Resources Management Committee **ICES CM 2001/D:02**

REPORT OF THE

WORKSHOP ON INTERNATIONAL ANALYSIS OF MARKET SAMPLING AND THE EVALUATION OF RAISING PROCEDURES AND DATA-STORAGE (SOFTWARE)

CEFAS, Lowestoft
28–30 November 2000

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Participants

Åge Fotland	Norway
Ângela Canha	Portugal
Antonio Punzon	Spain
Brian Rackham	UK
Carl O'Brien	UK
Chris Darby	UK
Colm Lordan	Ireland
Dália Reis	Portugal
David Hirst	Norway
David Maxwell	UK
Els Vanderperren	Belgium
Henrik Degel	Denmark
Iñaki Artetxe Irueta	Spain
John Simmonds	UK
Maria Hansson	Sweden
Martin Pastoors (Chair)	The Netherlands
Morten Vinther	Denmark
Paz Sampedro	Spain
Richard Millner	UK
Rick Officer	Ireland
Steve Flatman	UK
Tore Jakobsen	Norway

1.2 Terms of reference

A Workshop on **International Analysis of Market Sampling and the Evaluation of Raising Procedures and Data-Storage (software)** [WKIMS] (Chair: Dr M. Pastoors, Netherlands) will be held in Lowestoft from 28-30 November 2000 to report on:

a) how well the total international sampling effort covers the total fishing activity;

b) how different methods of combining national age compositions and weights at age affects the estimation of the international age compositions and weights at age;

c) estimation of uncertainty of age compositions and weights at age and the precision of estimated CV's and variances;

d) how raising procedures can be formalized;

e) how data-storage of these market sampling data should be organized.

Justification

The Group is set up to forward ICES in particular in respect to Priority 3 of the draft strategic plan. The strategic plan is detailed by RMC in setting its priorities and this group responds to the RMC priority 5: Promote the development of methods for resource evaluations and forecasts.

EU financed concerted actions and sampling programmes have addressed issues of market sampling for the estimation of biological characteristics of the catches, in particular the age compositions of the catches. These data are together with results from abundance surveys, the basis for the fish stock assessments on which the ACFM advice on fisheries management is based. The above mentioned studies have provided more insight in the performance of these sampling programmes and hopefully this insight can lead to more efficient sampling programmes. Of particular interest is the possibility for better international coordination of the sampling. It is therefore timely to present an overview of the state-of-the art, to discuss the specific results obtained through the EU financed programmes and to conclude on possible benefits that may accrue of international coordination of the future sampling schemes.

1.3 Structure of the report

The terms of reference were interpreted as dealing with basically three topics which will form the basis of the following sections in the report:

- Section 2 will deal with the international sampling coverage; i.e. how the international sampling effort maps on the fishing activities that are supposed to be sampled.
- Section 3 will deal with the estimation of uncertainty of age compositions and weights at age and also with the effects of these uncertainties in the stock assessment procedures.
- Section 4 will deal with all aspects of combination of national age compositions and weights at age to the international level. This involves the current procedures that are used and how these procedures affect the estimates of international age compositions. But this also involves the issues of standardization of raising procedures and outlines of standard software to realize the standardized raisings.

2 SAMPLING COVERAGE

2.1 How well does the international sampling effort cover the total fishing activity?

If sampling is to be representative of the exploited stock, it should cover the extent of the fishery in time and space and include all the main gears involved in the fishery. The SG on Market Sampling Methodology which met in Aberdeen in January 2000 (ICES, 2000a), looked at sampling coverage for three species in the North Sea and concluded that in 1998, around 22% of the plaice and herring landed went unsampled because the vessels were landing into foreign ports.

It is necessary to take into account that for some stocks a proportion of the landings may not be available for market sampling. This occurs for several different reasons. For example landings made into foreign ports are not normally sampled at all. One exception is for a number of countries involved in the EU funded programme SAMFISH. These countries have agreed to sample the landings of flag vessels. Even where there is agreement to sample, there may be practical problems in obtaining access to fish at the point of landing. For instance, landings made by flag vessels are often shipped directly from the vessels to markets elsewhere. Therefore these sectors of the fleet are probably under-sampled. Since the fishing gear and practice of these fleet segments may differ from those of the national-based fleet segment, a bias may result.

Table 2.1.1 gives an overview of the landings by species and by country with the percentage of the total landing (national and foreign) which is available for sampling in currently implemented sampling schemes (STECF, 2000). The figures presented are calculated with data extracted from Table 1b of that report. The row percentages for each country reflect the landings from which samples have been taken and do not indicate the actual level of sampling of that country for that particular species. The total percentage sampled compares the landings sampled with the landings from which no samples were taken, usually because the landings were made abroad.

The final column in the table indicates that the landings, which are available for sampling, constitute in excess of 75% of the total landings, for most stocks. In a smaller number of stocks, landings abroad, which are usually not sampled, make up between 20-70% of the total. These stocks included hake, herring, mackerel, horse mackerel, lemon sole, mackerel, plaice and saithe. There are also a few stocks (brill, turbot, skates and rays) where sampling levels were less than 10% because there is no international sampling programme.

The idea of reciprocal sampling (i.e. sampling of vessels in the country where they land instead of by the country of their flag) was briefly discussed during the Workshop but should be addressed more properly. In order to carry out sampling by country of landings, there is a need to obtain estimates of the fleet components that land their yield in a specific country (e.g. based on logbook statistics?). It may be considered to raise the foreign component of the yield by a separate ALK (if sampling is undertaken, and all necessary information on strata is available). Currently some sampling data is available for the landings of English vessels into the Netherlands and these could be used to explore the feasibility of this approach.

2.2 Minimum precision required from sampling

The minimum sampling level depends on the type of advice and on the level of precision required. Pope (1983) suggested that for roundfish stocks in the North Sea, coefficients of variation of 10% in all the input data would lead to an average coefficient of variation of <9% in the TAC. For a practical approach, in analytical assessments, it has been suggested that there should be a precision of +- 10% for each of the three most important age groups in the international age composition and 20-30% for other age groups which contribute significantly (Flatman, 1990, appendix D). This should apply both to the international age composition and to the age composition of any fleet whose CPUE is used to calibrate the assessment.

In other cases the minimum sampling level has been derived by practical considerations rather than statistical analysis. In NAFO, the recommended sampling level has been 200 length samples per quarter per division per 1000 tonnes landed (Anon 1970). Recently STECF recommended a range of sampling levels based on practical considerations, such as the data needs of the fishery and the level of landings.

2.3 Case studies

In order to look at how well sampling covers the aspects mentioned above, a number of stocks were selected for which information was available at the Workshop. The stocks selected were ones where some estimate of the precision of sampling had been calculated and this was compared with the sampling coverage by individual countries. The data used was taken from the International Sampling Level Database (see WD 2) for stocks in the NE Atlantic developed during the EU Study Contracts 94/013, 92.0059 (FIEFA) and 99/009 (SAMFISH).

2.3.1 Southern Hake and Sardine

2.3.1.1 Sampling

Three Fisheries Institutes are involved in taking data of southern stocks of hake and sardine. The sampling procedures and data capture are different for each institute (Brown, 1999):

- Instituto Portugues de Investigacao Maritima (IPIMAR): All landed weight are recorded by harbour, day, vessel, gear, species and commercial category. The sampling scheme is based on stratified random sampling resulting in a multi-stage process for pre-defined target species. The event sampled is the landings of the target species by boat per day. IPIMAR's sampling process aims for the estimation by area of length frequencies (and ALKs) by month or quarter and gear from the commercial fleets for the target species.

- Instituto Espagnol de Oceanografia (IEO): for landings the aim is to have a full census of landings made by the Spanish fleet by target species, ICES area, gear, port and month. In those cases where a census of landings at the port is not available, either because the area and gear are not designated or because monthly catches are not available, stratified sampling of landings by area of catch and type of gear, later converted to effort (number of fishing trips obtained from other sources) are used. For length distributions, two sampling strategies are used depending on the species: in the case of hake the sampling unit is the vessel and for sardine the commercial category landed. The procedure used is stratified sampling by species, ICES Area (Division or Sub-division), gear, port and month. A fixed number of age samples are collected by length class, quarter and ICES Division.

- AZTI: For landings the aim is to have a full census of daily landings made by all fleets landing in the ports of the Basque country by species, ICES area, gear, and port. Concerning length distributions, the procedure used is a stratified sampling scheme by species, commercial category, ICES Area (Division or Sub-division), gear, and month. Observations are raised to total landings by commercial category for the relevant cell (species, commercial category, gear, time and area). Age structures are collected in a parallel way with the aim of obtaining ALK by cell. The definition of cells depends on population. A fixed number of age structures by length class is pursued in each defined cell.

2.3.1.2 Gear coverage

In the case of hake the main landings came from trawl (56%), artisanal fleets (21%) and gillnet (14%). All gears were sampled. For sardine 99% came from purse seine.

2.3.1.3 Spatial coverage

The southern hake stock includes ICES Divisions VIIIc and IXa and the sardine stock includes Sub-area VIII and ICES Division IXa. Three different labs are involved in sampling for catches, length distributions and ageing. For hake the landings from both Division are similar. All Divisions were sampled (Table 2.3.1.1). In the case of sardine 85% came from IXa (Table 2.3.1.2).

2.3.1.4 Temporal coverage

There are two different frequencies of sampling, by month and by quarter. In the case of hake the differences in landings between quarters for all gears was not significant. All strata considered were sampled. For sardine, the most important variations in landings and sampling level (mainly in ICES area VIII) are due to commercial reasons (low prices in some seasons, other target species, etc.). Nevertheless, all significant sampling cells were sampled.

2.3.1.5 Coefficients of variation

In the sardine from the central sub-division of IXa (Jardim, 1999), analysis of the Portuguese age composition for all quarters showed a similar pattern of CVs (Figure 2.3.1.1). Levels of sampling were similar in each quarter. Lower CVs were observed for ages 2 to 5, where values were always less than 13%. Higher CVs were seen for the older age groups, probably due to the few readings made and the low number of samples, as for these ages the landings are poor. Although not shown in Figure 2.3.1.1, when the CVs of length and age were analyzed separately, it was apparent that the main components of CVs was due to age.

2.3.2 Western Channel plaice

2.3.2.1 Sampling of landings by country

Landings of plaice by country and gear from Division VIIe in 1997 are shown in Table 2.3.2.1. Landings into England and Wales are sampled, whereas landings into the other countries are not. In 1997 the proportion of total international landings from which samples were taken was 79%. Also shown in the table are numbers of length samples, fish measured and fish aged, by country and gear group.

2.3.2.2 Gear coverage

Table 2.3.2.1 shows that 96% of plaice landings in 1997 were from trawl gears (beam trawl and otter trawls), which are also the gears mainly sampled (beam 59%, otter trawl 40%, by number of samples).

2.3.2.3 Spatial coverage

Information on the spatial coverage of sampling for length is routinely presented in CEFAS annual data files as ICES rectangle charts of England & Wales total landings and landings by sampled vessels. Figures 2.3.2.1a and b show these data for 1996 and 1997. For 1997, it can be seen that all rectangles from which >1% of the landings were taken were actually sampled. In 1996 the sampling picture was different, but still covered those rectangles providing >5% of the landings. Assuming that the variability of catch at age was similar throughout the sampling area, then the proportion sampled by rectangle should ideally be similar to the landings proportion by rectangle, although ensuring that sampling covers the main rectangles fished is perhaps the main objective.

2.3.2.4 Temporal coverage

The England & Wales sampling scheme is designed to provide length and age samples throughout the fishing season. For VIIe plaice, landings are made throughout the year, and usually the sampling scheme provides length and age samples from each month. The fishing season is therefore considered to be adequately covered, assuming that monthly sampling continues at or above the levels achieved in 1997.

2.3.2.5 Data processing and raising procedure

Plaice are measured and processed by sex, maintaining the separation of processed data until the final combination to give annual UK(E+W) total numbers at age for sexes combined. The Age-Length Keys (ALKs) used in this process are also by sex, derived from monthly separate-sex otolith targets irrespective of gear. A full description of the sampling and raising protocols for ICES Sub-area VII demersal stocks is also available (Brown, 1999).

2.3.2.6 Detailed comparisons of available CV results

Annual CVs of numbers at age for England and Wales sampling of VIIe plaice are given in Figure 2.3.2.2 for 1996 and 1997. (See Section 2.4 for method of calculating CVs). It is clear that overall CVs were generally lower in 1996 than in 1997, and that the main component of the variation in both years is that due to age. The number of fish aged in 1997

(1486) represented a decrease of around 25% on the number aged in 1996 (1950), and the results in terms of CV is clearly apparent. For stock assessment purposes, the main age groups are 3 to 7, over which fishing mortality is averaged to present an annual index. The plus group age for this stock is set at 10, so ages 10 and above are not crucial to the tuning process. At the annual level, CVs of around 10% or better are achieved for the main age groups in 1996 and 1997. Note that UK(E+W) sampling is the only source of age data for this stock; if other nations supplied similarly-sampled age data then the total international CV of numbers at age would be lower still.

In order to examine the CVs of numbers at age at a finer level of detail the results for each quarter of 1996 were plotted (Figure 2.3.2.3). The graphs show that at the quarterly level most of the variation is again due to age, although at some ages the CV due to length is close to or above that due to age. Overall CVs are between 10 – 30% for the main ages.

Finally, to examine CVs at the lowest level of disaggregation, results for the fourth quarter for each gear group and sex were plotted (Figure 2.3.2.4). The males show much higher CVs than the females, and beam trawl results appear to be better than the otter trawl, reflecting sampling levels achieved. The general theme of most of the variation being due to age remains throughout. At this level of disaggregation, typical CVs for the main ages are between 20 – 50% for females and 20 - 100% for males.

2.4 Calculation of CVs

A common procedure for calculating Coefficient of Variation (CV) of numbers at age is to use the bootstrap method (Efron & Tibshirani, 1993). Application of this method for market sampling data is demonstrated in detail in the report of the Study group on Market sampling methodology (ICES 2000a). The variance of numbers at age can also be calculated analytically, given assumption on the error structure of the data and that the fish are sampled independently. A general procedure of the method is described in Appendix A.5 (also reported in Flatman, 1990). There are also several published papers presenting methods for analytical approaches to the calculation of variance of numbers at age, for example: Smith & Maguire, 1983; Gavaris & Gavaris, 1983; Baird, 1983. It should be noted that the in general the sampled fish will be very far from independent, at least if the sampling unit is the boat. Therefore, the analytical variance thus estimated may seriously underestimate the true variance in most real situations.

2.5 Conclusions

The analysis of two stocks for which information on CVs was available indicates that:

- Annual CVs at length are generally below 5% for the most exploited age groups

- the CVs at age for quarterly or annual data on the most exploited age groups were around 10% which is at the level likely to provide acceptable precision in the analytical assessments of the stocks

- improvements in CVs are likely to depend on increased sampling for age rather than length

Quarterly results disaggregated by gear and sex show CV levels of 20-50% for females and 30 – 100% for males, reflecting the sampling levels achieved.

Table 2.1.1. Overview of the landings by species and by country with the percentage of the total landing (national and foreign) theoretically available in currently implemented sampling schemes (North Sea 1998, calculated with data extracted from Table 1b F of the STECF meeting held in Lowestoft in January 2000 “Landings in tons for 1998 given by vessel flag country and by the country in which the landing has taken place.”).

Species		BEL	DEN	FAR	FRA	GER	NET	NOR	SWE	UK	Total landings	Landings from which samples taken	% of total sampled
Anglerfish	t	404	1432	16	13	590	231	58	8	11269	14021	10918	**77.9**
	%	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**96.9**			
Blue whiting	t	0	151	0	0	0	1	0	79	92	323	–	**–**
	%	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**			
Brill	t	157	57	0	13	54	807	0	0	182	1270	109	**8.6**
	%	**69.4**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**			
Cod	t	5987	22844	123	3003	8090	14680	1168	519	47967	104381	86025	**82.4**
	%	**53**	**91.6**	**-**	**-**	**100**	**99.6**	**-**	**-**	**94.9**			
Sole	t	1830	507	0	541	781	15198	1	1	855	19714	17580	**89.2**
	%	**67.4**	**-**	**-**	**94.3**	**-**	**99.8**	**-**	**-**	**39.8**			
Dab	t	778	1027	0	139	651	7971	50	0	2153	12769	–	**–**
	%	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**			
Haddock	t	0	2606	50	444	1347	292	386	472	55176	60773	57770	**95.1**
	%	**36.9**	**99.3**	**-**	**-**	**-**	**-**	**-**	**-**	**99.5**			
Hake	t	58	477	5	48	57	47	8	5	319	1024	283	**27.6**
	%	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**88.7**			
Herring	t	0	0	580	14474	18195	41795	25226	3221	32122	135613	90847	**67.0**
	%	**-**	**99.7**	**-**	**-**	**100**	**100**	**-**	**-**	**54.7**			
Horse mackerel	t	22	1993	0	216	4642	3813	0	10	446	11142	7081	**63.6**
	%	**-**	**100**	**-**	**-**	**-**	**100**	**-**	**-**	**-**			
Lemon sole	t	896	805	1	202	118	836	11	4	3562	6435	3086	**48.0**
	%	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**86.7**			
Mackerel	t	132	22782	2334	1845	487	1374	67	3466	7628	40115	27586	**68.8**
	%	**-**	**79.5**	**-**	**-**	**99.2**	**100**	**-**	**-**	**100**			
Megrim	t	7	19	0	15	0	29	0	0	2509	2579	2494	**96.7**
	%	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**99.4**			
Northern prawn	t	0	3236	0	0	0	0	21	187	1365	4809	2850	**59.3**
	%	**-**	**88.1**	**-**	**-**	**-**	**-**	**-**	**-**	**100**			
Norway lobster	t	287	1445	0	0	54	696	85	4	10945	13516	12604	**93.3**
	%	**92**	**97**	**-**	**-**	**-**	**-**	**-**	**-**	**100**			
Norway pout	t	0	39836	0	0		0	0	0	0	39836	39836	**100.0**
	%	**-**	**100**	**-**	**-**	**-**	**-**	**-**	**-**	**-**			
Plaice	t	5727	10430	0	545	2749	30561	312	2	19192	69518	52972	**76.2**
	%	**50.4**	**90.8**	**-**	**89.9**	**100**	**99**	**-**	**-**	**39.7**			
Saithe	t	352	2562	1292	12858	9752	8	4888	1462	6774	39948	17479	**43.8**
	%	**-**	**97.3**	**-**	**-**	**100**	**-**	**-**	**-**	**100**			
Sandeel	t	0	618019	0	0	0	0	1522	8520	6265	634326	624011	**98.4**
	%	**-**	**100**	**-**	**-**	**-**	**-**	**-**	**-**	**100**			
Skate and rays	t	384	21	0	4	9	544	1	0	1952	2915	–	**–**
	%	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**			
Sprat	t	0	131112	0	0	0	0	0	1690	184	132986	131296	**98.7**
	%	**-**	**100**	**-**	**-**	**-**	**-**	**-**	**-**	**100**			
Turbot	t	148	389	0	25	170	1693	4	0	571	3000	39	**1.3**
	%	**26.4**	**0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**			
Whiting	t	272	47	2	1932	94	1943	0	1	17665	21956	19702	**89.7**
	%	56.6	–	–	–	–	99.6	–	–	99.7			
t: tonnes landed		%: perc. sampled											

Table 2.3.1.1. Southern hake: landings sampled and individuals measured in 1998 by ICES division, gear and quarter (data from ISLDB).

Species	Southern Hake
Year	1998

			Quarter				
ICES Division	Gear	Data	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Ixa	Trawl	Landings (t)	554	629	530	344	2057
		Sample (n)	152	170	144	141	607
		Indiv. (n)	35596	37518	29719	28116	130949
	Artisanal	Landings (t)	240	472	450	350	1512
		Sample (n)	122	110	109	93	434
		Indiv. (n)	7279	7339	6879	6390	27887
	Gillnet	Landings (t)	15	29	29	15	88
		Sample (n)	6	6	6	6	24
		Indiv. (n)	617	681	651	697	2646
	Purse Seine	Landings (t)	1				1
		Sample (n)			1		1
		Indiv. (n)			26		26
	Unknown	Landings (t)	25	5	7	7	44
		Sample (n)					
		Indiv. (n)					
VIIIC	Hook	Landings (t)	109	222	156	135	622
		Sample (n)	5	6	4	6	21
		Indiv. (n)	216	345	380	408	1349
	Trawl	Landings (t)	551	471	572	566	2160
		Sample (n)	36	31	36	39	142
		Indiv. (n)	5296	4627	4831	4902	19656
	Artisanal	Landings (t)	17	29	21	17	84
		Sample (n)					
		Indiv. (n)					
	Gillnet	Landings (t)	313	254	227	187	981
		Sample (n)	27	26	23	17	93
		Indiv. (n)	3377	3639	3089	2330	12435
Total Landings (t)			1825	2111	1992	1621	7549
Total Sample (n)			348	349	323	302	1322
Total Indiv. (n)			52381	54149	45575	42843	194948
Total Otolith (n)			135	239	404	1132	1910

Table 2.3.1.2. Sardine: landings sampled and individuals measured in 1997 by ICES division, gear and quarter (data from ISLDB).

Species	Sardine
Year	1997

			Quarter				
ICES Division	Gear	Data	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total general
Ixa	Trawl	Landings (t)	905	290	211	414	1820
		Sample (n)	18		1		19
		Indiv. (n)	2630		110		2740
	Artisanal	Landings (t)	125	233	930	312	1600
		Sample (n)					
		Indiv. (n)					
	Purse Seine	Landings (t)	9727	22396	36813	21406	90342
		Sample (n)	61	163	158	87	469
		Indiv. (n)	6944	22860	19690	10857	60351
VIII	Purse Seine	Landings (t)	6115	3940	3041	2493	15589
		Sample (n)	58	52	72	34	216
		Indiv. (n)	4895	4546	5251	2902	17594
Total Landings (t)			16872	26859	40995	24625	109351
Total Sample (n)			137	215	231	121	704
Total Indiv. (n)			14469	27406	25051	13759	80685
Total Otolith (n)			2223	1419	1269	1072	5983

Table 2.3.2.1. Western Channel plaice: landings sampled and individuals measured in 1997 by country (top) and by gear (bottom). Note: data from ISLDB.

species	PLE
year	1997

			Quarter				
icesdivision	institute	Data	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
VIIE	CEFAS - England&Wales	Landings(tonnes)	341	121	310	246	1018
		Samples (n)	22	17	22	30	91
		Fish measured (n)	3226	2199	2939	3667	12031
		Fish aged (n)	422	395	377	292	1486
	Belgium	Landings (t)	3	2	1		6
	France	Landings (t)	189	38	36	29	292
Total landings(t)			533	161	347	275	1316
Total samples (n)			22	17	22	30	91
Total fish measured (n)			3226	2199	2939	3667	12031
Total fish aged (n)			422	395	377	292	1486

			Quarter				
icesdivision	gear	Data	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total general
VIIE	BEAM TRAWL	Landings(tonnes)	176	21	206	168	571
		Samples (n)	11	9	13	21	54
		Fish measured (n)	2186	1612	2230	2686	8714
		Fish aged (n)	356	307	251	250	1164
	TRAWL	Landings(tonnes)	161	94	94	59	408
		Samples (n)	11	7	9	9	36
		Fish measured (n)	1040	586	709	981	3316
		Fish aged (n)	66	79	126	42	313
	GILL NET	Landings(tonnes)	0	1	4	1	6
		Samples (n)	0	1	0	0	1
		Fish measured (n)	0	1	0	0	1
		Fish aged (n)	0	9	0	0	9
	POTS	Landings(tonnes)	1	1	1	15	18
		Samples (n)	0	0	0	0	0
		Fish measured (n)	0	0	0	0	0
		Fish aged (n)	0	0	0	0	0
	HAND LINES (INC GURDY)	Landings(tonnes)	0	0	0	2	2
		Samples (n)	0	0	0	0	0
		Fish measured (n)	0	0	0	0	0
		Fish aged (n)	0	0	0	0	0
	DREDGE	Landings(tonnes)	2	3	4	3	12
		Samples (n)	0	0	0	0	0
		Fish measured (n)	0	0	0	0	0
		Fish aged (n)	0	0	0	0	0
Total landings(t)			340	120	309	248	1017
Total samples (n)			22	17	22	30	91
Total fish measured (n)			3226	2199	2939	3667	12031
Total fish aged (n)			422	395	377	292	1486

Figure 2.3.1.1. CV's of numbers at age for 1997 Sardine landings from ICES division (Jardim, 1999).

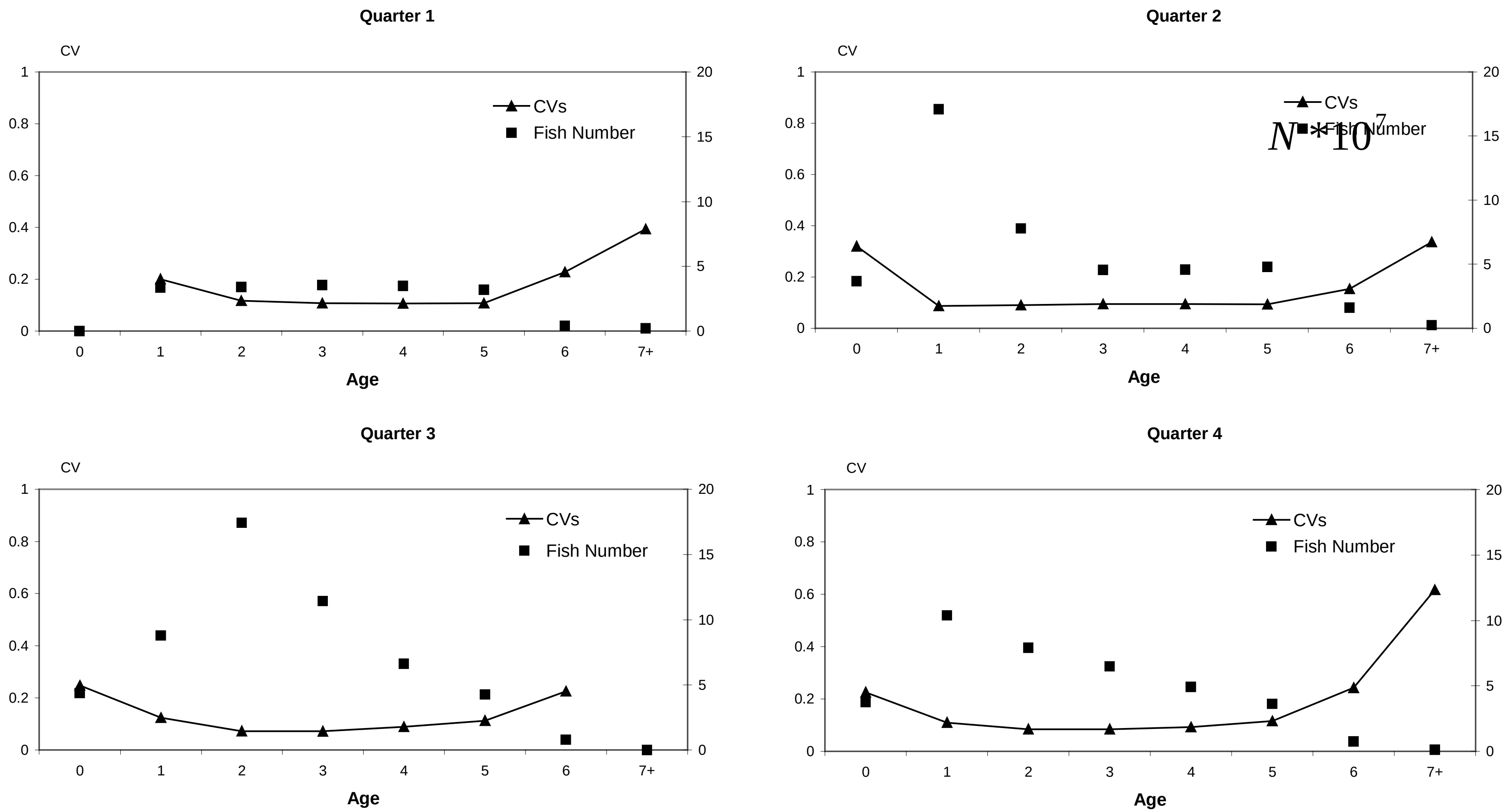


Figure x. 1997 Sardine CVs by quarter from IXa Central ICES Subdivision (Jardim, 1999)
Jardin, E., 1999. Análise da amostragem de sardinha (Sardina pilchardus) em 1996 e 1997- Cálculo dos coeficientes de cariaÇao do número de individuos capturados por classe de idade. Relatórios c

Figure 2.3.2.1a. Overview of 1996 plaice landings in the Western Channel (VIIe), landed into England and Wales. Bold figures are landings (tonnes), italic figures are sampled weights (tonnes).

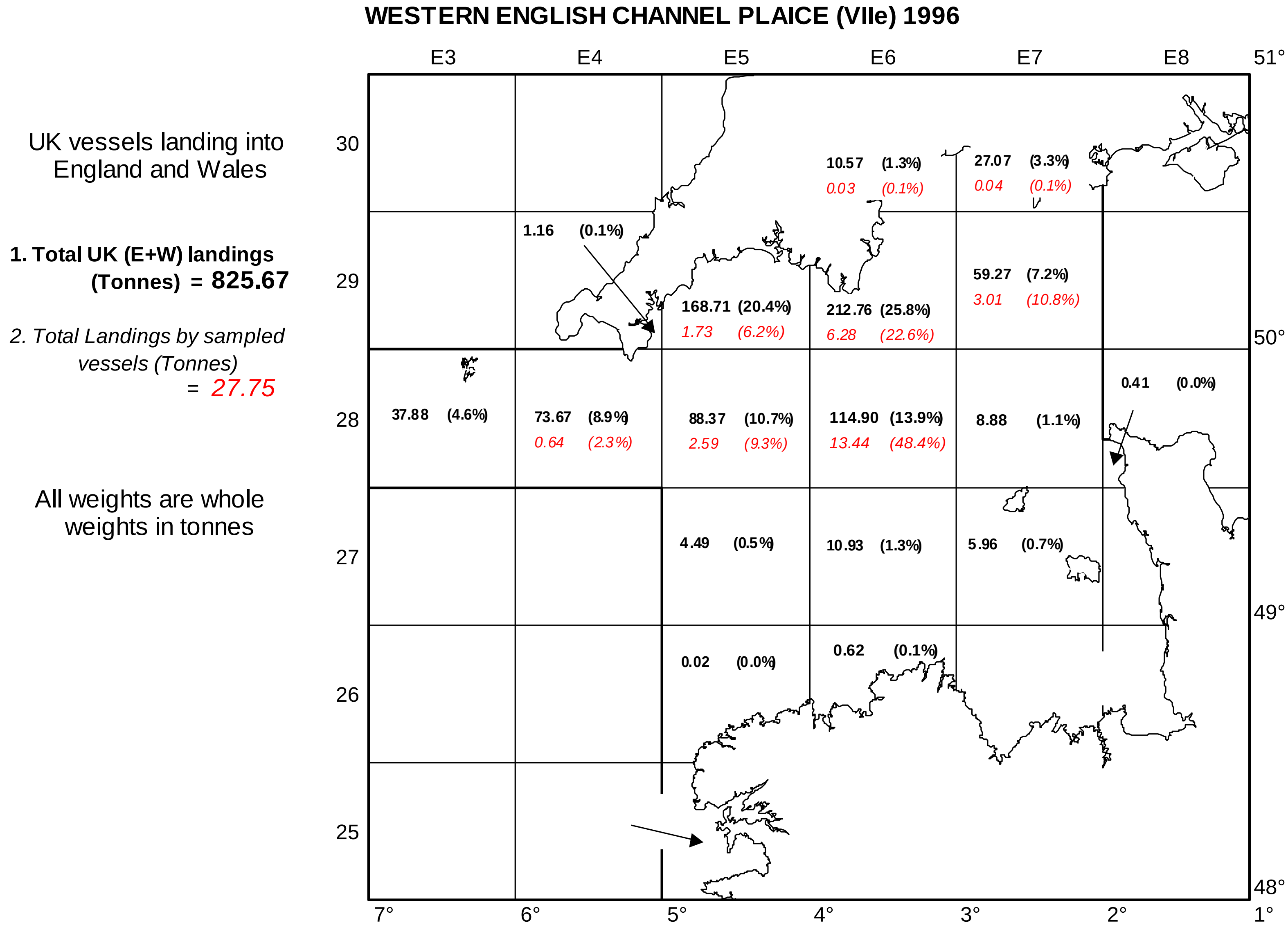


Figure 2.3.2.1b. Overview of 1997 plaice landings in the Western Channel (VIIe), landed into England and Wales. Bold figures are landings (tonnes), italic figures are sampled weights (tonnes).

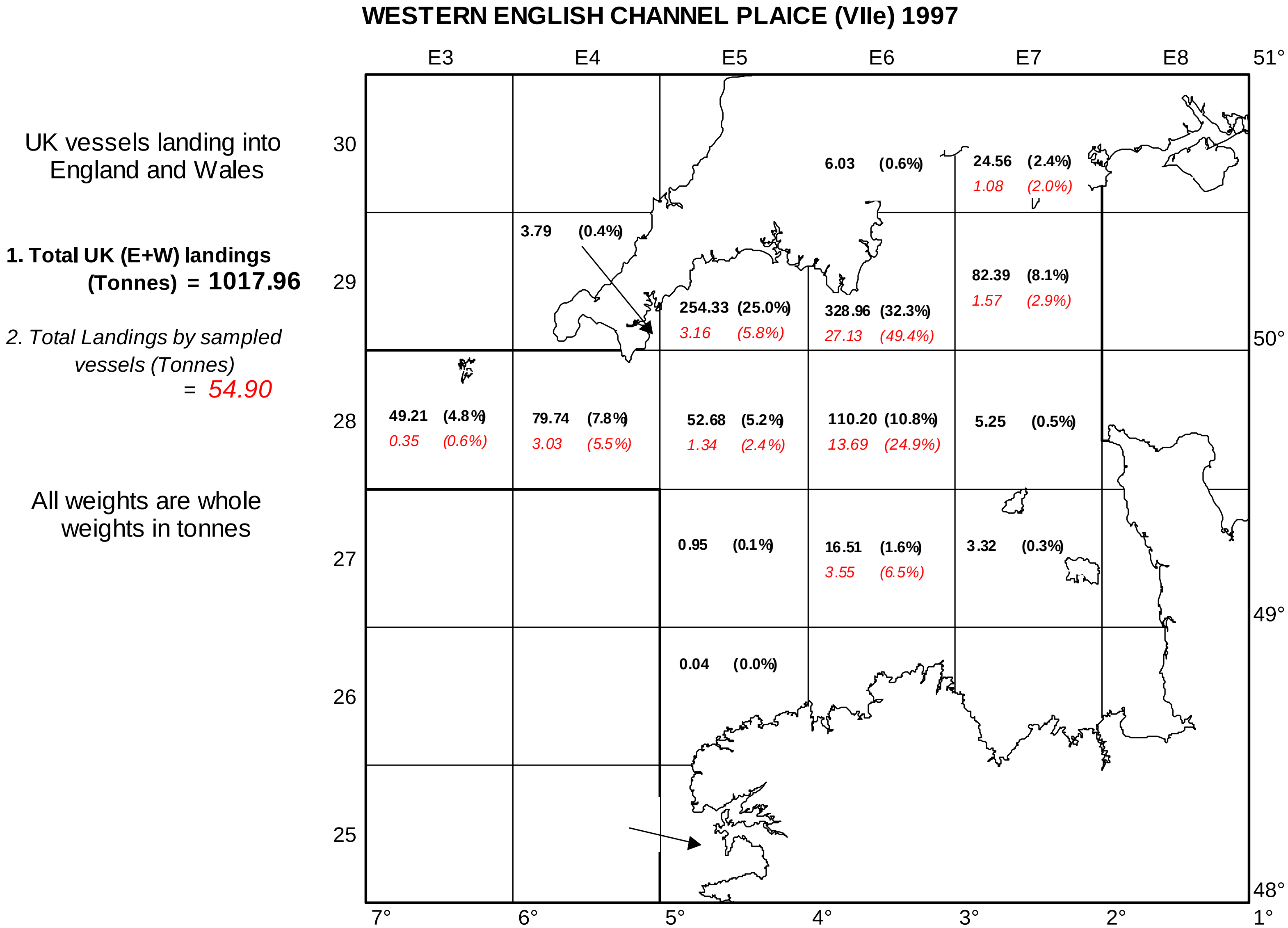
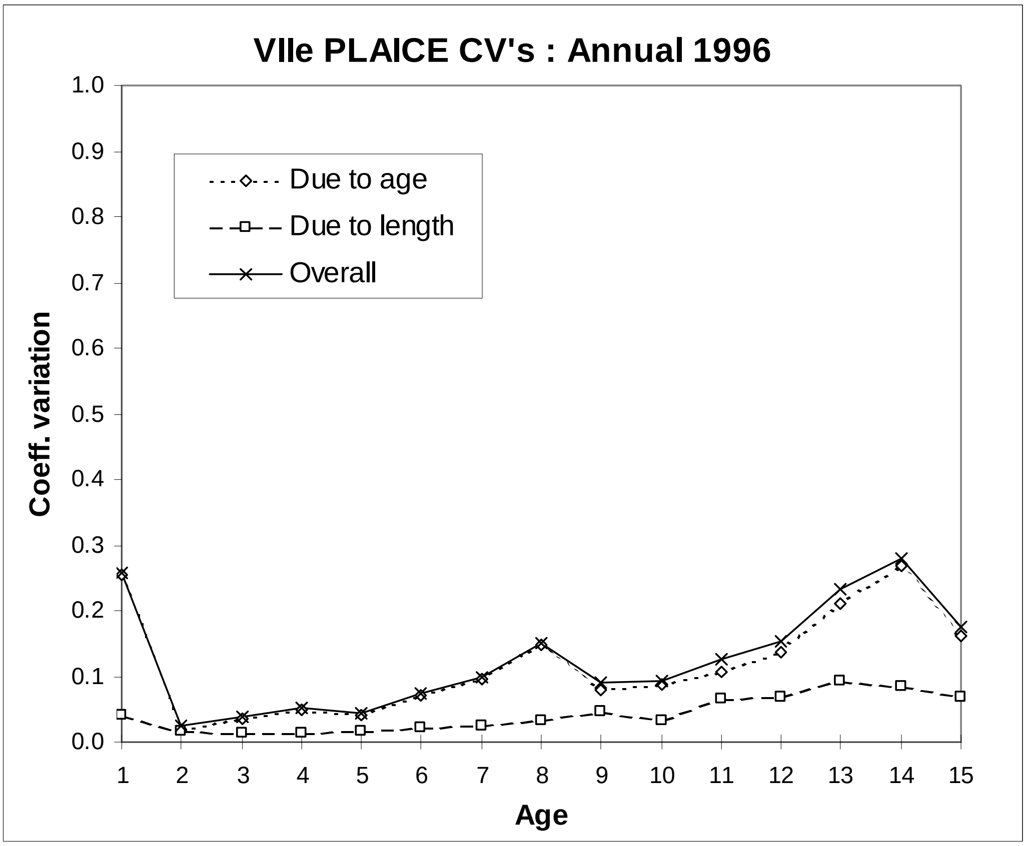


Figure 2.3.2.2. Annual CVs of numbers at age for England and Wales sampling of VIIe plaice for 1996 (top) and 1997 (bottom).



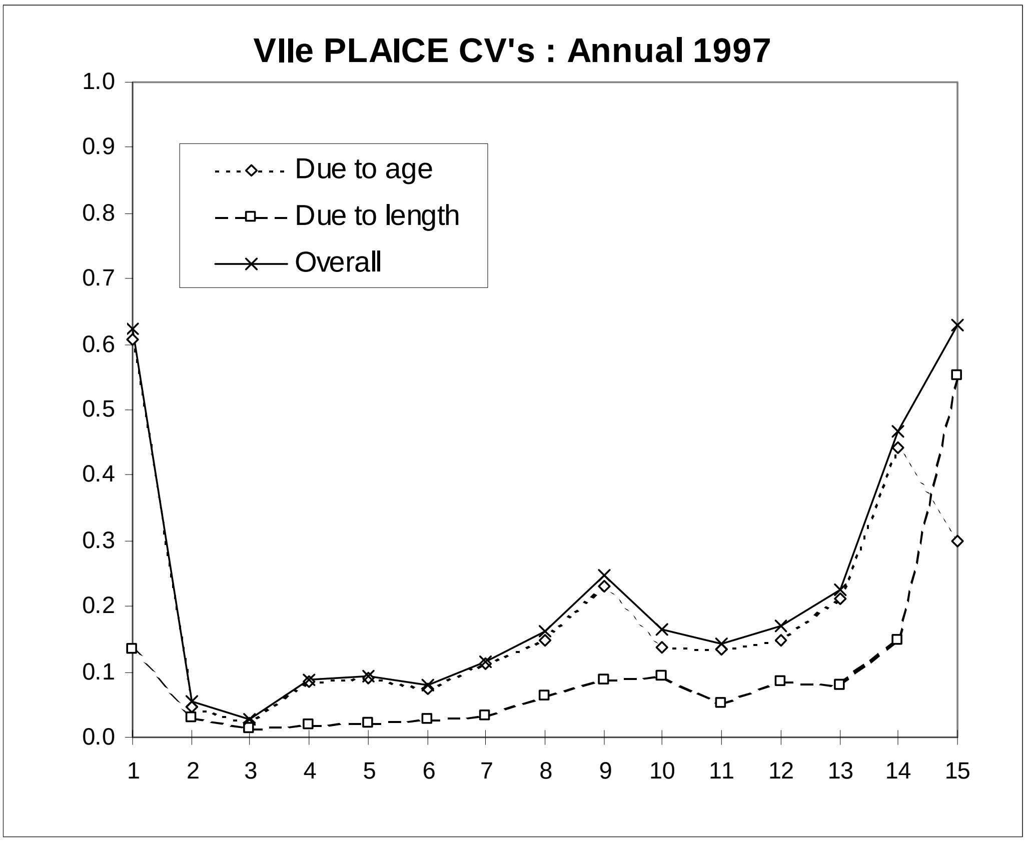


Figure 2.3.2.3. Quarterly CVs of numbers at age for England and Wales sampling of VIIe plaice for 1996.

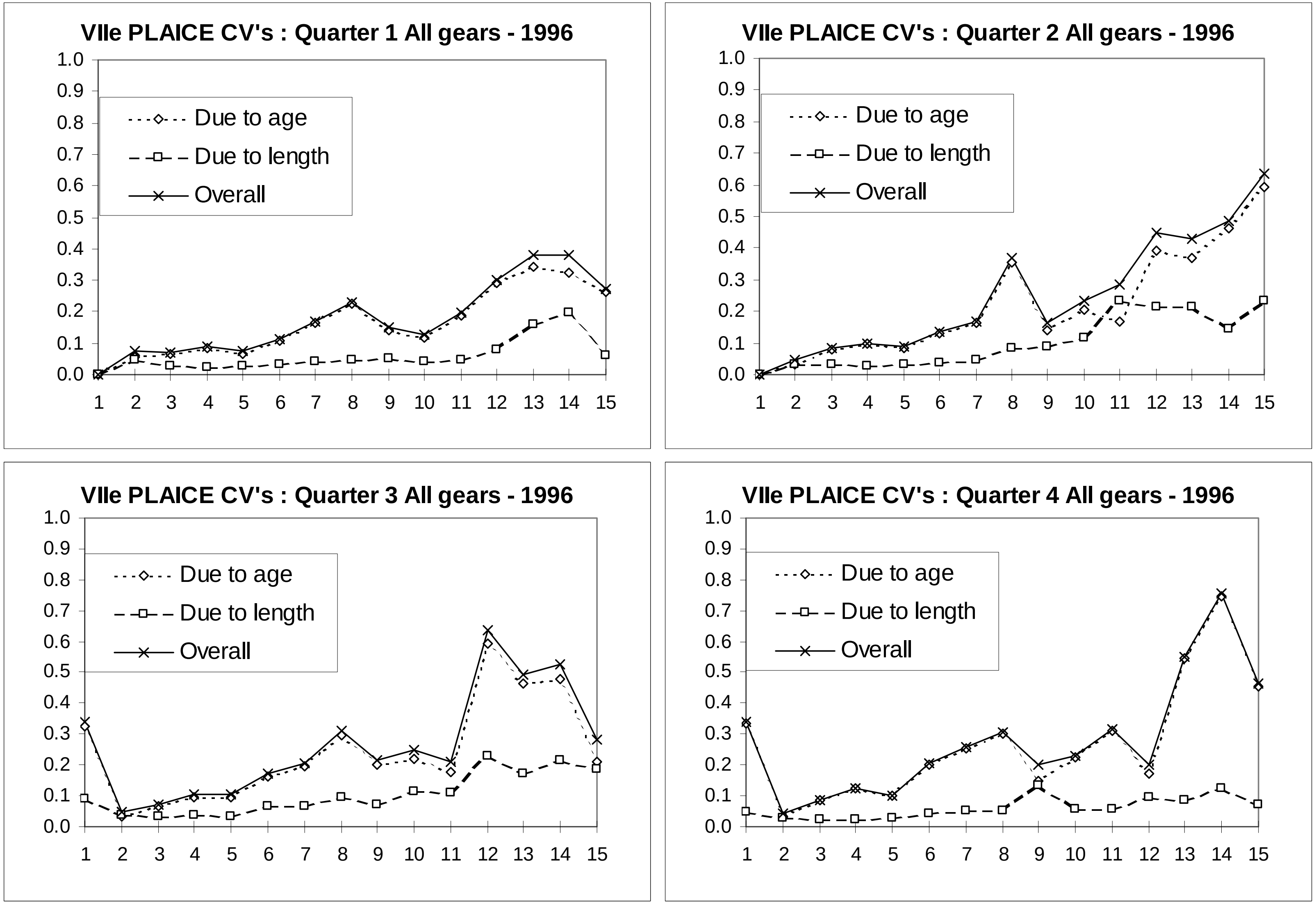
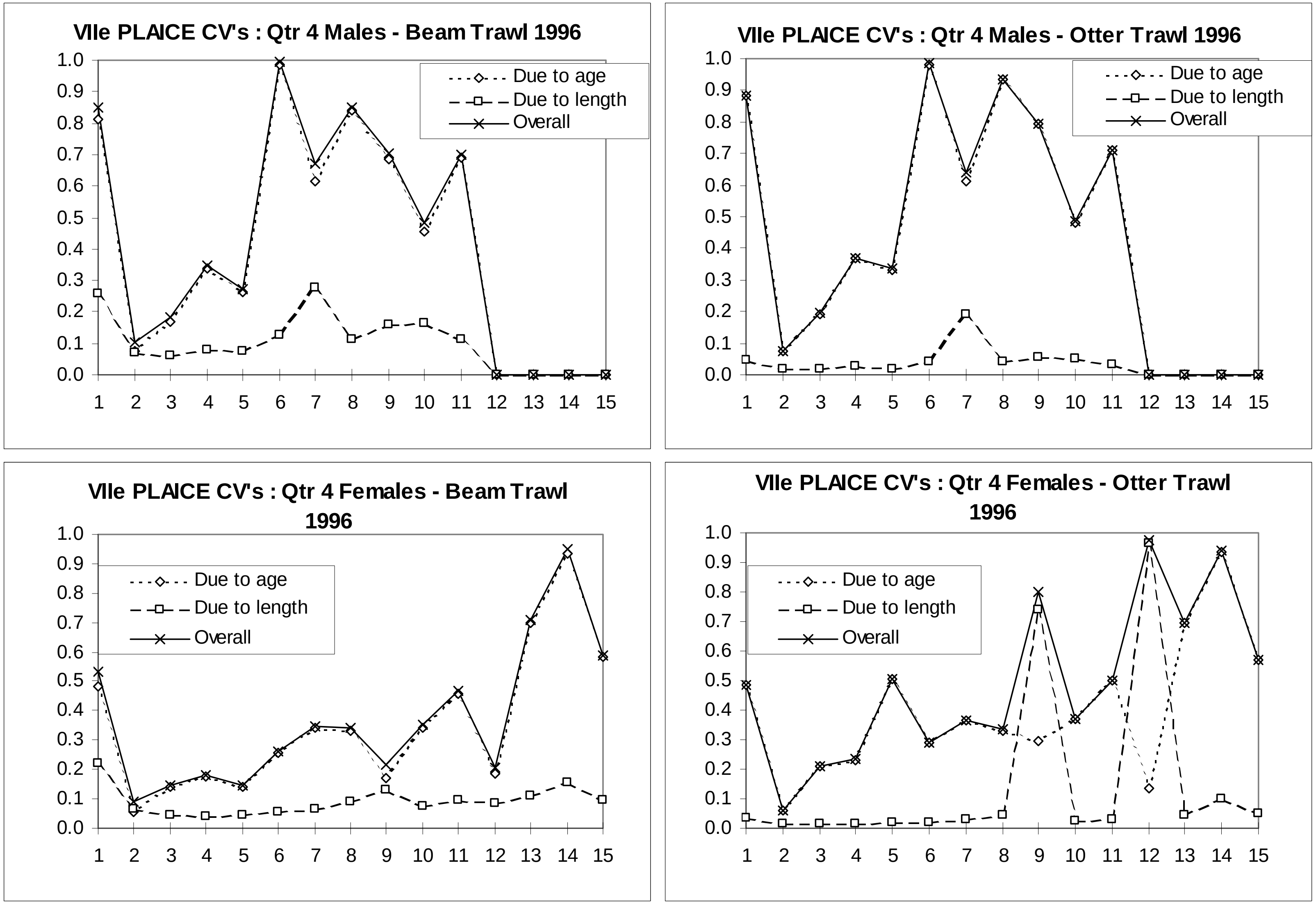


Figure 2.3.2.4. 4th quarter CV's of numbers at age by gear group (left: beam trawl, right: otter trawl) and sex (top: males, bottom: females) for England and Wales sampling of VIIe plaice for 1996.



3 UNCERTAINTY IN ESTIMATES OF AGE COMPOSITIONS AND MEAN WEIGHTS AT AGE

There are no comprehensive studies of the precision of international market sampling programmes and their implications for management available to this Workshop, so in this section we present initial results from studies of market sampling programmes for estimating catch at age of North Sea cod, herring and plaice for the period 1991 to 1998 (EMAS project). Market sample data from the major fishing countries for these species have been collated at minimum level and used to generate 1000 national and then international replicates for use in bootstraps of assessments. Sections 3.1 and 3.2 present the national and international coefficients of variation (CVs) for these species. In addition correlation in estimates of numbers at age and the relationship between mean and variance is documented. Section 3.3 discusses some differences between WG catch at age and the bootstrap estimates. Preliminary results for assessment using these bootstrap data are presented Section 3.4. along with preliminary observations on the their effect on the major management criteria. Some general conclusions are presented in Section 3.5

3.1 National catch at age data

The variance of mean weight and catch at age numbers were available for North Sea cod, plaice and herring from Denmark, England & Wales, Netherlands and Scotland. For all the species, the bootstrapping or jackknife method (Efron & Tibshirani, 1993) was used to estimate the variance. Details on the application of the method are given in ICES CM 2000/D:01, and this section just outlines the method. The basic idea is to resample the market samples; that is, take a simple random sample of the available market samples with replacement, of a size equal to the number of samples within the stratum. This resample of the market samples are then raised to the total catch weight level producing mean weights and catch at age numbers for each stratum. Data for each stratum are aggregated to produce the annual stock assessment data. The whole process is repeated e.g. 1000 times producing 1000 sets of mean weight and catch at age numbers from which the mean and variance can be calculated.

3.1.1 Methods by country

The sampling and raising procedures differ between nations and each country used a specific approach:

<u>Denmark</u>

For cod and plaice the raising procedure is stratified by quarter of the year, landing region and market size class. Approximately 50% of the strata used for cod and plaice have just one sample, which makes bootstrapping of just samples pointless. Therefore, the basic bootstrapping approach was extended by bootstrapping of individual fish within a resampled market sample. The Danish herring catches include landings for human consumption and landings for production of fish oil and meal, and the two categories were treated differently. For human consumption herring the stratification used was quarter and herring catch area (IVaE, IVaW, IVb, IVc and IIIa). Individual fish within a market sample was furthermore resampled, as for plaice and cod. The industrial herring fishery has relatively more samples such that resampling of just samples was possible.

<u>England & Wales</u>

Market data are sampled from individual vessel trips and vessel trip is used as the basic sampling unit in bootstrapping. For plaice, the market samples were stratified by quarter of the year, fleet (beam trawl, otter trawl, seine) and sex. For cod, the market samples were stratified by quarter, fleet and area. To give enough samples for resampling the fleets were beam trawl, gillnet, long lines and ‘bottom trawl’ defined as a combination of seine, otter trawl and pair trawl gears. Two areas were defined: North Sea roundfish areas 1,2,3,7 and North Sea roundfish areas 4,5,6 (see ICES CM 2000/D:01 fig 2.5 for the areas). The English raising procedures for North Sea plaice and North Sea cod given in ICES CM 2000/D:01 fig 2.9 were followed to produce the annual catch at age and weight at age estimates. There are no data on herring.

<u>Netherlands</u>

The bootstrap analysis of the Dutch catch at age data for cod followed the same approach as for England & Wales, however, the resampling was only performed at the year level and not at a quarterly level, because the number of samples was not sufficient to resample by quarter. The resampling for plaice and herring was also performed at the annual level, however, here the samples were only taken from the age-samples since the raising is performed on aged-samples only.

Scotland

Market samples are aggregated to monthly-based region and gear length distributions with age length keys. These data are collected from multiple samples, however as data are combined before entry into the database, it is no longer possible to separate the individual samples. Approximately 560 datacells are used for North Sea stocks. In the resampling algorithm (simple jack-knife, Efron and Tibshirani 1993 and ICES 2000/D:01) these monthly and gear categories were resampled and combined to give a number of samples by region and quarter subsequently used in the raising procedure.

3.1.2 Output of national sampling programs

The CV of the bootstrap replicates of catch at age numbers are presented by species and country in Tables 3.1.1-3.1.3. The same pattern of CV is found for all species with a relatively large CV on the youngest and oldest ages while the CV are smaller on the ages with high catch numbers. CV seem independent of sampling year.

For cod CV (Table 3.1.1) are similar for Denmark, Scotland and England & Wales, while the Dutch CV of catch numbers are slightly higher, probably due the to the lack of temporal stratification in the Dutch sampling.

For the age with high catch numbers of plaice, CV (Table 3.1.2) are similar for all the countries, however, Denmark has a relatively higher CV for the oldest ages.

The CV of herring catches (Table 3.1.3) are given for the ICES area IV and IIIa separately. For area IV the CV of the 0-1 groups are significantly lower for the Danish catches due to the Danish industrial fisheries of 0 and 1-group herring, while Scotland and the Netherlands catch only (older) herrings for human consumption. CV of the older herring are quite similar for the three countries.

3.2 Output of the international combination

The 1000 bootstrap replicates of mean weight and catch at age from each country were combined into 1000 replicates of international catch data. This data set represents just the four countries, however the landings make the majority of the total international landings. The combined data set is used for various analysis presented below.

3.2.1 CV of catch at age and mean weights

The CV of catch numbers at age for the combined data set are presented in Table 3.2.1.1. CV of the international catch numbers follow the same pattern as observed for the national data, with relatively higher CV on the very young and older age groups. As expected, the international CV are lower than the national CV. For both cod and plaice the CV of the most fished age groups are less than 5%, but the increase in CV by age is higher for cod than for plaice.

The CV of the combined mean weight at age (Table 3.2.1.2) are generally less than 5% for most age groups and about 2% for the dominant age groups of cod and plaice. Plaice and cod show relatively lower CV for the most commonly caught age groups, while there is no pattern in the CV over ages for herring.

3.2.2 International bootstrapped catch-at-age analyses – mean, variance and correlation

The relationship between the mean and variance of the numbers-at-age is fundamental to any future statistical modelling of catch numbers-at-age; as is the assumption of independence between numbers-at-age. The underlying relationship between mean-variance of catch numbers-at-age was investigated by considering the mean and variance of the numbers-at-age obtained from the resampling of the market sampling data and compared to the power relationship:

$$\text{variance}\{\text{bootstrapped numbers-at-age}\} = e^{a} \,.\, \text{mean}\{\text{bootstrapped numbers-at-age}\}^{b}$$

The fitted linear regressions to the natural logarithmic transformation of mean and variance of the bootstrapped numbers-at-age were produced by year and by species. Estimated values and asymptotic standard errors of the regression parameters a and b were calculated but the parameters a and b in the linear regression are negatively correlated. The mean Pearson product-moment correlation coefficient between estimates of numbers-at-age were calculated for the bootstrapped years 1991-1998 and tabulated by species.

The pattern of the mean-variance by year is shown in Figures 3.2.2.1-3.2.2.3 for North Sea cod, plaice and herring, respectively. In the case of North Sea cod and plaice, a locally weighted regression smoother (Cleveland and Devlin(1988)) is superimposed on each graph for comparison with the least squares linear regression fit (Figures 3.2.2.1. and 3.2.2.2). The variance-mean relationship appears to be proportional and the parameters are consistent over years within a species for the three North Sea species (cod, plaice and herring) considered (Tables 3.2.2.1-3.2.2.3). The relationship for North Sea plaice may warrant further investigation since each of the years 1991-1997 yields one potentially outlying mean-variance value. This might correspond to an age for which the bootstrapping procedures have induced additional variability in the estimated numbers-at-age.

The underlying correlation of catch numbers-at-age was estimated using the numbers-at-age obtained from the resampling of the market sampling data. The patterns of positive and negative correlation were similar across the years within a species and the mean correlation coefficients between estimates of catch numbers-at-age are given in the Tables 3.2.2.4-3.2.2.6. The correlation between estimates at age is positive for ages 4 to 10 for cod, ages 4 to 14 for plaice and ages 3 to 8 for herring. It appears from this analysis, that the process is dominated by groups of fish at older ages being landed together in groups, so the presence of a group of ages increases or decreases together. It is important that this type of correlation within the estimates of catch are dealt with correctly within the assessment and that the process inducing the correlation structure is understood.

3.3 Comparing bootstrap data with WG assessment data

3.3.1 North Sea cod catch at age combination

Bootstrap realizations of age compositions and weights at age for North Sea cod (including VIId and the Skagerrak) were generated based on the market sampling data from England, Scotland, Denmark and the Netherlands. Comparisons between the bootstrap realizations of these four countries and the estimates by the Working Group on the assessment of demersal stocks in the North Sea and the Skagerrak (WGNSSK) for the years 1991-1998 are shown in Figure 3.3.1 for catch numbers at age and Figure 3.3.2 for weights at age. In all years the WG estimate of catch number at age is on the upper side of the bootstrap distribution, especially for the younger ages. Weights at age estimated from the bootstrap realizations seem to be well in line with the WG estimates. It should be noted that the WG estimates are based on additional age compositions from France, Germany and Belgium, so that the bootstrap realizations miss around 30% of the landings (see Table 3.3.1). In the assessments generated from the bootstrapped data (Section 3.4), the data have been scaled to the total landings by year.

3.3.2 North Sea plaice catch at age combination

Bootstrap realizations of age compositions and weights at age for North Sea plaice were generated based on the market sampling data from England, Denmark and the Netherlands. Comparisons between the bootstrap realizations of these four countries and the estimates by the Working Group on the assessment of demersal stocks in the North Sea and the Skagerrak (WGNSSK) for the years 1991-1998 are shown in Figure 3.3.3 for catch numbers at age and Figure 3.3.4 for weights at age. In all years the WG estimate of catch number at age is on the upper side of the bootstrap distribution, especially for the younger ages. Weights at age estimated from the bootstrap realizations seem to be well in line with the WG estimates. It should be noted that the WG estimates are based on additional age compositions from France and Belgium, so that the bootstrap realizations miss around 25% of the landings (see Table 3.3.2). In the assessments generated from the bootstrapped data (Section 3.4), the data have been scaled to the total landings by year.

3.3.3 North Sea herring catch at age combination

The Workshop had available catch at age in detail for North Sea herring, 1000 replicates were provided for herring catch at age data for the period 1991 to 1998 by Denmark, Netherlands and Scotland. This fully sampled component constitutes on average 66% of the North Sea herring landings over this period. In addition to this fraction of the catch the area misreported data from VIa_{north}, and the English German and French fleets are usually raised by these samples in the Working Group, this increases the proportion of the catch covered by the sampling to 75% of the total. The major missing components are the unallocated landings and Norwegian samples, which were supplied to the Workshop but full bootstrap replicates could not be generated at the meeting,. For North Sea herring the bootstrapped components both underestimate and overestimate numbers at age because landings are both added and subtracted due to area misreporting, discards and catches of Baltic Spring Spawning herring in the North Sea. The bootstrapped catch at age from these samples are shown plotted with WG estimates of catch at age (ICES C.M. 2000 / ACFM: 10) can be seen in Figures 3.3.5a-d. This data was used in a bootstrapped assessment with varying input catch and mean weight at age in catch data. The Working Group mean weights at age in the catch and the bootstrapped estimates are shown in Figures 3.3.6a-d.

To carry out the assessment the catch estimated from the bootstrap replicates had to be scaled to the WG catch. Three methods were used for this:

Scn Scaling to WG numbers at age by year and age dependant multiplicative factors.

Scb Scaled to landings biomass, retaining bootstrap age structure but scaling with year dependant scaling factors.

Miss Difference between WG catch and mean bootstrapped replicated catch (positive or negative as necessary) was estimated. This missing catch at age by year was used to scale a simulated sampling scheme with the same variability as the Danish sampling scheme but with uncorrelated errors in the bootstrapped estimates.

1000 catch at age replicates were generated for 1991 to 1998 and using fixed catch for 1960 to 1990. Similarly 1000 replicates were generated for mean weights at age in the catch from 1991 to 1998 with fixed values for the period 1960 to 1990.

3.4 Stock assessments using bootstrap catch at age data

The results presented here represent preliminary work on the influence of the variability in international market sampling data on assessments. The datasets described above in Section 3.2 and 3.3 have been used as input data for multiple assessments. Two stocks each assessed with a different model are presented, North Sea plaice with XSA and North Sea herring with ICA.

3.4.1 Assessment of North Sea plaice

The Extended Survivors Analysis (XSA - Shepherd 1999, Darby and Flatman 1991) algorithm was modified to enable repeated fits of the model following replacement of the catch-at-age data for a user-specified range of years and ages. The estimates of the interest parameters - recruitment, spawning stock biomass (SSB) and average fishing mortality calculated over a user defined age range were output during each iteration.

The XSA was specified with the catchability models and shrinkage constraints described in the report of the ICES Working Group on the Assessment of Demersal Stocks in the North Sea (ICES 2000/ACFM:7). Catchability was fitted as independent of population abundance for all ages; the catchability at each age greater than 10 was constrained to be equal to that estimated at age 10. The terminal populations were shrunk to the arithmetic mean of the fishing mortality estimated for the penultimate 5 oldest ages and the years 1993 – 1997. The coefficient of variation of the means used in the shrinkage was set at 0.5 and the minimum permitted value for the standard error of log catchability set at 0.3. The assessment was applied to the catch at age data for the years 1957 – 1998 as recorded in the most recent ICES Working group Assessment (ICES 2001/ACFM:7). The catch per unit effort (CPUE) data for the tuning series was also extracted from that source. Two commercial and two surveys CPUE series for the years 1989 – 1998 were used, no time series taper weighting was applied.

The time series of estimates of recruitment, SSB and average fishing mortality for ages 2 – 10 derived from the bootstrapped assessment are presented in Figure 3.4.1. The results are consistent with those of the 1999 Working Group assessment, the Working Group estimates for each parameter lie within the 25 and 75 percentiles of the bootstrap time series. Totally consistent results would not be expected due to minor variations between the Working Group estimates of catch at age and the mean of the bootstrap replicates.

Re-sampling of the catch history for the cohorts present in the years 1991 – 1998 has resulted in only relatively minor variation in the estimated F recruitment and SSB series. The coefficients of variation of fishing mortality are larger than those SSB and recruitment. This would be expected as fishing mortality can be considered to be a function of the ratio of two bootstrap replicates from the cohort, whereas SSB and recruitment are derived from a weighted sum of the transformed replicates.

Assessment models that are based on an underlying population structure reconstructed by virtual population analysis (VPA) make the assumption that the catch at age data are exact or, at least, that effects of measurement errors in the catch at age data can be usually ignored. The low CV values illustrated in Figure 3.4.1 indicate that, for the relatively well-sampled North Sea plaice assessment, this assumption appears to hold.

VPA based assessment models also make the assumption that the dominant portion of the uncertainty in the estimated population abundance and exploitation rate results from the measurement errors associated with the CPUE tuning series. In order to compare the magnitude of the errors in the tuning time series, determined by the variance of log catchability, a second bootstrap of the plaice XSA model was run.

A non-parametric bootstrap of the plaice XSA assessment was carried out using the ICES Working Group catch at age data matrix for the years 1957 - 1998. After fitting of the initial XSA model, catchability residuals calculated for each fleet, at each age, were sampled with replacement and used with the average catchability and the XSA estimates of population abundance, to construct new survey and fleet CPUE series. The non-parametric bootstrap assumes independence of the residuals by series and age and of the two commercial fleets' CPUE data and the catch at age matrix.

The time series of percentiles of parameter values derived from 1000 non-parametric bootstrap assessments are illustrated in Figure 3.4.2. The bootstrap procedure re-constructs the CPUE series used to estimate the terminal populations of the VPA. Therefore, the main region of uncertainty is confined to the most recent years of the time series. Convergence of the VPA, conditional on the constant catch at age matrix, produces the convergence of the percentiles of the historic estimates. The coefficient of variation of the final year F values at age can be contrasted with the values derived by bootstrap the catch at age data in order to compare the components of uncertainty introduced by the CPUE time series and the catch at age data sampling and raising procedure.

For third comparative series the two assessment bootstrap processes described previously were combined. The time available for the study group allowed a run with 100 assessments using re-sampled CPUE series for each of 600 replicate catch data sets. The results are presented in Figure 3.4.3 where it is seen that the two components of uncertainty have been additive. The procedure assumes that there is no correlation in the re-sampling for the commercial fleet CPUE series and the catch at age data. As the fleet catches are a significant proportion of the catch data, this is an area for further exploration that will be evaluated in future work.

3.4.2 Assessment of North Sea Herring

The assessments carried out to study the effects of estimates of landings have been done using models, indices and procedures of the ICES Herring Assessment Working group (ICES C.M. 2000/ACFM:10)

Catch-at-age data

Catch-numbers at age (Section 2.2) were available for the year range 1960 to 1998. These data were revised in 2000 so data used were taken from the 2000 WG. The 1000 replicates are available for 1991 to 1998 for catch in documented above in number and mean weight in the catch, see Section 3.3.3.

Survey indices available

The following survey indices were available:

- MIK 0-wr index. Available and used since 1977 as a recruitment index (ICES ACFM:2000/10 Section 2.3)
- Acoustic 2-9+ wr index. Available since 1989 (ICES ACFM:2000/10 Section 2.4)
- IBTS 1-5+ wr index. Separated into a 1 wr index (used since 1979) and a 2-5+ wr index (used since 1983). (ICES ACFM:2000/10 Sections 2.3 and 2.6.)
- Multiplicative larvae abundance index (MLAI). Available since 1973, used since 1979 as an SSB index (ICES ACFM:2000/10 Section 2.5).

Natural Mortality and Proportion Spawning

Data from 2000 assessment were used for all other input parameters such as natural mortality, spawning proportions and proportion of mortality prior to spawning.

Choice of period of separable constraint

The standard ICA model includes the assumption of the exploitation pattern being constant over recent years. The regulations in 1996 and later years affected the various components of the fishery differently. The TACs for fleets A and C (the human consumption fleet in the North Sea and Division IIIa) were reduced to 50 %. By-catch ceilings for the other fleets (B, D and E) were implemented corresponding to a reduction in fishing mortality of 75 % compared to 1995. These fleets exploit juvenile herring as by-catch. As a result a single separability assumption is likely to be violated for the recent years.

At the 1999 meeting of this WG, the length of the separable period was investigated using an XSA analysis. The conclusion was that an abrupt change of selection pattern between 1995 to 1996 is appropriate, catch at age 1 and 0 wr does not change consistently at this point however, this provides the best compromise the two periods: from 1993 to 1995 and from 1996 to 1998.

Stock assessment model

Assessment of the stock was carried out by fitting the integrated catch-at-age model (ICA) including a separable constraint over a eight-year period as explained above (Patterson and Melvin 1996; Deriso *et al.* 1985; Gudmundsson, 1986). Input parameters and model setup for the ICA assessments are taken from the 1999 assessment WG (ICES, 1999b). The ICA program operates by minimising an objective function which is the sum of the squared differences for the catches (separable model), the indices (catchability model) and the stock-recruitment model.

Weighting

All catch data (within the separable period) where weighted with a weight of one. Each of the separate survey indices where also weighted with a weight of one, because errors were assumed to be correlated by age for both the acoustic survey and the age-disaggregated IBTS (2-5+) index. The stock-recruitment model was weighted by 0.1 as in WG assessment, in order to prevent bias in the assessment due to this model component.

Results

North Sea herring management is based on SSB, F adult and F juvenile, with short term projections dependant on estimates of recruitment. The median and 95% intervals of these four parameters for the last few years of the assessment are shown for all three methods of combining the catch at age data in Figures 3.4.4 and 3.4.5.

CV for fishing mortality is 4 and 8% for adult and juvenile mortality respectively (Figure 3.4.6). The CV on recruitment is 4% and 2% for SSB due to the precision of the catch estimation (Figure 3.4.6). However, it must be remembered that these CVs are conditional on the estimate of total landings.

3.5 Conclusions from detailed studies of cod herring and plaice.

3.5.1 Coefficients of Variation for numbers and weights at age in the catch

The international sampling programmes appear to be delivering estimates of catch at age that are rather precise, with CV's of 2.5% for cod, 3.5% for Plaice and 6% for herring for the best estimated ages rising to about 40% for cod, 15% for plaice and 30% for herring at the older ages. While the precision of the best estimated ages is good, the current scheme is delivering much poorer CVs on older ages. Care must be taken to ensure that the importance of estimating both old and young year classes is fully understood. These three stocks are possibly examples of the best monitored roundfish, flatfish and pelagic fisheries, it is unlikely that there are many fisheries with better sampling performance. Negative correlation is observed between estimation of younger age classes, in contrast positive correlation is found between estimates of older ages for the three species examined, correlations are higher for herring than for cod and place. The positive correlations at older ages are thought to be a property of the population distributions and the fisheries, older fish are caught and sampled in groups. In addition there is negative correlation between estimation of most of the old ages and most of the young ages. It is thought that this results from the above mentioned correlation in the estimates of older ages and the national raising procedures to total national catch. The mechanisms used to raise age structures to total catch result in a pattern of negative correlation between younger ages and all older ages.

3.5.2 Consequences of catch data on the assessments

The results of the analyses performed are also conditional on accurate catch census, and do not yet include bootstrapped CPUE indices from commercial fleets (which are part of the market sampling programmes) which may influence the variability of model output. The initial studies are suggesting that for the data sets examined the current levels of market sampling cause only small amounts of variability in assessment outputs. The studies reported here are incomplete and work is continuing. It is anticipated that more extensive studies will be presented at the ICES Annual Science Conference in 2001, where a theme session will be devoted to the quality and precision of basic data underlying stock assessments.

Relationships between mean and variance are observed for all three species, slopes on the log variance-mean relationships are 1.4 for cod and plaice and 1.7 for herring. Assessment models generally do not take this into account; changes to models or to weighting practices that would include these mean-variance relationships would be helpful.

The apparent proportionality for the variance-mean relationship will facilitate the development of appropriate statistical models of catch-at-age that do not assume a log-normal distribution for catch-at-age. Specifically, a potentially less restrictive approach to the stock assessment of catch-at-age could be to base the modelling process of fisheries data on a broad class of mean-variance relationships, without direct specification of an underlying error distribution. For example, define

$$\{Y_{yfa};\ y = 1991, 1992, ..., 1998;\ f = \text{cod, plaice, herring};\ a = 0, 1, 2, 3, \ldots, a_f+\}$$

to be the set of independent random variables Y_{yfa} which represent the catch of fish in the North Sea for an age-class *a* of a species *f* in a year *y*. The plus-group is denoted by a_f+ for a species f. From the analyses reported at this Workshop, the Y_{yfa} may justifiably be assumed to have the general expectation

$$E(Y_{yfa}) = \mu_{yfa}(\boldsymbol{\beta})$$

and variance

$$\mathrm{var}(Y_{yfa}) = \phi_f V_{yfa}(\mu_{yfa})$$

for the three species considered where $V_{yfa}(\mu_{yfa})$ represents a specified function of $E(Y_{yfa})$ such as the identity or $\{\mu_i(\boldsymbol{\beta})\}^p$, for some power p. Noting that knowledge of the variance function determines, for example, which member of the exponential family is being implicitly assumed, one is led to the idea of assuming only the form of this variance function, rather than the full distributional form, for the analysis of stock assessment data. This statistical technique is known as quasi-likelihood (Wedderburn, 1974) and the use of such modelling assumptions for catch-at-age warrants further investigation but is by no means trivial.

3.5.3 Main Sampling issues.

While the precision of well-sampled fisheries appears to be rather good, no attempt has been made to check whether the sampling is representative. It is particularly important if sampling methods are changed that care is taken to ensure that sampling covers the whole fishery.

Table 3.1.1. CV (%) of estimated catch numbers of **COD** in ICES area IV and IIIa 1991 to 1998, by country

Country=Denmark

	1991	1992	1993	1994	1995	1996	1997	1998	Average
1	7.0	5.8	16.6	8.1	13.9	19.7	20.9	27.2	14.9
2	2.8	2.5	2.6	3.4	2.9	3.1	2.2	4.7	3.0
3	3.0	4.7	5.0	4.1	7.7	3.0	3.3	6.1	4.6
4	6.0	6.4	7.9	8.9	6.5	8.9	5.6	8.6	7.3
5	9.0	9.0	10.7	10.3	11.3	8.3	10.2	10.1	9.9
6	9.8	15.2	18.6	14.0	12.4	12.4	11.4	13.7	13.4
7	17.2	12.7	27.1	28.1	21.9	17.3	19.9	25.1	21.2
8	20.9	33.4	30.3	40.8	38.8	29.4	48.9	42.8	35.7
9	52.7	61.2	57.1	74.1	59.4	36.3	49.9	49.8	55.1
10	43.8	59.8	73.0	54.2	65.3	47.9	50.4	49.0	55.4
11	59.6	48.1	76.4	71.1	46.8	65.4	58.0	51.8	59.6

Country=England & Wales

	1991	1992	1993	1994	1995	1996	1997	1998	Average
1	7.8	17.5	8.5	11.9	9.0	10.3	9.3	17.9	11.5
2	5.8	5.7	4.1	4.8	3.9	4.4	3.6	2.4	4.3
3	4.4	4.5	4.9	4.1	5.3	4.1	4.0	4.5	4.4
4	4.9	3.6	4.3	6.7	5.3	4.8	3.6	4.1	4.6
5	6.0	8.2	6.1	8.7	8.9	7.6	5.5	6.9	7.2
6	6.2	9.7	13.4	12.3	11.5	14.9	9.3	10.9	11.0
7	14.1	11.8	21.8	18.1	14.4	18.2	17.1	15.7	16.4
8	12.9	20.4	24.3	29.3	18.2	22.6	26.4	25.0	22.4
9	29.6	25.6	27.2	45.0	41.1	33.9	38.1	34.3	34.4
10	42.9	42.2	48.2	89.1	30.8	53.5	68.8	51.1	53.3
11	127.0	164.3	206.7	84.2	53.8	116.6	111.1	99.5	120.4

Country=Netherlands

	1991	1992	1993	1994	1995	1996	1997	1998	Average
1	5.2	2.4	12.2	8.5	6.3	12.4	7.7	122.2	22.1
2	5.7	4.4	2.3	14.7	4.1	4.4	8.8	2.5	5.9
3	7.8	8.7	8.2	10.1	18.0	10.1	6.6	16.5	10.7
4	6.3	7.2	10.1	18.7	7.5	17.3	13.5	15.8	12.1
5	8.8	11.3	9.2	17.2	23.2	8.9	20.4	16.1	14.4
6	10.1	12.0	16.3	18.4	23.7	26.6	15.1	41.1	20.4
7	50.3	16.4	28.1	29.6	24.0	30.9	32.5	20.0	29.0
8	70.8		21.9	34.5	48.2	39.5	32.0	49.7	42.4
9		58.6	52.7	67.3	51.1	72.3	58.3	55.5	59.4
10		48.9	48.6	110.7	65.7	58.9	52.0	59.8	63.5

Country=Scotland

	1991	1992	1993	1994	1995	1996	1997	1998	Average
1	14.4	13.6	18.4	15.9	17.0	22.4	12.9	19.6	16.8
2	5.5	4.4	3.5	6.8	4.0	6.2	6.0	3.9	5.0
3	5.1	5.6	7.4	4.3	5.9	4.5	4.2	5.8	5.3
4	11.2	6.4	8.9	5.5	7.1	6.2	5.2	6.6	7.1
5	9.6	10.7	10.3	8.5	8.9	9.0	8.1	9.5	9.3
6	9.1	10.7	15.5	9.8	12.6	12.9	8.5	9.1	11.0
7	13.6	12.8	22.2	17.0	20.6	22.8	13.4	11.8	16.8
8	14.9	17.5	16.6	21.5	24.6	27.3	23.7	23.0	21.2
9	23.9	17.5	24.5	17.6	25.2	18.4	22.8	21.7	21.4
10	22.1	18.7	28.0	26.6	27.3	28.9	16.7	26.2	24.3
11	57.6	57.4	129.5	81.8	95.5	53.1	95.2	159.8	91.2

Table 3.1.2 CV(%) of estimated catch at age numbers of North Sea **PLAICE** 1991-1998, by country

Country=Denmark

	1991	1992	1993	1994	1995	1996	1997	1998	Average
1					56.9				56.9
2	6.9	6.2	9.5	16.3	9.0	5.9	6.7	3.3	8.0
3	7.6	4.8	3.2	3.3	3.3	2.6	2.6	3.1	3.8
4	4.1	4.8	3.8	4.0	3.6	4.5	3.9	3.7	4.0
5	5.1	3.5	3.3	6.1	5.5	4.5	6.8	5.4	5.0
6	5.1	6.0	4.2	6.2	8.6	5.8	6.6	9.5	6.5
7	7.4	5.5	7.5	7.5	11.0	6.0	8.3	8.7	7.7
8	11.5	10.6	6.9	13.1	16.3	10.0	10.1	12.8	11.4
9	11.3	12.6	10.4	12.3	19.3	13.8	19.6	16.3	14.5
10	14.3	13.4	16.5	18.1	19.1	17.8	27.2	29.6	19.5
11	25.5	20.0	20.8	25.5	25.2	24.9	55.2	47.6	30.6
12	32.3	25.0	27.3	45.5	48.6	28.5	66.2	56.6	41.3
13	43.0	38.6	44.9	35.9	41.2	53.6	68.0	52.2	47.2
14	59.1	53.5	66.8	46.1	.	60.2	48.8	49.7	54.9
15	41.8	53.4	47.9	51.7	50.3	59.5	61.4	51.1	52.1

Country=England & Wales

	1991	1992	1993	1994	1995	1996	1997	1998	Average
1		80.4		90.3					85.3
2	17.0	15.7	18.8	17.0	16.6	18.4	21.7	13.6	17.4
3	9.5	7.3	7.3	6.9	8.8	9.9	7.7	6.2	7.9
4	4.9	5.8	4.4	5.4	4.9	6.7	5.1	4.4	5.2
5	4.6	5.4	5.2	5.9	7.1	4.9	6.6	5.9	5.7
6	3.2	6.2	5.5	6.9	6.6	6.3	5.5	7.4	5.9
7	7.3	5.2	7.5	7.9	8.9	7.2	6.9	7.2	7.2
8	10.2	11.1	5.8	11.0	10.1	9.5	8.0	8.6	9.3
9	11.5	12.4	9.4	8.6	11.2	9.0	8.9	9.5	10.1
10	10.0	16.2	12.4	11.7	10.8	11.0	13.6	9.6	11.9
11	16.4	13.2	12.4	13.7	15.7	9.8	16.2	12.4	13.7
12	14.9	19.6	11.9	14.1	17.1	12.7	13.1	13.4	14.6
13	18.2	17.0	18.7	14.6	15.4	16.7	14.4	11.0	15.7
14	27.5	20.0	19.2	17.0	15.8	17.8	17.0	16.1	18.8
15	9.1	11.3	8.2	10.1	10.9	9.9	9.5	9.4	9.8

Country=The Netherlands

	1991	1992	1993	1994	1995	1996	1997	1998	Average
1	42.3	72.1	40.2	43.5	34.8	43.0	53.3		47.0
2	13.3	12.6	11.6	8.0	9.1	6.7	7.7	8.2	9.6
3	6.1	5.5	6.7	4.9	5.0	4.4	3.7	4.0	5.0
4	5.9	5.8	5.1	5.5	5.0	5.0	5.4	3.9	5.2
5	5.7	6.7	7.2	6.6	6.3	6.8	7.8	6.1	6.6
6	5.4	7.4	8.1	8.1	10.2	8.4	6.7	10.3	8.1
7	10.6	8.6	8.7	9.8	10.6	9.7	10.1	15.7	10.5
8	13.1	13.4	9.1	10.0	10.4	11.9	13.2	13.0	11.8
9	13.7	12.8	12.1	10.6	13.0	10.9	14.8	16.3	13.0
10	13.2	15.2	15.8	14.2	9.6	17.9	15.8	16.0	14.7
11	15.3	15.0	13.2	16.1	18.9	11.8	18.6	16.9	15.7
12	23.3	21.9	23.5	20.7	21.7	20.8	18.3	18.3	21.1
13	28.5	29.7	27.9	21.2	38.3	26.0	27.3	24.4	27.9
14	27.8	27.3	30.3	55.9	32.8	41.0	32.3	29.7	34.6
15	20.7	19.2	33.1	28.4	31.3	33.4	25.5	40.1	29.0

Table 3.1.3 CV (%) of estimated catch numbers of North Sea herring 1991-1998 by country.

Country=Scotland

	1991	1992	1993	1994	1995	1996	1997	1998	Average
0									
1	25.2	323.7	47.9	31.2	48.9	46.9	174.2	49.9	93.5
2	30.9	76.2	27.8	12.1	10.5	19.6	139.3	11.9	41.0
3	25.0	31.3	14.1	19.1	10.5	6.2	19.3	13.7	17.4
4	7.5	17.1	12.3	18.4	31.0	13.3	6.2	16.1	15.2
5	7.7	10.1	17.8	21.4	30.9	17.8	5.8	28.7	17.5
6	11.6	7.6	16.7	16.8	42.5	32.3	19.6	37.6	23.1
7	23.6	7.0	21.1	23.2	43.8	25.9	22.6	41.3	26.1
8	72.1	13.8	24.0	24.7	31.4	32.8	23.5	38.2	32.6
9+	37.4	24.0	36.1	53.1	45.8	36.0	17.8	43.2	36.7

Country=The Netherlands

	1991	1992	1993	1994	1995	1996	1997	1998	Average
0									
1	38.4	22.7	54.2	48.5	29.0		58.3	56.5	43.9
2	9.0	11.0	11.4	10.6	8.0	14.0	12.5	8.5	10.6
3	6.8	10.2	5.5	6.4	7.5	6.8	7.5	8.0	7.3
4	6.1	14.6	12.3	6.6	9.3	13.6	8.4	12.0	10.4
5	5.9	11.1	15.1	13.5	12.7	17.4	18.4	13.7	13.5
6	8.6	11.6	13.0	14.9	16.2	19.9	26.9	19.4	16.3
7	20.8	12.8	13.7	17.0	26.7	36.6	34.2	38.6	25.1
8	31.4	31.3	16.9	19.6	25.5	73.5	58.7	46.3	37.9
9+	20.7	30.2	30.8	22.8	29.3	42.3	28.4	28.4	29.1

Country=Denmark and area=IV

	1991	1992	1993	1994	1995	1996	1997	1998	Average
0	14.3	15.5	7.9	14.6	11.6	11.7	12.2	14.9	12.8
1	23.7	14.1	10.7	13.5	12.6	20.6	9.0	37.4	17.7
2	21.7	7.2	15.8	4.3	14.5	14.2	7.0	19.6	13.0
3	10.4	21.6	9.4	8.4	15.5	5.2	11.9	9.0	11.4
4	9.4	13.7	9.9	12.0	14.6	12.3	5.2	11.9	11.1
5	10.0	11.2	10.8	13.2	20.5	29.0	14.6	14.6	15.5
6	16.4	10.8	14.1	12.3	36.9	54.4	19.3	14.6	22.4
7	27.7	22.7	16.8	13.6	34.7	36.4	47.1	16.5	26.9
8	34.5	44.5	21.0	24.4	39.0	45.7	66.8	20.7	37.1
9+	44.9	35.6	28.6	19.7	58.2	37.3	36.0	27.1	35.9

Country=Denmark and area=IIIa

	1991	1992	1993	1994	1995	1996	1997	1998	Average
0	25.6	10.5	12.4	16.5	11.3	10.9	15.8	11.1	14.3
1	9.0	15.3	13.7	10.0	13.5	6.6	37.8	7.2	14.1
2	20.9	20.0	13.1	4.6	11.7	8.0	19.4	23.4	15.1
3	19.0	11.4	26.2	10.4	15.2	13.0	5.2	17.8	14.8
4	26.4	15.5	18.0	14.8	21.6	12.7	11.6	5.4	15.8
5	18.2	19.1	31.2	26.8	35.5	27.2	36.4	5.2	25.0
6	22.6	17.3	39.5	30.8	50.1	36.7	55.1	19.3	33.9
7	40.1	17.5	39.8	57.6	41.9	36.6	67.1	32.3	41.6
8	62.7	39.1	56.2	94.4	36.2	62.6	40.8	33.7	53.2
9+	61.4	47.9	70.3		45.2	65.8	67.0	37.5	56.4

Table 3.2.1.1. CV (%) of estimated catch at age numbers, Combined data

Species= Cod

	1991	1992	1993	1994	1995	1996	1997	1998	Average
1	7.7	4.9	7.0	6.3	5.7	8.7	5.7	13.8	7.5
2	3.0	2.3	1.8	3.1	2.1	3.0	2.8	2.0	2.5
3	2.8	3.0	3.5	2.5	4.2	2.4	2.3	3.7	3.1
4	4.3	3.5	4.8	4.5	4.0	4.7	3.2	4.9	4.2
5	5.3	5.8	5.7	6.2	6.7	5.1	5.2	5.9	5.7
6	5.3	7.2	11.7	7.8	8.9	8.5	5.6	8.8	8.0
7	10.9	7.0	15.2	15.1	12.5	12.5	11.0	10.6	11.9
8	9.2	16.7	14.1	22.0	27.8	19.3	20.6	22.8	19.1
9	21.7	17.7	32.3	33.3	40.2	26.8	22.0	36.9	28.9
10	28.0	32.8	36.6	54.5	30.8	28.6	27.4	28.8	33.4
11+	37.5	33.5	58.2	56.8	22.1	43.0	53.5	62.5	45.9

Species=Plaice

	1991	1992	1993	1994	1995	1996	1997	1998	Average
1	42.3	76.2	40.2	44.9	34.6	43.0	53.3		47.8
2	11.9	10.7	10.8	7.5	8.2	5.9	6.5	5.4	8.4
3	5.0	4.2	4.7	3.4	3.9	3.1	2.7	3.0	3.8
4	3.8	3.9	3.2	3.6	3.1	3.7	3.3	2.8	3.4
5	3.5	3.6	3.8	3.9	3.8	4.1	4.7	3.7	3.9
6	3.3	4.3	4.1	4.4	5.3	4.5	3.7	5.8	4.4
7	6.5	4.1	5.4	5.5	6.1	4.8	4.8	6.3	5.4
8	7.5	7.1	4.5	6.8	6.8	6.1	5.6	6.6	6.4
9	7.7	7.5	6.3	6.0	7.8	6.0	7.0	7.4	7.0
10	7.1	9.8	8.8	8.1	7.4	9.0	9.8	8.3	8.5
11	10.4	9.7	9.3	9.7	12.7	7.9	12.6	10.0	10.3
12	12.0	12.5	10.0	12.3	14.4	10.3	11.1	11.0	11.7
13	14.5	13.9	14.8	12.2	13.8	15.0	13.4	10.3	13.5
14	21.0	16.3	16.9	16.3	14.7	16.1	15.5	14.8	16.5
15+	8.4	10.1	8.0	9.5	10.5	9.7	9.0	9.2	9.3

Species=Herring

	1991	1992	1993	1994	1995	1996	1997	1998	Average
0	12.6	9.4	6.7	12.6	9.4	9.7	10.2	11.6	10.3
1	16.2	10.1	9.0	8.1	9.8	11.7	20.7	14.6	12.5
2	10.4	6.2	8.7	4.2	5.6	7.9	9.0	7.0	7.4
3	6.6	8.4	7.0	5.4	6.3	3.7	5.4	5.7	6.1
4	5.2	7.6	6.6	5.3	7.7	7.4	3.7	7.9	6.4
5	4.3	6.4	9.2	8.5	10.4	11.3	7.3	10.6	8.5
6	6.4	5.8	9.0	8.1	13.5	15.3	14.2	11.3	10.5
7	12.8	6.4	9.6	10.4	17.8	16.8	16.7	16.8	13.4
8	31.4	12.6	13.1	13.3	18.3	24.6	23.6	21.8	19.8
9+	16.5	16.2	20.2	17.2	23.8	23.8	13.7	17.5	18.6

Table 3.2.1.2. CV (%) of estimated mean weight at age, Combined data

Species=Cod

	1991	1992	1993	1994	1995	1996	1997	1998	Average
1	1.1	1.9	2.5	3.0	2.1	2.4	2.4	2.5	2.2
2	1.6	1.6	1.3	1.6	1.1	1.3	1.2	1.2	1.4
3	1.5	1.5	1.6	1.6	2.3	1.5	1.6	2.1	1.7
4	1.6	1.5	2.0	1.7	1.3	1.6	1.3	1.9	1.6
5	1.9	2.1	1.6	2.2	2.0	1.3	1.6	2.0	1.8
6	1.9	2.7	2.4	2.4	2.6	2.1	1.2	1.9	2.2
7	1.9	2.2	2.4	3.2	3.8	2.2	2.1	2.4	2.5
8	1.5	4.6	2.8	6.2	5.5	5.0	3.8	5.8	4.4
9	5.2	3.8	5.4	4.4	6.3	4.7	3.6	11.2	5.6
10	8.8	4.6	18.0	10.1	7.1	12.2	8.2	7.8	9.6
11+	23.5	3.8	60.7	36.9	4.1	5.6	8.2	4.9	18.5

Species=Plaice

	1991	1992	1993	1994	1995	1996	1997	1998	Average
1	11.8	4.5	4.2	12.9	4.8	13.3	0.0		7.4
2	2.4	1.6	2.4	1.9	2.3	1.3	1.2	1.0	1.8
3	1.7	1.4	1.1	0.8	1.0	1.1	0.9	0.8	1.1
4	1.1	1.3	0.9	1.1	1.0	1.2	1.2	1.0	1.1
5	1.3	1.0	1.0	1.4	1.3	1.2	1.9	1.8	1.4
6	1.0	1.5	1.3	1.5	1.7	1.5	1.4	2.1	1.5
7	2.0	1.4	2.5	2.2	2.2	2.0	1.9	2.1	2.0
8	2.5	2.3	1.6	2.6	2.9	1.9	2.2	2.6	2.3
9	2.9	2.6	5.5	2.2	3.3	2.2	2.3	2.6	3.0
10	3.3	3.1	3.4	2.7	2.7	3.9	4.1	2.9	3.3
11	4.0	4.0	3.1	3.9	6.1	3.2	5.0	3.7	4.1
12	4.3	5.5	3.1	4.7	6.3	4.3	4.6	4.5	4.7
13	4.6	4.3	5.2	6.1	5.2	6.5	5.2	4.3	5.2
14	9.0	7.8	7.0	7.3	5.5	6.2	6.8	5.0	6.8
15+	3.5	4.7	2.9	4.3	3.8	3.3	3.6	4.3	3.8

Species=Herring

	1991	1992	1993	1994	1995	1996	1997	1998	Average
0	5.4	3.7	5.3	1.7	2.0	1.7	1.6	3.3	3.1
1	4.2	2.5	5.1	5.5	2.0	2.0	1.5	1.2	3.0
2	1.5	1.9	2.7	2.3	5.8	9.0	2.7	1.4	3.4
3	1.6	1.9	1.8	2.2	3.2	4.2	13.1	8.4	4.6
4	0.9	1.2	1.5	2.2	1.9	2.4	2.6	3.6	2.0
5	8.5	5.9	1.1	1.5	2.0	2.7	3.6	4.4	3.7
6	5.2	3.9	6.7	11.0	1.5	1.7	2.0	2.5	4.3
7	3.1	3.4	3.4	3.3	6.0	11.9	2.0	1.1	4.3
8	1.4	1.6	3.6	3.8	4.8	3.1	2.5	14.0	4.4
9+	2.6	1.9	1.9	2.2	2.0	2.0	2.8	2.2	2.2

Table 3.2.2.1 Intercept (a) and slope (b) estimates from a linear regression of log(Variance) on log(Mean) for combined Danish, E&W, Dutch and Scottish bootstrapped estimates. **COD**, ages 1-10.

Year	a	b	st error a	st error b
1991	-1.70	1.46	0.57	0.08
1992	-1.33	1.39	0.50	0.07
1993	-0.28	1.28	0.36	0.05
1994	-0.68	1.34	0.44	0.07
1995	-0.76	1.36	0.40	0.06
1996	-1.17	1.41	0.45	0.07
1997	-1.40	1.40	0.42	0.06
1998	-0.88	1.39	0.40	0.06
All years	-1.00	1.37	0.15	0.02

Table 3.2.2.2 Intercept (a) and slope (b) estimates from a linear regression of log(Variance) on log(Mean) for combined Danish, E&W and Dutch bootstrapped estimates. **PLAICE**, ages 1-14.

Year	a	b	st error a	st error b
1991	-0.48	1.47	0.94	0.11
1992	0.23	1.40	1.61	0.18
1993	-0.59	1.48	1.38	0.16
1994	0.26	1.37	1.04	0.12
1995	-0.67	1.48	1.26	0.15
1996	0.71	1.29	1.04	0.12
1997	1.00	1.25	1.00	0.12
1998	-0.97	1.44	0.39	0.05
All years	-0.22	1.42	0.40	0.05

Table 3.2.2.3. Slope and intercept for log variance / log number relationships by year for North Sea Herring 1991 to 1998

Year	Slope	Intercept
1991	1.8	-1.8
1992	1.9	-3.4
1993	1.8	-1.9
1994	1.8	-2.5
1995	1.7	-0.8
1996	1.6	0.4
1997	1.5	1.5
1998	1.7	-1.0
All years	1.7	-1.0

Table 3.2.2.4 Mean correlation coefficient for catch at age from 1991-1998.
for combined Danish, E&W, Dutch and Scottish bootstrapped estimates. COD.

	1	2	3	4	5	6	7	8	9	10	11+
1	1.00	-0.02	-0.23	-0.17	-0.10	-0.06	-0.04	-0.03	-0.03	-0.01	0.00
2		1.00	-0.22	-0.27	-0.19	-0.09	-0.11	-0.06	0.00	-0.02	-0.01
3			1.00	-0.09	-0.11	-0.06	-0.01	-0.02	-0.02	0.00	0.01
4				1.00	0.03	-0.05	0.01	0.02	-0.01	-0.02	0.00
5					1.00	-0.01	0.00	-0.01	-0.01	0.01	-0.01
6						1.00	-0.06	-0.05	-0.03	0.02	-0.01
7							1.00	0.01	0.02	0.00	-0.04
8								1.00	0.02	0.06	-0.02
9									1.00	0.02	0.02
10										1.00	0.01
11+											1.00

Table 3.2.2.5 Mean correlation coefficient for catch at age from 1991-1998.
for combined Danish, E&W and Dutch bootstrapped estimates. PLAICE.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1	1.00	0.23	-0.28	-0.19	-0.13	-0.11	-0.03	0.00	-0.01	-0.05	-0.03	0.01	-0.01	-0.01	-0.02
2		1.00	-0.30	-0.48	-0.39	-0.23	-0.15	-0.07	-0.07	-0.07	-0.07	-0.05	-0.03	-0.04	-0.02
3			1.00	-0.16	-0.26	-0.22	-0.23	-0.16	-0.12	-0.10	-0.06	-0.08	-0.05	-0.05	-0.06
4				1.00	0.11	0.01	-0.04	-0.08	-0.02	-0.01	-0.01	0.02	0.00	0.02	-0.04
5					1.00	0.24	0.18	0.06	0.05	0.03	0.04	0.00	0.00	0.00	-0.05
6						1.00	0.12	0.14	0.01	0.04	0.01	0.02	0.00	0.02	-0.02
7							1.00	0.17	0.14	0.05	0.02	0.03	0.05	0.03	0.03
8								1.00	0.13	0.05	0.05	0.09	0.02	0.07	0.07
9									1.00	0.10	0.04	0.09	0.05	0.10	0.05
10										1.00	0.09	0.05	0.06	0.08	0.08
11											1.00	0.09	0.03	0.04	0.10
12												1.00	0.04	0.08	0.14
13													1.00	0.10	0.16
14														1.00	0.19
15+															1.00

Table 3.2.2.6 Mean correlation coefficient for catch at age from 1991-1998.
for combined Danish, Dutch and Scottish bootstrapped estimates. North Sea Herring.

	0	1	2	3	4	5	6	7	8	9+
0	1.00	-0.29	-0.07	-0.06	-0.05	-0.02	0.01	-0.01	0.00	0.00
1		1.00	-0.22	-0.10	-0.07	-0.05	-0.03	-0.04	0.00	0.00
2			1.00	0.02	-0.37	-0.34	-0.30	-0.29	-0.26	-0.31
3				1.00	-0.02	-0.24	-0.31	-0.21	-0.17	-0.23
4					1.00	0.19	0.06	0.02	0.00	-0.04
5						1.00	0.29	0.20	0.08	0.06
6							1.00	0.22	0.15	0.31
7								1.00	0.18	0.37
8									1.00	0.22
9+										1.00

Table 3.3.1 Cod comparison between mean bootstrap SoP and Total landings estimated by the WGNSSK (ICES 2001).

Year	SOP bootstrapped countries	WG landings	%bootstrapped
1991	78879	102478	77%
1992	80334	114020	70%
1993	83670	121749	69%
1994	78932	110634	71%
1995	100500	136096	74%
1996	98064	126320	78%
1997	89736	124158	72%
1998	102282	146014	70%

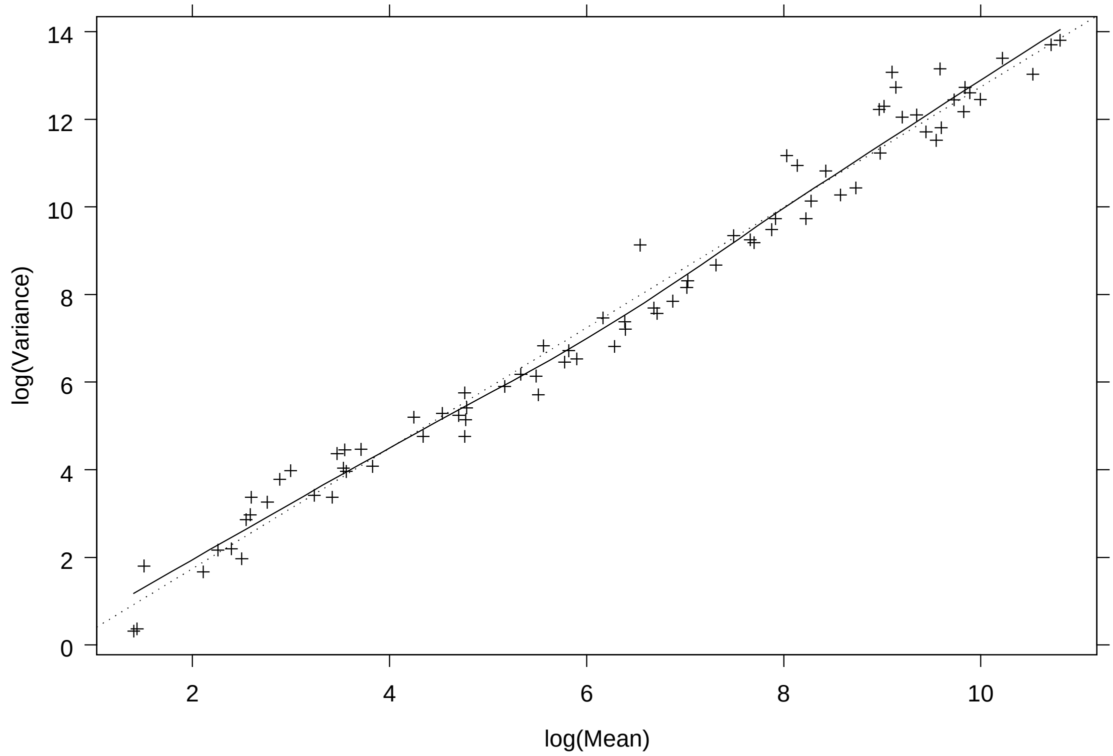
Table 3.3.2 Plaice comparison between mean bootstrap SoP and Total landings estimated by the WGNSSK (ICES 2001).

Year	SOP bootstrapped countries	WG landings	%bootstrapped
1991	113048	148003	76%
1992	94383	125190	75%
1993	87612	117113	75%
1994	86098	110392	78%
1995	73789	98356	75%
1996	62292	81673	76%
1997	63425	83048	76%
1998	52949	71534	74%

Table 4.2.1 Results from the 1999 raising of the North Sea autumn spawning herring either by the procedure followed by the herring WG or by simply raising the unsampled landings to the total age-composition.

HAWG2000	Simple raising	%difference
1923644	2547153	32%
324133	420525	30%
650494	664155	2%
1086225	1023579	-6%
302370	298260	-1%
141139	144252	2%
69799	72777	4%
27724	29852	8%
9426	9344	-1%
3410	3636	7%

Figure 3.2.2.1 log(Mean)-log(Variance) plots of combined Danish, E&W, Dutch and Scottish bootstrapped estimates. COD, ages 1-10. Top: all years, 1991 to 1998. Bottom: by year.



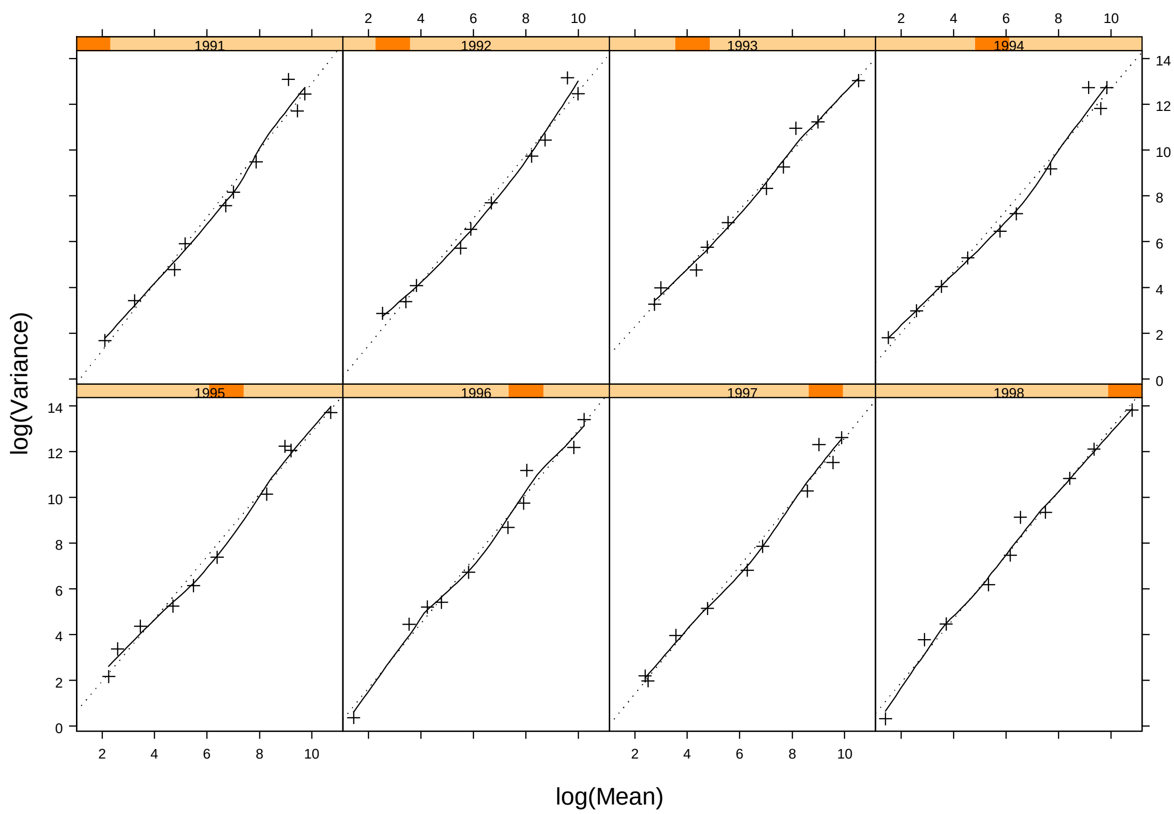


Figure 3.2.2.2 log(Mean)-log(Variance) plots of combined Danish, E&W and Dutch bootstrapped estimates. PLAICE, ages 1-14. Top: all years, 1991 to 1998. Bottom: by year.

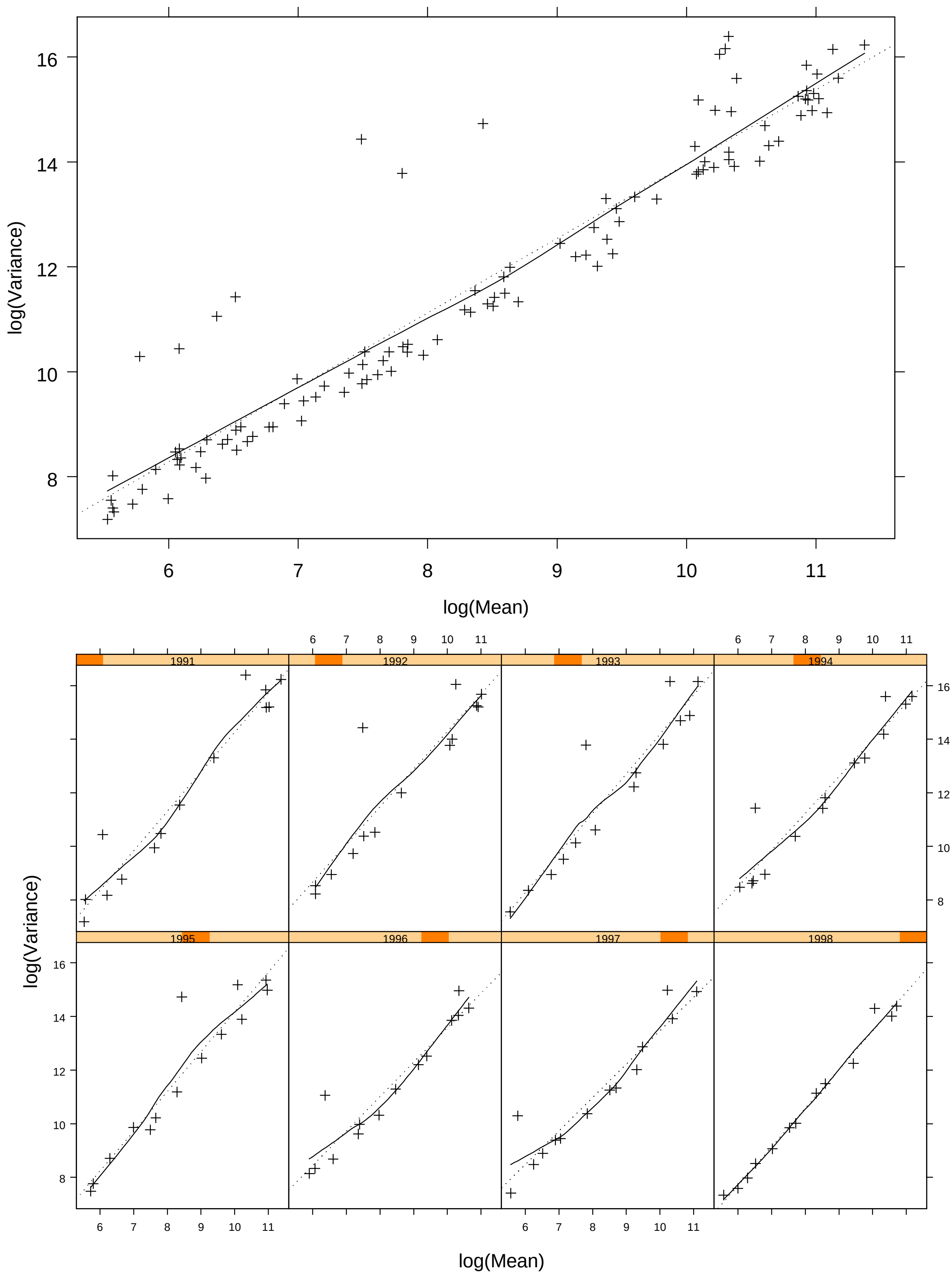


Figure 3.2.2.3a. Log variance plotted against log numbers by age class for the years 1991 to 1998 combined for North Sea Herring: <u>all years</u>

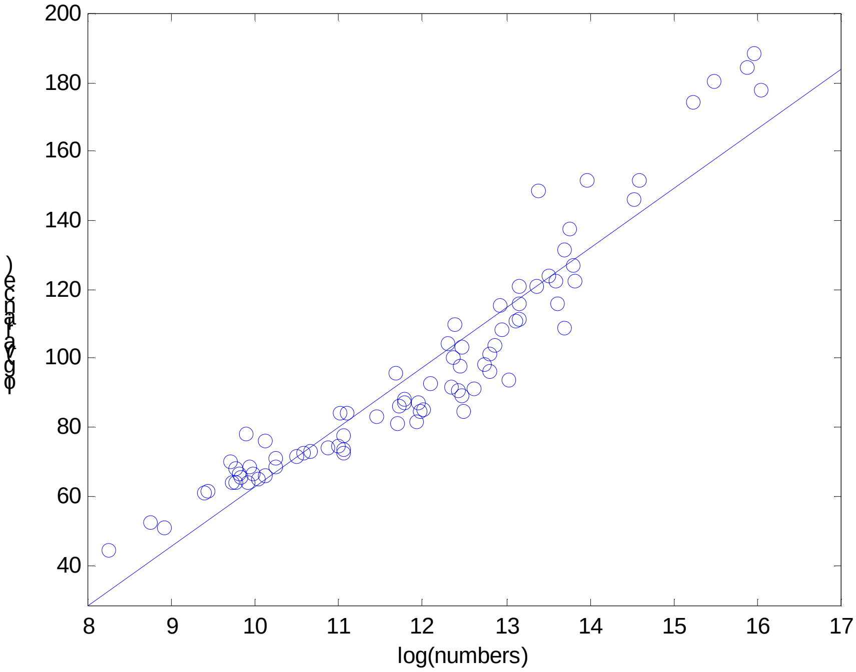


Figure 3.2.2.3b. Log variance plotted against log numbers by age class for the years 1991 to 1998 combined for North Sea Herring: 1991 – 1998 separately

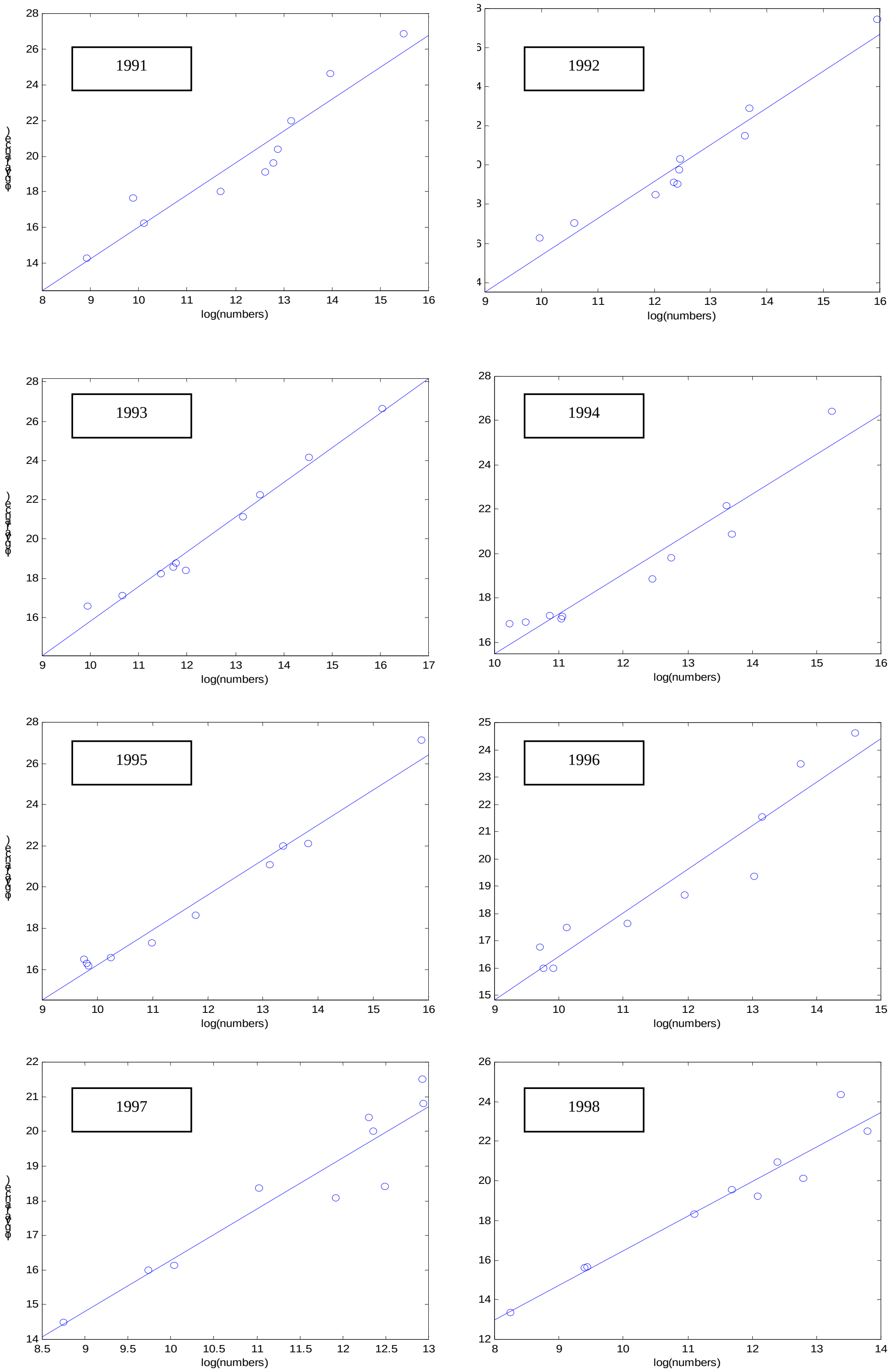


Figure 3.3.1 Estimated numbers of North Sea **COD** at age for 1991 to 1998, showing WG catch (line) and 1000 bootstrap estimates (points) from combination of Danish, Dutch, E&W and Scottish bootstrap estimates.

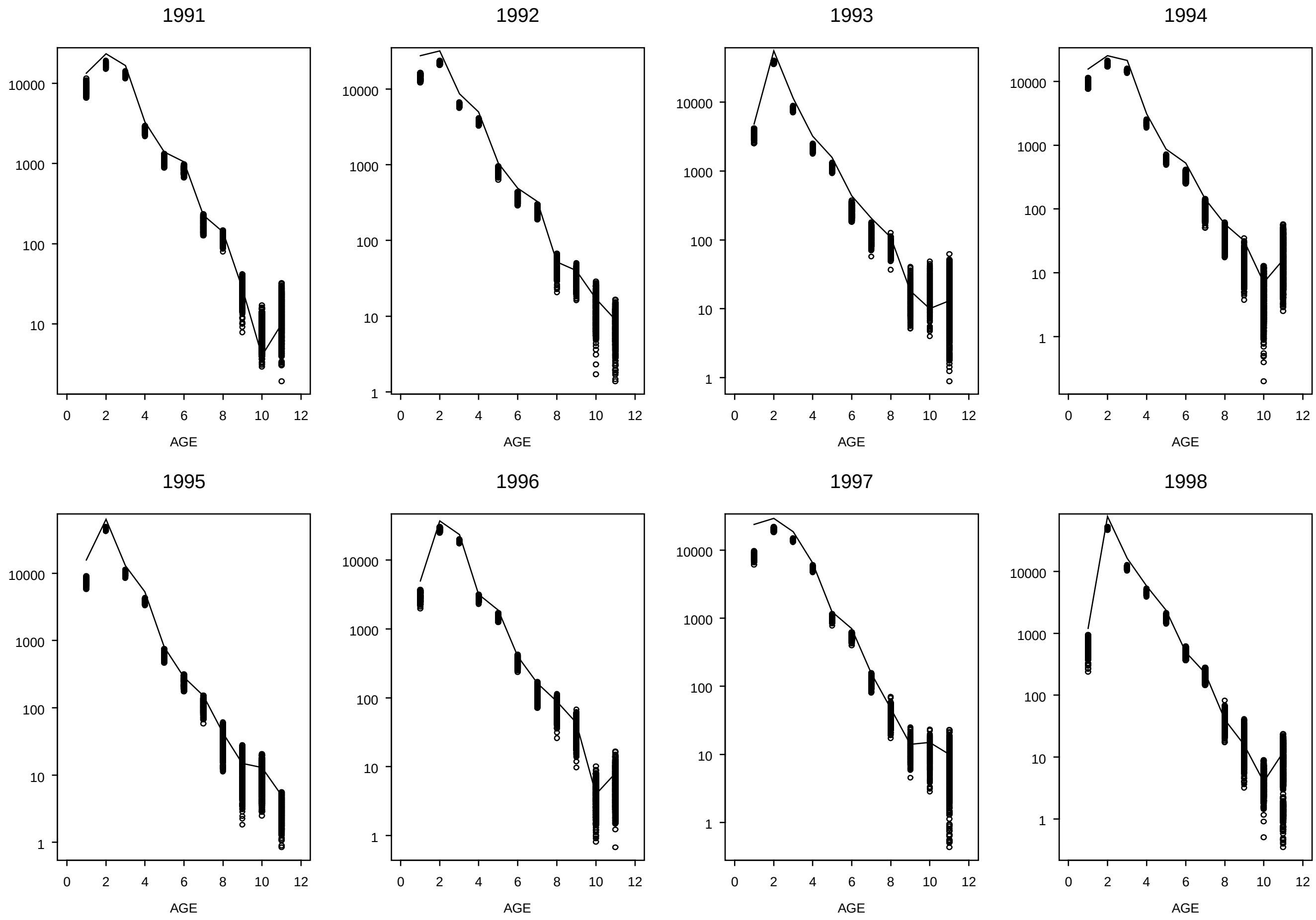


Figure 3.3.2 Estimated mean weights of North Sea **COD** at age for 1991 to 1998, showing WG weights (line) and 1000 bootstrap estimates (points) from combination of Danish, Dutch, E&W and Scottish bootstrap estimates.

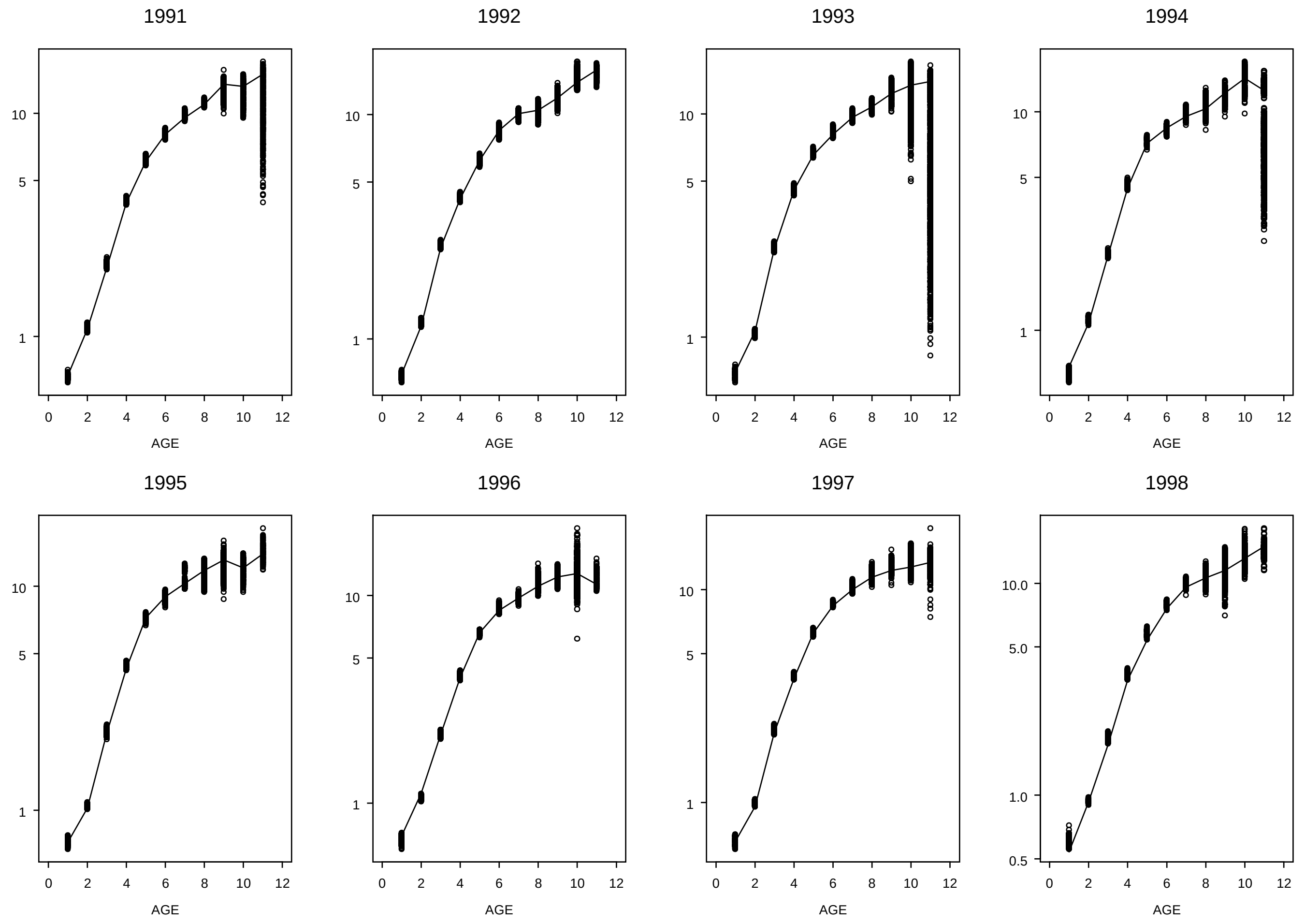


Figure 3.3.3 Estimated numbers of North Sea **PLAICE** at age for 1991 to 1998, showing WG catch (line) and 1000 bootstrap estimates (points) from combination of Danish, Dutch and E&W bootstrap estimates.

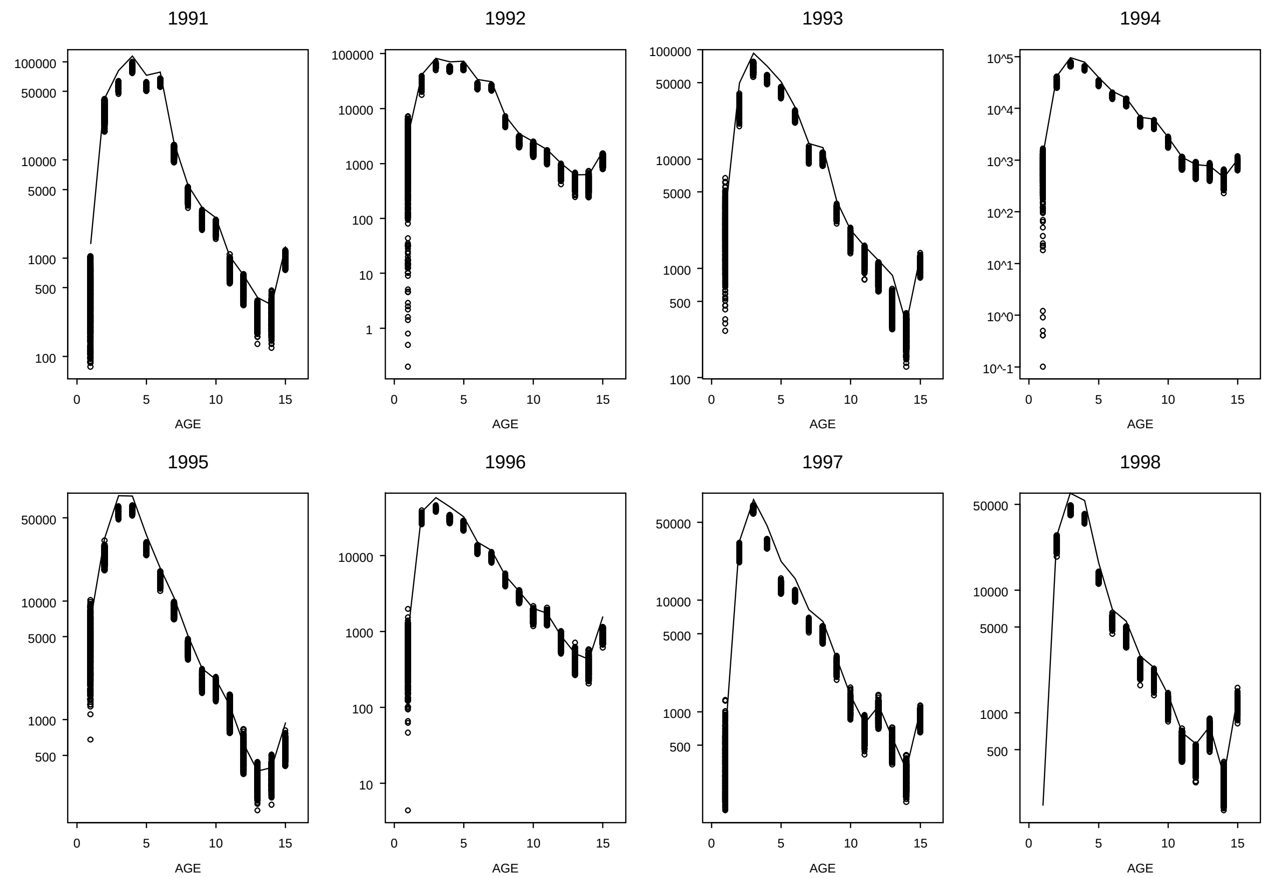


Figure 3.3.4 Estimated mean weights of North Sea **PLAICE** at age for 1991 to 1998, showing WG weights (line) and 1000 bootstrap estimates (points) from combination of Danish, Dutch and E&W bootstrap estimates

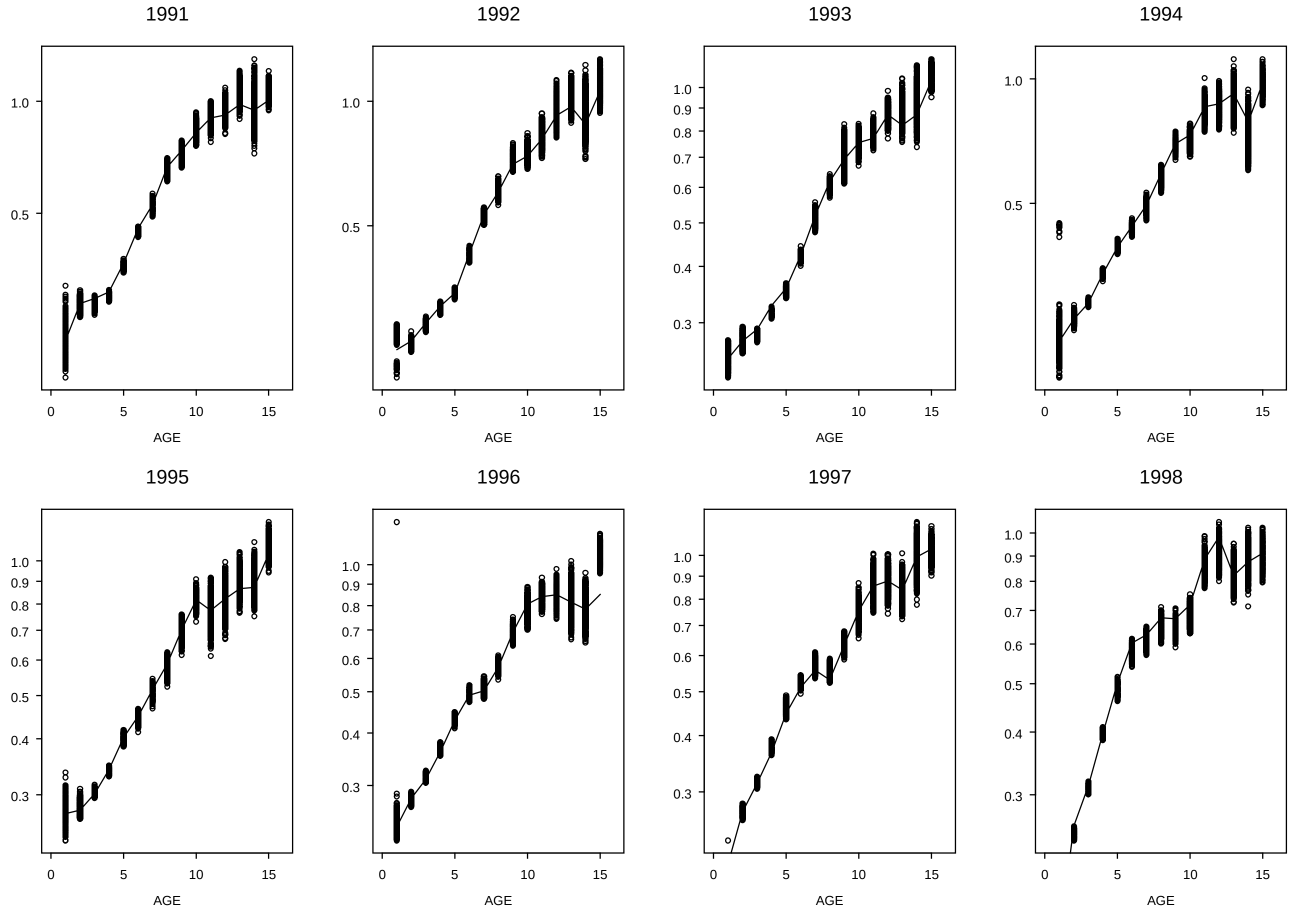
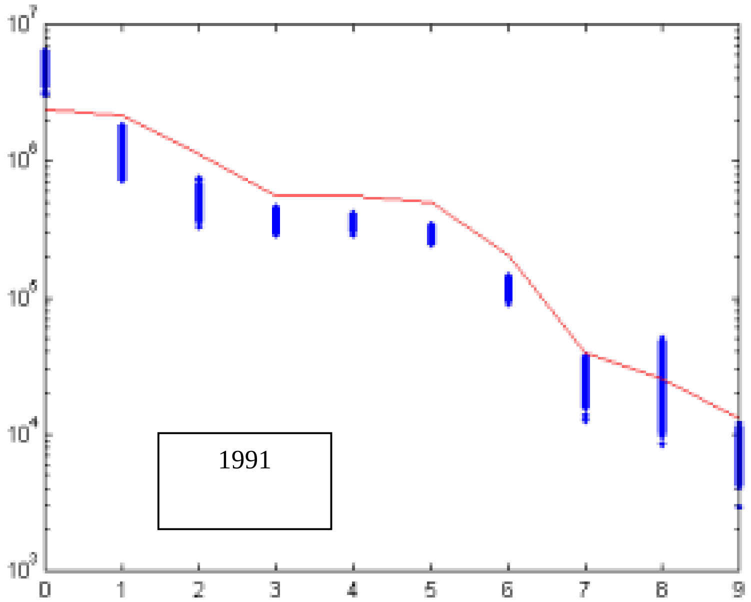


Figure 3.3.5a. Estimated numbers of North Sea herring at age for 1991 (top) and 1992 (bottom) showing WG catch (line) and 1000 bootstrap estimates (points) from combination of Danish Dutch and Scottish bootstrap estimates. Differences are due to both missing samples from other countries and area misreporting and unallocated catch.



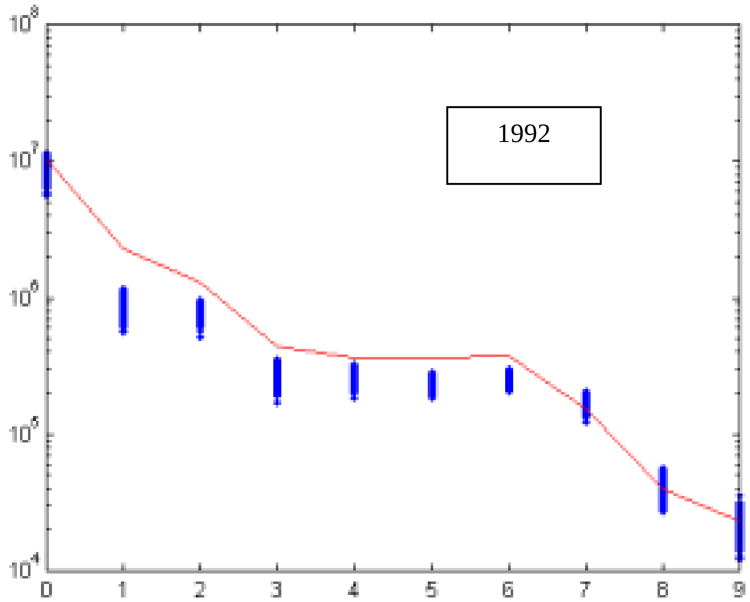
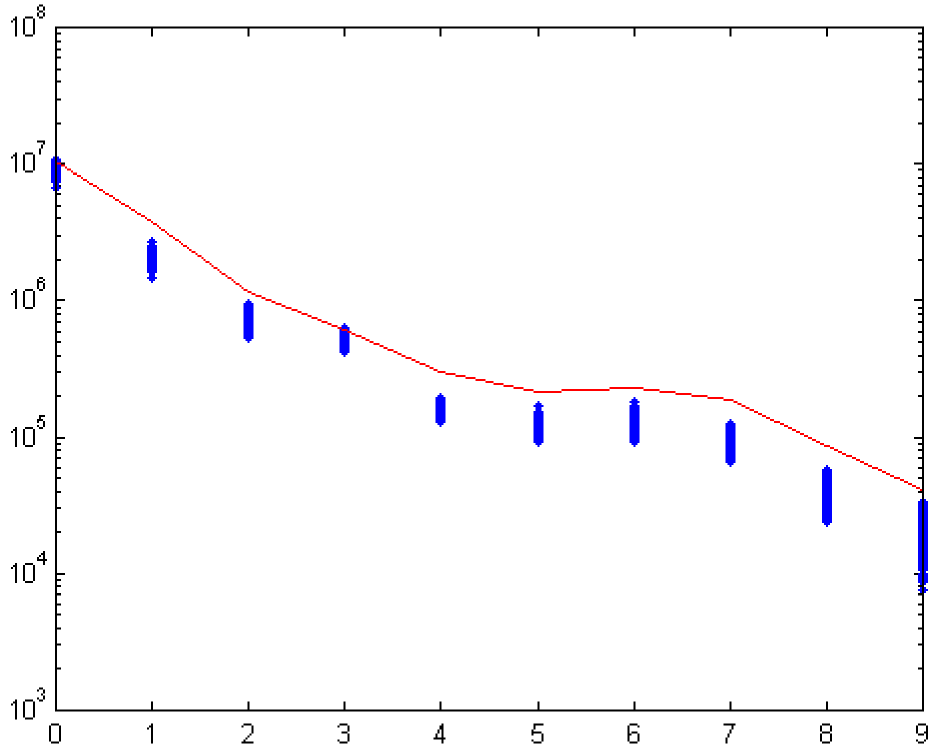


Figure 3.3.5b. Estimated numbers of North Sea herring at age for 1993 (top) and 1994 (bottom) showing WG catch (line) and 1000 bootstrap estimates (points) from combination of Danish Dutch and Scottish bootstrap estimates. Differences are due to both missing samples from other countries and area misreporting and unallocated catch.



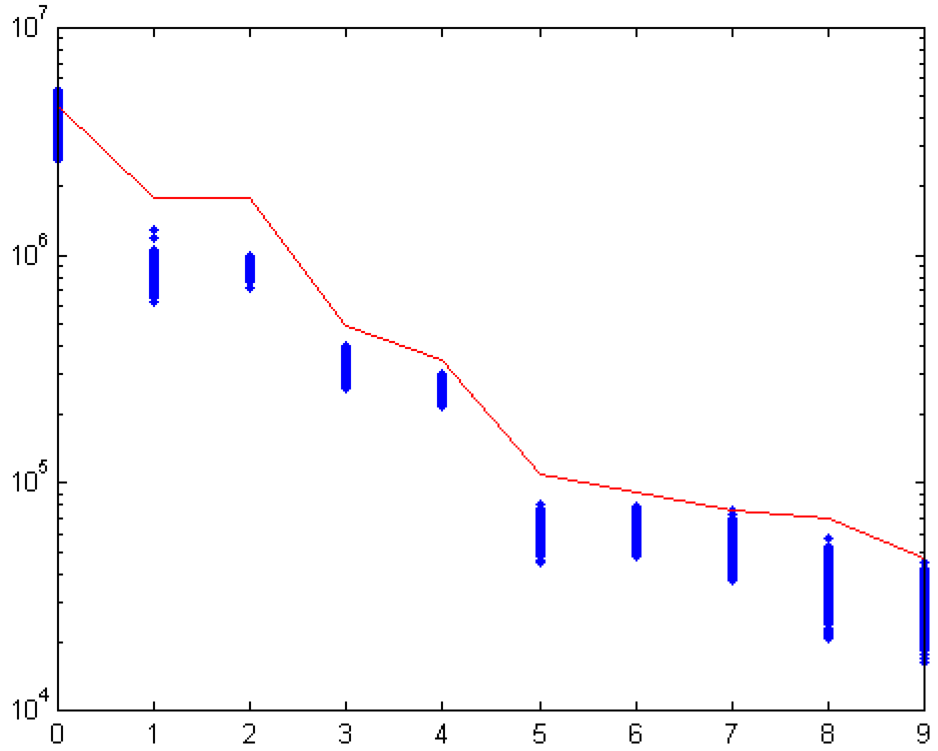


Figure 3.3.5c. Estimated numbers of North Sea herring at age for 1995 (top) and 1996 (bottom) showing WG catch (line) and 1000 bootstrap estimates (points) from combination of Danish Dutch and Scottish bootstrap estimates. Differences are due to both missing samples from other countries and area misreporting and unallocated catch.

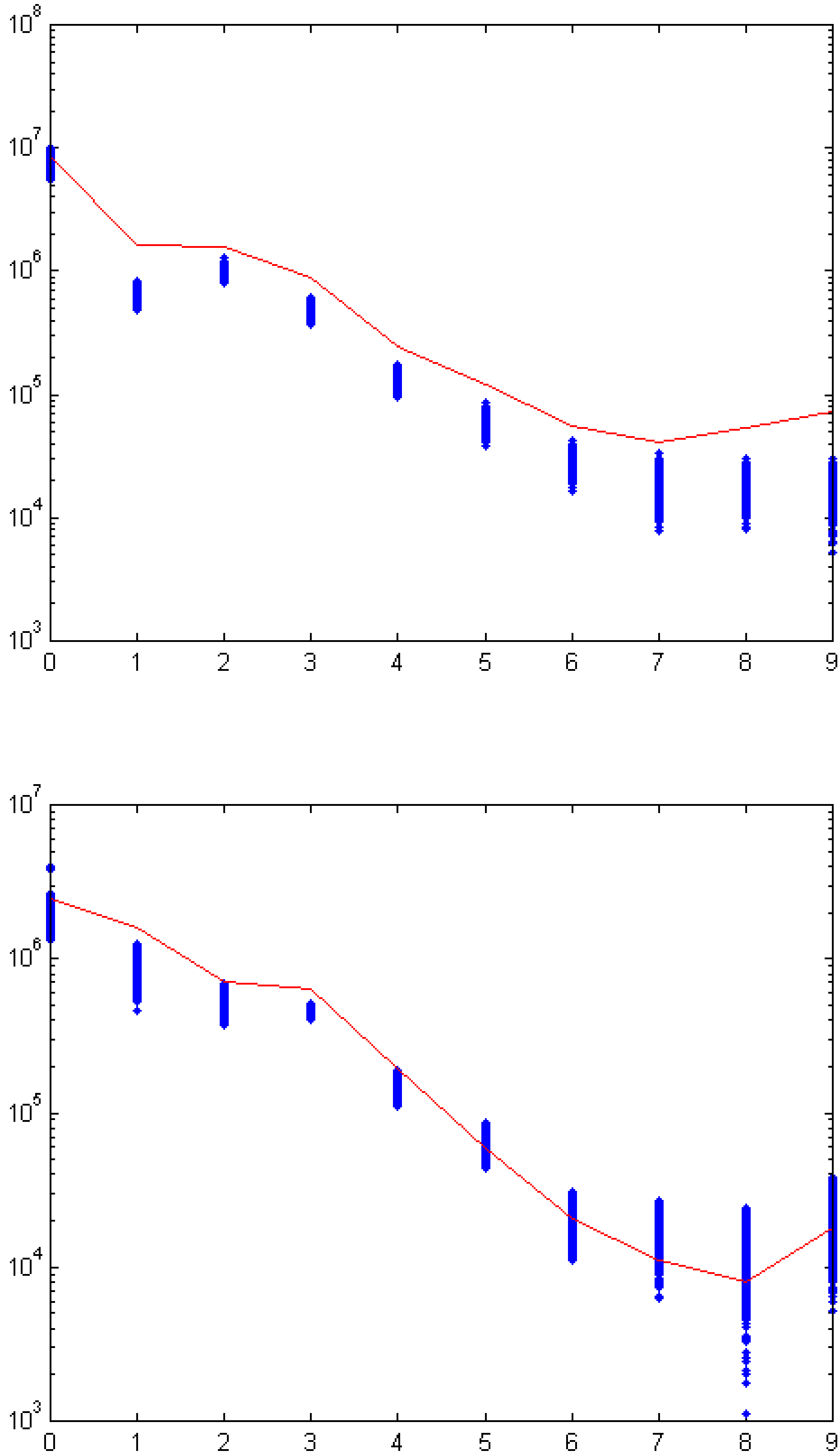
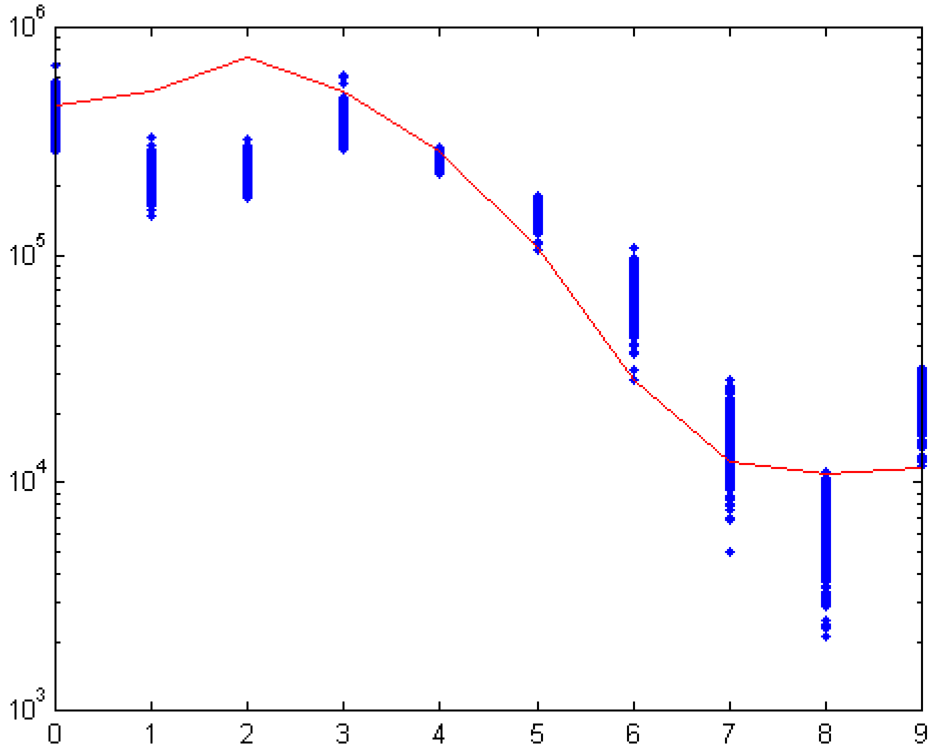


Figure 3.3.5d. Estimated numbers of North Sea herring at age for 1997 (top) and 1998 (bottom) showing WG catch (line) and 1000 bootstrap estimates (points) from combination of Danish Dutch and Scottish bootstrap estimates. Differences are due to both missing samples from other countries and area misreporting and unallocated catch.



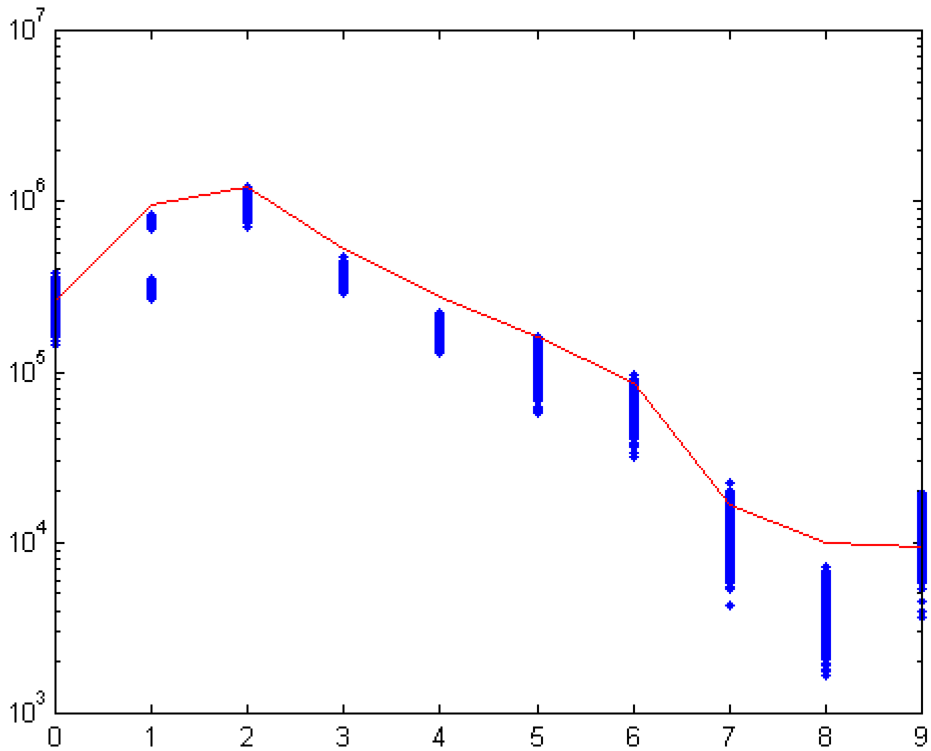
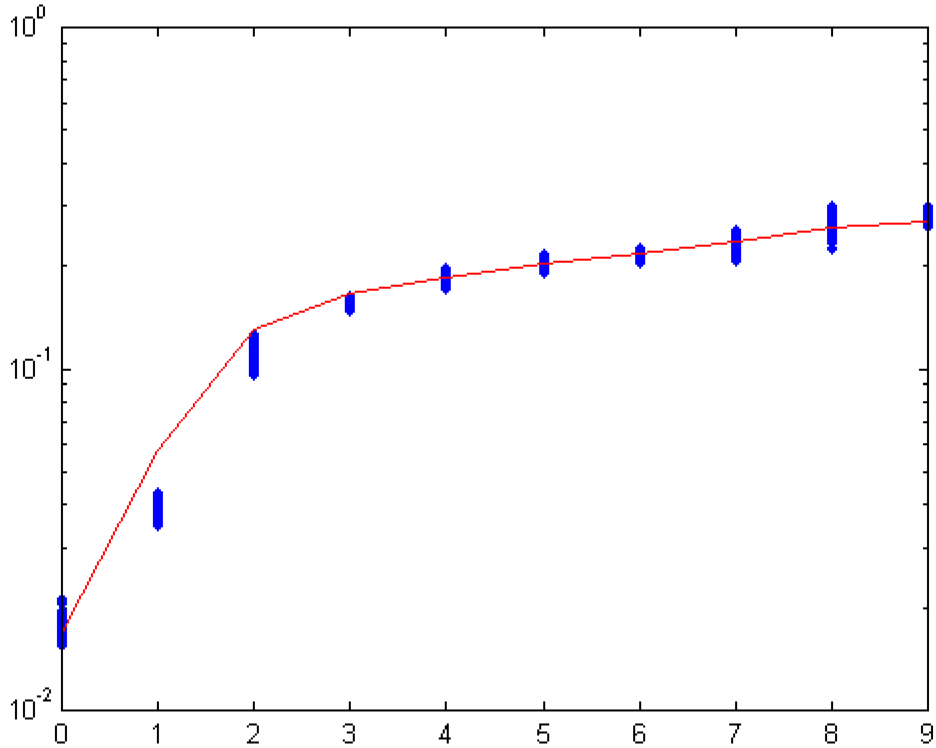


Figure 3.3.6a. Estimated mean weights of North Sea herring at age for 1991 (top) and 1992 (bottom) showing WG catch (line) and 1000 bootstrap estimates (points) from combination of Danish Dutch and Scottish bootstrap estimates. Differences are due to both missing samples from other countries and area misreporting and unallocated catch. and unallocated catch.



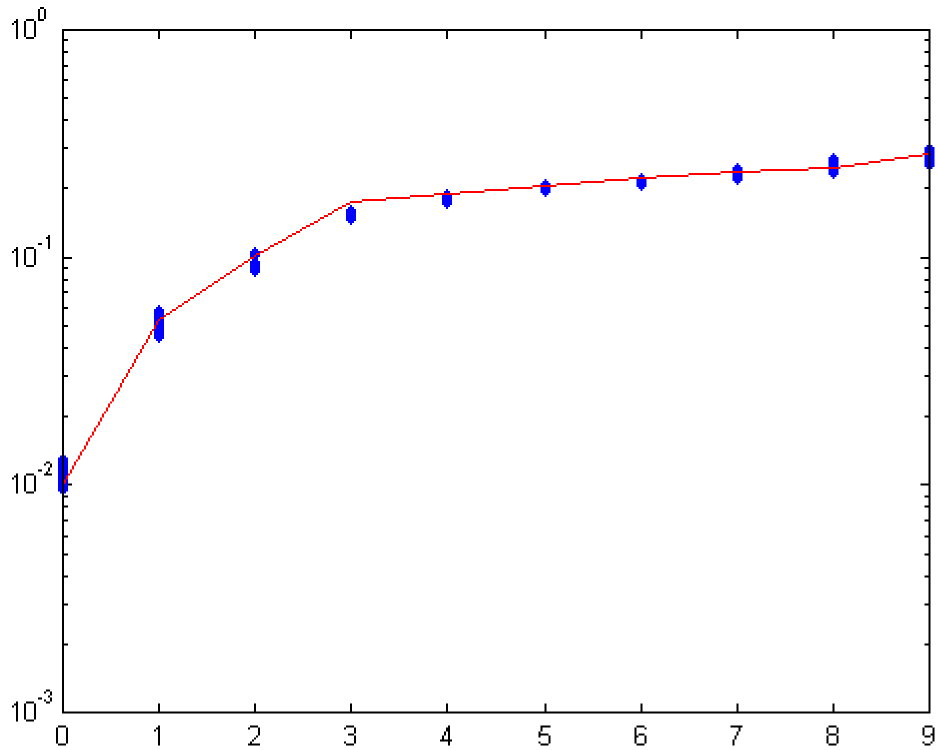


Figure 3.3.6b. Estimated mean weights of North Sea herring at age for 1993 (top) and 1994 (bottom) showing WG catch (line) and 1000 bootstrap estimates (points) from combination of Danish Dutch and Scottish bootstrap estimates. Differences are due to both missing samples from other countries and area misreporting and unallocated catch. and unallocated catch.

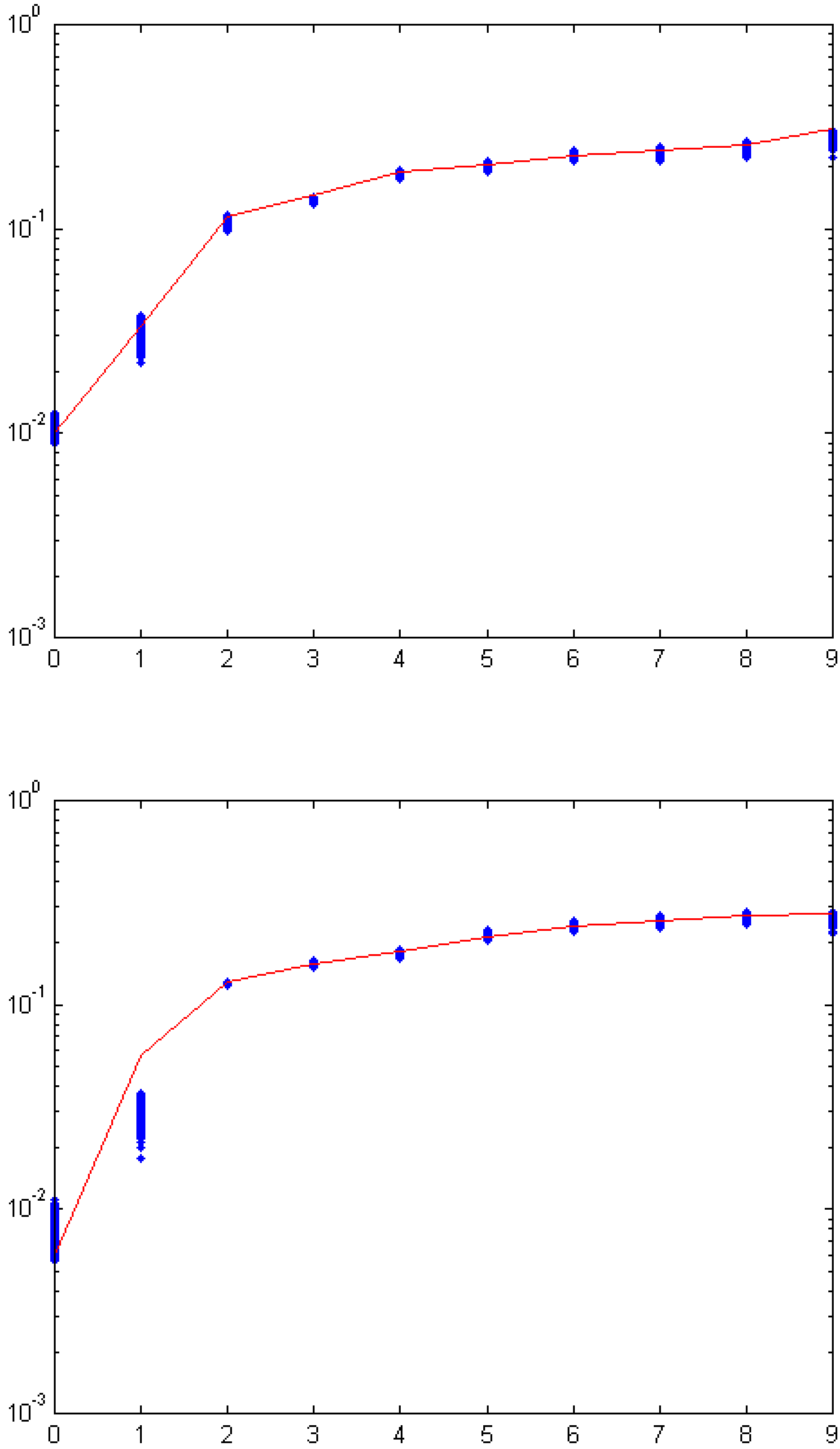
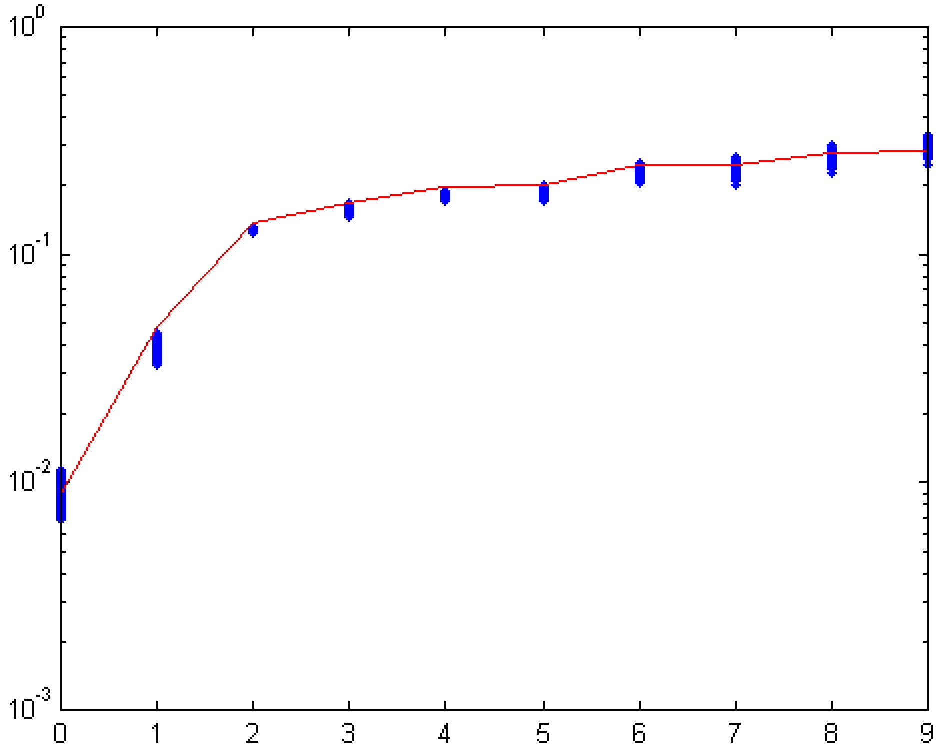


Figure 3.3.6c. Estimated mean weights of North Sea herring at age for 1995 (top) and 1996 (bottom) showing WG catch (line) and 1000 bootstrap estimates (points) from combination of Danish Dutch and Scottish bootstrap estimates. Differences are due to both missing samples from other countries and area misreporting and unallocated catch. and unallocated catch.



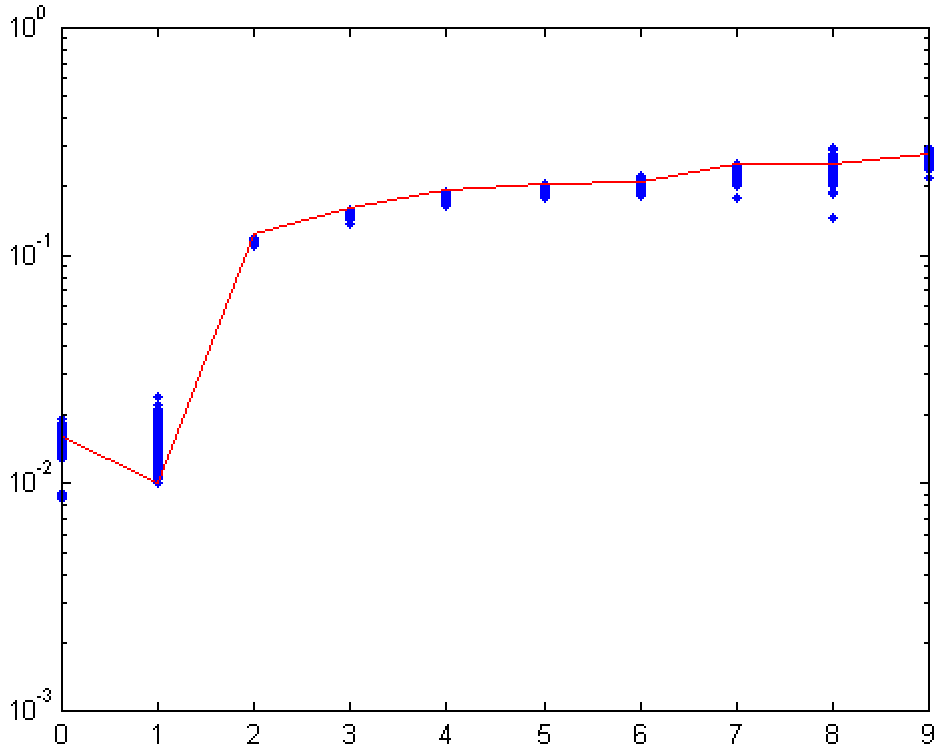


Figure 3.3.6d. Estimated mean weights of North Sea herring at age for 1997 (top) and 1998 (bottom) showing WG catch (line) and 1000 bootstrap estimates (points) from combination of Danish Dutch and Scottish bootstrap estimates. Differences are due to both missing samples from other countries and area misreporting and unallocated catch. and unallocated catch.

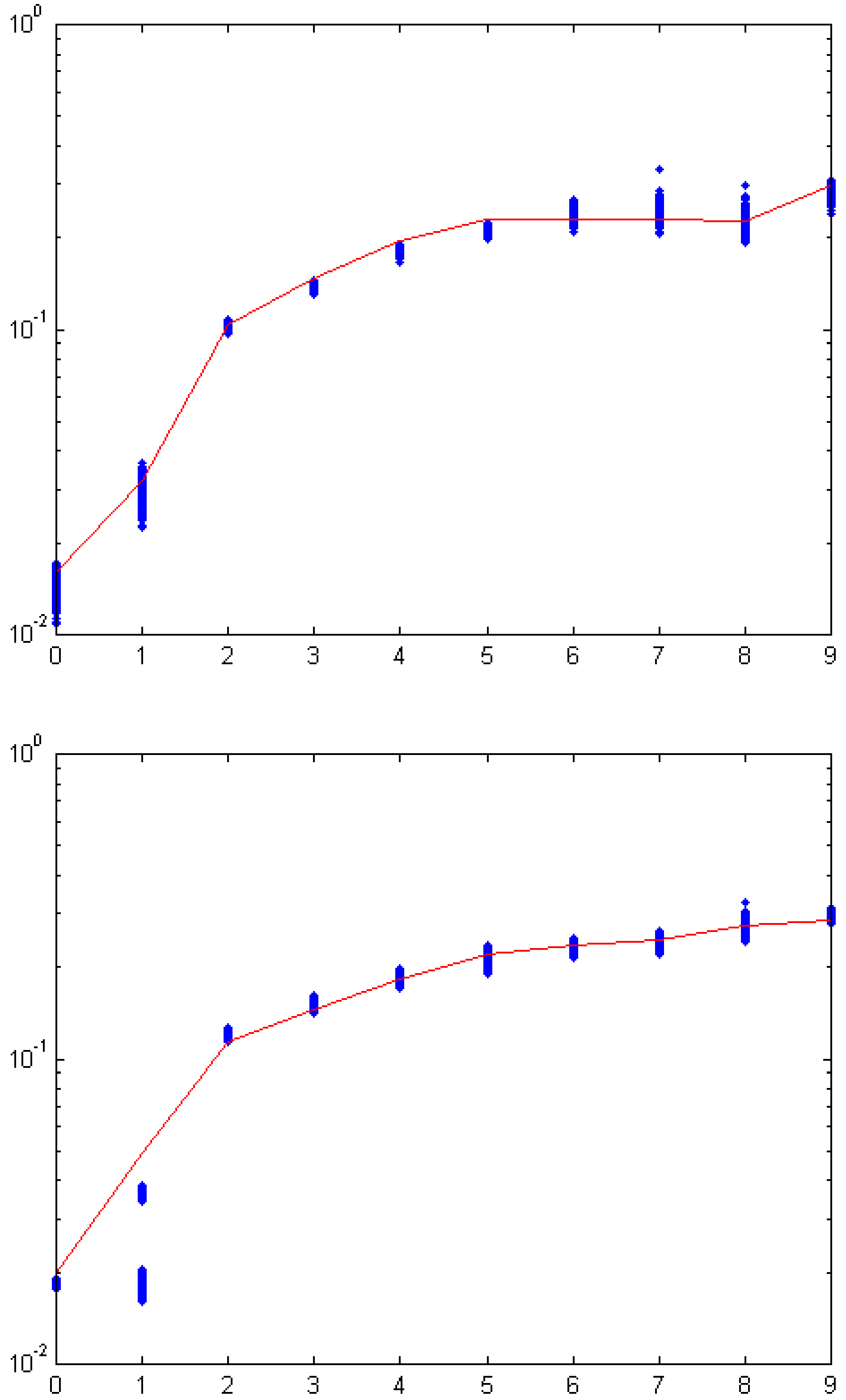


Figure 3.4.1 The 5,25,50,75,95th percentiles of Fbar (2-10), recruitment at age 1, SSB and F at age in the 1998 resulting from fitting the 1999 ICES WG XSA model to 1000 bootstraps of the North Sea plaice catch at age data for the years 1991 - 1998.

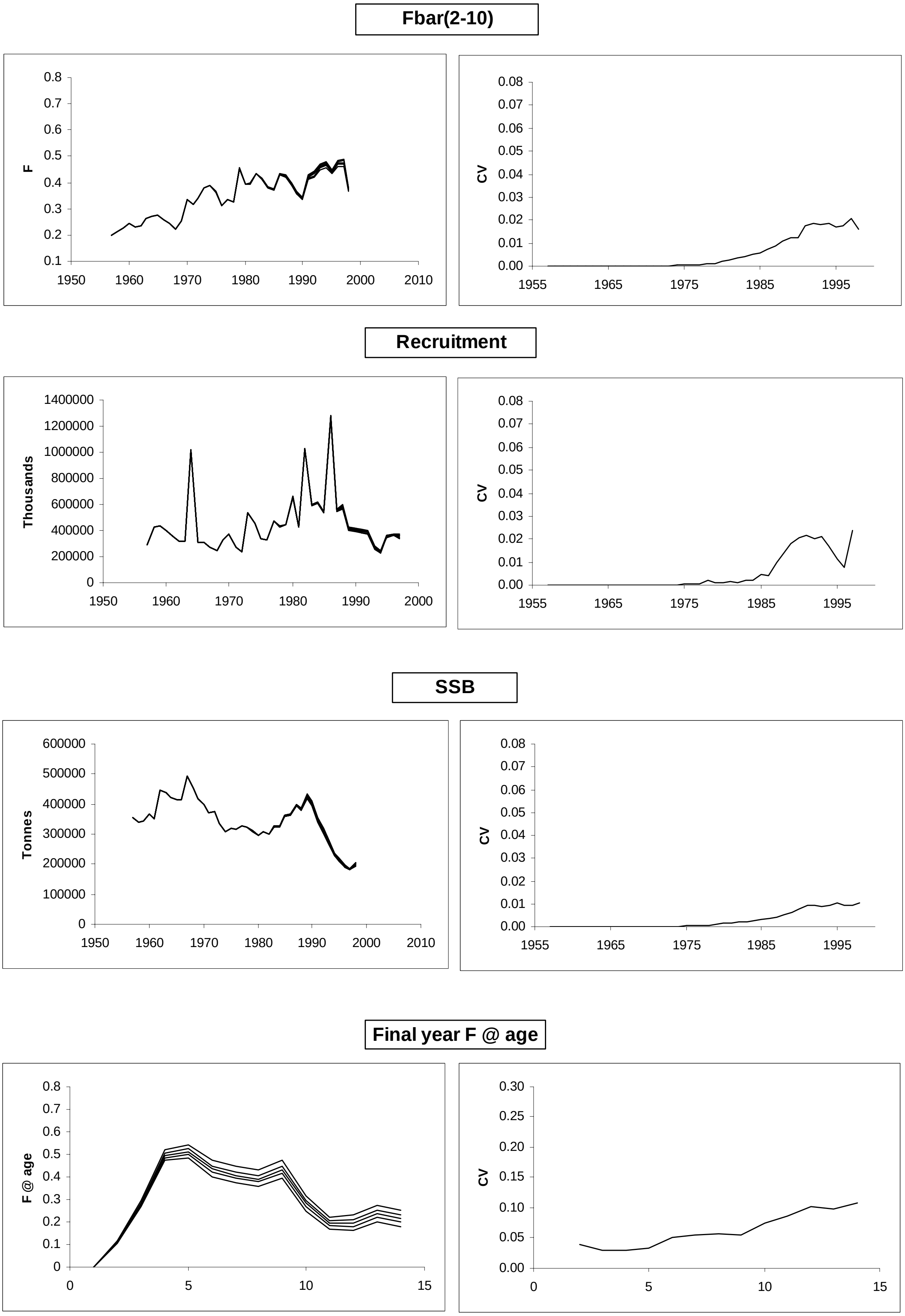


Figure 3.4.2. The 5,25,50,75,95th percentiles of Fbar (2-10), recruitment at age 1 and SSB resulting from fitting the 1999 ICES WG, North Sea plaice XSA model structure to 1000 non parametric bootstraps of the CPUE tuning series.

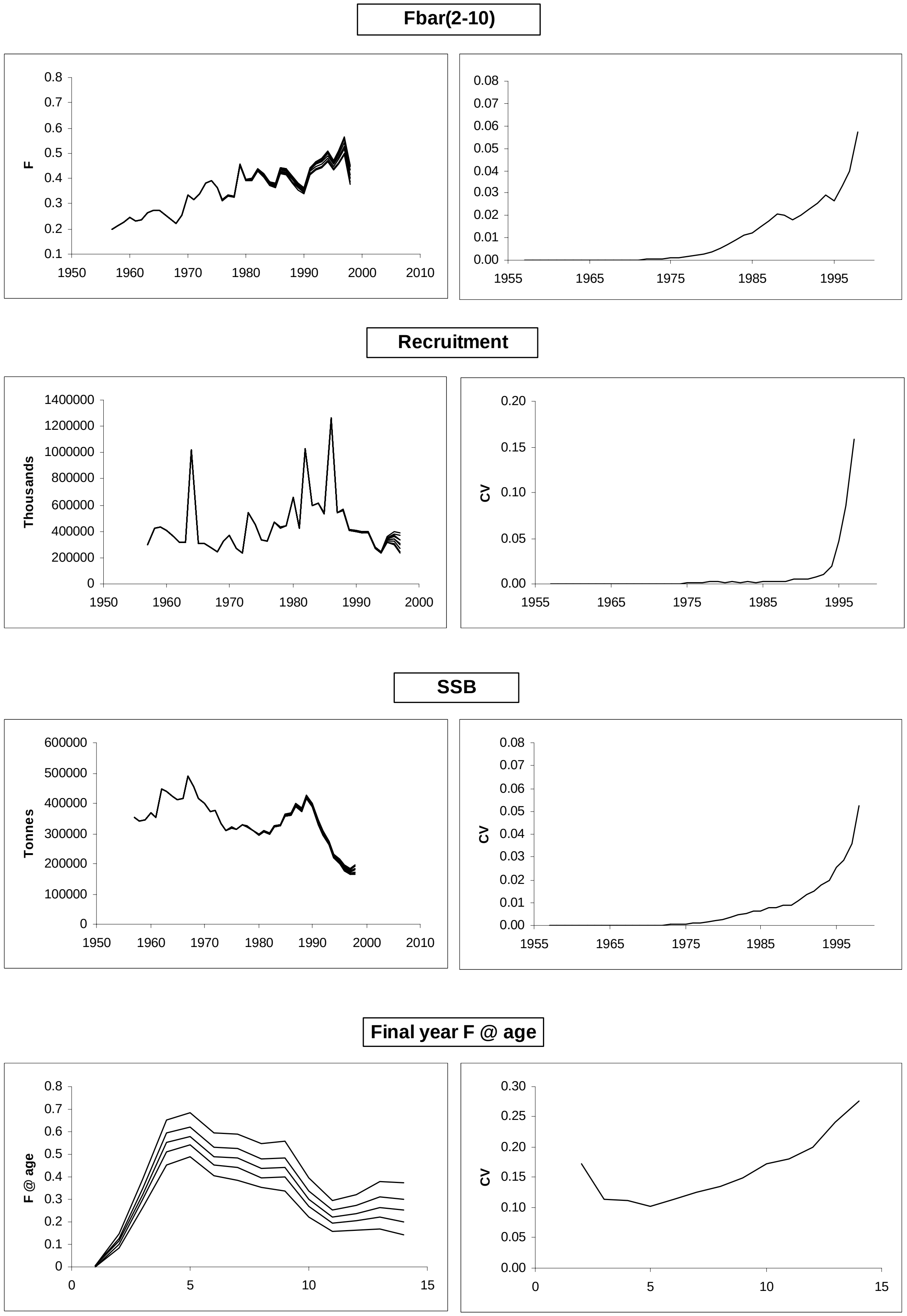
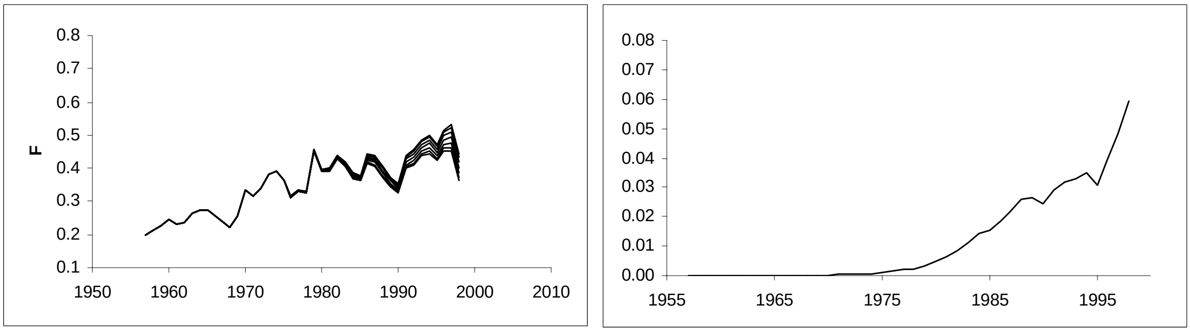
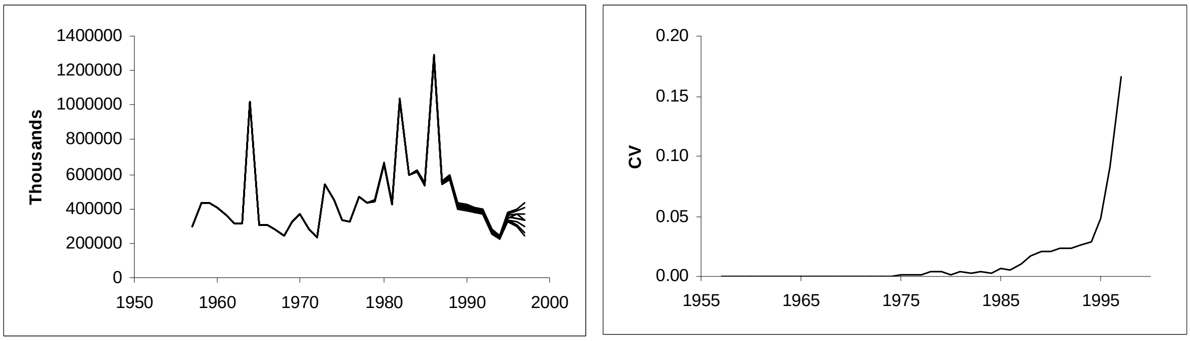


Figure 3.4.3. The 5,25,50,75,95th percentiles of Fbar (2-10), recruitment at age 1, SSB and F at age in the 1998 resulting from fitting the 1999 ICES WG XSA model to 600 bootstraps of the North Sea plaice catch at age data for the years 1991 - 1998 x 100 bootstraps of the CPUE tuning series.

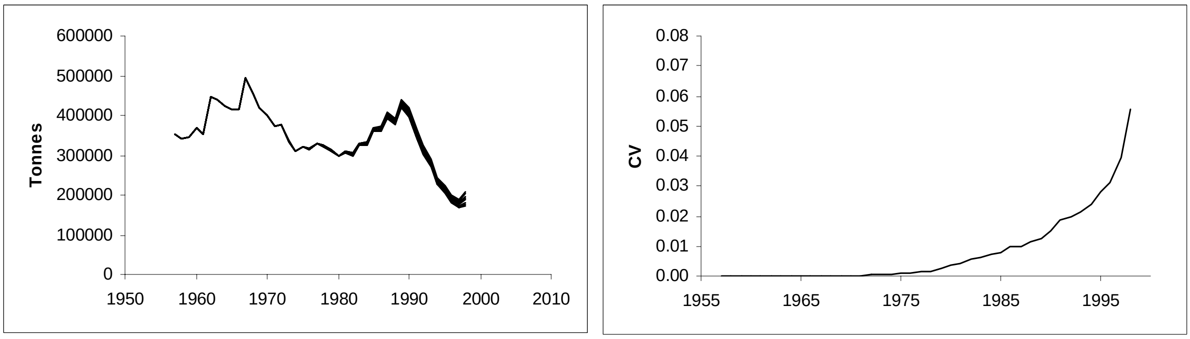
Fbar(2-10)



Recruitment



SSB



Final year F @ age

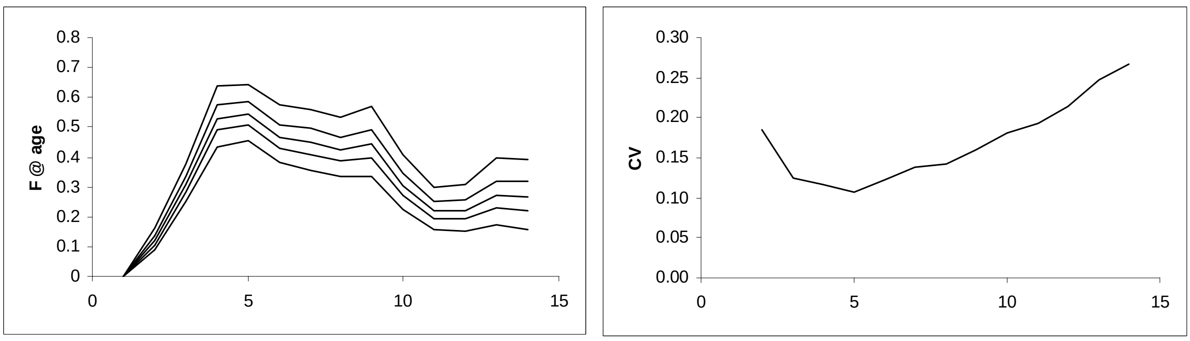


Figure 3.4.4. Juvenile F (top, ages 0 & 1) and Adult F (bottom, ages 2 to 6) for North Sea herring 1988 to 1998 from 1000 bootstrap assessments for three methods of estimating total catch. Scn (cross) WG numbers of catch at age with sampling variability from bootstrap. Scb (triangle): proportions of catch at age from Danish, Dutch and Scottish sampling raised to total WG landings. Miss (circle) WG numbers of catch at age with sampling variability from bootstrap including an additional uncorrelated missing catch sample based on Danish variability of catch at age.

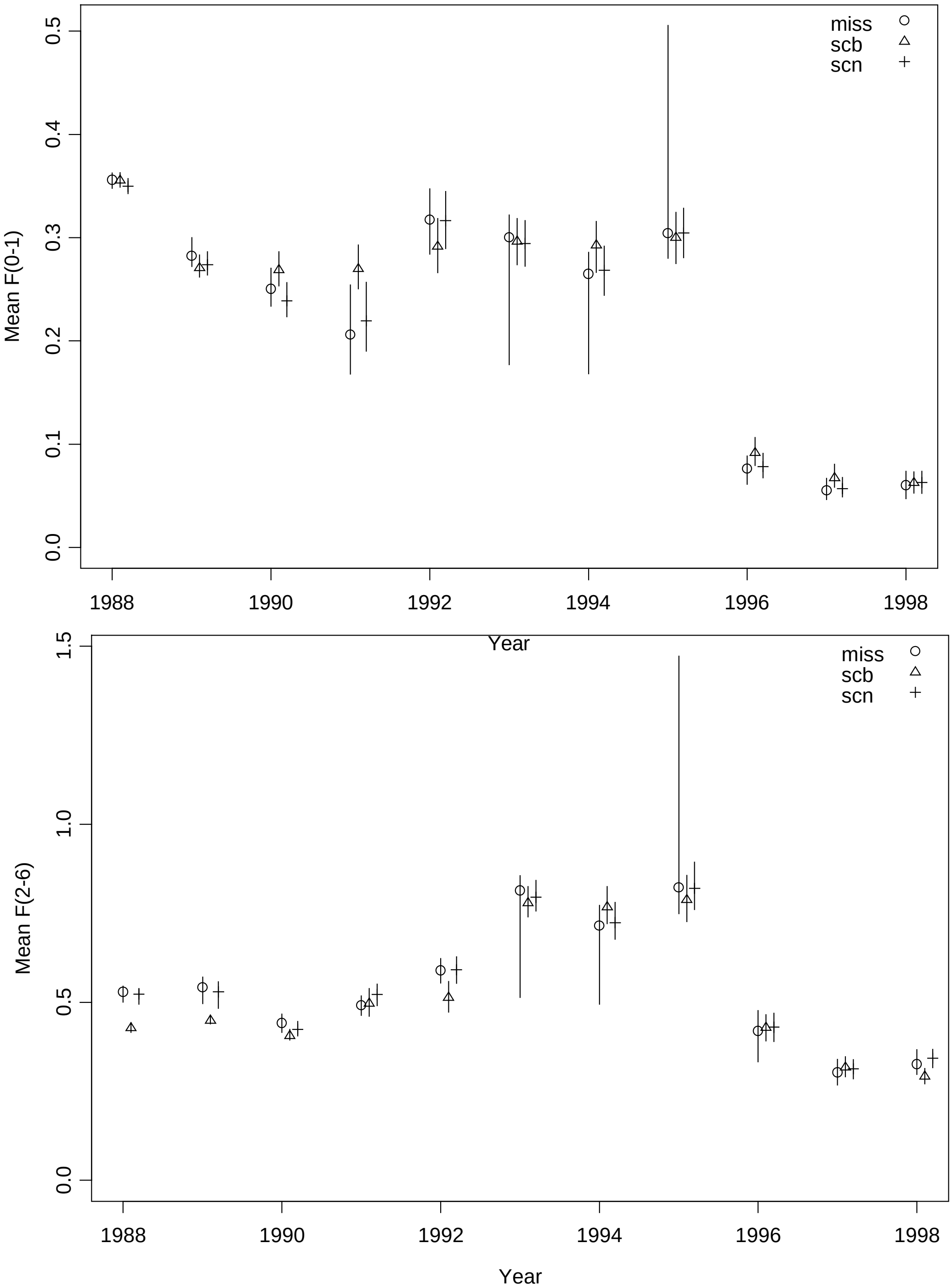
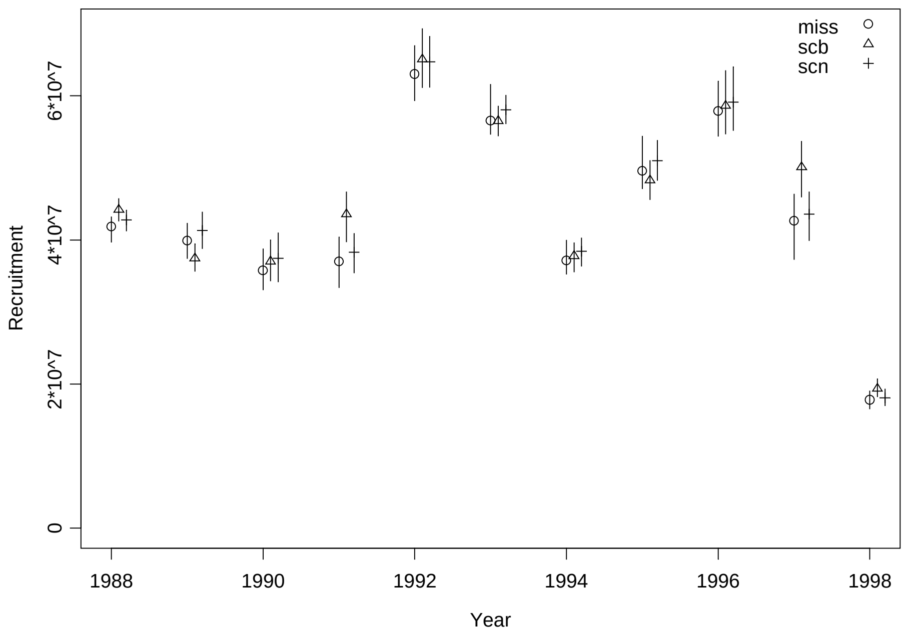


Figure 3.4.5. Recruitment (top) and SSB (bottom) for North Sea herring 1988 to 1998 from 1000 bootstrap assessments for three methods of estimating total catch. Scn (cross) WG numbers of catch at age with sampling variability from bootstrap. Scb (triangle): proportions of catch at age from Danish, Dutch and Scottish sampling raised to total WG landings. Miss (circle) WG numbers of catch at age with sampling variability from bootstrap including an additional uncorrelated missing catch sample based on Danish variability of catch at age.



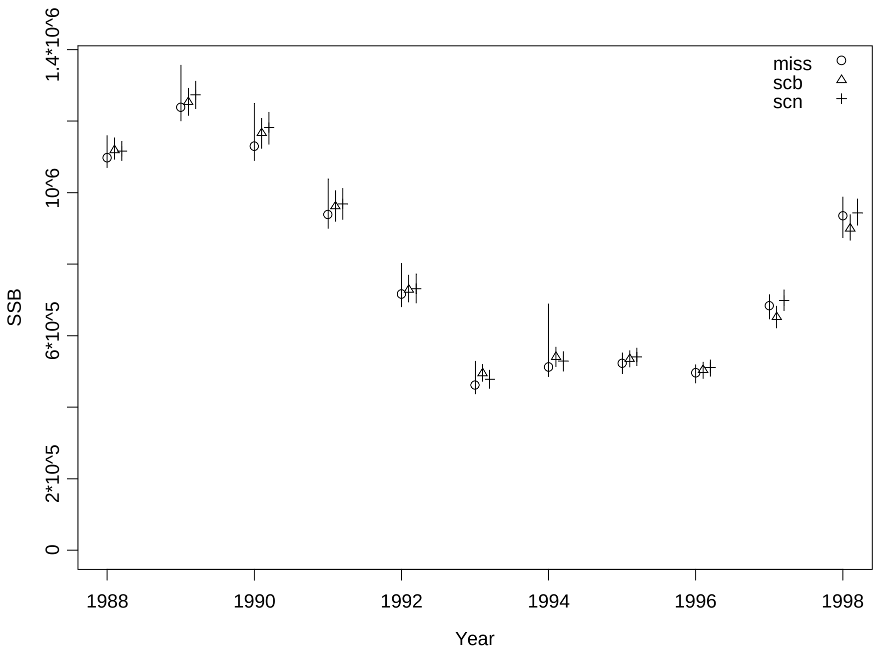
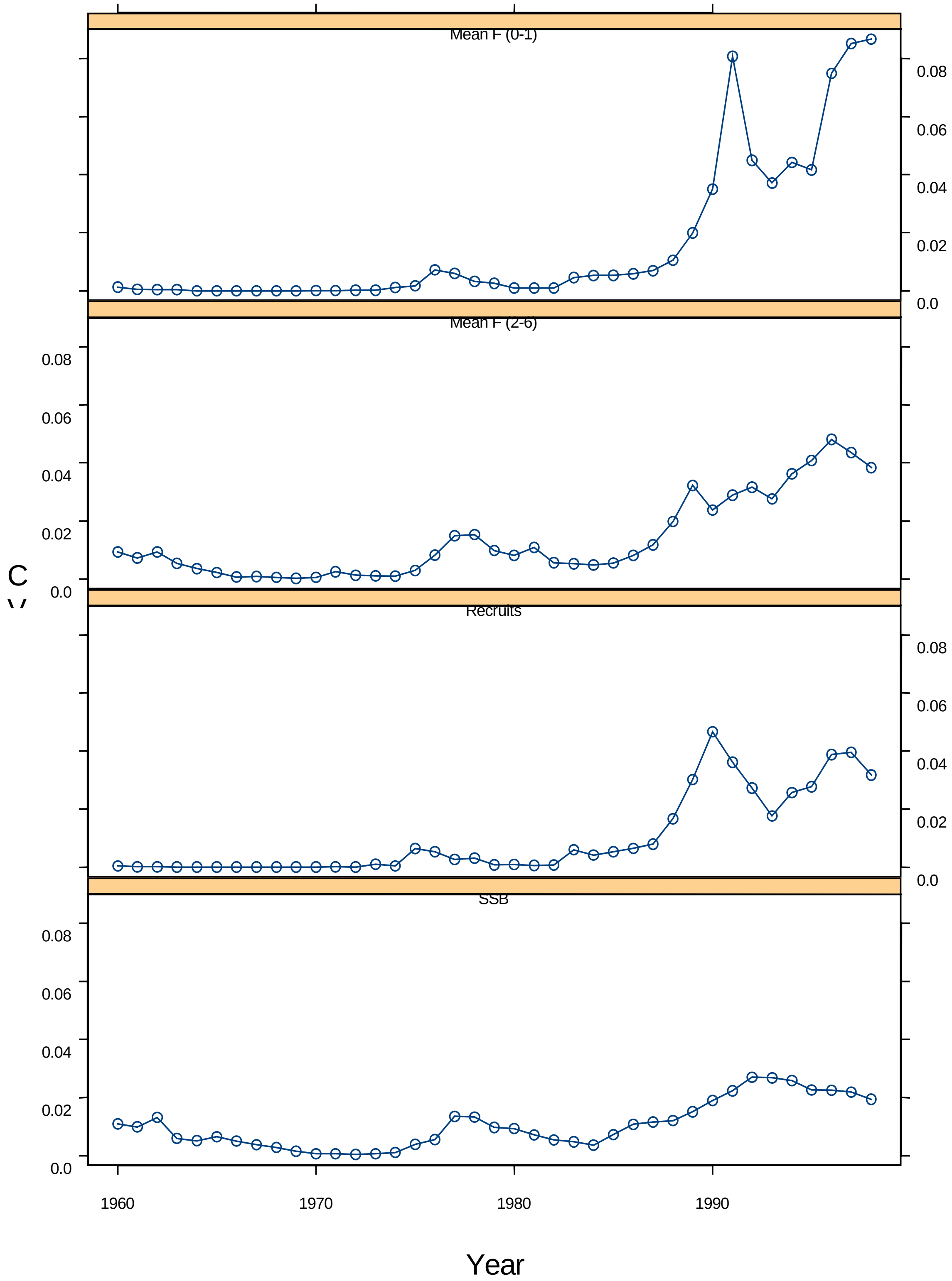


Figure 3.4.6 CV by year for assessment normalised to HAWG numbers at age using 1000 bootstrap replicates for 1991 to 1998 and standard assessment data for all other years and all other indices.



4 DATA STORAGE AND STANDARDIZATION OF RAISING PROCEDURES

Aggregating national assessment input data to the international level should be simple to achieve if all countries were in a position to submit a complete set of data where landing statistics stratified by species, fleet, season and area are matched with proper sampling of biological information. Unfortunately, this is not the case in most assessment Working Groups. Normally, several strata have no biological information available and the working Group has to apply some kind of filling in procedure. In most cases a filling-in procedure has already taken place on the national level before data are submitted to ICES (or to the species coordinator). These fill-ins usually represent missing information in strata where the country normally collects biological samples but for one reason or another does not have any information available. No countries supply adequate documentation for these national filling-in procedures. This very informal and undocumented procedure produces an unwanted situation where no or very little data transparency is present. This situation is not a helpful starting point for the quality assurance procedures currently being implemented by ICES.

4.1 Data Raising: The present situation.

The working group reports reveal that different working groups pay different attention to the documentation of the raising procedures. Below are some examples of how different assessment working groups have dealt with the documentation in the most recent working report. Some parts were extracted from the reports and some were obtained from personal communication with working group members.

4.1.1 Herring Assessment Working Group for the Area South of 62° N (HAWG) and the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy (WGMSHA).

National data are submitted on agreed spreadsheet forms similar in both Working Groups (ICES C.M. 2000 / ACFM:10 and ACFM:6). The SALLOC software (see Section 4.3.3) is used to raise national data to the international level. The WG's provides a well-documented overview of the sampling coverage from each country in the report. The SALLOC program provides a log listing the actual filling-ins made in order to cover all landings with missing biological information, but this list is not given in the WG reports. No list is available in the WG report giving the extrapolations made of each national data set before submitting the data to ICES.

4.1.2 Working Group on the Assessment of Northern Shelf Demersal Stocks (WGNSDS)

The report of the Working Group on the Assessment of Northern Shelf Demersal Stocks (WGNSDS, ICES C.M. 2000/ACFM: 1), includes two tables that summarise the assessment data provided by stock and by country. The WGNSDS describes the procedures used in the compilation and aggregation of catch data before the assessment stage. The stocks assessed by the WGNSDS are split into three groups for which different procedures are used. These are the area VI gadoids, the Irish Sea gadoids and the Irish Sea flatfish. For the other stocks, the WGNSDS notes that assessments are generally at a more preliminary stage and data compilation is achieved on a more *ad hoc* basis. Concerning filling-in procedures typically no documentation is provided in the WG report although some comments are made on missing ALK's. An exception is sole and plaice in VIIa where full documentation is provide due to the use of the XLRAISE2 spreadsheet based raising form.

4.1.3 Working Group on the Assessment of Southern Shelf Demersal Stocks (WGSSDS)

The report of the Working Group on the Assessment of Southern Shelf Demersal Stocks (WGSSDS, ICES C.M. 2001/ACFM: 5) does not have an extensive description of the procedures used in the compilation and aggregation of catch data before the assessment stage. The data were prepared in advance of the meeting, and all revisions to data are briefly discussed in the appropriate stock section. In most cases catch weights at age and stock weights at age have been SOP corrected.

Some documentation is presented in the WG report concerning coverage of biological information in relation to landing statistics and some information concerning filling-in gaps procedures is given. In no case any justification is given for the filling-ins. For some stocks it is not possible to give the landings as census of total landing but an estimate are given based on a sampling scheme. Only little documentation is given on this procedure.

4.2 Evaluating effects of raising procedures on estimation of age compositions

Different ICES working groups use different procedures to deal with missing samples and to aggregate national data to the international level. It is not clear beforehand, how one could evaluate the consequences of these procedures on the estimation of the international age compositions. It may be possible to show that different procedures results in different estimates, but this then does not give guidance on which procedure is better.

As an example, two different procedures for North Sea herring were compared. A comparison was made between the current WG procedure for the 1999 data and what would happen if all the unsampled catches were simply raised to the total landings. The WG estimate of landings in 1999 was 372341 tonnes of which 96024 tonnes were unsampled (26%). The age compositions of North Sea autumn spawning herring (exclusdng Baltic Spring Spawning herring caught in the North Sea) were first raised to the total landings from the sampled catches and then secondly raised to the total catch. The differences in the 1999 age composition between this new estimate (by age) to the estimate presented in the HAWG 2000 report is shown in Figure 4.2.1 and Table 4.2.1. The conclusion is that the main difference is in the estimation of the 0 and 1 WR (around 30%) and that the other ages show only relatively small differences (around 5%). Again, this does not 'decide' which of the procedures is the preferred one, it only shows that there are differences in the estimated age composition which can be traced to the assumptions in the raising process.

4.3 Available software

In the following section a brief overview is given of a number of software packages that are currently in use within ICES assessment working groups with the aim of either aggregating national age-compositions to the international level (Sections 4.3.1-4.3.4) or to provide information on the international sampling coverage (4.3.5).

4.3.1 Fishbase – North Sea flatfish raising procedure

The Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak

(WGNSSK) keeps a database system to store and aggregate data on the flatfish species in the North Sea. The database system (FISHBASE) consists of a user interface programmed in Pascal and a specific datafile format. Data are stored in separate datafiles by country, gear, area, sex (if available) and year. Different levels of aggregations may be used in the datafiles ranging from files, which have catch-numbers, weights at age and lengths at age by quarter, sex, gear, area and country to files, which only have total landings, by country and year. Raising is performed from the lowest level aggregation upwards. The strong points of Fishbase are that it forces the user to correctly specify the input data and that data can be exchanged in separate datafiles, so that national institutes can submit their data in those files. Also it allows a historical access to the underlying data and other arrangements may be implemented to raise the data. Negative points are that no manual is available, that the program does not allow combination of areas, that the input format is very difficult to generate with any other software than Fishbase itself and that there is no specification of reallocation rules. A more extensive discussion of the properties of the programs can be found in appendix A.1.

Information on Fishbase can be obtained from Frans van Beek (RIVO, IJmuiden): (f.a.vanbeek@rivo.wag-ur.nl)

4.3.2 Aberdeen programs for raising (roundfish) data

A series of basic programs are used to collect national age compositions and weights at age for roundfish stocks in the North Sea and west of Scotland. The programs were developed in the 1980s in the Marine Laboratory (Aberdeen) and are operated from the dos-prompt by invoking QBASIC. All data is stored in a common format. An exchange format is used for exchange of data. Strong points of the Aberdeen programs are that a rigid file structure is defined and that the raising procedure is carried through to generating the input files for stock assessment. Negative points are that there is a whole suite of programs, which should be used, in a specific order and that there are no explicit reallocation rules. A more extensive discussion of the properties of the programs can be found in appendix A.2.

Information on the Aberdeen programs can be obtained from (Robin Cook: cookrm@marlab.ac.uk)

4.3.3 Excel exchange sheets and SALLOC

The ICES Herring Assessment Working Group for the area south of 62° N (HAWG) and the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine, and Anchovy

(WGMHSA) both apply a double system of exchanging national data using standardized Excel spreadsheets and raising the national data to the international level with a stand-alone program Salloc.

In the first step national data is submitted to the data Co-ordinator in a standardized Excel spreadsheet (Table 4.3.3.1). This spreadsheet is tab separated and provides data by area and by fleet. The following types of data are exchanged:

- numbers-at-age, weights-at-age and lengths-at-age;
- numbers-at-length
- numbers by ICES rectangle
- sampling by area

The spreadsheets are kept on directories on the ICES system but are not reported in the WG report.

In the second step the data-coordinator uses the nationally submitted data to construct the input files to the SALLOC program:

- DISFAD.CSV summarizes both the age compositions and weights at age and the sampling information.
- (ALLOC.CSV, which allocates age information to those catches where no age information is available.

Finally, the Fortran programme (SALLOC) is applied (since 1999) The programme is intended to simplify data compilation by allowing the data Co-ordinators to concentrate on checking the input data provided and on making re-allocation choices. The tasks of routine calculation and preparation of standard tables for the report can be done automatically. A manual is available for the SALLOC program (Patterson, 1998).

The data file (disfad.csv) and allocation table (alloc.csv) are kept at the ICES system and not reported in the WG reports. The output generated from the SALLOC program is also not report in the WG reports. A summary of the SALLOC output on sampling levels is incorporated in the WG report.

Strong points of the Salloc program are that there is a rigid requirement for input data and that standardized output is generated. Also there is explicit treatment of catches for which no age compositions are available. No user interface is necessary. Disadvantages are that the program does not match to a data-storage structure (the input data-files are quite complicated to construct) and that no explicit treatment is incorporates for species by sex.

A more extensive discussion of the properties of the Salloc program can be found in appendix A.3. Information on the Excel exchange sheets or the Salloc program can be obtained from: Chris Zimmermann (Germany): zimmermann.ish@bfa-fisch.de

4.3.4 Xlraise2

Assessments of flatfish stocks in VIIa, VIIe, VIIf & g, and the North Sea utilise a CEFAS Excel spreadsheet (XLRAISE2) to raise landings data. The spreadsheet is macro driven and automates most procedures. Users are allowed flexibility in the choice of data used to raise landings for which ageing data are missing. These choices are documented and included in the output of the processing record spreadsheet. A manual has been written to describe the operation and output of the spreadsheet. The advantage of the spreadsheet is that automation reduces the need for user intervention and consequently also reduces the potential for errors. A disadvantage of the spreadsheet is that the record of processing is produced in a separate spreadsheet. The output of both XLRAISE2 and the processing record spreadsheet is required to fully document the procedures used in raising particular set of landings data.

Information on Xlraise2 can be obtained from Steve Flatman (CEFAS): s.flatman@cefas.co.uk.

4.3.5 International Sampling Level Database (ISLDB)

The International Sampling Level Database (ISLDB) has been developed in MSACCESS 97 and contains information about more than 50 species or groups of species (see Study Contract 99/009 – SAMFISH- for details). The submission of data is done using the format agreed in EU Study Contract 94-013. This format is as follows:

- The format of the files must be text separated by commas

- Each line refers to a record with the following fields: Country; Year; Month; ICES area; Gear; Species; Samples (N); Measured (N); Aged (N); Sample Weight (nominal live weight in kg); Landings (nominal live weight in tonnes); Others;

- If a field has no data it must have a value of '0' – DO NOT LEAVE EMPTY

- Only data referring the species and areas that are considered by the project can be submitted

- The FAO code for species must be used

The database contains aggregate information only, i.e. information on the level of sampling and landings by stratum and by country and species. See appendix A.4 for screenshots of the output of the database.

The International Sampling Level Database (ISLDB) was built and developed during the Study Contract 94/013, 97/0059 (FIEFA) and 99/009 (SAMFISH). The partner involved in the first project were IPIMAR (Portugal), DOP/UA (Açores), IEO (Spain), AZTI (Basque Country, Spain), MARLAB (Scotland) and FRC (Ireland). CEFAS (England & Wales) participated as observer. During FIEFA project CEFAS and IFREMER (France) became partners. During the FIEFA project a report template was defined and the routines to produce it were implemented in the database.

Further information on the ISLDB can be obtained from Ernesto Jardim (IPIMAR): ernesto@ipimar.pt.

4.3.6 Conclusion on available software

Software reviewed at the Workshop can broadly be divided into two categories: software aimed at collating and aggregating raised sampling data and software aimed at storing meta-data on sampling and landings.

The spreadsheet system used by the Herring WG (HAWG) and the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine, and Anchovy (WGMHSA) is used to collate and document the input data that is presented by the national laboratories. Basically it is an (complex) exchange format. It has the advantage of documenting a whole suite of relevant data at the expense of high complexity and a relatively error prone set-up.

The Fishbase and Aberdeen raising programs both do more or less the same thing: aggregate national catch information which is supplied at different levels of aggregation, but without the possibility to reallocate landings without samples to other aged information. They both operate on standardized data-formats, where the format for the Aberdeen software seems more accessible to external software (e.g. spreadsheet programs). Fishbase is the only program that explicitly incorporates the possibility to hold data by sex. Both systems do not have a great potential to be developed further.

The Salloc program seems a very promising approach to be further developed because it addresses several aspects that seem essential to this type of software:

- strict input and output format definitions

- logs all user choices that have been made

- handles reallocations of catches to sampled strata

The major disadvantages of Salloc are that the input file format is very complicated, that it does not handle data by sex and that it does not allow raising certain landings to the total age-composition instead of the age-composition of a certain (set of) countries. Also no explicit distinction is made between different types of catches (e.g. landings, discards, industrial bycatch), although this could be accommodated in an ad-hoc fashion by defining different fleets for these different catches.

Spreadsheet systems (like XLRAISE2) are relatively error-prone (see above) and are therefore not advisable.

The Workshop concluded that none of the reviewed software packages fully deals with the requirements that are wanted from this type of software (see Section 4.3).

4.4 Possible formalization of aggregation procedures.

We assume that the stratification is already internationally agreed, i.e. total catch and biological data (length and age distributions) are provided by each country for each combination of area, fleet, gear and season, for each species. We assume that total catch is always available, but that the biological information may be missing in some cells, or may be based on very limited sampling. If possible, the definition of area, season and species should be identical for every country, while fleet is still to be defined on a national basis. In order to make useful comparisons between fleets they should be described in detail, preferably in a quantitative way. It should be possible to define how similar different fleets are, or at least which fleets are most similar.

Problems arise when some cells have a non-zero catch but no biological data. Sometimes the countries will themselves decide how to deal with the problem; i.e. they will substitute some biological data that is believed to be similar. In other cases they will not attempt to do this, leaving it up to the Working Group to find other similar biological data from some other country. This may come from the same or a 'similar' area, species, season, or fleet. Note that there is an implication here that similarities between related cells exist (Reinert and Lewy 1999, Reinert 1999). In practice the correlation in the biological parameters between all cells is assumed to be zero, except when a cell is empty, when they are assumed to have correlation 1 with those in some other cell. It would make for more reliable estimates of catch at age, if these correlations were estimated and exploited appropriately.

At present, data is usually provided to working groups (or stock coordinators) in the form of numbers only, i.e. files which contain national catch numbers at age, CPUE information, survey indices etc. The group recognized that there is a need to document the procedures how these numbers were arrived at. A possible approach would be for each country to generate a data file workbook which contains both a textual representation of the data and a description of the procedures that were followed and/or the special situations in that fishery in that year. Also changes in data for earlier years could be documented in that workbook. CEFAS is now routinely producing data file workbooks for the data they are supplying. There should also be an infrastructure at ICES (or the stock coordinator) to store these datafile workbooks.

The desirable level of aggregation in the data that is supplied to working groups is to provide total catch and biological data where available (probably age-length keys and number of samples used to construct them). National estimates of numbers at age could be provided as suggestions, leaving the Working Group to provide a better estimate from all the international data. This may be very similar if there is substantial sampling from the relevant nation, but could be very different even if some limited sampling was available nationally. It is not clear at present what kind of modelling of the biological data might be most successful. Some suggestions can however be made. The problem is essentially to model a continuous bivariate age-length distribution, the parameters of which vary continuously in space and time, and which are correlated between similar fleets and species, given observations from this distribution. One possibility is to use a geostatistical approach, where the age-length distribution is 'kriged'; i.e. a spatially weighted average is formed at each point. One problem with this is that it is necessary to define a distance between cells, in terms of space, time and the 'distance' between species and fleets. The problem could be simplified by assuming all 4 covariates are separable, for example that the distance between 2 fleets is constant regardless of the spatial or temporal distance. Another simplification would be to assume that length given age is normally or log-normally distributed. In this case the means and possibly the variances of these distributions could be kriged separately for each length class.

4.5 Storage and data handling of market sampling data.

The issue of storage and organization of market sampling data at the international level has been addressed at several occasions (ICES 1995; 1998; ICES 1999a; WD 3). Here the relevant parts of these documents are generalized and commented upon.

As indicated above, the nature of the data supplied by individual nations will be determined to a large extent by national sampling schemes, the specification of which is outside the scope of this report. However, for nations accounting for a significant proportion of the landings from the stock, the ideal would be the provision of quarterly age compositions dis-aggregated across the principal metiers exploiting the stock. For widely distributed or migratory stocks, some area disaggregation may also be appropriate. An alternative would be to supply data as length compositions plus age-length keys. This issue, along with a proposed data format, is given in Anon. (1995). Such an approach allows for easier estimation of the uncertainty in the catch-at-age data through resampling techniques, and also has clear advantages in the case where ageing inconsistencies between nations arise. An extension of this approach would be for data to be supplied at the sample level, but this would require a common data storage and management system across all ICES nations which is not foreseen for the near future.

The data should be supplied in some pre-agreed electronic format, to minimise both the risk of transcription errors and the workload on the Co-ordinator. The format should be such that it can be easily read by the software used to store and aggregate the data and does not necessitate manual reorganizations (copy- and pasting).

In addition, in supplying the data all landed weights and weights at age should refer to live weight, and the conversion factors from gutted weight to live weight used should be documented in the data documentation workbook (see above). It should not be necessary to correct data for SoP errors. Where such errors in data for individual fleets are substantial it would be more appropriate to trace their source and correct at that stage, rather than at the data aggregation stage. See Lewy and Lassen (1997) for discussion of this. It is also important that if there is a marked discrepancy between the supplied landings figures and the officially reported total, then this should be noted and the reason for it given.

It is the responsibility of the stock Co-ordinator to ensure that the data are stored and archived in an appropriate manner. The Co-ordinator will also be responsible for compiling the national data and raising it to total international level. These are essentially routine operations, but it is nonetheless important that they are performed consistently and according to a documented procedure. For this reason it is desirable that these routine operations on the data are implemented in some form of software system. As indicated above, several Working Groups have already developed software to perform these tasks, and these systems will typically have many of the features given below. Here the main aim is to synthesize the available approaches in a single coherent approach.

The storage format should retain the level of disaggregation at which the data are supplied, i.e. if data are supplied as quarterly age compositions by gear for each nation, then this is how they should be stored - there should be no aggregation before storage.

The storage format should be such that it will not be sensitive to changes in the versions of commercial applications software in use. It is also desirable that the format allows ready access by the data management software, such that it is straightforward to recreate a full time-series of assessment data if, for example, the fill-in rules need to be changed.

The above requirements would be met by files retained in a fixed ASCII format, or as database files for a commercial DBMS package (e.g. ‘Paradox’ or ‘Access’). Spreadsheet files are more likely to suffer from version compatibility problems, and if source data are held in annual spreadsheet files, it is less straightforward to access the data for all years.

For fleets for which no age composition data are available, it is necessary to estimate age compositions from other fleets. If information is available on the areas fished and gears used by the unsampled fleets, then age compositions could be estimated from the sampled fleets to which the unsampled fleets most closely correspond. If no such information is available, it may be more appropriate to estimate age compositions using the total age composition from all sampled fleets. At any rate, the fill-in rules used should be documented and should be consistent across years.

If discard data are available, particular attention should be paid to specifying appropriate fill-in rules for this component of the catch, as the sampled component is likely to constitute a rather smaller proportion of the overall catch.

It is desirable that the fill-in rules are implemented in some form of software, which can access the source data files (e.g. a variant of the Salloc program). This should ensure that data can be reconstructed quickly and easily. It is also desirable that this software allows some checks on the data at the entry stage, particularly a sum-of product test on the data as a quick check for data entry errors.

Other routine data operations to be considered in implementing a data management system include the entry of annual landings totals from official statistics, and the raising of existing fleet age composition data to account for minor revisions to the reported total landings.

In addition to having documented procedures for raising catch-at-age data, it is also necessary to ensure that corresponding procedures exist for weight at age data, particularly stock weights at age.

4.6 Conclusions

It was found that current procedures for treatment of market sampling data within a number of (example) ICES assessment working groups is rather different in the level of detail with which it is reported and also in the technical systems that are implemented to perform the data storage and combination of national age compositions. Ideally, the procedures used both at the national and the international level should be documented in general terms in the working group reports and with full details in annual data reports that should be submitted by each institute delivering the data.

Of the already available software which has been reviewed at this Workshop, the Salloc program appears to offer the best basis for further developments, especially with regards to the raising procedures applied and documentation of that raising procedures. However, an important aspect to be incorporated in this approach is the data-storage for which it is recommended here that a formal database system be developed that will be able to import national data (e.g. in exchange format) and will hold data over multiple years.

Important elements to be included in this database system are:

- data should be submitted before fill-in's are applied
- either submit national age compositions or length compositions and separate age-length keys
- weights at age
- stratification possible by:
  - country
  - species
  - fleet (gear),
  - catch type (human consumption, discards, industrial bycatch)
  - ICES (sub-) area
  - quarter / month and year
  - spawning type (autumn spawner/spring spawner)
  - sex
- information on sampling levels by stratum (no. of samples, no. of length measurements, no. of age measurements)
- estimates of uncertainty of the age compositions and weights at age (e.g. by bootstrap analysis of analytical CV's).
- total yield officially reported to ICES (by stratum)
- total catch in biomass for the different catch components as estimated by the research institute (this may include 'negative' catches in case of misreporting)
- specification of re-allocation rules and fill-in's

Table 4.3.3.1 Example of excel spreadsheet used for exchange of national data of North Sea herring. A Excel spreadsheet file will be organized by country and will consist of age-information, length information (not shown) and catch information by rectangle (not shown) and sampling information.

CATCH NUMBERS, LENGTH AND WEIGHT Catch data (WG estimate) should include discards and unreported landings.

WG for the Assessment of Herring in the Area south of 62°N TONNES SHOULD ALWAYS BE FILLED IN (even if no numbers at age data are available !)

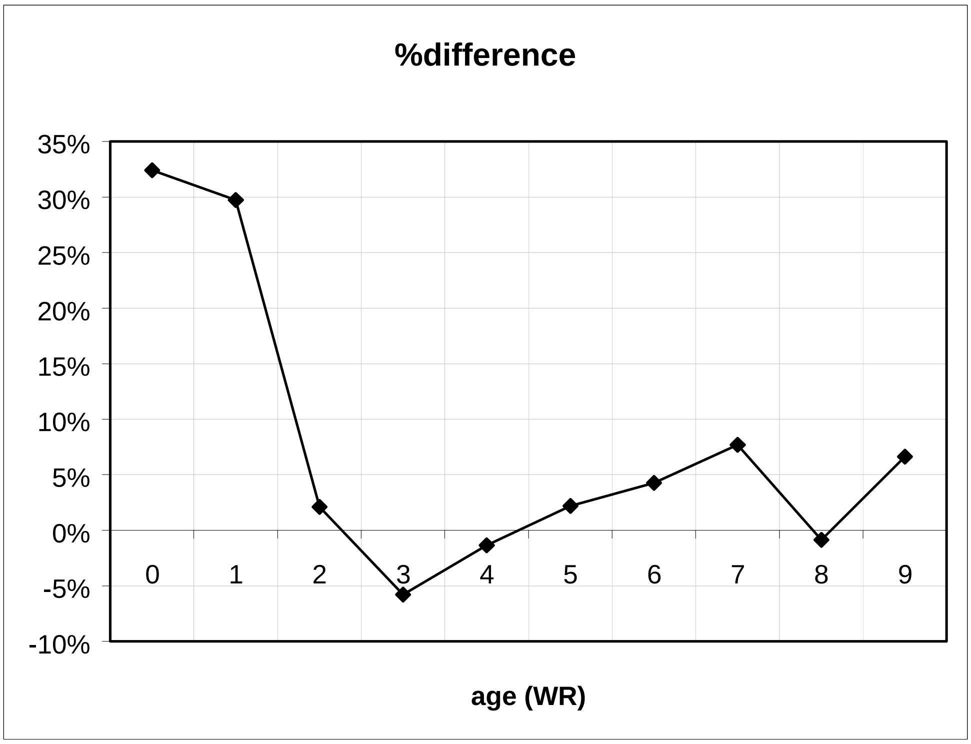
Country:	**NL**	Division :	**IIa**
Species:	**Herring** spring	Fleet :	**NL**
Year:	**1999**	Revised (date) :	**22-Feb-'00**

*only to be filled in if the reporting year is not equal to a calender year

	Quarter 1		1999	Quarter 2		1999	Quarter 3		1999	Quarter 4		1999	Quarter 1*		2000	All year		
Winter-Rings	Numbers at age ('000)	Mean Length (cm)	Mean Weight (kg)	Numbers at age ('000)	Mean Length (cm)	Mean Weight (kg)	Numbers at age ('000)	Mean Length (cm)	Mean Weight (kg)	Numbers at age ('000)	Mean Length (cm)	Mean Weight (kg)	Numbers at age ('000)	Mean Length (cm)	Mean Weight (kg)	Numbers at age ('000)	Mean Length (cm)	Mean Weight (g)
0																		
1																		
2																		
3																		
4				372	32.8	0.309										372	32.8	0.309
5																		
6				5 204	32.9	0.285										5 204	32.9	0.285
7				6 691	34.0	0.304										6 691	34.0	0.304
8				2 602	35.5	0.344										2 602	35.5	0.344
Plus-group 9+				3 717	37.2	0.361										3 717	37.2	0.361
Total/Mean -->	na	na	na	18 585	34.5	0.316	na	na	na	na	na	na	na	na	na	18 585	34.5	0.316

	Quarter 1		Quarter 2		Quarter 3		Quarter 4		Quarter 1*		All year	
Catch		(t)	5 870	(t)		(t)		(t)		(t)	5 870	(t)
SoP	na	(t)	5 869	(t)	na	(t)	na	(t)	na	(t)	5 869	(t)
SoP	na	(%)	100%	(%)	na	(%)	na	(%)	na	(%)	100%	(%)
No. aged		(n)	50	(n)		(n)		(n)		(n)	50	(n)

Figure 4.2.1 Percentage difference between the 1999 age composition of North Sea herring derived by raising unsampled catches to the total catch compared to the HAWG 2000 estimate which was based on allocating age information from other fleets to the unsampled landings.



5 DISCUSSION AND CONCLUSIONS

This section will attempt to link the conclusions from the previous sections to the terms of reference that were set for this Workshop.

5.1 How well the total international sampling effort covers the total fishing activity

Since the Workshop did not attempt to provide a census of sampling and fishing activities in the ICES area, a definitive answer to the issue of sampling coverage cannot be given. However, in the case-studies that were carried out in Section 2.1, it appeared that the landings that were available for sampling were usually over 75% of the total international landings (the difference being mainly due to landings in foreign countries). Case studies on Southern hake, Sardine and VIIe plaice indicate that the spatial, temporal and gear stratification in the sampling seem to match reasonably well with the structure of the landings. There are no strict criteria to relate sampling stratification to the structure of the landings. The ultimate criterion would be the level of uncertainty in the estimated age compositions, but this may then be biased due to selective sampling of only certain parts of the landings.

It was recognized that there is a need to standardize methods used for calculating coefficients of variations of age compositions and weights at age.

5.2 How different methods of combining national age compositions and weights at age affects the estimation of the international age compositions and weights at age

Different ICES working groups use different procedures to deal with missing samples and to aggregate national data to the international level. There is no clear evaluation method which will outline the best procedure to be followed. As an example, the raising procedure for North Sea herring have been revisited during the Workshop (Section 4.2). It was shown that the assumptions in the raising procedure do have consequences in the estimated age compositions. The trade-off between making the simplest assumptions possible and providing the most accurate estimate was not resolved during the Workshop.

5.3 Estimation of uncertainty of age compositions and weights at age and the precision of estimated CV's and variances

The international sampling programmes that have been analysed during the Workshop appear to be delivering estimates of catch at age that are rather precise, with CV's of 2.5% for cod, 3.5% for Plaice and 6% for herring for the best estimated ages rising to about 40% for cod, 15% for plaice and 30% for herring at the older ages. While the precision of the best estimated ages is good, the current scheme is delivering much poorer CVs on older ages. Care must be taken to ensure that the importance of estimating both old and young year classes is fully understood. These three stocks are possibly examples of the best monitored roundfish, flatfish and pelagic fisheries; it is unlikely that there are many fisheries with better sampling performance. While the precision of well sampled fisheries appears to be rather good, no attempt has been made to check whether the sampling is representative. It is particularly important if sampling methods are changed that care is taken to ensure that sampling covers the whole fishery.

Negative correlations were observed between estimation of younger age classes, and positive correlation were found between estimates of older ages for the three species examined, correlations are higher for herring than for cod and plaice. The positive correlations at older ages are thought to be a property of the population distributions and the fisheries, older fish are caught and sampled in groups. The mechanisms used to raise national age compositions to total catch results in a pattern of negative correlation between younger ages and all older ages.

Relationships between mean and variance were observed for all three species with slopes on the log variance-mean relationships of 1.4 for cod and plaice and 1.7 for herring. Assessment models generally do not take this into account so that changes to these models or to weighting practices that would include these mean-variance relationships would be helpful. The apparent proportionality for the variance-mean relationship will facilitate the development of appropriate statistical models of catch-at-age that do not assume a log-normal distribution for catch-at-age data.

The results of the analyses performed are conditional on an accurate catch census, and do not yet include bootstrapped CPUE indices from commercial fleets (which are part of the market sampling programme) which may influence the variability of model output. However, the initial studies carried out during the Workshop whereby bootstrapped age compositions were fed into regular stock assessment models, suggest that for the data sets examined the current levels of market sampling cause only small amounts of variability in assessment outputs. The studies reported here are incomplete and work is continuing.

5.4 How raising procedures can be formalized

Two important conclusions and recommendations can be drawn from the work on formalization of raising procedures:

- All steps in providing national data to a data coordinator should be well documented. This would include the presentation of the data in a common format and the documentation of how the data was arrived. The latter could be presented in the form of a national data workbook, that should be kept in the international data files at ICES.

- The international raising procedure (i.e. combining national age compositions to the international level) should start from data, which is presented without fill-ins. If countries report landings from which no samples were taken, they should report these landings without doing a national fill-in first. They may suggest certain fill-in rules, but it should be transparent to the data-coordinator and to the working groups how the international data was constructed from the raw national data.

5.5 How data-storage of these market sampling data should be organized

The issue of data storage and raising software is closely related to the formalization of raising procedures. The Workshop concluded that it is desirable that these routine operations on the data are implemented in some form of software system. Several Working Groups have already developed software to perform these tasks, and all these systems will typically have some desired features given below.

The storage format should retain the level of disaggregation at which the data are supplied, i.e. if data are supplied as quarterly age compositions by gear for each nation, then this is how they should be stored - there should be no aggregation before storage.

The storage format should be such that it will not be sensitive to changes in the versions of commercial applications software in use. It is also desirable that the format allows ready access by the data management software, such that it is straightforward to recreate a full time-series of assessment data if, for example, the fill-in rules need to be changed.

The above requirements would be met by files retained in a fixed ASCII format, or as database files for a commercial DBMS package.

For fleets for which no age composition data are available, it is necessary to estimate age compositions from other fleets. If information is available on the areas fished and gears used by the unsampled fleets, then age compositions could be estimated from the sampled fleets to which the unsampled fleets most closely correspond. If no such information is available, it may be more appropriate to estimate age compositions using the total age composition from all sampled fleets. At any rate, the fill-in rules used should be documented and should be consistent across years. It is also desirable that the fill-in rules are implemented in some form of software, which can access the source data files (e.g. a variant of the Salloc program). This should ensure that data can be reconstructed quickly and easily. It is also desirable that this software allows some checks on the data at the entry stage, particularly a sum-of product test on the data as a quick check for data entry errors.

Important elements to be included in this database system are:

- data should be submitted before fill-in’s are applied

- either submit national age compositions or length compositions and separate age-length keys

- weights at age
- stratification possible by:
  - country
  - species
  - fleet (gear),
  - catch type (human consumption, discards, industrial bycatch)
  - ICES (sub-) area
  - quarter / month and year
  - spawning type (autumn spawner/spring spawner)
  - sex
- information on sampling levels by stratum (no. of samples, no. of length measurements, no. of age measurements)
- estimates of uncertainty of the age compositions and weights at age (e.g. by bootstrap analysis of analytical CV's).
- total yield officially reported to ICES (by stratum)
- total catch in biomass for the different catch components as estimated by the research institute (this may include 'negative' catches in case of misreporting)
- specification of re-allocation rules and fill-in's

5.6 Other issues

The idea of reciprocal sampling (i.e. sampling of vessels in the country where they land instead of by the country of their flag) was briefly discussed during the Workshop but should be addressed more properly. In order to carry out sampling by country of landings, there is a need to obtain estimates of the fleet components that land their yield in a specific country (e.g. based on logbook statistics?). It may be considered to raise the foreign component of the yield by a separate ALK (if sampling is undertaken, and all necessary information on strata is available). More work is required on this issue.

There have been several discussions at the Workshop on the issue of optimization of sampling. In agreement with the ICES studygroup on sampling issues, it was noted that:

"Optimal allocations are seldom startingly better than the suboptimal solutions that pragmatic schemes generate. In any case allocations of otoliths that would have been optimal for last year's age distribution may not be for this year's. Futhermore, an optimal allocation means that some specific goal function has been optimised and it follows that other goal functions will not be optimised for that particular strategy." (ICES C.M. 1994 / D:1). Also the balance between the number of length measurements and age measurements is subject to this observation. However, in Section 2.3 it was shown that most of the variability in the age compositions is due to sampling for age, so that in order to increase the precision it is most likely better to invest in more ageings at the expense of length measurements.

6 REFERENCES

Anon (1970). Report of the Standing Committee on Research and Statistics. ICNAF Redbook 1970, Part 1.

Anon. (1998). Baltic Cod Stock Assessment: An International Program to Standardise Sampling Protocol, Age Determination and Trawl Surveys. Final Project Report.

Baird, J.W. 1983. A method to select optimum numbers for ageing in a stratified approach. In: Sampling commercial catches of marine fish and invertebrates (W. G. Doubleday and D. Rivard, eds.). Canadian Special Publication of Fisheries and Aquatic Sciences. 66**:** 161-164.

Brown, J. (ed.), 1999. Protocols Workshop. Study Contract D.G. XIV 97/0059.

Cleveland, W.S. and Devlin, S.J. 1988. Locally-weighted regression: an approach to regression analysis by local fitting. Journal of the American Statistical Association, 83: 596-610.

Darby, C. D. and S. Flatman (1994). Virtual population assessment: version 3.2 (windows/dos), User guide.

Deriso, R.B., Quinn, T.J. and Neal, P.R. 1985. Catch-at-age analysis with auxilliary information. Can. J. Fish. Aquat. Sci. 42: 815-824.

Efron, B. and Tibshirani, R.J. 1993. An introduction to the bootstrap. Chapman & Hall, New York.

Flatman , S. 1990. The evolution of biological sampling targets and precision of estimated age compositions with reference to demersal fish sampling in ICES divisions VIIa, VIIe, VIIf and g. DFR Report 21.

Gavaris, S. and Gavaris,C.A. 1983. Estimation of catch at age and its variance for groundfish stocks in the Newfoundland region. In: Sampling commercial catches of marine fish and invertebrates (W. G. Doubleday and D. Rivard, eds). Canadian Special Publication of Fisheries and Aquatic Sciences. 66**:** 178-182.

Gudmundsson, G. 1986. Statistical considerations in the analysis of catch at age observations. J. Cons. int. Explor. Mer, 43: 83-90.

ICES (1995). Report of the study group on assessment-related research activities relevant to Baltic fish resources. ICES C.M. 1995 / J:1.

ICES (1999a). Report of the Workshop on standard assessment tools for working groups. Aberdeen, 3-5 March 1999. ICES C.M. 1999 / ACFM: 25.

ICES (1999b). Report of the Herring Assessment Working Group for the Area south of 62^{o}N. ICES CM 1999/ACFM:12

ICES, 2000a. Report of the Study Group on Market Sampling Methodology. ICES CM 2000/D:1.

ICES, 2000b. Report of the Herring Assessment Working Group for the Area south of 62^{o}N. ICES CM 2000/ACFM:10

ICES, 2000c. Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES CM 2000/ACFM:6

ICES, 2000d. Report of the Assessment of Demersal Stocks in the North Sea and Skagerrak. ICES CM 2000/ACFM:7

ICES 2001e. Report of the Working Group on the Assessment of Northern Shelf Demersal stocks. ICES CM 2001/ACFM:1

ICES 2001f. Report of the Working Group on the Assessment of Southern Shelf Demersal Stocks. ICES CM 2001/ACFM:5

ICES 2001g. Report of the Assessment of Demersal Stocks in the North Sea and Skagerrak, 2000. ICES CM 2001/ACFM:7

Jardim, E. 1999. Análise da amostragem de sardinha (*Sardina pilchardus*) em 1996 e 1997- Cálculo dos coeficientes de variaÇao do número de individuos capturados por classe de idade. Relatórios científicos e técnicos, 37, 17pp.

Patterson, K. R. (1998). A Programme For Calculating Total International Catch-at-age and Weight at Age. Internal document.

Patterson, K.R. and Melvin, G.D. 1996. Integrated Catch at Age Analysis Version 1.2. Scottish Fisheries Research Report. No. 38.

Pope, J. G. and B. Knights 1975. Sources of variation in catch at age data and the optimal use of age reading effort. ICES C.M. 1975 / F:20.

Pope, J.G. 1983. Analogies to the *status quo* TACs: their nature and variance. In: Sampling commercial catches of marine fish and invertebrates (W. G. Doubleday and D. Rivard, eds.). Canadian Special Publication of Fisheries and Aquatic Sciences. 66**:** 99-113.

Reinert, R. and P. Lewy (1998). Sampling errors in estimated catch-at-age data in the Danish human consumption sampling program for the North Sea.

Reinert, R. (1999). An examination of ALKs obtained in the IBTS surveys and ALKs obtained in the Danish harbour sampling programme, DIFRES.

Shepherd, J. G. (1999). Extended survivors analysis: an improved method for the analysis of catch-at-age data and abundance indices. ICES Journal of Marine Science 56: 584-591.

Smith, S.J. and Maguire, J.J. 1983 Estimating the variance of length composition samples. In: Sampling commercial catches of marine fish and invertebrates (W. G. Doubleday and D. Rivard, eds.). Canadian Special Publication of Fisheries and Aquatic Sciences. 66**:** 165-170.

STECF (2000). Report of STECF Subgroup on North Sea Data Requirements, Lowestoft.

Wedderburn, R.W.M. 1974. Quasi-likelihood functions, generalized linear models, and the Gauss-Newton method. Biometrika, 61:439-447.

7 WORKING DOCUMENTS

WD 1. Sampling the commercial catch: the Amigo data. David Hirst & Tore Jacobsen.

WD 2. International sampling level database **–** ISLDB. Ernesto Jardim.

WD 3. Code of practice for data handling by assessment Working Groups. Stuart Reeves, Frans van Beek, Henrik Sparholt & Morten Vinther. Working Document prepared for the ICES Workshop on Standard Assessment Tools for Working Groups, WKSAT (ICES C.M. 1999 / ACFM: 25)

WD 4. Data compilation and raising for Demersal Assessment Working Groups. Stuart Reeves. Internal document Marlab, Aberdeen.

APPENDIX A.1 FISHBASE

The North Sea demersal WG (WGNSSK) keeps a database system to store and aggregate data on the flatfish species in the North Sea. The database system (FISHBASE) consists of a user interface programmed in Pascal and a specific datafile format. Data are stored in separate datafiles by country, gear, area, sex (if available) and year. Different levels of aggregations may be used in the datafiles ranging from files that have catch-numbers, weights at age and lengths at age by quarter, sex, gear, area and country to files that only have total landings by country and year. An example of a Fishbase datafile is presented in Table A1**.1**. Input datafiles are connected via an administration file, which lists the datafiles incorporated in the analysis.

Raising is performed from the lowest level aggregation upwards. First all files with sexed age information are added together, then quarterly un-sexed age information, then quarterly nominal landings information and then yearly nominal landings. The Fishbase system has been used for more than 10 years already, but so far only for a number of North Sea flatfish stocks.

The strong points about a dedicated program like Fishbase are that:

- it forces the user to correctly specify the input data,
- these data can be exchanged in separate datafiles,
- national institutes submit their data in a common file format,
- historical access to the underlying data is possible, and,
- other combination may be implemented for raising the data.

Negative aspects are that:

- the program does not allow combination of areas,
- the input format is very difficult to generate with any software other than Fishbase itself (which often implies retyping the information generated by a national raising procedure into the Fishbase format), and that,
- no manual is available for the program.

Table A1.1 Example of Fishbase file for North Sea plaice, Netherlands, males, area IV, All gear

```
PM499.NA       .
Plaice              .
male           .
North Sea (IV)                           .
Netherlands .
all gears      .
1999
1 1 1 1 0
1 1 1 1 0
1 1 1 1 0
1 1 1 1 0
0 0 0 0 0
 3  3  2  1  0
14 13  9 10  0
  1993.200   3001.800   2873.200    696.800    235.500    120.100    152.200     98.100     13.400     16.400      0.000     26.800
  3654.900   2309.200   1065.700    133.000     42.900     25.500     17.400     17.400      0.000      0.000      8.500
   263.800   8805.100   2212.100    293.500      5.800      0.000     46.500      5.800
   119.500   1348.400  11666.700   1345.000    277.200    353.000     34.100     69.200      0.000    197.300
     0.251      0.296      0.322      0.373      0.435      0.456      0.428      0.448      0.444      0.676      0.000      0.672
     0.245      0.284      0.315      0.360      0.495      0.476      0.534      0.297      0.000      0.000      0.435
     0.217      0.270      0.286      0.286      0.608      0.000      0.360      0.490
     0.293      0.267      0.275      0.296      0.430      0.368      0.383      0.362      0.000      0.343
    29.480     31.270     32.070     34.050     35.980     36.100     35.750     36.370     35.500     41.220      0.000     42.000
    29.050     30.820     32.090     34.000     37.480     36.500     39.500     33.500      0.000      0.000     37.500
    27.170     29.110     29.860     29.620     39.500      0.000     33.000     36.500
    30.500     29.020     29.500     31.310     33.970     32.980     33.500     33.000      0.000     32.950
  9090.600   6693.000   9451.000  13628.000
  9102.000                                    6702.000                                            9464.000                            13647.000
```

APPENDIX A.2 ABERDEEN PROGRAMS FOR RAISING (ROUNDFISH) DATA

A series of Basic programs is used to collect national age compositions and weights at age for roundfish stocks in the North Sea and west of Scotland. The programs were developed in the 1980s and are operated from the dos-prompt by invoking QBASIC. The basic sequence of events for a given stock in a given year is:

- Create Source-data file
- Add data to Source file / revise past data
- Raise data to obtain estimates of total international catches
- Combine data across areas
- Create VPA-input files.

The basic data are held in source-data or ‘S’ files (Table A2.1). These have names which are based on the species and area codes of the stock concerned, along with the year (and also quarter) to which the data refer. The empty source-data files for each year are created using the program ‘WGrp0.BAS’. Once the empty source data files have been created, the next stage is to start adding data to them. The procedures differ, depending on whether the data are Scottish, or are supplied by other WG members or are only available as annual totals from the ICES official statistics. Different procedures are followed depending on whether the data are from Scotland or from other countries. Ideally, all data for other nations would be provided in a standardized exchange format which would be straightforward to read-in to the Source files (Table A2.2). The exchange files are named using a combination of the nation code, the year, the area and the initial of the species. The program Wgread.BAS is used to read data into source data files. Data without age compositions (e.g. quarterly landing totals) are entered with the program ‘Intdata.exe’. Once all the data supplied by Working Group members has been added to the source files, these should be checked against the catches as officially reported to ICES, as there are usually also small landings made by other nations which should be added to the source file for the sake of completeness. These are annual totals and thus can only be added to the annual source files. This is done using the program WGRP1.bas.

Once all the basic source data is available in the updated S-files, the next stage is to raise the existing catch-at-age data to estimate catches at age for those fleets for which no data are available. This is done using the BASIC Program ‘WGRP2.BAS’. This reads the source or S-files for the specified year range and creates corresponding T-files and G- files. The T-files contain the estimated total international catches and weights at age by catch category (Table A2.3), and the G-files contain the catch numbers disaggregated by fleet (Table A2.4).

Once the T- and G- files are available, there are a number of different options for creating/updating VPA input files:

- Program GW2.exe – This will create a full set of VPA input files assuming all T and G files (and also a file called e.g. WHIIV.MR containing maturity and natural mortality information) are available. However, as compiled, the program will not work with data past 2000. Although we have the source code, the disk (dating from 1992) does not seem to be readable by current PCs.
- Programs Wgate.exe and Newgate.exe – The former will create all the CATON, CANUM and WECA files by category, and the latter will create tuning files from the commercial data held in the G-files. Both require a .VCF file (created using Program MAKEVCF.EXE). Note that Research vessel tuning indices must be updated manually, and that these programs do not create the other remaining VPA input files (Stock weights, maturity, Natural mortality etc.)
- Manual updating of existing files. Possible with care, being careful to check files headers, and revisions to past data as well to add data for the new data year
- Updating of existing spreadsheets. See below.

Table A2.1 Format of Aberdeen source data files (S-files)

In this example the file is WHIIVS.99, i.e. annual data for North Sea Whiting in 1999.

WHITING	*Species Name*	
IV	*Area code*	
1999 0 15 19	*Year, youngest age, oldest age, no. fleets*	
SCOTRLH	*Fleet name, fleet 1*	
0 54.191 567.175 502.372 223.041 214.933 64.883 2.833 .252 0 0 0 0 0 0 0		*Catch at age, fleet1*
0 236 227 275 347 366 369 598 448 0 0 0 0 0 0 0		*Weights at age, fleet 1.*
469.515	*total catch (tonnes), fleet 1*	
23859	*Total Effort (hours fishing) fleet 1*	
SCOTRLD	*Fleet name, fleet 2….*	
5.082 344.809 689.2 181.714 52.294 37.084 .729 0 0 0 0 0 0 0 0 0		
67 167 205 233 218 232 155 0 0 0 0 0 0 0 0 0		
261.595		
23859		
….		
….		
FRAOTHH		
-9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		
-9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		
386.288		
-9		
NORITRI	*Data for last fleet (no. 19 in this example)*	
5847.086 1868.561 2268.967 1481.504 1135.801 684.0768 27.40538 0 0 0 0 0 0 0 0 0		
8 60 128 233 228 286 0 0 0 0 0 0 0 0 0 0		
1356.524		

Table A2.2. Format of Aberdeen data exchange files.

In this example the file is ENGIV.99W, i.e. English data for North Sea Whiting in 1999.

ENG	*Nation code*
WHI	*Species code*
IV	*Area code*
1999	*Year*
1	*Youngest age*
15	*Oldest age*
1	*Quarter No.*
1	*No. fleets with data in quarter 1*
ALL	*Gear for fleet 1*
H	*Category for fleet 1 (H = human consumption landings; D = Discards; I =Industrial bycatch)*
623.339	*Tonnes caught by fleet 1 during quarter 1.*
-9	*Effort by fleet 1 during quarter 1 (no information in this case)*
0.291 233	*Age 1 catch at age and weight at age*
77.312 208	*Age 2 catch at age and weight at age*
366.968 242	*Age 3 catch at age and weight at age*
881.451 273	*Age 4 catch at age and weight at age*
545.402 297	*….*
286.817 339	*….*
80.512 379	
72.372 291	
26.018 286	
0 0	
0 0	
0 0	
0 0	*….*
0 0	*….*
0 0	*Age 15 (oldest age) catch at age and weight at age*
2	*Quarter No.*
1	*No. fleets with data in quarter 2.*
ALL	*Gear for fleet 1*
H	*(etc.…)*
297.457	
-9	
11.729 250	
115.219 231	
….	
….	
….	

[Etc. for remaining quarters.]

The file format consists of a header consisting of the first six lines as above. This is followed by a block for each quarter, consisting of the quarter number and the number of fleets in that quarter, then data for each of these fleets. The fleet data must contain the gear, category, catch weigh and effort information, followed by catch and weight at age information for the full age range specified in the file header. If no age data are available for a given fleet/quarter, then –9 should be used to indicate missing data.

Catch weights should be live weights in tonnes. Catch numbers at age should be in thousands and weights at age should be live weights in grammes.

Table A2.3 Format of files for Aberdeen total international data ("T-files")

Note that this file is called WHIIVT.99. i.e. annual data for North Sea Whiting in 1999.

WHITING *Species Name*
IV *Area Code*
1999 0 15 38 *Year, youngest age, oldest age, no. fleets*
77798.84 171938.8 84819.1 42528.11 32368.3 17754.54 7176.542 1973.227 …… *Total catch nos at age*
22.59013 73.16869 170.0368 226.5422 253.6209 290.2772 305.4444 313.085 …….*Total catch wts. at age*
54747.68 436981.9 *Total tonnes, total numbers*
53.77342 10548.79 20430.89 22763.87 21985.09 13934.71 6289.841 1806.858 …..*HC landings …*
5.8063 191.0883 236.683 263.96 278.6875 304.9336 317.0236 322.4175 …….
25980.94 98353.52
14697.12 84613.44 51739.69 14422.13 8843.79 3076.923 856.9396 166.3697 …….*Discards*
61.62328 100.4521 166.3971 197.1877 201.4059 224.9336 231.0625 211.7301 …….
23584.21 178501.2
63047.96 76776.54 12648.5 5342.116 1539.42 742.898 29.76187 0 ….. *Industrial bycatch*
13.39571 26.89863 77.27309 146.3453 195.6042 286 0 …….
5.8063 160127.2

The file consists of the three header lines the four blocks of data. Each block has the same format, consisting of :

Catch numbers at age (thousands) for age 0 to age 15 (the rows are shortened above for legibility)
Weight at age (grammes) for age 0 to age 15
Tonnes caught and total numbers (thousands)

The blocks are in order : total catches, Human consumption landings, Discards and industrial bycatches. The total is the sum of the three other categories (weighted averages for the weights at age). If one of the categories is not relevant or the data for that category are not used, there will be a block of zeros.

Table A2.4. Format of Raised international Fleet-disaggregated data files (G-files).

In this example the file is WHIIVg.99, i.e. annual data for North Sea Whiting in 1999.

```
WHITING                                    Species Name
IV                                         Area code
 1999      0        15       38            Year, youngest age, oldest age, no. fleets
 SCOTRLH                                   Fleet name, fleet 1
  0  55.13219  577.0258  511.0973  226.9148  218.666  66.0099  2.882204  .2563768  0  0  0  0  0  0  0
  0  236  227  275  347  366  369  598  448  0  0  0  0  0  0  0
  469.515
  1.017368                                 SOP Correction factor
  23859
 SCOTRLD
  5.8063    344…….
  .
  .
  .
   FRAOTHH*                                Asterisk indicates derived data
   .79  156.84  303.76  338.45 326.87  207.18  93.51  26.86  6.97  .86  .18  0  0  0  0  0
   134.44  191.08  236.68  263.96  278.68  304.93  317.02  322.41  289.54  360.90  323.48  0  0  0  0  0
   386.288
   0
  -9
  FRAOTHD*
   218.51  1258.04  769.27  214.43  131.49  45.748  12.74  2.47  .76156  .499159  0  0  0  0  0  0
   61.62  100.45  166.39  197.18  201.40  224.93  231.06  211.73  230.90  219.59  0  0  0  0  0  0
   350.6532
   0
   0
  .
  .
  .
```

The format of the G-files is very similar to that of the S-files, except that there is an additional line in each data block. This is the SOP correction factor which is placed between the tonnes caught and the effort figure for each fleet. Fleets for which age compositions were estimated from other fleets are indicated by an asterisk at the end of the fleet name, and these fleets have an SOP correction factor of zero.

APPENDIX A.3 SALLOC

The way national catch-at-age and weight-at-age data are compiled into a 'total international' data set for stock assessment purposes is in many cases rather problematic, in that current practice is usually for data coordinators to make ad-hoc allocations of age-structures to those catches that are not adequately sampled. The calculations are usually done on spreadsheets, which are notoriously error-prone and to document, and so it can be difficult to reproduce calculations. Also because of the lack of a standardized data format, historical data can be hard to recover.

As a first approach to the problem, a simple FORTRAN program was developed (SALLOC) that is intended to help address these problems (Patterson, 1998). It has been applied since 1999 by the Mackerel WG (WGMHSA) and the Herring Assessment WG (HAWG). The program is intended to make life easier by allowing the data coordinators to concentrate on checking the input data provided and in making re-allocation choices. Tasks of routine calculation and preparing standard tables for the report should be done automatically.

The program is intended to do the following:
1. Read data in a standardized format
2. Allow the data coordinators sufficient freedom in defining re-allocations of unsampled catches to specified age-structures
3. Perform standard calculations automatically and with no calculations done by the user.
4. Generate standard tables of catches by country and sampling intensity.
5. Document the choices made by the data coordinator in allocating age-structures to unsampled catches
6. Calculate the total international catch-at-age and weights at age.

Because treatment of stocks in respect of fleet units, areas and to time-periods can be rather different, the program should allow flexible use of time, fleet and area units.
The program reads two files, which must be named DISFAD.CSV (Disaggregated Fisheries Assessment Data) and ALLOC.CSV (Allocations). It generates one output file, always named SAM.OUT (Sample Allocations). If an error is encountered in reading the datafiles then an error message will be written to SAM.OUT. Examples of input files and the output file are presented in Tables A3.1-A3.3.

A manual is available for the Salloc program.

Table A3.1. Example of Salloc input datafile DISFAD.CSV. Two lines are scrolled onto a second line on this page (labeled 'continues') but in the physical datafile these are on a single line.

```
Record No,Country,Quarter,Area,Sampled,Official,WG,N samp,N aged,N meas,CN,CN,CN,CN,CN,CN,CN,CN,CN,CN,CW,CW,CW,CW,CW,CW,CW,CW,CW,CW,,
,,,,Catch,Catch,Catch,,,,0,1,2,3,4,5,6,7,8,9,0,1,2,3,4,5,6,7,8,9,,,,,,,,,,,,,,,,,,,,,
Herring in VIa(N),0,9,1997,
1,France,1,VIa(N),0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
2,France,2,VIa(N),0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
3,France,3,VIa(N),0,3093,3242.7,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
4,France,4,VIa(N),0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
5,Germany,1,VIa(N),0,10.475,10.475,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
6,Germany,2,VIa(N),0,940.083,940.083,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
7,Germany,3,VIa(N),7622.34,7622.34,7534.678,7,208,2429,0,0,0,391.075599,2523.018139,10931.70988,7866.490866,6859.067663,1705.044302,4287.106078,0,0,0,0.175,0.187,0.229,0.207,0.181,0.234,0.286,
8,Germany,4,VIa(N),0,300.008,300.008,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
9,Netherlands,1,VIa(N),0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
10,Netherlands,2,VIa(N),0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
11,Netherlands,3,VIa(N),3521,9873,3645,1,25,42,0,0,0,1354,4740,2709,4063,677,2709,677,0,0,0,0.175,0.187,0.229,0.207,0.181,0.234,0.286,,0,0,0,0.384549844,1.346208464,0.769383698,1.153933542,0.192274922,0.769383698,0.192274922,
12,Netherlands,4,VIa(N),0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
13,Scotland,1,VIa(N),564.3,755.2,564.3,1,81,212,0,0,482,964,819,550,415,395,395,511,0,0,0.0674,0.0965,0.1182,0.139,0.156,0.1485,0.1524,0.160021135,,0,0,0.854155591,1.708311182,1.451355662,0.974658869,0.73542442,0.699982279,0.6999822
(continues ) 79,0.905546695,
14,Scotland,2,VIa(N),0,30.8,30.8,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
15,Scotland,3,VIa(N),34117.4,58391.8,34117.4,7,565,1483,0,29,73787,48519,37440,11708,7827,1720,1782,6304,0,0.0843,0.1385,0.1808,0.2126,0.2358,0.2385,0.2388,0.2556,0.265228046,,0,0.000850006,2.162738075,1.422118919,1.097387257,
    (continues)   0.343168002,0.22941373,0.050414158,0.052231413,0.184773752,
16,Scotland,4,VIa(N),4808.2,5469.5,4808.2,6,484,1272,56,1365,17872,6693,4420,963,800,294,143,228.051134,0.0432,0.0903,0.1288,0.1582,0.175,0.1961,0.2066,0.2011,0.2138,0.214769536,
17,France,1,V,0,1000,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,,0,0.000283335,1.005631222,1.171659982,1.298317127,0.695736856,0.70625723,0.314223786,0.50719913,0.42753179,
18,France,2,V,0,2000,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
19,France,3,V,0,3000,3500,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
20,France,4,V,0,4000,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
21,Norway,1,V,0,1000,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
22,Norway,2,V,0,2000,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
23,Norway,3,V,0,3000,3500,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
24,Norway,4,V,0,4000,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
-1
```

Table A3.2 Example of Salloc reallocation file ALLOC.CSV

```
3,3,A,11,13,15,16
5,3,N,11,13,15,16
6,3,S,11,13,15,16
8,4,A,11,13,15,16
14,1,A,11,13,15,16
19,4,N,11,13,15,16
23,2,C,11,13,15,16
-1,
```

Table A3.3. Example of Salloc output file SAM.OUT

Summary of Sampling by Country

AREA : V

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
France	0.00	10000.00	0	0	0	0.00
Norway	0.00	10000.00	0	0	0	0.00
Total V	0.00	20000.00	0	0	0	0.00

Sum of Offical Catches : 20000.00
Unallocated Catch : -13000.00
Working Group Catch : 7000.00

AREA : VIa(N)

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
France	0.00	3093.00	0	0	0	0.00
Germany	7622.34	8872.91	7	2429	208	98.90
Netherlands	3521.00	9873.00	1	42	25	100.39
Scotland	39489.90	64647.30	14	2967	1130	99.86
Total VIa(N)	50633.24	86486.20	22	5438	1363	99.76

Sum of Offical Catches : 86486.20
Unallocated Catch : -31292.56
Working Group Catch : 55193.64

PERIOD : 1

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
France	0.00	1000.00	0	0	0	0.00
Germany	0.00	10.48	0	0	0	0.00
Norway	0.00	1000.00	0	0	0	0.00
Scotland	564.30	755.20	1	212	81	99.97
Period Total	564.30	2765.68	1	212	81	99.97

Sum of Offical Catches : 2765.68
Unallocated Catch : -2190.90
Working Group Catch : 574.78

PERIOD : 2

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
France	0.00	2000.00	0	0	0	0.00
Germany	0.00	940.08	0	0	0	0.00
Norway	0.00	2000.00	0	0	0	0.00
Scotland	0.00	30.80	0	0	0	0.00
Period Total	0.00	4970.88	0	0	0	0.00

Sum of Offical Catches : 4970.88
Unallocated Catch : -4000.00
Working Group Catch : 970.88

PERIOD : 3

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
France	0.00	6093.00	0	0	0	0.00
Germany	7622.34	7622.34	7	2429	208	98.90
Netherlands	3521.00	9873.00	1	42	25	100.39
Norway	0.00	3000.00	0	0	0	0.00
Scotland	34117.40	58391.80	7	1483	565	100.01
Period Total	45260.74	84980.14	15	3954	798	99.85

Sum of Offical Catches : 84980.14
Unallocated Catch : -29440.36
Working Group Catch : 55539.78

Table A3.3. continued

PERIOD : 4

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
France	0.00	4000.00	0	0	0	0.00
Germany	0.00	300.01	0	0	0	0.00
Norway	0.00	4000.00	0	0	0	0.00
Scotland	4808.20	5469.50	6	1272	484	98.85
Period Total	4808.20	13769.51	6	1272	484	98.85

Sum of Offical Catches : 13769.51
Unallocated Catch : -8661.30
Working Group Catch : 5108.21

Total over all Areas and Periods

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
France	0.00	13093.00	0	0	0	0.00
Germany	7622.34	8872.91	7	2429	208	98.90
Netherlands	3521.00	9873.00	1	42	25	100.39
Norway	0.00	10000.00	0	0	0	0.00
Scotland	39489.90	64647.30	14	2967	1130	99.86
Total for Stock	50633.24	106486.20	22	5438	1363	99.76

Sum of Offical Catches : 106486.20
Unallocated Catch : -44292.57
Working Group Catch : 62193.64

DETAILS OF DATA FILLING-IN

```
  Filling-in for record : (  3)   France              3 VIa(N)
Mean Weighted by Number of Age-Readings of:
  >>  ( 11)  Netherlands           3 VIa(N)
  >>  ( 13)  Scotland              1 VIa(N)
  >>  ( 15)  Scotland              3 VIa(N)

  Filling-in for record : (  5)   Germany             1 VIa(N)
Unweighted Mean of :
  >>  ( 11)  Netherlands           3 VIa(N)
  >>  ( 13)  Scotland              1 VIa(N)
  >>  ( 15)  Scotland              3 VIa(N)

  Filling-in for record : (  6)   Germany             2 VIa(N)
Mean Weighted by Number of Samples of:
  >>  ( 11)  Netherlands           3 VIa(N)
  >>  ( 13)  Scotland              1 VIa(N)
  >>  ( 15)  Scotland              3 VIa(N)

  Filling-in for record : (  8)   Germany             4 VIa(N)
Mean Weighted by Number of Age-Readings of:
  >>  ( 11)  Netherlands           3 VIa(N)
  >>  ( 13)  Scotland              1 VIa(N)
  >>  ( 15)  Scotland              3 VIa(N)
  >>  ( 16)  Scotland              4 VIa(N)

  Filling-in for record : ( 14)   Scotland            2 VIa(N)
Using Only
  >>  ( 11)  Netherlands           3 VIa(N)

  Filling-in for record : ( 19)   France              3 V
Unweighted Mean of :
  >>  ( 11)  Netherlands           3 VIa(N)
  >>  ( 13)  Scotland              1 VIa(N)
  >>  ( 15)  Scotland              3 VIa(N)
  >>  ( 16)  Scotland              4 VIa(N)

  Filling-in for record : ( 23)   Norway              3 V
Mean Weighted by Sampled Catches of:
  >>  ( 11)  Netherlands           3 VIa(N)
  >>  ( 13)  Scotland              1 VIa(N)
```

Table A3.3. continued.

Catch Numbers at Age by Area

Area	0	1	2	3	4	5	6	7	8	9
V	10.19	249.15	6305.09	6279.51	8975.00	4793.64	5835.95	1796.75	4016.71	2181.57
VIa(N)	57.46	1432.76	100864.34	64267.13	55272.61	28807.98	22563.38	10495.25	7571.22	13177.46
Total all Areas :	67.66	1681.91	107169.42	70546.63	64247.61	33601.63	28399.33	12292.00	11587.93	15359.03

Mean Weight at Age by Area (Kg)

Area	0	1	2	3	4	5	6	7	8	9
V	0.0108	0.0437	0.0788	0.1563	0.1755	0.2096	0.2007	0.1843	0.2198	0.2488
VIa(N)	0.0426	0.0899	0.1351	0.1760	0.2035	0.2286	0.2183	0.1923	0.2352	0.2670
Total all Areas	0.0378	0.0830	0.1318	0.1742	0.1996	0.2259	0.2147	0.1911	0.2298	0.2644

APPENDIX A.4 INTERNATIONAL SAMPLING LEVEL DATABASE (ISLDB)

The International Sampling Level Database (ISLDB) has been developed in MSACCESS 97 and contains information about more than 50 species or groups of species (see Study Contract 99/009 – SAMFISH- for details). The submission of data is done using the format agreed in EU Study Contract 94-013. The database contains aggregate information only, i.e. information on the level of sampling and landings by stratum and by country and species. Examples of the output are presented below in the form of two screenshots. More information on the ISLDB can be obtained from Ernesto Jardim (IPIMAR): ernesto@ipimar.pt.

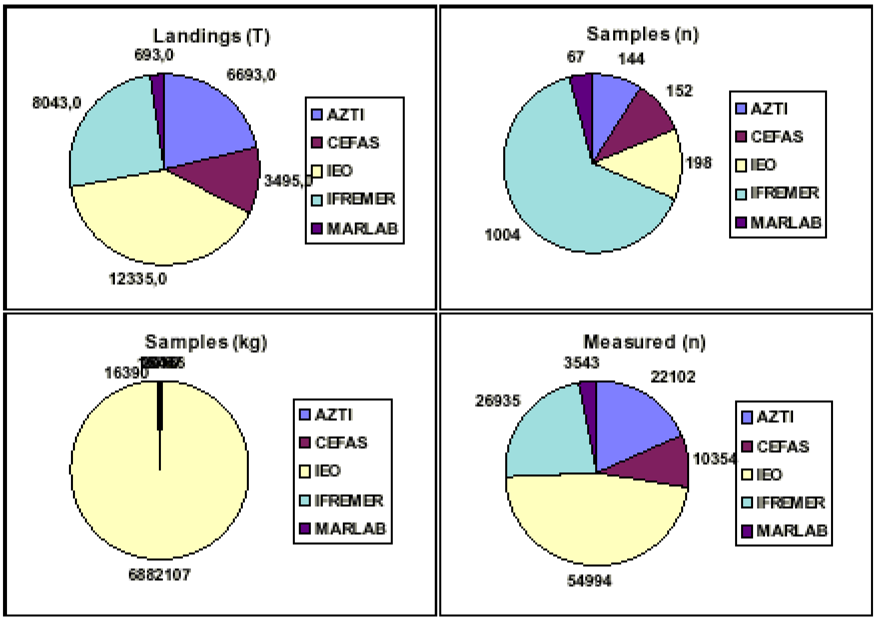
Screenshot 1: Sampling level report of sampling by country.

ISLDB SAMPLING LEVEL REPORT

Year: 1998 Species: HKE Component: NRTN

Sampling Level Summary

institute	*landings(T)*	*sample(n)*	*aged(n)*	*measured(n)*	*sampled weight(kg)*
AZTI	6693	144	1435	22102	16767
CEFAS	3495	152	0	10354	18446
IEO	12335	198		54994	6882107
IFREMER	8043	1004	108	26935	16390
MARLAB	693	67	0	3543	2036



Screenshot 2: sampling level report by gear and ICES division.

ISLDB SAMPLING LEVEL REPORT

Year: 1998 Species: HKE Component: NRTN

Sampling Intensity Table

Gear group	*ices division*	*Samp(%)*	*Land(%)*	*I*
ARTISANAL		0,0	0,0	0,00
	VI	0,0	0,3	0,02
	VIA	0,0	0,7	0,02
	VIB	0,0	0,2	0,00
	VII	59,6	20,8	2,86
	VIIA	0,0	0,0	0,00
	VIIB	0,0	0,1	0,00
	VIIC	0,0	0,3	0,00
	VIIE	0,0	0,1	0,11
	VIIF	0,1	0,4	0,20
	VIIG	0,0	0,4	0,11
	VIIH	0,0	0,2	0,12
	VIIIAB	7,7	3,8	2,01
	VIIIABD	0,0	1,8	0,02
	VIIIB	0,0	0,0	0,41
	VIIJ	0,0	1,2	0,01
	VIIK	0,0	0,6	0,00
	XII	0,0	0,0	0,00
NETS	VIIIA	0,0	0,9	0,01
	VIIIB	0,0	0,2	0,07
PSEINE	VIIA	0,0	0,0	0,00
	VIIG	0,0	0,0	0,00
	VIIJ	0,0	0,1	0,00
TRAWL	IVA	0,0	0,0	0,00
	IVB	0,0	0,1	0,00
	VI	0,0	0,3	0,06
	VIA	0,0	2,4	0,02
	VIB	0,0	0,0	0,00
	VII	22,1	19,2	1,15
	VIIA	0,0	1,5	0,02
	VIIB	0,0	0,4	0,00
	VIIC	0,0	0,5	0,00
	VIIE	0,0	0,1	0,11
	VIIF	0,0	0,0	0,46
	VIIG	0,0	0,1	0,03
	VIIH	0,0	0,1	0,24
	VIIIA	0,1	1,7	0,04

APPENDIX A.5 CALCULATING ANALYTICAL CV'S FOR MARKET SAMPLING DATA.

This method was originally reported in S. Flatman, 1990. Internal Report No 21. Directorate of Fish. Res., Lowestoft.

Estimated numbers at age:

$$\hat{N}a = \sum_g Ng \times Pga$$

Variance of the estimate:

$$Var(\hat{N}a) = \underbrace{\sum_g (Ng)^2 \times Var(Pga)}_{\substack{\text{variance due to} \\ \text{ALK sampling}}} \quad + \quad \underbrace{\sum_g Var(Ng) \times (Pga)^2}_{\substack{\text{variance due to} \\ \text{lenght sampling}}}$$

Where

g = length group
Ng = total number of fish in a length group
Pga = proportion of age ' *a* ' in the length group ' *g* '

and

Var (Ng) is independent of the number of otoliths,
Var (Pga) = Pga (1-Pga) / ng

Where *ng* = number of otoliths in length group *g*.

In order to determine the approximate effect of the number of otoliths on the CV of numbers at age, we need to consider the variance component due to age. For one age, *a*, let *Ng* be similar for each *g*, and be represented by *N*.

Then

$$Var(Na) = N^2 \sum_g \frac{Pga(1 - Pga)}{ng}$$

If we also assume that for all *g* the probability that [fish in group *g* = age *a*] is the same
Then

$$Var(Na) = N^2 Pa(1 - Pa) \sum_g \frac{1}{ng}$$

And
If the number of otoliths in each group *g* is the same:

$$Var(Na) = \frac{N^2 Pa(1 - Pa)G}{ng}$$

Where *G* = number of length groups and *ng* is now a constant.

$$So \quad Var(Na) = CONSTANT. \quad \sum_g \frac{1}{ng}$$

$$or \quad VAR(Na) = CONSTANT. \quad \frac{1}{ng}$$

We see that after simplification the variance of numbers at age (due to age) is proportional to 1 /*ng*, and therefore the coefficient of variation is proportional to $1 / \sqrt{ng}$. For instance, if half of the otoliths in an ALK came from research vessel samples, then removal of these otoliths would increase the CV by a factor of $\sqrt{2}$, i.e. 40%.

However, the increase in variance also depends on the between boat variance. It is possible that reducing (or increasing) the number of otoliths per boat would make virtually no difference to the variance. Imagine the situation where all fish within a length group from one boat are the same age, but this age differs from boat to boat. Taking only 1 otolith per length group per boat would give exactly the same variance as taking the entire catch. Taking otoliths from more or fewer boats on the other hand, would make a big difference.

APPENDIX A.6 PARTICIPANTS LIST

name	initial	address	telephone	fax	e-mail
Martin Pastoors (Chair)	MP	RIVO, P.O. Box 67, 1970 AB IJmuiden, The Netherlands	+31 255 564 690	+31 255 564 644	m.a.pastoors@ rivo.wag-ur.nl
Åge Fotland	AF	IMR, PO box 1870, 5817 Bergen, Norway	+47 55 238 682	+47 55 238687	aage.fotland@imr.no
Ângela Canha	AC	Departamento de Oceanografia e Pescas. Universidade dos Açores. 9901-862 Horta, Portugal	+351 292292988	+351 292292659	angela@ notes.horta.uac.pt
Antonio Punzon	AP	IEO. APDO-240, Santander, Spain	+34 94 2291060	+34 94 2279072	antonio.punzon@ st.ieo.es
Brian Rackham	BR	CEFAS, Pakefield road, Lowestoft, Suffolk, NR33 0HT, England	+44 1502 562244	+44 1502 513865	b.d.rackham@ cefas.co.uk
Carl O'Brien	COB	CEFAS, Pakefield road, Lowestoft, Suffolk, NR33 0HT, England	+44 1502 524256	+44 1502 513865	c.m.obrien@ cefas.co.uk
Chris Darby	CD	CEFAS, Pakefield, Lowestoft, Suffolk, NR33 0HT, England	+44 1502 524329	+44 1502 513865	c.d.darby@cefas.co.uk
Colm Lordan	CL	Marine Fisheries Services Division, Marine Institute, Abbotstown Laboratory Complex, Dublin 15.	switch +35318228200 direct: +35318228203		colm.lordan@marine.ie
Dália Reis	DR	Departamento de Oceanografia e Pescas. Universidade dos Açores. 9901-862 Horta Portugal	+351 292292988	+351 292292659	dreis@ notes.horta.uac.pt
David Hirst	DH	Norwegian Computing Centre, P.O.Box 114 Blindern, N-0314 Oslo, Norway	(+47)22 85 26 70	(+47)22 69 76 60	david.hirst@nr.no
David Maxwell	DM	CEFAS, Pakefield road, Lowestoft, Suffolk, NR33 0HT, England	+44 1502 562244	+44 1502 513865	d.l.maxwell@ cefas.co.uk
Els Vanderperren	EV	DVZ-CLO, Ankerstraat 1, B-8400 Oostende, Belgium	+32 59 342250	+32 59 342267	vanderperren.els@ online.be
Henrik Degel	HD	DIFRES, Charlottenlund slot, 2920 Charlottenlund, Denmark	+45 33 96 3386	+45 33 96 3333	hd@dfu.min.dk
Iñaki Artetxe Irueta	IA	AZTI, 48395 Sukarrieta, Bitkaia, Spain	+ 34 94 6870700	+34 94 6870006	iartetxe@azti.es

John Simmonds	JS	MLA, P.O. Box 101, Aberdeen AB11 9DB, Scotland	+44 1 224 295 366	+44 1 224 295511	simmondsej@ marlab.ac.uk
Maria Hansson	MH	Institute of Marine Research, Box 4, 45321 Lysekil, Sweden.	+46 523 18713	+46 523 13977	maria.hansson@ fiskeriverket.se
Morten Vinther	MV	DIFRES, Charlottenlund slot, 2920 Charlottenlund, Denmark	+45 33 963300	+45 33 963333	mv@dfu.min.dk
Paz Sampedro	PS	IEO Muelle de Animas s/n Apto. 130– Coruna, Spain	+34 981 205361		paz.sampedro@ co.ieo.es
Richard Millner	RM	CEFAS, Pakefield, Lowestoft, Suffolk, NR22 0HT, England	+44 1502 562244	+44 1502 513865	r.s.millner@cefas.co.uk
Rick Officer	RO	Marine Fisheries Services Division, Marine Institute, Abbotstown Laboratory Complex, Dublin 15.	switch +35 318228200 direct +35 31 8228216	+35 31 820 5078	rick.officer@marine.ie
Steve Flatman	SF	CEFAS, Pakefield, Lowestoft, Suffolk, NR33 0HT, England	+44 1502 562244	+44 1502 513865	s.flatman@cefas.co.uk
Tore Jakobsen	TJ	IMR, PO box 1870, 5817 Bergen, Norway	+47 55 238 636	+47 55 238687	torej@imr.no