0.3837 0.386 0.386 0.3183 0.1664 1991 0.006 0.0835 0.3479 0.6789 0.5913 0.525 | 0.0012 0.0657 0.3186 0.2462 0.3858 0.3211 0.5533 0.5116 0.4291 0.4291 0.365 0.1559 1992 0.0007 0.0418 0.1643 0.5722 0.4961 0.3541 0.36541 0.1615 0.2988 | 0.001 0.1296 0.3285 0.294 0.1846 0.4323 0.5249 0.46 0.4267 0.4267 0.3528 0.1666 1993 0.0002 0.0836 0.1758 0.425 0.425 0.425 0.425 0.425 0.425 | 0.004 0.1062 0.3115 0.2749 0.1543 0.2275 0.303 0.2645 0.2951 0.2951 0.2542 0.1462 1994 0.01 0.03 0.09 0.1 0.12 0.18 0.15 0.15 | 0.0036 0.0518 0.1434 0.3657 0.3551 0.2609 0.1636 0.1893 |
| AGE 1 2 3 4 5 6 7 8 9 +gp FBAR 3- 7 FBARP Table 8 YEAR AGE 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6 7 8 9 1 1 5 6 7 7 8 9 1 1 1 1 1 1 1 1 1 1 1 1 1 | 0.0011 0.1131 0.505 0.4132 0.2879 0.3888 0.4802 0.3627 0.4484 0.405 0.1922 Fishing me 1985 0.0003 0.0745 0.2627 0.2627 0.2627 0.2627 0.2627 0.3341 0.3247 | 0.0023 0.1653 0.6219 0.4082 0.5834 0.4209 0.467 0.4864 0.5774 0.5774 0.5774 0.5003 0.2254 ortality (F) a 1986 0.0084 0.0484 0.3451 0.9123 0.6645 0.442 0.5356 | 0.0095 0.103 0.4493 0.4295 0.4666 0.5081 0.386 0.5503 0.5585 0.5585 0.4479 0.1967 it age 1987 0 0.0786 0.188 0.6757 0.5415 0.5354 0.4745 | 0.0021 0.3874 0.5928 0.4304 0.3759 0.36 0.385 0.288 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.5588 | 0.0005 0.0686 0.2729 0.3279 0.3986 0.3693 0.33 0.3682 0.3835 0.3835 0.3835 0.3835 0.3835 0.3397 0.1542 1989 0.0011 0.0475 0.621 0.9326 0.7477 0.7365 0.5118 | 0.0016 0.3412 0.2222 0.3139 0.3905 0.4384 0.286 0.3794 0.3794 0.3794 0.3412 0.1517 1990 0.0031 0.0951 0.5696 0.7685 0.5054 0.6431 0.6916 | 0.0057 0.1137 0.3475 0.3474 0.2077 0.3144 0.3743 0.3837 0.386 0.386 0.3183 0.1664 1991 0.006 0.0835 0.3479 0.6789 0.5913 0.525 0.8954 | 0.0012 0.0657 0.3186 0.2462 0.3858 0.3211 0.5533 0.5116 0.4291 0.4291 0.365 0.1559 1992 0.0007 0.0418 0.1643 0.5722 0.4961 0.3541 0.3541 0.1615 | 0.001 0.1296 0.3285 0.294 0.46 0.4223 0.5249 0.46 0.4267 0.4267 0.3528 0.1666 1993 0.0002 0.0836 0.1758 0.425 0.4493 0.2485 0.1793 | 0.004 0.1062 0.3115 0.2749 0.1543 0.2275 0.303 0.2645 0.2951 0.2542 0.1462 1994 0.01 0.03 0.09 0.1 0.03 0.09 0.1 0.12 0.18 0.15 | 0.0036 0.0518 0.1434 0.3657 0.3551 0.2609 0.1636 |
| AGE 1 2 3 4 5 6 7 8 9 +gp FBAR 3-7 FBARP Table 8 YEAR AGE 1 2 3 4 5 6 7 8 9 +gp FBAR 3-7 FBAR 3-7 | 0.0011 0.1131 0.505 0.4132 0.2879 0.3388 0.4802 0.3627 0.4484 0.405 0.1922 Fishing me 1985 0.0003 0.0745 0.2627 0.2793 0.267 0.3241 0.3247 0.3126 | 0.0023 0.1653 0.6219 0.4082 0.5834 0.4209 0.467 0.4864 0.5774 0.5774 0.5774 0.5774 0.5003 0.2254 0.2254 0.2254 0.0084 0.0084 0.0484 0.3451 0.9123 0.6645 0.442 0.5356 0.4471 | 0.0095 0.103 0.4493 0.4295 0.4666 0.5081 0.386 0.5503 0.5585 0.5585 0.4479 0.1967 t age 1987 0 0.0786 0.188 0.6757 0.5354 0.4745 0.4654 | 0.0021 0.3874 0.5928 0.4304 0.3759 0.36 0.385 0.288 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.4746 0.588 0.588 0.588 0.5158 0.5495 0.8315 1.0727 | 0.0005 0.0686 0.2729 0.3279 0.3886 0.3693 0.33 0.3682 0.3835 0.3835 0.3835 0.3835 0.3397 0.1542 1989 0.0011 0.0475 0.621 0.9326 0.7477 0.7365 0.5118 0.6161 | 0.0016 0.061 0.3412 0.2222 0.3139 0.3905 0.4384 0.286 0.3794 0.3794 0.3794 0.3794 0.3412 0.1517 1990 0.0031 0.0951 0.5696 0.7685 0.5054 0.6431 0.6916 0.7545 | 0.0057 0.1137 0.3475 0.3474 0.2077 0.3144 0.3743 0.3837 0.386 0.386 0.3183 0.1664 1991 0.006 0.0835 0.3479 0.6789 0.525 0.8954 0.7864 | 0.0012 0.0657 0.3186 0.2462 0.3858 0.3211 0.5533 0.5116 0.4291 0.4291 0.365 0.1559 1992 0.0007 0.0418 0.1643 0.5722 0.4961 0.3541 0.36541 0.1615 0.2988 | 0.001 0.1296 0.3285 0.294 0.1846 0.4323 0.5249 0.46 0.4267 0.4267 0.3528 0.1666 1993 0.0002 0.0836 0.1758 0.425 0.425 0.425 0.425 0.425 0.425 | 0.004 0.1062 0.3115 0.2749 0.1543 0.2275 0.303 0.2645 0.2951 0.2951 0.2542 0.1462 1994 0.01 0.03 0.09 0.1 0.12 0.18 0.15 0.15 | 0.0036 0.0518 0.1434 0.3657 0.3551 0.2609 0.1636 0.1893 |
| AGE 1 2 3 4 5 6 7 8 9 +gp FBAR 3-7 FBARP Table 8 YEAR AGE 1 2 3 4 5 6 7 8 9 +gp FBAR 3-7 FBAR 3-7 | 0.0011 0.1131 0.505 0.4132 0.2879 0.3388 0.4802 0.3627 0.4484 0.405 0.1922 Fishing me 1985 0.0003 0.0745 0.2627 0.2793 0.267 0.2793 0.267 0.3341 0.3247 0.3126 0.324 | 0.0023 0.1653 0.6219 0.4082 0.5834 0.4209 0.467 0.4864 0.5774 0.5774 0.5003 0.2254 0.2254 0.2254 0.0084 0.0484 0.3451 0.9123 0.6645 0.442 0.5356 0.4421 0.5356 | 0.0095 0.103 0.4493 0.4295 0.4666 0.5081 0.386 0.5503 0.5585 0.4479 0.1967 1987 0.0786 0.188 0.6757 0.5415 0.5354 0.4745 0.4654 0.4804 | 0.0021 0.3874 0.5928 0.4304 0.3759 0.36 0.385 0.288 0.4746 0.4746 0.4288 0.2588 1988 0.2588 1988 0.0011 0.1722 0.4059 0.5158 0.5893 0.6495 0.8315 1.0727 0.7424 | 0.0005 0.0686 0.2729 0.3279 0.3986 0.3693 0.33 0.3682 0.3835 0.3835 0.3397 0.1542 1989 0.0011 0.0475 0.621 0.9326 0.7477 0.7365 0.5118 0.6161 0.7567 | 0.0016 0.061 0.3412 0.2222 0.3139 0.3905 0.4384 0.3794 0.3794 0.3794 0.3794 0.3794 0.3412 0.1517 1990 0.0031 0.0951 0.5696 0.7685 0.5054 0.5054 0.6431 0.6916 0.7545 0.7601 | 0.0057 0.1137 0.3475 0.3474 0.2077 0.3144 0.3743 0.3837 0.386 0.386 0.3183 0.1664 1991 0.006 0.0835 0.3479 0.6789 0.5913 0.525 0.8954 0.7864 0.7767 | 0.0012 0.0657 0.3186 0.2462 0.3858 0.3211 0.5533 0.5116 0.4291 0.4291 0.365 0.1559 1992 0.0007 0.0418 0.1643 0.5722 0.4961 0.3541 0.1615 0.2988 0.4138 | 0.001 0.1296 0.3285 0.294 0.1846 0.4323 0.5249 0.46 0.4267 0.3528 0.1866 1993 0.0002 0.0836 0.1758 0.425 0.425 0.4493 0.2485 0.1793 0.2485 0.1793 0.1191 0.3502 | 0.004 0.1062 0.3115 0.2749 0.1543 0.2275 0.303 0.2645 0.2951 0.2542 0.1462 1994 0.01 0.03 0.09 0.1 0.03 0.09 0.1 0.12 0.18 0.15 0.15 0.15 | 0.0036 0.0518 0.1434 0.3657 0.3551 0.2609 0.1636 0.1893 |
| AGE 1 2 3 4 5 6 7 8 9 +gp FBAR 3-7 FBARP Table 8 YEAR AGE 1 2 3 4 5 6 7 8 9 +gp FBAR 3-7 FBAR 9 1 2 3 4 5 6 7 8 9 +gp FBAR 3-7 FBAR 9 +gp FBAR 9 -7 FBAR 9 -7 -7 -7 -7 -7 -7 -7 -7 -7 -7 | 0.0011 0.1131 0.505 0.4132 0.2879 0.3388 0.4802 0.3627 0.4484 0.405 0.1922 Fishing me 1985 0.0003 0.0745 0.2627 0.2793 0.267 0.3341 0.3247 0.3247 | 0.0023 0.1653 0.6219 0.4082 0.5834 0.4209 0.467 0.4864 0.5774 0.5774 0.5003 0.2254 0.2254 0.2254 0.0084 0.0484 0.3451 0.9123 0.6645 0.442 0.5356 0.4471 0.5863 0.5863 | 0.0095 0.103 0.4493 0.4295 0.4666 0.5081 0.386 0.5585 0.4479 0.1967 0.1967 0.1967 0.0786 0.188 0.6757 0.5415 0.5354 0.4745 0.4654 0.4804 0.4804 | 0.0021 0.3874 0.5928 0.4304 0.3759 0.36 0.385 0.288 0.4746 0.4746 0.4288 0.2588 1988 0.0011 0.1722 0.4059 0.5158 0.5893 0.6495 0.5315 1.0727 0.7424 0.7424 | 0.0005 0.0686 0.2729 0.3279 0.3986 0.3693 0.33 0.3682 0.3835 0.3835 0.3835 0.3397 0.1542 1989 0.0011 0.0475 0.621 0.9326 0.7477 0.7365 0.5118 0.6161 0.7567 0.7567 | 0.0016 0.061 0.3412 0.2222 0.3139 0.3905 0.4384 0.286 0.3794 0.3794 0.3794 0.3412 0.1517 1990 0.0031 0.0951 0.5696 0.7685 0.5054 0.6431 0.6916 0.7545 0.7601 0.7601 | 0.0057 0.1137 0.3475 0.3474 0.2077 0.3144 0.3743 0.3837 0.386 0.3183 0.1664 1991 0.006 0.0835 0.3479 0.6789 0.5913 0.525 0.8954 0.7864 0.7767 0.7767 | 0.0012 0.0657 0.3186 0.2462 0.3858 0.3211 0.5533 0.5116 0.4291 0.4291 0.365 0.1559 1992 0.0007 0.0418 0.1643 0.5722 0.4961 0.3541 0.3541 0.3541 0.3541 0.3541 0.3541 0.3541 0.3541 | 0.001 0.1296 0.3285 0.294 0.1846 0.4323 0.5249 0.46 0.4267 0.3528 0.1666 1993 0.0002 0.0836 0.1758 0.425 0.4493 0.2485 0.1793 0.1191 0.3502 0.3502 | 0.004 0.1062 0.3115 0.2749 0.1543 0.2275 0.303 0.2645 0.2951 0.2542 0.1462 1994 0.01 0.03 0.09 0.1 0.03 0.09 0.1 0.15 0.15 0.15 0.15 | 0.0036 0.0518 0.1434 0.3657 0.3551 0.2609 0.1636 0.1893 |

TABLE 9. The relative (to the reference mean) fishing mortality-at-age calculated for the Blackfin stock using Traditional VPA.

Run titte : Blackfin: VPA course. Combined sex; plusgroup.

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| Table 9 | Re | Relative F at age | | | |
|---------|----|-------------------|--------|--|--|
| YEAR | | 1963 | 1964 | | |
| AGE | | | | | |
| | 1 | 0 | 0 | | |
| | 2 | 0.0605 | 0.0143 | | |
| | 3 | 0.6752 | 0.6932 | | |
| | 4 | 1.0966 | 1.0044 | | |
| | 5 | 1.0075 | 1.1281 | | |
| | 6 | 1.4683 | 1.0283 | | |
| | 7 | 0.7523 | 1.146 | | |
| | 8 | 1.7218 | 0.3703 | | |
| | 9 | 0.7218 | 0.5641 | | |
| +gp | | 0.7218 | 0.5641 | | |
| REFMEAN | | 0.2192 | 0.364 | | |

| Table 9 | R | elative F at | age | | | | | | | | | |
|---------|---|--------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------------|
| YEAR | | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | |
| AGE | | | | | | | | | | | | |
| AGE | 1 | 0 | 0 | 0 | 0.0003 | 0 | 0 | 0 | 0.0064 | 0.0329 | 0.0858 | |
| | 2 | 0.0313 | 0.0112 | 0.0447 | 0.0003 | 0.0399 | 0.0068 | 0.0456 | 0.5803 | 0.0329 | 0.4384 | |
| | 3 | 0.3839 | 0.6521 | 0.5252 | 0.5113 | 0.4915 | 0.5768 | 0.3105 | 1.5797 | 1.4632 | 1.4519 | |
| | 4 | 1.3315 | 1.1666 | 1.3697 | 1.2803 | 1.3415 | 1.1234 | 1.1631 | 1.3994 | 1.5091 | 0.9083 | |
| | 5 | 0.9977 | 1.5384 | 1.01 | 1.5223 | 1.2888 | 1.1849 | 1.2882 | 1.0311 | 0.9517 | 1.3138 | |
| | 6 | 1.161 | 0.9199 | 0.7831 | 0.7305 | 0.9825 | 1.1491 | 0.9752 | 0.5175 | 0.4799 | 0.502 | |
| | 7 | 1.1259 | 0.723 | 1.3119 | 0.9555 | 0.8957 | 0.9658 | 1.263 | 0.4723 | 0.596 | 0.824 | |
| | 8 | 0.8782 | 0.3471 | 0.9565 | 0.8879 | 0.9532 | 0.6036 | 2.2917 | 0.7435 | 0.525 | 2.4766 | |
| | ġ | 0.6622 | 0.5313 | 0.6816 | 0.6756 | 0.753 | 0.7377 | 1.2106 | 1.2609 | 1.184 | 1.3785 | |
| +gp | Ş | 0.6622 | 0.5313 | 0.6816 | 0.6756 | 0.753 | 0.7377 | 1.2106 | 1.2609 | 1.184 | 1.3785 | |
| REFMEAN | | 0.5184 | 0.4306 | 0.3741 | 0.2727 | 0.3154 | 0.2451 | 0.2915 | 0.2796 | 0.3635 | 0.3486 | |
| | | 0.0104 | 0.4300 | 0.0141 | 0.2121 | 0.0104 | 0.2451 | 0.2915 | 0.2730 | 0.0000 | 0.0400 | |
| | | | | | | | | | | | | |
| Table 9 | R | elative F at | | | | | | | | | | |
| YEAR | | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | |
| AGE | | | | | | | | | | | | |
| | 1 | 0.0027 | 0.0046 | 0.0211 | 0.0048 | 0.0014 | 0.0048 | 0.0179 | 0.0033 | 0.0027 | 0.0159 | |
| | 2 | 0.2793 | 0.3304 | 0.2299 | 0.9034 | 0.2018 | 0.1786 | 0.3573 | 0.1799 | 0.3673 | 0.4177 | |
| | 3 | 1.2469 | 1.2431 | 1.0031 | 1.3825 | 0.8033 | 0.9998 | 1.092 | 0.8728 | 0.9309 | 1.2251 | |
| | 4 | 1.0202 | 0.816 | 0.9589 | 1.0038 | 0.9651 | 0.6512 | 1.0916 | 0.6744 | 0.8331 | 1.0814 | |
| | 5 | 0.7108 | 1.1661 | 1.0418 | 0.8766 | 1.1733 | 0.9198 | 0.6526 | 1.057 | 0.5232 | 0.6069 | |
| | 6 | 0.8365 | 0.8414 | 1.1345 | 0.8394 | 1.0871 | 1.1444 | 0.9878 | 0.8799 | 1.2252 | 0.895 | |
| | 7 | 1.1856 | 0.9335 | 0.8617 | 0.8978 | 0.9713 | 1.2848 | 1.176 | 1.5158 | 1.4876 | 1.1916 | |
| | 8 | 0.8956 | 0.9721 | 1.2287 | 0.6715 | 1.0837 | 0.8381 | 1.2057 | 1.4017 | 1.3037 | 1.0403 | |
| | 9 | 1.1071 | 1.1541 | 1.2469 | 1.1068 | 1.1288 | 1.1118 | 1.2129 | 1.1757 | 1.2093 | 1.1608 | |
| +gp | 0 | 1.1071 | 1.1541 | 1.2469 | 1.1068 | 1.1288 | 1.1118 | 1.2129 | 1.1757 | 1.2093 | 1.1608 | |
| REFMEAN | | 0.405 | 0.5003 | 0.4479 | 0.4288 | 0.3397 | 0.3412 | 0.3183 | 0.365 | 0.3528 | 0.2542 | |
| | | 0.400 | 0.0005 | 0.4479 | 0.4200 | 0.3357 | 0.3412 | 0.3103 | 0.305 | 0.3020 | 0.2342 | |
| | _ | | | | | | | | | | | |
| Table 9 | | elative F at | | | 1000 | | 4000 | | 1000 | | | |
| YEAR | | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | MEAN 92-94 |
| AGE | | | | | | | | | | | | |
| | f | 0.0009 | 0.0146 | 0.0001 | 0.0018 | 0.0016 | 0.0048 | 0.0098 | 0.0021 | 0.0005 | 0.0781 | 0.0269 |
| | 2 | 0.2538 | 0.0834 | 0.1628 | 0.2878 | 0.0669 | 0.1496 | 0.1374 | 0.1196 | 0.2828 | 0.2344 | 0.2123 |
| | 3 | 0.8949 | 0.5951 | 0.3892 | 0.6783 | 0.8747 | 0.8961 | 0.5725 | 0.4698 | 0.5949 | 0.7031 | 0.5893 |
| | 4 | 0.9516 | 1.5732 | 1.3988 | 0.8619 | 1.3136 | 1.209 | 1.1171 | 1.6366 | 1.4379 | 0.7812 | 1.2852 |
| | 5 | 0.9095 | 1.1458 | 1.1211 | 0.9848 | 1.0532 | 0.795 | 0.973 | 1.4189 | 1,52 | 0.9375 | 1.2921 |
| | 6 | 1.1381 | 0.7622 | 1.1085 | 1.0854 | 1.0375 | 1.0117 | 0.864 | 1.0128 | 0.8407 | 1.4063 | 1.0866 |
| | 7 | 1.106 | 0.9237 | 0.9824 | 1.3895 | 0.7209 | 1.0881 | 1.4734 | 0.4618 | 0.6066 | 1.1719 | 0.7468 |
| | 8 | 1.0648 | 0.7711 | 0.9634 | 1.7925 | 0.8679 | 1.187 | 1.2941 | 0.8548 | 0.4031 | 1.1719 | 0.8099 |
| | 9 | 1.1037 | 1.011 | 0.9946 | 1.2406 | 1.0659 | 1.1958 | 1.2781 | 1.1836 | 1.1848 | 1.1719 | 1.1801 |
| +gp | | 1.1037 | 1.011 | 0.9946 | 1.2406 | 1.0659 | 1.1958 | 1.2781 | 1.1836 | 1.1848 | 1.1719 | |
| REFMEAN | | 0.2936 | 0.5799 | 0.483 | 0.5984 | 0.7099 | 0.6356 | 0.6077 | 0.3496 | 0.2956 | 0.128 | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

TABLE 10. The population number-at-age calculated for the Blackfin stock using Traditional VPA

Run title : Blackfin: VPA course. Combined sex; plusgroup.

At 1/02/2002 8:46

| Table 10 YEAR | Stock nu 1963 | imberatagi 1964 | e (start of y | ear) | Numbers' | 103 | | | | | | | |
|---|--|---|---|--|---|---|---|--|--|---|---|--|--|
| AGE | | | | | | | | | | | | | |
| 1 | 30399 | 19306 | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 2 | 13025 | 24888 | | | | | | | | | | | |
| 3 | 11869 | 10523 | | | | | | | | | | | |
| 4 | 3540 | 8381 | | | | | | | | | | | |
| 5 | 1815 | 2279 | | | | | | | | | | | |
| 6 | 859 | 1191 | | | | | | | | | | | |
| 7 | 527 | 510 | | | | | | | | | | | |
| 8 | 520 | 366 | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | |
| | 378 | 292 | | | | | | | | | | | |
| +9p | 365 | 551 | | | | | | | | | | | |
| TOTAL | 63296 | 68288 | | | | | | | | | | | |
| Table 10 | Stock nu | mber at ag | e (start of y | ear) | Numbers | *10**-3 | | | | | | | |
| YEAR | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | | | |
| AGE | | | | | | | | | | | | | |
| 1 | 18969 | 31238 | 22737 | 36038 | 26343 | 39047 | 35655 | 35364 | 32388 | 33584 | | | |
| 2 | 15807 | 15531 | 25575 | 18615 | 29503 | 21568 | 31969 | 29192 | 28902 | 26202 | | | |
| 3 | 20271 | 12733 | 12654 | 20592 | 15196 | 23853 | 17629 | 25829 | 20302 | 16700 | | | |
| 4 | 6695 | 13601 | 7873 | 8512 | 14665 | 10655 | 16955 | 13184 | 13597 | 9774 | | | |
| | | | | | | | | | | | | | |
| 5 | 4760 | 2748 | 6738 | 3861 | 4916 | 7864 | 6624 | 9890 | 7299 | 6432 | | | |
| 6 | 1238 | 2324 | 1160 | 3781 | 2087 | 2680 | 4816 | 3725 | 6069 | 4229 | | | |
| 7 | 671 | 555 | 1280 | 709 | 2537 | 1254 | 1656 | 2967 | 2639 | 4173 | | | |
| 8 | 275 | 306 | 333 | 642 | 447 | 1566 | 810 | 938 | 2129 | 1740 | | | |
| 9 | 262 | 143 | 216 | 191 | 412 | 271 | 1106 | 340 | 624 | 1440 | | | |
| | | | | | | | | 600 | 1477 | 2493 | | | |
| +10 | | 260 | 365 | 381 | 367 | | | | | | | | |
| | 516 69464 | 260 79438 | 365 78931 | 381 93322 | 367 96474 | 813 109571 | 877 118095 | 122029 | 115446 | 106767 | | | |
| TOTAL Table 10 | 516 69464 | | 78931 | 93322 | | 109571 | | | | | | | |
| TOTAL Table 10 YEAR AGE | 516 69464 Stock nu 1975 | 79438 mber at age 1976 | 78931 e (start of ye 1977 | 93322 9ar) 1978 | 96474 Numbers* 1979 | 109571 *10**-3 1980 | 118095 1981 | 122029 | 115446 1983 | 106767 1984 | | | |
| TOTAL Table 10 YEAR | 516 69464 Stock nu | 79438 mber at age | 78931 e (start of ye | 93322 9ar) | 96474 Numbers* | 109571 10**-3 | 118095 | 122029 | 115446 | 106767 | | | |
| TOTAL Table 10 YEAR AGE 1 | 516 69464 Stock nu 1975 24954 | 79438 mber at age 1976 17320 | 78931 e (start of ye 1977 18737 | 93322 ear) 1978 20363 | 96474 Numbers* 1979 23306 | 109571 *10**-3 1980 31208 | 118095 1981 29894 | 122029 1982 38984 | 115446 1983 40439 | 106767 1984 43073 | | | |
| TOTAL Table 10 YEAR AGE 1 2 | 516 69464 Stock nu 1975 24954 26686 | 79438 mber at age 1976 17320 20408 | 78931 e (start of ye 1977 18737 14148 | 93322 ear) 1978 20363 15196 | 96474 Numbers* 1979 23306 16638 | 109571 *10**-3 1980 31208 19072 | 118095 1981 29894 25509 | 122029 1982 38984 24336 | 115446 1983 40439 31878 | 106767 1984 43073 33077 | | | |
| TOTAL Table 10 YEAR AGE 1 2 3 | 516 69464 Stock nu 1975 24954 26686 18412 | 79438 mber at age 1976 17320 20408 19512 | 78931 e (start of ye 1977 18737 14148 14163 | 93322 9ar) 1978 20363 15196 10450 | 96474 Numbers* 1979 23306 16638 8445 | 109571 *10**-3 1980 31208 19072 12719 | 118095 1981 29894 25509 14692 | 122029 1982 38984 24336 18640 | 115446 1983 40439 31878 18659 | 106767 1984 43073 33077 22928 | | | |
| TOTAL Table 10 YEAR AGE 1 2 3 4 | 516 69464 Stock nu 1975 24954 26686 18412 8243 | 79438 mber at age 1976 17320 20408 19512 9098 | 78931 e (start of ye 1977 18737 14148 14163 8577 | 93322 9ar) 1978 20363 15196 10450 7399 | 96474 Numbers' 1979 23306 16638 8445 4729 | 109571 *10**-3 1980 31208 19072 12719 5263 | 118095 1981 29894 25509 14692 7404 | 122029 1982 38984 24336 18640 8497 | 115446 1983 40439 31878 18659 11098 | 106767 1984 43073 33077 22928 10999 | | | |
| TOTAL Table 10 YEAR AGE 1 2 3 4 5 | 516 69464 Stock nu 1975 24954 26686 18412 8243 5831 | 79438 mber at age 1976 17320 20408 19512 9098 4464 | 78931 e (start of yr 1977 18737 14148 14163 8577 4952 | 93322 9ar) 1978 20363 15196 10450 7399 4570 | 96474 Numbers' 1979 23306 16638 8445 4729 3939 | 109571 *10**-3 1980 31208 19072 12719 5263 2790 | 118095 1981 29894 25509 14692 7404 3450 | 122029 1982 38984 24336 18640 8497 4283 | 115446 1983 40439 31878 18659 11098 5439 | 106767 1984 43073 33077 22928 10999 6772 | | | |
| TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 | 516 69464 Stock nu 1975 24954 26686 18412 8243 5831 3331 | 79438 mber at age 1976 17320 20408 19612 9098 4464 3580 | 78931 e (start of ye 1977 18737 14148 14163 8577 4952 2040 | 93322 9ar) 1978 20363 15196 10450 7399 4570 2543 | 96474 Numbers* 1979 23306 16638 8445 4729 3939 2569 | 109571 *10**-3 1980 31208 19072 12719 5263 2790 2165 | 118095 1981 29894 25509 14692 7404 3450 1669 | 122029 1982 38984 24336 18640 8497 4283 2295 | 115446 1983 40439 31878 18659 11098 5439 2384 | 106767 1984 43073 33077 22928 10999 6772 3702 | | | |
| TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 | 516 69464 Stock nu 1975 24954 26686 18412 8243 5831 3331 2906 | 79438 mber at age 1976 17320 20408 19512 9098 4464 | 78931 e (start of ye 1977 18737 14148 14163 8577 4952 2040 1924 | 93322 9ar) 1978 20363 15196 10450 7399 4570 | 96474 Numbers' 1979 23306 16638 8445 4729 3939 2569 1452 | 109571 10**-3 1980 31208 19072 12719 5263 2790 2165 1454 | 118095 1981 29894 25509 14692 7404 3450 | 122029 1982 38984 24336 18640 8497 4283 2295 998 | 115446 1983 40439 31878 18659 11098 5439 | 106767 1984 43073 33077 22928 10999 6772 3702 1267 | | | |
| TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 | 516 69464 Stock nu 1975 24954 26686 18412 8243 5831 3331 | 79438 mber at age 1976 17320 20408 19512 9098 4464 3580 | 78931 e (start of ye 1977 18737 14148 14163 8577 4952 2040 | 93322 9ar) 1978 20363 15196 10450 7399 4570 2543 | 96474 Numbers* 1979 23306 16638 8445 4729 3939 2569 | 109571 *10**-3 1980 31208 19072 12719 5263 2790 2165 | 118095 1981 29894 25509 14692 7404 3450 1669 | 122029 1982 38984 24336 18640 8497 4283 2295 | 115446 1983 40439 31878 18659 11098 5439 2384 | 106767 1984 43073 33077 22928 10999 6772 3702 | | | |
| TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 | 516 69464 Stock nu 1975 24954 26686 18412 8243 5831 3331 2906 | 79438 mber at age 1976 17320 20408 19512 9098 4464 3580 1944 | 78931 e (start of ye 1977 18737 14148 14163 8577 4952 2040 1924 | 93322 9ar) 1978 20363 15196 10450 7399 4570 2543 1005 | 96474 Numbers' 1979 23306 16638 8445 4729 3939 2569 1452 | 109571 10**-3 1980 31208 19072 12719 5263 2790 2165 1454 | 118095 1981 29894 25509 14692 7404 3450 1669 1199 | 122029 1982 38984 24336 18640 8497 4283 2295 998 | 115446 1983 40439 31878 18659 11098 5439 2384 1363 | 106767 1984 43073 33077 22928 10999 6772 3702 1267 | | | |
| TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 8 9 | 516 69464 Stock nu 1975 24954 26686 18412 8243 5831 3331 2906 2564 601 | 79438 mber at age 1976 20408 19512 9098 4464 3580 1944 1472 1461 | 78931 e (start of yr 1977 18737 14148 14163 14163 8577 4952 2040 1924 997 741 | 93322 937) 1978 20363 15196 10450 7399 4570 2543 1005 1071 471 | 96474 Numbers' 1979 23306 16638 8445 4729 3939 2569 1452 560 657 | 109571 *10**-3 1980 31208 19072 12719 5263 2790 2165 1454 855 317 | 118095 1981 29894 25509 14692 7404 3450 1669 1199 788 526 | 122029 1982 38984 24336 18640 8497 4283 2295 998 675 428 | 115446 1983 40439 31878 18659 11098 5439 2384 1363 470 331 | 106767 1984 43073 33077 22928 10999 6772 3702 1267 660 243 | | | |
| TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 8 9 +gp | 516 69464 Stock nu 1975 24954 26686 18412 8243 5831 3331 2906 2564 | 79438 mber at age 1976 20408 19512 9098 4464 3580 1944 1472 | 78931 e (start of yr 1977 14148 14163 8577 4952 2040 1924 997 | 93322 ear) 1978 20363 15196 10450 7399 4570 2543 1005 1071 | 96474 Numbers* 1979 23306 16638 8445 4729 3939 2569 1452 560 | 109571 *10**-3 1980 31208 19072 12719 5263 2790 2165 1454 855 | 118095 1981 29894 25509 14692 7404 3450 1669 1199 768 | 122029 1982 38984 24336 18640 8497 4283 2295 998 675 | 115446 1983 40439 31878 18659 11098 5439 2384 1363 470 | 106767 1984 43073 33077 22928 10999 6772 3702 1267 660 | | | |
| TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 8 9 +gp TOTAL | 516 69464 Stock nu 1975 24954 26686 18412 8243 5831 2906 2564 601 1039 94566 | 79438 mber at ag 1976 20408 19612 9098 4464 3580 1944 1472 1461 3400 82659 | 78931 e (start of yr 1977 18737 14148 14163 8577 4952 2040 1924 997 741 2356 68634 | 93322 ear) 1978 20363 15196 10450 7399 4570 2543 1005 1071 471 3843 66910 | 96474 Numbers' 1979 23306 16638 8445 4729 3939 2569 1452 560 657 2605 64901 | 109571 10**-3 1980 31208 19072 12719 5263 2790 2165 1454 855 317 2835 78678 | 118095 1981 29894 25509 14692 7404 3450 1669 1199 768 526 2305 | 122029 1982 38984 24336 18640 8497 4283 2295 998 675 428 1446 | 115446 1983 40439 31878 18659 11098 5439 2384 1363 470 331 1595 | 106767 1984 43073 33077 22928 6772 3702 1267 660 243 889 | | | |
| TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 8 9 9 TOTAL Table 10 | 516 69464 Stock nu 1975 24954 26686 18412 8243 5831 2906 2564 601 1039 94566 | 79438 mber at age 1976 20408 19512 9098 4464 3580 1944 1472 1461 3400 | 78931 e (start of yr 1977 18737 14148 14163 8577 4952 2040 1924 997 741 2356 68634 | 93322 ear) 1978 20363 15196 10450 7399 4570 2543 1005 1071 471 3843 66910 | 96474 Numbers' 1979 23306 16638 8445 4729 3939 2569 1452 560 657 2605 | 109571 10**-3 1980 31208 19072 12719 5263 2790 2165 1454 855 317 2835 78678 | 118095 1981 29894 25509 14692 7404 3450 1669 1199 768 526 2305 | 122029 1982 38984 24336 18640 8497 4283 2295 998 675 428 1446 | 115446 1983 40439 31878 18659 11098 5439 2384 1363 470 331 1595 | 106767 1984 43073 33077 22928 6772 3702 1267 660 243 889 | 1995 | GMST 6 | 3-92 AMST 6 |
| TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 8 9 TOTAL Table 10 YEAR AGE | 516 69464 Stock nu 1975 24954 26686 18412 8243 5831 3331 2906 2564 601 1039 94566 Stock nu 1985 | 79438 mber at ag 1976 20408 19512 9098 4464 3580 1944 1472 1461 3400 82659 mber at ag 1986 | 78931 e (start of yr 1977 14148 14163 8577 4952 2040 1924 997 741 2356 68634 e (start of yr 1987 | 93322 9372 1978 20363 15160 10450 7399 4570 2543 1005 1071 471 3843 66910 2847 1988 | 96474 Numbers' 1979 23306 16638 8445 4729 3939 2569 1452 560 657 2605 54901 Numbers' 1989 | 109571 10**-3 1980 31208 19072 12719 5263 2790 2165 317 2835 78678 *10**-3 1990 | 19895 1981 29894 25592 14692 7404 3450 1669 1199 768 526 2305 87416 | 122029 1982 38984 2436 18640 8497 4283 2295 998 675 428 1446 100562 1992 | 115446 1983 40439 31878 18659 11098 5439 2384 1363 470 331 1595 113656 | 106767 1984 43073 33077 22928 10999 6772 3702 1267 660 243 689 9123410 1994 | | | |
| TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 8 9 7 TOTAL Table 10 YEAR AGE 1 | 516 69464 Stock nu 1975 24954 26686 18412 8243 5831 3331 2906 2564 601 1039 94566 Stock nu 1985 | 79438 mber at ag 1976 20408 19512 9098 4464 3580 1944 1472 1461 3400 82659 mber at ag 1986 30484 | 78931 e (start of yr 1977 14148 14163 8577 4952 2040 1924 997 741 2356 68634 e (start of yr 1987 30508 | 93322 937) 1978 20363 15196 10450 7399 4570 2543 1005 1071 471 3843 66910 9387 1988 22052 | 96474 Numbers' 1979 23306 16638 8445 4729 3939 2569 1452 560 657 2605 54901 Numbers' 1989 22043 | 109571 10**-3 1980 31208 19072 12719 5263 2790 2165 1454 855 317 2835 78678 '10**-3 1990 20945 | 118095 1981 29894 25509 14692 1699 1699 768 526 2305 87416 1991 28479 | 122029 1982 38984 24336 18640 8497 4283 2295 998 675 428 1246 100582 | 115446 1983 40439 31878 1868 5439 2384 1383 470 331 1595 113656 1993 | 106767 1984 43073 33077 22928 10999 6772 3702 1267 660 243 689 123410 1994 280 | 1995 0 | 27946 | 28936 |
| TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 8 9 TOTAL Table 10 YEAR AGE | 516 69464 Stock nu 1975 24954 26686 18412 8243 5831 3331 2906 2564 601 1039 94566 Stock nu 1985 | 79438 mber at ag 1976 20408 19512 9098 4464 3580 1944 1472 1461 3400 82659 mber at ag 1986 30484 18046 | 78931 e (start of yr 1977 14148 14163 8577 4952 2040 1924 997 741 2356 68634 e (start of yr 1987 | 93322 9372 1978 20363 15160 10450 7399 4570 2543 1005 1071 471 3843 66910 2847 1988 | 96474 Numbers' 1979 23306 16638 8445 4729 3939 2569 1452 560 657 2605 54901 Numbers' 1989 | 109571 10**-3 1980 31208 19072 12719 5263 2790 2165 317 2835 78678 *10**-3 1990 | 19895 1981 29894 25592 14692 7404 3450 1669 1199 768 526 2305 87416 | 122029 1982 38984 2436 18640 8497 4283 2295 998 675 428 1446 100562 1992 | 115446 1983 40439 31878 18659 11098 5439 2384 1363 470 331 1595 113656 | 106767 1984 43073 33077 22928 10999 6772 3702 1267 660 243 689 9123410 1994 | | | |
| TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 8 9 TOTAL Table 10 YEAR AGE 1 | 516 69464 Stock nu 1975 24954 26686 18412 8243 5831 3331 2906 2564 601 1039 94566 Stock nu 1985 | 79438 mber at ag 1976 20408 19512 9098 4464 3580 1944 1472 1461 3400 82659 mber at ag 1986 30484 18046 | 78931 e (start of yr 1977 14148 14163 8577 4952 2040 1924 997 741 2356 68634 e (start of yr 1987 30508 | 93322 937) 1978 20363 15196 10450 7399 4570 2543 1005 1071 471 3843 66910 298 298 22052 24977 | 96474 Numbers' 1979 23306 16638 8445 4729 3939 2569 1452 560 657 2605 64901 Numbers' 1989 22043 18035 | 109571 10**-3 1980 31208 19072 12719 5263 2790 2165 1454 855 317 2835 78678 '10**-3 1990 20945 | 118095 1981 29894 25509 14692 7604 1669 1199 768 526 2305 87416 1991 28479 17096 | 122029 1982 38984 24336 18640 8497 4283 2295 998 8575 428 1446 100562 1992 1992 42159 23179 | 115446 1983 40439 31878 18659 11098 5439 2384 1363 470 331 1595 113656 1993 109779 34492 | 106767 1984 43073 33077 22928 10999 6772 3702 1267 660 243 689 123410 1994 280 | 0 | 27946 22081 | 28936 |
| TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 8 9 TOTAL Table 10 YEAR AGE 1 2 3 | 516 69464 Stock nu 1975 24954 26686 18412 8243 5831 2906 2564 601 1039 94566 Stock nu 1985 22048 35123 24353 | 79438 mber at age 1976 17320 20408 19512 9098 4464 3580 1944 1472 1461 3440 82659 mber at age 1986 30484 18046 26692 | 78931 e (start of yr 1977 14148 14163 8577 4952 2040 1924 997 741 2356 68634 98634 997 741 2356 68634 997 741 2356 68634 997 741 2356 1987 | 93322 9372 1978 20363 1516 10450 7399 4570 2543 1005 1071 471 3843 66910 1988 22052 24977 18730 | 96474 Numbers' 1979 23306 16638 8445 4729 3939 2569 1452 560 657 2605 54901 Numbers' 1989 22043 18035 17215 | 109571 10**-3 1980 31208 19072 12719 5263 2790 2165 317 2835 317 2835 78678 *10**-3 1990 20945 18027 14081 | 118095 1981 29894 25509 14692 7404 3450 1669 1199 788 526 2305 87416 1991 28479 17096 13420 | 122029 1982 38984 24336 18640 8497 4283 2295 998 675 428 1446 100582 1992 1992 23179 12876 | 115446 1983 40439 31878 18659 11098 5439 2384 1383 470 331 1595 113656 1993 109779 34492 18200 | 106767 1984 43073 33077 22928 10999 6772 3702 1267 660 243 689 123410 1994 280 89866 89866 89866 89866 89865 | 0 227 71401 | 27946 22081 16286 | 28936 22899 16941 |
| TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 8 9 TOTAL Table 10 YEAR AGE 1 2 3 4 | 516 69464 Stock nu 1975 24954 26686 18412 8243 5831 3331 2906 2564 601 1039 94566 Stock nu 1985 22048 35123 24353 24353 313748 | 79438 mber at ag 1976 20408 19512 9098 4464 3580 1944 1472 1461 3400 82659 mber at ag 1986 30484 18046 26692 15332 | 78931 e (start of yr 1977 14148 14163 8577 4952 2040 1924 997 741 2356 68634 997 741 2356 68634 987 741 2356 68634 997 741 2350 86834 997 741 2350 86834 1987 1927 1927 1927 1927 1927 1927 1927 192 | 93322 937) 1978 20363 15196 10450 7399 4570 2543 1005 1071 471 3843 66910 9847 1968 22052 24977 18730 9550 | 96474 Numbers' 1979 23306 16638 8445 3939 2569 1452 560 657 2605 64901 Numbers' 1989 22043 18035 17215 10219 | 109571 109571 1980 31208 19072 12719 5263 2790 2165 1454 855 317 2835 78678 1990 20945 18027 14081 18027 14081 7575 | 118095 1981 29894 25509 14692 7404 3450 1669 1199 768 526 2305 87416 1991 28479 17096 13420 6522 | 122029 1982 38984 24336 18640 8497 4283 2295 998 675 428 1246 100582 1992 1992 42159 23179 12876 | 115446 1983 40439 31878 18659 11098 5439 2384 1383 470 331 1595 113656 1993 109779 34492 18200 8945 | 106767 1984 43073 33077 22928 10999 6772 3702 1267 660 243 689 123410 1994 280 89866 25975 12498 | 0 227 71401 19436 | 27946 22081 16286 9240 | 28936 22899 16941 9831 |
| TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 8 9 +gp TOTAL Table 10 YEAR AGE 1 2 3 4 5 | 516 69464 Stock nu 1975 24954 26686 18412 8243 5831 3331 2906 2564 601 1039 94566 Stock nu 1985 22048 35123 24353 13748 6841 | 79438 mber at age 1976 20408 19512 9098 4464 3580 1944 1472 1461 3400 82659 mber at age 1986 30484 18046 26692 15352 8512 | 78931 e (start of yr 1977 14148 14163 8577 4952 2040 1924 997 741 2356 68634 997 741 2356 68634 e (start of yr 1987 30508 24748 14077 15476 5041 | 93322 937) 1978 20363 15196 10450 7399 4570 2543 1005 1071 471 3843 66910 298 24977 18730 9550 6447 | 96474 Numbers' 1979 23306 16638 8445 4729 3939 2569 1452 560 657 2605 54901 Numbers' 1989 22043 18035 17215 10219 4668 | 109571 '10**-3 1980 31208 19072 12719 5263 2790 2165 1454 855 317 2835 78678 '10**-3 1990 20945 18027 14081 7575 3292 | 118095 1981 29894 25509 14699 1469 1669 1669 768 526 2305 87416 1991 28479 17096 13420 6522 2876 | 122029 1982 38984 24336 18640 8497 4283 2295 998 675 428 1446 100562 1992 1992 42159 23179 12876 7759 22708 | 115446 1983 40439 31878 18659 11098 5439 2384 1363 470 331 1595 113656 1993 109779 34492 18200 8945 | 106767 1984 43073 33077 23928 10999 6772 3702 1267 660 243 689 123410 1994 1994 280 89866 25975 12488 4788 | 0 227 71401 19436 9259 | 27946 22081 16286 9240 4687 | 28936 22899 16941 9831 5070 |
| TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 8 9 +gp TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 | 516 69464 Stock nu 1975 24954 26686 18412 8243 5831 2906 2564 601 1039 94566 Stock nu 1985 22048 35123 24353 13748 6841 | 79438 mber at ag 1976 20408 19612 9098 4464 3580 1944 1472 1461 3400 82659 mber at ag 1986 30484 18046 26692 15332 8512 8512 8512 | 78931 e (start of yr 1977 14148 14163 8577 4952 2040 1924 997 741 2356 68634 997 741 2356 68634 997 741 2356 68634 997 741 2356 68634 1987 | 93322 937) 1978 20363 15196 10450 7399 4570 2543 1005 1071 471 3843 66910 1988 22052 24977 18730 9550 6447 2402 | 96474 Numbers' 1979 23306 16638 8445 4729 3939 2569 1452 560 657 2605 54901 Numbers' 1989 22043 18035 17215 10219 4668 2928 | 109571 109571 1980 31208 19072 12719 5263 2790 2165 1454 855 317 2835 78678 1990 20945 18027 14081 7575 3292 1810 | 118095 1981 29894 25509 14692 7604 1669 1199 768 526 2305 87416 1991 28479 17096 13420 6522 2876 1626 | 122029 1982 38984 24336 18640 8497 4283 2295 998 675 428 1446 100582 1992 1992 42159 23179 12876 7759 23769 1303 | 115446 1983 40439 31878 18659 11098 5439 2384 1363 470 331 1595 113656 1993 109779 34492 18200 8945 3585 3585 | 106767 1984 43073 33077 22928 10999 6772 3702 1267 660 243 689 123410 1994 1994 280 89866 25975 12498 4768 1873 | 0 227 71401 19436 9259 3477 | 27946 22081 16286 9240 4687 2489 | 28936 22899 16941 9831 5070 2771 |
| TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 8 9 +9P TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 7 | 516 69464 Stock nu 1975 24954 26686 18412 8243 5831 3331 2906 2564 601 1039 94566 Stock nu 1985 22048 35123 24353 13748 6841 4752 2414 | 79438 mber at ag 1976 17320 20008 19512 9098 4464 3580 1944 1472 1461 3400 82659 mber at ag 1986 30484 18046 26692 15332 8512 4288 2785 | 78931 e (start of yr 1977 14148 14163 8577 4952 2040 1924 997 741 2356 68634 997 741 2356 68634 997 741 2356 68634 997 741 1987 30508 24748 14077 15476 5041 3566 2257 | 93322 9372 1978 20363 15160 10450 10450 2543 1005 1071 471 3843 66910 22052 24977 18730 9550 6447 24052 1719 | 96474 Numbers' 1979 23306 16638 8445 4729 3939 2569 1452 560 657 2605 54901 Numbers' 1989 22043 18035 17215 10219 4668 2928 1027 | 109571 109771 1980 31208 19072 12719 5263 2790 2165 2165 317 2835 78678 1990 20945 18027 14081 7575 3292 1810 1148 | 118095 1981 29894 25509 14659 14659 1469 1659 7788 526 2305 87416 1991 28479 17096 13420 6522 2876 13420 6522 2876 | 122029 1982 38984 24336 18640 8497 4283 2295 998 675 428 675 428 1446 100582 1992 42159 23179 12876 7759 2708 1303 788 | 115446 1983 40439 31878 18659 11098 5439 2384 1383 470 331 1595 113656 1993 109779 34492 18200 8945 3585 13505 779 | 106767 1984 43073 33077 22928 10999 6772 3702 1267 660 243 689 9123410 1994 280 89896 25975 12498 4788 1873 862 | 0 227 71401 19436 9259 3477 1281 | 27946 22081 16286 9240 4687 2489 1375 | 28936 22899 16941 9831 5070 2771 1597 |
| TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 8 9 9 TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 8 9 7 8 9 7 8 9 7 8 7 8 7 8 8 7 8 9 7 8 7 8 | 516 69464 Stock nu 1975 24954 26686 18412 8243 5831 3331 2906 2564 601 1039 94566 Stock nu 1985 22048 35123 24353 13748 6841 4752 2414 4752 2414 766 | 79438 mber at ag 1976 20408 19612 9098 4464 3580 1944 1472 1461 3400 82659 mber at ag 1986 30484 18046 26692 15332 8512 8512 8512 | 78931 e (start of yr 1977 14148 14163 8577 4952 2040 1924 997 741 2356 68634 997 741 2356 68634 997 741 2356 68634 997 741 2356 68634 1987 | 93322 937) 1978 20363 15196 10450 7399 4570 2543 1005 1071 471 3843 66910 1988 22052 24977 18730 9550 6447 2402 | 96474 Numbers' 1979 23306 16638 8445 4729 3939 2569 1452 560 657 2605 64901 Numbers' 1989 22043 18035 17215 10219 4668 2928 1027 613 | 109571 109571 1980 31208 19072 12719 5263 2790 2165 1454 855 317 2835 78678 1990 20945 18027 14084 1990 20945 18027 14084 1990 20945 18027 14075 32920 1810 1410 1805 18075 18075 18075 1990 1990 1990 1990 1990 1997 1990 1997 1990 1997 | 118095 1981 29894 25509 14692 7604 1669 1199 768 526 2305 87416 1991 28479 17096 13420 6522 2876 1626 | 122029 1982 38984 24336 18640 8497 4283 2295 998 675 428 1446 100582 1992 1992 42159 23179 12876 7759 23769 1303 | 115446 1983 40439 31878 18659 11098 5439 2384 1363 470 331 1595 113656 1993 109779 34492 18200 8945 3585 3585 | 106767 1984 43073 33077 22928 10999 6772 3702 1267 660 243 689 123410 1994 1994 280 89866 25975 12498 4768 1873 | 0 227 71401 19436 9259 3477 | 27946 22081 16286 9240 4687 2489 1375 743 | 28936 22899 16941 9831 5070 2771 1597 890 |
| TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 8 9 TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 7 | 516 69464 Stock nu 1975 24954 26686 18412 8243 5831 3331 2906 2564 601 1039 94566 Stock nu 1985 22048 35123 24353 13748 6841 4752 2414 | 79438 mber at ag 1976 17320 20008 19512 9098 4464 3580 1944 1472 1461 3400 82659 mber at ag 1986 30484 18046 26692 15332 8512 4288 2785 | 78931 e (start of yr 1977 14148 14163 8577 4952 2040 1924 997 741 2356 68634 997 741 2356 68634 997 741 2356 68634 997 741 1987 30508 24748 14077 15476 5041 3566 2257 | 93322 9372 1978 20363 15160 10450 10450 2543 1005 1071 471 3843 66910 22052 24977 18730 9550 6447 24052 1719 | 96474 Numbers' 1979 23306 16638 8445 4729 3939 2569 1452 560 657 2605 54901 Numbers' 1989 22043 18035 17215 10219 4668 2928 1027 | 109571 109771 1980 31208 19072 12719 5263 2790 2165 2165 317 2835 78678 1990 20945 18027 14081 7575 3292 1810 1148 | 118095 1981 29894 25509 14659 14659 1469 1659 7788 526 2305 87416 1991 28479 17096 13420 6522 2876 13420 6522 2876 | 122029 1982 38984 24336 18640 8497 4283 2295 998 675 428 675 428 1446 100582 1992 42159 23179 12876 7759 2708 1303 788 | 115446 1983 40439 31878 18659 11098 5439 2384 1383 470 331 1595 113656 1993 109779 34492 18200 8945 3585 13505 779 | 106767 1984 43073 33077 22928 10999 6772 3702 1267 660 243 689 9123410 1994 280 89896 25975 12498 4788 1873 862 | 0 227 71401 19436 9259 3477 1281 | 27946 22081 16286 9240 4687 2489 1375 | 28936 22899 16941 9831 5070 2771 1597 |
| TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 8 9 9 TOTAL Table 10 YEAR AGE 1 2 3 4 5 6 7 8 9 7 8 9 7 8 9 7 8 7 8 7 8 8 7 8 9 7 8 7 8 | 516 69464 Stock nu 1975 24954 26686 18412 8243 5831 3331 2906 2564 601 1039 94566 Stock nu 1985 22048 35123 24353 13748 6841 4752 2414 4752 2414 766 | 79438 mber at age 1976 20408 19612 9098 4464 3580 1944 1472 1461 3400 82659 1986 30484 18046 26692 15332 15332 8512 4288 2785 24288 2785 | 78931 e (start of yr 1977 14148 14163 8577 4952 2040 1924 997 741 2356 68634 e (start of yr 1987 30508 24748 14077 15476 5041 3356 2257 1335 | 93322 937) 1978 20363 15196 10450 7399 4570 2543 1071 471 3843 66910 24977 18730 9550 6447 24977 18730 9550 6447 2402 1719 1150 | 96474 Numbers' 1979 23306 16638 8445 4729 3939 2569 1452 560 657 2605 64901 Numbers' 1989 22043 18035 17215 10219 4668 2928 1027 613 | 109571 109571 1980 31208 19072 12719 5263 2790 2165 1454 855 317 2835 78678 1990 20945 18027 14084 1990 20945 18027 14084 1990 20945 18027 14075 32920 1810 1410 1805 18075 18075 18075 1990 1990 1990 1990 1990 1997 1990 1997 1990 1997 | 118095 1981 29894 25509 14692 7404 3450 1669 1199 768 526 2305 87416 1991 1991 28479 17096 13420 6522 2876 1626 779 471 | 122029 1982 38984 24336 18640 8497 4283 2295 998 675 428 1446 100562 1992 1992 42159 23179 12876 7759 2708 1303 785 2708 | 115446 1983 40439 31878 11098 5439 2384 1383 470 331 1595 113656 1993 109779 34492 18200 8945 3585 1350 749 549 | 106767 1984 43073 33077 22928 10999 6772 3702 1267 660 243 689 123410 1994 280 89866 25975 12498 4788 1873 862 513 | 0 227 71401 19436 9259 3477 1281 608 | 27946 22081 16286 9240 4687 2489 1375 743 | 28936 22899 16941 9831 5070 2771 1597 890 |

TABLE 11. The spawing stock number-at-age calculated at spawning time for the Blackfin stock using Traditional VPA.

Run title : Blackfin: VPA course. Combined sex; plusgroup.

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Traditional vpa using screen input for terminal F

| Table 11 YEAR | Spawning s 1963 | tock numb 1964 | er at age (spawning time) | Numbers*10**-3 |
|------------------|--------------------|-------------------|---------------------------|----------------|
| AGE | | | | |
| 1 | 0 | 0 | | |
| 2 | 0 | 0 | | |
| 3 | 0 | 0 | | |
| 4 | 0 | 0 | | |
| 5 | 1815 | 2279 | | |
| 6 | 859 | 1191 | | |
| 7 | 527 | 510 | | |
| 8 | 520 | 366 | | |
| 9 | 378 | 292 | | |
| +gp | 365 | 551 | | |

| Table 11 | Spawning s | tock numbe | eratage (sp | awning time) | Numb | ers*10**-3 | | | | |
|----------|------------|------------|---------------|--------------|------|------------|------|------|------|------|
| YEAR | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
| 105 | | | | | | | | | | |
| AGE | 0 | 0 | | • | ~ | 0 | • | • | • | • |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 4760 | 2748 | 6738 | 3861 | 4916 | 7864 | 6624 | 9890 | 7299 | 6432 |
| 6 | 1238 | 2324 | 1160 | 3781 | 2087 | 2680 | 4816 | 3725 | 6069 | 4229 |
| 7 | 671 | 555 | 1280 | 709 | 2537 | 1254 | 1656 | 2967 | 2639 | 4173 |
| 8 | 275 | 306 | 333 | 642 | 447 | 1566 | 810 | 938 | 2129 | 1740 |
| 9 | 262 | 143 | 216 | 191 | 412 | 271 | 1106 | 340 | 624 | 1440 |
| +gp | 516 | 260 | 365 | 381 | 367 | 813 | 877 | 600 | 1477 | 2493 |
| | | | | | | | | | | |
| Table 11 | Snawning s | took numbe | ar at ane (sr | awning time) | Numh | ers*10**-3 | | | | |
| YEAR | 1975 | 1976 | 1977 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
| 12/43 | 1313 | 10/0 | 1011 | 1970 | 1010 | 1300 | 1301 | 1302 | 1000 | 1004 |
| AGE | | | | | | | | | | |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | Ó | Ó | Ó | 0 | 0 |
| 3 | 0 | Û | Ō | Ō | Ō | 0 | Ō | Ō | 0 | 0 |
| 4 | Ō | Ō | Ō | Ō | Ō | ō | Ō | Ō | Ō | Ō |
| 5 | 5831 | 4464 | 4952 | 4570 | 3939 | 2790 | 3450 | 4283 | 5439 | 6772 |
| 6 | 3331 | 3580 | 2040 | 2543 | 2569 | 2165 | 1669 | 2295 | 2384 | 3702 |
| 7 | 2906 | 1944 | 1924 | 1005 | 1452 | 1454 | 1199 | 998 | 1363 | 1267 |
| 8 | 2564 | 1472 | 997 | 1071 | 560 | 855 | 768 | 675 | 470 | 660 |
| 9 | 601 | 1461 | 741 | 471 | 657 | 317 | 526 | 428 | 331 | 243 |
| +gp | 1039 | 3400 | 2356 | 3843 | 2605 | 2835 | 2305 | 1446 | 1595 | 689 |
| 0. | | | | | | | | | | |
| | | | | | | | | | | |
| Table 11 | Spawning s | tock numbe | | awning time) | | ers*10**-3 | | | | |
| YEAR | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
| | | | | | | | | | | |
| AGE | _ | | | _ | | | | | | |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | Q | 0 | 0 | 0 | 0 | 0 | Q | 0 | 0 |
| 5 | 6841 | 8512 | 5041 | 6447 | 4668 | 3292 | 2876 | 2708 | 3585 | 4788 |
| 6 | 4752 | 4288 | 3586 | 2402 | 2928 | 1810 | 1626 | 1303 | 1350 | 1873 |
| 7 | 2414 | 2785 | 2257 | 1719 | 1027 | 1148 | 779 | 788 | 749 | 862 |
| 8 | 766 | 1429 | 1335 | 1150 | 613 | 504 | 471 | 260 | 549 | 513 |
| 9 | 415 | 459 | 748 | 686 | 322 | 271 | 194 | 175 | 158 | 399 |
| +gp | 893 | 855 | 603 | 684 | 378 | 322 | 450 | 301 | 306 | 871 |
| | | | | | | | | | | |

TABLE 12. The stock biomass-at-age calculated at the start of the year (without SOP correction) for the Blackfin stock using Traditional VPA.

Run title : Blackfin: VPA course. Combined sex; plusgroup.

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| Table 12 | Stock bior | mass at age (start of year) | Tonnes |
|----------|------------|-----------------------------|--------|
| YEAR | 1963 | 1964 | |
| AGE | | | |
| 1 | 0 | 0 | |
| 2 | 11983 | 19911 | |
| 3 | 15429 | 15259 | |
| 4 | 6262 | 16845 | |
| 5 | 4265 | 6290 | |
| 6 | 2757 | 4480 | |
| 7 | 2200 | 2177 | |
| 8 | 1953 | 1853 | |
| 9 | 2004 | 1826 | |
| +gp | 2756 | 4021 | |
| TOTALBIO | 49609 | 72661 | |
| | | | |

| Table 12 | | | e (start of ye | , | Tonnes | | | | | |
|-----------|----------------|----------------|----------------|----------------|---------------|--------------|--------------|---------------|---------------|----------------|
| YEAR | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
| AGE | | | | | | | | | | |
| 1 | 0 | 0 | 0 | 17298 | 0 | 0 | 0 | 17965 | 10040 | 10378 |
| 2 | 11697 | 10095 | 27366 | 11728 | 23013 | 12941 | 20780 | 21835 | 17919 | 15433 |
| 3 | 23515 | 13879 | 15059 | 24504 | 15804 | 25761 | 16748 | 27947 | 22129 | 16249 |
| 4 | 11247 | 23666 | 12447 | 14301 | 20971 | 15119 | 21363 | 22519 | 18683 | 15707 |
| 5 | 11758 | 7531 | 15094 | 8456 | 11208 | 15571 | 11857 | 24467 | 18154 | 11037 |
| 6 | 4765 | 7503 | 4096 | 11301 | 6158 | 7904 | 13195 | 9392 | 18359 | 14893 |
| 7 | 3006 | 2564 | 4815 | 2870 | 8906 | 4601 | 5812 | 8629 | 9515 | 18860 |
| 8 | 1494 | 1780 | 1751 | 2868 | 2205 | 7639 | 3808 | 4586 | 10082 | 8673 |
| 9 | 1779 | 935 | 1286 | 1006 | 2363 | 1696 | 5837 | 2045 | 4168 | 8658 |
| +gp | 3875 | 2095 | 2637 | 2815 | 2778 | 5820 | 6439 | 4852 | 11974 | 20630 |
| TOTALBIO | 73135 | 70049 | 84549 | 97147 | 93404 | 97052 | 105839 | 144236 | 141023 | 140518 |
| 101112010 | , 0,00 | 10010 | 01010 | 01111 | 00101 | 01002 | 100000 | | | 110010 |
| | . | | | | _ | | | | | |
| Table 12 | | | e (start of ye | | Tonnes | 1000 | | 4000 | 1000 | |
| YEAR | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
| AGE | | | | | | | | | | |
| 1 | 11553 | 7690 | 8600 | 9795 | 11886 | 12951 | 11928 | 16841 | 15367 | 20287 |
| 2 | 19641 | 14000 | 9323 | 7628 | 11597 | 12397 | 17270 | 17376 | 21486 | 24014 |
| 3 | 17087 | 19883 | 11953 | 11798 | 11131 | 14818 | 16235 | 19945 | 23342 | 25404 |
| 4 | 12290 | 13264 | 11974 | 12556 | 9335 | 10147 | 12712 | 15023 | 20431 | 19700 |
| 5 | 15002 | 12438 | 11152 | 12061 | 9418 | 7378 | 10341 | 11657 | 16801 | 18088 |
| 6 | 11602 | 11805 | 6647 | 9893 | 8585 | 7689 | 6833 | 8891 | 8716 | 13040 |
| 7 | 13875 | 8287 | 8347 | 4838 | 6656 | 6623 | 6215 | 5277 | 6869 | 6008 |
| 8 | 14325 | 7416 | 5119 | 5868 | 3237 | 4730 | 4886 | 4149 | 2966 | 3853 |
| 9 | 3925 | 8624 | 4406 | 2891 | 4569 | 2069 | 3866 | 3321 | 2316 | 1863 |
| +gp | 8885 | 26915 | 18626 | 32940 | 24293 | 27368 | 22924 | 15443 | 17334 | 7496 |
| TOTALBIO | 128186 | 130324 | 96149 | 110267 | 100707 | 106171 | 113208 | 117923 | 135628 | 139752 |
| | | | | | | | | | | |
| Table 12 | Stock bio | mass at aq | e (start of ye | ar) | Tonnes | | | | | |
| YEAR | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
| AGE | | | | | | | | | | |
| AGE 1 | 8885 | 20455 | 13820 | 12349 | 11021 | 11520 | 16062 | 22092 | 67514 | 177 |
| 2 | 24656 | 13282 | 15047 | 17484 | 13346 | 13466 | 14788 | 18334 | 29387 | 84384 |
| 2 3 | 25497 | 23115 | 13444 | 19367 | 15992 | 12546 | 13004 | 14459 | 20056 | 30339 |
| 4 | | | | | | | | | | |
| 4 5 | 22959 17854 | 20438 18719 | 18323 10007 | 12836 10998 | 11843 7455 | 9309 6088 | 8055 5168 | 10397 5525 | 12827 7076 | 20147 11117 |
| 56 | | | | 7709 | | 4737 | | | 3906 | 5615 |
| 7 | 15348 | 13466 | 10952 | | 7545 | | 3848 | 3541 | | |
| 8 | 10384 | 11453 | 9977 | 7587 | 4505 | 4328 | 2530 | 3280 | 2912 | 3774 2758 |
| 8 | 4580 | 7355 | 7541 | 6375 | 3471 | 2871 | 2183 | 1313 | 2709 | |
| | 3050 | 2922 | 5413 | 4924 | 2237 | 1883 | 1268 | 1142 | 1008 | 2551 |
| +gp | 9866 | 8098 | 6620 | 6813 | 3306 | 2856 | 3914 | 2932 | 2619 | 7714 |
| TOTALBIO | 143081 | 139302 | 111144 | 106441 | 80723 | 69604 | 70820 | 83016 | 150013 | 168575 |

TABLE 13. The spawning stock biomass-at-age calculated at spawning time (without SOP correction) for the Blackfin stock using Traditional VPA.

Run title : Blackfin: VPA course. Combined sex; plusgroup.

At 1/02/2002 8:46

Traditional vpa using screen input for terminal F

Table 13 Spawning stock biomass at age (spawning time) Tonnes YEAR AGE 5 6 +gp TOTSPBIO

| Table 13 | Spawning | stock bioma | ass at age (s | spawning tir | ne) Toni | nes | | | | |
|----------|----------|-------------|-----------------------|--------------|----------|-------|-------|-------|-------|-------|
| YEAR | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
| AGE | | | | | | | | | | |
| AGE 1 | 0 | • | • | • | 0 | ~ | | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 11758 | 7531 | 15094 | 8456 | 11208 | 15571 | 11857 | 24467 | 18154 | 11037 |
| 6 | 4765 | 7503 | 4096 | 11301 | 6158 | 7904 | 13195 | 9392 | 18359 | 14893 |
| 7 | 3006 | 2564 | 4815 | 2870 | 8906 | 4601 | 5812 | 8629 | 9515 | 18860 |
| 8 | 1494 | 1780 | 1751 | 2868 | 2205 | 7639 | 3808 | 4586 | 10082 | 8673 |
| 9 | 1779 | 935 | 1286 | 1006 | 2363 | 1696 | 5837 | 2045 | 4168 | 8658 |
| +gp | 3875 | 2095 | 2637 | 2815 | 2778 | 5820 | 6439 | 4852 | 11974 | 20630 |
| TOTSPBIO | 26677 | 22409 | 29678 | 29316 | 33616 | 43231 | 46948 | 53971 | 72252 | 82751 |
| | | | | | | | | | | |
| Table 13 | Spawning | stock bioma | use at a na (s | nowning tir | ne) Tonr | - | | | | |
| YEAR | 1975 | 1976 | 193 at age (t 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
| | 1313 | 1310 | 1317 | 1370 | 1070 | 1300 | 1001 | 1302 | 1000 | 1504 |
| AGE | | | | | | | | | | |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | Ō | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 15002 | 12438 | 11152 | 12061 | 9418 | 7378 | 10341 | 11657 | 16801 | 18088 |
| 6 | 11602 | 11805 | 6647 | 9893 | 8585 | 7689 | 6833 | 8891 | 8716 | 13040 |
| 7 | 13875 | 8287 | 8347 | 4838 | 6656 | 6623 | 6215 | 5277 | 6869 | 6008 |
| 8 | 14325 | 7416 | 5119 | 5868 | 3237 | 4730 | 4886 | 4149 | 2966 | 3853 |
| 9 | 3925 | 8624 | 4406 | 2891 | 4569 | 2069 | 3866 | 3321 | 2316 | 1863 |
| +gp | 8885 | 26915 | 18626 | 32940 | 24293 | 27368 | 22924 | 15443 | 17334 | 7496 |
| TOTSPBIO | 67615 | 75486 | 54298 | 68491 | 56758 | 55858 | 55064 | 48738 | 55002 | 50348 |
| | | | 0.1200 | | | 00000 | | | ••••- | |
| | | | | | | | | | | |
| Table 13 | | stock bioma | | | | | | | | |
| YEAR | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
| | | | | | | | | | | |
| AGE | | • | ~ | ~ | ~ | ~ | ~ | • | • | • |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 17854 | 18719 | 10007 | 10998 | 7455 | 6088 | 5168 | 5525 | 7076 | 11117 |
| 6 | 15348 | 13466 | 10952 | 7709 | 7545 | 4737 | 3848 | 3541 | 3906 | 5615 |
| 7 | 10384 | 11453 | 9977 | 7587 | 4505 | 4328 | 2530 | 3280 | 2912 | 3774 |
| 8 | 4580 | 7355 | 7541 | 6375 | 3471 | 2871 | 2183 | 1313 | 2709 | 2758 |
| 9 | 3050 | 2922 | 5413 | 4924 | 2237 | 1883 | 1268 | 1142 | 1008 | 2551 |
| +gp | 9866 | 8098 | 6620 | 6813 | 3306 | 2856 | 3914 | 2932 | 2619 | 7714 |
| TOTSPBIO | 61083 | 62012 | 50509 | 44405 | 28519 | 22763 | 18911 | 17734 | 20229 | 33529 |

TABLE 14. The stock biomass at age calculated at the start of the year (with SOP correction) for the Blackfin stock using Traditional VPA.

Run title : Blackfin: VPA course. Combined sex; plusgroup.

At 1/02/2002 8:46

Traditional vpa using screen input for terminal F

 Table 14
 Stock biomass at age with SOP (start of year)

 YEAR
 1963
 1964
 Tonnes AGE 5 6 2911

| 2311 | 4055 |
|-------|------------------------------|
| 2322 | 2280 |
| 2062 | 1 941 |
| 2116 | 1913 |
| 2909 | 4212 |
| 52376 | 76120 |
| | 2322 2062 2116 2909 |

| YEAR 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 AGE 1 0 0 0 17024 0 0 0 18031 9327 10082 2 11508 10046 27975 11541 22720 12774 20451 21916 166846 14983 3 23138 13812 15394 24116 160503 25428 16482 20050 20557 15755 5 11569 7495 15430 8322 11065 15370 11669 4426 17054 14468 7 2957 2552 4922 2825 8792 4541 5745 6337 4870 11123 20041 *gp 3812 2085 2696 2770 2742 5745 6337 4870 11123 20041 TOTALBIO 71956 69712 86431 95605 92217 95799 | Table 14 | Stock bio | mass at age | e with SOP | (start of yea | r) Tonne | 9 \$ | | | | |
|---|----------|-----------|-------------|------------|---------------|----------|---------------|-------------------|--------|--------|--------|
| 1 0 0 0 17024 0 0 0 18031 19327 10082 2 11508 10046 27975 11541 22720 12774 20451 21916 16646 14993 3 23138 13812 15394 24116 15603 25428 16442 22602 17355 15259 5 11569 7495 15430 8322 10065 13707 11669 24557 16864 10722 6 4688 7467 1417 11122 6000 7002 12986 9426 17054 14488 7 2957 2552 4922 2827 707 2742 5745 6337 4603 9366 8426 9 17751 931 1314 990 2333 1674 5745 2052 3872 8411 TOTALBIO 71956 69712 86431 95605 92217 95799 1941 | YEAR | | | | | | 1970 | 1971 | 1972 | 1973 | 1974 |
| 1 0 0 0 17024 0 0 0 16031 9527 10082 2 11508 10046 27975 11541 22720 12774 20451 21916 16646 14993 3 23138 13812 15394 24116 15603 25428 16482 28002 13755 15259 5 11569 7495 15430 8322 10065 13370 11669 24557 18684 10722 6 4688 7467 4187 11122 6080 7002 12986 9426 17054 14488 8 1470 1772 1790 2822 2177 7540 3748 4603 9366 8322 9 1751 931 1314 990 2333 1674 5745 2052 3872 4871 11123 2041 TOTALBIO 71956 69712 86613 95707 7742 15799 | | | | | | | | | | | |
| 2 11508 10046 27975 11541 22720 12774 20451 28050 20557 15785 3 23136 13812 15394 24116 15603 25428 16482 28050 20557 15785 4 11066 23552 12724 14074 20705 14924 21024 22805 17355 15269 5 11569 7485 15430 8322 11065 15370 11669 9426 17355 15269 6 4688 7467 4187 11122 6000 7802 12986 9426 1751 931 1314 990 2333 1674 5745 2052 3872 8411 +gp 3812 2085 2696 2770 2742 5745 6337 4870 11123 20041 TOTALBIO 71956 69712 86431 95605 92217 9579 104162 144770 131003 136510 TABL 14 Stock biomass at age with SOP (start of year) Tonnes 1984 1497 | AGE | | | | | | | | | | |
| 3 23136 1312 15394 24116 15603 25428 14074 20705 14924 21024 22602 17355 15259 5 11569 7495 15430 8322 11066 15370 11669 24557 16864 10722 6 4688 7467 4187 11122 6080 7802 12988 9426 17054 144468 7 2957 2552 4922 2252 8792 4541 5720 8661 8838 18322 8 1470 1772 1790 2822 2177 7540 3744 4603 9366 8426 9 1751 931 1314 990 2333 1674 6470 11123 20041 TOTALBIO 71956 69712 86431 95605 92217 95799 104162 14470 131003 136510 Table 14 Stock blomass at age with SOP (start of year) Tonnes 19267 19763 1976 1972 1980 1981 1962 1983 | 1 | 0 | 0 | 0 | 17024 | 0 | 0 | 0 | 18031 | 9327 | 10082 |
| 4 11066 23552 12724 14074 20705 14924 21024 22457 17355 15259 5 11569 7495 15430 8322 1065 15370 11669 24557 16864 10722 6 4668 7467 4187 11122 6080 7802 12986 9426 17054 14463 7 2957 2552 4922 2277 7574 6337 4670 11123 20041 9 1751 931 1314 990 2333 1674 5745 6337 4670 11123 20041 TOTALBIO 71956 69712 86431 95605 92217 9579 104162 144770 13103 13651 4GE 1975 1976 1977 1378 1979 1980 1981 1982 1983 1984 AGE 1 11334 7488 8262 9489 11810 12893 11740 16665 15720 19989 2 19267 13632 <td< td=""><td>2</td><td>11508</td><td>10046</td><td>27975</td><td>11541</td><td>22720</td><td>12774</td><td>20451</td><td>21916</td><td>16646</td><td>14993</td></td<> | 2 | 11508 | 10046 | 27975 | 11541 | 22720 | 12774 | 20451 | 21916 | 16646 | 14993 |
| 5 11569 7465 15430 8322 11065 15370 11686 2457 18684 10722 6 4688 7467 4187 11122 6080 7802 12985 9426 17054 14468 7 2957 2552 4922 2822 2177 7540 3748 4603 9366 8426 9 1751 331 1314 990 2333 1674 6337 4670 11123 20041 TOTALBIO 71956 69712 86431 95605 92217 95799 104162 144770 131003 136510 Table 14 Stock blomass at age with SOP (start of year) Tonnes Tonnes 1975 1976 1977 1978 1979 1980 1981 1962 1963 1984 AGE 1 11334 7488 8262 9489 11810 12893 11740 16655 15720 19989 21962 19824 21980 | 3 | 23136 | 13812 | 15394 | 24116 | 15603 | 25428 | 16482 | 28050 | 20557 | 15785 |
| 6 4688 7467 4187 11122 6080 7802 12886 9426 17054 14488 7 2957 2552 4922 2825 8792 4541 5720 8661 8838 18322 9 17751 931 1314 990 2333 1674 5745 2052 3872 8411 TOTALBIO 71956 69712 86431 9605 92217 95799 104162 144770 131003 136510 TotALBIO 71956 69712 86431 95605 92217 95799 104162 144770 131003 136510 TotALBIO 71975 1976 1977 1978 1979 1980 1981 1982 1983 1964 AGE 1 11334 7488 8262 9489 11810 12893 11740 16665 15720 19989 2 19267 13630 11484 11430 | 4 | 11066 | 23552 | 12724 | 14074 | 20705 | 14924 | 21024 | 22602 | 17355 | 15259 |
| 7 2957 2552 4922 2822 2177 7540 3748 4661 8938 18322 9 1751 931 1314 990 2333 1674 5745 2052 3372 8411 +gp 3612 2085 2696 2770 2742 5745 6337 4470 11123 20041 TOTALBIO 71956 69712 86431 95605 92217 95799 104162 144770 13103 136610 Table 14 Stock biomass at age with SOP (start of year) Tonnes 1981 1982 1983 1964 AGE 1 11334 7488 8262 9489 11810 12893 11740 16665 15720 19989 2 19267 13632 8957 7390 11523 12342 16998 17141 12866 20300 19410 5 14771 12111 10714 11685 9587 3455 10178 | 5 | 11569 | 7495 | 15430 | 8322 | 11065 | 15370 | 11669 | 24557 | 16864 | 10722 |
| 8 1470 1772 1790 2822 2177 7540 3748 4603 9366 8426 9 1751 931 1314 990 2333 1674 5745 2025 3872 8411 TOTALBIO 71956 69712 86431 95605 92217 95799 104162 144770 131003 136510 TOTALBIO 71956 69712 86431 95605 92217 95799 104162 144770 131003 136510 ToTALE Tonnes Tonnes Tonnes 1 131303 1964 AGE | 6 | 4688 | 7467 | 4187 | 11122 | 6080 | 7802 | 12986 | 9426 | 17054 | 14468 |
| 9 1751 931 1314 990 2333 1674 5745 2052 3872 8411 TOTALBIO 71956 69712 86431 95605 92217 95799 104162 144770 131003 136510 Table 14 Stock blomass at age with SOP (start of year) Tonnes 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 AGE | 7 | 2957 | 2552 | 4922 | 2825 | 8792 | 4541 | 5720 | 8661 | 8838 | 18322 |
| +gp 3812 2085 2696 2770 2742 5745 6337 4870 11123 20041 TOTALBIO 71956 69712 86431 95605 92217 95799 104162 144770 131003 136510 Table 14 Stock blomass at age with SOP (start of year) Tonnes 1979 1980 1981 1982 1983 1984 AGE 1 11334 7488 8262 9489 11810 12893 11740 16665 15720 19989 2 19267 13632 8967 7390 11523 12342 16998 17194 21860 23661 3 16761 19360 11484 11430 11060 14752 15979 19736 23878 25030 4 12056 12916 11503 12164 9276 10102 12512 14868 2980 19410 54487 13178 17821 6 11382 1495 <td< td=""><td>8</td><td>1470</td><td>1772</td><td>1790</td><td>2822</td><td>2177</td><td>7540</td><td>3748</td><td>4603</td><td>9366</td><td>8426</td></td<> | 8 | 1470 | 1772 | 1790 | 2822 | 2177 | 7540 | 3748 | 4603 | 9366 | 8426 |
| TOTALBIO 71956 69712 86431 95605 92217 95799 104162 144770 131003 136510 Table 14 YEAR Stock biomass at age with SOP (start of year) Tonnes Tonnes 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 AGE | 9 | 1751 | 931 | 1314 | 990 | 2333 | 1674 | 5745 | 2052 | 3872 | 8411 |
| Table 14 YEAR Stock blomass at age with SOP (start of year) 1975 Tonnes 1977 Tonnes 1979 Tonnes 1980 1981 1982 1983 1984 AGE 2 19257 13632 8957 7390 11523 12342 16998 17140 16665 15720 19989 2 19267 13632 8957 7390 11523 12342 16998 17194 21980 23661 3 16761 19360 11484 11430 11060 14752 15979 1973 23878 25030 4 12056 12916 11503 12164 9276 10102 12512 14866 20900 19410 5 14717 12111 10714 11685 9358 7345 10178 11535 17187 17821 6 11382 1495 6386 9584 4830 7655 6725 8798 8916 12848 7 13611 8069 8019 4687 661 | +gp | 3812 | 2085 | 2696 | 2770 | 2742 | 5745 | 6337 | 4870 | 11123 | 20041 |
| YEAR 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 AGE | TOTALBIO | 71956 | 69712 | 86431 | 95605 | 92217 | 95799 | 104162 | 144770 | 131003 | 136510 |
| YEAR 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 AGE | | | | | | | | | | | |
| YEAR 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 AGE | | | | | | | | | | | |
| AGE 1 11334 7488 8262 9489 11810 12893 11740 16665 15720 19989 2 19267 13632 8957 7390 11523 12342 16998 17194 21980 23661 3 16761 19360 11484 11430 11060 14752 15979 19736 23878 25030 4 12056 12916 11503 12164 9276 10102 12512 14866 20900 19410 5 14717 12111 10714 11685 9358 7345 10178 11535 17187 17821 6 11382 11495 6386 9584 8530 7655 6725 8798 8916 12848 7 13611 8069 8019 4687 6614 6594 6117 5222 7027 5520 8 14052 7221 4918 5684 3217 4709 4809 4105 3034 3797 9 3851 8398 4233 2801 4540 2060 3806 3286 2369 11385 +gp 8716 26207 17894 31912 24138 27246 22563 15282 17733 7386 TOTALBIO 125746 126897 92371 106627 100064 105698 111426 116691 138744 137696 XGE 1 8802 1987 14669 12251 10449 11074 16182 22133 67483 176 2 24424 12589 15971 17345 12653 12944 14898 18369 29374 83959 3 25257 21908 14269 19213 15162 12060 13101 14487 20047 30186 4 22742 19371 19448 12734 11229 8949 8115 10417 12821 20047 30186 4 22742 19371 19448 12734 11229 8949 8115 10417 12821 20047 30186 4 22742 19371 19448 12734 11229 8949 8115 10417 12821 20047 30186 4 22742 19371 19448 12734 11229 8949 8115 10417 12821 20047 30186 4 22742 10367 14669 12251 10449 11074 16182 22133 67483 176 5 17686 17742 10621 10911 7668 5852 5206 5537 0703 11061 6 15203 12763 11624 7648 7153 4554 3876 3548 3904 5586 7 10287 10855 10590 7527 4271 4160 2549 3286 2911 3755 8 4537 6971 8004 6324 3291 2759 2199 1316 2708 3268 2911 3755 8 4537 6971 8004 6324 3291 2759 2199 1316 2708 2744 9 3022 2769 5754 6488 7527 4221 8100 1278 1144 1007 2588 2744 9 3022 2769 5754 6488 7527 4221 8100 1278 1144 1007 2588 2014 | Table 14 | Stock bio | mass at age | e with SOP | (start of yea | r) Tonne | 95 | | | | |
| 1 11334 7488 8262 9489 11810 12893 11740 16665 15720 19989 2 19267 13632 8957 7390 11523 12242 16998 17194 21980 23676 3 16761 19360 11484 11430 11060 14752 15979 19736 23878 25030 4 12056 12916 11503 12164 9276 10102 12512 14866 02900 19410 5 14717 12111 10714 11685 9358 7345 10178 11535 17187 17821 6 11382 11495 6386 9584 8530 7555 6725 8798 8916 12848 7 13611 8069 8019 4687 6614 6594 6117 5222 7027 5920 8 14052 7221 4918 5684 3217 4709 4809 4105 3034 3797 9 3851 8398 4233 280 | YEAR | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
| 1 11334 7488 8262 9489 11810 12893 11740 16665 15720 19989 2 19267 13632 8957 7390 11523 12242 16998 17194 21980 23676 3 16761 19360 11484 11430 11060 14752 15979 19736 23878 25030 4 12056 12916 11503 12164 9276 10102 12512 14866 02900 19410 5 14717 12111 10714 11685 9358 7345 10178 11535 17187 17821 6 11382 11495 6386 9584 8530 7555 6725 8798 8916 12848 7 13611 8069 8019 4687 6614 6594 6117 5222 7027 5920 8 14052 7221 4918 5684 3217 4709 4809 4105 3034 3797 9 3851 8398 4233 280 | | | | | | | | | | | |
| 2 19267 13632 8957 7390 11523 12342 16998 17194 21980 23661 3 16761 19360 11484 11430 11060 14752 15979 19736 23878 25030 4 12056 12916 11503 12164 9276 10102 12512 14866 20900 19410 5 14717 12111 10714 11685 9358 7345 10178 11535 17187 17821 6 11382 11495 6386 9584 8530 7655 6725 8798 8916 12848 7 13611 8069 8019 4687 6614 6594 6117 5222 7027 5920 8 14052 7221 4918 5684 3217 4709 4809 4105 3034 3797 9 3851 8398 4233 2801 4540 2060 3806 3286 23681 13354 13769 ToTALBIO 125746 126897 | AGE | | | | | | | | | | |
| 3 16761 19360 11484 11430 11060 14752 15979 19736 23878 25030 4 12056 12916 11503 12164 9276 10102 12512 14866 20900 19410 5 14717 12111 10714 11685 9358 7345 10178 11535 17187 17821 6 11382 11495 6386 9584 8530 7655 6725 8798 8916 12848 7 13611 8069 8019 4687 6614 6594 6117 5222 7027 5920 8 14052 7221 4918 5684 3217 4709 4809 4105 3034 3797 9 3851 8398 4233 2801 4540 2060 3806 3286 2369 1835 +gp 8716 26207 17894 31912 24138 27246 22563 15282 17733 7386 TOTALBIO 125746 126897 92371 | 1 | 11334 | 7488 | 8262 | 9489 | 11810 | 12893 | 11740 | 16665 | 15720 | 19989 |
| 4 12056 12916 11503 12164 9276 10102 12512 14866 20900 19410 5 14717 12111 10714 11685 9358 7345 10178 11535 17187 17821 6 11382 11495 6386 9584 8530 7655 6725 8798 8916 12848 7 13611 8069 8019 4687 6614 6594 6117 5222 7027 5920 8 14052 7221 4918 5684 3217 4709 4809 4105 3034 3797 9 3851 8398 4233 2801 4540 2060 3806 3286 2369 1835 +gp 8716 26207 17894 31912 24138 27246 22563 15282 17733 7386 TOTALBIO 125746 126897 92371 100647 19598 111426 11691 138744 137696 Z 24424 12589 15971 17345 | 2 | 19267 | 13632 | 8957 | 7390 | 11523 | 12342 | 16998 | 17194 | 21980 | 23661 |
| 5 14717 12111 10714 11685 9358 7345 10178 11535 17187 17821 6 11382 11495 6386 9584 8530 7655 6725 8798 8916 12848 7 13611 8069 8019 4687 6614 6594 6117 5222 7027 5920 8 14052 7221 4918 5684 3217 4709 4809 4105 3034 3797 9 3851 8398 4233 2801 4540 2060 3806 3286 2369 1835 +gp 8716 26207 17894 31912 24138 27246 22563 15282 17733 7386 TOTALBIO 125746 126897 92371 106827 100064 105698 111426 116691 138744 137696 AGE | 3 | 16761 | 19360 | 11484 | 11430 | 11060 | 14752 | 15979 | 19736 | 23878 | 25030 |
| 6 11382 11495 6386 9584 8530 7655 6725 8798 8916 12848 7 13611 8069 8019 4687 6614 6594 6117 5222 7027 5920 8 14052 7221 4918 5684 3217 4709 4809 4105 3034 3797 9 3851 8398 4233 2801 4540 2060 3806 3286 2369 1835 +gp 8716 26207 17894 31912 24138 27246 22563 15282 17733 7386 TOTALBIO 125746 126897 92371 106827 100064 105698 111426 11691 138744 137696 Table 14 Stock biomass at age with SOP (start of year) Tonnes Tonnes Tonnes 1985 1986 1989 1990 1991 1992 1993 1994 AGE | 4 | 12056 | 12916 | 11503 | 12164 | 9276 | 10102 | 12512 | 14866 | 20900 | 19410 |
| 7 13611 8069 8019 4687 6614 6594 6117 5222 7027 5920 8 14052 7221 4918 5684 3217 4709 4809 4105 3034 3797 9 3851 8398 4233 2801 4540 2060 3806 3286 2369 1835 +gp 8716 26207 17894 31912 24138 27246 22563 15282 17733 7386 TOTALBIO 125746 126897 92371 106827 100064 105698 111426 116691 138744 137696 Table 14 Stock biomass at age with SOP (start of year) Tonnes Tonnes Tonnes Tonnes 1983 1999 1990 1991 1992 1993 1994 AGE | 5 | 14717 | 12111 | 10714 | 11685 | 9358 | 7345 | 10178 | 11535 | 17187 | 17821 |
| 8 14052 7221 4918 5684 3217 4709 4809 4105 3034 3797 9 3851 8398 4233 2801 4540 2060 3806 3286 2369 1835 +gp 8716 26207 17894 31912 24138 27246 22563 15282 17733 7386 TOTALBIO 125746 126897 92371 106827 100064 105698 111426 116691 138744 137696 Table 14 Stock biomass at age with SOP (start of year) Tonnes 1 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 AGE | 6 | 11382 | 11495 | 6386 | 9584 | 8530 | 7655 | 6725 | 8798 | 8916 | 12848 |
| 9 3851 8398 4233 2801 4540 2060 3806 3286 2369 1835 +gp 8716 26207 17894 31912 24138 27246 22563 15282 17733 7386 TOTALBIO 125746 126897 92371 106827 100064 105698 111426 116691 138744 137696 Table 14 Stock biomass at age with SOP (start of year) Tonnes 1 1990 1991 1992 1993 1994 AGE 1 8802 19387 14669 12251 10449 11074 16182 22133 67483 176 2 24424 12589 15971 17345 12653 12944 14898 18369 29374 83959 3 25257 21908 14269 19213 15162 12060 13101 14487 20047 30186 4 22742 19371 19448 12734 11229 | 7 | 13611 | 8069 | 8019 | 4687 | 6614 | 6594 | 6117 | 5222 | 7027 | 5920 |
| +gp TOTALBIO 8716 26207 17894 31912 24138 27246 22563 15282 17733 7386 TOTALBIO 125746 126897 92371 106827 100064 105698 111426 11691 138744 137696 Table 14 Stock biomass at age with SOP (start of year) Tonnes 1989 1990 1991 1992 1993 1994 AGE 1 8802 19387 14669 12251 10449 11074 16182 22133 67483 176 2 24424 12589 15971 17345 12653 12944 14898 18369 29374 83959 3 25257 21908 14269 19213 15162 12060 13101 14487 20047 30186 4 22742 19371 19448 12734 11229 8949 8115 10417 12821 20045 5 17686 17742 10621 10911 | 8 | 14052 | 7221 | 4918 | 5684 | 3217 | 4709 | 4809 | 4105 | 3034 | 3797 |
| TOTALBIO 125746 126897 92371 106827 100064 105698 111426 116691 138744 137696 Table 14 YEAR Stock biomass at age with SOP (start of year) 1985 Tonnes 1986 Tonnes 1989 Tonnes 1990 1991 1992 1993 1994 AGE | 9 | 3851 | 8398 | 4233 | 2801 | 4540 | 2060 | 3806 | 3286 | 2369 | |
| Table 14 YEARStock biomass at age with SOP (start of year) 1985Tonnes 1986Tonnes 1987Tonnes 1988AGE1880219387146691225110449110741618222133674831762244241258915971173451265312944148981836929374839593252572190814269192131516212060131011448720047301864227421937119448122989498115104171282120045517686177421062110911706858525206553570731106161520312763116247648715345543876354839045586710287108551059075274271416025493286291137558453769718004632432912759219913162708274493022276957454885212018101278114410072538+gp9773767570266759313527453943293826177675 | +gp | 8716 | 26207 | 17894 | 31912 | 24138 | 27246 | 22563 | 15282 | 17733 | 7386 |
| YEAR 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 AGE 1 8802 19387 14669 12251 10449 11074 16182 22133 67483 176 2 24424 12589 15971 17345 12653 12944 14898 18369 29374 83959 3 25257 21908 14269 19213 15162 12060 13101 14487 20047 30186 4 22742 19371 19448 12734 11229 8949 8115 10417 12821 20045 5 17686 17742 10621 10911 7068 5852 5206 5535 7073 11061 6 15203 12763 11624 7648 7153 4554 3876 3548 3904 5586 7 10287 10855 10590 7527 4271 4160 | TOTALBIO | 125746 | 126897 | 92371 | 106827 | 100064 | 105698 | 111426 | 116691 | 138744 | 137696 |
| YEAR 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 AGE 1 8802 19387 14669 12251 10449 11074 16182 22133 67483 176 2 24424 12589 15971 17345 12653 12944 14898 18369 29374 83959 3 25257 21908 14269 19213 15162 12060 13101 14487 20047 30186 4 22742 19371 19448 12734 11229 8949 8115 10417 12821 20045 5 17686 17742 10621 10911 7068 5852 5206 5535 7073 11061 6 15203 12763 11624 7648 7153 4554 3876 3548 3904 5586 7 10287 10855 10590 7527 4271 4160 | | | | | | | | | | | |
| YEAR 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 AGE 1 8802 19387 14669 12251 10449 11074 16182 22133 67483 176 2 24424 12589 15971 17345 12653 12944 14898 18369 29374 83959 3 25257 21908 14269 19213 15162 12060 13101 14487 20047 30186 4 22742 19371 19448 12734 11229 8949 8115 10417 12821 20045 5 17686 17742 10621 10911 7068 5852 5206 5535 7073 11061 6 15203 12763 11624 7648 7153 4554 3876 3548 3904 5586 7 10287 10855 10590 7527 4271 4160 | | | | | | | | | | | |
| AGE 1 8802 19387 14669 12251 10449 11074 16182 22133 67483 176 2 24424 12589 15971 17345 12653 12944 14898 18369 29374 83959 3 25257 21908 14269 19213 15162 12060 13101 14487 20047 30186 4 22742 19371 19448 12734 11229 8949 8115 10417 12821 20045 5 17686 17742 10621 10911 7068 5852 5206 5535 7073 11061 6 15203 12763 11624 7648 7153 4554 3876 3548 3904 5586 7 10287 10855 10590 7527 4271 4160 2549 3286 2911 3755 8 4537 6971 8004 6324 3291 2759 2199 1316 2708 2744 9 3022 2769 5745 4885 2120 1810 1278 1144 1007 2538 +gp 9773 7675 7026 6759 3135 2745 3943 2938 2617 7675 | Table 14 | Stock bio | mass at age | e with SOP | (start of yea | r) Tonne | es | | | | |
| 1 8802 19387 14669 12251 10449 11074 16182 22133 67483 176 2 24424 12589 15971 17345 12653 12944 14898 18369 29374 83959 3 25257 21908 14269 19213 15162 12060 13101 14487 20047 30186 4 22742 19371 19448 12734 11229 8949 8115 10417 12821 20045 5 17686 17742 10621 10911 7068 5852 5206 5535 7073 11061 6 15203 12763 11624 7648 7153 4554 3876 3548 3904 5586 7 10287 10855 10590 7527 4271 4160 2549 3286 2911 3755 8 4537 6971 8004 6324 3291 2759 2199 <t< td=""><td>YEAR</td><td>1985</td><td>1986</td><td>1987</td><td>1988</td><td>1989</td><td>1990</td><td>1991</td><td>1992</td><td>1993</td><td>1994</td></t<> | YEAR | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1 99 1 | 1992 | 1993 | 1994 |
| 1 8802 19387 14669 12251 10449 11074 16182 22133 67483 176 2 24424 12589 15971 17345 12653 12944 14898 18369 29374 83959 3 25257 21908 14269 19213 15162 12060 13101 14487 20047 30186 4 22742 19371 19448 12734 11229 8949 8115 10417 12821 20045 5 17686 17742 10621 10911 7068 5852 5206 5535 7073 11061 6 15203 12763 11624 7648 7153 4554 3876 3548 3904 5586 7 10287 10855 10590 7527 4271 4160 2549 3286 2911 3755 8 4537 6971 8004 6324 3291 2759 2199 <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<> | | | | | | | | | | | |
| 2 24424 12589 15971 17345 12653 12944 14898 18369 29374 83959 3 25257 21908 14269 19213 15162 12060 13101 14487 20047 30186 4 22742 19371 19448 12734 11229 8949 8115 10417 12821 20045 5 17686 17742 10621 10911 7068 5852 5206 5535 7073 11061 6 15203 12763 11624 7648 7153 4554 3876 3548 3904 5586 7 10287 10855 10590 7527 4271 4160 2549 3286 2911 3755 8 4537 6971 8004 6324 3291 2759 2199 1316 2708 2744 9 3022 2769 5745 4885 2120 1810 1278 1144< | | | | | | | | | | | |
| 3 25257 21908 14269 19213 15162 12060 13101 14487 20047 30186 4 22742 19371 19448 12734 11229 8949 8115 10417 12821 20045 5 17686 17742 10621 10911 7068 5852 5206 5535 7073 11061 6 15203 12763 11624 7648 7153 4554 3876 3548 3904 5586 7 10287 10855 10590 7527 4271 4160 2549 3286 2911 3755 8 4537 6971 8004 6324 3291 2759 2199 1316 2708 2744 9 3022 2769 5745 4885 2120 1810 1278 1144 1007 2538 +gp 9773 7675 7026 6759 3135 2745 3943 2938 | | 8802 | 19387 | 14669 | 12251 | 10449 | 11074 | 16182 | 22133 | 67483 | |
| 4 22742 19371 19448 12734 11229 8949 8115 10417 12821 20045 5 17686 17742 10621 10911 7068 5852 5206 5535 7073 11061 6 15203 12763 11624 7648 7153 4554 3876 3548 3904 5586 7 10287 10855 10590 7527 4271 4160 2549 3286 2911 3755 8 4537 6971 8004 6324 3291 2759 2199 1316 2708 2744 9 3022 2769 5745 4885 2120 1810 1278 1144 1007 2538 +gp 9773 7675 7026 6759 3135 2745 3943 2938 2617 7675 | | 24424 | 12589 | 15971 | 17345 | 12653 | 12944 | 14898 | | 29374 | |
| 5 17686 17742 10621 10911 7068 5852 5206 5535 7073 11061 6 15203 12763 11624 7648 7153 4554 3876 3548 3904 5586 7 10287 10855 10590 7527 4271 4160 2549 3286 2911 3755 8 4537 6971 8004 6324 3291 2759 2199 1316 2708 2744 9 3022 2769 5745 4885 2120 1810 1278 1144 1007 2538 +gp 9773 7675 7026 6759 3135 2745 3943 2938 2617 7675 | 3 | 25257 | 21908 | 14269 | 19213 | 15162 | 12060 | 13101 | 14487 | 20047 | |
| 6 15203 12763 11624 7648 7153 4554 3876 3548 3904 5586 7 10287 10855 10590 7527 4271 4160 2549 3286 2911 3755 8 4537 6971 8004 6324 3291 2759 2199 1316 2708 2744 9 3022 2769 5745 4885 2120 1810 1278 1144 1007 2538 +gp 9773 7675 7026 6759 3135 2745 3943 2938 2617 7675 | | 22742 | 19371 | | 12734 | 11229 | | 8115 | | | |
| 7 10287 10855 10590 7527 4271 4160 2549 3286 2911 3755 8 4537 6971 8004 6324 3291 2759 2199 1316 2708 2744 9 3022 2769 5745 4885 2120 1810 1278 1144 1007 2538 +gp 9773 7675 7026 6759 3135 2745 3943 2938 2617 7675 | | 17686 | 17742 | 10621 | 10911 | 7068 | | | | | |
| 8 4537 6971 8004 6324 3291 2759 2199 1316 2708 2744 9 3022 2769 5745 4885 2120 1810 1278 1144 1007 2538 +gp 9773 7675 7026 6759 3135 2745 3943 2938 2617 7675 | | 15203 | 12763 | 11624 | 7648 | 7153 | | 3876 | 3548 | | |
| 9 3022 2769 5745 4885 2120 1810 1278 1144 1007 2538 +gp 9773 7675 7026 6759 3135 2745 3943 2938 2617 7675 | 7 | 10287 | | 10590 | | | | | 3286 | 2911 | 3755 |
| +gp 9773 7675 7026 6759 3135 2745 3943 2938 2617 7675 | | 4537 | | 8004 | 6324 | 3291 | 2759 | 2199 | 1316 | 2708 | |
| | 9 | 3022 | 2769 | 5745 | 4885 | 2120 | 18 1 0 | 1278 | 1144 | 1007 | |
| TOTALBIO 141731 132030 117968 105595 76532 66908 71349 83173 149945 167727 | +gp | 9773 | 7675 | 7026 | 6759 | 3135 | 2745 | 3943 | 2938 | 2617 | 7675 |
| | TOTALBIO | 141731 | 132030 | 117968 | 105595 | 76532 | 66908 | 71349 | 83173 | 149945 | 167727 |

TABLE 15. The spawning stock biomass-at-age calculated at spawning time (with SOP correction) for the Blackfin stock using Traditional VPA.

Run title : Blackfin: VPA course. Combined sex; plusgroup.

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Traditional vpa using screen input for terminal F

 Table 15
 Spawning stock biomass with SOP (spawning time)
 Tonnes

 YEAR
 1963
 1964

AGE

| AQL . | | |
|----------|-------|-------|
| 1 | 0 | 0 |
| 2 | 0 | 0 |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 4503 | 6590 |
| 6 | 2911 | 4693 |
| 7 | 2322 | 2280 |
| 8 | 2062 | 1941 |
| 9 | 2116 | 1913 |
| +gp | 2909 | 4212 |
| TOTSPBIO | 16824 | 21630 |
| | | |

| Table 15 | Spawning | stock biom | ass with SC |)P (spawnin | atime) Ta | onnes | | | | |
|----------|----------------|--------------|---------------|-------------------|--------------|--------------|---------------|--------------|--------------|----------------|
| YEAR | 1965 - | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
| | | | | | | | | | | |
| AGE | ^ | • | • | 0 | 0 | • | ~ | 0 | • | • |
| 1 | 0 0 | 0 | 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 3 | 0 | 0 0 | 0 | 0 | 0 | 0 | 0 | 0 0 | 0 | 0 0 |
| 3 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 11569 | 7495 | 15430 | 8322 | 11065 | 15370 | 11669 | 24557 | 16864 | 10722 |
| 6 | 4688 | 7467 | 4187 | 11122 | 6080 | 7802 | 12986 | 9426 | 17054 | 14468 |
| 7 | 2957 | 2552 | 4922 | 2825 | 8792 | 4541 | 5720 | 8661 | 8838 | 18322 |
| 8 | 1470 | 1772 | 1790 | 2822 | 2177 | 7540 | 3748 | 4603 | 9366 | 8426 |
| 9 | 1751 | 931 | 1314 | 990 | 2333 | 1674 | 5745 | 2052 | 3872 | 8411 |
| +gp | 3812 | 2085 | 2696 | 2770 | 2742 | 5745 | 6337 | 4870 | 11123 | 20041 |
| TOTSPBIO | 26246 | 22301 | 30338 | 28851 | 33189 | 42673 | 46205 | 54170 | 67118 | 80391 |
| | 20210 | ZEGOT | 00000 | 20001 | 00100 | TEOIO | 40200 | 04110 | 01110 | 00001 |
| | | | | | | | | | | |
| Table 15 | | stock bioma | | | | onnes | | | | |
| YEAR | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 |
| 105 | | | | | | | | | | |
| AGE | • | ~ | | • | • | • | • | ~ | ~ | • |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 14717 11382 | 12111 | 10714 6386 | 11685 9584 | 9358 | 7345 7655 | 10178 6725 | 11535 | 17187 | 17821 12848 |
| 7 | 13611 | 11495 | | | 8530 | | | 8798 | 8916 | |
| 8 | 14052 | 8069 7221 | 8019 4918 | 4687 5684 | 6614 3217 | 6594 4709 | 6117 4809 | 5222 4105 | 7027 3034 | 5920 3797 |
| 9 | 3851 | 8398 | 4916 | 2801 | 4540 | 2060 | 3806 | 3286 | 2369 | 1835 |
| +gp | 8716 | 26207 | 17894 | 31912 | 24138 | 27246 | 22563 | 15282 | 17733 | 7386 |
| TOTSPBIO | 66328 | 73501 | 52165 | 66354 | 56396 | 55609 | 54197 | 48229 | 56265 | 49607 |
| | 00020 | 10001 | 02100 | 00004 | 00000 | 00000 | 04101 | 70220 | 00200 | -3001 |
| | | | | | | | | | | |
| Table 15 | | stock bioma | | | | onnes | | | | |
| YEAR | 1985 | 1986 | 1987 | 1 9 88 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
| AGE | | | | | | | | | | |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | ŏ | ŏ | ŏ | õ | ŏ | ŏ | ŏ | ŏ | ŏ | ŏ |
| 3 | ŏ | ő | ő | ŏ | ŏ | õ | ŏ | ŏ | ŏ | ŏ |
| 4 | ŏ | Ő | ő | ő | ő | ů | ŏ | ŏ | ŏ | ŏ |
| 5 | 17686 | 17742 | 10621 | 10911 | 7068 | 5852 | 5206 | 5535 | 7073 | 11061 |
| 6 | 15203 | 12763 | 11624 | 7648 | 7153 | 4554 | 3876 | 3548 | 3904 | 5586 |
| 7 | 10287 | 10855 | 10590 | 7527 | 4271 | 4160 | 2549 | 3286 | 2911 | 3755 |
| 8 | 4537 | 6971 | 8004 | 6324 | 3291 | 2759 | 2199 | 1316 | 2708 | 2744 |
| 9 | 3022 | 2769 | 5745 | 4885 | 2120 | 1810 | 1278 | 1144 | 1007 | 2538 |
| +gp | 9773 | 7675 | 7026 | 6759 | 3135 | 2745 | 3943 | 2938 | 2617 | 7675 |
| TOTSPBIO | 60507 | 58775 | 53611 | 44052 | 27039 | 21881 | 19052 | 17767 | 20220 | 33360 |
| | | | | | | | | | | |

TABLE 16. The stock summary table (without SOP correction) for the Blackfin Traditional VPA.

Run title : Blackfin: VPA course. Combined sex; plusgroup.

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Table 16 Summary (without SOP correction)

| | | TOTALBIO | TOTSPBIO | LANDINGS | YIELD/SSB | FBAR 3-7 | FBARP |
|--------|-------------|-------------------|----------|-------------------|-----------|----------|-----------------|
| | Age 1 | | | | | | |
| 1963 | 30399 | 49609 | 15935 | 6594 | 0.4138 | 0.2192 | 0.1061 |
| 1964 | 19306 | 72661 | 20647 | 13596 | 0.6585 | 0.364 | 0.1395 |
| 1965 | 18969 | 73135 | 26677 | 18395 | 0.6896 | 0.5184 | 0.1665 |
| 1966 | 31238 | 7004 9 | 22409 | 18584 | 0.8293 | 0.4306 | 0.1594 |
| 1967 | 22737 | 84549 | 29678 | 16034 | 0.5403 | 0.3741 | 0.1454 |
| 1968 | 36038 | 97147 | 29316 | 12787 | 0.4362 | 0.2727 | 0.1181 |
| 1969 | 26343 | 93404 | 33616 | 17124 | 0.5094 | 0.3154 | 0.1319 |
| 1970 | 39047 | 97052 | 43231 | 14536 | 0.3362 | 0.2451 | 0.1071 |
| 1971 | 35655 | 105839 | 46948 | 19863 | 0.4231 | 0.2915 | 0.122 |
| 1972 | 35364 | 144236 | 53971 | 29219 | 0.5414 | 0.2796 | 0.1 81 6 |
| 1973 | 32388 | 141023 | 72252 | 33832 | 0.4683 | 0.3635 | 0.2475 |
| 1974 | 33584 | 140518 | 82751 | 35973 | 0.4347 | 0.3486 | 0.207 |
| 1975 | 24954 | 128186 | 67615 | 30800 | 0.4555 | 0.405 | 0.1922 |
| 1976 | 17320 | 130324 | 75486 | 41747 | 0.553 | 0.5003 | 0.2254 |
| 1977 | 18737 | 96149 | 54298 | 27210 | 0.5011 | 0.4479 | 0.1967 |
| 1978 | 20363 | 110267 | 68491 | 31370 | 0.458 | 0.4288 | 0.2588 |
| 1979 | 23306 | 100707 | 56758 | 21604 | 0.3806 | 0.3397 | 0.1542 |
| 1980 | 31208 | 106171 | 55858 | 22102 | 0.3957 | 0.3412 | 0.1517 |
| 1981 | 29894 | 113208 | 55064 | 23574 | 0.4281 | 0.3183 | 0.1664 |
| 1982 | 38984 | 117923 | 48738 | 23884 | 0.49 | 0.365 | 0.1559 |
| 1983 | 40439 | 135628 | 55002 | 28890 | 0.5253 | 0.3528 | 0.1666 |
| 1984 | 43073 | 139752 | 50348 | 21641 | 0.4298 | 0.2542 | 0.1462 |
| 1985 | 22048 | 143081 | 61083 | 26595 | 0.4354 | 0.2936 | 0.1432 |
| 1986 | 30484 | 139302 | 62012 | 39886 | 0.6432 | 0.5799 | 0.2022 |
| 1987 | 30508 | 111144 | 50509 | 31369 | 0.6211 | 0.483 | 0.1764 |
| 1988 | 22052 | 106441 | 44405 | 34178 | 0.7697 | 0.5984 | 0.2152 |
| 1989 | 22043 | 80723 | 28519 | 25577 | 0.8968 | 0.7099 | 0.2287 |
| 1990 | 20945 | 69604 | 22763 | 19865 | 0.8727 | 0.6356 | 0.225 |
| 1991 | 28479 | 70820 | 18911 | 16995 | 0.8987 | 0.6077 | 0.2 |
| 1992 | 42159 | 83016 | 17734 | 11804 | 0.6656 | 0.3496 | 0.1531 |
| 1993 | 109779 | 150013 | 20229 | 13943 | 0.6892 | 0.2956 | 0.1466 |
| 1994 | 280 | 168575 | 33529 | 1042 9 | 0.3111 | 0.128 | 0.0755 |
| Arith. | | | | | | | |
| Mean | 30566 | 108445 | 44524 | 23125 | 0.5532 | 0.3893 | 0.1691 |
| Units | (Thousands) | (Tonnes) | (Tonnes) | (Tonnes) | | | |
| | , | | | , | | | |

Appendix 1: The Lowestoft Stock Assessment Suite

Tutorial 2

Separable VPA

by

Chris Darby CEFAS, Lowestoft Laboratory, Pakefield Rd Lowestoft (Suffolk), England NR33 OHT, United Kingdom

Abstract

This document is the second in a series of tutorials designed to assist users of the Lowestoft VPA Suite assessment software and prediction programs that utilise the results. This tutorial takes the user through fitting a Separable VPA model to catch at age data and analysis of the diagnostic output.

Introduction

This tutorial assumes that the user has installed the VPA program described in Darby and Flatman (1994), that the required data files have been placed in a directory c:\vpas\data and that the assessment index file (Blackfin.ind) contains path names which point to the appropriate files.

In the following text action to be taken by the user is highlighted in bold. The symbol \bot is used to represent the Return or Enter key on the keyboard.

Separable VPA

Open the program and read in the index file C:\VPAS\DATA\BLACKFIN.IND. Use the default year, age and summary means settings until the main menu is reached.

| ES C VWINNT VPROFI | LES\cdd00\DESK10P\VPA95.com | | |
|--------------------|--|---------------------|------|
| | | | |
| ***** | LOWESTOFT UPA PROGRAM CENTRAL MENU | ***** | |
| Assess | nent methods: | | |
| 12074 | User-defined UPA/Cohort ar Separable UPA Ad hoc tuning Extended Survivors Analys: | | |
| 9 8 | Print input dats and recul Stop | lts | - 13 |
| C Ynu have | so far spleated the options | narlond < • > 0 | |
| Please | select one of the options : | $ \longrightarrow $ | |

At the main menu Type 2 , to select Separable VPA.

The first input screen is used to define the year weights for the log catch ratios to which the model is fitted. Usually the default settings, which utilise the data from the most recent six years, provide a suitable model for an assessment. However to demonstrate the use of year weighting we shall use the last 11 years.





| S INVERNING A STANDARD SKI OP VPASS. ene | |
|--|---|
| | |
| The manual orighting of year ratios is performed by you giving the first and last year that you wish the weight applied to. | |
| The carliest year is 1963 and the latest year is 1994 | |
| The maximum weight allowed is 1.8 the minimum weight allowed is 0.001 Press the RETURN key only to transate the input of year weights | |
| Corrent Year Veight Values | |
| 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1973/74 1974/75 1975/76 1976/77 1977/70 1978/79 1979/30 1900/81 1901/82 1 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1.000 1983/84 1984/85 1985/86 1986/87 1987/88 1988/89 1989/90 1998/91 1991/92 1 | 972/73 1.488 982/83 1.000 992/93 1.000 |
| Enter First year. last year and weight> 1963,1983.0.001_ | |

In order to select the most recent years for fitting the model we down-weight data from the early years.

Type 1963, 1983, 0.001↓

This can be repeated until all of the years have been weighted as required.

Type ↓ to exit year weighting.

| Ng C:\WINNT\PROFILES\cdd00\DESKTOP\VPA95.exe 1993/54 1.880 | |
|---|---|
| Enter first year, last year and onight> 1963,1983,0.801 | |
| Current Year Weight Values | |
| . 281 . 681 . 681 . 681 . 281 . 381 . 681 | 972/73 .001 982/83 .001 992/93 1.000 |
| ext first year,last year and weight> | |
| *** Age weighting choice : *** | |
| 1. Automatic (set by inverse variance) 2. Manual (defined by the user) | |
| Your choice ? (default= 1)> | |

The next screen presents the options for user-defined age weighting. This would merit a tutorial on its own, and further information on using the option is contained in the referenced user guide. In general it is best left to the program and here we shall take the default and let the program calculate the weights.

Type I To take the default Automatic weighting

Input is now required for the reference age for unit selection (full recruitment). The selection at each age will be scaled relative to the estimate for this age. The choice as to which age to use is not usually critical and an age in the middle of the range is suitable.

Type 5 ↓

The program allows up to 3 terminal F values to be fitted for each of 3 terminal selection values. Here we shall only run one of each. A terminal F of 0.2 and a selection at the oldest age of 1.0

Type 1 → for a single terminal F value

Type 0.2 ↓ the terminal F value to be used in fitting the model

Type 1 → for a single selection value

Type 1.0 L the terminal selection value to be used in fitting the model (make sure it is 1. 0 bug/feature)

| C VWINNT VPROFILE S Acidu00 ADE SKT OP AVPA95. exe | |
|---|--|
| *** Age veighting choice : *** | |
| 1. Automatic (set by inverse pariance) 2. Manual (defined by the user) | |
| Your choice ? (default= 1>> | |
| Youngest age chosen is 1 ; oldest is 9 Please give a reference age for unit selection (not oldest) (If in doubt try the third age group)> 5 | |
| Please enter number of terninal Fs to be run> 1 Please enter 1 terminal F(s)> 0.2 | |
| Please enter number of torminal Sz to be rom $\longrightarrow 1$ Please enter 1 terminal S(z) $\longrightarrow 1.0$ | |
| Do you want the Separable f- and population matrices printed ? {default = No? | |

Type V \rightarrow to print the separable F's and population numbers. **Type** \rightarrow to take default option to use the separable results to start a VPA.

Type a directory path and filename for the Separable VPA diagnostics file Type to run exact VPA

| C VWINNTAPROFILES/cdd00/DESKTOP/VPA95 exe | |
|---|--|
| De you want the Separable F- and population matrices printed ? (default - No>> Use reparable values to start a UPO/cohort analysis ? (Default - Y(es>> | |
| Enter report filename (LPI1 for lime printer)> c:\scws\output\sepdiag.csv | |
| ++++++ Calculating ++++++ | |
| Starting F 2000.S 1.00000 | |
| Virtual Population Analysis Menu | |
| Traditional upa ('exact' method) Cohort analysis (Pope's approximation) | |
| Please select your analysis <default=1>></default=1> | |

This completes the fitting of the separable model to the catch at age data and the calculation of a VPA based on the marginal fishing mortalities. To output the SSB and biomass values resulting from the run option 9 must be selected from the main menu.

The Separable VPA Diagnostic File

The separable method produces a diagnostic output file which is listed in Tables 1-5 and illustrated in Figures 1-4. The bracketed numbers within each of the following paragraphs refer to the reference numbers (x) added to the tables and figures.

The printed output consists of:

The title, time and date of the run (1), the year and age range of the data and the terminal F and terminal S value for this run (2) (Table 1).

The number of iterations taken to reach the solution (3), and the initial and the final sum of squared **unweighted** residuals (SSQ). This provides a measure of the fit to the separable model and should be reduced in the final solution. For the Blackfin model the sum of squares is reduced from 1160 to 221: a significant reduction on the sum of squares indicating a good fit to the catch data set. The final value can be used to derive the root mean square residual (\equiv standard error) of the fit to the log catch ratios, an approximation for the coefficient of variation implied if all the lack of fit were due to uniform random variation in the catch-at-age data.

Model RMSE
$$\cong$$
 catch-at-age data CV $\approx \sqrt{\frac{\text{Final SSQ}}{2((a-1)(y-1)-2)}}$

where a is the number of ages and y the number of years of catch-at-age data. The variance of the fit to the log catch ratios is $2 \times$ that of the fit to the catch-at-age data. Often the lack of fit is not due to uniform variation and a few residuals contribute a significant proportion.

The matrix of residuals showing the difference between the observed log catch ratio and the estimated log catch ratio (4). Positive values indicate that the model expects a greater change in the catches between years than observed. Row and column totals of **weighted** residuals are given (5), as is the grand total (6), which the algorithm is attempting to minimize. The row and column totals should be near zero. If they are not the analysis is a poor fit. Row and column weights are printed at the edges of the table.

Often the SSQ value is the result of a few high residuals which indicate poor data for that year and age; these may occur with poorly sampled age groups. The automatic weighting should cope with this adequately, but occasionally it may be necessary to either (i) exclude the age groups by removing younger ages from the analysis or incorporating the older ages in the plus group, or (ii) down-weight specific years manually.

Pattern in the residuals may indicate systematic lack of fit to the model (i.e. a changing selection pattern). Figure 4 illustrates some of the ways in which the residuals can be plotted in order to detect patterns. The figure presents a bubble plots for each age within a year and time series for all ages combines and at each age. Look for year effects running down the columns, age effects across the rows and year class effects which follow the cohort diagonals. If the selection pattern has changed a chequered flag effect can result with positive residuals in diagonally opposed quadrants and negative residuals in the other two.

The fully exploited fishing mortality Fo(y) for each year (7) (Table 2), referred to the reference age, is plotted in Figure 2. The exploitation pattern S(a) for each age (8), referred to unity on the reference age, and set to the user-defined value on the oldest age, is plotted in Fig. 3.

The Separable model fishing mortalities (9) (Table 3) for each cell in the age/year matrix are obtained from the product of the overall fully-exploited fishing mortality for the year, Fo(y), and the selection-at-age value for the particular age S(a). These are the smoothed model estimates of fishing mortality derived from the fit to the log catch ratios.

The Separable VPA populations-at-age (10) (Table 4) are derived by calculating the recruitment (i.e. initial population for each cohort) values that would, using the separable F values, give the best fit to the catch-at-age data over the whole cohort.

After a run with only one value for terminal F and terminal S, the user can choose whether to run a VPA or Cohort analysis. The terminal F starting values for the run are calculated using the raw catch data (including errors), along with the 'smooth', Separable VPA-generated, terminal population abundances (estimated at the start of the year). The F and population numbers tables generated by the VPA or Cohort analysis (Tables 8 and 10 from option 9 of the main menu) are produced by an exact fit to the raw catch data. They will exhibit differences from the 'smoothed' Separable VPA tables ((9) and (10)). The differences in fishing mortality are given in (11) (Table 5), the F residuals ($F_{sep} - F_{vpa}$).

Terminal Fishing Mortality and Selection at the Oldest Age

Each of the user-specified values for the fishing mortality at the reference age in the final year, and selection at the oldest age, result in model fits that are equally good interpretations of the data (as judged by the final sum of squares); each statistically valid. The choice as to which is the appropriate interpretation can only be made using additional information e.g. trends in effort over time, groundfish survey data, assumptions about exploitation patterns, etc. An appropriate example is the Separable VPA assessment carried out for the Western mackerel by Anon. (MS 1993). Spawning stock biomasses (SSB) generated by a Separable VPA were 'tuned' to estimates of SSB derived from triennial egg surveys and the sum of squares between estimated and observed biomasses minimised to find a value for the terminal year fishing mortality. Selection at age was assumed to be constant over the oldest ages.

By definition S on the reference age is 1.0. Using the same value for S on the oldest age, without thought, can lead to: an increasing trend in F with age for the older ages if one has a dome shaped selection pattern (Fig. 1a); or a spuriously domed exploitation pattern if one has selected a reference F at a partially recruited age group (Fig. 1b).

The values of natural mortality-at-age and of selection-at-age are confounded within the separable model. Therefore, the user-defined pattern of natural mortality-at-age can influence the shape of the selection-at-age pattern derived from the analysis. If natural mortality varies with age, the influence of the variation on the selection pattern must be taken into consideration.

The final choice is made on the basis of the user's perception of the most likely shape of the selection-at-age curve. In the absence of any prior information, and if natural mortality is considered to be constant for the oldest ages, it may be prudent to choose a terminal selection value that produces a level exploitation pattern for the oldest ages.

References

- ANON. MS 1993. Report of the Working Group on the Assessment of Mackerel, Horse Mackerel Sardine and Anchovy. *ICES* C.M. Doc., No. 1993/Assess:19, 274 p. (mimeo).
- DARBY, C. D. and S. FLATMAN. 1994. Virtual Population Analysis: version 3.1 (Windows/DOS) user guide. Information Technology Series. MAFF Directorate of Fisheries Research, Lowestoft, 1: 85 p.
- POPE, J. G., and J. G. SHEPHERD. 1982. A simple method for the consistent interpretation of catch-at-age data. *ICES J. Cons.*, 40: 176-184.

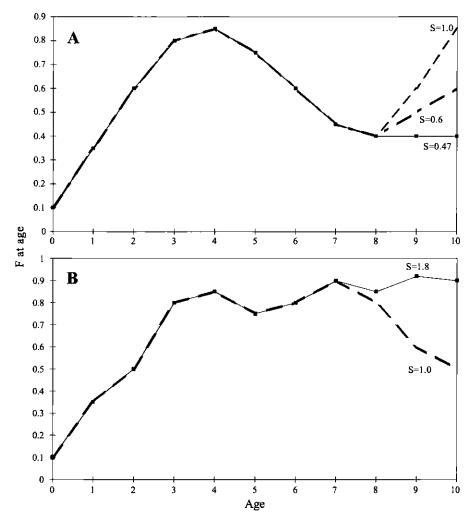


Fig. 1. (A) an illustration of the effects on estimated F-at-age of an inappropriate selection for the value of S on the oldest age (Reference age = 4, terminal F = 0.85) and (B) an illustration of the effects on estimated F-at-age of an inappropriate selection for the value of S on the oldest age (Reference age = 24, terminal F = 0.5).

TABLE 1. The Separable VPA diagnostic file : model specification and log catch ratio residuals.

(1)Title : Blackfin: VPA course, Combined sex; plusgroup. At 4/02/2002 13:48 (2)Separable analysis from 1963 to 1994 on ages 1 to 9 with Terminal F of .200 on age 5 and Terminal S of 1.000 Initial sum of squared residuals was 1160.180 and (3)final sum of squared residuals is 221.386 after 126 iterations Matrix of Residuals (4)Years, 1963/64, Ages 1/2, -2.594, -1.308, 2/3, 3/4, -.008, 4/ 5, -.305, 5/6, -.157, 6/7, .165, 7/8, .441, 8/9, 1.108, тот , .000, WTS , .001, Years, 1964/65,1965/66,1966/67,1967/68,1968/69,1969/70,1970/71,1971/72,1972/73,1973/74, -3.037, -2.718, -3.948, -2.319, -.717, -1.852, -3.388, -6.398, 1/2. -.689, 1.853 2/3, -1.833, -1.889, -2.279, -1.123, -2.403, -1.366, -2.078, -2.105, .505. 1.294. .224, -.266, 3/4, .253, -.684, -.271, -.228, .327, -.992, .673, 1.212. 4/5, -.155, .423, -.044, .096, .079, .250, .162, -.053. .127. .162. 5/6, .040, .702, .361, 1.180. .388, .231. .719. .878. .559, .618. .041, .447, 6/ 7. .255, .425, .072, -.171. -.087. -.417. .621. -.614. .610, .072, -.365, -1.186, 7/ 8, 1.076, .548, .189, .392, -.185, .542, -.346, .394, -.095, 8/9, -.332, .481, .520, .425, .953, -.468, -.799, TOT . .000, .000, .000. .000. .000. .000. .000. .000. .000. .000. WTS , .001, .001, .001, .001, .001, .001, .001, .001. .001. .001. 1974/75,1975/76,1976/77,1977/78,1978/79,1979/80,1980/81,1981/82,1982/83,1983/84, Years. 1/ 2, 2.886, -.483, .425. .525, .538, -.625, .052. 1.917. -.390. -.786. 2/3, .194, .004, .367, -.456, 1.638, -.244, -.354, .446, -.270. .167. .937, .432, 1.039, .663. .561, 3/4, .748, 1.028, .945. .562. .360. 4/5, -.322, -.286, -.488, -.338, -.259. -.217, -.333, -.206, -.109. -.045. .186, 5/6, -.262, .112, .016, -.241, .035, -.040, -.462, -.126, -.729. 6/7, -1.226, -.164, -.093, .059, -.211, .060, -.443, -.165. -.510. -.010. 7/8, -.404. .269. -.204. .003, -.185, .094. .216, -.140, .303, .389. 8/9, ~.058, -.190, .956, -.105, .141, -.452, .093, .136, .369, .238, тот , .000, .000, .000, .000, .000, .000, .000, .000, .000, .000. WTS , .001, .001, .001, .001, .001, .001, .001, .001, .001, .001, (5)Years, 1984/85,1985/86,1986/87,1987/88,1988/89,1989/90,1990/91,1991/92,1992/93,1993/94, TOT, WTS, 1/2, .000, .149, 1.447, -.331, 1.826, -3.592, .451, -.201, .955, 1.680, -.623, -1.590, 2/3, -.316, .148, -1.163, -.044, -.307, .569, .384, .083, -.033, .693, .000, .290, 3/ 4. .777. .033, -.286, -.230, -.268, .375, .356, -.615, -.612, .462. .000, .537, 4/ 5, -.089, -.432, .344, .437, -.677, .410, .011, -.542, .021, .518, .000,1.000, 5/ 6. -.743, .012, .105, .272, -.260, .135, -.233, -.221, .532, .397, .000, .694, -.307, .398, 6/ 7. .112, -.343, .081, .136, .059, -.292, .311, -.153, .000, .842, 7/ 8, .085, .255, -.042, -.190, .396, -.445, -.058, .553, -.074, -.483, .000, .718, 8/ 9, .102, -.189, .008, .116, .749, -.105, .173, -.246, -.808, .000, .656, .198, TOT , .000, .000, .000, .000, .000, .000, .000, .000, .000, .000, -21.683, WTS . 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, (6)

| Fishing Mortalities (F) | | | | | | | | | (7) | |
|-------------------------|-----------------|-----------------|---|---|---|--|---|--|-----|---|
| , F-values, | 1963, .1445, | , | | | | | | | | |
| , F-values, | 1965, .3150, | - | - | , | | | , | | | |
| F-values, | | 1976, .5330, | , | | , | | , | | | , |
| , F-values, | | 1986, .5460, | | | | | | | | |

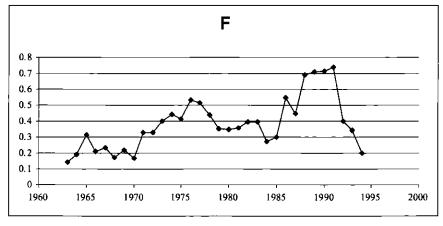


Fig. 2. Fishing mortality at the reference age, by year, for the Blackfin data set as estimated by Separable VPA.

Selection-at-age (S)

(8)

, 1, 2, 3, 4, 5, 6, 7, 8, 9, S-values, .0026, .1841, .6919, 1.1884, 1.0000, .9778, .9324, .9099, 1.0000,

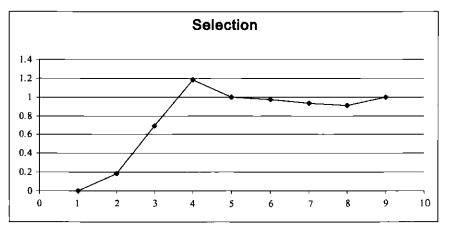


Fig. 3. Selection (y-axis) at age (x-axis) for the Blackfin data set as estimated by Separable VPA.

TABLE 3. The Separable VPA diagnostic file : Separable model estimates of fishing mortality at age.

Run title : Blackfin: VPA course. Combined sex; plus group. At 4/02/2002 13:48

Traditional vpa Terminal populations from weighted Separable populations

SEPARABLY GENERATED FISHING MORTALITIES

(9)

| YEAR, Age | 1963, | 1964, | | | | | | | | |
|--------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 1, | .0004, | .0005, | | | | | | | | |
| 2, | .0266, | .0347, | | | | | | | | |
| З, | .1000, | .1303, | | | | | | | | |
| 4, | .1717, | .2238, | | | | | | | | |
| 5, | .1445, | .1883, | | | | | | | | |
| 6, | .1413, | .1841, | | | | | | | | |
| 7, | .1347, | .1756, | | | | | | | | |
| 8, | .1315, | .1713, | | | | | | | | |
| 9, | .1445, | .1883, | | | | | | | | |
| - / | , | .1005, | | | | | | | | |
| YEAR, AGE | 1965, | 1966, | 1967, | 1968, | 1969, | 1970, | 1971, | 1972, | 1973, | 1974, |
| 1, | .0008, | .0006, | .0006, | .0004, | .0006, | .0004, | .0009, | .0009, | .0010, | .0012, |
| 2, | .0580, | .0388, | .0431, | .0312, | .0403, | .0308, | .0601, | .0602, | .0735, | .0817, |
| З, | .2179, | .1457, | .1621, | .1173, | .1515, | .1156, | .2259, | .2262, | .2761, | .3072, |
| 4, | .3743, | .2502, | .2785, | .2015, | .2602, | .1986, | .3880, | .3885, | .4743, | .5276, |
| 5, | .3150, | .2106, | .2343. | .1696, | .2190, | .1671, | .3265, | .3269, | .3991, | .4439, |
| 6, | .3080, | .2059, | .2291, | 1658, | .2141, | .1634, | .3192, | .3197, | .3902, | .4341, |
| 7, | .2937, | .1963, | .2185, | .1581, | .2042, | .1558, | .3044, | .3048, | .3721, | .4139, |
| 8, | .2866, | .1916, | .2132, | .1543, | .1993, | .1521, | .2971, | .2975, | .3631, | .4039, |
| 9, | .3150, | .2106, | .2343, | .1696, | .2190, | .1671, | .3265, | .3269, | .3991, | .4439, |
| 51 | .5250, | | .2515, | .10507 | .2250, | ,10,1, | , | , | | |
| YEAR, AGE | 1975, | 1976, | 1977, | 1978, | 1979, | 1980, | 1981, | 1982, | 1983, | 1984, |
| 1, | .0011, | .0014, | .0013, | .0011, | .0009, | .0009, | .0009, | .0010, | .0010, | .0007, |
| 2, | .0762, | .0981, | .0948, | .0805, | .0650, | .0643, | .0655, | .0729, | .0725, | .0502, |
| з, | .2862, | .3688, | .3563, | .3025, | .2443, | .2417, | .2463, | | .2724, | .1887, |
| 4, | .4916, | .6334, | .6120, | .5195, | .4196, | .4152, | .4230 | .4703, | .4678, | .3241, |
| 5, | .4137, | .5330, | .5150, | .4371, | .3531, | .3494, | .3559, | - | .3936, | .2728, |
| б, | .4045, | .5211, | .5035, | .4274, | .3452, | .3416, | .3480, | .3870, | .3849, | .2667, |
| 7, | .3857, | .4969, | .4802, | .4076, | .3292, | .3258, | .3319, | .3690, | .3670, | .2543, |
| 8, | .3764, | .4849, | .4685, | .3977, | .3212, | .3179, | .3238, | .3601, | .3581, | .2482, |
| 9, | .4137, | .5330, | .5150, | .4371, | .3531, | .3494, | .3559, | .3958, | .3936, | .2728, |
| - / | , | , | | , | , | | , | | , | , |
| YEAR, AGE | 1985, | 1986, | 1987, | 1988, | 1989, | 1990, | 1991, | 1992, | 1993, | 1994, |
| 1, | .0008, | .0014, | .0012, | .0018, | .0019, | .0019, | .0019, | .0010, | .0009, | .0005, |
| 2, | .0553, | .1005, | .0824, | .1273, | .1305, | .1316, | .1358, | .0737, | .0635, | .0368, |
| 3, | .2078, | .3778, | .3096, | .4782, | 4906, | .4945, | .5104, | .2770, | 2387, | .1384, |
| 4, | .3570, | .6489, | 5317 | 8214, | .8427, | .8493, | .8766, | .4757, | .4099 | .2377, |
| 5, | .3004, | .5460, | .4474, | .6912, | .7091, | .7147, | .7376, | .4003, | 3449 | .2000, |
| 6, | .2937, | .5339, | .4375, | .6758, | .6933, | .6988, | .7212 | | .3373, | .1956, |
| 7, | .2801, | .5091, | .4172, | .6445, | .6612, | .6664, | .6878, | • | .3216, | .1865, |
| 8, | .2733, | .4968, | .4071, | .6289, | .6452, | .6503, | .6711, | .3643, | .3138, | .1820, |
| 9, | .3004, | .5460, | .4474, | .6912, | .7091, | .7147, | .7376, | .4003, | .3449, | .2000, |
| - 1 | | | | | | | | | , | |

TABLE 4. The Separable VPA diagnostic file : Separable model estimates of population numbers at age.

Run title : Blackfin: VPA course. Combined sex; plusgroup.

At 4/02/2002 13:48

Traditional vpa Terminal populations from weighted Separable populations

SEPARABLY GENERATED POPULATION NUMBERS

| YEAR, AGE | 1963, | 1964, |
|--------------|--------|--------|
| 1, | 24065, | 15604, |
| 2, | 10245, | 19695, |
| З, | 11781, | 8167, |
| 4, | 3641, | 8728, |
| 5, | 1887, | 2511, |
| 6, | 1076, | 1337, |
| 7, | 534, | 765, |
| 8, | 775, | 382, |
| 9, | 411, | 556, |

| YEAR, | 1965, | 1966, | 1967, | 1968, | 1969, | 1970, | 1971, | 1972, | 1973, | 1974, |
|--------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| AGE | | | | | | | | | | |
| l, | 14828, | 22851, | 17496, | 33170, | 22244, | 28525, | 27075, | 26727, | 32305, | 33217, |
| 2, | 12769, | 12130, | 18699, | 14315, | 27145, | 18202, | 23344, | 22148, | 21863, | 26421, |
| з, | 1557 6, | 9866, | 9554, | 14663, | 11360, | 21346, | 14451, | 17998, | 17074, | 16632, |
| 4, | 5870, | 10255, | 6982, | 6651, | 10676, | 7993, | 15568, | 9439, | 11752, | 10606, |
| 5, | 5713, | 3305, | 6538, | 4327, | 4452, | 6738, | 5365, | 8647, | 5240, | 5988, |
| 6, | 1703, | 3414, | 2192, | 4234, | 2990, | 2928, | 4667, | 3169, | 5105, | 2878, |
| 7, | 911, | 1025, | 2275, | 1427, | 2937, | 1976, | 2036, | 2777, | 1885, | 2829, |
| 8, | 526, | 556, | 689, | 1497, | 998, | 1961, | 1385, | 1229, | 1676, | 1064, |
| 9, | 263, | 323, | 376, | 456, | 1050, | 669, | 1379, | 842, | 747, | 954, |
| | | | | | | | | | | |
| YEAR, AGE | 1975, | 1976, | 1977, | 1978, | 1979, | 1980, | 1981, | 1982, | 1983, | 1984, |
| 1, | 23809, | 12172, | 17935, | 20008, | 33649, | 35767, | 29760, | 31543, | 31867, | 42547, |
| 2, | 27165, | 19472, | 9952, | 14664, | 16362, | 27524, | 29257, | 24343, | 25798, | 26063, |
| З, | 19934, | 20610, | 14453, | 7411, | 11077, | 12553, | 21131, | 22434, | 18530, | 19645, |
| 4, | 10016, | 12258, | 11670, | 8286, | 4484, | 7104, | 8071, | 13524, | 13968, | 11554, |
| 5, | 5124, | 5016, | 5327, | 5181, | 4035, | 2413, | 3840, | 4329, | 6918, | 7163, |
| 6, | 3145, | 2774, | 2410, | 2606, | 2740, | 2321, | 1393, | 2202, | 2386, | 3821, |
| 7, | 1527, | 1718, | 1349, | 1193, | 1392, | 1588, | 1350, | 805, | 1225, | 1329, |
| 8, | 1531, | 850, | 856, | 683, | 650, | 820, | 939, | 793, | 456, | 695, |
| 9, | 581, | 861, | 428, | 439, | 376, | 386, | 488, | 556, | 453, | 261, |
| VEND | 1985, | 1986, | 1987, | 1988, | 1989, | 1990, | 1991, | 1992, | 1993, | 1994, |
| YEAR, AGE | 1965, | 1900, | 1987, | 1900, | 1909, | 1990, | 1991, | 1992, | 1999, | 1994, |
| 1, | 26575, | 29947, | 24098, | 21306, | 23627, | 18269, | 19298, | 33853, | 47221, | 5329, |
| 2, | 34810, | 21741, | 24483, | 19707, | 17413, | 19308, | 14929, | 15769, | 27687, | 38627, |
| З, | 20294, | 26967, | 16097, | 18460, | 14207, | 12512, | 13859, | 10671, | 11993, | 21274, |
| 4, | 13318, | 13497, | 15132, | 9671, | 9369, | 7121, | 6247, | 6811, | 6623, | 7734, |
| 5, | 6841, | 7630, | 5775, | 7280, | 3482, | 3303, | 2494, | 2129, | 3465, | 3599, |
| 6, | 4465, | 4147, | 3619, | 3023, | 2986, | 1403, | 1323, | 976, | 1168, | 2010, |
| 7, | 2396, | 2725, | 1991, | 1913, | 1259, | 1222, | 571, | 527, | 540, | 682, |
| 8, | 844, | 1482, | 1341, | 1074, | 822, | 532, | 514, | 235, | 297, | 321, |
| 9, | 444, | 526, | 739, | 731, | 469, | 353, | 227, | 215, | 134, | 178, |

(10)

(11)

TABLE 5. The Separable VPA diagnostic file : Fishing mortality at age residuals F_{sep} - F_{vpa}

Run title : Blackfin: VPA course. Combined sex; plusgroup.

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Traditional vpa Terminal populations from weighted Separable populations

Fishing mortality residuals

| YEAR, AGE | 1963, | 1964, |
|--------------|--------|--------|
| | 0004 | 0005 |
| 1, | 0004, | 0005, |
| 2, | 0146, | 0297, |
| З, | .0279, | .0943, |
| 4, | .0290, | .0800, |
| 5, | .0428, | .1343, |
| б, | .0936, | .1175, |
| 7, | .0267, | .0964, |
| 8, | .0998, | 0398, |
| 9, | 0001, | 0770, |

| YEAR, AGE | 1965, | 1966, | 1967, | 1968, | 1969, | 1970, | 1971, | 1972, | 1973, | 1974, |
|--------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 1, | 0008, | 0006, | 0006, | 0004, | 0006, | 0004, | 0009, | .0009, | .0110, | .0283, |
| 2, | 0432, | 0341, | 0257, | 0283, | 0272, | 0290, | 0468, | .1067, | .2717, | .0714, |
| З, | 0266, | .1068, | .0289, | .0290, | .0034, | .0326, | 1323, | .2160, | .2777, | .1916, |
| 4, | .2021, | .2250, | .1609, | .1350, | .1913, | .0765, | 0277, | .0198, | .0755, | 1908, |
| 5, | .0783, | .2679, | .1129, | .1591, | .1665, | .1519, | .0486, | 0135, | 0310, | .0157, |
| 6, | .1070, | .0589, | 0480, | .0125, | .0109, | .0982, | .0035, | 1752, | 1961, | 2443, |
| | • | • | | | , | • | | 1501, | | • |
| 8, | • | • | • | | | • | | 1153, | | • |
| 9, | .0179, | 1046, | 0827, | 0895, | 1205, | 0908, | 0412, | 1727, | 0385, | .1902, |
| | | | | | | | | | | |
| YEAR, | 1975, | 1976, | 1977, | 1978, | 1979. | 1980. | 1981. | 1982, | 1983. | 1984. |
| AGE | | | | | | | · | | | |
| 1, | .0000, | .0009, | .0080, | .0009, | 0005, | .0007, | .0047, | .0002, | 0001, | .0033, |
| 2, | .0352, | .0640, | .0076, | .3033, | .0027, | 0035, | .0473, | 0081, | .0563, | .0557, |
| З, | .2204, | .2392, | .0812, | .2857, | .0250, | .0940, | .1001, | .0418, | .0504, | .1202, |
| 4, | 0877, | 2230, | 1983, | 1063, | 0957, | 1967, | 0833, | 2252, | 1775, | 0556, |
| 5, | 1004, | .0292, | 0446, | 0816, | .0220, | 0408, | 1525, | 0222, | 2100, | 1209, |
| 6, | 0639, | 0452, | 0263, | 0631, | 0042, | .0157, | 0409. | 0744, | .0272, | 0407, |
| 7, | | | | | | | | .1648, | | |
| | | | | | | | | .0623, | | |
| | | | | | | | | 0602, | | |
| | | | | | | | | | | |
| YEAR, | 1985, | 1986, | 1987, | 1988, | 1989, | 1990, | 1991, | 1992, | 1993, | 1994, |
| AGE | | | | | | | | | | |
| 1, | 0005, | .0073, | 0011, | 0007, | 0008, | .0017, | .0070, | 0001, | 0006, | .0000, |
| 2, | .0189, | 0520, | 0009, | .0495, | 0817, | 0376, | 0382, | 0101, | .0400, | .0320, |
| з, | .0540, | 0342, | 1207, | 0535, | .1552, | .0974, | 1675, | 0806, | .0457, | 0245, |
| 4, | 0807, | .2578, | .1391, | 3023, | .1797, | 0166, | 1465, | .0835, | .1354, | 0599, |
| 5, | - | - | | | | | | .1664, | | |
| | | | | | | | | .0732, | | |
| | | | | | | - | | 1015, | - | |
| 8, | .0119, | 0555, | .0355, | .3017, | 1005, | .0514, | .0365, | 0362, | 0904, | .0540, |
| 9, | 0012, | 0364, | .0232, | 0127, | 1568, | 1111, | 0680, | 0554, | .0545, | .1220, |

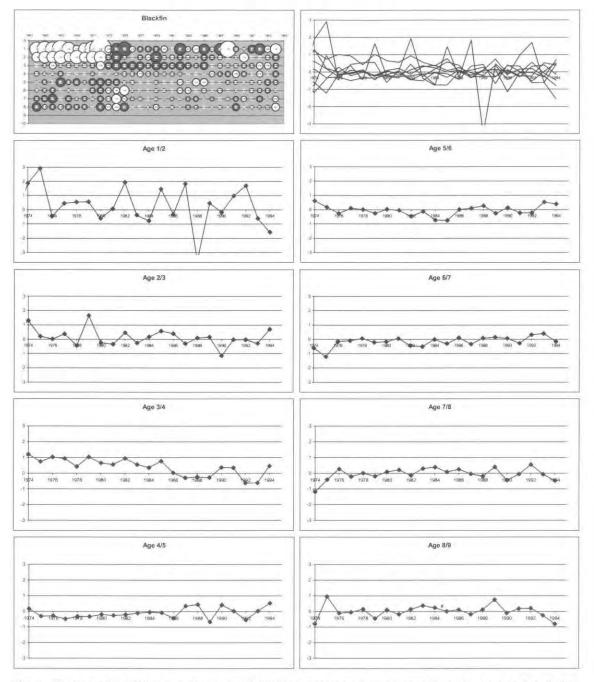


Fig. 4. The Separable VPA log catch ratio residuals illustrated using three diagnostic plotting approaches: bubble plots (solid circles positive) and time series plots of residuals at all ages and each age independently.

.

Appendix 1: The Lowestoft Stock Assessment Suite

Tutorial 3

Ad hoc VPA tuning

by

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Abstract

This document is the third in a series of tutorials designed to assist users of the Lowestoft VPA Suite assessment software and prediction programs that utilize the results. The tutorial takes the user through the options required for running the Laurec-Shepherd and Hybrid *ad hoc* VPA tuning algorithms.

Introduction

This tutorial assumes that the user has installed the VPA program described in Darby and Flatman (1994), that the required data files have been placed in a directory c:\vpas\data and that the assessment index file (Blackfin.ind) contains path names which point to the appropriate files. This tutorial also assumes that the user has either read Tutorial 1 which covers reading and selection of input data, or has previous experience of running the program.

In the following text action to be taken by the user is highlighted in bold. The symbol \downarrow is used to represent the Return or Enter key on the keyboard.

Ad hoc VPA Tuning

Open the program and read in the index file C:\VPAS\DATA\BLACKFIN.IND. Take the default year, age and summary mean settings until the main menu is reached.

| CAWINE TAPROFI | LE S\cdd00\DE SKTDP\VPA95 exe | | | | |
|--|--|-------------|--|--|--|
| ***** | TOUTOINT GIRL TROUBLY | **** | | | |
| Assess | ment methods: | | | | |
| 1 2 7 4 | User defined UPA/Cohort analy Separable UPA Ad hoc tuning Extended Survivors Analysis | ysis | | | |
| 9 Print input data and results B Stop | | | | | |
| < You have : | so far selected the options man | wed < + > > | | | |
| Please | select one of the options : $-$ | > <u>-</u> | | | |

At the main menu Type 3 I to select Ad hoc VPA tuning.

The first two questions require input of the names for the data file containing the catch and effort data that will be used to calibrate the VPA and the diagnostics output file into which will be written the results of the calibration analysis.

Type ↓ to take the default filename which has been read from the assessment index file

Type a path and filename for the tuning diagnostics output file.

| S VPA95 | |
|---|--|
| Ado 🗉 🗆 🕲 🕲 🗳 🗛 | |
| | |
| | |
| | |
| | |
| exame UPB tuning module exame | |
| [] [] 그는 것은 것을 가지만 여행하는 것은 것을 하는 것을 가지? | |
| | |
| Please give (path]name of fleet effort and catch data file | |
| Default – clivpacidataiblacktun.dat | |
| \rightarrow | |
| | |
| Default accepted | |
| | |
| Enter report filename (LPT1 for line printer)> c:\opAs\results\lstan.cav | |
| starts for time princers | |

We now have to select the range of data years from the index series to which we wish to fit the VPA. Current "accepted wisdom" is to take the last ten years of data. In general it is expected that catchability will have altered over a longer period.

Type 1985 ↓



The data file title is printed for cross-reference.

We are then asked whether we wish to apply a time series weighting to the model, down weighting the influence of historic tuning data in the fitted model. The models available are discussed in Darby and Flatman (1994). Since we have only taken ten years of tuning data for the calibration model we shall not down-weight historic data.

Type No J, N J or n J

During the selection of the range of ages to be used in the assessment we used the default settings provided by the program, that is ages 1-10+. We have therefore opted for age 9 as the oldest true age.

In order to reduce the number of parameters that are estimated during the calibration of the VPA the *ad hoc* algorithms make the assumption that the fishing mortality at the oldest true age is a function (arithmetic mean) of the values calculated at younger ages in the same year. The program requires the number of ages over which we wish to calculate the average mortality and a scalar multiplier to be applied to that average (for example a value of 0.5 would apply half of the average fishing mortality). In this example we will calculate the fishing mortality at age 9 as the arithmetic mean of the values at ages 6, 7 and 8. Therefore the number of ages is 3 and the multiplier 1.0.

Type Yes J, Y J or y J to calculate the fishing mortalities as an average of younger ages

Type 1.0 , for the scalar.

Type 3 J for the number of ages used for the average fishing mortality.



Examination of the calibration data set C:\VPAS\DATA\BLACKFIN\BLACKTUN.DAT reveals that the final year cpue data value at ages 1, 8 and 9 is zero. Zero cpue values are considered to be missing data. Unlike XSA, the *ad hoc* algorithms do not use information from catches taken from the cohort at younger ages in the estimation of the terminal population; only final year cpue values are used. Therefore, in order to estimate the fishing mortality at these ages in the final VPA year, a similar constraint to that at the oldest ages is applied. The algorithm known as shrinkage is described later; but here we are required to supply starting estimates for the fishing mortality at the ages with missing data. The starting values will be replaced by shrinkage estimates in the fitted model.

Type the starting values 0.01 ↓, 0.15 ↓, 0.15 ↓

| V5 VPA95 | |
|--|-----|
| HAR I LINE B REA | |
| Enter F for age 1 (Default8888 >> 0.81 | |
| Enter F for age 0 < Default00000 >> 0.15 | |
| Enter Ffor age V C Default00000 >> 0.15 | |
| wwww Tuning Mathod Menu sawa | |
| 1. Hybrid Method | |
| 2. Laures-Shepherd Method | |
| 3. Hulp | |
| Please select an option < default * 2 > | > 2 |

For the initial run we shall fit the constant catchability Laurec-Shepherd model to the data

The program requires a threshold to be set for the minimum number of non-zero cpue values that are used for the calculation of catchability at each age. If, for any age, the fleet data set contains fewer values than the threshold, the fleet data will not be used in the overall weighted mean for the age. The recommended (default) value for the minimum number of data points is 5. This should prevent the assessment from being dominated by estimates from series with low standard errors, associated with small numbers of data points.

Type ↓ to take the default value for the minimum number of data points

As described previously, we do not have calibration data for the final year at ages 1, 8, 9. Therefore we will use the average fishing mortality calculated over the preceding 5 years for the final year F at those ages, a constraint commonly called shrinkage.

Shrinkage is a constraint on the estimates derived from a time series of observations. The procedure can be described as making the assumption that, if a time series is being used to predict the current value of a particular parameter, e.g. F-at-age, and no major changes are known to have taken place, then as an initial starting value for the estimate, a mean of recent values of the parameter is appropriate. For the ages where we have no calibration information from the cpue series, we can only use the mean of the last few years. This is equivalent to the assumption used to estimate F at the oldest ages as an average of the values at younger ages. A more comprehensive description of the rationale behind shrinkage is given in Darby and Flatman (1994).

When using shrinkage at ages where fishing mortality estimates from the fleet tuning data series are available, the final year mortality is a weighted average of the estimates from the fleet series and the historic average fishing mortality. The weights for the fleet derived estimates are taken from the inverse of the variance of catchability at that age. The user must enter a weight for the average F. The value is given relative to the standard error of the log catchabilities; an approximation to the c.v. of the catchability. A shrinkage weight of 1.0 is a reasonable value for this data set (a 100% coefficient of variation). The estimate can be refined using retrospective analysis procedures to examine the influence of its magnitude on the consistency of the assessment estimates.

Type y \dashv to use shrinkage Type 1.0 \dashv for the log standard error weight

This completes the specification of the *ad hoc* tuning algorithm and the program begins to fit the model. The algorithm runs for 10 iterations. If convergence of the final year F values has not been achieved after 10 iterations then the program seeks guidance as to whether to continue further, in batches of 10 iterations.

| VPA95 | |
|--|--|
| | |
| Minimum number of data points for an analysis ? Minimum 1. Default (52 | |
| Shrink R estimates towards mean of the last 5 years ? (V)/N | |
| Enter a Log(G.E.) for the means to which the estimates are shruck < 0.5 is suggested >>1.0 Shrinkage Log.S.E | |
| ****** luning started ****** | |
| ** Tuning has not converged after 10 iterations. ** | |
| The sum across ages of the absolute residuals of the Final year Ps. Metween iterations. 9 and 18 is .000314 | |
| Do you with to continue the turing fur 10 more iterations. $\forall 	au(N)$ (y | |

Type Y I, y I or yes I to continue the model fitting

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There is no change in the terminal year fishing mortality values after 11 iterations and the calibration algorithm is complete. The program now offers a choice as to the method of calculation of the cohort population numbers and fishing mortalities at age: Exact VPA or cohort analysis.

Type y ↓ to use the default Exact VPA.

| °∋ VPA95 | and the second | खान (अ |
|------------------------------|--|--------|
| Aut: + | | |
| | | |
| ******* | LOVESTOFT UPA PROCESH | |
| BETETZNI | wathd:- | |
| + ¹ 2 + 1 4 | User-defined UPA/Cohert analysis Generable UPA Ad hes tuning Extended Servivers Analysis | |
| Output) N Y | esthods: Output precautionery approach data Output input data and results | |
| 5 | Stup | |
| | in far inlected the optimar marked (=)) select one of the optimus τ > | |

The program returns to the central menu. Note that we have calibrated the VPA using an *ad hoc* tuning algorithm (denoted by the star) and that we have a tuning diagnostics file for the Laurec-Shepherd method. However, we do not have tables of population numbers, SSB or fishing mortality at age; they are only printed after selecting option 9.

The Ad hoc Tuning Diagnostics file

The results from the current run should be in the file c:\vpas\results\lstun.csv. The file can be opened in a text editor word processing or spreadsheet package. The file lists the tuning data file used in the run, the selected range of ages, years and the model options chosen by the user.

Table 1 presents the results for the converged run. In the following text bold numbers (x) refer to labels added to the table. The file listing contains the date and time at which the run was performed, the tuning file used for calibrating the VPA (1), a record of the selected assessment options (2), and the convergence results (3). If convergence was not achieved, the final year fishing mortality estimates from the last two iterations are printed. The fishing mortality values will indicate the ages that are varying between iterations and the degree of variation.

Examine the fishing mortality values resulting from the run (4). Check for extreme values, especially those at the older ages that generally result from noise in poor quality catch at age or calibration data. This would indicate that the ages might better be incorporated into the plus group.

Examine the log catchability residuals for each age for all fleets (5). An incidence of 99.99 indicates a missing (zero) fleet catch at age value. The values can indicate changes in the stock – fleet interactions. Look for year effects running down the columns, age effects across the rows and year class effects that follow the cohort diagonals. Recent and sudden changes in catchability may require removal of the fleet from the assessment. For each age, plots of the residuals against time can be used to reveal trends in log catchability. One way to achieve this is to give the tuning output file a comma separated file name extension (.csv) and import it into a spreadsheet package (Fig. 1, 2, 3, 4).

Note: If only one fleet data set is available and the Laurec-Shepherd constant log catchability model is used without shrinkage to the mean, the residuals in the final year will all be 0.0; the terminal F values are generated using the fleet's average catchability for the age. If shrinkage to the mean is selected or the assessment is tuned with more than one fleet, F in the final year is a weighted mean. The estimate of catchability derived for each age will differ from the fleet's mean and the final year residuals will not be zero.

The significance of any trends in time in log catchability noted from the residual tables can be tested using the diagnostics presented in the summary statistics (6). As a quick check, look at the slope of the log catchabilities for each age (8), for each fleet separately. Slopes which exceed twice their standard error consistently, for most of the important age groups, are considered significant and indicate that the assumption of constant catchability used to fit the model may not be correct. Changes in the sign of the slope across ages usually indicate noise in the data.

If there are significant trends in the catchability of the fleets then the use of the Hybrid model could be appropriate. This model allows trends in catchability for selected fleets. If it is used, constant catchability should be maintained for as many fleets as possible. Remember that these are log catchabilities and that a trend with time indicates an exponential trend in catchability.

Examine the mean log catchability (pred. log q) and its standard error for each age and fleet (7). The standard error of the log catchability is an indicator of the quality of the data (a fractional coefficient of variation). Values greater than 0.5 indicate problems with that age for the fleet. High standard errors for the older ages of all fleets indicate that the assessment should probably be re-run with the problem ages incorporated into a younger plus group.

When combining fleet-derived estimates of terminal F at each age, weighting by the inverse of the prediction variance of the log catchability will reduce the influence of poor fleet data. However, if for any fleet, the standard errors of the majority of the important ages are poor, the user may wish to remove the fleet from the analysis altogether.

The estimate of the partial F contributed by the fleet (9) and the raised F (10) are printed. Raised F's are the individual fleet predictions of overall F: the level that would have been recorded if the fleet had taken the whole of the international catch for that age. The values can be used to identify incompatible predictions from the individual fleet data sets.

For each age, the overall weighted mean terminal F is printed (11) along with its internal (SIGMA(int)) and external (SIGMA(ext)) log standard errors. Also given is the overall standard error (SIGMA(overall) (12); it is the larger of the internal and external values.

The internal standard error for an age is calculated from the (prediction) standard errors of the fleet's final year log catchabilities; it corresponds to the within samples variance. The external standard error is calculated from the scatter of the logarithms of the raised F values; it corresponds to the between samples variance (Topping, 1978). If shrinkage to the mean has been selected, the internal and external standard errors include the F shrinkage value.

SIGMA(overall) is a good approximation to the fractional coefficient of variation of the mean F and should be used as a measure of the accuracy of the prediction. If it is large (greater than 0.3) for important age groups, then the assessment should be treated with caution.

If the values of the internal and external standard errors differ significantly, there is a discrepancy between the fleet estimates for overall F (the raised F's (10)). The variance ratio (13), (external s.e.)²/(internal s.e.)², may be tested as an F statistic with n and n-1 degrees of freedom, where n is the number of fleets contributing a raised F estimate. Values exceeding 3 imply conflicting signals from the fleets. Too small a value implies an unexpected correspondence of the tuning fleets in relation to the inherent noise.

Figures 1–4 present diagnostic plots for the fleets used to fit the Blackfin Laurec-Shepherd calibration model. In each figure the top left hand plot is a bubble plot of the log catchability residuals. This format is useful for looking for year and age effects in the estimates of log catchability. The top right plot presents the log catchability residuals as a time series for all ages together. Individual trends in log catchability at age are separated in the lower plots.

It is relatively obvious from the residual plots that the model assumption of constant catchability in time is being violated by the calibration series used in this fit.

- The Otter trawl residuals show a strong increase in the early period of the time series and a downward trend in recent years.
- The light trawl data are constant in time with no obvious pattern but are noisy.
- The prawn trawl cpue series shows a strong decrease in time.
- The seine data shows a strong increase in catchability in the recent years.

The trends in catchability are carried forward into differences in the estimates of terminal year fishing mortality derived from the four cpue series. Where a fleet has an increasing trend in catchability the assumption of constant catchability induces an under-estimate of the terminal fishing mortality. A downwards trend results in an over estimate of catchability. In the summary diagnostics for each age the difference is clearly illustrated at age 4. The two fleets with strong trends have marked differences in their estimates of the final year fishing mortalities (raised F). Fleet 3, the prawn trawlers, which have a downward trend in q contribute a terminal F estimate of 0.48 to the overall mean. Fleet 4, the seine netters, have an upward trend and F is consequently underestimated (0.05). The trends in residuals result in the estimates from these fleets having a high standard error in log catchability and they are therefore down-weighted in the final inverse-variance weighted estimate of fishing mortality.

In general the fitting of an assessment model to data series that violate the assumptions of the model is not ideal, and the fleets could be excluded from the model fit. Alternatively the Hybrid model, which is also available within the Lowestoft package, can be used to fit trends in time to the log catchability series. If this is carried out the fleet estimates of terminal fishing mortality are more consistent.

References

DARBY, C. D. and S. FLATMAN. 1994. Virtual Population Analysis: version 3.1 (Windows/DOS) user guide. Info. Tech. Ser., MAFF Direct. Fish. Res., Lowestoft, 1: 85 p.

POPE, J. G., and J. G. SHEPHERD. 1985. A comparison of the performance of various methods for tuning VPA's using effort data. *ICES J. Cons.*, **42**: 129–151.

TOPPING, J. 1978. Errors of observation and their treatment. Chapman and Hall Ltd, London. 119 p.

TABLE 1. The tuning diagnostic file for Laurec Shepherd tuning.

Lowestoft VPA Version 3.1

7/09/2000 23:31

Blackfin: VPA course. Combined sex; plusgroup.

CPUE data from file c:\vpas\data\blacktun.dat

Catch data for 32 years. 1963 to 1994. Ages 1 to 10.

| F | leet | First | Last | First | Last |
|-------------|------|-------|------|-------|------|
| | | year | year | age | age |
| Otter traw | I | 1985 | 1994 | 2 | 6 |
| Light trawl | | 1985 | 1994 | 2 | 7 |
| Prawn trawl | | 1985 | 1994 | 2 | 4 |
| Seine | | 1985 | 1994 | 2 | 5 |

Disaggregated Qs

Log transformation The final F is the (reciprocal variance-weighted) mean of the raised fleet F's.

No trend in Q (mean used) Terminal Fs derived using L/S (with F shrinkage)

Shrinkage Log S.E = 1.000 Tuning converged after 11 iterations

Regression weights

| | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
|------------|-----------|-----------|------------|---|---|---|---|---|---|---|
| Oldest age | F = 1.000 |)*average | of 3 young | | | | | | | |

Missing catch or tuning data at age 1 8 9

Fishing mortalities

| Age | 1985 | 1986 | 19 8 7 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
|-----|-------|-------|---------------|-------|-------|-------|-------|-------|-------|-------|
| 1 | 0.000 | 0.008 | 0.000 | 0.001 | 0.001 | 0.003 | 0.011 | 0.001 | 0.001 | 0.010 |
| 2 | 0.073 | 0.047 | 0.078 | 0.172 | 0.048 | 0.084 | 0.091 | 0.076 | 0.159 | 0.208 |
| 3 | 0.261 | 0.339 | 0.182 | 0.405 | 0.621 | 0.581 | 0.301 | 0.181 | 0.355 | 0.186 |
| 4 | 0.276 | 0.900 | 0.657 | 0.495 | 0.927 | 0.769 | 0.704 | 0.459 | 0.487 | 0.237 |
| 5 | 0.259 | 0.652 | 0.527 | 0.559 | 0.692 | 0.499 | 0.591 | 0.530 | 0.319 | 0.144 |
| 6 | 0.337 | 0.424 | 0.517 | 0.619 | 0.667 | 0.555 | 0.515 | 0.354 | 0.274 | 0.115 |
| 7 | 0.324 | 0.544 | 0.445 | 0.776 | 0.471 | 0.572 | 0.667 | 0.157 | 0.179 | 0.169 |
| 8 | 0.270 | 0.447 | 0.477 | 0.936 | 0.539 | 0.649 | 0.549 | 0.185 | 0.115 | 0.150 |
| 9 | 0.311 | 0.471 | 0.480 | 0.777 | 0.559 | 0.592 | 0.577 | 0.232 | 0.189 | 0.145 |

72

(1)

(2)

(3)

(4)

TABLE 1 (Cont'd). The tuning diagnostic file for Laurec Shepherd tuning.

| Log | catchabilit | y residuals |
|-----|-------------|-------------|
|-----|-------------|-------------|

| Log ca | ichaonny r | esiduais | | | | | | | | |
|---------|-------------|--------------|-------------------------|------------|-------------|----------|-----------|---------|----------------|-------|
| Fleet: | Otter trawl | | | | | | | | | |
| Age | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
| 2 | 0.91 | 1.32 | -1.01 | 0.33 | -1.12 | -1.6 | 1.14 | 0.05 | 0.16 | -0.18 |
| 3 | -1.65 | -0.05 | -1.52 | 0.29 | 0.88 | 1.38 | 0.56 | 0.11 | 0.08 | -0.08 |
| 4 | -2.4 | -1.07 | -0.24 | 0.28 | 0.61 | 2.49 | 1.19 | 0.08 | -1.32 | 0.38 |
| 5 | -2.82 | -1.4 | -1.10 | 0.67 | 0.34 | 2.74 | 1.63 | 0.72 | -1.26 | 0.47 |
| 6 | -1.54 | -1.1 | -0.56 | -0.27 | 0.65 | 2.42 | 0.76 | 0.43 | -0.55 | -0.25 |
| 7 | No da | ta for this | fleet at th | is age | | | | | | |
| Fleet: | Light trawl | | | | | | | | | |
| Age | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
| 2 | -0.41 | -1.16 | 0.97 | 0.32 | -0.97 | 0.05 | 0.35 | 0.13 | 0.6 | 0.12 |
| 3 | 0.34 | 0.17 | -0.50 | -0.36 | 0.34 | 0.63 | -0.24 | -0.35 | 0.02 | -0.04 |
| 4 | 0.47 | 0.64 | -0.87 | -0.79 | -0.18 | 0.91 | 0.59 | -0.1 | -0.77 | 0.10 |
| 5 | -0.80 | 0.75 | -0.47 | 0.39 | -0.40 | 0.36 | 1.10 | 0.15 | -1.26 | 0.17 |
| 6 | 0.17 | -0.39 | -0.49 | -0.65 | 0.12 | 0.11 | 0.49 | 0.02 | 0.37 | 0.26 |
| 7 | -0.79 | -0.01 | -0.23 | -1.09 | -0.10 | 0.73 | 0.70 | -0.19 | 0.60 | 0.37 |
| Els at. | Prawn traw | 4 | | | | | | | | |
| Age | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
| 2 | 0.84 | 0.59 | 0.95 | 1.12 | -1.11 | 0.29 | -0.34 | 0.00 | -0.76 | -1.58 |
| 3 | 1.70 | 2.62 | 0.93 | -1.39 | | -0.67 | -0.34 | | -0.78 -1.19 | -1.38 |
| | 1.70 | 0.75 | | | 1.46 | | | -1.36 | | |
| 4 5 | | | 0.06 | -1.94 | 0.19 | 1.13 | 0.13 | -0.23 | -0.49 | -0.71 |
| 6 | | | fleet at th fleet at th | | | | | | | |
| 0 7 | | | | | | | | | | |
| / | INO GA | ta for this | fleet at th | is age | | | | | | |
| Fleet: | Seine | | | | | | | | | |
| Age | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
| 2 | -2.08 | -1.16 | 0.48 | -0.68 | -1.43 | -1.34 | 0.75 | 1.58 | 1.92 | 1.96 |
| 3 | -0.87 | -0.28 | -1.56 | -0.63 | -0.29 | -0.24 | 0.49 | 0.67 | 1.19 | 1.52 |
| 4 | -0.56 | 0.67 | -1.65 | -0.82 | -0.55 | -0.41 | 0.27 | 1.48 | -0.04 | 1.61 |
| 5 | -1.67 | 1.10 | -1.93 | 0.22 | -1.31 | -0.13 | 0.24 | 1.70 | 0.26 | 1.53 |
| 6 | No data | a for this f | leet at this | age | | | | | | |
| 7 | No data | a for this f | leet at this | age | | | | | | |
| SUMM | ARY STA | TISTICS I | FORAGE | 2 | | | | | | |
| Fleet | Pred (7) | | | ial Raised | Slope (8 | | Intro | • | se | |
| _ | log q | (log q) | F (9) | | | Slope | | | trcpt | |
| 1 | -14.93 | 1.041 | 0.0009 | 0.2483 | | 1.14E-01 | | - | | |
| 2 | -16.23 | 0.702 | 0.0156 | 0.1844 | 8.51E-02 | 7.21E-02 | | | | |
| 3 | -18.79 | 0.971 | 0.0026 | 1.0100 | -2.36E-01 | 6.88E-02 | | | | |
| 4 | -15.81 | 1.594 | 0.0029 | 0.0294 | 4.11E-01 | 1.02E-01 | -15.8 | 06 0.48 | 1 | |
| | bar (11) | Sigma(in | | | Sigma(overa | | nce ratio | | | |
| ∩ | 208 | 0 476 | | 5 | 0.5 (12) | 1 102 | 113 | | | |

(6)

(5)

TABLE 1 (Cont'd). The tuning diagnostic file for Laurec Shepherd tuning.

SUMMARY STATISTICS FOR AGE 3

| Fleet | Pred. | se | Partial | Raised | Slope | se | Intrcpt | se |
|-------|--------|---------|---------|--------|-----------|----------|---------|---------|
| | log q | (log q) | F | F | | Slope | | Intrcpt |
| 1 | -14.10 | 0.997 | 0.0021 | 0.2009 | 1.49E-01 | 9.78E-02 | -14.099 | 0.301 |
| 2 | -15.54 | 0.386 | 0.0312 | 0.1943 | -1.87E-02 | 4.24E-02 | -15.538 | 0.116 |
| 3 | -19.11 | 1.536 | 0.0019 | 0.4181 | -3.60E-01 | 1.14E-01 | -19.107 | 0.463 |
| 4 | -15.53 | 1.002 | 0.0038 | 0.0408 | 2.81E-01 | 5.08E-02 | -15.529 | 0.302 |
| | | | | | | | | |

| Fbar | Sigma(int.) | Sigma(ext.) | Sigma(overall) | Variance ratio |
|-------|-------------|-------------|----------------|----------------|
| 0.186 | 0.331 | 0.288 | 0.331 | 0.757 |

SUMMARY STATISTICS FOR AGE 4

| Fleet | Pred. | se | Partial | Raised | Slope | se | Intrcpt | se |
|-------|--------|---------|---------|--------|-----------|----------|---------|---------|
| | log q | (log q) | F | F | | Slope | | Intrcpt |
| 1 | -14.69 | 1.439 | 0.0012 | 0.1618 | 1.78E-01 | 1.47E-01 | -14.689 | 0.434 |
| 2 | -15.73 | 0.683 | 0.0257 | 0.2136 | -2.47E-02 | 7.55E-02 | -15.735 | 0.206 |
| 3 | -19.82 | 0.971 | 0.0009 | 0.4832 | -1.18E-01 | 9.97E-02 | -19.822 | 0.293 |
| 4 | -15.71 | 1.078 | 0.0032 | 0.0475 | 2.04E-01 | 9.60E-02 | -15.714 | 0.325 |

| Fbar | Sigma(int.) | Sigma(ext.) | Sigma(overall) | Variance ratio |
|-------|-------------|-------------|----------------|-------------------|
| 0.237 | 0.469 | 0.397 | 0.469 | 0.71 6 |

SUMMARY STATISTICS FOR AGE 5

| Fleet | Pred. | se | Partial | Raised | Slope | se | Intropt | se | |
|--------------------------------------|--------|---------|---------|--------|----------|----------|---------|---------|--|
| | log q | (log q) | F | F | | Slope | | Intropt | |
| 1 | -14.98 | 1.719 | 0.0009 | 0.0895 | 2.73E-01 | 1.65E-01 | -14.979 | 0.518 | |
| 2 | -16.31 | 0.758 | 0.0145 | 0.1214 | 3.67E-03 | 8.44E-02 | -16.307 | 0.229 | |
| 3 No data for this fleet at this age | | | | | | | | | |
| 4 | -16.45 | 1.347 | 0.0015 | 0.0313 | 2.56E-01 | 1.20E-01 | -16.45 | 0.406 | |

FbarSigma(int.)Sigma(ext.)Sigma(overall)Variance ratio0.1440.6170.3260.6170.279

SUMMARY STATISTICS FOR AGE 6

| Fleet | Pred. | se | Partial | Raised | Slope | se | Intrcpt | se |
|-------|--------|------------|--------------|------------|----------|----------|---------|---------|
| | log q | (log q) | F | F | | Slope | | Intrcpt |
| I | -14.72 | 1.178 | 0.0011 | 0.1473 | 1.54E-01 | 1.19E-01 | -14.72 | 0.355 |
| 2 | -16.46 | 0.401 | 0.0124 | 0.0893 | 7.31E-02 | 3.65E-02 | -16.46 | 0.121 |
| 3 | N | o data for | this fleet a | t this age | | | | |
| 4 | N | o data for | this fleet a | t this age | | | | |

| Fbar | Sigma(int.) | Sigma(ext.) | Sigma(overall) | Variance ratio |
|-------|-------------|-------------|----------------|----------------|
| 0.115 | 0.38 | 0.143 | 0.38 | 0.142 |

SUMMARY STATISTICS FOR AGE 7

| Fleet | Pred. | se | Partial | Raised | Slope | se | Intrept | se |
|-------|--------|------------|--------------|------------|----------|----------|---------|---------|
| | log q | (log q) | F | F | | Slope | | Intrept |
| 1 | N | o data for | this fleet a | t this age | | | | |
| 2 | -16.54 | 0.648 | 0.0115 | 0.1165 | 1.28E-01 | 5.62E-02 | -16.541 | 0.195 |
| 3 | N | o data for | this fleet a | t this age | | | | |
| 4 | N | o data for | this fleet a | t this age | | | | |

Fbar Sigma(int.)Sigma(ext.)Sigma(overall)Variance ratio

0.169 0.648 0 0.648 0

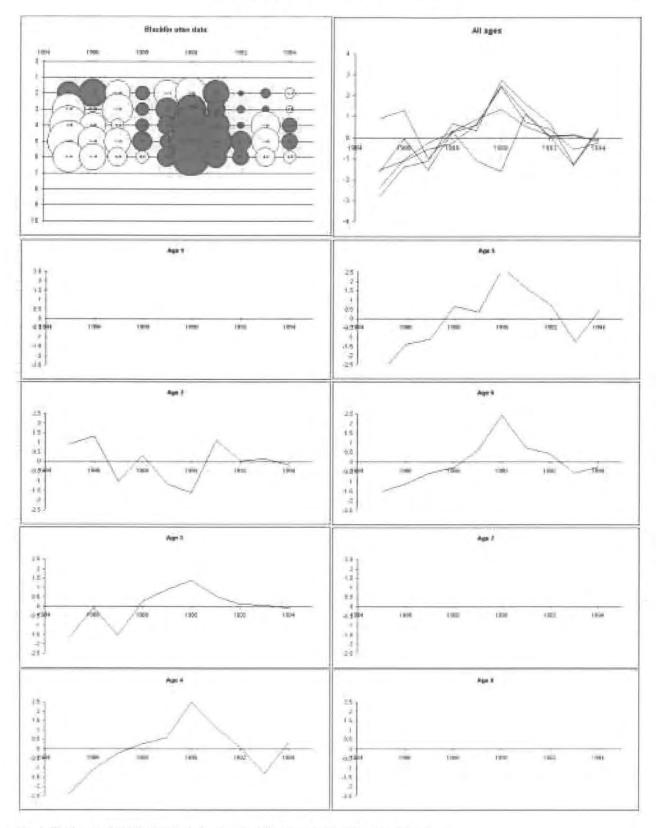


Fig. 1. The log catchability residuals for the Blackfin Otter trawl calibration data set.

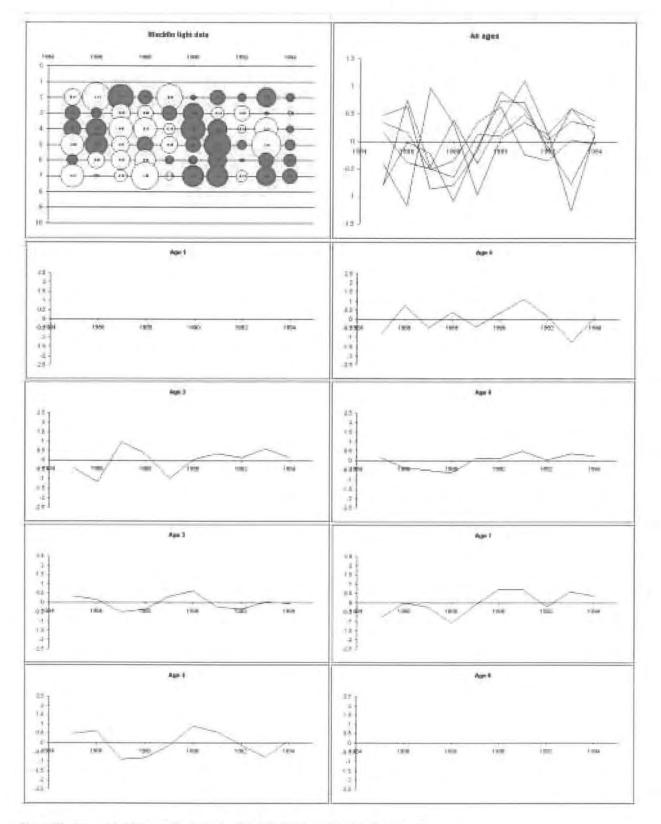


Fig. 2. The log catchability residuals for the Blackfin light trawl calibration data set.

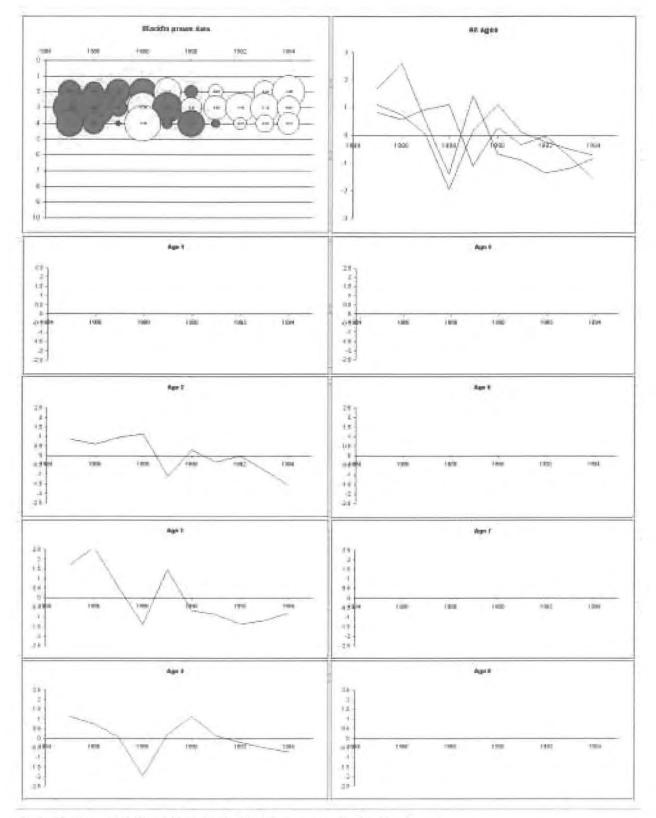


Fig. 3. The log catchability residuals for the Blackfin prawn trawl calibration data set.

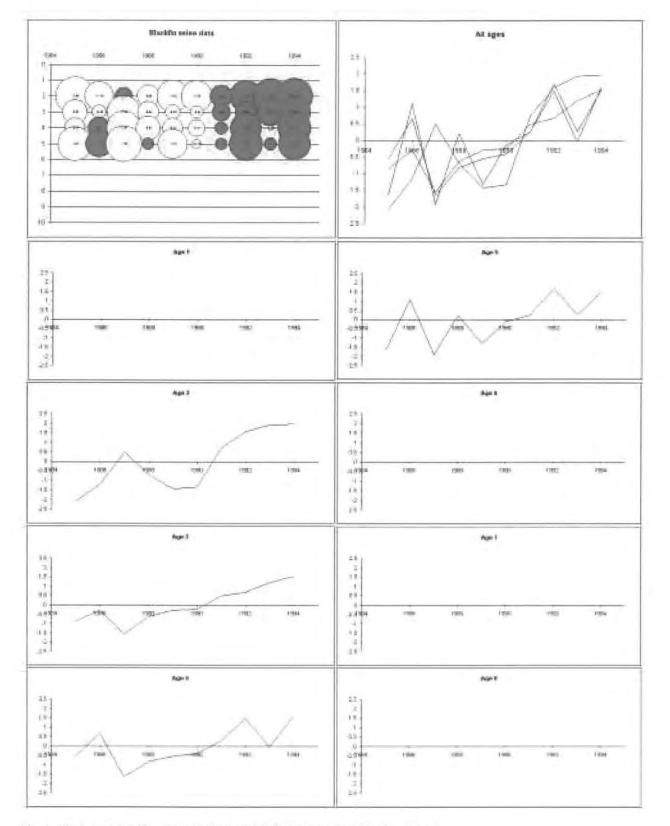


Fig. 4. The log catchability residuals for the Blackfin seine trawl calibration data set.

Appendix 1: Lowestoft Stock Assessment Suite

Tutorial 4

Extended Survivors Analysis (XSA)

by

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Abstract

This document is the fourth in a series of tutorials designed to assist users of the Lowestoft VPA Suite assessment software. The tutorial takes the user through the options required for running the Extended Survivors Analysis (XSA) assessment model.

Introduction

This tutorial takes the user through the options required for running the Extended Survivors Analysis (XSA, Shepherd, MS 1992) tuning algorithm. Each of the tutorial series assume that the user has installed the VPA program VPA95.exe, described in Darby and Flatman (1994); that the required Blackfin data files have been placed in a directory c:\vpas\data\, and that the assessment index file (Blackfin.ind) contains path names which point to the appropriate files. This tutorial assumes that the user has either studied Tutorial 1which covers input of the data structures, or has previous experience of running the program.

In the following text action to be taken by the user is highlighted in bold. The symbol \downarrow is used to represent the Return or Enter key on the keyboard.

Extended Survivors Analysis

Open theVPA suite program and read in the index file C:\VPAS\DATA\BLACKFIN.IND. Take the default year, age and summary mean settings until the main menu is reached.

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| | 1 User-defined UPA/Cohort analysis 2 Separable UPA 3 Ad hoc tuning 4 Extended Survivors Analysis | |
| Outp | ut methods: 8 Output precautionary approach data 9 Output input data and results | |
| | 8 Stop | |
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Type 4 ↓ to select the XSA model.

Type → to select the default tuning data file, Blacktun.dat

Type a path and name for the tuning diagnostics output file. If a file of this name is located in the given directory, the program will ask for conformation of replacement.

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The program reads the data file and then requires the user to select the range of years of cpue tuning data that will be used for calibrating the VPA. The current fad is to use only the last 10 years of data it is considered that technology creep will not have altered catchability substantially during this time period.

Type 1985 ↓

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| Title of fleet catch file is Blackfin: UPA course. Juning date. | |
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| Inter the first age for normal (stock-size) independent ratchability analytis. If in doubt use the default. (Age range : 1 - 8). < Default : 3>> 3 | |

We now select the catchability models for each age. Two models are available:

direct proportionality or constant catchability cpue = q Nand the power model cpue = $q N^{p}$

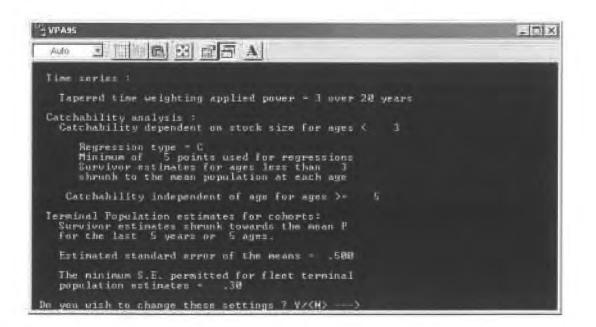
where q is catchability, N is population abundance and p the power coefficient. Unlike most formulations of ADAPT (Gavaris, MS 1988) and ICA (Patterson and Melvin 1996), which allow catchability models to be selected independently for each age within a cpue series, XSA currently fits all series with the specified catchability model at the selected age. If we use a power model at age 2, all calibration series will have this model fitted to the data at that age. In this tutorial we shall fit a power model for catchability at the first age, age 2. Note that the program requires us to input the first age at which the direct proportionality model is to be fitted, age 3.

Type 3 , as the first age for the constant catchability model, that is, age 2 has a power model.

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| Enter the first ago at which q K Range : 3 - 8). (Default : | is considered to be independent of equ. : $? >>5$ |

The next model specification required is the age at which we wish to constrain catchability. XSA reduces the number of parameters that are estimated by constraining catchability at the oldest ages to be equal to that at a younger age (the q plateau). Here we shall constrain catchability for ages greater than 5 to be equal to the value estimated at age 5. Once again this applies to all of the indices.

Type 5 \downarrow so that catchability at ages older than 5 is set at that estimated at age 5.



The next screen presents the default settings for the XSA time series weights, the estimation of the regression model parameters, shrinkage and the minimum standard error threshold. For this assessment the default settings are not appropriate. We do not require the time series weights as we have reduced the time series for the indices to the data collected during the last 10 years. Also, the range of ages used for the fishing mortality shrinkage mean is also too large, extending into ages that are not fully recruited.

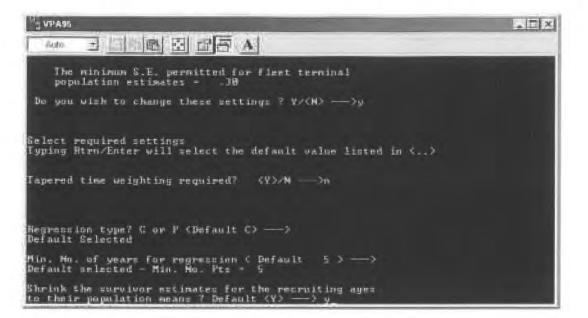
Type Y → in order to change the default settings provided

The first question allows us to set time series weights in order to down - weight older data in the time series. In this example we have only selected the last 10 years and this is not required.

Type N → to use all data in the 10 year time series with equal weight.

We now specify the regression model to be used to estimate the catchability parameters within the power model. We shall use Calibration regression, which assumes that the measurement errors are significantly larger in the survey observations than the estimated population abundance. Setting a minimum for the number of data points to which a regression model is fitted prevents the user from fitting regression models to times series of data that are too short and could therefore exhibit spurious correlation. In this case we can take the default option, as there are 10 years of data. Note that this does not equate to 10 data points in the regression, we could have zero cpue values, which are treated as missing in the analysis.

Type \downarrow to take the default calibration regression model Type \downarrow to take the default of a minimum of 5 data points for the fitting of a regression model.



Within XSA two forms of shrinkage are used to provide constrained terminal population estimates. The first form of shrinkage is shrinkage to the population mean. This is described in detail in the user guide. It is only applied to the survivors estimated for the ages at which a power model is fitted. Terminal population estimates (calculated at the end of a year) for age a are shrunk to the time series weighted geometric mean of the population abundance estimates for age a+1 (calculated by the preceding VPA iteration, at the beginning of a year). The weight given to the shrinkage mean is the inverse of the variance of the time series weighted geometric mean population at the older age.

Rosenberg *et al.* (1992) have used simulation analysis to show that when estimating year class strength, prediction accuracy can be improved by the use of calibration regression with shrinkage to the population mean. The default settings supply this combination. If predictive regression is used, shrinkage to the population mean is equivalent to a double shrinkage and should be avoided.

Type I to take the default option of shrinkage to the population mean with the calibration model.

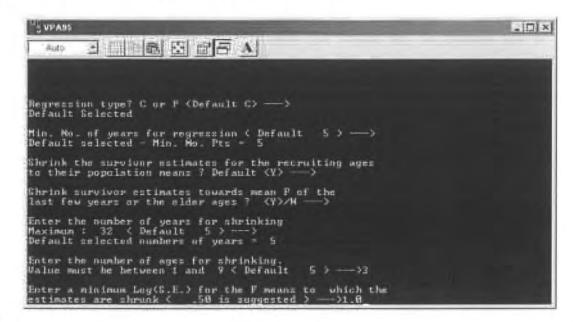
We are then asked whether we wish to use the mean F, calculated over recent years at each age and over the oldest ages to constrain the estimation process (F shrinkage). My personal preference is to start with a low shrinkage weight, allowing the cpue data to determine the survivors. The shrinkage constraint can then be increased later if required. Although it is not required to fit an XSA model, the main reason for keeping the shrinkage option is that we have years of catch data for which we wish to calculate a VPA but have no tuning data. If shrinkage is used, the terminal populations for the oldest age are calculated from the F values at younger ages, a procedure equivalent to the fixed exploitation pattern used within *ad hoc* tuning. By using F shrinkage with a low weight, cohorts without tuning data are initialised by survivor estimates derived from the average fishing mortality. In years for which there is calibration data the high c.v. minimises the influence of the fishing mortality mean. Note that the terminal population estimates are inverse variance weighted averages of the estimates from each cpue series. The weight given to the shrinkage mean (a user supplied value entered as a fractional c.v.) must be chosen relative to the c.v. of the values from the cpue series. A relatively high c.v. of 1.0 may still have a significant weight if the cpue series are noisy.

Type ↓ to take the default of using shrinkage to the mean fishing mortality.

The range of ages over which we are fitting the assessment model is 2–9. The fishing mortality shrinkage mean is calculated over a user-defined range of ages that precede the oldest true age. If the range is too large we will

include ages that are not fully recruited to the fishery and could force the assessment to have a dome-shaped selection pattern. We will use a mean taken over three ages.

Type \downarrow to use 5 years in the mean across years. Type 3 \downarrow to use 3 ages in the mean across ages. Type 1.0 \downarrow for the weight to be used for the fishing mortality means.



We are using inverse variance weighting within the model fitting procedure. Occasionally one data set can have too great an influence on the fitted assessment and dominate the fit of the model. In order to prevent this we set a maximum for the weight that any observation can take. The weight is specified by entering a minimum for the standard error of any observation. The default value of 0.3 is suitable for this model.

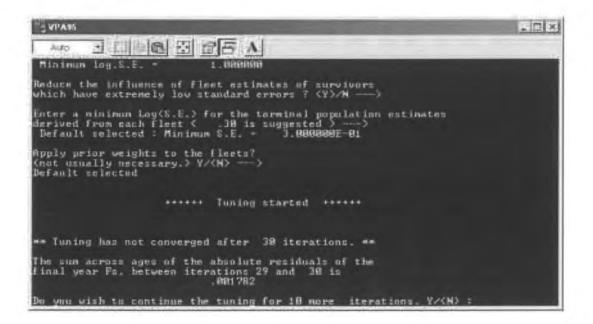
Type \downarrow to use a minimum value for the standard error. Type \downarrow to set the minimum to 0.3.



Individual fleet weights can be used to down-weight, usually exclude, some indices from the analysis. In this preliminary run we do not wish to use this.

Type ↓ to take the default option of no individual fleet weighting.

The model now runs the iterative fitting algorithm. Initially 30 iterations are attempted and if convergence is not achieved, measured by the change in final year F values between iterations, then the model asks the user if they wish to run more iterations in batches of 10.



In this example convergence has not been achieved after 30 iterations. We could continue for more but as we are setting up a model it is better to stop the fitting process and examine the diagnostic output file before proceeding.

Once converged or the user has stopped the fitting process, the option is given to print a detailed breakdown of the estimates contributing to the population means. This can be useful in an understanding of which data series contribute most to the fitted model.

Type \dashv to stop the fitting algorithm Type 1 \dashv to take the full diagnostics output. Type y \dashv to print adjusted CPUE data.

We return to the main menu and can examine the diagnostics file in a spreadsheet package or text editor. Note that although we have fitted the assessment model we have not calculated the population biomass or printed any results tables. These are created using option 9 at the main menu.

The XSA Tuning Diagnostics File

The results from the current run should be in the file c:\vpas\results\xsatun.csv. The file can be opened in a text editor, word processing or spreadsheet package. The file lists the tuning data file used in the run, the selected range of ages, years and the model options chosen by the user.

Tables 1 - 12 present the results for the converged run; in the following text bold numbers (x) refer to labels added to the table. The file listing contains (1) the date and time at which the run was performed and the tuning file used for calibrating the VPA. (2) The ranges of the catch and calibration index data used to fit the XSA model. (3) The specification of the time series weights applied to down-weight older data. (4) The specifications for the catchability models. (5) The specification of the method for calculating the terminal population estimates. (6) The number of iterations performed to reach convergence, or if convergence was not achieved (as in the example), the differences between the final year F values for the last two iterations. (7) The time series weights used in down weighting historic data.

Following the model specifications is a selection of the model estimates. The tables are (8) the fishing mortalityat-age table for the final ten years of the assessment time series. (9) The estimated population numbers-at-age for the last ten assessment years; (10) the survivor estimates for the end of the final year (the terminal populations) and (11) the taper weighted geometric mean of the final VPA. If the population shrinkage option was selected, the terminal population estimates at the ages at which the power model was fitted were shrunk to the taperweighted geometric mean population numbers of the next age. In the Blackfin example, the survivors for age 2, estimated at the end of the year, were shrunk to the mean of the population estimates at age 3 (calculated at the beginning of the year). The weight applied to the population shrinkage mean was the reciprocal of the square of the standard error (12) of the geometric mean population numbers.

The diagnostics tables from the run are used to examine the fit of the XSA model to the time series of indices at each age; each fleet (13) is presented in sequence. The log catchability residuals table (14) can be used to examine changes in the fleet – stock interactions (changes in catchability). An incidence of 99.99 indicates a missing (zero) total catch or fleet catch value. Look for year effects running down the columns (e.g. 1987 in the seine residuals), age effects, across the rows and year-class effects that follow the cohort diagonals (e.g. the 1984 cohort at age 2 in 1986 in the light trawl residuals). Recent and sudden changes in catchability may require removal of the fleet from the assessment since departures from the assumptions used in the catchability models can lead to biased estimates of population numbers and exploitation levels.

For the ages with constant catchability with respect to time, examine the log catchability means (15) and their standard error (16). The standard error of the log catchability is an indicator of the quality of the data (a fractional coefficient of variation of the fleet's catchability for that age). Values greater than 0.5 indicate problems with that age in the fleet data. High standard errors for the older ages indicate that the assessment should probably be re-run with the problem ages incorporated in a younger plus group.

When combining estimates of terminal population derived from the fleet catches taken at each age, weighting by the inverse of the log catchability variance will reduce the influence of poor quality fleet data. However, if the standard errors of the majority of the important ages for a fleet are poor, the user may wish to remove the fleet from the analysis altogether.

Catchability on the oldest age is poorly determined and, to overcome this, the catchability values for the oldest ages are taken to be equivalent to that of a younger but fully recruited, age. In the initial Blackfin run log catchability at age 6 was constrained to the value at age 5 (15). In order to introduce the greatest possible degree of stability to the assessment, it is necessary to set the age at which catchability is independent of age as low as possible in the fully recruited age range, without affecting the fit of the model at the older ages. The selection of the appropriate age is a process of model refinement. Examine the log catchability values for the ages with constant log catchability with respect to time (15) and their standard errors (16). Fig. 2c plots catchability +/- one standard error against age. If, for the oldest ages, catchability does not exhibit large

variation from age to age and there are no trends with respect to age, the youngest fully recruited age at which catchability appears to be independent of age is the preferred choice. At the selected age, examine the log catchability standard errors for each fleet; an alternative selection may be required if all of the fleets' log catchabilities, at the selected age, are poorly estimated by the model (s.e.'s >0.5). It is often seen that, if the age at which catchability is held constant is inappropriate, the catchability residuals for the subsequent ages generate blocks of all positive or negative values. Plots such as presented in Figures 2b - 5b aid the detection of problems.

If the log catchability standard errors are acceptable, a series of runs with a stepwise reduction in the age above which catchability is fixed, from the oldest true age-1 to the selected age, can be carried out and the log catchabilities and their standard errors compared with the standard run. Noticeable differences between runs should indicate when to stop.

One reason for choosing the penultimate age for the initial run is that if a trend in catchability with age exists, it is possible to force an inappropriate plateau by selecting too young an age. Also, large variations in catchability for all of the oldest ages in the assessment make it difficult to choose an appropriate age for fixing catchability. In either of these situations it is recommended that the assessment is carried out with catchability for the oldest age determined from the penultimate age. This removes the constraints on the older ages and allows the model to determine the majority of their catchability values independently. In addition, F shrinkage should be used, otherwise the model is badly under-determined and noisy. Due to the increased freedom within the model, the run may require more iterations to achieve a solution.

For each fleet, examine the regression statistics (17) for the ages with catchability dependent on year class strength, especially the slope (18), the R square (19) and the overall regression standard error (20). The slopes should be tested to see whether they are significantly different from 1.0, if not then catchability is constant with respect to population abundance (direct proportionality). The t-value (21) given in the table is derived from t = (slope - 1.0)/se slope. It can be tested against the t statistic for the required confidence level, obtained from Student's t table with n-2 degrees of freedom – n is the number of data points used for the regression (No Pts) (22).

The XSA algorithm fits the catchability proportional to year class abundance regression to all ages, regardless of whether the results are used within the analysis. This allows an examination of the regression slopes and standard errors for ages fitted with the catchability independent of year class strength model. The column labelled Mean Q (23) in the regression diagnostics lists the value of average log catchability derived independently at all ages. Comparison of values with the mean q values listed in (15) on the log or un-transformed scale (Fig. 2c-5c) will aid detection of inappropriate values for the age at which catchability is held constant with age.

If requested, XSA will print the final iteration's transformed CPUE values after a run (40). Plotting the log of the CPUE values against the log of the VPA population abundance estimates given in (9), allows an examination of the distribution of the data points about the fitted regression relationships. The graph can be used to examine whether one or two extreme values are dominating the relationships. This practice has also proved useful when examining the fleet CPUE data for ages at which calibration regression generates extreme values that are subsequently weighted out from the tuning process.

For each final year terminal population, the program prints the year class, the age of the cohort in the final year and the model used to derive catchability-at-age (24). If the user selects the long format diagnostics output the program prints the estimate of the terminal population at the end of the final assessment year (25) and its raw weight (26) estimated for each fleet and each age in the cohort's history. The raw weights are used with the individual estimates of survivors to calculate the fleet-based and overall weighted means. Zero values indicate that the fleet has no data for the age. If the short diagnostics output is selected the individual fleet estimates at age will be omitted and only the following statistics will be tabulated:

A fleet-based weighted mean of the cohort's survivors (27). This is derived from the estimates obtained from the fleet catches at each age in the cohort's history (the raw weights, printed in the long format output, can be used to identify the specific contribution of each estimate).

The internal standard error of the terminal population estimate obtained from a fleet (28). It is derived by combining the standard errors associated with each estimate in the weighted mean and corresponds to the within samples variance of the fleet-based terminal population estimate.

The external standard error of the estimate of survivors obtained from each fleet (29). This is the standard error of the terminal population estimates derived at each age; it corresponds to the between samples variance.

If the values of the internal and external standard errors differ significantly, this indicates a discrepancy between the individual estimates generated by the fleet catches. The variance ratio (30), (external s.e.)²/(internal s.e.)², may be tested as an F statistic with n-1 degrees of freedom. n is the number of estimates of terminal population abundance contributing to the mean, i.e. the number of years in which the fleet removed catches from the cohort. Values exceeding 3 imply that the independent estimates obtained at each age are providing conflicting signals. Too small a value implies an unexpected correspondence of the tuning fleets in relation to the inherent noise.

The scaled weights (31) are a measure of the proportional contribution of the fleet's estimates (for all ages) to the overall survivors estimate for the cohort. The weights are not actually used in the derivation of the overall mean, which is a weighted mean (using the raw weights (26)) of all the disaggregated (by fleet and age) estimates, including the population and F shrinkage means (if used). The scaled weight is given so that contributions from each fleet can be compared.

The terminal F that would be generated by using the estimate of survivors derived from the fleet to initiate the VPA (32) is equivalent to the fleet's raised F generated by the ad hoc tuning procedures. Discrepancies in the signals provided by the fleet data sets can be detected by comparing the F values or the survivor estimates.

If the age is a recruiting age in the assessment and shrinkage to the population mean has been selected, then the estimate of survivors used in the population shrinkage is printed with its standard error, scaled weight and F. The F shrinkage terminal population, the s.e. supplied by the user, scaled weight and F, are also given (33).

The overall weighted geometric mean estimate of survivors at the end of the final year (34) is derived by combining all of the estimates of terminal population abundance; the estimates at each age from all fleets and the shrinkage estimates The raw weights used for the overall weighted mean are listed in (26).

The internal standard error (35) and external standard error (36) of the overall mean, and the variance ratio (38) are printed. If the variance ratio exceeds 3, conflicting signals are being given by the disaggregated (by fleet and age) estimates of terminal population. The F test carried out for the individual fleet estimates can be repeated for the overall mean. In this case n is the summation, across fleets, of the number of years in which a fleet removed catches from the cohort. The individual estimates of terminal population abundance (25) and the fleet variance ratios (30) can be used to identify the fleets and/or ages that are causing problems.

The overall terminal F value for the cohort (39) is calculated using the overall weighted mean terminal population and the catch in the final year.

After the diagnostics for each age are printed an optional output of each fleet's corrected CPUE data is tabulated (40). The data are transformed to the beginning of the year using the total fishing mortality values from the final iteration and the alpha and beta values entered in the diagnostics file. The data can be used to examine the distribution of data points about the fitted catchability regressions, as described previously.

The Blackfin example run

The otter trawl fleet cpue series has trends in time in the historic catchability residuals. Catchability increased during the late 1980's then declined during the early 1990's. This is inconsistent with the assumption of constant catchability in time and the large standard errors of log catchability reflect this mismatch. The catchability values are also inconsistent with the proportional to population abundance model, large standard errors and low R square correlation. The high standard errors will result in terminal population estimates from this fleet being heavily down-weighted in the final model estimates and therefore the fleet should be removed from the XSA model. However, the exclusion of the fleet from the model fit on the basis of the lack of correlation between the cpue data and the populations calculated from the catch at age data assumes that the fleet data does not reflect the stock dynamics. If the catch data is biased the VPA estimated populations will be biased and the fleet cpue may reflect the "truth".

The Light trawl cpue series has no trends in log catchability in time. There is a year class effect of low catchability values for the 1984 year class but the values are not extreme relative to the noise in the series. Given that the cohort effect does not reach the final assessment year it will add noise to the terminal population estimates but will not cause any bias. The power model (catchability dependent on population size) is not appropriate for the cpue data at age 2. The t-value indicates that the slope is therefore not significantly different from 1.0 (direct proportionality). The extra parameter fitted in the XSA model is not required. The age (five) at which catchability has been held constant, with respect to age, has resulted in some skew in the residuals calculated for ages 6 and 7 (Fig. 4b). This may be introducing bias at the oldest ages and the sensitivity of the results to this selection should be examined using a re-run with catchability at age seven constrained to that at age six. It would not be expected that the bias has a significant effect on the overall estimates since the catchability values at the oldest ages are not extremely different from the value at age five (Fig. 4c) and the population numbers at the oldest age are generally low.

The prawn trawl cpue series has pattern in the log-catchability residuals at the oldest ages and consequent high standard errors. Any pattern at the youngest age has been removed by fitting the power model at that age (see also Fig. 4b). The regression model statistics for the fitting of a power model at age 3 are provided even though the model was not used. They indicate that a power or proportional to population abundance model may be appropriate for the cpue at this age (t-value > 2.0, r-square > 0.5, low regression standard error).

The seine trawl cpue has a strong upward trend in catchability during the most recent years. The standard errors are high and for the ages with catchability constant in time have coefficients of variation of greater than 100% indicating that the estimates are poorly determined. Fitting of a power model at age 2 improves the fit of the model and reduces the standard errors through the introduction of the extra parameter. However the level of noise is still substantial. In addition, the slopes of the regression model are all negative, catchability increasing with decreasing population abundance. A clue to the underlying cause of the difficulty in fitting a catchability model is found in the values of R-square, the correlation coefficients for the regression points. The value is very low (close to zero) indicating poor correlation. We therefore have slopes that are potentially significantly different from 1.0 and yet low R-square. This can result from a cloud of data points with outliers that have high leverage, dominating the fitted regression model. Plotting the VPA estimated population abundance against the cpue data corrected to the beginning of the year could help resolve the issue. It would indicate that the data has no signal as to the trends in the stock (as estimated from the catch data) and that the fleet cpue series should not be used in the fitting of the XSA model.

Tables 7-11 present the detailed diagnostic output for the estimation of the terminal populations at the end of the final assessment year. Age 1 in the assessment has catch at age but no calibration or tuning data series. Therefore the estimate of the terminal population at age 2 in the following year is derived from two sources, the time series weighted geometric mean (population shrinkage) and the fishing mortality shrinkage mean. The two estimates of the terminal population differ by two orders of magnitude. This is reflected in the high external variance and the high variance ratio both characteristic of a difference in the estimates from the contributing data sources. The greatest weight (scaled weights) in the final estimate of the terminal population is contributed by the geometric mean. However, even at the low weight given to the fishing mortality shrinkage the very low value has a strong effect on the estimated survivors and raises a question as to the value of including age 1 in the assessment.

At age 2 (Table 7) the final estimate is dominated by the estimate of survivors from the Prawn trawl at age 2 and the population shrinkage geometric mean. This results from the relatively lower standard errors of the two series (Int se). At this age the population shrinkage estimate is higher than all of the fleet estimates and the overall mean is raised by the inclusion of the time series mean. After excluding the noisy fleet cpue series and changing the catchability models, as discussed above, the weighting of the estimates contributed from the series will change and this should be examined here.

Table 8 presents the results for ages 3 and 4. Note that, at these ages, catchability has been modelled as constant in time and therefore the population shrinkage is not used. The summary tables show that the weighted estimates are predominantly derived from the Light trawl and Prawn trawl series and the detailed breakdown shows that the contribution is mostly from ages 2 and 3. The dominance of estimates from separate ages and fleets reflects the poor fit of the catchability models at the youngest ages.

The XSA model should now be re-run and the model parameter and constraint selections altered to the optimum settings for the cpue series. The Otter trawl and seine fleets should be removed from the fitted model. The fastest way of achieving this is to give them a weight of zero using the prior fleet weighting option. In the current XSA program the selection of the age ranges at which the catchability models are applied is specified for all fleets concurrently. However, the most appropriate catchability model for the Light trawl fleet would be the simple proportionality model at all ages, whilst a power model seems appropriate for ages two and three of the Prawn trawl data. In order to fit a model that allows for both options we would go on to fit a power model at the first two ages. For the Prawn trawl fleet this is the required model, for the Light trawl fleet we estimate the slope and intercept rather than forcing them to be one and zero (we waste a parameter). The diagnostics of the new model fit should be examined for the fit of the regression to the Prawn trawl data at age three. Following the examination of the catchability models at the youngest ages, the age at which catchability is held constant with age should be re-evaluated. As noted previously there is a bias in the residuals when age 5 is used as the estimate for ages six and seven. Changes to this assumption should be examined for their effects on residual bias, standard errors and population estimates.

References

- DARBY, C. D. and S. FLATMAN. 1994. Virtual Population Analysis: version 3.1 (Windows/DOS) user guide. *Info. Tech. Ser.*, MAFF Direct. Fish. Res., Lowestoft, 1: 85 p.
- GAVARIS, S. MS 1988. An adaptive framework for the estimation of population size. CAFSAC Res. Doc., No. 29, 12 p.
- PATTERSON, K. R. and G. D. MELVIN. 1996. Integrated Catch At Age Analysis Version 1:2, Scottish Fisheries Research Report. FRS: Aberdeen.
- ROSENBERG, A. A., G. P. KIRKWOOD, R. M. COOK and R. A. MYERS. 1992. Combining information from commercial catches and research surveys to estimate recruitment: a comparison of methods. *ICES Mar. Sci.*, **49**: 379–387.

SHEPHERD, J. G., MS 1992. Extended survivors' analysis: an improved method for the analysis of catch-at-age data and catch-per-unit-effort data. Working paper No. 11, ICES Multispecies Assessment Working Group, June 1992, Copenhagen, Denmark, 22 p.

| Extended Surviv | ors Analysis | 6 | | | | | | | | |
|---|---|---|--|--------------------------|-------------|--------|-------------------|-----------------------------|--------|--|
| Blackfin: VPA co | ourse. Comi | bined sex; p | olusgroup. | | | | | | | |
| CPUE data from | file c:\vpas | \data\blackt | un.dat | | | | | | | |
| Catch data for 3 | 32 years. 19 | 63 to 1994. | Ages 1 to | 10. | | | (2 | 2) | | |
| Fleet | First | Last | First | Last | Alpha | Beta | | | | |
| | year | year | age | age | | | | | | |
| Otter trawl | 1985 | 1994 | 2 | 6 | 0 | 1 | | | | |
| Light trawl | 1985 | 1994 | 2 | 7 | 0 | 1 | | | | |
| Prawn trawl | 1985 | 1994 | 2 | 4 | 0 | 1 | | | | |
| Seine | 1985 | 1994 | 2 | 5 | 0 | 1 | | | | |
| Time series weig | ime series weights : | | | | | | | 3) | | |
| Tapered time | weighting n | ot applied | | | | | | | | |
| Catchability anal | atchability analysis : | | | | | | | | | |
| Catchability d | lependent or | n stock size | for ages < | 3 | | | | | | |
| | type = C | and for road | | | | | | | | |
| Minimum of | f 5 points u timates shru | ink to the po | opulation m | ean for age | s < 3 | | | | | |
| Minimum of Survivor es Catchability ir | f 5 points u timates shru ndependent | ink to the po of age for a | opulation m | ean for age | s < 3 | | (5 | 5) | | |
| Minimum of Survivor es Catchability ir | f 5 points u timates shru ndependent tion estimati nates shrunl | unk to the po of age for a ion : k towards th | opulation m ges >= 5 ne mean F | ean for age | s < 3 | | (5 | 5) | | |
| Minimum of Survivor es Catchability ir Terminal populat Survivor estin | f 5 points u timates shru ndependent tion estimati nates shrunl i years or the | ink to the po of age for a ion : k towards the 3 oldest ; | opulation m ges >= 5 ne mean F ages. | | | | (5 | 5) | | |
| Minimum of Survivor es Catchability ir Terminal populat Survivor estin of the final 5 | f 5 points u timates shru ndependent tion estimati nates shrunl i years or the ean to which ndard error f | ink to the po of age for a ion : k towards the 3 oldest i n the estima for populatic | opulation m ges >= 5 ne mean F ages. Ites are shr | | | | (5 | 5) | | |
| Minimum of Survivor es Catchability ir Terminal populat Survivor estin of the final 5 S.E. of the me Minimum star | f 5 points u timates shru ndependent tion estimati nates shrunl i years or the ean to which ndard error f rived from ea | Ink to the po of age for a ion : k towards the 3 oldest in the estima for populatic ach fleet = | opulation m ges >= 5 ne mean F ages. Ites are shr | | | | (5 | 5) | | |
| Minimum of Survivor es Catchability ir Terminal populat Survivor estin of the final 5 S.E. of the me Minimum star estimates der | f 5 points u timates shru ndependent tion estimati nates shrunl is years or the ean to which ndard error f rived from ea ing not applie | Ink to the po of age for a ion : k towards the 3 oldest i n the estima for populatic ach fleet = id | opulation m ges >= 5 ne mean F ages. ites are shr on .300 | | | | (5 | 5) | | |
| Minimum of Survivor es Catchability ir Terminal populat Survivor estin of the final 5 S.E. of the me Minimum star estimates der Prior weightin Tuning had not of Total absolute re | f 5 points u timates shru ndependent tion estimati nates shrunl i years or the ean to which ndard error f rived from ea ng not applie converged al | ink to the po of age for a ion : k towards th e 3 oldest ; n the estima for populatio ach fleet = id fter 30 itera | ages >= 5 ne mean F ages. ntes are shr 0n .300 ations | | | | (s | - | | |
| Minimum of Survivor esi Catchability ir Terminal populat Survivor estin of the final 5 S.E. of the me Minimum star estimates der Prior weightin Tuning had not of Total absolute re 29 and 30 = .1 | f 5 points u timates shru ndependent tion estimati nates shrunl i years or the ean to which ndard error f rived from ea g not applie converged al converged converged converged converged converged converged converged converged converged converge | ink to the po of age for a ion : k towards the 3 oldest : n the estima for populatic ach fleet = id fter 30 itera een iteration | ages >= 5 ne mean F ages. tes are shr .300 ations | unk = 1.0 | 00 | | (6 | 5) | | |
| Minimum of Survivor esi Catchability ir Terminal populat Survivor estin of the final 5 S.E. of the me Minimum star estimates der Prior weightin Tuning had not o Total absolute re 29 and 30 = Final year F valu | f 5 points u timates shru ndependent tion estimati nates shrunl i years or the ean to which ean to which ndard error f rived from ea g not applie converged al converged converged co | Ink to the po of age for a ion : k towards the 3 oldest i in the estima for populatic ach fleet = id fter 30 item een iteration | opulation m ges >= 5 ne mean F ages. tes are shr on .300 ations ns | unk = 1.01 | 5 | 6 | | - | 9 | |
| Minimum of Survivor esi Catchability ir Terminal populat Survivor estin of the final 5 S.E. of the me Minimum star estimates der Prior weightin Tuning had not of Total absolute re 29 and 30 = Final year F valu Age Iteration 29 | f 5 points u timates shru ndependent tion estimati nates shrunl i years or the ean to which ean to which ndard error f rived from ea g not applie converged at converged at co | Ink to the po of age for a ion : k towards the 3 oldest i in the estima for populatic ach fleet = id fter 30 itera den iteration 2 0.1885 | ations 0.2254 | unk = 1.01 4 0.219 | 5 0.1901 | 0.1541 | (e 7 0.1489 | 5) 8 0.1175 | 0.1368 | |
| Minimum of Survivor esi Catchability ir Terminal populat Survivor estin of the final 5 S.E. of the me Minimum star estimates der Prior weightin Tuning had not o Total absolute re 29 and 30 = Final year F valu | f 5 points u timates shru ndependent tion estimati nates shrunl i years or the ean to which ean to which ndard error f rived from ea g not applie converged al converged converged co | Ink to the po of age for a ion : k towards the 3 oldest i in the estima for populatic ach fleet = id fter 30 item een iteration | opulation m ges >= 5 ne mean F ages. tes are shr on .300 ations ns | unk = 1.01 | 5 | | (6 7 | 5) | - | |
| Minimum of Survivor esi Catchability ir Terminal populat Survivor estin of the final 5 S.E. of the me Minimum star estimates der Prior weightin Tuning had not of Total absolute re 29 and 30 = Final year F valu Age Iteration 29 | f 5 points u timates shru ndependent tion estimati i years or the ean to which ndard error f rived from ea nd ard error f rived from ea nd applie converged at scidual betwe 00178 les 1 0.0001 0.0001 | Ink to the po of age for a ion : k towards the 3 oldest i in the estima for populatic ach fleet = id fter 30 itera den iteration 2 0.1885 | ations 0.2254 | unk = 1.01 4 0.219 | 5 0.1901 | 0.1541 | (e 7 0.1489 | 5) 8 0.1175 0.1173 | 0.1368 | |

TABLE 2. The XSA estimates of fishing mortality and population numbers at age during the final 10 years of the assessment time series.

| Fishing me | ortalities | | | | | | | | (8) | |
|------------|----------------|-------------|--------------|-------------|--|----------|----------|----------|----------|-------|
| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
| 1 | 0 | | | 0.001 | 0.001 | 0.004 | 0.01 | 0.002 | 0.001 | 0 |
| 2 | 0.072 | 0.047 | 0.077 | 0.168 | 0.047 | 0.091 | 0.102 | 0.072 | 0.186 | 0,188 |
| 3 | 0.26 | 0.334 | 0.18 | 0.401 | 0.604 | 0.569 | 0.332 | 0.207 | 0.335 | 0.225 |
| 4 | 0.279 | 0.914 | 0.645 | 0.49 | 0.923 | 0.729 | 0.68 | 0.534 | 0.595 | 0.219 |
| 5 | | 0.668 | 0.539 | 0.541 | 0.683 | 0.491 | 0.533 | 0.496 | 0.401 | 0.19 |
| 6 | 0.35 | 0.444 | 0.539 | 0.645 | 0.629 | 0.54 | 0.501 | 0.3 | 0.247 | 0.154 |
| 7 | 0.376 | 0.578 | 0.478 | 0.85 | 0.504 | 0.513 | 0.638 | 0.15 | 0.145 | 0.149 |
| 8 | 0.293 | 0.563 | 0.528 | 1.109 | 0.641 | 0.738 | 0.457 | 0.172 | 0.11 | 0.117 |
| 9 | 0.342 | 0.532 | 0.716 | 0.962 | 0.817 | 0.828 | 0.742 | 0.178 | 0.173 | 0.136 |
| XSA popu | lation numb | ers (Thousa | ands) | | | | | | (9) | |
| | AC | GE | | | | | | | | |
| YEAR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| | | 3.63E+04 | | | | | | | | |
| | | 1.88E+04 | | 1.56E+04 | | | | | | |
| | | 2.52E+04 | | 1.62E+04 | | | | | | |
| | | 2.57E+04 | | 1.00E+04 | | | | | | |
| | | 1.82E+04 | | 1.05E+04 | | | | | | |
| | | 1.88E+04 | | | | | | | | |
| | | 1.42E+04 | | | | | | | | |
| | | 1.36E+04 | | | | | | | | |
| | | 1.64E+04 | | | | | | | | |
| 1994 | 2.00E+04 | 1.55E+04 | 1.11E+04 | 6.07E+03 | 3:14E+03 | 2.17E+03 | 8,73E+02 | 6,48E+02 | 4.37E+02 | |
| Estimated | population | abundance | at 1st Jan 1 | 995 | | | | | (10) | |
| | 0.00E+00 | 1.64E+04 | 1.05E+04 | 7.27E+03 | 4.00E+03 | 2.13E+03 | 1.53E+03 | 6.17E+02 | 4.73E+02 | |
| Taper weig | ghted geom | etric mean | of the VPA | populations | | | | | (11) | |
| | 2.68E+04 | 2.17E+04 | 1.62E+04 | 9.34E+03 | 4.80E+03 | 2.58E+03 | 1.42E+03 | 7.84E+02 | 4.23E+02 | |
| Standard e | error of the v | weighted Lo | g(VPA popi | ulations) : | | | | | (12) | |
| | 0.2871 | 0.2954 | 0.3078 | 0.3797 | 0.4307 | 0.5088 | 0.6226 | 0.6843 | 0.7408 | |
| Standard e | | | | | e weighted Log(VPA populations) : ?1 0.2954 0.3078 0.3797 | | | | | |

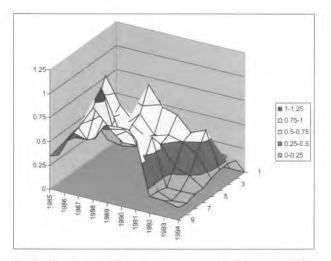
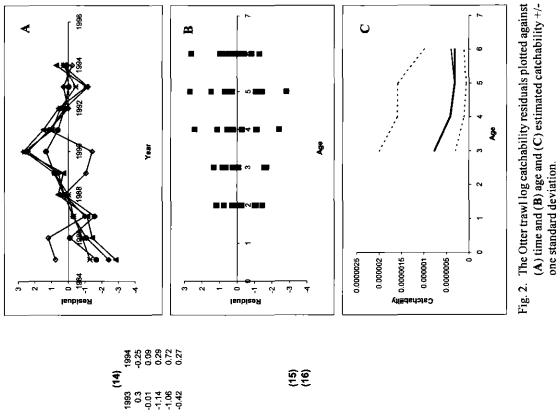


Fig. 1. Fishing mortality-at-age by year as estimated by XSA, note the very strong change in selection at the oldest ages in the most recent years.

TABLE 3. The Otter trawl log catchability residuals at age, the estimated log catchability and the power model regression diagnostics.



| (14) | 1993 0.3 -0.01 | -1.06 | | (15) | | | | | | |
|--------------------|-------------------------------|--|---|---------------------------------|--|-------------------------------|--|----------------|--------------------------------------|---|
| | #~ 9 F | | | | | | | | | |
| | 1992 0.02 0.22 | 0.00 | | | | | | | | |
| | 1991 1.17 0.63 | 0.96 | | | | Mean Log q -14.92 | | o S | -14.08 -14.68 -14.85 -14.72 | |
| | - | | | | | | | Mean O (23) | | |
| | 1990 -1.42 -1.32 -42 | 2.69 | | | | Reg s.e 20) 0.98 | | Reg s.e | 5.45 1.42 0.81 6.41 | |
| | | 0 0 N | | | | Reg (20) | ē | R | <u>5555</u> | |
| | 1989 1.06 0.82 0.58 | | bility | | | No Pts (22) | t w.r.t. tin | No Pts | ~~~~ | |
| | 1988 0.25 0.25 | 0.0 | h catcha .t. time | 6 -14.954 1.1215 | | uare 0.1 | constan | RSquare | 0 0.07 0.21 | |
| | | | as with | | | - " |) and | | a 10 4 M | |
| | 1987 -0.98 -1.56 | -2.82 -1.42 -1.11 -1.28 -0.83 -0.29 No data for this fleet at this age | Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time | 5 -14.954 1.6025 | Regression statistics : (17) Ages with q dependent on year class strength | Intercept 14.56 | Ages with q independent of year class strength and constant w.r.t. time. | Intercept | 34.59 2.76 4.34 35.17 | |
| | 1986 1.21 0.09 | -1.42 -0.83 fleet at | dard er ngth an | 4 -14,6821 1,3325 | r class | 67 | ar clas | e | -0.875 -1.641 -2.376 -1.472 | |
| (13) | | r tist tist | d stan s strei | | (17) ^M yea | t-val (21) | t of ye | t-value | | |
| | 1985 0.77 -1.68 | -2.82 -2.82 -1.28 data fo | ility and ar clas | 3 -14.0782 0.9547 | tics : ndent o | ре 0.93 | endeni | 8 | 5.63 -1.16 -0.62 -6.23 | |
| trawi | 200 | v Z ≺eet | t of ye | | statis deper | Slope (18) 2 0 | indep | Slope | | , |
| Fleet : Otter traw | | · + · | log c: Bnden | Age Mean Log q S.E(Log q) | Regression statistics : Ages with q dependent | | with q | | | |
| Fleet | Age | | Mean indepr | Age Mean Log (S.E(Log q) | Regre Ages | Age | Ages | Age | | |

Log catchability residuals.

Fleet : Light trawf å

| 1994 | 9 | 0.12 | 0.01 | 0.42 | 0.36 | -0.02 | |
|------|--------------|---------------|-------|-------------|------------------|-------|--|
| 1963 | 0.87 | 90.0 | -0.59 | -1.06 -1 | 0.09 | 0.13 | |
| 1992 | 0.01 | -0.25 | 0.0 | 0,05 | -0.33 | -0.5 | |
| 1891 | 0.49 | -0.17 | 0.53 | 0.96 | 0.28 | 0.38 | |
| 1990 | 0.13 | 0.58 | 0.83 | 0.31 | -0.11 | 0.35 | |
| 1989 | -1.23 | 0.28 | -0.21 | -0.45 | -0.13 | Ð.J | |
| 1988 | 0.41 | 98.0 | -0.81 | 0.32 | - 0.8 | -1.28 | |
| 1987 | 1.21 | -0.5 7 | 6.0 | -0.48 | -0.64 | -0.43 | |
| 1986 | 4 | 0.12 | 0.63 | 0.74 | 5 .9 | -0.22 | |
| 1985 | 6 .4 | 0.31 | 0.46 | 8.0- | 0.02 | -0.91 | |
| | 7 | e, | 4 | ŋ | ç | ~ | |
| ₽. | | | | | | | |

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

| 7 | -16.2817 0.6058 | |
|-----|--------------------------|--|
| 9 | -16.2817 0.4326 | |
| ŝ | -16.2817 0.6706 | |
| 4 | -15.7286 0.6204 | |
| ŝ | -15.5176 0.3457 | |
| Age | Mean Log q S.E(Log q) | |

Regression statistics :

Ages with q dependent on year clase strength

| Ъ. | t-value Intercept RSquare -0.22 17.58 0.13 |
|------|---|
| - 82 | 2 |

0.00000015

Catchability

| Mean Q | -15.52 | -15.73 | -16.28 | -16.46 | -16.56 |
|-----------|--------|--------|---------|----------|--------|
| Reg s.e | 0.29 | 0.81 | 0.9 | 0.57 | 1.05 |
| No Pts | 10 | ţ | | <u>6</u> | 10 |
| RSquare | 0.62 | 0.18 | 0.18 | 0.4 | 0.16 |
| Intercept | 14.39 | 17.33 | 18.44 | 20.67 | 26.54 |
| t-value | 0.688 | -0.324 | -0.364 | -1.114 | -1.334 |
| skope | 0.81 | 1.24 | 1.28 | 1.49 | 2.07 |
| ũ | e | 4 | un, | ę | 7 |
| Age | | | | | |

| 0.0 0.0 0.0 0.0 0.0 0 0.0 0 0 0 0 0 0 0 |
|--|
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|-------------------------|-----------------------------|------------|
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Fig. 3. The Light trawl log catchability residuals plotted against
(A) time and (B) age and (C) estimated catchability +/-one standard deviation

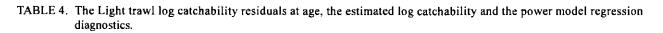
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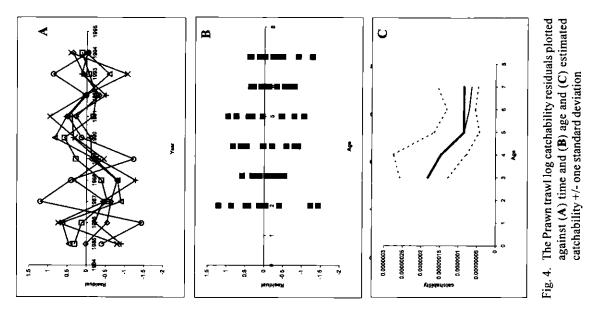
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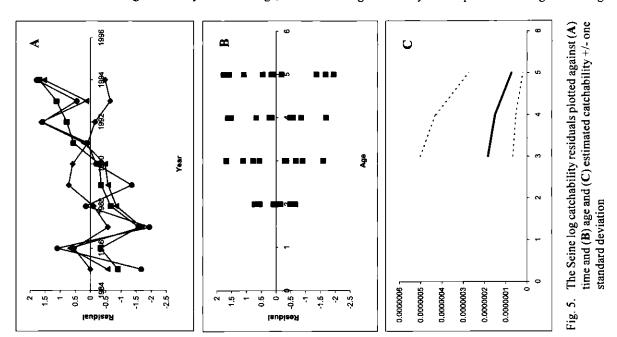
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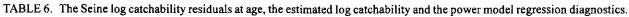
TABLE 5. The Prawn trawl log catchability residuals at age, the estimated log catchability and the power model regression diagnostics.



| 1991 | 0.14 0.13 0.21 -0.09 -0.72 -0.82 -1.25 -1.28 | 0.07 -0.1 | | | | | | Reg s.e Mean Log q | 0.25 -18.79 | | Reg s.e Mean Q | 0.22 -19.09 |
|------|---|-----------|--|---|---------------------------------|-------------------------|--|--------------------|-------------|---|----------------|-------------|
| 1989 | -0.35 | 0.17 | | yility | | | | No Pts | 10 | it w.r.t. time. | No Pts | 10 |
| 1988 | 0.18 | -1.97 | | Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time | | | | RSquare | 0.63 | Ages with q independent of year class strength and constant w.r.t. time | RSquare | 0.74 |
| 1987 | 0.14 | 0.03 | this age this age this age | nror of ages nd constant | | | strength | Intercept | 12.86 | s strength a | Intercept | 11.84 |
| 1986 | 0.21 | 0.74 | No data for this fleet at this age No data for this fleet at this age No data for this fleet at this age | Mean log catchability and standard error of ages with catch ndependent of year class strength and constant w.r.t. time | 4 -19.8161 0.9164 | | Ages with q dependent on year class strength | t-value | 2.446 | of year clas | t-value | 3.643 |
| 1985 | -0.14 | 1.12 | No data for No data for No data for | hability and if year class | 3 -19.0864 1.4344 | atistics : | apendent or | Slope | 0.34 | dependent | Slope | 0.23 |
| Ade | ~ | 4 | 402 | in log catc | Age Mean Log q S.E(Log q) | Regression statistics : | s with q de | Age | 7 | s with q in | Age | ŝ |

Fleet : Prawn trawl





| 2 | \$ | 88 | 1.52 | 12 |
|---|----|----|------|----|
| 6 | Ò, | ÷ | Ť | ÷ |

Fleet : Seine

| 1993 -0.65 1.11 0.14 0.45 | | | | | | | | |
|--|--|---------------------------------|-------------------------|--|------------------------|--|-----------|----------------------------|
| 1992 -0.15 1.62 1.59 | | | | | | | | |
| 1991 0.08 0.22 0.11 | | | | | Mean Log q -15.8 | | Mean Q | -15.51 -15.71 -16.42 |
| 0.59 0.59 0.28 0.19 0.19 | | | | | Reg s.e 0.52 | | Reg s.e | 0.86 1.64 4.52 |
| 1989 0.72 -0.35 -0.58 -1.36 | ability | | | | 5 | nt w.r.t. time | No Pts | 00 00 00 00 |
| 1988 -0.1 -0.67 -0.65 -0.85 0.15 | s with catch it w.r.t. time | | | | RSquare No Pts 0.28 | and constar | RSquare | 0.15 0.05 0.01 |
| 1987 -0.57 -1.59 -1.69 -1.94 t this age t this age | error of age and constan | 5 -16.4243 1.3153 | | s strength | Intercept 7.31 | ss strength | Intercept | 3.37 -2.26 -19.71 |
| 1985 1986 198 0.01 0.55 -0.5 -0.9 -0.32 -1.5 -0.56 0.67 -1.6 -1.67 1.09 -1.9 No data for this fleet at this age No data for this fleet at this age | d standard ss strength a | 4 -15.7074 1.0477 | | m year clas | t-value -2.516 | t of year cla | t-value | -2.485 -1.811 -1.187 |
| | chability an of year clas | 3 -15.5078 1.0043 | statistics : | tependent c | Slope -0.43 | ndependeni | Stope | -1.07 -1.75 -3.52 |
| А 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 | Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time | Age Mean Log q S.E(Log q) | Regression statistics : | Ages with q dependent on year class strength | Age 2 | Ages with q independent of year class strength and constant w.r.t. time. | Age | ю4 n |

| • | | | | | | | | | | | | | | | | |
|---|------------------------|--------------------------------|----------------------|--------------------|-----------------------------|---|---|------------------------------------|---|---|--|-----------------------|-----------------------------|------------|--|--|
| Age 1 Catchability dependent on age and year class strength | dependent c | on age ar | od year o | lass stre | hgth | | | | Age 2 Catchability dependent on age and year class strength | lependent on | age and j | year class | strength | | | |
| Year class = 1993 | | | | | | | | | Year class = 1992 | | | | | | | |
| Otter trawl Age Survivors Raw Weights | | -00 | | | | | | | Otter trawi Age Survivors Raw Weights | 2 8174 0.759 | -00 | | | | | |
| Light trawl Age Survivors Raw Weights | | -00 | | | | | | | Light trawl Age Survivors Raw Weights | 2 10140 0.936 | -00 | | | | | |
| Prawn trawl Age Survivors Raw Weights | | -00 | | | | | | | Prawn trawl Age Survivors Raw Weights | 2 6904 9.203 | -00 | | | | | |
| Seine Age Survivors Raw Weights | | -00 | | | | | | | Seine Age Survivors Raw Weights | 2 6505 2.387 | -00 | | | | | |
| Fleet Otter trawi Light trawi Prawn trawi Seine | Estimated Survivors | ed Srs t t t t Sre t | 0000 | 0000 8.6 8.6 | Var Ratio 0 0 0 | z | Scaled Weights 0 0 0 0 0 0 | Estimated F 0 0 0 0 | Fleet Otter trawl Light trawl Prawn trawl Seine | Estimated Survivors 8174 10140 6904 6505 | Int s.e 1.045 0.941 0.3 0.3 | о о о о е щ е щ | Var Ratio 0 0 0 | z | Scaled Weights 0.038 0.038 0.038 | Estimated F 0.236 0.195 0.274 0.289 |
| P shrinkage mean F shrinkage mean | 21733 657 | | 0.3 | | | | 0.92 0.08 | 0 0.003 | P shrinkage mean F shrinkage mean | 16215 20703 | 0.31 | | | | 0.425 0.04 | 0.126 0.1 |
| Weighted prediction : Survivors at end of year 16- | 412 | Int Ext s.e s.e 0.28 9.7 | Ext N s.e 9.75 | N | Var Ratio 34.421 | щ | o | | Weighted prediction : Survivors at end of year 10518 | int s.e 0.19 | Ext s.e 0.26 | o z | Var Ratio 1.372 | F 0.188 | | |

Fleet disaggregated estimates of survivors :

 TABLE 7. The XSA estimates of Blackfin terminal population numbers and fishing mortality and their standard errors at ages 1 and 2.

| Age 3 Catchability constant w.r.t. time and dependent | constant w.r. | .t. time and | i dependen | it on age | | | | | Age 4 Catchability constant w.r.t. time and dependent on age | constant w.r. | t. tìme and | dependen | it on age | | | |
|---|--|--|---------------------------------------|--|---------------------------|---|---|--------------|--|--|---|---------------------------------------|--|---------------------------------------|--|--|
| Year class = 1991 | | | | | | | | (24) | Year class = 1990 | | | | | | | |
| Otter trawl Age Survivors Raw Weights | 3 7940 0.796 | 2 9770 0.62 | -00 | | | | | (25) (26) | Otter trawl Age Survivors Raw Weights | 4 5338 0.411 | 3 3955 0.573 | 2 4058 0.495 | -00 | | | |
| Light trawl Age Survivors Raw Weights | 3 8210 6.073 | 2 17278 0.712 | -00 | | | | | | Light trawl Age Surnivors Raw Weights | 4 4045 1.898 | 3 3743 4.374 | 2 4027 0.6 | +00 | | | |
| Prawn Irawl Age Survivors Raw Weights | 3 3814 0.353 | 2 6620 7.365 | ~ 00 | | | | | | Prawn trawl Age Suntvors Raw Weights | 4 1788 0.87 | 3 1112 0.254 | 2 4940 5.941 | -00 | | | |
| Seine Age Survivors Raw Weights | 3 39081 0.72 | 2 3781 1.824 | -00 | | | | | | Seine Age Surnivors Raw Weights | 4 18174 0.665 | 3 12077 0.518 | 2 3429 1.643 | -00 | | | |
| Fleet Otter traw/ Light trawf Prawn trawf Seine | Estimated Survivors (27) 8695 8876 6455 6455 7321 | Int s.e 0.722 0.34 0.34 0.294 | Ext s.e 0.103 0.115 1.052 | Var Ratio (30) 0.14 0.67 0.39 2 | z | Scaled Weights (31) 2 0.073 2 0.349 2 0.349 2 0.349 | led Estimated ghts F (31) (32) 0.073 0.192 0.349 0.188 0.397 0.25 0.131 0.224 | T | Fieet Otter trawi Light trawi Prawn trawi Seine | Estimated Survivors 4336 3849 4131 6396 | Int s.e 0.65 0.304 0.284 0.463 | Ext s.e 0.092 0.296 0.528 | Var Var Ratio 0.14 0.09 1.04 1.14 | e e e e e e e e e e e e e e e e e e e | Scaled Weights 0.077 0.357 0.367 0.367 0.147 | Estimated F 0.203 0.226 0.212 0.142 |
| F shrinkage mean Weighted prediction : | 3599 | * | | | | 0.051 | 0.412 | (33) | F shrinkage mean Weighted prediction : | 996 | - | | | | 0.052 | 0.699 |
| Survivors at end of year 7272 (34) | Int s.e 0.19 (35) | Ext s.e 0.16 (36) | и (37) 9 | Var Ratio 0.848 (38) | F 0.225 (39) | <u>م</u> | | | Survivors at end of year 3997 | int s.e 7 0.18 | Ext s.e 0.16 | z č | Var Ratio 0.867 | F 0.219 | | |

TABLE 8. The XSA estimates of Blackfin terminal population numbers and fishing mortality and their standard errors at ages3 and 4.

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| Age 5 Catchability constant w.r.t. time and dependent on age | / constant w.r | .t. time and | l dependei | nt on age | | | | Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) | constant w.r. | t. time and | age (fixed | i at the valu | le for age) | 5 | |
|--|--------------------|--------------------|------------|-----------------------|--------|---------|-----------|--|--------------------|--------------------|------------|-----------------------|-------------|---------------|-----------|
| Year class = 1989 | | | | | | | | Year class = 1988 | | | | | | | |
| Otter trawl Age | ى س | 4 | ŝ | 2 | | - | | Otter trawi Age | G | 'n | 4 | co | 2 | ~- | |
| Survivors | 4380 | 680 | 2648 | 6875 | | 0 | | Survivors | 2005 | 529 | 1886 | 2879 | 368 | 0 | |
| Raw Weights | 0.293 | 0.234 | 0.37 | 0.291 | | 0 | | Raw Weights | 0.62 | 0.203 | 0.172 | 0.241 | 0.169 | 0 | |
| Light trawf | | | | | | | | Light trawl | | | | | | | |
| Age | S | 4 | ო | 2 | | • | | Age | 9 | сл | 4 | ო | 2 | - | |
| Survivors | 3229 | 1185 | 1666 | 3469 | | 0 | | Survivors | 2191 | 528 | 1585 | 1287 | 1739 | 0 | |
| Raw Weights | 1.672 | 1.077 | 2.82 | 0.38 | | 0 | | Raw Weights | 4.164 | 1.161 | 0.795 | 1.838 | 0.251 | 0 | |
| Prawn trawl | | | | | | | | Prawn trawl | | | | | | | |
| Age | ŝ | 4 | e | 2 | | • | | Age | 9 | ю | 4 | ო | 2 | ~ | |
| Survivors | 0 | 1560 | 607 | 2422 | | Ð | | Survivors | 0 | 0 | 1385 | 671 | 1753 | 0 | |
| Raw Weights | 0 | 0.494 | 0.164 | 3.719 | | 0 | | Raw Weights | 0 | o | 0.364 | 0.107 | 2.45 | 0 | |
| Seine | | | | | | | | Seine | | | | | | | |
| Age | ŝ | 4 | ĉ | 2 | | • | | Age | 9 | ŝ | 4 | e | 2 | - | |
| Survivors | 12545 | 2453 | 4636 | 2300 | | 0 | | Survivors | 0 | 2398 | 7703 | 2669 | 2755 | 0 | |
| Raw Weights | 0.435 | 0.378 | 0,334 | 1.088 | | D | | Raw Weights | 0 | 0.302 | 0.279 | 0.218 | 0.666 | 0 | |
| Fleet | Estimated | Int | Ext | Var | z | Scaled | Estimated | Fleet | Estimated | ц | Ext | Var | s z | Scaled | Estimated |
| | Survivors | S.e | S.e | Ratio | | Weights | | | Survivors | 5, 0 | S.0 | Ratio | 5 | Weights | Ľ |
| Otter trawl | 2899 | 0.643 | 0.462 | 0.72 | | 4 0.08 | | Otter trawl | 1424 | 0.637 | 0.357 | 0.56 | ŋ | 0.094 | 0.164 |
| Light trawl | 1977 | 0.293 | 0.223 | 0.76 | | | | Light traw | 1530 | 0.273 | 0.241 | 0.89 | S | 0.547 | 0.153 |
| Prawn trawl | 2189 2500 | 0.283 | 0.204 | 0.72 | | 3 0.297 | | Prawn trawi | 1644 | 0.284 | 0.135 | 0.48 | e . | 0.195 | 0.144 |
| Cerre | 7605 | 0.452 | 0.361 | 20 | | 4 0.152 | 7L1.0 2 | Seine | 5241 | 0.400 | 0.244 | 75.0 | 4 | 0.096 | c/n'n |
| F shrinkage mean | 644 | - | | | | 0.068 | 3 0.525 | F shrinkage mean | 451 | ÷ | | | | 0.067 | 0,447 |
| Weighted prediction : | ï | | | | | | | Weighted prediction : | | | | | | | |
| Survivors at end of year 2132 | Int s.e 0.18 | Ext s.e 0.15 | л 16 | Var Ratio 0.851 | ц С | 0.19 | | Survivors at end of year 1529 | Int s.e 0.19 | Ext s.e 0.15 | 2 8 | Var Ratio 0.777 | F 0.154 | | |
| | | | | | | | | | | | | | | | |

TABLE 9. The XSA estimates of Blackfin terminal population numbers and fishing mortality and their standard errors at ages 5 and 6.

TABLE 10. The XSA estimates of Blackfin terminal population numbers and fishing mortality and their standard errors at ages7 and 8.

| Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) | constant w. | r.t. time an | xi) age br | ed at the | value for ¿ | 3Ge) 5 | | Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) | constant w.r | t. time a⊓ | d age (fix | ed at the v | /alue for a | ige) 5 | | |
|--|------------------------|--------------------|----------------|---------------------|----------------|-------------------|----------------|--|----------------------|--------------------|----------------|-----------------------|-----------------|---------------------|----------------|-------------|
| Year class = 1987 | | | | | | | | Year class = 1986 | | | | | | | | |
| Otter trawl Age | 2 | ග | ŝ | 4 | ŝ | 2 | | Otter trawl Age | 80 | 2 | ú | 'n | 4 | ო | 7 | ~ |
| Survivors | 0 | 405 | 1137 | 1915 | 2315 | 213 | 0 | Survivors | 0 | 0 | 769 | 2094 | 5304 | 1074 | 608 | 0 |
| Raw Weights | 0 | 0.487 | 0.145 | 0.106 | 0.117 | 0.093 | 0 | Raw Weights | 0 | 0 | 0.412 | 0.118 | 0.083 | 0.088 | 0.068 | 0 |
| Light trawl | | | | | | | | Light trawl | I | i | | I | | | , | |
| Age | 7 | 9 | ŝ | 4 | m | 2 | - | Age | 80 | ~ | ç | ç | 4 | ო | 2 | - |
| Survivors | 604 | 671 | 645 | 1048 | 1095 | 181 | 0 | Survivors | 0 | 536 | 339 | 1234 | 1086 | 625 | 708 | 0 |
| Raw Weights | 2.135 | 3.27 | 0.829 | 0.491 | 0.894 | 0.106 | 0 | Raw Weights | 0 | 1.906 | 2.767 | 0.676 | 0.381 | 0.67 | 0.08 | 0 |
| Prawn trawl | | | | | | | | Prawn trawl | | | | | | | | |
| Age | 7 | 9 | ŝ | 4 | რ | 7 | - | Age | 8 | 7 | 9 | 5 | 4 | ო | 2 | |
| Survivors | 0 | 0 | 0 | 663 | 300 | 436 | 0 | Survivors | 0 | 0 | ¢ | 0 | 1355 | 1916 | 562 | 0 |
| Raw Weights | 0 | 0 | 0 | 0.225 | 0.052 | 1.246 | 0 | Raw Weights | 0 | 0 | 0 | 0 | 0.174 | 0.039 | 0.828 | 0 |
| Seine | | | | | | | | Seine | | | | | | | | |
| Age | 7 | 9 | ŝ | 4 | e | 2 | - | Age | 8 | 7 | 9 | ŝ | 4 | ო | 2 | ~ |
| Survivors | 0 | 0 | 3032 | 767 | 461 | 1266 | 0 | Survivors | 0 | o | 0 | 524 | 291 | 331 | 428 | 0 |
| Raw Weights | 0 | 0 | 0.216 | 0.172 | 0.106 | 0.328 | o | Raw Weights | o | 0 | • | 0.176 | 0.133 | 0.079 | 0.244 | 0 |
| Fleet | Estimated Survivors | ut v | с Ч | Var Ratio | z | Scaled Weights | Estimated F | Fleet | Survivors | int Be | EXt a | Var Ratio | ٥s z | Scaled Weights | Estimated F | |
| Otter trawl | 658 658 | 0.694 | 0.392 | 0.57 | | 0.079 | 014 | Otter trawl | 1124 | 0.713 | 0.327 | 0.46 | | 220.0 | 0.051 | |
| Light trawl | 694 | 0.278 | 0.115 | 0.41 | 9 09 | 0.643 | 0.133 | Light trawl | 511 | 0.284 | 0.196 | 0.69 | e G | 0.653 | 0.109 | |
| Prawn trawl Seine | 458 1258 | 0.288 0.507 | 0.119 0.358 | 0.41 0.71 | ლ 4 | 0.127 0.068 | 0.195 0.076 | Prawn trawl Seine | 682 404 | 0.293 0.513 | 0.273 0.126 | 0.93 0.25 | κυ 4 | 0.105 0.064 | 0.083 0.136 | |
| F shrinkage mean | 205 | - | | | | 0.083 | 0.393 | F shrinkage mean | 110 | - | | | | 0.101 | 0.426 | |
| Weighted prediction : | | | | | | | | Weighted prediction : | | | | | | | | |
| Survivors at end of year 617 | Int s.e 7 0.21 | Ext s.e 0.13 | N †9 | Var Ratio 0.6 | F 0.149 | | | Survivors at end of year 473 | Int s.e 3 0.22 | Ext s.e 0.17 | 2 7 2 | Var Ratio 0.744 | F 0.117 | | | |

TABLE 11. The XSA estimates of Blackfin terminal population numbers and fishing mortality and their standard errors at age 9.

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 5

| Year class = 1985 | i | | | | | | | | |
|---------------------|-----------|-------|-------|-------|-------|---------|-----------|-------|---|
| Otter trawl | | | | | | | | | |
| Age | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Survivors | 0 | 0 | 0 | 816 | 4597 | 560 | 400 | 117 | 0 |
| Raw Weights | 0 | 0 | 0 | 0.295 | 0.088 | 0.051 | 0.066 | 0.055 | 0 |
| Light trawl | | | | | | | | | |
| Age | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Survivors | 0 | 0 | 189 | 412 | 426 | 253 | 211 | 1046 | 0 |
| Raw Weights | 0 | 0 | 1.667 | 1.981 | 0.505 | 0.234 | 0.505 | 0.055 | 0 |
| Prawn trawl | | | | | | | | | |
| Age | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Survivors | 0 | 0 | 0 | 0 | 0 | 369 | 75 | 359 | 0 |
| Raw Weights | 0 | 0 | 0 | 0 | 0 | 0.107 | 0.029 | 0.683 | 0 |
| Seine | | | | | | | | | |
| Age | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Survivors | 0 | 0 | Û | 0 | 260 | 175 | 160 | 176 | 0 |
| Raw Weights | 0 | 0 | 0 | 0 | 0.131 | 0.082 | 0.06 | 0.197 | 0 |
| Fleet | Estimated | Int | Ext | Var | N | Scaled | Estimated | | |
| | Survivors | s.e | s.e | Ratio | | Weights | F | | |
| Otter trawl | 788 | 0.71 | 0.479 | 0.68 | 5 | 0.071 | 0.056 | | |
| Light trawl | 293 | 0.294 | 0.176 | 0.6 | 6 | 0.635 | 0.145 | | |
| Prawn trawl | 340 | 0.285 | 0.207 | 0.73 | 3 | 0.105 | 0.126 | | |
| Seine | 194 | 0.507 | 0.106 | 0.21 | 4 | 0.06 | 0.212 | | |
| F shrinkage mea | n 303 | 1 | | | | 0.128 | 0.14 | | |
| Weighted prediction | on : | | | | | | | | |
| Survivors | Int | Ext | N | Var | F | | | | |
| at end of year | s.e | s.e | | Ratio | | | | | |
| | 0.24 | 0.12 | 19 | 0.502 | 0.136 | | | | |
| | | | | | | | | | |

Otter trawl

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Prawn trawl

| CPUE adjusted to start of year | to start of yea | 4 | | | | | | | CPUE adjuster | CPUE adjusted to start of year | - | | |
|--------------------------------|-----------------|---------|---------|---------|---------|---|---|--------------|---------------|--------------------------------|---------|---------|---|
| | AGE | | | | | | | | | AGE | | | |
| YEAR | 1 2 | ŝ | 4 | ю | 9 | 2 | œ | 6 | YEAR | 1 | e | 4 | ŝ |
| 1985 | 0 0.02893 | 0.00354 | 0.00053 | 0.00013 | 0.00041 | o | 0 | 0 | 1985 | 0 0.00057 | 0.00067 | 0.0001 | 0 |
| 1986 | 0 0.02282 | 0.01939 | 0.00222 | 0.00067 | 0.00061 | 0 | 0 | 0 | 1986 | 0 0.00023 | 0.00187 | 8.1E-05 | 0 |
| 1987 | 0 0.00296 | 0.00238 | 0.00519 | | 0.00086 | 0 | 0 | 0 | 1987 | 0 0.00044 | 0.00012 | 4.1E-05 | 0 |
| 1988 | 0 0.01142 | | 0.00544 | | 0.00078 | 0 | 0 | 0 | 1988 | 0 0.00053 | | 3.5E-06 | 0 |
| 1989 | 0 0.00191 | 0.03114 | 0.00789 | 0.00215 | 0.0024 | 0 | 0 | • | 1989 | 0 4E-05 | - | 3.1E-05 | 0 |
| 1990 | 0 0.00134 | _ | 0.03761 | 0.01603 | 0.0091 | o | 0 | 0 | 1990 | 0 0.00019 | 3.6E-05 | 5.7E-05 | 0 |
| 1991 | 0 0.01618 | 0.0204 | 0.00862 | 0.00447 | 0.00143 | 0 | 0 | 0 | 1991 | 0 7.8E-05 | ••• | 1.8E-05 | 0 |
| 1992 | 0 0.00446 | 0.01001 | 0.00429 | 0.00162 | 0.00079 | 0 | 0 | 0 | 1992 | 0 8.9E-05 | | 1.9E-05 | 0 |
| 1993 | 0 0.00735 | 0.00789 | 0.00094 | 0.00044 | 0.00029 | Ċ | 0 | 0 | 1993 | 0 6.2E-05 | • | 1.3E-05 | 0 |
| 1994 | 0 0.00385 | 0.00934 | 0.00341 | 0.00207 | 0.00091 | o | 0 | 0 | 1994 | 0 2E-05 | 3E-05 | 6.7E-06 | 0 |
| Light trawl | | | | | | | | | Seine | | | | |
| CPUE adjusted to start of year | to start of yea | - | | | | | | | CPUE adjuster | CPUE adjusted to start of year | - | | |

5.4E-05 0.0006 ŝ 9.5E-05 0.00187 0.00136 0.00119 00124 0.00457 00045 0.00088 0.00074 0.00065 0.00417 0.001 0.0018 0.0023 0.00196 0.00453 0.00185 0.00369 0.0042 0.00055 0.00577 0.01101 0.00061 0.00079 0.00546 0.00173 0.00058 0.00073 0.00459 0.0178 0.00855 0.01349 AGE 00000000000 YEAR 1985 1985 1988 1988 1989 1990 1993 1993 ***** 7.4E-05 0.00018 0.00013 4.1E-05 6.6E-05 0.00017 0.0001 ģ 9.4E-05 0.00025 0.00016 0.00021 0.00016 0.0004 1.2E-05 G 0.00019 0.00026 0.0001 0.00027 0.00039 0.0007).00026 ŝ 00153 00081 0.0004 00027 0.00012 0.00024 0.00066 0.00125 0.0027 0.00166 0.00057 0.00127 0.00325 0.00434 0.00091 0.0009 0.00156 0 0.00235 0 0.0043 0 0.00216 0.00613 0.00149 0.00177 0.0057 0.00229 0.0019 0.00201 0.00131 0.00052 0.00586 0.00308 0.00308 0.0031 0.0021 ₿ E YEAR 1985 1986 1988 1988 1989 1991 1992 1993

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TABLE 12. The Blackfin catch-per-unit effort data corrected to the beginning of the year using the estimated fishing mortalities and natural mortality.

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Appendix 1: Lowestoft Stock Assessment Suite

Tutorial 5

Retrospective Analysis (RETVPA00.EXE)

by

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Abstract

This document is number five in a series of tutorials designed to assist users of the Lowestoft VPA Suite assessment software and prediction programs that use the results. The tutorial takes the user through the options required for running the retrospective program RETVPA00.EXE.

Introduction

Retrospective studies have established that patterns of consistent under- or over-estimation bias in estimates of F and population numbers-at-age can be produced by the application of assessment methodologies to fish stock data (Sinclair *et al.*, MS 1990, ICES, MS 1991). Such biases may cause problems in the advice given to managers and therefore need to be examined and if possible removed from the assessment and subsequent predictions.

This tutorial takes the user through the options required for running the program RETVPA00.EXE and carrying out a retrospective analysis of an XSA model structure. The tutorial assumes that the required Blackfin data files have been placed in a directory c:\vpas\data\, and that the index file (Blackfin.ind) contains path names that point to the appropriate files.

Description of the method

For each stock and analysis procedure a series of assessments are performed with the terminal year decreased by one year at each run. This simulates the results of assessments with progressively shorter time series. All input parameters to the analysis are held constant, e.g. number of tuning data years, time series weights, reference ages. The values estimated by the most recent assessment, derived from all available data, are assumed to be the 'truth' and compared with the estimates from the runs which pre-date it. The accuracy of an assessment methodology is determined by its ability to consistently predict the 'truth'. Bias is the degree to which the method consistently under- or over-estimates the 'truth'. The analysis procedure usually involves the creation of retrospective time series plots for particular assessment estimates (e.g. F, population numbers-at-age, SSB) followed by a statistical or subjective analysis of the accuracy and bias of the method.

When carrying out retrospective analyses the selection of tuning fleets to be used in the assessments is important. Fleets with short time series should be avoided. As the program steps back through the data range they may drop out when there are insufficient years of fleet data for the specified analysis. In addition, short series with artificially low standard errors may erroneously dominate the assessment. The use of short time series can introduce sudden changes in the retrospective patterns and should be avoided. If required, the short series can be reintroduced for restricted retrospective analyses after the full runs.

Retrospective Extended Survivors Analysis

In the following text action to be taken by the user is highlighted in bold. The symbol \dashv is used to represent the Return or Enter key on the keyboard.

Open the VPA suite program and read in the index file C:\VPAS\DATA\BLACKFIN.IND. Take the default year, age and summary mean settings until the main menu is reached.



Note that we only have two options for the assessment model that we can run.



Type 2 ↓ to select the XSA model.

Type ↓ to select the default tuning data file, Blacktun.dat

The retrospective program steps back in time fitting assessment models which finish in successively earlier years. It produces tuning diagnostic and population summary files. The user can specify where the files are to be placed.

Enter a directory path for the output files.



The program asks for a three letter code to prefix the output files for later identification. The program will create each tuning file by adding RT < yr > .CSV to the end of the prefix, < yr > represents the terminal year for the assessment being performed.

Enter a three letter code for the data files.



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In addition to the tuning diagnostics files, the program generates output tables with one of two user-selected formats. They are:

- F and population numbers-at-age tables for each assessment in the retrospective series and the stock time series summary (Tables 8, 10 and 16 from the main menu of the output from the main suite). The program will create each output file by adding RO<yr>.CSV to the end of the user-defined prefix.
- A single file containing the F and population numbers tables from each run in the format defined for the SAS program used to generate the figures and summary tables presented in ICES (MS 1991) and ICES (MS 1993).

Type 1 to output separate files.

We now set up the XSA analysis model that we wish to use retrospectively. The options are taken from Tutorial 4 that describes the fitting of the XSA model to the Blackfin data set.

Type 3 \dashv as the first age for the constant catchability model, that is, age 2 has a power model.

Type 5 I so that catchability at ages older than 5 is set at that estimated at age 5.



Type $Y \downarrow$ in order to change the default XSA settings.

Type N J to use all data in the time series with equal weight.

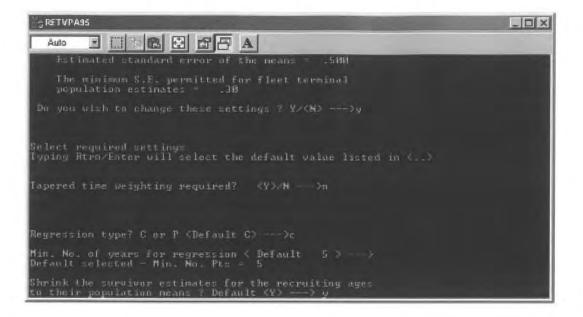
Type → to apply the default calibration regression model

Type I to take the default of a minimum of 5 data points for the fitting of a regression model.

Type → to use the default option of shrinkage to the population mean with the calibration regression.

Type ↓ to take the default of using shrinkage to the mean fishing mortality.

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Type ↓ to use 5 years in the fishing mortality shrinkage mean across years.

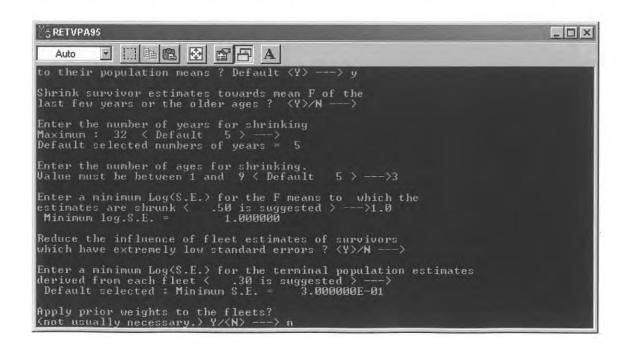
Type 3 \dashv to use 3 ages in the fishing mortality shrinkage mean across ages.

Type 1.0 \downarrow for the weight (c.v) to be used for the fishing mortality shrinkage means.

Type ↓ to use a minimum value for the standard error.

Type \dashv to set the minimum to 0.3.

Type \downarrow to take the default option of no individual fleet weighting.



After selection of the assessment method and model fitting options, the program asks an additional series of questions in order to define the characteristics of the retrospective run:

The first question refers to the use of the tuning data time series. The user can select between:

- (1) a tuning range window, e.g. 10 years of fleet data, which is moved backwards with the terminal year for each new assessment, or
- (2) the full data range in the tuning file and the removal of the most recent years data as the program steps back for each new terminal year.

Time series weights, if used, are moved back with the assessment terminal year.

Type 2 to use a tuning window that will be moved back in time for each assessment.

Type 10 for the number of years to use for the tuning range

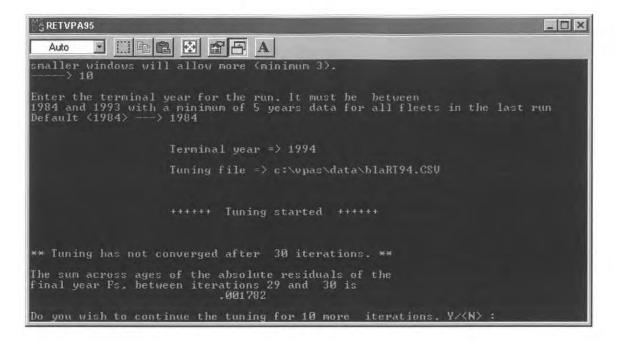
The next question defines the number of years for which the retrospective analysis is to be run. Enter the finishing year for the run: the earliest terminal year. Acceptable values lie between the penultimate year in the data file and the earliest year in the complete tuning range that allows 5 years of data for each fleet. Short fleet tuning series should be removed if a retrospective series with sufficient comparison years for an acceptable analysis is to be achieved (8 years of tuning data will give 4 assessments in the retrospective series).

Type 1984 for the final assessment year.



The program then begins the retrospective analysis of the data sets, printing the terminal year for the current assessment to the screen.

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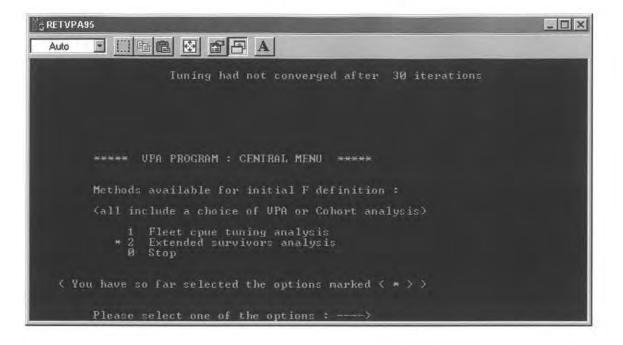


If the assessment has not converged after the required numbers of iterations (described earlier for each of the methods) the program will request clearance for further iterations.

When converged or the current assessment is terminated by the user, the program will write the output data to the file defined earlier. It will then proceed with the next assessment in the series.

| ₩S RETVPA95 | _ 🗆 × |
|---|--------------|
| | |
| | |
| Terminal year => 1992 | |
| Tuning file => c:\vpas\data\blaRT92.CSV | |
| 에 눈이 이는 지정이 걸렸다. 것이 같아 같아 같아 같아? | |
| +++++ Tuning started ++++++ | |
| Replacement of extreme values for : | |
| Age: 2 Fleet: 4 Iteration: | 6 |
| Replacement of extreme values for : Age : 2 Fleet : 4 Iteration : | 7 |
| nge · 2 ricet · 4 riceration · | |
| ** Tuning has not converged after 30 iterations. ** | |
| The sum across ages of the absolute residuals of the final year Fs, between iterations 29 and 30 is .002215 | |
| Do you wish to continue the tuning for 10 more iterations. | ¥/ <n> :</n> |

After fitting an assessment to each of the user defined year ranges, the program returns to the central menu.



Results

In the directory specified for the retrospective analysis output files the program will write a tuning analysis and output summary file (Table 16) from each model fit. They are identified by the three character prefix followed by ____RT<yr>.CSV, for the tuning file name and ____RO<yr>.CSV for the summary files; <yr> represents the terminal year of the fitted assessment.

The analysis procedure involves the creation of retrospective time series plots for particular assessment estimates. Fig. 1–3 present the retrospective plots for the Blackfin assessment model. Fig. 1 is a plot of the time series of average fishing mortality estimates from each fit of the XSA model, Fig. 2 the estimates of recruitment and Fig. 3, spawning stock biomass.

The objective of the analysis is to compare the variation between the 'truth', the final assessment in the series, and the values estimated in each terminal year by earlier assessments. Note that this assumes that the most recent assessment, which uses all of the available data is the most unbiased.

For the majority of the time series of assessments, XSA estimates of the Blackfin stock fishing mortality are consistent from year to year (Fig. 1). The first two model fits overestimated fishing mortality; and in the most recent assessment runs there is a systematic under-estimation of average F with this XSA model structure. The model has consistently picked up the trends and the change points in fishing mortality.

The XSA estimates of Blackfin recruitment have been relatively consistent from year to year (Fig. 2). Historically there are three years in which the level of recruitment was underestimated and in recent years there is a systematic over-estimation of recruitment when using the specified XSA model structure. When fitting the XSA model we have used the power model at age 2.

The retrospective pattern for spawning stock biomass is of greater concern. Overall the assessments show an increase in the stock size during the 1960s and 1970s with a decline since the early 1980s. However, the rate at which that decline took place and when it began is uncertain (Fig. 3a). The most recent assessments with terminal years from 1990 to 1994 indicate that with the addition of more years of data the estimation of SSB is more consistent from year to year. There is no retrospective pattern that would cause concern (Fig. 3b).

Retrospective series should now be used to investigate the influence of particular assessment parameters (e.g. shrinkage to the mean F) on the accuracy and bias of the terminal year estimates. Changes to the assessment model structure are evaluated not only in terms of their influence on the model diagnostics, but also their ability to remove bias in the retrospective patterns of key model estimates. For SSB the changes to the model structure may not be required. For this stock we would be trying to improve the consistency of the estimates of fishing mortality and recruitment in the most recent years. For example a repeat of the retrospective run with a proportional catchability model at age 2 could be used to test the improvement in the predictions for recruitment.

Retrospective runs should be performed with a range of values for the selected parameter (all other parameter values are held constant), and the model structure producing the 'best' retrospective pattern chosen as the optimum value for the assessment of the particular stock. In order to simplify the analysis, it is assumed that there are no interactions in the effects on the assessment predictions.

Discussion

Sinclair *et al.* (MS 1990) and ICES (MS 1991) have shown that the biases in F and N estimates appear to be stock specific, and data induced. They are not attributable to a particular tuning methodology. Sinclair *et al.*, (MS 1990) concluded that the retrospective patterns found in the estimates for the stocks of the Northwest Atlantic could result from patterns of misreporting, trends in catchability, or mis-specification of natural mortality. Each will affect the data in a particular way and therefore influence the outcome of the tuning procedures.

ICES (MS 1991) established that the degree of bias could usually be reduced by the introduction of shrinkage to the mean F to the assessment packages. Subsequent work by the Methods Working Group has examined the influence of the degree of shrinkage imposed on the assessment (ICES, MS 1993). It recommended that retrospective analyses be used regularly to screen stock assessments.

The retrospective problem has been recognized as widespread and serious. The reasons why this problem appears are not fully known. There is a general understanding that trends in catchability, when used in models that assume constancy can cause this effect. However, it has been clearly demonstrated that the problem is more complex and that for example trends or shifts in natural mortality, discards and misreporting, misspecification of selection and catchability at age can contribute to the problem, sometimes in a quite complex way (ICES, MS 1997).

Warning

There may be cases where the present estimate of the stock trajectory is biased, whilst those in the past may have been "right" (ICES, MS 1997). This is illustrated by the early retrospective series of the Blackfin retrospective sequence. The retrospective assessments carried out with the terminal years between 1984 and 1988 (Fig. 3c) show that the SSB was apparently consistently under-estimated during those years. In each successive year the level of SSB is increased and the latest assessment in the sequence estimates that there was a high stable stock between 1973-84.

Taking the final assessment estimates, with terminal year 1988, as the "truth", the assessment model structure would usually be altered to make the earlier assessment as consistent as possible with it. However if we examine the most recent assessments with the early series (Fig. 3c) is seen that the retrospective pattern noted in the early years was caused by the assessment estimates having a successively greater bias from the "truth" – the most recent (1994) perception of the stock trends. The estimated SSB series terminating in 1988 was actually the most distant (biased) from the most recent perception of the stock dynamics. This is a warning case where alteration of the assessment model structure to correct the retrospective pattern would have induced bias to the assessment results. Simply changing the assessment model structure to correct a retrospective pattern would have been incorrect in this instance.

References

DARBY, C. D. and S. FLATMAN. 1994. Virtual Population Analysis: version 3.1 (Windows/DOS) user guide. *Info. Tech.* Ser., MAFF Direct. Fish. Res., Lowestoft, 1: 85 p.

ICES. MS 1991 Report of the Working Group on Methods of Fish Stock Assessment. *ICES C.M. Doc.*, No. /Assess: 25, 147 p. 1993 Report of the Working Group on Methods of Fish Stock Assessment. *ICES C.M. Doc.*, No. /Assess:12, 86 p.

1997 Report of the Working Group on Methods of Fish Stock Assessment. ICES C.M. Doc., No. /Assess:12, 86 p.

SINCLAIR, A., D. GASCON, R. O'BOYLE, D. RIVARD and S. GAVARIS, MS 1990. Consistency of some Northwest Atlantic groundfish stock assessments. *NAFO SCR Doc.*, No. 96, Serial No. N1831, 26 p.

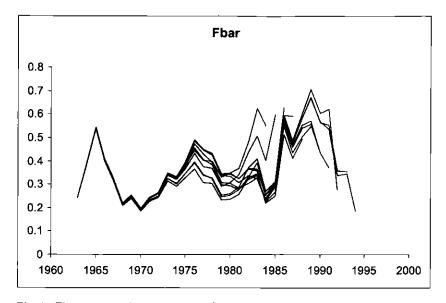


Fig. 1. The retrospective time series of XSA estimates of Blackfin average fishing mortality.

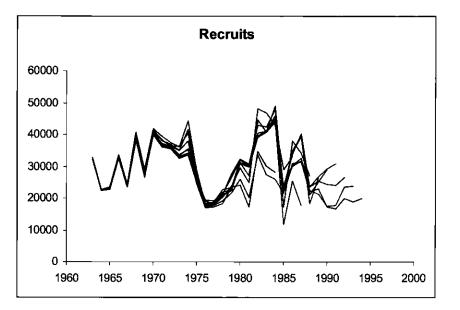


Fig. 2. The retrospective time series of XSA estimates of recruitment-at-age 1 to the Blackfin stock

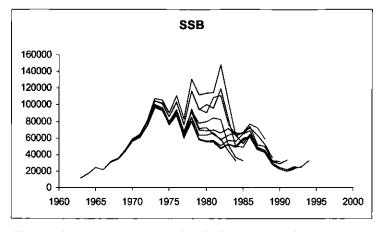


Fig. 3a. The retrospective time series of XSA estimates of spawning stock bioass of the Blackfin stock for the assessments ending in the years 1984–94.

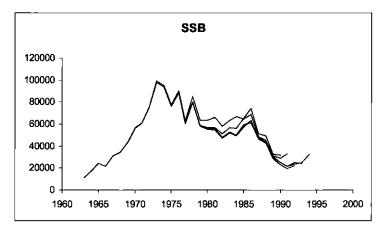


Fig. 3b. The retrospective time series of XSA estimates of spawning stock bioass of the Blackfin stock for the assessments ending in the years 1990–94.

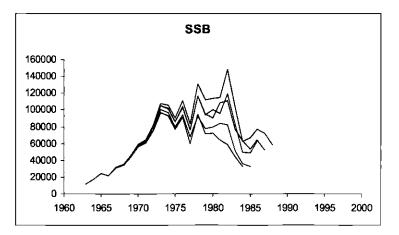


Fig. 3c. The retrospective time series of XSA estimates of spawning stock bioass of the Blackfin stock for the assessments ending in the years 1984 – 1988.

Appendix 1: Lowestoft Stock Assessment Suite

Tutorial 6

The Multi-Fleet Deterministic Projection Program (MFDP)

by

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Abstract

This document is number six in a series of tutorials designed to assist users of the Lowestoft VPA Suite assessment software and prediction programs which use the results. The tutorial takes the user through the options required for running the multi-fleet deterministic projection program MFDP developed for ICES at CEFAS.

Introduction

This document is part of a series of tutorials that provide an introduction to the Lowestoft VPA Suite assessment software and programs which make use of the results from it. The tutorial takes the user through the options required for running multi-fleet deterministic projection program MFDP1a.exe. The tutorial assumes that the required Blackfin data files have been placed in a directory c:\vpas\data\prediction, and that the prediction index files (Blpred_standard.ind, Blpred_discards.ind) contain path names that point to the appropriate files.

In the following text action to be taken by the user is highlighted in bold. The symbol \downarrow is used to represent the Return or Enter key on the keyboard.

Installation of the Program

Copy the directory C:\VPAS\PROGRAMS\MFDP\ to a directory on your computer. Using Explorer go to the directory C:\VPAS\PROGRAMS\MFDP\Disk1. Start the program Setup.exe and follow the on screen instructions

Data Files

The program will carry out predictions using historic data sets from age structured assessments. The user selects the targets for fishing mortality or TAC constraints for each fleet from within the user dialogs. In addition the program will allow the user to set up future selection pattern and catch weight files that can be used to examine potential changes in selection etc. Here we only consider runs from historic data.

The program uses an index file that is similar to (but not the same as) the Lowestoft format index file used for inputting data to the Lowestoft VPA Suite stock assessment program (Darby and Flatman 1994). The index file for historic data is given below, the differences in the index files are that the first, ninth, tenth and eleventh files from the VPA suite list have been omitted in MFDP. The missing files are the total landings and the optional fishing mortality on the oldest age, fishing mortality in the final year and fleet tuning files.

Several files have been added to the list required for MFDP, these are:

for single fleet or category disaggregated predictions

1) the fishing mortality at age for each of the historic assessment years;

2) population numbers at age for the historic assessment years and one extra year the survivors at the start of the year after the final assessment year;

in addition for multifleet predictions

- 3) a file for each fleet with total and category disaggregated catch numbers at age
- 4) a file for each fleet with total and category disaggregated catch weights at age

The complete index file list for a run using historic data is given below:

| Index file contents | Index file number |
|---|-------------------|
| Title | |
| Historic data flag (1 = Historic, 0 = Future) | |
| Total catch numbers at age numbers file name and path | 2 |
| Weight at age in the catch file name and path | 3 |
| Weight at age in the stock file name and path | 4 |
| Natural mortality file name and path | 5 |
| Proportion mature file name and path | 6 |
| Proportion of F before spawning file name and path | 7 |
| Proportion of M before spawning file name and path | 8 |
| Fishing mortality file name and path | 12 |
| Population numbers file name and path | 13 |

If the prediction is not fleet or category disaggregated then this is sufficient, however if fleet or category disaggregation is required then the following lines are required.

| Index file contents | Index number |
|--|--------------|
| Number of fleets | |
| Fleet 1 catch numbers at age file name and path | 2 |
| | 2 |
| Fleet n catch numbers at age file name and path | 2 |
| Fleet I weight at age in the catch file name and path | 3 |
| | 3 |
| Fleet n weight at age in the catch file name and path | 3 |
| An optional control file, if specified it must always be the last fi | le. |

Note: If the population and fishing mortality files from the final assessment have a different age range to that of the initial VPA suite input data files, the program will make the adjusment to the new range for the user.

Running the Program for a Single Fleet Prediction

Open program MFDP1a.EXE from within Windows Explorer or using the Start button

Press the F1 key, this is the undocumented way to see the help file and documentation. The help files are installed in the C:\windows\help directory during setup.

Initially, the program presents the inputs dialog screen. The run identifier should be entered, the plus group specified and the index file located using the browse button. If errors are encountered in the input data then control will return to the inputs dialog and an error message is displayed in red type. The user can makes changes to the files, within a text editor, without closing the program and press browse again to continue. If no errors are encountered a message is displayed detailing the directory in which output files will be saved.

116

| DIO | wse for index file | | |
|------------|------------------------|---------------|-------------------|
| Last ag | je is a plus group | | Continue |
| | | | Exit |
| Inits - Ch | oose applicable option | | |
| S | tock and catch numbers | Weight at age | Yield and biomass |
| • | Thousands | Kilograms | Tonnes |
| 0 | Millions | Grams | Tonnes |
| 0 | Millions | Kilograms | Kilotonnes |

Enter run identifier.

Enter any log file comments required.

Check if the last age is age plus group for this projection run and set the option box.

Check the units for the run

Browse for the projection run index file C:\VPAS\DATA\PREDICTION\Blpred_standard.ind.

| Z Last a | ge is a plus group | | Continue |
|------------|-------------------------|---------------|-------------------|
| | | | Exit |
| Inits - Cl | noose applicable option | | |
| Ś | Stock and catch numbers | Weight at age | Yield and biomass |
| • | Thousands | Kilograms | Tonnes |
| 0 | Millions | Grame | Tonnes |
| Ć. | Millions | Kilograme | Kilotonnes |

Note that on return from the browsing the data file, the program has parsed the data files and should report any errors as red text printed above the log file comments box. If there are no errors the program will inform the user that the output files will be put in the same directory as the index file.

Press the continue button.

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| name 7 rulture /4 1998 Calch / /* | |

The text at the top of the control file box should describe the run type that you are trying to achieve. In this example we are running a single fleet projection with no disaggregation into discards or multiple use of the landed catch.

APPENDIX 1: Tutorial 6: The Multi-fleet Deterministic Projection Program

Set the minimum and maximum age for the Fbar age range.

Set the number of projection years to the required time series.

The "normal" catch forecast table has three years: the intermediate year of the assessment, the TAC year and the SSB forecast year. The defaults settings are for this form of forecast table.

Set the recruitment values for the initial age to the values required for the projection years.

Set the intermediate year forecast option to either an F constraint or a catch constraint.

These options allow the user to specify whether a catch or F multiplier is to be used in each intermediate year. If the number of years is altered then the F multiplier and catch option buttons will be added to, or removed from the dialog. If the run is a multi target type run then these controls are not visible and are presented by fleet on a subsequent dialog.

Enter the F multiplier or catch target for the intermediate year.

In this example we shall use a status quo fishing mortality constraint in the intermediate year; an F multiplier of 1.

The management option table minimum, maximum and increment can usually be left unchanged. The default setting will give the standard management option table.

| Control file | | - |
|--|-----------------------------|------|
| You have total population data (no final or category distaggregation). Use the check and test boses to induce catch constraints or Finulliples; for interest seen and/to and this reconstraints and Pour age range | | |
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| Total Fbot age Min. 3 tangez Hax 7 Number of years 3 Complete | | |
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| Trianin Fridible JF | | |
| inam reader r jest Cado C options Taget 1.0 | | |
| 21 FNullplier manager will be run in the projection year. Select the minimum and increment to not th | the sample of F multipliers | |
| Nanagament scientistic Minimum Emultiplies 0 Finalityles increment 01 | Maximum Fnultiplet | |

Press the complete button.

The button vanishes and the Continue button is enabled if the settings conform to the required input. The red information text changes and the program creates a control file for future usage.

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| and the second s | |

Press the Continue Button. The program now requires us to set up the vectors used for the predictions. Initially this is carried out using the usual averaging process but the individual year vectors can be modified subsequently if required.

| | options you w | VPA input and output. Indicate wish to use to summarise these data | Continu |
|----------------------|---------------|---|---------|
| s avoings state voor | 013. | | Exit |
| Averaging options | | 0-1-1-0-1 | - |
| Fishing mortality | No.Years | Scale to final year | |
| Catch weights | 3 | | |
| Stock weights | 3 | | |
| Maturity | 1 | | |
| Natural mortality | h | | |

Set the required time periods to be used in calculating the average vectors.

Set the scale to the final year box if required.

Press the continue button.

If we require user input of specific values of population numbers, weights or fishing mortalities etc. we can check any of the required boxes and edit the vectors to be used in the forecast. The vectors should always be reviewed for outliers.

| The data have been averag tate vectors. If you wish to i | | | |
|---|--------------|----|----------|
| nodify any of the state vecto theci, the appropriate box b | in them | 11 | Continue |
| Population number: | 1999 1997 | 1 | Exit |
| and a second second | | - | |
| Fiching montality | H | | |
| Catch weight: | 4 | | |
| Stock weights | v | | |
| Mahidajir | ঘ | | |
| Natural mortality | A. | | |
| Pico E before spawning | ব | | |
| Prop. M before spawning | 4 | | |

Each of the input data vectors is presented in turn in the format shown below.

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|--|-------------------|-------------------|--------------|---------------|---|-----------------------|----|
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| * <u>31 (00)</u> # | | | | | | | |
| | | | | | | | |
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| | | | | | | | |
| | | | | | | | |

After reviewing each input data set the program runs to completion

| Fini | shed | |
|------|------|--|
| | | |
| 2 | | |
| 1 | OK | |

New Input Data Files

The program creates up to a series of 12 new input data files in the same directory as the index file. The files are prefixed by the run identifier entered by the user and contain the vectors of fishing mortalities, maturity at age etc. for the years over which the projection was made. They allow repeat runs using the same prediction vectors, without having to go through the set up process again. The file names are:

| File contents | Filename | |
|---------------------------------|----------------------|--|
| Index | RunCode + "ind.txt" | |
| Natural mortality | RunCode + "M.txt" | |
| Total catch weight | RunCode + "CWt.txt" | |
| Stock weight | RunCode + "SWt.txt" | |
| Maturity | RunCode + "Mat.txt" | |
| Proportion of F before spawning | RunCode + "PF.txt" | |
| Proportion of M before spawning | RunCode + "PM.txt" | |
| Population numbers | RunCode + "N.txt" | |
| Total fishing mortality | RunCode + "F.txt" | |
| Control file | RunCode + "Ctrl.txt" | |
| | | |

If the data are fleet disaggegated then fleet disaggegated files will be produced giving the fleet selection patterns and catch weights and the total fishing mortality and total catch weight files will not be created.

| File contents | Filename |
|---------------------------------|--|
| Disaggregated selection pattern | RunCode + "FleetF" + fleet number + ".txt" |
| Disaggregated catch weights | RunCode + "FleetCWt" + fleet number + ".txt" |

Output Files

The following 5 files of output are produced:

Results in a comma delimited file with a format based on that specified by the ICES Workshop on Standard Assessment Tools for Working Groups (MS 1999), but with minor modifications (see Modifications to Workshop on Standard Assessment Tools for Working Groups output format, below). This file is named with a filename of the run index and the file extension .pro. If no run index has been specified then results will be appended to a file named MFDP.pro (Table 1).

Results in a comma delimited file with a structure similar to that of the prediction with management options table currently used by ICES. This file is named with a filename of the run index and the file extension .prm. If no run index has been specified then results will be appended to a file named MFDP.prm (Table 2).

Results in a comma delimited file with a structure similar to the single option prediction: detailed tables currently used by ICES. This file is named with a filename of the run index and the file extension .prs. If no run index has been specified then results will be appended to a file named MFDP.prs (Table 3).

A comma delimited file containing the steady state vectors used for the projection, in a form similar to the prediction with management: input data table used by ICES. This file is named with a filename of the run index and the file extension .prd. If no run index has been specified then results will be appended to a file named MFDP.prd (Table 4).

A log file in comma delimited format containing the files used for the run, the raw data, the options chosen, truncated data when appropriate, the steady state vectors, and a summary of the results. The log file is named with the run code and the file extension .prl. If no run code has been specified then this file is named MFDP.prl (Table 5).

NOTE: If repeat runs are made with the same run identifier, the results for each run are appended to the existing files along with the run name, program name and version, stock name, time and date.

Plotting and Tablulating Results

Open the spreadsheet TEMPLATE1.XLS

Open the output file from the MFDP run TUTORIAL.PRM in EXCEL. The file is comma separated.

Copy the sheet from TUTORIAL.PRM and paste it into the prm sheet of TEMPLATE1.XLS.

On the sheet labeled Chart (Fig. 1), the right hand graph is the standard ICES short-term forecast plot which shows the forecast catch at different levels of fishing mortality two years beyond the assessment series and for SSB three years ahead. The data is automatically plotted when the prm sheet is updated.

Running the Program for a Multi fleet or Single fleet with Discards Prediction

Open program MFDP.EXE from within Windows Explorer or using the Start button

Enter run identifier.

Enter any log file comments required.

Check if the last age is age plus group for this projection run and set the option box.

Check the units for the run

Browse for the projection run index file C:\VPAS\DATA\PREDICTION\Blpred_standard.ind.

If errors are encountered in the input data then control will return to the inputs dialog and an error message is displayed in red type. The user can makes changes to the files, within a text editor, without closing the program and press browse again to continue. If no errors are encountered a message is displayed detailing the directory in which output files will be saved.

The index file for a multi fleet (or a single fleet disaggregated by category) contains more information than the single fleet index file. The user must supply catch numbers at age files with total catch at age in each year and also the values for each fleet (see the help F1) and disaggregated catch weight at age files.

| BIU | wse for index file | | |
|------------|------------------------|---------------|-------------------|
| Last ag | je is a plus group | | Continue |
| | | | Exit |
| Jnits - Ch | oose applicable option | | |
| S | tock and catch numbers | Weight at age | Yield and biomass |
| • | Thousands | Kilograms | Tonnes |
| 0 | Millions | Grams | Tonnes |
| 0 | Millions | Kilograms | Kilotonnes |

| Browse for index file | Vpss/Data/prediction/Blpred_discard | b ed |
|--|--|--------------------|
| type | | And and the second |
| Arhave fleet disaggregated data. You a single target -i.e. combined fleet TAR | C or one F multiplier applied to all fiber | ii. |
| muliple targets i i in individual flerit que a you wists to use a single or multi targe | oras or individuality multiplets for each 9 ptageotion? | (Deer,) |
| | Muth larget | Esh |
| | South Unidea | E-MI |
| Single target | | |
| single target | | |

The program reads the information in the index file and notes that this will be a two category (human consumption and discards) prediction.

Select a single target such as a combined fleet TAC or F multiplier or a multi target run.

On return from the browsing the data file, the program has parsed the data files and should report any errors as red text printed above the log file comments box. If there are no errors the program will inform the user that the output files will be put in the same directory as the index file.

Press the continue button.

| ast at | e is a plus group | | Continue |
|---------|------------------------|---------------|-------------------|
| and any | er er er bren Bronkr | | Exit |
| la - Ch | oose applicable option | | |
| S | tock and catch numbers | Weight at age | Yield and biomass |
| | Thousands | Kilograma | Tonnes |
| | Millions | Grams | Tonnes |
| | Millions | Kilograms | Kilotonnes |

The multi fleet program has similar input settings to those of the single fleet run.

Enter the reference ages for fishing mortality of each fleet.

Select the number of years for the forecast and enter the recruitment at the first age for each year.

Enter the fishing mortality multiplier, in this case 1.0 for a status quo projection.

Do not adjust the range of F's or increment it is not usually necessary.

Press complete, to indicate that the inputs are complete. The program notes that the data are historic and sets up a control file. Press continue.

| Control file | |
|---|-------------------------------------|
| You have fleet disaggregated data and have opted for a single target run. Use the check and test boxes to indicate catch constraints or F multiplies for interim year and to set the recent/wents and Poar age range. | rs. |
| Runtype Number of lisets | E-train Eat |
| reaction of meets | Lin Lin |
| Total Reet1 | |
| Postege Min 3 3 nangen Mas 7 7 | |
| Number of years | |
| 1995 1996 1997 | |
| Recruikment 1000 1000 1000 | |
| Interno Finulipiler (* gebar Calch C options Target 1 | |
| 21 FMultiplier scenarios will be run in the projection year. Select the minimum and increment | nt to set the range of F multipless |
| Manageword scenarios Minimum Finultiplier 0 Finultiplier increment 01 | |

| onfroi file | |
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| nbernn F. Hudipiles (* yend Calch (* options Target) | |
| TPMultiplier scenarios will be run in the projection year. Select the minimum and increa | nent to set the range of F multipliers |
| fanagement scenarios Minimum Finultiplier 0 Finultiplier increment | 0.1 Nasinsura F multiplier 2 |

As before the program requires us to set up the vectors used for the predictions. Initially this is carried out using the usual averaging process but the individual year vectors can be modified subsequently if required.

Set the required time periods to be used in calculating the average vectors.

Set the scale to the final year box if required.

APPENDIX 1: Tutorial 6: The Multi-fleet Deterministic Projection Program

| Your files consist of historic data - VPA input and output. Indicate below, the averaging options you wish to use to summarise these data to average state vectors. | Continue |
|---|----------|
| | Exit |
| Averaging options No.Years Scale to final year | |
| Fishing mortality 3 | |
| Catch weights 3 | |
| Stock weights 3 | |
| Maturity 1 | |
| Natural mortality | |

Press the continue button.

If we require user input of specific values of population numbers, weights or fishing mortalities etc. we can check any of the required boxes and edit the vectors to be used in the forecast. The vectors should always be reviewed for outliers.

| Inspection options | | |
|--|-----------------------|----------|
| The data have been average state vectors. If you wish to i modify any of the state vecto check the appropriate box be | nspect or irs then | Continue |
| Population numbers | | Exit |
| Fishing mortality | | |
| Catch weights | V | |
| Stock weights | R | |
| Maturity | | |
| Natural mortality | | |
| Prop. F before spawning | | |
| Prop. M before spawning | | |

Each of the input data vectors is presented in turn in the format shown below.

After reviewing each input data set the program runs to completion

| Inspe | cting - popu | lation numb | 15 | |
|-----------------|---|---------------|---|------------|
| Input | vectors for po | pulation numb | ns are given below. You may use this form to make a | mendments. |
| class 1 2 | 1995 1000.0000 5963.0000 | 1996 | 1997 | |
| 3 4 5 | 10549.0000 5334.0000 1328.0000 | | | |
| 6789 | 584.0000 352.0000 157.0000 91.0000 | | | |
| 10 | 225.0000 | | | |

| MFDI |) | × |
|------|------|---|
| Fini | shed | |
| [| OK | |
| | On | |

Output Files

The output files of are the same 5 file types produced for by the single fleet run.

NOTE if repeat runs are made with the same run identifier, the results for each run are appended to the existing files along with the run name, program name and version, stock name, time and date.

Plotting and Tabulating Results

Open the spreadsheet TEMPLATE2.XLS

Open the output file from the MFDP run TUTORIAL2.PRM in EXCEL. The file is comma separated.

Copy the sheet from TUTORIAL2.PRM and paste it into the prm sheet of TEMPLATE2.XLS.

On the sheet labeled Chart, the right hand graph is the short-term forecast plot which shows the forecast catch at different levels of fishing mortality two years beyond the assessment series and for SSB three years ahead. The data is automatically plotted when the prm sheet is updated.

References

- DARBY, C. D. and S. FLATMAN. 1994. Virtual Population Analysis: Version 3.1 (Windows/DOS) user guide. Info. Tech. Ser., MAFF Direct. Fish. Res., Lowestoft, 1: 85 p.
- ICES, MS 1999. Report of the Workshop on Standard Assessment Tools for Working Groups, Aberdeen, United Kingdom, 3–5 March 1999. ICES C.M. Doc., No. 1999/ACFM:25.

TABLE 1. The MFDP short-term forecast results in the ICES SGFADS file format (*.pro)

| Short term 1 | MFDP vers | Blackfin: A: | Run:tutoria | 01:55 | 03/02/02 | |
|-----------------|----------------------|----------------------|-------------|----------------------|----------|----------|
| 3 | | | | | | |
| 21 | | | | | | |
| 1995 | | | | | | |
| Total | - | | | | | |
| 3 | 7 | 0.004000 | 0 | 40000 44 | • | |
| -99 1996 | 1 | 0.601933 | 0 | 12060.11 | 0 | 9363.821 |
| Total | | | | | | |
| 1 | 0 | 0 | 0 | 0 | 0 | 9575.09 |
| 2 | 0.1 | 6.02E-02 | Ő | 1288.179 | Ő | 9575.09 |
| 3 | 0.2 | 0.120387 | Ő | 2493 309 | Ő | 9575.09 |
| 4 | 0.3 | 0.18058 | Ō | 3621.171 | Ō | 9575.09 |
| 5 | 0.4 | 0.240773 | 0 | 4677.126 | 0 | 9575.09 |
| 6 | 0.5 | 0.300967 | 0 | 5666.144 | 0 | 9575.09 |
| 7 | 0.6 | 0.36116 | 0 | 6592.838 | 0 | 9575.09 |
| 8 | 0.7 | 0.421353 | 0 | 7461.483 | 0 | 9575.09 |
| 9 | 0.8 | 0.481547 | 0 | 8276.05 | 0 | 9575.09 |
| 10 | 0.9 | 0.54174 | 0 | 9040.221 | 0 | 9575.09 |
| 11 | 1 | 0.601933 | 0 | 9757.415 | 0 | 9575.09 |
| 12 | 1.1 | 0.662127 | 0 | 10430.81 | 0 | 9575.09 |
| 13 | 1.2 | 0.72232 | 0 | 11063.34 | 0 | 9575.09 |
| 14 | 1.3 | 0.782513 | 0 | 11657.76 | 0 | 9575.09 |
| 15 | 1.4 | 0.842707 | 0 | 12216.6 | 0 | 9575.09 |
| 16 | 1.5 | 0.9029 | 0 | 12742.23 | 0 | 9575.09 |
| 17 | 1.6 | 0.963093 | 0 | 13236.84 | 0 | 9575.09 |
| 18 | 1.7 | 1.023287 | 0 | 13702.47 | 0 | 9575.09 |
| 19 | 1.8 | 1.08348 | 0 | 14141.03 | 0 | 9575.09 |
| 20 21 | 1.9 2 | 1.143673 1.203867 | 0 | 14554.27 14943.84 | 0 | 9575.09 |
| 1997 | 2 | 1.203007 | U | 14943.04 | v | 9575.09 |
| 1331 | 20127.82 | | | | | |
| 2 | 18739.4 | | | | | |
| 3 | 17450.9 | | | | | |
| 4 | 16254.92 | | | | | |
| 5 | 15144.62 | | | | | |
| 6 | 14113.67 | | | | | |
| 7 | 13156.23 | | | | | |
| 8 | 12266.88 | | | | | |
| 9 | 11440.63 | | | | | |
| 10 | 10672.85 | | | | | |
| 11 | 9959.259 | | | | | |
| 12 | 9295.893 | | | | | |
| 13 | 8679.091 | | | | | |
| 14 | 8105.463 | | | | | |
| 15 | 7571.872 | | | | | |
| 16 17 | 7075.415 6613.403 | | | | | |
| 17 | 6183.349 | | | | | |
| 10 | 5782.951 | | | | | |
| 20 | 5410.074 | | | | | |
| 21 | 5062.745 | | | | | |
| - · | | | | | | |

Input units are thousands and kg - output in tonnes

TABLE 2. The Blackfin MFDP single category short-term forecast management options table output (*.prm).

MFDP version 1a Run: tutorial Blackfin: Assessment course. Combined sex; plusgroup. Time and date: 01:55 03/02/02 Fbar age range: 3-7

| 1995 | | | | | | |
|---------|-----|------|-------|---|-------|----------|
| Biomass | SSB | | FMult | | FBar | Landings |
| 34816 | | 9364 | | 1 | 0.601 | 9 12060 |

| 1996 | | | | | 1997 | |
|-----------|------|------|--------|----------|---------|-------|
| Biomass S | SB F | Mult | FBar | Landings | Biomass | SSB |
| 23924 | 9575 | 0 | 0 | 0 | 27071 | 20128 |
| | 9575 | 0.1 | 0.0602 | 1288 | 25476 | 18739 |
| • | 9575 | 0.2 | 0.1204 | 2493 | 23988 | 17451 |
| • | 9575 | 0.3 | 0.1806 | 3621 | 22601 | 16255 |
| | 9575 | 0.4 | 0.2408 | 4677 | 21306 | 15145 |
| | 9575 | 0.5 | 0.301 | 5666 | 20098 | 14114 |
| • | 9575 | 0.6 | 0.3612 | 6593 | 18970 | 13156 |
| | 9575 | 0.7 | 0.4214 | 7461 | 17917 | 12267 |
| | 9575 | 0.8 | 0.4815 | 8276 | 16933 | 11441 |
| • | 9575 | 0.9 | 0.5417 | 9040 | 16014 | 10673 |
| • | 9575 | 1 | 0.6019 | 9757 | 15154 | 9959 |
| | 9575 | 1.1 | 0.6621 | 10431 | 14350 | 9296 |
| | 9575 | 1.2 | 0.7223 | 11063 | 13598 | 8679 |
| | 9575 | 1.3 | 0.7825 | 11658 | 12894 | 8105 |
| | 9575 | 1.4 | 0.8427 | 12217 | 12236 | 7572 |
| • | 9575 | 1.5 | 0.9029 | 12742 | 11619 | 7075 |
| | 9575 | 1.6 | 0.9631 | 13237 | 11041 | 6613 |
| | 9575 | 1.7 | 1.0233 | 13702 | 10499 | 6183 |
| | 9575 | 1.8 | 1.0835 | 14141 | 9991 | 5783 |
| | 9575 | 1.9 | 1.1437 | 14554 | 9515 | 5410 |
| | 9575 | 2 | 1.2039 | 14944 | 9068 | 5063 |

Input units are thousands and kg - output in tonnes

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TABLE 3. Blackfin MFDP single category short-term forecast detailed status quo forecast table output (*.prs).

MFDP version 1a Run: tutorial Time and date: 01:55 03/02/02 Fbar age range: 3-7

| Year: | | 1995 | F multiplier | · 1 | Fbar: | 0.6019 | | | | |
|-------|----|--------|--------------|-------|----------|---------|-----------|----------|----------|---------|
| Age | F | | CatchNos | Yield | StockNos | Biomass | SSNos(Jar | SSB(Jan) | SSNos(ST | SSB(ST) |
| | 1 | 0.001 | 1 | 1 | 1000 | 590 | 0 | 0 | 0 | 0 |
| | 2 | 0.178 | 884 | 761 | 5963 | 5132 | 0 | 0 | 0 | 0 |
| | 3 | 0.4037 | 3197 | 3616 | 10549 | 11931 | 0 | 0 | 0 | 0 |
| | 4 | 0.8263 | 2756 | 4029 | 5334 | 7798 | 0 | 0 | 0 | 0 |
| | 5 | 0.7633 | 651 | 1374 | 1328 | 2805 | 1328 | 2805 | 1328 | 2805 |
| | 6 | 0.592 | 239 | 685 | 584 | 1676 | 584 | 1676 | 584 | 1676 |
| | 7 | 0.4243 | 111 | 460 | 352 | 1458 | 352 | 1458 | 352 | 1458 |
| | 8 | 0.3877 | 46 | 236 | 157 | 804 | 157 | 804 | 157 | 804 |
| | 9 | 0.4707 | 31 | 201 | 91 | 585 | 91 | 585 | 91 | 585 |
| | 10 | 0.4707 | 77 | 698 | 225 | 2036 | 225 | 2036 | 225 | 2036 |
| Total | | | 7992 | 12060 | 25583 | 34816 | 2737 | 9364 | 2737 | 9364 |

| Year: | | 1996 | F multiplier | · 1 | Fbar: | 0.6019 | | | | |
|-------|----|--------|--------------|-------|----------|---------|--------------|----------|----------|---------|
| Age | F | | CatchNos | Yield | StockNos | Biomass | SSNos(Jar | SSB(Jan) | SSNos(ST | SSB(ST) |
| | 1 | 0.001 | 1 | 1 | 1000 | 590 | 0 | 0 | 0 | 0 |
| | 2 | 0.178 | 121 | 104 | 818 | 704 | 0 | 0 | 0 | 0 |
| | 3 | 0.4037 | 1238 | 1400 | 4086 | 4621 | 0 | 0 | 0 | 0 |
| | 4 | 0.8263 | 2980 | 4357 | 5768 | 8433 | 0 | 0 | 0 | 0 |
| | 5 | 0.7633 | 937 | 1978 | 1911 | 4037 | 19 11 | 4037 | 1911 | 4037 |
| | 6 | 0.592 | 207 | 595 | 507 | 1454 | 507 | 1454 | 507 | 1454 |
| | 7 | 0.4243 | 83 | 346 | 265 | 1096 | 265 | 1096 | 265 | 1096 |
| | 8 | 0.3877 | 55 | 283 | 189 | 965 | 189 | 965 | 189 | 965 |
| | 9 | 0.4707 | 30 | 192 | 87 | 561 | 87 | 561 | 87 | 561 |
| | 10 | 0.4707 | 55 | 502 | 162 | 1463 | 162 | 1463 | 162 | 1463 |
| Total | | | 5708 | 9757 | 14792 | 23924 | 3120 | 9575 | 3120 | 9575 |

| Year: | | 1997 | F multiplier | · 1 | Fbar: | 0.6019 | | | | |
|-------|----|--------|--------------|-------|----------|---------|-----------|----------|----------|---------|
| Age | F | | CatchNos | Yield | StockNos | Biomass | SSNos(Jar | SSB(Jan) | SSNos(ST | SSB(ST) |
| | 1 | 0.001 | 1 | 1 | 1000 | 590 | 0 | 0 | 0 | 0 |
| | 2 | 0.178 | 121 | 104 | 818 | 704 | 0 | 0 | 0 | 0 |
| | 3 | 0.4037 | 170 | 192 | 560 | 634 | 0 | 0 | 0 | 0 |
| | 4 | 0.8263 | 1154 | 1688 | 2234 | 3266 | 0 | 0 | 0 | 0 |
| | 5 | 0.7633 | 1013 | 2139 | 2067 | 4365 | 2067 | 4365 | 2067 | 4365 |
| | 6 | 0.592 | 298 | 856 | 729 | 2093 | 729 | 2093 | 729 | 2093 |
| | 7 | 0.4243 | 72 | 300 | 230 | 951 | 230 | 951 | 230 | 951 |
| | 8 | 0.3877 | 42 | 213 | 142 | 725 | 142 | 725 | 142 | 725 |
| | 9 | 0.4707 | 36 | 231 | 105 | 673 | 105 | 673 | 105 | 673 |
| | 10 | 0.4707 | 44 | 395 | 127 | 1152 | 127 | 1152 | 127 | 1152 |
| Total | | | 2951 | 6118 | 8012 | 15154 | 3399 | 9959 | 3399 | 9959 |

Input units are thousands and kg - output in tonnes

TABLE 4. The Blackfin MFDP single category short-term forecast input data file (*.prd).

MFDP version 1a Run: tutorial Time and date: 01:55 03/02/02 Fbar age range: 3-7

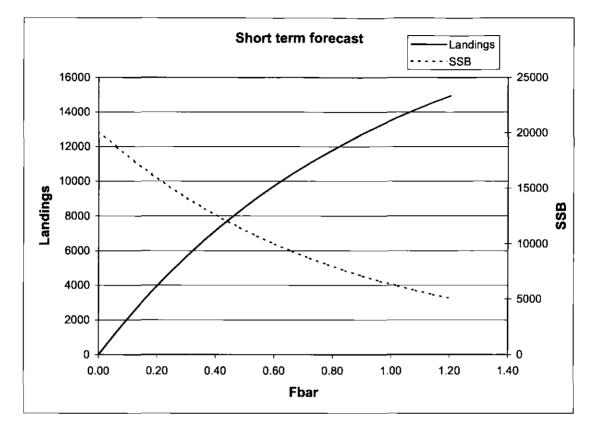
| | 1995 | | | | | | | | |
|-----|------|-------|-----|----|----|-----|-------|-------|-------|
| Age | Ν | М | Mat | PF | PM | SWt | | CW | |
| | 1 | 1000 | 0.2 | 0 | 0 | 0 | 0.590 | 0.001 | 0.590 |
| | 2 | 5963 | 0.2 | 0 | 0 | 0 | 0.861 | 0.178 | 0.861 |
| | 3 | 10549 | 0.2 | 0 | 0 | 0 | 1.131 | 0.404 | 1.131 |
| | 4 | 5334 | 0.2 | 0 | 0 | 0 | 1.462 | 0.826 | 1.462 |
| | 5 | 1328 | 0.2 | 1 | 0 | 0 | 2.112 | 0.763 | 2.112 |
| | 6 | 584 | 0.2 | 1 | 0 | 0 | 2.869 | 0.592 | 2.869 |
| | 7 | 352 | 0.2 | 1 | 0 | 0 | 4.143 | 0.424 | 4.143 |
| | 8 | 157 | 0.2 | 1 | 0 | 0 | 5.120 | 0.388 | 5.120 |
| | 9 | 91 | 0.2 | 1 | 0 | 0 | 6.426 | 0.471 | 6.426 |
| | 10 | 225 | 0.2 | 1 | 0 | 0 | 9.051 | 0.471 | 9.051 |
| | 1996 | | | | | | | | |
| Age | N | М | Mat | PF | PM | | Sel | CW | |
| | 1 | 1000 | 0.2 | 0 | 0 | 0 | 0.590 | 0.001 | 0.590 |
| | 2. | | 0.2 | 0 | 0 | 0 | 0.861 | 0.178 | 0.861 |
| | 3. | | 0.2 | 0 | 0 | 0 | 1.131 | 0.404 | 1.131 |
| | 4. | | 0.2 | 0 | 0 | 0 | 1.462 | 0.826 | 1.462 |
| | 5. | | 0.2 | 1 | 0 | 0 | 2.112 | 0.763 | 2.112 |
| | 6. | | 0.2 | 1 | 0 | 0 | 2.869 | 0.592 | 2.869 |
| | 7. | | 0.2 | 1 | 0 | 0 | 4.143 | 0.424 | 4.143 |
| | 8. | | 0.2 | 1 | 0 | 0 | 5.120 | 0.388 | 5.120 |
| | 9. | | 0.2 | 1 | 0 | 0 | 6.426 | 0.471 | 6.426 |
| | 10. | | 0.2 | 1 | 0 | 0 | 9.051 | 0.471 | 9.051 |
| | 1997 | | | | | | | | |
| Age | N | М | Mat | PF | PM | SWt | | CW | |
| | 1 | 1000 | 0.2 | 0 | 0 | 0 | 0.590 | 0.001 | 0.590 |
| | 2. | | 0.2 | 0 | 0 | 0 | 0.861 | 0.178 | 0.861 |
| | З. | | 0.2 | 0 | 0 | 0 | 1.131 | 0.404 | 1.131 |
| | 4. | | 0.2 | 0 | 0 | 0 | 1.462 | 0.826 | 1.462 |
| | 5. | | 0.2 | 1 | 0 | 0 | 2.112 | 0.763 | 2.112 |
| | 6. | | 0.2 | 1 | 0 | 0 | 2.869 | 0.592 | 2.869 |
| | 7. | | 0.2 | 1 | 0 | 0 | 4.143 | 0.424 | 4.143 |
| | 8. | | 0.2 | 1 | 0 | 0 | 5.120 | 0.388 | 5.120 |
| | 9. | | 0.2 | 1 | 0 | 0 | 6.426 | 0.471 | 6.426 |
| | 10. | | 0.2 | 1 | 0 | 0 | 9.051 | 0.471 | 9.051 |

Input units are thousands and kg - output in tonnes

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TABLE 5. The first few lines of the Blackfin MFDP single category short-term forecast log file (*.prl).

MFDP version 1a Run: tutorial Blackfin: Assessment course, Combined sex; plusgroup. Time and date: 01:55 03/02/02 IndexFile C:\Vpas\Data\prediction\Blpred_standard.ind Comments VPA course tutorial ***** Data files ***** c:/vpas/data/prediction/blackCN.DAT c:\vpas\data\prediction\blackCW.DAT c:\vpas\data\prediction\blackSW.DAT c:\vpas\data\prediction\blackNM.DAT c:\vpas\data\prediction\blackMO.DAT c:\vpas\data\prediction\blackPF.DAT c:\vpas\data\prediction\blackPM.DAT c:\vpas\data\prediction\f.txt c:\vpas\data\prediction\n.txt Input units are thousands and kg - output in tonnes Last age is a plus group ***** Averaging options ***** Variable Average Y(ScaleToFinalYr Selection Natural mortality Catch weight Stock weight Maturity ***** Projection type ***** Single fleet Historic data ***** Control File ***** Number of years Number of fleets 1 Fleet disag #FALSE# Population Fbar age Future recruitment Target is catch constraint flag #FALSE# Targets ***** Raw Data ***** Population numbers



MFDP version 1 Run: tutorial Blackfin: NAFO course 2000. Combined sex; plusgroup. Time and date: 01:55 03/02/02 Fbar age range: 3-7

Input units are thousands and kg - output in tonnes

Fig. 1. The short-term projection options figure for the Blackfin stock, showing the forecast catch at different levels of fishing mortality two years beyond the assessment series and for SSB three years ahead.

Appendix 1: Lowestoft Stock Assessment Suite

Tutorial 7

The Multi-Fleet Yield-per-Recruit Program

by

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Abstract

This document is number seven in a series of tutorials designed to assist users of the Lowestoft VPA Suite assessment software and prediction programs that use the results. The tutorial takes the user through the options required for running the multi-fleet deterministic yield per recruit program MFYPR developed for ICES at CEFAS.

Introduction

This tutorial takes the user through the options required for running multi-fleet deterministic projection program MFYPR2a.exe. The tutorial assumes that the required Blackfin data files are placed in a directory c:\vpas\data\prediction, and that the prediction index files (Blpred_standard.ind, Blpred_discards.ind) contain path names that point to the appropriate files.

In the following text action to be taken by the user is highlighted in bold. The symbol i is used to represent the Return or Enter key on the keyboard.

Installation of the Program

Copy the MFYPR Disk1 and Disk2 files to a directory on your computer here it is assumed that we are using C:\VPAS\PROGRAMS\MFYPR. Using Explorer go to the directory C:\VPAS\PROGRAMS \MFYPR\Disk1. Start the program Setup.exe and follow the on screen instructions

Data Files

The program will carry out yield per recruit using historic data sets from age structured assessments. The analysis is per recruit, hence no units of numbers are required. The user is prompted on the inputs dialog to indicate the units of weight being used. This unit will be indicated in the output. No checks on the units are carried out and it is the responsibility of the user to ensure they are consistent.

The program uses an index file that is similar to (but not the same as) the Lowestoft format index file used for inputting data to the Lowestoft VPA Suite stock assessment program (Darby and Flatman 1994). The index file for the yield per recruit data is given below, the differences in the index files are that the first, ninth, tenth and eleventh files from the VPA suite list have been omitted in MFYPR. The missing files are the total landings and the optional fishing mortality, fishing mortality in the final year and fleet tuning files.

Several files have been added to the list required for MFYPR, these are, for single fleet analyses:

- 1) the fishing mortality at age for each of the historic assessment years;
- 2) population numbers at age for the historic assessment years and one extra year the survivors at the start of the year after the final assessment year; although the program runs a yield per recruit the stock numbers file is kept here for consistency with the program MFDP.

For multifleet predictions

- 3) a file with total and fleet disaggregated catch numbers at age
- 4) a file with total and fleet disaggregated catch weights at age

The complete index file list for a run using historic data is given below:

| Index file contents | Index file number |
|---|-------------------|
| Title | |
| Historic data flag (1 = Historic, 0 = Future) | |
| Total catch numbers at age numbers file name and path | 2 |
| Weight at age in the catch file name and path | 3 |
| Weight at age in the stock file name and path | 4 |
| Natural mortality file name and path | 5 |
| Proportion mature file name and path | 6 |
| Proportion of F before spawning file name and path | 7 |
| Proportion of M before spawning file name and path | 8 |
| Fishing mortality file name and path | 12 |
| Population numbers file name and path | 13 |

The population numbers file is not needed for a yield per recruit run. It can be replaced by four stars (****). However, if it is placed in the index file the index file can be used for both yield per recruit and short term prediction.

If the prediction is not fleet or category disaggregated then this is sufficient, however if fleet or category disaggregation is required then the following lines are required.

| Index file contents | Index number |
|--|--------------|
| Number of fleets | |
| Fleet 1 catch numbers at age file name and path | 2 |
| | 2 |
| Fleet n catch numbers at age file name and path | 2 |
| Fleet 1 weight at age in the catch file name and path | 3 |
| | 3 |
| Fleet n weight at age in the catch file name and path | 3 |
| An optional control file, if specified it must always be the | e last file. |

Note: If the population and fishing mortality files from the final assessment have a different age range to that of the initial VPA suite input data files, the program will make the adjusment to the new range for the user.

Running the Program

Open program MFYPR2a.EXE from within Windows Explorer or using the Start button

Press the F1 key, this is the undocumented way to see the help file and documentation. The help files are installed in the C:\windows\help directory during setup.

Initially, the program presents the inputs dialog screen. The run identifier should be entered, the plus group specified and the index file located using the browse button. If errors are encountered in the input data then control will return to the inputs dialog and an error message is displayed in red type. The user can makes changes to the files, within a text editor, without closing the program and press browse again to continue. If no errors are encountered a message is displayed detailing the directory in which output files will be saved.

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APPENDIX 1: Tutorial 7: The Multi-fleet Yield-Per-Recruit Program MFYPR

| Browse for index file | |
|--------------------------|----------|
| Last age is a plus group | Continue |
| Jnits of weight | Exit |
| | |

Enter run identifier.

Enter any log file comments required.

Check if the last age is age plus group for this projection run and set the option box.

Check the units for the run

Browse for the projection run index file C:\VPAS\DATA\PREDICTION\Blpred_standard.ind.

| Browse for index file C:\Vpas\Data\prediction\B | Ipred_standard.ind |
|---|--------------------|
| Last age is a plus group | Continue |
| nits of weight 5 Kilograms C Grams C Tonnes | Exit |

Note that on return from the browsing the data file, the program has parsed the data files and should report any errors as red text printed above the log file comments box. If there are no errors the program will inform the user that the output files will be put in the same directory as the index file.

Press the continue button.

| Control You have total population data (no Use the text boxes to set the Fbar a | | | | | point estimation | | |
|--|---------------------------|----------|-----------|---|------------------|-----------------|----------|
| Number of fleets | Run typ otal - No fiee | | registion | Γ | Tennis In | | End |
| Total Pbarage Min 3 ranges Max 1 | | | | | | | |
| Enter SSB/R values for estimation of Freference points99 will omit estimation of the reference point | Flow | Fmed | Fhigh | RefP4 | | Complete | |
| 21 FMultiplier scenarios will be sun. Nanagement scenarios Minimum P | | onimum a | | eni to set the rar whiplier incremen | | Maximum F multi | olier [2 |

The text at the top of the control file box should describe the run type that you are trying to achieve. In this example we are running a single fleet yield per recruit with no disaggregation into discards or multiple use of the landed catch.

Set the minimum and maximum age for the Fbar age range.

If required set the SSB/B values for the reference points in this example leave them unchanged.

The management option table minimum, maximum and increment can usually be left unchanged. The default setting will give the standard management option table.

Press the complete button.

The button vanishes and the Continue button is enabled if the settings conform to the required input. The red information text changes and the program creates a control file for future usage.

| | Flunt | Vpe | | | | |
|---|-------------|--------------|----------|--------|----------|------|
| unber of fleets | oral - No P | leet disaggr | egiation | | Continue | Ewit |
| | | | | - | | |
| Total | | | | | | |
| arage Min 1 | | | | | | |
| Nac. 7 | | | | | | |
| max 17 | | | | | | |
| | | | | | | |
| ter SSB/FI values for estimation | Floer | Fried | Fhigh | ReiPi4 | | |
| Freference points -93 will omit imation of the relevance point | -99 | -99 | 39 | - 199 | | |
| anyous or use research board | 1 au | 1.00 | 20 | Last. | | |

If a fleet disaggregated data set has been input to the program the only difference in the option box is that there are two fishing mortality mean ranges to define.

| Control | | | - | | | | |
|---|--------------|-----------|------------|---------------|---------------------|-------------|--------------|
| The endex file operation that the data | ens historic | Dick = | ontinue to | oet up file e | www.ging.cpliona | | |
| | | | | | | | |
| | Bunta | pe | | | | | |
| Number of fleetz | last di agge | balage | | | Contin | ue | Ent |
| | - | | | | | | |
| Fbarage Min 3 | Fleet1 | | | | | | |
| ranges Max 7 | 7 | | | | | | |
| | | | | | | | |
| Enter SSB/R values for estimation of Frederence points, 499 will omit | Row | Freed | Fhigh | Re/PH | | | |
| estimation of the reference point | -99 | -99 | /99 | -99 | 100 | | |
| 21 FMultiplier scenarios vill be run. | Select the | ninimum (| and increm | ent to set th | e sange of F multip | ápra | |
| Nanagement scenarios Minimum F | multiplier | Þ | Fa | ulipler incr | ensent 0.1 | Hastinurs F | raubiplier 2 |
| | | - | | | - | | |

Press the Continue Button. The program now requires us to set up the vectors used for the predictions. Initially this is carried out using the usual averaging process but the individual year vectors can be modified subsequently if required.

| our files consist of historic data - VPA input and elow, the averaging options you wish to use to a overage state vectors. | |
|--|------|
| | Exit |
| Averaging options | |
| No.Years Scale to final | year |
| Catch weights 3 | |
| Stock weights 3 | |
| Maturity 1 | |
| Natural mortality | |

Set the required time periods to be used in calculating the average vectors.

Set the scale to the final year box if required.

Press the continue button.

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If we require user input of specific values of population numbers, weights or fishing mortalities etc. we can check any of the required boxes and edit the vectors to be used in the forecast. The vectors should always be reviewed for outliers.

| he data have been average ate vectors. If you wish to in | nspect or . | Continue |
|--|-------------|----------|
| odify any of the state vector neck the appropriate box be | | Exit |
| Fishing mortality | N | |
| Catch weights | | |
| Stock weights | | |
| Maturity | V | |
| Natural mortality | | |
| Prop. F before spawning | V | |
| Prop. M before spawning | V | |

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Each of the input data vectors is presented in turn in the format shown below where the two fleet inspection box is illustrated.

| 0.8607 0.8607 1.1310 1.1310 1.4620 1.4620 2.1120 0.0000 2.8693 0.0000 4.1430 0.0000 5.1203 0.0000 6.4260 0.0000 9.0507 0.0000 | 0.5903 | 0.5903 |
|---|--|--------|
| 1.4620 1.4620 2.1120 0.0000 2.8693 0.0000 4.1430 0.0000 5.1203 0.0000 6.4260 0.0000 | | |
| 2.1120 0.0000 2.8693 0.0000 4.1430 0.0000 5.1203 0.0000 6.4260 0.0000 | | |
| 2.8693 0.0000 4.1430 0.0000 5.1203 0.0000 6.4260 0.0000 | A contract of the second se | |
| 4.1430 0.0000 5.1203 0.0000 6.4260 0.0000 | | |
| 5.1203 0.0000 6.4260 0.0000 | and the second sec | |
| 6.4260 0.0000 | A CONTRACTOR OF | |
| | | |
| | | |
| | | |

After reviewing each input data set the program runs to completion

| тfy | /pr2 | × |
|-----|--------|---|
| Fi | nished | |
| 5 | | |
| | OK | |

New Input File Set

The program creates up to a series of 12 new input data files in the same directory as the index file. The files are prefixed by the run identifier entered by the user and contain the vectors of fishing mortalities, maturity at age etc. for the years over which the projection was made. They allow repeat runs using the same prediction vectors, without having to go through the set up process again. The file names are:

| File contents | Filename |
|---------------------------------|----------------------|
| Index | RunCode + "ind.txt" |
| Total catch weight | RunCode + "CWt.txt" |
| Stock weight | RunCode + "SWt.txt" |
| Maturity | RunCode + "Mat.txt" |
| Proportion of F before spawning | RunCode + "PF.txt" |
| Proportion of M before spawning | RunCode + "PM.txt" |
| Total fishing mortality | RunCode + "F.txt" |
| Control file | RunCode + "Ctrl.txt" |

If the data are fleet disaggregated then no file for total F and catch weight will be produced, but files will be produced for each fleet giving the fleet partial Fs and fleet catch weights.

| File contents | Filename |
|---------------------------------|--|
| Disaggregated selection pattern | RunCode + "FleetF" + fleet number + ".txt" |
| Disaggregated catch weights | RunCode + "FleetCWt" + fleet number + ".txt" |

Producing the modified file set allows subsequent runs to be undertaken without editing the data on each occasion.

Output Files

The following 4 files of output are produced. They are listed in Tables 1-4.

1) Output (Table 1)

Results in a comma delimited file with the format specified by the ICES Workshop on Standard Assessment Tools for Working Groups (1999), see the Yield per recruit results section. This file is named with a filename of the run index and the file extension .yro. If no run index has been specified then results will be appended to a file named MFYPR.yro. The results for each run are appended to the file along with the run name, program name and version, stock name, time and date.

2) Summary (Table 2)

Results in a comma delimited file with a structure similar to that of the yield per recruit summary table currently used by ICES. This file is named with a filename of the run index and the file extension .yrs. If no run index has been specified then results will be appended to a file named MFYPR.yrs. The results for each run are appended to the file along with the run name, program name and version, stock name, time and date.

3) Data (Table 3)

A comma delimited file containing the steady state vectors used for the yield per recruit analysis. This file is named with a filename of the run index and the file extension .yrd. If no run index has been specified then results will be appended to a file named MFYPR.yrd. The data for each run are appended to the file along with the run name, program name and version, stock name, time and date.

4) Log (Table 4)

A log file in comma delimited format containing the files used for the run, the raw data, the options chosen, truncated data when appropriate, the steady state vectors, and a summary of the results. The log file is named with the run code and the file extension .yrl. If no run code has been specified then this file is named MFYPR.yrl.

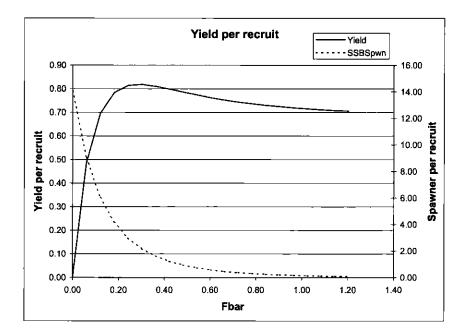
Plotting and Tabulating Results

Open the spreadsheet TEMPLATE1.XLS

Open the output file from the MFYPR run YPR.YRS in EXCEL. The file is comma separated.

Copy the sheet from YPR.YRS and paste it into the .yrs sheet of TEMPLATE1.XLS.

On the sheet labeled Chart, the left hand graph is the standard ICES yield per recruit plot which shows the yield in kilograms at different levels of fishing mortality. The data is automatically plotted when the .yrs sheet is updated.



MFYPR version 2a Run: blackfin SAC Time and date: 17:51 04/03/03

| Reference point | F multiplier | Absolute F |
|-----------------|--------------|------------|
| Fbar(3-7) | 1.0000 | 0.6019 |
| FMax | 0.4720 | 0.2841 |
| F0.1 | 0.2661 | 0.1602 |
| F35%SPR | 0.2545 | 0.1532 |

Weights in kilograms

Fig. 1. The Blackfin single category yield per recruit plot and fishing mortality reference points.

References

DARBY, C. D. and S. FLATMAN. 1994. Virtual Population Analysis: version 3.1 (Windows/DOS) user guide. Info. Tech. Ser., MAFF Direct. Fish. Res., Lowestoft, 1: 85 p.

ICES. MS 1999. Report of the Workshop on Standard Assessment Tools for Working Groups, Aberdeen, United Kingdom, 3–5 March 1999. ICES C.M. Doc., No. 1999/ACFM:25.

| Blackfin: as | Yield per re | MFYPR ve | Run:ypr | 23:08 | 06/02/02 |
|--------------|--------------|----------|---------|----------|----------|
| 1 | • | | | | |
| 1 | | | | | |
| 21 | | | | | |
| Total | | | | | |
| 0.601933 | 0 | 3 | 7 | | |
| 1 | 0 | 0 | 0 | 14.06572 | 16.9212 |
| 2 | 0.1 | 0.487108 | 0 | 9.004979 | 11.80153 |
| 3 | 0.2 | 0.697293 | 0 | 6.03255 | 8.772971 |
| 4 | 0.3 | 0.784026 | 0 | 4.182221 | 6.869175 |
| 5 | 0.4 | 0.813972 | 0 | 2.98003 | 5.616035 |
| 6 | 0.5 | 0.817871 | 0 | 2.172361 | 4.759802 |
| 7 | 0.6 | 0.810366 | 0 | 1.614692 | 4.155827 |
| 8 | 0.7 | 0.798509 | 0 | 1.220628 | 3.717597 |
| 9 | 0.8 | 0.785654 | 0 | 0.936535 | 3.391363 |
| 10 | 0.9 | 0.773323 | 0 | 0.728067 | 3.142674 |
| 11 | 1 | 0.762133 | 0 | 0.572655 | 2.948862 |
| 12 | 1.1 | 0.752258 | 0 | 0.455133 | 2.794664 |
| 13 | 1.2 | 0.743665 | 0 | 0.365107 | 2.669597 |
| 14 | 1.3 | 0.736235 | 0 | 0.295328 | 2.566328 |
| 15 | 1.4 | 0.729822 | 0 | 0.240662 | 2.47964 |
| 16 | 1.5 | 0.724278 | 0 | 0.197415 | 2.405766 |
| 17 | 1.6 | 0.719471 | 0 | 0.162896 | 2.341944 |
| 18 | 1.7 | 0.715284 | 0 | 0.135122 | 2.286121 |
| 19 | 1.8 | 0.711619 | 0 | 0.11261 | 2.236752 |
| 20 | 1.9 | 0.708393 | 0 | 0.094242 | 2.192656 |
| 21 | 2 | 0.705537 | 0 | 7.92E-02 | 2.152925 |

TABLE 1. The MFYPR yield per recruit results in the ICES SGFADS format.

Weights in kilograms

| TABLE 2. | Blackfin MFYPR yield-per-recruit table output. |
|----------|--|
| | |

| MFYPR ve | rsion 2a | | | | | | | | |
|--------------|---------------|----------|--------|----------|---------|-----------|---------|----------|----------------|
| Run: ypr | | | | | | | | | |
| Time and d | late: 23:08 0 | 06/02/02 | | | | | | | |
| Yield per re | sults | | | | | | | | |
| FMult | Fbar | CatchNos | Yield | StockNos | Biomass | SpwnNosJ. | SSBJan | SpwnNosS | SSBSpwn |
| 0 | 0 | 0 | 0 | 5.5167 | 16.9212 | 2.4788 | 14.0657 | 2.4788 | 14.0657 |
| 0.1 | 0.0602 | 0.1572 | 0.4871 | 4.7338 | 11.8015 | 1.739 | 9.005 | 1.739 | 9.005 |
| 0.2 | 0.1204 | 0.2603 | 0.6973 | 4.2221 | 8.773 | 1.2683 | 6.0326 | 1.2683 | 6.0326 |
| 0.3 | 0.1806 | 0.3322 | 0.784 | 3.8657 | 6.8692 | 0.9512 | 4.1822 | 0.9512 | 4.1822 |
| 0.4 | 0.2408 | 0.3849 | 0.814 | 3.6058 | 5.616 | 0.7287 | 2.98 | 0.7287 | 2.98 |
| 0.5 | 0.301 | 0.4249 | 0.8179 | 3.409 | 4.7598 | 0.5677 | 2.1724 | 0.5677 | 2.1724 |
| 0.6 | 0.3612 | 0.4563 | 0.8104 | 3.2555 | 4.1558 | 0.4483 | 1.6147 | 0.4483 | 1. 6147 |
| 0.7 | 0.4214 | 0.4814 | 0.7985 | 3.1327 | 3.7176 | 0.3581 | 1.2206 | 0.3581 | 1.2206 |
| 0.8 | 0.4815 | 0.5021 | 0.7857 | 3.0322 | 3.3914 | 0.2889 | 0.9365 | 0.2889 | 0.9365 |
| 0.9 | 0.5417 | 0.5194 | 0.7733 | 2.9483 | 3.1427 | 0.2349 | 0.7281 | 0.2349 | 0.7281 |
| 1 | 0.6019 | 0.5342 | 0.7621 | 2.8773 | 2.9489 | 0.1924 | 0.5727 | 0.1924 | 0.5727 |
| 1.1 | 0.6621 | 0.5469 | 0.7523 | 2.8161 | 2.7947 | 0.1586 | 0.4551 | 0.1586 | 0.4551 |
| 1.2 | 0.7223 | 0.5581 | 0.7437 | 2.7627 | 2.6696 | 0.1314 | 0.3651 | 0.1314 | 0.3651 |
| 1.3 | 0.7825 | 0.568 | 0.7362 | 2.7156 | 2.5663 | 0.1095 | 0.2953 | 0.1095 | 0.2953 |
| 1.4 | 0.8427 | 0.5768 | 0.7298 | 2.6736 | 2.4796 | 0.0915 | 0.2407 | 0.0915 | 0.2407 |
| 1.5 | 0.9029 | 0.5847 | 0.7243 | 2.6358 | 2.4058 | 0.0768 | 0.1974 | 0.0768 | 0.1974 |
| 1.6 | 0.9631 | 0.592 | 0.7195 | 2.6016 | 2.3419 | 0.0647 | 0.1629 | 0.0647 | 0.1629 |
| 1.7 | 1.0233 | 0.5986 | 0.7153 | 2.5703 | 2.2861 | 0.0547 | 0.1351 | 0.0547 | 0.1351 |
| 1.8 | 1.0835 | 0.6047 | 0.7116 | 2.5415 | 2.2368 | 0.0463 | 0.1126 | 0.0463 | 0.1126 |
| 1.9 | 1.1437 | 0.6104 | 0.7084 | 2.515 | 2.1927 | 0.0393 | 0.0942 | 0.0393 | 0.0942 |
| 2 | 1.2039 | 0.6156 | 0.7055 | 2.4903 | 2.1529 | 0.0335 | 0.0792 | 0.0335 | 0.0792 |
| | | | | | | | | | |

| Reference I | F multiplier A | bsolute F |
|-------------|----------------|-----------|
| Fbar(3-7) | 1 | 0.6019 |
| FMax | 0.472 | 0.2841 |
| F0.1 | 0.2661 | 0.1602 |
| F35%SPR | 0.2545 | 0.1532 |

Weights in kilograms

TABLE 3. Blackfin MFYPR yield-per-recruit input data table.

MFYPR version 2a Run: ypr Blackfin: assessment course. Combined sex; plusgroup. Time and date: 23:08 06/02/02 Fbar age range: 3-7

| Age | М | Mat | PF | PM | | SWt | Sel | CWt |
|-----|----|-----|----|----|---|----------|----------|----------|
| | 1 | 0.2 | 0 | 0 | 0 | 0.590333 | 0.001 | 0.590333 |
| | 2 | 0.2 | 0 | 0 | 0 | 0.860667 | 0.178 | 0.860667 |
| | 3 | 0.2 | 0 | 0 | 0 | 1.131 | 0.403667 | 1.131 |
| | 4 | 0.2 | 0 | 0 | 0 | 1.462 | 0.826333 | 1.462 |
| | 5 | 0.2 | 1 | 0 | 0 | 2.112 | 0.763333 | 2.112 |
| | 6 | 0.2 | 1 | 0 | 0 | 2.869333 | 0.592 | 2.869333 |
| | 7 | 0.2 | 1 | 0 | 0 | 4.143 | 0.424333 | 4.143 |
| | 8 | 0.2 | 1 | 0 | 0 | 5.120333 | 0.387667 | 5.120333 |
| | 9 | 0.2 | 1 | 0 | 0 | 6.426 | 0.470667 | 6.426 |
| | 10 | 0.2 | 1 | 0 | 0 | 9.050667 | 0.470667 | 9.050667 |

Weights in kilograms

0.24

0.475

0.722

0.333

0.477

0.224

0.227

0.133

0.202

0.571

0.211

0.562

0.204

0.393

0.231

0.247

0.113

0.303

0.39

0.372

0.644

0.31

0.379

0.208

0.224

0.141

0.254

0.39

0.372

0.644

0.31

0.379

0.208

0.224

0.141

0.254

TABLE 4. The first few lines of the Blackfin MFYPR yield-per-recruit log file describing the analysis settings

MFYPR version 2a Run: ypr Time and date: 23:08 06/02/02 Blackfin: assessment course. Combined sex; plusgroup.

Comments

Weights in kilograms

IndexFile C:\Vpas\Data\prediction\Blpred_standard.ind Data files c:\vpas\data\prediction\blackCN.DAT c:\vpas\data\prediction\blackCW.DAT c:\vpas\data\prediction\blackSW.DAT c:\vpas\data\prediction\blackNM.DAT c:\vpas\data\prediction\blackMO.DAT c:\vpas\data\prediction\blackPF.DAT c:\vpas\data\prediction\blackPM.DAT c:\vpas\data\prediction\blackPM.DAT c:\vpas\data\prediction\blackPM.DAT

| , nonaging option | • | |
|-------------------|------------|------------------|
| Variable Avera | ige Yi Sca | leToFinalYr |
| Selection | 3 | 0 |
| Natural mo | 1 | |
| Catch weig | 3 | |
| Stock weig | 3 | |
| Maturity | 1 | |
| Fleet details | | |
| Number of | 1 Flee | et disag #FALSE# |
| Population | 3 | 7 |
| | | |
| | | |

| Reference poi | ints - SPR | values | | | |
|---------------|------------|--------|-------|-------|-------|
| -99 | -99 | -99 | -99 | | |
| Raw Data | | | | | |
| Historic data | | | | | |
| Fishing mo | 1963 | 1994 | 1 | 10 | |
| 0 | 0.013 | 0.146 | 0.244 | 0.241 | 0.351 |
| 0 | 0.005 | 0.245 | 0.362 | 0.421 | 0.423 |
| 0 | 0.014 | 0.186 | 0.666 | 0.511 | 0.63 |
| 0 | 0.004 | 0.239 | 0.461 | 0.617 | 0.388 |
| 0 | 0.016 | 0.161 | 0.407 | 0.331 | 0.261 |
| 0 | 0.003 | 0.133 | 0.271 | 0.294 | 0.167 |
| 0 | 0.012 | 0.15 | 0.399 | 0.286 | 0.195 |
| 0 | 0.002 | 0.133 | 0.264 | 0.267 | 0.176 |
| 0 | 0.013 | 0.088 | 0.314 | 0.355 | 0.254 |

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Appendix 1: Lowestoft Stock Assessment Suite

Tutorial 8

Running the PA Software Excel Add-in (PASoft)

by

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Abstract

This document is number eight in a series of tutorials designed to assist users of the Lowestoft VPA Suite assessment software and the prediction programs that use the results. The tutorial takes the user through the options required for running the PA software EXCEL add-in used to estimate reference points and developed for ICES at CEFAS.

Introduction

This tutorial takes the user through the options required for running the PA software EXCEL add-in. The tutorial assumes that the user has followed the previous XSA tutorials and can run the VPA suite package to produce the required files or has constructed the sen and sum output files resulting from the Aberdeen medium term suite of programs.

In the following text action to be taken by the user is highlighted in **bold**. The symbol \bot is used to represent the Return or Enter key on the keyboard.

Installing the PA Software

The software is intended to be used with Microsoft Excel Version 7 upwards. The software is an Excel add-in and results are output as Excel workbooks.

Copy the PA soft directory to your hard drive. Enter the directory disk 1 and run the setup.exe. Follow the instructions to install the pa add in.

Open EXCEL

From the menu bar Select "Tools", "Add-ins"

| Add-Ins | ? × |
|--|--------|
| Add-Ins available: | ОК |
| Microsoft Bookshelf Integration | A |
| MS Query Add-in for Excel 5 Compatibi | Cancel |
| | |
| Solver Add-In | Browse |
| S-PLUS Add-In | |
| Template Utilities Template Wizard with Data Tracking | |
| Update Add-in Links | |
| Web Form Wizard | |
| Analysis ToolPak | |
| | |
| | |
| | |

Browse for the file PAXLA.XLA which will have been placed in the installation directory.

| | Browse | | | - | | | 7 |
|--|-------------|--------------------------------|---|--------------------|----------|-----|--------------------|
| Add Ins available: Microsoft Boolshelf Integration Microsoft Boolshelf Integration Microsoft Add-In CODC Add-In Report Manager Solver Add-In Microsoft Boolship | Lookini | PA Soft | - | | | | |
| | Cata | | | | | | OK |
| | Ty pards | u zohni | | | | - 1 | Cancel |
| S-PLUS Add-In Template Utilities Template Weard with Data Tracking Upshale Add-In Linka Web Form Witand | | | | | | | Advanced. |
| Analysis ToolPak | | | | | | | |
| | | that watch these search criter | | | | | |
| | File Dame | ÷ [] | 2 | Tends or property: | 1 | 1 | Eind Now |
| | Files of St | pet Add-ins (*, xla; *, xli) | | Last godfred | any tine | | Ne <u>m</u> Search |
| | 1 file(a)) | 10.04 | | | | | |

Select PAXLA.XLA and press OK

| dd-Ins available: Microsoft AccessLinks Add-In Microsoft Bookshelf Integration MS Query Add-in for Excel 5 Compatibi | Cancel |
|---|--|
| Microsoft AccessLinks Add-In Microsoft Bookshelf Integration MS Query Add-in for Excel 5 Compatibi | tunner and the second |
| Microsoft Bookshelf Integration MS Query Add-in for Excel 5 Compatibl | Cancel |
| MS Query Add-in for Excel 5 Compatibi | Cancel |
| | |
| ODBC Add-In | Designed |
| PA add-in | Browse |
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| AUDIYSIS TUUIFOR | |
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| | |
| | Report Manager Solver Add-In S-PLUS Add-In Template Utilities Template Wizard with Data Tracking |

Note that the PA add-in box has been entered and checked.

Select OK

Notice that the PASummary drop down menu has been added to the menu at the top of Excel.

Note: If you do not want to keep loading the PA add-in every time Excel is opened select "Tools", "Add-ins" and uncheck the PA add-in box. The add in box can be re-checked each time the program is required.

Run the program VPA95.exe for the stock for which you wish to estimate the PA reference points. Select the options for the age range, reference means etc selected in previous tutorials. When the assessment model has been fitted select option 8 from the main menu. This option will print a file that contains all of the VPA suite output in a form that can be read by the PA software.

Return to EXCEL

The PA Software Help File

At the menu bar select the "PASummary" drop down menu. Select the Help menu option

During installation a help file is added to the Windows\system\ directory for reference when using the program. The methods used in the calculation of the reference points are detailed in the help system.

| @ Open ab Sot US Print | Mavigate | Search | Back. | History | Glossage | |
|---|--|---|--|--|--|--|
| Introduction | 54 | 22 | | | | |
| Purpose Construct Structure process Construct Structure process Construct Structure Struc | Guida | nce to | worki | ng grou | sdr | |
| | require of fishi | d to pro | vide pro ality and | | are ary levels s part of | |
| Situx rectal sets: Parametric stock recruitment relationship: Non-parametric stock recruitment relationship: Situx and Floss Plus group in reference point estimation Discard selection in reference point estimati. Industrial selection in reference point estimat. Contents / End / Index / Tables / | Blim m operate working only Fg operate Blim m | oust be o onally u g group: ta and E onally b | unambig seful for s and for pa will y ACFIV enved f | r ACFM be used 1, but Fli or the pu | nd sessment . Normally m and urpose of | |

Calculation of the PA Reference Points

In this section we shall run the PA software to calculate fishing mortality and biomass reference points. This will allow us to examine the approach and the results of the methodology. In the following section we shall run a diagnostic routine to examine the selection of settings used for the smoothers used to estimate particular reference points.

At the menu bar select the "PASummary" drop down menu.

Select "Run PA Soft" and "XSA file input" Note that two other input file formats are permitted, spreadsheet entry and the .sen and .sum files created by the Aberdeen suite program INSENS.

| at <u>T</u> ools <u>D</u> ata S-PLUS | PASummary Window | w Help FL | | |
|--------------------------------------|------------------|-------------------|-----------|--|
| 、 略風ダ の・ | Diagnostics | f= 4 2 4 | 13 · 2 | |
| • B / U = 1 | Run PA Soft 🔸 | SenSum file input | - A - A - | |
| | Advice plot | XL Sheet input | | |
| | Help | XSA file input | - | |

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| XSA pa summary file inpu | rt dialog | ? × |
|---|---|--------|
| Assessment pa data file C:\Vpas\Data\blackpre.da | st | Browse |
| Averages 3 Average years 3 FbarMinAge 7 FbarMaxAge | Maximum age | OK |
| Scale selection to Fbar 400000 User-defin Equilibrium LOWESS 1 Span Origin included Origin included Origin rection Monte Carlo Percentiles 5 & 95 25 & 75 | And MBAL 0.1 M year CV Gloss LOWESS 1 Span Origin included Log transformation Bias correction Iterations 1000 Stock recruitment Data pairs C LOWESS residuals | Help |
| Label points with year on d Stock and recruitment SSB on F phase plot Yield on F phase plot User-defined random t | plot | |

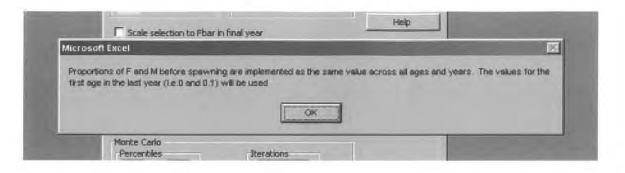
Browse for the PA software XSA input file created during the XSA run.

The range of ages for calculating average fishing mortality should correspond to those used in the XSA assessment. Default options for the setting of two LOWESS models are presented. These should be chosen after reference to the diagnostic output presented below. Other options for the percentile used in the summary plots and the number of iterations to use in the Monte Carlo simulations can be user defined. The user guide for the program details selection criteria.

The default number of iterations for the PA Software is 100 as with this number the output can be obtained fairly quickly. This is however a relatively small number for a Monte Carlo and for a final run a larger number such as 1000 is likely to give more stable estimates of the percentiles.

After completion of the selections press the OK button.

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The program informs us that, as the proportions of F and M are equal for all ages and years it will use the values for the final year.

Select the OK button.

The PA soft program runs the Monte Carlo iterations sampling from the distributions of the input data and then creates five EXCEL sheets containing data and results.

Sheet Intro (Table 1)

This sheet provides a brief introduction to the results.

Sheet RefPts (Fig. 1 and Table 2)

This sheet summarizes the estimated reference points. Box and whisker plots showing the 5th, 25th, 50th, 75th and 95th percentiles of the F reference points are plotted. A table showing the deterministic value of the reference point together with the median and 2 user-specified pairs of percentiles is produced for stock and fishing mortality reference points. If the user has specified 5th, 25th, 75th and 95th percentiles then the 75th and 95th percentiles would be displayed for the stock reference points, while the 5th and 25th would be displayed for the F reference points.

The RefPts sheet also provides a record of the run specification, these include:

Spans used by the LOWESS smoothers and data transformations. Stock name. Averaging details for Fbar and the steady state vectors (the latter will be zero when these vectors are the input, i.e. Sen_Sum input and XLSheet input). Number of iterations. The type of Monte Carlo for the stock recruitment data. The data source. Details of the FishLab DLL used for reference point estimations. The PASoft version. The date and time of the run.

Sometimes certain combinations of data may cause some reference points (particularly F_{max} , F_{hlgh} and F_{loss}) to give unreliable results, for example F_{max} may tend to infinity. The percentiles are based on the full distribution of the reference points estimations and will include these points. The output sheet "PDist" contains the estimates of all the reference points by iteration number and can be checked for outlying values. "PDist" acts as the input for the box and whisker plots hence if different percentiles are required on these plots the user can alter the percentile function calls at the foot of the data in "PDist".

Sheet Plots (Fig. 3)

This sheet provides graphical output of deterministic results. 4 plots are presented:

Recruitment against SSB Spawner per recruit and yield per recruit curves against Fbar Equilibrium SSB against Fbar Equilibrium yield against Fbar

In plots 1, 3 and 4 the points are linked in chronological order by a dashed line and a colored solid line represents expected values estimated from the LOWESS smoothed stock recruitment relationship. The user also has the option to label each point with the year when the program is run.

In plots 1 and 2 a number of fishing mortality reference points are indicated as labeled points on the right axis of the stock recruit plot and at the top of the SPR and YPR chart.

Plot 1, the stock recruit plot, gives details of the LOWESS span and data transformations used for the smoother in the top left corner. This smoother is used to estimate the expected values (the solid line) in plots 3 and 4. The data used to plot the charts are held on the Plots sheets in columns U to AP.

Sometimes a large value for a reference point may cause the stock recruitment plot to be squashed at the bottom of the chart. This is because Excel has scaled the chart automatically to the largest value of R. By selecting the outlying point (which lies under the label) and deleting it the chart will re-scale more appropriately. This has been carried out for the Floss point in the Blackfin example.

Sheet Pdist (Table 3)

This sheet provides the estimates of each reference point by iteration number. These data form the input for the box and whisker plots on the "RefPts" sheet. The complete distributions of the reference point estimation allow the user to check for erroneous values or to further investigate the empirical distributions.

Sheet SV (Table 4)

The SV sheet provides the user with the steady state vectors used during the PA run. For Sen_Sum file input or XLSheet input these should be the same as the input data. For the other input formats they will be derived from the data and as such provide a useful record of the steady state vectors.

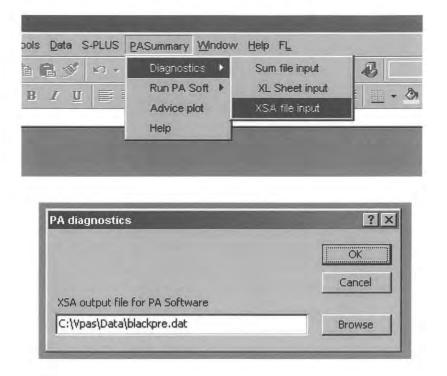
The sheet is presented in a suitable format to be used as input for further PA runs using the XLSheet dialog and can therefore be used as the basis for more investigative work. For example the effects of mortality, weight and maturity at age schedules could be explored, or the effects of different CVs investigated. This may be of particular interest where the variables or CVs are assumptions.

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Diagnostic Calculation for the Lowess Smoother

At the menu bar select the "PASummary" drop down menu.

Select "Diagnostics" and "XSA file input" Note that two other input file formats are permitted, spreadsheet entry and the .sen and .sum files created by the "Aberdeen suite program INSENS".



Browse for the PA software XSA input file created during the XSA run.



The program informs us that, as the proportions of F and M are equal for all ages and years it will use the values for the final year.

Select the OK button.

The diagnostics program runs and creates four EXCEL graphs in a new sheet they present diagnostic plots used for determining the settings of the models used for the precautionary approach reference point calculations.

PASoft Diagnostic Output Graphs

Fig. 3 presents the diagnostic plots produced by PASoft within Excel.

The top left-hand chart shows recruitment (Recruits) plotted against spawning stock biomass (SSB); together with the LOWESS fits corresponding to the two spans of 0.5 (Rhat0.5) and 1.0 (Rhat1.0). The relative difference in G_{loss} between the two spans can be judged by the discrepancy in fitted values corresponding to the lowest observed SSB; i.e. the extreme left-hand points of each LOWESS fit. This graph will assist in the qualitative assessment of the effect that span has on expected recruitment.

The top right-hand chart shows the time series of recruitment with recruitment estimates obtained from the LOWESS fits corresponding to spans of 0.5 (Rhat0.5) and 1.0 (Rhat1.0). This graph, in conjunction with the one described in the previous paragraph, will assist in a qualitative assessment of time trends in the level of recruitment.

The bottom left-hand chart shows the log-normal residuals obtained from the two LOWESS fits with spans of 0.5 (LnRes0.5) and 1.0 (LnRes1.0) plotted against SSB. In addition, the residuals obtained from the LOWESS fit with a span of 1.0 are connected through time with a dashed line. This graph will aid in the detection of heteroscedasticity; i.e. non-constant variance, and the detection of patterns and trends with SSB/time that might violate modelling assumptions.

The bottom right-hand chart shows an improved Akaike information criterion (Hurvich *et al.*, 1998) for a range of LOWESS fits obtained with spans in the interval (0.5, 1], generally thought appropriate for stocks within the current ICES areas (O'Brien, 1999). A span is selected to minimise the bias-corrected Akaike information criterion (AIC) but it is important to remember that any smoothing parameter selection should be viewed as only a guideline (or benchmark), and can be adjusted based upon other factors. Such factors might include: prior knowledge about the shape of the stock-recruitment (S-R) relationship; suitability of the S-R relationship for deriving equilibrium plots; and sensitivity of the estimates of G_{loss} to outliers in the S-R data. To give an indication of the stability of the reference point G_{loss} , numerical estimates are shown (denoted by Gloss) at each span calculated. In general, a LOWESS fit with a high span near to 1.0 is appropriate for the S-R relationship if the production of equilibrium plots is required, whereas a low span will *track* the data and give inappropriate equilibrium values. Furthermore, a LOWESS fit with a high span near to 1.0 is likely to produce more robust estimates of G_{loss} and this is especially true if the data are *noisy*.

All the LOWESS fits have been achieved by inclusion of the origin as a pseudo-data point; i.e. zero recruitment from a non-existent SSB, and with the assumption that recruitment variation may be considered to follow a log-normal distribution.

For the Blackfin data set the plots show that the most appropriate span for the smoother, based on the Akaike information criterion is 1.0. However there is no significant trend in Gloss across all values of the smoother range.

The time series plot of the estimated recruitment with the observed values shows time series correlations in the residual patterns which are also obvious in the residual plots against expected value. The diagnostics illustrate that the model is a poor estimator of recruitment in the most recent time period and would not be appropriate for the estimation of recent recruitment and the value of Gloss. The fit of the smoother and therefore the estimate of Gloss appears to be highly dependent on the recruitment at the two lowest SSB values, which are the first years in the assessment time series. A sensitivity analysis exploring the influence of these point on the estimated reference points would therefore be appropriate.

References

O'BRIEN, C. M. 1999. A note on the distribution of G_{loss}. ICES Journal of Marine Science, 56: 180-183.
 HURVICH, C. M., J. S. SIMONOFF, and C. L. TSAI. 1998. Smoothing parameter selection in nonparametic regression using an improved Akaike information criterion. Journal of the Royal Statistical Society, B60: 271-293.

TABLE 1. The Introduction sheet from the Blackfin PaSoft Excel output file.

Introduction to PA Add-in outputs

Four sheets of results are included in this workbook:

RefPts - provides stochastic output in the form of a table of reference points and a chart summarising the distributions of some reference

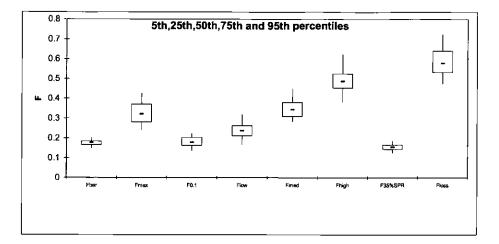
Plots - provides 4 plots:

A stock recruitment plot with a LOWESS smoother as a possible stock recruitment relationship. Some reference points are also indica A plot of YPR and SPR curves with some reference points indicated.

A plot of historical SSB against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship. A plot of historical yield against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship.

PD - gives the value of the reference points during each iteration of the simulation and the percentiles plotted on the chart on RefPts.

SV - contains the steady state vectors and stock recruitment series used. These can be used as the basis for further runs.



| Reference point | Deterministic | Median | 75th percentile | 95th percentile | Hist SSB < ref pt % |
|-----------------|---------------|--------|-----------------|-----------------|---------------------|
| MedianRecruits | 26149 | 26149 | 29338 | 31387 | |
| MBAL | 0 | | | | 0.00 |
| Bloss | 11711 | | | | |
| SSB90%R90%Surv | 31674 | 30240 | 33223 | 37964 | 31.25 |
| SPR%ofVirgin | 30.31 | 30.47 | 33.53 | 38.20 | |
| VirginSPR | 14.07 | 14.16 | 15.81 | 21.70 | |
| SPRIoss | 0.56 | 0.50 | 0.55 | 0.60 | |
| | | | | | |
| | Deterministic | Median | 25th percentile | 5th percentile | Hist F > ref pt % |
| FBar | 0.18 | 0.18 | 0.16 | 0.15 | 96.88 |
| Fmax | 0.31 | 0.32 | 0.28 | 0.24 | 65.63 |
| F0.1 | 0.18 | 0.18 | 0.16 | 0.14 | 96.88 |
| Flow | 0.21 | 0.24 | 0.21 | 0.17 | 96.88 |
| Freed | 0.34 | 0.34 | 0.31 | 0.28 | 62.50 |
| Fhigh | 0.48 | 0.49 | 0.45 | 0.38 | 21.88 |
| F35%SPR | 0.15 | 0.16 | 0.14 | 0.12 | 100.00 |
| Floss | 0.56 | 0.58 | 0.53 | 0.47 | 18.75 |

For estimation of Gloss and Floss:

A LOWESS smoother with a span of 1 was used.

Stock recruit data were log-transformed

A point representing the origin was included in the stock recruit data.

For estimation of the stock recruitment relationship used in equilibrium calculations:

A LOWESS smoother with a span of 1 was used.

Stock recruit data were log-transformed

A point representing the origin was included in the stock recruit data.

Blackfin: VPA course. Combined sex; plusgroup.

Steady state selection averaged over 3 years. FBar averaged from age 4 to 7

Number of iterations = 100 Random number seed = -99 Stock recruitment data Monte Carloed using residuals from the equilibrium LOWESS fit

Data source: C:\vpas\data\xsapadata.csv

FishLab DLL used FLVB32.DLL built on Jun 14 1999 at 11:53:37 PASoft 4 October 1999

14/02/03 13:18:25

Fig. 1 and Table 2. The PA Reference Point estimates estimated for the Blackfin stock and listed in the RefPts sheet from the PaSoft Excel output file.

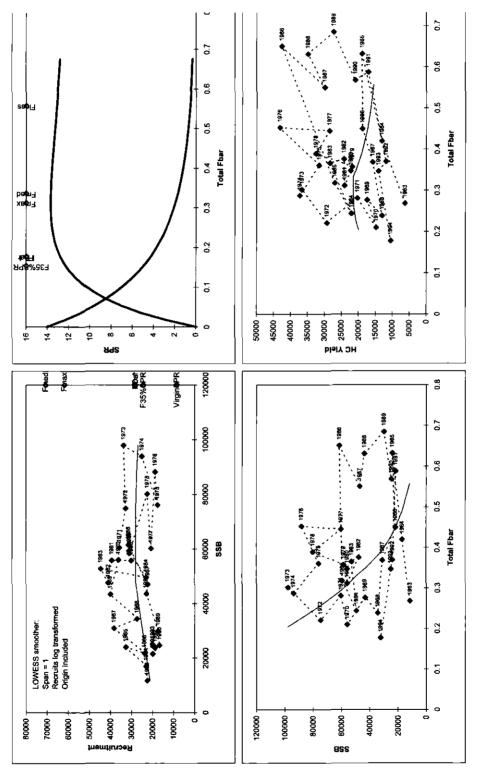


Fig. 2. The PA Reference Point plots for the Blackfin stock, presented in the Plots sheet from the PaSoft Excel output file. Top left – Recruitment against SSB; Top right – Spawner per recruit and yield per recruit curves against Fbar; Bottom left – Equilibrium SSB against Fbar; Bottom right – Equilibrium yield against Fbar.

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| 0 11710.78 23300.66 0 11710.78 27819.15 0 11710.78 30253.14 0 11710.78 26555.73 0 11710.78 26555.73 0 11710.78 28658.1 0 11710.78 28658.1 0 11710.78 29646 0 11710.78 29798.36 | 30226.5 35.03407 | 15.23995 0.598271 | 0.150278 | 0.312342 | 0.17861 | 0.263362 | 0.327842 | 0.452285 | 0.15(|
| 0 11710.78 27819.15 0 11710.78 30253.14 0 11710.78 30255.73 0 11710.78 31653.4 0 11710.78 28658.1 0 11710.78 28658.1 0 11710.78 28646 0 11710.78 29092.28 0 11710.78 29798.36 | 23300.66 32.65281 | 14.29413 0.452 | 0.190465 | 0.392838 | 0.220128 | 0.249938 | 0.39822 | 0.594555 | 0.17: |
| 0 11710.78 30253.14 0 11710.78 26555.73 0 11710.78 26555.73 0 11710.78 28658.1 0 11710.78 28658.1 0 11710.78 28646 0 11710.78 29092.28 0 11710.78 29798.36 | 27819.15 29.81821 | 12.20651 0.418844 | 0.179038 | 0.333256 | 0.189511 | 0.210965 | 0.303154 | 0.445012 | 0.15 |
| 0 11710.78 26555.73 0 11710.78 26558.1 0 11710.78 28658.1 0 11710.78 28646 0 11710.78 24092.28 0 11710.78 29798.36 | 30253.14 27.79232 | 12.10182 0.51839 | 0.19315 | 0.338441 | 0.186312 | 0.258973 | 0.3325 | 0.475037 | 0.15! |
| 0 11710.78 31653.4 0 11710.78 28658.1 0 11710.78 28646 0 11710.78 24092.28 0 11710.78 29798.36 | 26555.73 31.11318 | 15.18016 0.518481 | 0.150074 | 0.242278 | 0.142524 | 0.224594 | 0.307531 | 0.46416 | 0.13 |
| 0 11710.78 28658.1 0 11710.78 28646 0 11710.78 24092.28 0 11710.78 29798.36 | 31653.4 28.91018 1 | 8.59249 0.462596 | 0.169392 | 0.245365 | 0.150577 | 0.274225 | 0.358615 | 0.487562 | 0.14 |
| 0 11710.78 28646 0 11710.78 24092.28 0 11710.78 29798.36 | 28658.1 22.99329 | 18.25419 0.428346 | 0.202298 | 0.261919 | 0.150539 | 0.276289 | 0.370082 | 0.498208 | 0.138 |
| 0 11710.78 24092.28 0 11710.78 29798.36 | 28646 24.74067 1 | 3.50679 0.494508 | 0.197191 | 0.322591 | 0.17394 | 0.214684 | 0.283565 | 0.460055 | 0,14 |
| 0 11710.78 29798.36 | 24092.28 28.66087 1 | 12.11946 0.49517 | 0.186122 | 0.358012 | 0.174597 | 0.230333 | 0.300794 | 0.502544 | 0.15: |
| | 29798.36 30.14793 | | 0.179867 | 0.358814 | 0.18154 | 0.166608 | 0.29823 | 0.447809 | 0.15! |
| 26148.7 0 11710.78 37572.37 34.43 | 37572.37 34.4339 | 14.18645 0.613901 | 0.153254 | 0.32775 | 0.183061 | 0.240253 | 0.342903 | 0.436936 | 0.15(|
| 30074.89 0 11710.78 23825.86 30.986 | 23825.86 30.98678 1 | 5.91894 0.40612 | 0.178543 | 0.30738 | 0.179479 | 0.231221 | 0.358914 | 0.545596 | 0.15/ |
| 26148.7 0 11710.78 34895.76 31.596 | 34895.76 31.59613 1 | 1.31906 0.50573 | 0.178534 | 0.362696 | 0.192132 | 0.215579 | 0.332003 | 0.42874 | 0.16 |
| 30964.5 0 11710.78 28727.33 33.313 | 28727.33 33.31394 | 11.76719 0.480599 | 0.163386 | 0.312125 | 0.171665 | 0.185222 | 0.308376 | 0.472055 | 0.15! |

TABLE 4. The input data for the estimation of the PA Reference Point for the Blackfin stock, presented in the SV sheet from the PaSoft Excel output filefile.

| Age | N | м | CWt | SWt | Mat | F | FPreSpwn MPn | eSpwn |
|------------|----------|-----|----------|----------|-----|----------|--------------|-------|
| 1 | 0 | 0.2 | 0.590333 | 0.590333 | 0 | 0.000443 | 0 | 0 |
| 2 | 16412.25 | 0.2 | 0.860667 | 0.860667 | 0 | 0.106141 | | |
| 3 | 10517.84 | 0.2 | 1.131 | 1.131 | 0 | 0.165427 | | |
| 4 | 7271.93 | 0.2 | 1.462 | 1.462 | 0 | 0.260107 | | |
| 5 | 3997.49 | 0.2 | 2.112 | 2.112 | 1 | 0.211053 | | |
| 6 | 2131.86 | 0.2 | 2.869333 | 2.869333 | 1 | 0.141556 | | |
| 7 | 1528.56 | 0.2 | 4.143 | 4.143 | 1 | 0.098364 | | |
| 8 | 617 | 0.2 | 5.120333 | 5.120333 | 1 | 0.085274 | | |
| 9 | 472.54 | 0.2 | 6.426 | 6.426 | 1 | 0.103553 | | |
| 10 | 992.17 | 0.2 | 9.050667 | 9.050667 | 1 | 0.103553 | | |
| FbarMinAge | 4 | | | | | | | |
| FbarMaxAge | 7 | | | | | | | |

M year CV

0.1

| NCV | MCV | CWtCV | SWtCV | MatCV | FCV |
|---------|-----|----------|----------|-------|----------|
| 0 | 0.1 | 0.098371 | 0.098371 | 0.1 | 0.68172 |
| 9.75222 | 0.1 | 0.086421 | 0.086421 | 0.1 | 0.72884 |
| 0.26225 | 0.1 | 0.029814 | 0.029814 | 0.1 | 0.381266 |
| 0.19439 | 0.1 | 0.09449 | 0.09449 | 0.1 | 0.165987 |
| 0.18015 | 0.1 | 0.087517 | 0.087517 | 0.1 | 0.116818 |
| 0.1817 | 0.1 | 0.049484 | 0.049484 | 0.1 | 0.097805 |
| 0.18811 | 0.1 | 0.059178 | 0.059178 | 0.1 | 0.443046 |
| 0.2105 | 0.1 | 0.045287 | 0.045287 | 0.1 | 0.359722 |
| 0.22298 | 0.1 | 0.011354 | 0.011354 | 0.1 | 0.275606 |
| 0.22298 | 0.1 | 0.068573 | 0.068573 | 0.1 | 0.275606 |

| Year | SSB | Recruitment | Yield | Fbar |
|-------------------|----------|-------------|----------|----------|
| 1963 | 11710.78 | 32415.01 | 6280.488 | 0.268748 |
| 1964 | 17014.45 | 22357.53 | 13070.21 | 0.420165 |
| 1965 | 23999.6 | 22889.08 | 18876.47 | 0.632308 |
| 1966 | 21826.96 | 32779.56 | 18836.04 | 0.44973 |
| 19 67 | 30964.24 | 23605.62 | 15793.87 | 0.368828 |
| 1968 | 34441.75 | 38390.83 | 13060.77 | 0.238885 |
| 1969 | 43435.16 | 27259.93 | 17454.17 | 0.276788 |
| 1970 | 56042.43 | 40147.54 | 14796.16 | 0.21009 |
| 1971 | 60518.81 | 36124.96 | 20298.13 | 0.281355 |
| 1972 | 74879.81 | 35679.46 | 29303.82 | 0.22157 |
| 1973 | 97936.71 | 32747.65 | 36686.26 | 0.30204 |
| 1974 | 93920.01 | 33736.42 | 37281.2 | 0.28761 |
| 1975 | 76136.96 | 25037.47 | 31620.7 | 0.36094 |
| 1976 | 88272.5 | 17554.59 | 43184.3 | 0.452655 |
| 1977 | 60282.17 | 18780.98 | 28509.34 | 0.445075 |
| 1978 | 80184.72 | 20692.79 | 32564.8 | 0.389535 |
| 1979 | 58436.55 | 22519.5 | 21849.07 | 0.35779 |
| 1980 | 55866.28 | 30925.31 | 22303.76 | 0.347528 |
| 1981 | 55837.82 | 30074.89 | 24071.67 | 0.311733 |
| 1982 | 47672.17 | 39271.43 | 24283.43 | 0.376188 |
| 1983 | 52781.94 | 40946.7 | 28404.82 | 0.365575 |
| 1984 | 49608.76 | 44469.4 | 22082.54 | 0.244073 |
| 1985 | 59340.07 | 22956.38 | 27004.21 | 0.317903 |
| 1986 | 61470.84 | 31003.69 | 42551.18 | 0.65082 |
| 1987 | 47081.24 | 31370.43 | 29839.76 | 0.550345 |
| 1988 | 43667.4 | 22295.84 | 34828.51 | 0.6314 |
| 1989 | 29895.96 | 23007.31 | 27311.24 | 0.68496 |
| 1990 | 24651.49 | 17353.34 | 20885.03 | 0.568433 |
| 1991 | 21559.32 | 16793.23 | 17017.17 | 0.587965 |
| 19 9 2 | 23878.47 | 20007.37 | 11868.62 | 0.370095 |
| 1993 | 25044.56 | 18950.84 | 14055.82 | 0.347048 |
| 1994 | 32347.56 | 20043.07 | 10528.84 | 0.17777 |

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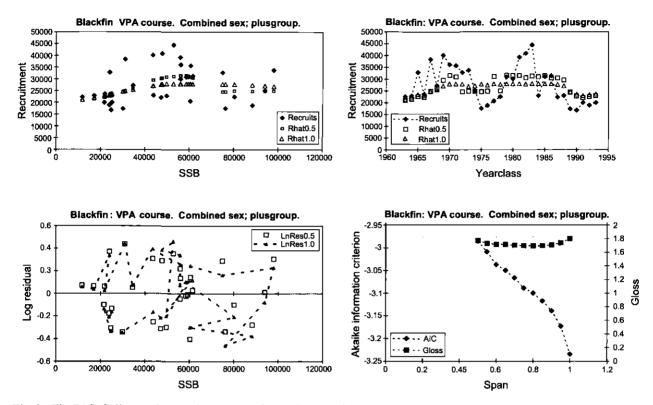


Fig. 3. The PASoft diagnostic plots for the Blackfin stock. Top left – recruitment plotted against SSB; with the LOWESS fits corresponding to the spans of 0.5 and 1.0. Top right – the time series of recruitment with recruitment estimates obtained from the two LOWESS fits. The bottom left – the log-normal residuals obtained from the two LOWESS fits.